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Cosmetic Surgery

Techniques for the Most Popular Aesthetic
Surgery Procedures

Edited by Angelo L. Cuzalina



Cosmetic Surgery -
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Popular Aesthetic Surgery
Procedures

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Meet the editor



Dr. Angelo Cuzalina is an award-winning cosmetic surgeon known for his artistry, innovation, and leadership in aesthetic surgery. He was board-certified in facial and full-body cosmetic surgery and served as President of the American Academy of Cosmetic Surgery and the American Board of Cosmetic Surgery. He is the founder of Tulsa Surgical Arts, and he has performed over 18,000 procedures. He is internationally recognized for his expertise in complex revisional surgery, achieving dramatic yet natural-looking results. Dr. Cuzalina lectures worldwide, trains fellow surgeons and has authored numerous scientific publications. As a former collegiate wrestler turned accomplished sculptor and surgeon, he brings discipline and passion to his surgical practice and personal life.

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Preface

Cosmetic surgery has become increasingly popular as individuals seek to enhance their appearance, restore confidence, and improve overall quality of life. The decision to undergo cosmetic procedures is deeply personal and influenced by cultural, psychological, and social factors. The list of cosmetic procedures, both surgical and non-surgical, continues to grow, and patients are seeking the best advice and expertise for a wide range of aesthetic problems they want to address.

With advances in surgical techniques and medical technology, cosmetic procedures are now safer, more effective, and offer quicker recovery times than ever before. Surgeons and aesthetic providers are tasked with staying up-to-date with the latest innovations and safest procedures to deliver their clients the desired results.

From facial rejuvenation to body contouring, today's cosmetic surgeries are designed to provide natural-looking results while minimizing downtime and risk. The chapters present a thoughtful perspective, ranging from fundamental or standard basic procedures to complex and revisional cosmetic surgery procedures performed by those with decades of experience.

Patients now have access to a wide array of surgical and non-surgical options tailored to their unique aesthetic goals. Procedures such as breast augmentation, liposuction, facelifts, and rhinoplasty continue to evolve with the integration of new technologies and patient-focused techniques. This book is divided into three easily followed sections. Starting with

The book begins with Section 1, which offers a detailed description of techniques for endoscopic brow lifting, various face and neck lifting (including deep plane facelifts), as well as lip lifts, facial implants, and filler injection techniques. Section 2 focuses on breast and body cosmetic surgery. Exploring various techniques for breast reduction, breast augmentation, simultaneous augmentation and breast lifts, revisional breast surgery, high-definition liposuction, abdominoplasty, as well as body contouring after massive weight loss. Section 3 will review various methods to enhance healing after cosmetic surgery, including lymphatic therapy and the use of hyperbaric oxygen.

This book provides a comprehensive overview of the most commonly performed cosmetic surgery procedures, current best practices, and patient-centered approaches in aesthetic surgery. It also highlights key innovations and perspectives from leading surgeons worldwide.

The contributions of our authors—each an expert in their field—are gratefully acknowledged. Their dedication to advancing aesthetic surgery and sharing their valuable insights is what makes this work possible. I would like to extend my sincere gratitude to all the authors for their valuable contributions, as well as to the reviewers

whose insightful feedback has helped refine the content of this book. Special thanks go to the Publishing Process Manager, Mrs. Ivana Barac, for her invaluable support and expertise throughout the editorial process. We hope this text inspires further research and innovation in cosmetic surgery, leading to improved results and enhanced safety.

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Section 1

Facial Cosmetic Surgery

Chapter 1

Facelift (Cervicofacial Rhytidectomy) Surgery

Anthony Congiusta, Angelo Cuzalina and Maria Jubran-Khoury

Abstract

This chapter will highlight how facelift surgery has evolved over the course of the last century and describe the current techniques and trends in facelift surgery. As more surgeons become familiar and competent with facelift surgery, different techniques develop to achieve long-lasting esthetic results. Surgeons must balance the risk of complications such as facial nerve injury, sialocele, and unnatural appearance with the potential for superior and longer-lasting results that meet or supersede patient expectations. The facelift techniques described in this chapter will include subcutaneous, deep plane, and extended deep plane facelift surgery. The chapter will also include treatment of the neck, with particular attention to management of the platysma muscle and the submandibular glands.

Keywords: facelift, deep plane facelift, rhytidectomy, submandibular gland reduction, SMAS, platysma, submentoplasty

1. Introduction

The face is one of the earliest areas of the body to appear aged. Thus, the goal of many surgeons, estheticians, and nurse injectors is to remove, decelerate, halt, and reverse the signs of aging in order for patients to appear more youthful.

To address these objectives, a facelift may have more impact than any other surgical procedure [1]. For the majority of the twentieth century, facelift surgery dissection was limited to the subcutaneous plane. Surgeons who performed these procedures were looked down upon by their peers due to taking “unnecessary” risks to satisfy what was considered to be an extremely vain goal of looking younger [2, 3]. With the negative connotation over facial cosmetic surgery at the time came a slow evolution of facelift techniques. Over time, however, the desire for a more rejuvenated physical appearance became more widespread throughout society, leading to increased public demand of the procedure. As facial surgical anatomy became better understood, the quality of anesthesia increased, the number of surgeons increased, and the desire for long-lasting results intensified, different techniques were developed involving manipulation of other facial structures besides the skin and subcutaneous tissue [3].

Within the past few decades, there have been many types facelift surgery dissections described in the literature such as the subcutaneous facelift, biplane facelift, composite facelift, deep-plane facelift, subperiosteal facelift, the endoscopic facelift,

and the minimal access cranial suspension (MACS) facelift. Many of these techniques involve management of the platysma muscle and the superficial musculoaponeurotic system (SMAS), which were initially described by Skoog [4] and Mitz and Peyronie, [5] respectively, in the 1970s.

Skoog is the first surgeon who developed a technique where the deep structure was moved as well as the skin [6]. By the 1980s, a combination of complete platysma muscle transection, plication, and lateral pulling was presented as the way to achieve a superior result [1]. It has become common practice for facelift surgeons to manipulate a musculofascial plane to achieve improved and longer-lasting results [2]. It is crucial for surgeons to appreciate and realize the face as a continuous unit, comprised of different subunits, and that to achieve an esthetically balanced “youthful” or “rejuvenated” look may require additional adjunct surgical and nonsurgical procedures.

Facelift discussions in this chapter will focus on the author’s preferred technique while offering insight to other methods.

2. Pertinent anatomy

A deep understanding and knowledge of the clinical anatomy and of the etiopathogenesis of facial aging is mandated for facelift surgery, regardless of technique used.

Facial tissue and structures are arranged in layers in a predictable configuration, though the thickness and density of each layer is variable [7]. The face has been traditionally described as having five distinct layers: skin, superficial fat, superficial fascia or SMAS, deep fat and areolar tissue, and periosteum or deep fascia (Figures 1 and 2) [1, 7–9].

Skin thickness varies throughout the face. While the thinnest skin is found in the upper and lower eyelids (approximately 400 microns) [7], the thickest skin is found

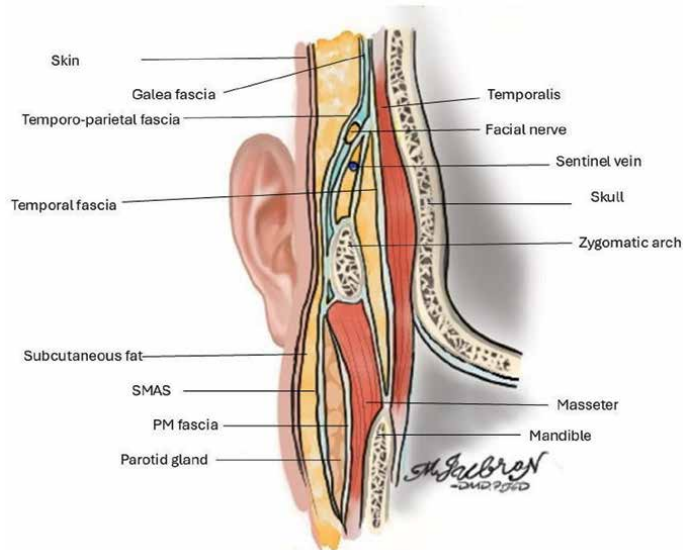


Figure 1. Cross sectional facial anatomy depicting facial layers and relevant structures for facelift surgery. The facial nerve resides in the layer deep to the temporo-parietal fascia and superficial musculoaponeurotic system (SMAS).

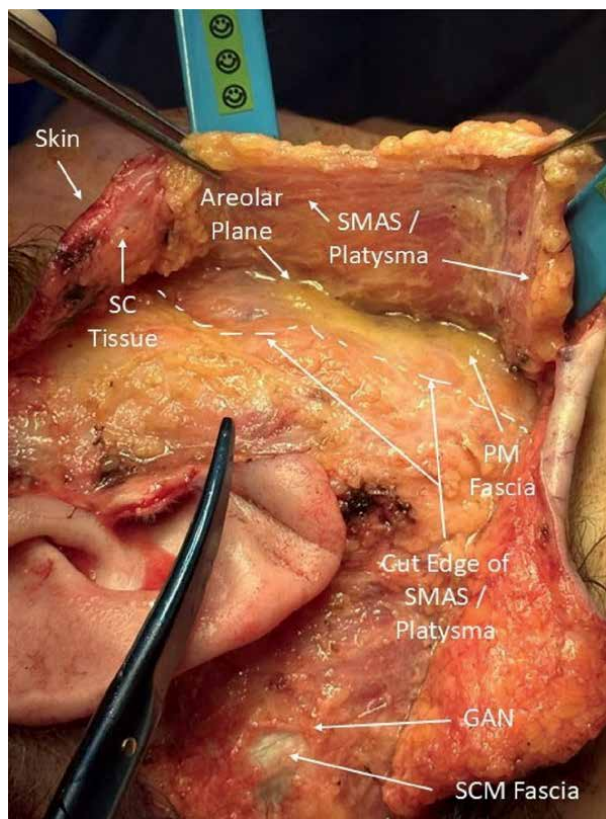


Figure 2.
An intra-operative view of a deep-plane lower face and neck lift depicting the five facial layers: skin, subcutaneous (SC) tissue, superficial musculoaponeurotic system (SMAS), the areolar plane, and the deep fascia, which includes the parotidomasseteric (PM) fascia. The platysma is continuous with the SMAS inferiorly. Posterior to the ear, the fascia of the sternocleidomastoid (SCM) muscle and the greater auricular nerve (GAN) are visualized.

in the forehead and mentum (approximately 2300–2500 microns) [7] and nasal tip (approximately 2900 microns) [10]. The blood supply to the skin comes from the dermal plexus of blood vessels. To ensure maintenance of this blood supply and flap viability, an even layer of several millimeters of fat should be left adherent to the facelift flap. This will also help minimize contour irregularities of the skin once the flap is repositioned.

The subcutaneous layer and superficial fat are located between the dermis and the SMAS. This plane is generally considered as “safe” due to the scarcity of important anatomic structures present in this layer. The subcutaneous tissue is thickest along the cheeks, anterior neck, and nasolabial folds and is thinnest in the eyelids, lips and mastoid regions. Some authors go one step further in saying that it is nonexistent in the lower eyelid [7]. Dissection during facelift surgery over the malar region, in an area called “McGregor’s Patch,” can be tenuous due to fibrous retaining ligaments attaching this layer to the periosteum. Additionally, “McGregor’s Patch” contains blood vessels and nerves that make the dissection more challenging. The retaining ligaments that are present throughout the subcutaneous layer attach dermis to periosteum and are known as the “retinacular cutis” [1].

The third layer is the superficial fascia, which envelops the facial mimetic muscles and separates the more superficial subcutaneous fat from vital structures such as the parotidomasseteric fascia and facial nerve branches. This layer is continuous from scalp to clavicle and has different names depending on the region of the head it is located (**Figure 3**). The most superior subregion is the galea aponeurotica, which envelops the frontalis and occipitalis muscles. Over the temporalis muscle is the superficial temporal fascia or the temporoparietal fascia, which is continuous with the galea aponeurotica superiorly and the SMAS inferiorly. The SMAS extends from the temporoparietal fascia to the platysma and superficial cervical fascia. The superficial cervical fascia extends from the inferior border of the mandible to the clavicles and envelops the platysma muscle.

The SMAS layer was first described as a fibromuscular layer between facial mimetic muscles and the dermis [5]. While its existence was called into question by authors such as Jost and Levet [11], many surgeons at the present time agree that the SMAS separates the subcutaneous fat from the underlying parotidomasseteric fascia and treat this layer frequently during facelift surgery.

The platysma muscle is another important structure in facelift surgery. Anterior neck laxity and platysmal banding are classic signs of aging (**Figure 4**). Platysmal banding occurs as a result of a weakened and redundant muscle fibers and dehiscence of fibers in the midline of the neck [8, 12] Platysma anatomy may vary and can be classified into three types. Type I, the most common variation, consists of platysma muscle fibers that are separated at the suprahyoid region and are interlaced at about 2 cm below the chin. In Type II, the platysma muscle fibers are interlaced at the level of the thyroid cartilage. In Type III, the platysma medial fibers remain separated up to the chin [13].

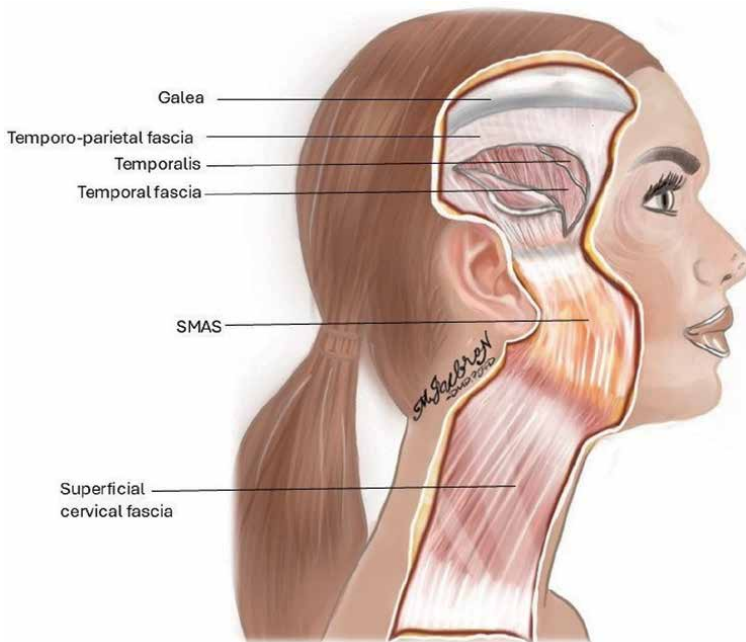


Figure 3. The SMAS in continuous with the temporoparietal fascia superiorly and the platysma / superficial layer of the deep cervical fascia inferiorly. The galea aponeurotica is continuous with the temporoparietal fascia.



Figure 4. Platysmal banding (arrows) can be a telltale sign of aging. As a person ages, the platysma muscle may become lax or hyperactive leading to redundant muscle fibers and even an increased cervicomenal angle.

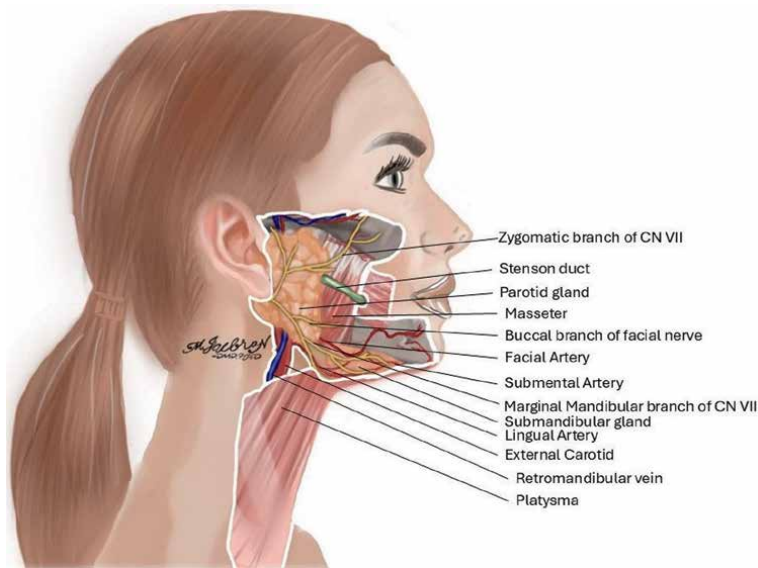


Figure 5. Deep to the SMAS lies several important anatomic structures that the surgeon must be mindful of while dissecting in this plane.

The deep fascia layer is located deep to the SMAS-platysma layer, separated only by a virtual plane of fascial spaces and retaining ligaments, i.e. the “loose areolar connective tissue layer” [9]. Deep to the SMAS, the surgeon will encounter branches of the facial nerve, the parotid gland and duct, the external jugular vein, the greater auricular nerve, and facial artery and vein (Figure 5). The areolar plane separates the superficial fascia from the deep fascia and periosteum. Within this plane are the muscles of facial expression, all of which are innervated by the facial nerve along their deep surfaces, with the exception of the mentalis, buccinator, and levator anguli oris muscles, which

are innervated along their superficial surfaces. Minelli et al. write that unless surgically opened, this fourth layer is not present as part of human facial anatomy and that it exists as a potential dissection plane within specialized areas of deep fascia [14].

Deep fascia and periosteum make up the fifth layer of the face. The deep fascia is divided into three subregions: deep temporal fascia, the parotidomasseteric fascia, and the deep layer of the deep cervical fascia [8]. Over bony structures like the zygoma and cranium, this layer is indistinguishable from periosteum [1]. The deep temporal fascial overlies the temporalis muscle and divides into superficial and deep layers at the level of the zygomatic arch. The parotidomasseteric fascia invests the parotid gland and overlies the masseter muscle. The deep layer of the deep cervical fascia encompasses the deep fascial layers, including the pretracheal, prevertebral fascia, and carotid sheath.

It is also important to recognize submandibular gland ptosis because if it goes unnoticed, the esthetic result of facelift surgery will be less than satisfactory as the patient may have a residual bulge in the submandibular triangle (**Figures 6** and 7) [12]. Submandibular gland ptosis may be difficult to detect pre-operatively if excess skin laxity and jowling are present. While it is generally accepted that submandibular gland reduction can improve the neck contour of patients with prominent glands, the procedure remains controversial as it is neither easy to learn nor easy to perform [15]. The capsule of the submandibular gland, formed by the investing deep fascia of the neck, is the key to surgical control of this region [15]. The vessels on the capsule immediately lateral to the gland include a tributary of the facial vein and the facial artery on the deeper aspect, which may extend a branch into the gland (**Figure 8**). A deep perforator artery courses through the substance of the gland from deep to superficial and often goes unnoticed until the superficial part of the gland has been excised [15].

Regarding facial nerve branches (and some other important structures), facelift surgeons must be mindful of three main danger zones: the mid-zygomatic temporal region, the malar eminence, and the area at the mandibular inferior border near the angle [16].

The mid-zygomatic arch area contains the frontotemporal branches of the facial nerve, which cross over the arch anywhere from 10 to 31 mm anterior to the most



Figure 6. A 52-year-old white female showing 3 views before and 5 months following a submentoplasty with submandibular gland (SMG) reductions, chin implant and facial fat grafting. The bulge in the submandibular triangle is obvious pre-operatively and would have been more noticeable following a facelift or submentoplasty had the glands not been reduced.

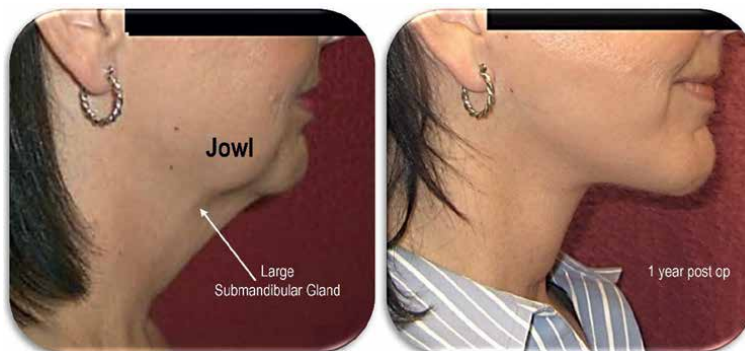


Figure 7. A female patient before and after a lower face and neck lift that included a submentoplasty and chin implant. The submandibular gland bulge seen in the before (left) photograph would have been more obvious post-operatively had it not been reduced, diminishing the esthetic outcome of the surgery.

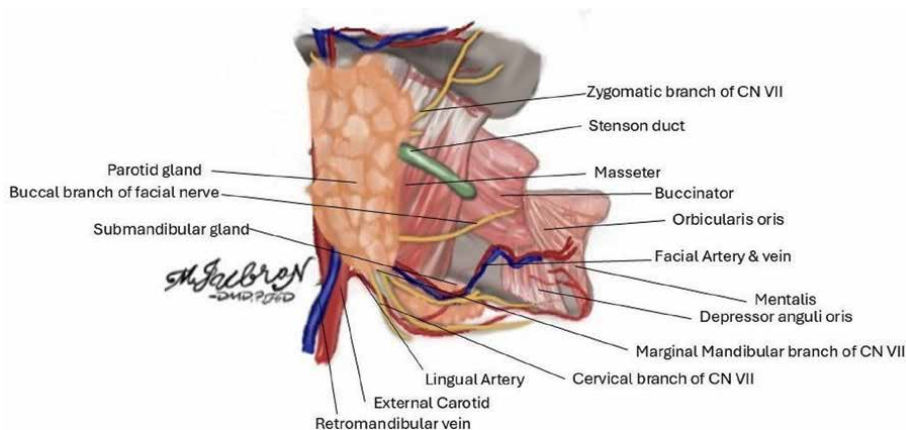


Figure 8. The facial artery and submandibular gland share an intimate relationship. During submandibular gland reduction, meticulous technique and strict hemostatic control are crucial to avoid excessive bleeding.

anterior point of the tragus [17]. This represents an area at risk because there is less soft tissue present over the bony arch, leaving the nerve more vulnerable to injury [16, 17].

The second danger zone to be aware of is at the malar eminence and is colloquially known as “McGregor’s Patch” or “the bloody gulch” [1]. This area contains zygomatic retaining ligaments that perforate the SMAS and adhere to dermis. The zygomatic branch of the facial nerve, which crosses cephalad near the lateral canthus is also within “McGregor’s Patch” [16]. The region receives blood supply from the transverse facial, angular and infraorbital arteries and also includes perforating branches of the transverse facial artery and a venous plexus composed of transverse facial and angular veins. This danger zone must be undermined and passive for most patients undergoing facelift surgery as freeing this area separates the zygomatic ligaments [1].

The third danger zone, a short distance anterior to the mandibular angle and below its inferior border, concerns the marginal mandibular branch of the facial nerve. This motor nerve courses just below the inferior border of the mandible in approximately 20–50% of cases and may be found as inferior as 1.5 cm below the inferior border of the mandible. Injury to this nerve denervates the depressor labii

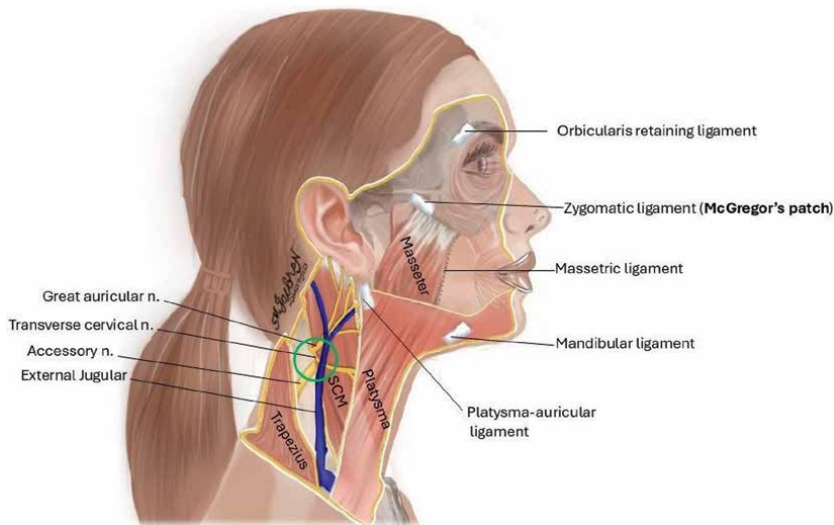


Figure 9. Erb's point (green circle) is an important anatomic landmark as three important structures can be found here: the external jugular vein, great auricular nerve, and spinal accessory nerve.

inferioris and the depressor anguli oris muscles, resulting in the lower lip to drop when speaking or smiling [18].

Another “danger zone” exists in the neck by the name of Erb's point or McKinney's point (**Figure 9**). It is a point approximately 6.5 cm inferior to the external auditory meatus where the greater auricular nerve and other cervical plexus nerves, the spinal accessory nerve, and external jugular vein exit from behind the posterior border of the sternocleidomastoid muscle. The greater auricular nerve provides sensory innervation to the earlobe and lateral cheek. It is the most commonly injured nerve in facelift surgery [1, 19].

3. Patient selection

Indeed, a large part of achieving excellent facelift results is patient selection. A discussion with the individual should center first on his or her desires and motivations for seeking surgical correction [20]. Although patients are becoming more well-educated, most do not have a true understanding of all the factors that contribute to facial aging and their respective surgical remedies, leading them to often present with inaccurate or incomplete conceptions of treatment options [1].

Cosmetic surgeons should be vigilant in their surgical work-up and pre-operative evaluation as patients tend to downplay their medical comorbidities. Based on the medical history, certain laboratory tests and studies may be required. The health and welfare of the patient is always paramount.

When a patient seeking facelift surgery presents to the surgeon's office, it is important to discuss risks, benefits, alternatives, and limitations of the procedure. Additionally, it is crucial to determine if the patient has adequate social support and time off from work to sufficiently recover from surgery.

Patients with unrealistic expectations, with body dysmorphic disorder, with overly narcissistic or immature personalities, who speak negatively about other surgeons,

who overreact to small flaws, who “know” more about a procedure than the surgeon, and who complain about financial arrangements should be considered nonsurgical candidates or, at the very least, should be referred elsewhere [21]. Other “red flags” that may be predictive of patient management issues include patients who continuously talk and not listen, unfriendly or impersonal patients, patients who are rude to staff members and nurses, patients motivated to undergo surgery due to a failing marriage, promotion, or some type of loss, patients who are overly impulsive, those obsessed with online cosmetic surgery ads and websites, and young patients who have already had numerous surgeries [21]. Patients with severe systemic diseases, such as heart failure, renal failure, and poorly controlled diabetes are not candidates for facelift surgery. Additionally, patients with skin disorders, such as Ehlers-Danlos Syndrome, progeria and elastoderma can experience severe wound healing issues and, therefore, are not candidates for rhytidectomy [22].

3.1 Patient evaluation

There are many different indications for facelift surgery involving age-related facial changes. Cutis laxa of the jowls and cervical region, deepened nasolabial folds, and plastysmal banding are main complaints that can be targeted by a facelift surgeon [16]. Other complaints such as “age-spots”, discoloration, and rhytids in the upper facial third should be addressed with different modalities.

While typical facelift surgery addresses the lower third of the face and neck, it is important that the initial consultation is comprehensive and that the patient understands that other procedures may be indicated for other areas of the face. An excellent facelift result may be compromised by severe facial rhytids and brow ptosis in the upper third of the face that was not addressed. Younger patients with genetically obtuse necks and good skin tone may be candidates for an isolated submentoplasty (**Figure 10**). Preoperative evaluation of the patient’s face and neck should involve inspection and palpation of facial structures [22]. The cosmetic surgeon should evaluate the face and neck as a unit and then divide the face into even vertical fifths and horizontal thirds. The patient’s Fitzpatrick skin type (**Figure 11**), overall facial fat content, Dedo classification of cervical abnormalities (**Figure 12**), and asymmetries all play a role in treatment planning. Patients with higher Fitzpatrick skin types may be predisposed to hypertrophic scar formation and pigment changes along incision lines [22]. Patients with less facial fat volume at baseline typically demonstrate better



Figure 10. Patients with a genetically obtuse neck who present without jowling and with good skin tone do not require facelift surgery and can achieve great jawline definition and an acute cervicomenal angle with an isolated submentoplasty.



Figure 11. The Fitzpatrick skin classification generalizes skin types from type 1 (top left) to type 6 (bottom right). The system is based upon skin response to sunlight and generalizations with hair, eye color and the amount of melanin.

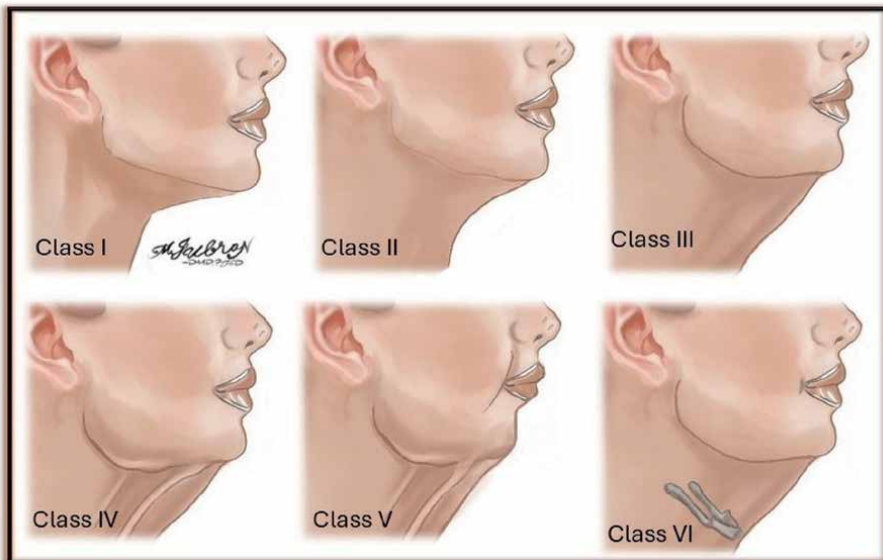


Figure 12. The Dedo classification for cervical abnormalities. Class I: well-defined cervicomental angle, good muscle tone, minimal submental fat. Class II: Lax skin without fat accumulation and without platysmal weakness. Class III: Excess submandibular and submental adipose tissue. Class IV: Platysmal attenuation. Class V: microgenia/retrognathia. Class VI: low hyoid.

postoperative contouring when compared with patients with greater facial soft tissue volume [22]. Those with a higher Dedo classifications, i.e. classes V and VI, should be informed of limitations of the postoperative esthetic appearance of the neck if

undergoing facelift surgery alone, and should be offered concomitant procedures, such as a chin implant, if indicated.

Obtaining a standardized set of photographs are absolutely essential in any cosmetic practice. Patients undergoing cosmetic facial surgery should have frontal, profile, and three-quarter views taken while the head is in neutral position and the face is in repose. A frontal photograph in full smile is also obtained, as is a worm's eye view. Addressing objective findings, such as facial asymmetries, to the patient during the initial consultation is an important step in setting expectations, limitations and establishing trust. These photographs taken at the initial consultation visit and/or during the preoperative appointment will become invaluable when assessing postoperative results and may be used to remind patients of certain findings that may have been present all along.

3.2 Patient preparation

After the appropriate work-up has been completed and surgical consent has been obtained, the patient is reminded of key pre-operative instructions: avoiding non-steroidal anti-inflammatory medications (NSAID), such as aspirin and ibuprofen, and Vitamin E 2 weeks prior to surgery to minimize platelet dysfunction and unwanted bleeding intra-operatively [16]. The patient is encouraged to refrain from alcohol consumption for 3 days prior to and 2 weeks after surgery. Herbal supplements are also stopped 2–3 weeks preoperatively to avoid adverse reactions intraoperatively or postoperatively: chondroitin, ginko and garlic (bleeding), ephedra (cardiac effects), Echinacea (barbiturate and halothane toxicity, allergic reaction, immunotoxicity), glucosamine (hypoglycemia), goldenseal (photosensitivity, sedation), kava root (sedation), and milk thistle (volume depletion) [22].

Other preoperative measures include a thorough washing of the face and hair with germicidal soap the night before and the morning of surgery. Due to increased anxiety levels, certain patients may benefit from preoperative oral sedation with a mild benzodiazepine the night before and the morning of surgery [16]. The patient should be instructed not to wear any facial makeup on the day of surgery.

On the day of surgery, the patient is marked while in an upright position to ensure proper identification of anatomic landmarks, areas of concern, and boundaries. The hair is taped or braided prior heading to the operating room. Wrapping the patient's hair and head with paper tape can be helpful in avoiding the nuisance of loose hair while attempting to suture [16].

Once the appropriate depth of anesthesia has been achieved, the patient is lightly prepared with alcohol or povidone-iodine just before local anesthesia is infiltrated along the planned incision lines. The surgeon should wait at least 15 minutes before making an incision as it takes that amount of time to achieve maximum benefit of local vasoconstriction. At this time, the patient typically receives a weight-based dose of cefazolin and 8 mg of dexamethasone intravenously [16].

4. Anesthesia

A crucial component of a successful and smooth surgery is profound local anesthesia, whether the patient is undergoing monitored anesthesia care (MAC) or general anesthesia. Regional nerve blocks are helpful to improve pain control, especially if the patient is under MAC.

Tumescent anesthesia consisting of 50 mL of 2% lidocaine and 0.5 mL of 1:1000 epinephrine mixed in a 250 mL bag of 0.9% normal saline is infiltrated throughout the patient's face and neck using a 20- or 22-gauge spinal needle connective to an automatic pump. The resultant solution consists of 0.4% lidocaine and 1:500,000 epinephrine. Alternatively, a 500 mL bag of 0.9% normal saline may be mixed with 50 mL of 1% lidocaine and 1 mL of 1:1000 epinephrine. Tranexamic acid (TXA), an antifibrinolytic that inhibits conversion of plasminogen to plasmin, may be mixed with local anesthetic or into the bag of tumescent anesthesia to reduce the risk of intraoperative bleeding and postoperative drainage [23]. In a prospective study involving 39 patients undergoing facelift surgery, Kochuba et al. demonstrated that the use of subcutaneous TXA injection, in conjunction with local anesthesia with epinephrine, has been shown to be safe, with less bleeding time, operating room time, and drain output when compared with traditional local anesthesia with epinephrine [24].

Another technique of local anesthesia administration is using 50 mL of a 1:1 mixture of 1% lidocaine with 1:100,000 epinephrine with 0.5% bupivacaine with 1:200,000 epinephrine. The resulting epinephrine concentration is 1:150,000, the lidocaine concentration is 0.5%, and the bupivacaine concentration is 0.25%. This solution is injected via standard needles on 10-mL syringes along planned incision lines and in the subcutaneous plane.

5. Technique

Early techniques of facelift surgery focused on small incisions near the hairline in natural skin creases with excision of skin and closure without undermining [3]. The main goal of the subcutaneous facelift is to tighten the loose facial skin and remove the excess without addressing deeper tissues. While relatively straightforward and safe, it fails to address ptosis of the midface and the effects of aging on structures deep to the skin [3].

Facelift surgery begins with a submentoplasty depending on the amount of subplatysmal fat, platysmal laxity, skin quality, and patient goals of treatment. Many facelift surgeons perform midline platysmal plication, which may reduce the amount of laxity of the muscle, but may also compromise some of the elevation that could otherwise be obtained in the jowl region.

A #15 blade is used to create a 2.5 to 3.5 cm curvilinear incision along the submental skin crease, or just posterior to it if a concomitant chin implant is to be inserted (**Figure 13**). The incision is undermined circumferentially in the subcutaneous plane to allow for insertion of facelift scissors. The facelift scissors are used to release the mandibular ligaments bilaterally and to undermine the skin while leaving an even layer of subdermal fat on the underside of the skin flap to maintain its blood supply. With the use of a lighted retractor, supraplatysmal dissection is carried inferiorly to the clavicles, posteriorly to the sternocleidomastoid muscle, and superiorly to the inferior border of the mandible (**Figure 14**). Wide skin undermining is necessary to allow proper skin redraping after treatment of deeper tissues has occurred [16].

Open suction-assisted lipectomy is then performed using a 6 mm spatulated cannula on the fat overlying the platysma muscle. Not only does open liposuction allow for better cervical contouring, but it also allows for better visualization of the platysma muscle and its boundaries.

Next, the medial edges of the platysma are identified and excised from the location of the submental incision inferiorly towards the clavicle using monopolar

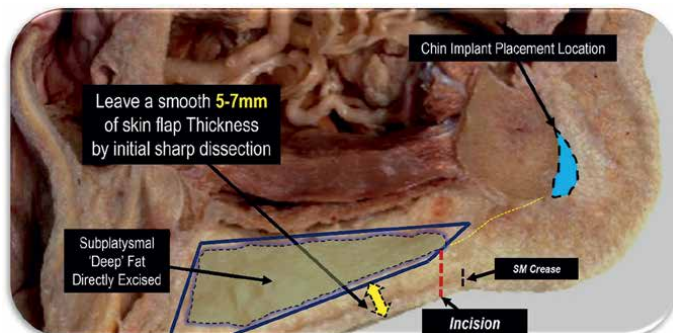


Figure 13.
It is critical to maintain an even healthy later of fat on the skin surface when planning direct excision of deep fat.



Figure 14.
A submental skin flap is made through a submental crease incision and supraplatysmal undermining is performed sharply using facelift scissors. Electrocautery is used for hemostasis while use of suction is critical in removing heat from the surgical site.

electrocautery. The cut edges of the platysma are identified and then bilateral platysmal myotomies are performed approximately 2 cm inferior to and parallel to the inferior border of the mandible. It is at this point where the bulging of the submandibular gland becomes most evident. Once the superior myotomy is completed, a second and more inferior myotomy is performed and extend to the most posterior end of the superior myotomy, thus creating a wedge of platysma muscle that is to be removed (**Figure 15**). Any associated subplatysmal fat is sharply removed with the platysma muscle.

After the subtotal platysmal excision, the submandibular gland is identified. If indicated for removal, the submandibular gland is exposed by making an incision through the superficial layer of the deep cervical fascia (SLDCF) along the inferior aspect of the bulge, parallel to the inferior border of the mandible. If the incision were placed more superiorly, the marginal mandibular branch of the facial nerve would be at higher risk of injury. Once the incision is made, the ptotic submandibular gland is visualized as it often herniates through the fascia (**Figure 16**). Carefully, the superficial portion of the submandibular gland is excised using monopolar electrocautery. The remaining deep portion of the submandibular gland is cauterized to ensure hemostasis. The SLDCF is then closed using resorbable suture to help reduce the risk of a post-operative sialocele. The submental incision is the packed with moist gauze while the lateral and posterior dissections take place.

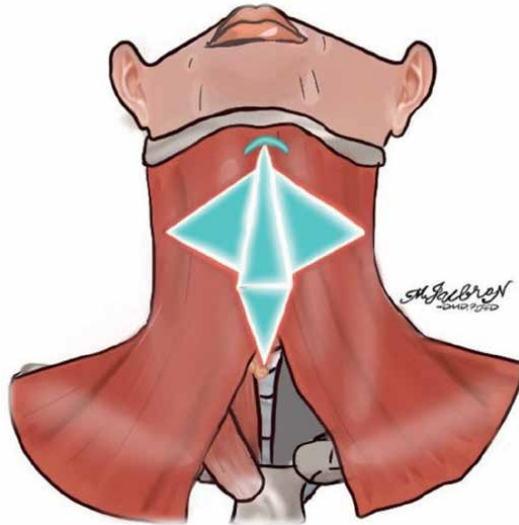


Figure 15. The platysmal muscle and subplatysmal fat are sharply removed with electrocautery from the level of the curvilinear submental incision (blue curve) inferiorly towards the clavicles. A triangular platysmal wedge is excised laterally (blue triangle), with the superior border of the cut being parallel and approximately 2 cm inferior to the inferior border of the mandible.



Figure 16. The left submandibular gland (SMG) is seen herniating through an incision made in the superficial layer of the deep cervical fascia (SLDCF). The surface of the SMG resembles that of a walnut or a human brain.

The subcutaneous lateral dissection begins with a curvilinear beveled incision in the temporal tuft, above the level of the ear. The incision is through skin and into the subcutaneous layer. The incision is extended along the pre-auricular crease, endaural



Figure 17. *Planned lateral facelift incisions. Advantages include a posterior scar hidden within the hairline and less risk for tissue ischemia because of thicker flaps. Disadvantages include a more challenging alignment of the posterior hairline.*

along the tragus, and then in the crease of the ear lobe. Posteriorly, the incision is made along the ear crease, slightly on the conchal cartilage and extended towards the mastoid prominence within the hairline (**Figure 17**).

Facelift scissors are used to sharply dissect in a subcutaneous plane anteriorly to the area of the nasolabial fold, orbicularis oculi muscle, and about 1 cm lateral to the oral commissure, leaving an even layer of fat on the skin flap approximately 4–6 mm thick (**Figure 18**). The subcutaneous plane is connected with the neck dissection that was performed through the submental incision.

The posterior dissection occurs in the plane deep to the hair follicles to ensure that an adequate amount of fascia remains present for resuspension. Dissection is carried inferiorly to the level of the sternocleidomastoid fascia and extended approximately 2 cm inferiorly and medially. Facelift scissors are then used to connect with the neck dissection and the anterior subcutaneous dissection.

At this point, a decision is made on how to treat the SMAS. The key factor in determining how to treat the SMAS layer is what is required to give the patient the ideal and necessary elevation, making this portion of facelift surgery opportunistic [25].

The SMAS is incised along or just below the zygomatic arch, approximately 1 cm anterior to the helix. Sub-SMAS dissection then extends approximately 2 to 3 cm anteriorly. The SMAS is then undermined inferiorly in front of the ear and to the level of the cut platysma edge, which is about 2 cm inferior to the inferior border of the mandible (**Figure 18**). Care must be taken while in this plane to keep the parotidomasseteric fascia intact and to ensure adequate tissue coverage over the zygomatic arch and facial nerve branches. Once the posterior edge of the SMAS is adequately released, dissection proceeds anteriorly across the anterior border of the parotid gland and may expose the underlying masseteric fascia. At this point, the buccal branch of the facial nerve and Stensen's duct may be identified (**Figure 8**).

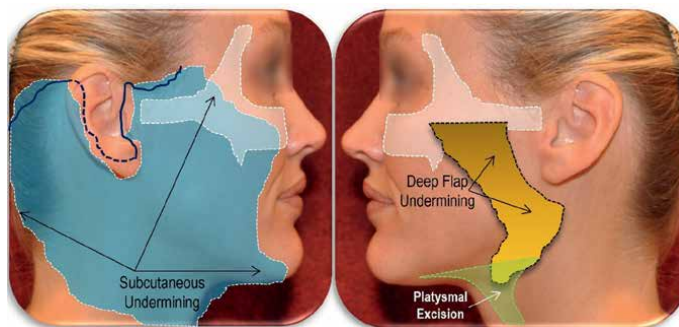


Figure 18.
Average incisions, subcutaneous and deep plane dissection planes.

As dissection approaches the inferior border of the mandible, care is taken to avoid injuring the marginal mandibular branch of the facial nerve. This may be done by clearly visualizing the deep surface of the platysma muscle and keeping the fascia intact over the nerve.

Once hemostasis is achieved and adequate deep plane dissection has occurred based on the patient's tissue quality and retaining ligaments, the vector of elevation is determined. Generally, a posterosuperior vector is chosen for deep plane and skin flap elevation. However, vectors differ slightly anterior to and posterior to the ear in order to provide the most naturally esthetic outcome. The deep plane is lifted more superiorly in front of the ear, whereas the skin is slightly more oblique anteriorly. The opposite is true posterior to the ear, where the skin is re-draped in a more superior vector and the deep plane is more obliquely positioned (**Figure 19**) [25]. In this region, the platysma and SMAS may be manipulated in a number of ways. The cut edge of the platysma may be cut, folded upon itself, and plicated in the region of the mandibular angle to accentuate the gonial angle (**Figure 20**).

Regardless of whether the surgeon is using more conservative SMAS techniques, such as plication or imbrication, or the deep plane approach, key anchoring sutures are crucial to elevating and resuspending the SMAS. The first key suture is placed at the inferior tragus and then the superior tragus. The cut edge of the platysma muscle is then suspended to the mastoid fascia. The temporoparietal fascia and

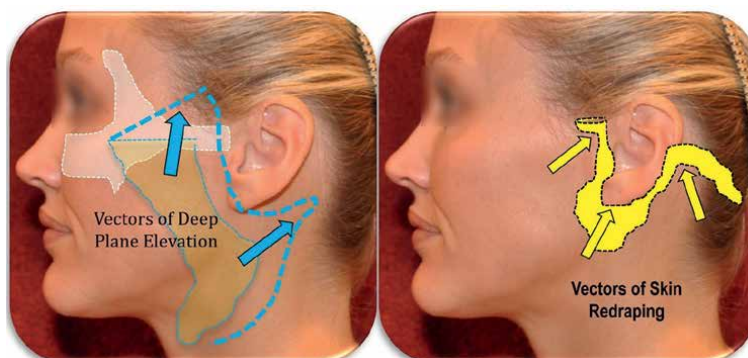


Figure 19.
The vectors of deep plane elevation / lifting shown above are different than those of skin elevation / re-draping. The vectors of skin re-draping prior to excision are passive with minimal tension.

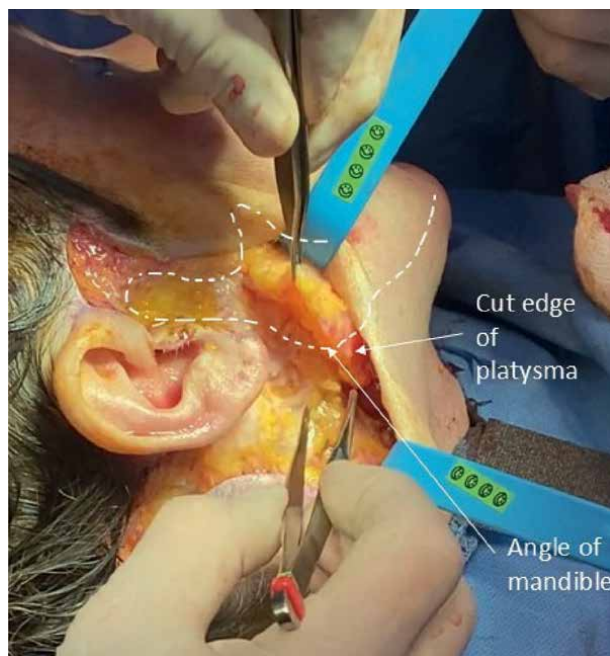


Figure 20.
The cut edge of the platysma can be manipulated and plicated to ‘auto-augment’ the mandibular angle. The mandible, outlined in white, can be augmented or accentuated in other ways such as the platysmal hammock, in which the platysma is secured to the mastoid fascia and draped under the angle of the mandible, fat grafting, and mandibular angle implants.

SMAS are sutured to the deeper temporalis fascia and the subcutaneous tissue is subsequently closed.

Next, the skin is re-draped. The position of the earlobe base is chosen so as to not apply tension in the inferior direction and result in a pixie ear deformity. The skin is secured to the base of the earlobe. The posterior skin flap is advanced anteriorly towards the ear, ensuring that the hairline is aligned properly. The skin flap is closed in layers as the excess skin is trimmed with facelift scissors to allow for tension-free closure. The skin is closed with resorbable suture.

If indicated, a Jackson-Pratt drain may be placed through the submental incision, exiting the undermined tissue in the postauricular region. The submental incision is closed in layers. Finally, antibiotic ointment or Aquaphor is generously applied to the incisions after suture placement and dressings are placed with minor pressure to avoid vascular compromise to the skin flaps [25].

5.1 SMAS techniques

Soon after the SMAS layer was thoroughly described by Mitz and Peyronie, [5] a major paradigm shift in facelift surgery occurred. The fibrous adhesions of the SMAS to the overlying subcutaneous fat and skin allowed for surgical manipulation of the SMAS to effect changes in the skin [3]. The main methods for addressing the SMAS involve either plication or imbrication [3]. Plication relies on suture suspension alone whereas imbrication consists of an incision within the SMAS layer with resection of a portion of the SMAS followed by suture suspension of the ends to reverse vectors of aging [3]. Richard Webster was one of the first to recommend a “short flap” with

SMAS plication [26]. Imbrication typically involves a limited sub-SMAS dissection to the anterior border of the parotid gland [3].

When performed properly, SMAS plication and imbrication pose minor risk to the facial nerve while achieving good long-term results [3]. However, SMAS plication and imbrication are less effective in rejuvenating the midface and melolabial fold as they are the jaw-neck line [3].

5.2 Deep plane techniques

A glaring weakness of employing SMAS techniques during facelift surgery is its inability to effectively rejuvenate the midface and malar fat pad [3]. In 1990, Dr. Hamra described the deep-plane rhytidectomy to address this problem, in which he elevated the soft tissues of the midfacial region between the superficial and deep fascia [27]. Dr. Hamra's technique consisted of a subcutaneous dissection in the pre-auricular region that extended anteriorly to a line extended from the lateral canthus to the angle of the mandible, at which point dissection proceeded in the sub-SMAS plane. The sub-SMAS dissection is carried medially over the zygomaticus major and minor muscles to an area lateral to the melolabial fold [3].

The deep-plane technique is meant to improve the nasolabial fold, neck and midface to a greater extent than either SMAS plication or imbrication. However, whether or not it truly does is a matter of debate. Proponents for the deep-plane technique also claim longer lasting improvement, a natural appearance, and decreased incidence of hematoma and flap compromise [3]. The disadvantages of the deep-plane technique include more extensive tissue trauma, longer recovery period, more technical dissection with increased risk of injury to the facial nerve, and longer operative time [3]. Even when performed by experienced surgeons, the deep-plane facelift places facial nerve branches at more risk of injury during dissection than the SMAS techniques [28].

Ivy et al. found no detectable improvements in a side-by-side comparison in patients with SMAS facelifts versus composite rhytidectomies [3, 29]. Becker and Bassichis concluded that for patients under the age of 70 years, the deep-plane facelift did not offer superior results over SMAS plication facelifts [3, 28]. In their small study population, however, they did note that patients aged 50–69 years had a trend towards obtaining better results from SMAS plication facelifts whereas patients aged 70–80 years had a trend towards obtaining better results from a deep-plane facelift [28].

The composite facelift, which addresses the neck, lower face, midface / lower lid junction, and upper face with volume augmentation, is a more comprehensive technique for facial rejuvenation. It involves repositioning of essentially every deep structure whose character influences the topography of the face [6]. This approach, which was first described in 1992, incorporates the orbicularis oculi muscle with the facelift flap so that the orbicularis oculi muscle, malar fat, and platysma muscle would all be left with the skin and their intimate relationship would be maintained [6, 30, 31]. According to Choucair and Hamra, there are four structures that need to be addressed in a composite rhytidectomy: the platysma / SMAS, the meso-mandibularis mesentery, the fat overlying the zygomaticus major and minor muscles, and the lower eyelid fat [6]. The composite facelift vector involves a strong superior medial vector of the upper face and an obligatory medial vector of the forehead lift [6]. Lastly, an arcus marginalis release with preservation of the lower eyelid fat is necessary to create more youthful appearing lower eyelid [6].

5.3 Less invasive techniques

Shortly after the deep-plane facelift became popular, a counter school of thought emerged towards less invasive techniques. Deep-plane facelifts required more operative time, involved more risk, and necessitated longer recovery periods. The minimally invasive techniques offered less downtime, less surgical time, and were often less risky and could be performed under local anesthesia [3]. However, skepticism remains at large as some believe that “short scar” facelifts are much less than a true facelift and provide less result and longevity when compared to a traditional rhytidectomy [21].

One of the “non-surgical” techniques that emerged in the 1990s was the threadlift. This technique involved the placement of barbed threads subcutaneously which were pulled in the appropriate vector to achieve a lifting effect, with excess suture being trimmed at the entry point [3]. A main advantage of this technique was its “non-surgical” nature and instant results. However, the longevity and effectiveness of the procedure was shortly brought into question [3].

In 1999, the “S-lift” was brought back into popularity by Dr. Saylan, who claims the technique was originally developed in the 1960s. This short-scar technique involved an S-shaped skin excision across the non-hair-bearing skin at the helical root, skin excision, and vertical and O-shaped purse-string sutures through the SMAS and parotid fascia in small bites. The permanent sutures were secured to posterolateral periosteum of the zygomatic arch to achieve the lift [32]. The most obvious shortcoming of this technique was the inability to improve the cervicomental angle and overall neck laxity [33].

The S-lift technique was later modified by Tonnard et al. who dubbed the procedure the Minimal Access Cranial Suspension Lift (MACS lift). The authors changed the location of the incision to follow the border of the sideburn, excised skin after the lift, and placed purse-string plication sutures to the temporal fascia, rather than the zygomatic arch [3, 34]. The MACS lift was noted to have similar results to SMAS plication and imbrication techniques [35].

5.4 Volumetric techniques

Facial aging does not solely involve the descent of soft tissue as a result of gravity, but other processes such as loss of facial volume and tissue elasticity. It is now understood that deflation is a major component of the complex facial aging phenomenon and cannot be corrected by facelift surgery alone [36]. Contemporary surgeons appreciate that adding volume in the midfacial region, whether by injectables or facial implants, results in greater rejuvenation than facelift surgery alone [21]. Younger-appearing people tend to have fuller cheeks and a more rounded facial contour which eventually give way to a more aged appearance with hollowing, accentuation of bony contours and thin skin. While many surgical techniques focus on addressing the soft tissue descent, they are limited in addressing volumetric changes and skin quality. This is why many cosmetic and plastic surgeons today incorporate volumization into their treatment algorithms while performing facelifts [3].

The idea of soft tissue fillers has been around since the late 1800s. Materials still being used today include autologous fat, silicone, collagen, calcium hydroxyapatite, poly-L-lactic acid, and hyaluronic acid products. Of these, the hyaluronic acid products are most widely used due to their longevity, efficacy, safety, and reversibility [3]. Hyaluronidase is readily available to be injected and breakdown the injected

hyaluronic acid filler, which can help reverse rare catastrophic events such as intra-arterial infiltration [3]. The development of longer lasting injectable fillers and the realization of the benefit of adjunctive volume restoration have led surgeons to select simpler facelift techniques [6].

Another option for facial volumization is facial implants. Malar, infraorbital, and nasal implants offer ways to add volume back to the midface whereas chin and mandibular angle implants offer ways to add volume to the lower facial third.

6. Complications

Several factors have been shown to consistently predispose patients to complications after facelift surgery: preoperative intake of aspirin or other anti-platelet or anticoagulant drugs, active smoking, intraoperative use of epinephrine, postoperative emesis, and poorly controlled blood pressure [22]. Male patients also carry a much higher risk of postoperative hematoma due to the more vascular, sebaceous, thicker facial skin compared with females [22].

As patients undergoing facelift surgery are often elderly and may have multi-system disease while being on several medications, it is essential to have patients properly screened, medically optimized by their physician(s), and undergo a proper preoperative work-up. With proper preoperative screening, older patients can undergo rhytidectomy with relatively low risk [19]. One of the surest ways to prevent tragic complications, such as death, is for the surgeon to do his or her due diligence in preparing the patient appropriately.

Complications from facelift surgery can be divided into three broad categories: intraoperative, early postoperative, and late postoperative.

Intraoperative complications include: unexpected bleeding, anesthetic complications, undiagnosed ptotic submandibular glands, cyanotic flap or perforated flap, nerve injury, and irregularities [25].

Submandibular glands tend to descend and become more ptotic with age despite coverage from the superficial layer of the deep cervical fascia. A ptotic gland, however, may go unnoticed preoperatively due to older patients often presenting with skin laxity and jowling. When the SMAS is pulled posterosuperiorly intraoperatively, a ptotic submandibular gland may be recognized as a persistent bulge in the antegonial notch region. To address this issue, some surgeons advocate for a submandibular sling to elevate the gland superiomedially. This technique does not always achieve its intended goal and, thus, a better course of action would be to redirect and manipulate the SMAS layer or perform a submandibular gland reduction [16].

Smokers present well-known surgical and anesthetic risks to facelift surgery. From an anesthetic perspective, smokers tend to have more reactive airways, increased secretions, decreased lung capacity, and oxygenation problems [37].

Early postoperative complications include: hematoma, infection, wound dehiscence, skin flap necrosis, and motor and sensory nerve dysfunction [25].

Preoperative management of baseline hypertension is critical to decrease the risk of hematoma [22]. Indeed, elevated systolic blood pressure is the most common modifiable risk factor for postoperative hematoma [19]. Administering clonidine 0.1 to 0.2 mg before surgery has been useful in stabilizing and lowering blood pressure adequately during the perioperative period to reduce the risk of hemorrhage [16, 22, 37]. Preoperative smoking, a history of aspirin or NSAID intake, and male gender have also been shown to increase the risk of hematoma formation [38].

Early intervention in suspected expanding hematoma is the most reliable measure to prevent devastating complications of the facelift surgery [22]. Small, undrained hematomas may lead to skin contour irregularities and pigment changes [12, 19]. An expanding hematoma is a true emergency in facelift surgery and requires expeditious surgical evacuation to prevent airway compromise and skin flap necrosis [19, 37].

Postoperative infection following rhytidectomy is uncommon. In a systematic review of various SMAS facelift techniques, Jacono et al. report an postoperative infection rate of 0.53, 0.77, 0.73, and 1.12% in SMAS plication, SMASectomy / imbrication, deep plane, and composite facelifts, respectively [39]. The main pathologic offenders of postoperative infection tend to be members of the *Staphylococcus* species. To reduce the incidence of postoperative methicillin-resistant *Staphylococcus aureus* (MRSA) infections, patients who are MRSA carriers should be treated with topical nasal mupirocin ointment, chlorhexidine mouth rinse and full-body chlorhexidine soap for 5 days preoperatively [40]. Additionally, MRSA carriers should be given vancomycin, rather than a first-generation cephalosporin, as a preoperative antibiotic [19].

Active smoking is the most common preoperative risk factor for skin necrosis postoperatively. In a retrospective study, Rees et al. report that smokers were 12.46 times more likely to suffer skin sloughing when compared with nonsmokers and that smokers have a 7.5% chance of developing skin slough after rhytidectomy [41].

Patients undergoing facelift surgery should be counseled preoperatively about some sensory deficits after their procedure, especially in the pre- and postauricular areas [37]. Usually, the altered sensation is temporary and may resolve over a 90-day period. Similarly and fortunately, weakness of the muscles of facial expression, caused by injury to branches of the facial nerve, is typically temporary and resolves over a period of weeks to months. Damage to the facial nerve branches may be caused by direct injury, neuropraxia, thermal injury, compression injury, or other causes [37]. For both sensory and motor nerve injuries, patient should be reassured that the effects are likely temporary. For motor nerve injuries that do not improve over the course of 90 days, consultation with a microneurosurgeon is strongly advised [37].

Late postoperative complications include: abnormal wound healing, earlobe distortion, alopecia, hairline changes, platysmal banding, skin pigment changes, chronic pain, numbness, or facial weakness, sialocele, seroma, and a dissatisfied patient [25].

Incision design plays a vital role in proper healing and preventing distortion of anatomic structures. Patients should be marked while in an upright position and prior to injection of any tumescent or local anesthesia to avoid gravitational changes in skin draping and prevent distortion of anatomical landmarks, respectively. Improper incision placement may lead to unesthetic scarring, transposition of hair-bearing skin to a region normally without hair, increased wound tension, and distortion of anatomic structures.

Due to the nature of a deep-plane facelift, including submentoplasty, the large amount of dead space that is created increases the chance for postoperative fluid accumulation in the form of seroma, sialocele or hematoma. Sources of sialoceles post-facelift surgery may be the parotid or submandibular gland. Although sialoceles rarely require surgical management, treatment often requires serial aspirations, antisialagogue medication, and gentle pressure dressings. Sialoceles from the parotid gland tend to have much higher fluid collections than those from the submandibular gland and may take up to 1 month to fully resolve [12]. If parotid gland injury is detected intraoperatively, the injured tissue may be cauterized and sealed under



Figure 21. Patients are shown before and after facelift surgery in conjunction with other facial cosmetic procedures. One of the most drastic areas of improvement for these patients is the cervicomental region which was obtuse pre-operatively and is now more acute. Additionally, their jawline is more defined. (SMG – submandibular gland).

SMAS closure to reduce the risk of a parotid sialocele [19]. Similarly, after submandibular gland reduction, the SLDCF may be closed over the submandibular gland to minimize risk of a submandibular gland sialocele. It should be noted that the reliability of these methods is unclear.

Patients who are unhappy or dissatisfied with their results are likely to voice their opinions to the surgeon. The surgeon must be attentive, listen carefully, and not be defensive. Ideally, through the detailed consultation and preoperative evaluation, patients with unrealistic expectations would have been denied surgery or gone elsewhere. The patient must be advised that if a revision surgery is indicated, enough time should pass to allow adequate healing from the initial procedure as this will allow for a better, rather than rushed, result.

7. Conclusion

Facelift surgery has evolved dramatically since its inception. Better understanding of surgical anatomy, advances in technology, and the increase in number of well-trained and qualified surgeons have led to the development of safe, reproducible, long-lasting, and effective techniques. Despite these advances, the surgeon must be patient, understand his or her patients, and develop a comprehensive treatment plan to prevent complications and obtain superior results (Figure 21).

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Chapter 2

Endoscopic Forehead and Eyebrow Surgery

Anthony Congiusta, Angelo Cuzalina and Maria Jubran-Khoury

Abstract

Esthetic concerns of the forehead and eyebrow regions affect people within a wide range of age groups. While many facial cosmetic surgical procedures are typically performed on patients in their mid-40s or older, an endoscopic forehead and brow lift, as well as other types of browlifts, may be performed on younger patients because of their genetic predisposition. Additionally, aging does eventually lead to forehead and brow ptosis for nearly all patients. The surgeon must address all problems to achieve optimal results and patient satisfaction. The goal of this chapter is to review relevant facial anatomy, indications and contraindications, surgical technique, and complications as they pertain to eyebrow and forehead cosmetic surgery.

Keywords: browlift, endoscopic browlift, blepharoplasty, forehead lift, minimally invasive

1. Introduction

The forehead, eyebrows and eyes are among the most important determinants of facial expression. They allow people to express a range of emotions. Raised eyebrows and wide-open eyes may indicate surprise whereas scrunched brows and squinted eyes may indicate anger. Indeed, Charles Darwin, in his book *The Expression of the Emotion in Man and Animals*, refers to the corrugators as “grief-muscles” due to their conjoint yet opposed action resulting in the formation of furrows on the forehead and their association with the emotional states of grief and sadness [1, 2]. The upper third of the face plays an integral role in facial harmony and esthetics. As aging occurs, many people experience similar changes, namely tissue descent, in the upper facial third due to gravity, sun exposure, and genetic factors. Heavy forehead and glabellar skin with deep facial rhytids and eyebrow ptosis lead to a tired and aged appearance [3].

Many techniques have been developed to rejuvenate the upper facial third, none more popular than injection of botulinum toxin type A, which is the most common cosmetic procedure globally [4]. When treating the aging face, it is critical to correctly diagnose and identify areas that need to be addressed. There are several types of surgical techniques to address the brows and forehead including the endoscopic, coronal, direct, anterior hairline, posterior hairline, transblepharoplasty, suture suspension, barbed threads, and radiofrequency browlifts [5].



Figure 1. A 57 year-old woman shown before and 1.5 years following a deep plane facelift, endoscopic forehead and brow lift, and facial laser resurfacing. The outer third of her eyebrow region (hooding) is the defining area improved by a good brow lift.

Unlike the lower third of the face, which may require treatment in many patients older than 40 years, the upper third of the face may be indicated for rejuvenation in patients in their 20s or 30s due to genetic predisposition [6, 7]. Thus, a comprehensive examination of the entire face must be performed by the cosmetic surgeon in order to achieve superior outcomes and patient satisfaction. Failing to address the upper third of the face in a patient who, for example, is presenting for facelift surgery, will lead to suboptimal results.

Due to gravity and time, the aging process causes a descent of soft tissues and typically results in forehead and brow ptosis which, in turn, may lead to lateral hooding and visual field deficits (**Figure 1**) [8]. Patients who present with signs of aging of the upper facial third also typically present with excessive wrinkling, fatigued-appearing eyes, and excess upper eyelid skin laxity [7]. They may also present with facial volume loss and evidence of photodamage. Specific elevation and correction of the upper facial third and lateral eyelid hooding, along with a reduction in wrinkling and treatment of any photodamage can result in a naturally appearing and rejuvenated look that will enhance the patient's overall beauty. The goals of a browlift are to stabilize the brow at an esthetically pleasing height and morphology and to decrease forehead and glabellar rhytids, lateral canthal hooding, and infrabrow skin while concealing scarring and avoiding the stigmata of facial cosmetic surgery, namely an elevated hairline, over elevated brows, and a surprised appearance [8, 9].

The goal of this chapter is to review relevant facial anatomy, indications and contraindications, the author's preferred surgical technique, and complications as they pertain to eyebrow and forehead cosmetic surgery.

2. Anatomy

The face is commonly thought of as being divided into equal horizontal thirds and vertical fifths. The upper facial third is measured from trichion (the midline point of one's normal hairline) to glabella (the smooth prominence between one's brows) [6, 10]. The middle and lower facial thirds are measured from glabella to subnasale (the midline point where the nasal septum meets the upper lip) and from subnasale to menton (the most inferior point of the chin), respectively [6]. The vertical facial fifths are measured from the pinna to the lateral canthus on both sides, the lateral canthus to medial canthus on both sides, and medial canthus to medial canthus centrally (**Figure 2**) [10].

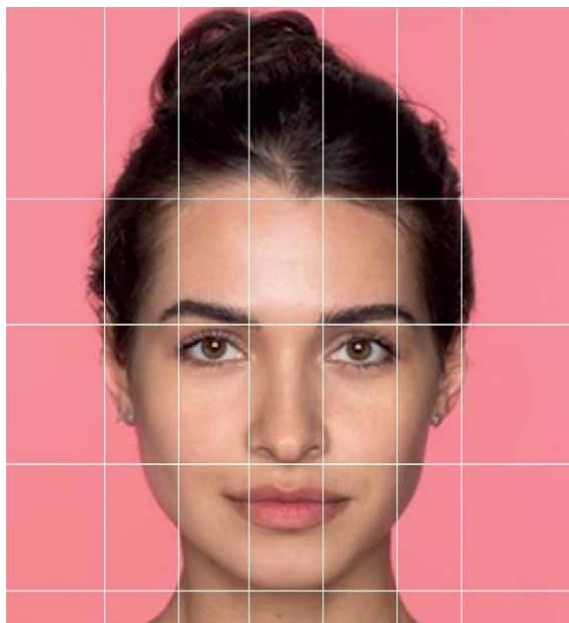


Figure 2.
While no patient's face is perfectly symmetric, understanding the relationship between facial height and width will allow the cosmetic surgeon to better achieve facial harmony.

Generally, in a non-receded hairline, the hairline should be 5 cm from the brow in females and 6 cm from the brow in males [10]. An esthetic female eyebrow is arched and positioned just above the orbital rim with the peak of the brow between the middle and lateral third of the brow. The lateral third of the female brow ideally lies roughly 0.5–1 cm above the orbital rim [6].

Regarding the bony anatomy, the frontal bone comprises much of the upper facial third. Male foreheads are longer, with a vertically oriented slope that increases in projection over the frontal sinus whereas female foreheads are rounder and have a less prominent glabellar ridge that smoothly transitions into the nasal dorsum without increased projection over the nasofrontal area [11]. Parts of the zygoma, parietal bone, nasal bones, and maxilla also provide important landmarks for surgeons during many browlift approaches. Suture lines such as the nasofrontal, fronto-zygomatic, lambdoid, and coronal, are important landmarks to identify during the endoscopic forehead and browlift technique because they can represent limits of subperiosteal dissection and act as reference points for navigating the surgical equipment during the procedure [6]. Important anatomic structures can also be identified and protected once the suture lines are encountered, such as the sentinel vein, or the medial zygomaticotemporal vein, and frontal branch of the facial nerve which run just posterior and inferior to the fronto-zygomatic suture line (**Figure 3**).

The nasofrontal suture is an important bony landmark as endoscopic subperiosteal dissection only needs to proceed a few millimeters past this suture line onto the nasal bones for adequate release. If nasal tip rotation is indicated or if the nasofrontal angle needs to be slightly modified, the dissection can proceed further caudally along the nasal bones. The paired procerus muscle is also located near the nasofrontal suture and may be transected if necessary.

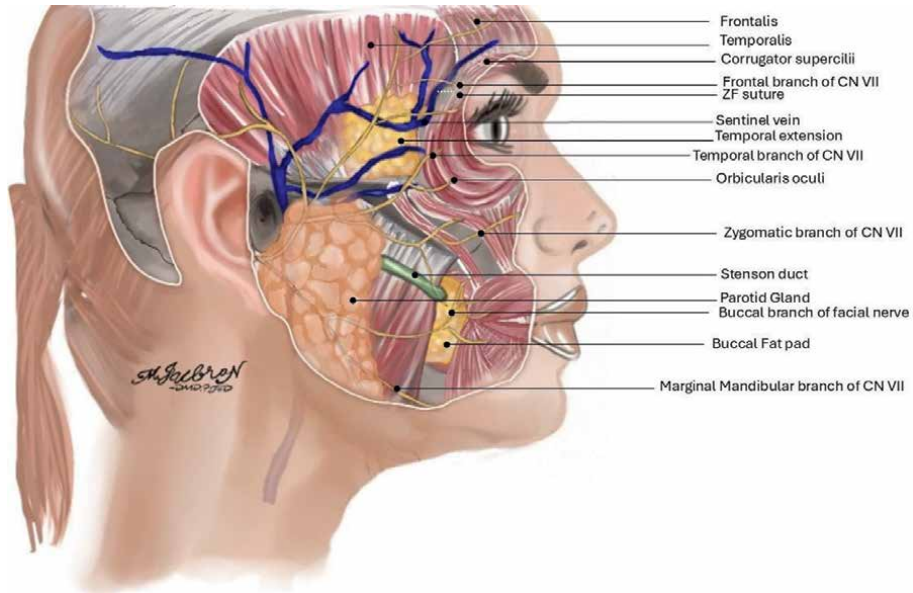


Figure 3. Anatomy of the frontal branch of the facial nerve (CN VII) and its proximity to the sentinel vein, also called the medial zygomaticotemporal vein. As illustrated by the white dotted line, the sentinel vein is approximately 1–2 cm lateral to the zygomaticofrontal (ZF) suture. Damage to this vein may result in unwanted bruising and swelling in this area. It may also be difficult to achieve hemostasis. One should be aware of the frontal branch of the facial nerve nearby, which may be damaged while attempting to achieve hemostasis.

The superior orbital rim and its associated arcus marginalis represent the inferior limit of dissection over the orbit. These landmarks must be well-visualized endoscopically and freed of periosteal attachments in order to lift the brow and its associated fat pads for long-lasting results [6]. Along the superior orbital rim lies the supraorbital foramen or notch, which may be found within 1 mm of a line drawn in a sagittal plane tangential to the medial limbus [6, 12]. This landmark may be marked on the skin to give the surgeon a reference point that reveals the bony exit point of the supraorbital nerve. A deep division of the supraorbital nerve may be present in 10% of patients and may exit from another foramen which may be up to 1.5 cm above the orbital rim. This has led some surgeons to advocate the use of the endoscope once dissection has reached 2 cm from the superior orbital rim in order to reduce the risk of injury to the supraorbital nerve [6].

The temporal ridge is another important landmark that must be identified during dissection. Along this ridge lies a zone of fixation: a dense collection of fascia approximately 1 cm wide that extends the length of the superior temporal line and ends inferiorly just above the fronto-zygomatico suture line at the fascial attachment known as the orbital ligament (**Figure 4**) [6]. Lateral to the orbital ligament lies the orbicularis-temporal ligament, which is where fibers from the orbicularis oculi, temporalis fascia and temporo-parietal fascia fuse.

Bone thickness is another important anatomic factor to consider when using fixation methods that require drilling into the skull. Although bone thickness increases posteriorly near the occiput, fixation in this region is relatively difficult and not required. The safest site for bone tunnel or fixation screw placement for brow elevation is the frontal bone along a parasagittal line extended from the lateral limbus or

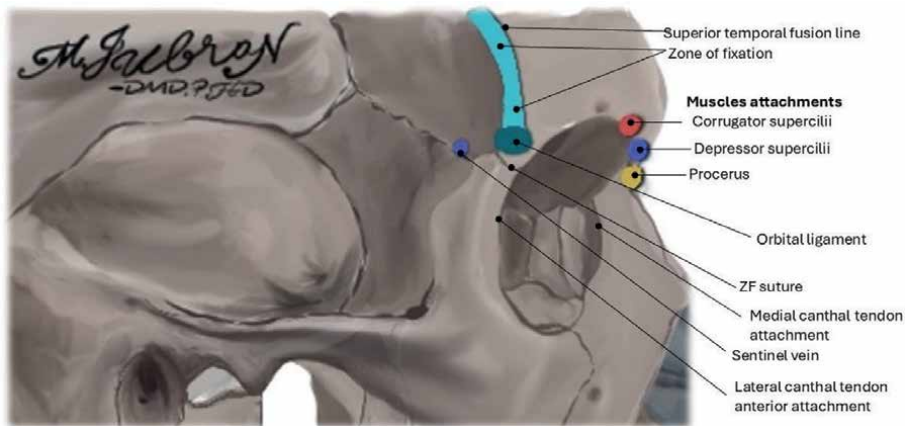


Figure 4.
The zone of fixation spans the length of the temporal ridge and ends just above the zygomaticofrontal (ZF) suture.

mid-pupil and anterior to the coronal suture [6]. Bone screw or tunnel fixation should not be near midline due to the presence of the sagittal sinus and a higher density of venous lakes on the inner surface of the skull near the sagittal suture. Also, caution must be taken to avoid bone penetration near the temporalis muscle laterally where potential injury to the middle meningeal artery, a branch of the internal maxillary artery, may occur.

The anatomy of the forehead is similar to the rest of the scalp, with some minor exceptions. Indeed, the acronym SCALP can be applied to forehead anatomy: skin, subcutaneous tissue, galea aponeurotica, loose areolar tissue, and periosteum. In the forehead region, the galea aponeurotica, which is also continuous with the temporo-parietal fascia in the temporal region, is fused into the frontalis muscle.

The muscles of the forehead and brow region are paired and include the frontalis, corrugator supercilii, procerus, depressor supercilii, orbicularis oculi, and temporalis muscles. The frontalis muscle is unique in that it is the only true elevator of the forehead and brows. The remaining aforementioned paired muscles act as forehead and brow depressors. The frontalis muscle originates from the galea aponeurotica and inserts into the orbital portion of the orbicularis oculi muscle. Its lateral extension fuses into the zone of adherence along the superior temporal line [6]. Laterally, the frontalis muscle's absence over the tail of the brow results in more unopposed action of the depressor muscles, causing the lateral tail of the brow to descend to a greater degree than its medial counterpart as one ages [13].

The procerus and corrugator supercilii muscles are the two most recognized depressors as they are often the target of many providers offering neuromodulator treatment for dynamic rhytids in the glabella region. The procerus muscles are paired superiorly and fuse into a single muscle belly inferiorly (**Figure 5**). They originate from the nasal bones and cartilages and insert into the medial frontalis muscle and overlying dermis. The procerus is responsible for brow depression at the midline, between the brows and eyes, that often create a horizontal crease across the upper art of the nose.

The corrugator supercilii muscles originate from the frontal bone near the midline, just above the nasal bones, and insert into the dermis of the medial brow. The two heads to the corrugator muscles, the oblique and transverse, act synchronously in

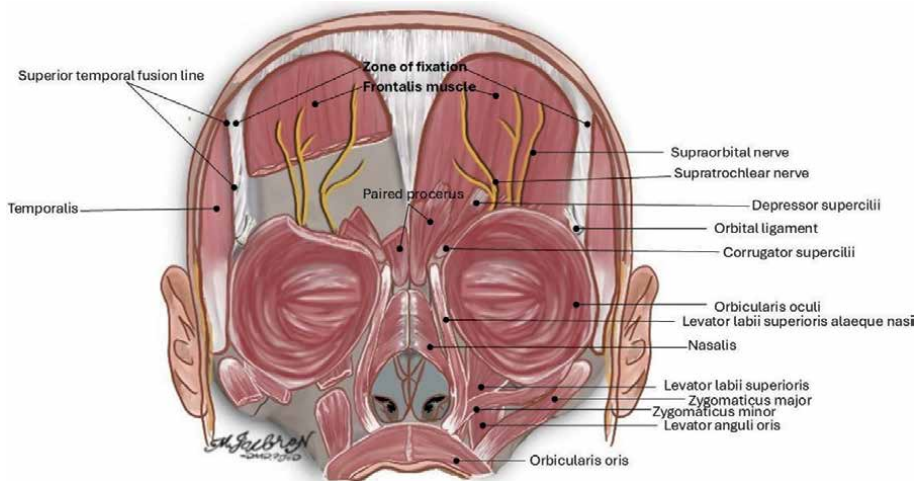


Figure 5. Muscular anatomy of the forehead. The procerus and corrugator supercilii muscles are responsible for vertical rhytid formation (“11 s”) in the glabellar region and are commonly targeted areas during browlift surgery and neuromodulator treatment.

order to pull the medial brow down and towards midline. The muscles act obliquely across the glabella and produce vertical lines or “11 s” while making certain facial expressions such as squinting and frowning and contribute to an “angry” or “grieving” appearance. The corrugator supercilii and procerus muscles are often transected during an endoscopic forehead or brow lift procedure to achieve a smooth, long-lasting result, akin to a “permanent Botox” effect.

The depressor supercilii muscle originates from the frontal process of the maxilla, just inferior and superficial to the origin of the corrugator supercilii. It inserts into the medial frontalis muscle and dermis just above the medial brow [6]. While performing an endoscopic forehead and browlift, this muscle may be transected via aggressive dissection through the corrugator muscle. This maneuver often leads to over-elevation of the medial brow to a position above the superior orbital rim, which may result in a post-operative “surprised” look [6, 14]. A similar outcome may occur if the depressor supercilii is inadvertently treated with neuromodulators: elevation of the medial brow.

More superficial to the depressor supercilii lies the orbital portion of the orbicularis oculi muscle which originates, in part, from the medial canthal tendon and inserts into parts of adjacent depressor muscles, the frontalis, and the dermis [6].

The temporalis muscles are located in the temporal fossa, from where they originate, and insert onto the coronoid process of the mandible. Its overlying fascia is useful and important to identify during upper facial cosmetic surgery because it aids in delineating surgical planes and may be used in fixation. The dense, shiny white temporalis fascia adheres to the underlying temporalis muscle and separates into superficial and deep layers in the lower half of the temporal fossa. Superficial to the temporalis fascia lies the temporoparietal fascia which is continuous with the superficial musculoaponeurotic system (SMAS) inferiorly and houses the frontal branch of the facial nerve under its deep surface (Figure 6).

Arterial blood supply to the forehead region is derived from branches of both the internal and external carotid arteries (Figure 7). The facial artery, a branch

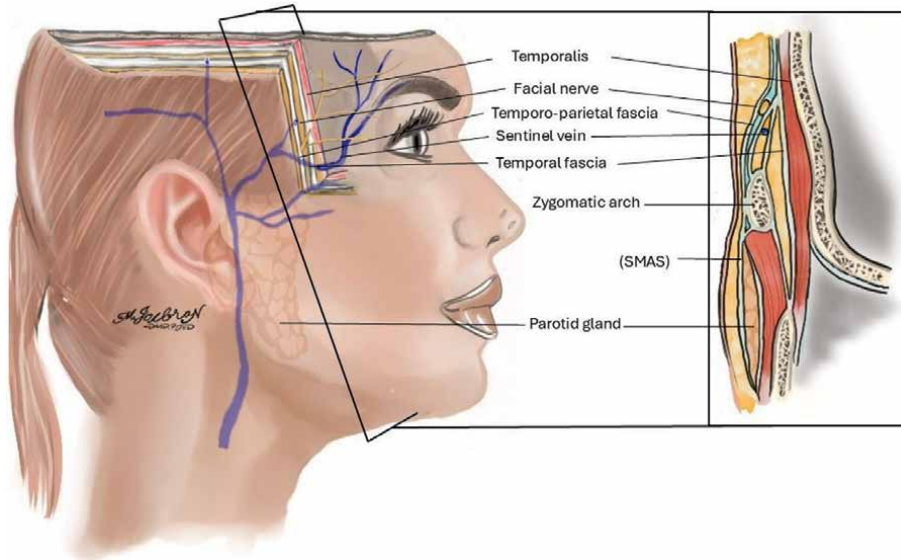


Figure 6.
 Cross sectional anatomy of the frontal branch of the facial nerve and its proximity to the sentinel vein, also called the medial zygomaticotemporal vein. Damage to this vein may result in unwanted bruising and swelling in this area. It may also be difficult to achieve hemostasis. One should be aware of the frontal branch of the facial nerve nearby, which may be damaged while attempting to achieve hemostasis.

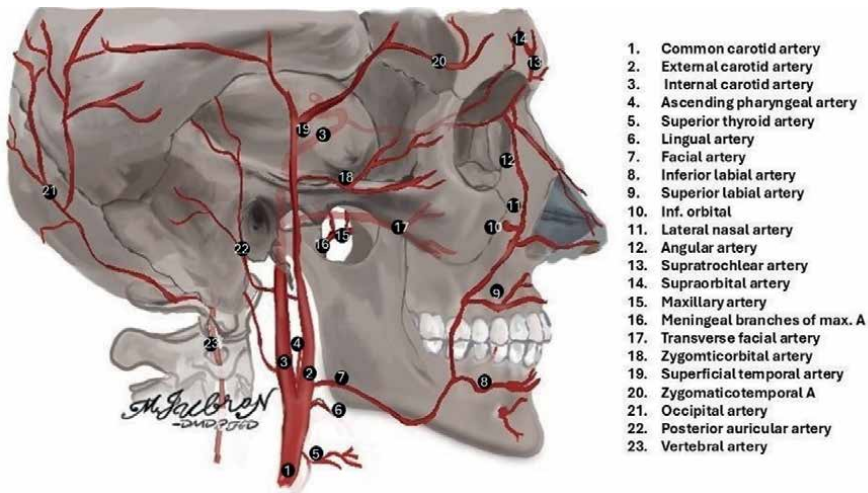


Figure 7.
 Arterial blood supply to the face is derived from external carotid and internal carotid artery systems.

of the external carotid artery, gives rise to the angular artery, which supplies the medial canthal region. The superficial temporal artery, one of the terminal branches of the external carotid artery, gives rise to a frontal or anterior branch, which supplies the lateral canthal region. The maxillary artery, the other terminal branch of the external carotid artery, gives rise to the middle meningeal artery which supplies part of periosteum along the inner surface of cranial bones and

the dura mater. Perforating branches of the middle meningeal artery also reach the diploe and may even at times reach the external surface of the skull [15]. The ophthalmic artery, a branch of the internal carotid artery, gives rise to the supra-orbital and supratrochlear arteries which exit their respective foramina to supply much of the forehead and mid-scalp regions [6].

Venous drainage of the upper facial third corresponds to the respective arterial supply, but may have some variations. The sentinel vein or the medial zygomaticotemporal vein remains relatively consistent in its course among patients. It runs perpendicularly through the temporalis fascia approximately 1–2 cm lateral or posterior to the fronto-zygomatico suture line and within 2 mm of the temporal branch of the facial nerve (Figure 6) [6, 8]. Careless dissection in this region may lead to injury to the sentinel vein which may result in bruising and a reduced field of visualization.

Nerve supply to the upper face also parallels its arterial supply. Most of the forehead is innervated by the supraorbital and supratrochlear nerves (Figure 8). These nerves exit the same foramina or notch as their respective blood vessels and are both divisions of the trigeminal nerve's first branch: the ophthalmic nerve. Once it exits its foramen, the supraorbital nerve gives off two divisions. The deep or lateral division supplies the lateral and posterior part of the forehead and scalp whereas the superficial or medial division pierces the frontalis muscle early in its course and travels superficially to the muscle supplying sensation to the lower and mid-forehead along the mid-pupillary line [6]. The deep branch is larger than the superficial branch and is located closer to the periosteum [12].

The supratrochlear nerve exits near the superior orbital rim, approximately 9 mm medial to the supraorbital foramen or notch, and supplies sensation to the mid-forehead region, with its territory overlapping somewhat with that of the supraorbital nerve. The infratrochlear nerve, which also originates from the ophthalmic nerve, exits just below the supratrochlear nerve around the medial orbital rim to supply sensation to the upper nose and medial orbit. The lateral orbit and temporal regions of the face receive sensory input from branches of the maxillary nerve, the second division of the trigeminal nerve: the zygomatico-frontal and zygomatico-temporal nerves.

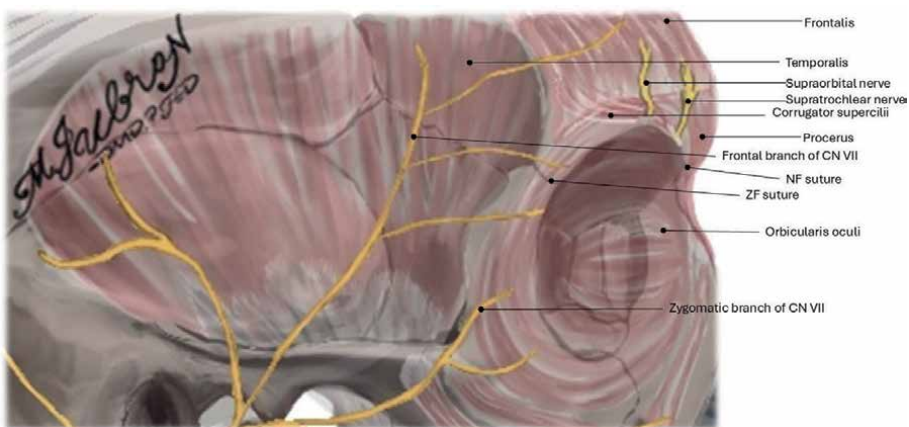


Figure 8.
Innervation of the upper facial third.

Part of the temporal region is also supplied by a branch of the mandibular nerve, the third division of the trigeminal nerve. The auriculotemporal nerve, supplies sensation to the front of the ear, the temporal skin above the zygomatic arch, and to the skin that is superficial to the superficial temporal artery [6]. It runs within 1 cm anterior to the tragus and parallel to the superficial temporal artery. Knowing its anatomic location will help prevent the surgeon from confusing it with the frontal branch of the facial nerve, which runs roughly 2 cm anterior to the tragus when it crosses the zygomatic arch at a more oblique angle and just deep to the SMAS and temporoparietal fascia above the arch.

Branches of the facial nerve, namely the frontal (or temporal) and zygomatic branches, are responsible for supplying motor innervation to the forehead and glabella. The temporal branch innervates the frontalis muscle, the superior portion of the orbicularis oculi muscle, the superior portion of the procerus muscle, and the transverse head of the corrugator supercillii muscle [6]. The nerve leaves the parotid gland deep to the SMAS and crosses the middle third of the zygomatic arch between the SMAS and periosteum. Once superior to the zygomatic arch, the temporal branch of the facial nerve travels within the temporoparietal fascia until it inserts into the deep site of the musculature [8]. The temporal branch has typically divided into two rami at the level of the zygomatic arch and into at least four branches at the level of the eyebrow. The zygomatic branch of the facial nerve supplies the medial orbicularis oculi muscle, the inferior portion of the procerus muscle, and the depressor supercillii muscle.

During an endoscopic forehead and browlift, the surgeon must identify key anatomic landmarks and create enough space in order to insert the endoscopic equipment. Once in the subperiosteal plane, the zone of fixation along the superior temporal crest becomes an important consideration during the dissection. While the less tenacious zone of adherence along the entire temporal crest may be elevated with blunt finger dissection, as the surgeon approaches the superior-lateral orbital rim and the inferior edge of the temporal crest, endoscopic guidance is used to achieve optimal release [6]. The attachments at the lateral orbital rim consist of an intermix of fibers from the periosteum, galea, temporalis, and temporoparietal fascia. During dissection, it is crucial to stay in the subperiosteal plane, against the bone, and in the sub-temporoparietal fascial plane, against the temporalis fascia, to avoid injury to the frontal branch of the facial nerve and the sentinel vein [6].

3. Pre-operative evaluation

As with all cosmetic surgical procedures, an accurate diagnosis and treatment plan is crucial to optimizing the final outcome and ensuring a high level of patient satisfaction. Knowing and understanding the patient's desires and expectations, while ensuring the patient understands the risks, benefits, and alternative treatments will help all parties develop trust among one another and the best outcome possible. After a forehead and browlift, new dynamic rhytids may appear as a result of the newly positioned tissue and, while some of the pre-existing rhytids may be improved, these lines will not be completely treated by browlifting, alone. Patients should be made to understand that other treatment modalities, such as neuromodulator injection, may be necessary to address these particular lines.

Patients should also be aware that forehead and browlifting, alone, will not change any intrinsic skin damage that has occurred due to sun exposure, age, and smoking. Topical

medications and skin care along with skin resurfacing may be considered to address these changes. Chemical peels or laser resurfacing may be performed simultaneously with an endoscopic forehead and browlift, in which dissection is carried out in a subperiosteal and subgaleal plane. Patients who desire aggressive, high-fluence simultaneous ablative laser resurfacing require a deeper plane of dissection than a subcutaneous plane because the laser may place the thin lipocutaneous at risk of vascular after an aggressive laser [5].

Traditionally, the “ideal” female brow position is arched above the superior orbital rim, with it peaking between the middle and lateral third of the brow, which corresponds with the level of the lateral limbus of the iris [11]. This is known as a Westmore-shaped eyebrow and its point is typically 5–10 mm above the orbital rim [6, 14]. In reality, an ideal brow morphology is more dependent on one’s facial shape: the Westmore eyebrow is not well-suited to long or square faces since it can negatively accentuate the angularity of these faces. Conversely, a laterally peaked Westmore eyebrow may add necessary angularity to a round face [14].

The male brow, on the other hand, is lower, usually at the level of the superior orbital rim, thicker, and tends to have a flatter, more horizontal contour [5, 11, 16]. Males undergoing browlift surgery typically require a more “straight-up” elevation of the entire brow to avoid feminization of their upper facial third, which may occur if the lateral brow was over-elevated. To achieve this, the parasagittal incisions may be placed in the scalp directly above the midline of the iris [17]. Relative contraindications for an endoscopic forehead and browlift include females with high hairlines, males with male pattern baldness, patients with thick adherent skin, and patients with extensive bone attachments [8].

Those who have brow ptosis or dermatochalasis may lead to subconscious frontalis muscle activity to lift the excess tissue and improve their visual field. Over time, this gives rise to deep forehead wrinkles (**Figure 9**).

Any bony irregularities that are noted upon examination may be further evaluated through use of a cephalometric radiograph or a computed tomography (CT) scan. Limited bony contouring may be performed via an endoscopic approach, however, major reduction for significant bony hypertrophy, such as frontal bossing, is best achieved by an open (coronal) approach [6]. Bone reduction may be limited by pneumatization of the frontal sinus, which may be evaluated pre-operatively with a CT scan. While CT scans are not necessary to treatment plan the location of bone tunnels for fixation, a cephalometric radiograph may be useful in determining the thickness of corticocancellous bone and provide reassurance to the surgeon [6].

Patients should be instructed to avoid medications that could increase the risk of intra-operative and post-operative bleeding such as aspirin and other nonsteroidal anti-inflammatory drugs, vitamin E, and several over-the-counter herbal medications, such as ginkgo, *Echinacea*, and St. John’s wort, for at least 2 weeks pre-operatively [18]. Patients should also be instructed to wash their hair the night before and morning of surgery with antibacterial soap, such as Hibiclens[®], or an antiseptic type of shampoo. Hairspray and other hair products are to be avoided immediately before surgery. Smokers and smokeless tobacco users should be instructed to discontinue nicotine products at least 3 weeks before and after their procedure.

Pre-operatively, five standard photographs of the patient are taken, along with close-up views of the eyes in closed and open gazes, lateral gaze, and upward gaze [8]. The patient is marked while sitting or standing in an upright position. The patient is then brought to the operating room and situated on the operating room table in a supine position. General anesthesia is induced by laryngeal masked airway or endotracheal intubation. The bed is rotated away from the anesthesia provider so that the

'Subconscious' Horizontal Rhytids are Treatable



Figure 9. The two patients in the image presented with deep forehead rhytids due to subconscious overactive frontalis activity. The patient on the left was treated with blepharoplasty only and the patient on the right was treated with an endoscopic forehead and brow lift. The removal of laxity over the eyes allowed for both patients to stop raising the eyebrows subconsciously, which improved the forehead wrinkles. The patient who underwent the brow lift procedure had a more dramatic improvement in subconscious forehead lines.

endoscopic tower or screen may be placed near the foot of the bed while the surgeon stands unobstructed at the head of the bed. The bed may be tilted in 5–10 degrees of reverse Trendelenberg position to facilitate insertion and maneuvering of the endoscopic equipment. Once the appropriate level of anesthesia has been achieved, the patient is prepped and local and tumescent anesthesia are administered. Lidocaine 1% with 1:100,000 epinephrine is injected along the superior orbital rim, glabella and lateral orbital rim. Tumescent anesthesia (250 mL normal saline with 1 mL 1:1000 epinephrine and 20 mL 2% lidocaine) is then injected into the forehead, temporal region, and posterior scalp. Alternatively, 20 mL (266 mg) of liposomal bupivacaine may be injected across the brow, the temple bilaterally, and circumferentially across the scalp, thus blocking supraorbital, supratrochlear, zygomaticofrontal, and zygomaticotemporal nerves regionally [19]. Shaving or cutting of the hair is usually not necessary, although it may be performed if the surgeon desires.

4. Surgical technique

Once the patient is prepped and draped, the author prefers to place five separate 2.5 cm incisions about 1 cm posterior to the hairline (**Figure 10**). The first incision is placed in the midline of the sagittal plane. Two more incisions are placed on either side of the first incision, in a line tangential to the lateral third of the brow. The final two incisions are placed in the temporal region in a line that is roughly parallel to the path of the temporal branch of the facial nerve.



Figure 10. Incisions of various browlift approaches. The endoscopic forehead and browlift incisions (green) are placed about 1 cm posterior to the hairline in the midline, parasagittal and temporal areas.

The location of these incisions is not arbitrarily decided upon. The midline incision, along with the two parasagittal incisions are parallel to each other and aligned vertically to avoid transection of branches of the supraorbital nerves originating inferiorly. The two parasagittal incisions are placed in line with the lateral third of the brow, where maximum lift is typically desired in female patients. For male patients, these parasagittal incisions may be placed slightly more medial in order to attain a more even brow elevation.

The decision to place the parasagittal incision in the described location is multifactorial. They are placed medial to the temporal crest to gain access to the skull, rather than the temporalis fascia, where bone tunnels will be placed and fixation will occur. Bony fixation may be safely performed in this area since it is one of the thickest regions of the frontal bone and it has a relatively low density of venous lakes to help prevent inadvertent intracranial injury. Another reason for placing the parasagittal incisions medial to the temporal crest is to easily gain access to the subperiosteal plane. If the incisions were further lateral, over the zone of fixation or the temporalis muscle, there would likely be increased bleeding and difficulty creating a subperiosteal pocket, making endoscopic visualization more obstructed.

In patients with receding hairlines, the incisions may become more noticeable. Instead of employing the aforementioned parasagittal incisions, 1-cm horizontal incisions may be placed at the upper forehead, at the level of the temporal limbus of the iris, within apparent horizontal forehead rhytids [20]. The midline and temporal incisions may be placed in the same locations as in those with non-receding hairlines.

The two temporal incisions are placed on either side of the head to allow for direct access to the thick deep temporal fascia. They are made perpendicularly to the desired

vector of elevation from the lateral canthal region [6]. They are also designed to avoid injury to nerves and vessels: they are parallel to and 2–3 cm superior to the temporal branch of the facial nerve and also parallel the superficial temporal artery and vein.

Sharp dissection is performed through the aforementioned incisions down to pericranium medial to the temporal crest and down to the deep temporalis fascia lateral to the crest. With blunt finger dissection and with long, curved endoscopic periosteal elevators, the tissues are elevated to a point 2 cm above the orbital rims and the zygomatic arch [6]. Blunt dissection is used to release and elevate the temporal tissues to a few centimeters posterior to the ear, where the temporal fossa becomes self-limiting. At least 10 cm of posterior scalp elevation is required to achieve adequate undermining, but it can extend as far posterior as the lambdoid suture if needed. Blunt dissection is subsequently carried out to connect all incisions in the subpericranial and sub-temporoparietal fascial planes. It is recommended that blunt dissection occurs from the temporal incision towards the parasagittal incisions to avoid inadvertently releasing the deep temporal fascia from the temporal crest and creating a false tunnel, which would be easier to do if dissection were to proceed from medial to lateral. It is critical to stay firmly against the periosteum and deep temporal fascia in order to avoid facial nerve injury.

