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Comparison of Mini Implant in Fixed and Removable Prosthodontics: A Review Article

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Abstract

Mini implants were developed as an alternative to conventional implants for usage in narrow alveolar ridges because of their smaller length and size. In orthodontic procedures, they also serve as anchors. Mini-implants provide streamlined therapeutic approaches with minimal cost, and perhaps a flapless surgical procedure that can decrease post-operative morbidity. As is the case with all implant research, they underwent *in vivo* testing using animal models before being used in clinical use. Mini-implants have a high rate of acceptability in therapy among patients thanks to their biomechanical characteristics. This article examines the use of prostheses and micro-implants in the treatment of edentulous individuals and provides recommendations for effective results.

Keywords: *Mini Implants; Dental Implants; Fixed Prosthetics; Removal Prosthetics*

Introduction

To achieve optimal treatment outcomes in orthodontics, proper anchoring is essential. Accordingly, the use of mini-implants as an intermittent skeletal anchoring system in orthodontics has significantly changed the available anchorage alternatives in the past [1]. Mini-implants, a novel and more effective tactic, have helped to lessen the anchoring instability seen with conventional anchorage methods. Additionally, they offer benefits including requiring less patient participation, being easy to implant and remove, and having minimally invasive surgical procedures that are inexpensive and have a high success rate [2].

Orthodontic mini-implants (OMIs) clinical success is strongly connected with the support of mechanical stability, low pain, and the lack of peri-implant inflammation. Primary stability is given soon after the device installation procedure, and secondary stability is demonstrated during the healing process. Numerous factors, such as the device's surface form, the surgical procedure, and the physiological repair process, affect the maintenance of OMI in bone [3,4].

However, despite their widespread usage and high success rate, implant failure owing to instability is a common downside. Regulating the durability of mini-implants is therefore still a hard factor to consider. The durability or stability of mini-implants consists of two stages of initial and long-term stability. Initial stability conveys a mechanical connection. A variety of factors as the thickness and size of cortical

bone surrounding the mini-implant screws while insertion. It is to be noticed that the size, shape of the screw, and the angle of insertion, may have an impact on this mechanical connection. Long-term biological stability is correlated with bone remodeling and aggregation throughout the healing process [5,6].

There are now more implant recovery procedures available for patients with partial dentures because to the many dental implant loading regimens that have been shown. Today, the majority of implant recipients-up to 90% of all implant patients-are people with partial dentition. The advancement of appropriate augmentation techniques and the implementation of cutting-edge implant surfaces have produced favorable treatment outcomes even in situations where aesthetics is of the utmost importance. The aesthetic results of the replacement teeth have improved as a result of surgical and prosthetic operations [7,8].

Unfortunately, traditional two-piece implants are expensive and may call for bone augmentation treatments in constrained alveolar ridges. One-piece mini implants with diameters of 1.8 to 2.9 mm should primarily be used to stabilize removable dentures in ridges that have atrophied and are too narrow. Therefore, mini implants may lessen the surgical intervention's invasiveness, resulting in decreased postoperative morbidity and lower initial treatment costs. Because of this, mini implants are particularly appropriate for individuals who are in poor health or have little resources. By doing this, it may be possible to persuade patients, especially older ones who decline sophisticated procedures to select implant-supported rehabilitations [9-11].

Purpose of the Study

The purpose of this article is to start establishing standards for the usage of mini dental implants by discussing their proper application.

Fixed prosthetics

The worldwide drive towards digitization is currently dominating all aspects of dentistry. New clinical techniques and production methods may now be developed thanks to computerized dentistry, especially in the technique-focused discipline of fixed prosthodontics. Even while the continual advancement of CAD/CAM (computer-aided design and manufacturing) process is the primary approach behind dental technology. Clinical operations have seen tremendous modification in recent years by using intraoral scanners. These technologies have made it possible to fully digitally treat tooth-borne and implant-indorsed monolithic fixed dental prostheses (FDPs) in a single session [12,13].

A prosthetic crown or fixed partial denture's marginal integrity, marginal integrity with an external gap, and preservation of pulpal and periodontal health are all crucial issues to consider. The position of a gap, namely whether it is supragingivally, paragingivally, or subgingivally, is crucial. Better dental hygiene can be maintained in supragingival gaps and prevent subsequent caries or periodontal disease [14].

