REVIEW ARTICLE

Mini Screws in Orthodontics: An Insight

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ABSTRACT

One of the goals of any orthodontic treatment is to achieve desired tooth movement with a minimum number of undesirable side effects. Intra oral anchorage savers such as Transpalatal arch, Nance holding arch were introduced. These appliances do help in reinforcing the molars; however, their worthiness in providing absolute anchorage is doubtful. In orthodontic treatment mechanics we often have inadequate mechanical systems to control anchorage, which leads to anchor loss of reactive units and often lead to incomplete correction of Intra and inter-arch alignment procedures. Moreover, an attempt to overcome these limitations, clinicians often incorporates bulky acrylic appliances or extra-oral appliances. These extra-oral appliances can overcome the limitations of intra oral anchorage systems but have their own limitations like patient compliance, the increasing demand for orthodontic treatment methods requiring minimal compliance and maximal anchorage control has led to the exploration of temporary anchorage devices.

KEYWORDS: Anchorage, mini implants, mini screws, temporary anchorage devices

INTRODUCTION

The goal of any orthodontic treatment is to achieve desired tooth movement with a minimum number of undesirable side effects. Anchorage is one of the important factors for the treatment of dental and skeletal malocclusion with fixed appliances and is a critical factor in determining the success of orthodontic treatment. The difficulty in establishing a stable anchorage system has always been a great concern to the orthodontist because the success of orthodontic treatment generally relies on anchorage protocol planned for that particular case.

HISTORICAL BACKGROUND

Skeletal anchorage was suggested more than 50 years ago as an alternative to achieve conventional anchorage. Gainsforth and Higley [1] used vitallium screws and stainless steel wires in dog mandibles to apply orthodontic forces in the ramus of the mandible, secure a spring that was used for distalization of maxillary canine. However, the application of force resulted in screw loss with in 16 to 31days. Per Ingvar Branemark [2] was using specially designed optical titanium chambers to study the intravascular dynamics of bone marrow circulation by transillumination in vivo. Bone grew into the thin spaces in the titanium and could not be easily removed. Based on these and other findings by the Branemark et al. he advocated a healing time of 4 to 6 months before functional loading because function allowed some minor movements, which permitted fibrous tissue growth and subsequent failure. Linkow [3, 4] used mandibular blade-vent implants for applying class II elastics, and he used an implant as a substitute for a missing molar which was then used as an anchor tooth. He subsequently used the implants as bridge abutments to complete the patient's treatment. Sherman[5] used six vitreous carbon dental implants at the extraction sites in dogs and used them for the application of orthodontic forces. Smith [5] performed animal studies to study the effects of loading bioglass-coated aluminum oxide implants and reported no significant migration of the implants during force application. Creekmore et al. [6] evaluated that a small sized vitallium bone screw could withstand a constant force of adequate magnitude over a long period of time for retraction of the entire anterior maxillary dentition. He used a vitallium screws inserted just below the anterior nasal spine to treat a patient with a deep impinging overbite. Block and Hoffman [7] developed and introduced the first Onplant for orthodontic anchorage, which is a classic example of a subperiosteal implant consisting of a thin circular titanium disc disk (2mm high & 10mm in diameter); made of textured and coated with a hydroxyapatite (HA) on one side and with an internal thread on the other side. Roberts et al. [8, 9] evaluated osseous adaptations of rigid endosseous implants to continuous loading for six to twelve weeks after placing titanium screws in rabbit femurs, a 100 gms force were loaded for 4 to 8 weeks by stretching a spring between the screws. All except 1 of 20 implants remained rigid. Titanium implants developed osseous contact, and continuously loaded implants remained stable. The results indicated that titanium implants provided firm osseous anchorage for orthodontics and dentofacial orthopedics.

How to cite this article:
Sri Ram Reddy H, Reddy YM, Cherukuri S, Reddy BV, Praveen Raj GK, Reddy BR. Mini Screws in Orthodontics: An Insight. Int J Oral Health Med Res 2017;3(5):98-102.

Ryuzo Kanomi [10] reported that 1.1mm diameter and 5-7 mm length titanium mini-implants provided sufficient anchorage and could be used successfully for anterior intrusion and retraction, and molar intrusion. Branemark [11] introduced surgical anchorage system using titanium miniscrew implants and coined the term cortical anchorage. Food and Drug Administration finally cleared the use of titanium screws for anchorage, and, by 2005, 10 to 16 miniscrew systems were available on the US market.

