

Minimally Invasive Techniques in Periodontal Therapy – A Review

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Abstract

Minimally invasive periodontal surgery (MIPS) has emerged as a preferred technique for performing regenerative therapy in periodontal defects due to its focus on minimizing surgical trauma and maximizing patient comfort and esthetic outcomes. It can be performed using magnification from surgical microscopes, surgical telescopes, or endoscopic visualization. MIPS seals the healing wound from the contaminated oral environment by ensuring primary closure. Preserving soft tissues and maintaining minimal gingival recession, minimal hypersensitivity claims to be essential requisites to meet the demands of the patient and the clinician in the esthetic zone. Minimally invasive methods for periodontal treatment yield long-term reductions of probing depths and enhanced clinical attachment levels. The exclusive property of MIPS is that it reduces the chair time required to perform the procedure and results in limited morbidity to the patient during the surgical procedure, as well as in the post-operative period. However, its application should be guided by careful case selection and consideration of patient needs to ensure optimal treatment outcomes.

Keywords: Minimally invasive, Periodontal therapy, Soft tissue.

INTRODUCTION

Periodontitis indeed involves inflammation that affects the periodontium, which includes the tissues surrounding and supporting the teeth. This condition goes beyond gingivitis (which is limited to inflammation of the gingiva or gums) and can lead to significant damage to the connective tissue attachment of the teeth and even the underlying bone.

The goals of periodontal therapy are generally twofold by halting disease progression and Promoting regeneration. Regular monitoring and maintenance are often necessary to ensure the success of treatment and to prevent recurrence of periodontitis.

Regeneration is an advanced healing event that occurs when the systemic and local conditions are favorable and when therapy is properly applied.^[1] The systemic conditions include the control of periodontitis, a low total bacterial load in the mouth, and cessation of smoking habits.^[2-4] The local conditions include the presence of space for the formation of the blood clot at the interface between the flap and the root surface,^[1] the stability of the blood clot to maintain continuity with the root surface avoiding formation of a long junctional epithelium and the soft tissue protection to avoid bacterial contamination.^[5-7]

Minimally invasive periodontal surgery (MIPS) represents a significant advancement in the field of periodontal regenerative therapy. Conventionally, periodontal surgeries involved more extensive procedures that required larger incisions and more aggressive manipulation of soft tissues to access and treat the affected areas. However, with the development of MIPS, there has been a shift towards techniques that aim to achieve the same therapeutic outcomes while minimizing the trauma to surrounding tissues.

The key principles of MIPS include:

1. Smaller incisions: MIPS techniques involve making smaller incisions compared to traditional periodontal surgeries. This reduces the amount of tissue that needs to be cut and manipulated, leading to less postoperative discomfort and faster healing

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2. Preservation of soft tissues: MIPS focuses on preserving as much of the surrounding soft tissue as possible. This is achieved through careful planning and precise surgical techniques that minimize trauma to the gums and other periodontal structures
3. Enhanced healing: By reducing surgical trauma, MIPS promotes quicker healing and recovery. Patients often experience less pain, swelling, and discomfort after surgery compared to traditional methods
4. Technological advances: Advances in instrumentation and technology have also contributed to the development of MIPS. Techniques such as laser surgery, microsurgery, and minimally invasive access flaps have enabled periodontists to perform surgeries with greater precision and minimal tissue disruption
5. Improved aesthetic outcomes: MIPS techniques often result in better esthetic outcomes because they preserve the natural contours and appearance of the gums and surrounding tissues.

This approach is particularly beneficial for patients requiring periodontal regenerative procedures aimed at restoring lost attachment apparatus and promoting periodontal health.

Harrel and Rees, in proposing minimally invasive surgery (MIS), focused on several key principles to improve periodontal surgical techniques: minimal wounds, minimal flap reflection, gentle tissue handling, and preservation of blood supply.

Further modified minimally invasive surgical technique (M-MIST) additionally incorporated the concept of space provision for regeneration.

CLINICAL STRATEGIES

The objective of treating a periodontal defect is to achieve optimal clinical outcomes with minimal adverse effects during and after the procedure. MIST and its modified version (M-MIST) represent approaches tailored to specific types of periodontal defects:

1. MIST: This technique is typically employed for treating multiple intrabony defects. This approach helps preserve the surrounding soft tissue and maintain the integrity of the gingival architecture, which is crucial for aesthetic outcomes and post-operative comfort
2. M-MIST: M-MIST is a variation of the technique that is specifically adapted for treating isolated intrabony defects. Isolated defects refer to individual or singular pockets of bone loss around a tooth. M-MIST may incorporate additional strategies such as creating space for regeneration or optimizing wound closure to enhance the conditions for periodontal tissue healing and regeneration.

