Minimally Invasive Periodontics - Need of the Hour!!

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ABSTRACT

Recent advances in dentistry promote the use of minimally invasive procedures. These techniques have evolved from magnification devices to advanced surgical instruments and modified procedures. Periodontal diseases are a heterogeneous group of diseases characterized by inflammation and the subsequent destruction of the tooth-supporting tissue. Conventional periodontal regenerative procedures involving large periodontal flaps for access are employed to improve short- and long-term clinical outcomes of periodontally compromised teeth. Conversely minimally invasive therapeutic approaches with minimized incisions and trauma to the soft tissue have proven to be advantageous over the conventional therapy. This article reviews various minimally invasive procedures and highlights the advantages of minimally invasive surgical and non-surgical therapy.

Keywords: Minimally Invasive Periodontal Surgery, periodontitis.

INTRODUCTION

Historically surgical techniques were governed by specific incisions and surgical principles. Until the mid-nineteenth century, surgical procedures were extremely brutal and ablative and had minimal application. The introduction of anaesthesia and improved surgical techniques enabled the surgeons to undertake complicated procedures; however minimal thought was given to the surgical trauma to the patient leading to numerous deaths. Scientific innovations and advances in technology led to the idea that surgeries could be performed more elegantly and less traumatically.[1] This realization gave rise to the concept of minimally invasive (MI) treatment with its primary goal to achieve a satisfactory therapeutic result with minimized trauma during any interventional process.[2]

MINIMALLY INVASIVE DENTISTRY

Oral cavity is affected primarily by caries and periodontal diseases. Minimally invasive caries management comprises of early detection, diagnosis, intercepting and treatment at a microscopic level.[3] The earlier concept of "Extension for prevention" has shifted to new paradigm of "minimally invasive dentistry".

Tyas and Colleagues[4] in 2000 gave the following concepts:

1. Early caries diagnosis
2. The classification of caries depth and progression using radiographs
3. The assessment of individual caries risk (high, moderate, low)
4. The reduction of cariogenic bacteria, to decrease the risk of further demineralization and cavitation
5. Arresting of active lesions
6. Remineralization and monitoring of non-cavitated arrested lesions
7. Placement of restorations in teeth with cavitated lesions, using minimal cavity design
8. Repair rather than the replacement of defective restorations
9. Assessing disease management outcomes at pre-established intervals.

MINIMALLY INVASIVE PERIODONTICS

Periodontitis can be defined as the inflammation of the supporting tissues of the teeth usually a progressively destructive change leading to loss of bone and periodontal ligament.[5] The ultimate goal of periodontal therapy is the regeneration of the lost periodontal tissues.[6]

Intra-bony defects have been previously treated using various membranes and bone grafts. Various clinical studies on barrier membranes (Nyman et al. 1982, Gottlow et al. 1986), demineralized freeze-dried bone allograft (DFDBA, Bowers et al.1989), combination of barrier membranes and grafts (Camelo et al. 1998, Mellonig 2000) and Enamel Matrix Derivative (EMD, Mellonig 1999, Yukna and Mellonig 2000) demonstrated significant clinical attachment level gain and pocket probing depth reduction. However exposure of the regenerative material leading to contamination is a critical issue and hampers the clinical outcomes (Nowzari et al. 1995, De Sanctis et al. 1996). 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 (Cortellini et al. 1995, 1999). In 1990, Wickham and Fitzpatric described the techniques of using smaller incisions as "minimally invasive surgery". The concept of minimally invasive surgery was further refined by Hunter and Sackier in 1993 who described the surgical approach as "the ability to miniaturize our eyes and extend our hands to perform microscopic and macroscopic operations in places that could previously be reached only by large incisions".[7] Tibbetts and Shanelec in 1994, 1998 described periodontal microsurgical instruments and technique. These techniques primarily concentrated on soft tissue regeneration and augmentation procedures using microsurgical instruments and improving visualization using a surgical operating microscope.[8] In 1995, minimally invasive surgery (MIS) was

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introduced by Harrel and Ress, in order to minimize wounds and flap reflection. This concept also helps in handling hard and soft tissues gently during periodontal surgery. Isolated defects not extending beyond the interproximal site were considered ideal for this technique. Incisions were aimed at conserving the soft tissue as much as possible. In cases of multiple isolated defects, individual incisions for each site should be given. Tunnel Technique used for regenerative surgeries is an integral part of MIS.[9]

