

Chapter

Root Amputation or Hemisection in the Management of Teeth with Perio-Endodontic Lesions

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Abstract

The preservation of multirooted teeth affected by advanced periodontal diseases and endodontic lesions, or perio-endo lesions, remains a complex clinical challenge. Root amputation, hemisection, or bicuspidisation are conservative surgical procedures aimed at preserving multirooted teeth affected by both localized periodontal and endodontic diseases. By removing the affected root while preserving the healthy portion of the tooth, these procedures allow the removal of infection, enhance the anatomical form for plaque control, and restore function. Successful outcomes depend on careful case selection, with favorable tooth morphology, adequate periodontal support, successful endodontic treatment, appropriate restorative management, and patient compliance. When done within a multidisciplinary framework and supported by systematic maintenance, root resection or hemisection offers a predictable alternative to extraction and implant placement, contributing to the long-term preservation of natural dentition.

Keywords: compromised tooth, endodontic, hemisection, perio-endodontic lesion, root amputation

1. Introduction

The maintenance of a multirooted tooth with localized advanced periodontal breakdown and an evident endodontic lesion has been a clinical challenge for most clinicians. The amputation of a selected root or hemi-section of a molar may be a conservative alternative to be considered. Such a procedure is designed to retain a functionally important tooth with localized loss of periodontal support. Regardless of the increasing prevalence of implant therapy, these procedures continue to represent biologically sound alternatives when careful case selection and multidisciplinary coordination are implemented.

The decision for root resection or hemisection must be based on a comprehensive clinical and radiographic evaluation, including periodontal status, endodontic feasibility, restorative potential, occlusal considerations, and patient-related factors. A collaborative approach among periodontic, endodontic, and restorative disciplines is essential to ensure predictable long-term outcomes.

2. Historical perspective

Before the emergence of predictable implant therapy, retention of compromised molars represented an important therapeutic objective in periodontology and restorative dentistry. The historical development of root amputation reflects the broader evolution of dentistry from extraction-oriented management toward biologically conservative approaches aimed at maintaining natural dentition.

A multirooted tooth with localized periodontal attachment loss may show an acceptable prognosis for being retained in normal biological function with root resection. Root resection is the procedure of removing the root/roots of multirooted teeth at the level of the cementoenamel junction without the removal of any portion of a crown. This was an alternative to the extraction of a questionable tooth, avoiding complete extraction of strategically valuable teeth. It was earlier termed as root amputation in 1884 by Farrar [1].

During the first half of the twentieth century, improvements in operative dentistry, prosthodontics, and periodontal surgery gradually expanded the indications for retaining multirooted teeth. Increasing understanding of periodontal pathogenesis led clinicians to recognize that not all furcation-involved teeth required extraction. Instead, selective removal of the diseased root could reduce anatomical complexity, improve access for plaque control, and preserve the function of the remaining root structure. This period also marked the emergence of the principle that long-term prognosis depended not only on surgical removal of diseased tissue but also on the establishment of a maintainable periodontal architecture.

By the 1960s and 1970s, root amputation became more clearly defined within periodontal and restorative literature. Authors distinguished root amputation from hemisection, with root amputation referring to the removal of one root of a multirooted tooth at or near the furcation while preserving the entire crown, whereas hemisection involved sectioning the tooth and removing one root together with its associated crown portion. During this period, clinicians increasingly emphasized the importance of careful case selection, endodontic feasibility, root morphology, prosthetic design, and occlusal considerations as determinants of treatment success [2, 3].

The 1980s and 1990s saw further refinement of clinical indications and interdisciplinary treatment planning. Root amputation became accepted as a treatment option for molars with advanced Class II or Class III furcation involvement, root perforation, root caries, vertical root fracture confined to one root, and persistent localized periodontal-endodontic lesions. Long-term observational studies from this period demonstrated that survival of resected teeth was strongly associated with adequate endodontic treatment, appropriate restorative design, and adherence to supportive periodontal therapy [4].

The introduction of osseointegrated dental implants in the late twentieth century substantially altered the therapeutic landscape. Implant-supported rehabilitation provided a predictable alternative for severely compromised molars, resulting in a decline in the routine use of root resection procedures. Nevertheless, evidence accumulated that root amputation could provide durable long-term outcomes in appropriately selected patients. A systematic review published in 2019 reported survival rates ranging from 40.3% to 100%, with approximately half of the included studies demonstrating survival rates greater than 90% over observation periods extending up to 23 years. These findings reaffirmed that root amputation remains a valid tooth-preserving option rather than merely a historical procedure [5].