Both MIST and M-MIST emphasize reducing the surgical footprint while ensuring effective treatment of periodontal defects. By minimizing intraoperative trauma and preserving

tissue integrity, these techniques aim to mitigate postoperative discomfort, accelerate healing, and improve overall patient outcomes. They are part of a broader trend in periodontal therapy toward less invasive approaches that prioritize patient comfort and long-term periodontal health.

The basic ideology behind MIST follows the concepts of MIS and in addition involves the application of papilla preservation techniques (PPTs) with a microsurgical approach. The design of M-MIST allows both access to root surface instrumentation and minimization of flap elevation through the elevation of the buccal flap alone.

SURGICAL APPROACHES

MIST

The MIST is based on the elevation of the defect-associated interdental papilla along with minimally extended buccal and lingual flaps.^[8] The PPT, the modified PPT (MPPT), and the simplified papilla preservation flap (SPPF) are important elements in terms of MIST since they can guarantee minimal access to the periodontal defect.

PPT

Takei *et al.* proposed a new surgical approach called the PPT.^[9] The buccal aspect of the flap is elevated with a sulcular incision around each tooth, without involving the interdental papilla. The lingual/palatal flap design involves a sulcular incision along the lingual or palatal aspect of each tooth and a semi-lunar incision across each interdental papilla. This incision dips apically from the line angles of the tooth so that the papillary incision line is approximately 5 mm from the gingival margin. This enables the interdental tissue to be dissected from the lingual/palatal aspect so that it can be elevated intact with the facial flap.

MPPT

Cortellini *et al.* published this new approach as a modification of Takei's technique for interproximal regenerative procedures.^[10] A horizontal incision is performed on the buccal papillary tissue at the base of the papilla. A full-thickness palatal flap, along with the interdental papilla, is elevated. A buccal full-thickness flap is raised with vertical releasing incisions and periosteal incisions, when required.

SPPF

Cortellini *et al.* proposed the SPPF.^[11] It is initiated with an oblique incision across the defect-associated papilla, from the gingival margin at the buccal line angle of the involved tooth to the mid interproximal portion of the papilla below the contact point of the adjacent tooth. A full-thickness palatal flap, including the papilla, and a split-thickness buccal flap are then elevated.

Importance of width of interdental space in the selection of flap design

The entry incision in MIST, which is performed on the buccal side of the interdental papilla, is dissected with two different

methods depending on the width of the interdental space. The width of the interdental space is measured with a periodontal probe as the distance between the two root surfaces. The periodontal probe is positioned horizontally about 2-mm apical to the tip of papilla. The SPPF is preferred whenever the width of the interdental space is 2 mm or less, while the MPPT is used at sites with an interdental width >2 mm, and the crestal incision is applied next to an edentulous area.

Modified MIST

The overall idea of the M-MIST is to provide a very small interdental access to the defect through a small buccal window without elevating palatal flap.^[12] The entry incision is performed on the buccal side of the interdental papilla and follows the same principles described for the MIST approach. The interdental incisions involve the buccal aspect of the teeth neighboring the defect and do not involve the next papillae. A triangular buccal flap is minimally elevated to expose the residual buccal bone crest without detaching interdental papilla from the residual interdental bone crest and supracrestal fibers. The microblade is positioned to dissect the supracrestal interdental tissue from the granulation tissue. Then, the granulation tissue is carved away from under the papilla and the root surface is completely debrided with mini-curettes. At the end of the procedure, the buccal flap is repositioned and sutured to the interdental supracrestal soft tissue which is still anchored with their fibers to the root cementum.

Conventional periodontal surgery versus MIPS

Radical changes in dental surgical procedures and armamentarium with the evolution of novel instruments and materials have drastically reduced the invasiveness of conventional periodontal surgery.

TECHNICAL IMPLICATIONS

Application of MIST and M-MIST requires surgical skills and a proper surgical setting. The major disadvantage is the lack of visibility and proper manipulation of the surgical field. The minimal flap reflection reduces the angle of vision and light penetration into the surgical field. To overcome these problems, microsurgery came into play.