Though the concept of MIS was proposed and introduced earlier, it did not emphasize on the wound stability and closure. To lay more stress on wound and blood clot stability and primary wound closure for blood-clot protection, Cortellini and Tonetti proposed the Minimally Invasive Surgical Technique (MIST) in 2007. They later improvised it further by incorporating the concept of space provision for regeneration with the Modified Minimally Invasive Surgical Technique (M-MIST, Cortellini and Tonetti 2009) The use of operating microscopes, Surgical telescopes (loupes) and microsurgical instruments increased the surgical prognosis (Cortellini and Tonetti 2001, 2005). These instruments provided magnification and optimal illumination of the surgical field thereby improving the visual acuity. Improved control of surgical instruments under magnification resulted in reduced surgical trauma thereby leading to reduced flap reflection and better post-surgical healing.[10]

CLINICAL STUDIES AND OUTCOMES

The application of minimally invasive surgical approaches has been reported in Tables 1 and 2.

NON-SURGICAL PERIODONTAL THERAPY

Dental endoscope is an imaging device which aids in accurate diagnosis and treatment of periodontal disease. It provides sub-marginal gingival imaging to locate and evaluate the extent and nature of root deposits.[19]A preliminary study indicated that up to 95% of all root surfaces may be accessed for visualization with this instrument.[20]

SURGICAL PERIODONTAL THERAPY

Minimally Invasive Surgical Technique (MIST, Cortellini and Tonetti 2007a, 2007b) 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 narrow interdental spaces a diagonal cut is selected, as described in the Simplified Papilla Preservation Flap (SPPF, Cortellini et al. 1999); conversely, in cases of wide interdental spaces, horizontal cut is performed as described in Modified Papilla Preservation Technique (MPPT, Cortellini et al. 1995a, 1995b).

MODIFIED PAPILLA PRESERVATION TECHNIQUE

Cortellini et al. modified the Papilla preservation technique described by Takei et al in 1984. This technique was introduced as a new approach for interproximal regenerative procedures called 'the modified papilla preservation technique'. Application of this technique is limited to wide interdental spaces (2 mm). The main advantage of this technique includes primary closure of tissues and papilla preservation in 75% of cases. At the base of the defect associated buccal interdental papilla, a horizontal incision is made and a full-thickness palatal flap including the interdental papilla is elevated. A full-thickness buccal flap is elevated with vertical releasing incisions, when needed. A barrier membrane is placed to cover the defect. The membrane is completely covered by the repositioned interdental tissues

MIST	Type of study (quality of evidence)	Interventions	No. pax	No. defects	CAL gain	PD reduction	Recession
Cortellini and Tonetti[10]	Case cohort (level 2)	MIST+EMD	13	13	4.8±1.9	4.8±1.8	0.1±0.9
Cortellini and Tonetti[11]	Case cohort (level 2)	MIST+EMD	40	40	4.9±1.7	5.2±1.7	0.4±0.7
Cortellini et al.[12]	Case cohort (level 2)	MIST+EMD	20	44	4.4±1.4	4.6±1.3	0.2±0.6
Ribeiro et al.[13]	RCT (Level 1)	MIST	15	15	2.82±1.19*	3.55±0.88*	0.54±0.58*
		MIST+EMD	14	14	3.02±1.94*	3.56±2.07*	0.46±0.87*
Ribeiro et al.[14]	RCT (level 1)	MIST	14	14	2.85±1.19*	3.51±0.90*	0.48±0.51*
		MINST (RPL)	13	13	2.56±1.12*	3.13±0.67*	0.45±0.46
MINST, minimally invasive non-surgical technique (RPL with the aid of a microscope); MIST, minimally invasive surgical technique; EMD, emdogain, *No statistical difference							

Table-1: Application of minimally invasive surgical approaches

M-MIST/SFA	Type of study	Interventions	No. pax	No. defects	CAL gain	PD reduction	Recession
Cortellini and Tonetti[15]	Case cohort	M-MIST+EMD	15	15	4.5±1.4	4.6±1.5	0.07±0.3
Cortellini and Tonetti[16]	RCT	M-MIST	15	15	4.1±1.4*	4.4±1.6*	0.3±0.6*
		M-MIST+EMD	15	15	4.1±1.2*	4.4±1.2*	0.3±0.5
		M-MIST+EMD+BioOss	15	15	3.7±1.3*	4.0±1.3*	0.3±0.7*
Trombelli et al.[17]	RCT	SFA	12	12	4.4±1.5*	5.3±1.5*	0.8±0.8*
		SFA+HA+GTR	12	12	4.7±2.5*	5.3±2.4*	0.4±1.4*
Mishra et al.[18]	RCT	M-MIST	12	12	2.6±0.8*	3.8±0.9*	0.5±0.5*
		M-MIST+rhPDGF-BB	12	12	3.0±0.9*	4.2±0.6*	0.8±0.6*
M-MIST, modified minimally invasive surgical technique; SFA, single flap approach; rhPDGF-BB, recombinant human platelet derived growth factor, *No statistical difference							

