Minimally invasive periodontal therapy

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ABSTRACT

Historically, surgical techniques were governed by specific incisions and surgical designs. With the advent of anesthesia, the complicated cases were managed but at the cost of the tissues leading to morbidities of various degrees. The innovations and the advances in the surgical techniques led to the ideology that surgeries could be done with minimal tissue manipulation and sacrifice. Thus the concept of “minimally invasive dentistry” was introduced with the primary goal to achieve satisfactory therapeutic results with minimal trauma during the process. In context to the management of periodontitis, this modality includes use of conservative incisions which preserves as much soft tissue as possible, avoiding continuous incisions and vertical incisions, use of magnification etc. The ultimate goal of any treatment modality is the resolution of the disease and regeneration if possible with minimal postoperative pain and morbidity. Minimal invasive periodontal therapy involves treatment options which cure the disease with reduced postoperative pain, improved healing and better patient acceptance. This paper covers the advent of minimal invasive periodontal therapy modalities both surgical and non-surgical along with the literature review.

1. Introduction

Periodontitis is the chronic inflammation of the periodontium that extends beyond the gingiva and involves the destruction of the connective tissue attachment of the teeth. The treatment involves debridement of the tooth surface and the adjacent areas employing scaling, root planning and periodontal flap surgery. While scaling and root planning are non-surgical treatment modalities and are conservative; periodontal flap surgery gains access to the underlying bone for complete debridement achieving pocket depth reduction, periodontal regeneration and maintenance of periodontium in healthy condition feasible by routine home care methods by the patient.

Over the past century, conventional flap surgeries were employed to treat advanced periodontitis cases wherein extensive flaps were used to gain access to the underlying diseased tissues. These procedures lead to loss of interdental papillary gingiva, loss of gingival height and contour, root sensitivity and crestal bone resorption. These changes were considered as the unavoidable sequelae of the surgical procedures. Extended duration of the surgeries leads to extensive tissue manipulation resulting in increased post-operative pain, swelling, edema and delayed healing. There has been a constant surge to reduce or eliminate these complications of surgery.

With the technological advances, there was a shift from resection to regeneration. In the early 1980s, researchers started looking for options

involving less extensive procedures minimizing postoperative mortality and morbidity. Any procedure should be easy to perform, causes lesser trauma to the tissues both during intraoperative phase and post-operative healing phases, is less time consuming, is not an economic burden for the patient and overall be beneficial to general population. Considering all these factors Wickham and Fitzpatrick introduced the Minimally Invasive Surgery (MIS) defined as “These are smaller and more precise surgical procedures, utilizing small incisions, utilizing operating microscopes and microsurgical instruments and materials, to achieve same surgical end point as that of conventional surgical techniques i.e. probing depth reduction and regeneration of bone and supporting tissues, but with minimal negative changes in soft tissue contours, and better esthetic results.”¹ Hunter and Sackier (1993) refined the concept of MIS, as “the ability to miniaturize our eyes and extend our hand to perform microscopic and macroscopic operations in places that could previously be reached only by large incisions”.² This concept was not new to the general surgery field, as laparoscopic surgeries, use of lasers in eye surgeries and use of magnification in Neurosurgery were already in practice.

In 1995, minimally invasive surgery (MIS) was first introduced in periodontology literature by Harrel and Rees.³ The method involves surgical access that minimizes tissue trauma due to reflection and manipulation that results in better stabilization of the blood clot with reduced surgical morbidity. As the methods become minimally

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invasive, the instruments and armamentarium gets upgraded, it becomes mandatory that the operators and the surgeons also upgrade their operating skills because the procedures become more and more technique sensitive.

2. Minimally invasive dentistry (MID)

The World Congress of MID defines minimally invasive dentistry as those techniques which respect health, function and esthetics of oral tissue by preventing disease from occurring, or intercepting its progress with minimal tissue loss.⁴ Dr G.V. Black, the father of modern dentistry, gave the concept of “extension for prevention”; this ideology was completely opposite to the principles of MID which stresses upon early diagnosis, interception of the disease with minimal sacrifice of the uninvolved tooth structure, to change the cariogenic flora either chemically or mechanically, to remineralise early lesions, and to promote repair rather than replacing defective restorations.

