

Minimally Invasive Surgical Technique in Periodontal Therapy

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ABSTRACT

Minimally invasive therapeutic approaches have become the standard of care for many medical procedures. Conventional periodontal surgical therapies involve extensive tissue reflection resulting in morbidity like thermal sensitivity, food impaction, and compromised esthetics. The clinical innovation in periodontal flap design and handling has radically changed surgical approach, which has allowed a drastic reduction in wound failure when compared to conventional flap approach. Thus, it stands to reason out that a reduced access to surgical sites or minimally invasive surgical approach for periodontal therapy would result in less morbidity for the patient. This review summarizes the available minimally invasive surgical approaches for the management of periodontal disease.

Keywords: Microsurgical approach, Minimally invasive periodontal therapy, Minimally invasive surgery, Modified minimally invasive surgical technique.

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INTRODUCTION

Nowadays, the patient's periodontal disease is increasingly recognized at an earlier stage than in the past. With the delivery of extensive nonsurgical treatment prior to referral for surgical treatment, the patient usually presents with isolated rather than generalized periodontal disease

sites.¹ But the traditionally practiced periodontal surgical techniques were designed for the treatment of generalized disease,² which involves relatively long incision and extension into non-periodontally involved areas. These extensive tissue reflections could result in attachment loss³ and can lead to morbidities like thermal sensitivity, food impaction, and compromised esthetics.⁴

In recent years, novel periodontal surgical approaches were developed to diminish these negative outcomes by modifying flap design and handling and addressing only the periodontally involved sites. This has allowed a drastic reduction in the inter-dental wound failure when compared to conventional flap approach.⁵ Thus, it stands to reason out that a reduced access surgical site or minimally invasive approach would result in less morbidity for the patient.⁶ This review summarizes the available minimally invasive surgical approaches for the management of periodontal disease.

Minimally Invasive Surgery

In medicine, the term "minimally invasive surgery" was first coined by the general surgeons Fitzpatrick and Wickham in 1990.⁷ It was further explored by Hunter and Sackier in 1993.⁸ They defined minimally invasive surgery as the ability to perform a traditional surgical procedure and achieve the same or better outcomes utilizing a surgical opening that was smaller than the traditional surgical access.⁶ The advantages of minimally invasive surgery were reported as less postoperative discomfort, more rapid healing, less morbidity, and equal or improved long-term surgical outcomes. All these were attributed to the use of a small incision, which resulted in minimal damage to surrounding tissues.⁸ With the advances in dental technology, the access and visualization of these surgical sites were possible, despite their smaller incisions and openings. These procedures were initially described by the instrument used to perform it, for example, laparoscopic surgery or microsurgery. As medical procedures and technology begin to change, many of the surgical procedures based on the instrument were found to be no longer completely accurate. Thus, finally the need for non-instrument-based description of surgical procedure was recognized, and those surgical procedures using smaller incision were described as minimally invasive surgeries.⁶

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Minimally Invasive Surgery in Periodontal Regeneration

Minimally invasive surgery for periodontal therapy was introduced by Harrel SK in 1998.⁹ Objectives of this surgery are (1) minimal mesiodistal extension of periodontal flap, (2) minimal flap elevation to expose only 1 to 2 mm of alveolar bone, (3) to avoid placement of vertical incision, but if necessary confined within attached gingiva and not extending beyond mucogingival junction, and (4) to avoid periosteal incision.¹

Surgical Procedure

Incisions

The incisions are designed to preserve as much of the soft tissue as possible. It is started with intra-sulcular incisions surrounding the teeth adjacent to the defect. These incisions are not connected across the interproximal tissue and should be made as separate incisions to preserve the inter-proximal tissue. Sulcular incisions are connected with a horizontal incision placed 2 to 3 mm from the crest of the papilla either on the buccal or the lingual/palatal side depending on whether it involves the esthetic areas.¹

Flap Elevation

Flaps are elevated utilizing sharp dissections only. It is considered that the use of sharp dissection minimizes trauma and preserves blood supply to the flap. The use of blunt dissection is avoided because it causes blanching during reflection and a darkened bruised appearance on the time of closure. This results in an increased incidence of postsurgical flattening of papilla, interproximal cratering, and loss of soft tissue height. Re-shaped Orban's knife is utilized to carry out sharp dissection as well as to perform thinning and undermining of the incision.¹

Visualization

The surgical sites can be visualized and magnified by the use of surgical telescope of at least 3.5× or by surgical microscope.¹

Defect Debridement

The granulation tissue is removed using a curette with its tip inserted vertically into the defect and its shank held parallel to the long axis of the tooth. This will minimize the trauma to the flap. The ultrasonic scaler can be additionally used to break up the granulation tissue into smaller fragments. A granulator can also be utilized to remove the remaining granulation tissue. Final root planing and smoothing is accomplished with a high-speed surgical length finishing bur.¹

