

Chapter

A New Articulating Laparoscopic Instrument in Bariatric Surgery

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Abstract

Recent literature confirms an increasing use of robotic surgery in the field of bariatrics. However, recent meta-analyses do not show the advantages of robotics compared to traditional laparoscopy in terms of complications, reoperations, and hospital stays, despite significantly longer operative times and costs. In this context, articulated laparoscopic instruments can be a valid alternative to the more modern robotic technology in bariatric surgery. In the last 3 years, we have introduced ArtiSential® Articulating Laparoscopic Instruments (LIVSMED, Seongnam, Republic of Korea). This new Multi-DOF (Degree of Freedom) laparoscopic instrument provides undeniable advantages due to its extreme flexibility, thanks to the double distal articulation, which consent 360° of movement at the surgical site. In this chapter, we report our experience with the use of ArtiSential® instruments (scissors, graspers, dissectors, needle holders) during bariatric surgery procedures, analyzing their advantages and applications.

Keywords: bariatric surgery, sleeve gastrectomy, gastric bypass, ArtiSential, articulated instruments

1. Introduction

Obesity is a worldwide chronic disease with an associated high numbers of costly disorders [1]. All over the world, the number of obese and superobese people is growing, and bariatric surgery is performed more frequently to avoid serious complications related to obesity. Lots of therapies could be chosen for patients with obesity (e.g., drugs, dietary therapies, physical exercise, etc.), but their effect was unobvious for compliance and not effective in the long term [2]. Nowadays, bariatric surgery is a validated option performed all around the world with different standardized procedures. The effectiveness of bariatric surgery is a significant and sustained weight loss related to an improvement of the comorbidities. Patients can in fact lose 50% or more of their excess weight [3]. Bariatric surgery has been shown to improve type 2 diabetes, high blood pressure, sleep apnea syndrome, hyperlipidaemia, and GERD (GastroEsophageal Reflux Disease) [4].

There were lots of bariatric procedures that can be applied in clinical practice, including restrictive and malabsorptive ones (Sleeve Gastrectomy, Gastric Bypass,

One Anastomosis Gastric Bypass, Adjustable Gastric Band, etc.) [5–6]. All these types of surgeries are performed using either laparoscopic or robotic surgery. Both methodologies obtained minimally invasive techniques, high-definition vision, and precise operation [7], but robotic bariatric surgery may acquire more advantages for both patients and surgeons in the long run.

With the advent of robotic surgery, an increasing number of centers in the world have challenged their bariatric laparoscopic procedure in robotic and, nowadays, robotic surgery is extremely diffused. The robotic system has been the most ergonomic instrument with the widest range of motion, but operative time was showed longer in robotic bariatric surgery (RBS) and length of hospital stay was not significantly different between RBS and laparoscopic bariatric surgery (LBS). Moreover, estimated blood loss was reported no significant difference in RBS. Reoperation within 30 days, leaks, strictures, pulmonary embolism, and overall complications show no significant difference between LBS and RBS. RBS may be not inferior to LBS during different periods for weight loss assessed by Excess Weight Loss (EWL%) and Body Mass Index (BMI) loss.

Since its introduction, price and costs represent a critical problem of the robotic system, as well as the low cost-effectiveness [8, 9]. The small quantity of units for the institution, the need for an operating theater designated for robotic surgery, and an expert staff to prepare the console constitute further limits to the diffusion of this technology.

Robotic bariatric surgery has also demonstrated that ergonomics has become an important issue in terms of surgeons' fatigability. Based on these problems, a bridge can be obtained by articulated instrument introduction. Through time, some articulating laparoscopic devices with increased freedom of movement have been proposed

