ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 5, Issue – 4, July - 2022, Page No. : 226 - 234

Minimally invasive periodontal surgery- review

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Citation of this Article: Dr. Rabees Ahmed, Dr. Anil Melath, Dr. Subair K, Dr. Arjun m r, Dr. Arunagiri, "Minimally invasive periodontal surgery- review", IJDSIR- July - 2022, Vol. – 5, Issue - 4, P. No. 226 – 234.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

The success of periodontal therapy depends on proper diagnosis and treatment. Minimally invasive periodontal therapy aims to develop an approach that will allow less manipulation of surrounding tissues than conventional procedures while accomplishing the same objectives. 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 conventional therapy.

Keywords: minimally invasive, trauma, conventional therapy.

Introduction

Earlier surgical techniques were done by specific incisions and surgical principles. Until the middle of the 19th century, surgical procedures were extremely brutal and had minimal application. The introduction of anesthesia and improved surgical techniques enabled surgeons to undertake complicated procedures. Scientific innovations and advances in technology led to the idea that surgeries could be performed with less trauma. [1] This realization led to the concept of minimally invasive (MI) periodontal treatment with its primary goal to achieve a satisfactory

therapeutic outcome with minimized trauma during any interventional process. [2]

History

In 1990, Wickham and Fitzpatrick described the techniques of using smaller incisions as "minimally invasive surgery". The concept was further refined by Hunter and Sac kier in the year 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.[3] In 1995, minimally invasive surgery (MIS) was introduced by Harrel and Ress, to minimize wounds and flap reflection. In 2007, Cortellini and Tonetti proposed the Minimally Invasive Surgical Technique (MIST). They later improvised it by incorporating the concept of space provision for regeneration with the Modified MIST. [1]

Minimal invasive periodontics

The ultimate goal of periodontal therapy is to regenerate the lost periodontal tissues. Clinical

studies on barrier membranes, demineralized freeze-dried bone allograft, the combination of barrier membranes and grafts [1], and Enamel Matrix Derivative (EMD) and rh PDGF-BB with β- tricalcium phosphate [4] demonstrated significant clinical attachment level gain and pocket probing depth reduction. [1] The use of operating microscopes, surgical telescopes (loupes), and microsurgical instruments increased the prognosis. These provide magnification and optimal illumination of the surgical field thereby improving visual acuity. Also resulted in reduced surgical trauma thereby leading to reduced flap reflection and better post-surgical healing. [1] The objective of minimally invasive surgery was to aid in appropriate wound healing, minimal flap reflection, and precise management of both soft and hard tissues during surgical procedures. [4]

Armamentarium used: [4]

- Micro-periosteal elevator
- Bone scraper
- 12b blade
- Micro-scalpel holder
- Needle holder
- Micro-scissor
- A dental micro-forceps
- modified Or ban knife
- monofilament suturing materials
- microscopes

Advantages of MIPS: [4]

- Less operative pain and trauma
- No scarring
- Speeds recovery
- Reduces post-surgical complications.

Disadvantages of MIPS: [4]

- Special equipment required
- Specialist training required
- Expensive equipment
- Time-consuming

Discussion

The difference in these surgeries lies in the technique of accessing the periodontal defects, handling of soft tissue, debridement method, flap closure, reducing surgical chair time, and reducing patient discomfort and side effects. These differences are significant compared to the traditional surgical techniques where the surgical techniques use wide incisions and wide access to the root and bone for proper visualization and with advancement in the use of MIPS, the same can be accessed by smaller opening so the need for wide access has to be reassessed. [4] Presently patient acceptance and

satisfaction with MIPS have been excellent. It is difficult to quantify but periodontal treatment done by this technique appears to be more frequently and easily acceptable. [4]

The different types of surgeries done in mist

Non-Surgical Periodontal Therapy

A dental endoscope is an imaging device that helps in the accurate diagnosis and treatment of periodontal disease. It provides submarginal gingival imaging to locate and evaluate the nature and extent of root deposits. [1]

Surgical Periodontal Therapy

MIST focuses on the conservative elevation of both buccal and lingual flaps of the defect associated with interdental papilla. Depending upon the width of the interdental space, the papilla may be dissected either diagonally or horizontally. In cases of narrow interdentally spaces a diagonal cut is selected, as described in the Simplified Papilla Preservation Flap conversely, in the case that there are wide interdental spaces, a horizontal cut is performed as described in the Modified Papilla Preservation Technique. [1]