Wound Closure and Suturing

The wounds are closed using a vertical internal mattress suture placed in the body of the papilla. This will pull the buccal and lingual tissue coronally at the base of the flap. The tips of the papilla are then approximated with gauze and finger pressure. Periodontal dressing is not routinely used in minimally invasive surgery.¹

Review of the Literature

Harrel SK in 1999 retrospectively analyzed the results obtained from a minimally invasive periodontal surgical approach. A total of 194 sites in 87 patients were treated. The results obtained after a mean healing time of 21.7 months showed statistically significant improvement in probing depth and attachment level. Postsurgical gingival margin was at or within 1 mm of the cement–enamel junction for 58% of the sites treated. It was concluded that minimally invasive surgical approach yielded results that were equivalent to more traditional approaches with the retention of soft tissue height post surgically.¹

In another study, Harrel SK in 2005 prospectively assessed the use of enamel matrix protein in conjugation with minimally invasive surgery. Sixteen patients with 160 sites were treated. Surgical sites were re-evaluated after 11 months. The mean probing depth reduction and attachment level improvement were significantly greater than 3 mm, and the mean change in recession following surgery was negligible (0.01 mm). This showed that minimally invasive surgical approach with enamel matrix protein produced little or no increase in recession.¹⁰

Harrel SK in 2010 presented the 6-year result of the above-mentioned study using minimally invasive surgery and enamel matrix protein. The 6-year data were available only for 142 sites in 13 patients. Probing depth, attachment level, and recession were unchanged from the 11-month results. This shows that the results obtained from minimally invasive surgery was maintained for long-term till 6th-year follow-up.¹¹

Minimally Invasive Surgical Technique

A novel surgical approach for periodontal regeneration, the minimally invasive surgical technique (MIST), was proposed by Cortellini and Tonetti et al in 2007.⁵ The background foundations for MIST were the concepts of papilla preservation techniques and minimally invasive surgery in combination with passive internal mattress suture to seal the regenerating wound from the oral environment. The clinical rationale for the development of MIST includes the following: (1) Reduction of surgical trauma, (2) increase in flap or wound stability, (3) improvement of primary closure of wound, (4) reduction in surgical chair time, and (5) minimization of intraoperative

and postoperative patient discomfort and morbidity. Minimally invasive surgical technique is preferably performed with the use of operating microscope or high power magnification loupes.⁵

Surgical Procedure

Surgical procedure differs from minimally invasive surgery in aspects of accessing the defect associated with interdental papilla either with simplified papilla preservation flap or the modified papilla preservation technique based on the amount of inter-dental space available. It also involves elevation of the full-thickness flap instead of sharp dissection followed by defect debridement.⁵

The flaps are approximated using a single modified internal mattress suture at the defect-associated interdental area providing primary closure in the absence of any flap tension. The additional interdental space, if accessed, is also sutured using the same technique.⁵

Review of the Literature

Cortellini et al in 2007 evaluated the clinical performance of MIST associated with the application of an enamel matrix derivative in the treatment of isolated deep intra-bony defects. Forty patients providing 40 defects were treated with the aid of an operating microscope and micro-surgical instruments. The 1-year follow-up results showed significant reduction in probing depth and gain in clinical attachment level with minimal increase in gingival recession (0.4 ± 0.7 mm). No patients reported intraoperative pain, while only 12 subjects reported moderate postoperative pain that lasted for 26 ± 17 hours.⁵

Cortellini et al in 2008 reported the efficacy of clinical performance of MIST with Enamel Matrix Derivative (EMD) in the treatment of multiple deep intra-bony defects in a single surgical procedure. A total of 20 patients (≥ 2 defects/patients) were treated. After 1-year follow-up, significant clinical attachment gain with minimal increase of gingival recession (0.2 ± 0.6 mm) was recorded. During the procedure, 12 patients felt some hardship while only 6 subjects reported moderate postoperative pain.¹²

Ribeiro et al in 2011 investigated the impact of EMD on the outcome of MIST for the treatment of intra-bony defects in single-rooted teeth. A total of 30 patients were treated and evaluated after 6 months. Based on the results, it was concluded that the use of EMD did not provide any superior benefit and outcome over MIST alone.¹³

Ribeiro et al in 2011 compared the performance of minimally invasive nonsurgical technique (MINST) and surgical approaches MIST. Six-month results showed no statistically significant difference between the groups except for higher chair time required in the MIST group.¹⁴

Cosyn et al in 2012 prospectively evaluated the clinical and esthetic outcome of MIST combined with a collagen-enriched bovine-derived xenograft. One-year results demonstrated favorable clinical outcomes with the risk for failure and advanced midfacial recession in defects associated with non-supporting anatomy.¹⁵

Modified minimally Invasive Surgical Technique

It was proposed by Cortellini et al in 2009. It was designed to (1) improve flap stability, (2) maintain space for regeneration, and (3) preserve an increased portion of blood supply at the level of crest of the papilla.¹⁶