Subgingival gaps should be adequately assessed since they prevent the maintenance of appropriate oral hygiene. There is still no established method for determining the ideal margin gap value. Some scholars think the figure is 120 millimeters. Others believe it should be < 100 μm for it to be ideal. Furthermore, it is still believed that the ideal value should fall between 20 and 75 m [15].

The deterioration of periodontal tissues caused by margin mismatch after getting prosthetic therapy with conventionally constructed metal-ceramic restorations generates a retentive zone that allows tooth plaque to accumulate. Periodontitis, which is linked to mechanical damage to the gum during tooth preparation and gingival retraction as well as to uneven contours and the topography of the crown edge, is the undesirable side effect of metal-ceramic mixtures on the periodontium [16].

In comparison to fixed dental constructs constructed using traditional manufacturing methods, subjects who had fixed prosthetic restorations created using CAD/CAM technology showed a superior periodontal response. These permanent restorations function in a very complicated oral environment that is subject to uncontrollable fluctuations in temperature, pH, and masticatory strain. Therefore, the prosthetic structure's performance may be influenced by a variety of factors, including biomaterials, manufacturing methods, operator expertise, and host-related factors [17].

Cellular and non-cellular immunity are encouraged as adaptive immune responses when inflammation caused by fixed prosthetic structures develops into a chronic condition. These immune defenses are crucial for tissue regeneration, repair, and decreasing the inflammatory reaction during the healing process. Self and acquired immune processes must function together to heal the wounded tissue and restore it to balance [15].

The smaller diameter of mini implants makes it possible to do minimally invasive surgery without often raising a flap. Greater patient comfort, quicker healing, and a considerable decrease in the difficulty of the procedure, the length of the recovery period, and the cost are all benefits of flapless implant placement, which also protects more blood flow and leaves the periosteum intact. Furthermore, as the population ages, Mini-implant-supported fixed restorations (MISFRs) may be beneficial for old patients who cannot handle the adverse outcome of complex bone grafting and traditional implant surgical procedures [18,19].

MISFRs may decrease the need for bone grafting and the hazards engaged in such procedures, reduce patient morbidity related to invasive surgical interference, shorten the period of treatment, lessen costs, and reduce the requirement for cantilevered pontics. Furthermore, using them lessens the necessity for orthodontic treatment that could be needed to provide enough interdental space to accommodate traditional dental implants. Such restorations may also improve patient satisfaction and ease due to the elimination of detachable equipment and the possibility of improved mastication [20].

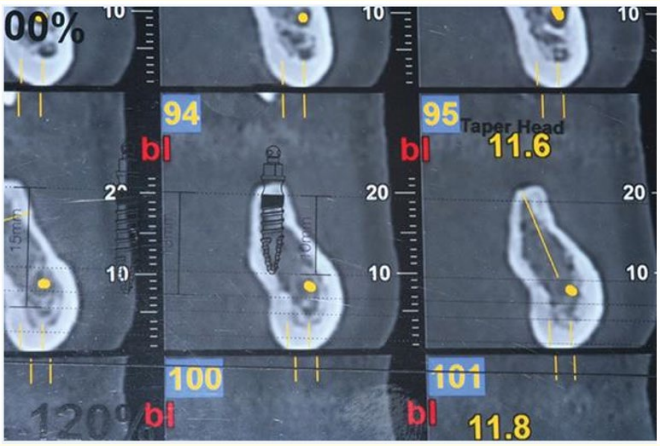

Figure 1: *Cone-beam computed tomography (CBCT) with mini-implant overlay (1:1) [20].*

Figure 2: *Two MDIs in the No. 19 and 20 positions [20].*

Figure 3: *Panoramic radiograph showing cemented two-unit splinted porcelain-fused-to-metal (PFM) mini-implant-supported fixed restorations (MISFR) for Nos. 19 and 20 3.5 years after cementation of final restoration [20].*

Removable prosthetics

Some of the treatment options available to patients without a posterior are the creation of conventionally designed removable partial dentures (RPD) held in place by clasps or exactitude attachments, implant-assisted removable partial dentures, or implant-supported fixed partial dentures. By migrating tissue wards throughout masticatory loadings, the free-end saddles of conventional RPDs put abutments in danger by applying rotational forces that might be detrimental. This accelerates the breaking down of the underlying bone [21,22].