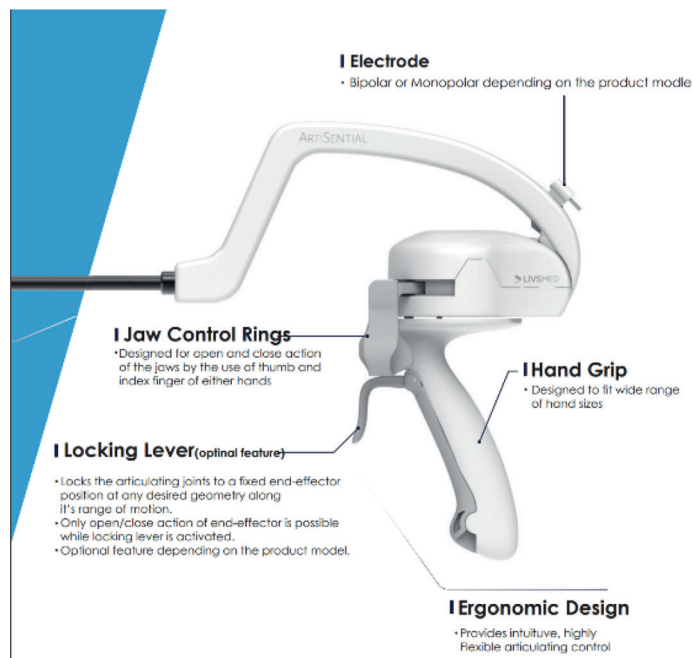


Figure 1.
Handle of the instruments.

in the market. However, most of them have been unsuccessful [10]. ArtiSential® is the first mechanical laparoscopic instrument with the widest angle of motion (360°), that perfectly mimics the movements of the robotic joint (**Figure 1**).

2. ArtiSential® articulating laparoscopic instruments

Straight laparoscopic instruments are limited because the end terminal is aligned on the same axis as the laparoscope. This can lead to a collision between instruments, named also “sword fighting,” which hampers free manipulation during the operation. To overcome such limitations, several flexible instruments with articulation have been introduced to overcome the restrictions of maneuverability and for use in laparoscopic surgery. One of these is the new device with multi-degree-of-freedom (DOF) articulation, the ArtiSential, a wide line of single-use articulated instruments.

In the last 3 years we have introduced in our experience ArtiSential® Articulating Laparoscopic Instruments (LIVSMED, Seongnam, Republic of Korea). It has a multi-joint structure that works with a pulley mechanism, whereas the end tool of the conventional laparoscopic instrument has no joint. This structure allows the end tool of ArtiSential® to move 90° up, down, left, and right. The thumb and index finger go into the two holes of the handle (**Figure 2**). The free manipulation provides intuitive movement of the end tool that perfectly matches the movement of the user’s fingers and wrists (**Figure 3**). The rest of the fingers grab the main handle for support. On the main handle, there is a lever to activate the “hold” mode. The “hold” mode can fix the end effector at any angle (like a conventional instrument) and allow the insertion of the instrument into the trocars (**Figure 1**).

Several different effectors are available, like Fenestrated Forceps, Bipolar Fenestrated Forceps, Maryland Dissector, Bipolar Maryland Dissector, Bipolar Precise Dissector, Bipolar Curved Dissector, Needle Holder, Precise Needle, Holder Clip Applier Medium Large, Monopolar Spatula, and Monopolar Hook. In commerce there

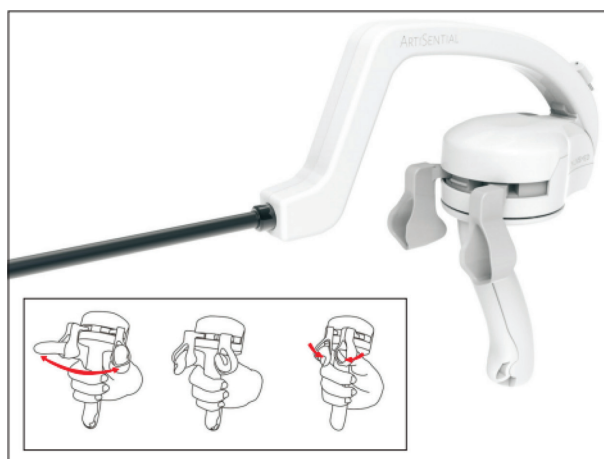


Figure 2.
ArtiSential instrument handle. The thumb and index finger, mainly used for grabbing, go into the two holes on the handle. The movement of this handle and the end tool show identical motion.

