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Review Article

Precision Dentistry in Action: Minimally Invasive Techniques in Periodontics and Implantology - A Narrative Review

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Abstract

The growing emphasis on precision dentistry necessitates a shift towards minimally invasive (MI) techniques. This narrative review explores how MI techniques are revolutionizing periodontics and implantology. In periodontics, microsurgical techniques, tunneling techniques, and papilla preservation flaps allow for targeted procedures with minimal tissue disruption, leading to reduced discomfort, faster healing, and improved aesthetics. Implantology benefits from MI techniques like piezoelectric surgery, computer-guided surgery, and immediate implant placement, offering faster healing times, potentially fewer surgeries, and potentially improved success rates. By minimizing invasiveness while maintaining precision, MI techniques represent a significant advancement in both periodontics and implantology, aligning perfectly with the core principles of precision dentistry.

Keywords: Minimally Invasive Techniques; Precision Dentistry; Periodontics; Implantology; Microsurgery; Tunneling Techniques; Papilla Preservation Flaps; Piezoelectric Surgery; Computer-Guided Surgery; Immediate Implant Placement

Introduction

The landscape of dentistry is undergoing a remarkable transformation driven by the concept of precision dentistry. This data-driven approach emphasizes tailoring treatments to the unique needs of each patient [1]. Minimally invasive (MI) techniques are revolutionizing how dental care is delivered, and their impact is particularly profound in the fields of periodontics and implantology. This narrative review delves into the world of MI techniques, exploring how they embody the core tenets of precision dentistry and offer significant advantages for both patients and practitioners.

Periodontitis is a chronic disease affecting periodontal tissue, causing tooth loss. Regeneration of lost periodontal tissues has been the ultimate goal of periodontal therapy. Various principles have been used for periodontal regeneration, including barrier membranes, demineralized freeze-dried bone allografts, a combination of membranes and grafts, and enamel matrix derivative (EMD) [2]. However, flap dehiscence at regenerative sites is common, and contamination of regenerative materials is a critical issue. To increase surgical effectiveness, the use of operating microscopes and microsurgical instruments, such as Microimplant Periodontal (MIPS), has been suggested. MIPS technique allows for minimal soft tissue trauma and removal of granulation tissue from periodontal defects using a smaller surgical incision [3]. Data shows clinical improvements in pocket depth reduction, attachment level gain, and recession after application of MIPS in different types of defects. MIPS is ideal for isolated defects, but generalized horizontal bone loss or multiple interconnected vertical defects are contraindicated [4].

Minimally Invasive Periodontal Surgery (MIPS) is a surgical approach that aims to conserve as much soft tissue as possible. Incisions for MIPS are designed to be made as separate intrasulcular incisions made on the teeth adjacent to the defect, not being continuous across the interproximal tissue [5]. The Tunnel Technique (TT) is an important element of MIPS, originated from the Envelope Technique (ET) developed by Raetzke in 1985 for the treatment of single gingival recessions [6].

Flap elevation is another important aspect of MIPS, which uses sharp dissection only. This can be achieved using Orban knives that have been reshaped to one third to one fourth of their original size. The use of this technique minimizes trauma to the flap and preserves much of the blood supply to the soft tissue. It is recommended to achieve the incisions for flap elevation in the form of "splitting," so that the periosteum tissue is left on the bone surface [7].

Papilla preservation techniques have been proposed to prevent or reduce excessive apical displacement of the gingival margin in the treatment of periodontal defects. Takei., *et al*. proposed the papilla preservation technique, which involves a sulcular incision around each tooth, with no incisions made through the interdental papilla [8]. The modified papilla preservation technique, published by Cortellini., *et al*. involves a horizontal incision on the buccal papillary tissue at the base of the papilla, a full-thickness palatal flap, including the interdental papilla, and a barrier membrane. A horizontal internal crossed mattress suture is placed beneath the mucoperiosteal flaps between the base of the palatal papilla and the buccal flap, relieves all tension of the flaps, and a second suture (vertical internal mattress suture) is placed between the buccal aspect of the interproximal papilla and the most coronal portion of the buccal flap to ensure primary closure [9].

The simplified papilla preservation flap (SPPF) 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 midinterproximal portion of the papilla under the contact point of the adjacent tooth. A full-thickness palatal flap, including the papilla, and a split-thickness buccal flap are then elevated, and the interdental tissues are positioned and sutured to obtain primary closure of the interdental space [10,11].