Kennedy class I circumstances, which are frequently in the premolar locations, can be strategically improved to class III situations by putting standard dimension dental implants. As a result, the pressures are transferred more favorably, the direct retainer moves less adjacent to the edentulous area, and the periodontal ligament stress is reduced. The amount of free-end saddle movement is decreased since the implant bears the majority of the load. According to several studies, RPDs supported by teeth and implants are a dependable alternative with outstanding prosthesis and implant survival rates. In RPDs with implants placed distally (in the molar region), retentive clasps are typically observed on the front abutments. Implants can be situated more anteriorly and nearer to the abutment tooth to prevent the clasp and still retain the Kennedy class I situation [23-25].

Many people who have worn RPDs for a long time lack enough bone volume to install standard-dimension implants. The difficult and drawn-out procedure of bone augmentation is commonly rejected by patients. However, dental implants can be altered in size, and smaller implants can be inserted without bone augmentation in a small amount of residual ridge. Mini-implants (MDIs), which are known to be one-piece implants with a diameter below 2.5 mm, are the smallest and first group of small-diameter implants (category 1) [26].

It is to be known that due to the prosthetics' flexibility and ability to contact both soft as well as hard tissue undercuts, patients reported higher levels of pleasure. Additionally, RPDs constructed of flexible resins fall and feel more comfortable inside the mouth. Through the use of translucent, undetectable clasps on the abutment teeth, they further enhance the aesthetic criteria. Instead of separate support sites, flexibility allows for a more even distribution of masticatory forces, and for support and retention, they additionally touch the ridge undercuts in addition to the abutment tooth [27].

A favorable insertion path is selected, especially when there are undercuts in the soft and hard tissues, to maintain better tissue adaption, on the other hand, is seen as a difficult goal in flexible RPD. Furthermore, to compensate for their poor impact strength, flexible RPDs are designed larger than cast metal RPDs, making it harder to construct occlusal rests [28].

Discussion

The diameter of mini implants is between 1.8 to 7 mm. The small implant is a dental implant that consists of the same biodegradable material as standard dental implants but has a smaller diameter (less than 3 mm) and shorter length. The diameter of mini implants is less than 3 mm, whereas the diameter of narrow/conventional implants is more. Since the implant's smaller diameter enables placement in areas with little bone, using micro implants to preserve overdentures, helps the adoption of less complicated surgical procedures. These implants are related to quick stabilization, elevated rates of survival, lessened postoperative discomfort, better patient satisfaction, and improved quality of life [29].

MDIs are mainly used for denture stabilization. They have several benefits over traditional implants. The operation is less intrusive than traditional implant surgery, resulting in less morbidity for the patient. A single pilot drill can be used for transmucosal implantation, and these are frequently filled immediately. Gingival recovery normally takes about 2 to 5 days; a prolonged healing period with MDIs is usually unnecessary [30].

Mini dental implants are utilized on individuals who have clinical issues or circumstances that necessitate the use of a smaller diameter implant. The strength of the jaw support, bone thickness, surface stress distribution issues at the foundation, adequacy of retention, implant stability, and muscle and occlusal balance are some criteria that may affect the decision to use a micro dental implant. Researchers found that small-diameter implants are relatively inexpensive, easier, and quicker to install, create less bleeding, need quick healing, and require fewer or no surgical procedures. They are also easy to insert and remove [31].

Endosseous implants have a typical diameter ranging from 3.75 to 7 mm. If used on narrow ridges, bone grafting, ridge enhancement, and ridge expansion procedures are necessary. Treatments including bone grafting, ridge enhancement, and ridge expansion are labor-intensive and have questionable results. The cortical bone is primarily responsible for implant stability. However, investigations have revealed the production of trabecular bone in the transplanted region, with no indication of grafted bone maturation to cortical bone [32].

There are extremely small or "mini" diameter implants with sizes from 1.8 to 3 mm, as well as small diameter implants with dimensions ranging from 3.0 to 3.3 mm. People with little inter-radicular bone, thin ridges, or mesiodistal prosthetic space might consider mini-implants. For the more affordable stabilization of removable complete or partial dentures, several mini implants may be used. Mini-implants are seen in the fine ridges of edentulous or partly edentulous arches. Especially in the front maxilla, there is a reduced palato-labial bone width and/or insufficient interdental space [33].

The four anatomical regions of the mouth were found to have significant discrepancies in their bone densities in earlier studies; the anterior mandible produced the largest mean bone density value, followed by the anterior maxilla, posterior mandible, and posterior maxilla. Wood, polyvinyl chloride, and pig bone were used as test materials in several earlier studies [34,35].