The endoscope is then carefully inserted through one of the three medial incisions (**Figure 11**). If it feels too tight, remove the endoscope and ensure that the scalp and forehead have been adequately elevated. The surgeon must be mindful to not apply excessive retracting forces on the undermined scalp and forehead to avoid skin perforation. Endoscopic dissection proceeds medially over the nasofrontal suture and the orbital rims with a curved, smooth, and rounded elevator. Once the entire rolled edge of the superior orbital rim is visualized, needle tip electrocautery is used to precisely incise the periosteum. A laser on a low power setting may also be used for this maneuver. The supraorbital nerves and vessels can be located near the orbital rim at a level tangential to the medial limbus. Periosteal release in this area should be avoided to prevent injury to these vital

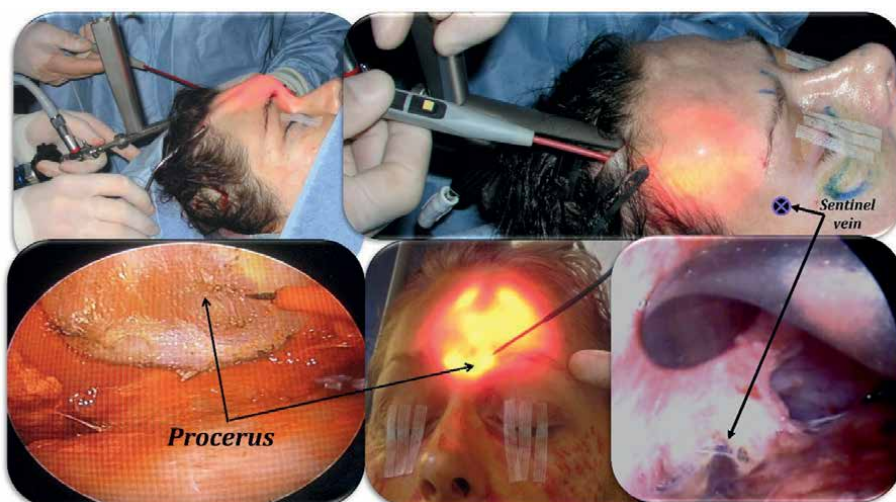


Figure 11. The endoscope is inserted through the right parasagittal incision. Once the periosteum is released, the musculature of the forehead is visualized and may be transected if indicated.

structures. To maintain a clear visual field during electrocautery or laser use, the temporal incisions may be used as suction ports so that a suctioning tool, such as a Yankauer suction tip, can be inserted without interfering with the endoscope and other instruments utilizing the three medial incisions. With hemostatic control and an unobstructed visual field, the corrugator supercillii and procerus muscles are transected from their deep surfaces. Any bleeding that occurs that cannot be controlled easily may be managed by applying pressure over the external surface over the rim until visualization improves and pinpoint, accurate cauterization may be used to achieve hemostasis without nerve injury.

Transection of the corrugator supercillii and procerus muscles will improve vertical and horizontal glabellar rhytids, respectively (**Figure 12**). This leads to a more natural appearance in the upper facial third whereas more aggressive muscle removal and surgical avulsion of these muscles, as advocated by some surgeons, may lead to post-operative irregularities and abnormal facial expression unless otherwise corrected with adjunctive procedures such as fat grafting [6]. However, in a retrospective study that evaluated 31 post-operative endoscopic forehead and browlift patients, Jones et al. found that depressor muscle resection in conjunction with a brow lift reduces glabellar lines on short- and long-term follow-up [14].

Once the periosteum has been completely released across the orbital rims and muscle transection has occurred, periosteal elevators are used to separate the cut periosteal edges by at least 1 cm to facilitate release at the arcus marginalis [6]. This separation is crucial to achieving long-lasting results (**Figures 13 and 14**). Then, the orbital ligament and zone of fixation laterally must be released in order to expose the lateral orbital rim in the subperiosteal plane. One should stay close to periosteum and deep temporal fascia to prevent damage to the temporal nerve and for better hemostatic control. Aggressive retraction in this area may lead to nerve injury. Subperiosteal dissection should proceed in a clean plane inferiorly along the lateral

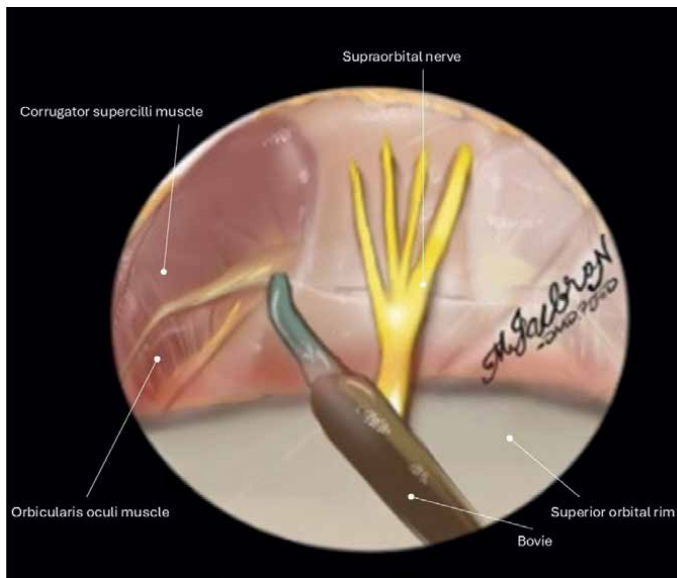


Figure 12. Illustration of an endoscopic view of release of periosteum at the level of the superior orbital rim while protecting the supraorbital nerve.

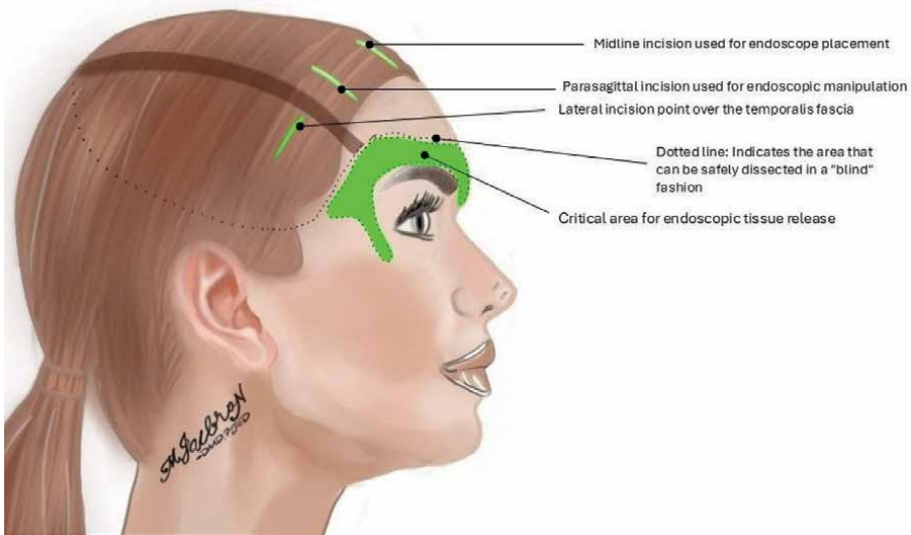


Figure 13.
 The green highlighted area illustrates the area of subperiosteal release anteriorly, which extends along the lateral orbital rim into the malar region. The endoscope may be inserted through any of the three middle incisions for visualization.

Right Brow Elevation after Internal Release (No fixation)

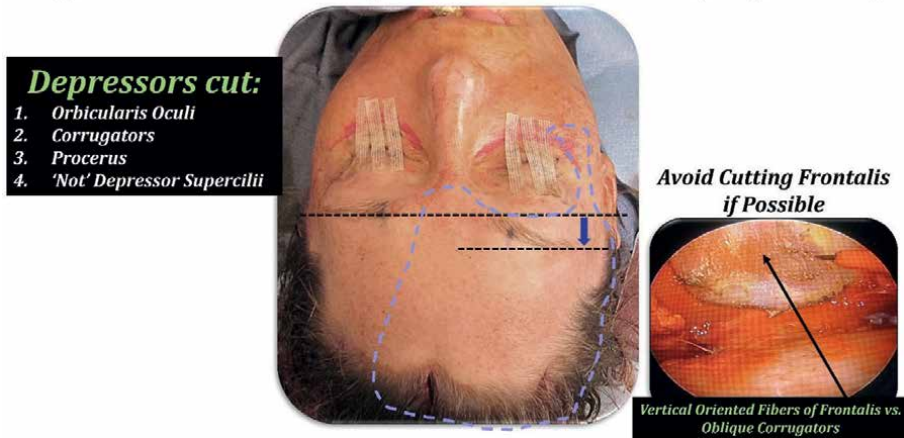


Figure 14.
 The right brow has been sufficiently released and the depressor muscles have been transected. The frontalis muscle, the sole brow elevator, should be preserved. One can distinguish between the brow elevators and depressors by the muscle fiber orientation.

orbital rim, past the zygomaticofrontal suture, to about 1 cm from the level of the zygomatic arch.

Once adequate dissection has been completed, forehead and brow elevation with fixation is performed. There are several types of fixation techniques that the surgeon may choose such as tissue suture only, bone screws and plates, resorbable screws, bone tunnels, tissue glue, temporalis muscle exposure for added scarification, and others. Regardless of the method chosen, adequate lower forehead release remains the

most important element in achieving adequate long-term fixation. Failure to sufficiently release the forehead tissues will inevitably lead to brow ptosis relapse.

The surgeon must now decide on the vector of lift to achieve the most esthetically pleasing result. For females, the lateral third of the brow is elevated most. This may be up to 1 cm above the superior orbital rim. The vector of pull is straight up and fixation may occur at or just posterior to the hairline. The galeal tissue may be secured to bone at this point while the lateral brow is held at its desired height or even a couple of millimeters above the desired level. The medial portion of the brow, however, should only be slightly elevated above the rim to avoid a more surprised or shocked appearance. The glabellar area is typically elevated without the need for fixation. One way of avoiding medial brow elevation is to leave the periosteum partially attached in this region so that there is little to no elevation of this part of the brow. During the recovery period, brow position remains relatively stable despite the presence of post-operative edema. Periosteal adhesions may begin to develop within the first few days post-operatively, adding to the stability of this procedure's long-term outcomes. Relapse of brow position is rare with proper technique and may only average 1–2 mm after 2 weeks of recovery [6].

It is the authors' preference to fixate the galea and periosteum just slightly posterior to the hairline to a bone tunnel created in the outer cortex of the calvarium in line with the parasagittal incisions. The bone tunnels should be placed in the frontal bone are created using a carbide fissure bur on a surgical drill or rotating osteotome [21]. The bur is held tangentially to the scalp to avoid inadvertent intracranial injury (**Figure 15**). The tissue is secured to the bone tunnel with a heavy suture, such as 0 Vicryl[®]. An alternative to creating a bone tunnel could be the use of a MicroAire forehead-specific endotine [3]. The lateral tail of the brow may be fixated through the

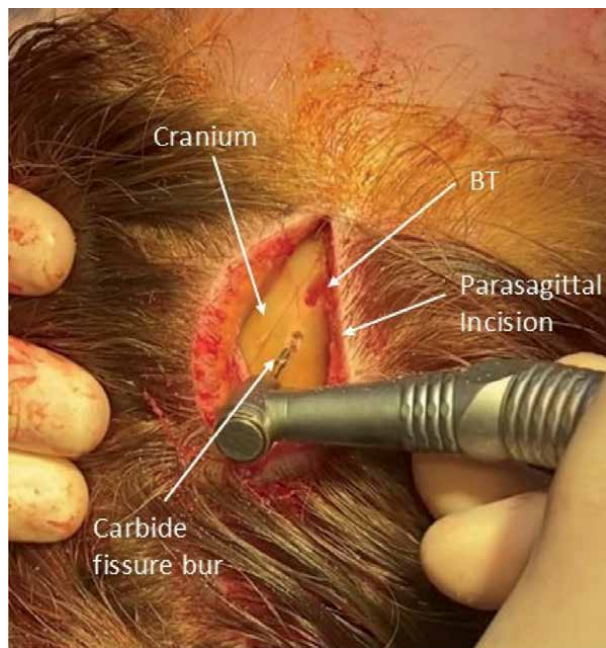


Figure 15. A bone tunnel (BT) is created through a parasagittal incision using a carbide bur on a surgical handpiece held tangentially to the cranium. The bone tunnel should be in line with the point of desired maximal brow elevation.

temporal incisions, where a heavy suture is used to plicate the temporoparietal fascia to the deeper temporal fascia in a posterosuperior vector, following an imaginary line drawn from the outer nasal ala passing just lateral to the lateral canthus [6]. A small area of temporalis muscle may be exposed to facilitate scar formation and fixation. At the end of fixation, it is necessary to stop for a few minutes to evaluate the position of both sides of the eyebrows. This is an ideal time to assess the results and achieve the best possible outcome and symmetry.

Closure of the five incisions may be performed with skin staples alone. As there is no skin excised during the procedure and there is no tension on the incisions upon closure, patients have excellent scar formation. Although forehead and brow elevation does create some redundant and excess tissue in the scalp, it is easily redistributed over the previously elevated posterior scalp without any obvious signs of bunching [6]. The patient should be made aware pre-operatively that, because of the scalp elevation, the hairline may be slightly elevated post-operatively. No post-operative drains are typically placed for an isolated endoscopic forehead and browlift.

One main advantage of the endoscopic forehead and browlift is the ease with which it may be combined with other cosmetic surgery procedures. The temporal incisions may be connected with the preauricular incisions of a lower face and neck lift. Also, if performing a subperiosteal mid-facelift, the intraoral subperiosteal dissection can be connected to the subperiosteal plane from the endoscopic browlift near the lateral orbital rim.

A disadvantage of the endoscopic forehead and browlift is widening of the interbrow distance. In a retrospective cohort study, Hollabaugh et al. found that about 1.5 mm of widening does occur between the brows, even without corrugator muscle resection, but without an adverse effect on postoperative esthetics [3].

5. Post-operative instructions and care

Once the procedure is finished, the patient's head is wrapped in a compression bandage to limit edema, help prevent small hematoma formation, and possibly improve fixation. While resting during the first 3 days post-operatively, the head should be elevated at least 30–45 degrees. Cold compresses over the forehead, brows and eyelids are encouraged and the patient is instructed to limit physical activity. There should be no strenuous activity nor heavy lifting for at least 2 weeks post-operatively [6, 8]. Similarly, applying any hair products or chemicals should be avoided for at least 2 weeks to avoid unwanted hair loss.

On the first post-operative day, the patient may remove the compression bandage and replace it with a less compressive head wrap. This also gives the patient or his or her caretaker to inspect the surgical site for any issues. The patient is allowed to shower and gently shampoo their hair after 24 hours after surgery, but they are instructed to avoid the shower water from directly hitting the incision sites. The incision sites are cleaned daily with dilute hydrogen peroxide and a thin layer of antibiotic ointment for the first 7 days. The patient is also instructed to avoid bending over during the first few weeks post-operatively to avoid increased pressure on the face.

Due to the extensive release of scalp and deep facial tissues during the endoscopic forehead and browlift, post-operative pain control typically requires a short course of narcotic medication. Indeed, the browlift operation may be the most painful of the common facial cosmetic procedures [19]. Patients are also advised to take ibuprofen and acetaminophen, if there are no contraindications, to provide multi-modal

post-operative pain control. To decrease the need for narcotic pain medication, patients may also elect to receive bupivacaine liposome injectable solution, which is typically administered intra-operatively and can provide up to 72 hours of post-operative pain relief [19].

Surgical staples are removed at the one-week mark. Patients are informed that areas of the scalp may be anesthetic for months after surgery and that the use of hot curling irons or similar devices should be used with extreme caution to prevent accidental self-inflicted burns or hair loss.

6. Complications

In order to decrease the likelihood of complications, the surgeon must be thorough in his or her patient selection process, preoperative planning, surgical technique, and postoperative care instructions. However, minor complications may be inevitable despite a surgeon's best efforts. Extensive edema and ecchymosis are typically not complications but may require the surgeon to provide comfort and reassurance to the concerned patient.

Complications after browlift surgery include poor scar formation, wound dehiscence, hematoma, skin sloughs or perforations, asymmetry, sensory disturbance, facial paralysis, eyelid ptosis, corneal abrasion, dry eye syndrome, alopecia, infection, relapse, contour irregularities, and irregular facial expressions [6, 9]. Expert knowledge of clinical anatomy and meticulous surgical technique are crucial in avoiding complications. While direct injury to the temporal branch of the facial nerve is rare, temporary post-operative neuropraxia is more common [9]. Hematomas must be diagnosed early and treated promptly: smaller collections may be aspirated, but larger ones may require surgical drainage. When bleeding occurs, the source is typically from either the superficial temporal and/or the zygomaticotemporal vessels [8]. Avoiding improper retraction, aggressive electrocautery, and excessive thinning of the flaps when transecting forehead muscles are ways to prevent complications from occurring during and after browlift surgery.

Alopecia and sensory disturbances can be troubling to the patient, but may not be permanent. With proper technique, an endoscopic forehead and browlift has a high rate of full sensory nerve recovery, but it may take several months for this to occur. The most crucial factor in preventing permanent sensory disturbances is careful and meticulous dissection around the supraorbital nerve. Alopecia is also usually temporary, but it is a matter of significant concern to many patients. Its risk is less with the endoscopic technique than with the coronal approach [8]. Local alopecia may resolve after a 4–8 month period of dormancy in the hair follicle. *Telogen effluvium* is a condition in which up to 70% of hair may fall out due to stress or a “shock” to the body [6]. This condition may take up to 6–8 months to resolve and is typically self-limiting. Permanent hair loss, on the other hand, is typically the result of excessive tension on the flaps, rough handling of wound margins, or excessive use of electrocautery near hair follicles.

Corneal abrasions are often painful and can be avoided with proper surgical technique. Eye lubricant should always be used and the eye should be additionally protected with corneal shields, placement of temporary sterile bandages, or a tarsorrhaphy suture so that the likelihood of inadvertent corneal scratches will be minimized. Severe pain requires prompt evaluation to rule out vision-threatening conditions such as a retrobulbar hematoma. Suspected corneal abrasions should be



Figure 16. Potential issues with aggressive brow lifting hollowing above and below the eyebrow may become evident and require fat grafting or filler at a later date.

treated with appropriate ophthalmic drops or bandage contact lenses for pain and with patching of the affected eye for 12–24 hours. Blurry vision for the first 12 hours post-operatively due to chemosis and the use of ophthalmic ointment is not unusual and the patient should have been made aware of this possibility pre-operatively.

Lagophthalmos is also a risk of browlift surgery. Once the arcus marginalis is released and the brow is elevated, upper eyelid elevation will also occur. Those at highest risk are patients who have had a previous upper blepharoplasty. One way to limit the risk of lagophthalmos is to perform the brow lift prior to the upper blepharoplasty [8]. An overly aggressive browlift, especially in conjunction with an upper blepharoplasty, may result in excessive hollowing under the eyebrow. This may be corrected at a later date with fat grafting or filler (**Figure 16**).

7. Conclusion

Complete facial rejuvenation begs the cosmetic surgeon to address the upper facial third. The widespread use of the endoscope and neuromodulators in this region have made treatment of the upper facial third increasingly popular. As with any cosmetic procedure, patient selection and proper diagnosis are key factors in obtaining great outcomes. Any brow lift procedure should stabilize the brow at an esthetically pleasing height, shape and orientation, provide long-lasting results, have concealed scars, preserve forehead sensation, and avoid an unfavorable hairline position (**Figure 17**) [8].

While the endoscopic forehead and browlift provides well-hidden scars, some surgeons argue that its significant learning curve, extensive armamentarium, effect on forehead length, and “unpredictable” longevity make other approaches, such as the subcutaneous browlift, more favorable [5]. A subcutaneous browlift offers certain advantages such as no specialized instrumentation needed, minimal concern for frontal nerve injury, lesser degree of a learning curve, and no need for osseous fixation [5].



Figure 17. *Endoscopic browlift longevity. The patient is shown before and 5 years following an endoscopic forehead and browlift, fat grafting and laser resurfacing.*

While foreheads, brows, and skin problems may vary widely among patients, no one can escape the effects of gravity. Brow ptosis and wrinkles will inevitably occur, but the degree to which it happens and when it happens is variable. While patients above the age of 40 years old may be candidates for facelift surgery, patients in their 20s and 30s may be candidates for brow lifting. It behooves the cosmetic surgeon to be well versed in various browlift, blepharoplasty and injectable techniques to address patients' upper facial thirds.

The aging population wants to feel and look more youthful while today's younger population wants to remain looking youthful. Patients are becoming more educated and well-versed in cosmetic surgery thanks, in part, to social media. It is the surgeon's duty and responsibility to provide the patient with the best and safest techniques available to achieve their realistic, desired outcomes.

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Chapter 3

The Lip Lift, Pearls about the Procedure, How to Avoid Complications and How to Obtain Patient's Satisfaction

Alicia Sigler

Abstract

In this study, the author shares her experience from performing 488 lip lift procedures. The procedure technique is shared with all the details of the preop and postop instructions in order to avoid complications. The success of the procedure was based on the assessment of scar appearance, length of the upper lip, and patients' satisfaction with their upper lip length.

Keywords: lip lift procedure, lip lift technique, lip lifting, patient satisfaction, complication prevention

1. Introduction

It has been described that a youthful and beautiful upper lip should allow the upper teeth to show when the person is talking and to be fully seen when the person poses a big smile [1–4]. There is a standard distance between the base of the nose and the white roll of the upper lip for an attractive upper lip height such as 10–12 mm for women and 15 mm for men [5, 6].

Height shortening of the upper lip or lip lift procedure has been challenging for some surgeons since the resulting scar may be visible or unpleasant, that's why the bullhorn pattern was designed to hide the scar in the area where the shadow of the nasal base covers it [7]. If the plastic surgeon considers the characteristics of the patient and follows the correct surgical steps to obtain normal wound healing and good scar tissue, the results will be beautiful and will bring a youthful appearance to the aging lip.

2. Methods

The patients that participated in this study agreed to getting a bullhorn lip lift by the author, and patients were excluded when they could not be located after the procedure or when they declined to be part of it.

Assessment of the results in scar appearance, length of the upper lip, and patients' satisfaction with their upper lip length were performed by the author 3 and 6 months

after the lip lift procedure. Ideally, the surgeon should have the patient's input on how much tissue should be excised. The author suggests having the patient face a mirror and pull with the index fingers the upper lip to provide the resulting shape and height of her/his ideal upper lip, that way the surgeon will be able to calculate the amount in millimeters of tissue to be removed (**Figures 1–4**). A Bullhorn pattern was designed before the skin removal and was based on measurements to obtain the total ideal length of the upper lip without including the vermilion part: ideally 10-12 mm for female patients and 15 mm for male patients (**Figure 5**) etc. After locally injecting with lidocaine 2% and epinephrine, the first incision was made on the marking located superiorly (on the base of the nose) and only included skin. The dissection was performed only under the skin that had the area to be removed. After performing a test where traction was done on the inferior limit of the marked area to observe if the result would be as planned and requested by the patient, the amount of skin that is contained inside those markings



Figure 1.
Measurement of the upper lip at rest from the base of the nose to the white roll of the lip.



Figure 2.
The patient is asked in front of a mirror to pull with index fingers the appearance and height she/he would like her/his upper lip to get.



Figure 3.
The desired height of the upper lip is measured from the base of the nose to the white roll.



Figure 4.
The desired height measurement is subtracted from the total height of the upper lip at rest and the resulting measurement is equal to the measurement in millimeters that will need to be excised.



Figure 5.
Measurements method suggested by the author.

was removed. The edge of the lower incision was released from tension trimming under the skin about one or two millimeters more. No dissection nor management was performed on the SMAS nor on the orbicularis oris muscle of the upper lip. The wound was closed with 5-0 nylon stitches for the deep dermis layer and 6-0 nylon stitches for the superficial skin layer (**Figure 6**). The superficial stitches were removed after 2 weeks of the procedure. Very detailed instructions were given to the patients before the surgery such as avoiding smoking and vaping, NSAIDs, herbal medications, and vitamin E 1 month before the surgery. After the lip lift, the patients were instructed to cleanse the wound with peroxide and apply triple antibiotic ointment three times a day for 1 week, avoid sunlight, and heat to the lip area, and all anti-edema measures after a facial surgical procedure for 2 weeks, such as sleeping at a 45-degree angle, avoid heavy lifting, exercising, bending over, etc. One week after the stitch removal, the patients massaged the wound in the process to become a scar with scar treatment gel and moderate pressure for 5 minutes, 3 times a day, until the scar felt soft, and its color was resembling the color of the patient's skin. It was also recommended to cover the scar with sunscreen with a 50 SPF (sun protection factor).



Figure 6.
Lip lift sutures.

Patients were seen 1, 3, and 6 months after the procedure for follow-up, and at 3 and 6 months follow-up visits, the total length of the upper lip without including the vermilion and the scar characteristics were documented. The patients answered to the questions: are you satisfied with the length of your upper lip after the lip lift? Are you satisfied with the scar resulting from the lip lift?

3. Results

During a period of 10 years, the author has performed 488 lip lifts on patients with ages ranging between 18 and 76 years old. Ninety eight percent of the patients were female including 5 trans women (**Figures 7 and 8**), and 2% were male patients (**Figures 9 and 10**). From the total: 88% were Caucasian, 10% were Hispanic, 1% were Asian, and 1% were Afro-American. The amount of skin removed from 98% of the patients was 6–8 mm to obtain the length of 10–12 mm in women and 15 mm in men. From all the patients, 98% of the patients were satisfied with the result in length of the upper lip as well as the scar (**Figures 11–16**). Long-term results will be the subject for another study. Only 2% of the patients in



Figure 7.
Lip lift preop female patient.



Figure 8.
Lip lift postop female patient.



Figure 9.
Lip lift preop male patient.



Figure 10.
Lip lift postop male patient.

this study required surgical revisions to reduce even more the length of the upper lip. Three patients, all Hispanic, two females and one male, developed hypertrophic scars, they requested treatment for them due to their appearance that was difficult to hide. These three patients were the ones not satisfied with their scars even when they were satisfied with the length obtained with the procedure. The hypertrophic scars improved with the intralesional triamcinolone injections to the point of patients' satisfaction, and they stated the scars were not noticeable anymore. The hypertrophic scars were diagnosed due to their characteristics: they were pink in color, painless, felt hard to touch and they raised less than 1 mm from the skin surface. The scars did not extend beyond the initial site of the wound (**Figure 17**) [8].



Figure 11.
Preoperative appearance of upper lip.



Figure 12.
Lip lift postoperative result.



Figure 13.
Asymmetrical preoperative markings for a lip lift in a female patient's lip with asymmetrical length. She also was having a lower lip lesion removed.



Figure 14.
The postoperative result of a lip lift procedure with asymmetrical markings, to obtain height symmetry of the upper lip.

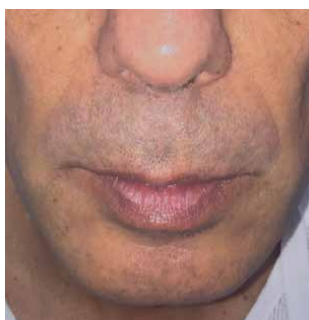


Figure 15.
Preoperative appearance of a long upper lip in a male patient.



Figure 16.
Postoperative result of the lip lift in a male patient.



Figure 17.
Hypertrophic scar from a lip lift procedure.

4. Discussion

There have been multiple authors providing information about their experience related to the pattern they prefer for the lip lift skin resection and how they determine the measures of that pattern. They also share and describe the surgical technique of their preference [9–12]. Zhang et al. added a T-shaped resection of the orbicularis oris to the lip lift procedure [13]. Talei and Pearlman propose suturing the SMAS of the upper lip to the piriform ligament before suturing the skin which allows the wound edges to approximate without tension [14]. In this series of patients treated by the author, there was no need to treat the SMAS nor the orbicularis oris muscle. The three patients that developed hypertrophic scars had more than 10 mm of lip length removed, and there is a possibility that this caused tension on the wound edges and predisposed them to develop this type of scar. The author recommends removing less than 10 mm of lip height to avoid this kind of scar tissue. It is important for the surgeons who will be more involved with this procedure to create their own protocol based on what has been described to avoid complications and to provide their patients with the best results. The strategies used in this protocol to obtain good scar formation are the creation of a moisture-rich environment for faster epithelialization by the prophylactic local antibiotics and the avoidance of tension on the suture line. It is also of great importance to prevent wound infection by the topical application of the triple antibiotic ointment, and to massage the scar for the degradation of excessive and nonpliable collagen. The use of sunscreen reduces the scar hyperpigmentation when exposed to the ultraviolet light stimulation [15]. Patients should adhere to all the preoperative and postoperative instructions for their prompt recovery and an unnoticeable scar.

5. Conclusion

The lip lift has become a popular procedure since the upper lip is considered a feature to project beauty and youth. To obtain the optimal results and avoid complications, the surgeon must consider the patient's expectations, plan very carefully the design of the pattern to be used and the amount of skin to be removed, and perform the procedure following all the principles to avoid suture tension, wound infection, and excessive use of the electrocautery to prevent increased edema. Most of the patients undergoing this approach are satisfied with the length obtained on their upper lips.

Compliance with ethical standards

Conflict of interest statement

The author declares that she has no conflict of interests to disclose.

Statement of human or animal rights, or ethical approval

This article does not contain any studies with human participants or animals performed by the author.

Informed consent


For this type of study informed consent is not required.

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Chapter 4

Upper and Lower Face Lifting Surgery

Artem Krutyansky and Angelo Cuzalina

Abstract

The face is often the first area to exhibit signs of aging. Over the past two decades, the popularity of rejuvenating the aging face has grown significantly. Historically, traditional incisional face-lifting was the primary technique for facial rejuvenation. However, in the past 10 years, cosmetic surgery has evolved to include a variety of procedures such as alloplastic facial implants, chemodenervation, injectable fillers, and skin resurfacing through laser or chemical exfoliation. Despite the availability of these diverse methods for addressing facial aging, the “modern” face-lift remains the benchmark for treating generalized facial cutis laxa (rhytidosis), jowling, excess skin in the cervicomental region, and platysmal banding. This chapter will examine upper and lower facelifting with the experience of Dr. Cuzalina in 30 years of clinical practice.

Keywords: facelift, submentoplasty, jowling, neck laxity, jaw-line

1. Introduction

The main factors contributing to facial aging are genetics, age, and smoking. The primary concerns addressed by current face-lifting techniques include loose skin in the jowls and neck area, pronounced nasolabial folds, and platysmal banding. Typically, patients seek lower face-lifting and neck-lifting treatments between the ages of 45 and 65, though this range can vary widely. Esthetic concerns related to the forehead and brow areas affect individuals across various age groups. Unlike the traditional lower face and neck rhytidectomy, which is typically sought by patients over the age of 45, cosmetic issues in the upper third of the face can become noticeable in patients as young as their twenties and thirties, often due to genetic factors. The second subsection of this chapter will concentrate on upper face lifting.

1.1 Lower face lifting

1.1.1 Body

1.1.1.1 History

The early descriptions of face-lifts in the literature focused solely on skin excision. Despite the temporary benefits and often unnatural appearance, some surgeons still

employ this method for patients with unique anatomy or for revision procedures. Nowadays, face-lifting techniques are diverse, with most involving the manipulation of the superficial musculoaponeurotic system (SMAS). This approach was first introduced by Mitz and Peyronie in their landmark 1976 article [1].

Historical details regarding face-lifting are documented in various publications. During that period, both surgeons and patients were hesitant to publicly acknowledge their interest in cosmetic surgery [2]. Consequently, technical advancements were slow to emerge and spread. Despite extensive undermining of skin flaps in face-lifts performed decades ago, the outcomes were only partially effective and did not address issues related to the neck and platysma. A significant advancement in understanding facial anatomy was made by Skoog in 1974, whose techniques in manipulating facial tissue paved the way for future improvements in face-lifting surgery [3]. Subsequently, Webster and colleagues highlighted that extensive subcutaneous dissection exposed larger raw areas, increasing the risk of complications [4]. Richard Webster was among the first to advocate for a “short flap” with basic SMAS plication, suggesting that the skin would adequately advance from its attachment to the elevated deep tissue.

Experienced surgeons now have a deeper understanding of achieving long-lasting, significant results. Cosmetic surgery has always focused on contouring and sculpting. Since 1999, we have been advancing rhytidectomy, beginning with Dr. Cuzalina’s pioneering partial resection of the submandibular glands (**Figures 1 and 2**).



52-year-old female shown before and 5 months following a submentoplasty with submandibular gland (SMG) reduction and simultaneous chin implant placement. Classic SMG excessive fullness can be seen in the pre-operative photos.

Figure 1. 52-year-old female shown before and 5 months following a submentoplasty with submandibular gland (SMG) reduction and simultaneous chin implant placement. Classic SMG excessive fullness can be seen in the pre-operative photos.

73 y.o. 3 weeks s/p Facelift, submentoplasty & SMG reduction



Figure 2.
73 y.o. 3 weeks s/p Facelift, submentoplasty & SMG reduction. Face/Neck lift with Submentoplasty & Submandibular Gland Reduction.

This procedure resulted in sharper jawlines and prevented bulging in the submandibular area. Additionally, Dr. Cuzalina performed superficial parotidectomies on patients with excess masseter hypertrophy to soften the face. These techniques are now being adopted by experienced cosmetic surgeons to create more defined, enduring results.

1.1.2 Anatomy

A surgeon must be vigilant of three primary danger zones: the mid-zygomatic temporal region, the malar eminence region, and the area along the inferior border of the mandible near the angle. The mid-zygomatic arch area houses the temporal or frontal branch of the facial nerve, which crosses over the arch approximately 2 cm from the external auditory meatus [5]. This nerve is particularly vulnerable in the area over the bony prominence, where there is minimal soft tissue coverage.

The second zone is located at the zygomatic/malar eminence. This area contains a network of vessels connecting the transverse facial artery and the facial artery proper, along with the zygomatic branch of the facial nerve, which crosses upward near the outer corner of the eye. This region is referred to as the “MacGregor patch” due to the strong fibrous attachments between the zygomatic bone and the skin.

The third zone is at the lower border of the mandible, slightly in front of the mandibular angle. The marginal mandibular branch of the facial nerve runs just below the mandible’s lower border approximately 20–50% of the time, but it can

be found up to 1.5 cm below this border [6]. Initial dissection over the platysma muscle helps avoid damaging the marginal mandibular nerve, while further dissection below the platysma must be performed with greater caution to preserve the nerve's integrity.

Several sensory nerves may be injured during a rhytidectomy, with the most notable being the greater auricular nerve. It is essential for patients undergoing any cosmetic procedure to have reasonable expectations. Undermining the skin or any fascial plane typically results in some degree of numbness. However, if this potential outcome is communicated to the patient preoperatively, it transforms the “complication” into a nonissue for the patient.

Anatomically, it is crucial to understand that during a deep plane facelift, the deep plane becomes subcutaneous beyond the masseter muscle or in the region of McGregor's patch (**Figure 3**). Otherwise, there is a risk of facial nerve injury, a detail often not elaborated upon in the literature. In the biplane technique, a short deep plane SMAS flap is utilized. Despite this, the results can be comparable due to the equivalent extent of dissection performed.

1.1.3 Procedure

As with any surgical procedure, obtaining informed consent and proper documentation is essential before moving forward. Ideally, the consent form should be reviewed by the patient well before the surgery date.

Depending on the patient's medical history, specific laboratory tests might be necessary. For patients over 40 years old, a 12-lead electrocardiogram, urinalysis, and hematocrit are recommended. The need for additional advanced tests, such as electrolytes, prothrombin time, partial thromboplastin time, or chest radiography, will be determined based on a thorough history and physical examination.

Patients should be advised to avoid aspirin and non-steroidal anti-inflammatory drugs, and to stop taking Vitamin E 2 weeks prior to surgery to reduce platelet dysfunction and the risk of bleeding.

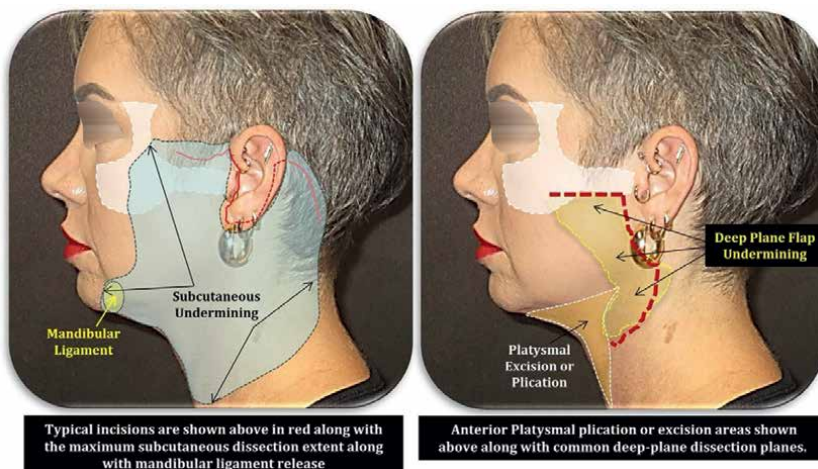


Figure 3. Typical incisions are shown above in red along with the maximum subcutaneous dissection extent along with mandibular ligament release. Anterior Platysmal plication or excision areas shown above along with common deep-plane dissection planes.

Many patients may not realize that the instruction to fast does not mean they should skip their regular morning blood pressure medications; they can take these with a small sip of water. For patients with borderline preoperative blood pressure but no history of hypertension, preoperative clonidine may be beneficial. A small dose of clonidine before surgery can help stabilize blood pressure during the procedure [7].

Other preoperative procedures involve having the patient thoroughly wash their hair and face with germicidal soap on the morning of the surgery. Some patients may benefit from mild benzodiazepine sedation administered the night before and on the morning of the procedure.

Before transporting the patient to the operating room, the incision site should be marked, and the hair should be taped, shaved, or braided. Following sedation or general anesthesia, wrap paper tape around the patient's hair and head just posterior to the incision sites in the temporal and mastoid regions. Hair in front of the temporal incision site can be twisted and secured with a rubber band or paper tape. If incisions are planned entirely within the hairline, shaving is not required. Wrapping the patient's hair with paper tape helps prevent loose hair from interfering with suturing. During surgery, K-Y jelly or Polysporin ointment can be useful if hair encroaches on the wound.

A light preparation with alcohol or povidone-iodine (Betadine) is recommended prior to the infiltration of local anesthetic. Additionally, during skin preparation, administer 1 g of cefazolin and 8 mg of dexamethasone (Decadron) intravenously. Since it takes about 15 minutes to achieve maximal local vasoconstriction, this step should ideally be completed before the surgeon scrubs and drapes.

We believe that submentoplasty is essential for most candidates undergoing rhytidectomy. With 30 years of experience in performing facelifts, it's evident that the primary concern often lies in neck laxity and rhytids. Referring to it simply as a facelift may be somewhat misleading; a more accurate term would be a lower face and neck lift.

Face-lift scissors are employed to carefully undermine the skin while maintaining an even layer of subdermal fat. The dissection extends inferiorly to the lower border of the thyroid cartilage and laterally to the posterior border of the mandible. Extensive skin undermining is essential to facilitate proper skin redraping once the deep tissues have been treated. Insufficient skin undermining can result in bunching after midline plication of the platysma. If skin elasticity is assessed as inadequate during the preoperative evaluation, a combination of face-lift and submentoplasty is generally required.

A flat spatulated cannula can then be utilized for liposuction of the fat overlying the platysma under direct visualization. A lighted Aufricht retractor enhances visibility through the small submental incision. Any excess submental fat is subsequently excised. A Kelly clamp or large hemostat is positioned in the midline to hold the platysma and fat, while a needle-tipped cautery or scissors is used for resection. At this stage, the anterior jugular veins may be encountered.

Achieving proper hemostasis is crucial for the successful completion of the operation and to minimize the risk of postoperative hematoma. After resecting the midline fat, the anterior borders of the platysma and the hyoid bone should be identified. The platysma is then backcut starting at the level of the hyoid bone. This backcut extends approximately 5 to 7 cm, remaining parallel to the inferior border of the mandible and well below the inferior extent of the submandibular gland (**Figure 4**). Caution is required to avoid damaging the facial vessels or nerve during this incision. The platysma is then undermined superior to the backcut area. In cases of submandibular

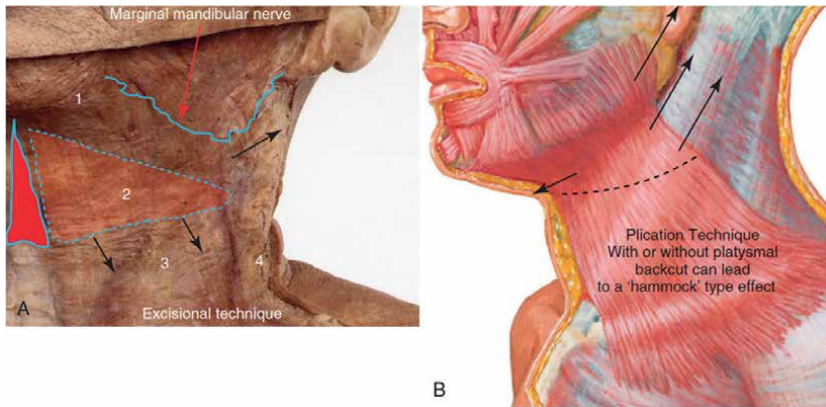


Figure 4. *Dueling face-lift and anterior platysmal plication may compete, but some surgeons believe that it may also create a positive “hammock” effect on the neck.*

gland ptosis or enlargement, resection of the gland’s superficial portion with a needle-tipped cautery may be necessary; however, this procedure is complex and not recommended for novice surgeons. Bleeding may be challenging to control due to the small incision and limited access.

Following bilateral mobilization of the platysma, a corset platysmaplasty is performed using a running 2–0 Vicryl suture. The inferior edges of the platysma are plicated at the midline to the fascia over the hyoid bone. If a chin implant is required to improve a poorly defined cervicomental angle caused by a low hyoid position, it should be inserted at this stage (**Figure 5**).

The temporal incision may extend directly upward from the preauricular sulcus incision, or it might curve around the front edge of the temporal hair tuft. The latter approach is especially useful if the temporal tuft is high, such as in patients who have had previous face-lifts. The superior portion of the incision curves slightly forward but remains well concealed within the dense temporal hair. It extends upward into the hair as needed (typically 3 to 4 cm) to facilitate lifting of the mid-face region. The incision in the hair should follow the direction of the hair follicles, or the upper edge should be beveled to ensure that hair growth covers the scar.

A standard face-lift incision is generally divided into three main sections: temporal, periauricular, and mastoid. For men, the incision is placed in the preauricular sulcus, just in front of the tragus, to prevent hair growth over the tragus after surgery. Women may also use this incision, but many surgeons place it at the posterior edge of the tragus to better camouflage the scar.

Retroauricular or mastoid incisions can be made in the hair-bearing scalp or just in front of the hairline. These incisions start at the upper end of the retroauricular sulcus incision, level with the external auditory canal, or where the postauricular hair meets the ear helix. The skin incision should be about 90 degrees to avoid necrosis. Incisions in front of the mastoid hairline are straightforward and prevent postoperative changes to the hairline or hair loss but might leave a noticeable, widened scar if there’s excessive tension during closure. Fortunately, even short hairstyles will eventually cover this incision. When incisions extend directly into the hair, the scar is well hidden, but this may lead to hair loss and complications in aligning the hairline properly.



Figure 5.
A: A 52-year-old patient before undergoing a facelift and submentoplasty, which involved the removal of deep fat, a minor reduction of the digastric muscle, platysmal back cuts with undermining, and anterior plication. B: Six months after surgery.

Using double-pronged hooks to lift and separate the skin edges allows for dissection with minimal trauma to the skin. It is crucial to maintain a well-controlled subcutaneous plane with a healthy fat layer during the development of a long subcutaneous flap.

To avoid damaging the branches of the superficial temporal artery or vein, stay superficial to these structures, just beneath the temporal tuft hairline incision. Care must be taken to ensure an adequate superficial flap thickness of approximately 6–8 mm, while staying above the deep fascia. The thickness of the flap can vary across different facial areas and from patient to patient. The region over the sternocleidomastoid and the greater auricular nerve is often the thinnest and most fibrotic. Direct blade or cautery over this cervical area helps avoid external jugular vein injury compared with other nondirect or blind elevation techniques.

In the mastoid and occipital regions, the dissection plane should be positioned well beneath the hair follicles to prevent alopecia. Initially, flap elevation posterior to the ear is performed immediately above the occipital fascia and the investing fascia of the sternocleidomastoid muscle using needle-tip electrocautery. The flap is thickest in the occipital scalp and gradually thins as it extends distally over the cervical fascia. The scalp is also elevated superiorly from the occipital region by 1 to 2 cm to facilitate more precise closure and alignment with the posterior hairline. The dissection continues inferiorly and anteriorly to connect with the subcutaneous flap created during the anterior submentoplasty, which is performed prior to lateral dissection from the ears.

We utilize the deep posterior biplane dissection technique. This method is referred to as an opportunistic technique because the extent of deep plane dissection is guided not by anatomical landmarks but by what is necessary to achieve the desired elevation for the patient. The biplane and opportunistic aspects of this facelift are performed through the submental incision and the posterior dissection.

The initial incision starts along or just below the zygomatic arch and extends forward by 2 to 3 cm from a point approximately 1 cm in front of the helix. The

horizontal superior incision continues downward in front of the ear and curves back anteriorly across the posterior platysmal border, approximately 2 cm below the mandibular border.

The flap is initially elevated using electrocautery and is further lifted with facelift scissors. The inferior dissection of the musculofascial flap often connects with the anterior platysmal myotomy below the mandibular border.

The depth of dissection is easily determined when there is a sufficient SMAS layer, staying just above the parotidomasseteric fascia and below the cervical platysma. The upper limit of dissection is near the zygomatic arch, and care must be taken to maintain adequate tissue coverage over the frontal nerve branches.

As the dissection proceeds anteriorly, it approaches the anterior margin of the parotid gland, potentially exposing the underlying masseter fascia. The buccal branch of the facial nerve and Stensen's duct should be carefully avoided.

At the inferior border of the mandible, it is crucial to avoid damaging the marginal mandibular nerve by carefully observing the underside of the platysma and ensuring the fascial coverage over the nerve remains intact. Once the flap is sufficiently elevated and hemostasis is achieved, it can be secured in place. The approach to releasing the deep flap depends on the quality of the tissue, the retention of ligaments, and the surgeon's comfort with the anatomy.

If tissues are insufficient for deep elevation, a basic plication may be used. Typically, the elevation is directed posterior-superiorly, but the vectors are adjusted slightly in front of and behind the ear to achieve the most natural and esthetically pleasing result. In front of the ear, the deep plane is elevated more superiorly, while the skin is angled slightly more obliquely anteriorly. Conversely, behind the ear, the direction is reversed.

Key anchoring sutures include one from the temporal region, running superiorly along the cut edge, down to the cervical platysma, which is elevated and plicated to the mastoid fascia. Due to the release of deep tissue, the tension on the tissue suture anchorage is minimal, allowing for the use of resorbable sutures.

After folding, the skin is readjusted around the ear. Any slight skin dimples or folds should be smoothed out before continuing. Sometimes, additional loosening of the skin is required. The excess skin is then gradually removed to ensure the wound can be closed without undue tension. Starting the skin removal process from the earlobe is recommended, with careful attention to avoid pulling the earlobe downward (**Figure 6**).

If the hairline was crossed by the initial incisions, it should be realigned at this stage. Using isolated staples at key points during skin excision helps prevent over-trimming and the formation of dog-ears. Subcutaneous sutures are then placed, ensuring enough space is left in the postauricular sulcus to insert a closed suction drain behind each ear and potentially extending down into the neck, if desired. Staples are applied to the hair-bearing incisions, and the preauricular incisions are closed with 6-0 nylon or plain gut sutures, starting at the earlobe and progressing towards the temple (**Figure 7**).

After sutures are placed, Polysporin ointment is applied to the incisions. If dressings are used, they should be applied with gentle pressure to avoid disrupting the blood flow to the skin flaps.

A dressing made of 3 M Reston foam 1563 L (3 M Medical-Surgical, St. Paul, Minn) and a Nexcare Coban (3 M Medical-Surgical) head wrap is then placed over the submental area and worn for 24 hours. The following day, after the patient returns, the wrap is removed and replaced with a compression garment, such as a face-lift

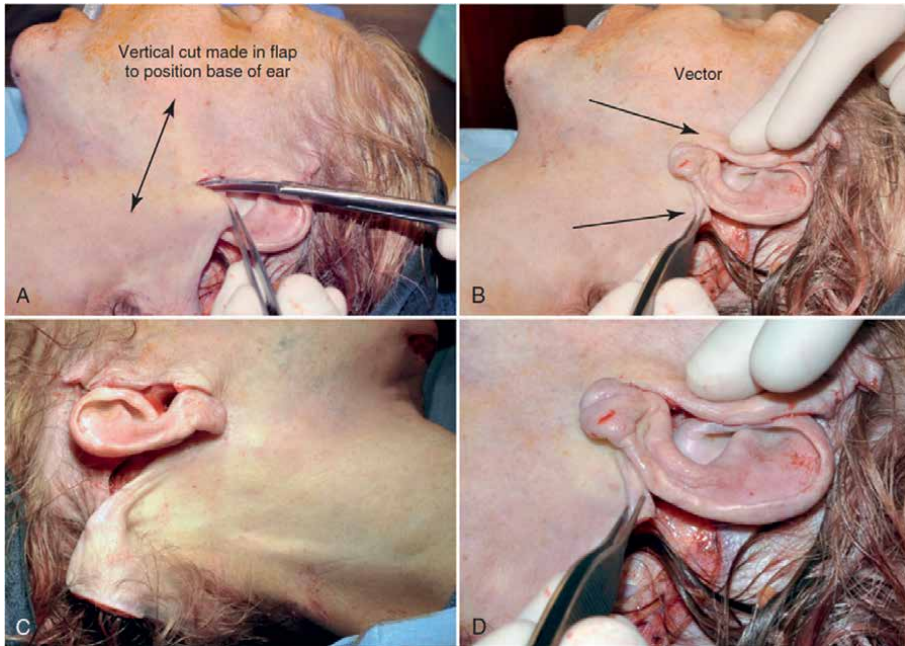


Figure 6. Positioning the base of the ear is crucial once the primary work is finished. The angle of lift should be guided by what appears most esthetically pleasing and natural. Proper placement of the ear's base in relation to the flap is essential for normal skin redraping and proper alignment of the posterior hairline. Cutting too far in either direction can lead to significant challenges during closure.

bra, which should be worn as much as possible, both day and night, for the first week. After 1 week, the garment should be worn only at night for an additional 2 weeks.

Based on extensive experience, we have found that pressure dressings are generally unnecessary. Although patients might expect them, you can use this as a marketing advantage by highlighting that they are not needed with your facelifts. The key to success is ensuring complete hemostasis and maintaining consistency in the sequence of the facelift to enhance efficiency and smoothness.

Sutures in the preauricular area are taken out 5 days post-surgery, while final staple removal happens between 8 to 10 days later. The next follow-up appointment is typically set for 1 month after the procedure, provided there are no complications. Patients are advised against driving due to the risk of sudden neck movements. Smoking is prohibited for at least 2 weeks following the surgery.

1.2 Conclusion

There is ongoing debate about the most effective facelift technique due to the numerous variables involved, which prevent a purely scientific comparison. Proponents of the deep plane technique believe it yields superior and longer-lasting results, though this has not been scientifically validated and remains contested by many surgeons.

The senior author has employed the biplane facelift technique for over 25 years, performing nearly 1500 procedures with excellent outcomes. Our experience shows that the biplane facelift enhances esthetics and durability while minimizing complications. This technique, when executed correctly, effectively elevates the submalar,

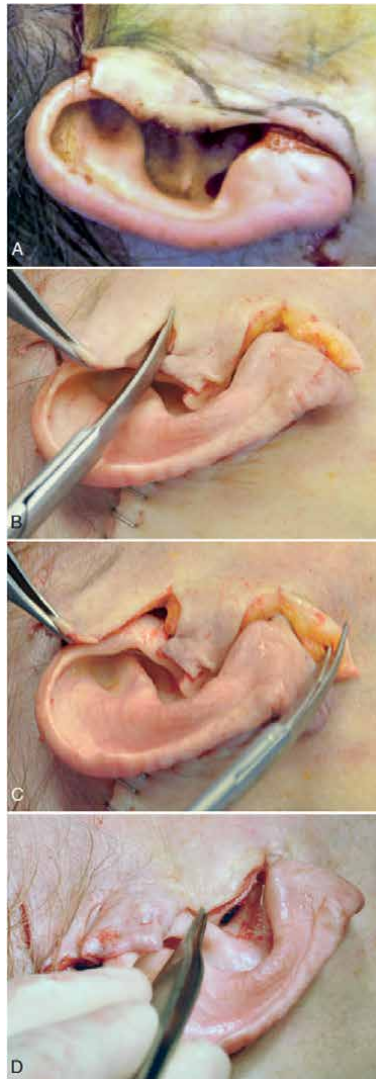


Figure 7. *Trimming the skin around the tragus is essential. It's best to work from the bottom up. Making horizontal pre-cuts on both sides of the tragus simplifies the process of removing excess skin and helps prevent skin tension.*

jowl, and neck areas (**Figure 8**). The pronounced effects of facial aging are primarily due to changes in the deeper musculofascial plane, which the biplane facelift addresses by allowing precise elevation of this layer. The sharply dissected, long subcutaneous flap minimizes damage to the underlying fat and vascular networks, and the flexibility of the deep flap elevation is based on the patient's needs rather than anatomical landmarks.

The biplane facelift offers several advantages and some drawbacks. Benefits include a smoother deep musculofascial flap, which may provide fewer irregularities and more lasting results compared to basic plication or short flap techniques. The release of zygomatic and mandibular ligaments, along with thorough platysma



Figure 8.
Male patient status post rhytidectomy including superficial parotidectomy. Angle of the jaw is more defined with this maneuver.

treatment, can significantly improve challenging cases. Additionally, the biplane approach in the anterior neck can achieve a more acute chin-neck angle than many other facelift methods that restrict anterior and subplatysmal manipulation. However, the procedure is more labor-intensive in the anterior neck and technically challenging in the posterior facial region.

It is important to recognize that not every patient requires a full biplane dissection. Treatment plans should be tailored to each patient's specific needs and anatomical constraints (**Figure 9**). Due to the extensive dissection involved, this technique is not recommended for novice surgeons.

1.3 Upper face lifting

1.3.1 Body

1.3.1.1 History

Elevation and rejuvenation of the forehead, brow, and upper eyelids have been achieved by reducing the forces responsible for dynamic forehead wrinkles and restoring the involved structures to their natural anatomical positions. Endoscopic brow lifting, first introduced by Keller in 1991 [8], has been part of our practice since 1996. Over time, our patients have generally favored the endoscopic method over more traditional open approaches. However, open techniques may still be preferred in patients with a high hairline or deep forehead rhytids. In this chapter we will focus on the endoscopic approach as it has become a staple for long term results in the primary authors' practice. The endoscopic forehead and eyebrow lift has gained significant popularity due to its minimally invasive nature compared to traditional coronal and trichophytic procedures. This technique allows cosmetic surgeons to effectively address signs of aging in the forehead, eyebrows, and glabella while reducing the risks of hypoesthesia and hair loss [9].



**Face / Neck lift with Submentoplasty & Brow Lift
Submandibular Gland Reduction**



Ideal Facelift Patient vs Difficult Facelift Patient

- | | |
|--|--|
| <ul style="list-style-type: none"> ❖ Mild Skin Laxity ❖ Thin-Average Frame ❖ Minor Banding ❖ Normal Hyoid ❖ No Gland Ptosis ❖ Good Bone Structure ❖ Normal Digastrics | <ul style="list-style-type: none"> ❖ Heavy (thick) Necks ❖ Poor Muscle Tone ❖ Low Hyoid ❖ Ptotic or Large Glands ❖ Obtuse Neck ❖ Digastric Hypertrophy ❖ Poor Jaw structure |
|--|--|



Figure 9.
Face/neck lift with submentoplasty & brow lift submandibular gland reduction.

2. Anatomy

The frontalis muscle is the primary elevator of the brow, while several other depressor muscles significantly contribute to facial expression and the appearance of aging. These depressor muscles include the corrugator supercillii, procerus, depressor supercillii, and orbicularis oculi (**Figure 10**). The procerus muscle is an extension of the frontalis muscle. It originates from the nasal bones and inserts upward into the frontalis muscle fibers before attaching to the dermis. When this pyramid-shaped muscle contracts, it forms horizontal wrinkles (bunny lines) over the nasal radix [10]. Typically, this muscle is transected during an endoscopic brow lift procedure. Some of the primary authors colleague believe that transection is not necessary as the

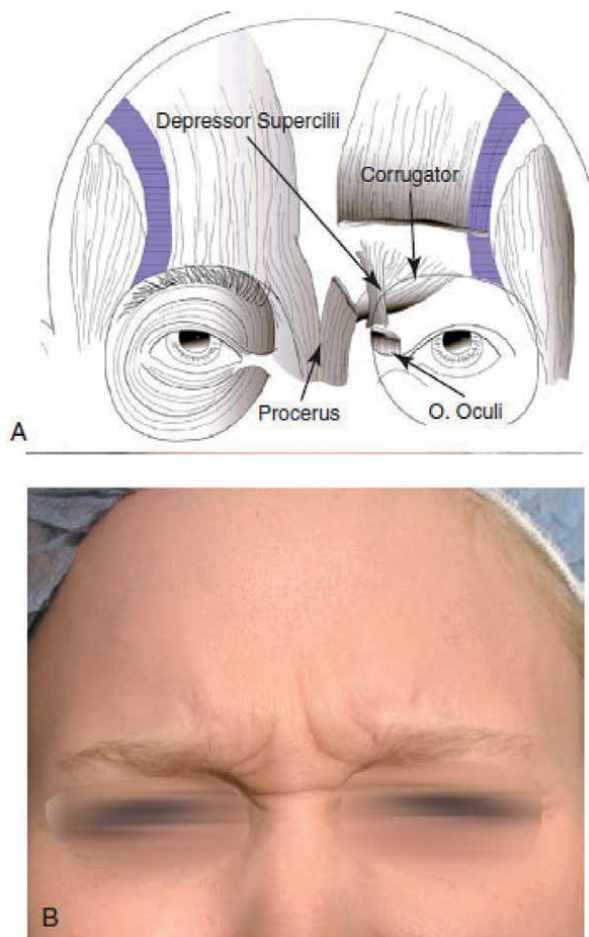


Figure 10.
A. The primary muscle responsible for elevating the eyebrow and forehead is the frontalis. Several depressor muscles are visible beneath the cut frontalis, including the corrugator supercilii, procerus, depressor supercilii, and orbicularis oculi. B. The patient exhibits typical wrinkles caused by two major depressor muscles. The horizontal wrinkle (commonly known as bunny lines) at the nasal radix is produced by the procerus, while the vertical wrinkles in the glabella are formed by the corrugator muscles.

muscle heals, these fibers reattach. Over resection of the depressor muscles can lead to an overlifted medial brow (**Figure 11**). However, Transection of the lateral orbital portion of the orbicularis oculi muscle is typically required to achieve a satisfactory upper third facelift procedure.

In the lateral temporal region, the frontalis muscle merges with a dense fascial layer referred to as the zone of adherence. This zone establishes a connection between the galea of the upper face and the superficial fascial system of the lower face. A thorough understanding of the fascial layers in this area is essential, as their release is necessary to achieve the desired long-term lifting effect during an endoscopic brow lift [11, 12].

The temporoparietal fascia, which is spongy in texture, is continuous with the galea aponeurotica. This layer houses the superficial temporal artery and the frontal branch of the facial nerve. The deep temporal fascia exhibits a thicker structure and a white, glistening appearance. Beneath the zygomatic arch, this fascia divides into

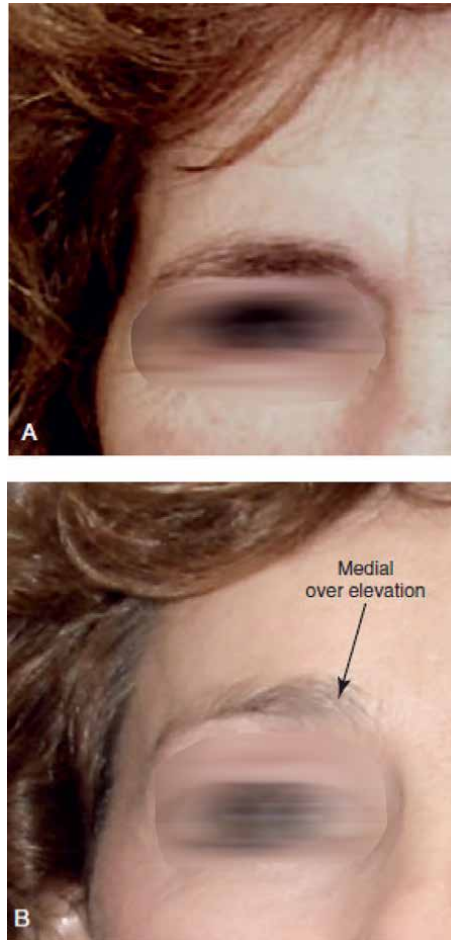


Figure 11.

Excessive dissection of the depressor supercillii muscle may result in an unnaturally elevated brow. If the medial eyebrow is raised higher than the lateral eyebrow, it can create a “surprised” expression, which is generally considered esthetically undesirable.

two layers known as the intermediate temporal fascia and the deep temporal fascia. The temporoparietal fascia is continuous with the superficial musculoaponeurotic system (SMAS) below the zygomatic arch and the galea aponeurotica, which is also connected to the frontalis muscle [13].

For the endoscopic browlift blunt dissection is done up to 2 cm away from the orbital rim. The final 2 cm should be dissected under endoscopic visual guidance. It is recommended by the authors to perform the dissection above the superficial temporal fascia through the lateral incisions, allowing access to the central subperiosteal plane, referred to as the “safe zone” (Figure 12).

Maintaining depth to the periosteum is crucial for preventing injury to the deep divisions and branches of the supraorbital nerve, which are located within the subgaleal plane near the fixation zone. Dissection towards the occiput is conducted subperiosteally, or occasionally in the subgaleal plane, to facilitate scalp elevation and to enhance the maneuverability of the endoscope [14].

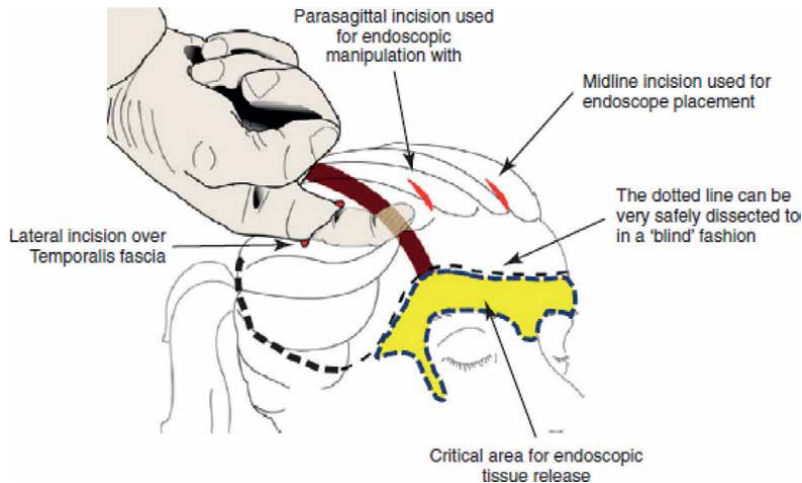


Figure 12. Access to the subperiosteal plane is achieved through finger dissection following the elevation of the medial portion of the scalp with instruments. Blunt and blind dissection can be safely conducted up to 1.5 cm above the orbital rims. Additional dissection in the yellow-shaded area should be carried out under direct visualization.

The initial focus is on the lateral aspect of the elevated forehead flap, where the fixation zone begins at the lateral corner of the superior orbital rim. This location represents the convergence point of all fascial layers. Lateral dissection in this area aims to expose the lateral orbicularis oculi while carefully releasing the zone of fascial convergence. It is important to proceed with precision, as the temporal branch of the facial nerve curves medially in this region on its ascent towards the forehead, necessitating caution to avoid injury. Additionally, the surgeon should be aware of the sentinel vein, located approximately 1 cm lateral to the zygomaticofrontal suture line, which traverses the temporoparietal fascia at a perpendicular angle. While the sentinel vein can be sacrificed, it is critical to avoid cauterizing the area where the vein can retract and continue to bleed [15, 16].

The central dissection plane advances to the level of the superior orbital rim, ensuring that the entire superior rim is adequately visualized. The endoscope should provide a clear view of the periosteum raised in a relatively bloodless plane. Dissection through the periosteum will expose the subgaleal fat, except at the location of the supraorbital nerve. The nerve, along with its accompanying artery and branches, can be observed as they penetrate the fascial layers towards the frontalis and subcutaneous tissue, originating from the supraorbital notch and aligning with the medial limbus. As the surgeon continues superficial dissection towards the muscles of the glabella and medial eyebrow, it is essential to remain aware of the position of the supraorbital nerve and artery. The supraorbital nerve runs in alignment with the medial limbus of the eyebrow, and medial to this nerve bundle, the corrugator supercilii is identifiable with its two heads. Upon transecting the oblique head of the corrugator, the supratrochlear nerve and depressor supercilii muscle will be encountered, which should be preserved unless transection of the depressor supercilii is warranted due to over-elevation (**Figure 13**).

2.1 Procedure

The procedure commences with the creation of five distinct incisions in the scalp. Each incision measures approximately 3 cm in length, beginning 1 cm posterior to the

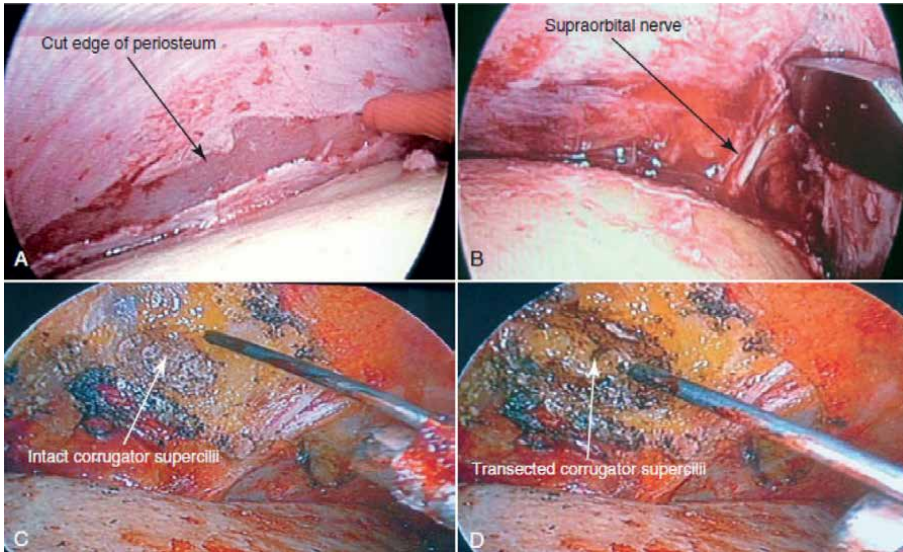


Figure 13.
The left corrugator muscle is in close proximity to the supraorbital nerve, with the muscle belly positioned superficially to the nerve on both the medial and lateral sides.

hairline and extending backward. The first incision is positioned along the midline in a sagittal plane, followed by two paramedian incisions made in a parasagittal plane, approximately 3 to 4 cm apart and parallel to the midline incision. This vertical arrangement of incisions helps prevent the transection of sensory nerves to the scalp, facilitating access to the entire anterior forehead and eyebrow regions. Care must be taken to ensure that the parasagittal incisions are not placed too laterally over the zone of fixation. These incisions should be located over the thick region of the frontal bone, preparing for the creation of bone tunnels or the placement of bone screws, while also being positioned as far as possible from the venous lakes of the skull.

The final two lateral incisions are made obliquely over the temple, running parallel to the temporal branch of the facial nerve and the temporal artery and vein, thereby reducing the risk of damage to sensory and vascular supply to the scalp. The position of the supraorbital nerve is marked by tracing a line from the medial limbus of the iris to the eyebrow. Dissection begins in the central area of the subperiosteal plane, remaining medial to the temporal lines. The posterior elevation is carried out to approximately 10 cm behind the incisions, while anteriorly, the subperiosteum is elevated to a horizontal line 2 cm above the superior orbital rims and the zygomatic arch (**Figure 14**). Blunt finger dissection can facilitate complete elevation of the forehead and scalp within the specified limits.

Upon completion of this step, a connection is established from the lateral incisions to the subperiosteal plane through the upper portion of the zone of fixation, utilizing blunt finger dissection. Dissection below this level, where the branches of the facial nerve are located, should be avoided. The direction of finger placement should move from the lateral incisions towards the central subperiosteal space, rather than the reverse, to prevent inadvertent tunneling within the spongy temporoparietal fascia, which contains the superficial temporal artery and the frontal branch of the facial nerve. It is crucial to maintain close contact with the periosteum and temporalis fascia during the initial elevations.

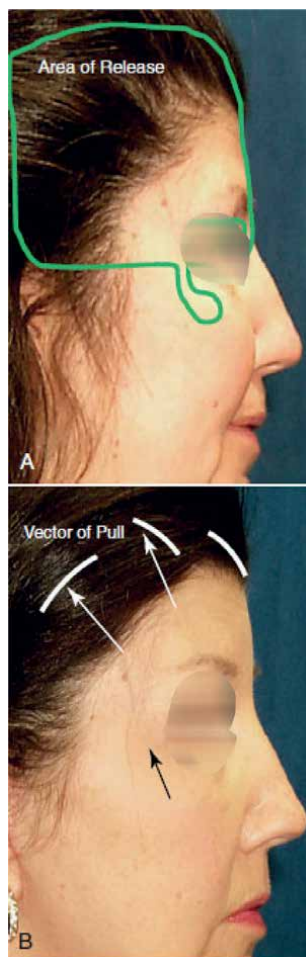


Figure 14. This is a previous patient from the lower facelifting subsection. This image shows a before and after. Take notice on the vector of pull. The green area shows subperiosteal dissection.

Direct visualization is essential for continuing the dissection down to the superior orbital rims and the nasofrontal junction. The endoscope is carefully inserted through one of the three median incisions, taking particular care in the area of the elevated flap. Excessive retraction may lead to skin perforation or significant postoperative neurapraxia. A smooth, curved periosteal elevator is utilized to release the periosteum over the superior orbital rims bilaterally and in the nasofrontal region. The dissection should be performed bimanually, with the non-dominant hand positioned over the patient's face to control the tip of the elevator. The assistant should hold the endoscope and suction cannula. The dissection should progress laterally over the lateral orbital rim and the zygomatic bone (**Figure 15**).

The periosteum is incised using either a needle-tipped electrocautery device or a laser set to low power. It is essential for the surgeon to be aware of the trajectory of the supraorbital vessels towards the frontalis muscle and forehead at the level of the medial limbus on both sides. The use of three ports facilitates the maneuverability of the endoscope, cautery or laser, and suction cannula. Temporal incisions can serve

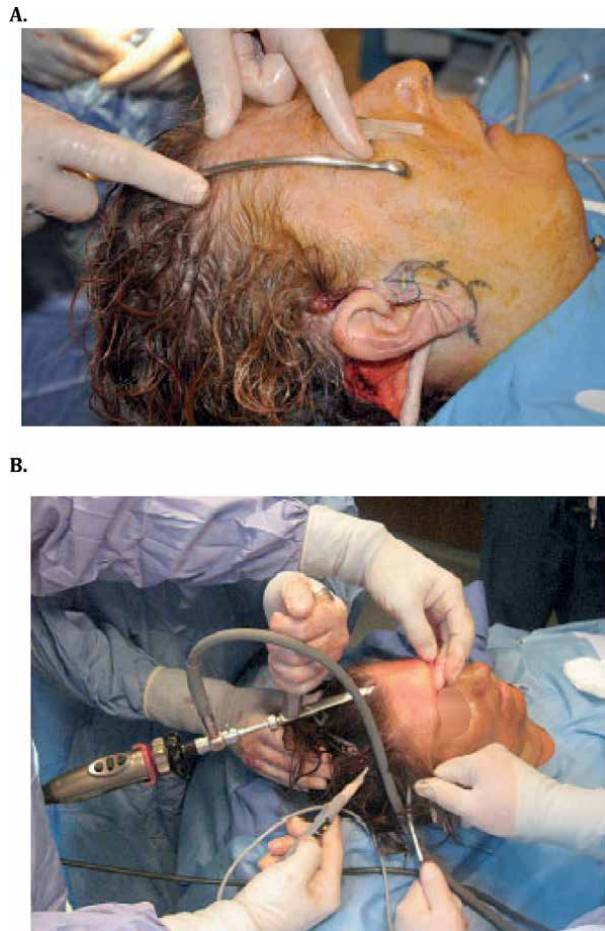


Figure 15. A. An intraoperative image illustrating the subperiosteal dissection, which is tunneled over the lateral orbital rim into the malar prominence. The elevator is utilized through a parasagittal incision located just behind the hairline. The globe is consistently protected throughout the procedure. B. The typical configuration of the surgeon and assistants during an endoscopic brow lift procedure involves the surgeon managing the cautery with one hand while applying counterpressure to the skin with the opposite hand to maintain control and prevent perforation. The first assistant is responsible for holding the endoscope, while the second assistant, if present, operates the suction device and ensures the correct positioning of the patient's head.

as effective suction ports if the medial ports are congested with the endoscope and cautery device. Bimanual cauterization is recommended due to the relatively short distance the cautery must traverse to penetrate the skin, particularly in the glabellar region and nasofrontal junction.

Following the exposure of the corrugator supercilii and procerus muscles, careful transection is performed with precise cauterization to minimize bleeding. If bleeding occurs at the muscle edges, gentle cauterization may be applied after exerting external pressure to enhance visualization. Hypertrophy of the depressor muscles can be addressed through muscle avulsion. The authors have observed that muscle debulking poses a significant risk of nerve damage and postoperative irregularities in the glabellar region. It is advisable to gently separate the muscle edges using a periosteal elevator by at least 1 cm to facilitate the release of the arcus marginalis, which may lead to a notably prolonged brow elevation effect.

Subsequently, dissection is conducted along the anterior and inferior aspects of the temporal crest, extending down to the zygomaticofrontal suture line. It is crucial to be aware of the proximity of the sentinel vein (zygomaticotemporal vein), which lies laterally to the dissection pathway and may need to be sacrificed to achieve adequate exposure for surgical intervention (**Figure 16**). The lateral dissection and elevation are essential for determining the degree of eyebrow elevation and fixation upon the completion of the endoscopic brow lift procedure (**Figure 17**).

This dissection area demonstrates significant compatibility with various facelift procedures when utilizing an endoscopic approach. In cases where an extended mid-face lift is planned, the tissue over the zygomatic arch can be elevated between the superficial and deep temporal fascia layers. Alternatively, abbreviated mid-face lifts can be performed by remaining in the subperiosteal plane along the lateral orbital rim. Another option includes a mid-face lift using intraoral dissection, which allows for a connection between the subperiosteal forehead plane and the intraoral zygomatic periosteal plane laterally.

Once periosteal dissection and muscle transection are completed, flap elevation and fixation are the next steps. Several techniques have been described for securing the forehead flap to the underlying bone in its new retracted position, such as suture fixation, bone screws and plates, resorbable screws, bone tunnels, local skin excision, tissue adhesive, tight head wraps, and temporalis muscle unroofing to enhance scarring. While many of these options are effective, it is crucial to highlight that an inadequately released tissue flap may revert to its original position, regardless of the

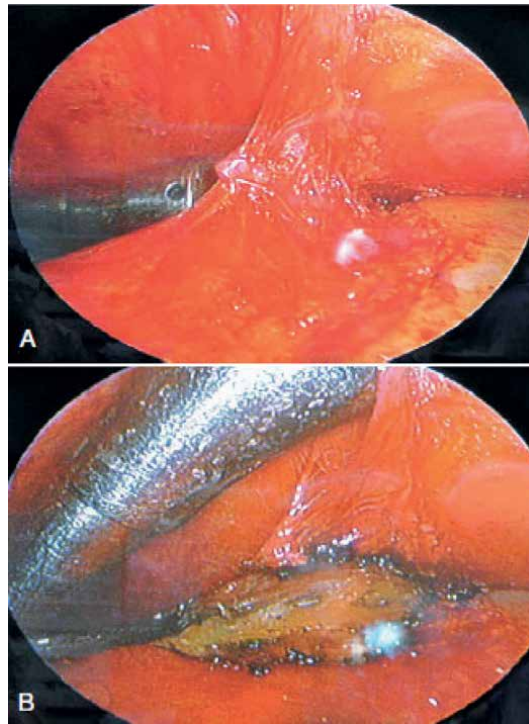


Figure 16.
The left lateral orbital ligament (A) prior to release and at the moment of initial release (B). This ligament is observed during the release process over the lateral orbital rim.

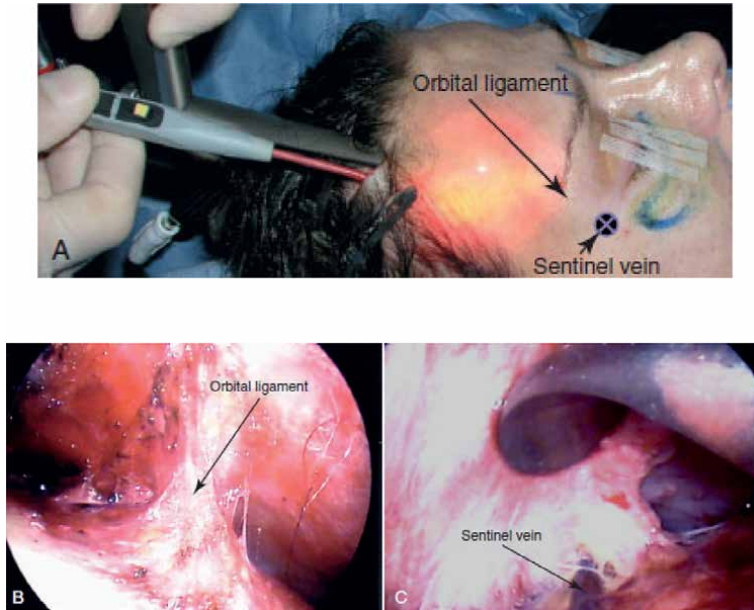


Figure 17. The release of the orbital ligaments is essential for achieving sufficient stability in brow lift procedures. The image illustrates the endoscopic release of the orbital ligaments, which allows access to the lateral orbicularis oculi. The sentinel vein, located at the inferior border of the ligament, can be cauterized, ligated, or preserved during this process.

fixation method employed. Fixation is achieved through parasagittal incisions by elevating the lateral third of the brow to its maximum height and securing the periosteum to the cranial structure (**Figure 18**). The medial brow and glabella will naturally elevate with the maximal stretching of the lateral eyebrow, ensuring that the medial brow remains lower than the lateral side and preventing overcorrection, which could lead to patient dissatisfaction due to a long-term surprised appearance. For enhanced effect, fixation of the lateral brow tail can be accomplished through imbrication of the temporoparietal fascia in a posterior and superior direction via the lateral incisions. This vector can be visually represented by a line connecting the outer nasal ala to a point just behind the lateral canthus.

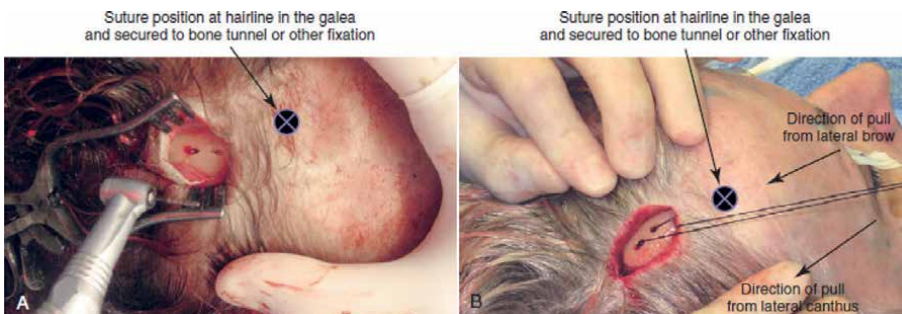


Figure 18. Bone tunnels are one method of fixation. The image depicts a right parasagittal bone tunnel located near the coronal suture. A secure galeal suture is sutured from the hairline below to the bone tunnel above. The parasagittal bone of the skull is quite thick, enabling the safe placement of a shallow tunnel.

Minimal relapse is anticipated in the early postoperative phase, with a typical 1- to 2-mm descent expected within the first 2 weeks. Various estimates exist regarding the time required for the periosteum to adhere to its new position, with recent findings indicating that sufficient fusion occurs within 7 to 9 days, contrary to earlier suggestions of 12 weeks. This is evidenced by the efficacy of transcutaneous bone screws, which are usually removed after 1 week and exhibit excellent long-term retention. The incision is closed using skin staples, resulting in anticipated excellent healing outcomes. Redundancy of the forehead flap is resolved through redistribution over the posterior 10 to 20 cm of occipital periosteal elevation, accounting for the acceptable minimal elevation of the hairline.

2.2 Conclusion

Upper facial rejuvenation has reached a pivotal turning point. The successful implementation of minimally invasive brow lifting and chemodenervation (Botox) has established the endoscopic forehead and brow lift as the gold standard for addressing brow ptosis. This subsection focused on endoscopic brow lifting and its ability to address the upper face. A thorough understanding of anatomical structures



Figure 19.
Primary authors dramatic before and after changes with isolated endoscopic upper face lift.

and the locations of critical nerves has enhanced the safety of cosmetic procedures on the upper face, yielding excellent long-term outcomes (**Figure 19**).

Rejuvenating the upper face requires proficiency in multiple techniques by the cosmetic surgeon. The current demand for minimal downtime, reduced invasiveness, and exceptional results has propelled endoscopic forehead and brow lifting to the forefront of upper facial rejuvenation. This chapter emphasizes the importance of ensuring a safe surgical procedure through comprehensive knowledge of relevant anatomy and the meticulous application of endoscopic techniques. Ultimately, the procedure has demonstrated safety, consistency, and favorable long-term results for patients with aged, ptotic eyebrows (**Figure 19**).

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Perspective Chapter: Facial Implants – Enhancing Aesthetics and Reconstructive Outcomes

Mohammad K.H.B. Abdulaziz and Mohammad Kamal

Abstract

The choice of aesthetic operations is much influenced by facial looks; a disparity between perceived and actual age could cause discontent and affect self-esteem. Beautiful faces influence social and professional contacts by often being connected with success and ability. As such, good facial aesthetic treatments can improve social contact and self-awareness. Wrinkles, poor skin texture, and uneven, soft tissue define facial aging, which alters youthful, symmetrical features and consequently affects attractiveness and self-esteem. These developments can also influence personality and emotional perception, therefore causing misunderstandings of emotions. Treatments that restore a young, balanced look can help with these problems, boosting self-confidence and social contacts. Rising desire for facial beauty has resulted in the creation of several cosmetic operations targeted on volume restoration and facial augmentation, including less invasive techniques like lifting procedures, injectable fillers, fat transfer, and facial implants. Research shows that people view faces as a whole rather than by individual characteristics; hence, a comprehensive approach including several modalities is utilized increasingly to evaluate the full face. Available in metals, polymers, and ceramics, facial implants give long-lasting support and may be less expensive than regular injections. Modern techniques and materials are made possible by historical developments in cosmetic surgery, therefore greatly improving facial repair and augmentation. Improvements in materials and surgical techniques, as well as a greater knowledge of facial aging, keep improving the effectiveness and results of facial implant operations. The present chapter aims to cover the fundamental aspects of facial implantology and explore future advancements.

Keywords: facial skeletal, alloplastic, aesthetic, craniofacial, infections, implant

1. Introduction

Facial appearance plays a key role in selecting aesthetic procedures, as a mismatch between perceived and actual age can lead to dissatisfaction and affect self-esteem. Attractive faces are often viewed as more competent and successful, influencing social and professional interactions. Thus, effective facial aesthetic treatments can improve

self-image and social relationships [1–3]. Facial aging signs, such as wrinkles, poor skin texture, and uneven, soft tissue, disrupt youthful, symmetrical features, impacting attractiveness and self-esteem. These changes can alter how others perceive one's emotions and personality, often leading to miscommunication of feelings. Addressing these issues with treatments that restore a youthful, balanced appearance can enhance self-image and improve social interactions [4, 5]. The rising demand for facial beauty has led to the development of various cosmetic procedures focused on volume replacement and facial augmentation. Advances in aesthetic medicine now include less invasive techniques such as lifting procedures, injectable fillers, fat transfer, and facial implants. A holistic approach, assessing the entire face with diverse modalities, is increasingly used as research shows that people perceive faces as a whole rather than by individual features [6, 7].

Restoring facial form and function after trauma, tumors, infection, or congenital deficiencies is essential in facial plastic surgery. Aging often causes volume loss in the maxilla and mandible, leading to the use of facial implants for augmenting areas like the malar eminences, chin, and mandibular angle. Implants, available in metals, polymers (silicone, porous polyethylene, Gore-Tex, MMA), and ceramics (hydroxyapatite), provide lasting support and may be more cost-effective compared to repeated injections [8–11]. Overall, facial aging involves epidermal thinning, soft tissue volume loss, and skeletal resorption, transforming the face from a youthful to a more rectangular shape. While injectable fillers are popular for their minimal invasiveness, skeletal implants offer durable results by providing lasting support and reducing the need for frequent treatments [12, 13].

1.1 A historical perspective

The history of aesthetic surgery began in 1845 when Johann Friedrich Dieffenbach first described reducing large noses through external incisions [14]. Although he did not illustrate it, Julius von Szymanowski later detailed the procedure in his handbook [15, 16]. In 1881, Edward T. Ely performed one of the first purely aesthetic surgeries for correcting prominent ears [17]. Around the same time, John Orlando Roe demonstrated bulbous nose reduction and hump removal under local anesthesia [18, 19]. Robert Weir introduced the “Weir operation” for alar base excision [20]. Meanwhile, in Berlin, Jacques Joseph refined otoplasty and rhinoplasty techniques, which remain largely unchanged today [21].

In the late 19th and early 20th centuries, the rising focus on personal appearance led to a surge in charlatans and “beauty doctors” operating commercially in salons. These practitioners, advertised in newspapers and magazines, promised quick, simple cosmetic enhancements at high costs, claiming that improved appearance could boost job prospects and social relationships. Charles C. Miller (1880–1950), considered by some a charlatan and by others the “father of modern cosmetic surgery,” published “The Correction of Featural Imperfections” in 1907. His work included illustrations of facial procedures and promoted paraffin injections for improving facial features and wrinkles [22].

2. Types of facial implants

Facial implants are utilized for post-traumatic reconstruction, congenital abnormality correction, and aesthetic enhancement. Traditionally, facial skeletal augmentation used autogenous bone grafts, but advancements now favor alloplastic materials. These implants offer benefits such as greater availability and avoidance of

donor-site issues like scarring and resorption. Additionally, they simplify graft shaping, reducing surgical time and complexity [23, 24]. The following section provides an overview of autogenous and alloplastic implants in further detail.

2.1 Autogenous implants

Autogenous options (e.g., bone, cartilage, fat, dermis, fascia) have long been viewed as the gold standard for facial profile modifications, embodying the principle of “replacing self with self” for both the facial skeleton and soft tissues. It is a process that uses the patient’s body tissues to rebuild or improve facial structures while reducing the possibility of rejection and fostering good tissue integration [25].

2.1.1 Bone grafts

Bone grafts from the calvarium or iliac crest often face stability issues due to resorption. Calvarial grafts are more stable than iliac crest grafts, but alloplastic materials are preferred for their predictability and avoidance of donor-site complications [26, 27].

2.1.2 Cartilage grafts

Autogenous and lyophilized allogeneic cartilage are used for facial augmentation. Lyophilized cartilage integrates well with tissue and has low infection rates, but can resorb up to 20%. Fresh frozen allogeneic cartilage is effective in rhinoplasty with low complication rates [28, 29].

2.1.3 Autologous fat transfer

Used for facial balancing, autologous fat transfer cannot replace skeletal augmentation. Fat retention ranges from 50 to 80%, and it provides only temporary contour improvements [30, 31].

Autograft use in cosmetic augmentation is limited by unpredictable bony resorption. According to Wolff’s Law, bone remodels in response to stress, so insufficient stimulation at implant sites leads to decreased density and increased resorption [23, 32]. Although once considered the gold standard in facial implantology, autologous options have drawbacks, including donor-site morbidity, longer surgery times, and less stable outcomes due to predictable attrition [27].

2.2 Alloplastic implants

The synthetic materials used in facial reconstruction and augmentation are grouped into alloplastic implants. These implants provide customizable shape and volume, enhance symmetry, avoid donor-site issues, and offer lower complication risks with shorter operative times. They are also potentially reversible. Standard alloplastic facial implants are listed below and detailed in the succeeding section.

2.2.1 Titanium mesh

Rigid, non-resorbable, and inert. Used for recontouring deficient mandibular angles, with fenestrations for tissue growth and stability.

2.2.2 High-density porous polyethylene (HDPE)

Rigid and noncompressible, with pore sizes ranging from 80 to 400 microns, influencing tissue ingrowth (bone or fibrous). Implants with 100–250 micron pore size allow bony ingrowth but require fixation to prevent disruption of neovascularization. Can be recontoured by heating to 180°F.

2.2.3 Silicone

Nonporous, available as solid silicone or dimethylsiloxane subunits. Requires fixation to prevent encapsulation, migration, and bony resorption, reducing tissue ingrowth and seroma formation [33].

3. Common materials used in facial implants and their ideal properties

Facial implants are categorized based on their location, such as chin, paranasal, malar, submalar, and more. They can be prefabricated, anatomical, or custom-made and come in various shapes and sizes. These implants are made from different materials, each with its own advantages and disadvantages. Therefore, surgeons must be well-acquainted with these materials [34].

3.1 Metal used in facial implants

3.1.1 Stainless steel (Fe-Cr-Ni alloys)

The biocompatibility of metals is largely determined by their resistance to corrosion and the tissue reactions, both local and systemic, to the products of corrosion [35]. A stainless-steel implant is a biomedical device crafted from iron-chromium-nickel alloys, which have been in use since the 1920s. These implants are utilized extensively in plastic surgery, particularly for craniofacial and hand surgeries. They are also employed in hemoclips, cranial plates, artificial joints, and dental implants. Despite their widespread use, stainless-steel implants are susceptible to corrosion over time, which can lead to implant failure [36–38].

3.1.2 Titanium

Titanium is the preferred material for craniofacial plating systems due to its high mechanical strength, corrosion resistance, biocompatibility, and non-ferromagnetic properties. It is suitable for MRI imaging and has low artifacts on CT scans. Its stability and rigidity make it ideal for craniofacial fracture fixation, but it is less suitable for aesthetic augmentation due to its high elastic modulus. This rigidity can cause a “stress shielding effect,” weakening adjacent bone and potentially loosening the implant. Titanium plates used in mandibular reconstruction have a high complication rate, including infection and plate removal. Despite its benefits, titanium can be visible under thin skin, particularly in the periorbital region, and can cause thermal sensitivity and discomfort, often necessitating removal [35, 39, 40].

3.1.3 Vitallium (CoCrMo alloys)

Vitallium, a base metal alloy (CoCrMo), has been used in dentistry and medicine since 1929. It is widely used in orthopedic and maxillofacial surgery and is well tolerated. Single case reports from the 1990s documented its use in midface bone defect reconstruction without significant morbidity or complications [41]. Initially, Vitallium was particularly recommended for orbital fracture cases to maintain normal eye appearance and function. In large follow-ups, no postoperative orbital infections or implant removals were necessary. However, Vitallium is not recommended without rigid fixation. Studies in animal models found it to be less biocompatible than titanium, showing decreased biomechanical fixation and increased metal ion accumulation around the implant. Additionally, Vitallium presents challenges in shaping and causes radiographic scatter. Despite these issues, the choice between titanium alloy and CoCrMo should be based on a comprehensive review of factors influencing clinical implant survival [42].

3.1.4 Tantalum

Tantalum is gaining significant attention as a biomaterial due to its exceptional biocompatibility. It boasts an outstanding ability to form bone-like apatite, does not release cytotoxic ions, and resists dissolution in local, systemic, and remote organs, contributing to excellent osseointegration. Renowned for its strength and anti-corrosion properties, tantalum stands out as a promising material for bioperformance applications [43]. Since the 1940s, it has been utilized in the medical field, with Burke pioneering its use in skin applications, subcutaneous and tendon sutures, and various plates. Tantalum's ability to form a compact, passive, and extremely thin yet robust and tenacious oxide layer that adheres strongly to its surface is noteworthy. This oxide layer supports bone ingrowth *in vivo* by developing bone-like apatite, promoting adhesion of both hard and soft tissues [44].

3.2 Polymer

Polymers are large organic macromolecules composed of numerous equivalent sub-molecules. While metallic implants are commonly used for skeletal fixation and bone augmentation, polymers are preferred for soft tissue augmentation and contouring. The use of polymers in these applications has increased significantly over the past decade. Naturally occurring polymers like collagen (tropocollagen polymer) have been utilized, but facial implantology primarily employs synthetic polymers such as medical-grade polysiloxane (silicone) and polyethylene. These materials are chosen for their effectiveness in enhancing soft tissue contours and their biocompatibility [45].

3.2.1 Polyethylene

Polyethylene, a polymer made from ethylene monomers, has several forms used in facial implants, including HDPE and ultra-high-molecular-weight polyethylene. HDPE, used in products like Medpor, is firm and porous, allowing for tissue ingrowth, which helps stabilize implants but complicates their removal. Though their removal is more difficult, porous polyethylene implants offer better integration with

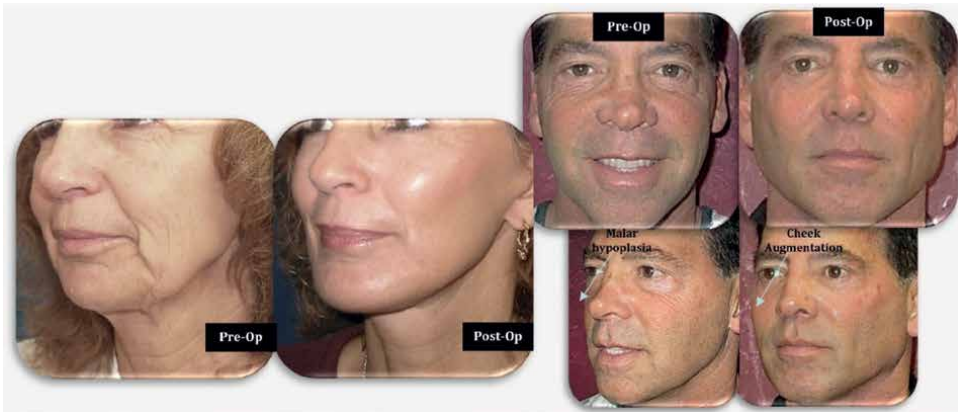


Figure 1. Female and male patients of Dr. Cuzalina, after placement of prefabricated silicone mandibular angle implants, a chin implant, as well as cheek implants for each patient, with good aesthetic outcomes.

tissue and are less prone than silicone implants to migrate. Commonly used in facial reconstruction, polyethylene implants provide several consistencies and mechanical characteristics fit for different uses [46].

3.2.2 Silicone (Polysiloxane)

Made in solid, gel, or liquid forms, silicone implants, known for their biocompatibility and adaptability, have fibrous tissue capture them; it makes removal easier but may cause problems like seroma development and migration. Silicone implants may promote bone resorption and are more prone to displacement, even with a low infection rate and good aesthetic results, as shown in **Figure 1**. Their simplicity of molding and sterilizing makes them extensively applied in facial implantology [34, 47, 48].

3.3 Hydroxyapatite (bioceramic)

Highly osteo-conductive and inductive, hydroxyapatite (HaP), a ceramic made of calcium and phosphate, shines in bone tissue engineering. It is less likely to need removal since it encourages better cellular adhesion and integration than other implants. Usually used without screw fixation in face augmentation, HaP is volume stable and available in block and granular forms. With recent research demonstrating that HaP granules are replaced by neo-bone and well-encased by host collagen, they progressively blend into host bone. HaP is sometimes used with polylactic acid to increase mechanical strength and thereby enhance its brittleness [49, 50].

4. Indications and common areas for implantation

4.1 Aesthetic augmentation, improving aesthetics

Facial reconstruction and augmentation in plastic surgery address trauma, tumors, infections, and congenital defects. Aesthetic concerns, such as age-related volume loss

and reduced projection, often reflect predictable changes in the facial skeleton. Facial balance is a critically important concept for aesthetic and reconstructive treatment planning of the facial skeleton [50]. Procedures for volume replacement and facial augmentation include lifting techniques, injectable fillers, autologous fat transfer, and facial implants [51–55]. Facial implants are often ideal due to their permanence, diverse shapes and sizes, ease of placement, minimal recovery time, and low complication rate. In particular, alloplastic implants provide a durable solution for skeletal augmentation, facial irregularity correction, and rejuvenation [34, 56].

4.2 Reconstructive needs (post-traumatic post-oncologic reconstruction)

Besides enhancing aesthetics, facial implants are used to reconstruct post-traumatic defects and address developmental and congenital abnormalities [47]. Craniofacial deformities affecting vision, breathing, and chewing typically require skeletal osteotomies for treatment. For less severe midface and mandibular hypoplasia, where occlusion is normal or has been corrected with orthodontics, extensive surgery may not be necessary. Instead, facial implants can effectively simulate the results of osteotomies, offering a less invasive and more appealing alternative. Patients with craniofacial syndromes or corrected deficiencies can benefit from implant augmentation with proven results in Treacher-Collins syndrome and Stickler syndrome [27, 57, 58]. Alloplastic implants can be effective for reconstructing post-traumatic and post-ablative craniofacial deformities. However, they are best suited for non-load-bearing areas, as implants in load-bearing sites risk micromotion, bone erosion, and extrusion. Chronic exposure to the sinuses can lead to bacterial contamination and infection. Reliable applications of alloplastic implants include parts of the cranial vault and internal orbit [27]. A flowchart presentation of facial deformity classifications and recommended treatment options is provided in **Figure 1** [59].