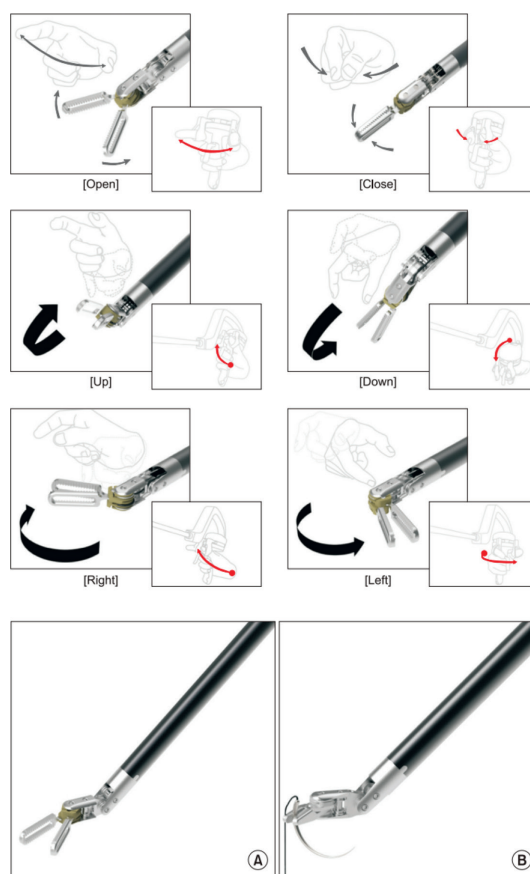


Figure 3.

Instrument hand-end tool coordination. The movement of the thumb, index finger, and wrist perfectly match the movement of the end tool.

are 8 mm diameter instruments with monopolar/bipolar connection, and also 5 mm diameter instruments (ArtiSential 5), both in standard (38 cm shaft length) and short (30 cm) versions.

Like in robotic surgery, Artisential® needs a learning curve, necessary to adapt to the new multi-DOF instruments, which can be easily divided by time [11]:

- In the first approach we need 30–60 minutes to understand the motion of the instruments;
- The next step requires from 4 to 8 hours in the dry lab to begin confident with the motion. This phase is variable in accordance with the experience of the surgeon;
- After achieving the motion, it is safe to step to the patient with a single instrument at a time, choosing and alternating dominant or nondominant hand. Also, in this phase would be necessary up to 10 consecutive procedures to adjust the process and master the use;

- When surgeons are confident with the use of the single instrument, it is time to introduce the use of ArtiSential® in both hands;
- The last phase of the learning curve is the introduction of the needle holder which has more complex movements and needs an initial attitude to articulated instruments suturing.

The learning curve is easily satisfied in a short while and the ability of the surgeon can improve fast case by case.

ArtiSential allows for meticulous dissection with two instruments in the smallest possible space without collision and with maximum control and optimal tactile feedback.

With this instrument, it is possible to reduce tissue trauma generated from the lateral traction of standard laparoscopic instruments by a perpendicular grip of the ArtiSential grasper. A gentle and direct grip is allowed without tension or traction. The articulation consents to a wider variety of surgical maneuvers than stray-fixed laparoscopic instruments.

The experienced laparoscopic surgeon can achieve difficult suturing tasks with the ArtiSential, similar to the robotic system. Another advantage of the ArtiSential is it easily usable during every operation, like any other laparoscopic traditional instrument, also in emergency settings, by simply opening the package [12].

A particular attention merits the control part of the instrument, for the cumbersome appearance that can limit the movements between the camera and the hands of the surgeon. Sometimes we need to modify a little the trocar position to avoid conflicts (**Figure 4**).

Surgeons, in the first procedures, can experience physical stress from the heavier and bigger instruments compared to conventional ones. This is a temporary drawback that will disappear with the use and the exercise. Also, surgeons with small



Figure 4.
External vision during surgery.

hands could have difficulties using it, but, actually, there are adjustable Velcro straps attached to the handle rings to fit the user's fingers.

3. Tips and tricks with articulated instruments

In our experience, bariatric surgery is an optimal field of application of articulated instruments, for multiple dissections, manipulations, and gastrointestinal sections and sutures.