- 1) Early diagnosis is important as the amount of tooth substance lost could be prevented. This requires newer caries detection methods like laser fluorescence, ultraviolet illumination etc; so that caries are diagnosed as opposed to methods which detect caries unless it has progressed to enamel.
- 2) Methods which promote remineralization of initial caries.
- 3) Newer techniques to remove carious dentin minimizing excessive tissue removal like use of Preventive Resin Restoration (PRR), use of sealants Placement of sealants in suspect teeth within six months of tooth eruption, employing Atraumatic Restorative Technique (ART), conservative designs for cavity preparation.
- 4). Utilizing chemo-mechanical methods for caries removal like use of carisolv gel, use of Ozone gas (oxidizing agent, eliminates decay causing bacteria) etc.
- 5). Conservative access opening designs retaining as much dentin as possible, discouraging the use of Peeso reamers and Gates Glidden drills as they weaken the root walls
- 6). To prefer Mini-implants (≈ 1.8 mm) over standard-size dental implants (≈ 3.75 mm)
- 7). To place veneers instead of crowns as the latter are invasive and most of the times compromises the tooth vitality.
- 8). To prefer Digital radiography instead of conventional radiograph as the former involves about 80% less radiation exposure.

3. Minimally invasive periodontal therapy

Regeneration of lost periodontal tissues has always been the ultimate goal of periodontal therapy. Periodontal regeneration of intrabony defects has been achieved with different principles. These include barrier membranes, demineralized freeze-dried bone allograft, a combination of barrier membranes and grafts, and enamel matrix derivative (EMD).

In the last decade, a special emphasis has been focused on the design and performance of surgical procedures for periodontal regeneration. Specific surgical approaches have been proposed to preserve the soft tissues and to reach a stable primary closure of the wound in order to seal the area of regeneration from the oral environment.

Since late 1980's, there has been a primary focus on the outline and execution of surgical procedures for periodontal regeneration. Utmost importance is given to preservation of soft tissue and to attain stable primary closure of the wound in order to prevent contamination from oral environment. Thus, in order to further increase surgical effectiveness, the use of operating microscopes and microsurgical instruments in terms of Minimally invasive periodontal surgery (MIPS) has been suggested, and the use of a microsurgical approach in combination with different regenerative materials resulted in maintenance of primary wound closure in more than 92% of the treated sites for the whole healing period.⁵

Periodontal microsurgical techniques were introduced and studied using operating microscopes and microsurgical instruments to enhance magnification and visual acuity with reduced surgical trauma producing minimal wounds, minimal flap reflection for better post-surgical healing.⁶

In the Minimally Invasive Surgical Technique (MIST) approach, the defect-associated interdental papilla is accessed either with the modified papilla preservation technique (MPPT) in large interdental spaces,⁷ or the simplified papilla preservation flap (SPPF) in narrow interdental spaces.⁸

Minimally Invasive Surgical Technique (MIST) focuses on the conservative elevation of both buccal and lingual flaps of the defect-associated interdental papilla. Depending upon the width of the interdental space, the papilla may be dissected either diagonally or horizontally. In cases of wide interdental spaces, horizontal cut is performed as described in Modified Papilla Preservation Technique (MPPT, Cortellini et al., 1995)⁷; conversely, in cases of narrow interdental spaces a diagonal cut is selected, as described in the Simplified Papilla Preservation Flap (SPPF, Cortellini et al., 1999).⁸

Indications for MIST:

- Isolated interproximal defect which does not extend beyond the interproximal region
- Multiple, isolated interproximal defects within a quadrant.

Contraindications of MIST:

- Generalized horizontal bone defects
- Multiple, interconnected vertical defects.

General considerations of MIST:

- Incision design is such that is minimally invasive, extensive reflections avoided
- Multiple, isolated areas are accessed separately rather than being involved in a single flap design
- Continuous incisions avoided
- Vertical incisions are avoided
- Flap reflection is by sharp dissection
- To promote regeneration and interproximal papilla preservation, wherever used, the graft material or the membrane are covered completely
- Procedures are done under magnification using operating microscopes, loupes etc
- Thorough root surface debridement with limited flap elevation is achieved using miniaturized instruments and ultrasonic scalers
- The flaps are secured using vertical mattress sutures.

4. Features of MIST

1) Incision:

- Intrasulcular incisions are made along the involved teeth at the interproximal site
- Limited extension towards the buccal or palatal/lingual side
- Defects are approached separately and continuous incisions avoided
- Vertical releasing incisions are avoided
- Interproximally, attempts are made to conserve as much interdental tissue as possible
- The two intrasulcular incisions are connected with horizontal incision around 2–3 mm from the papillary crest
- In esthetic zone, the horizontal incision is placed palatally, whereas in nonaesthetic zone, it can be placed either buccally or lingually.