Contemporary periodontal practice has seen renewed interest in preserving natural dentition whenever biologically and functionally feasible. Current concepts of minimally invasive dentistry, preservation of periodontal proprioception, maintenance of alveolar architecture, and individualized risk-based treatment planning have contributed to the re-evaluation of root amputation. Recent literature continues to support its clinical relevance. A 2024 updated review documented successful functional retention of a maxillary molar for approximately 14 years following root amputation, reinforcing that carefully selected cases managed through coordinated periodontal, endodontic, and restorative care may achieve favorable long-term outcomes [5].

Therefore, although performed less frequently than in previous decades, root amputation remains an important component of contemporary multidisciplinary periodontal therapy. Its historical evolution illustrates a continuing commitment within periodontology to preserve natural teeth whenever sound biological principles, restorative feasibility, and long-term maintenance can be achieved .

3. Biologic rationale

Root amputation and hemisection are biologically based treatment approaches designed to preserve strategically important multirooted teeth affected by combined periodontal and endodontic destruction. Their biologic rationale is founded on selective removal of the diseased root and its associated periodontal attachment apparatus while retaining the healthy, maintainable portion of the tooth. In carefully selected cases, this permits elimination of the principal source of infection, preservation of residual alveolar bone, and maintenance of function without complete extraction. Contemporary evidence supports preservation of strategically important teeth where biologic, restorative, and patient-related factors are favorable [6–10].

The pulp and periodontium are developmentally, anatomically, and pathologically interconnected. Communication occurs through the apical foramen, lateral and accessory canals, furcation canals, and exposed dentinal tubules. These pathways permit bidirectional microbial migration between the root canal system and periodontal tissues. Consequently, pulpal infection may manifest clinically as periodontal breakdown, while periodontal disease may secondarily influence pulpal health [6, 10, 11]. This interrelationship explains why teeth with perio-endodontic lesions frequently present with deep periodontal pocketing, attachment loss, vertical

bone defects, furcation involvement, suppuration, increased probing depth, and periapical radiolucency [6, 8, 12].

A central biological principle underlying root resective therapy is that disease in multirooted teeth is frequently root-specific rather than uniformly distributed. One root may demonstrate advanced attachment loss, vertical bone destruction, root fracture, perforation, severe furcation involvement, or endodontic failure, while adjacent roots may retain favorable periodontal support and structural integrity. Under these circumstances, removal of the compromised root reduces microbial burden and eliminates the principal site of chronic inflammation while preserving the biologically viable root-periodontium complex [10, 13, 14].

From a periodontal perspective, furcation involvement is a critical determinant of prognosis. Furcation areas possess complex root anatomy, concavities, and restricted access that favor plaque accumulation and hinder complete instrumentation. Persistent microbial colonization within these sheltered anatomical niches sustains chronic inflammation and progressive attachment loss. Root amputation or hemisection removes the anatomical component responsible for this inaccessible environment and converts a complex multirooted tooth into a simpler root form that is more accessible for professional debridement and patient-performed plaque control [10, 15–17]. This ecological modification of the root surface and surrounding periodontal environment is fundamental to long-term periodontal stability [16, 17].

From an endodontic perspective, the biologic rationale is equally compelling. When pathology is confined predominantly to one root, or when one root is structurally or endodontically compromised beyond predictable repair, removal of that root may preserve the remaining tooth, provided the retained root can be predictably treated endodontically. Healing depends on the elimination of intraradicular infection, adequate sealing of the root canal system, and prevention of coronal or apical microbial leakage. Recent literature emphasizes that successful management of endodontic-periodontal lesions requires simultaneous control of both pulpal and periodontal sources of infection rather than isolated treatment of one compartment alone [6, 7, 11, 18].

The healing response following root amputation or hemisection is influenced by several local biologic determinants. These include the quantity and morphology of residual alveolar bone support, root trunk length, root divergence, root surface area of the retained segment, crown-to-root ratio after resection, and the morphology of the remaining furcation area [8, 10, 14]. Adequate root separation and favorable residual bone architecture enhance the ability of periodontal tissues to establish a maintainable environment. Conversely, inadequate residual support or unfavorable anatomy may compromise healing and long-term stability [13, 19].

The biologic rationale must also be integrated with restorative and biomechanical considerations. The retained root must be capable of withstanding functional occlusal loading without creating excessive biomechanical stress. Proper restorative contour, emergence profile, and occlusal design are essential to facilitate plaque control and reduce the risk of root fracture, recurrent periodontal breakdown, or restorative failure [14, 20, 17]. Long-term studies have shown that the prognosis of root-resected teeth is closely related to meticulous maintenance care, supportive periodontal therapy, and patient compliance [16, 17, 20].