It is to be mentioned that regardless of length or density, all microimplants moved to variable degrees after being inserted into the bone. A 10mm implant in 20pcf artificial bone displayed the maximum deflection when the lengths and densities were tested, whereas a 6mm implant in 40pcf artificial bone revealed the smallest deflection. With rising bone density (20pcf, 30pcf, and 40pcf), there was a steady decrease in deflection when length and diameter were maintained constant. All three short implant lengths (6 mm, 8 mm, and 10 mm) exhibit the same decreasing trend in deflections [36].

Furthermore, while maintaining the same implant diameter and bone density, there was a continuous rise in implant displacement with length (6 mm, 8 mm, 10 mm). This trend for deflection to rise as micro implant length rises is continuous throughout all bone densities (20pcf, 30pcf, and 40pcf). Studies on prosthetic implants by Cristache., *et al*. showed that the length of lengthier implants fluctuated during implantation. Shorter implants exhibited a lesser divergence than longer implants, according to research by Jan D'haese., *et al*. This difference can be attributed to the longer implants' larger apical deviation from drilling deeper into the bone at the same insertion angle. The mechanical characteristics of cortical bone and titanium alloy vary, which is one of the factors contributing to the small implant [37,38].

Many clinicians have been using MDIs for fixed applications successfully despite problems with their use, such as the possibility of implant fracture, their capacity to endure functional and parafunctional load, the degree of osseointegration that can be achieved within the mini implant, the necessity of clear clinical and laboratory processes, and the necessity for more long-term studies [39,40].

Preoperative planning attempts to incorporate as much diagnostic information as feasible. For 3D planning, a cone beam CT scan is recommended, particularly when there are small ridges, but a panoramic X-ray will do in most cases. Raising a flap or going flapless: A flapless transgingival approach for the pilot drill is feasible if the ridge is wide enough. However, it is advised to create a little flap (crestal incision) to reveal the bone when a thin ridge of thick soft tissue is present. This would make it possible to precisely position the implants in the bone at the right angulation [41].

The self-tapping threaded screw design of the micro dental implant system permits minimally invasive surgery. For good osteointegration and a high rate of success, the initial stability of the micro implant, which is reliant on the caliber of the bone, the configuration of the implant, and the surgical method utilized, is crucial. The face angulation of the maxillary implants, thick masticatory mucosa necessitating longer implant abutments, and disparallelism of the unpainted implants generating micro movements are all blamed for the failure of the small implant-supported maxillary detachable prosthesis [41,42].

The micro implant-supported overdenture's retention rings should be replaced regularly. The tiny dental implants are placed using a ratchet with a 35 N/cm torque. To prevent implant damage and overload-induced bone loss around the implants, it is crucial to frequently reline the small implant-supported detachable full prosthesis and execute occlusal changes for the best force and movement distribution. The steps involved in implant insertion are as follows: The skin just below the tongue is imprinted with the left and right mental foramens. A ridge 7 mm anterior to the mental foramen with a notation on it indicates the size of the most distal implant. This safety zone includes a potential anterior loop of 3 to 5 mm and a 2 mm security buffer [43-45].

Figure 4: *Implant position and removable partial denture [46].*

Conclusion

Mini dental implants can be utilized to support removable prostheses as well as fixed full and partial dentures. Anatomical sites, bone quality, cosmetic factors, and preventive occlusal designs all affect how well a treatment goes. In several modest investigations, the feasibility, predictability, and relative effectiveness of mini-implant treatment have been demonstrated. Here are a few basic suggestions for the use of micro-implants.

- The best bone sites for mini implants are Type I and Type II (Misch) bone sites.
- Thickness of the lingual and facial cortical bones must be at least 1 mm.
- Occlusal relief for fixed prosthesis of about 100 m.
- A basic, rounded occlusal table.
- 0.5 mm must be left between a tooth and a mini implant.
- A minimum of 6 small implants in the maxilla for detachable full dentures.
- 4 minimum tiny implants are required for detachable full dentures in Its mandible.
- For splinted fixed full prosthesis in the maxilla, a minimum of 10 tiny implants are required.
- For splinted fixed full prosthesis in the mandible, a minimum of 8 tiny implants are required.

- Fixed prosthesis with an occlusal design that protects implants.
- Prior to surgery, aesthetic requirements are addressed.
- Working die material made of polyurethane or another durable substance.
- An additional die separator may be recommended.

Case studies, retrospective data, or uncontrolled research provide support for the majority of the mini-implant findings. To further validate this therapy, randomized, controlled, prospective, longitudinal human studies are required.

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