The Tunnel technique can be considered as minimally invasive

Fig. 1. Schematic diagram showing Single Incision technique for harvesting Connective tissue graft from the palatal region.

periodontal surgical (MIPS) procedure for the management of recession wherein a suprapariosteal tunnel is prepared over the defect site and the subepithelial connective tissue graft is secured with sutures.

Using MIPS, subepithelial connective tissue graft can be procured using single incision technique (Fig. 1) rather than the trap door incision technique (Fig. 2).

2) Flap reflection:

- In MIPS, flap reflection is by sharp dissection only.
- Blunt dissection causes embarrassment of the blood supply of the papilla leading to post-operative flattening and cratering of the papilla.
- Miniaturized periodontal knives and instruments are used
- Because of splitting the flap, periosteum is always left covering the bone surface; hence post surgical bone loss and edema are reduced.

3) Papilla preservation:

- Modifications of original papilla preservation technique by Takei (1985)⁹ were introduced by Cortellini et al. (1995, 1999) in the form of modified papilla preservation technique (MPPT) and simplified papilla preservation flap technique (SPPT) for preservation of interproximal tissue in regenerative procedures depending upon the width of interdental region.^{7,8}

4) Suture technique:

- Suturing is an important aspect of MIPS, not only in terms of the suture material but also the technique.
- Monofilaments are preferred over multifilament sutures as the

Fig. 2. Schematic diagram showing Trap door technique for harvesting Connective tissue graft.

latter cause tissue contamination by ‘wicking action’ of the suture material.

- In anterior region, vertical mattress suture are preferred and in posterior region, modified mattress sutures are preferred to enhance optimal adaptation of wound edges.

5) Use of microinstruments for precise surgical procedure.

6) Magnification:

- The procedures are done under magnification in the form of loupes or operating microscopes.
- Illumination systems with Head bands are utilized for enhanced vision.
- The purpose is enhanced visual acuity under magnification so the procedure can be carried out with minimal tissue manipulation.

5. Minimally invasive periodontal therapy techniques

5.1. Laser assisted periodontal therapy

Application of Lasers in the treatment of periodontal diseases can be considered as an effective and minimally invasive treatment modality for moderate to advanced periodontitis cases. Initial laser irradiation by Nd:YAG, diode or erbium laser causes bacterial reduction and debridement of diseased epithelial lining. Erbium lasers remove calculus also from the root surface. In case of other lasers, calculus removal could be achieved by conventional instrumentation. Karlsson et al. (2008) from their systematic review did not find lasers efficacious as an adjunct or as monotherapy for chronic periodontitis.¹⁰ Slots et al. (2009) in their systematic review did not find Nd:YAG as an adjunct or as monotherapy superior to traditional treatment modalities of initial periodontitis.¹¹ Some studies have shown the benefits of lasers as an adjunct in conventional flap surgeries,¹² however some systematic reviews find insufficient evidence of the same.¹³ Laser assisted new attachment procedure (LANAP) using an Nd:YAG laser is a minimally invasive periodontal pocket treatment modality and the only laser procedure to have human histologic evidence to justify the United States Food and Drug Administration clearance for cementum mediated periodontal ligament attachment in the absence of long junctional epithelium.^{14,15}

5.2. Minimally invasive surgical technique (MIST)

Most of the researches pertaining to MIST can be attributed to the works of Cortellini and Tonetti. The procedure focuses upon the conservation of the interproximal tissues with conservative elevation of both buccal and lingual flap of the defect-associated papilla. Intracutaneous incisions are given along the defect associated papilla with extension up to the midbuccal or mid-lingual aspect of the associated tooth. Depending upon the width of the interdental space, the horizontal incision is given either horizontally or diagonally.

5.2.1. Modified Papilla Preservation Flap (Cortellini et al., 1995)⁷

This technique is limited to wide interdental spaces (> 2 mm). A horizontal incision is given at the base of the defect, buccally (Fig. 3). A full thickness buccal flap is reflected. The interdental papilla is a part of the palatal flap which is also reflected in full thickness. A barrier membrane is placed interdentally. Primary closure is achieved and interproximal tissues are repositioned and sutured.

5.2.2. Simplified Papilla Preservation Flap (Cortellini et al., 1999)⁸

In cases where the interdental spaces are narrow (< 2 mm), simplified papilla preservation flap technique is employed. 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 under the contact point of the adjacent tooth is given (Fig. 3). Intracutaneous incisions are given along the defect and tiny buccal and lingual flaps are reflected. A split-thickness buccal flap is reflected and a full thickness palatal flap including the buccal papilla is

Fig. 3. Incision design in case of Simplified papilla preservation flap technique (SPPT) and Modified papilla preservation flap technique (MPPT).

elevated. Debridement of the defect is done by sharp dissection of the soft tissue in the interdental region using mini curettes and power driven instruments. Root surface conditioning is done. Interdental tissues are repositioned and sutured using modified internal mattress sutures and primary closure of the papilla achieved.

