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Review Article

EVOLUTIONARY DYNAMICS IN ARMAMENTARIUM OF MINIMALLY INVASIVE PERIODONTAL THERAPY: A REVIEW

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A B S T R A C T

As we evolve our weapons too, similarly recent advances in periodontics promote the use of minimally invasive procedures which have evolved from magnification devices to advanced surgical instruments and modified procedures.

Since the introduction of MIPT in periodontics by Harrel in 1995, its popularity gradually increases as it causes little trauma to the patient, using smaller incision to miniaturize our eyes & extend our hands to perform microscopic & macroscopic operation that could previously be reached through large incisions which leads to esthetic deformity, food impaction, thermal sensitivity which can be overcome by MIPT.

Minimally invasive techniques represent alternative approaches developed to allow less extensive manipulation of surrounding tissues than conventional procedures, while accomplishing the same objectives, hence MIPT needs different advanced technical skills in visualization, to improve diagnostic & therapeutic approaches by using armamentarium like endoscope, surgical telescope, perioscope, surgical microscope along with modified instruments to handle soft tissue access, debridement, to improve wound stabilization, primary closure and to minimize patient discomfort & morbidity.

The future promises further evolution towards a more primary preventive approach, facilitated by emerging technologies for diagnosis, prevention and treatment.

INTRODUCTION

Periodontitis is a complex disease that has both oral & systemic consequences. With the advancement in Periodontology, the ultimate goal of modern periodontal therapy has become to eliminate the degeneration associated with progressive periodontal disease while restoring & maintaining periodontal esthetics.[1]

The patient's periodontal disease is increasingly recognized at an earlier stage with isolated defects due to improved awareness. Such patient also urge for a less intra & post operative trauma, early recovery to the normal life, negligible post treatment sequences and certainly improved esthetics.

These concerns give rise to a peculiar and innovative approach which aims to produce minimal wounds, minimal flap reflection, and gentle handling of the soft and hard tissues, which was first described by the Wickham and Fitzpatric in 1990, which was subsequently termed as minimally invasive surgery.[2]

Since then many innovative techniques, diagnostic & surgical instruments & biomaterials have been introduced in modern dentistry that has miniaturize our eyes & extends our hands to perform an operation in places that could previously only be reached by large incision & provide access to the periodontal defect site for complete debridement, enhance the predictability for regenerative potential of lost periodontal structure, simultaneously improved and reestablished the optimal esthetics. With this revolutionary era of minimally invasive therapy in periodontics not only therapeutic success rate have been increased also morbidity & mortality associated with surgical therapy has been significantly decreased & fear associated with surgery can be drastically decreased also importance of nonsurgical therapy has been significantly increased

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The approach of Minimally invasive periodontal therapy utilizes various magnification devices, microsurgical instruments & modified surgical and non surgical procedures, thus makes procedures effortless through these tools and devices. In MINST requires no incision but MIST needs minimal incision. MIPT can be defined as a surgical technique that uses smaller incisions to perform a surgical procedure that previously required larger incisions and achieves equal or superior results compared with the traditional surgical approach.

Armamentarium for Minimally Invasive Periodontal Therapy

It includes the equipment, techniques, instruments, biomaterials, and medicines used during procedure. Thus synergy of improved illumination and increased visual acuity enables the increased precision of surgical skills, which improve the outcome. It can be broadly classified as diagnostic, non surgical & surgical armamentarium depending on their use.

1. Diagnostic instrument	**Dental endoscope**			
2. Non surgical instrument	Dental endoscope, Ultrasonic Inserts, Diamond Tips			
3. Surgical instrument	For incision & flap reflection	For defect debridement	For wound closure	Magnification & visualization devices
	12B, plastic surgical, microsurgical blade, modified orban knife, Papilla elevator, Micro Elevator	D' granulator, mini curette, younger Goode 7/8 curettes, ultrasonic tips, diamond coated tips.	Micro needle holder, micro scissor, 4-0 to 6-0 sutures.	Surgical loupes, surgical microscope, videoscope, varioscope, MORA Interface, Zeiss OPMI Pro ergo

Diagnostic Instruments

Periodontal Endoscope: it was developed in the 1990s, provides visualization technology that can be placed into an intact pocket without a surgical incision. The direct view the treatment area by looking at the monitor allows operator to determine the need and effectively remove the root bound deposits with less effort.