BASIC COMPONENTS OF A MINI SCREW

A screw is a simple machine that converts rotational motion into translatory motion while providing a mechanical advantage. Generally, a screw has three basic components:[12]

- Core
- Helix
- Head

1. Head: Serves two purposes, to provide a means for applying twisting torque to the core and thread and to act as an application point of force
2. Core: Forms the support of the screw, is attached to the head and is wrapped in the helical thread. The cross sectional area of the core called the root area of the screw determines the torsional strength of the screw.
3. Shank is the part of the screw that extends from the head to the start of the threads. The adjacent spaces present between the threads are called pitch.
4. The lead of the screw refers to the distance that the screw will advance with each turn. In a screw with a single thread, the pitch will equal the lead.

IMPLANT POSITIONING AND PLACEMENT

Optimal positioning has always been critical to the effectiveness of dental implants. The choice of location depends on the initial diagnosis, the purpose of the implant therapy, the proximity of adjacent structures such as the mandibular nerve, maxillary sinus, and aesthetic factors. Therefore, to determine the optimal position and suitable insertion direction of mini-implants, different methods have been used, including radiographs, computed tomography (CT), cone beam CT, and dental CT scans.

Safe zones for insertion of mini screws into maxillary and mandibular arch: Kim et al. [13] did a study using volumetric topographic images evaluating the thickness of bone in the interradicular areas and concluded the following order of safer sites available in the interrradicular spaces. Selection of interradicular insertion sites is determined by three factors: biomechanics of chosen appliance, patient's anatomy and dimensions of mini-implant.

In the posterior maxilla:

- The interradicular space present between the maxillary first molar and second premolar, on the palatal side is 2-8 mm from the alveolar crest.
- The interradicular space present between the maxillary second and first molars, on the palatal side is 2-8mm from the alveolar crest
- Between the second and first premolar, both on the buccal or palatal side should be between 5-11mm from the alveolar crest.
- Between the first premolar and canine, both on the buccal or palatal side should be between 5-11mm from the alveolar crest.
- The interradicular space between the first molar and second premolar, on the buccal side should be 5-8 mm from the alveolar crest.
- The location becomes safer in the maxilla, the more anterior and the more apical the implant is placed or inserted.

In the posterior mandible:

- Interradicular spaces between the second and first molar and pre molar should be 11mm from the alveolar crest.
- Interradicular spaces between the first molar and second premolar should be 11mm from the alveolar crest. Whereas, the same for the first premolar and canine.

These areas represent a guide for orthodontist's but a radiographic interpretation in each individual case should be must before miniscrew insertion.

Ludwig et al. [14] in his cross sectional study recommended placing the screws as apically as possible in the attached gingiva. From mesial to distal, roots generally diverge apically, thus determining the available spaces. The amount of bone width can be calculated in any patient by adding the screw diameter plus two times a width of .5mm for bone on either side and an additional two times .25mm to respect the periodontium for successful implantation. This information can reduce the risk of loss or failure in mini-implant anchorage treatment.

CLINICAL APPLICATIONS OF MINI SCREWS

Miniscrews or Mini-implant as a source of anchorage in orthodontic procedures is an excellent for adjunctive tooth movements like en masse anterior retraction, molar distalization or mesialization, molar intrusion or extrusion; correction of canted or tilted occlusal plane and vertical control.

Stationary Anchorage control in space closure: The use of miniscrew anchorage provides a good control for closing space present from extracted or missing teeth or created as a result of molar distalization in orthodontic treatment procedures

Use of microimplant anchorage with sliding mechanics:

The center of resistance of the six anterior teeth was estimated to be midway between the center of resistance of the four incisors and canines. By using an upward and backward force passing near the center of resistance, the maxillary anterior teeth showed bodily intrusion and retraction.The occlusogingival position of mini screw implants determines the force direction so that the retraction of the anterior teeth can be controlled.