4.3 Mandible, malar region, chin, and nasal areas

Facial implants are frequently used to enhance the chin, zygomas, and mandibular angles. According to a 2020 American Society of Plastic Surgeons survey, malar implants are the most common facial implant procedure and the third most popular cosmetic surgery, with a 938% increase in popularity since 2000. Chin implants have risen by 63% over the same period. Implants are less commonly used on other bony areas, such as the nose, glabella, and temple [33]. Facial implants are classified by their placement sites (e.g., malar, submalar, paranasal, chin) and can be prefabricated, anatomical, or custom-made. They come in various shapes and sizes. Submalar implants restore lost volume in the midface due to aging, whereas malar implants augment and alter the patient's appearance. Smaller implants typically restore a previous look, while larger ones change the facial profile. The submalar area, experiencing significant atrophy, is often treated with smaller implants for women and medium ones for men. Larger implants are used for both volume restoration and enhancing unsatisfactory appearances. Chin augmentation addresses microgenia effectively with alloplastic implants, which are safe and straightforward to place. Mild to moderate chin deficiencies are well treated with these implants, while severe cases may require additional soft tissue filling and tension restoration for optimal results [34]. **Figure 2** illustrates the effectiveness of chin implants in improving the patient's jaw appearance.



Figure 2. Two years s/b submentoplasty, chin implant, and submandibular gland reduction by Dr. Cuzalina. The patient was also a candidate for a jaw crease, but she preferred an implant. Her lip apposition pre-op was relatively normal, so that a chin implant could be used and not deepen her labiomental crease beyond normal. The chin implant greatly improved the results from neck surgery by increasing chin projection and neck length.

5. Surgical techniques and considerations

5.1 Preoperative planning procedure choice and implant shaping

Effective patient selection is crucial for facial reconstruction with implants. Avoid high-risk candidates, such as diabetics or smokers [60]. Assess whether malar, submalar, or combined implants are needed for midface reconstruction, and note that chin implants mask rather than correct issues like micrognathia. Evaluate occlusion and facial proportions, and present all options, including implants, orthognathic surgery, and genioplasty if implants alone are unsuitable [61]. Proper shaping of implants, both preoperatively and intraoperatively, is essential to prevent complications. Yang et al.'s modified Gore-Tex carving technique involves V-grooves for improved curvature and fit, minimizing visible edges and gaps [62]. Wong's technique for silicone forehead implants includes corrugated edges and central perforations for better contour and fixation, reducing capsule contraction [63].

5.1.1 Preoperative antibiotic loading and implant infection control

Intraoperative antibiotics are standard in head and neck surgeries, including facial reconstruction with implants, to prevent infections. Ridwan-Pramana et al. noted a 7.2% infection rate in Medpor implants with pre- and/or intraoperative antibiotics but without antibiotic-soaked implants or reported postoperative oral antibiotics [64]. Some experts recommend short courses of intravenous (IV) and oral corticosteroids to mitigate inflammatory responses.

Antibiotic preloading of alloplastic implants has been explored with methods such as dipping, immersing, and using negative pressure. A 2009 study by Keefe and Keefe found negative pressure most effective in reducing *Staphylococcus* growth on Gore-Tex and Medpor implants [65]. However, there is limited evidence on the effectiveness of these methods in preventing infections. Niechajev's study, using suction to impregnate Medpor implants with cloxacillin, achieved a 2.8% infection rate in nasal reconstructions. Despite some advocacy for preoperative antibiotic impregnation, controlled trials are lacking [46]. Godin and collaborators (2003) found no significant difference in infection rates with preoperative antibiotic soaking for Gore-Tex chin implants and did not address perioperative or postoperative antibiotic use [66].

5.2 Surgical procedure and techniques

5.2.1 Nasal alloplastic implants

Made from either silicone, ePTFE, or porous polyethylene, nasal alloplastic implants are used for nasal augmentation. While less prone to infection than ePTFE, which has a greater infection rate but can be readily removed, silicone implants need anchoring to stop movement. Porous polyethylene implants might induce tissue ingrowth, which would complicate removal. Autologous cartilage is often preferred to avoid complications [8, 67, 68].

5.2.2 Premaxillary augmentation

Often used in rhinoplasty, particularly for enhancing nasal projection and midface contour. Implants are placed via an intranasal incision after elevating the periosteum of the premaxilla. Options include prefabricated silicone or ePTFE implants.

5.2.3 Midface augmentation

Aims to address volume loss and aging signs. Implants restore midface volume, improving projection and reducing nasolabial folds. These implants can be used alone or with rhytidectomy for enhanced results.

5.2.4 Mandibular augmentation

5.2.4.1 Anterior mandibular implants

Provide 6–9 mm of projection in men and 4–7 mm in women. Severe cases may require 10–12 mm. Access is through intraoral or submental approaches.

5.2.4.2 Mandibular angle implants

Inserted via a mucosal incision along the retromolar trigone, with subperiosteal dissection and secured with a titanium screw. **Figure 3** illustrates a CT-guided custom mandibular angle implant.

5.2.4.3 Total mandibular implants

Address comprehensive micrognathia, using both submental and retromolar approaches, and can be customized with computer-aided design [8, 59].

5.2.5 Lip augmentation

Traditionally done with fillers, but ePTFE implants like Advanta offer a longer-lasting solution. Implants are inserted through small incisions near the oral commissure, requiring proper dermal placement to prevent visibility and extrusion. Fillers and surgical lifts are alternative options [8, 68, 69]. An overview of essential principles for intraoperative techniques in facial implants is depicted in **Figure 2** [68].



Figure 3. Female patient of Dr. Cuzalina following placement of 3D CT-guided custom mandibular angle implants with prejowl implant fill and submentoplasty (no facelift).

5.3 Postoperative care and monitoring

Opinions on postoperative antibiotic use vary. Some advocate a short 5–7-day prophylactic course, while others argue it has no impact on infection rates. Villarreal et al. [70] found no significant difference in infection rates among patients who received amoxicillin-clavulanate, clindamycin, or no postoperative antibiotics after orbital floor reconstruction with Medpor implants ($p = 0.958$) [70]. All patients had received pre- or intraoperative IV antibiotics, and the infection rate was 12.5%. In contrast, Shadfar and colleagues reported a 2.9% infection rate in nasal reconstructions with Medpor implants, using a 7-day postoperative antibiotic course but no preoperative antibiotic soak [60].

6. Complications and risk management

Postoperative implant complications are usually minor and temporary. Prevention through proper patient selection, planning, and protocol is essential. Early issues can often be treated with anti-inflammatories and pain relievers. Numbness may occur, but it typically resolves within a week. A follow-up visit at 1–2 weeks is recommended to check for complications [71, 72]. A summary of the common complications associated with different sites of reconstruction is mentioned in **Figure 3** [68].

6.1 Short-term outcomes

6.1.1 Infection, extrusion, and inflammation

In the immediate postoperative period, patients may experience a range of short-term complications, primarily due to the surgical procedure itself and the initial response by the body triggered due to the implant. In facial reconstruction, *infection* remains a significant concern, particularly with alloplastic materials such as titanium, porous polyethylene (Medpor), and polyetherketone (PEEK) [46]. These materials, while advantageous for reducing donor site morbidity and enhancing surgical efficiency, are not immune to infection risks and can harbor bacteria [64, 73]. Biofilm formation is a key factor in these infections. Biofilms are dense clusters of microorganisms encased in a protective matrix, making them highly resistant to antibiotics and immune responses. Contamination of implants before surgery can lead to the development of biofilms, which are difficult to manage and may require implant removal for treatment [74, 75]. Malaisrie and coworkers demonstrated the development of

biofilms in guinea pig models within one week after contamination with *Staphylococcus aureus*. Their study showed anatomical evidence of biofilm formation on various facial bioimplants, including titanium, silicone, ion-bombarded silicone, expanded polytetrafluoroethylene (e-PTFE; GORE-TEX), and porous high-density polyethylene (PHDPE; Porex Surgical Inc.). This highlights the rapid onset and complexity of biofilm-related infections in facial implants [76]. The incidence of infections, though, varies between different implant materials. Rojas and colleagues, following a literature search, revealed significant differences in infection rates between Medpor and silicone implants. Specifically, the infection rate for silicone implants stands at 2.2%, whereas Medpor implants have a considerably lower infection rate of 0.7% [9].

Implant *extrusion* is rare but often linked to underlying infection, which weakens the overlying tissues. It occurs when the implant breaches the skin or incision site, such as through the intraoral approach for cheek implants or into the maxillary sinuses. Factors like poor vascularization, previous surgeries, and excessively large implants increase the risk [71, 77]. Implant extrusion rates are higher in mobile soft tissue regions, like the columella or ala, due to muscle contracture. The orbicularis oris muscle's role in facial movement, swallowing, and respiration increases the risk of infection and extrusion [8]. Immediate intervention, including repositioning or removal of the implant, may be necessary to prevent further complications.

Inflammation is another common issue, and even a well-tolerated alloplastic implant acts as a foreign body, triggering a host response. Host proteins adhere to the implant, denature, and cause inflammation, leading to collagen deposition on and around the implant [78]. Uncontrolled inflammation can increase morbidity at implant sites. A meta-analysis conducted by Oliver and colleagues reported that the methyl methacrylate (2.50%) and Lactosorb (8%) implants had higher inflammation rates, with frontal implants also having poor cosmetic outcomes (5.20%). Orbital implants had an 8% inflammation rate [56]. Choi and colleagues describe how a silicone implant was moved into the frontal sinus following a nose job, emphasizing the dangers of inflammation and other difficulties that come with artificial implants as opposed to autologous tissues [30]. Proper surgical technique, with meticulous hemostasis and gentle tissue handling, is crucial to minimize risks. Postoperative care includes anti-inflammatory medications, fluid drainage, and close monitoring. Complications of facial implants have also included edema, postoperative asymmetry, lipid dysfunction, neuropraxia, seroma, and hematoma [34, 79].

6.2 Long-term complications and safety profiles

6.2.1 Chronic infections, migration, and resorption

Chronic infections may manifest long after the initial surgery, often presenting subtle signs such as chronic pain or low-grade fever. Chronic inflammation, on the other hand, may also lead to the formation of a fibrous capsule around the implant [68, 71]. Migration of the implant is another long-term issue, typically resulting from mechanical factors such as poor fixation or the absence of adequate tissue encapsulation. Migration can cause noticeable asymmetry, discomfort, and dissatisfaction with the aesthetic outcome. Surgical revision may involve re-securing the implant or using a different material to better match the patient's anatomy [34]. Recently, two cases of eyelid implant migration cases, with facial palsy have been discussed in implant

migration. In both cases reported, the decision was made to remove the implant without reimplantation [80].

Bone resorption is a common and high-risk issue with alloplastic chin implants, particularly beneath the implant's surface in contact with the mandible [81, 82]. Resorption of the underlying bone can occur due to the pressure exerted by the implant, particularly if the implant is too large or improperly positioned. The first failures of alloplastic implants were reported by Robinson in 1972, where 12 of 14 patients with acrylic and silicone implants experienced up to 5 mm of bone resorption. This was attributed to implant shape, position, pressure from large implants, subperiosteal placement, and implant hardness [83, 84]. In a case series, the authors discussed four patients with alloplastic chin implants, where three exhibit varying degrees of bone erosion beneath the prostheses, while one has a normal bony contour [82]. In another recent report, the authors present two clinical cases of anterior chin cortex bone resorption associated with silicone implants [85].

6.2.2 Stability and integration of implants

The long-term stability of facial implants depends on the material and surgical technique used. Porous implants, such as porous polyethylene material (Medpor), foster fibrovascular ingrowth for better stabilization but are difficult to remove if complications occur. Smooth implants like silicone are less integrated with surrounding tissues, making them prone to movement but easier to remove if needed. Bone resorption, especially with oversized implants, can alter facial contours and affect both aesthetics and function, making radiographic monitoring crucial for early detection [34, 71].

6.3 Management of complications

Historically, implant infections were treated with antibiotics, incision, and removal. Recent methods in cardiothoracic, vascular, and orthopedic surgery now use debridement and systemic and local antibiotics to salvage implants. Orthopedics employs two-stage revisions with antibiotic-loaded spacers, and trauma surgery uses gentamicin beads and collagen sheets. These techniques are now being explored for facial implants, with mixed results [86–88].

Studies on Medpor grafts have identified higher failure risks in certain sites (nose, maxilla, ear) and patient conditions (syndromic patients) [89]. Porous polyethylene implants, especially when placed transorally or without proper coverage, have shown increased infection and exposure risks [90, 91]. Biofilms on implants, such as those found in a GORE-TEX dorsal nasal implant case, complicate treatment, requiring prolonged antibiotic use and often implant removal [92].

Bacterial infections vary, with common skin flora and atypical bacteria like mycobacteria requiring different treatments. Mycobacterial infections often evade routine cultures and need specialized testing and extended antibiotics [93]. Exposed implants usually require surgery, with techniques like tissue flaps and antibiotic irrigation showing partial success but still facing high complication rates [94]. Future treatments might include non-antibiotic methods to disrupt biofilms, such as laser waves and ultrasound. Preventing infections through thorough preoperative evaluation, sterility, debris minimization, and careful site selection is crucial [88, 95].

Summarizing this, effective management of chronic complications often requires long-term antibiotics and surgical removal of infected implants. For migration,

resorption, or capsular contracture, surgical intervention, such as repositioning or replacing the implant, is typically necessary.

7. Case studies and clinical outcomes

7.1 Review of significant studies

The overview of some of the studies on facial implants, the success rates, patient satisfaction, and functional outcomes is presented in **Table 1**.

Implant material	Uses	Patients	Results	Reference
<i>Polyethylene (Medpor)</i>	Midface contouring in cleft patients	51	Reliable, long-term stable materials for effectively enhancing paranasal, subnasal, and malar areas, as well as a solid nasal dorsum in cleft patients, Medpor implants have few problems.	Schwaiger et al. [96]
	Skeletal augmentation	44	For face skeletal augmentation, high-density porous polyethylene is a dependable substitute for autogenous grafts; with enough soft tissue covering, it produces good long-term results with few complications.	Deshpande & Munoli [97]
	Single oral and maxillofacial surgeon	61	Results showed a 2.5% complication rate over a three-year follow-up, demonstrating that this midfacial correction technique is successful in both the short and long term.	French et al. [98]
	Correction of secondary unilateral cleft lip nasal deformity	32	One patient experienced delayed incision healing, with no other complications, resulting in a 96.9% satisfaction rate.	Zhuwei et al. [99]
<i>Silicone</i>	Mentoplasty	17	There were no permanent complications, with 15 patients (88.2%) extremely pleased with the procedure. Additionally, 16 patients (94.12%) showed significant improvement after solid silicone augmentation mentoplasty, and no revisions were needed.	Altintas et al. [100]
	Mandibular angle augmentation	58	Patients received 116 bilateral silicone implants at the mandibular angle, with 96 intact and no complications.	Al-Jandan & Marei [101]
	Chin alloplastic augmentation	10	Silastic alloplastic chin implants effectively augment moderate chin retrusion, with all patients showing significant profile improvement and high satisfaction according to the Genioplasty Outcome Evaluation.	Abdelmabood et al. [102]
	Chin augmentation	28	There were no complications with the implants, and all patients reported satisfaction with facial symmetry and cosmetic results, benefiting from the absence of visible scars.	Alasseri et al. [103]

Implant material	Uses	Patients	Results	Reference
<i>Hydroxyapatite</i>	Malarplasty	430	Hydroxyapatite/collagen composite used in malarplasty yields successful outcomes, though it has a longer learning curve compared to more commonly used implantable biomaterials.	D'Agostino et al. [104]
	Facial Skeleton	17	The study confirmed that only the placement of hydroxyapatite granules leads to initial collagen formation, followed by bone conversion, integrating the implant with the host bone for long-term stability.	Huggins & Mendelson [105]
	Neck rejuvenation	15	93.3% of patients showed at least a 1-grade improvement on the 5-point scale, with no serious adverse events reported, most being mild and transient.	de Sanctis Pecora [106]
<i>Titanium</i>	Aesthetics, deformity, and malformation surgery	12	3D printing accuracy of 0.1 mm facilitates precise jaw angle implant planning, with patients valuing preoperative renderings, while infections can be managed through careful selection and technical recommendations.	Mommaerts [107]
	Maxillofacial bones	16	Patient-specific titanium implants yielded satisfactory outcomes for various oral and maxillofacial defects.	Lim et al. [108]
	Maxillofacial surgery	32	Significant improvement and total recovery were observed in 32 cases, concluding that building anatomical models based on CT studies is financially viable for repairing orbital floor fractures.	Yusupov [109]

Table 1.

Here is an overview of some studies on facial implant success rate, patient satisfaction, and functional results:

7.2 An insight into case studies

Used for both cosmetic and reconstructive objectives, facial implants have shown great success rates over several anatomical areas. These implants give those with facial abnormalities resulting from disease, trauma, or congenital problems structural support and enhance their appearance. Often concentrating on certain areas such as the orbital, nasal, and auricular areas, several studies have assessed the effectiveness and longevity of various implants.

The success and survival rates of extraoral implants in the orbital, nasal, and auricular areas were evaluated in a 2017 Heitor Batista dos Reis et al. With no appreciable variation depending on anatomical area or past radiation exposure, this study indicated that the success rates were 95.9% for orbital implants, 92.9% for nasal implants, and 92% for auricular implants [110]. With a 79.5% total implant survival rate, Subramaniam et al. [111] also published long-term results showing temporal implants had the highest success rate (97.0%) compared to nasal (87.5%) and orbital implants (63.3%) [111].

Yoshino et al. [112] investigated the value of connective tissue grafting combined with instantaneous implant implantation. With an overall implant success rate of

100% at the one-year mark [112], their study found that connective tissue grafts helped preserve the facial gingival level. Moreover, a 2011 study by Kan and colleagues verified that although constant monitoring of facial gingival tissue was essential due to possible recession, favorable implant success rates and peri-implant tissue responses could be obtained with immediate placement and provisionalization [113].

Generally speaking, facial implants show good success rates, especially in non-irradiated areas and under appropriate surgical methods. Outcomes are significantly influenced by the implant material and anatomical placement; auricular and nasal implants usually show better success rates than orbital implants. Constant developments in surgical methods and materials will probably help to raise these success rates and lower complications.

8. Future perspective

Facial implants are expertly positioned as a permanent medical device inside the face to shape and fashion a patient's characteristics. For individuals interested in these surgeries, there are plenty of choices ranging from cheek to jaw implants; now, there is another choice utilizing your own tissue. Facial implants have bright futures with continuous technological and medical innovation opening the path for more efficient, safer, and aesthetically acceptable solutions. Highly tailored implants that better fit patients' anatomical needs are resulting from technological advancements, including 3D printing and the creation of biocompatible materials (especially polyetheretherketone and titanium alloy plates), therefore lowering problems and increasing satisfaction [114–116]. Furthermore, regenerative medicine and tissue engineering's stem cell integration and bioengineered implants created from a patient's own cells are providing amazing opportunities for natural tissue regeneration and lowering the danger of rejection. Minimally invasive techniques are also becoming more popular since they shorten recovery times and cause little scarring, therefore reducing the risk of operations [117, 118].

Furthermore, the merging of robotics and artificial intelligence is revolutionizing the planning and execution of facial implant procedures, therefore enabling perfect design and customized treatment plans [119, 120]. While highlighting aesthetic and functional improvements, future implants will most likely solve hereditary defects, injuries, or diseases affecting facial features. More tailored treatment plans will result from genetic testing and improved imaging as personalized medicine advances. Along with technology advancements, ethical and legal concerns will shift to ensure patient safety and management of costs. As these technologies become more readily available, offering more opportunities and more acceptance among a bigger audience, the market for facial implants is expected to develop. Using computer-designed patient-specific implants nowadays helps to more precisely reconstruct maxillofacial abnormalities. Higher patient satisfaction results from this method, which also removes the typical difficulties connected with previous implants. The great expense is the main disadvantage, though [121]. Advancement of implant technology depends on the improvement of biocompatibility, durability, and infection control. Crucially, there are innovations in individualized implants, minimally invasive approaches, and neural interfaces. Furthermore, greatly improving health outcomes and quality of life will involve addressing cost, accessibility, ethical issues, and patient-centered results.

9. Conclusion

Facial implants play a critical role in both aesthetic and reconstructive facial surgeries. They address the complex needs arising from trauma, congenital abnormalities, and age-related volume loss. The evolution of materials from metals and polymers to bioceramics has significantly enhanced the durability, safety, and integration of implants. Historical progress in aesthetic surgery has laid the foundation for modern techniques that ensure better patient outcomes. Despite the high success rates of facial implants, ongoing research and technological advancements promise even greater improvements in biocompatibility, customization, and minimally invasive procedures. The future of facial implants looks promising, with potential innovations in regenerative medicine and personalized treatment plans offering new possibilities for enhancing facial aesthetics and function.

Additional materials

This video provides a step-by-step breakdown of the cheek implant surgery process. Download the video here: <https://bit.ly/4dTp5qV>.

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Chapter 6

Injection Techniques for Perioral Enhancement

Riekie Smit

Abstract

This chapter will focus on the injection techniques for perioral rejuvenation using botulinum toxin and dermal filler injections. The perioral region is a very mobile region that shows aging changes at various levels. The most common concerns of patients include perioral wrinkling, mouth corners turning down, lip inversion and volume loss. The correct use of botulinum toxin A could minimize perioral wrinkles, give slight eversion (“lip flip”) and help to reduce mouth corner drooping. Fillers can be utilized to treat perioral volume loss and to manage the fine wrinkles around the lips. These procedures require in-depth knowledge of the perioral anatomy and the layers of structures, good knowledge of the products and their respective pharmacokinetics and rheology, and lastly, good injection skills. This will ensure minimizing side effects or complications.

Keywords: botulinum toxin A, lip wrinkles, perioral lines, lip fillers, perioral aging, lip flip, mouth corners

1. Introduction

The aging changes in the perioral region have a significant impact on appearance, attractiveness and revealing one’s age.

There are numerous factors contributing to the aging changes that are visible in the perioral region, ranging from skin aging due to chronological, intrinsic and extrinsic aging; soft tissue, fat and muscular changes; and also dental factors and bony resorption [1, 2]. Another important factor affecting the perioral and, specifically, lip aging process is the hormonal decline in females, especially after menopause [3].

The need for esthetic enhancement in the perioral region is high due to the impact that this region has on the perception of age and attractiveness [4–6].

There are numerous types of treatments and protocols for perioral rejuvenation. It is very important that the physician understand the aging pathology in the perioral region, know how to evaluate the perioral region and choose the correct individualized treatment plan to ensure patient satisfaction.

2. Perioral evaluation

The perioral region should be evaluated in relation to the whole face. Ideal proportions of the perioral region should be considered according to the ethnicity of the

patient and care should be taken not to measure all patients according to the generally defined Caucasian proportions.

The relation of the perioral region to the whole face is often described by the artistic proportions dividing the face into thirds (**Figure 1**) [7–9].

The upper third of the face extends from the hairline to the nasion. The middle third of the face then extends from the nasion to the subnasale, and the lower third then to the menton. The inferior third is then further divided into the height of the upper lip compared to the height of the lower lip and chin.

On a lateral view, Rickett's e-line is used to evaluate the lip prominence and relation to nose and chin [7–9].

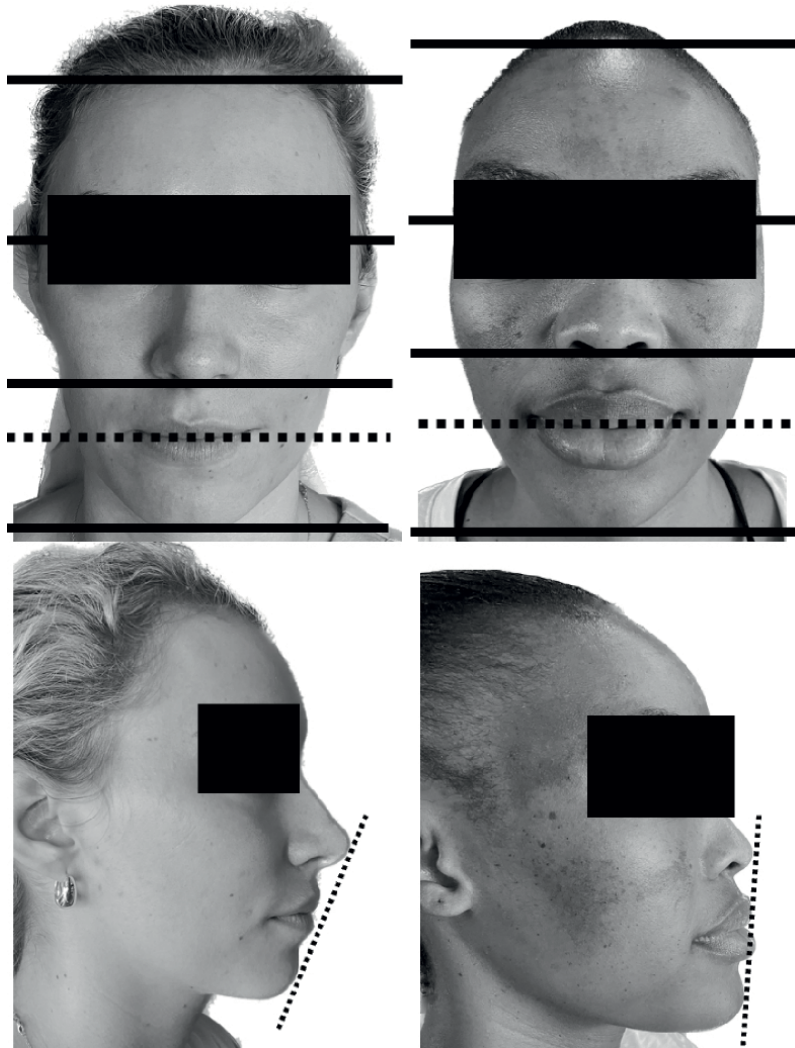


Figure 1. The proportions of the facial thirds on frontal view and the lateral view proportions using Rickett's e-line. Image by Dr. Smit with permission from patients.

The major differences in the perioral region between different races are noticeable in the lateral view. There are numerous different proportional lines, reference planes and angles that can be used for the evaluation of lip prominence and its relation to the nose and chin. The Rickett's line is an easy line to use during evaluation and during treatment. This line is described as the line from the tip of the nose to the pogonion. In Caucasian patients the upper lip should be 3–4 mm behind this line and the lower lip 2 mm behind this line [9–12]. This is not the same for ideal proportions in other ethnicities [9]. In the Asian and African populations, the lips will often cross this line and still remain esthetically pleasing and attractive [9–12].

It remains important to take into consideration that skeletal and dental factors also influence the lower face proportions. This may necessitate a referral to a dentist or maxillofacial surgeon in some cases.

3. Perioral aging

The perioral region is one of the first regions in the face to show signs of facial aging due to intrinsic factors and is often aggravated by extrinsic factors, especially smoking and excess sun exposure [1, 2].

The aging signs in the peri-oral region may include the following visible changes:

- Loss of lip volume
- Vermillion border and Cupid's bow loss
- Inversion of upper lip
- Vertical lines extending from upper and lower lip (often referred to as barcode wrinkles or smoker's lines)
- Down-turned mouth corners and marionette folds
- Worsening of nasolabial and melo-labial folds
- Pre-jowl sulcus
- Chin dimpling (**Figure 2**).



Figure 2. Aging changes that occur perioral, starting from younger to older perioral region. Images by Dr. Smit with permission from patients.

4. Perioral rejuvenation

The perioral enhancement techniques are focused on managing the aging pathology in this region. Often, a combination of techniques may be required to address the various pathological aspects of skin aging, volume loss, or muscular hyperactivity.

Treatments for perioral rejuvenation are not exclusively injection techniques, as chemical peels and energy-based devices are other successful treatments for perioral rejuvenation, particularly for skin aging changes.

The injection techniques for perioral rejuvenation include:

1. Skin rejuvenation injections
2. Botulinum toxin injections
3. Filler injections

Non-invasive esthetic procedures for rejuvenation of the perioral region have advanced significantly, offering satisfactory outcomes in a minimally invasive and uncomplicated way. The three mentioned treatments are often used in combination, and their success in combination has been published [13, 14].

Skin rejuvenation injections, often referred to as esthetic or anti-aging mesotherapy injections, involve the use of dermal injection techniques of revitalizing, nourishing and hydrating solutions to improve skin quality, firmness and superficial wrinkles [13–16].

Botulinum toxin injections are used to reduce hyperactive mimetic muscles that lead to wrinkles of expression or depression of facial features, such as the depressor anguli oris muscle depressing the mouth commissure.

Subdermal filler injections are used to address wrinkles and fold with medium-density products or volume restoration using high-density products for injection.

4.1 Skin rejuvenation injections in the perioral region

The purpose of skin rejuvenation techniques is to reverse cutaneous aging signs including wrinkles. Ablative and exfoliative treatments are commonly used for skin rejuvenation, such as peelings, lasers and microdermabrasion. In contrast to exfoliation or ablation, revitalizing or rejuvenation injections focus on replenishment and nourishment to improve skin aging signs. This concept, unique to the technique of skin rejuvenation mesotherapy or revitalization, focuses on the replacement and nourishment of the vital components of the skin with mostly poly-vitamin solutions and especially non-cross-linked hyaluronic acid [17].

The injectable products used for skin rejuvenation should be sterile, registered for injection within the dermis and suitable for intradermal injections. The ideal product to use should contain ingredients that will replenish the extracellular matrix, reduce oxidation, nourish the fibroblasts and stimulate neocollagenesis. Polycomponent preparations for mesotherapy or intradermal injections are developed to supply the necessary substrates to aging skin that are needed for optimal functioning of the fibroblast [14, 15]. This will typically include free hyaluronic acid, vitamins, minerals, antioxidants, coenzymes and new types of ingredients with scientific evidence of fibroblast stimulation or collagen-boosting properties [14–17]. There are many new

products entering the market for improving skin quality including innovative substances such as peptides, enzymes and exosomes.

Various injection techniques have been recommended, used, or studied to deliver these substances to the dermal fibroblasts and the surrounding extracellular matrix.

Different techniques for delivering skin-replenishing or revitalizing substances include:

- Classic mesotherapy injection techniques—epidermal, dermo-epidermal and dermal techniques
- Intradermal injections with a needle (such as 32G × 4 mm needles)
- Intradermal injections with needle devices (such as Nanosoft™)
- Skin needling rollers (dermal rollers)
- Electronic skin needling devices (Demapen®, Mesopen®)
- No-needle injection devices (**Figure 3**).

To achieve successful results without complications, there are some important rules to follow, which include but are not limited to the following:

- Use a good quality product with scientific evidence of efficacy.
- Use good-quality injection needles or devices.
- Good skills in injection techniques.
- Thorough cleansing and disinfection before injections.
- Do not mix solutions.
- Use only new, unopened vials for injections.
- Check the expiry date of products.
- Be careful of topical anesthesia that may cause skin reactions.



Figure 3. Skin rejuvenation techniques. This method of replenishment of the skin and reverse aging signs are often combined with either fillers, botulinum toxin or both [13, 17]. Image by Dr. Smit with permission from patients.

- There are many reports in literature of contact dermatitis to topical anesthesia [18]. These reactions may be further aggravated with multiple needle punctures to the skin barrier as performed by these techniques.

4.2 Botulinum toxin injections in the perioral region

Botulinum toxin injections have been used for various esthetic indications, particularly for the upper face, but also for the middle and lower face and the neck [19].

Several consensus recommendations for the use of botulinum toxin in the lower face have been developed despite this region being off-label indications.

The use of botulinum toxin in the perioral region includes:

- Treatment of perioral wrinkles with small doses in the superficial orbicularis oris muscle.
- Reduction of gummy smile (excessive gingival exposure on smiling) by reducing the activity of the relevant lip elevators.
- Reducing the activity of the depressor anguli oris muscle will give an elevation of the mouth corner.
- Reducing the chin dimpling effect and melomental crease with the relaxation of the mentalis muscle.

The use of botulinum toxin injections in the perioral region requires an in-depth knowledge of the location of the muscles, their depths, their relation to surrounding muscles and their vectors of movement (**Figure 4**).

When treating perioral wrinkles with botulinum toxin injection, the depth of injection should be superficial and close to the vermilion border of the lip [19–21].

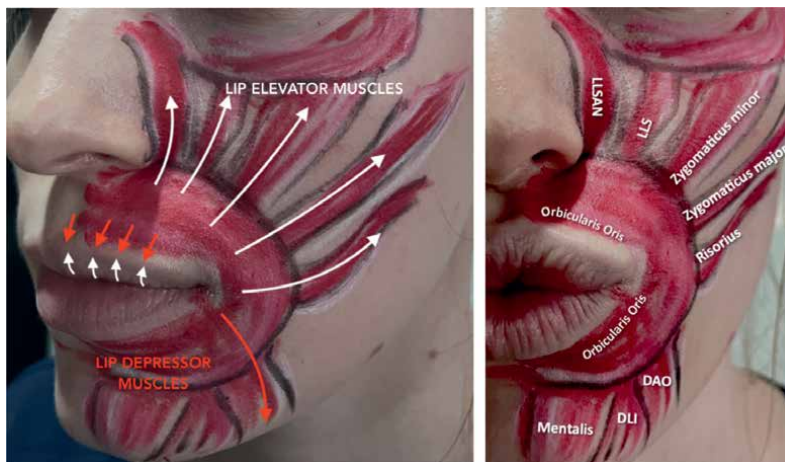


Figure 4. Perioral muscles. DAO: depressor anguli oris muscle; DLI: depressor labii inferioris muscle; LLSAN: levator labii superioris alaeque nasi muscle; LLS: levator labii superioris muscle. Image and illustration by Dr. Smit with permission from patient.

This will ensure that the deep fibers of the orbicularis oris muscle are not injected, ensuring effective reduction of the perioral wrinkles and mild eversion of the upper lip (**Figures 5 and 6**).

4.3 Filler injections in the perioral region

The use of fillers for lip rejuvenation and lip enhancement remains a very popular esthetic medical procedure [21]. The most widely used filler material remains hyaluronic acid fillers due to their natural properties, numerous scientific studies and safety aspects, especially since they can be reversed with the enzyme hyaluronidase. Hyaluronic acid fillers are widely used in esthetic medicine for facial rejuvenation and volume enhancement in different body regions and their popular use includes the lips [21, 22].

A frequently misunderstood aspect of beauty is the notion that beautiful lips are synonymous with full lips. While full lips are commonly associated with attractiveness compared to thinner lips, the reality is more complex. Attractive lips encompass more than just their fullness, encompassing factors beyond the absence of perioral wrinkles and the presence of a well-defined Cupid's bow [23].



Figure 5. Perioral wrinkle treatment with botulinum toxin. The recommended dosage for this indication is 2 Units of Abobotulinum toxin A or 1 unit of Onabotulinum toxin A per point of injection superficially [19, 20]. Image by Dr. Smit with permission from patient.



Figure 6. Mouth corner lifting treatment with botulinum toxin. The recommended dosage for this indication is 4–6 units of abobotulinum toxin A or 2–4 units of onabotulinum toxin A per point of injection very superficially to avoid spread to the depressor labii inferioris muscle. The location of injection of the depressor anguli oris can also be determined by drawing a line from the mouth corner 1 cm lateral and then 1 cm inferior [19, 20]. Image by Dr. Smit with permission from patient.

In many cases of perioral rejuvenation, augmenting fullness can certainly address and improve specific concerns in the perioral area. However, it may not constitute a comprehensive or suitable treatment strategy for the patient's unique indications or concerns. Unfortunately, a common issue that arises is not just an excess of fullness but, more frequently, the improper placement of that fullness within the patient's lips.

The most important step in achieving successful results with lip enhancement is a good proportional evaluation of the lips and the perioral region from a frontal and lateral view, as discussed earlier. The lips themselves also need to be evaluated according to their subunits as known by artists and originating from the embryological development of the lips (**Figure 7**).

These lip subunits need to be evaluated according to loss of volume or excess volume and this will help guide the treatment plan for lip enhancement.

Further to this, the perioral region needs to be evaluated. Only enhancing the lips and leaving perioral concerns untreated will not result in a satisfactory result (**Figure 8**).

Perioral lines or wrinkles may reduce the attractiveness of the lips. This may include perioral (barcode or smoker's lines) (A), nasolabial folds (B) or marionette folds (C) or even an unaesthetic chin profile.

Following the evaluation of the lip subunits and the perioral region, the treatment can be planned according to the aims of treatments for the lips, which may be volumization, contouring, restoration or purely perioral rejuvenation (**Figure 9**).

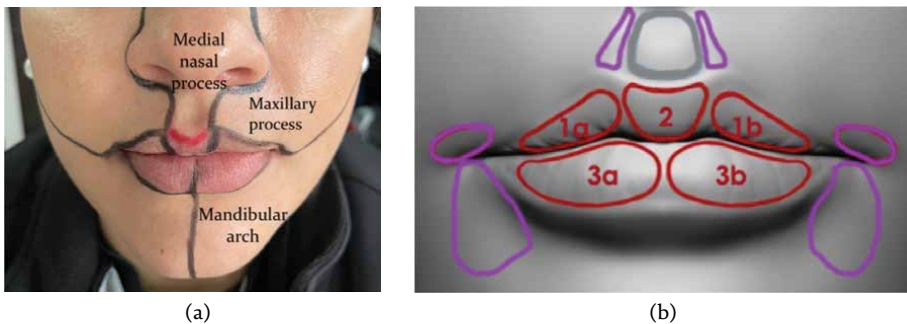


Figure 7. Lip subunits. a: the lip subunits, according to embryological development. The lip subunits can be evaluated according to the following subunits: superolateral subunits (1a and 1b), the superomedial subunit (2) and the inferolateral subunits (3a and 3b) [23]. Images and illustrations done by Dr. Smit and with permission from patient.

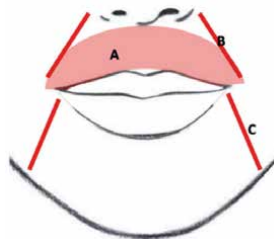


Figure 8. The evaluation of the perioral region when planning lip enhancement. Illustration by Dr. Smit with permission.

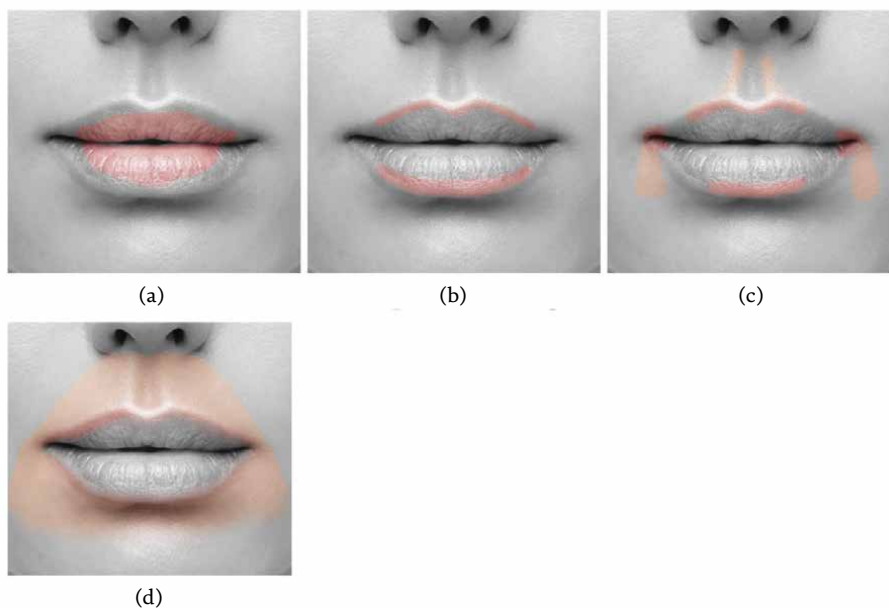


Figure 9. Different aims of treatments with lip filler injection techniques. a: lip volumization; b: lip contouring; c: perioral restoration; d: perioral rejuvenation. Illustrations by Dr. Smit with permission.

Techniques of injection of fillers will depend on the product rheology and the aim of treatments. The lip region remains a highly vascularized and highly dangerous zone for the risk of intravascular injection. The vascular supply of the lips derives from the superior and inferior labial arteries branching from the facial artery [21]. Safe and successful procedures in the perioral region depend on a thorough, comprehensive knowledge of facial anatomy, in particular vascular anatomy. Insufficient familiarity with this aspect can result in significant complications [25].

The use of cannula of 25G or thicker (22 or 23G) reduces the risk of intravascular injection but does not completely eliminate the risk. When using needles, smaller needles and the use of smaller amounts per injection with continuous monitoring of capillary refill are recommended to reduce the risk for intravascular complications [21–25]. Other complications with fillers in the perioral region could arise due to lack of sterility, incorrect choice of product for the depth, existing localized infection, recent viral infections and other side effects, which are often classified into technique-related or product-related adverse events. All professionals performing these procedures should be familiar with the risks of adverse events, how to avoid or reduce the risks, as well as knowledge of managing such events.

Further to injection techniques, one needs to understand the rheology of the hyaluronic acid (HA) fillers to ensure that the correct product is used for the specific indication. The various factors influencing the viscosity and elasticity such as the length of HA chains, the amount of cross-linking, the molecular weight, G-prime and other factors should be taken into consideration when choosing the product for the indication, the depth of injection and the region of injection (**Figures 10–12**) [24].

When treating the perioral region, it may also be necessary to balance the profile of the nose, lip and chin region. The evaluation of the frontal and lateral profile measurements is vital to ensure the profile remains balanced and esthetically pleasing (**Figure 13**).

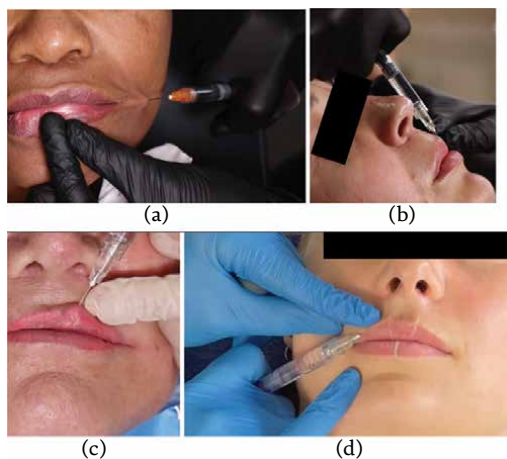


Figure 10. Techniques of injections for lip enhancement. a: using a blunt cannula remaining in the superficial plane of the lips; b: superficial retro-tracing technique with a needle for eversion of the upper lip; c: superficial retro-tracing technique with a needle for eversion of the upper lip; d: superficial needle technique for contouring the lip vermilion border. Images by Dr. Smit with permission from patients.



Figure 11. Results before and after with hyaluronic acid fillers for lip enhancement. 1 ml of a medium cross-linked HA filler was used.



Figure 12. Results of injection of the perioral region with a low cross-linked HA filler using a cannula in a fanning pattern on the upper and lower white lip perioral region. a: before treatment; b: after treatment; c: technique of injection with a cannula in the perioral region. Images by Dr. Smit with permission from patients.



Figure 13.
Balancing of the perioral region with fillers. Image by Dr. Smit with permission from patient.

5. Conclusion

Injection techniques for perioral enhancement remain an important tool to enhance patient self-esteem and satisfaction with their appearance [2].

There are various tools available for rejuvenating and restoring perioral concerns and there are numerous developments in this field of medicine to ensure higher satisfaction and safety. The treatment options for the perioral region does not only include injectable treatments with botulinum toxin A, dermal fillers and skin revitalizers; but also, energy-based devices for skin rejuvenation and tightening [2, 21].

The duty of the practitioner is to remain updated on the knowledge of the existing and new products that can be used, the techniques of use, the anatomical knowledge, safety precautions and management of adverse events with techniques in the perioral region [24].

Artistic insight and an understanding of profilometry, facial measurements and the differences between races and genders are other important factors that ensure success with perioral procedures.

The perioral region requires insight from an injector into the holistic facial proportions in relation to the lips, as well as the understanding of the lip subunits and how these should be respected to maintain natural proportions during enhancement procedures [23]. Respecting these natural proportions while also considering the inter-ethnic and gender variations will ensure natural results that will enhance the attractiveness of the patient. Furthermore, it remains vital to understand the different types of techniques of injection for specific indications combined with the knowledge of the specific rheology of fillers needed for the indication, especially when treating the lips.

It is also important that only qualified and experienced professionals perform such procedures to minimize the risk of complications.

Lastly, the importance of combination treatments should be understood for success with perioral rejuvenation, especially with progressing age. The multifactorial aging of the perioral region occurs in various layers from bone to skin [2]. Therefore, the need of a multilayered and combination approach will be necessary to ensure patient satisfaction. Practitioners treating the perioral region should thus have knowledge and be skilled to use these different methods to treat the perioral region.

Conflict of interest


The author declares no conflict of interest.

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Section 2

Breast and Body Cosmetic Surgery

Chapter 7

Simultaneous Breast Augmentation with Mastopexy

Chase Nelson, Angelo Cuzalina and Sebastian Gutierrez De Pineres

Abstract

Breast lift and augmentation are often desired by the female patient to address ptotic breasts. Historically, this was performed with a staged mastopexy followed by augmentation at a later date. More recently, the two procedures have been found to be safely and effectively performed as a single stage procedure. This affords the patient a more cost effective (only one operation and one anesthesia fee) and timely strategy for reaching their esthetic goals. Furthermore, prior literature describes fairly stringent restrictions on implant size. We present our technique of using a superomedial-central pedicle with total submuscular implant placement to achieve appropriate breast position with preserved nipple-areola-complex vascularization whilst having the freedom to place a proportionately sized implant, even relatively large implants if so desired by the patient. The described technique has proven to have extremely durable results leaving the patient with a youthful appearing breast with a propensity to withstand future ptosis and/or waterfall deformity.

Keywords: breast augmentation, mastopexy, breast lift, breast augmentation with mastopexy, wise pattern, total submuscular breast augmentation, superomeidal central pedicle

1. Introduction

Deflated, ptotic breasts are commonplace complaints in cosmetic surgery practice. Loss of breast fullness and descent of the nipple-areola-complex (NAC) below the inframammary fold (IMF) can occur as a result of pregnancy, lactation, weight loss, and congenital deformity. The desired outcome of affected patients is generally “larger, perkier” breasts. Simultaneous breast augmentation and mastopexy offers a single stage solution. This procedure is among the most challenging cosmetic surgical procedures as the surgeon strives for symmetric manipulation of the breast skin envelope, parenchyma, NAC, IMF, and chest wall anatomy whilst maintaining adequate vascularization. While it is a challenging procedure to perform, it is extremely rewarding for both patient and surgeon when performed in an expert manner. Complications, revisions, and litigation are higher than many other cosmetic surgeries. This Chapter is aimed at providing detailed clarity on the anatomy, clinical evaluation and decision making process, surgical marking,

surgical technique, and potential complications of simultaneous breast augmentation and mastopexy with the goal of helping surgeons appropriately plan and execute this enjoyable procedure.

2. Anatomy of the breast

2.1 Surface anatomy

The female breast assumes a conical form with rounding at the inferior pole. The gland extends from the 2nd to the 6th rib along the midclavicular line in the vertical plane and from the sternocostal junction across to the midaxillary line in the horizontal plane [1]. Superolaterally, the mammary gland extends toward the axilla to form the tail of Spence [2]. The breast overlies the pectoralis major, external oblique, serratus anterior and upper rectus muscles (**Figure 1**) [1, 2].

2.2 Nipple-areola complex

The NAC is composed of stratified squamous epithelium. The lactiferous ducts converge and open into mammary pits that elevate and form the nipple. Failed formation of this lactiferous duct convergence and elevation results in an inverted nipple which affects 2–4% of females [2]. The NAC measures 2–4 cm in diameter and is ideally located in the center of the breast mound [2]. Ideally the NAC should be approximately 1/3rd of the overall breast diameter and the nipple itself should be 1/3rd of the areolar diameter [2, 4]. The NAC is ideally positioned slightly above the IMF [5]. A 21 cm sternal notch-to-nipple distance is often considered ideal with a nipple-to-IMF distance of 7–10 cm (**Figure 2**) [2, 7]. However, these distances do vary based on certain factors discussed in the “preoperative marking” section of this chapter.

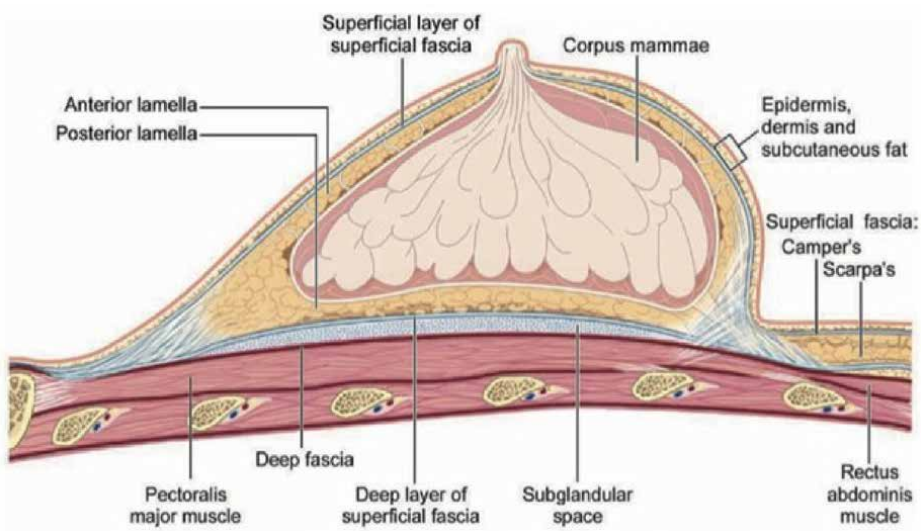


Figure 1. Surface anatomy of the breast including underlying pectoralis major and rectus upper rectus abdominis muscle [3].

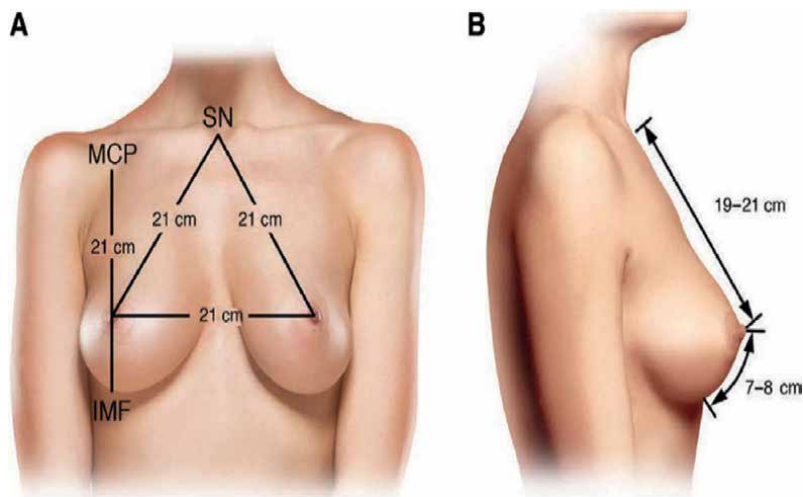


Figure 2.
A. MCP - midclavicular point, IMF - inframammary fold, SN - sternal notch. Ideally, the sternal notch-to-nipple distance and nipple-to-nipple distance are ideally equidistant. B. The superior measurement shows the ideal sternal notch-to-nipple distance of 19–21 cm and a nipple-to-IMF distance of 7–8 cm [6].

2.3 Glandular anatomy

The glandular tissue is composed of 15–25 lobes, the functional unit of the breast, which extend toward the NAC as lactiferous ducts and open at the nipple (**Figure 3**). The breast gland has no discrete fascia, instead it has fibrous Cooper's ligaments that provide scaffolding support to the glandular breast. Additionally, the inframammary crease ligament contributes to a well defined inframammary crease and extends from the medial aspect of the 5th rib and laterally to the fascia of the 5th and 6th ribs [4]. The inframammary crease ligament that gives rise to the inframammary fold and acts a sling for the breast parenchyma. During augmentation mammoplasty, the release of the pectoralis muscle with preservation of the ligament to the bony framework

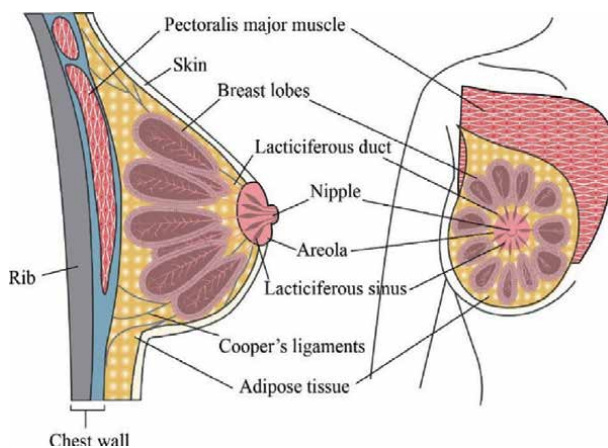


Figure 3.
Schematic view of the breast parenchyma anatomy [8].

will minimize risk of bottoming out [9]. Weight fluctuation, pregnancy and aging can attenuate Cooper’s ligaments and lead to varying degrees of mammary ptosis (**Figure 4, Table 1**) which is based on the nipple position in relation to the inframammary fold [2, 4].

2.4 Neurovascular supply

Arterial supply to the breast is from perforating branches of the internal thoracic artery (internal mammary artery), branches of the lateral thoracic artery, and direct branches from the 2nd-5th intercostal arteries. The internal mammary artery is the primary blood supply to the NAC with perforators from the 2nd-5th intercostal spaces immediately lateral to the parasternal border (**Figure 5**).

Venous outflow is through an anastomotic plexus in the subcutaneous tissue beneath and around the NAC that drain peripherally via large subcutaneous veins that empty into the intercostal, axillary, and internal thoracic veins [4]. The most important and reliable venous routes are located in the superomedial and inferior pedicles and congestion of these routes can be a primary cause of NAC ischemia and necrosis in mastopexy procedures [4, 11].

Nerve supply of the NAC includes the 3rd- 5th anterior/medial intercostal cutaneous branches, and most prominently the lateral cutaneous branch of the 4th intercostal nerve and its deep branch which tends to run along the fascia of the pectoralis major before emerging to innervate the nipple from its posterior surface (**Figures 6 and 7**) [4]. Additionally, the cervical plexus contributes to sensory innervation of the superior aspect of the breast [12].

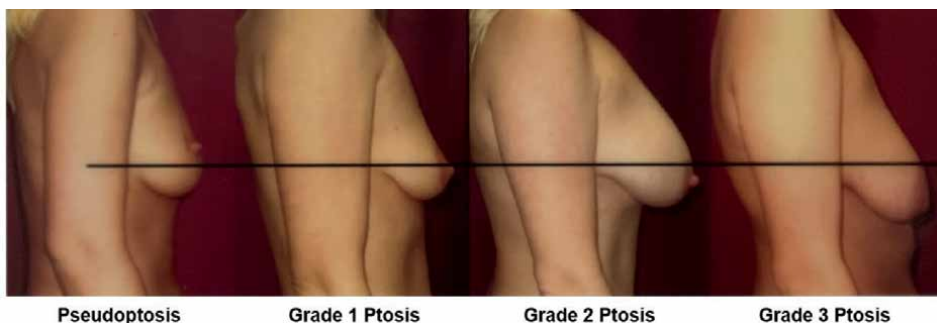


Figure 4. Ptosis grading. Dark line indicates the IMF which is used as the reference point for ptosis grade.

Regnault’s classification of ptosis	
Minor ptosis (1st degree)	Nipple at the IMF or 1 cm inferior to IMF
Moderate ptosis (2nd degree)	Nipple inferior to IMF & superior to lower breast contour
Severe ptosis (3rd degree)	Nipple inferior to IMF & at lower breast contour
Glandular ptosis	Nipple superior to IMF & breast tissue inferior to the breast fold
Pseudoptosis	Nipple superior to IMF; breast is hypoplastic & inferior to the breast fold

Table 1. Ptosis as described by regnault.

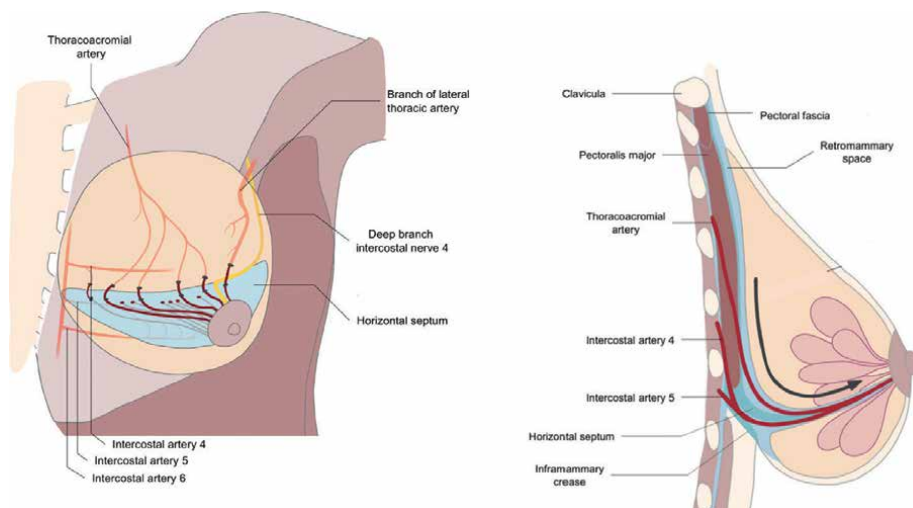


Figure 5.
Left: Anterior view schematic of the breast's arterial supply. Right: Lateral view schematic of the breast's arterial supply [10].

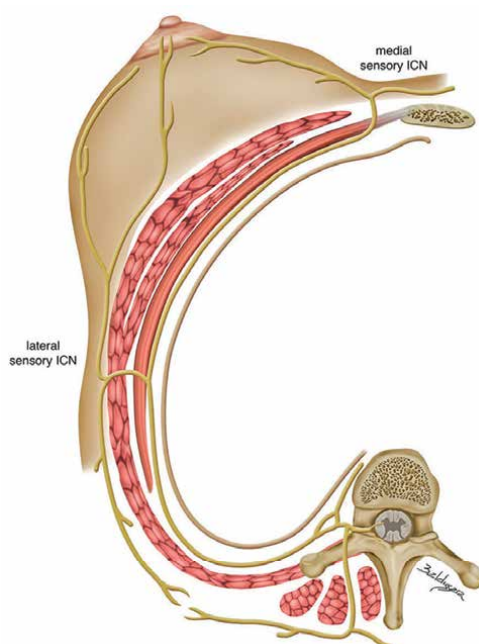


Figure 6.
Axial view schematic showing the cutaneous nerve supply of the breast [12].

2.5 Lymphatics

The primary lymphatic drainage of the breast flows into the axilla through the external mammary nodal group, however, additional drainage occurs through the medial, transpectoral and postpectoral routes as well [4].

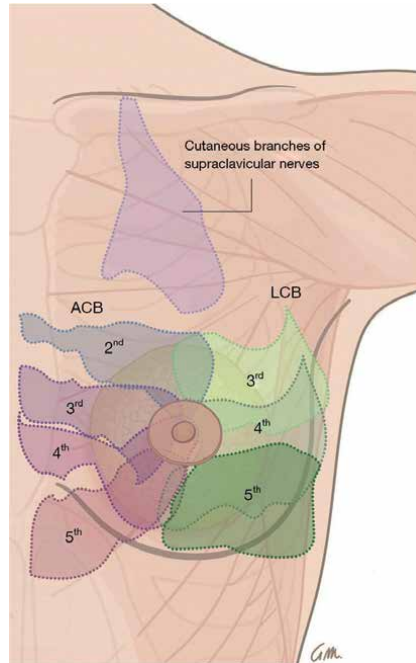


Figure 7. Schematic representation of the nerve supply of the anterior chest wall, indicating the individual contributions of the 2nd–5th anterior, and 3rd–5th lateral cutaneous branches of the intercostal nerves. ACB, anterior cutaneous branch; LCB, lateral cutaneous branch [13].

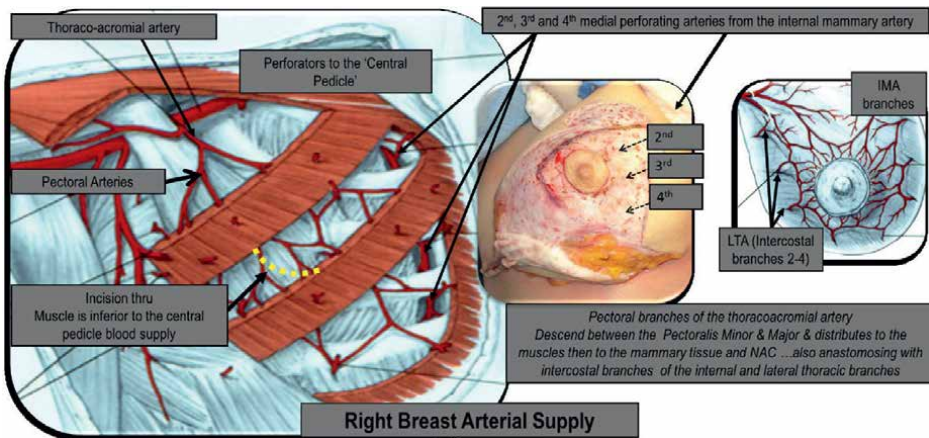


Figure 8. The figure demonstrates the two major sources of blood supply to the superomedial-central (SMC) pedicle. The medial source from branches of the internal mammary artery and central component from the pectoral perforators. The 2nd medial perforator supplies the most superomedial area of the SMC pedicle. Maintaining all these sources during dissection produces a robustly vascularized pedicle.

2.6 Chest musculature

The chest wall musculature includes the Pectoralis Major, Pectoralis Minor, Serratus Anterior, External Oblique, Rectus Abdominis, and Intercostal muscles.

When performing total submuscular placement of a breast implant, the implant is below the pectoralis major muscle, preserving the perforating pectoral branch vessels of the pectoral branch of the thoracoacromial artery [4, 9]. Of key importance, the 2nd-4th medial perforating arteries from the internal mammary artery along with pectoral arterial branches from the thoracoacromial artery supply the NAC in the majority of our combined mastopexy with or without augmentation cases; which utilize a superomedial central pedicle (SMC) (**Figure 8**).

3. Clinical evaluation

3.1 Patient interview

A thorough preoperative evaluation permits an understanding of the most appropriate options available to achieve the desired result, and allows the surgeon to obtain medical and social history, perform a physical exam, and partner with the patient to set achievable expectations based on anatomical limitations that may exist. The patient's desired breast size is ascertained. In addition, this is an opportunity to explain the postoperative process, as well as the risks and benefits of alternative options.

When performing clinical evaluation we focus on obtaining a thorough medical history and social history including use of nicotine products, i.e. vaping, chewing tobacco, and cigarettes, as these can impact the healing process. History of breast-feeding and number of pregnancies is discussed in order to appreciate the associated changes in breast volume and position. For patients over the age of 40 or patients who are at high risk of breast cancer, i.e. strong family history, breast masses, +BRCA test should undergo mammography prior to surgery [14].

3.2 Physical exam

Physical examination of the patient begins with inspection of the breasts and evaluating the skin envelope with regard to laxity and quality, breast volume, position

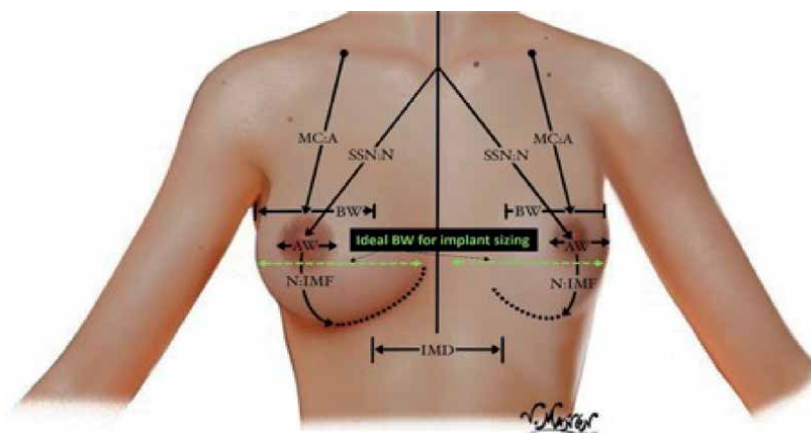


Figure 9. Schematic showing the markings that are obtained during initial patient evaluation. SSN:N - suprasternal notch-to-nipple distance, N:IMF - nipple-to-IMF distance, BW - base width or breast width, IMD - Inframammary distance, MC:A - midclavicular axis, AW - areola width.

of the NAC, areolar size, asymmetries including deformities of the chest or spine that can contribute to such asymmetries [9]. The degree of ptosis is assessed which is defined as the position of the nipple in relation to the inframammary fold and skin envelope.

Topographical measurements from fixed points on the torso on the breast itself are used to analyze the breast (**Figure 9**) [9].

Sternal Notch-to-Nipple: Determines the location of the NAC complex on the chest wall. The nipple is most often situated 19–25 cm from suprasternal notch [9].

Nipple to IMF: The appropriate distance from the nipple to the IMF is approximately 7 cm [9]. This is critical to establish an esthetic lower fullness and overall breast shape. The upper pole slope is linear or slightly concave, and the lower pole is convex.

Breast Width/Base Width: Typically different from the actual breast width of the native breast tissue, and can be measured as the distance from the Anterior Axillary line to within 1 cm from chest midline. This measurement dictates the appropriate implant width.

Intermammary Distance: Distance from nipple to nipple; usually 21 cm [9].

4. Treatment planning

4.1 Pedicle design

The operative plan depends largely on physical exam and evaluation of topographic measurements of both breasts in conjunction with noting the location of the breast mound and its location on the chest wall. A Sternal Notch-to-Nipple distance >25 cm and/ or Nipple-IMF distance >10 CM usually signifies that the patient will require a mastopexy alone or in conjunction with augmentation [2]. Indications for augmentation with simultaneous mastopexy include any patient that requires correction of ptosis and desires increased breast volume [2]. Generally, pedicle design is based on sternal notch to nipple distance (**Table 2, Figure 10**). We have found the following measurements (**Table 2**) and their respective pedicle designs to yield reliable vascular supply to the NAC while permitting good areola rotation without significant kinking of the pedicle.

The SMC pedicle provides the most robust blood supply in combined mastopexy augmentation procedures when the the sternal notch-to-nipple distance is ≤ 30 cm as the majority of the blood supply to this pedicle originates from the Internal mammary artery via intercostal perforators and a central component with trans-pectoral perforators from the pectoral branch of the thoracoacromial artery. Of note, the central vascularization can only be maintained well when placing implants in a subpectoral plane. Placing implants in the subglandular plane sacrifices the central pedicle (**Figure 11**) [4].

Sternal notch to nipple distance	Pedicle choice
<30 cm	Superomedial Central (SMC)
30–36 cm	Medial Central (MC)
> 36 cm	Inferior pedicle or No pedicle w/ Free nipple grafting

Table 2.
Pedicle design choice based on the sternal notch-to-nipple distance.

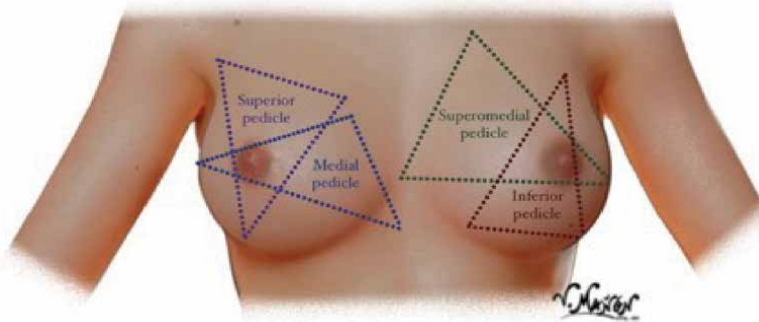


Figure 10.
 Schematic showing the different axes associated with different pedicle choices.

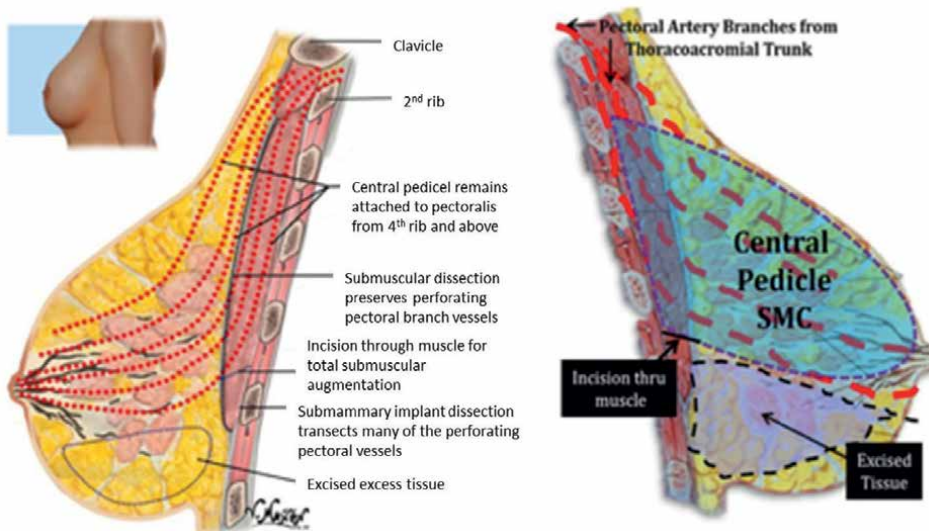


Figure 11.
 Schematic lateral view of the breast showing the central component of the SMC and MC pedicles which is only maintained with a subpectoral dissection.

The MC Pedicle provides a good alternative when the sternal notch-to-nipple distance is >30 CM but <36 cm. This option maintains the medial mammary and pectoral perforator arterial branches while allowing a better arc of rotation of the pedicle into its final position without excessive kinking or tension to the pedicle [4].

The Inferior Pedicle is used in very long sternal notch-to-nipple distance whilst also having a comparatively short nipple-IMF distance of <5 cm. Since the inferior pedicle bottoms out more than other pedicles, the vertical limbs should be reduced close to 5 cm compared to the usual 7 cm length of the SMC and MC pedicles that exhibit very limited stretching [4].

A free nipple graft, obviating the use of a pedicle, is considered for a sternal-notch-to-nipple distance of >36 cm, in a breast that has had previous surgeries to have likely violated the blood supply relied upon in a SMC or MC pedicle, or in any other situation in which vascular supply is deemed compromised.

4.2 Implant size

Determining appropriate implant size can prove difficult. The patient's desired breast size must be balanced with what can be safely accommodated. Implant size will be limited to a degree based on the patient's anatomy, tissue quality, and breast skin laxity. Undoubtedly, the appropriate implant size that is used in simultaneous mastopexy with augmentation varies among surgeons. The plastic surgery literature suggests that most implants used in this single stage procedure are less than 400 cubic centimeters [15–17]. However, in select patient's larger implants can and have been safely placed. An acceptable upper limit of implant size has not been defined as breast characteristics will dictate what size can be safely accommodated. Intraoperative sizers, as discussed below, are informative as to the tension that will be placed on the breast for a given implant size. Caution must be exercised regarding implant size as to avoid overaggressive sizing resulting in excess breast tension, compromised blood supply, and wound breakdown. Conservative implant sizing is the rule in order to minimize complications.

4.3 Preoperative markings

There are few if any cosmetic surgical markings that are as nuanced and difficult to correctly perform as the mastopexy. The Wise pattern mastopexy is the most widely used method to address moderate to severe breast ptosis and is appropriate for a nipple to IMF distance >10 cm. A vertical or "lollipop" lift is appropriate in most cases in which the nipple-IMF distance is <10 cm, minimal lifting is needed, and a large amount of breast tissue excision is not indicated or desired. There are markings common to all mastopexy procedures as they are used for reference regardless of the incision pattern chosen.

4.4 Reference markings

The patient is in the standing position with arms relaxed at the sides. The midline sternal notch is marked. A vertical line extending from the sternal notch is drawn down the midline of the sternum between the breasts. The mid clavicular line is marked. The breast meridian is marked by extending a straight line from the mid clavicular point down the breast through the NAC and down through the inframammary fold. The inframammary fold position is transposed and marked on the anterior surface of the breast (**Figure 12**). The medial aspect of the planned breast implant pocket is marked at 1 cm lateral to the midline. This marking is carried superiorly and laterally with a gentle arc to define the superomedial limits of the breast implant position. NAC position is then determined. Several factors are considered in marking its position. (1) The NAC should sit at or slightly above the inframammary fold. (2) Appropriate nipple position has been described as being level with the midpoint of the humerus (3) sternal notch to nipple distances usually ranges from 19 to 21 cm, (4) finally the planned NAC position is looked at subjectively to ensure it lies in an esthetic position. Based on these factors, the top of the new areola position is marked. Once the new areola position is determined, the reference markings are concluded and incision marking takes place.

4.5 Wise pattern mastopexy

A template is then used to make the "Wise pattern" incision markings. First the incision for the new areola position is marked in semicircular fashion. Vertical

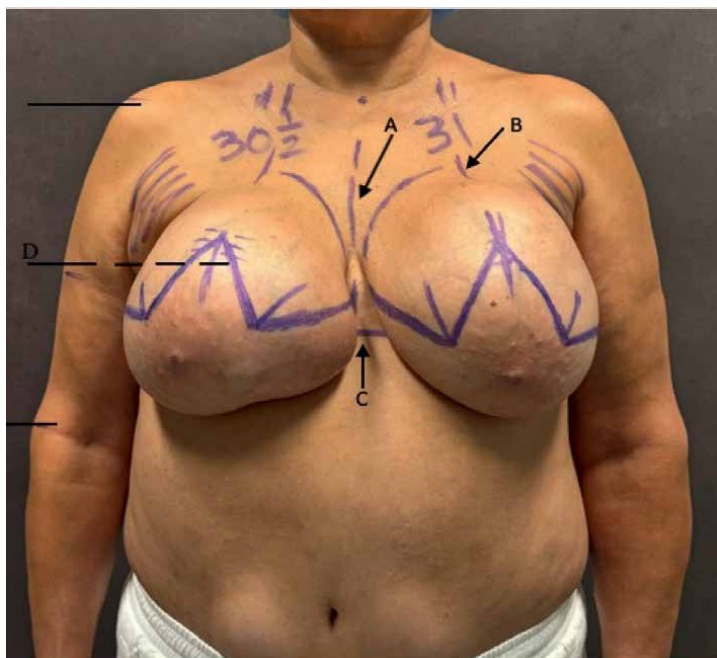


Figure 12.

(A) vertical line extending from the sternal notch is drawn down the midline of the sternum between the breasts. (B) The breast meridian is marked by extending a straight line from the mid clavicular point down the breast through the NAC and down through the inframammary fold. (C) The inframammary fold position is transposed and marked. (D) The NAC should sit at or slightly above the inframammary fold.

limbs are then drawn. The vertical limbs define the new nipple to fold distance and should be 7 cm in length. Great care is taken to ensure both limbs are the same length. A judgment must be made as to what angle the vertical limb incisions diverge from the areola marking. Clearance of the native areola will in part dictate this angle. A more obtuse angle equals more parenchymal excision while a more acute angle will yield less parenchymal excision. Hence, for the wider breast a more obtuse vertical incision is marked and for a more narrow breast, a more acute vertical incision is marked. The IMF incision is then marked approximately 1 cm superior to the actual fold. The length of the IMF incision changes based on the preoperative breast size and extent of lifting required. Larger, more ptotic breasts require a longer fold incision while those that require less lifting but are not candidates for a vertical mastopexy are best addressed with a rather short fold incision. The vertical limb markings are then connected via a horizontal limb to the medial and lateral ends of the IMF incision marking (**Figure 13**). One must keep in mind that with a short IMF incision there will be minimal excision of lateral and medial breast tissue at the breasts inferior pole. In a patient with large breasts, particularly a wide inferior pole, too little medial and lateral breast parenchyma excision at the inferior pole of the breast will result in a wide, boxy, even square shaped breast. Conversely, an IMF incision that is excessively long will not necessarily result in a displeasing inferior pole shape, but produces an unnecessarily long scar. Finally, areas planned for liposuction are made. As with all cosmetic surgery, an eye of esthetic judgment must be maintained whilst following a dogmatic approach to surgical marking.

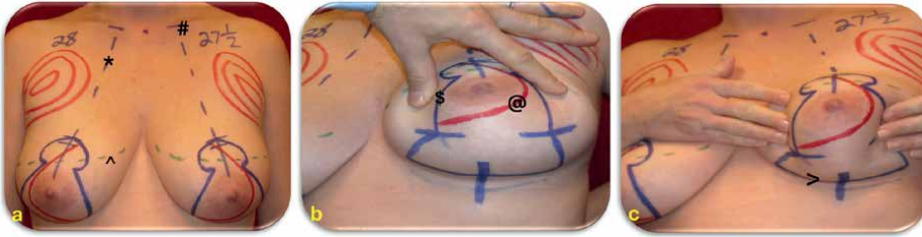


Figure 13. Reference markings and incision marking for wise pattern mastopexy. Dashed lines represent reference markings. Solid blue lines are incision markings. Red concentric circles are areas of planned liposuction. a. # midclavicular point, * midclavicular line extending through breast meridian, ^ transposed IMF. b. § 7 cm medial vertical limb incision, @ SMC pedicle design. c. > IMF.

4.6 Vertical mastopexy

When the nipple-IMF distance is normal or near normal, i.e. <10 cm, omitting the horizontal incisions of the Wise pattern mastopexy may be appropriate. One situation in which vertical mastopexy would not be appropriate with a near normal nipple-IMF distance is in a wide breast with a voluminous inferior pole necessitating a large amount of inferior pole breast tissue excision. In such a case, the only way to eliminate skin redundancy after an abundant inferior pole parenchymal excision is to excise the skin which is accomplished via the Wise pattern.

A template is used to mark the new areola position and vertical incisions. The vertical incisions again need to clear the edges of the areola and are then tapered medially to come to a point above the inframammary fold. There are times when the gentle tapering of the vertical incisions comes to a point below the IMF. In this situation, the vertical incision markings are gently curved laterally to avoid the incision crossing the IMF (**Figure 14**).

4.7 Anesthesia

It is extremely difficult and technically challenging to achieve adequate local anesthesia of the chest wall musculature which will be heavily manipulated during

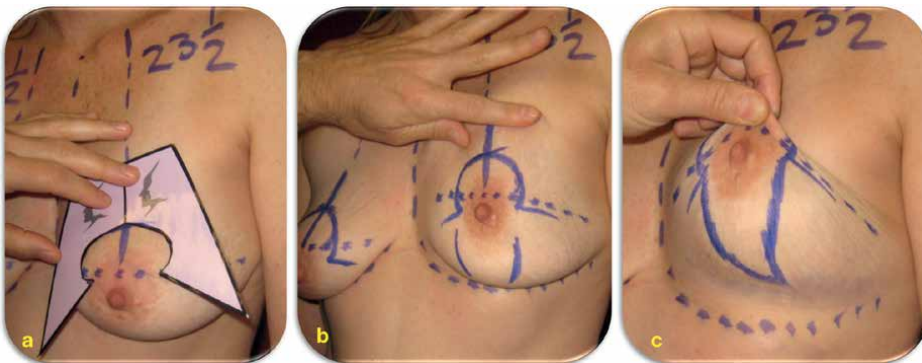


Figure 14. Vertical mastopexy markings. Dashed lines are reference markings indicating the IMF and transposed IMF onto the breast skin. a. Template being used to mark the new areola position. b. Vertical limbs are drawn. c. vertical limb is completed by bringing the tapered end laterally to avoid the incision crossing the IMF; the nipple-to-IMF distance is approximately 7 cm.

submuscular implant pocket creation, therefore, the procedure is best performed under general anesthesia. To aid in limiting the amount of analgesia administered systemically, local tumescent anesthesia is used. With anesthesia induction complete, modified Klein Solution made up of 1 L Normal Saline, 30 mL 1% lidocaine, and 1 mL of 1:1000 epinephrine is infiltrated into the planned incisions, the area to be de-epithelialized, and into the subpectoral space with care not to violate the chest wall and inadvertently causing a pneumothorax.

5. Operative technique

5.1 Liposuction

Liposuction is a wonderful adjunct to breast surgery and offers improved definition of the breast resulting in a more refined, rounded shape. Unaddressed fullness adjacent to the breast diminishes its contour and underwhelms the expected result. Prior to surgery, the decision is made as to whether liposuction of the perimammary fat is indicated. The areas to be liposuctioned are marked preoperatively. Liposuction is performed in the patient with excess subcutaneous fat causing abnormal fullness overlying the anterior aspect of the superolateral pectoralis major, within the axilla and lateral thorax, and/or the upper abdomen. .

5.2 Areola diameter and marking

Areola diameter is marked with an areola marker with a 38–42 mm diameter while the breast is compressed circumferentially to stretch or expand the areola. Care is taken to ensure stretching is symmetric in order to avoid overstretching or understretching a portion of the areola thus resulting in an oblong segment of areola following incision.

5.3 Skin incisions and de-epithelialization

Initial skin incisions are made 360° around the areolar only down to the dermis. Remaining incisions based on preoperative markings are made. The areolar inset incision and vertical limb incisions are made down to the dermis. The horizontal limbs and IMF incisions are made full thickness down through the dermis.

De-epithelization is performed in a superior to inferior direction. One must remain aware of the areola position so that it is not inadvertently undermined. De-epithelization is continued inferiorly to just beyond the level of the horizontal limb incisions where the skin is left attached and removed en bloc with the breast parenchyma to be excised later.

5.4 Pedicle design—Superomedial central and medial central pedicle

Pedicle design is based on sternal notch-to-nipple distance as described previously. The SMC pedicle is marked with a curvilinear incision beginning superiorly at 12 o'clock with respect to the de-epithelialized skin and extending in an inferolateral direction around the NAC and then medially to end at the corner of the vertical and horizontal limb of the medial pillar.

For a medial pedicle, the incision is made beginning at 2 o'clock for the right breast, 10 o'clock for the left breast with respect to the areola inset incision. Again the

incision is brought laterally and curved around the NAC, then medially to the corner of the vertical and horizontal limb of the medial pillar. This slight positional change compared to the SMC pedicle allows for rotation of the more ptotic NAC into its new position without undue tension and kinking of the pedicle (**Figure 15**).

5.5 Parenchymal excision

At this point, full thickness horizontal limb incisions and IMF incisions have been made. The medial extent of parenchymal excision is defined by the border of the pedicle. At this point, there will be a small area of dermis that has not yet been incised just lateral to the pedicle. This dermis is incised following the already made skin incisions (**Figure 15c**).

Initial parenchymal dissection is begun inferiorly at the inframammary fold. The parenchyma is incised and dissection is carried deeply with a bevel headed in the superior direction at an angle of approximately 30° until the pectoralis fascia is encountered. The pectoralis fascia is followed superiorly to the level of the inferior limits of the pedicle. Any undermining beyond the inferior edge of the pedicle will violate the pectoral perforator vascular supply of the central component of the pedicle. The horizontal limb incisions are carried through the parenchyma at 90° respective to the skin down to the pectoralis fascia. The lateral vertical limb incision is likewise carried at 90° down through the parenchyma to the pectoralis fascia. The pedicle defining incision (at the pedicle's lateral edge) is then carried deeply through the parenchyma down to the pectoralis fascia. The parenchymal dissection around the pedicle is performed with a bevel away from the NAC, thus forming a pyramid of parenchyma beneath the NAC (**Figure 16**). The parenchyma defined by these incisions down to the pectoral fascia is then divided off of the pectoral fascia and removed.

5.6 Pectoralis major entry and total submuscular pocket creation

The entry point for a total submuscular pocket is through the pectoralis major at the point which underlies the new NAC position (**Figure 17**). The pectoralis muscle

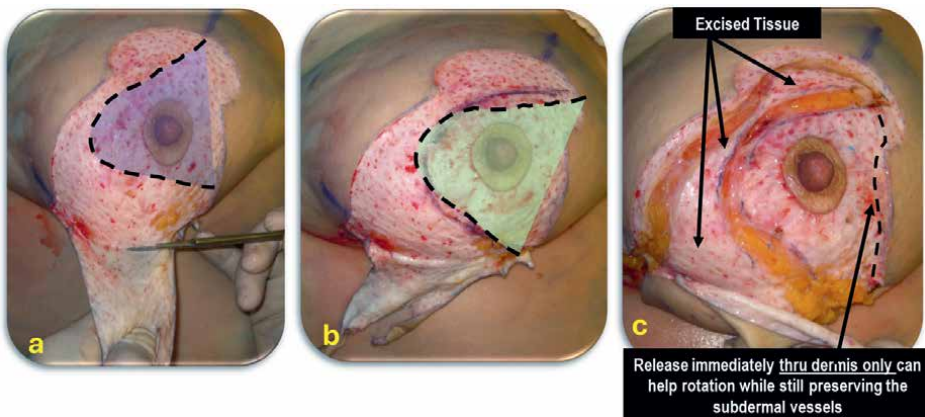


Figure 15. Right breast. Pedicle design and parenchymal excision. a. Superomeial-central pedicle design for a sternal notch-to-nipple distance <30 cm. b. Medial central pedicle design for sternal notch-to-nipple distance of >30 cm and < 36 cm. c. A medial pedicle has been delineated and incisions through the dermis have been made. These incisions define the area of parenchyma that will be excised.

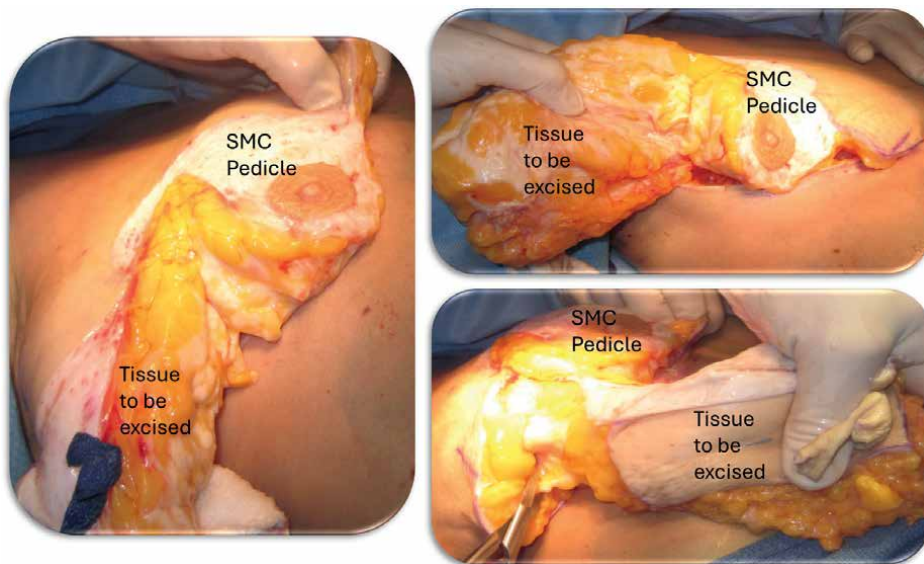


Figure 16. Right breast. A superomedial central pedicle has been defined. Parenchymal incision takes place down to the pectoralis fascia and parenchyma is excised lateral and inferior to the pedicle. ** The pedicle is not undermined. The parenchyma underlying the pedicle is full thickness down to the pectoralis fascia.

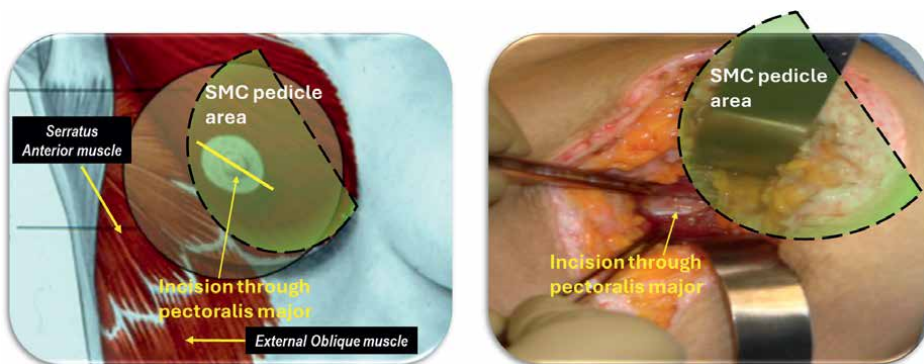


Figure 17. Right breast. The pectoralis entry point directly underlies the new areola position.

is incised parallel to the muscle fibers. The incision should be 3–4 cm in length and initially quite superficial. A safe entry is aided with an alic clamp at each side of the incision lifting the pectoralis major off of the chest wall. The incision is then carried through the pectoralis major muscle to the subpectoral fibrofatty tissue.

At this point a finger is inserted into the submuscular space and directed superiorly along the chest wall. As with any breast implant surgery, care is taken not to violate the limits of the anterior axillary line laterally and the medial implant placement marking. Finger sweeping is first performed from superior to medial to inferior, then from superior to lateral, ensuring not to breach the anterior axillary line. To achieve total submuscular coverage, an effort is made laterally to finger dissect beneath a portion of the serratus anterior and external oblique. Finally,

blunt finger dissection is carried out inferiorly. At the inferior portion of the pocket, the muscular attachments can be quite adherent and must be elevated off of the chest wall with care not to perforate the overlying tissue. The inferior dissection is taken down to the inframammary fold (**Figure 18**). In instances where the inferior dissection seems likely to perforate or where a perforation has already been made, monopolar diathermy can be used to complete the dissection without causing additional perforations or extension of already present perforations. When dissecting the inferior portion of the pocket, care must be taken to avoid going beneath the rectus abdominis fascia which is palpated as a thick, tight, horizontal band of fascia approximating the inframammary fold. The defining factor in total submuscular implant placement is the incorporation of the chest wall musculature lateral and inferolateral to the pectoralis major, namely the serratus anterior and occasionally the external oblique.

5.7 Freeing the pedicle to permit rotation

Using monopolar diathermy on cut function and Adson forceps to lift the dermis, the dermis is incised along the medial aspect of the pedicle (**Figure 15c**). This is performed slowly, with great precision in a “layer by layer” fashion until the full thickness of the dermis has been incised. Subdermal vessels are visualized and kept intact.

Next, the parenchyma at the inferomedial aspect of the pedicle, immediately adjacent to the medial pillar is minimally incised with the monopolar diathermy to a depth of approximately 1 cm. This step is necessary to permit rotation of the NAC into position without distorting the medial pillar and avoid undue tension on the pedicle.

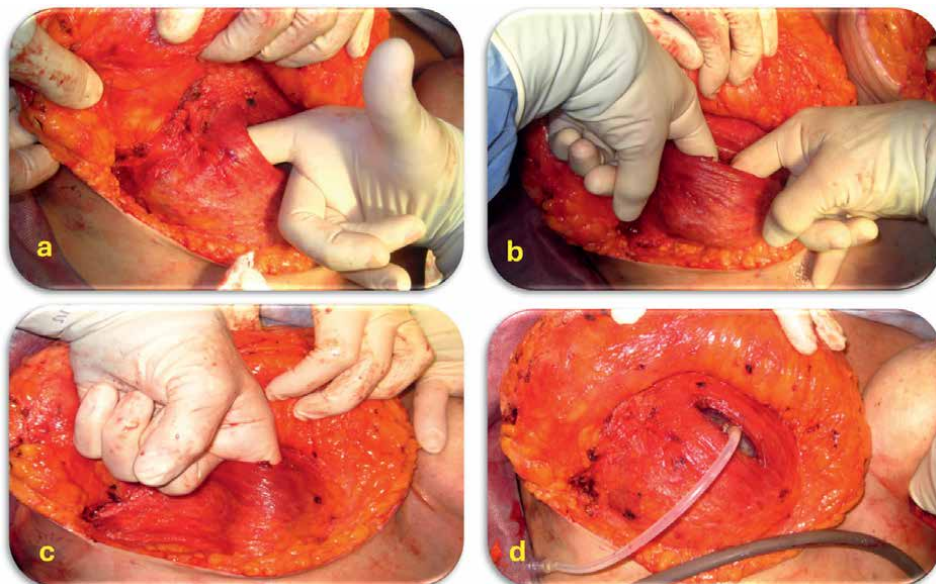


Figure 18. Right breast. a. Blunt finger dissection is performed superiorly initially. b. The pocket is further developed with finger dissection more inferiorly. c. Finger dissection is performed down to the level of the IMF. d. A sizer has been placed showing total coverage within the total submuscular pocket.

5.8 Initial sutures

A 2-0 polyglactin (Vicryl) suture is used to approximate the superior portion of the vertical limbs by placing two sutures in the deep dermis. The NAC is then rotated into its new position and secured in place with a buried, deep dermal 2-0 polyglactin suture at 12, 3, 6, and 9 o'clock positions. Four 4-0 poliglecaprone (Monocryl) sutures are then placed in the dermis between the polyglactin sutures in buried fashion. This initial closure permits evaluation of the breast size, shape and tension when the sizer is introduced into the pocket.

5.9 Sizers and implant size selection

A temporary sizer is inserted and filled to the volume estimated pre-operatively. Once inflated, the overlying breast tissue tension is assessed. The breast at this point is not fully closed, therefore some manual manipulation of the breast tissue, particularly the pillars is performed to estimate breast tissue tension if the breast were to be closed at the current sizer volume. The sizer volume is adjusted accordingly to balance the patient's desired breast size with minimal breast tissue tension. If obvious areas of restriction inhibit proper positioning of the sizer, blunt finger dissection and stretching of the pocket can be performed to relieve these restrictions.

5.10 Hemostasis

The sizer is removed. Hydrogen peroxide soaked lap sponges, usually 3–4 of them, are placed into the implant pocket and left in place for 2–3 minutes. The sponges are then removed and the pocket is visually assessed for any bleeding. Meticulous hemostasis is achieved using monopolar diathermy.

5.11 Implant delivery

The implant pocket is irrigated with betadine and antibiotic solution containing 1 g cefazolin and 80 mg gentamicin in 500 ml of saline. The implant is soaked in the same solution and is then delivered into the pocket using a Keller Funnel. Valve position is confirmed. Again, blunt finger dissection and/or stretching of the pocket is performed as needed to accommodate proper implant position. The patient is sat up at this point and implant height is assessed and the pocket is adjusted as needed to achieve symmetry.

5.12 Closure

Closure of the pectoralis entry point is often unnecessary, but can be closed if desired. A strong suture such as a 0 polyglactin suture is used in "three-way" fashion to place a parenchymal suture that approximates the inferior aspect of the pillars and then approximates the pillars to scarpa's fascia at the inframammary fold. Deep dermal sutures are then placed in buried interrupted fashion to reapproximate the remaining portion of vertical incision and the inframammary fold incision. The authors prefer to use a 2-0 polyglactin suture for this. These sutures should bear the majority of any tension placed on the breast. The skin of the inverted-T incision and the areola are then closed with a 3-0 barbed poliglecaprone (Mondoderm Quill) suture.

5.13 Dressings

Mastasol and Robbins tape is placed over all incisions. A supportive bra is then placed and often a superior strap is used.

6. Post-operative care

6.1 Breast support and incision care

A supportive post-surgical bra is worn for 1 week. If a superior strap is used to prevent superior displacement of the implant, it is generally worn for 1 week. After 1 week, a supportive sports bra is worn for 3 months. Robbins tape is left on for 1 week. At the 1 week post operative appointment, tape is replaced with brown paper tape which is left in place for 5 additional weeks. Silicone tape is then recommended to be worn whenever feasible for the following 3 months.

6.2 Activity/restrictions

- Week 1:
 - *No*: lifting >10 lbs., lifting the arms above 90°, exercise, submerging the incision in water, doing anything that engages the pectoralis muscle
 - *Yes*: daily showering using hibiclens soap, light walking
- Week 2:
 - *No*: lifting >10 lbs., exercise, submerging the incision in water, doing anything that engages the pectoralis muscle
 - *Yes*: daily showering using hibiclens soap, light walking, slowly progressing to raise the arms over the head
- Week 3–6:
 - *No*: resistance training that flexes the chest or shoulder, i.e. bench press, shoulder press, push ups, dips, tricep presses.
 - *Yes*: resume cardiovascular exercise as long as there is no bouncing, i.e. walking at incline, elliptical, stationary bike with plenty of bra support.

7. Complications

Complication rates of simple breast surgery are notable. Studies have consistently shown a 15–25% reoperation rate post primary augmentation, and clinical experience shows that this rate is consistent when augmentation is combined with

mastopexy [18]. Interestingly, these studies have shown that combined surgery complication rates are not exponential nor additive compared to two stage approaches [19]. Significant complications like implant extrusion, infection and nipple necrosis are very uncommon. More prevalent complications include Implant displacement, Hematoma, and capsular contracture.

7.1 Infection

Meticulous sterile technique is paramount in any surgery, but even more so when dealing with an implant of any kind. Studies show that in addition to meticulous sterility, infection following breast implant surgery is mitigated by soaking the implant and irrigating the implant pocket prior to insertion with povidone-iodine (PI) with or without antibiotic solution [20]. Our preference is to soak the breast implant and irrigate the implant pocket in solution containing PI with 1 g Ancef and 80 mg gentamicin. A Keller funnel is used for implant placement. Keller funnel for placement of implant reduces the amount of skin contact and has been shown to decrease potential parenchyma contamination compared to digital insertion technique [21].

