



Minimally Invasive Surgical Therapy in Periodontology-A Comprehensive Review

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ABSTRACT:

Minimally invasive surgical therapy (MIST) has introduced a new direction in periodontology, offering reliable outcomes with less surgical trauma. Traditional periodontal surgeries often required extensive flap elevation, which contributed to complications such as gingival recession, root sensitivity, and esthetic concerns. MIST is based on limited incisions, split-thickness flap elevation, advanced visualization with loupes, microscopes, or videoscopes, and precise wound closure that maintains blood supply and accelerates healing. These features improve patient comfort while supporting predictable regenerative success. The approach is applied in regenerative procedures, mucogingival surgeries, and implant interventions. Techniques such as the Whale's Tail design, Pinhole Surgical Technique, and Vestibular Incision Subperiosteal Tunnel Access have shown promising esthetic and functional outcomes. In implantology, modified trephination and balloon-assisted sinus lift highlight its clinical versatility. Although MIST is technique-sensitive and requires advanced training, future integration of imaging technologies and robotic assistance may enhance precision. Collectively, it represents a patient-centered and regenerative approach in periodontal therapy.

A. Introduction and Background

Minimally invasive treatment is becoming a standard part of dental care, improving procedures from cavity preparation to surgery. In periodontal therapy, past methods required large mucogingival flaps for access, but minimally invasive techniques now provide better long-term outcomes, including reduced probing depths and increased clinical attachment levels, with less thermal hypersensitivity and almost predictable gingival recession.¹

The "Minimally Invasive Surgery (MIS)" with the aim to produce minimal wounds, minimal flap reflection and gentle handling of the soft and hard tissues - Harrel & Nunn 2001. The Minimally Invasive Surgical Technique (MIST) to stress the aspects of wound and blood clot stability and primary wound closure for blood-clot protection.²

In 1995, the first minimally invasive method for periodontal surgery was introduced, which utilized a surgical device for debridement through small access



incisions.³ This technique evolved to focus on periodontal regeneration through the use of bone grafts and regenerative materials, leading to the coining of the term "Minimally Invasive Surgery for Periodontal Regeneration." In 2007, the Minimally Invasive Surgical Technique (MIST) was developed, based on the papilla preservation technique, further advancing the field of minimally invasive periodontal surgery.^{4,5}

This review discusses a minimally invasive technique for treating soft tissue defects, specifically through a tunnel procedure for graft placement.

B. Visualization for minimally invasive periodontal therapy

The most significant advancements in technology are related to visualization. The key to successfully performing minimally invasive procedures lies in the ability to clearly see the surgical site, which is essential for effectively executing the necessary surgical techniques. Enhanced visualization leads to improved outcomes.⁶

Closed root planing has consistently been shown to improve periodontal health; however, the end result often includes residual calculus on the root surfaces. Inspections of root surfaces using an endoscope or videoscope have revealed visible areas of retained calculus and biofilm. Consequently, the limited visibility in traditional closed techniques can lead to periodontal deterioration and the need for further treatment, which often involves surgery.⁷

One of the most common treatments in traditional periodontal surgery is open-flap debridement, which enables proper visualization of the root surface and access to periodontal defects. However, the incisions used for visibility often extend over multiple teeth, including areas with little or no periodontal damage.

These large flap reflections may lead to various complications, such as post-surgical root exposure, food impaction, thermal sensitivity, and aesthetic deformities. In contrast, minimally invasive periodontal therapy aims to use the smallest incision possible, allowing access to and examination of only the areas that need periodontal treatment.⁷

Visualization for closed root planning procedure: The currently available glass fiber endoscope is the only

device that allows visualization of the root surface without the need for surgical access. As a result, this instrument is unique, and there are no other options for closed root planing visualization. However, there are concerns about the endoscope that have limited its acceptance for routine periodontal treatments. One major issue is the lack of clarity in the images displayed on the monitor, which is primarily due to the limited number of glass fibers used to transmit the image.^{6,7,8}

Visualization for minimally invasive periodontal surgery: Surgical microscopes and telescopes have traditionally been used in small incision periodontal surgery, often referred to as loupes. Both instruments provide magnification and usually incorporate an integrated light source.