Therefore, in the management of teeth with perio-endodontic lesions, root amputation and hemisection should be regarded not merely as conservative alternatives to extraction but as biologically selective procedures. Their objective is to localize disease, remove the non-maintainable root unit, preserve the maintainable root-periodontium complex, and establish conditions compatible with long-term supportive periodontal care [6–10, 16].

4. Indications

Root amputation or root resection is a tooth-preserving surgical procedure performed on multirooted teeth in which one compromised root is removed while the remaining root structure and crown portion are retained. The primary objective of this treatment is to eliminate localized pathology while maintaining a functional and strategically important tooth within the dentition. Root resection is most frequently indicated in maxillary molars due to their root anatomy and accessibility, although mandibular molars may also be considered in selected cases. The procedure should only be performed after careful interdisciplinary assessment involving periodontal, endodontic, restorative, and prosthetic considerations [21]. Appropriate case selection is essential because long-term success depends on the periodontal support of the retained roots, adequate endodontic treatment, favorable crown-root ratio, occlusal stability, and the patient's ability to maintain meticulous plaque control [22, 23].

4.1 Periodontal indications

4.1.1 *Advanced vertical bone loss confined to a single root*

Advanced vertical bone loss involving only one root of a multirooted tooth, with the other roots having adequate periodontal attachment and bone support, is a principal periodontal indication for root amputation. This localized pattern of periodontal destruction is often seen in maxillary molars, where one root may show severe attachment loss secondary to anatomical factors, plaque accumulation, or occlusal trauma, while the adjacent roots are relatively unaffected (**Figure 1**).

In such cases, extraction of the entire tooth may be unnecessarily aggressive, especially when the remaining roots are periodontally stable and strategically important for maintaining occlusion and mastication. Root resection allows the elimination of the diseased root while preserving the healthy root complex and surrounding alveolar bone [21, 24].

The rationale behind this treatment approach is based on the concept of reducing the bacterial burden and removing the portion of the tooth associated with severe periodontal destruction. By eliminating the compromised root, the clinician may create a more favorable periodontal architecture that facilitates plaque control and improves the patient's ability to maintain oral hygiene. Additionally, the retained roots may continue to provide adequate periodontal support for functional loading when properly restored. Studies have demonstrated that carefully selected molars treated with root resection can remain functional for many years when supported by appropriate periodontal maintenance therapy [14].



Figure 1.

Preoperative periapical radiograph of a maxillary molar demonstrating localized periodontal and endodontic compromise affecting a single root, which is the MB root, with associated furcation involvement. The remaining roots exhibited adequate periodontal support, supporting the decision for root resection therapy as a tooth-preserving treatment approach.

Advanced vertical defects confined to a single root may also compromise the prognosis of regenerative periodontal procedures. In situations where the morphology of the defect is unfavorable for regeneration or where extensive attachment loss has rendered one root hopeless, root amputation may provide a more predictable outcome compared with regenerative surgery alone. The decision to perform root resection should therefore be based on comprehensive clinical and radiographic assessment, including furcation involvement, root trunk length, root divergence, mobility, crown-root ratio, and the restorative value of the tooth [22, 23].

4.1.2 Through-and-through (class III/IV) furcation involvement with adequate support of remaining roots

Root amputation is also indicated in molars exhibiting advanced furcation involvement, particularly Class III or Class IV furcation defects, when one root is severely compromised but the remaining roots retain sufficient periodontal support. Furcation involvement represents one of the most challenging aspects of periodontal therapy because the complex anatomy of the furcation area promotes plaque accumulation and limits access for effective debridement. In Class III furcation defects, the furcation is completely penetrable, whereas Class IV defects exhibit through-and-through furcation involvement associated with gingival recession and clinical exposure of the furcation area [25].