7.2 Capsular contracture

Capsular contracture is the most common reason for reoperation following breast implant surgery. The reported incidence of capsular contracture varies by source. A recent database search of MEDLINE shows an incidence of 10.6% [22]. Certain factors have been shown to decrease this incidence. Less than a decade ago, implant choice between textured, polyurethane coated implants and smooth implants was an option. Capsular contracture rates were noted to be less with micro-textured and polyurethane coated implants. In 2019, a link between breast implant associated-anaplastic large cell lymphoma was found and such implants were recalled. The remaining implant choices are between manufacturers and silicone vs. saline filled. New generation silicone implants, which dominate the current implant market, show acceptably low capsular contracture rates of approximately 4% [22].

Surgical technique used has also been shown to affect capsular contracture rates. It is well known that subglandular implant placement confers increased risk of capsular contracture. Submuscular implant placement was shown to have a 2.8% rate of capsular contracture vs. 8.6% for subglandular placement [23].

Management of capsular contracture depends on degree of contracture and implant integrity [9]. For Baker grades I and II, the patient may be instructed to perform daily massages to soften the breast capsule or take a leukotriene inhibitor (montelukast/zafirlukast) for several months to prevent worsening and reduce the degree of contracture. Leukotriene inhibitor therapy (Zafirlukast/Montelukast) has been shown to reduce capsular contracture grade and even decrease the risk of capsular contracture development [14]. For moderate to severe cases with Baker grades III or IV, surgical intervention is indicated with either capsulotomy, capsulectomy, implant pocket exchange, use of acellular dermal matrices, or soft tissue/muscle flaps (**Figures 19 and 20**) [9]. The success rate of resolution after reoperation and implant exchange is 79%. Unfortunately, the recurrence rate is ~54% [24]. However, a more recent systematic review performed by Wan and Rohrich, found that implant exchange is associated with 0–26% recurrence rate of capsular contracture compared with no implant exchange.



Figure 19. Grade IV capsular contracture. Patient with Grade IV capsular contracture. Patients with capsular contraction who desire a breast lift with augmentation must be informed of the high revision rate and risk of complications.

7.3 Hematoma

Hematoma is among the more common postoperative complications related to breast implant surgery. The obvious remedy is avoidance with meticulous hemostasis. Untreated hematoma results in increased risk of capsular contracture, results in increased breast tissue tension and potentially reduced perfusion of at risk breast tissue. In the event of hematoma, the implant pocket should be explored and hematoma evacuated.

7.4 Implant displacement

Implant displacement is mitigated by submuscular placement of the implant. It is important to avoid inadequate release of the inferior aspect of the breast pocket to avoid superior displacement, however, care must also be taken not to dissect beyond the IMF as this too predisposes the implant to displacement but in the inferior direction. Similarly, avoid lateral or medial malposition by avoiding over dissection of the submuscular pocket. Clear post operative instructions are given that are conducive to adequate healing and breast support.

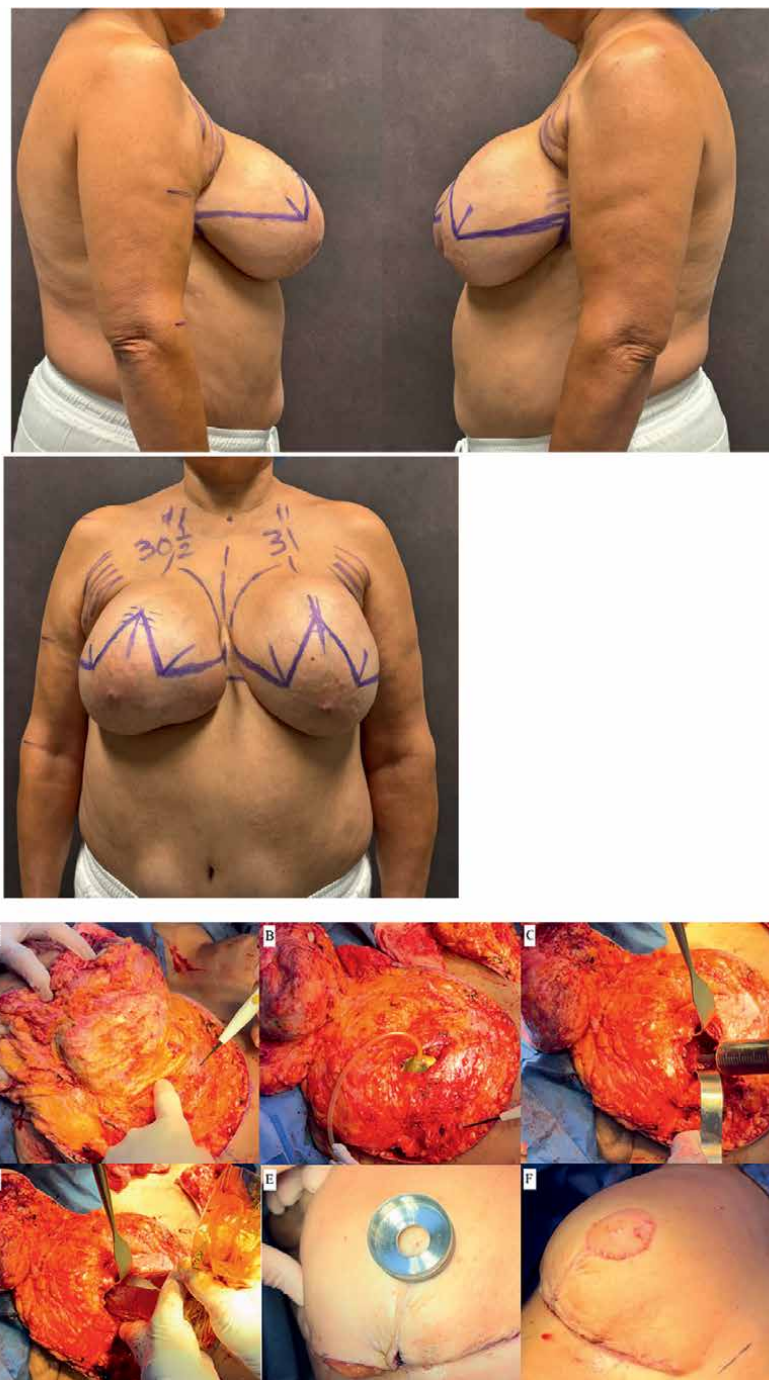


Figure 20. Grade IV capsular contracture. 64 year old female with 30 year history of subpectoral 300 cc silicone implants desiring softer but equal or slightly larger size. Planned for removal and replacement of implant, total capsulotomy, augmentation with silicone implants, and free nipple graft. (A) Dissection of Capsulotomy (B) Utilizing Sizers to determine appropriate implant size (C) Implant pocket irrigated in solution containing PI with 1 g Ancef and 80 mg gentamicin (D) Keller funnel is used for placement of 450 cc SRF silicone implant (E) Areolar marker to outline position of new nipple and area to deepithelialize. (F) Free nipple graft positioned and sutured with 5-0 plain gut suture.

In the event of early malposition of the implant, manual force applied to the breast overlying the implant in the direction of needed movement is applied 3× daily for a constant 60 seconds until implant position is appropriate. Alteration to the patient's sports bra can be made such as placing a gauze padding inferiorly or laterally to apply a medially or superomedially directed force. In the event of impending medial displacement and symmastia, a thong bra should be worn.

7.5 NAC necrosis

Fortunately, NAC necrosis is rare. Its prevention is best assured by appropriate pre-operative planning i.e. proper patient selection, patient avoidance of nicotine-containing substances, and appropriate pedicle design.

If signs of mild NAC vascular compromise are noted intraoperatively, any periareolar hematoma should be evacuated and hemostasis assured. Nitropaste application is also helpful in relieving minor venous congestion. Further intervention to relieve vascular compromise includes removal of suture around the NAC and/or implant removal. These maneuvers decrease extrinsic vascular pressure leading to decreased venous congestion and increased tissue perfusion. Finally, hyperbaric oxygen has shown promise in avoiding NAC necrosis when vascular compromise is present or suspected.

7.6 Wound breakdown

The most common site of wound breakdown is at either point trifurcation. Surgical technique that leaves adequate subcutaneous tissue underlying the corners of the trifurcation is requisite for successful healing. Overzealous implant sizing resulting in increased tissue tension upon closure potentially compromises wound healing. Finally, tension bearing suture placement directly at the trifurcation should be avoided as this tends to be a source of inflammation leading to suture spitting and skin breakdown.

8. Summary

Simultaneous mastopexy with breast augmentation, while technically challenging, when performed with appropriate patient evaluation and selection and proper surgical planning provides the patient and surgeon a single stage, rewarding experience with a high probability of success. The SMC and MC pedicles with total submuscular implant placement provide ideal implant coverage with a robust NAC vascular supply. Combined mastopexy with augmentation should be part of the armamentarium of the cosmetic breast surgeon as it obviates a second stage procedure with its associated increased patient costs and delay in achieving the patient's ultimate desired result.

9. Case studies

9.1 Case 1

See **Figure 21**.

9.2 Case 2

See **Figure 22**.

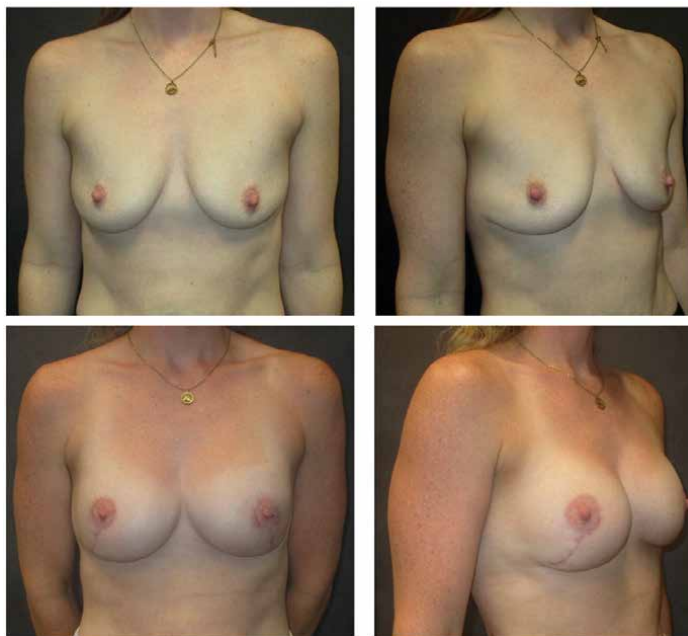


Figure 21. 33 year old woman with grade 2 ptosis and significant deflation. Sternal notch-to-nipple distance: right 23.5 cm, left 23 cm; nipple-IMF distance: right 7 cm, left 7.5 cm. 6 weeks after vertical mastopexy was performed using a SMC pedicle. 320 cc silicone implant. Total submuscular placement.

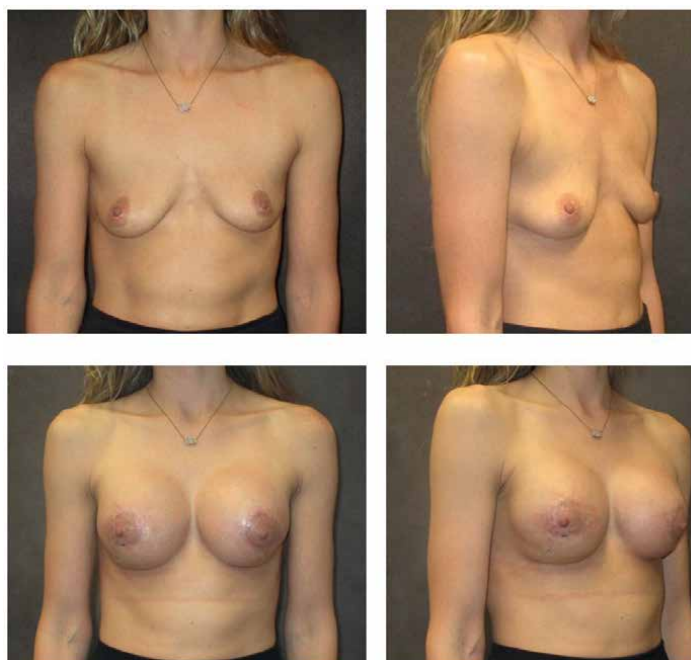


Figure 22. 32 year old female, grade 1 ptosis with significant deflation. Sternal notch-to-nipple distance: right 21 cm, left 19.5 cm; nipple-IMF distance: right 6 cm, left 4.5 cm. 6 weeks after vertical mastopexy was performed using a SMC pedicle. 345 cc silicone implant, total submuscular placement.

9.3 Case 3

See **Figure 23.**

9.4 Case 4

See **Figure 24.**

9.5 Case 5

See **Figure 25.**

9.6 Case 6

See **Figure 26.**

9.7 Case 7

See **Figure 27.**

9.8 Case 8

See **Figure 28.**

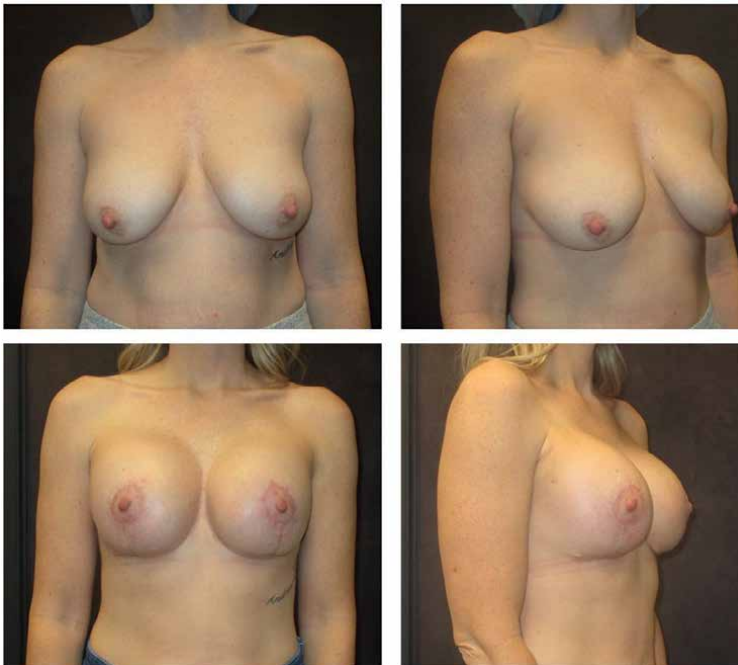


Figure 23. 34 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 26 cm, left 25 cm; nipple-IMF distance: right 7 cm, left 8 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 365 cc silicone implant, total submuscular placement.

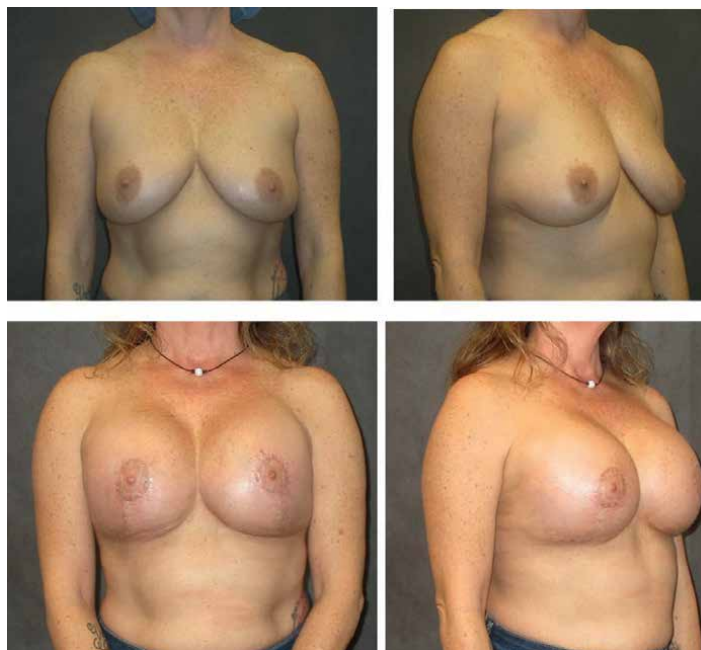


Figure 24. 54 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 25 cm, left 25.5 cm; nipple-IMF distance: right 9 cm, left 9.5 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 485 cc silicone implant, total submuscular placement.

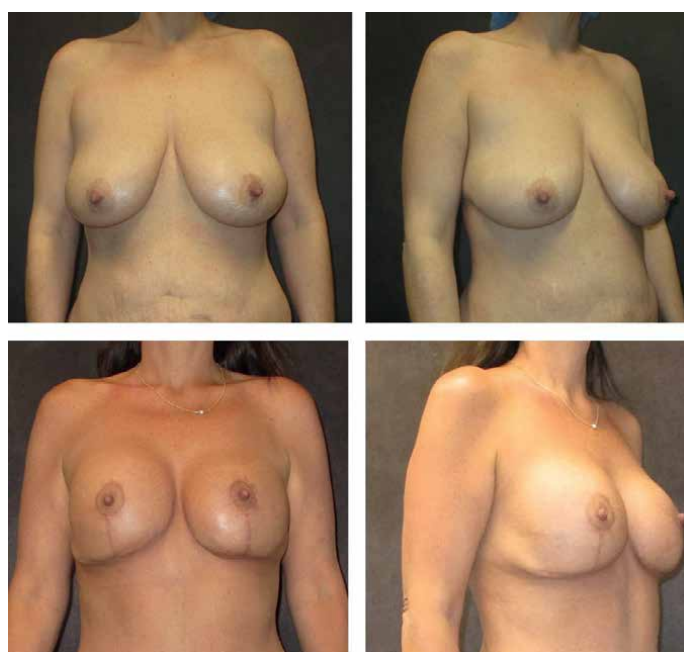


Figure 25. 44 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 28 cm, left 29 cm; nipple-IMF distance: right 9 cm, left 10 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 295 cc silicone implant, total submuscular placement.

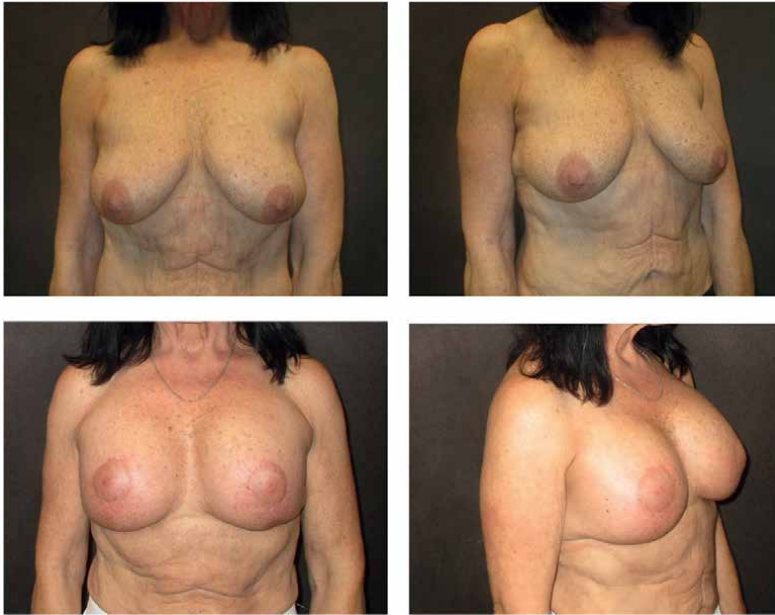


Figure 26. 68 year old female, grade 3 ptosis. Sternal notch-to-nipple distance: right 27.5 cm, left 27 cm; nipple-IMF distance: right 7 cm, left 8 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 360 cc silicone implant, total submuscular placement.

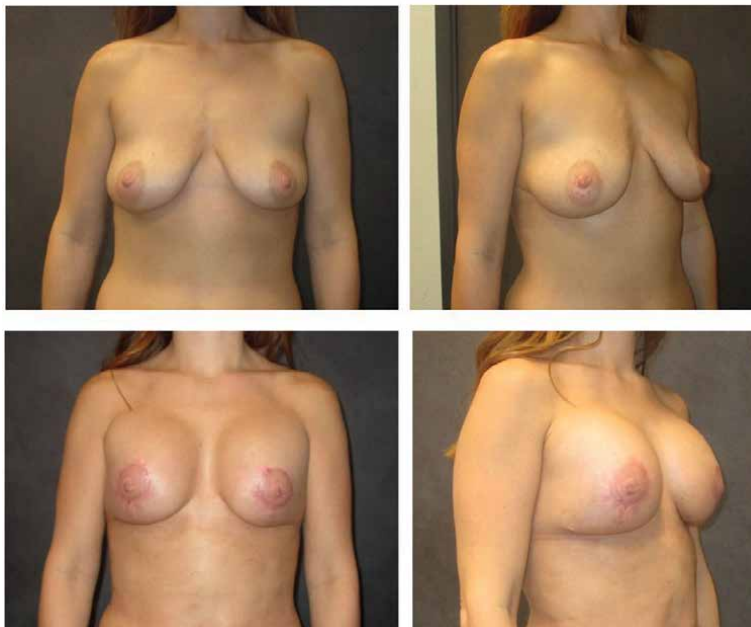


Figure 27. 32 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 23 cm, left 22.5 cm; nipple-IMF distance: right 8 cm, left 7.5 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 365 cc silicone implant, total submuscular placement.

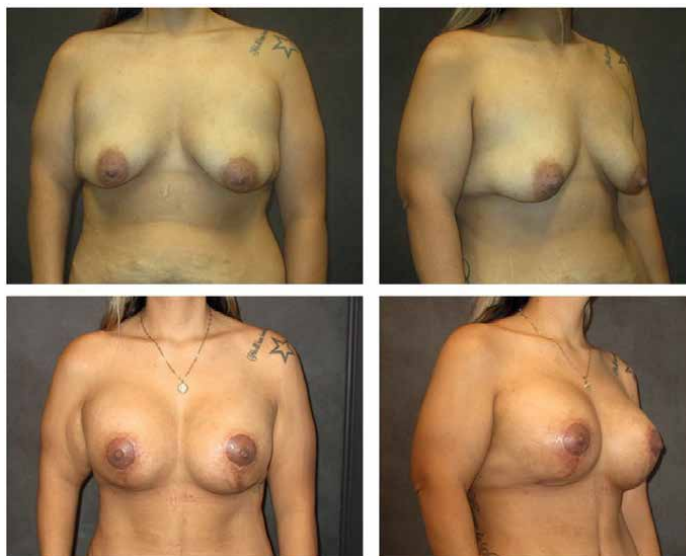


Figure 28.
36 year old female, grade 3 ptosis, tubular breasts. Sternal notch-to-nipple distance: right 26.5 cm, left 27.5 cm; nipple-IMF distance: right 8 cm, left 9 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 520 cc silicone implant, total submuscular placement.

9.9 Case 9

See **Figure 29.**

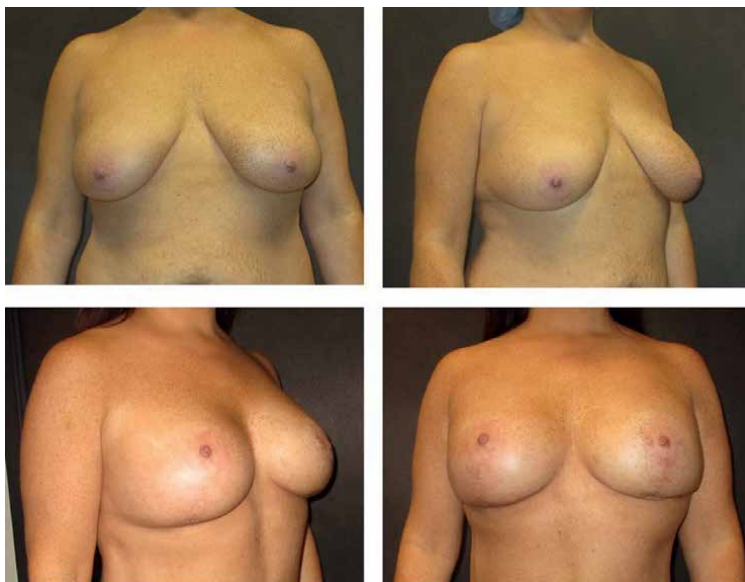


Figure 29.
39 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 29 cm, left 30 cm; nipple-IMF distance: right 8 cm, left 8.5 cm. 10 months after Wise pattern mastopexy was performed using a SMC pedicle. 445 cc silicone implant, total submuscular placement.

9.10 Case 10

See **Figure 30.**

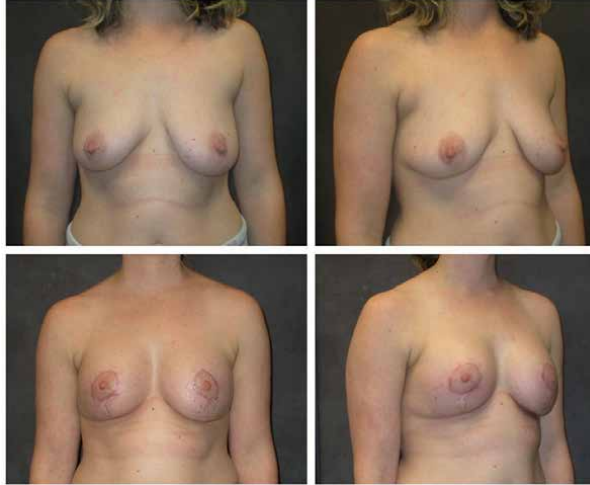


Figure 30.
39 year old female, grade 2 ptosis. Sternal notch-to-nipple distance: right 21.5 cm, left 22 cm; nipple-IMF distance: right 7 cm, left 9 cm. 6 weeks after Wise pattern mastopexy was performed using a SMC pedicle. 295 cc silicone implant, total submuscular placement.

9.11 Case 11

See **Figure 31.**




Figure 31.
35 year old female, grade 2 ptosis. Status post implant replacement and breast lift. Implant 575 cc silicone implants replaced with SRD 485 cc Silicone implants. Capsulotomy and capsulorrhaphy were performed. Left implant was found to be ruptured intraoperatively.

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Chapter 8

Breast Reduction

*Chandler Hinson, Victoria Bouillon, Hallie Masters,
Polly Jasper and Ronald Brooks*

Abstract

This chapter on breast reduction provides a comprehensive overview of the surgical and non-surgical procedures aimed at reducing the size and reshaping the breasts. It delves into the goals of breast reduction surgery, including alleviating physical discomfort, improving body proportions, and enhancing overall quality of life. This chapter discusses the surgical planning involved, considering factors such as desired breast size, nipple placement, and patient anatomy. Various breast reduction techniques are discussed, including the traditional wise pattern and vertical scar methods. The chapter also discusses the use of various pedicles versus free nipple grafting. Lastly, this chapter discusses the importance of monitoring and following patient outcomes post-surgery, assessing factors such as healing, scarring, and patient satisfaction. Through a comprehensive examination of these components, this chapter serves as a valuable resource for both patients considering breast reduction and healthcare professionals involved in their care.

Keywords: breast reduction surgery, mammoplasty, reduction mammoplasty, breast hypertrophy, pedicles, free nipple grafts, macromastia, gigantomastia, wise pattern reduction, vertical pattern reduction

1. Introduction

1.1 Definition

Breast hypertrophy, also known as macromastia, is a medical condition characterized by the excessive growth of adipose and fibrous tissue [1]. This overgrowth can lead to significant physical and psychological discomfort for affected individuals [2–4]. Extensive breast hypertrophy is known as gigantomastia, which is a rare medical condition characterized by the rapid and excessive growth of breast tissue to an exceptionally large size [5]. While there is no standardized definition of gigantomastia, it is arbitrarily defined as excessive breast growth of over 1.5 kilograms per breast [5]. This condition, along with macromastia, can cause significant chronic back, neck, and shoulder pain, skin infections under the breast from retained moisture, impaired posture, and psychological distress from body dysmorphia. The exact cause of macromastia and gigantomastia is not well understood, but both are believed to be linked to hormonal imbalances, the use of certain medications, and genetic factors [6]. Lifestyle modifications and weight loss is the first step in treatment. Definitive management involves a reduction mammoplasty to remove excess breast tissue.

1.2 Pathogenesis

The pathogenesis of breast hypertrophy results from the pathologic imbalance of hormones and growth factors. Estrogen and progesterone, which regulate normal breast development, are believed to play a significant role in the excessive growth seen in breast hypertrophy [7, 8]. During periods of hormonal change, such as puberty, pregnancy, and menopause, some women experience an exaggerated response to these hormones, leading to the rapid and excessive growth of breast tissue. Genetic factors may predispose individuals to breast hypertrophy, as evidenced by cases of familial macromastia [9]. Other contributing factors may include obesity because increased body fat can elevate estrogen levels. Certain medications that influence hormone levels, such as steroids, penicillamine, or buccillamine have also been linked to macromastia [10, 11].

1.3 Epidemiology

While breast hypertrophy can affect women of all ages, it is most common during periods of significant hormonal fluctuation, such as puberty and pregnancy. The prevalence of breast hypertrophy is not well-documented due to the variability in severity of the condition and its subjective nature [9, 12, 13]. Specifically for gigantomastia, studies have estimated incidences ranging from 1 in 28,000 to 1 in 100,000 [14]. It is important to note that breast hypertrophy can also occur in men and referred to as gynecomastia. Gynecomastia is often associated with hormonal imbalances or certain medical conditions that result in elevated estrogen levels. Nevertheless, the incidence of gynecomastia in men is far less than macromastia in women [15, 16].

1.4 Symptoms and physical findings

Women affected by excess breast hypertrophy frequently report back, neck, and shoulder pain due to the excessive weight of their breasts [17–19]. Shoulder grooving from the pressure of bra straps on the shoulders also results from the excess weight. Skin irritation and infections can occur under the breast crease where moisture accumulates [17–19]. The excess weight tends to shift the individual's center of gravity and can lead to poor posture [19]. Physical findings in breast hypertrophy include enlarged and pendulous breasts, stretched skin with striae (known as 'stretch marks'), and downwardly displaced nipples and areolas [2, 20, 21]. In addition to physical symptoms, affected individuals may experience psychological distress, including self-consciousness and social embarrassment [9].

1.5 Breast ptosis

Breast ptosis, or breast sagging, is a condition usually associated with breast hypertrophy but can occur independently due to aging, rapid weight gain or loss, or pregnancy [22, 23]. Ptosis refers to the downward displacement of the breast tissue and nipple-areolar complex (NAC). There is a grading system based on the position of the nipple relative to the inframammary fold (IMF). **Figure 1** is a visual schematic of grades of breast ptosis [24].

1.5.1 Grades of breast ptosis

- *Grade I (mild ptosis)*: The nipple is at the level of the IMF but above the lowest point of the breast gland.

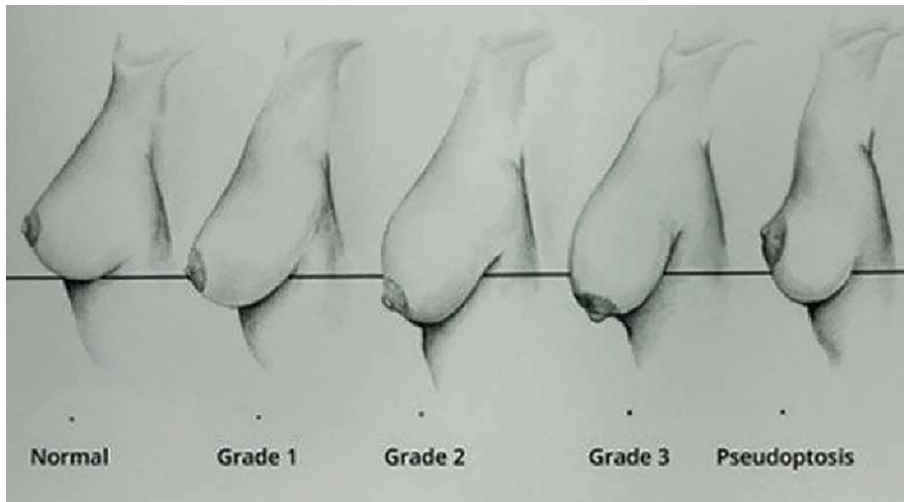


Figure 1.

A depiction of the breast ptosis grading system proposed by Regnault et al. Normal: Areola above the inframammary fold (IMF) and above the gland contour; Grade I: Areola at the IMF and above the gland contour; Grade II: Areola below the IMF and above the gland contour; Grade III: Areola below the IMF and below the gland contour; Pseudoptosis: Areola at the IMF with glandular ptosis.

- *Grade II (moderate ptosis):* The nipple is below the level of the IMF but still above the lowest point of the breast gland.
- *Grade III (severe ptosis):* The nipple is below the level of the IMF and at the lowest point of the breast gland, often pointing downward.
- *Pseudoptosis:* The nipple is at or above the level of the IMF, but the breast gland hangs below the fold.

Breast ptosis can significantly impact a woman's body image and self-esteem. The severity of ptosis influences the surgical approach in reduction mammoplasty and mastopexy procedures. Effective management involves a detailed assessment of the degree of ptosis and a tailored surgical plan to reposition the NAC and reshape the breast for a more youthful and esthetically pleasing contour.

2. Anatomy

The anatomy of the breast involves a complex arrangement of soft tissue, vasculature, nerves, and lymphatics. The breast is composed primarily of glandular tissue whose primary function is milk production and delivery of that milk via the lactiferous ducts to the NAC during times of childbearing. The adipose and connective tissue, known as Cooper's ligaments, give the breasts their fullness, maintain their shape and integrity, and generate the esthetic appearance of the female chest. The breast is situated on the chest wall and is anchored to the pectoralis major muscle by the pectoralis fascia. **Figure 2** illustrates the internal structure of the breast [25].

2.1 Breast borders and measurements

The anatomical borders of the breast are defined by specific landmarks on the chest. Superiorly, the breast extends to the second or third rib. Inferiorly, it terminates at the sixth rib. The medial border lies along the lateral edge of the sternum, and the lateral border extends to the mid-axillary line. The areola, the pigmented area surrounding the nipple, marks the central point of the breast. Many key measurements for surgical planning are in relation to the position of the nipple. These include the distance from the sternal notch to the nipple (SNN), the nipple-to-inframammary fold distance (NIMF), and the nipple-to-nipple distance (**Figure 3**) [26]. These measurements are crucial for ensuring symmetry during breast procedures.

2.2 Arterial and venous blood supply

The breast has a robust blood supply (**Figure 4**) [27]. The primary arterial supply comes from perforator branches of the internal mammary artery, also known as the internal thoracic artery, which is a branch of the subclavian artery. Additionally, the lateral thoracic artery, a branch of the axillary artery, supplies the lateral aspect of the breast. Smaller contributions come from the thoracoacromial artery and the intercostal arteries. The venous drainage of the breast mirrors the arterial supply and involves a network of veins that drain into the axillary vein, the internal thoracic vein, and the intercostal veins. This extensive vascular network is vital for maintaining the health of breast tissue and for healing post-surgery.

2.3 Nerve supply

The sensory innervation of the breast can be broken into three groups: intercostal nerves, lateral cutaneous nerves, and supraclavicular nerve branches (**Figure 5**) [28]. The fourth, fifth and sixth intercostal nerves provide sensation to the medial breast tissue. The lateral breast receives its sensory innervation from the third, fourth, fifth,

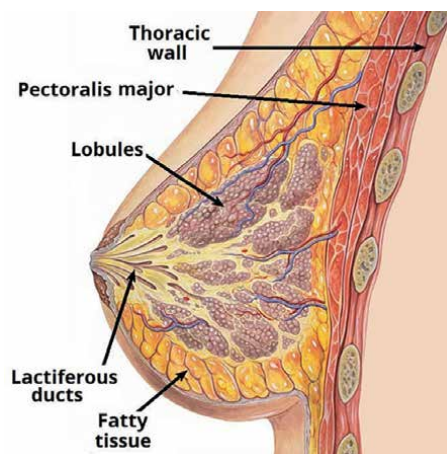


Figure 2.
The internal structure of the breast.

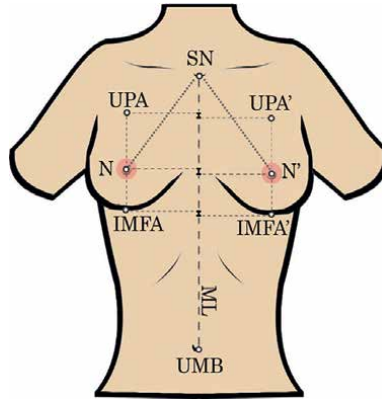


Figure 3.
 Illustration of important landmarks and measurements of the breast. SN = sternal notch, UPA = upper pole apex, N = nipple, IMFA = inframammary fold apex, ML = medial line, UMB = umbilicus.

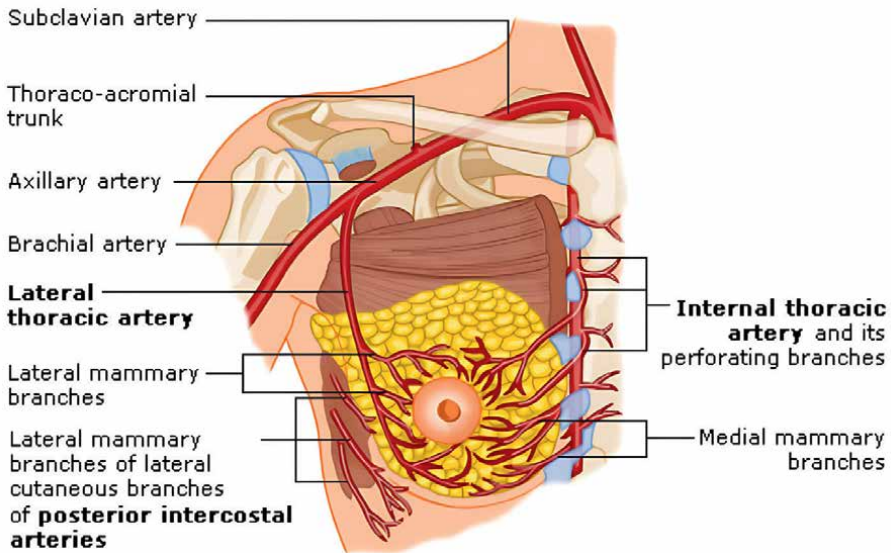


Figure 4.
 Figure of the three main arterial systems within the breast.

and sixth branches These nerves are not only important for sensation of the breast and its overlying skin, they also play a key role in activation of the reflexes involved in lactation. The NAC is supplied by the fourth lateral cutaneous branch which travels medially in the deep fascia to the midclavicular line and then directs itself toward the deep surface of the nipple. The supraclavicular nerves, originating from the cervical plexus, contribute to the sensory innervation of the upper portion of the breast.

2.4 Lymphatic system

The lymphatic system of the breast is an essential component for maintaining fluid balance and facilitating immune responses. Lymph drainage flows via two main pathways: the axillary and internal mammary lymph channels (**Figure 6**) [29].

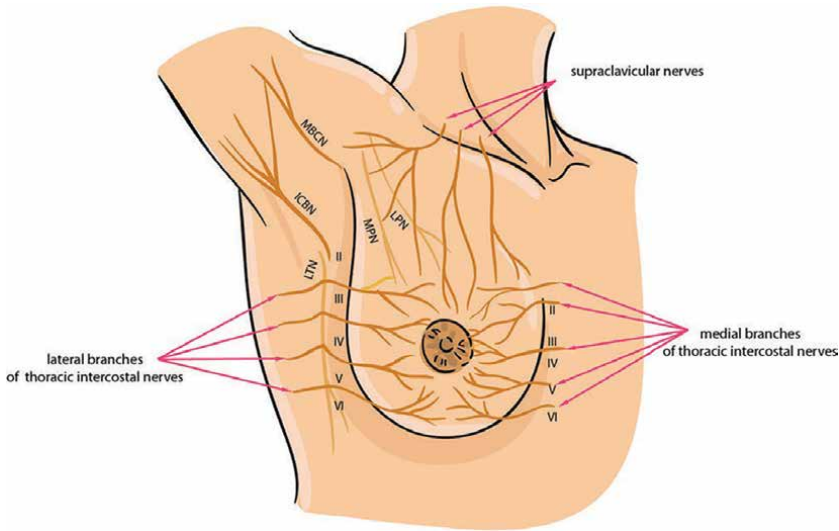


Figure 5. Innervation of the axilla and breast. ICBN = intercostobrachial nerve; LTN = thoracic nerve; LPN = lateral pectoral nerve; MBCN = medial brachial cutaneous nerve; MPN = medial pectoral nerve. Figure created by Dr. Barbara Versyck.

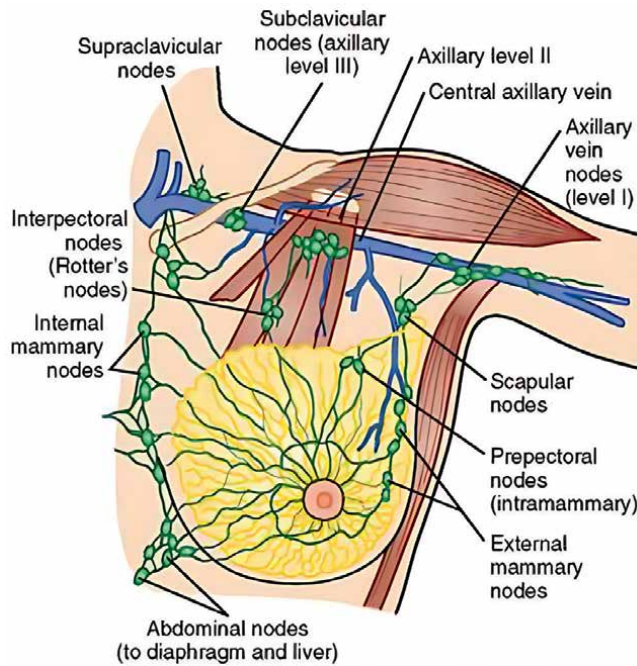


Figure 6. Lymphatic drainage schematic created by Dr. Iram Dubin.

Approximately 75% of the breasts' lymphatic fluid drains to the axillary lymph channels. The superficial axillary nodes are divided by location: lateral, central, apical, and subscapular groups of nodes. The deep axillary lymph nodes are subdivided into three levels based on their anatomical position relative to the pectoralis minor muscle. The

minor lymphatic drainage routes lymph toward the internal mammary nodes located along the internal thoracic vessels.

3. Surgical management

Breast reduction surgery, known as reduction mammoplasty, is a procedure designed to decrease breast size and alleviate discomfort associated with overly large breasts. This surgery consists of two main components: parenchymal excision and skin excision. Parenchymal excision is the removal of glandular tissue and fat from the breast to reduce its overall volume. Skin excision removes excess skin to reshape and lift the breast, thereby providing a more esthetically pleasing and proportionate appearance. Together, these components achieve the desired reduction in breast size and improve the overall contour of the breasts.

3.1 Parenchymal excision

Parenchymal excision is a critical component of breast reduction surgery. Excess glandular tissue and fat are removed to decrease breast volume.

Several excisional techniques exist including pedicle-based excisions and free nipple grafting. The technique utilized is determined by the planned volume of tissue resection. Other important considerations include desired final breast size, shape, preoperative degree of ptosis, and the preoperative position of NAC. A pedicle-based excision preserves the NAC on a tissue stalk, or pedicle, in order to maintain native blood and nerve supply to the nipple. This method is preferred because it maintains nipple sensation and function, and cosmetic outcomes are thought to be superior. In contrast, FNG involves the complete removal of the NAC and reattaching a portion of the areola as a skin graft, which may be necessary in some cases of macromastia or significant ptosis. The chosen technique is driven by the patient's specific anatomical needs and desired outcomes.

3.1.1 Inferior pedicle

The inferior pedicle technique preserves the NAC via a stalk that stems from the inferior pole breast tissue. Vascular supply of this pedicle includes the lateral thoracic artery and intercostal artery perforators. Preservation of the blood supply allows for the safe relocation of the NAC higher on the breast mound while reducing the overall breast volume.

Creating the inferior pedicle involves several critical steps (**Figure 7**) [30]. First, The pedicle is de-epithelialized. The pedicle is then incised and dissected free from the surrounding tissue that will later be excised. Excess breast tissue, fat, and skin are removed from the upper, lateral, and medial portions of the breast. It is crucial not to incise or violate the base of the pedicle in order to preserve the blood supply. The goal base width of the pedicle is approximately 8 cm with a length to width ratio of 3:1 as to reduce risk of pedicle ischemia [30, 31]. The resultant pedicle is about 2 cm in thickness and will resemble an inverted 'U' with a broad base. The de-epithelialized dermis and underlying parenchyma remains attached to the inframammary fold. Plication of the inferior portion of the pedicle is performed when necessary to achieve the appropriate pedicle length and IMF to NAC distance as depicted in **Figure 8** [32]. Once the desired volume is excised, the NAC is positioned cephalad. The incisions are

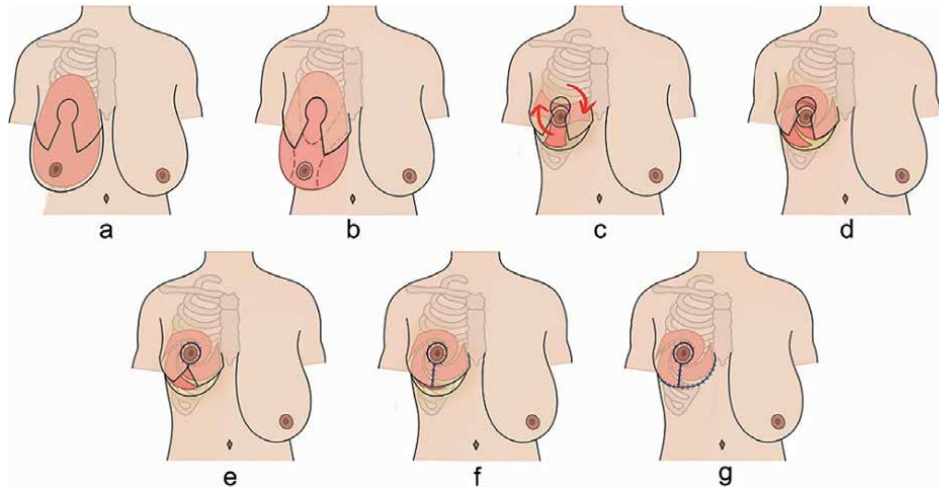


Figure 7. Schematic drawing of the inferior pedicle mammoplasty operation steps with a wise pattern skin incision. (a) Flap design. (b) De-epithelialized skin and designed gland removal. (c) Shifted and rotated flap to reshape the breast. (d) Sutured and fixed breast gland. (e) Periareolar incision suturing. (f) Vertical incision suturing. (g) Breast IMF incision suturing.

closed in multiple layers to support the new position of the breast mound. While not recommended by the American Society of Plastic Surgeon, drains may be placed to prevent fluid accumulation [30].

The inferior pedicle technique is reliable for achieving large volume reductions while maintaining sensation to the NAC [33]. It also ensures a robust blood supply to the NAC, reducing the risk of ischemia and necrosis [30, 34]. This technique is highly versatile and can be adapted to various breast sizes and shapes [31]. It is particularly effective for patients with severe macromastia and significant breast ptosis because it allows the surgeon to substantially decrease the length between the IMF and the NAC which allows for repositioning the NAC and eliminating ptosis. The primary disadvantage of the inferior pedicle technique is the risk of “bottoming out,” in which the lower pole of the breast becomes overly full and droops over time creating a phenomenon known as pseudoptosis [35, 36]. Pseudoptosis occurs because the bulk of the remaining breast tissue is below the NAC. Therefore, if the patient should experience glandular hypertrophy or the breast skin becomes more compliant, the most likely affected area will be the inferior pole of the breast causing pseudoptosis. While the technique can be used in various patients, those with optimal skin elasticity tend to have better esthetic outcomes.

3.1.2 Superomedial pedicle

The superomedial pedicle (SMP) technique preserves the blood supply and innervation to the NAC from the upper and medial portions of the breast. The neurovascular supply originates from the internal mammary system. This approach allows for the repositioning of the NAC to a higher location using a rotational method.

Creating the SMP involves several precise steps (**Figure 9**) [37]. The pedicle is created such that the NAC remains attached to the breast tissue in the superior and medial quadrants of the breast. The goal pedicle length is between 8 and 18 cm, with a width of 6–8 cm [37, 38]. Excess breast tissue, fat, and skin are excised from the lower

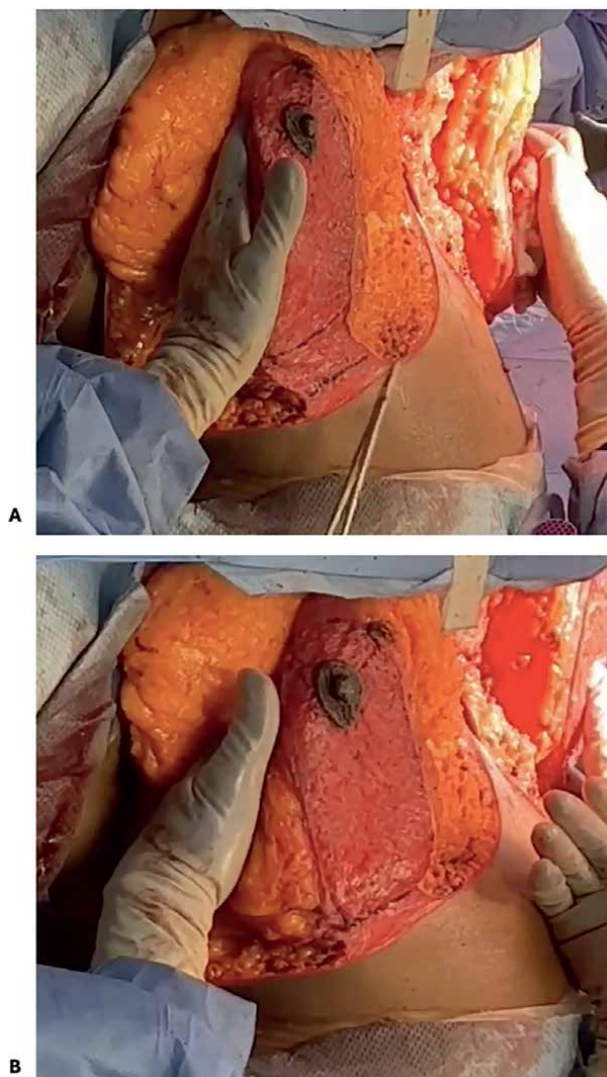


Figure 8.
The inferior pedicle is plicated to achieve a pedicle length of approximately 8 cm and decreasing the distance between the IMF and NAC.

and lateral portions of the breast. The pedicle is then rotated laterally to reposition the NAC and create a satisfactory breast shape. Stitches may be used to secure the distal aspect of the pedicle to the upper chest until sufficient scar tissue forms. The incisions are closed in layers to provide support for the pedicle. As with any reduction, drains may be placed to prevent fluid accumulation at the discretion of the surgeon [37].

The SMP technique is ideal for patients with large breasts with mild to moderate breast ptosis. It allows for substantial lifting and repositioning of the NAC [38]. The SMP often results in a more natural breast shape compared to other techniques, with a well-defined upper pole and a gentle slope toward the lower pole [37]. This method is quite versatile, making it suitable for a wide range of breast sizes and shapes, and cosmetic outcomes are generally favorable [39]. Similar to the inferior pedicle, those with good skin elasticity tend to have better esthetic outcomes, as their skin can

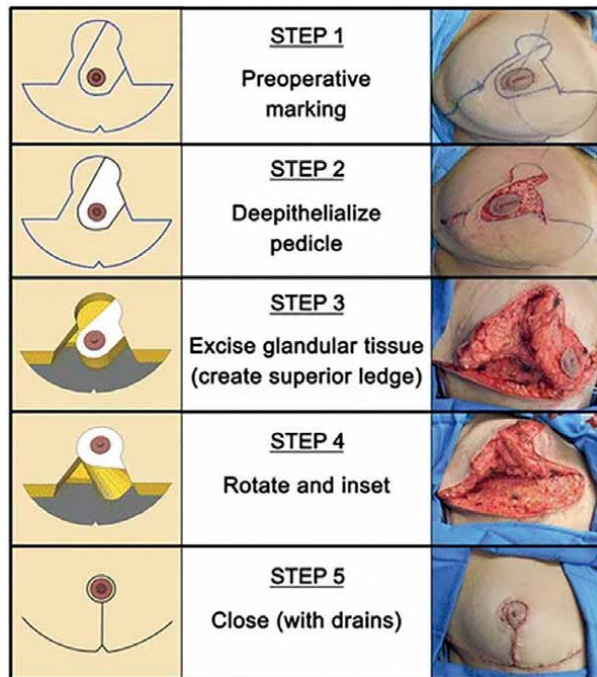


Figure 9. Drawings and photograph of various steps within the superomedial pedicle reduction.

support the weight of the pedicle and can accommodate the stretching and reshaping more effectively. With the SMP, the NAC has a robust vascular supply from the internal mammary artery perforator and nipple loss is rare [39]. One disadvantage of this technique is that to achieve adequate pedicle rotation to NAC reattachment, it is necessary to detach the distal pedicle from the underlying tissue. This sometimes requires a generous amount of undermining of the pedicle, particularly in large breasts with long pedicles. Given this degree of mobilization, blood supply to the distal aspect of the pedicle can become compromised which would affect viability of the NAC [38].

3.1.3 Superior pedicle

The superior pedicle technique preserves the blood supply and innervation to the NAC from the upper portion of the breast. The internal mammary perforators and neurovascular bundle are from the second intercostal space and are the main suppliers of this pedicle. This approach allows the NAC to be repositioned higher on the breast mound while reducing the overall breast volume.

Creation of the superior pedicle involves several critical steps (**Figure 10**) [40]. After preoperative markings and initial incisions, the pedicle is created by preserving tissue from the upper pole of the breast to the NAC. This technique utilizes a wide pedicle of 12–18 cm and a width to length ratio of 2:1 or 1:1 to minimize the risk of ischemia and necrosis [41]. Excess breast tissue, fat, and skin are excised from the lower, lateral, and medial portions of the breast (**Figure 11**) [42]. For a more generous reduction, excess tissue can be excised from the underside of the pedicle. This is safe for NAC viability as long as a pedicle thickness of at least 3 cm is maintained. The NAC is elevated and the remaining skin and soft tissue are closed in multiple layers.

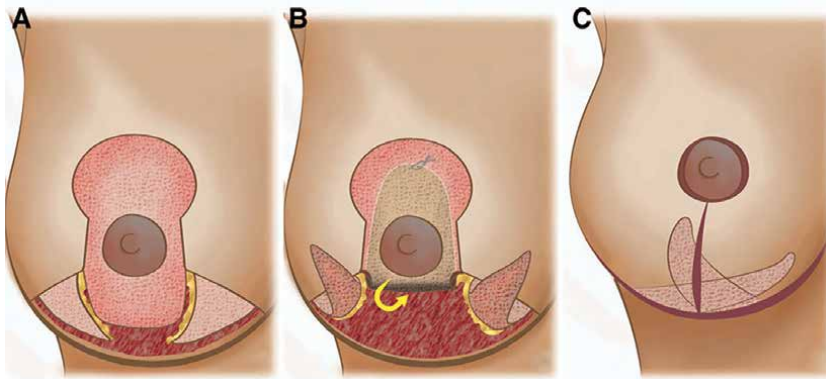


Figure 10.

Diagram of performing a modified approach to superior pedicle flap. (a) Superiorly based pedicled glandular flap dissected and both dermal flaps de-epidermized. (b) Cranial rotation to increase upper pole fullness. (c) Final result after medial fixation of the lateral triangular flap.

The superior pedicle technique offers several advantages. The superior pedicle technique is particularly beneficial for patients with moderate breast size and significant ptosis where the bulk of the excess parenchyma is below the NAC. This technique allows for significant reduction and lifting of the breast. The superior pedicle method often results in a well-defined upper pole [43]. This technique is relatively versatile and can be used in smaller and medium sized reductions. The resultant scars from a superior pedicle approach can be less extensive because the skin excision options are not limited to the conventional wise pattern and can also include vertical and peri-areolar patterns [41]. Major disadvantages to the superior pedicle technique include limited use in large reductions and a high risk of sensory loss at the NAC. The superior pedicle is not ideal for larger resection, particularly in patients with excess upper pole tissue, as it can be difficult to inset the pedicle [44]. The superior pedicle also has a significantly higher risk of sensory loss of the NAC, with studies demonstrating



Figure 11.

Superior pedicle wise pattern excision. (A) Patient's right breast shows a completed parenchymal and skin excision and beginning of skin closure. Patient's left breast showed the pedicle which has been de-epithelialized. The round aspect of the keyhole is the anticipated new site of the NAC. The skin and soft tissue inferior to the de-epithelialized segment will be excised. (B) The inferior skin and parenchyma has been excised. The pedicle has also been debulked—the excess tissue deep to the pedicle has been excised and the pedicle is a minimum thickness of 3 cm. The NAC is then plicated to the center of the circular area.

decreased in sensation as high as 70% of women who have undergone a reduction with a superior pedicle [45, 46].

3.1.4 Medial pedicle

Medial pedicle breast reduction preserves blood supply and innervation to the NAC from the medial portion of the breast. Preservation of tissue extending from the medial breast to the NAC creates a pedicle with a retained blood and nervous supply to the NAC via internal mammary perforators and medial intercostal nerves, respectively.

Creating the medial pedicle involves several key steps (**Figure 12**) [47]. Firstly, the desired pedicle is outlined. After, the pedicle is de-epithelialized. Excess breast tissue, such as fat and skin, are excised from the upper, lateral, and inferior portions of the breast (**Figure 13**) [48]. The resultant pedicle length is approximately 4–5 cm. It is important to maintain a pedicle width of approximately 7–8 cm to ensure adequate blood supply from the third internal mammary artery [49]. The de-epithelialized pedicle is then rotated upward to reposition the NAC to a higher location [49]. Drain placement is not required to prevent fluid accumulation, though ultimately, the decision to place a drain is left to the discretion of the surgeon [50]. The incisions are closed in multiple layers [50].

The medial pedicle technique offers several advantages. This technique lifts and reshapes the breast more in comparison to the SMP technique due to elimination of the superior pedicle attachment and thus, a wider arc of rotation is available to the pedicle. Additionally, this method proves to have a high rate of sensation preservation and viability of the NAC while allowing for significant parenchymal excisions [51, 52]. The rate of

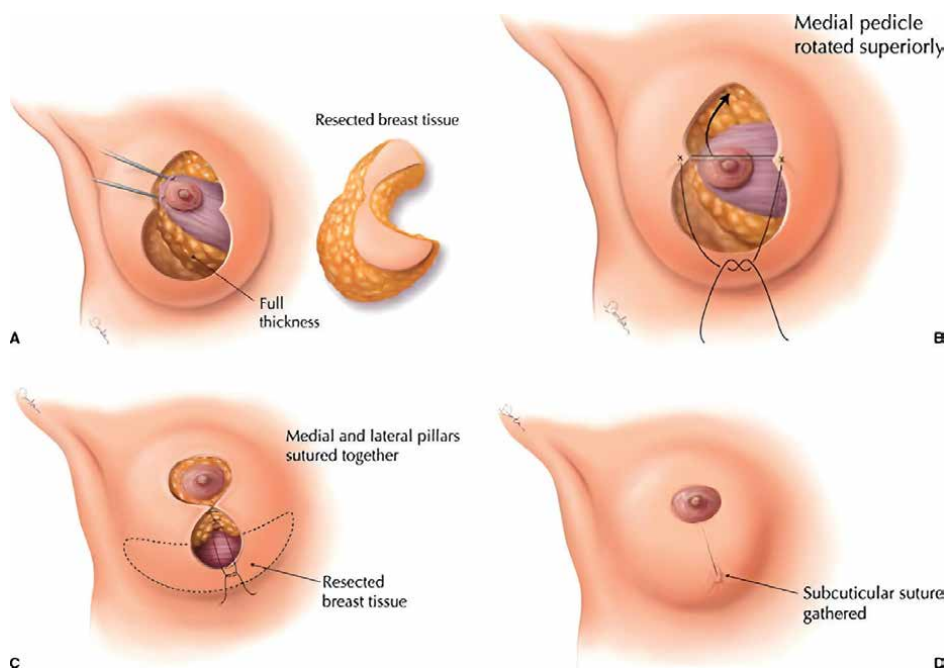


Figure 12. Diagram of performing a medial pedicle flap. (a) Medial pedicle and skin resection pattern. (b) Rotation of pedicle. Note that the inferior border of the medial pedicle is now the medial pillar. (c) Closure of the pillars. (d). Closure of the areola and skin.



Figure 13.

Medial pedicle with wise pattern reduction. The patient's right side shows the remaining pedicle after removal of excess lateral and inferior tissue. The patient's left shows the planned skin closure around the pedicle.

pseudoptosis is lower compared to the inferior pedicle technique [30]. Furthermore, this technique is particularly beneficial for patients with pronounced medial fullness or those who desire to have greater projection of the medial aspect of the breast post-operatively. Disadvantages include limited overall breast projection and suboptimal breast shape [49, 50]. Additionally, this technique is limited in ability to remove large volumes of breast tissue unless dog ears are created to accommodate excess removal [49].

3.1.5 Central mound

The central mound technique maintains blood supply and innervation to the NAC through the central portion of the breast. This approach elevates the NAC while reducing overall breast volume.

Breast tissue extending from the NAC to the central portion of the breast is preserved, ensuring that the NAC retains its blood supply and nerve connections through the pectoralis major muscle. (**Figure 14**) [53–55]. The excess breast tissue is preferentially taken from the superolateral quadrant (**Figure 15**) [56]. The superomedial breast tissue is preserved to maintain upper breast fullness. If additional tissue excision is required, tissue is taken from the inferior medial breast. The inferolateral tissue on the mound is rotated into the space created by the superolateral resection and secured to the pectoralis fascia [54]. This re-establishes the rounded shape of the breast, narrows the base width, and fills the upper pole of the breast. The medial dermal flaps are also secured to the pectoralis muscle fascia thereby providing internal support that does not rely solely on the skin flaps [54]. Skin flaps of at least 2 cm thick are created superiorly [55]. The flaps are then closed in multiple layers around the pedicle, creating a new IMF crease [54, 55].

The central mound method results in the most natural breast shape with a well-defined upper pole and a gentle slope toward the lower pole [53]. This technique provides a balanced projection throughout the breast and preserved sensation of the NAC, even in cases of severe breast hypertrophy due to the central blood and nervous

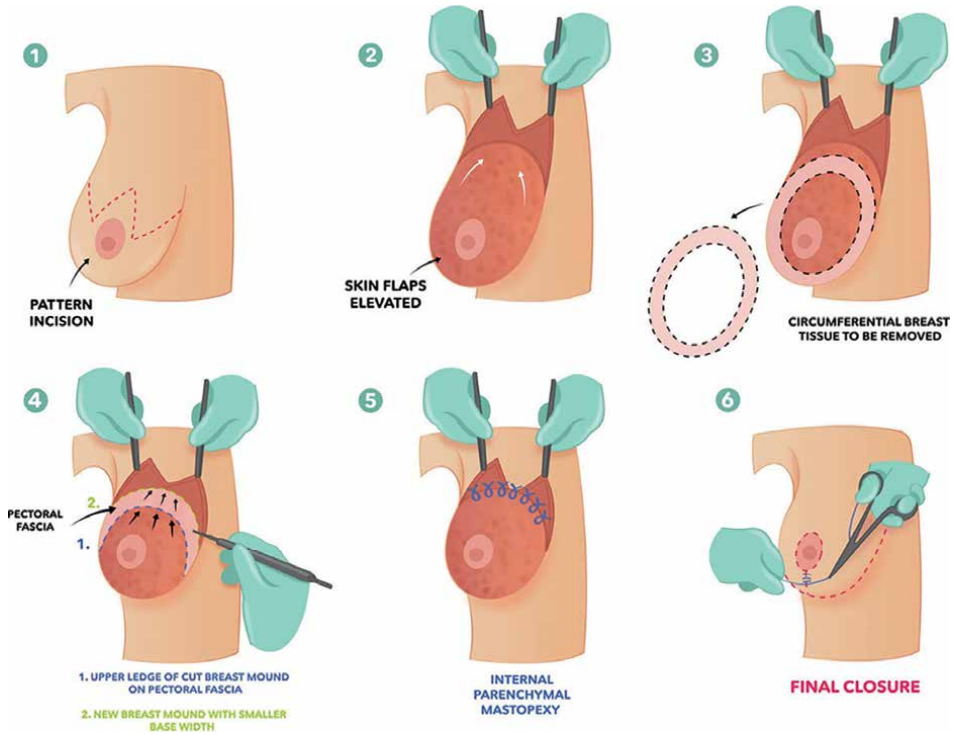


Figure 14. Schematic depicting the central mound reduction technique. (1) A standard wise-pattern incision is marked on the patient. (2) The superior skin flaps are elevated in the plane between the breast capsule and subcutaneous tissue. (3) The desired base width is marked, and the breast parenchyma is resected to preserve the central mound cone. (4,5) The central mound pedicle is secured to the upper parenchymal ridge as an internal mastopexy. (6) Closure.

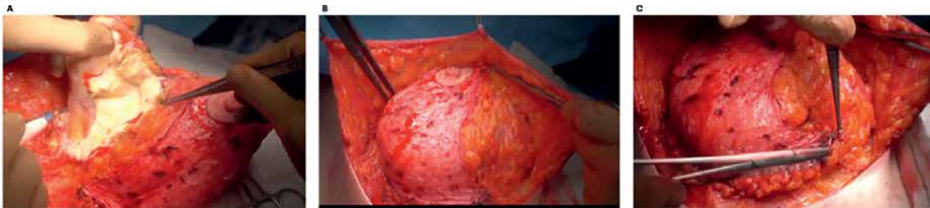


Figure 15. Central mound pedicle (A) excision of the excess tissue in the superolateral quadrant (B) plication of the lateral tissue to the lateral upper pectoral fascia (C) securing the medial dermal flap to the medial pectoral fascia.

supply from the chest wall [55, 57]. Other advantages include the multiple sources of vascularity and possibility for extensive resection circumferentially [53]. However, the most notable disadvantage of the central mound technique includes difficulty achieving symmetry, particularly in patients with pre-existing asymmetry along either horizontal or vertical axes.

The central mound technique is especially suited for those with moderate to large breast size, even distribution of tissue and moderate ptosis who desire significant lift [55]. It is particularly useful for those seeking a more natural breast shape with a well-defined upper pole and gentle lower pole slope with balanced projection throughout the breasts.

3.1.6 Free nipple graft

Free Nipple Graft (FNG) is a technique used for patients with severe gigantomastia who require such a substantial reduction that compromised blood flow to the NAC is very likely. Most reduction techniques are centered around a pedicle of tissue in which the key objective is to maintain the blood supply to the nipple. This approach allows for more extensive tissue removal and reshaping of breast tissue.

When performing the FNG technique, the NAC is completely excised and the areola is harvested as a full thickness skin graft to be applied to the breast mound at the end of the reduction. (**Figures 16 and 17**) [58, 59].

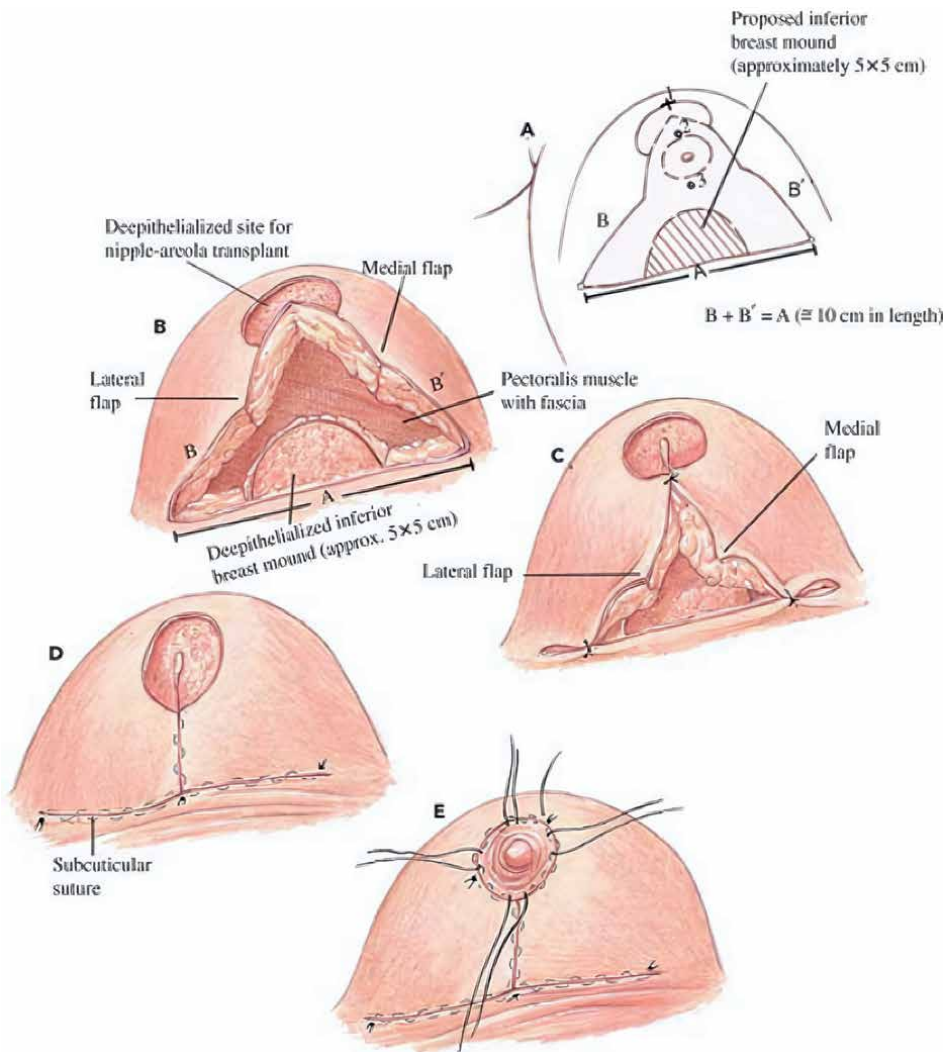


Figure 16. FNG with retained inferior breast mound technique. (a) View of the markings from underneath. Points 1, 2, and 3 correspond to the top of the areola, bottom of the areola, and inferior point of the vertical closure, respectively. (b) Resection of the breast tissue in a perpendicular fashion with relation to the flaps and their medial margins and retention of the deepithelialized breast mound. (c) The initial sutures are shown, and the inferior closure is started at the medial and lateral ends rather than in the middle so any differences can be adjusted without extending the incision. (d, e) Closure before and after suturing the graft.

The FNG technique offers several advantages. One of the main benefits is the ability to achieve significant reduction in breast size that would not be possible with traditional pedicle techniques [60]. This method is particularly useful for patients with extremely large or pendulous breasts, where the blood supply to the NAC might be compromised if left attached during the procedure because it would be impossible to maintain the recommended length to width ratio of 3:1 while still achieving a generous reduction. By using the FNG technique, the risk of NAC necrosis is eliminated. Additionally, this technique allows for more flexibility in positioning the areola, resulting in better esthetic outcomes [61]. However, the FNG technique also has some notable disadvantages such as the loss of sensation and function to the nipple, as the nerves are severed during the removal for grafting. This results in permanent numbness and dysfunction of the nipple and areola. Additionally, the ability to breastfeed is lost [61]. Further, there is always a risk of skin graft failure.

Indications for the FNG technique are patients with markedly pendulous breasts and excessively long distance between the sternal notch and nipple. This is because the blood supply to the nipple in the native breast has a long course before reaching the NAC. After a reductive surgery, these patients have a proportionally higher risk of nipple death given the chance of blood flow compromise. Additionally, older patients or those with certain medical conditions that might impair wound healing or blood flow to the NAC are often considered for this technique.

3.2 Skin excision

Skin excision is a fundamental aspect of breast reduction procedures. This aspect of the procedure focuses on the removal of excess skin. The excision patterns include vertical, Wise pattern (“inverted T”), and periareolar. The technique utilized is determined by the amount of excess skin, the location of the excess skin, the patient’s skin type, and the desired cosmetic scar outcome.

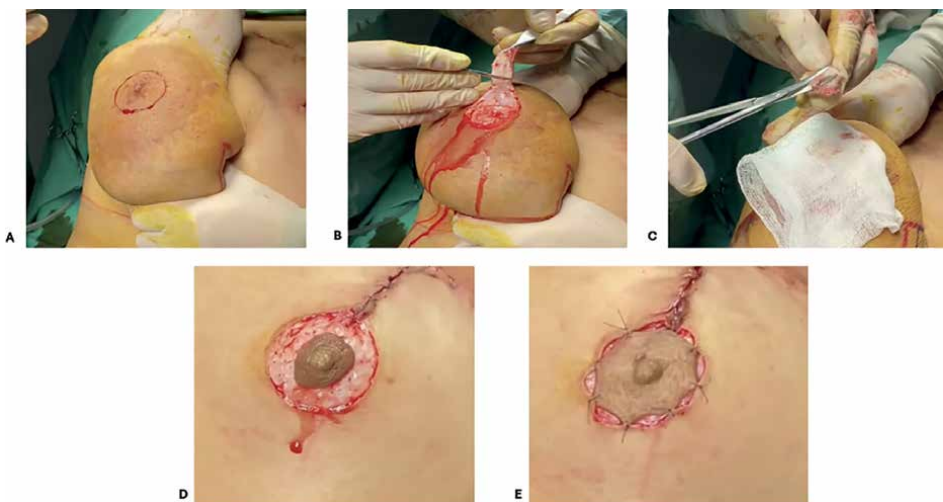


Figure 17. Free nipple graft (A) incision around the NAC (B) harvesting the NAC graft (C) thinning the graft (D) overlay of the graft onto de-epithelialized dermis (E) securing the nipple graft with suture.

3.2.1 Vertical

Vertical breast reduction, also known as the vertical scar or lollipop incision, focuses on minimizing scarring while achieving significant reduction and reshaping of breasts.

Conducting a vertical skin excision begins with a circumferential areolar incision (**Figure 18**) [62]. First, the desired pedicle is created. Medial and lateral dissections are performed with generous undermining, resulting in the desired size of the reduced breast [62]. Next, excision of skin and soft tissue inferior to the NAC and its associated pedicle is performed. This excised tissue usually resembles a semicircle or oblong shape and extends to the IMF (**Figure 19**) [63]. This pattern of excision resembles a lollipop [62]. Once sufficient tissue is removed, the vertical limbs are approximated and the nipple is set [62]. If there is redundant skin at the inferior

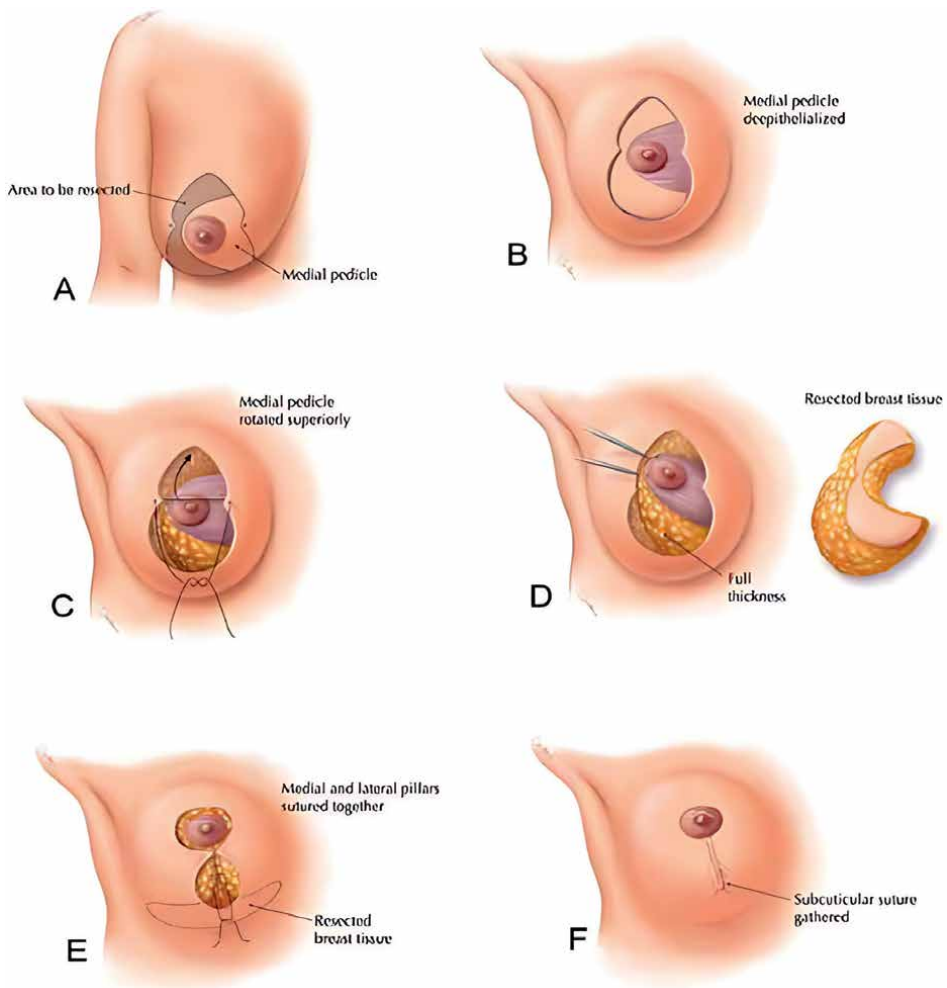


Figure 18. A medial pedicle technique with a vertical pattern skin excision. (A) Markings. (B), Pedicle design. (C) Creation of the pedicle. (D) Parenchymal resection. (E) Closure of the vertical pillars and resection of lower pole skin and parenchyma. (F) Incision closure.

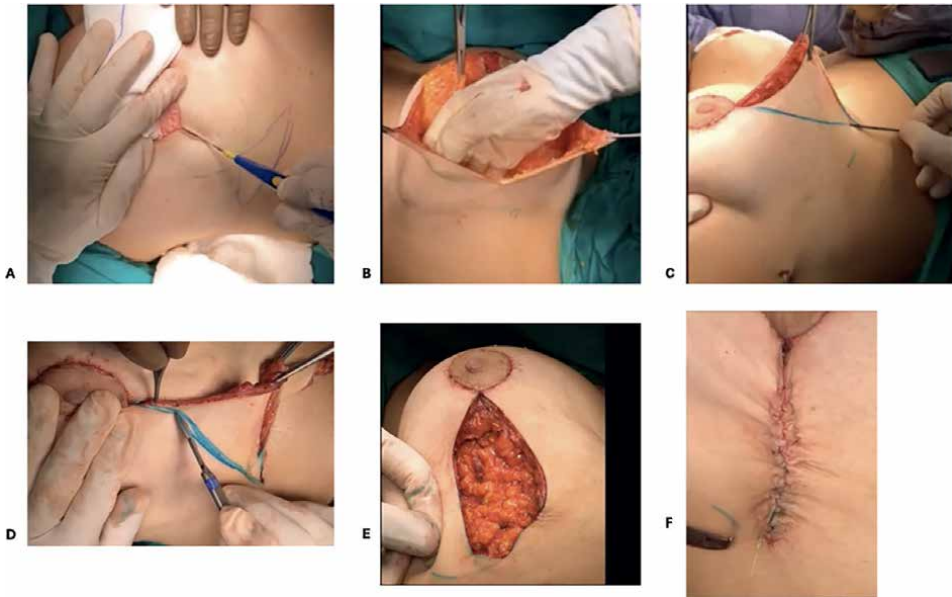


Figure 19. Vertical skin excision (A) incision skin at the midline of the breast below the NAC to the IMF (B) create wide skin flaps and perform the parenchymal excision (C) pulling the skin taut, determine the amount of excess vertical skin can be excised (D) excise the redundant vertical skin (E) resultant defect after skin excision (F) approximate the vertical limbs.

aspect of the incision, the midpoint is secured at the IMF and the lateral dog ears are removed, creating a very small horizontal IMF scar.

Advantages of vertical skin excision include lack of an inframammary incision, reducing the surface area of scarring. This proves especially helpful in patients with a propensity of keloids or hypertrophic scars [64]. Additionally, the vertical technique allows for effective lifting and reshaping of the breast, resulting in a more natural breast shape with a well-defined upper pole (**Figure 20**) [64, 65]. The vertical scar supports the new breast shape more effectively than many other methods, reducing the risk of lower pole fullness or pseudoptosis [44, 64]. Disadvantages include possible puckering of the lower end of the scar or decreased effectiveness for extensive tissue removal of very large breasts as the limited skin excision might not provide adequate access for reduction [44, 64]. Another disadvantage includes possible visualization of the vertical incision below the level of the new inframammary fold [64].

Skin elasticity typically found in younger patient populations proves to be helpful and provides for better esthetic outcomes with more effective accommodation for reshaping alongside reduction. The vertical skin excision pattern is sufficient for patients with moderate breast hypertrophy and ptosis who desire reduction with minimal scarring, offering a balance between tissue removal, skin excision, and esthetic outcomes [64].

3.2.2 Wise pattern

Wise pattern skin excision, also known as the ‘inverted T’ or anchor incision, is a widely used technique which allows for significant tissue removal and dramatic reshaping.

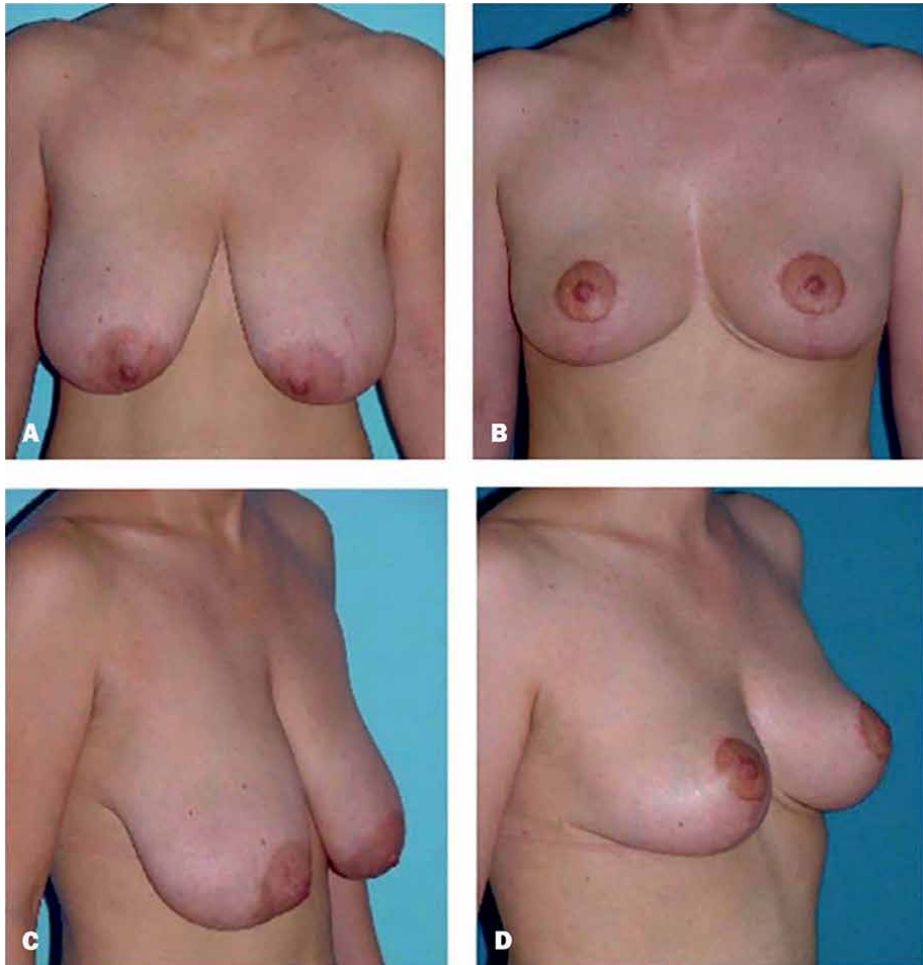


Figure 20.

(A,C) Preoperative views of bilateral ptosis. (B,D) Postoperative views of bilateral breast reduction with a vertical skin excision pattern.

Conducting a Wise pattern skin excision begins with preoperative marking (**Figure 21**) [66]. The breast meridian is measured and marked at 6–8 cm from the sternal notch and a vertical line is made down each breast. The upper breast border (UBB) is determined by manually lifting the breast and identifying where the breast projection begins. The anticipated NAC position is marked approximately 20 cm from the sternal notch along the breast meridian which should roughly equate to 8 cm from the UBB. From the NAC position, two vertical limbs are designed to make an inverted V, each limb measuring approximately 10–11 cm. The length of the limbs vary among patients. They are dependent on preoperative breast size, desired reduction outcome, and are usually longer for larger breasts. The IMF is outlined and connected to the inverted V.

Once the pedicle size and shape are deemed satisfactory, the skin and soft tissue between the inverted V and inframammary fold are removed. The skin is then brought together as depicted in **Figure 14**. The two vertical limbs are brought down and secured to the midpoint of the inframammary fold incision. The vertical limb

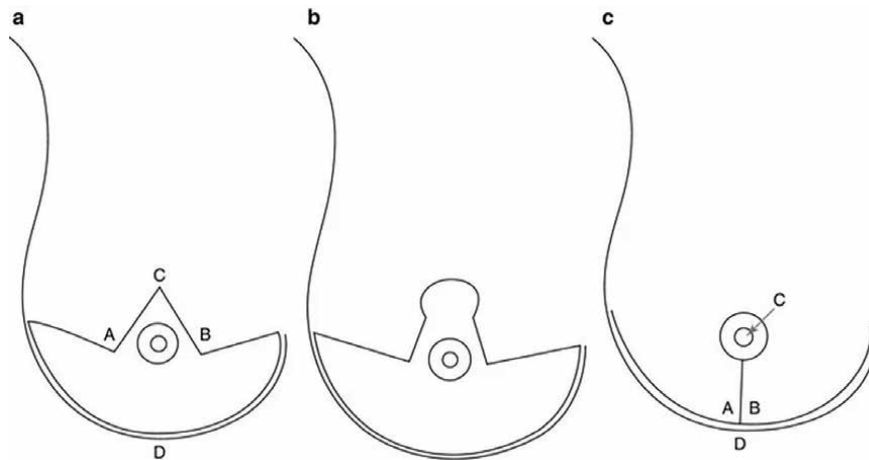


Figure 21. Traditional markings for a wise pattern breast reduction. The points A and B are brought together to point D. (C) The new nipple position is usually centered on point C.

is then tacked closed to assist with the inset of the nipple. The nipple is set approximately 7–8 cm superior to the IMF. A keyhole is incised for the nipple.

The Wise pattern is particularly advantageous for patients with large breasts and significant ptosis, as it provides extensive access to the breasts for tissue removal and reshaping from multiple points as compared to more limited incision patterns (**Figure 22**) [67, 68]. This method allows for better control over the final breast shape and position of the NAC, ensuring optimal symmetry and proportion. Disadvantages of the Wise pattern include extensive scarring associated with the anchor-shaped incision. The horizontal scar along the inframammary fold, in addition to the vertical and periareolar scars, can be more noticeable and may be a cosmetic concern. Additionally, the extent of incision increases the risk of wound healing complications such as infection and scarring irregularities such as hypertrophic scars and keloids.

Overall, the Wise pattern skin excision is best suited for those with very large breasts and significant ptosis who require substantial reduction and reshaping but is effective for all patients desiring breast reconstruction. Additionally, those with poor skin elasticity or excess skin may achieve better esthetic outcomes with the Wise pattern, as it provides the most effective approach for removing excess tissue and manipulation of NAC positioning. Patients with significant asymmetry or complex breast anatomy may especially benefit from Wise pattern breast reduction due to the extensive alterations that may be achieved with this method.

3.2.3 Periareolar pattern

The periareolar skin pattern involves solely making an incision around the areola (**Figure 23**) [69]. This technique begins with creating a circumferential areolar incision. Parenchymal excision is performed through this incision alone. If a more extensive reduction is required, other techniques such as a vertical extension can be performed for more access to the breast tissue along with excising more excess skin.

A pronounced benefit to this approach is that the scar is well-hidden at the natural pigment transition of the breast and areola. This technique is particularly effective

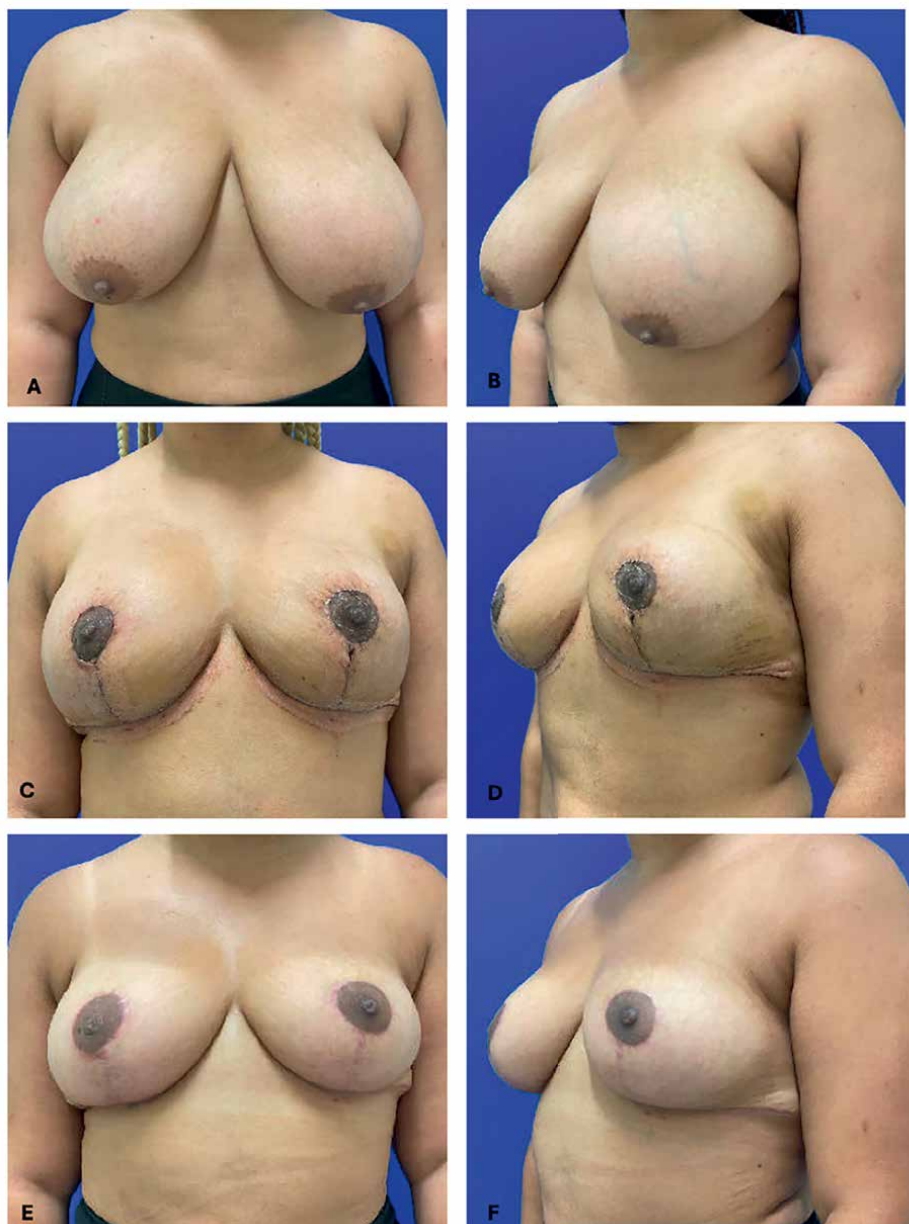


Figure 22. Perioperative wise pattern. (A) Preoperative anterior view (B) preoperative left oblique view (C) anterior view 2 weeks post-op (D) left oblique view 2 weeks post-op (E) anterior view 6 weeks post-op (F) left oblique view 6 weeks post-op.

for patients with moderate breast size and mild ptosis who do not generally require a significant amount of skin excised and do not require a dramatic relocation of the NAC.

A drawback to the periareolar pattern is the restrictive working space. Additionally, the amount of parenchyma and skin that can be removed is limited

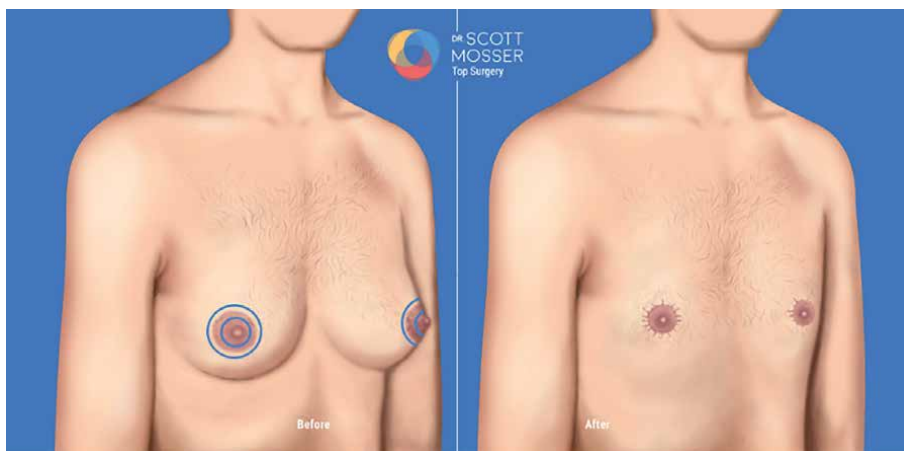


Figure 23. Figure demonstrating location of periareolar incisions in a male patient with gynecomastia undergoing a reduction.

compared to more extensive and open excision patterns like the Wise pattern. This technique may not be suitable for patients with very large breasts or significant ptosis because it may not provide sufficient access for the necessary tissue removal and reshaping [70]. This approach can also result in changes to nipple sensation and function and can cause areolar stretching or widening over time.

Overall, the periareolar skin excision is suitable for patients with mild to moderate breast hypertrophy and minimal ptosis and minimal excess skin who desire a reduction with minimal visible scarring. This method is ideal for patients seeking a more conservative reduction with a focus on esthetic outcomes. The periareolar pattern is also a good option for patients with mild to moderate asymmetry.

4. Postoperative care

After breast reduction surgery, post-operative care is crucial to ensure optimal recovery. Inflammation and ecchymosis are common after surgery and patients are advised to wear a supportive surgical bra or compression garment to minimize swelling and provide adequate support.

During the initial recovery phase, patients are instructed to avoid strenuous activities and heavy lifting to prevent strain on the surgical incisions. Drain management is part of recovery in a few instances and drains are typically removed once daily output is less than 30 cc per day.

Follow-up appointments with the surgeon are scheduled to monitor progress, assess healing, and address any concerns. During these visits, the surgeon may provide guidance on scar management which may include the use of topical emollients or silicone sheets.

The emotional and psychological adjustment to the appearance of a patient's new breasts can also be a significant aspect of post-operative care. Patients may experience a range of emotions, from relief and satisfaction to temporary feelings of discomfort or body dysmorphism as they adapt to their new appearance. Support from healthcare professionals, as well as family and friends, can play a crucial role in recovery.

4.1 Postoperative complications

In this section, we will discuss our institution's experience with common postoperative complications after bilateral reduction mammoplasty using a cohort of 182 patients [71].

Immediate postoperative complications include excess bleeding from a transected arterial vessel. If a large hematoma forms, this may necessitate return to the operating room for hematoma evacuation and ligation of the inciting vessel. Postoperative hematoma requiring reoperation occurred in 2.75% of patients.

Other postoperative complications include seroma formation. This would be identified several weeks after surgery as breast asymmetry and notable firmness or bogginess of the affected breast. Aspiration of the seroma followed by compression is the treatment for postoperative seroma. Seroma was encountered in 0.55% of patients. Fat necrosis is a self-limiting condition in which devitalized fat solidifies. It presents like a nodule under the skin. This does not require surgical excision and will self-resolve with time. Wound breakdown is the most common postoperative complication. The most likely sites are the area under the most tension. For example



Figure 24.

This figure depicts a minor dehiscence at the T point of a wise pattern skin closure after a breast reduction.



Figure 25.

Keloid of inframammary incision after a breast reduction.

in a wise pattern reduction, the ‘T point,’ where the two vertical limbs come together at the IMF, is the area under the most tension and where patients may develop a minor wound dehiscence (**Figure 24**) [72]. Areas where moisture is most likely to be retained are also at high risk for wound breakdown; for example, the IMF. Local wound care is usually sufficient to promote wound healing. In our cohort, dehiscence occurred at a rate of 36%. Wound healing setbacks may result in scar widening in the affected areas. Keloids were seen in 1.1% of post-operative patients (**Figure 25**) [73]. Scar revision was required in 3.3% of patients. Loss of nipple sensation occurred in 4.95% of patients and hypersensitivity was seen in 0.55% of patients. Partial and full nipple loss occurs if the blood supply to the NAC is compromised. Partial nipple loss was seen at a rate of 2.2% and full nipple loss at a rate of 0.55%. Partial and full nipple loss was managed with local wound care.

5. Nonoperative management

Non-operative management of breast hypertrophy focuses primarily on lifestyle modification including diet and exercise for weight loss. This approach aims to reduce overall body fat, including fat deposits in the breasts, potentially leading to a decrease in breast size and alleviation of associated symptoms such as discomfort and physical strain. In select cases, targeted liposuction for fat reduction can be useful.

Liposuction offers a less invasive option for managing breast hypertrophy, particularly for patients who have excess adipose tissue of the breasts but have minimal glandular hypertrophy or ptosis. This procedure involves inserting a stiff cannula through a small incision near or on the breast to evacuate excess fat. It allows for targeted fat removal, resulting in a modest reduction in breast volume. Liposuction is generally suitable for patients with optimal skin elasticity and minimal breast ptosis, given that by nature of the procedure, breast parenchyma and fat are removed but excess skin is not.