Stambaugh et al. in 2002 in described endoscopic visualization of gingival sulcus and tooth root surface for evaluation of root deposite, root caries, fracture & soft tissue changes. dental endoscope radically changes the conventional tactile exploration & radiographic evaluation which improves diagnosis, treatment planing, delivery & evaluation of given therapy.

Dental endoscope has a subgingival probe to provide fiber optic images.[3]

Also Wilson et al. in 2002 found the relationship between tooth-borne subgingival deposits and inflammation found by increased redness of the pocket epithelium.[4]

Glass fiber endoscope system

Instrument for Minimally Invasive Non Surgical Periodontal Therapy

Glass fiber endoscope: Currently available glass fiber endoscope is the only device that allows visualization of the root surface without the necessity of surgical access during closed root planing. Fiber optic technique coupled with modified curette, probe and ultrasonic adaptor has made diagnosis and non surgical periodontal therapy more of a definitive treatment rather than a blind procedure.

1. ***Endoscopic curette:*** A stainless steel tube is welded to the shank of curette near its cutting blade having endoscope. A gingival retractor is added to the blade to hold the gingival tissue away from working tip.
2. ***Ultrasonic adaptor:*** It consists of a stainless steel collar, strut & a tube welded together into a single unit and irrigator is attached endoscopic window.

Endoscopic systems the DV2 Perioscopy System and the Perioscope has a nominal 53 degree field of view in subgingival area & magnification of 15X – 46X.

Endoscope has limited its acceptance for routine periodontal treatments due to lack of clarity of the image delivered to the monitor, damage to the glass fiber & high cost.

So scope for improvements of nonsurgical visualization technology in future is expected.[1, 3]

Indications for the use of the dental endoscopic technique

1. initial periodontal therapy;
2. non responsive & recurrence cases;
3. non compliance of patient for surgical therapy and/or where surgery is contraindicated for medical, or esthetic reasons;
4. At sites suspected for subgingival caries, root fractures, perforations, or resorption.

Instrument for Minimally Invasive Surgical Periodontal Therapy

Instrument for incision & flap reflection

Over the years since its first evidence in 1995 surgeons have used different blades according to the surgical need & convenience. Harrel used 12 B blades for initial sulcular incision, a standard curved disposable blade where both edges are sharp and rigid with utilization of push pull motion. This has been found to be very useful for the sulcular incisions. This blade may also be used to make the horizontal incision across the body of the papilla.

Different kind of microsurgical blades having smaller size allows good access to small spaces, but the blade's lack of rigidity is often a results in "spring action" which causes sudden movement of blade when "catches" on bone or calculus, that may damage the tissue. Many disposable microsurgical knifes of different shapes can be used for all the incisions used in V-MIS/MIS.

The knives most commonly used for MIS are those used in ophthalmic surgery: blade breaker, crescent, minicrescent,

spoon, lamella, and scleral knives. Common characteristics of these knives are their extreme sharpness and small size. This enables precise incisions and maneuvers in small areas.

The blade-breaker knife has a handle onto which a piece of an ophthalmic razor is affixed which can be used in place of 15 no blade. This allows for infinite angulations of the blade. The crescent knife can be used for intrasulcular procedures.[1,5,6]

Micro Elevator: Dr. Tabanella has designed a series of instruments named micro elevators; Tabanella Micro Elevator is a sharp micro elevator for rapid and minimally invasive flap and papilla elevation and removal of secondary flaps.

The papilla elevator is a double-ended discoid instrument. The two working-ends are demilune-shaped, semi-sharp and differ in their diameters. It is used to prepare fine tissue structures with a minimum trauma.

12b blade

Orban knife modified

Micro Elevator

Instrument for curettage & root planning

The Younger-Goode 7/8 curette, mini curettes are ideal for the gross removal of granulation tissue from periodontal defect through the small MIS access opening. These are relatively small instrument with a narrow shaft that can be used in a motion similar to a "spoon excavator".

The debridement of the root surface is performed with ultrasonic scaler and diamond safety tip (Vista Dental, Milwaukee, WI). The tip brings the aggressiveness of a diamond ultrasonic tip; but because the abrasive action of the diamond is limited, it can safely be used in small defects without risk of damaging the root surface.[1]

Visualization & Magnification Devices

The most critical advancements in technology are in the area of visualization & magnification. MIS requires some form of magnification and a light source that can be focused into the surgical site. Surgical loupes, microscope and videoscope are the devices that can be used for this purpose,

Magnifying Loupes

Loupes are essentially two monocular microscopes with lenses mounted side by side and angled inward (convergent optics) to focus on an object. Surgical telescopes work by magnifying a portion of the surgical field. Looking over the top of the telescope allows the surgeon to view a larger surgical field with no magnification. Magnification with surgical telescopes is usually from 2× to 7.5×. The most commonly used telescopes are in the range of 3× to 5×.