Dental implants have significantly improved the rehabilitation of partially or completely edentulous patients and have become a predictable method of tooth replacement. The concept of prosthetic-driven implantology is gaining attention in the modern era, focusing on non-invasive surgical and restorative techniques to reduce tissue trauma, decrease pain and swelling, and improve postoperative experiences [7,9]. The correct placement of the implant is based on a three-dimensional assessment of the site, including mesiodistal, buccolingual, and occlusogingival direction. Digital planning with guided placement offers valuable contributions to achieving accurate and precise implant positions, avoiding complications. The focus is now shifting towards nature-like tooth replacement, minimally invasive surgical and restorative techniques, with time and cost efficiency. Advantages include preserving circulation, hard tissue volume, soft tissue architecture, reduced surgical time, improved patient comfort, and accelerated recuperation [12].

The present review systematically scrutinizes the current scientific literature and focuses on various methods to achieve minimally invasive periodontal and implant dentistry, such as Papilla preservation techniques , simplified papilla preservation flap , the Tunnel Technique, 3D Guided implant surgery, angled implants, mini dental implants, short implants, and piezoelectric surgery.

Methodology

Search criteria

A meticulous search strategy was employed to comprehensively explore minimally invasive techniques (MITs) in periodontics and implantology. Reputable databases like PubMed and Google Scholar were utilized.

To achieve a focused yet inclusive approach, the search combined MeSH terms and keywords relevant to both periodontics ("minimally invasive periodontal therapy," "flapless surgery") and implantology ("minimally invasive implant placement," "computer-guided implant surgery"). Boolean operators ("AND" and "OR") were used to refine the search.

For optimal results, a set of inclusion and exclusion criteria were strictly applied. Priority was given to articles published within a recent timeframe to capture the latest advancements in MITs. Authorship by recognized researchers in the field and titles clearly reflecting the use of MITs in periodontics and implantology were also crucial factors. The research focus of the articles needed to directly align with the objectives of this review, and English language publications were chosen for efficient analysis.

Conversely, conference proceedings, non-original research papers (reviews, opinions, case reports), studies outside the dental/

medical fields, and overly detailed articles were excluded from the search. This meticulous selection process ensured the incorporation of high-quality and relevant research, building a strong foundation for understanding the current state of minimally invasive techniques in periodontics and implantology.

Review

Periodontics and Minimally Invasive Techniques

Traditional periodontal surgery, while effective in treating gum disease, often involved a more invasive approach using scalpels to create large gum flaps. This led to increased patient discomfort during and after surgery, slower healing times due to extensive tissue disruption, and potential aesthetic concerns like gum recession. The advent of MI techniques has transformed the way periodontal procedures are performed. These techniques prioritize a more targeted and controlled approach, minimizing disruption to healthy tissues [13].

Minimally Invasive Periodontal Surgery (MIPS) focuses on conserving soft tissue and using Tunnel Technique (TT) to treat single gingival recessions. The Tunnel Technique involves intrasulcular incisions followed by supraperiosteal preparation of a tunnel through defect areas, allowing the transplantation of Sub-Epithelial Connective Tissue Graft (SECTG) in sulcular areas. The Single Incision Technique (SIT) is more preferable for extracting SECTG from the palate [14].

Flap elevation is another important technique in MIPS, using Orban's knives that are one third their original size. This technique allows for a thinning and undermining incision, leaving the periosteum tissue on the bone surface. The modified papilla preservation technique, introduced by Cortellini., *et al*. is performed in wide interdental spaces (2 mm) and offers primary closure of tissues and papilla preservation in 75% of cases [15].

The Simplified Papilla Preservation Flap (SPPF) is applicable in narrow interdental spaces (< 2 mm). It involves 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 next tooth. A full-thickness palatal flap including the buccal papilla is elevated, and the interdental tissues are positioned and sutured to obtain primary closure of the interdental space [16].

In mucogingival surgery, microsurgical methods and practice are essential for achieving desired treatment outcomes. Microsurgery in periodontics has proven to improve predictability of gingival transplantation procedures, reduce operative trauma and discomfort, and make complete root coverage extremely predictable in class I and class II marginal tissue recession defects [12].

Root coverage procedures involve dexterity of the surgeon, excellent visualization of the operating field, and an atraumatic surgical approach. Factors influencing the degree of coverage must be controlled to maximize treatment outcomes.Papilla reconstruction remains a challenge, but microsurgical procedures can be useful due to the small dimensions of the interdental papilla and limited access [10,13].