Good candidates for non-operative management include individuals with mild to moderate breast hypertrophy who are motivated to pursue weight loss through lifestyle changes. These patients should have good overall health and realistic expectations regarding the outcomes of weight loss or liposuction. They should also have adequate skin elasticity to accommodate potential changes in breast size and contour.

Conversely, poor candidates for non-operative management typically include patients with severe breast hypertrophy characterized by significant glandular tissue and ptosis. These individuals may not achieve satisfactory results through weight loss alone, as the excess skin cannot be effectively reduced without surgical intervention. Patients with poor skin elasticity or a history of unsuccessful attempts at weight loss may also be less suitable for non-operative approaches. In such cases, surgical options like breast reduction surgery may be more appropriate to achieve the desired reduction in breast size and improvement in symptoms.

6. Conclusion

In conclusion, this chapter has provided an in-depth exploration of breast reduction surgery, a crucial procedure for addressing the physical and psychological burdens of breast hypertrophy. By examining the pathogenesis, epidemiology, and anatomical considerations, this chapter has provided a solid foundation for

understanding the complexities involved in surgical planning. The discussion of various surgical techniques underscores the importance of tailoring the surgical strategy to each patient's unique anatomy and desired outcomes. Furthermore, the potential complications and postoperative considerations highlight the need for planning and patient-centered care to optimize results and minimize risks. As breast reduction surgery continues to evolve, ongoing research and clinical experience will undoubtedly refine these techniques, enhancing both functional and esthetic outcomes for patients. This chapter serves as a comprehensive resource for clinicians and patients, offering valuable insights and foundational knowledge on breast reduction surgery.

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Conflict of interest

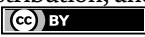
The authors declare no conflict of interest.

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Chapter 9

Axillary Breast

Niran Maharjan

Abstract

The axillary breast despite being a relatively frequent entity, the attention attributed to plastic surgery is sparse. The lack of awareness about the possibility of treatment results in underreporting. Knowledge about it has important implications for patient care; if it is not recognized for what it is, then a normal variant may be misdiagnosed as an abnormality. It can present in any form as polymastia, polythelia, or aberrant breast tissue. Though most of the swelling is asymptomatic, fear of malignancy and cosmetic reasons are the common cause of the presentation. The clinical examination along with ultrasonography of the lump is mostly enough for initiating its remedy. Either liposuction and surgical excision alone or in combination can be implemented in daycare surgery or inpatient basis. In the hands of an experienced plastic surgeon, the procedure is totally safe and is recommended as the disease processes like that of the normal breast tissue can occur.

Keywords: axillary breast, accessory breast, breast cancer, liposuction, mammary crest, pendulous mass, surgical excision

1. Introduction

Axillary breast is defined as the development of breast tissue at the axillary region due to the persistence of the mammary crest that normally regresses. This condition is also known as aberrant breast tissue, ectopic breast, extra breast tissue, or accessory breast tissue. The incidence of axillary breast in women is 2–6% while that in men is 1–3% [1, 2].

It is more common in the Asian population; the attributing factor might be either the true increased incidence or the lower threshold for presentation. In 1/3rd of the population with the axillary breast, it is present bilaterally; however, right-sided prevalence is noted [1].

Despite being asymptomatic, the axillary breast tissue can not only undergo cyclical hormonal changes but also be affected by any type of benign or malignant breast pathology. The lack of awareness about the possibility of treatment results in underreporting. Knowledge about it has important implications for patient care; if it is not recognized for what it is, then a normal variant may be misdiagnosed as an abnormality. It can present in any form as polymastia, polythelia, or aberrant breast tissue [2].

Fear of malignancy and cosmetically unappealing can easily be corrected in the form of liposuction and surgical excision alone or in combination.

2. Anatomy

2.1 Embryology

Prenatal breast development can be classified into two main processes: the formation of a primary mammary bud and the development of a rudimentary mammary gland. Around 4 to 6 weeks of gestation, mammary-specific progenitor cells are seen in the form of paired proliferation of epithelial cells in the epidermis of the thoracic region. This discrete area of proliferation extends in a line between the fetal axilla and inguinal region and forms two ridges called the mammary crests or milk lines (**Figure 1**).

Most of the mammary crest atrophies except for paired solid epithelial masses in the pectoral region at the fourth intercostal space, which form the primary mammary buds [3]. Failure of apoptosis at any region along the milk lines results in either polymastia, polythelia, or aberrant breast tissue. The persisting mammary crest at the axillary region results in the formation of an axillary breast [4].

The developed axillary breast or presence of a supernumerary breast along the milk line is addressed by the embryologic theory, which states the persistence of the tissue due to the failure of regression or displacement of the milk line. **Figure 2** depicts the regressing milk line.

However, the aberrant breast tissue beyond the milk line, such as in the face, neck, ear, lateral thigh, buttock, or knee, is not addressed by this theory. Thus, Hughes in 1950 proposed the independent migration theory, which states the migration of the nests of the primordial breast cells. Later in 1984, Craigmyle proposed the modification theory stating the aberrant breast tissue is due to the modification of the apocrine sweat glands [4].

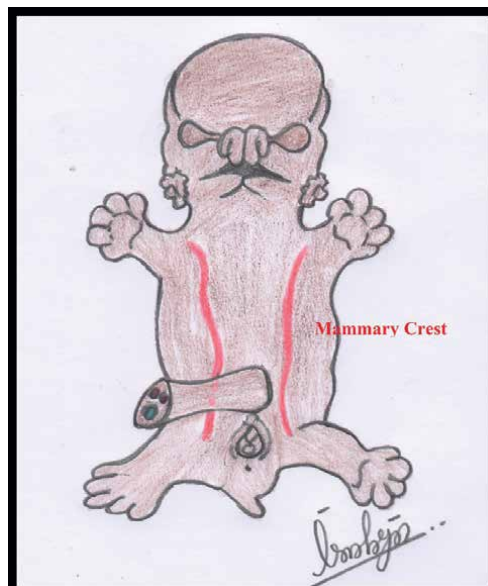


Figure 1.
Ventral view of an embryo at 28 days gestation showing mammary crests.

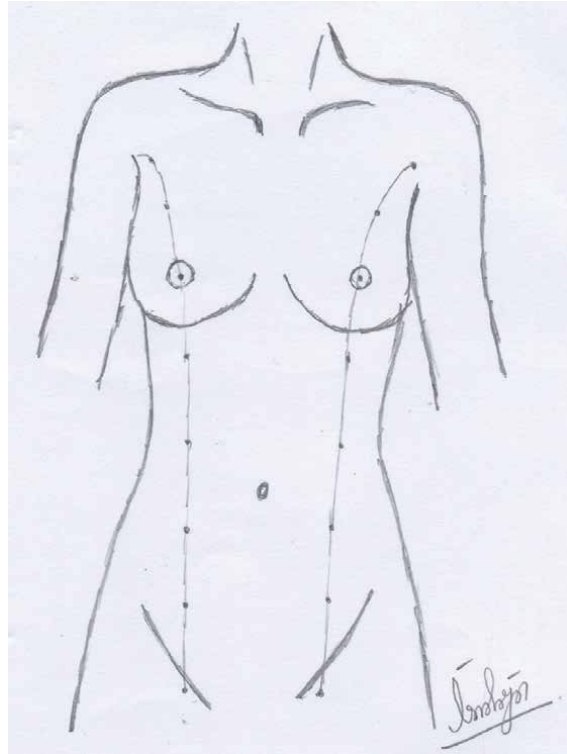


Figure 2.
The milk line as addressed by embryologic theory.

2.2 Hormone and development

The earliest stages of embryogenesis are largely hormone-independent. In the second trimester, the hormones and regulatory factors secreted by mesenchyme are important for breast development.

At 6 months of gestational age, the basic framework of the gland is established and is apparent in both boys and girls. The complex interplay between fetal, placental, and maternal hormones that have not yet been elucidated, and limited secretory activity in the late-term fetus and newborn infant may occur.

The normal gland remains quiescent from 2 years of age to puberty. Falling levels of maternal estrogens in the neonate stimulate the neonatal pituitary gland to produce prolactin, which results in unilateral or bilateral breast enlargement and/or transient secretion of milk.

At puberty, under the influence of sex hormones, in particular estrogen, the development of the breast first begins. Although the pubertal surge of estrogen is the immediate stimulus to mammary development, the action of estrogen depends upon the presence of pituitary growth hormone and the ability of growth hormone to stimulate the production of insulin-like growth factor-1 (IGF-1) in the mammary gland [3]. **Figure 3** depicts the normal development of the breast in the pectoral region with a normal axilla, while **Figures 4** and **5** demonstrate the presence of axillary breast on the right side and bilateral side with pendulous lump simultaneously.

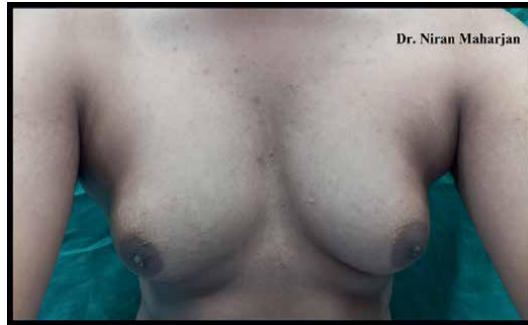


Figure 3.
Normal anatomy of breast and axilla.



Figure 4.
Right-sided axillary breast.



Figure 5.
Axillary breast on the bilateral side with pendulous tissue.

2.3 Applied anatomy

The axilla, an area of transition between the neck and the arm, is an irregularly shaped pyramidal space (**Figures 6 and 7**) with

- 4 sides
- An apex (inlet)
- A base (floor) [5]

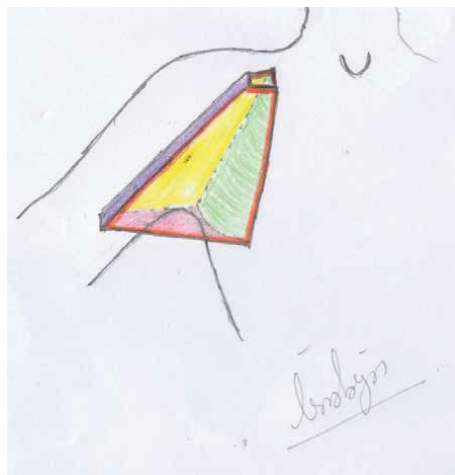


Figure 6.
Pyramidal space at the axilla.

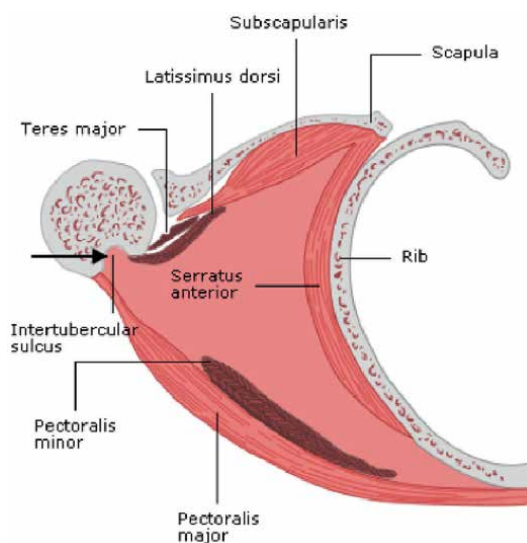


Figure 7.
Anatomical axillary space.

The salient point that every plastic surgeon should bear in mind is that the axilla is a pyramidal structure with a concave floor; thus, after the removal of the lump, it is difficult to obliterate the resultant space with the application of the pressure garment. When the arm is abducted, the neurovascular structures lying near the root are displaced downward, thus making them liable to be injured during liposuction. The esthetic landmarks of the axillar are not well discussed in the literature, but the anterior and posterior axillary folds (**Figure 8**) are the boundaries of the axilla that should not be violated to achieve an esthetically appealing result [2].

In 1915, Kajava [6] published a classification system for supernumerary breast tissue, which can be summarized as in **Table 1**. The supernumerary breast contains

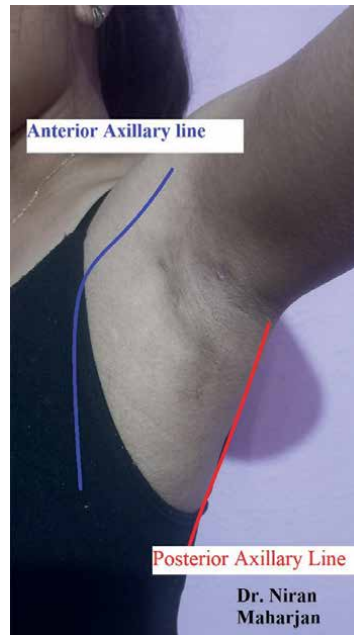


Figure 8.
Esthetic boundaries of the axilla.

Kajava Class	Areola	Gland	Nipple	Terms given
1	√	√	√	Polymastia
2	×	√	√	—
3	√	√	×	—
4	×	√	×	—
5	√	×	√	Pseudomamma
6	×	×	√	Polythelia
7	√	×	×	Polythelia areolaris
8	×	×	×	Polythelial pilosis (patch of hair)

√ → presence of the tissue × → absence of the tissue.

Table 1.
Kajava classification.

either all or part of the normal breast tissue—parenchyma, areola, and nipple. The most common clinical manifestation of axillary breast is Class 4 [4].

3. Pathophysiology

As it can present in a fully developed form or any combination of glandular, nipple, and areola, it is subjected to not only the same physiological changes, such as cyclical hormonal changes and milk secretion but also the same disease processes of aberration of normal development and involution (ANDI). Thus, the benign and malignant pathology it can carry are:

- Abscess formation
- Mastitis
- Milk fistula
- Cyclical mastalgia
- Cysts
- Fibroadenoma
- Fibroadenosis
- Hamartomas
- Phyllodes tumors
- Tuberculosis
- Duct ectasia
- Carcinoma

The incidence of axillary breast carcinoma is 0.2 to 6%. The higher incidence might be due to the stagnation in the ductal system and bears a poor prognosis due to its proximity to the axillary lymphatics and lymph nodes [1, 2, 4].

4. Clinical features

Axillary breast mostly is asymptomatic. The fear of malignancy, anxiety from the presence of a lump, pain, and tenderness, restriction of arm movement, irritation from clothing, and cosmetic problems are the presenting symptoms. Very few might present with pain along the medial arm and sticky skin causing discomfort.

Breast cancer awareness has positive and negative effects. Due to high alert, the presence of a lump that gets painful and tender on touch and also mild change in size definitely makes one think of the malignancy. Pain, swelling, and irritation along with limited movement of the arm may get worsen during puberty, menstruation, and/or pregnancy [1, 3, 7].

The lumpy armpit that gets easily visualized makes one restrict from wearing not just the sleeveless dress but even a properly fitting dress. The discomfort might hinder them from participating in social activities too.

5. Differential diagnosis

The fear that any unnatural lump in the body can be a form of cancer has dwelled deeply in the thoughts of everyone, and the credit goes to the awareness programs. When one finds a lump in their axillary region is definitely a malignancy.

Other lesions that might mimic the clinical presentations are as follows:

- Lipoma
- Axillary lymphadenopathy
- Hidradenitis suppurative
- Sebaceous cyst
- Vascular malformation [2, 8].

6. Investigation

A thorough clinical examination is mostly enough to rule out other causes of the swelling and to make a diagnosis. But without conducting an investigation, it will be almost difficult to reassure the patient. Thus, noninvasive and easily available ultrasonography can be used to support the preliminary diagnosis. When in doubt, either a mammogram or MRI can be advised. For the confirmatory diagnosis, either fine needle aspiration cytology (FNAC) or surgical incisional biopsy can be used.

7. Treatment

Reassurance or counseling might work for the asymptomatic patients who have a small negligible lump. But for those who either have symptoms or present due to fear of malignancy or moderate to severe skin laxity with visible lump, counseling or reassurance alone is never enough. For these patients, definitive treatment is the only option that must be protruded.

The known treatment modalities for taking care of this armpit swelling are either liposuction and surgical excision alone or in combination. But with recent advancements, there is the introduction of nonsurgical modalities too. As per Kurtzman et al. [7], the newer nonsurgical modalities are the use of Kybella and CoolSculpting.

Kybella (deoxycholic acid) is a prescription medicine approved in 2015 by the FDA for the treatment of double chin [9]. This synthetic medicine when injected into the submental region, breaks down fat by destroying its cell membrane. The common complications after its use are swelling, pain, numbness, and hardness, but the dreaded complication is an injury to underlying nerves and vessels [10]. Thus, the FDA has not approved its use in the axilla as the region contains important neurovascular supplies to the upper limb.

CoolSculpting or cryolipolysis is the FDA-approved noninvasive procedure that vacuums the skin above the area of fatty tissue into an applicator that freezes the fat cells to break it down as these cells are more affected by the cold temperatures than other cells. The broken-down fat cells are then removed by the body within 4 to 6 months. The complications associated with this procedure are diminished sensation in the treated area followed by swelling, bruising, redness, and localized pain [11]. However, it will not tighten the overlying skin thus skin redundancy might be more visible.

Both of the abovementioned noninvasive procedure works only if the axillary swelling is purely due to fat cell accumulation. As the most common axillary breast is

Kajava IV, the glandular portion must be addressed. Thus, invasive techniques in the form of surgical excision of the tissue along with the redundant skin or liposuction alone or in combination with glandular excision must be sought.

Surgical excision is done by placing a commonly used elliptical incision or a different one to address the pendulous skin present at the armpit so that the resultant scar can be hidden under the axilla. The markings on the skin are made prior to when the patient is in full consciousness and either on the table or before transferring to the operation theater. Patients are laid on the operation table and then are anesthetized with general anesthesia (GA). The arms are kept in an abducted position and the scalpel is run with controlled hemostasis. The excess of the skin and the glandular tissue are excised. Depending on the condition at the time of closure, either a closed drain is placed or opted for direct closure. The space is obliterated by placing a bulky dressing so that there will not be any collection underneath the skin. Collection in the form of seroma or hematoma, wound infection, and bruising are the usual complications associated with this technique. The resultant scar is generally accepted by the patients in comparison to carry on the lump.

Liposuction is usually preferred by the patients as the resultant scar is negligible in comparison to the excision technique but failure to address the glandular tissue of complete removal, thus creating a chance of leaving a remnant glandular tissue and non-address of the pendulous skin limits its choice. Thus, this can be addressed by combining the technique with the excision of the glandular tissue. But then the incision must then be lengthened. Liposuction is usually done under local anesthesia (LA), but some might prefer the GA. The Klein's solution, which is prepared by adding 100 mg of lignocaine, 10 ml of 8.4% sodium bicarbonate, and 1 ampoule of adrenaline in 1 liter of normal saline (NS), is infused in the axilla up to the lateral chest wall. The tumescent technique where more than 2 ml of the fluid is infiltrated for suctioning out half the volume is preferred by plastic surgeons. After the infiltration of the fluid, surgeons wait for at least 7 minutes for the adrenaline to show its effect. This helps to minimize the bleeding. A small stab incision of 3 to 5 mm depending on the size of the liposuction cannula is made on the axillary fold. The cannula is then attached to the suctioning apparatus of the surgeon's choice or availability. With the negative pressure exerted and the to-and-fro movements, the fat molecules are suctioned out. The to-and-fro movement is continued in a fanning shape so as to address all the swelling present on the armpit. The suctioning apparatus is turned off when the swelling has completely subsided or failed to suction out the glandular tissue, which is usually a fibrous tissue requiring the surgical excision. After confirming the hemostasis, the incision is closed, and the wound is dressed with utmost care to obliterate the space created under the skin. Complications associated are similar to the surgical excision technique but with much smaller-sized scars.

7.1 Surgeon's technique

The surgical site is prepped and draped. Klein's solution is injected with the 10 ml or 50 ml syringe till the lump turns firm. Then, we wait for 7 to 10 minutes for the adrenaline in Klein's solution to work. At the middle of the axillary fold, a stab incision with a 15 number bladed is given. The cannula is guided to the lump and then after is attached to the suctioning apparatus. The machine is turned on to generate negative pressure up to 400 mmHg; the cannula then is moved in to-and-fro movements. The maneuver is continued at one place till the presence of the lump or skin thickness gets thin as desired or there is notice of bleeding on the suctioning pipe.

The direction of the cannula is then changed, and as doing so, the fat molecules are suctioned out. From the same stab incision, which usually gets a bit stretched during the to-and-fro movement, the remaining fibrous tissue is pulled out gently and cut with sharp scissors. By remaining above the deep fascia and below the dermis, there is minimal bleeding noted. After resection of the fibrous parenchymal tissue, the cavity is irrigated with normal saline to check the hemostasis and to secure the capillary bleed. Repeating the irrigation for a couple of times and reassurance of the complete hemostasis thus achieved, the irrigated normal saline is completely drained and the incision is closed with polypropylene 6–0 sutures.

Initially, the redundant skin seems pendulous, but with due time, it shrinks; thus, the skin is repositioned and a bulky tight dressing is placed, which is changed on an alternate day basis. After removal of the suture in a week or 10 days depending on the wound condition, the pendulous skin is supported in the correct position with the use of the compression cloth and placement of the gauze pad on the underarm. A correctly implemented method aids in early recovery. It generally takes 6 weeks to 3 months for the skin to retract.



Figure 9.
Preoperative right axillary breast with markings.

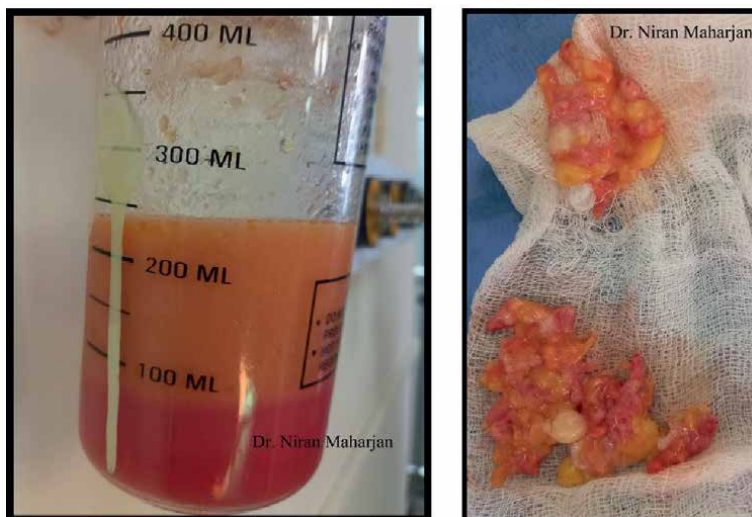


Figure 10.
Intra-op aspirated fluid along with fat and parenchymal tissue.



Figure 11.
5th postoperative day with the sutured wound on transverse axillary fold.



Figure 12.
35th postoperative day with retracting skin and camouflaged scar.



Figure 13.
Pre- and early postoperative pictures.

The limitation of incorporating this technique is the presence of a large pendulous lump as the skin recoiling may not be achievable to the desired amount.

Figures 9–13 followed below are the pictorial demonstration of the right axillary breast in the preoperative status through to the 5th postoperative week pictures for early comparison of lump status and skin retracting quality of humans.

8. Complications

The most common complication of the nonsurgical treatment is that it is not FDA approved.

The common complications associated with the interventive methods are:

- Seroma
- Hematoma
- Residual tissue
- Infection
- Intercostal brachial nerve (ICBN) injury
- Poor scar [1, 4].

9. Conclusions

The axillary breast can be treated with liposuction and excision of the glandular tissue on a daycare surgery basis. The pendulous tissue can be addressed intraoperatively with the excision of the excess tissue without jeopardizing the esthetic boundaries of the axilla thus resulting in a cosmetically pleasing resultant scar. The procedure is safe and recommended in the hands of an experienced plastic surgeon.

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Conflict of interest

The authors declare no conflict of interest.

Notes/thanks/other declarations

I would like to thank all the patients who trusted me and waited with patience before the final outcome of the desired result came.


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Perspective Chapter: Mastopexy/ Augmentation and Revision Aesthetic Breast Surgery

Pasquale G. Tolomeo and Angelo Cuzalina

Abstract

Breast enhancement remains one of the most frequently performed procedures in aesthetic surgery, with patients pursuing a variety of techniques to improve the shape, contour, and overall appearance of the breasts. Augmentation-mastopexy, which simultaneously corrects glandular hypoplasia or hyperplasia as well ptosis, is an essential but complex technique within a cosmetic surgeon's skill set. Achieving optimal outcomes requires careful consideration of multiple anatomical and aesthetic factors, including desired implant volume, existing breast dimensions, symmetry, nipple-areolar complex (NAC) size and placement, inframammary fold (IMF) position, and the thoracic contour. Combining mastopexy with augmentation presents technical challenges due to the contrasting objectives: mastopexy aims to tighten and elevate the breast, while augmentation involves expanding the tissue to enhance volume. These conflicting goals can complicate tissue management, vascular integrity, and implant positioning. Even with detailed preoperative planning, some cases may result in suboptimal outcomes. Potential complications include asymmetry, implant displacement, rupture, surface rippling, and capsular contracture. Addressing these issues through revision surgery demands advanced surgical acumen and experience, as it involves restoring harmony, contour, and patient satisfaction in a highly individualized manner.

Keywords: breast mastopexy, breast augmentation, aesthetic breast surgery, breast revision, implant malposition, capsular contraction

1. Introduction

Cosmetic breast surgery continues to rank among the top procedures requested by patients. According to data from the American Society of Plastic Surgeons (ASPS), breast augmentation was the second most performed cosmetic procedure in 2023, and mastopexy being the seventh most popular procedures [1]. Patients pursue a variety of interventions, ranging from implants, autologous fat transfer, lifts, reductions, or a combination of these procedures, to achieve their ideal

breast aesthetics. Achieving an ideal aesthetic result depends heavily on harmony in breast size, shape, and symmetry. Importantly, the concept of beauty is inherently subjective, shaped by an individual's preference and goals. Successful breast surgery integrates both scientific principles and artistic sensibility, rooted in a comprehensive understanding of human proportions and the subtle interplay of soft tissue dynamics.

Combining mastopexy with augmentation to address both breast ptosis and glandular hypoplasia/hyperplasia is a core competency in aesthetic surgery. Achieving an optimal cosmetic result requires thoughtful control over numerous factors, including implant volume, existing breast dimensions, shape, symmetry, position and diameter of the nipple-areolar complex (NAC), inframammary fold placement, and overall thoracic contour. Common contributors to breast deflation and ptosis include pregnancy, breastfeeding, weight changes, and congenital anatomy. Over time, these factors may lead to a mismatch between the breast mound and the NAC, with the descent of the NAC below the fold and deflating the upper pole. While mastopexy alone is more frequently performed, combining it with an augmentation introduces added complexity and is less routinely undertaken due to the detailed preoperative planning and technical precision required. Surgeons capable of harmonizing these competing variables while recognizing anatomical limitations are more likely to deliver outcomes that align with both functional goals and patient expectations.

As with any operative procedure, breast surgery carries certain risks, including asymmetry, implant rippling, displacement, deflation, and the development of capsular contracture. When complications arise or results fall short of expectations, revision breast surgery becomes necessary to restore a more aesthetic outcome. This revision procedure allows for refinement in breast shape and size, correction of prior complications, and can significantly enhance a patient's body image and self-esteem.

That said, revision procedures often present greater challenges compared to primary surgeries. Factors such as scar tissue formation, disruption of anatomical planes, and possible implant issues may increase the complexity of the revision. Risks such as bleeding, infection, and anesthesia-related complications remain, but the likelihood of these events is slightly elevated due to the altered surgical field. Because of this, aesthetic breast revision requires a surgeon with not only advanced technical proficiency but also substantial experience in managing the nuances of revisionary cases. Patients are strongly encouraged to seek out a provider with a demonstrated track record in complex breast surgery to ensure a safe process and satisfactory long-term results.

The field of breast surgery has seen continuous innovation, with new techniques and refined approaches enhancing both safety and aesthetic outcomes. As procedures become more advanced, the modern surgeon must be well-versed in a variety of operative strategies to effectively address diverse patient anatomies and expectations. Achieving reliable and lasting results requires more than technical skill, it demands a thorough understanding of the anatomical landscape. While surgical tools and methods may evolve, foundational anatomical knowledge remains essential. This understanding allows surgeons to preserve critical structures during surgery, reducing complication rates and improving the quality of postoperative results.

2. Pre-operative planning

The initial consultation is a cornerstone of successful aesthetic breast surgery. Given that many individuals seek opinions from multiple providers, establishing trust and professionalism early on is critical. During this visit, the surgeon's goals include identifying the patient's concerns, collecting a detailed medical and surgical history, conducting a comprehensive physical assessment, and offering a tailored treatment plan. This also includes outlining the benefits, risks, and limitations of proposed interventions. Importantly, this phase allows the surgeon to align expectations with realistic outcomes and educate the patient on their condition and procedural options, thereby empowering them to make informed decisions about their care.

2.1 Patient evaluation

A comprehensive pre-operative assessment is fundamental to achieving a safe and effective surgical outcome. The process begins with documenting the patient's primary concern, ideally expressed in their own words to ensure an accurate understanding of their goals. Utilizing open-ended questions encourages meaningful dialog and provides insight into their expectations. The medical review should encompass current diagnoses, a full list of medications (including dosage and frequency), allergies, and previous surgical interventions. Social factor, such as tobacco or nicotine use, are particularly relevant due to their negative effects on circulation and wound healing. Additionally, understanding the patient's occupation helps the surgeon anticipate potential limitations during the recovery period. A thorough family history, particularly regarding breast cancer, should be obtained, and for patients over 40 or those with elevated risk, preoperative imaging like a mammogram is strongly advised to ensure patient safety and comprehensive planning [2].

2.2 Patient examination

The breast examination should begin with a careful visual assessment, focusing on several critical elements. These include evaluating the quality and elasticity of the skin envelope, overall breast volume, positioning and size of the nipple-areola complex, degree of ptosis, presence of any asymmetry, and, if applicable, the location of the existing implant pocket. Aesthetic analysis is further enhanced by referencing the principles outlined by Mallucci and Branford, who highlighted four essential features in defining breast beauty: the upper-to-lower pole ratio, nipple angulation, the contour of the upper pole, and the convexity of the lower pole [3]. The surgeon should be adept at recognizing both subtle and significant differences in breast size and shape. Typically, a volume discrepancy of less than 10% is considered physiologically normal [4].

Beyond breast contour and proportions, any structural anomalies of the chest wall or spinal column must be noted, as these may contribute to visual asymmetry. A thorough palpation of the breasts and axillary regions is essential to detect any abnormal masses or lymphadenopathy, including along the supraclavicular and axillary lymph node chains.

To classify ptosis, the Regnault system is often used, which evaluates nipple position in relation to the inframammary fold (IMF) and skin envelope (**Table 1; Figure 1**) [5].

Regnault's classification of ptosis	
Minor ptosis (1st degree)	Nipple at the IMF or 1 cm inferior to IMF
Moderate ptosis (2nd degree)	Nipple inferior to IMF & superior to lower breast contour
Severe ptosis (3rd degree)	Nipple inferior to IMF & at lower breast contour
Glandular ptosis	Nipple superior to IMF & breast tissue inferior to the breast fold
Pseudoptosis	Nipple superior to IMF; breast is hypoplastic & inferior to the breast fold

Table 1.
Regnault's classification of breast ptosis [5].

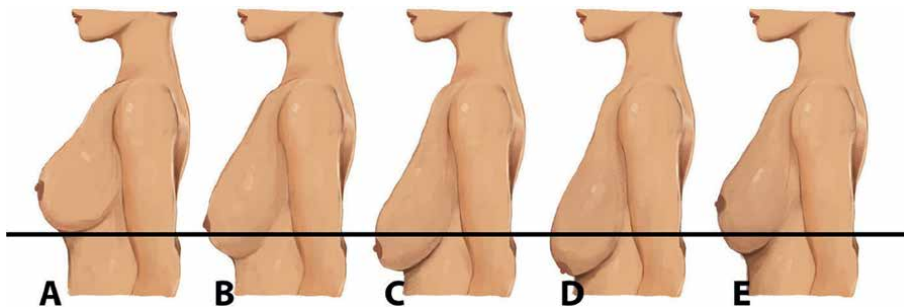


Figure 1.
Breast ptosis classification [5]. A: Normal. B: 1st degree. C: 2nd degree. D: 3rd degree. E: glandular ptosis.

The final part of the examination includes measurements and clinical photography (**Figure 2**).

Relevant dimensions include [3, 4, 6–8]:

1. Breast width (BW): midline to the anterior axillary line
2. Breast thickness (BT): upper pole thickness
3. Sternal notch to nipple (SSN-N): ideal measurement of 19–21 cm
4. Mid-clavicle to areola (MC-A): ideal measurement of 19–21 cm
5. Inter-nipple distance: ideal measurement of 19–21 cm
6. Areolar width (AW): ideal measurement of 3.5–4.5 cm
7. Nipple to inframammary fold (N-IMF): ideal measurement of 6–8 cm
8. Intermammary distance (IMD): ideal measurement of 19–21 cm from nipple to nipple
9. Ptosis: relative position of nipple to IMF

10. Mid-humeral point (MHP): mid-point between the acromion and lateral epicondyle; the ideal location of the nipple
11. Breast parenchyma size: lower pole is greater than the upper pole.
12. Skin quality
13. Parenchyma quality and elasticity

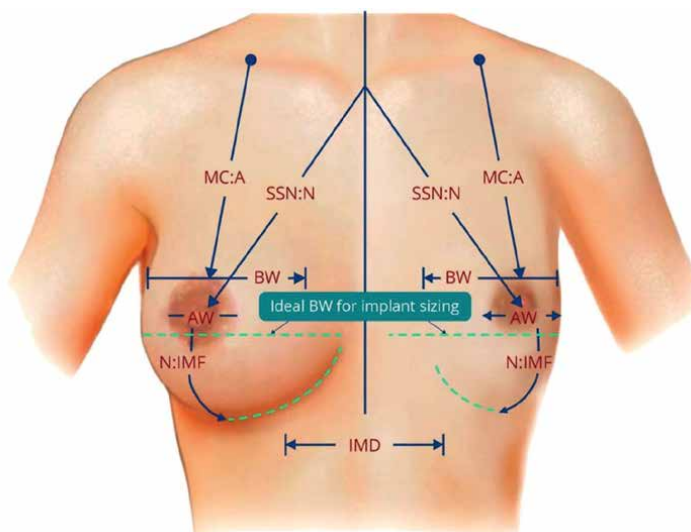


Figure 2.
Breast measurements and 'ideal' base width.

Among the key parameters in breast surgery are the breast base width, the distance from the sternal notch to the nipple, and the vertical distance from the nipple to the inframammary fold. The “ideal” or desired base width (BW) often differs from the patient’s actual BW and is generally measured from the anterior axillary line to approximately 1 cm lateral to the chest midline. This desired BW is used during implant sizing to select the appropriate implant width (**Figure 2**). Precise BW ensures correct implant width to prevent issues like symmastia or lateral displacement. The nipple-to-IMF distance is particularly important in achieving desirable lower pole projection and harmonious breast proportions. Likewise, the sternal notch-to-nipple distance plays a vital role in defining the correct vertical position of the nipple-areola complex [6]. Accurate evaluation of these metrics, while staying within the breast’s anatomical limits, is essential for obtaining consistent, aesthetically pleasing outcomes.

It is essential to understand that not every patient is well-suited for a simultaneous mastopexy and augmentation. These two procedures have inherently opposing goals, mastopexy involves tightening and reducing excess skin, while augmentation focuses on enhancing breast volume. When performed together, these objectives may conflict, particularly regarding the available skin envelope and vascular supply, potentially compromising the outcome. The added volume can place undue tension

on the skin, which may impair arterial inflow and venous return, thereby risking reduced perfusion to the NAC.

Patients presenting with significant ptosis, constricted or tubular breast morphology, or those desiring substantial volume enhancement often achieve more favorable outcomes with a staged surgical plan. In such scenarios, separating the procedures allows for safer tissue handling and more precise contouring. Likewise, individuals with underlying health issues or those who have undergone prior breast surgeries are more likely to benefit from a phased approach. This strategy helps mitigate complications such as ischemia or NAC necrosis by allowing for improved vascular preservation and soft tissue management (Figure 3).

A comprehensive pre-operative assessment is essential for formulating an effective surgical plan that aligns with the patient's goals and ensures optimal aesthetic results.

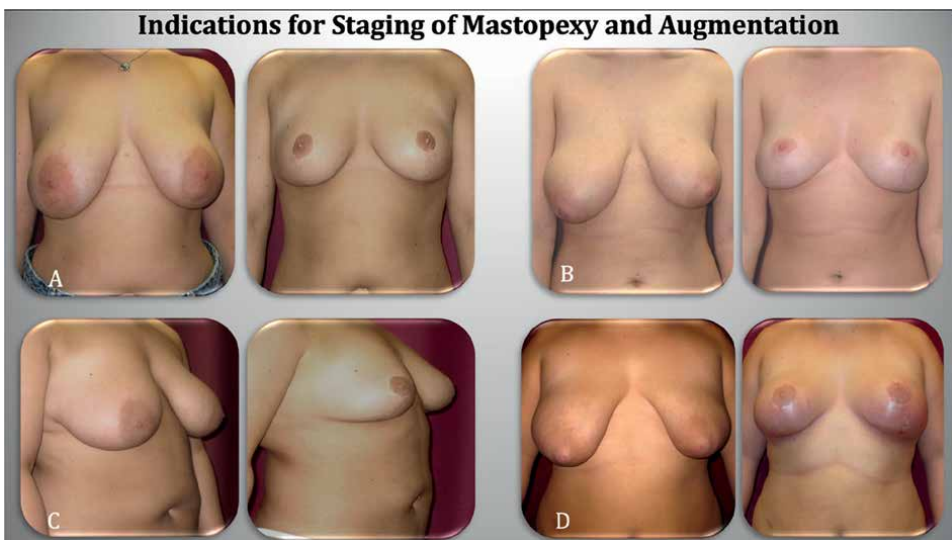


Figure 3. Surgical staging serves to reduce the likelihood of ischemic complications affecting both the breast parenchyma and the NAC. Patients with significant breast hypertrophy and pronounced ptosis, or those exhibiting tubular or constricted breast anatomy, are at elevated risk for vascular compromise. In such cases, performing the mastopexy as a preliminary step, followed by augmentation at a later stage, offers a safer, more controlled approach. A. Dense/Asymmetric breasts with Grade 3 ptosis. B. Tubular/Constricted breasts & Grade 3 ptosis. C. Breast Reduction using Medial-Central (MC) pedicle D. Breast reduction (Right breast) & mastopexy (Left breast) with Superior-Medial Central (SMC) pedicle.

2.3 Patient discussion

It is critical to convey that no two breasts are identical, and perfect symmetry is rarely achievable, as natural variations in shape and size are the norm. The surgeon must align the patient's expectations with feasible surgical outcomes, ensuring the approach remains both safe and realistic. Open communication during the consultation is essential, with patients encouraged to clearly articulate their goals and concerns. Educating patients on the indications, limitations, and possible risks of each surgical option fosters transparency and trust, key elements in achieving a successful and satisfying aesthetic result.

3. Mastopexy incision design

The primary objective of mastopexy is to restore a breast that is well-balanced in size and shape, with results that remain stable over time. When performed in combination with other procedures, mastopexy typically includes lifting the NAC along with excision of excess skin and glandular tissue. This approach addresses ptosis while reshaping the breast to improve contour and proportion [6]. The choice of incision pattern is influenced by the extent of ptosis and the specific aesthetic goals (Table 2).

Mastopexy incision design	Indications	Advantages	Disadvantages
Periareolar/ Crescent	Grade I or II ptosis, NAC asymmetry	1. Subtle NAC elevation (1–2 cm) 2. Concealed scar	1. Flattened breast projection 2. Risk of scar widening
Vertical/ Teardrop	All grades of ptosis	1. Correction of ptosis & resection of excess tissue 2. Maintains NAC projection	1. Possible residual asymmetry 2. Diminished lower pole projection
Wise pattern/ inverted T	Grade II–III ptosis	1. Greater skin/parenchymal excision 2. Allows for breast reduction & lift in conjunction with augmentation	1. Increased scar presence 2. Elevated risk of wound breakdown
Multi-Planar L Scar	All ptosis grades	1. Correction of ptosis & resection of excess tissue 2. Preservation of nipple mound projection 3. Minimal Scarring	1. Decreased lateral breast projection 2. Seroma/Hematoma formation 3. Need for Surgical Drains

Various mastopexy designs and their clinical advantages [9, 10].

Table 2.
Mastopexy design.

3.1 Periareolar/crescent

Periareolar mastopexy is most appropriate for patients presenting with Grade I or II ptosis, minor NAC asymmetry, or limited skin redundancy. This method allows for elevation of the NAC by approximately 2 centimeters, offering a subtle lift without significant excision of breast tissue or skin. It is particularly useful for addressing NAC asymmetry with minimal disruption to the underlying breast structure. However, when applied to reduce the skin envelope, this technique may create a periareolar defect, increasing the likelihood of complications such as compromised wound healing, distortion of the NAC, and a reduction in breast projection [6].

A primary drawback of the periareolar mastopexy is the tendency for the periareolar scar to widen over time. To help prevent this, two techniques may be employed. First, placing the incision under maximal tension during the marking phase ensures a more predictable final NAC contour and minimizes excessive stretch during healing. Second, securing the closure with a permanent purse-string suture helps evenly distribute tension and reinforces the incision. Polytetrafluoroethylene (PTFE) is

a commonly chosen material for this purpose, as it maintains suture strength and resists deformation, thereby reducing the likelihood of NAC distortion or scar expansion [6].

The crescent mastopexy represents a variation of the periareolar approach, involving the excision of circumareolar breast tissue. This technique is especially useful in patients presenting with nipple asymmetry or those needing a minimal NAC lift of approximately 1–2 cm. By selectively removing tissue in a crescent shape above the NAC, minor discrepancies in height can be corrected while limiting scarring and maintaining a subtle contour enhancement.

Benelli described a periareolar mastopexy technique that integrates reshaping of the breast parenchyma [11]. This approach is particularly helpful in managing larger breasts while employing the periareolar method. It involves excision of the surrounding skin and soft tissue around the areola. This procedure confines the incision along the areola while allowing for reshaping of the areola.

According to both the authors' experience and supporting literature, periareolar mastopexies tend to carry a higher likelihood of requiring revision due to aesthetic shortcomings, limited breast projection, and frequent recurrence of ptosis [9, 12].

3.2 Vertical-teardrop

The vertical mastopexy technique aims to elevate the NAC and address ptosis by facilitating the removal of glandular tissue, which contributes to more durable results. This method combines a periareolar incision with a vertical limb, enabling comprehensive reshaping of the breast and generally yielding more sustained aesthetic improvements than other lift approaches.

The Hall-Findlay method is a preferred technique due to its adaptable pedicle configuration, limited visible scarring, and ability to maintain breast projection. It commonly employs either a Superior-Medial-Central (SMC) or Medio-Central (MC) pedicle, both recognized for their dependable vascular inflow and drainage, which support optimal perfusion to the NAC. The procedure involves excising a wedge of tissue from the inferior breast pole, followed by approximation of the medial and lateral pillars to reinforce support beneath the NAC. This maneuver simultaneously reduces excess volume and enhances breast contour and elevation [13]. It is important to position the lower end of the vertical incision above the inframammary fold (IMF), as the IMF may shift upward over time. This placement helps prevent the scar from migrating onto the upper abdomen, which could compromise aesthetic outcomes.

When determining the appropriate implant pocket, both subglandular and subpectoral placements can be considered, especially since the vascular integrity of the 2nd and 3rd internal mammary perforators is typically maintained. This vascular preservation supports sufficient perfusion to the surrounding tissues, aiding in the overall safety and viability of the chosen placement technique [9]. Utilizing this approach, the breast initially exhibits enhanced upper pole fullness with a relatively flatter lower pole contour. Over time, typically several months, the implant gradually settles into position, allowing the inferior pole to achieve its intended projection and shape.

3.3 Wise pattern/inverted T

The Wise Pattern mastopexy, also referred to as the Inverted-T or anchor incision technique, remains one of the most comprehensive and widely utilized methods for

addressing moderate to severe breast ptosis, particularly when concurrent breast reduction or augmentation is desired. This technique is particularly beneficial for patients with significant excess skin and breast tissue, offering enhanced reshaping capabilities and long-term projection control.

This approach involves a triad of incisions, periareolar, vertical, and horizontal, that together create the classic anchor shape. The periareolar and vertical incisions facilitate elevation and centration of the nipple-areolar complex (NAC), while the horizontal component allows for the excision of redundant skin and parenchyma. This facilitates restoration of an aesthetically pleasing lower pole and provides the necessary foundation for consistent NAC positioning. It also permits more precise control of the IMF distance, ensuring balanced proportions and symmetry in the final contour [12].

A key advantage of the Wise Pattern mastopexy is its adaptability in pedicle selection. Depending on the patient's breast anatomy and prior surgeries, the surgeon may choose from superior, inferior, medial, central, or combined pedicles to preserve vascular integrity while optimizing shape and projection [12]. This flexibility is critical in revision cases, where prior incisions and concern for vascular compromise may influence flap viability.

Despite its versatility, the Wise Pattern technique is not without limitations. One major concern is the potential for increased scar burden. Scars may be more visible, especially in patients with poor wound healing or keloid tendencies. Additionally, when employing an inferior pedicle, surgeons must be vigilant of the increased risk of lower pole redundancy or "bottoming out" over time. This phenomenon results from diminished structural support at the lower pole, which can compromise implant positioning and aesthetic outcomes [14].

Furthermore, in combined augmentation-mastopexy procedures, the intersection of the vertical and horizontal incision, the so-called trifurcation point, is particularly prone to wound dehiscence. This area endures higher tension due to the added implant weight, making it susceptible to delayed healing or tissue breakdown. To mitigate this, meticulous tension distribution and layered closure are recommended, along with careful selection of implant size and placement plane [9].

Overall, the Wise Pattern technique provides the highest degree of control for reshaping, lifting, and reducing the breast, particularly in cases of massive ptosis or macromastia.

3.4 Multi-planar L scar

The Multiplane L-Scar Augmentation Mastopexy, pioneered by Dr. Adel A. Bark Jr., represents a sophisticated advancement in aesthetic breast surgery. This technique aims to limit visible scarring while offering precise control over breast contour, projection, and volume. By individually addressing the skin, breast parenchyma, and muscle, the method enables tailored reshaping and improved long-term outcomes [10].

The procedure begins with the skin, marking the first phase of a triple-layered approach. An initial incision is made to expose the underlying breast parenchyma and pectoralis major. A thin dermofat flap is elevated while maintaining the subdermal vascular plexus to optimize tissue perfusion and healing. This also facilitates greater access and maneuverability for the deeper stages of dissection.

Once the skin elevation is complete, attention shifts to the parenchyma. An internal inverted-T incision is performed within the breast parenchyma to allow for repositioning and volume adjustment. The parenchyma is separated from the muscle, preserving a 2–3 cm layer of tissue to maintain blood supply and prevent recurrent ptosis.

Subsequently, the muscle is addressed in accordance with Tebbetts' method, which involves developing a modified submuscular implant pocket while conserving both medial and lateral muscular attachments [15]. The implant is then placed into this pocket, with intraoperative adjustments made for symmetry and projection. The central parenchyma is anchored to the pectoral fascia above the NAC to reinforce the upper pole and stabilize the breast mound, while the medial and lateral tissue is drawn caudally to reduce dead space. Additional contouring and approximation of the pillars are performed at this stage.

The final stage revisits the skin envelope, completing the second part of the skin strategy. Redundant skin is excised by advancing the medial and lateral flaps toward each other, often resulting in a dog-ear deformity that is corrected via a lateral L-shaped incision.

The Multiplane L-Scar Mastopexy focuses on reshaping the breast parenchyma while treating the skin as a separate entity. This technique avoids the need for a medial horizontal incision, ensuring long-term stability and optimal aesthetic results [10].

3.5 Surgeon's preference

In breast surgery, it is essential for the surgeon to establish a clear surgical plan and thoroughly inform the patient of potential complications. Obtaining prior operative reports is crucial to understanding the original planes of dissection, implant pocket selection, and pedicle design, helping to minimize the risk of further complications. When the pedicle design from previous procedures is unknown, selecting a pedicle with multiple perforators is advisable. The Superomedial-Central pedicle is often preferred for sternal notch-to-nipple distances under 30 cm, due to its robust blood supply from both medial and central sources, which enhances tissue viability and healing (**Figure 4**).

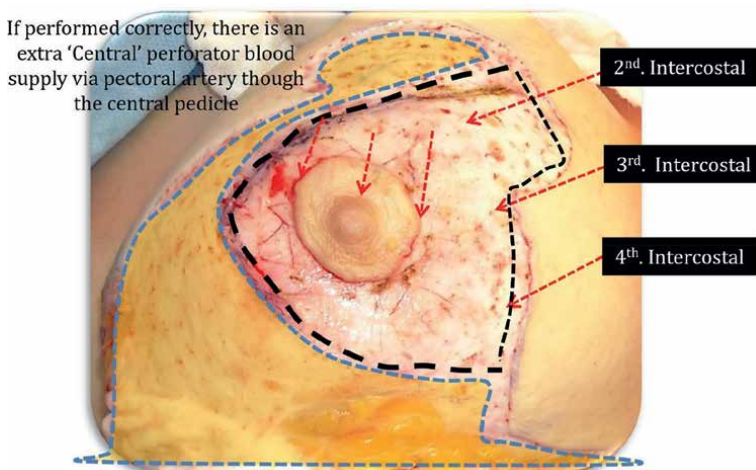


Figure 4. Superomedial-Central Pedicle. This pedicle designs demonstrate the excellent dual blood supply to the breast and NAC via medial as well as central perforators.

The surgeon should be familiar with the range of pedicle configurations and their specific indications for use (**Figure 5**). Among these, the superior-medial (SM) pedicle, when integrated with a central (C) pedicle, offers the greatest versatility due to its extensive and reliable vascular network. This composite pedicle receives blood supply primarily from the internal mammary artery, reinforced by the 2nd to 4th internal mammary perforators (supporting the superior-medial pedicle) and the trans-pectoral perforators that branch from both the internal mammary and medial mammary vessels (supporting the central pedicle). With a base width ranging between 6 to 10 cm, this pedicle configuration ensures sufficient perfusion. However, in patients with a history of breast augmentation using a subglandular implant, the vascular integrity of the central pedicle may be compromised due to disruption of key perforators (**Figure 6**).

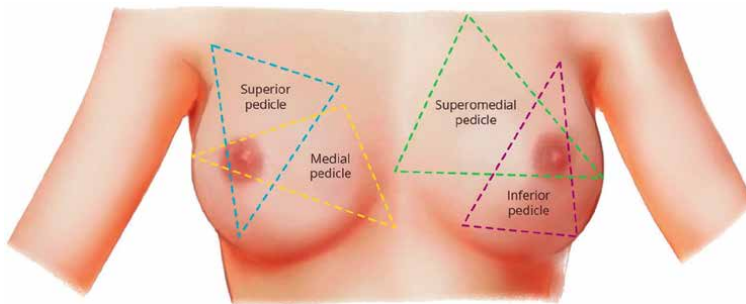


Figure 5. Breast Pedicles. The pedicle configurations illustrate the extensive vascular support provided to the breast and NAC.

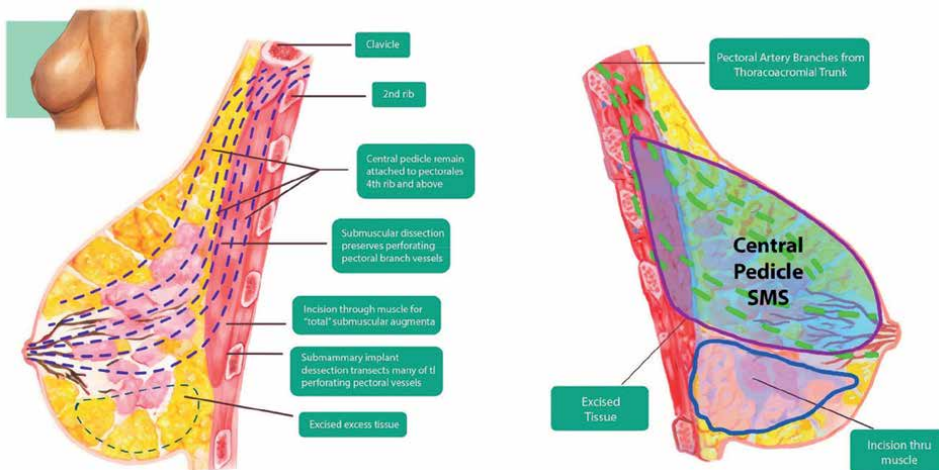


Figure 6. Pectoral Vessels. Creating a submammary implant pocket can compromise vascular supply to the central pedicle by disrupting key perforators. In contrast, placing the implant in a total submuscular plane helps preserve these perforating branches, even when substantial excision of the inferior gland has been performed.

The selection of pedicle design remains a critical factor in complex cases. For patients presenting with pronounced ptosis or heavily pendulous breasts, often defined by a sternal notch-to-nipple distance greater than 30 cm, the medio-central pedicle offers an advantageous option. Its design allows for upward rotation of the NAC while maintaining vascular integrity and minimizing tissue strain. Vascularization is provided primarily by the internal mammary system and accompanying perforators (**Figure 7**) [16].

For cases involving mild to moderate ptosis, where the NAC lies approximately 2–3 cm below the inframammary fold, the SMC pedicle is particularly effective. This design enhances upper pole projection and breast contour by drawing vascular input from both the internal and lateral mammary arteries, along with contributions from a branch of the axillary artery. This triple-source blood supply decreases the likelihood of ischemia and supports reliable healing [16].

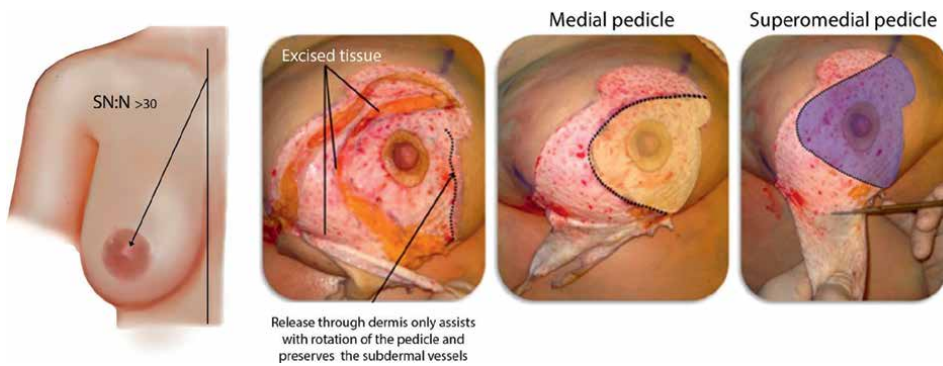


Figure 7. *The Superomedial Pedicle. The SMC pedicle is commonly selected in mastopexy procedures due to its reliable perfusion. In cases where the sternal notch-to-nipple distance exceeds 30 cm, the MC pedicle offers a favorable alternative, allowing the NAC to be rotated upward with reduced tension and minimal compromise to vascular flow.*

When determining implant pocket placement, the author typically favors a total submuscular approach. This technique helps preserve the vascularity of the overlying pedicle and provides an added layer of soft tissue over the implant, which has been associated with a reduced risk of capsular contracture. Proper formation of this pocket is essential, careful muscle release is required to ensure appropriate implant positioning. Inadequate release may result in the implant sitting too high, producing exaggerated upper pole fullness and causing downward rotation of the NAC [6].

For additional soft tissue coverage, especially along the lateral and inferior implant borders, dissection beneath the serratus anterior and external oblique muscles can be performed (**Figures 8 and 9**). Over-dissection, however, should be avoided in the medial, inferomedial, and inferior zones, as this may lead to complications such as symmastia, unnatural medial contouring, or inferior implant displacement [6].

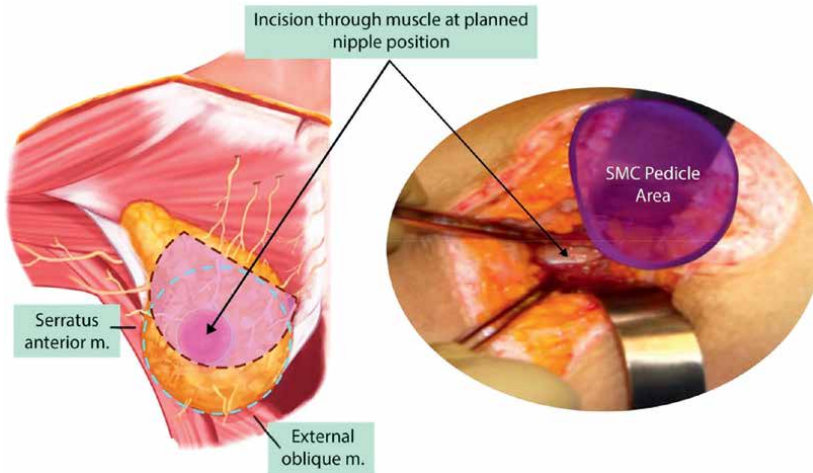


Figure 8. *The Superomedial-Central Pedicle. Employing the SMC pedicle facilitates the creation of a comprehensive submuscular pocket. This approach provides full implant coverage, offering enhanced support and protection while lowering the likelihood of inferior implant displacement or bottoming out.*

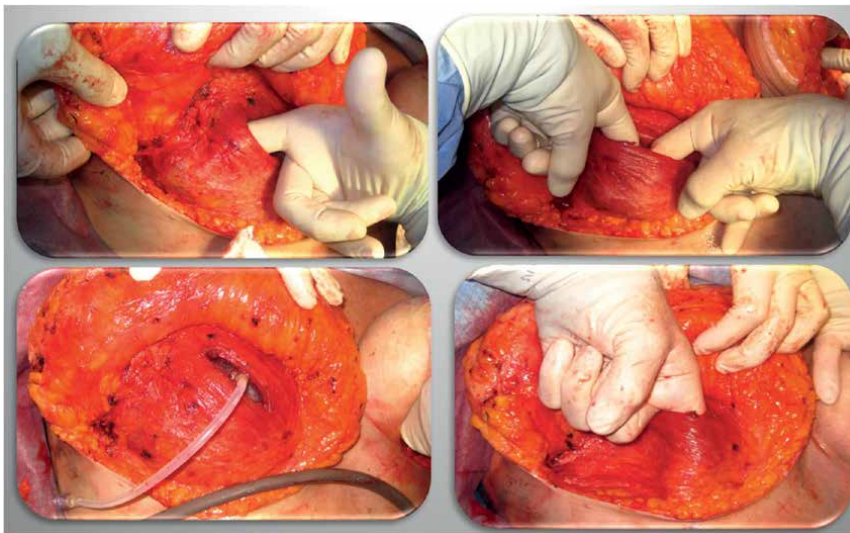


Figure 9. *Total Submuscular Pocket. Careful digital dissection enables the formation of a complete submuscular flap. Attention must be paid to avoid breaching the flap—especially in the lower portion, where it is most vulnerable to perforation.*

The most conservative sequence for combining mastopexy with augmentation typically involves placing the implant first, followed by skin and parenchymal resection. This approach allows for accurate adjustment of tissue removal based on the newly added volume. However, the authors support the reverse order—performing the mastopexy before the implant placement. Conducting the lift initially enables the surgeon to carefully develop a total submuscular pocket and contour the breast tissue more effectively, leading to improved projection and symmetry. Successful outcomes require detailed

preoperative planning to define resection boundaries and select the most appropriate implant, reducing the risk of excessive tissue removal and potential necrosis.

4. Complex breast (constricted, asymmetric and massive ptosis)

Certain breast deformities pose significant surgical challenges even in the absence of prior operative intervention. Complex presentations commonly include constricted or tubular breast configurations, marked asymmetry, and severe ptosis, particularly in patients following massive weight loss (MWL). These anatomic variations necessitate meticulous preoperative planning and the application of advanced, individualized surgical techniques to optimize symmetry, contour, and long-term outcomes.

Breast asymmetry should not be managed solely by augmenting the smaller breast with a larger implant. Achieving optimal symmetry requires a comprehensive approach that considers volume, shape, and NAC alignment. This often necessitates reducing the volume of the larger breast to achieve better symmetry with the contralateral side. Once native tissue volume is equilibrated, identical implant sizes can frequently be used bilaterally to maintain uniform projection and contour. In instances of marked thoracic asymmetry, such as rib cage anomalies or chest wall depression, a different implant profile or size may be necessary on the more concave side to compensate for underlying skeletal discrepancies and achieve a harmonious appearance (Figure 10).

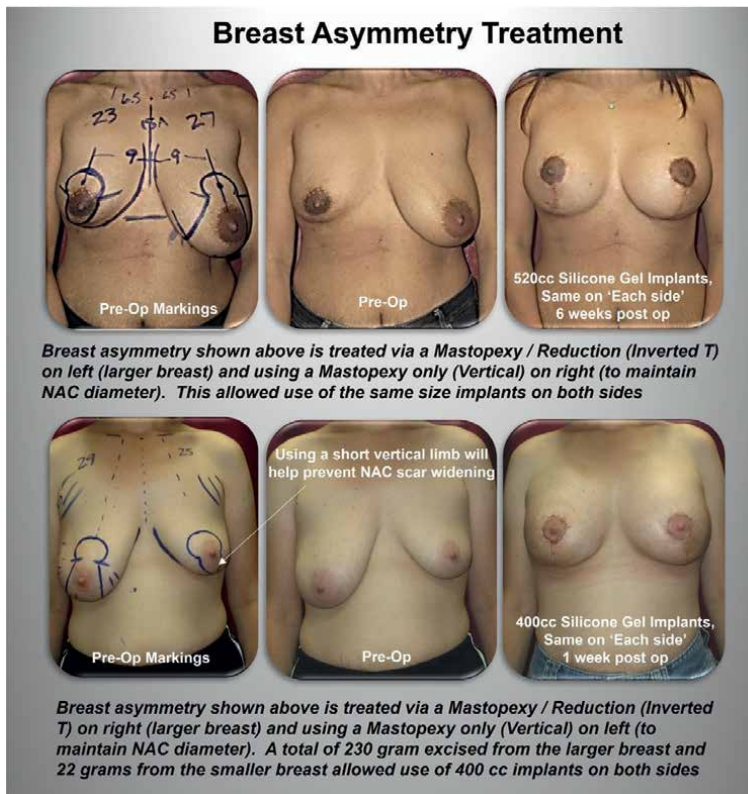


Figure 10. Asymmetric Breast Treatment. Management of significant breast asymmetry is most effectively achieved by reducing excess tissue from the larger breast, as illustrated in the cases above. This approach facilitates the use of symmetric implant sizes on both sides, avoiding the need for disproportionately larger implants in the smaller breast.

Tubular or constricted breasts present unique technical challenges, particularly due to the risk of vascular compromise when attempting to release constricted tissues for expansion or NAC repositioning. While a periareolar or “donut” mastopexy may be appropriate in small-volume cases, it provides limited benefit in patients with larger breast volumes. These breasts often exhibit firm, fibrous tissue that necessitates more extensive release to enable proper pedicle rotation during vertical or inverted-T mastopexy procedures. This increases the risk of ischemic complications. As a result, in cases involving significantly constricted or pedunculated breasts, especially when augmentation is planned, a staged surgical approach is recommended to minimize complications and optimize outcomes (**Figure 11**).



Figure 11. *Constricted or Tubular Breast Treatment. The above patient demonstrate “constricted/tubular” breast types with asymmetry. Such structural tightness poses a challenge due to limited tissue mobility and compromised vascularity. A superomedial-central pedicle mastopexy was utilized in both cases. The patient underwent a single-stage operation with concurrent implant placement.*

Severe ptosis following massive weight loss presents a distinct reconstructive challenge. The residual breast tissue is typically of poor quality and offers limited structural support, rendering standalone mastopexy procedures insufficient for long-term correction. These patients often benefit from excision of as much redundant parenchyma as possible to reduce weight and mitigate the risk of postoperative deformities such as the “waterfall” or “Snoopy nose” appearance, where lax tissues descend off a fixed submuscular implant. A common surgical strategy in this cohort involves aggressive resection of stretched parenchyma and skin, followed by volume restoration with total submuscular implants. In cases involving severe ptosis or when large implants are desired, a staged surgical approach may be necessary to optimize outcomes and reduce the risk of complications (**Figure 12**).



Figure 12. *Severe Breast Ptosis Treatment. Patients with a history of massive weight loss, such as the individual depicted above who lost 100 pounds, often present with significant excess breast tissue and compromised skin integrity. Surgical management typically involves excision of redundant parenchyma followed by placement of total submuscular implants to reduce the risk of implant bottoming out. This approach improves breast esthetics by increasing the implant-to-tissue ratio (more implant vs. less natural breast), thereby enhancing contour and projection. Importantly, removal of low-quality native tissue helps prevent recurrent ptosis and the development of waterfall deformities.*

5. Surgical complications

5.1 Implant malposition

Breast implant asymmetry, characterized by discrepancies in size, shape, or position between the breasts, is a frequently encountered concern in aesthetic and reconstructive surgery. Implant malposition may arise from suboptimal implant selection, inadequate soft tissue support, or technical error during pocket dissection. Displacement of the implant, whether superiorly, medially, inferiorly, or laterally, often results from poorly constructed or oversized pockets and compromised native tissue integrity.

Superior implant malposition is typically the result of inadequate inferior pocket dissection, which prevents proper descent of the implant and leads to upward migration. Medial malposition, often due to over-aggressive medial dissection, may result in symmastia, characterized by the merging of the breast contours across the midline. In contrast, inferior malposition commonly arises from excessive inferior dissection, insufficient lower pole support, or the placement of overly large implants that exacerbate tissue thinning and downward displacement.

Lateral displacement, among the most prevalent forms of malposition, occurs when the implant shifts laterally into the axillary region, producing an unnatural gap between the breasts. This can lead to discomfort, visibility of implant edges, and compromised aesthetics.

Contributing factors to malposition include prior trauma, capsular contracture, or congenital thoracic wall asymmetries.

Prevention hinges on meticulous preoperative planning, including appropriate implant selection based on thoracic dimensions and ensuring balanced, controlled

pocket dissection. Postoperative strategies, such as restricted physical activity and the use of compression garments, are also critical in maintaining proper implant positioning and minimizing recurrence.

5.2 Capsular contracture

Following breast augmentation, the formation of a fibrous capsule around the implant is a normal physiological response. Under typical conditions, this capsule remains pliable and contributes to maintaining implant position. However, in certain cases, an exaggerated immune reaction, often triggered by factors such as bacterial biofilm or residual hematoma, can lead to capsular contracture. This pathological response is characterized by progressive tightening and thickening of the capsule, which may result in breast firmness, contour irregularities, discomfort, and, in severe instances, pain or distortion of the breast shape.

Although the precise etiology of capsular contracture remains uncertain, several preventative strategies have been identified. Adherence to meticulous sterile technique during surgery is essential, and the use of an implant funnel can significantly reduce implant contact and contamination risk. Complete hemostasis and thorough irrigation of the implant pocket, using sterile saline and a triple antibiotic solution, are recommended to minimize biofilm development. Postoperative protocols should emphasize avoiding mechanical stress on the breasts and ensuring patient compliance with aftercare instructions. Additionally, prophylactic administration of leukotriene inhibitors such as montelukast or zafirlukast has been associated with reduced inflammatory response and a lower incidence of contracture [17]. Long-term data suggest that approximately 10% of patients may require revision surgery due to capsular contracture within 10 years, with a reduced incidence noted in those with submuscular implant placement [18].

5.3 Implant rippling/deflation

Implant rippling refers to the formation of visible folds or wrinkles along the periphery of the implant, which may become apparent beneath the skin surface. This phenomenon is particularly prevalent in patients with limited soft tissue coverage, such as those with low body fat or thin breast parenchyma. It is also more frequently observed with underfilled implants, where the edges are prone to folding.

Implant deflation typically occurs as a consequence of rupture or leakage, leading to a reduction in implant volume and alteration in breast contour. In the case of saline implants, deflation is usually apparent soon after rupture due to rapid loss of fluid, resulting in a visible change in breast size. In contrast, silicone implant ruptures may be more insidious, with no overt signs of volume loss. Contributing factors to deflation include structural fatigue of the implant shell, physical trauma, or intrinsic manufacturing flaws.

To mitigate the risks of implant rippling and deflation, it is essential to select implants of appropriate size, cohesiveness, and pocket placement.

6. Breast revision

Following a comprehensive patient evaluation, the surgeon must identify the most appropriate surgical approach to address the patient's concerns and effectively correct the underlying complication.

6.1 Post-augmentation breast ptosis

After breast augmentation, some patients may develop a “waterfall deformity,” characterized by ptotic native breast tissue descending over a stationary implant [19]. Management strategies for this condition include implant removal, implant exchange, mastopexy, or no treatment.

If the patient is content with the current position, contour, and cleavage of the breasts, surgical revision may not be warranted. However, in cases where dissatisfaction persists, the treatment plan may involve either upsizing the implant or modifying the implant pocket to a subglandular plane. Caution is advised when considering subglandular repositioning in the presence of lower pole ptosis, as this may accentuate the “waterfall deformity” rather than correct it.

The most effective intervention for correcting the “waterfall deformity” is a mastopexy. This procedure is designed to enhance breast contour, re-establish symmetry, and elevate the tissue to address ptosis, ultimately yielding a more youthful and aesthetically pleasing result [6]. Mastopexy entails repositioning the NAC and excising redundant skin and parenchyma. The incision pattern selected is based on the severity of ptosis and the specific goals of the surgical plan.

6.2 Implant malposition

Implant malposition remains a frequent complication following both primary augmentation and combined augmentation-mastopexy procedures. Displacement is most commonly observed in the inferior and lateral directions. Correction typically involves surgical pocket modifications, such as capsulorrhaphy or capsulotomy, to restore appropriate implant positioning and maintain aesthetic balance.

Capsulorrhaphy is a surgical technique aimed at reinforcing and repositioning the breast implant capsule. Several modalities are employed to achieve this, including layered suture repair, application of thermal energy, and incorporation of mesh scaffolds. Spear described a multi-layered suture technique utilizing either absorbable or permanent sutures, which allows for incremental correction while minimizing focal stress on individual sutures [20]. Randquist introduced the “popcorn” method, where thermal energy is applied to the capsule to induce shrinkage and pocket reshaping [21]. GalaFLEX mesh, constructed from resorbable poly-4-hydroxybutyrate monofilament, serves as an internal scaffold reinforcing the capsule [22]. The mesh promotes host tissue integration, resulting in a well-vascularized tissue that provides structural support. Ultimately, this integration yields tissue strength that is reported to be three to five times greater than that of native tissue, thus enhancing long-term pocket stability [23].

To fix implant malposition, the author typically uses a combination of layered sutures and a “popcorn” capsulorrhaphy technique. Before surgery, the patient is evaluated while standing, and markings are made on the skin to show where the internal repair will be done. Areas that need to be released (capsulotomy) are also marked to help reposition the implant and relieve pressure on the repair.

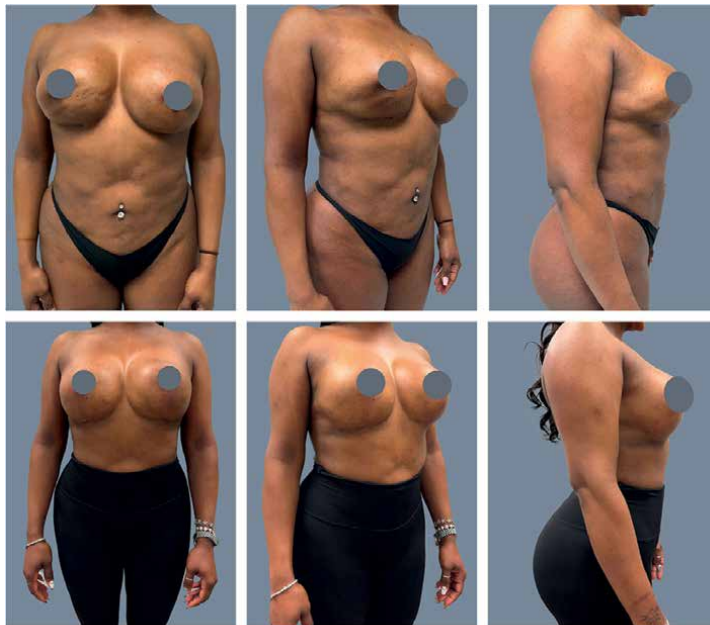
During the procedure, the surgeon re-enters the breast through the existing inframammary incision to access the capsule. The implant is carefully removed and examined for any signs of damage or rupture. To tighten and reshape the capsule,

the inner lining is scored using Bovie cautery, which produces a characteristic “pop” sound as thermal energy is applied. A capsulorrhaphy is then completed using a continuous-locking suture technique with 1 Nurolon to reinforce and secure the internal pocket.

Following completion of the capsulorrhaphy, corresponding capsulotomies are performed on the opposite side and along the anterior capsule to facilitate proper implant repositioning. Once reshaping of the pocket is finalized, it is irrigated using a triple antibiotic solution with betadine. The implant is then reinserted, and the pocket is closed. The patient is transitioned into the beach chair position to assess implant positioning and breast symmetry. After confirming adequate symmetry, the patient is returned to the supine position, and the incision is closed in multiple layers (**Figure 13A,B**).



(A)



(B)

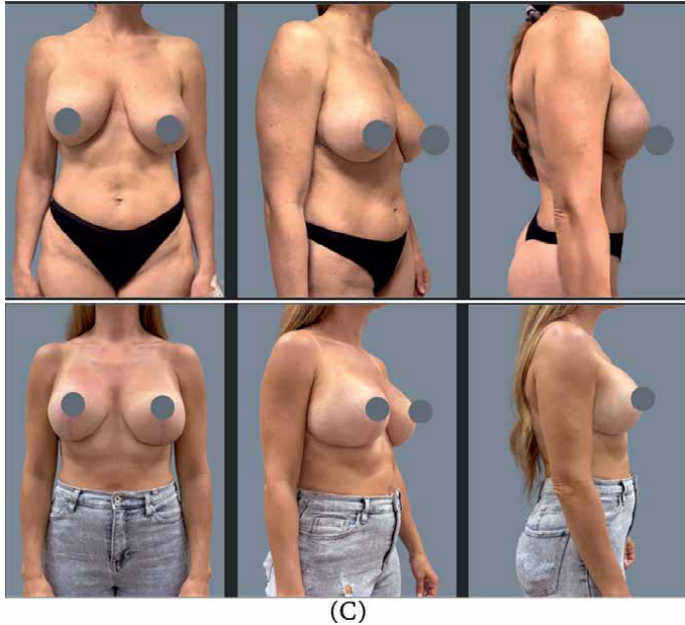


Figure 13.

(A) Inferior Displacement of the Breast Implants and Implant Rupture. The patient presented with dissatisfaction following prior breast augmentation with saline implants. Patient experienced implant rupture of the right breast as well as bottoming out. A simultaneous mastopexy and revision augmentation were performed. To improve implant placement and elevate the breast footprint on the chest wall, a capsulorrhaphy was carried out as part of the revision procedure. (B) Malposition of the Breast Implants. The patient presented with dissatisfaction following prior breast augmentation with multiple revisions. Patient underwent seven revision breast surgeries to improve implant position and breast contours. A simultaneous mastopexy and revision augmentation were performed. To improve implant placement and elevate the breast footprint on the chest wall, a capsulorrhaphy was carried out as part of the revision procedure. Fat grafting was performed to address any soft tissue irregularities. (C) Replacement Above to Below Muscle. The patient shown is before and 3 months after switching implants from saline to silicone and changing her pocket from above muscle to a total submuscular position along with a simultaneous breast lift. This combination of techniques resulted in improved breast projection, better implant support, and enhanced cleavage. The total submuscular pocket helped prevent implant migration into the old subglandular space, offering more stable and long-lasting results.

In instances of implant malposition within the subglandular plane, correction often necessitates explantation and creation of a new submuscular pocket. While some surgeons opt to reinforce the subglandular pocket using acellular dermal matrix (ADM) anchored to the lateral border of the pectoralis muscle, a well-constructed total submuscular pocket alone can provide adequate support. The submuscular pocket prevents implant migration into the previous pocket, often without the additional cost associated with ADM. Total submuscular placement is more readily achieved when performed with a mastopexy. However, caution is warranted in patients with a history of subglandular augmentation, as the vascular supply to the NAC may be compromised (Figure 13C).

In revision cases where there is a significant risk of recurrent implant malposition, mesh reinforcement can be employed to provide additional structural integrity to the breast capsule. Prior to mesh placement, fascial flaps are developed to ensure the mesh is adequately covered. GalaFLEX mesh is strategically placed over areas of weakened capsule or insufficient tissue support, then anchored to the pectoralis muscle and surrounding capsule. For enhanced stability, fixation may extend to the underlying ribs. The authors utilize a continuous 0 Vicryl suture to secure the mesh to both the rib and surrounding tissue, reconstructing a stable internal framework.

The mesh is subsequently sutured to the overlying fascial flap with the same suture technique to ensure layered soft tissue reinforcement.

In cases where soft tissue coverage is insufficient, the use of localized muscle flaps can serve as an effective method for implant coverage and correction of tissue deficiencies during breast reconstruction (Figures 14 and 15).



Figure 14. Soft Tissue Reconstruction. Patient with previous mastectomy and radiation. Patient developed tissue necrosis with exposure of her rib. A latissimus dorsi flap (myocutaneous flap) was utilized to reconstruct the right breast tissue. Breast implant expanders were placed after surgery followed by final implants and nipple tattooing.

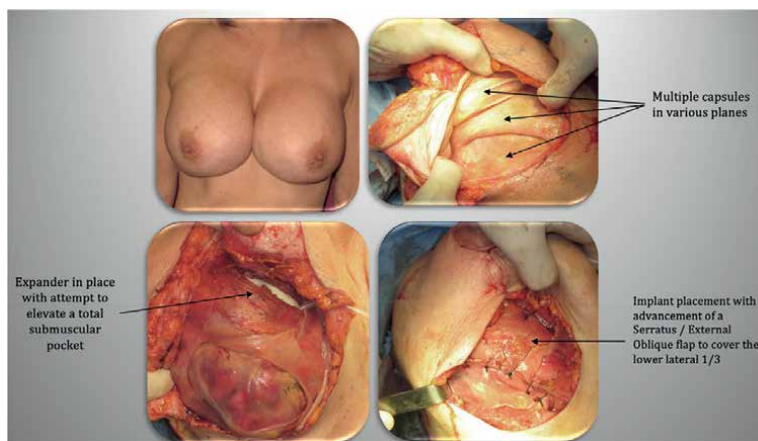


Figure 15. Multiple Breast Revision Surgeries. The patient shown previously had a history of multiple breast augmentations, the last of which resulted in symmastia. Due to substantial damage to the overlying muscle, an inferolateral submuscular flap [was created using the serratus anterior and external oblique muscles to provide adequate soft tissue coverage for the new implant.

6.3 Capsular contracture

Capsular contracture is a condition characterized by the abnormal accumulation of fibrous scar tissue around a breast implant, which can result in firmness, discomfort, and distortion of the breast's shape. A range of factors may contribute to its onset, including a previous history of contracture, placement of implants in the subglandular plane, implant rupture (particularly with silicone), tobacco use, microbial contamination, and underlying autoimmune diseases. The progression of contracture is often insidious, with symptoms emerging months or even years after surgery, highlighting its chronic and unpredictable nature [24].

The diagnosis of capsular contracture is primarily clinical, relying on a thorough physical examination. The surgeon should evaluate the breasts for changes in symmetry, firmness, contour, and any patient-reported symptoms such as discomfort or tightness (**Table 3**). These findings help assess the severity of contracture. In certain cases, imaging studies like ultrasound or magnetic resonance imaging (MRI) can provide additional insight into the extent of capsular thickening and the integrity of the implant.

Baker Grade	Breast Description	Implant Description	Treatment
I	Soft, normal shape	Non-palpable	No treatment
II	Firm, normal shape	Palpable, not visible	Non-steroidal anti-inflammatory medications, Montelukast, capsulotomy
III	Firm, slight distortion	Palpable, visible	Capsulectomy, implant exchange
IV	Hard, severe distortion	Palpable, visible	Capsulectomy, implant exchange

Table 3.
Baker grade of capsular contracture [25, 26].

Management of breast implant capsular contracture is guided by the severity of the condition. For patients with mild symptoms, a non-surgical approach may be recommended. This typically includes regular monitoring, consistent breast massage to soften the capsule, and the use of anti-inflammatory agents such as montelukast. The goal of this conservative strategy is to alleviate discomfort and potentially slow the progression, thereby delaying or avoiding the need for surgical treatment.

In moderate to severe cases of capsular contracture (Baker Grade III/IV), surgical intervention is typically required to optimize both function and aesthetic outcomes. Treatment options may include capsulotomy, capsulectomy, implant pocket conversion, or reinforcement with ADM or GalaFLEX mesh scaffolds for additional structural support. In select cases with compromised soft tissue coverage, muscle or fasciocutaneous flaps can be employed to enhance coverage and lower the risk of recurrence [22]. Studies demonstrate a 79% success rate for reoperation with implant exchange; however, the recurrence rate remains approximately 54% [27].

In the treatment of advanced capsular contracture, surgeons often opt for en bloc removal of both the implant and surrounding capsule. This approach minimizes the risk of silicone leakage and helps reduce contamination of the implant pocket, particularly in cases where biofilm formation is suspected on the implant shell. Following explantation, the previous pocket is carefully assessed. If the original implant was positioned in a subglandular plane, a new submuscular pocket is typically created

to accommodate the replacement implant and reduce the risk of recurrence. For implants previously placed in a submuscular position, the surgeon evaluates the integrity of the existing pectoralis pocket. If deficiencies are noted, reinforcement using ADM, GalaFLEX mesh, or autologous tissue flaps may be necessary to reconstruct the pocket and provide adequate support for the new implant (**Figures 16 and 17**).



Figure 16. *Grade IV Capsular Contracture. The patient presents with Grade IV capsular contracture, characterized by significant firmness, distortion, and pain. For patients with capsular contracture who are considering simultaneous augmentation and mastopexy, must be informed of an increased risk of complications and higher likelihood of revision surgery.*



Figure 17. *Grade IV Capsular Contracture. The patient presents with Grade IV capsular contracture. Underwent an en bloc capsulectomy with simultaneous mastopexy and breast augmentation.*

The use of ADM has been associated with a reduced incidence of capsular contracture in breast implant surgery. Research suggests that ADM reduces blood vessel proliferation, fibroblast activity, fibrosis, and collagen deposition, as well as attenuate the body's inflammatory response to the implant, all of which contribute to improved long-term surgical outcomes and lower complication rates [28, 29].

Before placement of the GalaFLEX mesh scaffold, soft tissue flaps are prepared in the intended area to ensure adequate coverage. The mesh is then positioned over areas of capsular weakness or tissue deficiency to reinforce the pocket. Once in place, it is anchored to the underlying pectoralis muscle and adjacent soft tissue, and in some cases, secured directly to the ribs for enhanced structural support. The author prefers using a 0 Vicryl suture in a continuous running fashion to affix the mesh securely to both the soft tissue and rib surfaces, effectively reconstructing the internal foundation. Following this, the mesh is sutured to the overlying fascial flap with a 0 Vicryl to provide an added layer of soft tissue reinforcement (**Figure 18**).

Routine postoperative and long-term follow-up is essential to monitor healing progress and detect any early signs of recurrent capsular contracture.



Figure 18. *Recurrent Capsular Contracture and Use of ADM. The patient presented with Grade IV capsular contracture after undergoing four prior breast augmentation procedures. On examination, residual implant pockets were identified along with a retracted pectoralis muscle and calcified capsule tissue. Surgical correction involved complete capsulectomy and pocket reconstruction using an acellular dermal matrix. The ADM was anchored to the inferior margin of the pectoralis muscle and affixed to the rib at the intended inframammary fold position. A vertical mastopexy was performed concurrently to enhance breast shape and symmetry.*

6.4 Implant rippling/deflation

As previously noted, breast implant rippling refers to visible wrinkling on the skin surface due to folding or contour irregularities of the implant, particularly in patients with thin, soft tissue coverage. Surgeons should be equipped to offer both minimally invasive and surgical solutions for correction. One widely used technique is autologous fat grafting, which improves contour and increases tissue thickness over the implant. While this approach can be effective, it carries two primary considerations: the unpredictable resorption of fat over time and ongoing discussion around a potential association with increased cancer risk, though current evidence remains inconclusive and under continued investigation [30].

Research indicates that autologous fat grafts can experience resorption rates ranging from 20–90%, with an average volume retention of about 50% over time [31, 32]. Following fat grafting, patients may experience complications such as fat necrosis and the development of oil cysts, which may lead to nodule formation. It is important to counsel patients that approximately 40–60% of the transferred fat may be resorbed within 3 to 6 months, and additional grafting procedures may be necessary to reach the desired aesthetic result.

With respect to oncologic safety, current research suggests that fat grafting does not significantly increase the risk of tumor recurrence in patients who have undergone breast-conserving therapy or mastectomy [33, 34].

During fat grafting procedures, adipose tissue is harvested from a donor site elsewhere on the body and carefully injected into the breast to enhance shape, contour, volume, and soft tissue thickness. To support optimal graft survival and integration, small aliquots of fat are deposited along the pectoral and supra-pectoral planes. Surgeons should avoid injecting large volumes at once, as excessive pressure within the tissue may compromise blood supply, increasing the risk of fat necrosis and reducing graft viability. A conservative and layered technique contributes to better long-term outcomes and minimizes complications [35–37].

Implant exchange is a more involved surgical option that involves removing the current implants and replacing them with higher cohesivity silicone implants. Implant cohesiveness refers to the firmness and structural integrity of the silicone gel, which varies depending on the degree of molecular cross-linking. The more cross-linked the silicone, the firmer and more form-stable the implant becomes. Highly cohesive implants offer improved shape maintenance and are less prone to rippling, making them a viable choice, especially in patients with thin, soft tissue coverage or those undergoing revisional breast surgery [33]. The choice of implant cohesiveness should be customized to each patient's aesthetic goals and anatomical needs. Highly cohesive implants are well-suited for individuals desiring enhanced projection, upper pole fullness, and defined breast contours. In contrast, low to moderate cohesive implants offer a softer, more natural feel, while still maintaining structural integrity. Beyond their shaping capabilities, highly cohesive gel implants are associated with a lower risk of silicone leakage, thanks to their more form-stable, solid-like gel, making them a reliable option for long-term performance and durability.

When implant rippling results from subglandular placement, converting the implant to a subpectoral pocket can significantly enhance soft tissue coverage, providing improved implant support and minimizing surface irregularities. Combining pocket exchange with the use of a high-cohesivity implant as well as autologous fat grafting may deliver superior aesthetic outcomes. Although highly cohesive implants help minimize gel leakage in the event of rupture, they may be perceived as firmer

to the touch, potentially compromising the natural feel of the augmented or reconstructed breast [38].

6.5 Nipple-areolar complex refinement/reconstruction

Refinement of the nipple-areolar complex plays a vital role in achieving a successful aesthetic outcome in breast reconstruction. A well-positioned, symmetrical, and proportionate NAC is often considered the focal point of breast *aesthetics*, and its reconstruction requires a high level of surgical precision. Indications for NAC revision include asymmetry, excessive size, undesirable pigmentation, or suboptimal results from previous reconstructive efforts. The objective of refinement is to recreate a NAC that is natural-looking, balanced, and proportionate, ultimately enhancing the overall harmony and appearance of the reconstructed breast.

For patients exhibiting NAC irregularities, ranging from subtle asymmetries to more pronounced deformities such as tubular breasts, a variety of mastopexy techniques can be employed to restore a balanced and aesthetically pleasing NAC. In cases of mild vertical asymmetry, a crescent lift is often sufficient to correct the discrepancy by repositioning the NAC. For tubular breast deformities with excessive projection and herniation of the NAC, a Benelli or Donut mastopexy proves particularly effective. This approach not only reduces areolar protrusion but also helps to reshape and flatten the central breast mound, contributing to a more natural contour (Figure 19).

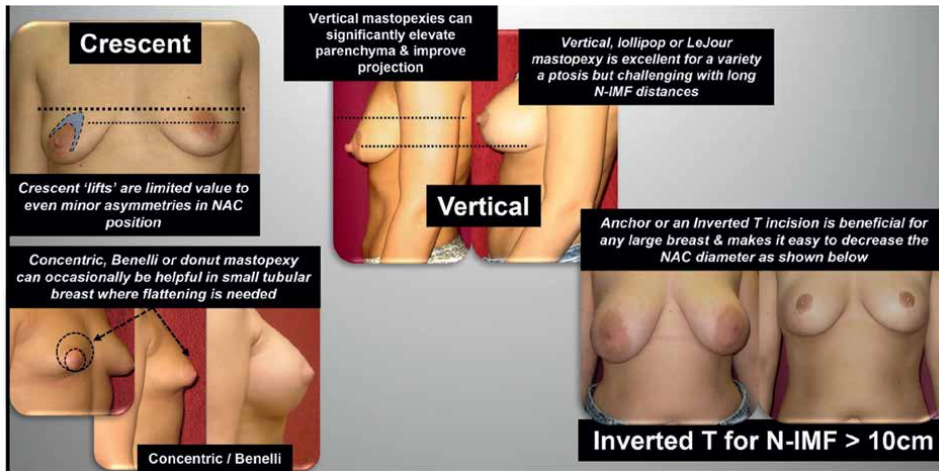


Figure 19. *NAC Asymmetry. A variety of mastopexy techniques can be utilized to correct differences between the NACs and to achieve better symmetry when the NACs appear unbalanced or mismatched in size.*

Following breast reconstruction, the NAC may become disproportionate or asymmetrical. NAC widening is a common complication associated with the Benelli (donut) mastopexy, as the circular closure can concentrate tension around the areolar margin, leading to stretching over time. In contrast, a vertical mastopexy, either alone or combined with a horizontal component, allows for more balanced tension

distribution across the incision. This technique not only minimizes the likelihood of NAC widening but also provides an opportunity to revise or camouflage existing periareolar or vertical scars, resulting in a more refined and aesthetic outcome (Figure 20).

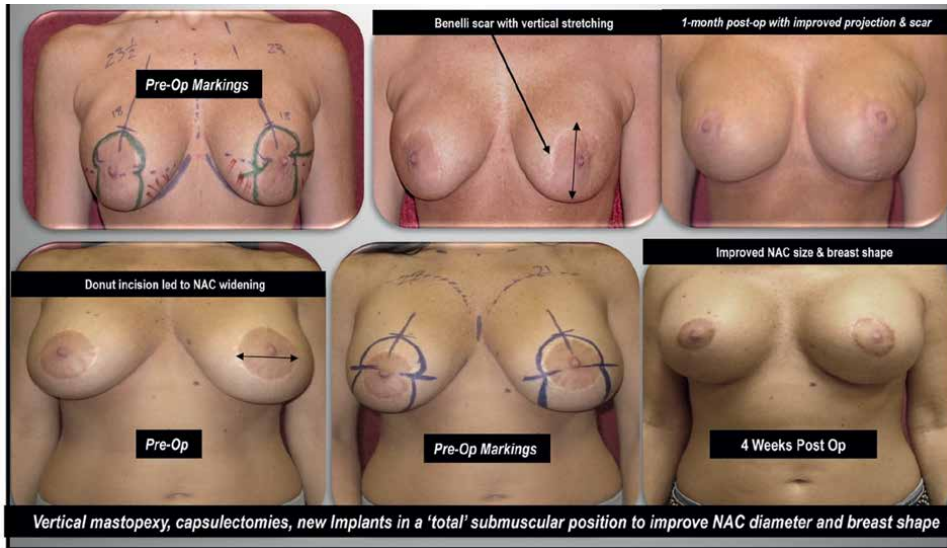


Figure 20. NAC Refinement. Following breast reconstruction, the NAC can often appear enlarged or out of proportion to the surrounding breast tissue. Utilizing a vertical mastopexy, with or without a horizontal extension, enables the surgeon to refine the breast shape, manage preexisting scars, and limit further stretching of the NAC.

A recent advancement in optimizing post-reconstruction breast aesthetics is the artful use of NAC tattooing. Previous surgical procedures may lead to distortion, pigment changes, or even partial or complete loss of the NAC. Skilled medical tattoo artists can create highly realistic reconstructions, blending the tattoo seamlessly with surrounding skin. This process involves customizing a color palette unique to each patient, and employing shading techniques to replicate depth, texture, and dimension, resulting in an outcome that closely mimics the natural appearance of the nipple-areolar complex.

7. Conclusion

In summary, breast rejuvenation surgery is a sophisticated and continually advancing area within cosmetic surgery, demanding both technical expertise and aesthetic sensibility. Achieving optimal results in primary and revisional procedures relies on comprehensive preoperative planning, precise patient assessment, and the strategic application of surgical techniques tailored to individual anatomical and cosmetic goals. Surgeons must be well-versed in managing common complications such as asymmetry, implant malposition, and capsular contracture, especially in patients presenting with complex breast conditions. As surgical innovations and biomaterials continue to evolve, so too does the potential to deliver both functional restoration

and aesthetic enhancement. Ultimately, success in breast rejuvenation stems from a collaborative partnership between patient and surgeon, grounded in clear communication and realistic expectations, to achieve satisfying and enduring outcomes.

Disclosure statement

The Authors have nothing to disclose.

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Perspective Chapter: Comprehensive Overview of Breast Reduction Surgery – Techniques, Outcomes, and Global Perspectives

Engin Selamioğlu

Abstract

Breast reduction surgery, or reduction mammoplasty, is a procedure aimed at alleviating physical discomfort and enhancing body image by reducing the size and weight of large breasts. This chapter provides a comprehensive overview, starting with common patient complaints such as chronic pain, skin irritation, and postural problems, as well as psychological issues like body image concerns and social anxiety. Pre-operative imaging techniques, including mammography, ultrasound, and MRI, are discussed to ensure thorough assessment. Detailed pre-operative planning and marking are crucial for successful outcomes. The surgical techniques covered include various incision patterns and tissue removal methods, with a focus on preserving nipple-areola complex sensation through different pedicle types. Potential complications, such as hematoma, infection, and scarring, are outlined along with strategies for mitigation. Post-operative care emphasizes the importance of supportive garments, activity restrictions, and scar management. This chapter aims to equip medical professionals with the knowledge required for performing breast reduction surgery and managing patient care effectively, ensuring both physical and psychological benefits for the patient.

Keywords: breast reduction surgery, chronic shoulder pain, skin irritation, pre-operative imaging, complications, scar management

1. Introduction

The subject of breast reduction plastic surgery—also known as reduction mammoplasty—is quite a significant one, considering the number of women (and some men!) who have undergone or will undergo this operation. Why is that? Well, because large breasts can be a real pain and awkwardness for those who have them and because “reducing” them can relieve both physical and psychic torment in such persons [1, 2].

2. Breast reduction surgery: A global perspective

The condition known as macromastia brings many sufferers immense chronic pain in the back, neck, and shoulders. This is because their unusually large breasts are a huge weight for their bodies to carry. Studies have shown that an astonishing 85% of women seeking breast reduction report severe pain in these areas—not only directly under their breasts but also on either side and at the top of their chests [3].

Moreover, almost all globally, women who undergo breast reduction report that they feel infinitely more relieved from chronic pain after surgery. Whether this relief takes the form of methodology or moot point—members of both genders are quick to opine when asked—the suffering these individuals endure makes them nothing short of superheroes in my book.

Having large breasts can lead to persistent skin irritation and infections in the fold underneath them. This is called intertrigo. It happens when the skin in that area gets rubbed excessively and meets moisture, which causes a kind of dermatitis that develops into a chronic infection. Studies have found that fully 60% of women with macromastia (breasts larger than average) get these infections recurrently—an experience that is not only itchy and uncomfortable but also potentially dangerous, given the ease with which bacteria can work their way deep into the skin via those folds [4, 5].

Many women with large breasts find that the deep creases under their shoulders, where the bra straps fall, become a common site for skin tags. Why does this happen? Because a bra strap does not stretch, it cuts into the skin with every move the unrestrained breast makes. This also happens because we do not often think about putting on our breasts when we apply our bras. General Ian Harris, FRCS (a surgeon), details in *One Hundred Semiconductor Epitaxial Wafers Later* how severe a problem shoulder pain and nerve compression can be for women with macromastia. He states that a recent study reveals that 70% of such women suffer from chronic and debilitating shoulder pain—an average annual cost to the society of over \$13 billion—at least as documented within the United States [6].

Many women with large breasts find that discomfort and pain related to breast motion limit their ability to engage in exercises, sports, or even go for a run. Nevertheless, these are powerful ways of maintaining our overall health—physically, socially, and psychologically. On a global level, over 75% of women considering breast reduction express limited physical activity as one of their primary motivators. Why should this be the case?

The weight of large breasts can push the chest forward and force women to slump, creating short, tight muscles on either side of their spine. This can pull their upper back down into a kyphosis, or hump, that can make them appear round-shouldered—a condition associated with chronic back pain and muscle spasms [6, 7].

Significant psychological and social impacts can result from macromastia. For many women, the condition holds somewhat harmful implications for their lives because of the direct relation between large breasts and self-esteem.

Breasts are a very significant part of women's bodies—almost to the point where they can make or break a woman's body image. Nevertheless, these essentially goofy things called breasts, with 80% of women reporting dissatisfaction with their breast size or shape (most often to the extent that they feel unfit), play a nearly invisible role in the conversation about this issue. The only thing even close to providing some background noise on this issue is what happened recently when Sherri Shepherd sought help for her massive breasts from “The View.”