3.1 Sleeve gastrectomy

- *Entrance and set up:* Pneumoperitoneum with Verres needle in the left subcostal quadrant. Pneumoperitoneum of 14 mmHg. Positioning of the optical trocar and four other operating trocars (1 of 10 mm; 2 of 5 mm; 1 of 15 mm).
- *Mobilization of the greater curvature:* Incision of the Bertelli peritoneal reflection and asportation of the gastric fundus fat. Dissection of the greater curvature begins by dividing the greater omentum 6 cm proximal to the pylorus. The gastroepiploic vessels are coagulated and sectioned using an energy device for all of the greater curvature toward the short gastric vessels. This dissection is continued to completely divide the gastrophrenic ligament and mobilize the angle of His to identify the left crus of the diaphragm. In this phase, ArtiSential® can provide a better grip on tissue, with less trauma and with easy movements in little space, like during mobilization of the His Angle (**Figure 5**). It is also very useful during diaphragmatic pillar dissection in hiatal hernia repair, frequently performed during all bariatric procedures due to the small space of work (**Figure 6**).
- *Posterior mobilization:* After gaining access into the lesser sac the stomach is lifted anteriorly, sectioning all the adhesions, until all the posterior gastric wall.
- *Bougie placement:* We insert a 40 French bougie under laparoscopic visualization in the stomach directed to the initial divided omental attachments.

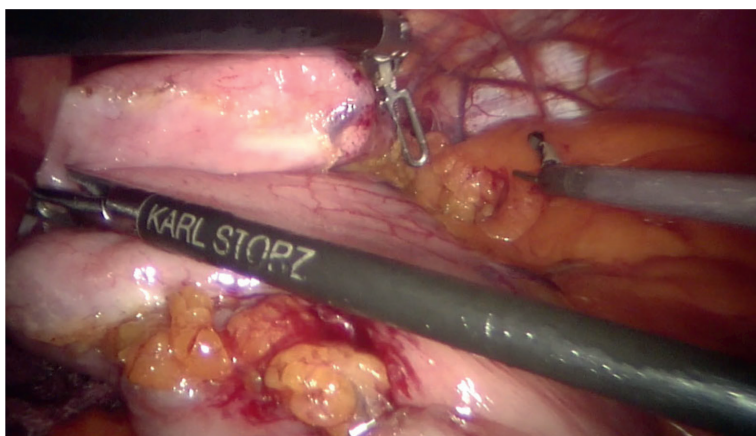


Figure 5.
Mobilization of the angle of his during sleeve gastrectomy.

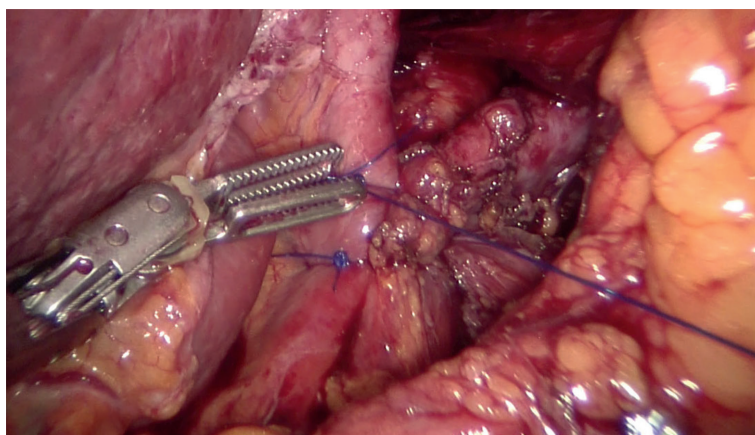


Figure 6.
Suture of the diaphragmatic pillars during hiatal hernia repair.

- *Creation of a stapled sleeve gastrectomy:* A 60 mm endoscopic stapler is inserted in the 15 mm trocar and is used for the gastric section. The first firing is begun to 6 cm to the pylorus along the bougie and parallel to the lesser curvature. Correct ArtiSential grasper traction on the margin of the greater curvature is fundamental to avoid sleeve spiralization. The staple lines are sequentially fired along the bougie, remaining 3–4 cm to the angular notch dividing the fundus at a distance of 1–2 cm lateral to the esophagus at the angle of His. The resected stomach is then removed through the 15 mm port.
- *Closure:* A fascial closure is done at the 15 mm port site, and skin closure is done at all sites.