5.2.3. Modified-minimally invasive surgical technique (M-MIST)

Cortellini and Tonetti (2009) proposed the modified minimally invasive surgical technique.¹⁶ The technique involves giving only the buccal intrasulcular incisions along the interdental defect. A horizontal incision connects the intrasulcular incision. Surgical access is gained through the small buccal window. Tiny buccal triangular flap is reflected preserving the supracrestal attachment. The granulation tissue filling the defect is sharply dissected and debridement done using mini curettes and power driven instruments. Primary closure is achieved by single internal modified mattress suture.

This greatly enhances the potential to provide space and stability for regeneration by leaving the interdental papillary soft tissue attached to the root surface. This method preserves the soft tissue roof over the defect. The vascular supply of the papillary tissue is retained thus enhancing the postoperative healing and maintain esthetics. This technique also evades the necessity of using any supporting biomaterial for regeneration.

5.3. Videoscope assisted minimally invasive surgery

This method involves the use of videoscope that uses a small digital camera at the end of a flexible tube with a light source allowing direct access to the surgical site under a very high magnification (60X). Harrel et al. (2014) conducted a study to evaluate the residual defects following non-surgical periodontal therapy performed using a videoscope. The results showed statistically significant improvement in mean probing depth and clinical attachment level.¹⁷

5.4. Future perspectives: Robot assisted minimally invasive surgery

With the technological advances and the reported advantages of minimally invasive surgical methods, it is anticipated that there would be future developments in the minimally invasive surgeries. Robot assisted minimally invasive surgery promises to be a revolutionary step towards the same. It can be expected that such a procedure would improve the accuracy and dexterity of the surgeon with minimal trauma to the patient. Application of robotics would allow surgical procedures to be carried out automatically by the surgeon with a remote control.

6. Discussion

Several studies have been conducted to assess the effectiveness of MIST in terms of clinical performance and patient's perception. Harrel et al. (2005) in their study concluded that MIS along with enamel matrix protein resulted in statistically significant reductions in probing depths and gains in clinical attachment levels in 16 patients with multiple sites with deep pockets.¹⁸ Some other studies too gave significantly improved clinical findings.^{19,20}

Cortellini and Tonetti (2007) in their case cohort study involving 13 intrabony defects inferred that MIST along with enamel matrix derivative resulted in gain in clinical attachment level and gain in the bone fill with limited patient morbidity.²¹

In a meta-analysis conducted by Liu et al. (2016), there were no statistically significant difference regarding clinical attachment level gain and probing pocket depth reduction, gain in the recession levels and radiographic bone fill between the MIS plus biomaterials group and the MIS group alone indicating that it is important to take costs and benefits into consideration while making a decision about therapeutic approach.²²

Advantages of MIST:

- 1 Reduced post-operative healing phase
2. Reduced post-operative complications like edema, pain, root sensitivity.
3. Enhanced esthetic results due to minimal reflection and manipulation of the flaps, minimal manipulation of the papillary tissue, limited or no scarring.
4. Post-operative gingival recession is minimal or non-existent.
- 5 Improved papillary soft tissue height and contour.
- 6 Increased patient's acceptance.

Disadvantages of MIST:

- 1 The procedure becomes technique sensitive due to limited accessibility.
2. Requires specialized equipment like operating microscope, loupes, micro-instruments.
- 3 This may incur increased cost to the procedure.
- 4 Operator's skill becomes a dictating factor.
5. It may increase the operating time as the procedure becomes highly technique sensitive.
6. It may be difficult to gain access to the palatal defects through the limited buccal window.
7. This technique cannot be applied universally to all the defects.

7. Conclusion

The ultimate goal of any treatment modality is resolution of the disease with regeneration of the lost tissues, if possible producing minimum post-operative morbidity. Minimally invasive surgery is one such treatment modality that is giving promising results in terms of reduced surgical trauma, increased wound stability, excellent primary closure of the wound with minimal patient's discomfort and side effects. Many studies have given promising results proving MIS to be an effective treatment modality. Further studies are still required to prove minimally invasive surgical techniques can replace the traditional surgical methods achieving same or even better results as conventional treatment options with minimal postoperative morbidity.

Disclosure

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Declaration of competing interest

None.

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