Minimally invasive surgery (MIS) has emerged as a promising method for periodontal treatment, focusing on wound healing and tissue regeneration following flap surgery. Techniques such as the single flap approach and modified MIST have shown excellent clinical results in securing blood clot stability in bone defects. MISs are associated with superior periodontal tissue regeneration and less gingival recession than conventional flap designs [17].

Er: YAG laser debridement is advantageous in narrow and deep bone defects during MISs due to its high accessibility. Critical factors in wound healing of periodontal tissues include blood clot stability, migration and adhesion of cells to the root surface, and cell proliferation and differentiation. Er: YAG laser-irradiated root and bone surfaces have better biocompatibility for blood clot adherence compared to mechanically treated surfaces, and coagulation of clot surfaces with defocused irradiation can be stabilizing [18].

Dyer and Sung performed MIST combined with Er, Cr: YSGG laser for the treatment of periodontal pockets remaining following Single-Root Prosthesis (SRP). They observed that with 7-9mm initial PPD, the mean PPD and CAL improved from 7.5 ± 0.6 and 7.6 ± 0.6 mm at baseline to 3.7 ± 1.2 and 3.6 ± 1.2 mm at 2 years, respectively [19].

Flapless surgery using Er:YAG laser could be an effective adjunct in MISs to facilitate procedures and obtain enhanced healing and regeneration. However, further development of endoscopy may be required for the detection and confirmation of diseased soft tissue and calculus. In blinded conditions during flapless surgery, thorough debridement of all internal pocket aspects would still need to be performed as well or better than direct surgical access [18,19].

The periodontal endoscope (perioscope) is a nonsurgical device that allows subgingival visualization of closed pockets without surgical intervention, reducing the risk of over-instrumentation and excessive removal of cementum. It is the only device that allows visualization of root surfaces without the need for surgical access. However, it is not widely adopted due to associated costs and lack of image clarity caused by degradation of optical glass fibers and debris suspended in irrigation liquid [12,18].

Videoscopes, which use a small camera inserted into the field, avoid the problems associated with the periodontal endoscope but are limited to minimally invasive surgery. Minimally invasive nonsurgical therapy (MINST) has shown promising clinical and patient-reported outcomes, with promising clinical and patient-reported outcomes reported in the literature [28]. In 2011, Ribeiro., *et al*. described MINST, which aimed to treat intrabony defects nonsurgically and with minimal trauma after the first phase of periodontal treatment. A randomized clinical trial compared MINST with the minimally invasive surgical technique (MIST) with 3 and 6 months of follow-up. Both therapies were efficient in improving the clinical condition, with most of the CAL gain and PPD reduction achieved at 3 months of reevaluation and minimal change between 3 and 6 months [19,20].

Minmal gingival recession (GR) is an important clinical outcome for periodontal treatment due to aesthetic sequels and intense tissue trauma generated during treatment. Patients reported minimal pain and discomfort, high satisfaction levels, and no significant difference between treatments. One relevant point in favor of MINST over MIST was reduced chair time [16].

The minimally invasive nonsurgical therapy (MINST) approach has been shown to lead to more favorable outcomes in treating intrabony defects compared to conventional nonsurgical periodontal therapy. Traditional nonsurgical treatment involves an early healing phase, including hemostatic and inflammatory phases. The hemostatic phase involves the formation of a blood clot, which serves two main purposes: temporarily protecting denuded tissues and serving as a provisional matrix for cell migration. The delayed healing phase includes a continued inflammatory phase and granulation and remodeling phases [21].

In the inflammatory stage, the clot is populated with inflammatory cells, chiefly neutrophils and monocytes, which destroy residual bacteria present at the site and prevent wound reinfection. In the late part of the inflammatory stage, macrophages migrate into the area within 3 days of treatment, phagocytosing not only bacteria but also damaged and apoptotic cells, such as leukocytes and erythrocytes, and matrix molecules. They release soluble mediators such as inflammatory cytokines and tissue growth factors, which recruit other inflammatory cells, fibroblasts, and endothelial cells [22].

New tissue formation occurs in the granulation phase, typically from day 4 after treatment. Angiogenesis is carried out by endothelial cells, while fibroblasts produce the extracellular matrix of the connective tissue. Seven days after the initiation of wound healing, granulation tissue dominates the wound site, with some fibroblasts turning into myofibroblasts responsible for expressing alpha-smooth muscle actin and generating strong contractile forces that lead to wound contraction [23].