In many of these cases, conventional nonsurgical periodontal therapy may fail to achieve adequate disease control due to persistent bacterial colonization within inaccessible furcation areas. Root resection may therefore be performed to eliminate the root associated with the furcation defect and convert the multirooted tooth into a more maintainable configuration, together with the

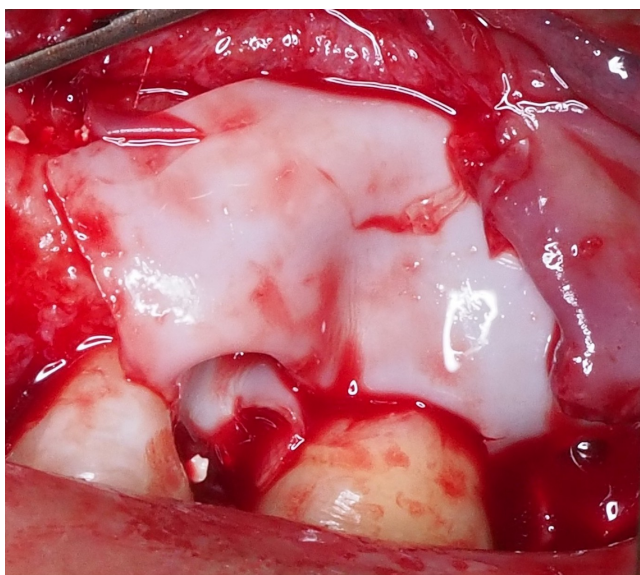


Figure 2.
Intraoperative view following root resection and debridement of the furcation defect. A resorbable membrane was adapted over the surgical site as part of guided tissue regeneration (GTR) therapy to promote periodontal wound stability and regeneration.

incorporation of regenerative periodontal surgery, which includes guided tissue regeneration (GTR) (**Figure 2**).

By simplifying the root anatomy, the procedure facilitates improved access for professional maintenance and patient-performed plaque control. This approach may significantly reduce periodontal pocket depth and inflammation while improving the long-term maintainability of the tooth [21, 24]. A post-operative radiograph is important to verify complete removal of the root segment and to check the contour of the remaining tooth structure as a baseline to monitor future bone healing (**Figure 3**).

Prognosis of root resection in furcation-involved molars is highly dependent on the amount of remaining periodontal support and the morphology of the retained roots. Teeth with divergent roots, long root trunks and good bone support generally have a better prognosis after resection therapy. However, the presence of roots with severe mobility, inadequate attachment support or unfavorable anatomy may compromise long-term stability. Several longitudinal studies have shown favorable survival rates of resected molars with appropriate case selection, periodontal maintenance, and restorative rehabilitation [14, 25].

4.1.3 Root proximity preventing effective plaque control

Root proximity is another important periodontal indication for root amputation. Root proximity refers to an anatomical condition in which adjacent roots are positioned extremely close to one another, typically with an interradicular distance of 1 mm or less. This close approximation creates narrow interdental spaces that are difficult for patients to clean effectively and may predispose the



Figure 3.

Immediate postoperative periapical radiograph following root resection of the compromised MB root in a maxillary molar. Removal of the affected root simplified the furcation anatomy and improved the maintainability of the remaining root structure.

area to plaque retention, inflammation, and progressive periodontal destruction [26].

When root proximity occurs in multirooted teeth, particularly maxillary molars, access for instrumentation during periodontal therapy becomes significantly compromised. The restricted embrasure space limits the effectiveness of scaling and root planing and may prevent proper maintenance of periodontal health even after active treatment. Persistent plaque accumulation within these inaccessible areas often results in recurrent periodontal pockets, bleeding on probing, and progressive attachment loss. In selected cases, removal of one root through root resection may create a more accessible architecture that enhances oral hygiene measures and improves periodontal stability [21, 23].

The decision to perform root resection in cases of root proximity should be based on the severity of periodontal destruction, strategic value of the tooth, and restorative considerations. Root separation and odontoplasty may sometimes provide sufficient improvement in access; however, when one root demonstrates poor periodontal prognosis or contributes significantly to plaque retention, root amputation may offer a more predictable long-term solution. The adjustment of crown and root profile following periodontal therapy permits better plaque control, thereby improving the prognosis of multirooted [24].

4.1.4 Severe root exposure secondary to dehiscence

Severe root exposure caused by dehiscence defects may also constitute an indication for root resection when the exposed root exhibits compromised periodontal support or poor long-term prognosis. Dehiscence refers to the absence of alveolar bone overlying the root surface, resulting in exposure of the root through the cortical plate. Such defects may occur secondary to periodontal disease, traumatic occlusion, thin alveolar housing, orthodontic tooth movement, or iatrogenic factors. Extensive dehiscence may predispose the

affected root to hypersensitivity, plaque accumulation, gingival recession, and progressive attachment loss [21, 22].

In multirooted teeth, one root may become significantly more affected by dehiscence than the remaining roots due to anatomical position or occlusal loading patterns. When severe root exposure compromises periodontal stability and contributes to persistent inflammation or mobility, removal of the affected root may improve the prognosis of the remaining tooth structure. Root resection may also facilitate improved flap adaptation and simplify plaque control by eliminating inaccessible root surfaces associated with deep recession defects [23].