Videoscope Assisted Minimally Invasive Surgery (V-MIS)

V-MIS is used to describe the surgery performed with the aid of a video scope. Proper visualization of the surgical site is of utmost importance. Hence a video scope comprising of a small digital camera was developed which is placed at the surgical site to provide direct visualization and greater magnification. V-MIS was performed utilizing the video scope for surgical visualization. There was a mean post-surgical increase in soft tissue height with a decrease in recession seen. [1]

Robot-Assisted Minimally Invasive Surgery (RMIS)

Robotically assisted surgery uses end-effectors and manipulators of the robotic arms to perform the actual surgery on the patient. These arms can be controlled by telemanipulation or through computer control. In the former, the surgeon performs the normal movements associated with the surgery while the robotic arms replicate them onto the patient. In the latter, the surgeon uses a computer to control the robotic arms. Major drawbacks include large size footprints and cumbersome robotic arms. [1]

Probes used for minimally invasive periodontal surgery

Probe types were classified by Pihl Strom in 1992 into three generations: [5]

First Generation Conventional / Manual Probes

Do not control the probing pressure; not suited for automatic data collection; e.g., Williams periodontal probe, The Community Periodontal Index of Treatment Need (CPITN) probe, the University of North Carolina-15 (UNC-15) probe, the Nabers probe, etc.

Second Generation Constant-Pressure Probe

pressure-controlled probes with visual measurement recording; Allow standardization of probing pressure; Pressure does not exceed 0.2 N / mm2. e.g., Prototype – True Pressure Sensitive Probe (TPS).

Third Generation Automated Probes

pressure-controlled electronic probes with direct computer data capture and storage; Controlled probing pressure – 15 gms; Automated detection of CEJ; e.g. - The Foster-Miller probe, The Florida Probe, The Inter-Probe. In 2000, Watts extended this classification by adding fourth and fifth-generation probes: [6] Fourth-generation Three-Dimensional (3D) Probes Currently under development.

Fifth Generation Ultra-Sonographic Probe

Aim to identify the attachment level without penetrating the junctional epithelium; e.g., Ultra Sonographic (US) probe

Instruments used in Mips

Detec Tar It is an electronic device and is known to be the "first and only objective calculus detector" overcoming the problem of inaccurate detections of clinically identifiable calculus. It can identify the characteristic optical signal of dental calculus, even in the presence of contaminants. An LED light of wavelength 20 - 40 nm is emitted from the probe tip. The light returned off the root surface is picked up by a fiber optic lead and converted into an electrical signal for analysis. A computer-processed algorithm determines whether the probe is in contact with dental calculus and activates a signal to notify the clinician of the presence of the calculus. [7] It has been proven to be ~91% efficient at detecting calculus. [8] Periodontal Endoscopy: Advancements in fiber optic technology, coupled with modifications of the periodontal armamentarium have led to the development of the Endoscope which provides the clinician with direct real-time visualization, access, and magnification of the subgingival root surface (up to 95% better access and visibility) [9] and sulcus thereby improving the diagnosis and management of periodontal disease in a conservative and non-invasive manner. Subgingival soft tissue, including the gingival attachment, sulcus wall, and sulcus contents can be assessed. Subgingival caries, root fractures, tooth root deposits, post perforations, and open restoration margins can easily be located. [10]

Periodontal ultrasonography

Because of the non-invasive nature and the copping-out of ionizing radiation, ultrasonography has a valuable place in periodontal diagnostics for measuring pocket depth and thus assessing periodontal health. It is useful for the determination of alveolar crest height, periodontal bone morphology, the width of the periodontal ligament, the thickness of gingival tissue, and also to assess the dynamics of mucosal dimensions after root coverage procedures. Also plays a significant role in osteotomies and sinus lift procedures through its piezoelectric ultrasonic vibrations. In addition, low-intensity pulsed is effective in periodontal healing and demonstrates the potential for periodontal regeneration.