Minimally invasive nonsurgical therapy differs from traditional nonsurgical treatment because it aims to guide healing in a more reconstructive manner, focusing on reducing surgical trauma and increasing wound stability. The formation and stability of the blood clot are of paramount importance in healing and promoting a regenerative response [24].

The effect of MINST may be mediated by improved blood flow, as a less invasive, less traumatizing flap leads to faster recovery of gingival blood flow postoperatively. This may result in higher stability of the blood clot in the interproximal area and more favorable healing of the intrabony defect. However, there is still a lack of data and research in this area, and further research is needed to determine the biologic response to MINST and optimize its approach [25].

Advantages of MI techniques in periodontics

Compared to traditional scalpel-heavy techniques, the shift towards MI (minimally invasive) techniques in periodontics offers a significant improvement in patient experience and outcomes. MI techniques prioritize smaller incisions, resulting in reduced discomfort and swelling after surgery. This translates to faster healing times and a quicker return to normal function, allowing patients to get back to their daily routine with minimal disruption [26]. Furthermore, MI techniques minimize disruption to healthy gum tissues. This not only promotes better long-term gum health but also reduces the risk of complications that can arise from extensive tissue manipulation. Finally, a key benefit of MI techniques is their focus on preserving gum tissue. This leads to more natural-looking gums and a more aesthetically pleasing smile, an aspect that can significantly impact a patient's self-confidence and overall well-being [27].

Minimally invasive techniques in implant dentistry

Traditional dental implant placement often involved a more involved and demanding process. Exposing the underlying bone for implant placement required surgery, which could be time-consuming. In some cases, multiple surgeries might be necessary for bone grafting, further extending the treatment timeline. Additionally, the extensive bone exposure and manipulation inherent in traditional techniques could lead to increased discomfort and longer healing times for patients [20,22]. Similar to periodontics, MI techniques are transforming the field of implantology by offering a more precise and less invasive approach.

Piezoelectric surgery

This innovative technique utilizes sonic vibrations with specialized instruments to remove bone with exceptional precision. This minimizes trauma to surrounding tissues compared to traditional drills, leading to faster healing and reduced post-operative discomfort.Piezoelectric surgery is advancing due to its precise, customized cutting and improved healing conditions. Reduced blood loss and constant irrigation reduce thermal damage, reducing the risk of bone necrosis. Overheating during implant preparation negatively impacts osseointegration and rehabilitation outcomes. Smooth tips generate the lowest temperature, while other factors like cutting technique and bone features also influence temperature rise. In a study comparing sonic and ultrasonic devices with rotary burs in porcine jaws, piezosurgery showed the highest temperature rise [28].

The piezoelectric device is a versatile tool used in implantology, particularly for the preparation of implant sites. It can be employed in healthy bony conditions to reduce thermal and mechanical damage to the bone. In 2007, Preti., *et al*. found that more newly formed bone with an increased amount of osteoblasts was visible on the piezoelectric implant site during the early phase (7-14 days). This stimulation of peri-implant osteogenesis and a reduction of pro-inflammatory cytokines was observed in the piezoelectric group [29].

Piezoelectric surgery has gained wide approval for sinus lift evaluation, but many people still believe it does not show clear benefits. Another advantage of piezoelectric surgery is its use during the same surgical session for harvesting bone. Stacchi., *et al.* published a scraping-pulling fashion, in which the gained bone chips can then be used for the augmentation or they can be mixed with various nonautologous materials and placed in the sinus [30].

Bone grafting is another application of the piezoelectric device. Dental implants are only possible if sufficient residual bone volume is available. Different techniques for ridge augmentation have been published and proven to be very sufficient. Autogenous bone grafts from the chin or the ramus are the most common choices if only a limited amount of bone is needed. For larger bone volumes, other donor sites, such as the iliac crest, have to be considered [31].

Bone grafts from the jaw region show good osteogenic properties, little resorption, and thus stable conditions. Piezosurgery requires much less hand pressure than traditional rotary instruments, and the shape of the graft can be accurately removed from the donor site, keeping donor-site morbidity as low as possible [39]. Majewski investigated the possibility of harvesting individual bone blocks with an individual piezoelectric cut design, which also enables surgeons to remove grafts from regions that are more difficult to reach [32].