3.2 Laparoscopic gastric bypass

- *Set up:* Pneumoperitoneum with Verres needle, in left under costal quadrant, of 15 mmHg. Positioning of a supraumbilical optical trocar and other four trocars (2 of 10 mm; 2 of 5 mm).
- *Preparation of the stomach pouch:* To preserve the left gastric artery, a retro gastric tunnel is formed starting at 5–6 cm below the gastroesophageal junction from the lesser curvature in a “peri-gastric” fashioning. With ArtiSential is easy to perform the dissection at the angle of His and entering the lesser sac. Using a linear stapler the stomach pouch is formed with the bougie as calibration. The insertion of the stapler is facilitated by using the end effector of the grasper to take up the posterior wall of the stomach.
- *Fashioning the gastrojejunostomy:* After the omental split, the jejunum measuring is started from the Treitz ligament to 60–70 cm, measuring along the grasper and the bowel is transported antecolic near the stomach. Counting appears easily with the use of ArtiSential atraumatic grasper. The bowel it is opened antimesenterically, and a linear stapler is inserted in the proximal direction. The small end of the stapler is inserted into the gastric pouch, and a side-to-side 3 cm gastro-jejunostomy is fashioned to create a small enterostomy. The suture is performed

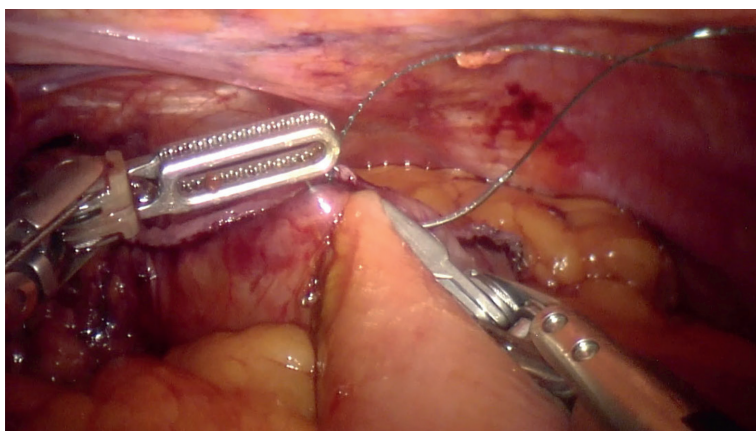


Figure 7.
Gastrojejunostomy anastomosis during laparoscopic gastric bypass.

rapidly with the ArtiSential device (**Figure 7**). For completing this anastomosis, enterotomy is closed with continuous seromuscular suture. A methylene blue test is performed. Starting from the right side of the enterotomy, a running suture completes the anastomosis.

- *Fashioning the jejunojejunostomy:* Again, measuring of the jejunum is started from the ligament of Treitz to 120–150 cm. The jejunum is opened antimesenterically, and a side-to-side 60 mm jejunojejunostomy is created using a linear stapler. The enterotomy is closed using a double suture in a seromuscular running technique. Proximal to the anastomosis, the jejunum is separated by a linear stapler, converting the omega loop into a Roux-en-Y Gastric Bypass. The ArtiSential needle holder is useful in this operation (with double anastomosis) because consent to the surgeon to maintain the same position during all the procedures.
- *Drainage and closure:* A drainage is placed side to the gastric pouch. All trocars are retrieved under view.