The clinician must carefully evaluate the remaining bone support and restorative feasibility surgically before proceeding with treatment (**Figure 4**). Teeth with severe generalized attachment loss or inadequate support of the remaining roots are poor candidates for root amputation. However, when the retained roots demonstrate stable periodontal attachment and favorable morphology, selective removal of the exposed root may preserve function and prolong tooth survival. Long-term success is strongly dependent on regular periodontal maintenance and patient compliance with oral hygiene measures [14].

4.2 Endodontic and restorative indications

4.2.1 Vertical root fracture limited to one root

Vertical root fracture involving a single root of a multirooted tooth is one of the most common endodontic indications for root amputation. Vertical root



Figure 4.
Intraoperative clinical view after removal of the compromised MB root, demonstrating preservation of the remaining root structure and surrounding alveolar bone. Selective root removal allows elimination of localized pathology while maintaining the strategic value of the tooth.

fractures typically originate from the root canal and extend longitudinally toward the periodontium. These fractures are frequently associated with endodontically treated teeth and may result from excessive canal preparation, obturation forces, post placement, or occlusal stress [27].

Clinically, vertical root fractures often present with localized periodontal destruction, deep, isolated probing defects, recurrent abscess formation, sinus tract development, and persistent discomfort during mastication. Radiographically, angular bone loss or J-shaped radiolucencies may be observed adjacent to the fractured root. Because complete healing of vertical root fractures is generally impossible, extraction of the affected root is often necessary to eliminate infection and inflammation [28].

When the fracture is confined to a single root and the remaining roots possess adequate periodontal and restorative support, root amputation offers a conservative alternative to extraction of the entire tooth.

This treatment approach preserves alveolar bone, maintains occlusal function, and may reduce the need for complex prosthetic replacement. Following root resection, the retained roots typically require appropriate endodontic treatment and definitive prosthetic rehabilitation to ensure long-term stability [22, 29].

4.2.2 Non-treatable perforation of the pulp chamber floor or root canal of a single root

Iatrogenic or pathological perforations involving the pulp chamber floor or root canal system may also indicate root amputation when repair is not feasible. Perforations may occur during endodontic access preparation, canal instrumentation, post preparation, or as a result of internal resorption and caries. The prognosis of perforation repair depends on several factors, including the size and location of the defect, the time elapsed before repair, the degree of contamination, and accessibility for treatment [29].

Perforations located in the furcation region are particularly problematic because they frequently result in periodontal breakdown and chronic inflammation. When the defect is extensive or inaccessible for predictable repair, the affected root may become hopeless despite otherwise favorable conditions of the remaining tooth structure. In such situations, root amputation may allow removal of the compromised root while preserving the rest of the tooth [21, 29].

This treatment approach is especially valuable in strategically important teeth where extraction would result in significant restorative challenges. Successful outcomes require elimination of infection, stabilization of the remaining roots, and adequate restorative planning to redistribute occlusal forces appropriately. Proper case selection and interdisciplinary management are therefore critical to long-term success [22].

4.2.3 Persistent periapical pathology confined to one root

Persistent periapical pathology affecting only one root of a multirrooted tooth may also justify root amputation when conventional endodontic retreatment or surgical endodontic therapy is unlikely to succeed. Chronic periapical lesions may persist due to missed canals, resistant microorganisms, root fractures,

perforations, extraradicular infection, or complex root anatomy that prevents adequate disinfection [30].

In cases where the pathology is isolated to a single root, removal of the affected root may eliminate the source of persistent infection while preserving the remaining healthy root complex. This conservative approach may be preferable to complete extraction, particularly in patients with limited restorative options or when the tooth serves as a key abutment in the dentition. Root amputation may also preserve alveolar bone and maintain proprioception associated with natural teeth [23].

Diagnosis and confirmation that the remaining roots are free of pathology and have sufficient periodontal support are necessary for successful treatment. A complete radiographic evaluation, including cone-beam computed tomography when indicated, can be helpful in determining the extent of disease and the feasibility of treatment. Post-resection restorative rehabilitation is important for favorable load distribution and long-term function [22, 30] (**Figure 5**).

4.2.4 Prosthetic failure involving a single compromised root of an abutment tooth

Root amputation may additionally be indicated in cases of prosthetic failure involving a single compromised root of an abutment tooth. Multirooted teeth frequently serve as abutments for fixed dental prostheses due to their favorable root surface area and strategic position within the arch. Greater plaque accumulation and gingival inflammation are seen on teeth with fixed prostheses, contributing to greater probing pocket depth and clinical attachment loss [31].