The removal of the graft itself is another aspect of the piezoelectric device. If performed with a conventional bur or saw, normally a chisel has to be used to remove the graft, which increases the risk of damaging teeth roots and soft-tissue structures. Therefore, the use of the piezoelectric device is a safer option, as movement of the patient can lead to iatrogenic slipping and serious complications [33].

Edentulous ridge splitting is a technique used to separate the lingual plate from the buccal plate of the edentulous ridge in cases where the width of the ridge is insufficient. This procedure is safe and avoids donor-site morbidity as no graft is needed. The piezoelectric device allows bone separation in difficult bony situations due to the precise and well-defined lateralization of the inferior alveolar nerve [29,30].

Maintaining the inferior alveolar nerve intact is crucial for a patient's quality of life. The localization of the nerve can vary in the edentulous mandible, but the horizontal layer seems to be stable. The piezoelectric device supports surgeons in interventions close to the inferior alveolar nerve, allowing for the removal of deeply impacted wisdom teeth and lateralization of the nerve. This procedure is an alternative to the augmentation technique for implants in an edentulous jaw, allowing for free and clear access to the nerve. The piezoelectric device can be used to perform cuts with the cortical lateral bone lid, ensuring the nerve structure is protected after nerve retraction and transposition. However, negative side effects may be higher if a rotating instrument comes into contact with the nerve [34].

The piezoelectric device is a highly effective and comfortable method of dental surgery, offering patients less stress and fear due to its low noise production. It is widely used in various dental fields, including orthodontics, oral surgery, maxillofacial surgery, orthognathic surgery, and even computer-assisted surgery for osteotomies. The device's high-precision cutting and reduced risk of nerve damage make it a popular choice for patients. It is also used in the harvesting of microvascular free bone flaps, and is used in interdisciplinary surgeries such as orbital surgery, ear, nose, throat surgery, hand surgery, and thoracic surgery. The device is also increasingly attractive and accepted in bone surgery in children. The only known disadvantage is the slightly longer operating time, but these advantages make it a popular choice in dentistry [35].

Computer-Guided Surgery

This technology leverages 3D imaging and digital planning software to precisely map the jawbone anatomy and determine the ideal implant position. This allows for minimally invasive implant placement with minimal flap reflection and often eliminates the need for extensive bone grafting procedures. The advantages of guided surgery include reduced trauma, duration of surgery, and greater precision than freehand surgery [48]. Disadvantages include lower primary stability and increased costs due to the need for a surgical guide, specific instruments, tools, and planning software. Computer-guided surgery may be more indicated in cases where the implant is planned to be placed near a critical anatomy, such as the proximity of the inferior dental nerve or maxillary sinus. The most suitable technique for guided surgery is fully guided surgery due to its great precision. However, in cases where fully guided surgery is not possible, the pilot drill-guided surgery technique could be indicated [36].

Limited limitations of guided surgery include higher costs, the need for favorable anatomical conditions in terms of buccal opening, and adequate adjustment of the surgical guides. In dynamic surgery, surgeon familiarization with the procedure is necessary, as the entry point is visualized on the monitor instead of directly observing the patient's jaw. Additionally, static guided surgery has limitations in detecting deviations in the implant position due to the closed and restrictive structure of the static guides, which does not occur in dynamic surgery because it allows complete visibility of the surgical area and the final position of the implant [37].

Complications in guided surgery are lower than in freehand surgery, with only 4.2% of implants placed with pilot drills having to receive a screw-retained restoration. No biological complications of invasion of neighboring structures were described for any of the techniques in any of the included studies.The use of software combining digital images from computerized tomography (CAD/CAM) and stereolithography has become a new trend in dentistry, providing professional tools for better planning and rehabilitation. This technology allows professionals to evaluate optical density, measure bone thickness, and choose implant size and positioning in the arch [38].

The drill guide inside the guide is crucial for assisting the direction of the surgical drill during perforation to avoid lateral deviations. The guides should be sterilized according to manufacturer instructions and tested to verify the appropriate position to the edentulous area and dental position. Virtual planning involves two steps in computed tomography (CT), with the patient's tomographic guide in position and the CT of the guide alone superimposing the images later in the software [35,38]. The CT is transformed into 3D images with DICOM extension and converted to a planning guide software like DentalSlice®.