- **Surgical Loupes:** Magnification with surgical loupes typically ranges from 2× to 7.5×, with the most commonly used options falling between 3× and 5×. The focal length is chosen based on the surgeon's preferences. They often come equipped with high-intensity lighting, which can be either halogen or LED, and can usually be focused to a very narrow beam. When performing procedures involving minor incisions, having a strong, focused light on the magnified area can be extremely beneficial. One advantage of surgical loupes over surgical microscopes is that surgeons maintain complete control over both magnification and illumination. This enables them to quickly examine multiple areas within the surgical field without needing to adjust any external equipment, such as a microscope. Additionally, if the patient moves, the surgeon can easily redirect the magnification simply by moving their head.^{6,7}

- **Surgical Microscope:** In periodontal surgery, the surgical microscope has become an indispensable tool for placing soft tissue grafts and performing periodontal plastic surgeries. By enabling precise handling of facial tissues and enhancing suturing techniques during aesthetic procedures, this technology greatly improves patient outcomes and satisfaction. Many reported MIST (Minimally Invasive Surgical Techniques) operations have successfully employed a facial flap approach, yielding favorable results for the use of microscope. While the procedure maybe highly technique sensitive, especially in the posterior and lingual areas, the use of mirrors can help offset the limitations of the microscope's straight-line viewing



field. It is important to note, however, that the surgical microscope requires refocusing if the patient shifts during treatment, necessitating careful attention from the practitioner. Overall, the advantages of using a surgical microscope in periodontal surgery far outweigh the challenges, making it an essential component of modern dental practices.⁸

C. Indications for MIST⁹

- Isolated, interproximal bone defect, not extending beyond the interproximal site
- Periodontal defects in the borders of edentulous areas
- Periodontal defects that extend buccally/lingually from inter proximal site
- Multiple separate defective sites in a single quadrant.

D. Contraindications for MIST⁹

- Generalized horizontal bone loss
- Multiple interconnected vertical bone loss

E. Principles of MIST⁹

- The first principle is to ensure optimal healing of the periodontal tissues where the prerequisite is to preserve as much blood supply as possible. This can be accomplished by employing split-thickness dissection for all flap reflections and avoiding the use of a periosteal elevator. The periosteum is of paramount importance to ensure blood supply to these tissues, and reflecting it with a periosteal elevator can significantly compromise the blood supply to both the gingival tissue and the underlying bone. Therefore, it's imperative to leave the periosteum undisturbed, exposing the bone only within the defect itself.
- The second principle emphasizes minimizing traumatic damage to the periodontal tissue. Traditional regenerative periodontal surgery typically involves making large flaps and extensively reflecting the soft tissue from the bone. In contrast, Minimally Invasive Surgery (MIS) employs small incisions, utilizes split-thickness dissection to lift the soft tissue only to the edge of the bone defect, and applies gentle handling throughout the procedure. When done correctly, the closure should result in tissue that closely resembles the surrounding untreated areas, avoiding any bruised or

cyanotic appearance. This method not only enhances healing but also prioritizes patient comfort and outcomes.

- Third principle is to restore the soft tissue to its original position—at or above the presurgical height—without any tension. Minimally invasive surgery avoids penetrating the delicate coronal portion of the papilla with a needle, as this can compromise its vital blood supply. Moreover, the use of a videoscope allows for smaller incisions and less extensive reflection of tissue, leading to improved closure and superior patient outcomes.

F. Application of MIST in Periodontics¹¹

1. Regenerative Procedures:

- Guided tissue regeneration (GTR)
- Guided bone regeneration (GBR) and other procedures where increasing the amount of bone needs special preparation forms of the soft tissue

- Accurate split thickness flaps

2. Mucogingival Surgery:

- Double papilla flaps
- Apical or coronal repositioned flaps
- Connective tissue grafts
- Pedicle or sliding flaps

3. Implantology

A. Periodontal Regeneration

Whale's Tail Technique:

This technique is a modification to the conventional Papilla preservation flap by Takei, wherein the flap was reflected from palatal to buccal, which significantly severed the blood supply during the healing period. Whale's tail technique proposed by Bianchi and Bassetti in 2009, for addressing wide intrabony defects in the esthetic zone. This approach involved elevating the flap from the labial to the palatal side to amplify access and visualization of the defect, enabling the regenerative process and preserving interdental tissue and securing the graft material or the membrane or a combination of both in place. Incisions positioned away from the defect and sutures placed distantly reduced bacterial colonization of biomaterials leading to desirable regenerative outcomes.¹²

B. Mucogingival surgery

i) Pin Hole Technique:

The pinhole surgical technique (PST), introduced by



Chao in 2012, provides a minimally invasive method for addressing recession defects. This technique involves a horizontal incision at the vestibule's base, preserving the interdental papilla. A transmucosal periosteal elevator is employed for blunt dissection, facilitating coronal and horizontal flap extension to elevate adjacent papillae. PST advances the mucogingival complex beyond the cemento-enamel junction, effectively mitigating the drawbacks of traditional approaches, such as compromised blood supply and scar formation.¹³ The technique discerningly overcame the complications of the coronally advanced flap which involved vertical releasing incisions and elevation of full thickness flap. In contrast, the pinhole surgical technique restricts tissue manipulation to mere pinholes, causing little or no damage to intrasulcular tissues with no requirements for sutures and enhanced healing due to minimal manipulation of soft tissues which increased the success rate and better post operative results in terms of root coverage.¹⁴

ii. Vestibular Incision Subperiosteal Tunnel Access (VISTA):

This technique was first introduced by Zadeh et al (2011), which involved creating a partial thickness mucoperiosteal flap at the mucogingival junction using tunnelling knives while sparing the interdental papillae. A subepithelial connective tissue graft (SCTG) or acellular dermal matrix graft (ADMG) is sutured in place, thereby maintaining the coronal position of the gingival margin and avoiding relapse.¹⁵ This minimally invasive approach enhances blood circulation, promotes healing, increases keratinized tissue width, and yields favourable cosmetic outcomes with optimal results obtained for root coverage with reduced dentinal hypersensitivity. In addition, the ability to customize the treatment plan catering to individual patients' needs is another noteworthy benefit¹⁶

C. Implantology Sinus Lift Procedures:

Replacement of posterior teeth in the maxillary arch may seldom be accompanied by a low maxillary sinus, which has to be elevated surgically, known as the maxillary sinus augmentation, to ensure optimal placement of the implant. Conventional approaches to this procedure include the lateral window technique and the transalveolar technique. The minimally invasive techniques for sinus augmentation include the modified

trephination technique and the antral balloon elevation.¹⁷ The lateral window technique takes the direct approach from the lateral wall of maxillary sinus to creating a window and directly lifting the sinus floor. The procedure is technique sensitive, highly invasive and requires a large flap elevation for visualization, and the predeterminant for success is the residual bone.^{18,19} The transalveolar technique is usually employed when the residual bone is 6mm or more and commences with the preparation of the osteotomy site, followed by the placement of a bone graft. The osteotome is then introduced into the site, and the bone graft is tapped, which further compresses the sinus membrane, thereby elevating it.^{20,21} The modified trephination technique utilizes a 3mm diameter trephine bur in the preparation of the osteotomy site, maintaining a distance of 1-2mm from the floor of the maxillary sinus. After this, an osteotome of a congruent diameter to that of the trephine bur is introduced in the prepared site, pushing the remnant bone cylinder apically to a depth that is 1mm short of the depth created by the bur, thereby elevating the sinus.²² This minimally invasive technique significantly reduces the risk of membrane perforation.¹⁷ The antral balloon elevation technique involves the preparation of the osteotomy site as the same in trephination technique but a latex balloon is introduced in the subantral space and slow controlled insufflations are made with saline solution, and the sinus membrane is detached to the desired height followed by placement of bone graft.²³

G. Future potential for MIST

The current techniques in minimally invasive surgery employ small incisions to address and regenerate damage caused by periodontal disease. These advancements represent an evolution in surgical periodontal treatment that has developed over the entire history of the field. Today, we can treat and regenerate periodontal damage through surgical openings that would have seemed unimaginable since 3 decades. The future of periodontal therapy is promising, as there is a growing acceptance of nonsurgical and minimally invasive approaches in medicine and dentistry. Advancements in imaging technology are likely to establish nonsurgical techniques as the primary initial treatment method. While many periodontal therapies may increasingly be performed nonsurgically, surgical intervention will remain



necessary in specific clinical cases.²⁴ Robot-assisted minimally invasive surgery is expected to enhance surgical accuracy and dexterity while minimizing patient trauma. This technology allows surgeons to perform procedures automatically using remote control.²⁵

H. Drawbacks²⁶

- More demanding and technique sensitive.
- Cost-effective.
- Challenges: restricted vision, loss of depth of field with increased magnification, loss of visual reference points.
- Time-consuming to develop.
- Requires physiologic tremor control, fine movement skills, and a steep learning curve for proficiency for optimal results.

Disadvantages of Minimally Invasive Surgery (MIS) (according to Jaffray)²⁴:

- Requires special equipment.
- Specialist training needed.
- Some additional equipment can be costly.
- Procedures may take longer than conventional surgeries, though hospitalization time is shorter.

I. Conclusion

Minimally invasive surgery has proven to be effective in periodontal regenerative surgery, particularly for treating intrabony defects, with low morbidity during and after the procedure. Successful application requires specialized training and specific instruments. Incorporating microsurgical techniques in periodontal surgery is crucial for enhancing treatment outcomes.

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