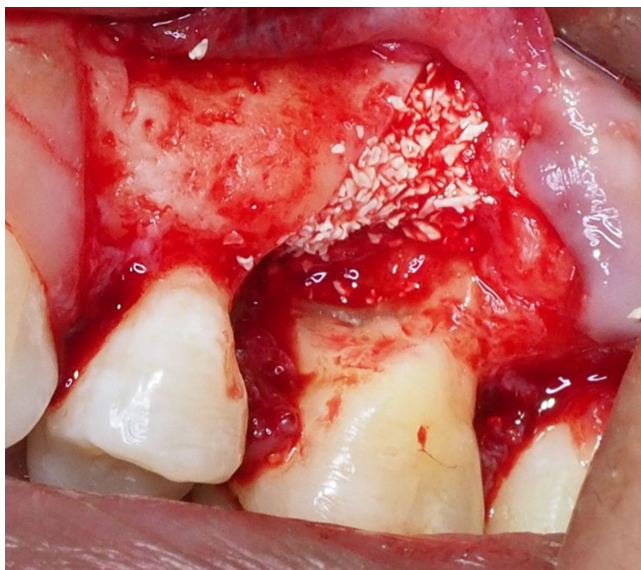


Figure 5.
Placement of bone graft material within the osseous defect following MB root resection. Regenerative procedures may be combined with root resection therapy to enhance defect fill, improve periodontal support, and facilitate long-term tooth preservation.

In such cases, extraction of the entire tooth may necessitate extensive prosthetic reconstruction or implant therapy. Root resection provides a more conservative alternative by allowing preservation of the sound roots and continuation of prosthetic function. This approach may reduce treatment cost, preserve alveolar bone, and maintain the integrity of the existing prosthesis when feasible [27].

Nevertheless, prosthetic management following root resection is complex and requires careful occlusal and biomechanical planning. The retained roots must possess sufficient periodontal support and a favorable crown-root ratio to withstand occlusal loading. In addition, prosthetic contours should facilitate plaque control and minimize excessive forces on the remaining tooth structure. Long-term success, therefore, depends on close collaboration between the periodontist, endodontist, and prosthodontist, as well as strict adherence to supportive periodontal therapy [21].

5. Comprehensive case selection criteria

Appropriate case selection is the critical factor for the long-term success of root resection or hemisection and usually requires a multidisciplinary approach [31]. When a tooth is evaluated for these complex procedures, the following detailed criteria should be meticulously assessed:

5.1 Anatomical and periodontal requirements

5.1.1 Bone support

Adequate periodontal support is a crucial prerequisite when considering the retention of the tooth. The remaining root/roots should demonstrate adequate surrounding alveolar bone support, preferably exceeding 50% of the root length, to provide long-term biological and mechanical stability of the tooth [32]. Compromised bone support may reduce the long-term prognosis by increasing the risk of mobility, impairing load distribution, and predisposing the retained segment to be more susceptible to periodontal breakdown [33].

5.1.2 Root morphology

Long and relatively straight roots are generally more favorable, as they provide better periodontal attachment, improved load-bearing capacity, and greater restorative potential. In contrast, short, tapered, or conical roots provide limited surface area for periodontal support, which may compromise the stability of the retained segment. These undesirable root forms may increase the risk of mobility, restorative failure, or recurrent periodontal issues [34].

5.1.3 Root divergence

Sufficient root divergence is essential to allow predictable separation and subsequent restoration of the retained segment. Teeth with well-separated roots

and an absence of root fusion provide better access for surgical sectioning, debridement, and contouring [4]. Conversely, fused or closely approximated roots may complicate the procedure, increase the risk of iatrogenic damage, and compromise the ability to establish a cleansable periodontal architecture [5].

5.1.4 Crown-to-root ratio

The preserved root segment must demonstrate a favorable post-treatment crown-to-root ratio to ensure adequate mechanical stability during functional loading [35]. Retention of a root segment with a compromised crown-to-root ratio is generally associated with reduced predictability and may adversely affect the long-term treatment success of the tooth [36].

5.2 Biomechanical and positional factors

5.2.1 Tooth angulation

Severely tilted molars, whether mesially, distally, buccally, or lingually, may complicate access, root separation, restoration, and long-term maintenance.

5.2.2 Mobility and occlusal forces

The tooth should demonstrate no significant mobility after occlusal adjustment. Occlusal forces must be carefully evaluated to ensure that the remaining root segment is not exposed to excessive functional stress [37].