Prosthodontics and surgery professionals can now use virtual planning in the software to choose the best three-dimensional position of each implant based on the quantity and quality of bone and the emergence profile of artificial teeth represented by the guide image. The guided surgery is highly accurate in implantology, transferring extensive information obtained in a virtual planning to the surgical field through stereolithography-manufactured surgical guides [39].

Indications for guided surgery include total edentulous patients and partially edentulous patients. However, it is counter-indicated for patients with reduced mouth opening, as it jeopardizes the positioning of surgical instruments on the guide. Before the tomography, a clinical exam is necessary to evaluate the existing prosthesis, relationship between arches, dental oclusal pattern, and inter maxillary distance. For total edentulous patients, the total prosthesis is fabricated with appropriate vertical dimension of occlusion, and radiopaque marks are made in the guide near the canine or molar region [40]. The guide is stabilized at the planned dental occlusion using silicone and retaining pins are screwed at the buccal region. Guided surgery can lead to early and late complications. Early complications include issues with primary stability, loosening prosthesis screws, slight tumefaction, speech difficulties, jugal hematoma, and tissue heating [41]. A study by Margonar., *et al*. 2010, found that the guide surgery technique heated bone tissue higher than conventional open flap surgery, but not to the threshold temperature causing immediate necrosis. Late complications include persistent pain, gingival recession, and osseointegration loss. The success rate ranges from 83 to 100% [42].

Immediate implant placement

In certain cases, with careful planning and favorable bone conditions, MI techniques allow for the placement of a dental implant immediately after tooth extraction. This reduces the number of surgeries needed and shortens the overall treatment time.Ganapathy V., *et al*. [43] evaluated the durability of immediate implant placement in periodontally compromised individuals. The study focuses on studies reporting clinical and radiologic outcomes from individuals who had been treated and maintained for at least five years. The results show that immediate implant therapy is safe, effective, and predictable for successful osseointegration and long-term functioning, with minimal differences in clinical and radiographic outcomes.

Immediate implant placement is crucial for maintaining good dental esthetics, and a careful analysis of factors such as tooth position relative to the free gingival margin, form of the periodontium, biotype of the periodontium, tooth shape, and position of the osseous crest before tooth extraction is essential. The surgical approach for immediate implant placement should consider the shift of the implant to the buccal side due to thin buccal plates with high bundle bone content and the nature of self-tapping implants [44].

Peridontal biotype affects the dimensions of peri-implant tissues, with thick biotypes being better candidates for immediate implant placement due to less chance of tissue receding postplacement and stable esthetics. However, immediate placement in patients with thin tissue biotype may expose the metal margin of the implant, leading to resorption of 50% of the original buccal plate width.

Minimum requirements for predictable immediate implant placement include a sufficient amount of crest ridge with width of 4 to 5 mm and height of 10 mm or more, maintaining a safety distance from vital anatomical structures, and a distance of ≤5 mm from the alveolar crest to the future prosthesis contact point [45].

Immediate placement of implants into chronic infection sockets can be a concern, but it can still achieve a successful outcome if the socket is debrided and disinfected effectively. A pre and post-operative protocol, including antibiotic administration, meticulous cleaning, and complete alveolar debridement before implant insertion, is necessary for successful placement [46].

Quirynen., *et al.* [47] found implant survival between 0% and 40% after immediate placement, with a mean of 6.2% loss. Submerged implants had a higher survival rate. Schwartz-Arad., *et al.* [48] showed a 5-year cumulative survival rate of 89%, with better prognosis in the mandible. Ribeiro., *et al*. [49] reported a high success rate of 93.5% for immediate nonfunctional loading of implants, but lower than delayed placement.

Studies suggest immediate implant placement in extraction sockets can preserve ridge contour, but limited human case reports show dimensional changes and reduced buccal bone resorption. Both delayed and immediate approaches resulted in significant reductions in bony defects [45,47,50].

Transgingival implant therapy is a minimal invasive technique for implant placement that involves a flapless surgery to prepare the implant osteotomy and place the implant without elevating a mucoperiosteal flap. This approach reduces operating time, post-operative bleeding, patient discomfort, and increases patient acceptance. It also helps preserve vascularity, soft-tissue architecture, hard tissue volume, and accelerate recovery [45,47].

For immediate implant placement in fresh extraction sockets, this technique is preferred to preserve vascular supply and existing soft-tissue contours, optimizing the healing of peri-implant tissues. However, it is associated with certain surgical risks and complications, including the increased risk of damage to vital structures like the underlying nerves or adjacent tooth. With the aid of computer-guided navigation, these drawbacks can be nullified [40,42,44].