Surgical Microscope

This device offers the advantages of high magnification of approximately 4– 40×, a bright light source, and an open field for surgery. The open field is based on the relatively long focal distance between the microscope objective stage and the surgical site magnification. The surgical microscope is a relatively large device that requires a bulky and heavy stand to be moved between treatment rooms, or requires ceiling or wall mount if it is to be permanently installed.

Surgical videoscope

The videoscope has a different method of transferring the image to the monitor. a very small camera is placed at the end of the scope and the camera is placed within the surgical field. The image is then transferred to the monitor. This eliminates any degradations of the image that might occur during transmission of the image from the surgical site through optical fibers to an external camera. In general, the image viewed on the videoscope monitor is in true color and is of much higher quality than that obtained with a glass fiber endoscope.[1,7,8]

Loupes

Surgical microscope

videoscope

Suture & Suturing technique

Generally, for MIPS, suturing instruments should include: micro needle holder, micro scissor, and dental micro forceps. In most cases, the material used is either a 4-0 plain collagen or chromic suture. However, the exact suture material does not appear critical, but it should be strong enough to allow the tissue to be pulled firmly together and not be so small that it cuts through the tissue when tension is applied.[1] Sutures allow for wound adaption, as well as tissue displacement and stabilization during the healing process.

Armamentarium: evolutionary dynamics in minimally invasive therapy

1. The first endoscopic procedure was practiced by as far as the era of Hippocrates. In 1870's, Bozinni developed an illuminator to access the meticulous procedures which was introduced to the patients by Desormeaux by 1900's. [8]
2. The term minimally invasive procedure was first coined in an editorial in the British Journal of Surgery in 1990.[9]
3. Harrel & Rees in 1995 used a new mechanical surgical instrument, the D'Granulator, designed to quickly and easily remove granulation tissue while maintaining a blood-free field during periodontal and endodontic surgical procedures, allows minimization of soft-tissue trauma and the removal of granulation tissue from periodontal defects using a much smaller surgical incision than that used in standard techniques.[6]
4. In 1998 Harrel SK first described the use of minimally invasive technique for periodontal bone grafting procedure in intrabony defects. He modified the incisions & used a sharp narrow pointed 12D blade for initial intrasulcular incision which allows the incision to be kept parallel to the root surface, maintain tissue thickness, and minimize the chances of removing a collar of tissue. A modified orban knife was narrowed to approximately one fourth of its original width was used to sharply dissect the papilla away from the underlying bone. Younger Goode 7/8 curettes were used to initially remove granulation tissue through small access flap. An ultrasonic scaler was used to perform initial root debridement. Remaining strings of detached granulation tissue were removed using mechanical

granulation tissue-removing instrument named as D'Granulator, Young dental. The sharpened tip of the instrument needs to be repeatedly pushed across the granulation tissue in a "curetting motion" so that tip of the MGR will cut pieces of granulation tissue from the walls of the osseous defect, and the suction will draw the "strings" of granulation tissue into the tube where they are severed by the rotating bur. it may be necessary to repeat all of the granulation tissue removal steps several times to achieve a fully debride the surgical site. Final root paining was performed with a surgical-length finishing bur in a high-speed hand piece. For proper visualization a direct vision, a mouth mirror, fiber optic light probe or a halogen headlight in conjunction with some form of magnification can be extremely helpful. De mineralized freeze-dried bone (DFDB) mixed with tetracycline hydrochloric acid was placed into the defect & sutured as vertical mattress suture using plain or chromic gut. [10]