Clinical applications

Scaling and root planning: Microstreaming or acoustic mainstreaming generated by ultrasound in the presence of a fluid disrupts bacterial cell walls and thus is effective in removing bacterial plaque. Imaging for periodontal assessment: The ULTRADERM ultrasonic scanner enables suitable assessment of the periodontium. Application to regrow teeth: High-intensity ultrasound has shown to stop bleeding in blood vessels non-invasively, whereas low-intensity pulsed ultrasound (LIPUS) has been effective in liberating preformed fibroblast growth factors, stimulating angiogenesis, enhancing bone growth into titanium porous implants, accelerating healing of resorption by reparative cementum and enhancing bone healing after fractures. [11]

Vector TM Ultrasonic System: The Vector TM system is a linear oscillating device, in which the addition of hydro xylapatite particles to the irrigation suspension removes subgingival deposits and polishes the root surface by hydrodynamic forces. [11] Optical Coherence Tomography: It is an effective optical diagnostic tool as it is a non-invasive, non-destructive, non-radiated, and real-time monitoring method.[12] Dental OCT detects qualitative and quantitative morphological changes of dental hard and soft tissues in vivo. It is also used for the early diagnosis of dental diseases which includes caries, periodontal disease, and oral precancerous and cancerous lesions because of the excellent spatial resolution.

Periodontal vaccines

The objective of the vaccine is to identify the antigens involved in periodontitis against which antibodies would form to exert protection. It also aims to induce mucosal antibody response with mild or moderate doses of vaccine. vaccines would not only prevent and modulate periodontal disease but also enhance the quality of life for whom treatment cannot be easily obtained.

Types of periodontal immunization

Active immunization: The whole bacterial cell, its sub-unit, or a synthetic peptide is inoculated into the host as antigens. [13]

Passive immunization: Antigens are injected into vectors that produce antibodies which are then inoculated into the host. E.g., Murine monoclonal antibodies and Pl antibodies. [13]

Genetic immunization: It is the insertion of genes into individual cells and tissues to treat a disease by using genetic engineering or recombinant DNA technology. E.g., Plasmid vaccines and live, viral vector vaccines. [13]

Gene therapy in periodontics

Gene therapy is the genetic modification of cells for therapeutic purposes. Implications in periodontics [14] include Guided tissue regeneration and the use of vector-encoding growth factors. It is being used for the development of periodontal vaccination, avoidance of biofilm antibiotic resistance, in-vivo gene transfer by electroporation for alveolar remodelling, antimicrobial gene therapy, and designer drug therapy.

Probiotics

With the widespread emergence of bacterial resistance to antibiotics, the concept of probiotic therapy has been considered for application in oral health. Dental caries, periodontal disease, and halitosis are among the oral disorders that have been considered for probiotic therapy in recent years.[15] Probiotics, most commonly belong to the genera: Lactobacillus and Bifidobacterium. Commercially available Probiotics for periodontal disease include Gum Perio Balance, Peri Biotic, Bifidumbacterin, Acilact, Vitanar, Wakamate D, and Prodentis.[15]

Local drug delivery (LDD)

Local Drug Delivery is a less invasive approach to antimicrobial therapy where the suspected

pathogens are controlled by administering an antimicrobial agent into the pocket [16] where its concentration can be established and maintained at any desired level for any duration required. Local drug delivery agents include devices with tetracycline, doxycycline, minocycline, metronidazole, and chlorhexidine,[17] Statins like simvastatin (SMV) & lovastatin, etc. are also being used as they modulate bone formation by increasing the expression of bone morphogenetic protein-2. Various herbal products like aloe vera, neem, tulsi, propolis, cocoa husk, Harungana madagascariensis leaf extract (HLE), pomegranate, cranberry, etc. are being used widely these days.[18] Various local drug delivery systems used in the treatment of chronic periodontitis include fibers, film, injectable systems, gels, strips and compacts, vesicular systems, microparticle systems, and nanoparticle systems.

Lasers

The use of lasers in the nonsurgical treatment includes sulcular and/or pocket debridement, reduction of subgingival bacterial loads, and scaling and root planing (SRP).[19] There is abundant proof of markedly less bleeding, particularly of highly vascular oral tissues during laser surgery. Laser-created wounds heal more quickly and produce less scar tissue than conventional surgery. Low-Level Laser Therapy (LLLT): Also called

