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Original Research

Mini Implants in Orthodontics- A Review

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ABSTRACT:
In orthodontic treatment teeth are moved to desired position, during this movement some undesirable movement also occurs. To prevent such undesirable movement anchorage units are used. The introduction of skeletal anchorage in the form of temporary anchorage devices (TADs) or miniscrews has greatly benefited orthodontists in finding a way of anchorage control with minimum patient compliance and without a complicated clinical insertion and removal procedures. This article provides comprehensive information about Temporary Anchorage Devices (TAD's).
Keywords: Orthodontic Implants, mini implants, micro implants, Temporary anchorage devices, TAD's, Anchorage unit.

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INTRODUCTION

"Secure Anchorage" is the primary requirement for successful treatment of various malocclusions. conventionally, anchorage requirement for orthodontic tooth movement was provided by the teeth, extra oral and/or inter maxillary appliances.[2] These methods often have inadequate mechanical systems for anchorage control that leads to anchorage loss of reactive units and results in unfinished intra and inter arch alignment. As an effort to eliminate this limitation, bulky acrylic appliances or extra oral appliances were inter grated by various clinicians but it resulted in poor patient compliance that contributed to loss of anchorage.[3]

The incorporation of mini implants into orthodontic treatment planning has allowed for predictable anchorage control and has increased the ability to correct severe skeletal and dental discrepancies. There are two different types of anchorage: direct and indirect. Determining the type of anchorage that is more favourable depends on the following clinical or radiological factors: local bone quality, available space in particular for inter radicular insertion and mucosal thickness. Orthodontic mini implants have been designed to circumvent the limitations posed by restorative dental implants. These smaller bone implants are significantly less expensive, are easily placed and removed, and can be placed in almost any intra-oral region, including between the roots of the teeth.[4]

The skeletal Anchorage is Absolute anchorage which is achieved with the advent of mini-implants. With the use of Mini-implants for the anchorage, maximum anchorage is possible with the reduction in the unwanted side-effects. The osseointegrated implant (endosteal) was the first one to be used for the purpose of orthodontic anchorage. They worked well providing the orthodontic anchorage, but they have limited application in terms of orthodontic use. They were basically needed to be used in edentulous spaces, which were not available in routine orthodontic cases. The generally accepted protocol for successful and predictable placement of mini-implants includes atraumatic surgical technique, short healing period, biocompatible materials, and patient management. To encourage regeneration and osseointegration, rather than repair with fibrous encapsulation, a primary healing environment at the bone-implant surface should be created.[5]

HISTORY[8]

The idea of metal segments being screwed into the maxilla and mandible to upgrade orthodontic anchorage was first distributed in 1945, with the utilization of vitallium screws to impact tooth development in dogs. Notwithstanding some achievement, the resultant tooth development was restricted because of the implants loosening inside within a month of beginning tooth development. After twenty years, Linkow depicted the endosseous blade implant for orthodontic anchorage, yet didn't cover the long term stability. Vitreous carbon implants demonstrated a failure rate of 67 percent while going through orthodontic loading, and endeavors at utilizing Bioglass-covered ceramic implants for orthodontic anchorage were nearly as not satisfying. Although all the above materials were viable with bone, none of them indicated reliable long term attachment of bone to implant interface, which implies they didn't accomplish genuine osseo-integration.

TYPES OF ANCHORAGE[5]

The miniscrew implants can provide 2 different types of anchorage: direct and indirect anchorage means that they are connected through bars or wires to the reactive unit, whereas direct anchorage means that they directly receive the reactive forces by acting as an anchor unit.

Head Design

The most frequent is the button like design with a sphere or a double sphere like shape or a hexagonal shape. With a hole through the head or neck of the screw, usually 0.8 mm in diameter, this design is mostly used for direct anchorage. Further a bracket like design and a hook like design is also available which can be used both for direct and indirect anchorage.

Thread design

The thread body can be either conical as in miniscrew anchorage system or parallel tapering only at the end as in orthodontic mini-implant. They are available in different lengths but it is that suggested 4 to 6 mm as safe in most regions. Most miniscrew implants have a thread diameter ranging from 1.2 to 2.0 mm and a length from 4.0 to 12.0 mm although some of them are also available at lengths of 14 or even 21 mm.