PERIODONTAL MICROSURGERY

Periodontal microsurgery is the refinement of conventional surgical procedures made possible by the improved visual acuity gained with the use of surgical microscope.^[13] Surgical microscopes use coaxial fiber-optic illumination and produce an adjustable, bright, uniformly illuminated, shadow-free, circular spot of light that is parallel to the optical viewing axis. Microsurgery incorporates three different principles:^[13] (1) Improvement of motor skills, thereby enhancing surgical ability, (2) an emphasis on passive wound closure with exact primary apposition of wound edge, and (3) the application of microsurgical instrumentation and suturing to reduce tissue trauma.

MICROSURGICAL INSTRUMENTS

Microsurgical instruments must be approximately 15 cm in length and circular in cross section to enable high-precision movement.^[14] The working tips of microsurgical instruments are sharper and smaller than those of regular instruments. However, shorter instruments with rectangular cross-section are not recommended.

MICROSURGICAL KNIVES

These knives have the characteristic ability to create clean incisions to prepare the sharp flap margins for healing by primary intention. Incisions are made at right angles to the surface using Castroviejo microsurgical scalpel. Magnification permits easy identification of ragged wound edges for trimming and freshening. Various types of knives such as crescent, lamellar, blade breaker, sclera, and spoon knife can be used. They offer the dual advantage of extreme sharpness and minimal size.

MICROSURGICAL SCISSORS

There are various types of scissors such as micro scissors, extra fine micro scissors (straight), and extra fine micro scissors (curved).

MICROSURGICAL NEEDLE HOLDERS

They are made of titanium and designed to hold fine needles. They differ in the way they grasp the needle, e.g., a grasp with flat surface if a flat needle is used. Microsurgical needles are made of stainless steel directly swaged onto the suture ends. Reverse cutting needle of size 16–19 mm is preferred. Techniques of microsurgery include accurate needle placement, optimal tissue union, and tying of square and slip knots.

MICROSURGICAL SUTURES

Periodontal microsurgery facilitates the use of 6-0 to 9-0 sutures. Microsurgical wound apposition reduces gaps or voids at the wound edges, thereby aiding in rapid healing with less post-operative inflammation and pain. The geometry of microsurgical suturing consists of the following points: (1) Needle angle of entry and exit of slightly <90°, (2) suture bite size of approximately 1.5 times the tissue thickness, (3) equal bite sizes (symmetry) on both sides of the wound, and (4) needle passages perpendicular to the wound microraspatorium, bone scraper, papilla elevator, microscalpel holder, and a dental microforceps are also routinely used in microsurgery.

APPLICATIONS OF PERIODONTAL MICROSURGERY

Perioesthetics

Periodontal microsurgery has wide implications in root coverage procedures such as rotational, free gingival, double papilla, and sub-epithelial connective tissue grafts since it causes minimal trauma and enhances the wound healing

process.^[15] The combination of small microsurgical instruments and delicate surgical techniques results in fine, crisp, narrow, and accurate incisions, gentle tissue handling, and precise repositioning of the wound margins with smaller needles and sutures. The main advantages of microsurgery are rapid wound healing, low morbidity, and less discomfort. In addition, narrow incisions and small surgical wounds further add on to the better esthetic results. The high survival rate of the vascularized graft is due to the retained blood supply from the base of the pedicle, which can be enhanced through microsurgery.

Periodontal flap surgery

Periodontal flap margins can be elevated with uniform thickness and scalloped butt-joint using microsurgical techniques. This aids in the precise adaptation of the tissue to the teeth or the opposing flap in an edentulous area, thus eradicating the gaps and dead spaces avoiding the need for new tissue formation and enhancing periodontal regeneration. Further, the coronal displacement of the flaps over the defects was at ease and experienced less tension with the microsurgical techniques, thereby facilitating rapid healing and return of the mucogingival line to its original position.^[16]

Root visualization and preparation

Success of periodontal therapy depends on visual access to the root surface for removing the residual calculus, treating the pathologically altered root surface, and achieving a clean and smooth root surface. Root planing is more effective when done under greater magnification and enhances periodontal regeneration.

Other applications

Periodontal microsurgery can also be effectively used in interdental papilla reconstruction, alveolar ridge deficiencies, esthetic implant reconstruction, and sinus lift procedures.