The second factor capable of changing the direction of the force is the vertical position of the anterior hooks. For example, the use of short anterior hooks would increase the vertical component and decrease the horizontal component of the force and vice versa. For bodily retraction of the anterior teeth with a slight intrusion, the proper position of the maxillary mini screw implants was 8-10mm apical to the bracket slot with the anterior hooks 5-6mm gingival to the bracket slot. As the force will pass just under the center of resistance and induce bodily retraction with only slight intrusion and linguoversion.

Effect of mini screw implants for open bite correction: For openbite correction, Hyo-Sang Park et al. [16] have used the micro implants. He treated a Class II case with a high mandibular plane with an open bite as extraction of the maxillary first premolars and the mandibular second premolars and mini screw implants for anchorage control. As the mandibular molars move forward, the fulcrum on the terminal molars could be moved forward thus closing the mandibular plane. Mini screw implants can be used to control the amount of tooth movement anteroposteriorly.

Maxillary micro implants (8mm long, 1.2mm in diameter) were placed into interradicular bone between the maxillary first molars and the second premolars, and the mandibular implants (6mm long, 1.2mm in diameter) were placed into the cortical bone of the mandibular arch between the first and second molars. The maxillary mini screw implants can provide anchorage for retracting anterior teeth and simultaneously intruding posterior teeth, and mandibular mini screw implants can prevent mesial tipping during space closure. Mini screw implants provide good anchorage to control open bite.

Effect of the maxillary and mandibular mini screw implants in retraction of the maxillary anterior teeth and vertical control of the mandibular molars: Park HS [17] treated a class II div 1 case with a large overjet, lip protrusion, mandibular retrusion, dolicofacial pattern with a high mandibular plane angle with an extraction of maxillary first premolars and orthodontic treatment with the aid of mini screw implants .The maxillary mini screw implants (1.2mm in diameter, 6mm long) were placed between the maxillary second premolar and first molar in the alveolar bone. Pre-adjusted 0.022 inch appliances were used, and forward movement is prevented by the tiebacks from the mini screw implants to the canines. After alignment of the anterior teeth, a 0.016X0.022 inch stainless steel archwire with anterior hooks was inserted, and a 150gms force was applied on each side with NiTi coil springs. As the anterior teeth have retracted, the overjet was minimized.

Mandibular second premolars were extracted, and the mandibular mini screw implants (1.2mm in diameter, 6mm long) were placed in the alveolar bone between the first and second molars for the vertical control of the mandibular molars during space closure. The facial profile showed remarkable improvement, and the remaining extraction space closed in a short period of time

Group distal movement of teeth using mini screw implant anchorage: Hyo-Sang Park, Soo-Kyung Lee and Oh-Won Kwon [17] performed a clinical study to evaluate the treatment effects of distalization of the maxillary and mandibular molars using mini screw implants. The success rate and clinical considerations in the use of the mini screw implants were also evaluated. Thirteen patients who had undergone distalization of the posterior teeth using forces applied against mini screw implants were selected. Among them, eleven patients had mandibular mini screw implants, and four patients had maxillary implants, including two patients who had both maxillary and mandibular ones at the same time. The maxillary first premolar and first molars showed significant distal movement with no significant distal movement of the anterior teeth. The mandibular first premolar and first and second molars showed significant distal movement, but no significant movement of the mandibular incisor was observed. The mini screw implant success rate in this study was 90% over a mean application period of 12.3+/-5.7months. The results support the use of the mini screw implants as an anchorage for group distal movement of the teeth.

Distalization appliances tend to open the mandibular plane by moving the molars distally'. Whereas mini-screw implants did not open the mandibular plane in distalizing the molars rather it closed the mandibular plane compared to the conventional distalization method. The intrusive component of force prevents the opening of the mandibular plane. The intrusive component of-of applied force can be determined by the vertical position of the mini screw implant head, where the elastic material is connected.

Mini screws used up righting molar: Greco et al. [18] presented a simple, quick, and esthetic option for second-molar uprighting using a single miniscrew for anchorage, in an adult patient with a missing lower left first molar. A miniscrew (12mm × 1.3mm Spider Screw) is placed in the retromolar area, about 5mm distal to the mesially inclined second molar. Buttons were bonded to the labial, lingual, and mesial surfaces of the second molar. Three short lengths of elastic chains connected to a stainless steel ligature and tied to the miniscrew head. Free ends of the elastic chain segments (the G-Chain) are attached to the bonded buttons

The intrusion of over-erupted teeth: In the past, intrusion of over-erupted teeth was practically impossible. The use of miniscrew anchorage allows convenient intrusion of these problematic teeth. Ishihara[19] had indirectly used implants and successfully treated over

erupted mandibular incisors in an adult patient with a Class II Division 1 malocclusion, a deep overbite, and an excessive mandibular curve of Spee by using miniscrew anchorage and segmented wires.