CLASSIFICATION[6]

Implants can be broadly classified under the following:

BASED ON THE LOCATION

Subperiosteal

In this design, the implant body lies over the bony ridge. This type has had the longest history of clinical trials but a decreased long-term success rate; probably due to the fact that the chances of getting it dislodged are high. Also, the complexity of their designs requires a precise casting procedure. The subperiosteal design currently in use for orthodontic purposes is the 'Onplant'.

TRANSOSSEOUS

In this particular variety, the implant body penetrates the mandible completely. These have enjoyed good success rate in the past. However, they are not widely used because of the possible damage to the intrabony soft tissue structures, like the nerves and vessels. Even in the field of orthodontics, transosseous implants have not been used.

ENDOSSEOUS

These are partially submerged and anchored within bone. These are the most popular and the widely used ones. Various designs and compositions are available for usage in specific conditions. The endosseous implants are also the most commonly employed types for orthodontic purposes. Based on the Configuration Design Root form implants: These are the screw type endosseous implants and the name has been derived due to their cylindrical structure.

SCREW DESIGNS
THESE INCLUDE:

1. Dentos absoanchor implant system
2. Aarhus implant
3. Spider screw, the OMAS system, the Leone miniimplant.

BLADE/PLATE IMPLANTS PLATE DESIGNS
THESE INCLUDE:

1. Skeletal anchorage system (SAS).
2. Graz implant-supported system.
3. Zygoma anchorage system.

ACCORDING TO THE COMPOSITION

- Stainless steel
- Cobalt-chromium-molybdenum (Co-Cr-Mo)
- **TITANIUM:**

– Alpha
– Beta
– Alpha-Beta phase (most commonly used)
– Ti-6Al-4V

- Ceramic implants
- Miscellaneous, such as vitreous carbon and composites.

ACCORDING TO THE SURFACE STRUCTURE

- Threaded or Non threaded

The root form implants are generally threaded as this provides for a greater surface area and stability of the implant.

- Porous or Nonporous

The screw type implants are usually nonporous, whereas the plate or blade implants (non threaded) have vents in the implant body to aid in growth of bone, and thus, a better interlocking between the metal structure and the surrounding bone.

CONTRAINDICATION

- Absolute Contraindications
- Severe systemic disorder, e.g. osteoporosis
- Psychiatric diseases, e.g. psychosis dysmorphia
- Alcoholics and drug abusers. Relative Contraindications
- Insufficient volume of bone
- Poor bone quality
- Patients undergoing radiation therapy
- Insulin dependent diabetes ï Heavy smokers.

PLACEMENT SITES[7]

Miniscrews are used in place of traditional appliances such as headgear and lingual arches in cases where absolute anchorage is necessary. From a biomechanical standpoint, miniscrews allow more bodily tooth movement during space closure by placing the force vectors closer to the center of resistance of the teeth. The sites most often utilized for MAS insertion in the maxilla include:

- **Infrazygomatic Crest Area Recommended microimplant size**: Diameters of 1.3 and 1.4 mm and a length of 5 to 6 mm.
- **Maxillary Tuberosity Area Recommended microimplant size:** Diameters of 1.3 and 1.5 mm and a length of 7 to 8 mm.
- **Between the Maxillary First Molar and Second Premolar Buccally Recommended micro implant size:** Diameters of 1.3 and 1.6 mm and a length of 6 to 7 mm.
- **Between the Maxillary First Molar and Second Premolar Palatally Recommended microimplant size:** Diameters of 1.3 and 1.6 mm and a length of 10 to 12 mm.
- **Mid-Palatal Area Recommended microimplant size:** Diameters of 1.5 and 1.8 mm and a length of 5 to 6 mm.
- **Mandible Retromolar Area Recommended microimplant size:** Diameters of 1.4 and 1.6 mm and a length of 5 to 10 mm.
- **Between the Mandibular First Molar and Second Premolar Bucally Recommended microimplant size:** Diameters of 1.3 and 1.6 mm and a length of 5 to 7 mm.
- Extraction spaces In our experience, the most useful locations are the interradicular spaces, either buccal or lingual, between the second premolars and first molars in both arches, or the buccal space between the upper lateral incisor and canine.