3.3 Laparoscopic OAGB (one anastomosis gastric bypass)

- *Entrance and set up:* Pneumoperitoneum with Verres needle, in left under costal quadrant, of 15 mmHg. Positioning of a supraumbilical optical trocar and other four trocars (2 of 10 mm; 2 of 5 mm)
- *Preparation of the stomach pouch:* The pouch is started under the Crow's Foot (the junction of the body and antrum of the stomach) along the small gastric curvature. Like in laparoscopic gastric bypass, ArtiSential can help perform better and easier dissection and gastric manipulation while performing the retro gastric tunnel (**Figure 8**). A 20 cm gastric tube is fashioned with multiple 60 mm staple firings along a 40 Fr. bougie for gastric calibration tube.
- *Gastrojejunostomy:* After omental split, the measuring of the jejunum is started from the ligament of Treitz to 180–200 cm, according to the Body Mass Index (BMI), measured using the grasper and transported antecolic. Counting seems

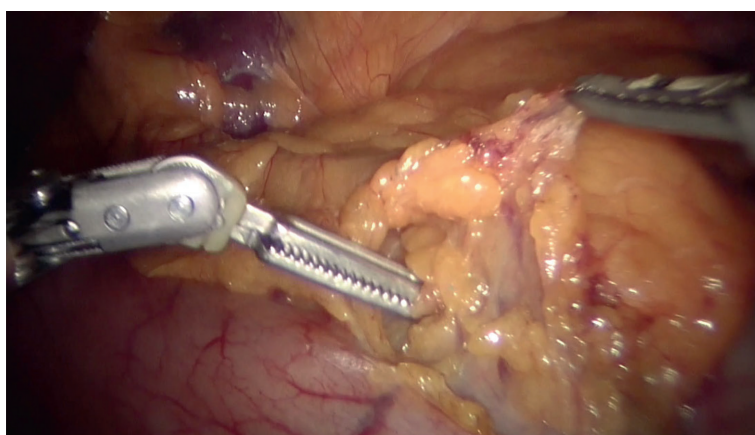


Figure 8.
One anastomosis gastric bypass (OAGB): performing the retro gastric tunnel.

to be easier with the use of ArtiSential. A side-to-side gastrojejunostomy, with a length of 4–5 cm, is created on the anterior gastric wall. The enterotomy is closed with a continuous seromuscular suture. A methylene blue test is performed. A running suture complete the anastomosis.

- *Drainage and closure:* A drainage is placed side to the gastric pouch. All trocars are retrieved under view.

4. Methods

In this retrospective vision, we performed above 70 surgery procedures with ArtiSential® between 2022 and 2024, including bariatric, general, and oncologic surgeries. Especially, 46 patients with bariatric conditions, 14 patients with diverticular stenosis, 11 patients with colorectal cancer, and three patients with stomach cancer are operated on with the ARTISENTIAL® articulated instruments. In this study, we will focus on bariatric patients, analyzing perioperative and short-term postoperative data.

All patients are chosen and preoperatively studied according to the Società Italiana di Chirurgia dell'OBesità (SICOB) e delle malattie metaboliche Guidelines 2023 and the choice to use ArtiSential® is completely random for trying to understand the several limitations of the application of the instruments. Retrospectively, we evaluated the data of patients like age, sex, Body Mass Index (BMI), postoperative stays, numbers of conversion, intraoperative bleeding, and postoperative complications.

In our excellent bariatric center Società Italiana di Chirurgia dell'OBesità (SICOB), two surgeons were implicated in this study, both with experience in the use of ArtiSential® and with a large experience in bariatric surgery. They performed 17 Sleeve gastrectomies, 25 Gastric Bypass, and four One Anastomosis Gastric Bypass (OAGB). All procedures were performed laparoscopically with ArtiSential® grasper, needle holder, and bipolar forceps.

All procedures are performed with a multi-port technique with five trocars. In the sleeve gastrectomy, the surgeon stays between the legs of the patients and operates with an energy device in his dominant hand and the ArtiSential® in his nondominant hand. Instead, we used ArtiSential® instruments in both hands to perform gastric

bypass and One Anastomosis Gastric Bypass (OAGB), without using any energy device (such as ultrasounds or radio frequencies).

5. Results

In total 46 patients (17 males/29 females) were operated on with the ArtiSential® device. In the ArtiSential® group, the patients had a median age of 38 years (range 23–55 years) and a median Body Mass Index of 48 kg/m² (range 36–59 kg/m²) (**Table 1**).