Surgical Procedure

It is a modified approach from MIST involving limited inter-papillary incision in which only the buccal triangular flap is elevated while the inter-dental papilla is left in place, connected to the root of the crest-associated tooth with its supra-crestal fibers. The palatal/lingual tissues are not involved in the surgery.¹⁶

Incisions

To expose the buccal crestal bone, only the buccal flap elevation is made. The inter-dental papillary tissues were partially dissected in a buccolingual and coronal direction with a microblade. The microblade was introduced with an inclination suitable to intercept the buccal side of the lingual bone crest, as close as possible to its coronal edge to isolate the granulation tissue filling the intrabony component of the depth from the supracrestal papillary tissue. No interdental or/and lingual intrasulcular incisions were performed. This allows the supracrestal interdental tissue to remain attached to the root cementum of the crest-associated tooth, continuing with the palatal tissue, and was not displaced.¹⁷

Debridement and Suturing

After proper debridement with manual and ultrasonic instruments, a single modified internal mattress suture was positioned at the defect-associated interdental areas.¹⁷

Advantages

It basically eliminates the use of barriers membrane, but allows the use of any biological material, grafting material, or their combinations.¹⁷

Disadvantages

As indicated, M-MIST is not always applicable when a defect wraps around the lingual aspects of the tooth,

elevation of the soft tissue becomes necessary, and a MIST becomes the preferred approach.¹⁶

Review of the Literature

Cortellini et al in 2009 preliminarily evaluated the applicability and clinical performance of M-MIST in the treatment of isolated deep intra-bony defects. It resulted in very limited patient morbidity and excellent clinical improvement.¹⁷

Cortellini et al in 2011 compared the clinical and radiographic efficacy of the M-MIST alone and combined with EMD or EMD plus bone mineral-derived xenograft in the treatment of isolated interdental intrabony defects. The results showed that M-MIST with or without regenerative material had a significant clinical and radiographic improvement, while these studies did not have sufficient power to detect inter-group CAL differences.¹⁶

Mishra et al in 2013 evaluated the efficacy of M-MIST combined with recombinant human platelet-derived growth factor (rhPGDF-BB gel) in the treatment of intrabony defects. Intergroup comparison showed no statistically significant differences. This shows that the improvement in both the groups could be attributed to the novel surgical technique rather than the addition of rhPGDF-BB gel.¹⁸

Single-flap Approach

Trombelli et al in 2009 proposed a new minimally invasive procedure known as the single-flap approach (SFA). It is specifically indicated for periodontal reconstructive procedures in intraosseous defects characterized by an extension prevalent on either buccal or facial side. The basic principle involves elevation of the flap to access the defect only on one side (buccal/facial) leaving the opposite intact.¹⁹

Surgical Procedure

The single-flap approach consists of an envelope flap with a sulcular incision performed either on the buccal or the lingual side in the interproximal area overlying the intraosseous defects. An oblique or horizontal incision is made following the profile of the underlying bone crest (i.e., greater the distance from the tip of the papilla to the underlying bone crest, the more apical and close the incision to the base of the papilla). It results in adequate amount of untouched supracrestal soft tissue connected to the undetached papilla to ensure flap adaptation and suturing.¹⁹

Debridement and Wound Closure

After proper debridement with manual and ultrasonic instruments, a horizontal internal mattress suture is placed between the buccal flap coronal to the mucogingival junction and to the base of the undetached oral

papilla to provide the repositioning of the buccal flap. A vertical or horizontal internal mattress suture is placed between the most coronal portion of the buccal flap and the most coronal portion of the oral papilla to ensure primary closure of the repositioned buccal flap.¹⁹

Advantages

The single-flap approach provides clinical and technical advantages, namely, it (1) facilitates flap repositioning and suturing, (2) stabilizes the buccal flap to the undetached oral papilla, (3) apparently helps in wound closure for primary intention, and (4) leaves a greater volume of supracrestal soft tissue intact for better preservation of the blood supply in the interdental area.¹⁹

Disadvantages

Defect morphology extending to the other side cannot be treated with single-flap approach.¹⁹

Review of the Literature

Trombelli et al in 2009 reported the preliminary data of a case series evaluating the clinical effectiveness of SFA with buccal access in combination with a collagen membrane with a hydroxyapatite-based biomaterial in the treatment of intraosseous defects. The results showed limited postsurgical recession, which represents SFA as a suitable option to surgically treat defects in areas of high esthetic demands.¹⁹

CONCLUSION

From this review it is evident that the application of MIST and its modification results in enhancement of clinical parameter and reduction of patient morbidity, when compared to more traditional periodontal surgical approaches. Apart from these novel changes in the surgical approach, the lack of its wider acceptance may be associated with the difficulty in visualizing the surgical site. Currently, they are performed using either surgical microscope or surgical telescope, which are less than completely satisfactory. In spite of providing excellent visualization, a surgical microscope needs a steep learning curve, and it is difficult to move from one visual angle to another rapidly. In future, better devices to assist in visualization and preparing small surgical sites and to aid in placement of regenerative materials are needed for wider application and acceptance of minimally invasive periodontal surgery.

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