Minimally invasive maxillary sinus elevation using the balloon system is a surgical technique developed as a less invasive alternative to the lateral window approach. It offers predictable results, is safe and effective, and eliminates complications associated with conventional lateral window techniques. One-piece implants are designed for use in narrow ridges and tight spaces, are less time-consuming, and can be immediately loaded in clinical situations where there is good bone quality.

The flapless technique is performed with the aid of a rotary burs or a tissue punch to gain access to the bone without flap elevation, facilitating the preservation of the vascular supply and surrounding soft tissue. Less surgical trauma with short operative time, rapid post-surgical healing, fewer postsurgical complications, and decreased patient discomfort are considered the main strengths of this technique [49].

Conventional flapless implant surgery with the aid of a soft tissue punch device necessitates a circumferential excision of keratinized tissue at the implant site, which avoids the preservation of the periimplant keratinized mucosa. Reduced keratinized mucosa around implants appears to be associated with inflammation and poor oral hygiene.

A drawback with this technique is that the true topography of the underlying available residual bone cannot be observed because the mucogingival tissues are not elevated. This approach is only indicated when the surgeon has planned the procedure in such a way that the underlying osseous anatomy is ideal relative to the planned implant diameter and three-dimensional placement in the alveolus [43,45,49,50]. Flowchart of Minimally Invasive Techniques in Periodontics and Implantology depicted in figure 1 .

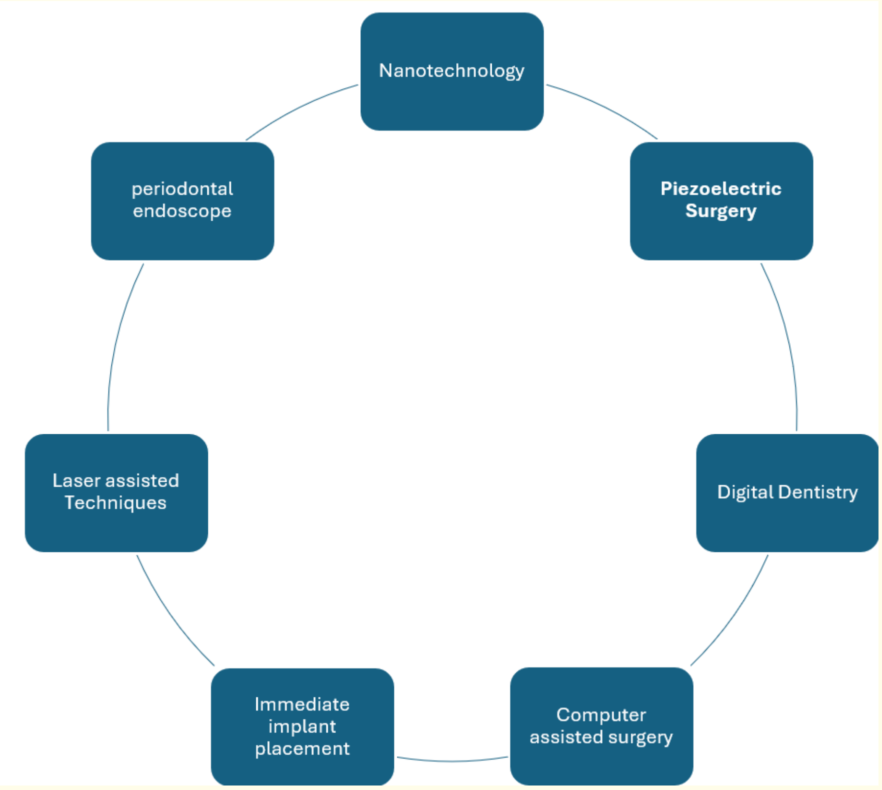

Figure 1: Minimally Invasive (MI) Techniques in of Periodontics and Implantology.

Conclusion

Minimally invasive (MI) techniques are revolutionizing the fields of periodontics and implantology. By prioritizing smaller incisions and preserving healthy tissues, MI techniques offer significant advantages for patients. These advantages include reduced discomfort, faster healing times, improved long-term outcomes, and enhanced aesthetics. As MI techniques continue to develop and gain traction, they have the potential to make periodontal and implant treatment more accessible and appealing to a wider range of patients.

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