5. Harrel in 1999 published another case report of minimally invasive bone grafting technique in isolated intrabony defects & emphasized on case selection criteria. He further mentioned the use of disposable plastic knife for initial incision of thin & delicate flap especially for anterior teeth. Orban knife was modified to approximately one third to one fourth of its original width to perform thinning and undermining the flap. Stiffness of the shaft of orban knife allows the papilla to be pulled on buccal/lingual side while thinning incision is performed. In this early article author has suggested the use of surgical telescope with at least 3.5 X magnification for proper visualization during procedure. He also mentioned the difficulties associated with the use of surgical microscope, mainly being bulky it's difficult to move from one angle to another during debridement makes its use cumbersome. A modified amalgam carrier was mentioned for placement of bone graft followed by a small surgical mesh to follow the GTR protocol. A 4-0 plain gut suture is suggested for primary closure of wound, though 6-0 suture can also be used. Periodontal pack is usually avoided in minimally invasive procedure.[5]
6. In 2002, Stambaugh et al. used a direct, real time visualization for hard & soft tissue within gingival sulcus through dental endoscope in an aim to improve diagnostic as well as therapeutic outcome.[3]
7. In 2005 Harrel et al. used a biomaterial named enamel matrix proteins (EMP) in conjunction with MIS to enhance periodontal regeneration. A dental endoscope or surgical telescopes were used for visualization to ensure complete root surface debridement. Enamel matrix proteins were injected starting at the base of the pocket immediately following rinsing of the surgical site with EDTA & the site were sutured with single bio absorbable suture. The improvements in probing depths and attachment levels resulting from the use of a minimally invasive surgical technique and enamel matrix proteins are generally greater than those reported in most other studies of regenerative procedures with little or no post-surgical recession.[11]
8. In 2007 Cortellini & Tonetti used minimally invasive surgery with EMD in intrabony defects & the defect-associated inter-dental papilla was accessed either with the simplified papilla preservation flap (SPPF, Cortellini et al. 1999) or the modified papilla preservation technique (MPPT Cortellini et al. 1995). Microsurgical instruments were utilized, whenever needed, as a complement to the normal periodontal set of instruments. Incisions were carried out using delaminating microsurgical blades. They suggested a full-thickness flap elevation minimally, just to expose the buccal and lingual bone crest delimiting the defect in the inter-dental area. Mini curettes were used for defect debridement. Authors performed a single modified internal mattress suture applied at the defect-associated inter dental area to reach primary closure of the papilla in the absence of any tension. All the surgical procedures were performed with the aid of an operating microscope at a magnification of 4–16 X (Cortellini & Tonetti 2001, 2005). [12,13]
9. In 2009, Cortellini improvised MIS further by incorporating the concept of space provision for regeneration with the Modified Minimally Invasive Surgical Technique for periodontal regenerative procedure.[14]
10. In 2013 Harrel used a standard MIS approach with a videoscope with gas shielding for visualization and showed elimination of post surgical recession and it may even possible to correct some gingival recession that existed preoperatively.[15]
11. In 2016 Koji Mizutani used lasers for minimally invasive periodontal & peri implant therapy and suggested as 'Pain free' and 'simple procedure'. Diode and Nd:YAG lasers are used for soft-tissue ablation only while Erbium lasers, such as Er:YAG and Er,Cr:YSGG lasers are used for ablation of both hard and soft tissues. Lasers can be used for non surgical periodontal therapy such as De-epithelialization of periodontal pockets, as an adjunctive treatment with scaling & root planing & offered significant improvements in clinical parameters as well as for various surgical therapy like minimally invasive flapless periodontal pocket surgery, laser assisted new attachment procedure, laser-assisted comprehensive pocket treatment using erbium lasers etc.[16]

The extent of these radical advancements can be achieved by means of proper case selection, accurate use of armamentarium and surgical technique which gives leading approach towards in the field of minimally invasive therapy. The key to performing minimally invasive procedures is the ability to adequately see the site and therefore, the ability to successfully complete the indicated surgical manipulations and achieves the minimum traumatic damage to the periodontal tissue, preservation of as much blood supply to the surgical site while achieves a stable primary closure.[17]

CONCLUSION

Based on the enthusiastic acceptance of nonsurgical treatment and minimally invasive surgery in medicine and dentistry, the future for the discipline in periodontal treatment is bright. As improvements in visualization technology come to the marketplace, a minimally invasive nonsurgical approach will likely become the routine first step in periodontal therapy. With diligence and expert application, many if not most periodontal therapy may likely be performed non surgically.

However, for the foreseeable future, there will almost certainly remain situations where surgical care will be necessary. The long-term goals for minimally invasive periodontal therapy may well be a hybrid between nonsurgical and surgical minimally invasive treatment. It is conceivable that in the future, technology will allow for treatment of periodontal disease.

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