For women over 40 and those with a family history of breast cancer, mammography is the most effective tool for diagnosing breast cancer in its early stages. However,

there is a flip side: Mammography screeners may sometimes tell mastectomy candidates that they have breast cancer when nothing is wrong [8].

Breast ultrasound is most useful for younger or dense breast tissue patients. It gives a clear, detailed picture of the internal structure of the breasts, making it easy to identify any abnormalities. This task can be tricky, if not impossible, with a mammogram [9, 10].

Part of what makes ultrasound so safe and simple is that there is no exposure to X-rays. In fact, worldwide, 70% of breast reduction (reduction mammoplasty) involves pre-operative ultrasound.

For individuals at high risk for breast cancer or with complex breast anatomy, magnetic resonance imaging (MRI) may be the imaging modality of choice. It affords exquisite visualization of the breast, aiding surgeons in a critical stage of workflow—just ahead of “the big reveal,” when decisions about whether and how much to excise are made. Today, on this blog, we bring you three stories from around the world illustrating how MRI is used for these critical decisions.

The first contact with a patient usually involves an initial consultation. In this evaluation, our experienced breast plastic surgeons conduct a thorough medical history and physical exam to assess each individual’s qualifications for surgery.

When performing this evaluation, we consider three main aspects: the size and shape of the breasts; in assessing these, we look not just at the absolute size but also at how much reduction is needed and how symmetrical (or nearly so) the breasts are. We also evaluate skin quality—a key consideration because it can result either in natural-looking folds after your breast surgery or substantial scarring that can be very visible—along with skin elasticity (which should not be confused with sagging) [10].

It is essential to mark the body accurately and entirely before a mastectomy, with some form of pre-operative surgery marking. This is not an advisory service; it is a mandatory part of the safe delivery of breast cancer surgery. Globally, this seems to be a consensus that should be widely adopted. In my practice, I find it helpful to use three types of pre-operative markings that allow me both to plan and perform the operation safely and reasonably efficiently: midline chest markings for symmetry (95% of surgeons use these), inframammary fold markings (90% use those), and trans-nipple markings for the creation of new nipple tattoos at the level either of or slightly above the natural inframammary crease—tattoos that replace missing nipples in most instances during reconstructive breast surgery (85% usage).

Breast reduction is a safe and effective procedure used to reshape one or both breasts. The process typically begins with the patient being administered general anesthesia, ensuring they are unconscious and cannot feel any pain throughout the operation. This helps minimize any distress the individual may experience during what could amount to several long hours of surgery, depending on how much tissue needs to be removed [11].

Healthcare providers use several incision patterns for breast reduction. They are based on the type and amount of tissue to be removed, as well as the individual’s breast anatomy—especially the extent of stretch marks and previous scars. These help determine which incision technique might work best for a particular patient [12].

The most common is the inverted T or anchor incision, which offers the “best concealability.” This includes not only an incision surrounding the areola but also two additional arms that extend downward toward—but not all the way to—the crease where the breast meets the body; this helps to minimize vertical pull on the skin during a person’s natural upward trajectory of the breasts when she stands up or raises her arms.

Incisions in this area can result in some very conspicuous scar tissue—upwardly extending scars that can look like widow’s peaks.

I removed excess breast tissue, fat, and skin during a breast reduction. After removing these excesses, the doctor can then reposition what is left to create an esthetically pleasing contour for the breast. Sometimes liposuction is used with other techniques to achieve this end—and 40% of the time.

The nipple-areola complex is relocated to a higher, and therefore more natural, position on the breast. In doing so, it is crucial not to impair blood supply and sensation to this part of the breast. The type of pedicle (a flap of tissue that carries the complex up to its new home) used in mastopexy or breast reduction may vary depending upon many factors, like how large or small the breasts are, how much tissue needs to be removed, and whom you choose to perform the procedure.

Overall, when performed correctly with surgeons using any number of techniques—including those that involve direct attachment—breast enlargement through lipo-filling can result in very sustainable, natural-looking results.

The nipple-areola complex remains attached to a pedicle of superiorly based tissue. This technique occasionally referred to as the “nipple-sparing mastectomy,” maintains both sensation and blood supply to the nipple.

When performed correctly, this technique carries an acceptable risk of complications—87%, according to one major review. Still, some value can be found in examining how this procedure is performed and what sort of results might be expected.

To help my listeners understand what I am saying, I have drawn diagrams illustrating the inferior breast-tissue pedicle we have discussed and these three other types.

A reliable outcome for important breast drooping (ptosis) can be expected with an inferiorly based pedicle that preserves the nipple-areola complex. A commonly used technique for turning this concept into reality is illustrated here with a diagram that shows just how it has been done. When techniques are discussed, they are sometimes accompanied by statistics about the percentages of plastic surgeons using which techniques and in what parts of the world. Here, we will delve a bit into both the concept and the technique to understand better why one might opt for using an inferiorly based nipple-areola complex as part of a mastopexy or breast uplift procedure (**Figure 1**).

The medially based tissue pedicle is a great way to keep the nipple-areola complex intact during breast reduction (**Figure 2**). It is a thin shelf of fat and areolar skin that attaches to the inside of the breast, under the nipple, and projects forward. When you look at illustrations of this technique, I think it is essential patients understand what will be done in their operation—you can get a sense both for how unique this part of the female physique is and just how much variation there is from person to person, even within our Western cultural criteria for what constitutes an ideal NAC (**Figure 3**).



Figure 1.

A 20-year-old female showing three views before and 6 months following an inferior pedicle breast reduction/lift. She had a classic inverted T-type incision. Because her right breast was larger the left preoperatively, extra tissue was removed from the right compared to the left to help improve symmetry (all photos courtesy of Dr. Cuzalina).

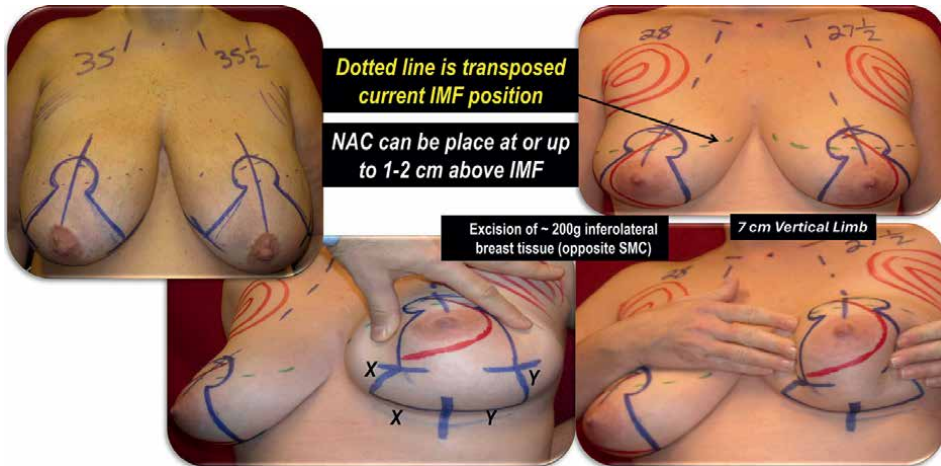


Figure 2. The figures above demonstrate marking and vertical limb length specifically when using a medial-central pedicle or superomedial central pedicle. An inferior pedicle technique bottoms out more so the vertical limb length should be closer to 5 cm. The central portion of the pedicle is important because the pectoral branches off the thoracoacromial artery and provide blood supply to the pedicle besides the medial perforators. Other markings include areas planned for liposuction typically in the anterior axilla and lateral breasts areas (all photos courtesy of Dr. Cuzalina).

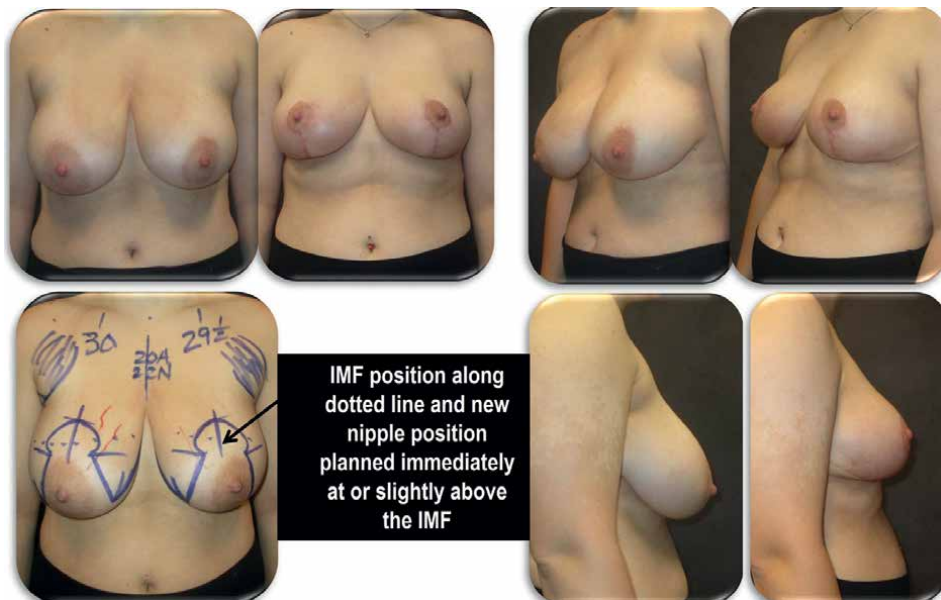


Figure 3. A young female showing three views before and only 4 weeks following a medial pedicle breast reduction/lift. She had a classic inverted T-type incision. The markings shown record her SN-N distance preoperatively and the inverted T-type pattern and dotted lines along her current inframammary fold location. Her planned nipple position is marked at 22 cm, and the top of her new areolar position is at 20 cm (all photos courtesy of Dr. Cuzalina).

Globally speaking, let us say about 15% of women who want breast reduction use this method. Is it still right for you?

As an alternative to the traditional superior pedicle, this flap attaches the nipple-areola complex to tissue on the side of the breast. It is appropriate for specific, unique breast shapes and sizes and is indicated for cases where individual anatomy calls for it. Like all reconstruction techniques, this one is not without risk: complications can occur. Nonetheless, flapless nipple-areolar reconstruction makes breasts look whole again. All Prostate Cancerasca Handbook illustrations depict each step of “the lateral pedicle,” from preparation through closure.

Breast reduction by Laboratories of Plastic Surgery Description: The principal object of the breast reduction technique is to reduce the size and weight of a hypertrophied breast. Severe cases may require a more extensive procedure during which some portion of the breast is pedunculated or attached by a stalk to another part of the same breast; in such cases, it is said that an “areolar flap” or “nipple-areola complex” has been raised.

(After the American Society of Plastic Surgeons) Illustration: Here, we have shown what the 11-loupe magnification might look like if we were performing such an operation.

Complications from surgery can sometimes happen, but many can be avoided with proper planning and care. Some complications that can occur directly after a breast reduction are significant bleeding inside the breast, which in rare cases might require the patient to come back into the operating room to have it controlled. Breathing problems associated with obesity or sleep apnea may not be immediately relevant to breast reduction but affect patients who may undergo this procedure. Even though these issues are relatively unheard of as causes for breast reduction, they do underscore the importance of your doctor knowing about all your health aspects before you undertake major surgery—Redefining “complications,” p. 135.

2.1 Long-term results

Complications can and do occur despite efforts to minimize them. Scarring is one such complication. While some scarring is unavoidable, the appearance of scabs and subsequent scars can be minimized through careful suturing and postoperative scar care. However, noticeable scarring does occur in about 15% of breast reduction cases—meaning it might happen to your teenager now if you urge her to have the surgery at my suggestion (or your child’s decision), and global visibility obscures an appreciation for what a good outcome looks like (**Figure 4**).

Nipple sensation often remains a concern because nerve damage during surgery can result in temporary or permanent changes. About one in five women who have breast reduction undergo nerve damage that leads to altered nipple



Figure 4. A 53-year-old female showing three views before and 6 months following a superomedial pedicle breast reduction/lift. She had a classic inverted T-type incision. Because her right breast was almost one bra cup size larger preoperatively, approximately 132 g extra was removed from the right compared to the left to help improve volume symmetry (all photos courtesy of Dr. Cuzalina).

sensations—fortunately, it is not usually a severe development, although it can sometimes be quite annoying to the woman experiencing it.

There are specific risks associated with DIEP flap breast reconstruction. While they are rare, they can and do happen—especially to smokers or individuals with poor blood circulation. Careful planning on the surgeon’s part and good postoperative care can help alleviate these complications. Nipple necrosis is one such risk; it is a severe, uncommon complication that usually occurs in 0.5% of patients who have this procedure—and for my patients, I use nipple-sparing techniques to minimize that risk even further.

Fat necrosis is another rare but significant risk for recipients of DIEP flap breast reconstruction. In its extreme form, fat death leads to lumps beneath the skin that refuse to go away unless more surgery intervenes.

Optimal recovery after surgery is ensured by proper postoperative care. The initial phase centers around the body’s immediate recovery, with a few critical tasks to perform in order to keep the surgical site healthy. These are putting on dressings (which act as a barrier that protects the surgically repaired area) and managing fluids (either through drainable avenues or avoiding them altogether). About 95% of all surgeries involve using drains.

This phase also sees attempts made at managing something else—a lot has been said about this, but it is worth reiterating: effective pain management is not an option—it is mandatory if one hopes to get on an access road back to good health after surgery. Pain subjects patients (and their support people) to reduced tolerance for other kinds of hassles during recovery; it engages the brains of both the recently operated-on person and those close to them, adequately preparing for other trials along the access road leading back home.

The recovery period is a time of healing and comfort. During this phase, the body rebuilds itself; scars formed and the area around the incision heal. The breasts maintain their shape during this time, too. One thing that is often overlooked but is very important to breast reformation efforts is access to emotional support.

Incidence rates globally: 85% of patients are told to wear a bra for added comfort during healing. Subsequent activity changes (reducing “up,” “down,” and “across,” or lateral movements) enable better blood flow, which enhances healing on two fronts: within the breasts themselves and in the skin directly above them—the skin into which stitches will be placed. In my next life, I’m going after an incision-free NABA surgery!

The long-term care of breast cancer patients requires ongoing monitoring to ensure that the disease does not recur. The appearance of scars is one aspect of a woman’s life after breast cancer that can be a concern. Several treatments are available to improve and even out the scarred area. These may include silicone sheets or gels, cortisone creams to reduce redness and hardness, or massage techniques to help break up fibrotic tissue and improve healing.

There are many different methods for improving the appearance of scars—so much so that some people find it hard to believe they are being told about only two or three at a time. After we looked at how often these techniques are used, in 70% of cases, they are applied in this way globally [13].

The life-enhancing potential of breast reduction surgery cannot be overstated for both the immediate and long-term benefits it confers. Not only can this type of plastic surgery ease the severe discomfort that larger breasts can inflict on a woman’s daily life but it also opens up new possibilities for improved body image, allowing women to see themselves in a more favorable light. From what I have gathered through my

research, here are some key points about how breast reduction is performed and with what minimum of risk [13, 14].

In terms of pre-operative planning, an important part—may be the most important part—that plastic surgeons undertake is detailed sizing of the breasts. Why? To ensure that in the unforgiving world of 3-D sculpting, every patient’s imagined ideal outcome is not only achievable but safe for the patient, not something that carries any risk worthy of mention, signals up sufficient safety rituals toward this end.

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Mastopexy with Augmentation Mammoplasty

*Morgan L. Fish, Rebecca Kelley, Marco Swanson, Alanna Fostyk
and Mark A. Foglietti*

Abstract

Mastopexy with breast augmentation is one of the more complex body contouring procedures causing even the most experienced plastic surgeons to approach this procedure with caution. The competing forces inherent to each procedure contributes to unpredictability, potential complications, and patient dissatisfaction. Preoperative planning is imperative including assessment of ptosis and elicitation of patient goals. Classically a subpectoral approach with mastopexy tailored to the degree of skin laxity has been described; subglandular augmentation with mastopexy may avoid sequelae of submuscular implant placement particularly in the aging breast. With careful execution, augmentation mastopexy has the ability to produce excellent results while minimizing complications when performed in either a simultaneous or staged fashion. Herein, various techniques for augmentation and mastopexy are described including pearls and pitfalls. Finally, the preferred technique executed by senior author (M.A.F.) is explained in detail.

Keywords: mastopexy, breast augmentation, breast lift, body contouring, esthetic surgery

1. Introduction

Augmentation mastopexy is arguably one of the most difficult esthetic surgeries performed by plastic surgeons. The opposing forces inherent to this operation, tightening of skin envelope to address ptosis with simultaneous stretching of skin and parenchyma for augmentation, lessen predictability and may contribute to higher rates of complications and patient dissatisfaction [1–3]. Despite this, with careful patient selection, attention to detail, and surgical execution, excellent surgical results are achievable.

2. Background

Since first described by Gonzales-Ulloa in 1960 and Regnault in 1966, various surgical approaches have been developed [3, 4]. Traditional mastopexy techniques including periareolar, vertical, and inverted T patterns with a combination of augmentation modalities including implants and auto augmentation have been utilized.

Historically, submuscular, or more commonly subpectoral, implant placement has been considered the standard approach. As trends in breast augmentation have evolved so have trends with augmentation mastopexy. Varying techniques utilized in augmentation mastopexy will be described below including the pitfalls associated with each approach.

3. Preoperative assessment

3.1 Patient evaluation

As with any surgical procedure, thorough preoperative patient evaluation, including a detailed history and focused physical examination, is essential. It is important to elicit history of diabetes, weight loss, smoking status, use of immunosuppressive medications, and prior radiation as these may predispose to risk factors such as delayed wound healing. It is paramount to explore and document any previous breast surgery to determine any disruption to the normal circulation of breast parenchyma and nipple-areola complex, increasing the risk of tissue necrosis [5, 6].

During the preoperative consultation, patient goals and expectations are discussed. It is important to determine if a mastopexy alone would suffice or if the patient desires increased volume or upper pole fullness which would warrant implant placement. In cases of mild ptosis, an implant alone may be adequate to provide a modest lift in patients that desire augmentation. As always, pre-existing asymmetries should be brought to light as these may persist despite attempts for correction at the time of surgery.

The ideal patient for augmentation mastopexy has a normal BMI, non-smoker, with excess breast skin and relatively deficient breast volume. There have been numerous algorithms and special tests described to determine if a patient will benefit from augmentation alone, mastopexy alone, versus augmentation mastopexy [7–9]. In the senior author's experience, in patients with excess skin compared to breast volume, augmenting the breast in addition to mastopexy provides the optimal result. Reducing the skin envelope while using an implant to restore upper pole fullness allows for creation of an ideal breast footprint.

3.2 Physical examination

Physical examination includes body mass index and breast analysis. Standard breast evaluation is performed with the patient in an upright position. First, the degree of ptosis is visually determined using Regnault classification [10]. The Regnault classification is a widely used system in which the degree of breast ptosis is determined based on the nipple position in relation to the inframammary fold (IMF). Grade 1 is defined as mild ptosis with the nipple at the level of the IMF. Grade 2 describes moderate ptosis where the nipple is positioned below the level of the IMF but not at the most dependent part of the breast. Grade 3 represents severe ptosis where the nipple is positioned below the IMF and at the most dependent portion of the breast. Pseudoptosis is characterized the nipple at or above the level of the IMF with the majority of breast parenchyma positioned below the level of the IMF [10, 11].

Next, measurements of the breast are obtained including base width, sternal notch to nipple, nipple to inframammary fold, nipple diameter, and inter nipple distance [11, 12]. Obtaining these objective measurements helps highlight any asymmetries and is essential in choosing the appropriate implant.

Breast skin quality and parenchyma should be noted including presence of any striae, thin skin, and relationship of skin excess to parenchyma volume [6]. The soft tissue pinch test is a useful adjunct to assess the soft tissue coverage. This is performed by pinching an area of the breast above the nipple areolar complex between the thumb and index finger. Classically, soft tissue pinch less than 2 cm is an indication for subpectoral implant placement to avoid implant visibility and rippling [13].

4. Surgical planning

Various measurements are taken into account when determining whether to perform augmentation-mastopexy simultaneously or in a staged manner. Vertical excess, defined as the difference between the desired nipple to IMF position measured under stretch from the new nipple position and the current IMF, degree of nipple elevation required, available breast tissue, and skin quality are all factors that may affect predictability and complication rate and are therefore important considerations during the decision-making process [7, 14, 15].

5. Techniques

5.1 Mastopexy

The main factors influencing the selection of mastopexy technique are degree of ptosis and skin excess. This decision is often finalized in the operating room after the implant is placed and the residual excess may be assessed. The most commonly used techniques are periareolar, vertical and wise pattern each with their own advantages and disadvantages (**Table 1**) [11, 16].

Periareolar technique can be utilized on patients with minimal ptosis (Grade 1 or 2). There are variations of this technique including crescent mastopexy, circumareolar or “donut” mastopexy, and Benelli procedures. Crescent mastopexy is performed by designing an eccentric oval circumferentially around the areola preferentially excising

Mastopexy type	Indications	Advantages	Disadvantages
Periareolar	Grade I or II	<ul style="list-style-type: none"> Minimal scar burden hidden along areolar border 	<ul style="list-style-type: none"> Widened scar NAC deformity Deprojection of the breast
Vertical (Hall-Findley)	Grades I-III	<ul style="list-style-type: none"> Ptosis correction Augments structural support with pillar unification 	<ul style="list-style-type: none"> Delayed final results Elongation of NAC to IMF distance Scar migration on to chest wall
Wise pattern	Grades I-III	<ul style="list-style-type: none"> Adaptive technique Excellent in cases of poor skin quality 	<ul style="list-style-type: none"> Scar burden Breakdown at T junction Bottoming out

Table 1.
Mastopexy techniques with indications and clinical implications.

tissue superior to the NAC to elevate the nipple [11]. Alternatively, a circumareolar or “donut” mastopexy is performed by designing a circular incision around the NAC. This can be utilized to modestly elevate the NAC (no more than 2 cm) and address enlarged areolar diameter. It is recommended not to exceed 7 cm diameter of the outer incision and maintain outer diameter to inner diameter ratio of 2:1 [16–18]. Lastly the Benelli procedure utilizes this same circumferential periareolar approach with the addition of parenchymal repositioning. This is achieved by performing extensive skin undermining, exposing the parenchyma, which is then incised creating medial and lateral flaps that are repositioned and overlapped at the midline [19, 20]. Although the Benelli procedure allows for decreased scar burden compared to other mastopexy techniques the breasts commonly have a narrow, coned appearance post operatively [16–18]. This technique also mandates a submuscular approach be utilized when combined with augmentation due to the wide undermining and parenchymal manipulation [11, 21]. Each variation of periareolar mastopexy carry the risk of pleating, widened scar, and deprojection of the breast [17].

Vertical mastopexy adds an additional vertical component down the meridian of the breast. This technique increases the ability to raise the nipple areolar complex and resect excess skin. There are a few variations of the vertical scar mastopexy. The most commonly used are short-scar periareolar inferior pedicle reduction (SPAIR) and Hall Findlay technique. Originally described by Hammond, the SPAIR technique transposes the nipple superiorly via an inferior pedicle technique [21, 22]. Due to the wide undermining of this approach traditionally employs it is not customary to use an implant [11]. Alternatively, the Hall Findlay approach can be utilized with an implant. This technique transposes the nipple on either a superior medial or medial pedicle. Since the blood supply to the nipple for this technique is the 2nd or 3rd internal mammary perforators, an implant can safely be placed in either the submuscular or subglandular plane [11, 23, 24].

The wise pattern or inverted T mastopexy is known to easily address those patients with severe ptosis and vertical excess. Similar to the previously described mastopexy techniques, this approach utilizes periareolar incisions and vertical limbs with the addition of horizontal limbs carried out both medially and laterally at the level of the inframammary fold [23, 25]. In the senior author’s experience, this technique can easily be used in a skin only fashion. When performed as skin only an implant can be placed submuscular or subglandular as perforators to the nipple have remained in continuity. Patients often voice concern about the addition of a horizontal scar, however this is easily hidden in the inframammary fold.

5.2 Pocket selection

5.2.1 Subpectoral

Submuscular and dual plane techniques are traditionally considered standard of care due to the safety profile. Placement of the implant in a subpectoral pocket, or partial subpectoral in the case of dual plane technique, provides relative protection of the implant in cases of wound breakdown, as well as vascular preservation and soft tissue coverage affording a more natural result in very thin patients. As the implant remains fixed under the pectoralis major muscle, upper pole fullness is maintained overtime with use of a subpectoral pocket. Immediately postoperatively, this pocket will result in a high riding appearance of the implants which take time, often months, to settle and drop into the appropriate position. As will subpectoral augmentation,

there is a risk for animation deformity where the implants become displaced with activation of the pectoralis muscle. In the long term, as breast ptosis occurs, there is also a risk of developing waterfall deformity where the soft tissue parenchyma cascades off the implant, which remains in the upper pole of the breast, creating an unnatural appearance.

5.2.2 Subglandular

Subglandular breast augmentation has become more common and produces excellent results in the appropriate patient (e.g. **Figures 1–3**). The rise in subglandular augmentation has paralleled the rise in prepectoral implant-based breast reconstruction,



Figure 1. Twenty year old female patient who underwent simultaneous augmentation-mastopexy; (a-b) preoperative photo demonstrating grade II ptosis and upper pole deflation; (c-d) 2 months post operative subglandular augmentation with 325 cc full profile silicone implants and wise pattern mastopexy.

which has demonstrated the relatively safety and effectiveness of prepectoral procedures. The safety of prepectoral implant placement has been demonstrated in direct to implant reconstructive cases during which the implant is placed subcutaneously under freshly devascularized soft tissue with similar complication profile relative to subpectoral placement. Still, many surgeons approach with caution or choose to avoid utilizing the subglandular pocket in esthetic augmentation out of concern for increased

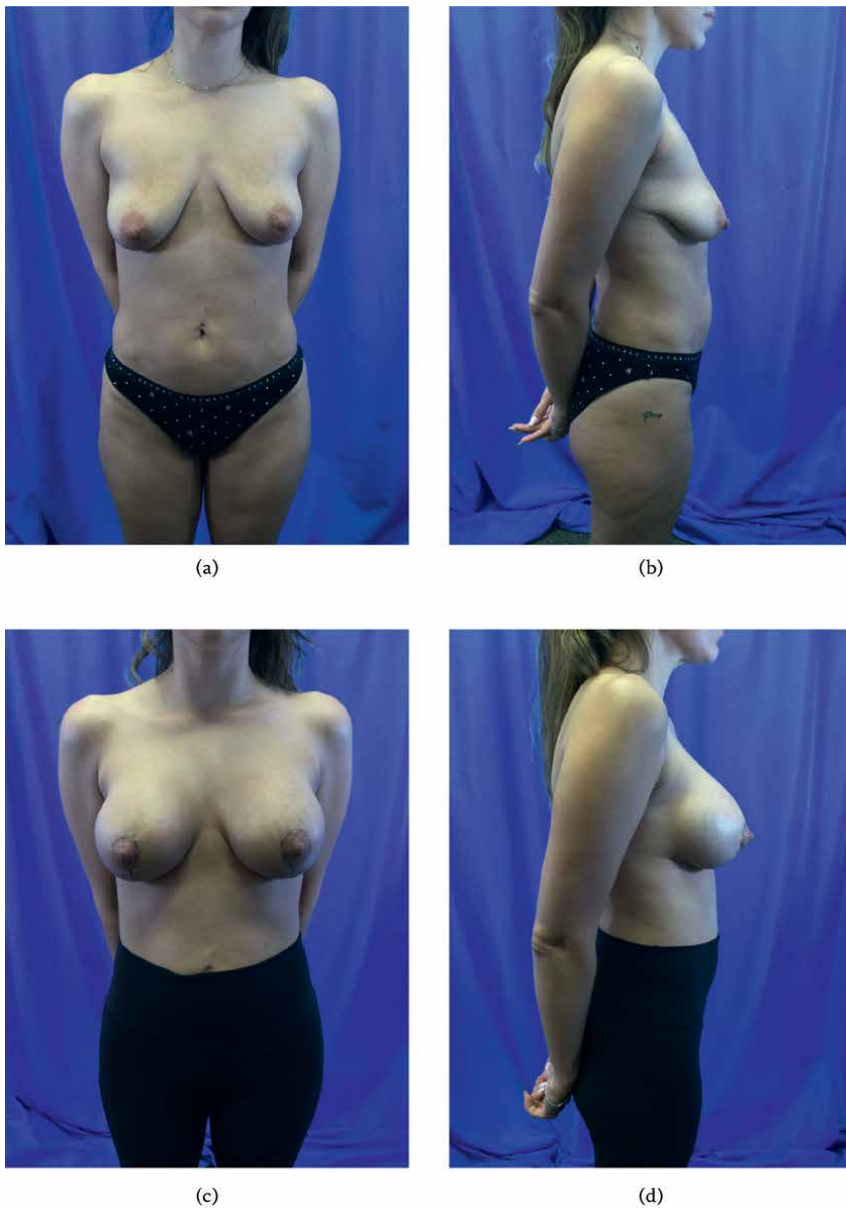


Figure 2. Thirty five year old female patient who underwent simultaneous augmentation-mastopexy; (a-b) preoperative photo demonstrating grade II ptosis and breast asymmetry; (c-d) 2 weeks post operative subglandular augmentation with 345 cc full profile silicone implants and wise pattern mastopexy with implants in a natural position in the immediate post operative period.

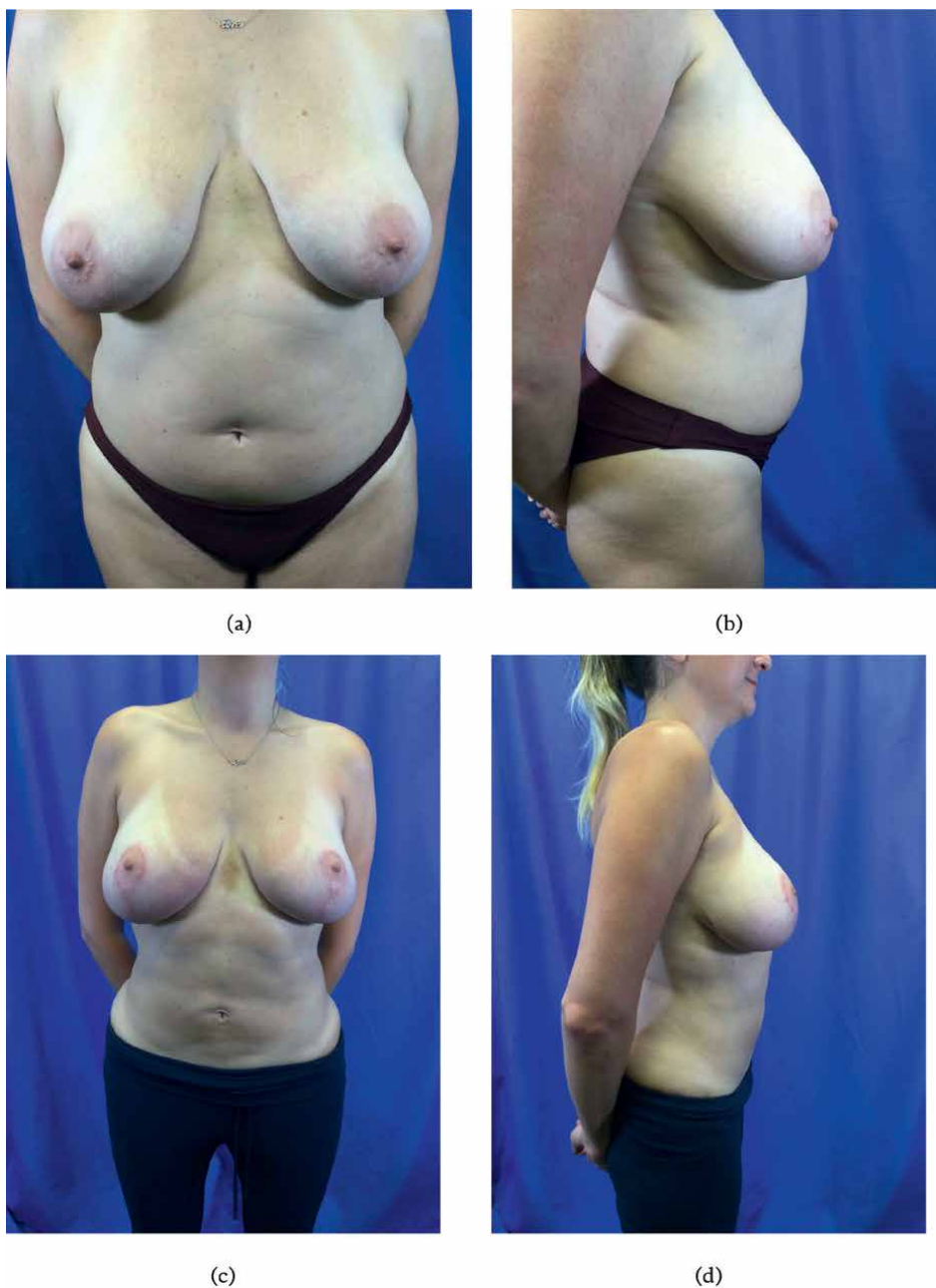


Figure 3. Thirty seven year old female patient who underwent simultaneous augmentation-mastopexy; (a-b) preoperative photo demonstrating grade II ptosis; (c-d) 5 months post operative subglandular mastopexy augmentation with 200 cc full profile silicone implants and wise pattern mastopexy.

incidence of capsular contracture and potential risk for implant exposure in the case of augmentation mastopexy. The subglandular pocket has the advantage of providing excellent immediate postoperative results as the implant is in the appropriate position and there is no need to wait for the implant to drop. This pocket also eliminates

potential for animation and minimizes surgical pain. As aging occurs, the subglandular implant tends to maintain a more natural position and effectively ages along with the ptotic breast offering a long-lasting result. With these observations, the senior author (M.A.F.) has altered his practice now performing mastopexy augmentations almost exclusively in the subglandular rather than the subpectoral plane, unless there is a compelling reason to favor the later such as very thin soft tissue coverage predisposing to implant visibility.

6. Operative sequence

The senior author's preferred technique for simultaneous augmentation-mastopexy is to use the subglandular implant pocket and tailor the mastopexy technique to the patient's needs (**Figure 4**). A goal photo is routinely chosen by the patient and reasonable expectations are discussed. The patient is routinely marked in the preoperative holding area in the upright position. Following induction of general anesthesia, the patient is prepped and draped in the usual sterile fashion and prophylactic IV antibiotics are administered. A 4.5 cm incision is designed in the inframammary crease centered at the nipple. The incision is made and dissection carried down with cautery to identify the plane above the pectoralis muscle. The subglandular pocket is dissected according to preoperative markings followed by placement of a

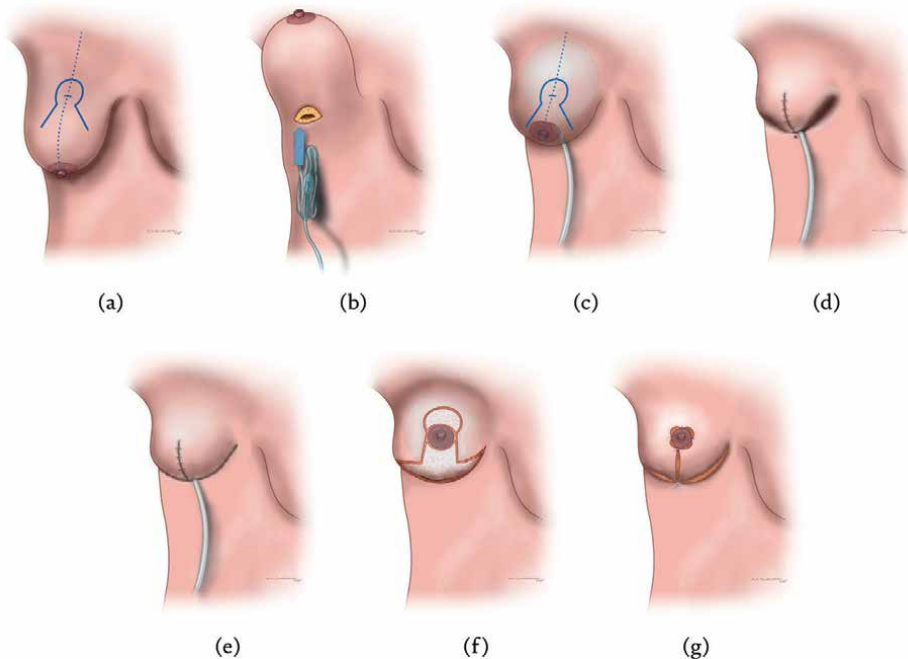


Figure 4. Operative sequence of subglandular augmentation-mastopexy; (a) preoperative mastopexy markings which are used as a guideline and adjusted following implant placement; (b) a subglandular pocket is dissected via IMF incision and saline sizer is placed; (c) the sizer is filled to the anticipated implant volume and adjusted to align with the patient's goals; (d) once and implant size is selected, a vertical mastopexy is tailor-tacked; (e) medial and lateral horizontal extensions are added; (f) incisions are made and the entire skin pattern is deepithelialized then scored along the incisions and periareolar; (g) NAC is advanced into position and incisions are closed.

saline sizer which is inflated to the anticipated implant volume. The patient is then sat in the upright position and implant volume is adjusted as needed. The patient is then returned to the supine position. A vertical mastopexy is performed which serves to contour the breast mound. Vertical skin excess is estimated by pinch, then marked and tailor tacked. Medial and lateral horizontal extensions are marked if needed based on esthetic contour and the distance from the inferior border of the areola to the IMF in order to prevent migration of the vertical scar onto the chest wall. Following confirmation of symmetry, the NAC is outlined with a cookie cutter, incisions are confirmed and made, then the entire skin pattern is de-epithelialized. The dermis is scored until subcutaneous fat is visible along the entire pattern approximately 1–1.5 cm from the skin edge to prevent thermal injury. Periareolar scoring is essential to achieve NAC elevation without undue tension. The sizer is then removed and hemostasis is confirmed. A round smooth silicone permanent breast implant is placed and all incisions are closed, then dressed with Steri-strips and a surgical bra. The patient is discharged home the same day. This technique has produced excellent immediate postoperative and long-term results.

7. Complications

Many surgeons approach simultaneous augmentation-mastopexy with caution or choose to stage the procedures altogether to avoid NAC vascular compromise and wound healing complications which could potentially lead to implant exposure. In reality, the incidence of these complications is relatively low [26]. Overall complication rate is estimated to be approximately 13% with the most commonly cited complication being recurrent ptosis [26]. Recurrent ptosis results in a waterfall deformity which is characterized by the breast parenchyma falling off the implant which remains in the upper pole underneath the pectoralis muscle (**Figures 5 and 6**). In patients who require subpectoral implant placement, some surgeons advocate for excision of

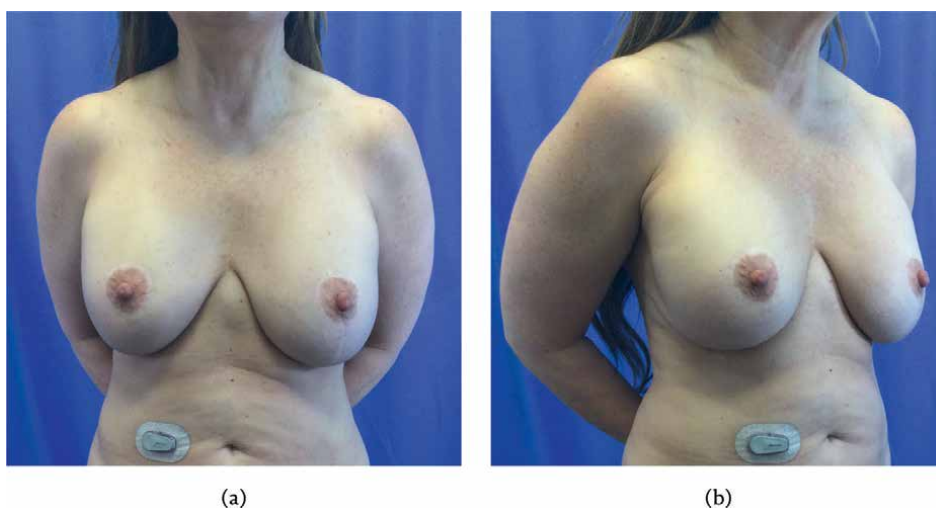


Figure 5.
(a-b): 56 year old female who underwent subpectoral augmentation-mastopexy at an outside facility with 350 cc saline implants. She presented with recurrent breast ptosis and waterfall deformity.

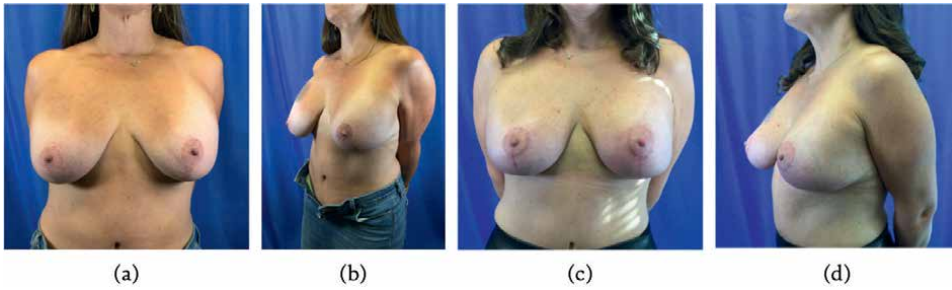


Figure 6. (a-b) 51 year old female who is 7 months status post subpectoral augmentation-mastopexy with 485 cc full profile silicone implants which resulted in waterfall deformity; (c-d) 2 months post operative revision mastopexy, capsular revision and replacement of previous implants.

the lower pole and increasing implant size accordingly at the index surgery in order to remove the natural weight of the breast lessening the tendency of soft tissue to slide off the implant [27]. Secondary correction of waterfall deformity requires redo mastopexy with or without pocket change. In the senior author's experience, subglandular implant placement at the time of mastopexy may reduce the risk of waterfall deformity which is often seen after subpectoral implant placement once ptosis recurs and may be addressed with redo mastopexy with or without pocket change. Capsular contracture should be discussed with all patients undergoing breast augmentation with implants with or without mastopexy and subglandular placement may increase this risk. Like any esthetic procedure in plastic surgery, patient dissatisfaction may arise despite a well-executed surgical procedure without postoperative complications.

8. Conclusion

Mastopexy with breast augmentation is indicated for patients with breast ptosis who desire a lift with added upper pole fullness. These procedures may be performed simultaneously or in a staged fashion. Various techniques exist and plastic surgeons performing esthetic breast surgery should have thee in their repertoire. Complications and unfavorable sequelae may occur, therefore careful preoperative planning and thorough patient counseling is essential. Overall, augmentation-mastopexy is an essential procedure in esthetic surgery with the ability to produce excellent results.

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Abdominoplasty Surgical Techniques

Andrew Sohn and Sebastian Gutierrez de Pineres

Abstract

This chapter offers a comprehensive exploration of abdominoplasty, focusing on the various types of techniques and the critical criteria for patient selection. It emphasizes the factors that influence the choice of surgical approach, ensuring optimal outcomes for different patient profiles. A detailed examination of abdominal anatomy is provided, as understanding this anatomy is essential for safe and effective surgical intervention and satisfactory outcomes. The chapter categorizes different abdominoplasty techniques, including the traditional approach, reverse abdominoplasty, high lateral tension, Fleur de Lis, and corset body lift. It details the specific indications, markings, surgical steps, and potential complications for each approach. Finally, the authors address comprehensive postoperative care guidelines to enhance recovery and minimize risks. Through this multifaceted discussion, the aim is to equip cosmetic and plastic surgeons with the knowledge needed to make informed decisions in the field of abdominoplasty.

Keywords: traditional abdominoplasty, mini abdominoplasty, Fleur de Lis, reverse abdominoplasty, corset abdominoplasty

1. Introduction

Abdominoplasty, commonly known as a tummy tuck, is a surgical procedure performed either alone or in combination with other procedures to address issues involving the skin, underlying fat, and muscles of the abdomen. Cosmetic surgeons performing abdominoplasty have recognized that variations in abdominal contour and presenting conditions require modifications to the surgical approach. For instance, patients with fat deposits and good skin quality may achieve excellent results with liposuction alone, which involves minimal scarring and morbidity compared to a full abdominoplasty. However, patients who have undergone full-term pregnancies or significant weight loss typically require a full abdominoplasty, with potential modifications tailored to their specific needs. These modifications aim to address individual concerns and provide a more personalized approach to the procedure.

2. Types of abdominoplasty

1. Traditional abdominoplasty:

- The original technique, introduced in the 1960s, involved a long incision and a more invasive approach. Modern techniques prioritize minimal scarring, reduced blood loss, and faster recovery times.

2. Mini abdominoplasty:

- A modified version of the traditional procedure designed for patients with less significant skin laxity and fat deposits limited to the area below the umbilicus.

3. Extended/lateral tension abdominoplasty:

- This variation targets the love handles, lower back area, lateral hips, and upper thighs, providing a more comprehensive body contouring solution.

4. Fleur-de-lis abdominoplasty:

- A modification of the traditional procedure to remove excess circumferential skin and fat from the abdomen. The incision is shaped like a fleur-de-lis, with a vertical component in the midline and two lateral extensions resembling the petals of the fleur-de-lis symbol.

5. Reverse abdominoplasty:

- Also known as an “upper tummy tuck”, this procedure targets the upper abdomen, focusing on the area above the umbilicus to remove excess skin and fat and improve contour.

6. Liposuction only:

- A viable alternative to abdominoplasty that removes excess fat from the abdominal area but does not address excess skin or muscle laxity.

These advancements have made abdominoplasty a safer, more effective, and personalized procedure for individuals seeking to rejuvenate their abdominal appearance.

3. Patient selection and criteria

Traditionally, abdominoplasty was primarily sought by women who wanted to regain their youthful appearance post-pregnancy and after subsequent weight loss. However, abdominoplasty has been increasingly sought by both men and women due to rising obesity rates, bariatric surgery, and the use of GLP-1 receptor agonists. Women post-pregnancy benefit from addressing muscle separation (diastasis recti) and skin laxity to restore pre-pregnancy contour. Individuals with significant weight loss may require extensive procedures to remove excess skin and fat, alleviating skin

irritation and discomfort. Gastric surgery patients often need abdominoplasty to address excess skin and improve body contour post-surgery.

4. Factors influencing surgical approach

1. Location of fat:

- Patients with localized fat deposits in the lower abdomen might be candidates for a mini abdominoplasty, which involves a smaller incision and focuses on the area below the umbilicus.

2. Skin laxity:

- The degree of skin laxity is a critical factor in determining the type of abdominoplasty. Extensive skin laxity might require a full abdominoplasty to remove excess skin and tighten the abdominal muscles.

3. Dermal breakdown and muscle separation:

- Patients with dermal breakdown or significant scarring may require a more complex procedure, such as a fleur-de-lis abdominoplasty, which can address extensive circumferential skin and fat removal. Muscle separation, common post-pregnancy, is typically corrected during a full abdominoplasty.

4. Type of procedure:

- Traditional abdominoplasty: A comprehensive approach for extensive skin laxity and muscle repair.
- Mini abdominoplasty: Suitable for minor skin laxity and fat deposits below the umbilicus.
- Extended/high lateral tension abdominoplasty: Addresses love handles, lower back, lateral hips, and upper thighs for more comprehensive body contouring.
- Fleur-de-lis abdominoplasty: Ideal for patients with significant circumferential skin and fat removal needs.
- Reverse abdominoplasty: Focuses on the upper abdomen, removing excess skin and fat above the umbilicus.
- Liposuction only: An alternative for patients with good skin quality but excess fat, without addressing skin laxity or muscle separation.

5. Patient selection criteria for abdominoplasty

- Age:
 - 18–65 years old.

- Health status:
 - Good overall health, free of chronic diseases.
- Body Mass Index (BMI):
 - Ideal: <30.
 - Acceptable: 30–35.
 - High-risk: >35.
- Smoking status:
 - Non-smoker or willing to quit.
- Pregnancy status:
 - No current or planned pregnancy.
- Weight stability:
 - Stable weight for at least 6 months.
- Abdominal anatomy:
 - Excess skin and fat.
 - Muscle separation (diastasis recti).
 - Bulging or protruding abdomen.
- Realistic expectations:
 - Understanding of the procedure's limitations and expected outcomes.
- Motivation:
 - Personal desire for improvement, not driven by external pressures.
- Psychological stability:
 - Emotionally stable, with no significant mental health concerns.
- Previous surgeries:
 - No significant abdominal scarring or hernias.
- Post-gastric surgery:
 - At least 1–2 years post-op, with stable weight and no complications.

These criteria help ensure a safe and successful abdominoplasty procedure. Your plastic surgeon may have additional or modified criteria based on individual circumstances.

6. Anatomy

A thorough understanding of abdominal anatomy is essential for performing abdominoplasty. This knowledge encompasses the layers of soft tissue, vascular structures, and blood supply to the abdominal tissues and umbilicus, as well as the separation and laxity of the fascia and muscles. Such anatomical insight, coupled with a detailed clinical examination, allows surgeons to develop a treatment plan tailored to each patient's unique needs. This expertise aids in determining optimal incision locations, flap elevation, and tissue removal, particularly in patients with minimal skin laxity or a history of prior abdominoplasty. This understanding is also crucial when combining procedures such as liposuction with abdominoplasty to ensure both esthetic and functional outcomes.

7. Skin

The abdominal wall is composed of seven distinct layers: skin, subcutaneous fat, Scarpa's fascia, subscarpal fat, the anterior rectus sheath, muscle, and posterior rectus sheath. These layers work together to support abdominal organs, protect internal structures, and facilitate movement. The skin serves as a protective barrier and sensory interface, while Camper's fascia contains superficial adipose tissue. Scarpa's fascia, a dense connective tissue layer, separates the superficial and deep adipose tissue, providing structural support. Below this lies the muscular layer, surrounded by the anterior and posterior rectus sheaths.

Skin quality in the abdominal region varies based on genetics, age, pregnancy history, and weight fluctuations, all of which affect its elasticity and response to surgical procedures. Skin elasticity, primarily determined by genetics and collagen production, dictates how well the skin can stretch and retract. Factors such as aging, significant weight changes, and pregnancy impact abdominoplasty outcomes by influencing skin tension and redundancy.

Body Mass Index (BMI) affects how the skin responds to weight changes. Higher BMI, indicative of increased body fat, can stretch the skin, reducing its elasticity. After weight loss, the skin may not fully retract, resulting in sagging and loose skin, especially in the abdomen.

Younger individuals generally have more elastic skin and better accommodating changes such as weight gain. In contrast, prolonged stretching, as seen with pregnancy or significant weight fluctuations, diminishes skin elasticity, leading to sagging and loose skin, particularly in the abdomen. Pregnancy presents additional challenges to abdominal skin elasticity and muscle tone, potentially leading to diastasis recti, where the abdominal muscles separate. While postpartum exercises can strengthen muscles, excess skin, and muscle laxity may persist, prompting consideration of abdominoplasty to restore shape and firmness.

Stretch marks (striae) result from dermal breakdown due to rapid changes like weight fluctuations and pregnancy. During abdominoplasty, stretch marks below the umbilicus may be removed, while those above typically remain. Various treatments

exist to reduce their appearance, but complete elimination is challenging. Understanding these factors helps manage expectations regarding abdominoplasty outcomes.

Abdominoplasty addresses these issues by removing excess skin and fat and tightening muscles to restore a contoured abdomen. Patients with higher BMIs may require more extensive surgical techniques due to greater skin laxity.

8. Fat

The abdominal adipose layer is divided into superficial and deep layers by Scarpa's fascia. Scarpa's fascia, situated deep within the abdominal wall, is composed of dense, relatively avascular fibrous connective tissue, providing structural support and separating deep adipose tissue and muscles from subcutaneous fat [1].

The superficial fat layer is typically thicker and denser, with a robust vascular supply from the subdermal plexus and underlying perforators from the musculocutaneous system. In contrast, the deep layer of adipose tissue is less dense and receives its blood supply primarily from musculocutaneous perforators. When considering lipectomy or liposuction during abdominoplasty, it is crucial to understand that the blood supply to deeper fat is separate from the skin's supply. Liposuction deep into Scarpa's fascia and skin excision can be performed safely without compromising skin vascularity. However, thinning the fat layer superficial to Scarpa's fascia can lead to vascular compromise and skin necrosis.

In surgical contexts, Scarpa's fascia is often referenced for deeper dissection to achieve optimal esthetic outcomes while minimizing complications. Understanding its role in fat layer dissection is crucial for preserving abdominal contour and stability (Figure 1).

9. Muscle

The abdominal wall muscles, including the rectus abdominis, external oblique, internal oblique, and transversalis abdominis, each plays unique roles in function and movement. The rectus abdominis muscle, commonly referred to as the "six-pack," is positioned centrally and runs vertically along the abdomen from the pubic bone to the sternum. It provides structural support to the anterior wall, flexes the lumbar spine, and stabilizes the pelvis.

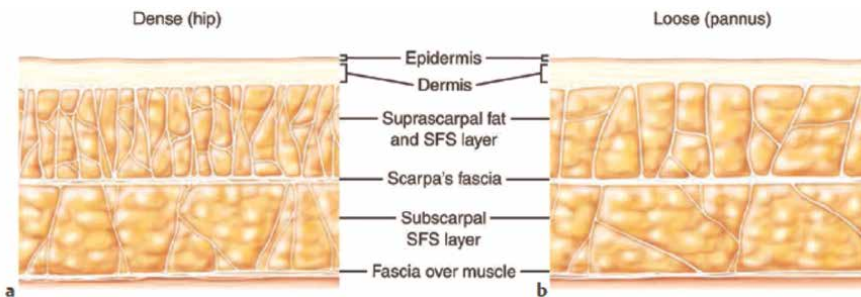


Figure 1.
Layers of the abdominal wall [2].

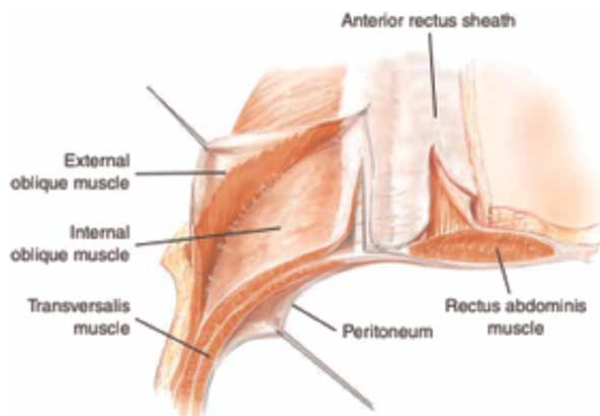


Figure 2.
Soft tissue layers of the abdominal wall [2].

Surrounding the rectus abdominis is the external oblique, internal oblique, and transversus abdominis muscles, which together support trunk rotation, flexion, and compression of abdominal contents.

The rectus abdominis is enclosed within the rectus sheath, formed by the aponeurosis of the transversalis abdominis and the two oblique muscles. These aponeuroses envelop the rectus abdominis, forming anterior and posterior sheaths that fuse in the midline to create the linea alba. Pregnancy and significant weight fluctuations can stretch the linea alba, causing rectus diastasis, which may require surgical repair for optimal abdominoplasty results.

The arcuate line, located approximately halfway between the umbilicus and the pubic symphysis, represents a transition point. Above this line, distinct anterior and posterior rectus sheaths exist; below it, aponeuroses from the internal oblique and transversalis join those from the external and internal obliques to form a single anterior rectus sheath, with no posterior sheath.

The peritoneum lines the abdominal cavity and covers abdominal organs, reducing friction and facilitating smooth organ movement during digestion and other bodily functions. Understanding the complex anatomy of the abdominal wall is crucial for diagnosing conditions, planning treatments, and ensuring optimal outcomes in surgical procedures like hernia repairs and abdominoplasty (**Figure 2**) [3].

10. Vascular supply

The blood supply to the abdominal wall originates from multiple sources, ensuring proper nourishment and function. The intercostal arteries, branching from the thoracic aorta, extend from the rib cage into the abdominal wall, supplying both skin and underlying tissues. The lumbar arteries, from the abdominal aorta, supply the posterior wall's skin and subcutaneous tissue. The superficial epigastric and circumflex iliac arteries, originating from the femoral artery, supply the lower abdomen and groin, critical during abdominoplasty.

The abdominal muscles receive blood from several key arteries. The superior epigastric artery, a continuation of the internal thoracic artery, descends into the rectus sheath, supplying the upper rectus abdominis muscle and overlying skin.

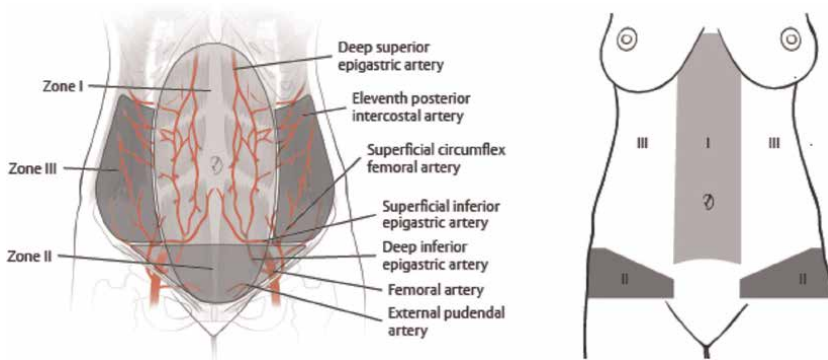


Figure 3.
Huger vascular zones [4].

During surgery, maintaining blood flow from this artery is essential for the viability of upper abdominal tissue. The inferior epigastric artery, branching from the external iliac artery, ascends within the transversalis fascia, entering the rectus sheath to supply the lower rectus abdominis, anastomosing with the superior epigastric artery. Preserving this artery ensures adequate blood supply to the lower abdominal wall. The deep circumflex iliac artery, also from the external iliac artery, runs along the iliac crest, supplying lower wall muscles, including the internal oblique and transversus abdominis, by penetrating their muscular layers. The intercostal and lumbar arteries provide additional blood flow to the lateral and posterior wall muscles, including the internal and external obliques and transversus abdominis, by traveling between muscle layers and giving off perforating branches (**Figure 3**) [5].

During abdominoplasty, elevating skin and fat flap may disrupt the blood supply. Although numerous anastomoses between arteries create a rich blood supply and collateral circulation, careful planning of incision lines and flap elevation is necessary to preserve key vessels, especially perforating branches that supply critical blood flow to the skin. By maintaining the integrity of these vessels, surgeons can help ensure proper healing and reduce the risk of complications such as flap necrosis. Understanding the vascular anatomy and the importance of these vessels is crucial for successful and safe surgical outcomes in abdominoplasty procedures.

11. Nerves

Sensation of the anterolateral abdomen is provided by the anterior branches of the spinal nerves T7–12 and L1. The anterior branches of the spinal nerves T7–T11 also known as intercostal nerves, after emerging from the intercostal muscles, travel between the internal oblique and transversalis muscles to penetrate the posterior rectus sheath, innervating the skin. The anterior branch of T12, the subcostal nerve, and the anterior branch of the L1, the spinal nerve are divided. The lateral cutaneous nerves perforate the intercostal muscles at the midaxillary line and travel within the subcutaneous plane. The T7 to T9 nerves predominantly return sensation from the inferior portion of the lateral thoracic wall above the umbilicus. The T10 innervates around the umbilicus while T11 to T12 nerves predominantly return sensation from the lateral anterolateral abdominal wall below the umbilicus [6]. During

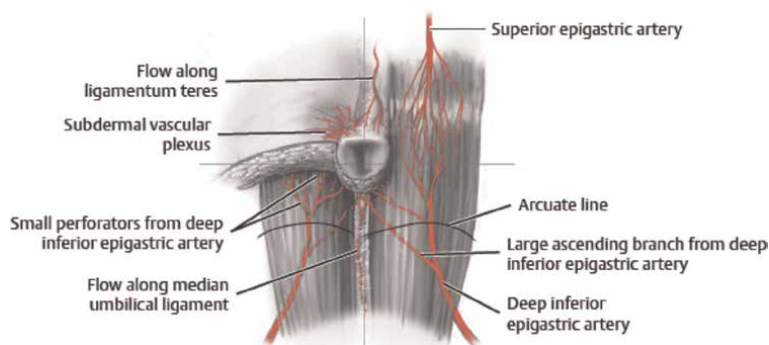


Figure 4.
Blood supply to the umbilicus [4].

abdominoplasty, a rearrangement of abdominal wall nerves can occur where dermatomes T5-T12 move inferiorly. Dermatomes T5-T9 become magnified in the abdominal wall and T10-T-12 are generally resected with the skin. This change in dermatome location is of profound importance for patients undergoing spinal anesthesia.

12. Umbilicus

The umbilicus, or navel, is a scar on the abdomen marking the site of the former umbilical cord attachment. Located on the anterior abdominal wall near the level of L3-L4 vertebrae, it is formed by the obliteration of umbilical vessels and the urachus, surrounded by skin and underlying connective tissue, with a central depression. Beneath the skin lies a rich subdermal plexus that plays a crucial role in the blood supply, receiving contributions from the deep inferior epigastric arteries, branches of the external iliac arteries [1]. The ligamentum teres (a remnant of the fetal umbilical vein) runs from the umbilicus to the liver, adding to its anatomical significance.

Esthetically, a pleasing umbilicus is typically small, vertically oval-shaped, and positioned midline on the abdomen, with a slight inward contour and moderate depth. Symmetry with the surrounding abdomen is crucial for esthetic balance. Features that contribute to an appealing umbilicus include a vertical shape, slightly superior hooding, shallow depth, and a well-defined lower margin. The surrounding skin should be taut and harmonious with the abdominal musculature. Excessive protrusion, retraction, or irregularities can detract from its appearance, emphasizing the importance of a well-defined navel in overall abdominal esthetics. Understanding the anatomical structure and vascular supply of the umbilicus is essential in abdominoplasty to preserve its blood supply and achieve a natural appearance post-surgery (**Figure 4**).

13. Patient education

Patient education and informed consent are crucial components of the abdominoplasty process, ensuring that patients have realistic expectations and are prepared for postoperative care. Patients should be informed that not all excess skin may be removed, and abdominal protrusion might still be present depending on factors such as intra-abdominal fat, scarring, and potential flap necrosis. It is essential

to discuss these limitations openly so patients have a clear understanding of the likely outcomes.

Prior to surgery, patients are instructed to follow several key preoperative measures: stopping smoking 2–3 weeks before and after the procedure to enhance healing, adhering to a high-protein diet to support tissue repair, and starting a bowel program to avoid constipation, which can complicate recovery. Patients are also advised to shower with antiseptic soap before the operation and follow specific wound care instructions to minimize the risk of infection.

During the surgery, anti-clot measures are implemented, including the use of compression stockings and intermittent pneumatic compression devices, both intraoperatively and postoperatively, to reduce the risk of deep vein thrombosis (DVT) and pulmonary embolism. Postoperative instructions include the use of an abdominal binder to support the healing area, proper care of any drains placed to remove excess fluid, and pain management with medications, including the potential use of exparel for long-acting pain relief. Patients should anticipate taking 1–2 weeks off from work, with a gradual return to light duties over the following 6 weeks.

To prevent complications and promote recovery, patients are encouraged to engage in light ambulation and leg exercises to reduce the risk of DVT and embolism. Swelling and bruising are common and typically resolve within 2–3 weeks, though some residual swelling may persist for up to 3–6 months. Drain removal is usually performed 1–2 weeks postoperatively. Overall, patient education plays a pivotal role in preparing individuals for the procedure and ensuring adherence to postoperative care, ultimately contributing to a smoother recovery and better surgical outcomes.

14. Procedure selection

Procedure selection for abdominoplasty involves careful consideration of skin tone, the amount of excess skin and fat, and individual patient needs. For patients with mild excess fat but good skin tone and no significant skin laxity, liposuction alone or combined with endoscopic diastasis repair may be sufficient. This approach is ideal for those seeking contour improvements without extensive skin removal. When patients present with excess fat primarily below the umbilicus and some skin laxity, a mini abdominoplasty combined with diastasis repair can address both concerns effectively, offering a less invasive option than a full abdominoplasty.

For individuals with significant fat deposits and excess skin, a traditional abdominoplasty with or without liposuction is generally recommended. This procedure removes excess skin and fat from the abdominal area, providing a more dramatic contour improvement. In cases where there is extensive excess skin laterally and around the back, especially after massive weight loss, a circumferential abdominoplasty may be necessary. This technique, also known as a body lift, addresses the skin around the entire torso, improving overall contour and tightening the abdomen.

Patients with excess skin in lateral abdominal areas, hips, thighs, pubis, and anterior medial thighs might require a lateral tension abdominoplasty. This technique focuses on tightening and lifting the lateral aspects of the abdomen and thighs, often following significant weight loss. For those with extensive excess skin in both vertical and horizontal dimensions, particularly in the upper midline region, a fleur-de-lis abdominoplasty may be indicated. This advanced technique allows for substantial skin

removal and contouring in multiple directions, addressing complex cases of skin redundancy and offering significant esthetic enhancement.

Each surgical approach is tailored to the patient's unique anatomy and goals, ensuring optimal results and addressing specific areas of concern. By selecting the appropriate procedure, surgeons can effectively manage excess skin and fat, improve abdominal contour, and enhance overall patient satisfaction.

15. Abdominoplasty

15.1 Surgical techniques

15.1.1 General overview

Management of excess skin

- The goal is to remove skin and fat that extends from *above the umbilicus down to pubis* and extending laterally enough to prevent dog ears from forming. All while maintaining the scar as low as possible.

Management of excess fat

- Perform liposuction

Management of abdominal wall

- Repairing tendency to demonstrate diastasis or reinforce the lateral musculofascial envelope – > the waist can be narrowed.

Management of the umbilicus

- By definition- abdominoplasty will translocate the umbilicus. — As opposed to the panniculectomy procedure, where a wedge of skin and fat simply is removed from the lower abdomen without translocation of the umbilicus.
- The basics: Create mild umbilical depression with a hidden scar properly positioned in the midline of the abdomen.

16. Full abdominoplasty

The patient presents with enough redundancy of skin and fat in the anterior abdominal wall that the resection pattern can occur above the umbilicus. This allows the scar to be positioned low along the abdominal wall while also allowing for transposition of the umbilicus (Foad). Abdominal wall plication is used classically. This is usually performed to correct the musculofascial laxity and diastasis recti deformity that many patients are concerned about. There are isolated areas of fat deposition where liposuction is performed prior to making any surgical incisions while ensuring that the supply to the eventual abdominoplasty flap is not violated as this could result in eventual complications of skin necrosis and failed procedure.

16.1 Patient marking

Demonstration video available to download at the end of the chapter.

16.2 Surgical technique

16.2.1 Selective liposuction and management of excess fat

After tumescent anesthesia is delivered to the lower and lateral abdomen we then focus on selective liposuction. Liposuction in the lateral abdomen is performed to facilitate flap eventual redraping while preserving the perforating blood supply from the deep epigastric vessels and lateral perforators.

16.2.2 Incision and dissection

10-blade was used to make the lower abdominal incision through the skin, subcutaneous tissues, and Scarpa's fascia down to approximately the rectus abdominal fascia. Sharp dissection with Bovie electrocautery is performed and carried to the umbilicus. Care must be taken to ensure that the umbilicus remains in place and attached to the stalk while avoiding inadvertent amputation. Sharp dissection is performed around the umbilicus with #11-blade and Bovie electrocautery. The abdominoplasty flap dissection continued with selective undermining along the midline from the umbilicus to the xyphoid process while maintaining hemostasis and preserving the lateral perforators.

16.2.3 Management of excess skin and abdominal wall

The table is then bent into a 30-degree angle and the abdominal flap is retracted inferiorly to determine the amount of excess skin to be excised. Using a hand-over flap, the surgeon's fingers bring the superior aspect of the flap to meet the inferior skin edge. This allows recognition of excess skin to be excised.

A 10-blade is then used to excise the skin and amputate the excess tissue. It is important to note that the umbilicus was kept intact at the stalk. The patient is returned to a non-inclined position. A 2 PDO suture is used to plicate from the xiphoid process to the pubic bone. A fully perforated JP drain is placed flat through the suprapubic flap.

A 2-Vicryl suture is used to suture the Scarpa's fascia of the inferior flap to the rectus fascia to prevent superior migration of the Mons. 0-monocryl suture was then used to center the inferior flap at the midline. Several key sutures are placed using 2 Vicryl to approximate Scarpa's to Scarpa's fascia tacked to the underlying rectus fascia. Then, 0-Monocryl was used to reapproximate the remaining Scarpa's to Scarpa's fascia along the abdominal flap. A 3-0 Monocryl is used to reapproximate the subcutaneous layer. Prior to the complete closure of deep layers, a flat JP drain was placed along the inferior aspect of the abdomen.

Starting from the later edges, staples are used to reapproximate the lateral component of the skin edges and move medially just lateral to an imaginary vertical line over the inguinal fold. Approximating the lateral edges of the skin first helps avoid dog ears. We then use a 3-0 monoderm quill to reapproximate the abdominal flap incision at the subcuticular level from the midline of the abdominal incision to two-thirds the

length of the incision laterally. Prior to the closure of the incision, it is important to identify the location of the umbilicus to recreate its opening and umbilical depression.

16.2.4 Management of the umbilicus

An incision was then made with a #10-blade to create the new umbilical position. Dissection was carried out to identify the previously dissected umbilicus. Once identified, the umbilicus was then secured to its new position using 2-0 Vicryl. The umbilicus is packed with xeroform dressing and covered with Robbins tape.

Pearls

- The upper pannus is a window shade that is pulled downward after undermining.
- The lower incision will ride up to meet it simply as a result of elasticity.
- The scar will be several cm above the lower mark.
- Closure should be started at the lateral edges of the wound to mitigate the formation of dog ears.
- Avoid marking the lower aspect of the incision directly over the pannus fold as it will cause postoperative un-anesthetic break over the scar, negating the surgery cosmetic goals.
- If possible, exparel should be given to all patients to reduce postoperative pain.

17. Reverse abdominoplasty

Reverse abdominoplasty is particularly relevant in patients with primarily or residual excess upper abdominal skin. This approach can be very synergistic when combined with a Wise pattern type of breast surgery.

Residual skin is a complication not really unique to the HLTA. In fact, there is a good argument that because this technique has a more oblique vector of pull, it can efface more of this redundancy. However, the patient with significant excess (a second pannus) should be informed preoperatively of its probable persistence. Only a fleur-de-lis or reverse abdominoplasty can treat this zone definitively and should otherwise be considered in the first place [2].

18. Fleur De Lis abdominoplasty

18.1 Indications

Consider Fleur De LI if there is excess circumferential skin at the waist or if there is excess skin with concomitant previous subcostal or midline scars. It is appropriate for patients who require aggressive treatment of excess skin throughout the abdomen and trunk but particularly at the upper pole of the abdomen and lower chest, waist, hips, and thighs.

The trade-off with this approach is the full midline scar that is required for more complete skin resection.

If the patient desires to avoid the midline scar, an alternative approach could be a traditional abdominoplasty or High Lateral Tension Abdominoplasty (HLTA) followed by reverse abdominoplasty in a second-stage surgery [2].

Another indication of the Fleur De Li abdominoplasty approach is when a patient has previous abdominal scars whereby the position of the previous incision may have already compromised blood supply from perforator vessels near the costal margins that are normally carefully preserved during formal abdominoplasty.

When combined with an HLTA the upper abdominal zone is addressed with direct excision, and there is an indirect corset effect on the entire anterolateral chest, flank, and back. This combination can address the pannus but also residual excess skin rolls. This is very beneficial in massive weight loss patients.

- In some circumstances, when adequate resection of skin following the Fleur de li approach is completed, most of the anterior abdominal wall is exposed and the peripheral “waistcoat” skin, lying in the wings, advances to close the defect [2].

18.2 Markings

Marking is performed with the patient in a standing position with hands held at their sides. The markings for a standard abdominoplasty are performed, extending laterally as indicated.

Once the upper traditional abdominoplasty incision line is marked, the redundant soft tissue in the midline abdomen is pinched together in a vertical fashion to allow visualization of approximate excess tissue to be removed. The vertical marking is from the xiphoid down to the upper abdominoplasty incision marking previously made (**Figure 5**).

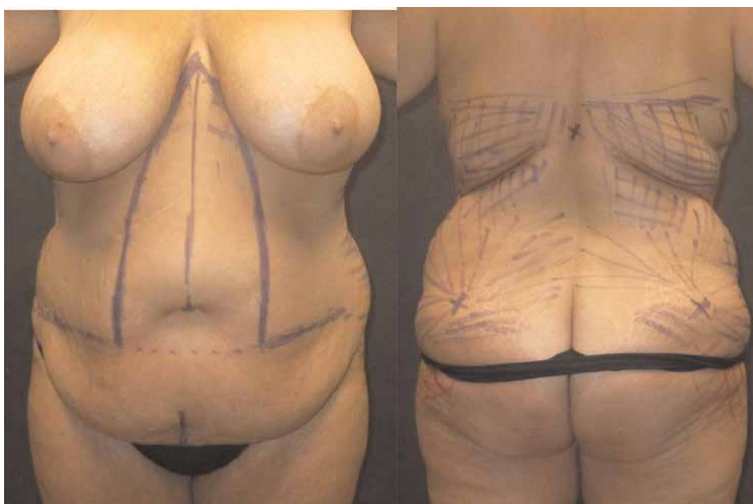


Figure 5.
Fleur De Lis preoperative markings including associated liposuction to back and hips.

18.3 Surgical technique

An incision is begun at the level of the xyphoid process in the upper abdomen through the skin, subcutaneous tissues, and Scarpa's fascia down to the rectus abdominis fascia (**Figure 6**).

A pre-rectus fascia dissection is carried inferiorly to the level of the umbilicus. Careful attention is directed toward identifying potential abdominal hernias that may require repair.

The suprapubic (lower abdominal) incision is then created approximately 7 cm superior to the vaginal cleft. This dissection is taken to the level of the rectus abdominis fascia. It is important to make every attempt to have the lateral extent of this incision at the same height to improve symmetry.

A periumbilical incision is created to free the umbilicus from the abdominal flap but attached to abdominal stalk.

In a 30-degree fixed position the abdominal flap is stretched inferiorly to assess excess tissue and this is then excised. A 2-0 PDO quill suture was used to plicate from the xiphoid process to the pubic bone to address areas of severe rectus muscle diastasis. Layered closure as previously described in the traditional abdominoplasty section is performed and the umbilicus is secured to a new position with 3-0 Monocryl (**Figure 7**).

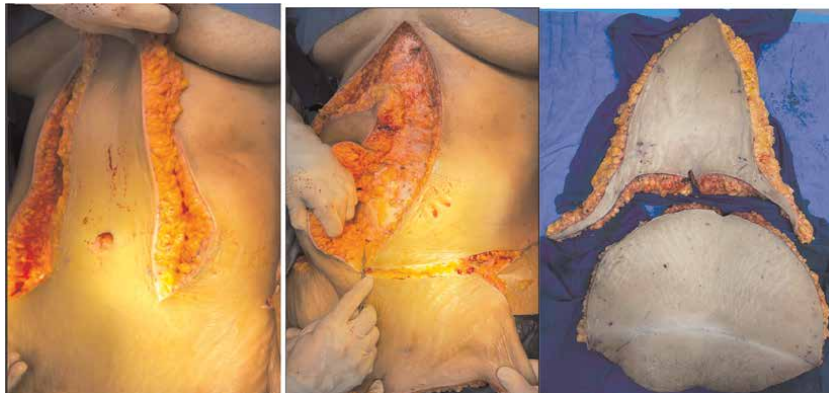


Figure 6.
Vertical and horizontal dissection of Fleur De Lis incision design and corresponding resected abdominal fat.



Figure 7.
Fleur De Li closure.

18.4 Problems and complications

Fleur De Li's abdominoplasty approach can have many of the same complications as a full abdominoplasty. However, this technique has a specific risk of having a midline scar that extends too far superiorly, leading to symmastia if the patient is having simultaneous breast augmentation surgery.

To avoid this, the surgeon must begin the superior aspect of the incision no higher than the inferior portion of the xiphoid process and avoid the impulse to chase excess skin found in the chest. Additionally, when performing a vertical incision, care to ensure both sides of the vertical component of inverted T are symmetrical is pivotal to prevent a curved vertical scar. If this is noted during surgery, an attempt to correct should be made by respecting necessary skin from one side or the other.

Pearls:

- The effects of the Fleur de Li technique can be the most dramatic given the recruitment of skin from the lateral trunk and correction made at the waist, back, and flank folds [2].
- The wide exposure of the fascia, especially in the epigastric region, allows powerful correction of abdominal wall deformity that may be constrained by traditional or HLTA's narrow tunnel of dissection.
- Despite extensive dissection, flap ischemia is not a major concern since segmental lateral perforators and large perforator vessels near the costal margin are preserved.

19. High lateral tension abdominoplasty

Generally: A successful result has to demonstrate the greatest degree of safety with zero tolerance complications, (2) give maximal esthetic results, (3) and must be consistent and reliable (Regardless of patient "Deformities" [2].

- Excess pubis should be corrected by excision rather than be used to close an exaggerated abdominal skin excision.

Consider laxity of the buttocks, the anterolateral and medial thigh, *as well as the mid and lower abdominal laxity*. Otherwise, the tissues below the incision may appear distractingly untreated

- Traditional abdominoplasty does not fully address excess skin laterally at the hip and thigh.
 - With the HLTA approach, the surgeon can achieve true body lift through an anterior incision only.
 - HLTA addresses excess lateral skin at the hip and thigh through the oblique incision vector whereby the emphasis is placed on resecting lateral redundancy of tissue in the hip, thigh, and buttock instead of the medial region to realize a superior correction of laxity [7].

- HLTA addresses skin at the epigastrium that the traditional abdominoplasty is unable to use for closure or removal.

HLTA approach takes advantage of proposed vectors of skin laxity of the abdomen depicted in **Figure 8** and allows designed incision to more efficiently treat redundant skin. This is particularly beneficial in patients with massive weight loss where the obvious suprapubic pannus is accompanied by excess fat and skin in the subcostal, lateral chest, hips, and anterolateral thighs.

With greater central tension, the mid portion of the final scar rises, resulting in a relatively horizontal scar orientation, even if the lateral initial incision did curve superiorly. With higher lateral tension, the scar remains low in the center and rises laterally [8].

19.1 Marking

With the patient in a standing position, with a wall as support which may be necessary during the traction-assisted process. Make suprapubic marking at a point 5–7 cm above the vaginal cleft or base of the penis [2].

A lateral vertical marking is made at the most lateral extent of the excess skin/pannus.

The original authors of HLTA describe creating a closure marking whereby the pen is moved superolaterally from the suprapubic mark to meet somewhere along the lateral mark. This line usually rests between the inguinal and abdominal wall gullies (Foad). In a post-massive weight loss patient with extensive excess skin, it may be useful to extend the marking to include the design of the posterior body lift.

Defining the lower margin of excision:

The marking pen is placed over the line of future closure, and this position is maintained while pulling excess tissue vigorously upward until taut. When this skin is tensed superiorly, the skin below the pen is marked. This maneuver is performed across the width of the abdomen [8].

Estimating the upper margin of excision:

By pinching excess skin with thumb on the lower incision and fingers at the superior extent of the excess, while maintaining the premarked final closure line at the middle of the skin roll. These markings begin laterally and extend medially.

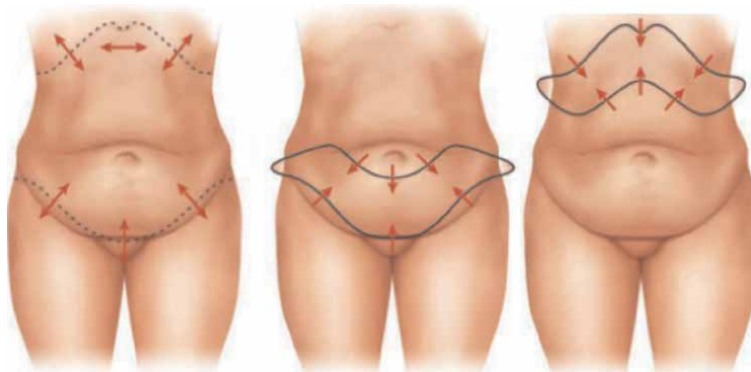


Figure 8.
Vectors of skin laxity of the abdomen [2].

To determine if the umbilicus should be floated inferiorly, the surgeon must note moderate excess skin below *and* above the umbilicus. In our practice the umbilicus is usually circumscribed at the skin, the stalk is left in place and the opening is recreated once the flap is positioned.

19.2 Operative technique

The principles described in the previous sections are similar. Lateral perforators are maintained, and there is minimal liposuction in the midline region in cases where the flap requires midline tunneling above the umbilicus. Umbilicus should be about 9–12 cm above pubis superior margin.

Rectus diastasis is corrected by plication of midline abdominal wall fascia with additional oblique or horizontal vector plication when indicated at the anterolateral abdominal wall to narrow waist and flatten appearance [2].

Excision of excess skin is made and layered closure with deeper fascial sutures with minimal skin tension is performed. All patients have a drain which is removed when output is less than 50 ccs per 24-hour period.

20. Mini abdominoplasty

20.1 General/preoperative evaluation

There are circumstances when there is minimal to moderate excess adipose, normal skin elasticity, but minimal skin laxity of the lower abdomen, making it unsafe to remove all the skin between the umbilicus and the pubis and still be able to achieve primary closure. In this situation, the upper incision of an abdominoplasty would have to be *below* the umbilicus—thus obviating the possibility of umbilical translocation, resulting in a scar that would be higher on the abdomen. This would be unaesthetic. To overcome this, a mini-abdominoplasty is performed whereby the redundant skin and fat of the lower abdomen are removed, the fascia of the lower abdomen can be plicated, and liposuction of the hip and abdomen can be performed as needed.

Another common situation when this procedure can be considered is when the umbilicus is located higher in the abdominal wall than what is considered to be esthetic. Some authors use a proportion of 1: to 1.6 or 1.5 as an esthetic proportion of the lower abdomen to the upper abdomen in relationship to the umbilicus [9]. Proportions of 1–1.4 or higher are considered to have a high umbilicus [9]. Other sources report the umbilicus should be 14 cm above the symphysis pubis in the midline or 10 cm above the pubic hair [2].

A high umbilicus in combination with little to moderate excess skin in the supraumbilical and infraumbilical segments with mild adipose tissue excess in abdomen and flanks can be treated with mini-abdominoplasty with resection of skin inferior to the umbilicus, detachment of the umbilical pedicle and reattaching it with a bolter suture in a more inferior position, and performing associated liposuction to flanks and indicated plication of fascia [9]. Although described, the authors have never performed this surgery in conjunction with the mini abdominoplasty.

It is important to identify an umbilical hernia that can be repaired during surgery. Diastasis should be noted and planned for repair with musculofascial tightening.

20.2 Marking

Guidelines to mark follow those of previous discussions. The superior incision is the predicted incision and it is below the umbilicus. The inferior committed incision is measured approximately 5–7 cm above the vaginal cleft in an effort to maintain the incision low. Hips and flanks are marked for liposuction.

If the patient has a previous low suprapubic scar, it should be included in the tissue to be excised.

20.3 Operative technique

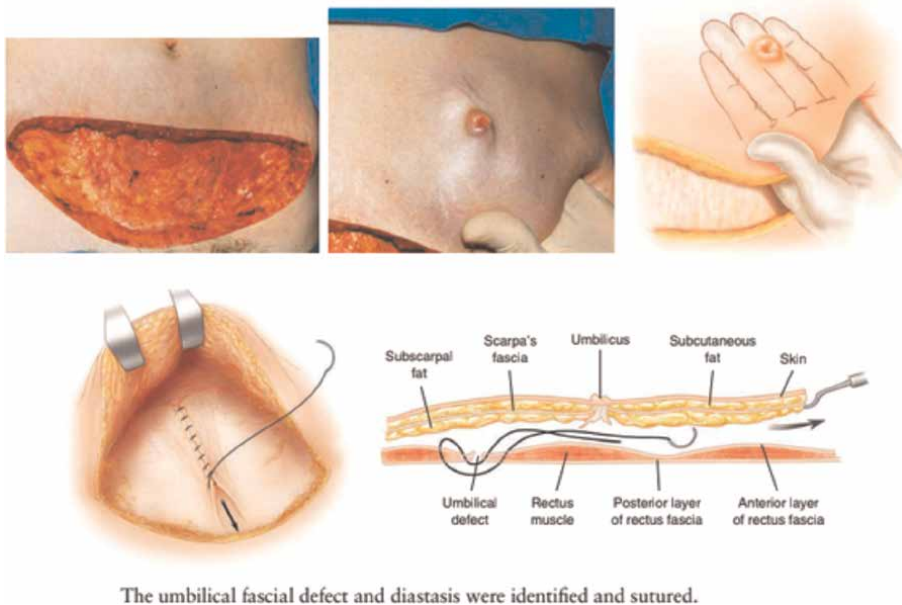


Figure 9. Mini abdominoplasty dissection and simultaneous floating umbilicus permitting superior midline tunneling for midline rectus diastasis correction.

21. Reverse abdominoplasty

21.1 Overview and indications

Reverse abdominoplasty has been described by some to be a procedure best utilized in combination with other techniques previously discussed. It addresses the superior abdominal fat and redundant tissue that is left when other forms of abdominoplasty techniques do not achieve maximum results in this area (**Figure 9**).

It is used in isolation when patients have skin excess and abdominal protuberance primarily in the upper pole of the abdomen [2]. This technique will also address major stria or surgical scars that are confined to the superior abdomen. This approach can be used in conjunction with inframammary incisions when performing mastopexy, or a

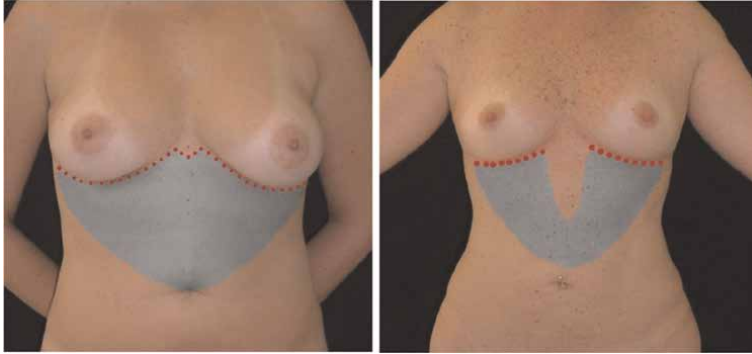


Figure 10. *Unification of Incision at the midline in a group with severe supraumbilical laxity (Left). Moderate supraumbilical skin laxity and no diastasis of underlying rectus muscle permitting two separate inframammary fold incisions [10].*

combination mastopexy and augmentation. If a patient has previous inframammary incisions/scars the surgeon should also consider the procedure.

Some authors characterize candidates for this procedure in two groups: Patients with larger amounts of skin to be resected at the upper pole of the abdomen that will require unification of incision at the midline and a second group with moderate supraumbilical skin laxity and no diastasis of the underlying rectus muscle that will permit two separate inframammary fold incisions without unification at the midline (**Figure 10**) [10].

21.2 Marking

The degree of laxity in the upper pole of the abdomen will help dictate whether the incision should be unified at the midline or if two separate inframammary incisions will be sufficient to address the entirety of the skin laxity [10].

The patient is marked in the supine position. The upper margin of resection is outlined initially. The mark should start as far lateral as the skin demands, while maintaining the final closure within the bra strap line [2]. The marks continue medially and meet at the epigastrium with “V” shape.

Excess skin at the upper pole of the abdomen is pinched and pulled superiorly to determine the approximate inferior line of redundancy. Maximum tautness during this pinch maneuver will determine the extent of skin resection [2].

21.3 Operative technique

We infiltrate the patient with a tumescent solution. The upper incision is made and the abdominal flap is elevated to the level of the rectus fascia. The inferior extent of the flap is made several centimeters above the umbilicus to avoid potential excessive advancement.

The inframammary fold is marked on the abdominal wall so the skin excision is appropriately estimated. This should be done with the patient in the upright position. If done supine, the fold can rise unnaturally by several centimeters and the eventual crease could be sutured too high [2].

Using Kocher clamps, we then provide upward and slightly lateral traction to determine the degree of excess skin to be excised. The resultant abdominal flap is then sutured to the planned location of the inframammary fold in the abdominal wall by capturing deep fascia at both ends using 2 Vicryl and then closing the remaining layers sequentially to achieve tension-free closure.

If performing simultaneous breast surgery, it is preferable to perform reverse abdominoplasty first to create a solid base on which the breast can be built.

One, 10 mm flat JP drain is placed before closure.

21.4 Complications

The most common complication with this technique is excessive advancement of the umbilicus superiorly. To avoid this, the inferior extent of the flap should finish several centimeters above the umbilicus. Another technique to halt the unwanted superior advancement of the umbilicus is to suture the umbilical stalk to the rectus fascia.

22. Body lift-corset

22.1 Overview

Post-massive weight loss patients provide the surgeon with complex and varied challenges. With the advent of bariatric surgery and now with the use of GLP-1 inhibitors, cosmetic surgeons should be comfortable providing options to patients who wish to complement their weight loss journey with a more esthetic contour.

The corset body lift procedure as described by Alexander Moya provides versatility of addressing multiple skin rolls in the upper, mid, and lower abdomen and can be used in patients who may have a BMI > 30. It is a good alternative for patients who would like to address a significant amount of abdominal laxity and value an improved contour over the extent and location of scars.

This procedure comprehensively addresses the contour of the entire vertical abdominal wall and indirectly addresses the posterior waistline to provide a 360° improvement.

22.2 Markings

All markings are performed supine after the patient has been prepped and prior to the tumescent solution to avoid infiltration from affecting incisional markings. Pre-operative reference lines consist of the vertical midline (1), the lower chest (2), and the pubic line (3) (**Figure 11**).

22.3 Operative technique

The incisional markings are infiltrated with the tumescent solution and the incision begins along the subcutaneous tissues previously outlined (**Figure 12**).

Vertical Closure of the remnant defect follows diastasis. See **Figure 13**.

Attention is then placed at resecting the redundant lateral chest skin. Again, utilizing the tailor tacking technique, the excess later chest skin is marked by pulling the

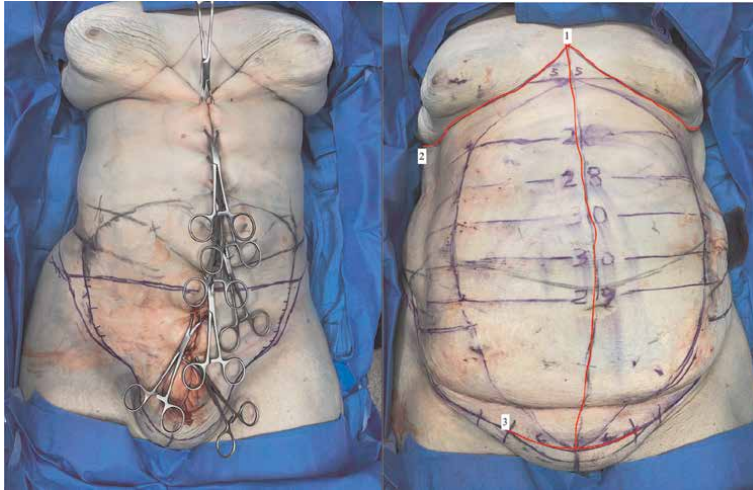


Figure 11.

Using tailor tacking technique, excess skin is approximated to help determine the extent of abdominal skin resection to be performed. Several transverse hash lines are drawn to aid in closure and they are maintained equidistant from the midline to ensure a straight vertical scar. A large vertical ellipse is outlined by connecting the midpoint of the lower chest, the lateral skin marks, and the midpoint of the reference line.

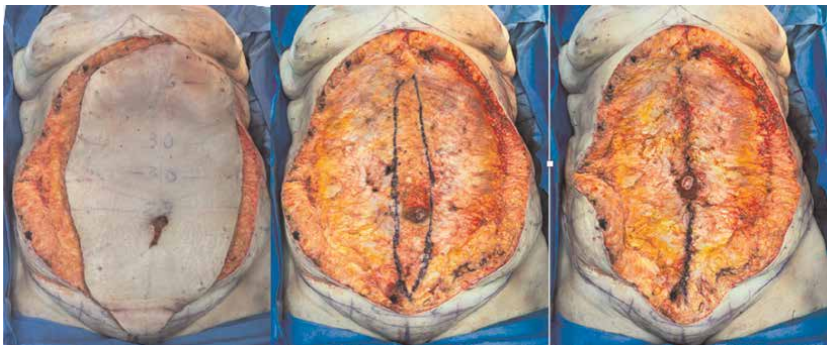


Figure 12.

(A) Vertical ellipse is incised with scalpel and Bovie electrocautery subsequent to release of umbilicus from the skin. Dissection is carried down to abdominal chest fascia circumferentially to excise the ellipse of skin and adipose. (B) Abdominal rectus muscle diastasis is visualized and outlined. (C) #2 Quill PDO suture is utilized for plication along the entirety of the vertical diastasis ensuring abdominal stalk is not strangulated and maintained with its remnant blood supply.

inferior tissue up to the lower chest reference line. The final resection outline incorporates the recreation of the IM folds (Moya). See **Figure 14**.

The next portion of the surgery focuses on performing lower trunk resection to remove the lower midline dog ear created by the vertical closure and resect the redundant lower waistline skin. This is performed while flexing the patient to maximize the removal of excess skin (**Figure 15**).

23. Complications and management

Like any other surgery, abdominoplasty does not come without risks.

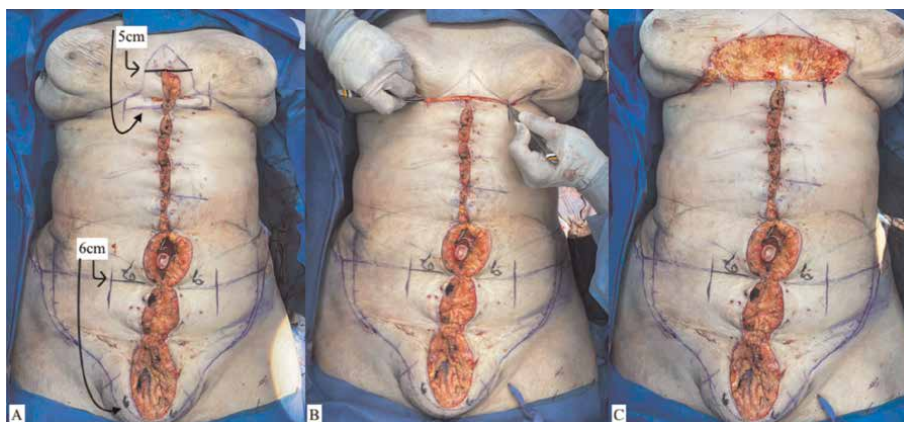


Figure 13. (A) Scarpa's fascia has been re-approximated with #0 Monocryl along the vertical defect while pushing skin edges together to reduce tension along the closure. This layer is reinforced using #2 PDO. Arrows point at the corresponding upper and lower matching transverse lengths made to match the lower chest reference line and lower abdomen reference lines respectively (B) Upper dog ear inferior resection margins assessed using tailor tacking technique (C) Upper dog ear resected.

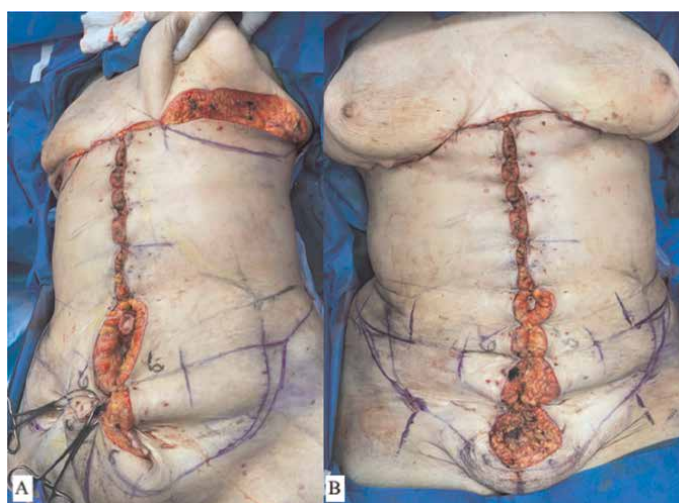


Figure 14. (A) Lateral excess chest skin marking. This resection can extend from one scapula to the other depending on the amount of redundant skin. Dissection is carried in perpendicular to the chest wall along the lower chest reference line to aid in identifying the position of IM fold during closure. Dissection is carried down along the inferior resection margin in an oblique fashion to the skin (away from the upper abdominal flap edge to aid preservation of vascularity of the skin edges). (B) Redundant skin was excised and IM fold has been recreated by suturing deep layer abdominal flap to chest wall followed by superficial layered closure.

23.1 DVT/thromboembolism

One of the most severe potential complications with this procedure is the development of deep vein thrombosis and associated thromboembolism. Factors that contribute to increased risk of thromboembolic events (VTEs) include advancing age, prolonged operative time, elevated BMI, previous history of cancer, previous history of DVTs, or clotting disorders [2].