Table-2: Application of minimally invasive surgical approaches

and sutured.[21]

SIMPLIFIED PAPILLA PRESERVATION FLAP

The SPPF is applicable in narrow interdental spaces (< 2 mm). 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. A full-thickness palatal flap including the buccal papilla is elevated. A split-thickness buccal flap is elevated. Degranulation along with regenerative procedures is performed. The interdental tissues are replaced into their original position and sutured using single modified internal mattress suture to provide primary intention closure of the interdental papilla.[22]

MODIFIED MINIMALLY INVASIVE TECHNIQUE

Cortellini and Tonetti in 2009 suggested a Modified Minimally Invasive Surgical Technique (M-MIST). The primary aim was to provide a minimal access to the defect only from the buccal side. This technique is initiated with minimal elevation of a triangular buccal flap to expose the residual crestal bone. The palatal flap is not elevated. All clinical steps are performed through the small buccal "surgical window". The granulation tissue is carefully dissected and separated from the underlying supra-crestal interdental fibres without causing any trauma to them. After removing the granulation tissue, the roots are scaled and planed. The buccal flap is placed back into its original position and sutured using a modified internal mattress suture. This helps to achieve primary closure. This technique has certain limitations and disadvantages. It cannot be employed in cases with complex and wide defects involving 3 or 4 surfaces of a tooth. Larger flaps have to be elevated in cases where the defect extends to the apical third or apex of the root.[15]

VIDEOSCOPE ASSISTED MINIMALLY INVASIVE SURGERY (V-MIS)

The term Videoscope assisted minimally invasive surgery (V-MIS) is used to describe MIS performed with the aid of a videoscope. Proper visualization of the surgical site is of utmost importance in MIS. Hence a videoscope comprising of a small digital camera was developed. This camera when placed at the surgical site provides direct visualization and greater magnification (Harrel et al. 2012, 2013). Harrel SK et al in 2014[23] conducted a study to evaluate residual defects following non-surgical therapy consisting of root planing with local anaesthetic. V-MIS was performed utilizing the videoscope for surgical visualization. Re-evaluation, 6 months post-surgery, showed statistically significant improvement ($p < .001$) in mean PPD and CAL (PPD 3.88±1.02 mm, CAL 4.04±1.38 mm) in 1, 2, and 3 wall defects. All PPD at re-evaluation were 3 mm or less. There was a mean post-surgical increase in soft tissue height (0.13±0.61 mm, $p = 0.168$) with a decrease in recession.

ROBOT-ASSISTED MINIMALLY INVASIVE SURGERY (RMIS)

Robot-assisted minimally invasive surgery (RMIS) promises to be a revolutionary step towards refining MIS. It would greatly improve the accuracy and dexterity of a surgeon while minimizing trauma to the patient. Robotically assisted minimally invasive surgery uses end-effectors and manipulators of the robotic arms to perform the actual surgery on the patient. These arms can either be controlled by a telemanipulator or through computer control.

In the telemanipulator approach, the surgeon performs the normal movements associated with the surgery while the robotic arms replicate them onto the patient. The computer controlled approach allows the surgeon to use a computer to control the robotic arms.[24] However; clinical studies using RMIS have shown only marginal success. A major disadvantage includes large size footprints and cumbersome robotic arms. Due to feasibility constraints, long term studies using RMIS have not been conducted.[25]

CONCLUSION

The goal of periodontal surgery has always been to alleviate or eliminate the degeneration associated with progressive periodontal disease and to regenerate lost tissues. Introduction of Minimally invasive surgery highlights various advantages such as less invasive surgery, shorter duration, favoured healing due to improved wound stability of minimally mobilized flaps, and benefiting the patient with reduced intra-operative and postoperative morbidity. The future promises further evolution towards a more primary preventive approach, facilitated by emerging technologies for diagnosis, prevention and treatment. However there are technical, cultural and economic obstacles to overcome for this to be fully realized in clinical practice.