5.2.3 Strategic value/location

The retained root segment should have clear functional or prosthetic value. For example, retaining part of a mandibular second molar may help maintain occlusal contact and prevent supraeruption of the opposing maxillary molar [38, 39].

5.2.4 Terminal abutments

Isolated mandibular teeth should generally not be used as terminal abutments for long-span fixed prostheses. Excessive leverage and occlusal loading may increase the risk of mechanical, periodontal, or restorative failure [40].

5.3 Endodontic and restorative considerations

5.3.1 Endodontic difficulty

The root canals selected for retention should be negotiable, adequately disinfected, and predictably obturated. Challenges such as separated instruments, calcified canals, ledges, or canal blockage may prevent proper canal preparation and limit effective disinfection, thereby reducing the predictability of treatment [41].

5.3.2 Assessment of restorability of the tooth

The retained segment should demonstrate sufficient structural integrity and an adequate ferrule to support a predictable definitive restoration [42]. Careful assessment should include the extent and pattern of bone loss, root trunk length, and any existing carious or structural compromise.

5.4 Patient-specific factors

5.4.1 Hygiene

Effective plaque control around the retained root segment and newly exposed furcation or root surfaces is essential. Adequate access for cleaning is required, as poor oral hygiene may lead to plaque accumulation, recurrent periodontal breakdown, and eventual failure of the procedure [35].

5.4.2 Motivation

The patient's financial capacity and motivation to complete the required periodontal, endodontic, and restorative phases require careful consideration [34, 43]. Clear discussion with the patient is necessary before treatment, as root resection or hemisection often involves multiple visits, good compliance, and long-term maintenance.

6. Contraindications

Root hemisection or root amputation is contraindicated in cases with fused roots or unfavorable root morphology, as these anatomical variations may complicate root separation and compromise periodontal maintenance and restorative outcomes. Teeth with insufficient bone support around the remaining root are also poor candidates because long-term stability and functional prognosis depend greatly on adequate periodontal support. In addition, cases in which satisfactory endodontic treatment cannot be achieved should be avoided, since persistent infection or inadequate canal debridement may lead to treatment failure [21, 22].

Patient-related and structural factors must also be carefully considered before considering hemisection or root amputation. Poor plaque control, inadequate oral hygiene, or lack of patient compliance significantly reduces the long-term success of the procedure because these treatments require meticulous maintenance and regular follow-up care. The presence of a vertical root fracture extending into the retained root represents a major contraindication, as the fracture can facilitate bacterial invasion and progressive periodontal destruction, ultimately resulting in tooth loss; therefore, it should be ruled out during the initial diagnostic stage [44].

7. Clinical workflow for root amputation (root resection)

7.1 Case selection and pre-operative assessment

Careful case selection is essential for successful management of root amputation. Clinical and radiographic examinations should confirm that periodontal destruction (**Figure 1**), root fracture, perforation, or endodontic pathology is confined to a single root, while the remaining roots have adequate periodontal support and a favorable crown-root ratio. Endodontic treatment of the retained roots should be completed before surgery, whenever possible. Cone-beam computed tomography (CBCT), when indicated, aids in evaluating root morphology, furcation anatomy, and defect configuration. Medical history, periodontal status, occlusion, restorability, and patient compliance should also be assessed before treatment planning.

7.2 Surgical access

After discussing and obtaining consent from the patient, local anesthesia is administered. Proper flap selection is essential to minimize postoperative gingival recession and preserve interdental soft tissue architecture. Consequently, papilla-preservation flap designs are generally preferred, particularly in esthetic areas and regenerative procedures, as they facilitate primary wound closure and help maintain papillary integrity [45]. Adequate flap reflection is also necessary to provide direct visualization of the furcation area and the root designated for resection.

7.3 Debridement and root preparation

All granulation tissue should be removed from the periodontal defect using curettes, and meticulous scaling and root planing are performed with hand or ultrasonic instruments. The surgical field is irrigated with sterile saline to remove debris and improve visibility. Thorough debridement facilitates healing and allows accurate assessment of the remaining periodontal support (**Figure 4**).

7.4 Root amputation

The selected root is sectioned at the furcation using a long-shank fissure bur under copious sterile irrigation while preserving the remaining tooth structure. The amputated root is carefully removed without damaging the retained roots or surrounding bone. The resected surface is then contoured and polished to eliminate sharp edges and create a cleansable anatomical form. Intraoperative radiographic verification may be performed to confirm complete root removal and appropriate resection (**Figure 3**).

7.5 Periodontal regeneration (when indicated)

If a residual intrabony defect is present, regenerative therapy may be performed. Following complete debridement, bone graft material is gently



Figure 6.