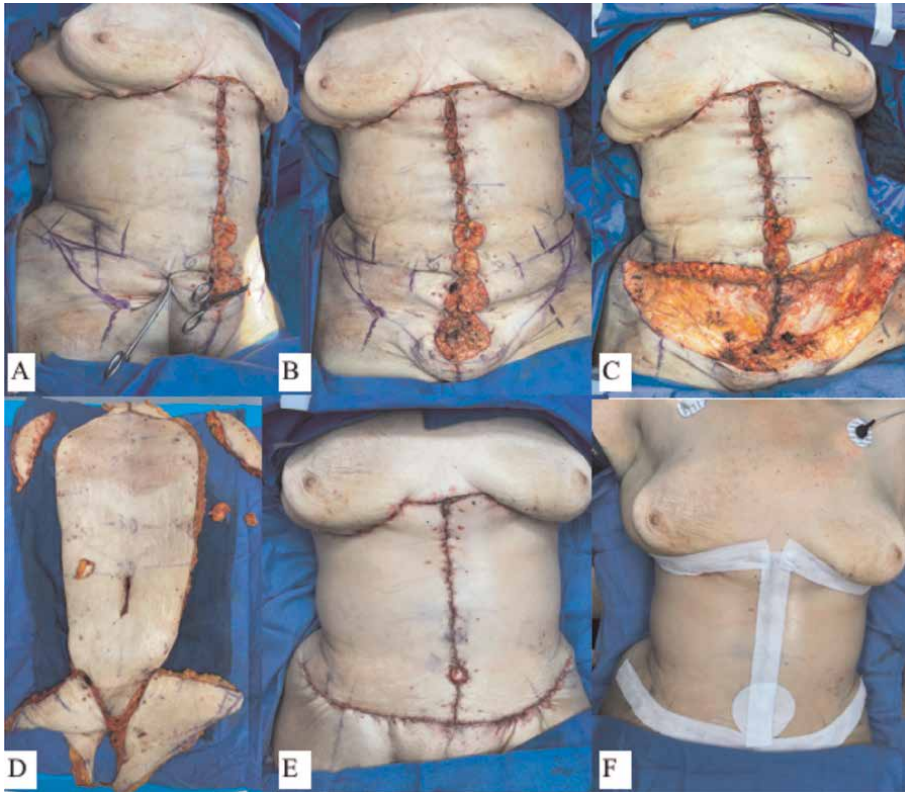


Figure 15.

(A) A tailor-tacking technique is used to identify the lower transverse lines along the abdominal flaps. The overall transverse length is made to match the pubic reference line (B) The lower waistline is addressed by marking the position of the lateral incision. In this case, they are placed high on the hips to enhance the abdominal-to-hip contour (C) Resection is completed. (D) 13 lbs. of skin removed (E) Closure follows the same layered closure of previous incisions starting with deep fascial o Monocryl, #2 PDO, #2-o Quill, #3-o Quill. Umbilicus is inset with 4-o Monocryl Suture. A drain is placed (F) Robins tape along incisions.

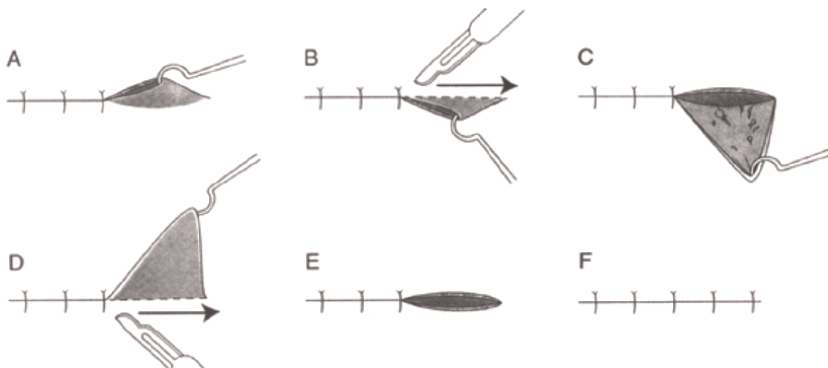


Figure 16.

Dog ear correction technique [11].

- **Management:** Preventive measures are the best course of action to address this potential risk. However, there is no current clear consensus in the literature regarding the course of time of chemoprophylaxis or whether it should be given

preoperatively or postoperatively. In our practice, we measure preoperative hemoglobin and hematocrit and then take this lab value postoperatively as well. This helps us make decisions about the administration of chemoprophylaxis postoperatively. If post-op H/H is within the allowable decrease and the patient is not otherwise showing signs or symptoms of postoperative anemia, we administer 1x chemoprophylactic dose of enoxaparin. Lower Extremity compression socks or pneumatic compression devices are also used in those patients that stay in our facility overnight. Ultimately, it is up to each individual surgeon to assess the risk of each patient who presents for abdominoplasty and determine the use of mechanical and chemoprophylaxis when appropriate.

- Ambulation in the same day of surgery is encouraged and is a regular part of our postoperative abdominoplasty regimen

23.2 Dog ear formation

One of the most common complications in abdominoplasty surgery is the formation of a dog ear at the ends of the lower abdominal scar. To prevent the formation of a dog ear, the surgeon should plan to extend incision/scar as much as possible laterally along the relaxed skin tension lines to maximize a smooth postoperative contour.

- *Management:* If the dog ear does, in fact, form, it can be re-excised under local anesthesia if the area is small or under sedation if the procedure is more involved. (Figure 16, demonstrates one technique to manage dog ear complication).

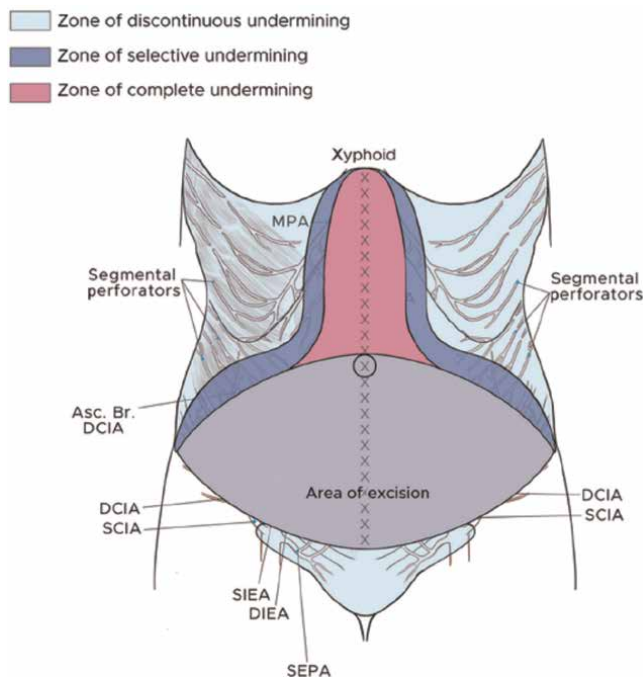


Figure 17.
Undermining should be tailored to esthetic goals while limiting disruption of blood supply from the underlying abdominal wall [12].

- Lateral dog ears can be best avoided intraoperatively by starting out with lateral closure first. Creating a perfect contour at the lateral edges and then adjusting as closure proceeds medially is one way to manage this complication. Another technique is to extend the incision laterally to maximize a straight-line closure.

23.3 Seroma

Fluid accumulation in the dissection spaces to an extent that it causes noticeable fluid waves across the lower abdomen. If the volume of this fluid is excessive, it can cause patient discomfort, pain, and a noticeable unaesthetic appearance. If not addressed, over time, the body may naturally seal off the accumulation of fluid and a formation cyst or abscess can form if infected.

- *Management:* Abdominal drain is an important component to prevent the formation of a seroma. However, if seroma forms subsequent to drain removal, serial aspirations, until seroma resolves, provide adequate treatment. In rare cases, it becomes necessary to temporarily place another drain.
- An abdominal binder in combination with the drain helps prevent seroma formation.
- We limit midline liposuction to the area above the xiphoid region to preserve lymphatics located superior to deep fascia and sub-scarpal. Tourani et al. found that lymphatic drainage of the lower abdomen also lies superficial to Scarpa's fascia in 8 hemi-abdomen specimens from four cadavers. However, a systematic review of four studies (including 630 patients) found that preservation of the Scarpa's fascia (and cutaneous tissues *deep to this layer*) was associated with significantly decreased seroma rate, time to drain removal, drain output, and hospital stay [12]. All of our abdominoplasty patients receive a postoperative day 1 manual lymphatic massage included as part of their surgery packet and are encouraged to continue lymphatic massages at least once a week for 6 weeks after surgery. In our experience, this significantly helps reduce postoperative lymphedema and thereby seroma formation. The physiologic mechanism of lymphatic massage remains unclear, but some sources propose that MLD promotes a decrease in distal lymphatic pressure, enhancing uptake, or that manual lymphatic drainage improves accessory lymphatic routes that enhance lymphatic reuptake [13].

23.4 Delayed wound healing/dehiscence/ischemia

This can be a difficult complication to address depending on the size of the tissue involved. Most of the time, poor wound healing is a result of decreased blood supply to a particular area. The wound edge just above the mons pubis is far from the peripheral blood supply that enters the skin and the soft tissues. This may lead to signs of ischemia that may progress to necrosis over the course of several days.

- *Management:* If an area of poor wound healing is less than 2 cm, the area can often be left to heal by secondary intention [2]. Larger areas are best managed with wet-to-dry dressing changes over a course of 1–2 weeks to allow the wound margins to demarcate. Once the margins are well demarcated, a decision to debride any necrotic tissue is performed. All non-viable tissue should be

removed because it serves as a nidus for infection and impairs wound healing [14]. Daily dressing changes are continued with frequent inspection to ensure adequate healing is taking place. If the wound allows it, retention-type sutures can be placed laterally to reduce the overall size of the defect and facilitate a more rapid closure. In certain cases, a negative pressure wound vac may be useful to allow for faster healing by secondary intention.

- During the elevation of the abdominoplasty flap, superficial inferior epigastric and superficial circumflex iliac artery systems are divided with the creation of the low transverse incision.
- We follow Saldanha's technique of abdominoplasty with selective undermining between the medial borders of the rectus and discontinuing undermining with liposuction in the lateral abdomen to facilitate flap redraping while preserving the perforating blood supply from the deep epigastric vessels. Blood supply to the skin and subcutaneous flap is from intercostal and subcostal segmental perforators. We maintain a minimum flap thickness of 2–3 cm to maximize subdermal plexus preservation (**Figures 17 and 18**) [12].
- Preventive measures to avoid wound breakdown are employed by reducing tension at wound edges. Two key, 2 Vicryl sutures are typically placed medial to inguinal fold and lateral to the midline on each side to approximate Scarpa's to Scarpa's tacked to the underlying rectus fascia. 0-monocryl is then used to reapproximate the remaining Scarpa's to Scarpa's fascia of the abdominal flap

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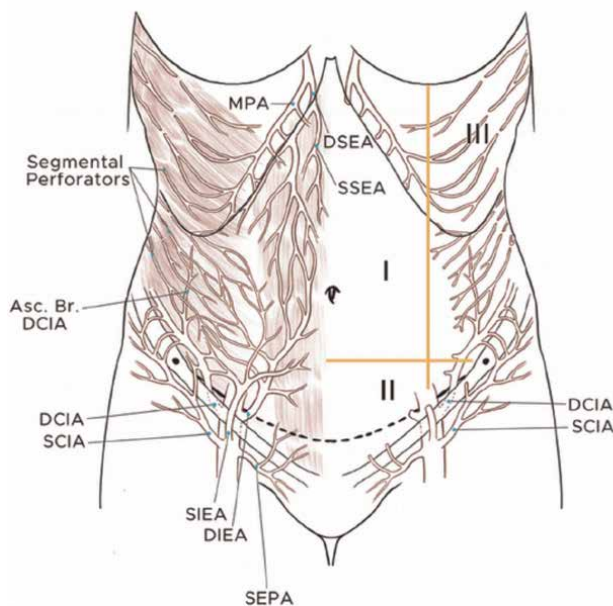


Figure 18. Illustration of Abdominal wall supply according to Huger zones (I, II, III). The right hemi-abdomen represents preoperative anatomy. The left hemi-abdomen represents an expected disruption of the perforating blood supply to the skin and subcutaneous tissue during abdominoplasty [12].

lateral to the inguinal fold. A 3-0 monocryl is then used to approximate the deep dermal layer and a 3-0 monoderm quill is then used in subcuticular fashion. Additionally, ensuring that the patient is in a 30° position when deciding on a superior cut is important to avoid excessive tension.

23.5 Hypertrophic scar

- Can be mitigated by careful closure of deeper tissues. Performing reapproximation of deeper tissues limits widened depressed scars. As mentioned previously we employ key fascial sutures to ensure minimal tension to superficial skin layers.
- The literature supports the use of intralesional triamcinolone acetonide +5-fluorouracil (5-FU) which has been shown to decrease pigmentation significantly faster compared to the administration of intralesional 5-FU or triamcinolone alone [15]. Therefore, we use small volumes of this combination of drugs in areas that may benefit.
- Even though we do everything possible to perform adequate tissue handling and promote postoperative care conducive to minimal scarring, some patients will inevitably form an unaesthetic scar which is revised by excision of skin, and creation of a sharp 90° wound edges with layered closure to support an esthetic result [2].

23.6 Umbilical deformity/necrosis

- We perform rectus plication superior and inferior of umbilicus from xiphoid down to superior pubis. The umbilical stalk is tethered at 6, 3, 9, and 12 o'clock to assist the creation of a pleasing umbilical depression. We avoid excessive tightening of the surrounding rectus fascia in this region of plication. Additionally, we avoid excessive defatting of the periumbilical fat and maintain a wider fatty base to ensure a pyramidal shape to the periumbilical fat.
- If ischemic changes were to ensue, immediate release of superficial dermal sutures should be performed to remove tension. If ischemia occurs, demarcation would be allowed to take place followed by debridement of eschar formation and secondary healing with regular dressing changes to allow stabilization of the wound (Foad).
- To help with the creation of umbilical depression, the senior author sometimes places a small marble or xeroform for a period of time to allow healing in the adequate shape.

23.7 Hematoma

- Meticulous attention to ensuring hemostasis during abdominal flap elevation helps prevent hematoma formation.
- All of our abdominoplasty patients receive abdominal binder; stay in our in-house suite and are examined postoperatively on the day of surgery and then again on the first postoperative day to recognize hematoma.

23.8 Contour irregularity/abdominal wall relaxation

- Epigastric bulging subsequent to abdominoplasty can occur when inadequate plication of rectus muscle in the superior abdominal wall occurs near the xiphoid. To avoid this, we undermine the flap in the midline up to xiphoid to allow complete access for full superior plication.

24. Postoperative care

24.1 Abdominal support and incision care

- Abdominal binder is worn 24 hours a day for 1 week. After 1 week, the binder is replaced with a “faja” best fitted to the patient, which is generally worn for 6 weeks. After 6 weeks, the patient may choose to stop wearing the “faja”.
- Robbins tape is left on for 1 week. At the 1 week postoperative appointment, the tape is replaced with brown paper tape which is left in place for up to five more weeks. Silicone tape is then recommended to be worn whenever feasible for the next 3 months.

24.2 Activity/restrictions

- Week 1:
 - No lifting >10 lbs. Remain flexed at the hip for the first 3 days after surgery. On postoperative day 4, patients may gradually increase extension at the hip when ambulating until they feel tension and holding that position for 30 s, then releasing the tension and re-bending at the waist. This is repeated throughout the day until patients are able to be fully erect.
 - Daily showering using hibiclens soap is allowed.
 - Should avoid heating pads, hot showers, or sunbathing until sensation in abdominal skin is regained to avoid potential burns.
 - Diet should include a minimum of 100 grams of daily protein and plenty of fluids (64 oz./day)
 - Prophylactic antibiotics are continued for 5 days
 - Pt should document drain output- removal when <50 cc/24 hours.
- Week 2:
 - Maintain the same activity restrictions as week 1.
- Week 3–6:
 - Light lower extremity exercises, like walking are permitted. Avoid abdominal muscle exercises for 3 months to protect abdominal wall plication.

25. Cases

25.1 Traditional abdominoplasty case 1



Pre Op: 37F, Weight: 162 lbs., Height: 64", BMI: 27.8.
Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist, and hips.
- Total Fat Removed after Liposuction: 2300 ccs
- Excised Skin Weight: 2.3 lbs.

Post Op Photos: 6 weeks.

25.2 Traditional abdominoplasty case 2



Pre Op: 43F, Weight: 202 lbs., Height: 63", BMI: 35.8.

Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist, hips, and back roll
- Total Fat Removed after Liposuction: 5000 (5300) ccs
- Excised Skin Weight: 5.6 lbs.

Post Op Photos: 6 months.

25.3 Traditional abdominoplasty case 3



Pre Op: 51F, Weight: 145 lbs., Height: 64", BMI: 24.9.

Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist, and hips.
- Total Fat Removed after Liposuction: 1600 ccs
- Excised Skin Weight: 3 lbs.

Post Op Photos: 8 weeks.

25.4 Traditional abdominoplasty case 4



Pre Op: 33F, Weight: 138 lbs., Height: 62", BMI: 25.2.

Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist. (Subcutaneous mastectomy and breast augmentation with silicone implants)
- Total Removed Fat after Liposuction: 200 ccs
- Excised Skin Weight: 1 lbs.

Post Op Photos: 6 weeks.

25.5 Traditional abdominoplasty case 5



Pre Op: 45F, Weight: 116 lbs., Height: 63", BMI: 20.5.

Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist, and hips.
- Total Removed Fat after Liposuction: 950 ccs
- Excised Skin Weight: 1.8 lbs.

Post Op Photos: 8 weeks.

25.6 Traditional abdominoplasty case 6



Pre Op: 48F, Weight: 185 lbs., Height: 69", BMI: 27.3.

Surgery:

- Full Abdominoplasty with associated liposuction to abdomen, waist, hips, and thighs. Simultaneous Breast Mastopexy and Augmentation with silicone implants. J plasma to thighs.
- Total Removed Fat after Liposuction: 4600 ccs
- Excised Skin Weight: 7 lbs.

Post Op Photos: 12 weeks.

25.7 Traditional abdominoplasty case 7



Pre Op: 26F, Weight: 168 lbs., Height: 68 BMI: 30.7.

Surgery:

- Mini Abdominoplasty with associated liposuction to abdomen and waist.
- Total Removed Fat after Liposuction: 2200 cc
- Excised Skin Weight: 1.25 lbs.

Post Op Photos: 6 weeks.

25.8 High lateral tension/extended abdominoplasty case 7



Pre Op: 34F, Weight: 142 lbs., Height: 62", BMI: 26.0, status post previous 120 lbs. weight loss.

Surgery:

- High Lateral Tension/Extended Abdominoplasty with associated liposuction to abdomen and waist after massive weight loss.
- Total Removed Fat after Liposuction: 400ccs
- Excised Skin Weight: 6.8 lbs.

Post Op Photos: 6 months.

25.9 High lateral tension/extended abdominoplasty case 8



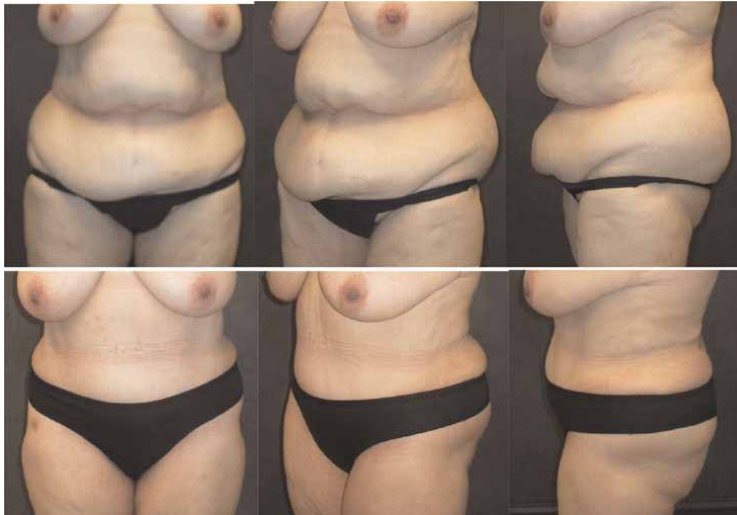
Pre Op: 52F, Weight: 206 lbs., Height: 63", BMI: 36.5.

Surgery:

- High Lateral Tension/Extended Abdominoplasty with associated liposuction to the abdomen and waist.
- Total Removed Fat after Liposuction: 3200 ccs
- Excised Skin Weight: 11.5 lbs.

Post Op Photos: 8 weeks.

25.10 High lateral tension/extended abdominoplasty case 9



Pre Op: 68F, Weight: 140 lbs., Height: 58", BMI: 29.3.

Surgery:

- High Lateral Tension/Extended Abdominoplasty with associated liposuction to the abdomen, waist, and hips
- Total Removed Fat after Liposuction: 1300 ccs
- Excised Skin Weight: 6.0 lbs.

Post Op Photos: 8 weeks.

25.11 Fleur De Lis case 10



Pre Op: 49F, Weight: 230 lbs., Height: 66", BMI: 37.1. Previous hx of emergent cholecystectomy with an abdominal incision.

Surgery:

- Fleur De Lis Abdominoplasty with associated liposuction to abdomen, waist, hips, mid back roll.
- Total Removed Fat after Liposuction: 4900 ccs
- Excised Skin Weight: 13 lbs.

Post Op Photos: 6 weeks.

25.12 Mini abdominoplasty case 11



Pre Op: 58F, Weight: 131 lbs., Height: 64", BMI: 22.5.

Surgery:

- Mini Abdominoplasty with associated liposuction to abdomen and waist.
- Total Removed Fat after Liposuction: 2200 cc
- Excised Skin Weight: 1.25 lbs.

Post Op Photos: 6 weeks.

Video materials

The video materials referenced in this chapter are available for download at the following link: <https://bit.ly/49zzWnS>

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High Definition Liposculpting

Pasquale G. Tolomeo and Manik S. Bedi

Abstract

High-definition liposculpting is an advanced body contouring technique designed to create a sculpted, athletic physique by selectively targeting fat layers and accentuating muscle definition. The advent of technologies like VASER (Vibration Amplification of Sound Energy at Resonance) and Renuvion (a helium plasma and radiofrequency device) has revolutionized this procedure, allowing for precise sculpting and improved definition of the body's contours. Ideal candidates are those seeking a more defined and athletic appearance with an emphasis on muscle visibility and skin tightening. The results yield a more esthetically pleasing silhouette. For optimal outcomes, patients must adhere to proper garment protocols and post-surgical lymphatic massages. Recovery is comparable to traditional liposuction but with the benefit of more dramatic, long-lasting results.

Keywords: high-definition liposuction, HiDef Lipo, Vaser, Renuvion, body sculpting, liposculpting

1. Introduction

A cosmetic surgeon performing high-definition liposculpting must possess both an artistic eye and a deep understanding of muscle anatomy to create a beautifully sculpted body. The artistic element comes into play when shaping the body's contours, as the surgeon must envision the final esthetic outcome, considering how light and shadow will enhance muscle definition. A thorough knowledge of the underlying muscles is crucial to ensure that fat removal highlights the natural curves and lines of the body, emphasizing a toned, athletic appearance [1]. By carefully blending artistry with anatomical precision, the surgeon can achieve a harmonious, balanced physique that looks natural and enhances the patient's overall proportions.

Traditional liposuction techniques have evolved from basic fat removal to more sophisticated contouring procedures aimed at revealing and enhancing the underlying musculature [2]. High-definition liposuction takes body sculpting to the next level, offering patients the possibility of achieving chiseled, athletic bodies. It focuses on strategic fat removal and redistribution to define specific muscle groups such as the abdomen, chest, arms, back, legs, and glutes.

In High-Definition Liposuction, the interplay of light, shadow, contour, and form is fundamental in achieving a sculpted, athletic look. Light and shadow naturally accentuate the body's peaks and valleys, so the surgeon strategically removes

fat to enhance these contrasts, creating the appearance of a more defined muscle structure. By carefully shaping the body's contours, the surgeon highlights natural lines, ensuring a smooth, harmonious flow across areas such as the abdomen, chest, and arms. The precise removal of fat emphasizes the underlying muscle forms, allowing the body's inherent structure to become more prominent. This meticulous attention to how light interacts with the body's curves results in a physique that is not only physically toned but also visually striking, with muscles clearly defined and enhanced.

An essential principle in high-definition liposuction (HDL) is the use of positive and negative spaces to create balance and definition. Positive space refers to areas where muscle bulk or prominence is desired, such as the abdomen, chest, or arms, which are accentuated by removing fat around them, making the muscles stand out more distinctly. Negative space, by contrast, involves selectively removing fat to create depth and separation between muscle groups, enhancing the visual contrast between defined muscles and the surrounding tissue. By balancing these spaces, the surgeon can achieve a dynamic, three-dimensional appearance that results in an athletic, esthetically refined physique. Through the careful manipulation of positive and negative spaces, the body appears naturally contoured, with enhanced muscle visibility and a more appealing, well-proportioned form [2].

The success of HDL relies not just on the surgeon's skill but also on the use of advanced technologies. VASER liposuction provides more control over fat removal, while Renuvion delivers skin-tightening effects that complement fat reduction by addressing skin laxity.

2. High-definition liposculpting

2.1 VASER liposuction

VASER (vibration amplification of sound energy at resonance) liposuction, also known as ultrasound-assisted lipoplasty, uses ultrasound waves to emulsify fat cells, making fat extraction easier during traditional liposuction. The vibration emitted from the cannula breaks down the bonds between fat cells while preserving the surrounding blood vessels, nerves, and connective tissue [3]. This technique enables highly precise fat emulsification, particularly in fibrotic areas such as the male chest and back, where fat tends to be more resistant. VASER allows for targeted fat removal across various layers of the body, giving surgeons the ability to sculpt and accentuate the natural muscle contours for a more refined and defined appearance. Beyond fat emulsification, VASER also promotes skin retraction due to its thermal effects on the dermis, leading to improved skin tightening. Additionally, the technique minimizes blood loss, contributing to a safer and more efficient procedure with smoother recovery [4].

VASER affects adipose tissue through three primary mechanisms: cavitation, mechanical disruption, and thermal energy. Cavitation occurs when ultrasound vibrations in the tumescent tissue create bubbles that expand and eventually burst, causing fat cells to detach from the surrounding fibrous network. Mechanical disruption happens as the tip of the cannula physically contacts and dislodges adipocytes, facilitating their removal. The thermal effect arises when the cannula remains in prolonged contact with fat cells, generating heat that can potentially burn the tissue if not properly controlled [3, 5].

The use of VASER in high-definition liposuction offers numerous advantages. It can be applied to various areas of the body, including the neck, arms, chest, abdomen, back, thighs, flanks, and calves. VASER enables precise removal of superficial fat layers, enhancing natural-looking muscle contours with greater definition. Its selective fat disruption minimizes trauma to surrounding tissues, leading to reduced swelling, bruising, and a faster recovery process. Additionally, the emulsified fat obtained through VASER liposuction is of higher quality, as it undergoes less trauma compared to traditional liposuction methods, which improves its viability for autologous fat transfer procedures [6].

2.2 Renuvion

Renuvion is a device that has greatly changed the game of HDL. Renuvion combines helium plasma with radiofrequency to create a dual-modality approach for skin retraction. The effects of the energy are delivered to the surrounding tissue via two methods: direct contact with the helium plasma and the flow of radiofrequency through the plasma to the tissue.

The flow of energy is through the path of least resistance. When applied to the subdermal plane, Renuvion targets the fibro-septal network (FSN) as opposed to other devices that focus on the dermis [7]. More than 80% of adipocytes are found in the FSN. Targeting these cells potentially has the most effect on soft tissue contraction, which may lead to a volume loss of up to 45% [7, 8]. As the device is advanced along the plane, radiofrequency energy travels through the tissue proximal to the device, creating new paths of distribution leading to a 360-degree soft tissue treatment [7, 9]. The dispersion of energy allows for adequate soft tissue heating while minimizing the depth of thermal spread.

The final results typically become visible around 6 to 9 months post-surgery, once the processes of neocollagenesis and healing are complete. During this time, the body undergoes collagen production and tissue remodeling, which help tighten the skin and refine the contours. As swelling subsides and the skin retracts, the full effects of the procedure, including muscle definition and improved body contours, are revealed.

Combining VASER and Renuvion enhances fat removal precision while addressing skin laxity, resulting in smoother contours and more defined muscle highlights. VASER's emulsification of fat allows for controlled removal, while Renuvion tightens the skin to create a natural, toned appearance. Together, they enable three-dimensional body sculpting, accentuating natural musculature in areas like the abdomen, flanks, and arms for an athletic physique. This combination also offers customizable treatments, allowing for tailored results based on the patient's anatomy and goals, from non-invasive skin tightening to precise fat removal for high-definition contours.

3. Pre-operative planning

The pre-operative consultation is a pivotal step in the high-definition liposculpting process, often shaping the patient's entire experience and setting the foundation for a successful outcome. Given that many patients consult with multiple surgeons before making a decision, it is essential to make a strong, positive impression. The primary goals of the consultation are to thoroughly understand the patient's esthetic goals, gather detailed medical history, conduct a comprehensive physical examination, and provide a clear diagnosis. Surgeons also explain the recommended procedures, along

with their potential risks and benefits. Additionally, this meeting offers a critical opportunity to manage the patient's expectations, helping them understand their condition and the various treatment options available. By ensuring that patients are well informed and have realistic expectations, the consultation plays a key role in preparing them for the procedure and enhancing overall satisfaction with the results.

3.1 Patient evaluation

A thorough pre-operative evaluation is crucial to ensuring the success and safety of any surgical procedure. The process begins by reviewing the patient's medical history and chief complaint, which should be described in the patient's own words to gain a clear understanding of their concerns and expectations. Open-ended questions are particularly effective for helping patients express their goals and worries. The evaluation also includes a detailed review of any medical conditions, current medications (including dosages and frequencies), allergies, and a complete surgical history including previous cosmetic procedures. Social factors, such as the use of tobacco or nicotine products, are vital to assess, as they can impair vascular health and negatively affect wound healing. Additionally, understanding the patient's occupation is essential, as it can influence post-operative restrictions and recovery plans.

The ideal candidate for HDL using VASER and Renuvion is an individual in good physical health who is near their ideal body weight. This procedure is best suited for individuals seeking enhanced muscle definition. Additionally, candidates with mild to moderate skin laxity can benefit from the skin-tightening effects provided by Renuvion, which works synergistically with VASER. Those patients who have unrealistic expectations are not candidates for HDL.

3.2 Patient examination

At this stage, the patient's overall body shape and appearance are carefully evaluated. Ideal candidates for HDL are individuals with localized fat deposits resistant to diet and exercise, coupled with well-developed underlying muscle anatomy. Patients with a body mass index under 30 are generally considered optimal candidates for this procedure. The assessment also includes screening for any skeletal abnormalities that could become more noticeable after fat removal, ensuring the results remain esthetically balanced.

The skin is then evaluated for scars, stretch marks (striae), and laxity. A pinch test is conducted to determine both the amount of fat available for resection and the degree of skin elasticity. Special attention is given to the abdomen, where any protrusion might indicate rectus diastasis or excessive intra-abdominal fat. In such cases, liposuction alone may not suffice to achieve a flat abdomen, and additional procedures may be required. Scars along the body are also assessed to identify any potential complications during or after the surgery, ensuring a smooth operative process and recovery.

3.3 Patient discussion

Both the patient and the surgeon must acknowledge that the human body is inherently asymmetric, and achieving perfect symmetry is rarely possible. It is the surgeon's responsibility to align the patient's desires with realistic, medically sound outcomes, ensuring that expectations are balanced with what can be safely achieved.

During the consultation, patients are encouraged to actively communicate their concerns and desired results. An informed patient, who understands the indications for specific procedures as well as the limitations and potential complications, is better prepared for the surgical journey. This open dialog fosters a strong surgeon-patient relationship, ensuring both parties are aligned in their goals, which contributes to a satisfying and realistic esthetic outcome.

3.4 Surgical preparation

Before surgery, patients must attend a pre-operative appointment to review the proposed treatment plan and consent forms including all associated risks and benefits. During this time, pre- and post-operative instructions are thoroughly discussed, such as stopping the intake of foods, supplements, and medications that may increase the risk of intra-operative bleeding, starting 2 weeks before surgery. Patients are advised to quit smoking at least 4 weeks before surgery and continue avoiding it for 3 months after to promote healing. Additionally, discontinuing birth control or hormone therapy 2 weeks before and after surgery helps reduce the risk of blood clots.

The appointment also covers the post-operative care plan, including the proposed schedule for manual lymphatic drainage and the proper use of compression garments, both of which are essential for optimal recovery and shaping results. Pre-operative photos are taken for documentation and comparison to assess the progression of results post-surgery. This thorough pre-operative preparation ensures the patient is well-informed and positioned for the best possible surgical outcome.

4. Pre-operative markings for male high-definition liposuction

Pre-surgical markings are essential for achieving optimal results in HDL. These markings guide the surgeon in highlighting the natural musculature while removing excess fat to create a sculpted, athletic look. On the day of surgery, the patient is marked in an upright position to ensure that natural body alignment is accurately reflected. Markings for male and female patients vary due to differing esthetic goals. Typically, men seek a sharper, more defined appearance, while women prefer softer contours.

The process begins with a thorough evaluation and palpation of the underlying musculature, which forms the foundation for the procedure. This initial assessment ensures that markings are precisely placed to enhance the natural muscle contours. Below is a step-by-step guide to the pre-operative markings for male HDL, focusing on the abdomen, chest, back, and arms.

4.1 Abdomen

The main goal of abdominal HDL is to enhance the appearance of the rectus abdominis and oblique muscles to create a defined, athletic core (**Figure 1**).

4.1.1 Anatomical landmarks

- i. Linea alba: vertical line from the xiphoid process of the sternum to the pubis.
- ii. Semilunar lines: lateral borders of the rectus abdominis muscle that separate from the external obliques.

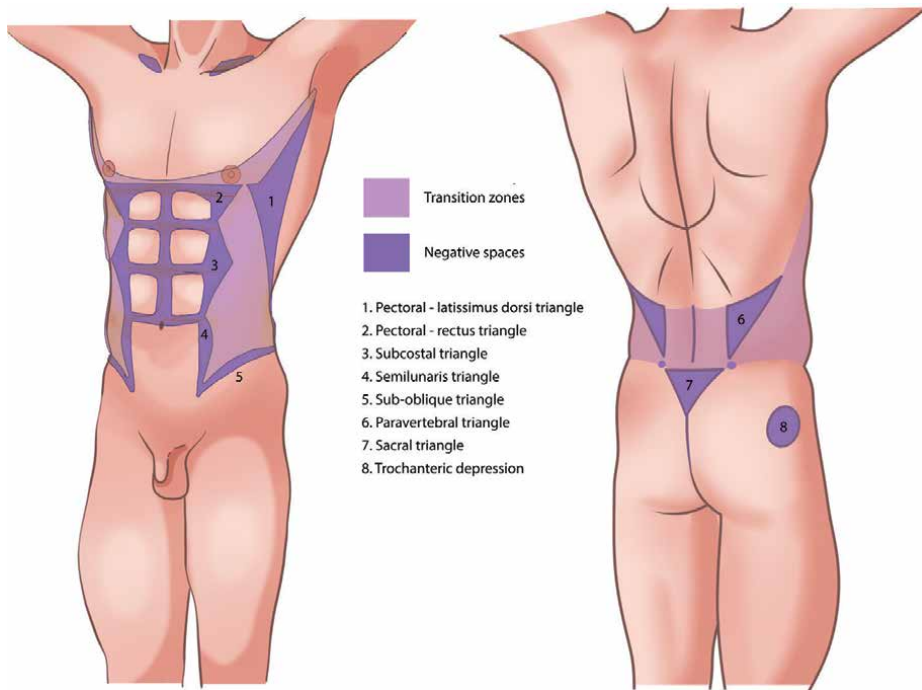


Figure 1. Negative and transition zones for the male abdomen/Torso/back HDL [2]. Dark purple- negative space, light purple- deep fat extraction.

iii. Bellies of the rectus abdominis muscle: muscular intersections that form the six-pack look.

iv. Anterior superior iliac spine (ASIS): starting points for the V-line along the lower abdomen; enhances the lower abdominal contour and tapers the waist.

v. Inguinal ligament: runs from the ASIS to the pubic tubercle and defines the lower border of the V-line.

4.1.2 Surgical markings

a. The costal margins are marked bilaterally as the patient inhales deeply; this will mark out the cartilaginous thoracic arch.

b. Identify and mark the xiphoid process and the anterior superior iliac spines.

c. Mark the linea alba along the midline from the xiphoid process to the supraumbilical area; no vertical mark is made below the umbilicus along the midline.

d. Mark the lateral border of the rectus abdominis; have the patient contract to assess the position of each belly of the rectus muscle and mark the intra-belly grooves.

e. Identify the transverse and oblique muscles bilaterally.

- f. Mark the V-line by drawing from the ASIS down to the pubic area.
- g. Mark the oblique lines following the natural slope of the external obliques, extending from the lateral ribcage down toward the ASIS.

4.1.3 Negative spaces: These areas form the shadows of the superficial anatomy

- a. Sub-oblique triangle – region between the external obliques and transverse muscles
- b. Subcostal triangle – region below the rib cage
- c. Supraumbilical area following the midline
- d. The region between the transverse inscriptions of the rectus muscle
- e. Pectoral- rectus triangle- region between the supero-lateral border of the rectus abdominis and lower border of the pectoralis major
- f. Pectoral- latissimus dorsi triangle- region between the lateral border of the pectoralis major and anterior border of the latissimus dorsi

4.2 Chest

For male HDL of the chest, the goal is to enhance the pectoral muscles, creating a firm, masculine contour while reducing fat deposits that may cause gynecomastia (excess breast tissue) (**Figure 2**).

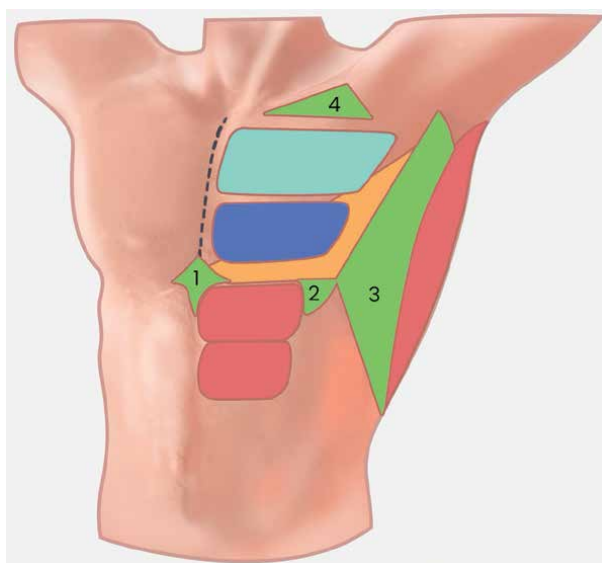


Figure 2. Surgical landmarks and negative zones for the male chest HDL [2]. 1. Interpectoral rhomboid, 2. Subpectoral triangle, 3. Pectoralis-latissimus dorsi triangle, 4. Subclavicular triangle, orange-pectoral region for deep fat extraction, green- negative zone.

4.2.1 Anatomical landmarks

- a. Sternal midline: vertical line in the center of the chest.
- b. Inferior pectoral border: inferior edge of the pectoralis major muscle.
- c. Lateral pectoral margin: outer edge of the pectoralis muscle that abuts the deltoid and anterior axillary fold.
- d. Clavicular line: superior aspect of the pectoralis muscle along the clavicle.

4.2.2 Surgical markings

- a. Mark a vertical line along the sternal midline.
- b. Mark the inferior border of the pectoralis muscle, extending from the sternal border to the axilla.
- c. Mark the lateral margin of the pectoralis muscle as it extends into the deltoid and axilla.
- d. Mark the clavicular border of the pectoralis muscle to define the upper definition.

4.2.3 Negative spaces

- a. Pectoralis-latissimus dorsi triangle- region between the anterior border of the latissimus dorsi and the lateral border of the pectoralis major
- b. Inferior pectoral triangle- region between the inferior border of the pectoralis and the lateral border of the rectus abdominis
- c. Pectoral line- lower border of the pectoralis major
- d. Interpectoral rhomboid- region between the medial aspect of the inferior pectoralis muscles and the bellies of the rectus abdominis
- e. Subclavicular triangle- region between the clavicle and upper border of the pectoralis muscle.

4.3 Back/torso

The male back is a significant area for HDL, focusing on accentuating the V-shape that is synonymous with a strong, masculine build. The areas of focus include the latissimus dorsi, trapezius, and lower back (**Figure 3**).

4.3.1 Anatomical landmarks

- a. Spinous processes: midline of the spine
- b. Inferior scapular border: lower edge of the scapula; assists with marking the latissimus dorsi

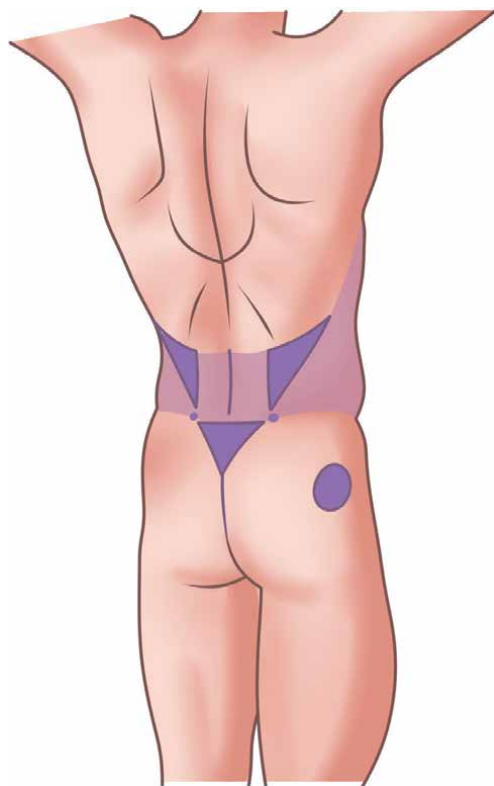


Figure 3.
Negative and transition zones for the male back HDL [2]. Light purple- fat extraction, dark purple- negative zone.

- c. Posterior axillary fold: marks the lateral extent of the latissimus dorsi
- d. Iliac crest: upper border of the pelvis

4.3.2 Surgical markings

- a. Mark the spinous process along the midline to assist with symmetrical fat removal.
- b. Mark the lateral border of the latissimus dorsi muscles bilaterally; the upper border begins at the inferior scapular border and extends down toward the axillary fold. The inferior portion of the muscle extends down toward the iliac crest.
- c. Outline the bony borders of the scapulae.
- d. Mark the lower back, following the natural V-shape created by the tapering of the latissimus dorsi to the iliac crest.

4.4 Arms

Defining the arms through HDL involves enhancing the contours of the deltoids, biceps, and triceps to create a strong, athletic look (**Figure 4**).

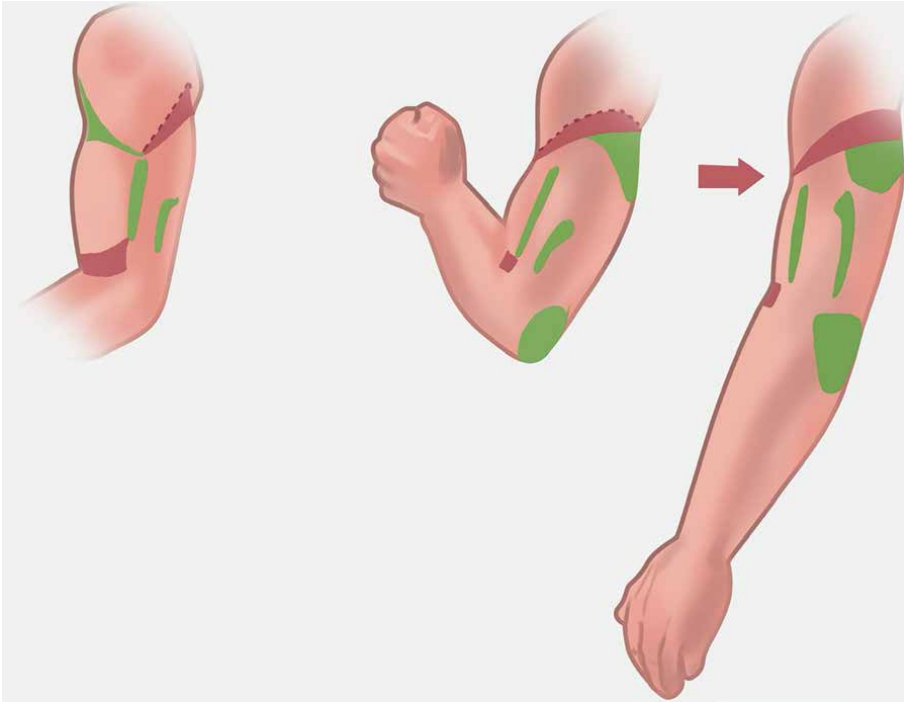


Figure 4. Dynamic and negative zones for the male arm HDL [2]. Red zone- dynamic muscle movement, green zone- negative zone. Negative zone- bicipital groove, tricipital tendon and posterior triceps.

4.4.1 Anatomical landmarks

- a. Deltoid insertion: tapering of the deltoid muscle into the upper arm.
- b. Biceps groove separation between the bicep and triceps muscles.
- c. Lateral and long heads of the triceps: major muscle group forming the posterior arm.

4.4.2 Surgical markings

- a. Mark the borders of the deltoid muscle, extending from the acromion process to the insertion into the upper arm.
- b. Mark the separation between the bicep and triceps muscles.
- c. Mark the lateral and long heads of the triceps along the posterior aspect of the arm.

5. Pre-operative markings for female high-definition liposuction

Pre-operative markings are a critical step in high-definition liposuction for women. These markings guide the surgeon in sculpting the body to enhance feminine

contours while reducing excess fat. Women typically seek a softer, more contoured appearance compared to the sharp, etched lines preferred by men. Markings for the torso, abdomen, chest, back, hips, breasts, and arms must reflect the patient's anatomical structure and esthetic goals, emphasizing natural curves and smooth transitions between regions.

The process starts with a comprehensive evaluation and palpation of the underlying musculature, which serves as the blueprint for the procedure. This critical assessment allows for precise placement of pre-operative markings, ensuring that natural muscle contours are highlighted and enhanced. What follows is a detailed, step-by-step guide to the pre-operative markings for female high-definition liposuction, focusing on the abdomen, breasts, hip, back, and arms.

5.1 Abdomen/torso

The primary goal for the female torso and abdomen in HDL is to sculpt a lean, toned core while maintaining a natural, soft, and feminine appearance (**Figure 5**). The objective is to create a narrower waist and subtly define the abdominal muscles, without over-emphasizing muscle definition.

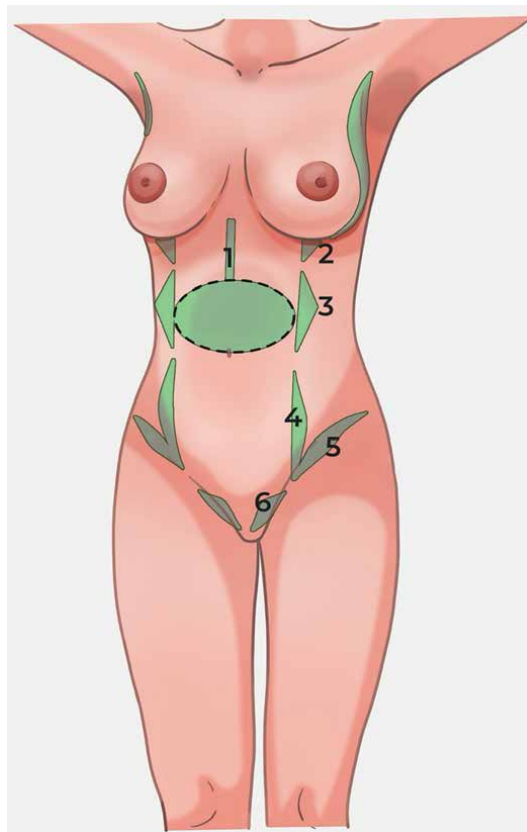


Figure 5. Negative zones for the female abdomen HDL [2]. 1. Midline, 2. Submammary triangle, 3. Subcostal triangle, 4. Semilunaris triangle, 5. Sub-oblique triangle, 6. Pubis triangle.

5.1.1 Anatomical landmarks

- a. Linea alba: central vertical line extending from the xiphoid process to the pubis.
- b. Semilunar lines: lateral borders of the rectus abdominis, separating it from the obliques.
- c. Umbilicus: natural center of the abdomen, around which markings should harmonize.
- d. Anterior superior iliac spines (ASIS): landmarks for marking the lower abdomen and waist.

5.1.2 Surgical markings

- a. Mark the linea alba from the xiphoid process to the pubic area.
- b. Mark the lateral borders of the rectus abdominis, tapering these lines into the ASIS.
- c. Draw curving lines from the lateral ribcage down toward the ASIS to emphasize the hourglass shape.
- d. Mark the oblique lines with gentle curves extending from the lateral ribcage toward the iliac crest. In women, these lines are often softer and less pronounced than in men.
- e. Mark the area around the umbilicus to maintain its natural position.

5.1.3 Negative spaces

- a. Midline space.
- b. Subcostal space- located below the rib cage, this area should be highlighted to enhance the waist.
- c. Semilunaris triangle- region between the semilunaris and inguinal ligament.
- d. Sub-oblique triangle- inferior to the external oblique muscle.
- e. Pubic triangle- wedge area to improve the pubic angle.

5.2 Breast

When performing HDL on the female chest and breasts, the goal is to enhance natural curves while avoiding a masculine, overly defined appearance. Care must be taken to preserve the natural softness of the breasts while defining the surrounding contours.

5.2.1 Anatomical landmarks

- a. Midline: vertical line that bisects the chest.
- b. Inframammary fold: inferior boundary of the breast.

- c. Lateral breast margin: lateral edge of the breast.
- d. Clavicle: superior boundary of the chest.

5.2.2 Surgical markings

- a. Mark a vertical line down the center of the chest.
- b. Mark the inframammary fold to ensure that fat removal does not disrupt the natural shape and position of the breasts.
- c. Outline the lateral breast margin where it blends into the chest and axilla to avoid removing fat that could flatten the upper chest.
- d. Mark the clavicle to maintain the upper chest contour, especially in cases where fat removal near the clavicle is required to create a smoother transition to the shoulders.

5.2.3 Negative spaces

- a. Sub-clavicular Triangle- space between the clavicle and the upper breast area, which should be left intact for a natural slope.
- b. Inframammary Triangle- area beneath the breast should retain volume to ensure a natural, curved breast contour.

5.3 Back

For female patients, the back should be contoured to enhance the natural curves and accentuate the waistline. Pre-operative markings ensure that excess fat is removed from the upper and mid-back, creating a smooth, feminine silhouette.

5.3.1 Anatomical landmarks

- a. Spinous processes: midline of the spine, serving as the central axis for symmetry.
- b. Inferior scapular borders: lower edges of the scapulae, important for marking the lateral extents of the upper back.
- c. Posterior axillary fold: lateral edge where the back blends into the arms and latissimus dorsi.
- d. Iliac crest: upper boundary of the pelvis and lower back.

5.3.2 Surgical markings

- a. Mark the spinous process along the midline from the cervical to the lumbar spine for symmetrical fat removal.
- b. Mark the lateral borders from the inferior scapular edge down toward the iliac crest.

- c. Mark the scapulae to maintain natural muscle contours and avoid over-resection.
- d. Mark the natural curve of the lower back, enhancing the feminine hourglass shape by tapering toward the waistline.

5.3.3 Negative spaces

- a. Thoracic triangle: area below the scapula and above the waistline that enhances the V-shape of the back.
- b. Lower lumbar triangle: region between the spine and the iliac crest, which, when accentuated, enhances the waist-to-hip ratio.

5.4 Hips and buttocks

One of the most important areas for female HDL is the hips and buttocks, where the goal is to create a curvaceous and lifted appearance (**Figures 6 and 7**). The pre-operative markings focus on accentuating volume in the buttocks while contouring the hips to create an hourglass silhouette.

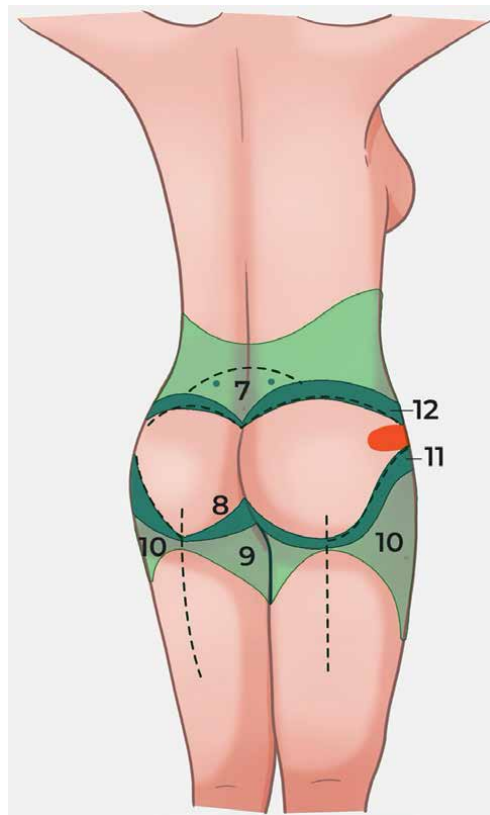


Figure 6. Negative and transition zones for the female back and gluteal region HDL [2]. 7. Sacral triangle, 8. Internal gluteal angle, 9. Inner thigh triangle, 10. Outer thigh zone, 11. Lateral inferior gluteal Transition zone, 12. Lateral superior gluteal Transition zone.

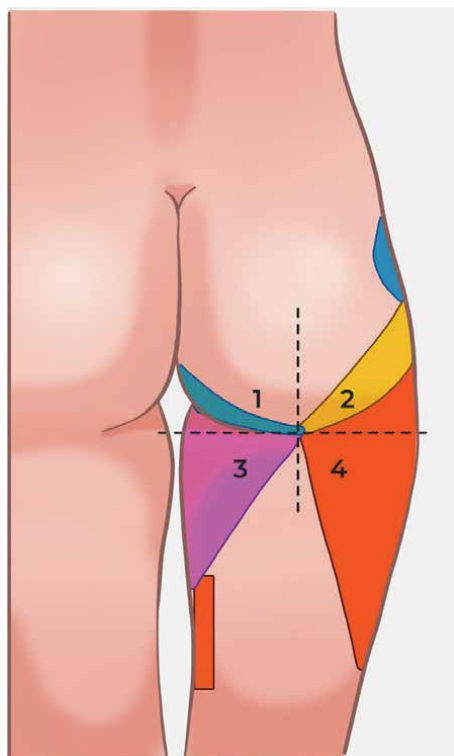


Figure 7.

Zones for the female inferior gluteal region HDL [2]. 1. Lower internal gluteal, 2. Lower external gluteal, 3. Inner thigh, 4. Outer thigh, 5. Blue arrow- zone of adhesion. Liposuction may be performed in these regions to accentuate the gluteal region. Liposuction is to be avoided along the middle inner thigh (blue arrow).

5.4.1 Anatomical landmarks

- a. Iliac crest: upper boundary of the hips.
- b. Greater trochanter: upper lateral edge of the femur, marking the widest point of the hips.
- c. Gluteal fold: natural crease at the inferior border of the buttocks.

5.4.2 Surgical markings

- a. Mark the natural inward curve of the waist and the outward curve of the hips, emphasizing the hourglass figure.
- b. Outline the buttocks, ensuring the central and upper regions retain volume while lower fat is reduced to create a lifted appearance.
- c. Mark the natural gluteal fold to ensure the area remains smooth and defined, avoiding an over-reduced or flattened look.
- d. Mark the lateral edges of the hips to sculpt them in a way that maintains fullness and creates a smooth transition between the buttocks and thighs.

5.4.3 Negative spaces

- a. Lateral hip curve: space below the iliac crest and above the greater trochanter, where the transition from waist to hips is emphasized.
- b. Posterior hip dip: area where fat is often preserved to avoid flattening the hips and buttocks.
- c. Lateral hip hollow: mark this area carefully to ensure it remains smooth, without excessive fat removal, preserving the curvature of the hips.
- d. Sub-gluteal triangle: area just below the buttocks, where fat removal should be minimized to prevent the appearance of sagging.

5.5 Arms

HDL of the arms in women focuses on slimming the arms while enhancing the natural curves of the deltoid, biceps, and triceps. The aim is to create a toned but not overly muscular appearance (**Figure 8**).

5.5.1 Anatomical landmarks

- a. Deltoid insertion: point where the deltoid tapers into the upper arm.
- b. Biceps-triceps groove: natural separation between the biceps and triceps muscles.
- c. Medial arm border: inner aspect of the arm, which should remain soft and smooth.

5.5.2 Surgical markings

- a. Mark the deltoid muscle from the acromion to its insertion into the upper arm, preserving the natural curve of the shoulder.
- b. Mark the groove separating these muscle groups to enhance arm definition.

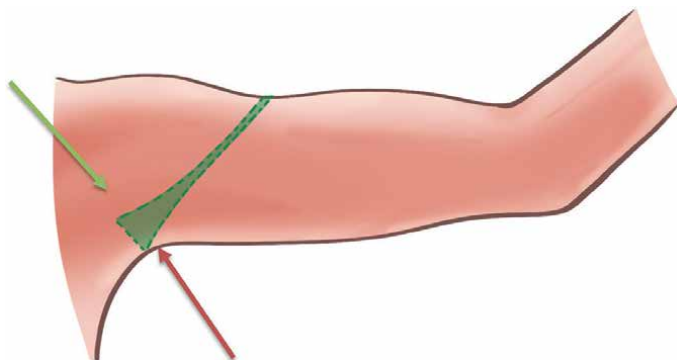


Figure 8. Zones for the female arm HDL [2]. The negative zone is a curved triangle located between the posterior axillary crease (red arrow) and the insertion of the deltoid (green arrow).

- c. Avoid marking the medial arm for aggressive fat removal, as this area should maintain a smooth, soft contour.

5.5.3 Negative spaces

- a. Deltoid triangle: space around the deltoid muscle that enhances shoulder curvature.
- b. Posterior triceps groove: space behind the triceps that, when subtly accentuated, helps define arm tone without creating an overly muscular look.

6. Surgical procedure

6.1 Tumescence anesthesia

Tumescence anesthesia is crucial for high-definition liposuction, enhancing both the safety and effectiveness of the procedure while significantly reducing discomfort for the patient. This technique utilizes a solution containing lidocaine, which provides localized pain control, and epinephrine, combined with tranexamic acid, to reduce bleeding and minimize post-operative bruising [10].

In addition to controlling pain and reducing bleeding, tumescence fluid plays a vital role in fat removal. By causing the fat cells to swell and become firm, it makes the fat easier to extract with less trauma to surrounding tissues. This gentler extraction process allows for greater precision in contouring and reduces the risk of damage to nerves, blood vessels, and connective tissue.

Overall, tumescence anesthesia significantly decreases trauma to surrounding tissues, minimizes blood loss, and accelerates the healing process. Patients benefit from a faster recovery, with less post-operative pain, swelling, and bruising, making the procedure more efficient and enhancing overall patient outcomes.

The author utilizes a tumescence anesthesia solution composed of 1000 cc of Lactated Ringer's, 1 mg of epinephrine, 250 mg of tranexamic acid, and 20 cc of 1% lidocaine. The generally accepted maximum safe dosage of lidocaine for tumescence anesthesia is 35 to 55 mg per kilogram of body weight, providing effective pain control while maintaining patient safety [11]. Additionally, the author follows a 1:1 ratio of tumescence anesthesia to the planned amount of fat removal; using a 1:1 ratio will decrease the excess stretch of the FSN which may lead to increase skin laxity.

Infiltration of the tumescence anesthesia is performed via surgical planned incisions. Hidden entry points are paramount to the HDL technique. The surgical area is first infiltrated with tumescence anesthesia along the deep layer, followed by infiltration into the superficial layer. This approach ensures that the anesthesia stays concentrated in the superficial layer, keeping it adequately hydrated throughout the procedure. Maintaining moisture in the superficial layer is essential during the emulsification stage as it facilitates more efficient fat breakdown and removal while also minimizing trauma to the surrounding tissues and promoting smoother contouring results.

6.2 Emulsification with Vaser

The emulsification process begins with the use of VASER technology along the superficial fat layer. The surgeon employs a 3-ring probe to initiate this process, with

the VASER power setting adjusted based on the quality of the fat and the fibrous connective tissue. The author starts at 70% power in pulsed mode to minimize the risk of excessive heat damage to the skin. The VASER probe is used until the treated area feels smooth and free of resistance, indicating proper emulsification.

Next, the deep fat layer is treated with careful attention to keeping the probe superficial to the muscle to prevent any unintended damage to the underlying muscle tissue. This technique also ensures complete emulsification of the deep fat layer.

Once all the planned treatment areas have been addressed and both the superficial and deep layers feel smooth with minimal resistance, aspiration of the emulsified fat is performed, effectively removing the loosened fat and completing the contouring process.

6.3 Aspiration of fat

The author approaches the body from a bottom-to-top sequence. The author employs a 4-mm cannula to assist with the deep fat extraction. During liposuction, it is important for the surgeon to use one's non-dominant hand to always identify and locate the cannula tip to ensure proper positioning.

The goal of deep fat layer aspiration is to achieve a flap thickness of 0.5-1 cm. While aspirating the fat, the surgeon should minimize damaging the subdermal plexus by utilizing a cannula with openings that face away from the dermis and skin.

Once adequate fat has been aspirated from the deep layer, attention is turned to the superficial layer. The author employs a 3-mm cannula to begin this process. The aim of superficial liposuction is to develop the framing of the HDL. Along the previously marked lines, the skin is pinched, and aggressive liposuction is performed. The main areas to be treated are the surgical lines and negative spaces. While performing superficial liposuction, the surgeon must follow the natural contour of the muscle and bony framework to avoid achieving a "fake" look. Upon completion of the superficial fat aspiration, one can appreciate the proper depressions and convex contours.

The author approaches the body using a bottom-to-top sequence, beginning with deep fat extraction using a 4-mm cannula. Throughout the liposuction process, it is essential for the surgeon to use their non-dominant hand to continuously locate and identify the tip of the cannula, ensuring proper positioning and minimizing the risk of inadvertent damage.

The goal of deep fat layer aspiration is to achieve a flap thickness of approximately 0.5 to 1 cm. During fat aspiration, the surgeon must take care to avoid damaging the subdermal plexus by using a cannula with openings that face away from the dermis and skin, preserving the integrity of the overlying tissue.

Once sufficient fat has been aspirated from the deep layer, the focus shifts to the superficial layer. For this phase, the author utilizes a 3- and 3.5-mm cannula to begin sculpting and refining the contours. The objective of superficial liposuction is to frame the high-definition liposuction results, following the previously marked lines. The skin is pinched and targeted, and aggressive liposuction is performed along the surgical lines and in the negative spaces to enhance muscle definition and body contours.

When performing superficial liposuction, the surgeon must follow the natural contours of the muscles and bony framework to achieve an authentic, sculpted look, avoiding an unnatural or "fake" appearance. Upon completion of the superficial fat aspiration, the desired depressions and convex contours become visible, highlighting the refined and well-proportioned body silhouette.

Surgeons are strongly advised to avoid excessive subdermal liposuction, as this can significantly increase the risk of complications. Over-aggressive fat removal in this

area can lead to a higher likelihood of seromas, contour irregularities, and damage to the subdermal plexus. Such damage compromises blood supply and tissue integrity, which can result in poor healing, increased scarring, and uneven skin contours. Maintaining a conservative approach in the subdermal layer is essential to preserving the overall health of the skin and achieving smooth, esthetically pleasing results.

6.4 Renuvion therapy

Upon completion of liposuction, it is crucial for the surgeon to ensure that no surface irregularities remain. Any noticeable skin inconsistencies, aside from the intentionally planned depressions, are addressed by the author using a 4-mm cannula in an off-suction mode. This technique is employed to blend and smooth the treated areas, ensuring a natural and even contour.

Following this, Renuvion therapy is applied to the FSN to further enhance skin tightening. The author utilizes a precise approach, performing three anterograde and retrograde passes over each treated area, with the device set to 75% power and a flow rate of 1.5 L/min. Each pass is spaced 1 cm apart to ensure uniform coverage and optimal tightening of both the superficial and deeper layers of the fibrous tissue. This controlled application provides consistent results, improving skin firmness and enhancing the overall esthetic outcome.

The combination of meticulous liposuction techniques and advanced skin tightening with Renuvion therapy offers a comprehensive approach to body contouring. By carefully addressing skin irregularities and applying plasma energy to stimulate tissue contraction, this method allows surgeons to achieve smooth, natural contours with enhanced skin tightening. Proper attention to technique ensures minimal complications, optimal esthetic results, and a quicker recovery, ultimately improving patient satisfaction.

7. Post-operative care

While the success of the surgery depends heavily on the surgeon's skill, post-operative care plays an equally crucial role in ensuring optimal results, minimizing complications, and promoting a smooth recovery.

7.1 Compression garments

One of the most critical components of post-operative care following high-definition liposuction is the use of compression garments. These garments apply consistent external pressure to the treated areas, offering several key benefits that enhance recovery and overall results:

1. *Reduction of swelling*: Compression garments help manage post-surgical swelling by applying evenly distributed pressure, which reduces fluid accumulation and promotes quicker resolution of edema.
2. *Skin retraction*: The applied pressure encourages the skin to adhere properly to the underlying tissue, facilitating smooth retraction and preventing sagging or irregularities in the skin.
3. *Improved circulation*: Controlled pressure from the garments enhances blood circulation, minimizing bruising and accelerating the body's natural healing processes.

4. *Support and comfort*: Compression garments provide essential support to the treated areas, reducing post-operative discomfort, and lowering the risk of complications such as seroma formation (fluid pockets). This support helps patients feel more comfortable and secure during their recovery.

Patients are instructed to wear compression garments according to their surgeon's recommendations, with the author advising the following schedule: wear the ****faja**** (compression garment) for 23 hours a day during the first month, followed by 12 hours a day during the second and third months. For optimal results, it is essential that the compression garment fits properly. It should be snug, providing firm support, but not overly tight. Excessive compression can compromise blood flow, potentially leading to tissue ischemia, while insufficient compression may delay healing and hinder skin retraction.

Maintaining proper hygiene, both in the garment and the skin, is crucial to preventing infections. Patients should be instructed to clean the garment regularly and ensure that the skin remains clean and dry under the garment.

To enhance post-operative compression, foam pads can be placed under the garment. Foam dressings help distribute compressive forces evenly, improving skin stabilization and contouring [12]. Patients should be advised to ensure that the skin is smooth and flat when applying the foam and garment to prevent any folds or creases in the skin, which can result in unwanted pressure marks or irregular healing.

7.2 Manual lymphatic drainage

Manual lymphatic drainage (MLD) is a specialized massage technique designed to stimulate the lymphatic system, reduce swelling, and promote healing after high-definition liposuction (HDL). By facilitating the movement of lymphatic fluid, MLD helps drain excess fluid and metabolic waste that has accumulated in the treated areas, significantly reducing post-surgical swelling. This drainage process also assists in the clearance of blood from surgical sites, which helps diminish bruising [13–15].

Two major benefits of MLD are the prevention of fibrosis and relief from pain. By continuously draining fluid from the tissues, MLD helps prevent the development of fibrosis (hardening of tissue) and supports the regeneration of healthy tissue. Additionally, the removal of fluid reduces tension on the skin, alleviating discomfort and minimizing post-operative pain [13–15].

The author recommends beginning MLD the day after surgery, with a schedule of two to three sessions per week during the first month, followed by one to two sessions per week during the second month. It is important to note that MLD is not the same as a deep tissue massage. It involves light, rhythmic movements designed to gently propel lymphatic fluid toward the lymph nodes, ensuring optimal drainage and promoting recovery without applying intense pressure to the treated areas.

7.3 Physical activity

Post-operative activity plays a crucial role in ensuring a rapid and successful recovery following high-definition liposuction. Patients are instructed to avoid heavy lifting and strenuous activities for the first 2 weeks after surgery to minimize stress on healing tissues. However, early ambulation is strongly encouraged, as walking immediately after surgery helps improve blood circulation, reducing the risk of blood clots (deep vein thrombosis) and promoting the healthy functioning of the lymphatic system, which aids in reducing swelling and fluid retention [16, 17].

After 2 weeks, patients can gradually resume light physical activity, including walking, slow jogging, and body weight exercises. At the 4-week mark, and if healing is progressing appropriately, patients are cleared for low-impact activities such as treadmill walking, cycling, and light weightlifting. By 6 weeks, most patients are cleared for all physical activities, assuming they have recovered without complications [16–18].

It is important for patients to listen to their bodies throughout the recovery process. Since each individual heals differently, patients should avoid activities that cause pain or discomfort and should wait until they are more fully recovered before resuming those activities. Additionally, as physical activity increases, so may fluid buildup in the treated areas. To manage this, the continued use of compression garments and manual lymphatic drainage (MLD) is recommended to reduce fluid accumulation and support proper healing.

7.4 Incision management

The author opts to avoid the placement of drains following high-definition liposuction (HDL). Instead, patients are instructed to maintain the patency of the liposuction incisions by using a Q-tip soaked in hydrogen peroxide or polysporin. This approach may help reduce the risk of surgical site infections by keeping the small incisions clean and preventing the buildup of bacteria. Additionally, keeping the sites open helps facilitate fluid drainage, reducing the risk of seroma formation [19, 20].

Patients are advised to open the liposuction sites three times a day for the first 2 weeks after surgery. This regular maintenance not only ensures the continued drainage of excess fluid but also helps prevent the early closure of the incision sites, which can lead to fluid accumulation and other complications. By following these guidelines, patients can effectively reduce the risk of seroma formation and promote proper healing [19, 20].

8. Results

See **Figures 9–17**.

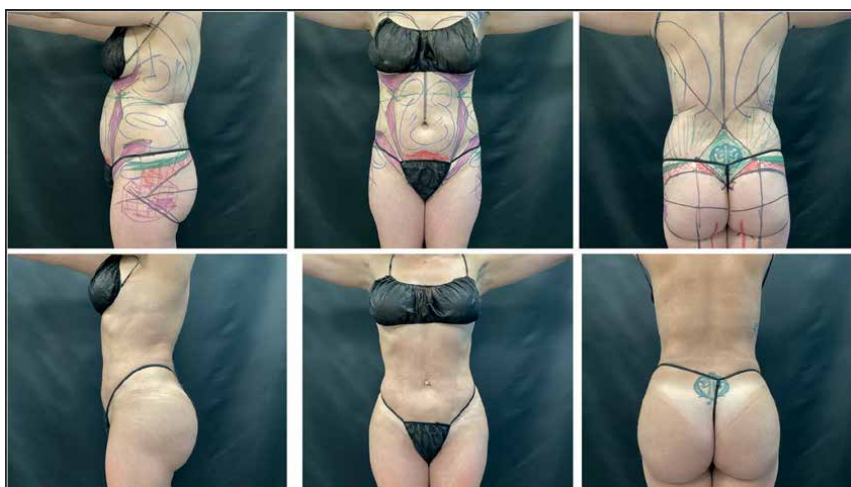


Figure 9. Soft high-definition liposuction. Patient underwent a HDL 360 with gluteal fat transfer. Patient is 6 months post-surgery.



Figure 10.
Athletic high-definition liposuction. Patient underwent a HDL 360 with chest liposuction. Patient is 6 months post-surgery.



Figure 11.
Athletic high-definition liposuction. Patient underwent a HDL 360 with chest liposuction. Patient is 3 months post-surgery.



Figure 12.
Athletic high-definition liposuction. Patient underwent a HDL 360 with chest liposuction. Patient is 6 months post-surgery.



Figure 13. Soft high-definition liposuction. Patient underwent a HDL 360 with gluteal fat transfer. Patient is 6 months post-surgery.

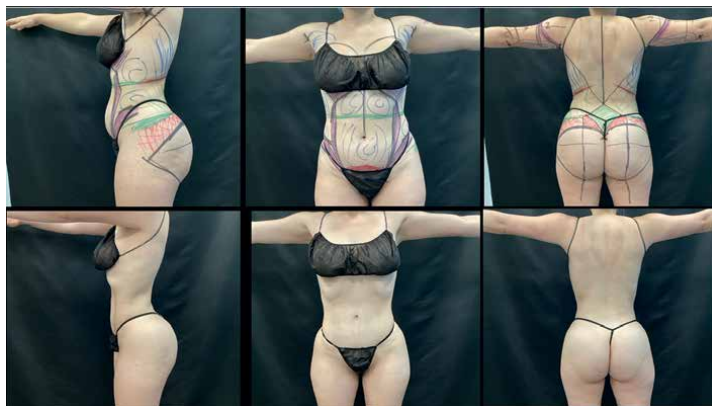


Figure 14. Soft high-definition liposuction. Patient underwent a HDL 360. Patient is 9 months post-surgery.



Figure 15. Athletic high-definition liposuction. Patient underwent a HDL 360 with chest liposuction. Patient is 1-year post-surgery.



Figure 16.
Athletic high-definition liposuction. Patient underwent a HDL 360. Patient is 1-year post-surgery.

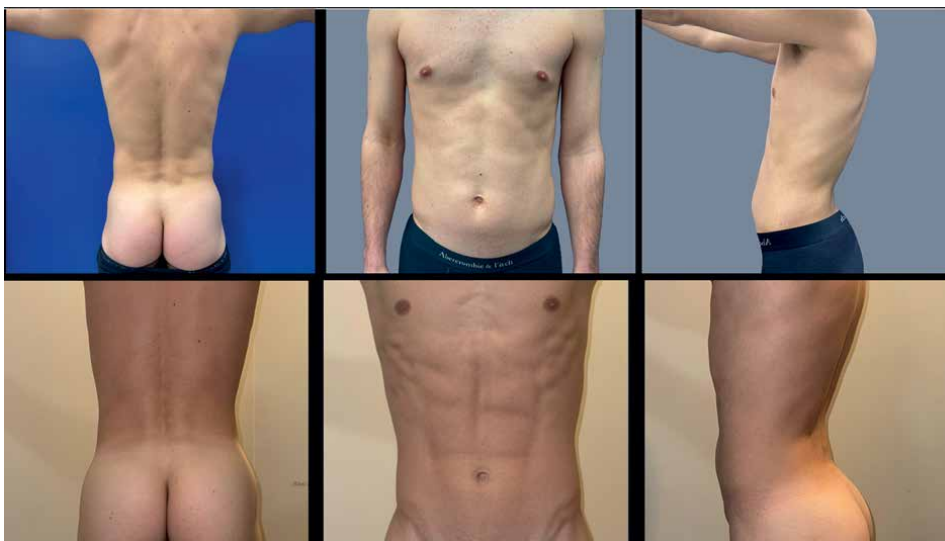


Figure 17.
Athletic high-definition liposuction. Patient underwent a HDL 360 with gluteal fat transfer. Patient is 1-year post-surgery.

9. Conclusion

High-definition liposuction (HDL) is a refined body sculpting technique that combines artistry with anatomical precision, enabling the creation of well-defined, athletic physiques. Achieving optimal results, however, extends beyond the surgery itself; it requires careful post-operative management to enhance the sculpted contours and ensure a smooth recovery.

Post-operative care following HDL is multifaceted, with key elements including the use of compression garments, manual lymphatic drainage (MLD), and a structured return to physical activity. Compression garments help manage swelling, improve skin retraction, and provide support during recovery, while MLD facilitates fluid drainage, reduces the risk of fibrosis, and alleviates post-surgical discomfort. Early ambulation and the gradual introduction of physical activity further promote healing by improving circulation and enhancing lymphatic function. Additionally, proper incision management is crucial for preventing complications such as infection and seroma formation.

The combination of advanced surgical techniques like VASER and Renuvion, along with meticulous post-operative care, allows for the creation of esthetically pleasing, natural contours with minimal complications. By following these carefully outlined post-operative protocols, patients can achieve superior results, a faster recovery, and long-lasting satisfaction with their high-definition liposuction outcomes.

Disclosure statement

The authors have nothing to disclose.

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Systematization Performing Multiple Body Contouring Procedures in One Stage after Massive Weight Loss with Minimal Complication Rate

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Abstract

Massive weight loss (MWL) results in excess, elastic and full of striae skin. The excess tissue in the arms, thighs, lower abdomen and breast ptosis causes difficult ambulation and sexual activity as well as psychological problems, including depression. This is a retrospective study analyzing the results of 1,435 massive weight loss patients who underwent multiple body contour procedures (at least 3) in less than 6 hours by the senior author and his team during the last 23 years of practice in public and private settings in Rio de Janeiro, Brazil. The preoperative markings and description of the surgical procedure techniques (lower body lift, fleur-de-lis pattern, breast lift, thoracoplasty, brachioplasty and thigh lift) are discussed. Postoperative management, including the lack of use of anticoagulation, using early ambulation and intraoperative measures for preventing DVT and PE is described. Mean operating time was 5.7 hours and average time to start ambulation, 4 hours. Seroma rate in lower body lift was 30–35%, lymphocele in brachioplasty less than 10% and skin suffering areas only 3–4%. No infections or necrosis has been documented. Low or no risk of severe complications such as PE, DVT or large blood loss was found.

Keywords: massive weight loss, body contouring after massive weight loss, markings for surgical body contouring procedures, complications after body contouring procedures, systematization for low or no risk during body contouring multiple procedures

1. Introduction

Morbid obesity has become a public health problem in many countries. The prevalence of obesity is estimated to be 603.7 million worldwide. The annual medical spending reported by Hua et al. is \$1429 (42%) higher than that of people on normal weight; comorbidities and higher weights increased the gap of spending [1]. Bariatric surgery has become an effective and safe method for treating obesity with heavy weight loss as well as stable postoperative results. Approximately 252,000 obese patients undergo bariatric surgery per year in the United States. The most common procedures are sleeve gastrectomy and Roux-en-Y gastric bypass, gastric bypass, and gastric banding. These data vary from country to country [1, 2]. Massive weight loss (MWL) is defined as 50% or greater loss of excess weight. The effects of this massive weight loss are not as great as a patient would expect it to be, inevitably resulting in excess skin, which tends to be inelastic and full of striae. The face, breasts and buttocks deflate and there are rolls in the upper and mid-back; the mid and lower abdomen as well as the pubic area develop pannus. There is excess tissue in the arms, thighs, lower abdomen, as well as breast ptosis [2]. All these changes, besides the unaesthetic appearance, result in musculoskeletal pain, rashes, infection -intertrigo-, which may be, in many cases, refractory to conventional therapy. Patients also have difficulties in ambulation and sexual activity, and present psychological problems, including depression [2, 3].

Bariatric surgery has been demonstrated to improve medical conditions, as well as suicide rates, self-harm and substance use disorders in previously obese patients [4]. Furthermore, it has been published that post-bariatric surgery allows patients to reach a sustained quality of life improvement, and it also helps them to have better long-term weight control after both bariatric and post-bariatric surgery [2].

When the patient has had successful results with massive weight loss either by modifying eating habits or through bariatric surgery, there is a big possibility for a plastic surgeon to be involved in further plans to improve the patient's body contour by removing large amounts of skin and fat. Weight loss and body contouring surgery will boost the patient's self-esteem and confidence to wear more appealing clothes and to perform activities in public, improving their social relationships. Another important fact to consider, is that removing all the extra skin after massive weight loss, improves the hygiene of these patients in the crease areas of their bodies and subsequently avoids bad odor and skin infections such as the ones produced by fungus. There has been consensus on when to perform the body contouring procedures: the ideal patient's conditions are related to BMI, nutritional and psychological status, lab work results and general health issues. Cabbabe and colleagues describe that good candidates for bariatric plastic surgery are those who had bariatric surgery 1 year prior with stable weight for at least 3–6 months; the best candidates are those with BMI less than 30, have few or no medical conditions, do not smoke and have reasonable expectations [2]. The plastic surgeons make the decision on which surgical procedures should be performed on a first stage and which ones on a second and even on a third stage based on the knowledge that surgical time over 6 hours may involve blood loss that may require transfusions, general health decompensations, main complications that may be life threatening such as deep vein thrombosis (DVT) and pulmonary embolism (PE) and wound complications. It was previously published by the senior author that the variable of operating time was the primary factor

influencing increase in plasma concentrations of stress markers, and therefore, of potential complications [5].

The main goal of this chapter is to show how multiple body contouring surgical procedures can be performed in one stage with minimal risk to the massive weight loss patient if the systematization proposed by the senior author is followed step by step, to avoid the main complications of blood loss, deep venous thrombosis (DVT), pulmonary embolism (PE) and other health problems such as hypothermia, wound complications, or poor postoperative healing due to an extended surgical time over 6 hours.

2. Method

We retrospectively analyzed 1435 massive weight loss patients (mean weight loss of 30 kg), who underwent multiple body contouring surgical procedures (at least 3) in a period of less than 6 hours by the senior author and his team during the last 23 years of practice. All surgeries were performed under general anesthesia in public or private hospital settings in Rio de Janeiro. The preoperative requirements for the patients to be considered as ideal candidates to undergo the proposed systematization plan were: normal physical and psychological health, this included patients whose comorbidities such as high blood pressure and diabetes mellitus were under control, adequate nutritional status which was proven by normal blood albumin levels; normal complete blood cell count (CBC), normal complete metabolic panel (CMP) as well as normal prothrombin time with INR (PT/INR) and partial thromboplastin time (PTT). A cardiovascular assessment based on a physical exam, electrocardiogram and lab work by a cardiologist, or an internist was performed in all patients. A urinalysis was done in all cases prior to surgery and, if any urinary tract infection was detected, it was treated. If a patient was found to have anemia, intravenous iron was administered every 3 days until achieving normal values.

3. Preoperative markings

Preoperative marking is vital in the surgical plan of these patients and must be carried out meticulously. Preoperative photographs and videos were obtained, trying to have the same positions, lights and shadows and taken in the same room to be able to compare objectively with postoperative ones. It is highly recommended to have plenty of time to plan where the incisions will be located in order to have the resulting scars in areas of the body where they will be easily hidden under clothes, undergarments and even beach clothing. The resulting scars ideally should be symmetrical, of excellent quality (not hypertrophic or keloid) and placed on areas that respect the esthetic units of the abdomen, torso, chest, arms and thighs.

The skin markings should be done 1 day before the surgery by the responsible surgeon who has had contact with the patient since the first office visit, who has evaluated and accepted the surgical case and has elaborated the plan in conjunction with the patient's desires, always in an orthostatic position. The surgeon uses a conventional marker in the beginning and, once the markings are checked and confirmed to be correct, they are re-marked with an indelible marker so that the markings on the skin will not disappear after the patient gets a shower the day of the surgery and

after the body surface is scrubbed in the operating room (view <https://youtu.be/aHzQC1iPsMs> for full-body markings -lower body lift, breast lift and brachioplasty).

3.1 Lower body lift

The surgical procedure will have the goal of lifting the mons pubis or reversing the buried penis appearance. The most inferior point is on the midline, pulling with 2 fingers (maximum 6 cm at the end of the surgery), simulating the tension that the abdominal flap will do, above the base of the penis or above the vulvar commissure, under tension. The upper limit is marked in the umbilical area. On the lateral side, the pinch test is done; inferiorly, it begins at the quadriceps insertion. This is then transferred to the contralateral side, in a perfectly symmetric way. The points are then connected. The senior surgeon usually marks a more conservative line, and a more ambitious one; during the surgical procedure he decides which one of these will be taken into account, and this will change towards the most ambitious as the surgeon gets more experienced. Laterally, to do the markings that will connect the anterior and posterior aspects of the lower torso, one should imagine where the bikini or underwear will be, and using the pinch test, do the markings that will remove the extra skin and also lift the lateral aspect of the thigh.

On the posterior aspect, the inferior point in the midline is marked on the most superior part of the intergluteal crease, and then a mark is done around half a centimeter above it. Then the pinch test is done asking the patient to bend over before determining the superior point (this avoids dehiscence when the patient bends over postoperatively). Laterally to this point, using the pinch test, the markings are done where the effect of pinching lifts the buttocks in a more anatomical position and the skin sagging on them is pulled up giving a more natural appearance to the lower part of the buttocks. The lines are connected, and the marking is finished. In men, we recommend not to do an arched and pronounced line in the posterior aspect, because it will give a feminine appearance that is not wished by most, if not all men. On the other hand, in women, the final pattern looks like a butterfly shape that will lift the gluteal area and the resulting scar will have a curvilinear shape (the more laterally this butterfly shape opens, the more the lifting of the gluteal area will take place as well as for the lateral area of the thighs).

It is recommended to confirm the symmetry of the markings by taking the xiphoid process as a hallmark and measure the distance to the lateral points on both sides, on the upper, and lower lines, on the anterior and lateral aspects. On the posterior aspect, this can be done as well by measuring the different distances and confirming them to be equal (**Figure 1**).

For the Fleur de Lis pattern, to decide the lowest lateral point, it has to reach the midline marking on the mons pubis. The pinch test is performed all the way from the lower marking on the mons pubis to the xiphoid process (**Figure 2**) (view <https://youtu.be/P4tsNI77B24> for lower body lift markings).

3.2 Breast lift

The smaller breast is always marked and operated on first. The first marking for a breast lift is found by the Pitanguy's maneuver to locate the ideal placement of the nipple. This is transferred from the smaller breast to the larger breast. Two centimeters above this marking is where a diagonal line will be drawn towards the medial and lateral breast and will have to measure 9 cm, 4 cm for the diameter of the areola and

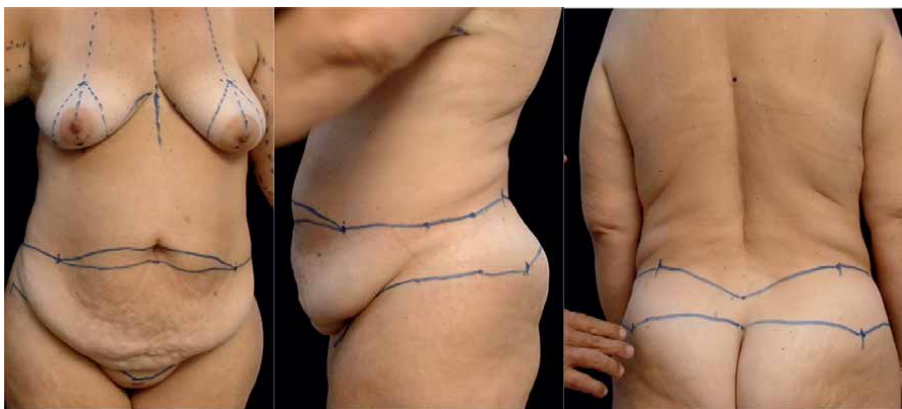


Figure 1.
Lower body lift markings.

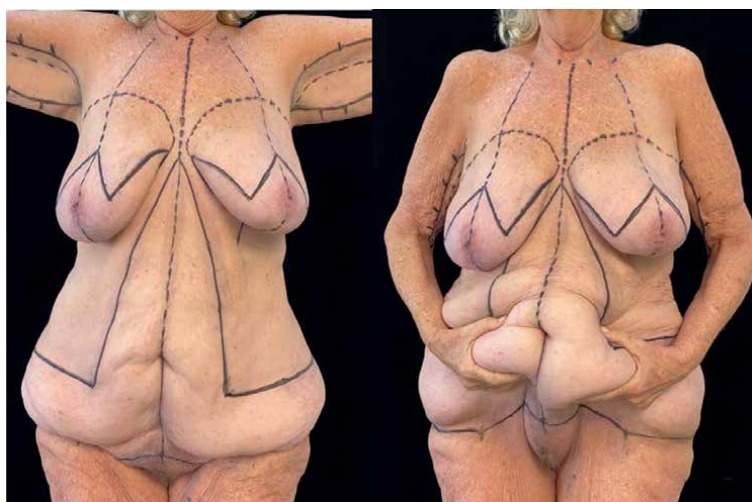


Figure 2.
Fleur de Lis pattern markings.

5 cm for the resultant vertical scar of the lift. To determine how oblique these two lines should be drawn, the surgeon should push with one hand the area below the areola inwards in order to approximate with the other hand the remaining area that corresponds to the pillars and gently approximate them with the breast crease that is already marked, The confluence point of the pillars with the crease on the meridian of the breast should be at 9–11 cm laterally from the midline, depending on how narrow or wide the patient's chest is (**Figure 3**).

3.3 Thoracoplasty

The scar on the back will follow the bra-line, and, as it is done simultaneously with the lower body lift, the pinch is verified at the same time for the thoracoplasty and the lower body lift, so there is no skin missing at the time of closure. The posterior scar



Figure 3.
Breast lift markings.

connects with the anterior aspect following the inframammary fold (**Figure 4**) (view <https://youtu.be/51xkHl5tHjY> for thoracoplasty markings).

3.4 Brachioplasty

A pinch test is performed involving the anteroinferior skin and tissue of the arm, drawing the site of the scar all along the bicipital groove and when it reaches the axilla, the patient is asked to lift the arm and a natural line is drawn on the skin showing where the marking should continue into the thorax if a thoracoplasty is planned with the arm lift and a breast lift (**Figure 5**).

3.5 Thigh lift

The markings of this procedure vary from men to women. It is important to remember that any resection of tissue on the skin where the groin area meets the

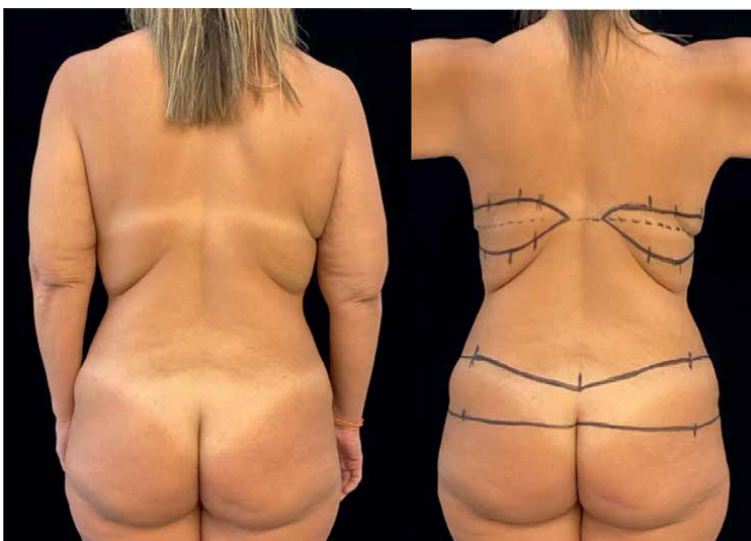


Figure 4.
Thoracoplasty markings.



Figure 5.
Brachioplasty markings.

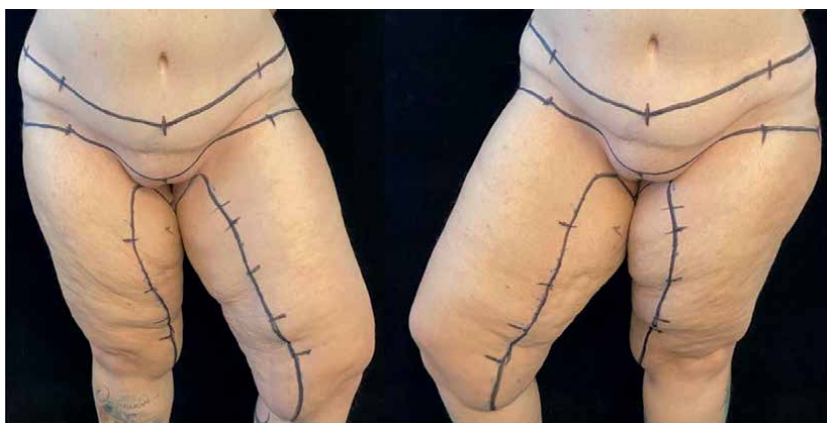


Figure 6.
Thigh lift markings.

thigh, will produce a scar that gravity and the lower tissues will pull downwards. The result will be a visible scar below the underwear or bathing suit and in women the labia majora will suffer distortion of their anatomy and could represent local disturbances in the vulvar region. That is why it is not recommended to make incisions in this area. In women, the recommendation is to hide the scar vertically on the medial aspect of the thigh, the amount of skin and fat to be resected is based on the pinch test and is done with an elliptical pattern. For the thigh lift on men, it is preferable a diagonal elliptical pattern that follows the sartorius muscle direction and the amount of skin to be resected is calculated with the pinch test (**Figure 6**).

4. Surgical procedures

No use of tranexamic acid or any fibrinolysis neutralizer is needed. Prior to the skin incision, a cefadroxil dose is administered to the patient. Patients who have intertrigo within the skin folds get a preoperative IV dose of fluconazole. All patients get intermittent compression stockings during surgery. During the whole procedure, electrocautery is used at 45 in coagulation mode. Before the skin is incised, the

vertical lines drawn within the marking lines, are tattooed using the back of the knife and methylene blue; this assures that during the closure, both flaps are sutured at the exact point where they should meet. This technique involves no infiltration of the tissues, there are two reasons for this: it is not necessary because there is no undermining of the tissues, and its use would interfere with the action of the cautery as the main tool of dissection. It should be emphasized that no liposuction is performed during these combinations of surgical procedures to avoid seromas or altered blood supply to the wounds. As the leading surgeon finishes the dissection, performs skin removal and repositioning of the tissues, he moves on to the next area and the assisting surgeon/s start the closure of the area.

4.1 Fleur de Lis

The skin is incised superficially with a cold knife and further dissection is taken with electrocautery, in a perpendicular manner -not beveling or undermining- all the way down to the fascia (**Figure 7**). The umbilicus is excised as the dissection is done. For the neoumbilicus, a 2×10 cm flap is designed in the lateral aspects that will be de-epithelized as needed, once the dissection and skin resection are completed; this has previously been similarly described by Mendes et al. [6]. A conservative plicature is performed with 0 Vicryl™ with cross stitching. The flap reserved for the umbilicus is trimmed to an adequate size in the right position -it should be small rather than large because it widens with the healing and scarring process-. The umbilicus is fastened to the fascia once the plicature is done with two stitches at 12 and 6 o'clock. The wound is closed in two layers, the first involving Scarpa's fascia and the second involving the subcutaneous tissue.

4.2 Lower body lift

The procedure starts with the patient in a prone position, once the dissection and resection are done, the closure in two layers takes place with prior placement of a



Figure 7.
Transoperative Fleur de Lis dissection.

drain that will go anteriorly and come out on the left side (**Figure 8a** and **b**). Then, the patient is turned on the table in a supine position. The anterior skin is incised with a cold knife and further dissection is taken with electrocautery, in a perpendicular manner -not beveling or undermining- all the way down to the fascia. The upper abdomen flap is undermined in a tunnel fashion preserving the abdominal perforators as recommended by Saldanha [7, 8], in an attempt to ensure the flap's viability. The patient's umbilicus base is preserved and a conservative plicature of the abdominal rectal muscles is performed with a 0 absorbable suture (**Figure 9**). The umbilicus is secured to the fascia once the plicature is done with two stitches at 12 and 6 o'clock. The skin on the abdominal flap is pulled down and a "Y" incision is done where the base of the umbilicus is located to suture their edges together to form the new belly button. The distance between the umbilicus and the abdominal wound should be 10–12 cm depending on the height of the patient. The extra skin and fat in the flap are excised. The wound is closed in two layers, the first involving Scarpa's fascia and the second involving the skin and then Prineo™ tape and cyanoacrylate glue are applied to all the wounds.



Figure 8.
(a and b) partial dissection and partial closure.

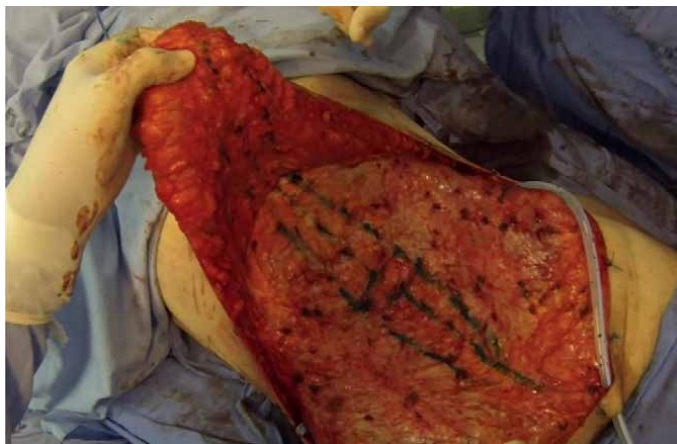


Figure 9.
Conservative recuts plicature.

4.3 Breast lift

For the breast lift in a massive weight loss patient, high profile round silicone gel breast implants, not beyond 280 ml in volume, are preferred, and placed in a subglandular pocket through a 5 cm incision on the crease marking. The upper limit of the pocket dissection is decided by pushing the breast tissue upwards to find the superior limit of the breast footprint. After a careful hemostasis, the pocket is closed with 2-0 Vicryl™ sutures. Then, the incisions are made on the markings already placed for the rest of the breast and around the areola (4 cm diameter) and a de-epithelization of the skin inside all these markings is done. The whole lower pole of the breasts is removed including breast tissue, fat and skin and closure is done with 3-0 nylon™ and 3-0 PDS™ in two layers.

4.4 Thoracoplasty

This procedure has to be planned depending on where the extra tissues have to be resected and the thorax contour corrected. In women, the areas of concern are below the axillary area and the upper back rolls. If the area below the axillary area is the problem, then a “J” pattern should be followed after finding the ideal markings with a pinch test. These markings should come from the axilla when the patient is extending superiorly the arms and be traced to join the sub mammary crease marking. When the excess of skin depends mostly on the upper back rolls, a horizontal line on the back where the resulting scar is desired should be traced with the marker and be placed where the brassiere will be covering it. The amount of skin and fat that will be removed will be determined by the pinch test on each side. In men, the markings have to be placed laterally on the chest and vertically, where the resulting scars can be covered by the arms in a resting position. Likewise, the excess of skin and fat to be removed should be based on the pinch test. Suturing is also based in doing it in two deep layers including the Scarpa fascia and the subdermal layer with 3-0 nylon™ and 3-0 PDS™.