ADVANCES IN MIPS

Videoscope-assisted MIS (VMIS)

This technique is indicated only for isolated defects.^[17] Single palatal or lingual flap is preferred since reflecting a buccal flap has a greater potential for visible gingival recession with possible negative esthetic consequences. Lingual access and visualization are much easier when a videoscope is available. The videoscope gives an improved method for direct visualization in surgical procedures that use very small incisions and a greater magnification than telescopes and surgical microscopes. It provides magnification up to $\times 60$.^[18] Videoscope chiefly comprises a very small digital camera that can be placed in the surgical site. It has a camera and light source that is a total of 2.7 mm in diameter with a 640-mm flexible insertion tube that makes it ideal for visualization in all parts of the oral cavity. Adaptation of the camera end of the insertion tube of the videoscope to a handle allows the surgeon to place the camera into the minimally invasive periodontal surgical access opening. Incorporated into the handle is a small carbon fiber retractor that can be rotated to

retract the very small flaps associated with VMIS. Since the videoscope camera can be placed directly into the periodontal defect, the root surface is visualized directly at a near 90° angle to the tooth. The modified videoscope with gas shielding technology that uses a constant flow of surgical gases or air over the lens has been developed to avoid blood and surgical debris from obscuring the optics of the instrument. Improved results reported with VMIS may be attributable to the ability to use smaller access incisions that result in less tissue trauma and post-surgical soft tissue recession, the ability to see and remove small islands of calculus, and root abnormalities such as microgrooves. Hence, the use of videoscope adds a new dimension to periodontal regenerative surgery. In the future, a detection device that can differentiate between dentine, cementum, and calculus shall be developed in combination with the videoscope to add on to the advantages.

Minimally invasive technique in guided bone regeneration

This technique is indicated for partially or completely edentulous healthy adults, with insufficient localized jaw bone volume to receive dental implants.^[19]

Tunnelling approach

A vertical full-thickness incision is done in the mesial aspect of the edentulous ridge from the free gingiva to beyond the mucogingival junction (MGJ). A dedicated mini-chisel is inserted through the incision between the bone and the periosteum and advanced to gently release the periosteum from the bone. Using this technique, the chisel was advanced from the alveolar crest to beyond the MGJ, until the distal border of the desired GBR segment was reached. Once an initial tunnel has been created, the Foley catheter is placed into the desired GBR zone. Dedicated inflator is used to inflate the balloon to a pressure of 2 atmospheres. Sequential inflations are executed from distal to proximal. After successive balloon dilatations, an adequately sized barrier membrane can be placed with autologous fibrin and bone graft substitute through this small incision which should be sutured so that membrane is secured to the tissue to prevent any mobility.

Periodontal endoscope with micro ultrasonic instruments

Endoscopic periodontal debridement is the only nonsurgical minimally invasive, real-time video technology available for the subgingival treatment of periodontal disease disclosing minute details such as caries, root fractures, perforations, resorption, biofilm, and calculus that previously may have been undetectable. Before periodontal endoscopy, visualization and complete debridement of the subgingival environment were only attained through surgical intervention through open-flap debridement. Even after traditional surgery, deposits of subgingival calculus have been shown to remain.^[20] After the advent of periodontal endoscopy, the ability to clearly visualize and remove calculus with nonsurgical therapy has improved since calculus found on the dental root structure commonly shows up as gold, yellow, or white due to the bright fiber-optic illumination. The periodontal endoscope allows for visual access to root surfaces with great magnification of $\times 24$ to $\times 40$,

lessening the need for surgical intervention.^[21] Combined with a simple array of micro ultrasonic instruments, endoscopic debridement can be accomplished in a conservative, minimally invasive way. The optic fiber present in endoscope is delivered to the gingival margin coupled with an instrument called an “explorer” for viewing subgingivally. The captured image is relayed to a screen so that the user can see “real time” video of the highly magnified environment. Micro ultrasonic instruments are probe-like (measuring 0.2–0.6 mm in diameter), driven at ultrasonic speeds (25,000 to more than 40,000 cycles/s), with active working sides on all surfaces of the vibrating instrument essential for supra and subgingival debridement, and provide ultrasonically activated lavage in the working field.

CONCLUSION

MIPS represents a significant advancement in periodontal therapy, focusing on achieving treatment goals with minimal surgical intervention. MIPS has shown promising results in improving clinical parameters and reducing patient morbidity, ongoing research and comparative studies are necessary to establish its efficacy and success rates relative to traditional periodontal surgical techniques. These efforts contribute to advancing evidence-based practices in periodontology and ensuring optimal outcomes for patients undergoing periodontal regeneration procedures.

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