SELECTION OF MINI-IMPLANT SIZE[7]

The diameter of the miniscrew will depend on the site and space available. In the maxilla, a narrower implant can be selected if it is to be placed between the roots. If stability depends on insertion into trabecular bone, a longer screw is needed, but if cortical bone will provide enough stability, a shorter screw can be chosen. The length of the transmucosal part of the neck should be selected after assessing the mucosal thickness of the implant site.

PLACEMENT PROTOCOL[7]

1. After the local anesthetic is applied, the assistant washes the implant area with .02% chlorhexidine.
2. In case of non–self-drilling miniscrew implants, a pilot hole is necessary. Pilot drilling should be done in asurgical environment. Firstly, soft tissue from the site of the placement is either incised or removed using a soft tissue punch. Thereafter, a pilot hole is drilled using a drill rotating no more than 1000 rpm. The pilot drill is usually 0.2 to 0.3 mm thinner than the miniscrew implant. The miniscrew implant is then screwed in place by using an appropriate screwdriver.

In case of self-drilling miniscrew implants, no incision or soft tissue removal is necessary. Infection control is similar to that for an extraction. After selecting the appropriate site, the miniscrew implant, and the corresponding site of placement, it is inserted in place. (preferably between the free and attached gingival)

3. When properly placed, the screw head will protrude through the soft tissue. Once the initial stability of the miniscrew has been confirmed, an orthodontic force of 50-250g can be applied immediately. The head of the miniscrew has been designed to prevent compression of the mucosa, but if this occurs after placement of a chain or nickel titanium coil spring, we suggest using Monkey Hooks instead.

APPLICATIONS[7]

Defining specific indications where orthodontic mini-implants can successfully be used has 2 potential benefits. First, using mini-implants appropriately will lead to improved treatment results. Second, not using them when traditional mechanics could lead to equally satisfying results prevents overtreatment. However, because of the versatility of mini-implant– enhanced mechanics, some situations that could be resolved with traditional mechanics might be treated in a shorter time or at least with a more predictable outcome. The following treatment objectives might benefit from mini-implants:

- **CLOSURE OF EXTRACTION SPACES**

Maxillary titanium screws can be used as anchorage for distal retraction of the anterior teeth, whereas mandibular titanium screws can be used to apply uprighting and intrusive force to the mandibular posterior teeth and for vertical control of the mandibular posterior teeth.

- **SKELETAL CLASS II CORRECTION**

Severe skeletal Class II malocclusion can be treated using miniscrew anchorage rather than traditional orthodontic mechanics of headgear and transpalatal arch.

- **MAXILLARY PROTRACTION FOR CORRECTION OF CLASS III MALOCCLUSIONS**

Maxillary hypoplasia in patients with Class III malocclusion can be corrected with the use of Class III elastics between miniplate skeletal anchorage in both jaws (bone anchored maxillary protraction which showed significant maxillary and zygomatic protraction).

- **OPEN BITE AND LARGE LOWER ANTERIOR FACIAL HEIGHT**

A skeletal Class II anterior open bite and a large Frankfort mandibular plane angle can be corrected by nonsurgical treatment combined with TADs which showed molar intrusion with TADs followed by forward rotation of the mandible leading to anterosuperior movement of the soft tissue menton. thus contributing to correction of the open bite and improvement of the soft tissue profile.

- **GUMMY SMILE AND FACIAL PROFILE CORRECTION**

The placement of a single miniscrew between the roots of the maxillary incisors, providing direct anchorage for incisor intrusion toreduce excessive gingival display. Miniscrews for intrusion of incisors are placed between the roots of the anterior teeth.

- **CORRECTION OF A CANTED OCCLUSAL PLANE**

Patients with facial asymmetry have canted occlusal planes caused by unilaterally extruded maxillary molars or asymmetric mandibular vertical development. TADs can be used to change canted occlusal plane by either intrusion of extruded molars or extrusion of intruded molars.

- **MANAGEMENT OF PALATALLY IMPACTED CANINES**

Management of palatally impacted canines requires surgical and orthodontic interventions. Skeletal anchorage is required if we were to move only impacted teeth before fixed-appliance orthodontic treatment onset.