There were no intraoperative complications, and estimated intraoperative bleeding was less than 30 ml. No cases of conversion laparotomy and no switch to using a standard laparoscopic instrument. Surgical time is similar due to procedures that we carry out on a daily basis with laparoscopic straight instruments, for Sleeve Gastrectomy the median surgical time was 39', for the Gastric Bypass the median time was 76' and for the One Anastomosis Gastric Bypass (OAGB) was of 65'. On 46 surgical interventions, there was no intraoperative mortality. In all patients no drain was placed (**Table 2**).

Only one patient, gastric bypass operated, was complicated by bleeding from the trocar access, treated with a conservative cure, and dismissed on the 5th day of stay. The median length of stay was 3 days (range 2–4 days). There was not any other immediate postoperative general complication, and all patient was dismissed with a liquid diet for the first month. There was no unrelated readmission with no mortality (**Table 3**).

Demographics	Mean ± SD
No. (Male/Female)	46 (17/29)
Age (years)	38 ± 11.2
Height (cm)	161.6 ± 9.3
Weight (kg)	125.2 ± 23.2
Body Mass Index (BMI) (kg/m ²)	48 ± 8.0
EW (kg)	54.6 ± 21.3
Median ASA score	II

Table 1.
Preoperative data undergoing bariatric surgery with the use of ArtiSential.

Operative Time Sleeve Gastrectomy (minutes) ± (SD)	37.78 ± 6.62
Operative Time Laparoscopic Gastric Bypass (minutes) ± (SD)	76.32 ± 9.43
Operative Time OAGB (minutes) ± (SD)	64.97 ± 12.64
Rate of conversions to open surgery number (%)	0 (0%)
Intraoperative Bleeding number (%)	0 (0%)
Intraoperative Mortality (%)	0 (0%)

Table 2.
Intraoperative data.

	No. of cases (%)
Grade I	1 (0.46%)
Grade II	0
Grade III	0
Grade IIIb	0
Grade IV	0
Grade IVa	0
Grade Ivb	0
Length of stay (days)	3.45 ± 1.29

Table 3.

Postoperative data. Postoperative complication sorted by Clavien-Dindo classification: Grade I: Any deviation from the normal postoperative course without the need for pharmacological treatment, or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside. Grade II: Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included. Grade III: Requiring surgical, endoscopic, or radiological intervention Grade III intervention not under general anesthesia. Grade IIIb: Intervention under general anesthesia. Grade IV: Life-threatening complication (including central nervous system complications) requiring IC/ICU management. Grade Iva: Single organ dysfunction (including dialysis). Grade Ivb: Multiorgan dysfunction Grade V Death of a patient.

In the follow-up to a 1 month, there were no gastric leaks, and the overall late complication rate was 0%.

The mean cost of the surgical material for ArtiSential® is 650 € and it is single-use, higher than the laparoscopic straight instruments, which can be also reusable, but significantly lower than the robotic set up. Wristed instruments could represent a standpoint for surgeons wanting a benefit from the advantages of robotic surgery from a cost-sensitive perspective.

6. Conclusion

This study has several limitations. First the small number of patients selected, this study has a descriptive nature and for this reason is impossible for us to compare the standard laparoscopy to the articulated one. This study shows that ArtiSential® in bariatric surgery can be safe and feasible, but comparative and randomized trials are needed to elaborate more on the results of this work.

Nowadays, articulated instruments are used not only in bariatric but in every field of abdominal surgery.

The new laparoscopic articulating devices are safe and feasible options that do not increase operative time, length of hospital stay, and intraoperative bleeding.

In our experience, ArtiSential® is helpful for performing otherwise difficult tasks in confined anatomical spaces, with lesser trauma on tissue and good tactile feedback. Moreover, these articulated instruments are readily available under any circumstance and can be used in everyday surgical practice, including emergency settings.

The learning curve of ArtiSential® is limited to a few hours in the dry lab and few operative cases. Also, the literature does not report a difference in learning between experts and young surgeons.

Articulated laparoscopic instruments, associated with 3D laparoscopy (like in our experience), can be a valid alternative to the more expensive robotic technology. A robotic center can also reduce the costs of surgery for procedures with a low cost-effectiveness ratio, returning from the robotic to laparoscopic articulated surgery.

Nowadays, more study needs to be published with a wider sample and prospective view and this is a wider field for research.

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