Postoperative follow-up demonstrating satisfactory soft tissue healing and maintenance of the retained root structure following root resection therapy.

placed into the defect without excessive compaction (**Figure 6**). A resorbable or non-resorbable barrier membrane is adapted to cover the defect and extend beyond its margins to facilitate guided tissue regeneration (GTR) (**Figure 2**). The membrane should be stabilized adequately to prevent displacement during healing.

7.6 Flap closure

The flaps are repositioned to achieve passive, tension-free primary closure over the surgical site. Interrupted and/or vertical mattress sutures using monofilament material are commonly employed to ensure flap stability and promote uneventful healing. A periodontal dressing may be placed when additional protection of the surgical site is desired.

7.7 Post-operative care and maintenance

Patients are prescribed appropriate analgesics, with antibiotics prescribed only when clinically indicated. Chlorhexidine mouth rinse (0.12–0.2%) is recommended twice daily for 1–2 weeks, while mechanical plaque control at the surgical site is temporarily avoided. Sutures are generally removed after 10–14 days.

Definitive prosthetic rehabilitation with a well-designed full-coverage crown is an integral component of root amputation therapy, as it restores function, protects the remaining tooth structure, and facilitates long-term periodontal maintenance (**Figure 7**). Careful occlusal adjustment is equally important to



Figure 7.

Review periapical radiograph demonstrates the definitive full-coverage crown in situ with satisfactory adaptation, while the retained distobuccal and palatal roots exhibit stable periapical and periodontal conditions without evidence of progressive pathology.

minimize excessive occlusal forces on the retained roots by reducing occlusal loading and eliminating premature contacts or interferences.

Long-term supportive periodontal therapy with regular clinical and radiographic reviews is essential to monitor healing, evaluate probing depths and attachment levels, assess regenerative outcomes, and maintain plaque control. Successful long-term prognosis depends on meticulous maintenance and patient compliance.

7.8 Review

Clinical evaluation at 3 to 6 months focuses on primary soft tissue maturation, resolution of mucosal inflammation, stabilization of probing depths, and verifying the patient's plaque control around the simplified root architecture. A 6-month post-treatment review assesses early endodontic healing and initial osseous maturation. The European Society of Endodontology (ESE) 2006 quality guidelines establish a minimum observation period of 1 year for complete radiographic evaluation of osseous repair, resolution of periapical/furcal radiolucencies, and confirmation of treatment success. Continued annual clinical and radiographic reviews for up to 4 to 5 years are indicated for complex regenerative and root-resection procedures to monitor long-term periodontal attachment stability and prevent disease recurrence is recommended by ESE.

8. Clinical outcomes and prognosis

Retrospective studies on the topic have shown positive survivability for root-resected molars when proper case selection and adherence to maintenance protocols are followed. Reported survival rates commonly go beyond 85–95% over extended

observation periods [14]. Comparative studies indicate that both dental implants and root-resected teeth exhibit good functionality upon strict periodontal maintenance programs.

Failures are mostly linked with progressive periodontal breakdown, root fracture, recurrent caries, or endodontic complications. Maxillary molars may demonstrate higher failure rates in comparison to mandibular molars due to anatomical complexity.

9. Follow-up and maintenance

Regular clinical and radiographic follow-up is necessary to assess periodontal stability, periapical healing, and prosthetic integrity of the affected tooth. Evaluation should align with established endodontic and periodontal healing to ensure long-term treatment success.

10. Conclusion

Root amputation and hemisection are important conservative treatments for multirooted teeth that have localized periodontal or endodontic issues. With careful case selection, teamwork between different specialists, and strict maintenance routines, these procedures can greatly extend the life of natural teeth and help postpone or prevent extraction and the need for implants.

Acknowledgments

We would like to express my sincere gratitude to the Faculty of Dentistry, Universiti Teknologi MARA (UiTM), for the continuous support, encouragement, and opportunities provided throughout this work. The authors would like to sincerely thank Dr. Melati Mahmud from the Department of Prosthodontics, Faculty of Dentistry, UiTM, for her expert guidance and valuable contribution to the fabrication of the fixed prosthesis.

The authors acknowledge the use of AI as a language-support tool in the preparation of the initial draft of this book chapter. The conceptualization of the work, development of original ideas from clinical case management, critical analysis, interpretation of findings and final content verification were undertaken entirely by the authors.

The authors declare that the clinical case presented in this chapter is original and based on their own clinical work. Written informed consent was obtained from the patient for the use and publication of clinical information, radiographs, and photographs.

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