4.5 Brachioplasty

Marking the skin should be done with the patient extending the arms laterally and tracing a line that will be the resulting scar on the bicipital groove or crease. With the pinch test the excess of skin is marked to trace the edges of an ellipse. The skin is incised with a cold knife through the subcutaneous tissue. On the distal third of the arm -around 5–6 cm from the most distal point near to the elbow, the dissection is superficial to preserve the lymphatic structures. Once that critical area is completed superficially, the rest of the dissection is taken all the way down to the fascia -this dissection is safe as all the critical structures are beyond the fascia-. Hemostasis is carried out with electrocautery and the wound is sutured in two layers with 3-0 nylon™ for the deeper layer and 3-0 PDS™ for the subdermal suture.

4.6 Thigh lift

The incisions and dissection should be made as already described for the lower body lift with the help of an electrocautery. After the skin and subcutaneous tissue are resected, the wounds are sutured in two layers as described for the brachioplasty after careful hemostasis with the electrocautery.

5. Systematizing the procedure

The systematization proposed to perform all possible combinations of these body contouring surgeries in less than 6 hours is based on the lead surgeon being the one marking the patient, performing the incisions and having all the other members in the surgical team intervene in different steps of the procedures such as removing the extra skin and fat and suturing the different layers of all the areas of the body being treated. This is the way it has been standardized:

- a. The patient is on a prone position and the lead surgeon performs the incisions on superficial skin, then, the lead surgeon and the surgeon assisting on this phase will remove the half of the posterior flap on each side without undermining the remaining flaps which will be sutured (superior flap with inferior flap) together with the technique already described. A closed drain system will be applied for this area and the tube will exit the body through the mons pubis.
- b. The patient is turned into a supine position and the excess of skin and fat located inside the markings for an abdominoplasty or a Fleur de Lis pattern is removed. The dissection of the flap to be removed goes from the lateral tissue of the flap to the medial one and the umbilical stalk is the one to be cut at the base once the surgeon has determined there are no hernias and it is safe to do so. If a hernia is encountered at any location of the abdomen, it should be reduced and treated

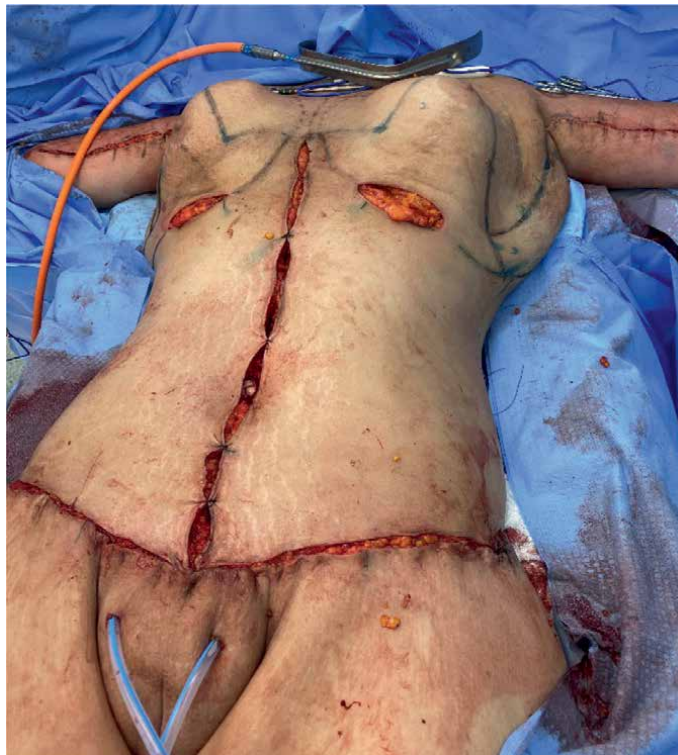


Figure 10.
Partial closure of abdominal and arms wounds, prior to mastopexy, with breast implants in place.



Figure 11.
Partial closure of abdomen, arms and breasts.

with a herniorrhaphy. The rectus abdomini plication is then performed by the assistant surgeon, careful hemostasis must be done and the abdominal flap is pulled down to close the wound horizontally and vertically in case of the Fleur de Lis abdominoplasty is needed. The umbilicus is reconstructed in the “Y” shape method that has already been described. A closed drain system is left for the abdominal area and its tube is brought outside through the mons pubis. While this is being done, the lead surgeon starts the mastopexy as described before with the help of another plastic surgeon. When the implants have been placed and the extra skin and lower pole of both breasts have been removed, then the lead moves on to performing the brachioplasty with the lateral thoracoplasty if needed. The sutures for the arms and thoracoplasty are performed by the other assistants and the lead surgeon moves on to performing the thigh lift on both sides, leaving the sutures on one side to the surgeon that has already finished the abdominal wall treatment and the lead surgeon suturing the other thigh wound. If a bra-line thoracoplasty is performed, this should be done when the patient is in the prone position at the beginning of the surgery (**Figures 10 and 11**).

6. Postoperative management

After all the wounds are closed in two layers, cyanoacrylate glue and mesh tape (Prineo™) are applied to the wounds, then the patient is draped on kinesiotape which has been found to lower the postoperative swelling, ecchymoses and pain, and avoids seroma formation. The wound areas are left without the taping so that they can be closely checked for dehiscence or signs of infection (**Figure 12**).

As commented before, there is no need for the patient to be put in any anticoagulant medication postoperatively. If the patient had a urinary catheter put in place, as requested by the anesthesiologist, it comes out right after the surgery is finished. For

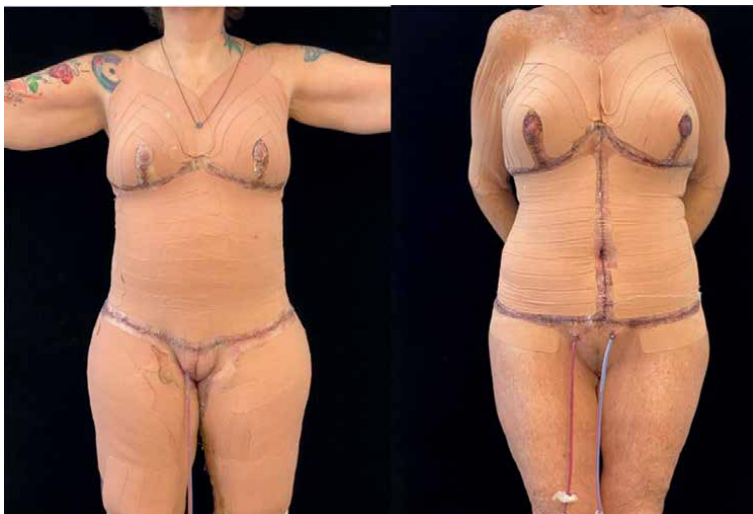


Figure 12.
Postoperative management.

outpatient pain management, ketorolac is administered orally; all patients are asked to take cefadroxil (azithromycin if allergic) for 7 days after the surgery. Patient exits the operating room to a recovery room and then transferred to the room to stay overnight under monitoring. The patient is encouraged to eat a healthy diet based on fiber and water -for a fast and healthy wound healing and recovery- avoiding anything that can cause allergy (seafood) and avoiding the use of laxative medication to prevent bacterial translocation to happen. The patient starts ambulation within 4 hours (late cases even within 2 hours) after the procedure and is discharged after evaluation the next day. Compression garments are ordered to be worn during 1 month for the areas treated. Drain tubes are removed within 7 days postoperatively or when the drain amount is below 30 ml per day.

After 1 week post op, the patient starts visiting the physical therapist, who changes the kinesiotapes and starts lymphatic massages, which are applied once a week for 3 to 4 weeks. Patients are encouraged to walk and do as many activities as possible, even going out to buy new clothes.

7. Results

The combinations of procedures performed are as follows: Lower body lift with or without Fleur de Lis pattern plus breast lift, with or without implants and thoracoplasty if needed, in 100% of the procedures; 50 to 60% may have a brachioplasty and/or thigh lift associated.

The mean time for these combinations of procedures performed was 5.7 hours and the average time to start ambulation is 4 hours. All patients are discharged after 1 day of hospital stay. No patients needed blood transfusion nor transfer to an Intensive Care Unit. None of them had DVT or PE either.

It is important to note that the psychological status of all patients improves amazingly, several patients got pregnant after surgery as their sexual health changed; they also got to wear clothes they never thought they would be able to



Figure 13.

72 year old female patient, ex-volleyball athlete, who lost 86 Kg after gastric sleeve 10 years before the procedure. The weight before surgery was 104 Kg, with a BMI of 30.6 and 27.05 after the surgery. The tissue removed in the procedure weighed 10.3 Kg. Surgery time was 4 hours and 56 minutes. She started deambulation 3 hours after surgery, did not require blood transfusion and was discharged after 24 hours.

wear, and got involved in many activities they had stopped joining due to the excessive weight. We show the example of a 72-year-old female patient, ex-volleyball athlete, who lost 86 Kg after gastric sleeve 10 years before the procedure. The weight before surgery was 104 Kg, with a BMI of 30.6 and 27.05 after the surgery. The tissue removed in the procedure weighed 10.3 Kg. Surgery time was 4 hours and 56 minutes. She started ambulation 3 hours after surgery, did not require blood transfusion and was discharged after 24 hours (**Figure 13**). A 62-year-old male patient who lost 150 Kg after bariatric surgery 20 years before the body contour procedure. The weight before surgery was 98 Kg, with a BMI of 39.36 and 33.44 right after the surgery. The tissue removed in the procedure weighed 14.5 Kg. The surgery time was 4 hours and 30 minutes. He started ambulation 4 hours after surgery, did not require blood transfusion, and was discharged 24 hours after the procedure (**Figure 14**).

8. Complications

In terms of postoperative complications, its incidence has lowered since the beginning of the senior author's practice, 23 years ago. Seromas have been found only in the lower body lift. No seromas in brachioplasty, thoracoplasty, mammoplasty or thigh lift. Currently, the seroma rate in lower body lift is 30–35%, the mean volume drained is 150–200 ml, with the largest having approximately 800 ml. Seromas are



Figure 14. 62 year old male patient who lost 150 Kg after bariatric surgery 20 years before the body contour procedure. The weight before surgery was 98 Kg, with a BMI of 39.36 and 33.44 right after the surgery. The tissue removed in the procedure weighed 14.5 Kg. Surgery time was 4 hours and 30 minutes. He started ambulation 4 hours after surgery, did not require blood transfusion, and was discharged 24 hours after the procedure.

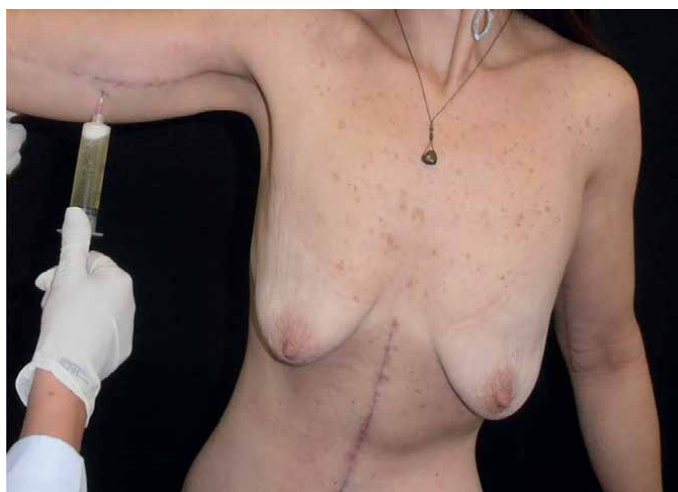


Figure 15. Lymphocele drainage in office.

drained twice a week until they resolve, which usually takes 4–6 weeks. Lymphoceles in brachioplasty are less than 10%; they are drained at the surgeon's office (nearly 5 ml of clear liquid is drained on each session), resolving in 2 to 3 weeks (**Figure 15**).

There have been some minor skin suffering areas which are no bigger than 4–5 cm; in the beginning of the practice its incidence was close to 10%, currently the rates are close to 3–4%. The management is always conservative, and this usually happens more in the lateral aspects of the abdominoplasty, thighs and coccyx (the bending of the patient during the marking of the patient has lowered dehiscence in this portion to zero). No infections or necrosis have been documented during the procedures.

No patient in this series has required blood transfusions, nor DVT or PE has occurred.

9. Anesthesia considerations

Morbid obesity induces metabolic and physical changes that are not fully corrected after massive weight loss. One of these changes is the airway, which must be meticulously evaluated and have the necessary devices for the management of difficult intubation. Anemia is another frequent factor in these patients; although it is possible to take them to surgery with mild anemia, it is preferable to correct this deficit promptly; oral or parenteral iron, oral folic acid, and frequent doses of erythropoietin are indicated. Other comorbid conditions are also crucial factors to consider; type 2 diabetes mellitus, insulin resistance, sarcopenia, chronic kidney failure, obstructive sleep apnea, oxygen desaturation, altered thyroid function, etcetera; aspects that are not always corrected after massive weight loss.

Medical tourism continues to grow exponentially, especially in plastic and obesity surgery. Tourist patients represent an additional challenge; pathologies typical of their race, their country of origin, acute changes secondary to prolonged travel, languages and customs different from the place where they will be operated on, stress, fatigue, anxiety, and other aspects that must be meticulously assessed by the medical team [9].

Anesthesia in this group of patients has special challenges, so it is desirable, although not essential, for the anesthesiologist to have experience in this field. The pre-anesthetic evaluation must be anticipated, not only to get to know each patient, but also to establish empathy and have enough time to request the opinion of other specialists and to be able to correct existing deficits when possible. Although some plastic surgery centers use regional anesthesia [10], it is more common to use general anesthesia, which may or may not be balanced with opioids, alpha2 agonists, ketamine, and/or regional anesthetic techniques. In pre-anesthetic medication, a pharmacological scheme that includes anxiolytics, amnesia, pre-emptive analgesics, and antiemetic's is recommended. Sublingual doses of lorazepam 1–2 mg, oral melatonin 10 mg, oral etoricoxib 90 to 120 mg, iv keratin 50 mg, iv magnesium sulfate 2 gr, and 8 mg of ondansetron are strongly recommended. Discontinuation of semaglutide-based medications should be considered prior to general anesthesia due to gastrointestinal side effects including delayed gastric emptying [11]. Anesthetic induction with propofol and a fast-acting neuromuscular relaxant such as rocuronium facilitate orotracheal intubation. Maintenance of anesthesia may be with desflurane or sevoflurane, with or without opioids. The use of neuromuscular relaxants eases mechanical ventilation, which should be volume controlled, recommending physiological PEEP, FiO2 0.5% with a mixture of air and oxygen.

The physiological changes caused by obesity change the response to some drugs, so it is mandatory to know the unique characteristics of the administered agents in order to provide safe anesthetic care. The variability in the tissue content of these patients justifies a different, personalized approach [12].

10. Discussion

Capla et al. suggest that prior evaluation includes standard medical and surgical history, as well as aspects of weight loss history (total weight loss, length of stable weight, type of weight loss surgery, etc). The safe cutoff accepted is BMI of 30 or less, stable weight for at least 3 months, ideally 6 months. Medical conditions that did not resolve with massive weight loss should be properly addressed prior to surgery [3]. Our criteria for eligibility for the procedures were mentioned above. Cabbabe and colleagues consider a patient candidate for post bariatric surgery 1 year after weight loss surgery and stable weight for 3–6 months. They operate on BMI's 25–35, with poor candidates being with BMI 35 or greater, active smokers, poor overall medical condition, on anticoagulants and unrealistic expectations [2, 3].

The study by Marchica and colleagues describes a series of modifiable and non-modifiable predictors for complications in abdominoplasty in massive weight loss patients; factors such as preoperative obesity and body mass index, active smoking, preoperative anemia, use of fibrin glue or quilting sutures were considered modifiable and factors as advanced age, diabetes mellitus, and surgical mode of weight loss were considered non-modifiable predictive factors for complications. A study by Bayter-Marin and colleagues including 409 patients to compare the use or not of blood management measures (iron and erythropoietin administration, use of normovolemic hemodilution, temperature maintenance) among patients undergoing body contouring surgeries, they found that hemoglobin value 24 and 72 hours after surgery was significantly higher in the intervention group; they also found an association between lower hemoglobin levels at 24 and 72 hours and longer time in the prone position [13]. We have described the results of the senior author's study describing that the surgery time less than 6 hours is predictive of complications [13, 14]. The senior author has found that, unlike what is suggested, the electrocautery does not cause skin necrosis or dehiscence complications; we recommend its use on a regular basis for all the dissection, for it allows a bloodless and faster procedure. No transfusions were performed in any patients.

The Dermabond™ Prineo™ Skin Closure System combines 2-Octyl cyanoacrylate with a self-adhering mesh for safe and reliable skin closure. It forms a watertight barrier over the incision, and it has been suggested that it forms a microbial barrier as well as providing an even distribution of tension across the incision. Although complications such as rash and allergic contact dermatitis have been described with its use, it is very convenient for skin closure without any of these, and its use is important to lower wound dehiscence and infection rates as well as lowering operating time by using it. Its use in these procedures started in 2007 [15].

Regarding skin suffering areas, these are thought to be due to the poor nutritional state of patients; in the beginning of the practice its incidence was close to 10% (now being 3–4%), by that time, the tension of the flaps, low protein levels, type of sutures used and layered closure may have played a role in dehiscence rate seen. The absence of wound infections or dehiscence nowadays, is most likely to be due to the particularity of not practicing undermining, not so many layers being sutured, and a good nutritional status of the patients.

Kinesiotaping has been recently added to the postoperative management of these patients. It is an elastic tape with longitudinal interwoven elastic fibers and acrylic glue with an elasticity of 130–140% that influences the skin and subcutaneous layers. Among the mechanisms of action to control edema, are that the pre-tension lifts the skin, improving lymphatic flow and directing it to pathways that suffer less congestion and providing a massage-effect during active movement. We have found that its use, which we started in 2020, added to the previously applied lymphatic massage, reduces postoperative edema and improves patient's recovery [16].

11. Conclusions

During 23 years of experience, 1435 procedures have been performed, with a complication rate of 12%. The most common complications have been seroma, lymphocele and small skin suffering areas. These complications were more prevalent in the first years of practice, and have been lowered as the technique and perioperative management practices have been improved. By reviewing the cases performed, the lower body lifting technique improves and even corrects the urinary incontinence in some patients, possibly because the urethral angle is repositioned.

Among the benefits of this systematized approach, we include: lower costs (hospital stay, medication, postoperative complications), one surgical stage opposed to 2 or 3 stages depending on the case (which involves more hospital admissions, anesthesia associated problems, more disability time and recovery periods), low/no risk of severe complications such as PE, DVT or large blood loss.

This is a reproducible technique, once the markings are correctly and accurately done, any plastic surgeon can perform each procedure and get it done with the same ideal results. If the markings are appreciated and respected, the scars will be put within the transition lines of the different esthetic units of the body. If the systematization proposed here is followed by other teams, then the time lapse for the combination of the procedures mentioned above will be as low as 6 hours or less, with diminished health risks and avoiding the use of anticoagulant medications.

The next step is to evaluate and report the patient's-reported outcomes, to correlate them with complication rates and surgeon-reported outcomes, for a more objective analysis.

Conflicts of interest

The authors declare that they have no conflicts of interest to disclose.

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Section 3

Enhancing Healing
in Cosmetic Surgery

Chapter 16

Enhancing Postoperative Healing with Hyperbaric Oxygen Therapy: Applications in Plastic Surgery Procedures

David Borg, Kristian Bugeja and Kurt Lee Chircop

Abstract

This chapter examines the application of Hyperbaric Oxygen Therapy (HBOT) in cosmetic surgery, focusing on its efficacy in enhancing wound healing and improving postoperative outcomes. Through a review of scientific principles and clinical data, the chapter outlines the mechanism of action of HBOT, which involves increasing tissue oxygenation to support critical healing processes, such as angiogenesis, collagen synthesis, and fibroblast activation. Clinical applications are discussed through case studies and research findings that highlight reduced recovery times and lower complication rates. The chapter also addresses potential risks and economic considerations associated with HBOT, alongside emerging research and technological advancements that may expand its use in cosmetic surgery. The overall assessment is that HBOT represents a valuable yet underutilized modality in cosmetic surgical recovery.

Keywords: Hyperbaric Oxygen Therapy, cosmetic surgery, wound healing, postoperative recovery, clinical applications of HBOT

1. Introduction

1.1 Objective

The primary aim of this chapter is to delineate the relevance and efficacy of Hyperbaric Oxygen Therapy (HBOT) within the realm of cosmetic surgery, particularly focusing on its role in enhancing wound healing. As cosmetic procedures continue to surge in popularity globally, the need for advanced therapeutic techniques to optimize healing and reduce recovery time is paramount [1]. HBOT presents a significant opportunity in this regard, offering accelerated wound healing and potentially superior outcomes in terms of both function and esthetics [1].

1.2 Background

Hyperbaric Oxygen Therapy, which involves the administration of 100% oxygen at elevated atmospheric pressures, has historically been utilized for a broad spectrum of medical conditions, including decompression sickness, chronic nonhealing wounds, and acute carbon monoxide poisoning. Its application has expanded into the domain of cosmetic surgery, where precise and effective wound healing is crucial for successful outcomes [2]. This therapy leverages the physiological benefits of increased oxygen availability to enhance tissue repair and angiogenesis, processes critical to effective postsurgical recovery [3]. Figures of Hyperbaric Oxygen Therapy chambers are shown in **Figures 1–3** below.

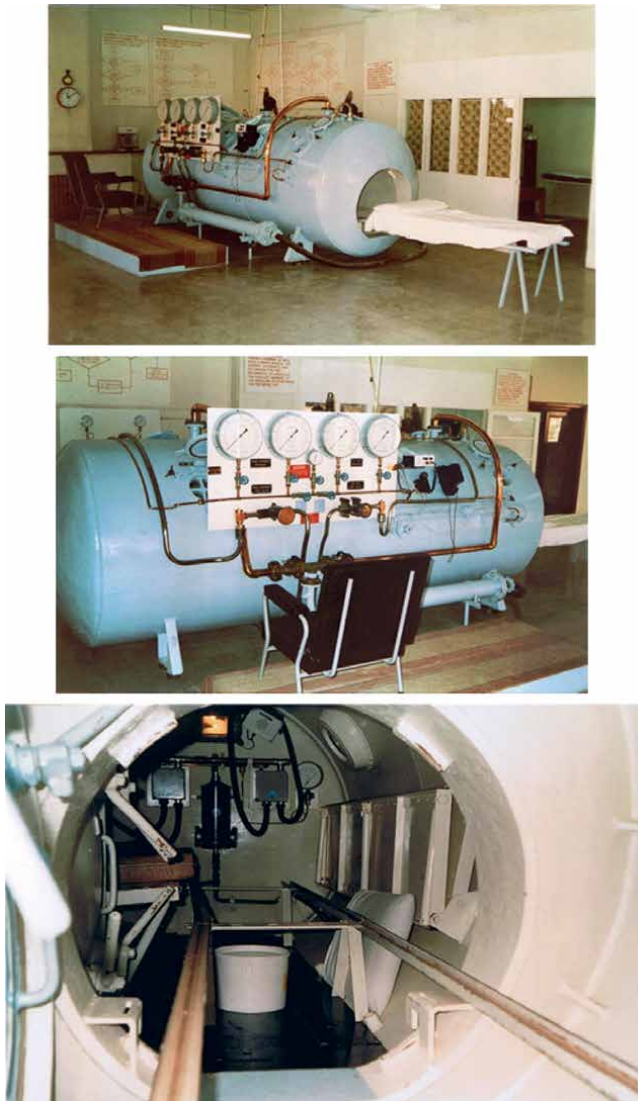


Figure 1. *Photos of the first Hyperbaric Unit at Kalafrana, Malta, and Europe. Pictures courtesy of Hyperbaric Unit staff [4].*



Figure 2.
Photos of the old-World War 2 era Japanese recompression chamber and the Italian recompression chamber obtained in 1994 at the former St. Luke's Hospital Hyperbaric Unit, Malta, and Europe. Pictures courtesy of Hyperbaric Unit staff [4].



Figure 3.
Modern Hyperbaric Oxygen Therapy chamber with four patients and a qualified hyperbaric nurse [5].

1.3 Scope

This chapter will explore the integration of HBOT into cosmetic surgical procedures, highlighting its mechanisms of action and the empirical evidence supporting its use. It will address various cosmetic surgeries that can benefit from HBOT, supported by data from recent studies and clinical trials. Additionally, the discussion

will extend to the limitations and potential risks associated with HBOT, providing a comprehensive overview that balances the therapy’s advantages against its constraints and challenges. This approach aims to furnish practitioners and researchers with a nuanced understanding of HBOT’s role in cosmetic surgical recovery, backed by current scientific and clinical evidence.

2. Theoretical foundations

2.1 Mechanism of action

Hyperbaric Oxygen Therapy (HBOT) operates on the principle of increasing atmospheric pressure to enhance the solubility of oxygen in the blood, which allows for higher levels of oxygen to be delivered to tissues [6]. This is represented in **Figure 4** below. Under normal atmospheric conditions, oxygen transportation is primarily hemoglobin-bound in the red blood cells. However, as represented in **Figure 5**, under hyperbaric conditions, oxygen dissolves directly into the plasma, cerebrospinal fluid, and other body fluids, substantially increasing tissue oxygenation without being reliant on hemoglobin. This elevated oxygen level under pressure saturates the tissue, promoting mitochondrial respiration and energy production, which are essential for cellular repair and regeneration processes [9].

2.2 Biological impact

The biological responses to HBOT are multifaceted and crucial for effective wound healing:

1. *Angiogenesis*: HBOT stimulates the release of growth factors such as vascular endothelial growth factor (VEGF) and stimulates the formation of new blood vessels. This process is vital for supplying sufficient blood flow to regenerating areas, improving oxygen and nutrient delivery which is crucial for wound healing.

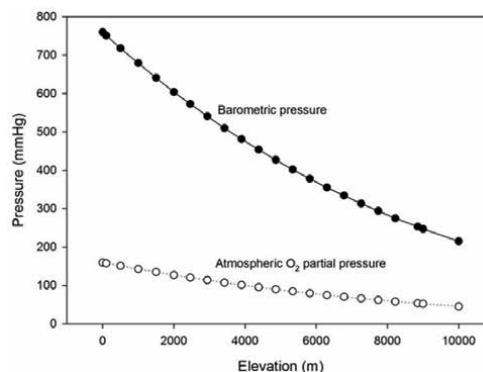


Figure 4. Relationship between elevation and Barometric Pressure (filled circles) and Atmospheric Partial Pressure of Oxygen (hollow circles). Calculations were based on the standard atmosphere [7].

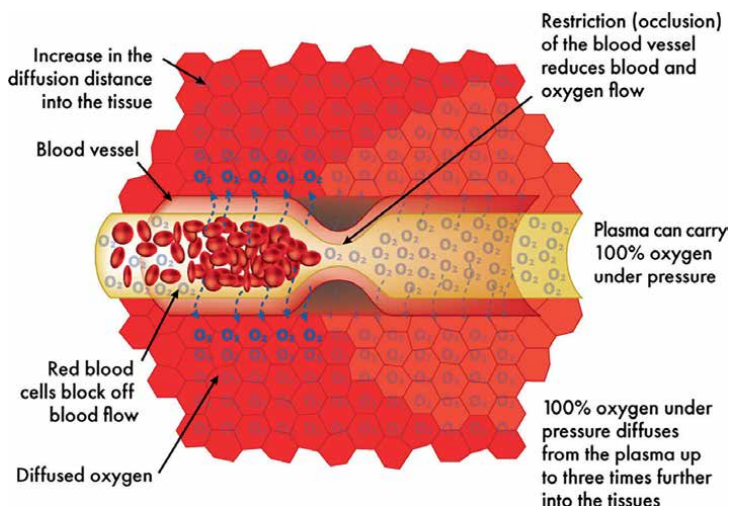


Figure 5. Figure representing the direct transfer of oxygen to plasma and surrounding tissue because of increased diffusion, a direct result of hyperbaric oxygen [8].

- 2. Fibroblast activation:** Fibroblasts play a critical role in the wound healing process by secreting collagen and other extracellular matrix components. Exposure to high oxygen levels enhances fibroblast proliferation and differentiation, thereby accelerating the maturation of the extracellular matrix and enhancing wound strength and durability.
- 3. Collagen synthesis:** Collagen is the main structural protein in the extracellular space in the various connective tissues in the body. Increased oxygen levels boost the hydroxylation of proline and lysine, two amino acids necessary for the stable formation of collagen molecules. Enhanced collagen synthesis under HBOT conditions leads to more robust and resilient tissue repair.
- 4. Reduction of inflammation:** HBOT has been shown to reduce local and systemic inflammation by decreasing pro-inflammatory cytokines and enhancing the activity of anti-inflammatory mediators. This reduction in inflammation can decrease swelling and pain, further aiding the healing process.
- 5. Bacterial oxidative killing:** The high levels of oxygen delivered during HBOT are toxic to certain anaerobic bacteria and enhance the oxidative killing capacity of leukocytes. This is particularly beneficial in wound healing, as it reduces the risk of infection, a common complication in surgical interventions.

By understanding these mechanisms and biological impacts, practitioners can more effectively utilize HBOT in cosmetic surgery to enhance outcomes and reduce recovery times. This scientific foundation not only supports the clinical application of HBOT but also guides further research into optimizing protocols for specific types of cosmetic procedures [10].

3. Clinical applications in cosmetic surgery

3.1 Case studies

Several clinical trials and case studies have demonstrated the efficacy of HBOT in enhancing wound healing in cosmetic surgery settings. For example, a controlled study published in the *Journal of Plastic and Reconstructive Surgery* compared postoperative healing in two groups of patients undergoing facelifts: one group received HBOT pre- and post-surgery, while the control group did not. The HBOT group exhibited significantly faster healing times, reduced swelling, and fewer complications, such as hematoma formation. These outcomes suggest that HBOT can be a valuable adjunct to traditional postoperative care in cosmetic surgery, enhancing patient outcomes and satisfaction [11].

3.2 Procedure types

HBOT has been found beneficial across a variety of cosmetic procedures, including:

- *Facelifts (Rhytidectomy)*: Enhances recovery by reducing swelling and bruising, leading to a quicker return to normal activities.
- *Breast augmentations*: Supports healing by promoting vascularization, which is crucial for the survival of fat grafts and reduction of capsular contracture.
- *Skin grafts and flaps*: Increases the success rate of grafts and flaps by improving oxygenation and reducing ischemic complications.

These examples highlight the versatility of HBOT in cosmetic surgery, catering to a range of procedures that require enhanced tissue repair and healing [1]. **Figures 6–8** are examples of the latter.

3.3 Treatment protocols

Typical HBOT protocols for wound healing in cosmetic surgery involve sessions lasting approximately 90–120 minutes, with patients receiving 100% oxygen at pressures between 1.5 and 2.5 atmospheres absolute (ATA). The frequency of treatments



Figure 6. Foot ulcer before (a) and after (b) hyperbaric treatment [12].

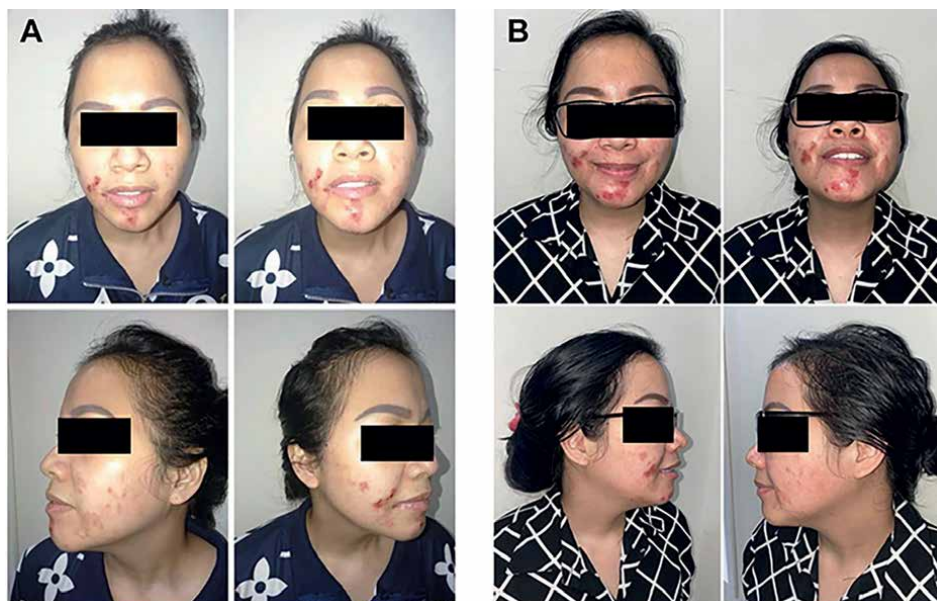


Figure 7.
Post thread lift allergy leading to facial excoriations. (A) Multiple wounds on the nasolabial folds and jawlines before HBOT. (B) Inflammation resided and wounds turned bright red as vascularization improved after 1 month of HBOT [13].

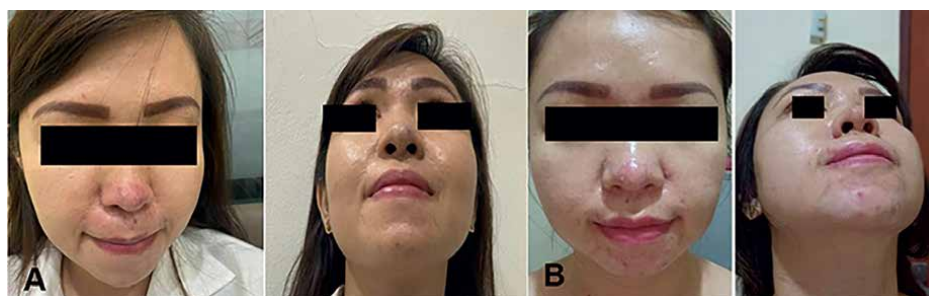


Figure 8.
Post-filler vascular occlusion of the nasal tip. (A) Erythema and blanching of the nasal tip before HBOT. (B) Excoriations turned bright red as vascularization began to improve after 1 month of HBOT [13].

can vary depending on the specific needs of the procedure and patient conditions, but commonly, a total of 5–10 sessions are recommended for optimal results [14]. For instance, in the case of facelifts, HBOT may be administered daily for the first few days post-surgery to maximize the reduction in swelling and bruising. Treatment protocols should always be tailored by medical professionals based on individual patient assessments and the specific type of surgery performed [10].

The integration of HBOT into cosmetic surgical practices offers a promising tool for improving outcomes. Its use is supported by scientific evidence demonstrating its benefits in speeding up the healing process, reducing the risk of complications, and enhancing the overall success of cosmetic procedures. As HBOT becomes more recognized in this field, its protocols continue to be refined, providing valuable insights for practitioners aiming to achieve the best possible patient outcomes [14].

4. Evidence-based benefits

4.1 Research overview

The utilization of Hyperbaric Oxygen Therapy (HBOT) in cosmetic surgery has been substantiated by numerous research studies that highlight its benefits in enhancing wound healing. These studies consistently show that HBOT increases oxygen delivery to surgical sites, accelerates the healing process, and reduces the incidence of complications such as infections and necrosis.

For example, a landmark study conducted on patients undergoing rhinoplasty demonstrated that those treated with HBOT showed a 35% decrease in healing time compared to the control group. The study attributed this improvement to the enhanced oxygenation and reduced inflammatory response facilitated by HBOT.

4.2 Statistical data

Statistical evidence further underscores the efficacy and safety of HBOT in cosmetic surgery:

- *Infection rates:* Research indicates that HBOT can reduce postsurgical infection rates significantly. A meta-analysis of over 3000 cosmetic surgery patients revealed that the infection rate in the HBOT group was only 2%, compared to 10% in the non-HBOT group [14].
- *Healing times:* A systematic review focused on breast reconstruction surgeries found that patients receiving HBOT had a 40% reduction in healing times, with improved scar quality and reduced incidence of revision surgery [15].
- *Complication rates:* Data from a multicenter study involving facelift surgeries showed a reduction in complication rates from 15% in the control group to 5% in the HBOT group. Common complications such as hematoma and seroma were notably less frequent among patients treated with HBOT [14].

5. Challenges and limitations

5.1 Risks and complications

While Hyperbaric Oxygen Therapy (HBOT) is generally considered safe, it does carry potential risks and complications, particularly when used in the high-risk environment of postoperative care in cosmetic surgery. Common risks associated with HBOT include:

- *Barotrauma:* Due to changes in air pressure, patients can experience ear pain or more severe injuries such as a ruptured eardrum.
- *Oxygen toxicity:* If administered improperly, the high levels of oxygen can lead to oxygen toxicity, affecting the central nervous system and pulmonary systems.

- *Claustrophobia*: The enclosed space of the hyperbaric chamber can induce feelings of claustrophobia in some patients.
- *Fire hazard*: Due to the high levels of oxygen used in HBOT chambers, there is an increased risk of fire if safety protocols are not meticulously followed.

5.2 Limitations in research

Despite the growing body of evidence supporting HBOT in cosmetic surgery, there remain significant gaps in the current research:

- *Lack of standardization*: There is considerable variability in the HBOT protocols used in studies, including differences in pressure levels, duration, and frequency of sessions. This lack of standardization makes it difficult to compare results across studies or establish optimal treatment guidelines.
- *Small sample sizes*: Many studies have relatively small sample sizes, limiting the generalizability of their findings.
- *Long-term effects*: The long-term effects of HBOT on cosmetic surgery outcomes are not well-documented, with most studies focusing on short-term results.

5.3 Cost-effectiveness

Incorporating HBOT into cosmetic surgical practices also presents economic considerations:

- *Initial investment*: The cost of acquiring and maintaining hyperbaric equipment is substantial. Additionally, the operational costs—including staffing, training, and safety compliance—can be significant.
- *Insurance and reimbursement issues*: In many regions, HBOT is not routinely covered by insurance for cosmetic procedures, potentially placing a financial burden on patients and limiting the accessibility of this treatment.
- *Cost vs. benefit*: While HBOT can reduce the time to recovery and decrease the incidence of complications, these benefits must be weighed against the high costs of the therapy. Economic analyzes are needed to determine whether the improved outcomes justify the additional expenses [16].

In conclusion, while HBOT offers promising benefits for enhancing wound healing in cosmetic surgery, it is crucial for practitioners to consider the associated risks, research limitations, and economic implications. Future research should aim to address these gaps, particularly through large-scale, randomized controlled trials, to better define the role of HBOT in cosmetic surgery and establish clear, evidence-based guidelines for its use.

6. Future directions

6.1 Emerging research

The field of Hyperbaric Oxygen Therapy (HBOT) in cosmetic surgery is ripe with potential for new research avenues that could further elucidate and expand its applications. Current research efforts are focusing on:

- *Extended applications:* New studies are examining the effectiveness of HBOT in less common cosmetic procedures, such as body contouring and nonsurgical facial rejuvenation techniques. These studies aim to establish broader, evidence-based applications for HBOT in cosmetic surgery.
- *Optimal treatment protocols:* Ongoing clinical trials are aimed at determining the most effective treatment protocols for HBOT, including the optimal number of sessions, duration of treatment, and specific pressures to be used for different types of cosmetic surgeries.
- *Patient-specific outcomes:* Researchers are also focusing on how individual differences, such as age, health status, and smoking habits, affect the outcomes of HBOT in cosmetic surgery. This could lead to more personalized treatment plans.

6.2 Technological advancements

Technological innovations continue to enhance the safety, efficiency, and applicability of HBOT:

- *Portable hyperbaric chambers:* Advances in technology have led to the development of portable hyperbaric chambers, which could be used in outpatient settings, making HBOT more accessible to patients.
- *Real-time monitoring systems:* Integration of real-time monitoring systems within HBOT setups can enhance patient safety by providing continuous feedback on patient vitals and the internal environment of the chamber. This can help prevent complications such as oxygen toxicity.
- *Automated pressure adjustment technologies:* New technologies that automate the adjustment of pressure levels based on real-time physiological responses are being developed. These systems aim to optimize the therapeutic effects of HBOT while minimizing risks.

7. Summary and conclusions

7.1 Recapitulation

This chapter has explored the integration of Hyperbaric Oxygen Therapy (HBOT) into cosmetic surgery, examining its scientific underpinnings, clinical applications, and the body of evidence supporting its efficacy and safety. The key points include:

- *Mechanism of action:* HBOT enhances the oxygenation of tissues, which supports various physiological processes crucial for wound healing, including angiogenesis, fibroblast activation, and collagen synthesis.
- *Clinical applications:* HBOT has been effectively applied in a range of cosmetic surgeries, including facelifts, breast augmentations, and skin grafts, demonstrating significant benefits in reducing recovery times and improving overall surgical outcomes.
- *Evidence-based benefits:* Research and statistical data have shown that HBOT can reduce infection rates, speed up healing processes, and lower the incidence of complications, making it a valuable adjunct in cosmetic surgical care.
- *Challenges and limitations:* Despite its benefits, HBOT comes with risks such as barotrauma and oxygen toxicity, and there are economic and practical considerations that can limit its application.
- *Future directions:* Emerging research and technological advancements are likely to enhance the effectiveness, safety, and accessibility of HBOT in cosmetic surgery.

7.2 Final thoughts

Looking ahead, the future of HBOT in cosmetic surgery appears promising. Continued research and technological development are crucial for overcoming current limitations and expanding its use. It is recommended that:

- *Standardized protocols:* The development and adoption of standardized treatment protocols based on robust clinical evidence will be essential for optimizing treatment outcomes and ensuring patient safety.
- *Personalized treatment plans:* Further studies should focus on how individual patient factors affect HBOT outcomes, which can lead to more personalized, effective treatment approaches.
- *Cost-effectiveness analysis:* Comprehensive economic evaluations are needed to better understand the cost-benefit ratio of HBOT in various cosmetic procedures, which will help in making informed decisions about its broader adoption.

In conclusion, HBOT holds significant potential to transform postoperative care in cosmetic surgery. By continuing to build on the current foundation of scientific research and by leveraging new technologies, practitioners can enhance the therapeutic benefits of HBOT, ultimately leading to better patient care and satisfaction in the field of cosmetic surgery.

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Perspective Chapter: Lymphatic Therapy and Post-Operative Care – The Science of a Seamless Recovery

Brandy Fenwick

Abstract

This chapter explores the history of manual lymphatic drainage (MLD) and its importance. Complete decongestive therapy (CDT), which utilizes both MLD and skilled wrapping techniques or garment compression for patients living with lymphedema and lipedema, or basic MLD for autoimmune disorders or general selfcare, has been historically utilized. Interestingly, the beauty of the lymphatic system and its function has come to the forefront of more recent conversation as it relates to pre/post-operative care. This profound technique has evolved through the hands-on experience and science-based findings of post-operative specialists internationally. This revolutionary concept of lymphatic work or “therapy” (MLD technique) as a foundational tool of complete post-operative care has truly optimized patient outcomes. These specialists, armed with staged treatment techniques, play a vital role in ensuring ideal results for patients who have experienced body altering procedures. Facilitating esthetically pleasing results based on each patient’s unique procedure and needs is the primary goal. Despite meticulous surgical planning and care, post-operative complications can still arise. There are multiple facets to the recovery process. Therefore, having the right post-operative care facilitated by surgeons, surgical staff, and post-operative specialists is essential.

Keywords: manual lymphatic drainage, lymphatic therapy and post-operative care, stages of healing, lymphangiogenesis, compression

1. Introduction

The art of body altering procedures has been around for centuries. However, in 1990, the volume grew tenfold. Surgeons became more innovative in their approach as new techniques and technologies surfaced. The utilization of tumescent (meaning swollen and firm) introduced by Dr. Klein in 1985 allowed efficiency and efficacy of surgeries, reducing blood loss and decreasing the

sympathetic response of the body during trauma while under either local or general anesthesia [1]. Adversely, this new process introduced an exponential amount of fluid within the extracellular matrix (ECM).

Within the cosmetic and plastic surgery industry, there was a paradigm shift around 2018, posing the concept of incorporating MLD as potentially helpful for cosmetic surgery patients [2]. In late 2019, receiving “lymphatic massages” after a cosmetic procedure, was becoming a trend. Surgeons were beginning to encourage this treatment. However, this technique seen across social media platforms was and is not lymphatic drainage, lymphatic massage, or lymphatic therapy. Rather, it is post-surgical drainage, literally manually “milking” the patient’s torso to rid them of interstitial post-surgical fluids. This technique is beneficial when performed gently rather than with oils and aggressive strokes. Aftercare should not induce additional pain or trauma to the patient or their tissues.

This misinformation became a segway for certified providers to originally implement MLD as a foundational tool along with post-operative care. This application of MLD has gradually morphed into a more applicable title of lymphatic therapy. The additional post-operative components include educating patients on the recovery process, drain management, compression guidance, incisional care, scar work, umbilicus training, hygiene, taking measurements and photos to document patient progress, selfcare instruction, incorporating mobility and neuromuscular re-education, encouraging proper nutrition, establishing home programs, and providing emotional support within our scope of practice.

As the number of patients undergoing cosmetic procedures continues to increase, there is a need for adjunctive therapies that promote patient recovery which is paramount to improve post-operative outcomes and enhance patient’s satisfaction. The Esthetic Society reported in 2022 that with 11,078 reviews of patient satisfaction across various platforms, esthetic appearance was the strongest predictor of rating across all procedures. Buccal fat removal (98.8%) and abdominoplasty (98.1%) had the highest satisfaction, and Brazilian butt lift had the lowest (88.2%). Additional significant contributors included staff interaction, bedside manner, health outcomes, complications, and post-operative care [3].

Although in its infancy, post-operative specialists are gaining traction as an intricate part of the surgical experience. In the past 5 years post-operative care has revolutionized the final outcomes of body altering procedures. Through the author experience, it has been expressed by surgeons that a patient at their 6-week follow-up may present as looking 6 months post-op. This may not always be the case. However, the science is there, and the critical thinking involved with creating a seamless recovery is a beautiful thing to see come to fruition.

2. History of complete decongestive therapy (CDT)

The original method of MLD was developed by Dr. Emil Voder and his wife, Estrid Voder, in the 1930s. Dedicating their studies to the lymphatic system and the techniques involved with intuition and practical treatments. The practice of MLD was first introduced in North America in 1972 and is taught in countries all around the world [4]. The utilization of compression and exercise came in the 1950s when Dr. Keith Stillwell published results for treating lymphedema post-mastectomy with massage, compression, and exercise. This later evolved in the 1980s when Professor Michael Foeldi combined both Voder’s and Stillwell’s approaches and revolutionized what is now known as Complete Decongestive Therapy (CDT) [5–7].

3. Anatomy and mechanisms of the lymphatic system (LS)

The lymphatic system is nothing short of remarkable as it works silently in the background, parallel with the circulatory system. It is supportive of the immune system and aids in homeostasis. When it comes to surgery and the recovery process it plays a crucial role.

3.1 Anatomy

The lymphatic system (LS) is an open system. At the capillary loops in the dermis, the initial lymph capillaries (ILC) effectively retrieve approximately 20% of the interstitial fluids (IF), comprised of 96% water, and the remaining 4% being plasma proteins, debris, bacteria, long chain fatty acids, and other cells too large to be picked up by the circulatory system at the capillary loops located in the corium papilla. Once the IF is within the LS, it is considered lymphatic fluid (LF). As illustrated in both **Figures 1** and 2, there is a sequence of events that occur to filter this fluid prior to reintroducing it to the circulatory system. Throughout this process, the LF is being transported via the superficial and deep

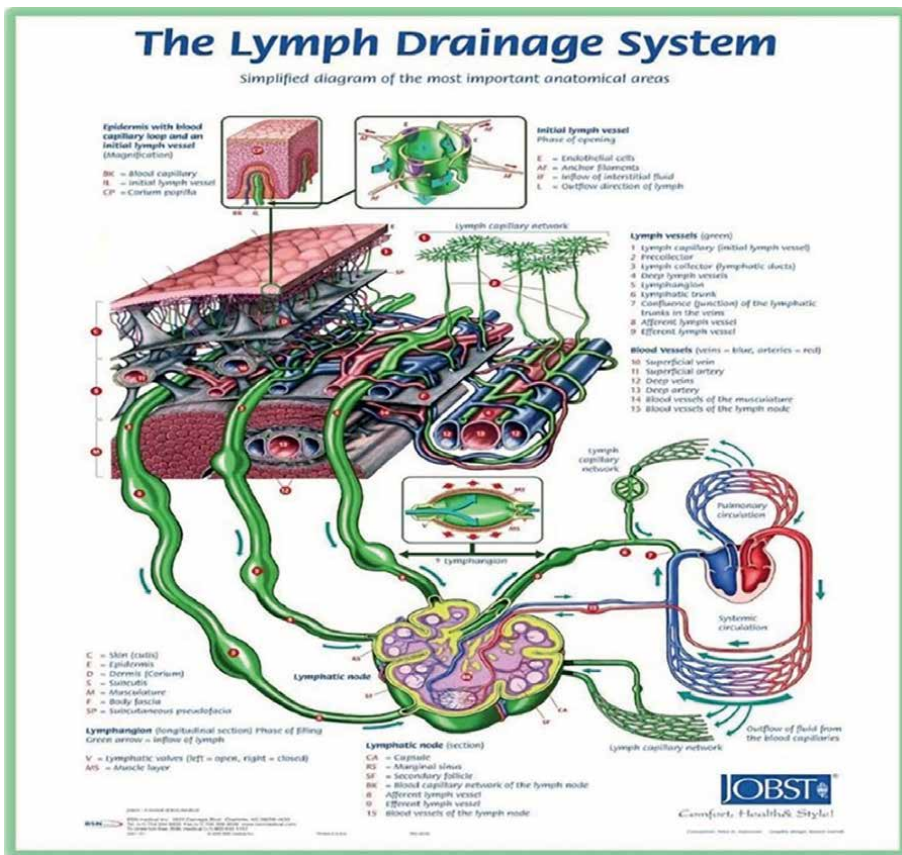
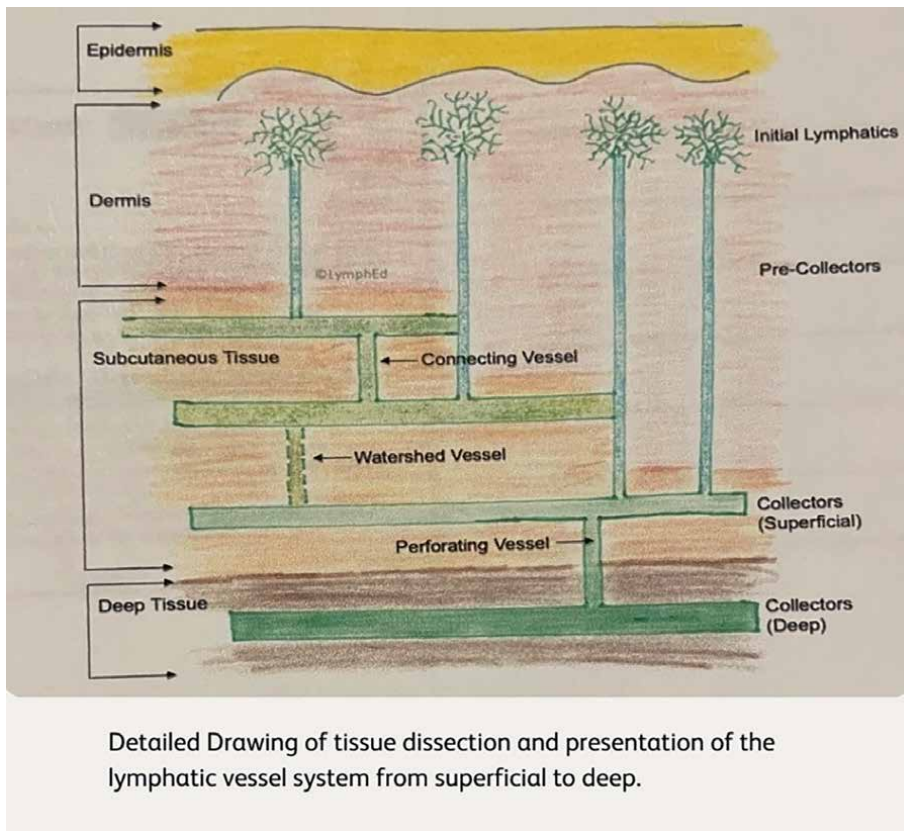


Figure 1.
 Jobst compression illustration of the lymphatic system.



Detailed Drawing of tissue dissection and presentation of the lymphatic vessel system from superficial to deep.

Figure 2.
DiCecco, Shelly. *Lymphatic system: Vessels, lymphed manual*. 2021 [6].

LS and filtered through 300-900 lymphnodes throughout the body. This movement is then carried onward to the lymphatic trunk (the largest lymph vessel) stationed behind the diaphragm. The lymphatic trunk manages the cyclic process of bilateral lower quadrants and the upper left quadrant of the trunk and extremities, the upper right quadrant is effectively managed by the right lymphatic duct. Then LF is transported from the lymphatic ducts to bilateral venous angles (supraclavicular fossa). Progressing to provide nutrients to vital organs and cells, provide any immune response, and finally the residual being expressed from the body through urination. This directional system can be compromised and become insufficient either dynamically or mechanically. A body altering procedure elicits a high-volume dynamic insufficiency, ultimately returning to normal function (**Figures 1–3**) [5–7].

The body is segmented into quadrants: four quadrants of the trunk, four of the face, and 2 of the breasts (25% sternal and 75% axillary). These established quadrants are separated by vessel blockades called watersheds. In the process of managing a post-surgical patient, there are multiple anastomoses that allow for redirecting LF during the dynamic insufficiency stage. The inguinal to/from

- NO CENTRAL PUMP
- Dynamic insufficiency: Healthy system is overwhelmed due to trauma
- one-way “directional”, open system, the initial lymph vessels can pick up interstitial fluid at any point. It then converts to lymph, is transported and processed through the lymph nodes, and then drains at the venous angles into the blood stream.
- It's interstitial fluid until it turns into lymphatic fluid once it's in the lymphatic system
- Superficial and deep system:
 - superficial initiates in epidermis at the capillary loop (corium papilla) – dermis (corium)
 - deep transitions via (perpendicular) perforating precollectors the to (parallel) collectors located in muscle/fascia/joints. Ex: Sternocostal joints, Intercostal muscles, pubis symphysis

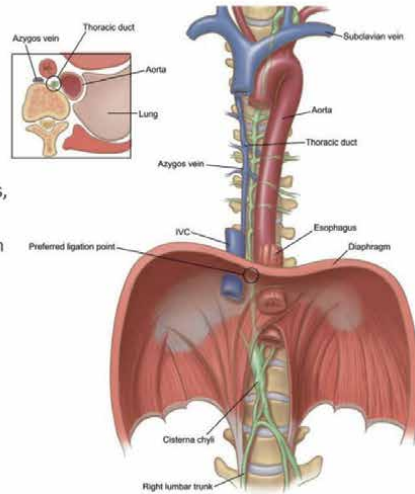


Figure 3.
 Summary of lymphatic anatomy and its functional mechanisms.

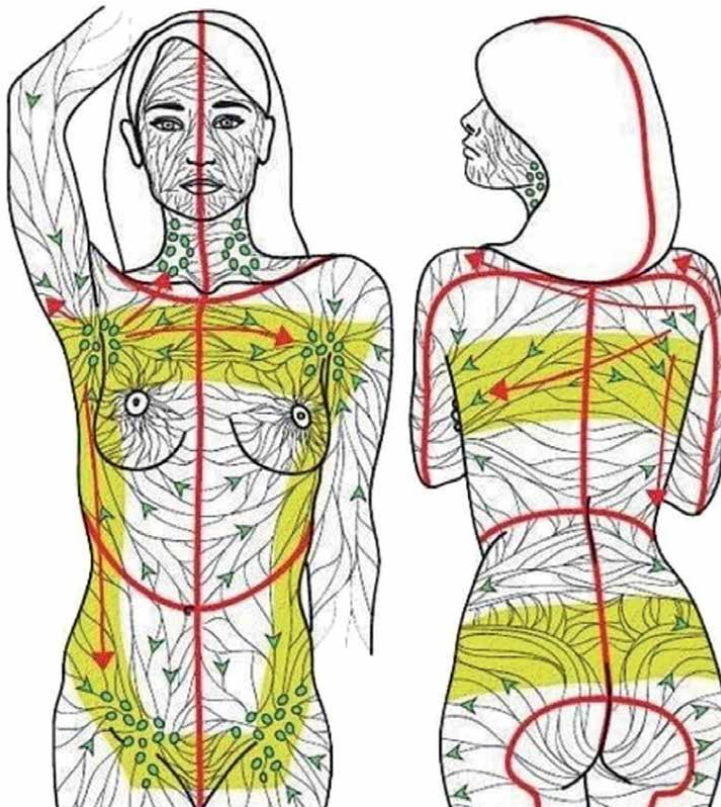


Figure 4.
 Illustration of watersheds (RED), major lymph node bundles (GREEN), and anastomosis (YELLOW).

axillary anastomosis is a primary mechanism for redirecting during the recovery process (**Figures 2 and 4**).

3.2 Lymphatic load and diffusion distance

The transport capacity (TC) of the LS is 10x greater than the lymphatic load (LL) in normal conditions. However, with a high-volume dynamic insufficiency such as *trauma induced from surgery*, the lymphatic vessels have been damaged, severed, or compromised thus effecting their function. With the influx of fluids introduced to the body both by external forces such as the injecting of tumescent and the natural inflammatory response, the LL will then exceed the transport capacity of the LS. When this occurs, the diffusion distance in skin-to-body relation increases and impedes the metabolic and healing processes. Therefore, a mechanism to facilitate reducing the diffusion distance is crucial for returning the body to homeostasis [5–7].

3.3 Lymphangiomotoricity

Lymphangiomotoricity is the speed at which the angions of the LS contract. Typically, the LS pumps at 10–12 pulses per minute (ppm) with a maximum of 60 ppm. With a sluggish or insufficient system due to trauma, lack of movement, and anesthesia, a therapist will in effect work to mimic the LS with a slight increase to approximately 20–30 ppm to “trick” the system and progress toward homeostasis [5–7].

4. Non-surgical to post-surgical

Putting the LS anatomy and mechanisms into perspective once the “normal system” is impacted by an invasive cosmetic procedure is strategic. The fundamental knowledge of the LS, the impact of surgery, proper awareness of body system responses, residual effects of surgery, and how to bridge the surgery to recovery gaps, are the greatest puzzle pieces of putting together a seamless recovery.

4.1 Dynamic insufficiency VS mechanical insufficiency

The body takes on physiological responses, a massive increase of interstitial fluids, and patients wake in a fight or flight sympathetic state. A body altering procedure is a high-volume dynamic insufficiency. However, it has the potential to evolve into a mechanical insufficiency if an excessive number of lymphatic passageways, superficial or deep, are damaged, or scar tissue impedes lymphatic flow. This can ultimately compromise the LS permanently.

4.2 Lymphatic therapy (LT)

With the growing popularity of post-operative care, there have been small road-blocks due to misinformation or misinterpretation. Through this author’s communication, patients have voiced fear of having “lymphatic massages” because of the word massage as it relates to the kneading of the skin. Others are fearful of being squeezed or having skin pulled on too harshly and unnecessarily to manually drain fluids, as seen in social media. Therefore, the post-op specialists currently in the industry are

progressing toward the utilization of verbiage such as “lymphatic therapy,” a distinct transformation from MLD to a more medically based, critical thinking technique of post-op care. Application of LT facilitates the beginning of a healing journey. The body is overloaded with tumescent, which includes lidocaine, a lipophilic substance that is easily sequestered in the fat and remains for several days, contributing to an already damaged and sluggish LS post-operatively. The superficial LS has endured a significant amount of damage, now having severed or traumatized lymphatic vessels, cauterized lymph nodes or potentially removal of lymph nodes [8].

LT continues to incorporate the Voder Method, utilizing both vertical and horizontal skin stretch strokes to move toward proper regional lymph bundles. These mentioned strokes are then modified in accordance with the palpation of the tissues and recognition of the stage of healing an individual is in. Thus, the reason hands-on palpation is crucial and truly supersedes machine use in the first 5–6 weeks of post-operative care. Famous osteopathic physician Viola Fryman said: “Palpation cannot be learned by reading or listening; it can only be learned by palpation” [9]. According to the Academy of Lymphatic Studies (ACOLS) the amount of pressure applied may vary from 5 to 10 g per cm², with the typical hand 10 cm x10 cm = 500 g–1000 g. This combined with Dr. Guimberteau’s (the founder of Kinesio Tape) Pressure 60 g – 130 g force (no more than the weight of a cell phone) to engage epidermis/dermis gives parameters necessary for engaging in LT and post-operative care (**Figure 5**) [7, 10].

4.3 Stages of healing

The four stages of healing are major components of understanding a treatment protocol post-surgically. As displayed in **Figure 6**, there is a vast amount of overlapping within the recovery process. Individuals recover at varying speeds depending on preoperative status. Regardless, all have a core healing process in effect. The four stages of healing are observable and palpable guides in the morphology of the tissue matrix. Ultimately a director of transforming each treatment session accordingly.



Figure 5. Symbolizes points of contact when palpating and when providing lymphatic skin stretch strokes; hand application will vary, but markers indicate all contacting surfaces.

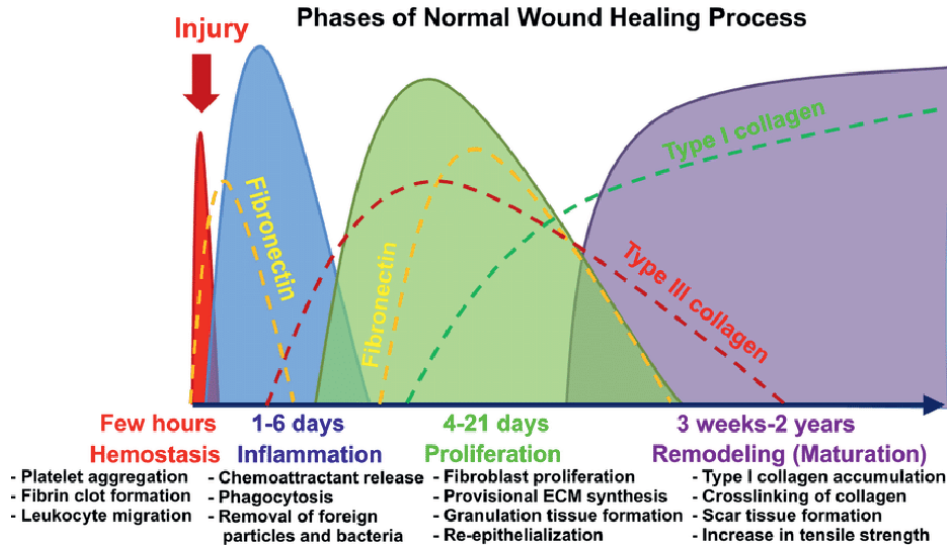


Figure 6.
Graphical presentation of the four stages of healing.

- i. Stage 1: Bleeding stage is when initial and overlaps more noticeably for 1–6 days after a cosmetic procedure. The body’s reaction to trauma is to establish homeostasis rapidly, with platelets adhering to the sub-endothelial wall and the first fibrin strands begin to adhere within about 60 seconds [10]. Now imagine this occurring with a mass influx of tumescent. This influx of fluids impedes the fibrin attachment, thus creating a post-surgical sensation, which is described as velcro pulling apart and tissues filling with “hot lava.”
- ii. Stage 2: Inflammatory stage is now when the injured vessels leak transudate (made of water, salt, and protein), causing localized swelling. Inflammation both controls bleeding and prevents infection. The fluid engorgement allows healing and repair cells to move to the site of the wound [11]. Patients undergoing a body altering procedure are impacted by a “wound” of greater surface area. The damaged cells, pathogens, and bacteria are removed from the wound area and white blood cells, growth factors, nutrients, and enzymes create the swelling, heat, pain and redness commonly seen. With the influx of transudate plus tumescent the body takes on a larger diffusion distance. Inflammation is a natural part of the wound healing process and is only problematic if prolonged or excessive. Therefore, implementing lymphatic therapies post-op day, one initiates the process of lymphatic homeostasis, which aids in reducing the expanded (greater than normal trauma) diffusion distance.
- iii. Stage 3: The proliferative phase of wound healing is the rebuilding of new tissue made up of collagen and extracellular matrix. In the proliferative phase, the surgical tissues contract as new tissues are laid down. This is an important stage for lymphangiogenesis, angiogenesis, and neurogenesis. These network vessels are now reconstructed so that the granulation tissue can be healthy and receive sufficient oxygen, nutrients, and information. Myofibroblasts cause the wound to contract by gripping the edges of surgical incisions and surface

tissues after liposuction and pulling them together or attempting to draw the tissues closer to the body's fibroseptal network using a mechanism like that of smooth muscle cells. This stage is also important to understand for any dehiscence that may occur post-surgically. It tactilely presents the firmness of the tissues impacted by the cosmetic procedure. When collagen is laid down, it is disorganized [11]. Treatment from week 2 and thereafter is required to help reduce the presence of indurated tissues, facilitate the next stage of healing and minimize risks of irreversible fibrosis (**Figure 7**).

- iv. Stage 4: The remodeling/maturation stage of wound and post-surgical healing is when collagen is remodeled from type III to type I. The cells used to repair tissues in phase 3 are no longer needed, thus removed by apoptosis, or programmed cell death. Collagen is now aligned along tension lines, and water is reabsorbed so the collagen fibers can lie closer together and cross-link. Cross-linking of collagen reduces scar thickness and makes the skin area of the wound stronger. Generally, remodeling begins about 21 days after an injury and can continue for a year or more. Even with cross-linking, healed wound areas continue to be weaker than uninjured skin, generally only 80% of the tensile strength of unwounded skin [11]. Manual sculpting is a perfect touch at this stage of healing. It's the opportune time for patients to focus highly on "snatching" their waist, if this is the desire for their recovery journey. The stages of healing can be a fragile process, and it requires knowledge and understanding of each stage both in wound healing and tissue morphology to progress a patient through their recovery (**Figure 8**).



Figure 7.
Stage 3, significant induration of the lower abdomen before and after four sessions and proper garment wear.



Figure 8.
Inner thigh lift dehiscence 4-day progression in healing.

4.4 The significance of day 1 treatment

There is significant value in day 1 post-operative treatment. This is the beginning of an import process. In **Figure 9**, this 1-day post-op patient has had multi-procedure surgery; educating and assessing her are highly beneficial to her first week of recovery. A post-op specialist has several things to provide and carry out in this session:

- i. Establish patient trust in care received
- ii. Assess skin through palpation and observation
- iii. Give patient the understanding that it is “ok to touch yourself”
- iv. Check drain (if applicable) for proper function
- v. Educate patient on selfcare and things to expect the first week of recovery
- vi. Determine treatment plan of frequency and duration

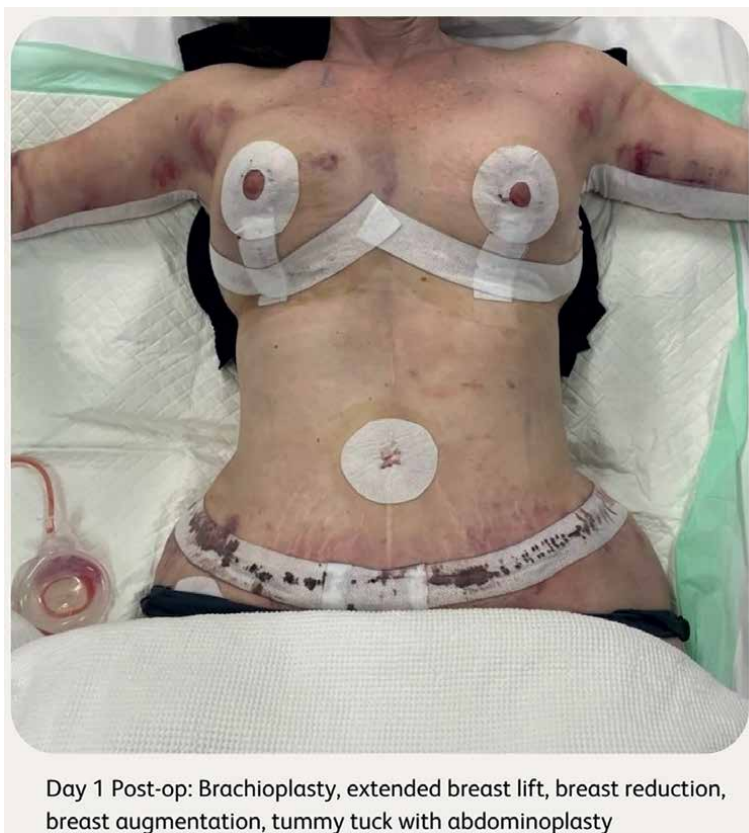


Figure 9.
Picture of day 1 post-op multiple procedure case.

From a medical standpoint, the post-op specialist assesses and provides:

- i. An analgesic (parasympathetic) effect.
- ii. Controlled modification of the skin stretch stroke of lymphatic therapy.
- iii. Monitor for infection or skin reactions.
- iv. Observing the patient for negative physiological effects that may need medical attention.
- v. Skin assessment of all bruising and any discoloration indicative of decreased blood flow to and incision site.
- vi. Communicate any findings to surgical staff or surgeon.

5. Lymphatic therapy in tandem with all post-operative care

As previously mentioned, LT is not to be mistaken for massage. It is skin stretch stroking of the superficial tissues and intermittent slightly deeper work pumping

perpendicularly to the deeper lymphatics *via* joints, muscles, and fascia. Not a soul application for post-operative care but the key component throughout the patient's journey. The treatment protocol will gradually shift, the use of LT decreases but it is always a part of the treatment. As the shift in treatment evolves, several distinct processes should occur.

5.1 Palpation for any tissue anomalies

Palpation is the key to understanding the body's progressive needs in treatments. There is potential for small absences, or unexpected occurrences as shown in **Figure 10**. The use of a cellulite release procedure followed by a Brazilian butt lift (BBL) resulted in channels of loose liquefied fat. Finding this anomaly in a timely manner allowed the patient to communicate with her surgeon to keep abreast of the issue and care for as needed.

5.2 Skin assessment for seromas, hematomas and allergic reactions

The prevention of seromas, hematomas, and allergic reactions is first and foremost in the immediate aftermath of surgery. The presence of a seroma is palpable as a “waterbed” if superficial enough. However, at times they may be deep or in an unexpected area such as the mons pubis. Observation and palpation are a must in after care to find these pockets of fluid and to listen to the patients explanation of what they may feel. Some patients will report pain and feeling bulgy, others do not even realize they have these 10 cc–500 cc or greater pockets present. Hematomas are more challenging to find if there is not a discoloration of the skin. There is a fluid like sensation under the skin but is less “waterbed” like and more gelatinous in palpation. Allergic reactions can be very traumatizing to the patient considering they are in post-surgical pain and now they are itching nonstop (**Figure 11**), this can be mitigated with over the counter products but may ultimately require surgeon intervention for use steroids etc

5.3 Improving active range of motion (AROM) and functional mobility

It is natural to guard when in pain. After patient's initial surgical instructed range restrictions such as tummy tuck or a breast augmentation, it is imperative



Figure 10.
Effects of BBL and cellulite release performed at the same time. These fat grafted channels (lighter skin areas) are palpable anomalies and are filled with liquefied fat that did not take.

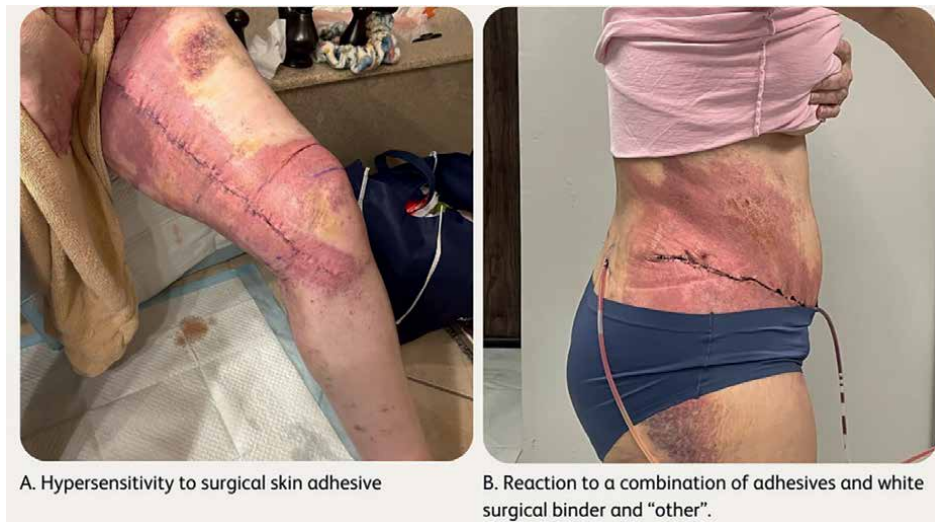


Figure 11.

A. After 3 surgeries and some closure technique, the patient's body reacted to surgical skin adhesive. The surgical skin adhesive migrated into the incisions and continued to create a systemic reaction for several months. B. Patient had an initial unknown reaction. It was later determined she reacted to the elastic binder and adhesives.

to incorporate small diagonal, postural, or extremity movements to begin slowly returning back to normal activities of daily living. There are exceptions; for example, if additional anchor sutures for a tummy tuck were placed, a patient should remain flexed at 45 degrees for a few days or weeks longer per specific surgeon's protocol. In the case of a breast augmentation with added mesh or securing pocket sutures, the protocol may be to not reach over the head and not lie on the side for several weeks.



Figure 12.

A. Patient is very limited due to stage 3–4 induration and natural holding patterns (guarding). B. 1 hour later, the patient has quality improvement in her AROM for normal activities of daily living.

With no surgical restrictions after arm liposuction, **Figure 12** displays limited upper extremity AROM. This was hindering the patient's work and caused axillary discomfort. This treatment session reduced these issues and improved her work day. Postural awareness is of extreme importance and can be highly problematic if not addressed from a holding pattern and mechanical standpoint (**Figure 13**).

5.4 Scar and adhesion work

Scar and adhesion work is instrumental in the laying down of the scaffolding of the new collagen. Although early scar massage is advised against in wound care literature, it is advisable through observation and practical application to apply modified LT strokes across covered incisions from any body altering procedure. This aids in stimulating lymphangiogenesis and improving the patterning of the underlying scar tissue. In week 4, actual scar work begins along with any incisions to aid in releasing adhesion and 30-day dissolvable sutures (Monocryl), fully absorbed in 90–120 days (**Figures 14 and 15**) [12]. Paying close attention to patients showing a history of Keloids, as this will require more frequent monitoring and care to reduce excessive scar production. Optimizing scar appearance spans from the preoperative period to scar maturation.

After extensive scar/incisional work in the first 5–6 weeks, it is truly beneficial to implement silicon scar tape during the day and scar repair creams or gels at night, thus allowing the skin to aerate. From multiple applications, this author



Figure 13. *Beginning at 4 weeks (first visit) to weeks, postural correction evolved with lymphatic therapy and manual tissue mobilization. Progression.*



Figure 14.
Top. Nipple reduction 5 weeks post-op. She began post-operative care in her 5th week of recovery with no scar release work. Bottom. After 2 sessions the areolas relaxed from manual scar massage, Monocryl suture releasing and mild adhesion releasing, the incision smooth for a more natural outcome.



Figure 15.
A. This draping of tissue is necessary after major weight loss followed by a tummy tuck to ensure approximation of incisional tissues. B. With scar work beginning 1–6 days after surgery and continuing on in week 4 to incorporate scar massage, Monocryl suture release, and adhesion release, the drape scar that began can become more cosmetically pleasing.

has found that the use of thicker post-surgical silicone strips presents a more effective micro-level scar massage throughout the day with active movement. The suggested guidelines for post-op patients (Table 1) give a baseline standard for optimal outcomes [13, 14].

Scar treatments noninvasive guideline		
Product	When to initiate treatment	Duration of treatment
Paper tape	POD 7	≥ 6 wk.
Scar gels/creams	Wk. 6 or once scabbing has resolved	3–6 mo. alternating with use of Silicone sheets
Silicone gel sheets	Wk. 6	3–6 mo. 12/ hours, alternating with scar gels/creams
Scar massage	3 wk.	≥ 6 wk.

Table 1.

Table of suggested effective guidelines in the use of silicone scar tapes and scar repair creams or gels.

Scar work helps reduce compensatory strategies due to adhesions developing from patients holding patterns and guarding mechanisms. As Jan Trewartha (2016) states, “the aim is to re-integrate the scar tissue into the three-dimensional fashion matrix or fashion septal network by directly changing the tissue tension and enabling the system to recognize itself. Therapies can change the appearance of scars and the way in which they influence the surrounding tissues thus leading to the client having more freedom mobility and improved sensory function” (p. 18) [15].

Additional adhesion work will become palpable in week 3–4. The treatment required may be as simple as stretching to add to the curvature of the vertical adhesion and contour the waist line. However, it can be as complex as manually releasing (popping) to improve posture, mobility, and decrease and discomfort ensued from this occurrence. It is imperative that the post-op therapist can palpate the differences in regular adhesions and hi-def ab etching. Hi-def sculpting, ab etching, soft sculpting, all have the same intention, to create a canal for fibrotic tissues to laydown and create a natural looking abdominal physique. This intentional scarring must not be confused with vertical adhesions or indurated tissues by the post-op specialist or patient. If they are not trained properly in manual work, they could potentially be ruined or have a less defined definition than intended by the surgeon (**Figure 16**).

5.5 Reducing risks of umbilical stenosis

The umbilicus is a key component contributing to the overall esthetics of the abdomen following liposuction 360 or any style of tummy tuck. This can be introduced at the time of surgery after closure. An earplug is placed in the umbilicus for approximately 1 to 2 weeks and then removed and replaced for several weeks thereafter [16]. There are certainly surgeon preferences on the process with umbilicus training. Some surgeons choose to defer this to the patient or post-op specialist in which **Figure 17** depicts the process for a post-operative session (**Figure 17**). Of researched articles, Dr. Milind Kachare [16] found “Most of the articles indicated that a smaller umbilicus was found to be aesthetically pleasing, but a numerical range of values were not specified” [17]. Therefore, helping optimize the presentation of the patient navel and training them how to carry over this routine care until no longer needed is a quality adjunct treatment during the post-operative session progression.

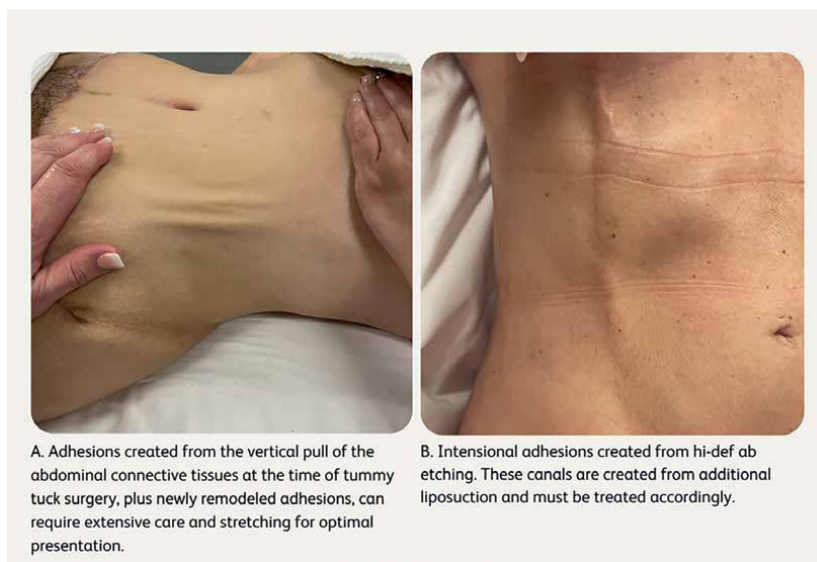


Figure 16.
A. Natural body adhesions B. Intentional scarring/adhesions for hi-def abs along semilunar lines.

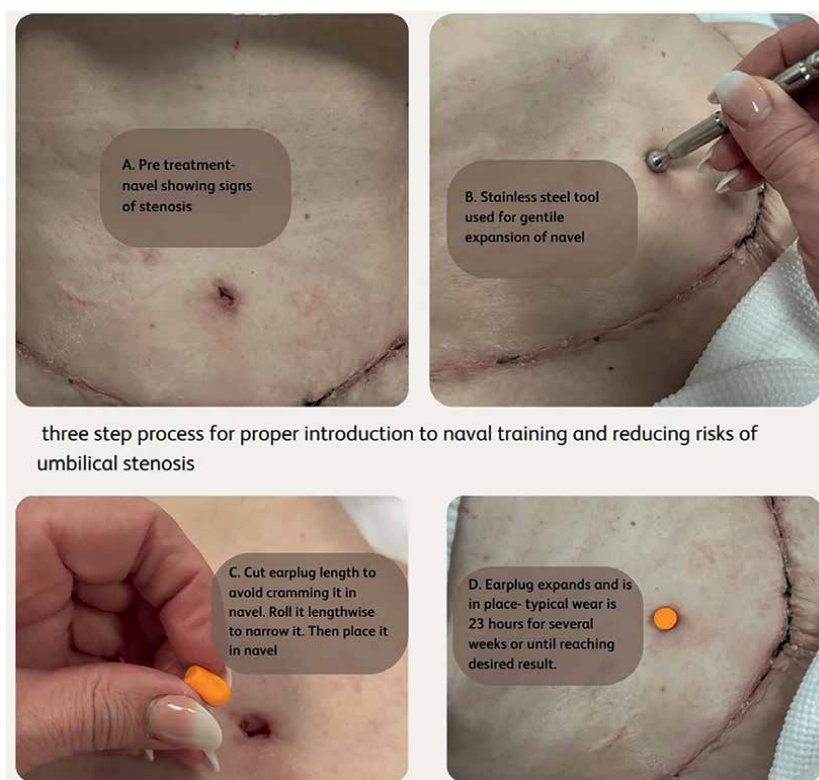


Figure 17.
A. Umbilicus in its narrowed state post-surgical B. Use of tool to manually do scar work and lightly stretch the navel. C. Shortening an ear plug to prevent cramming it in the umbilicus D. Utilizing the expanded and shortened ear plug as a soft dynamic stretch to the umbilicus to reduce umbilical stenosis.

5.6 Desensitizing

During the healing process, the body has natural internal itching, can be numb for an extended period, can be hypersensitive, and have neuropathic pain, or paresthesia. Mechanotransduction is defined as the process by which physical stimulation is converted intracellularly into various types of electrical or chemical signals [15], when the tissue matrix encompasses peripheral nerve endings/receptors [17, 18]. These specialized nerve endings may take up to 6 weeks or longer to regenerate and be responsive to stimuli. Until healing is complete, the above-mentioned occurrence of odd sensations or lack thereof may be normal for the patient.

Desensitization is a manual technique used in treatment and taught to the patient. For example, with a breast lift, reduction, or augmentation, the nipples may not have any sensation or lack symmetrical sensations, the torso may be hypersensitive to touch after liposuction 360, or the area distal to the tummy tuck scar may have paresthesia. For the nipples, there is a simple instruction for rotating the nipples between the fingers. For the body, the use of progressively rough materials, beginning with the hand, then wash rag, and ultimately tolerating a dry brush for the body is another means of desensitizing.

6. The optimal post-operative care knowledge

With post-op care, there are many things to take into consideration. When taking in the patient's information on medical history it is a helpful guide for care. Patients having comorbidities like diabetes, lipedema, or connective tissue disorders and may require adjustments to the treatment protocol.

6.1 Treatment metamorphosis and milestones

Regardless of comorbidities or not, each patient is an individual in their recovery process. The foundation of recovery “norms” is to be expected. However, it is safe to say that approaching each new case with a fresh template leads to quality care. Treatment is dictated by the patient's healing speed which will relay over to that individualized treatment metamorphosis.

From this authors repeated observation and personal experience, the patient will typically experience positive milestones in their recovery typically at 4 weeks, 4 months, 6 months, and 1 year, provided there are no unexpected interruptions in the healing process.

6.2 Emotional support *being equipped with the knowledge to educate*

Patients become hyper-aware of their body after a body altering procedure. They will observe asymmetries in the breast, buttocks, and body after a procedure. This is a normal occurrence due to our body not caring about symmetry while healing. Additionally, several aspects of a cosmetic procedure may involve “shape shifting” for 6 to 12 months as shown in **Figures 18** and **19** as it relates to the breast and buttocks (**Figures 18** and **19**).

Structural anomalies may give a distorted appearance of the results of a breast, tummy, or buttocks procedure regardless of if the patient knows they have a possible leg length discrepancy or scoliosis (**Figure 20**) or not; the realization of these impacting results can be emotional.

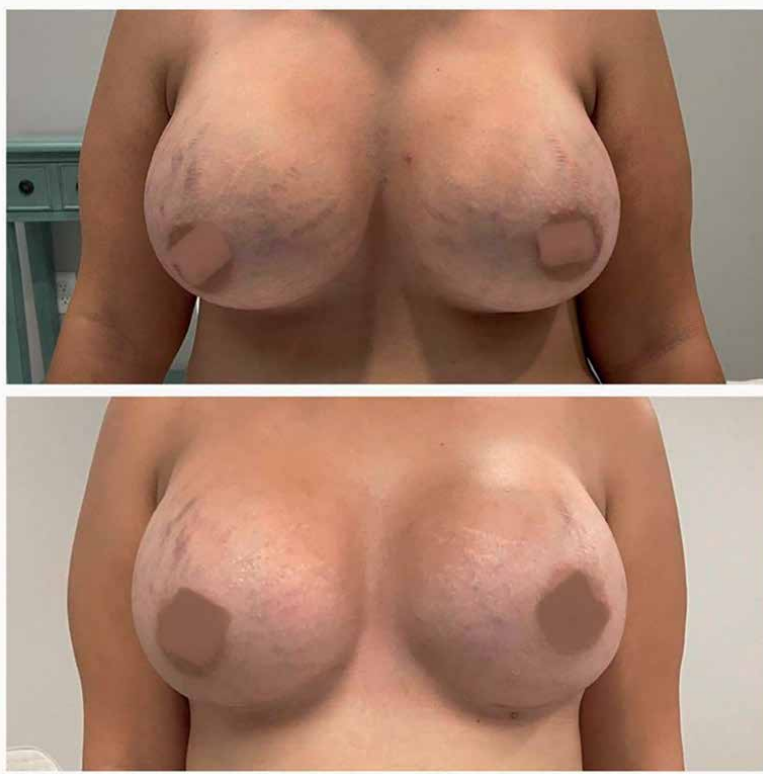


Figure 18.
Manual work weekly for 6 weeks along with patient training for pocket manipulation in the shape shifting process.



Figure 19.
At 4 weeks there is a dropping process after a BBL. The firm injected fat cells, and angry tissues begin to relax and soften, this begins the “fluffing” process. However, some patients fear they have lost their butt at this milestone and require education on the recovery process.

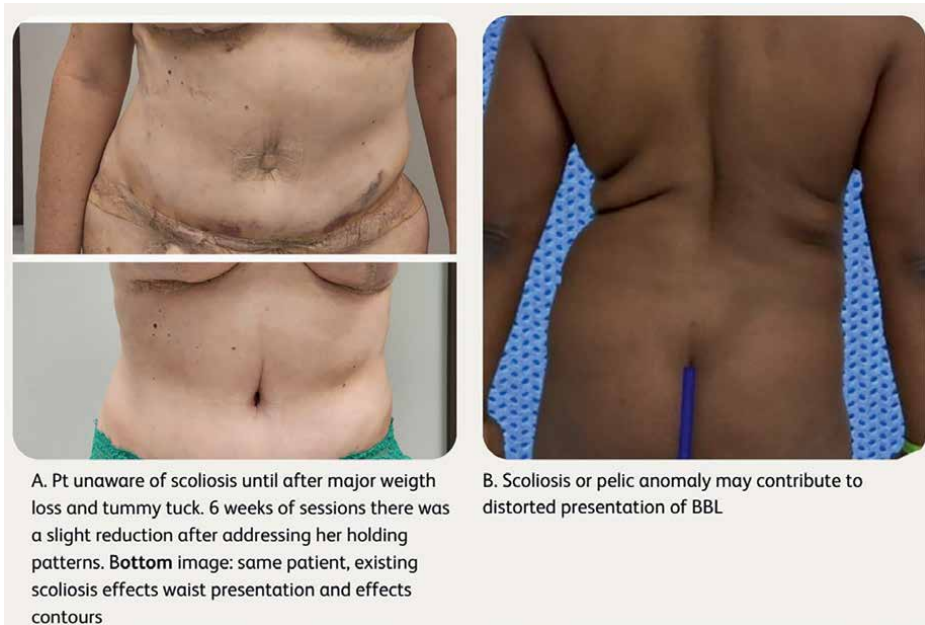


Figure 20.

A. Scoliosis was recognized after major weight loss and a tummy tuck. B. Scoliosis possible altering the outcome of a BBL.

The breast will go through possible shape shifting. However, when a patient begins to encounter a capsular contracture, this can be another emotional barrier to recovery. A patient may have a history of body dysmorphic disorder (DDD). Their body is something they have chosen to invest in and when things do not meet their expectations, they may begin to or already struggle with body image. The first several weeks of recovery can be an emotional roller coaster (Figure 21).

Post-op depression and **body dysmorphic disorder** are very real

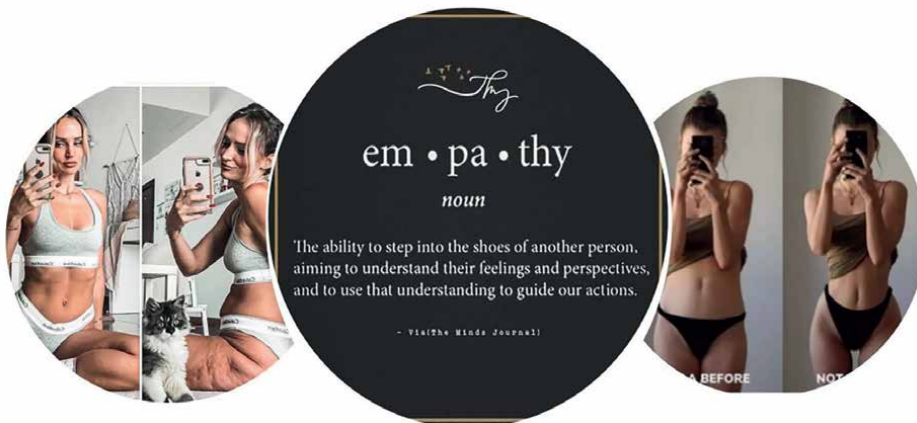


Figure 21.

Body dysmorphic disorder is not in our scope of practice to resolve. However, it is something a post-op specialist must be aware of to guide the patient through some education to ease their worries.



Figure 22.
A weekly list of possible things to expect post-surgically.

6.3 Patients' concerns - Normal or complication

Patients should be educated on things to expect (**Figure 22**).

- i. Burning or sensation of hot lava inside of the tissues as a result of liposuction
- ii. Electrical bolts or zingers as nerves begin responding
- iii. Swollen genitalia after torso liposuction or tummy tuck
- iv. Asymmetries and shape shifting of area recovering due to swelling and normal healing processes.


7. Patient home programs

For a year or more, recovery ensues, during this time the patient must become self-sufficient. With the proper therapist on board, they will be given home programs and have a means of communication for continued guidance. Post up care consists of multiple facets, tandem with patient's education and selfcare. The goal toward optimizing outcomes is to empower our patients. Giving them selfcare home programs makes them a part of the recovery team. Below are great examples of home programs (**Figures 23 and 24**).


8. Compression garments and recovery accessories

Not all compression garments are created equal, nor do they have standardized sizing. Compression is a necessary and beneficial component of aftercare. However, knowledge is key. Misinformation on social media can make this process with a patient somewhat difficult. The social media and patient goal may be to "get snatched," but this does not require a patient to squeeze their body unnecessarily into


Pelvic Mobilization



1. Tighten genitalia
2. Slowly draw/tighten up the lower abdomen and release
3. Do randomly lying, sitting, or standing



1. Tilt pelvis to front/back of body several times-slowly
2. This can be done lying or sitting
3. Recommend doing before you get out of the car



1. Gently move bent knees side to side- let gravity do the work

@thebrandyfenwick

Figure 23. At 2 weeks post-op liposuction or ant style of tummy tuck with abdominoplasty benefits from neuromuscular re-education and pelvic mobility.



BREAST PROGRAM #1	BREAST PROGRAM #2	BREAST PROGRAM #3
<p>* Sport bra-zip up (Purchase 2 sizes), remove pad inserts. Pick & wear the one that supports, but does NOT press inward on your breasts. Once on, adjust breast into proper alignment.</p> <p>*DO NOT T-REX (Move arms away from body), elbows bent and wing them away from torso like a bird (slowly) from time to time during your day. Dont be afraid to reach out or across your body-just NOT overhead.</p> <div style="text-align: center; margin-top: 10px;">  @thebrandyfenwick </div>	<p>*Use 3 finger tips or side of hand along breast bone (sternum) to the inside of each breast and give a gentle press & release. Do a few times throughout the day.</p> <p>*Place opposite full hand or same side inner arm along side breast-ribcage (not on actual breast or implant), press & hold a few seconds then releases. Do a few times throughout the day.</p> <div style="text-align: center; margin-top: 10px;">  @thebrandyfenwick </div>	<p>* Imagine an X crisscrossing on your breast, with the nipple in the middle. This will be your diagonal lines to move your implant in a crisscross fashion. Gently lift the implants, Do NOT grind against ribcage. Do a few times throughout your day.</p> <p>*Test nipple response/sensation by rolling nipples with fingers in a gentle pinch-rolling motion. Mainly in the shower.</p> <div style="text-align: center; margin-top: 10px;">  @thebrandyfenwick </div>

Figure 24. Properly sequenced to give out at weeks 1, 2, and possibly weeks 3–5, depending on recovery. This breast program helps reduce the risks of capsular contracture.



Figure 25.
Breast augmentation, 8-week results.

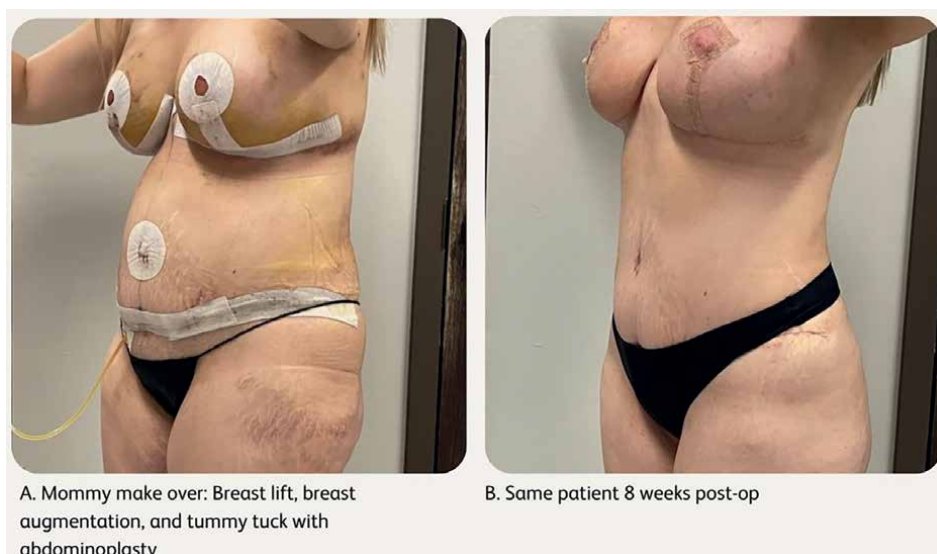


Figure 26.
Mommy makeover Breast lift, breast augmentation, and tummy tuck with abdominoplasty 8-week results.

excessively tight garments or fajas along with added accessories. Compression should be a firm hug, roughly 30–40 mmHg. The initial priority is to reduce the diffusion distance while allowing the natural healing, quality circulation, and intestinal peristalsis. Later as the stages of recovery progress, then the compression may progress and intensify. This is typically known as stage 1, stage 2, and stage 3 of post-surgical

garments or fajas. If the garment fits properly, there is very little need for accessories such as lipofoam and ab boards. There is a time and place for add-ins and it is helpful to have the guidance of a post-op specialist. No patient is cookie cutter in the fitting and shaping process of garments and accessories. Our goal as a surgical and post-operative team is optimizing outcomes like the results in **Figures 25** and **26**.

9. Conclusion

MLD has evolved into a newfound practice of lymphatic therapy and post-operative care in the body altering esthetics industry. Critical thinking, understanding the science, and implementing proper treatment strategies help empower the patient. Ultimately the collaboration between the patient, surgeon, staff, and a post-op specialist will facilitate the quality outcomes desired by all involved. We are here to help protect their investment and provide a seamless recovery.

Disclosure Statement


The Author has nothing to disclose.

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Edited by Angelo L. Cuzalina

Cosmetic surgery is more popular than ever worldwide. *Cosmetic Surgery – Techniques for the Most Popular Aesthetic Surgery Procedures* studies the cutting-edge techniques for some of the most popular procedures performed to rejuvenate the ageing face and body. Significant progress is being made in the field of cosmetic surgery, with new surgical techniques emerging rapidly, making it challenging to stay informed about all the available options. This book provides a comprehensive guide to increasingly popular procedures, including Brazilian butt lifts, mommy makeovers, deep plane facelifts, endoscopic brow lifts, facial fillers and implants, body lifts after massive weight loss, breast reductions, breast augmentations, breast lifts, and major breast revision surgery. Whether you are a beginner or an experienced aesthetic surgeon, each chapter in this book provides valuable and easy-to-understand tips to maximize results while limiting adverse outcomes.

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