'soft laser' is a red light or infrared light whose wavelength has a low absorption power and is capable of penetrating a depth of 3- 15mm into soft and hard tissues. Mechanism of action involves laser light absorption in the subcellular photo-receptors, especially the electron transfer in the respiratory chain of the mitochondria membrane.[20] When used after gingivectomy and gingivoplasty procedures, it results in increased epithelialization and better wound repair.[21] LLLT with modified Widman flap (MWF) would result in decreased pain and postoperative edema.[22] It may also be used to heal the wound at the site of the palatal graft door.[23] The second-stage surgery of submerged implants can also be performed with soft tissue lasers with minimal bleeding, trauma, and pain. Photodynamic Therapy (PDT): Also called photo radiation therapy, phototherapy, or photochemotherapy has been considered a promising non-invasive therapeutic approach for eradicating pathogenic bacteria in periodontal and peri-implant diseases. This process is defined as Anti-microbial Photo dynamic Therapy, Photodynamic Antimicrobial Chemotherapy (PACT), and Photo dynamic Disinfection or Lethal Photo sensitization. PDT involves three non-toxic ingredients:[24] Visible harmless light of suitable wavelength, a nontoxic photo sensitizer: porphyrins, toluidine blue, methylene blue, etc., and oxygen. It is based on the principle that a photosensitizer binds to the target cells and is activated by a suitable light following which, singlet oxygen and other very reactive agents are produced that are extremely toxic to certain cells and bacteria. It has been used for photodynamic diagnosis (PDD) of malignant transformation of oral lesions, treatment of oral leukoplakia, oral lichen planus, and head and neck cancer, and treatment of bacterial, fungal, parasitic & viral infections.[25]

Minimally invasive implants

Flapless Implants

The technique has been associated with the preservation of soft tissue architecture, and improved patient comfort, and satisfaction.[26] In addition, the intact periosteum maintains a better blood supply, thus reducing the early bone resorption. Short Dental Implants (SDI): implants shorter than 10 mm in length are termed short dental implants (SDIs). They are useful in carrying out complicated bone augmentation procedures because they are less invasive, require less chair-side time, and are more acceptable to the patient.[27]

Mini Dental Implants (MDI)

These are ultra-small diameter implants that slip into minimal width islands and columns of bone. Osteotomy is done using minimally invasive starter drills avoiding encroachment of any vulnerable adjacent tissues. Overt penetration of any cortical wall is avoided. These help in a better prognosis for the peri-implant environment.[28]

Narrow Diameter Implants

(Diameter < 3.75 mm): These implants may be used where bone width is reduced or in single-tooth gaps with limited mesiodistal space, such as for the replacement of lateral maxillary or mandibular incisors.[29] periodontal microsurgery It is the refinement of basic surgical techniques made possible by the improved visual acuity gained with the use of the surgical microscope. In the hands of a trained clinician, microsurgery offers enhanced outcomes not possible with traditional macro surgery, especially in passive wound closure and reduced tissue trauma.

Applications of periodontal microsurgery

Scaling and Root Planing, Esthetic periodontal plastic surgeries like gingival augmentation and root coverage procedures using CTG or FGG, papilla reconstruction, and pedicle grafts; regenerative procedure (viz. vertical

and horizontal bone augmentations, Guided Bone Regeneration, and Guided Tissue Regeneration),

extractions and ridge preservation procedures, sinus augmentation and repair, biopsies, flap surgeries, and all phases of implant treatment. [30,31]

Indications.[32]

- Isolated, interproximal bone defect, not extending beyond the

interproximal site

- Periodontal defects that border on an edentulous area
- The periodontal defect that extends from buccal/lingual from interproximal site
- Multiple separate defect sites within a single quadrant.

Contraindication.[32]

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

Surgical considerations of mist along with features of mis.[33]

- In the Esthetic zone, a horizontal incision palatally preserves the Papilla.
- The sharp incisions using a small or bans knife are given and are not continuous

to retain interproximal tissue and tissue height.

- Only the tooth defect is treated.
- If the defect is deep and cannot be accessed the incision can be extended to the

adjacent tooth.

- The vertical releasing incision is avoided but if there is excess tension, very short
- A vertical releasing incision within the attached gingiva is given.
- Passive internal mattress suture is advised for MIST.
- The use of magnifying loupes makes it less invasive, shorter duration, and less demanding.

Conclusion

Proper case selection, flap design, and equipment will be beneficial in evaluating the efficacy of MIS toward periodontal regeneration. Studies have shown limited patient morbidity and excellent clinical improvements with MIS. The future promises further evolution towards a more primary preventive approach, facilitated by emerging technologies for diagnosis, prevention, and treatment. The combination of positive scientific evidence and advances in technology will allow rapid advancement in the field of minimally invasive surgery.

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