REFERENCES

1. Wickham JEA. The new surgery. BMJ. 1987;295:1581-2.
2. Wickham JEA. Minimally invasive therapy. BMJ. 1991; 308:193-6.
3. Rainey JT. Air abrasion: an emerging standard of care in conservative operative dentistry. Dent Clin North Am. 2002;46:185-209.
4. Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry: a review. FDI Commission Project 1-97. Int Dent J. 2000;50:1-12.
5. Glossary of Peridontal Terms, 4th edition, 2001.
6. Aous Dannan. Minimally Invasive periodontal surgery. J Indian Soc Periodontol. 2011;15:338-343.
7. Hunter JG, Sackier JM. Minimally invasive high tech surgery; into the 21st century. In: Hunter JG, Sackier JM, eds. Minimally invasive Surgery. New York: McGraw-Hill. 1993;3-6.
8. Tibbetts LS, Shanelec DA. Periodontal microsurgery. Dent Clin North Am. 1998;42:339-59.
9. Harrel S K, Rees T D. Granulation tissue removal in routine and minimally invasive surgical procedures. Compend Contin Educ Dent. 1995;16:960–967.
10. Cortellini P, Tonetti MS. A minimally invasive surgical technique with an enamel matrix derivative in the regenerative treatment of intra-bony defects: a novel approach to limit morbidity. J Clin Periodontol. 2007;34: 87–93.
11. Cortellini P, Pini-Prato G, Nieri M, Tonetti MS. Minimally invasive surgical technique and enamel matrix derivative in intrabony defects: Factors associated with healing outcomes. Int J Periodontics Restorative Dent. 2009; 29:257-65.
12. Cortellini P, Nieri M, Prato GP, Tonetti MS. Single minimally invasive surgical technique (MIST) with

enamel matrix derivative (EMD) to treat multiple adjacent intrabony defects. Clinical outcomes and patient morbidity. J Clin Periodontol. 2008;35:605-13.
13. Ribeiro FV, Casarin RC, Júnior FH, Sallum EA, Casati MZ. The role of enamel matrix derivative protein in minimally invasive surgery in treating intrabony defects in single-rooted teeth: a randomized clinical trial. J Periodontol. 2011;82:522-32.
14. Fernanda V. Ribeiro, Renato C. V. Casarin, Maria A. G. Palma, Francisco H. N. Júnior, Enilson A. Sallum, Márcio Z. Casati. Clinical and microbiological changes after minimally invasive therapeutic approaches in intrabony defects: a 12-month follow-up. Clin Oral Investig. 2013; 17:1635-1644.
15. Cortellini P, Tonetti MS. Improved wound stability with a modified minimally invasive surgical technique in the regenerative treatment of isolated interdental intrabony defects. J Clin Periodontol. 2009;36:157–63.
16. Cortellini P, Tonetti MS. Clinical and radiographic outcomes of the modified minimally invasive surgical technique with and without regenerative materials: a randomized-controlled trial in intra-bony defects. J Clin Periodontol. 2011;38:365-73.
17. Leonardo Trombelli, Anna Simonelli, Mattia Pramstraller, Ulf M.E. Wikesjo, Roberto Farina. Single Flap Approach With and Without Guided Tissue Regeneration and a Hydroxyapatite Biomaterial in the Management of Intraosseous Periodontal Defects. J Periodontol. 2010; 81:1256-63.
18. Mishra A, Avula H, Pathakota KR, Avula J. Efficacy of modified minimally invasive surgical technique in the treatment of human intrabony defects with or without use of rhPDGF-BB gel: a randomized controlled trial. J Clin Periodontol. 2013;40:172-9.
19. Roger V. Stambaugh, Gayle Myers, Wendell Ebling, Bruce Beckman, Kathleen Stambaugh. Endoscopic Visualization of the Submarginal Gingiva Dental Sulcus and Tooth Root Surfaces. J Periodontol. 2002;73:374-82.
20. Stambaugh RV, Myers GC, Ebling WV, Beckman B, Stambaugh KA. Endoscopic visualization of submarginal gingival root surfaces. J Dent Res. [Abstract] 2000; 79:600-605.
21. Cortellini P, Prato GP, Tonetti MS. The modified papilla preservation technique. A new surgical approach for interproximal regenerative procedures. J Periodontol. 1995;66:261-6.
22. Cortellini P, Prato GP, Tonetti MS. The simplified papilla preservation flap: A novel surgical approach for the management of soft tissues in regenerative procedures. Int J Periodontics Restorative Dent. 1999;19:589-99.
23. Harrel SK, Abraham CM, Rivera-Hidalgo F, Shulman JD, Nunn ME. Videoscope assisted minimally invasive periodontal surgery (V-MIS). J Clin Periodontol. 2014;41: 900–907.
24. Saini R, Giri PA. Robotic Surgery: the next generation technology. Pravara Med Rev. 2014;6:50-56.
25. Satava RM, Bowersox JC, Mack M ET AL. robotic surgery: state of the art and future trends. Contemp Surg. 2001;57:489-99.

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