Miniscrew assisted palatal expansion: One major problem with rapid or slow expansion is considerable dent alveolar movements associated with the procedure; Lee et al. [20] demonstrated miniscrew assisted rapid palatal expansion (MARPE) was fabricated with some modification of the conventional RPE. An impression was made with the bands on the first premolars and first molars, and a conventional hyrax expander was constructed on the cast. Four rigid connectors of stainless steel wire with helical hooks were soldered on the base of hyrax screw body. Two hooks were positioned on the rugae region, and the other 2 posterior hooks were placed on the parasagittal area. The hooks were adjusted for passive contact with the underlying tissues. The MARPE was then placed and cemented on the patient's first premolars and molars. Orthodontic miniscrews (Orlus, Ortholution, Seoul, Korea) with a 1.8-mm collar diameter and a 7-mm length were placed in the center of the helical hooks under local infiltration anesthesia. The wires were adjusted to maintain passive contact with the collar of the miniscrews

Biodegradable implants for orthodontic anchorage: If the alloplastic implant is individually used for anchorage purposes, it has to be removed in a secondary operation at the conclusion of orthodontic treatment. A stable positioned implant which could consider a stationary anchorage function for an adequate period but could then be readily removed or, preferably resorbed within the tissues. Based on this objective, bioresorbable implant anchor for orthodontics system (BIOS) was developed by Glatzmaier et al. [21] made of biodegradable polylactide alpha-polyester This material remains stable for 9-12 months and is then degraded.

The resorbable implant body was produced by injection fashion and sterilized using ethylene oxide. The dimensions and design of the biodegradable implant with respect to the external thread were derived from an ITI-Bonefit screw implant (Straumann, Waldenburg, Switzerland) with a fixture of 6 mm length which has the advantage of reducing the number of instruments required for implantation, as BIOS-implants can thus be inserted with conventional instruments, making use of well-tried surgical techniques. The implants were screwed into delrin block polymerisate test pieces into which threads had previously been cut with the Bonefit instruments, according to the. Clinical procedure. The loading capacity of the BIOS implant was found to be adequate for clinical application in orthodontics as forces of this size are not required in orthodontic tooth movement.

COMPLICATIONS OF ORTHODONTIC MINI SCREWS

The risks associated with miniscrew placement should be clearly understood by both the clinician and the patient.[22]

Complications can arise during miniscrew placement and after orthodontic loading that affects solidity and patient safety.

Complications arecategorized into three categories.

- *Complications during insertion*
- *Complications during orthodontic loading*
- *Soft tissue complications*
- *Complications during removal*

Complications during insertion :

- Trauma to periodontal ligament or dental root
- Miniscrew slippage
- Nerve involvement
- Nasal and maxillary sinus perforation:
- Miniscrew bending, fracture, and torsional stress

Complications during orthodontic loading:

- Stationary anchorage failure
- Miniscrew migration

Soft tissue complications :

- Aphthous ulceration
- Soft tissue inflammation, infection, and implantitis

Complications during removal :

- Miniscrew fracture
- Partial osseointegration

CONCLUSION

In conclusion, the incorporation of dental implants into dental treatment plans has had a tremendous impact on virtually the entire field of dentistry. They represent a viable alternative for orthodontics in obtaining maximum dental movement. Thereby, it does not only allow to challenge the Newton's third law and carry out orthodontic actions without reaction - which was one of the greatest worries of orthodontist throughout the history - but it also facilitates many usually very difficult treatments, such as molar intrusion, uprightness distalization, and protraction. Because of the reduced size, low costs and especially, lack of necessity of the patient's cooperation and the fact that they do not jeopardize aesthetics, mini-implants can be inserted in many different spots, making innumerable clinical application possible and being demanded increasingly at orthodontic clinics.

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Source of Support: Nil
Conflict of Interest: Nil