- **PREPROSTHETIC MOLAR UPRIGHTING USING SKELETAL ANCHORAGE**

The second molar may tip mesially after extraction or loss of a first molar, into the edentulous space. Mini-implant can be used in an dentulous first-molar site as anchorage for uprighting amesially tipped second molar.

- **MINISCREW FOR MOLAR DISTALISATION**

The miniscrews provide sufficient anchorage for incisor retraction in Class II treatment without unwanted orthodontic side effects. Miniscrew anchorage not only prevents flaring of maxillary incisors, an undesirable side effect of molar distal movement.

- **UPPER THIRD MOLAR ALIGNMENT**

An upper third molar can be uprighted with a fixed sectional wire, utilizing a palatal miniscrew for skeletal anchorage to limit unwanted extrusion of the molar.

- **ALIGNMENT OF DENTAL MIDLINES**

When an entire arch needs to be moved laterally to correct the posterior malocclusion a screw can be placed either lingually or buccally so that the head stands out at the crown margins to align the dental midlines without exerting vertical forces as exerted by intermaxillary elastics.

COMPLICATION IN TAD'S

Implants should be placed in the inter-radicular bone between teeth. Trauma to the periodontal ligament or the dental root during insertion can lead to ankylosis, loss of vitality or osteosclerosis

- Miniscrew slippage: The clinician might fail to fully engage cortical bone during placement and inadvertently slide the miniscrew under the mucosal tissue along the periosteum
- Nerve involvement: Nerve injury can occur during placement of miniscrews in the maxillary palatal slope, the mandibular buccal dentoalveolus, and the retromolar region. Most minor nerve injuries not involving complete tears are transient with full correction in 6 months
- Air subcutaneous emphysema
- Nasal and maxillary sinus perforation
- Miniscrew bending and fracture during insertion
- Aphthous ulceration due to tissue irritation
- Soft tissue coverage of the miniscrew head and auxiliary
- Soft tissue inflammation, infection and peri-implantitis
- Miniscrew fracture during removal.

LONG-TERM STABILITY OF MINI-IMPLANTS[12]

Miyawaki et al analyzed the success rate of 3 different screw sizes and a miniplate design. Their sample consisted of 51 patients who had 134 different implants used for conserving anchorage. The implants were in the form of screws (134 in number) of 1.0, 1.5 and 2.3 mm diameter as well as 17 miniplates. On 1 year after placement, they drew the following conclusions:

- The implant screws of 1 mm diameter had a high failure rate and are not recommended for clinical use as orthodontic anchors.
- Implant screws of 1.5 and 2.3 mm diameter had reasonable success rates—84 and 86% respectively, and therefore could be used in majority of the cases.

- The miniplates had the best stability (96%), but the surgical intervention and patient discomfort was greater when compared to miniscrews. Miniplates have been recommended in high angle patients.
- Peri-implant hygiene is one of the major factors which could affect the stability of these implants.

REASONS FOR MINI-IMPLANTS FAILURE[10]

- Interdental alveolar bone crests are flexible and deformable. For this reason, they have little mobility to offer and may not provide the ideal absolute anchorage. The more cervical the structures, the more delicate they are, thus offering less mechanical interlocking for mini-implant placement.
- Alveolar bone crests of triangular shape are more deformable, whereas those of rectangular shape are more flexible.
- The bases of alveolar processes of the maxilla and the mandible are not flexible, for this reason, they are more likely to receive mini-implants.
- The more cervical a mini-implant is placed, the higher the risk of loss. The more apical a miniimplant is placed, the better its prognosis will be.
- Before mini-implant placement, it is advisable that a 3D analysis be carried out on the site by means of periapical radiographs, particularly by bisection and interproximal techniques, and occlusal radiograph with periapical film. Volumetric computed tomography with its several evaluation slices may replace conventional radiography.

CONCLUSION

Osseointegrated implants can now be used as absolute anchorage units in orthodontics. They are very useful in cases were the compliance of patient is poor. The continuing development of orthodontic implants has led to the production of smaller designs which are easy to insert and remove, and do not require a long healing period prior to loading. In the future, as developments occur in implant technology, they may have a significant role as anchorage reinforcement aids and make headgear obsolete. However, there is a need for high quality research in this area.

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