Mini implants in Orthodontics - A concept Review

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ABSTRACT

Anchorage preparation has been a perennial problem in fixed orthodontic treatment and the success of orthodontic treatment depends on proper treatment planning and conservation of anchorage. Conventional anchorage systems like Trans palatal arch and Nance palatal arch have been using intra-oral sites to obtain anchorage and are not effective in controlling anchorage in all three planes of space. Extra oral devices like Head gear are dependent on patient compliance and have inherent limitations. The orthodontist can use Mini- implants as a part of the fixed appliance therapy used to obtain either direct or indirect for anchorage. This article gives an overview of the implant systems used in orthodontics, their indications, clinical management and of implants used in orthodontics, their potential complications and limitations.

Key words: Anchorage, Orthodontic Mini implant, Mini screws.

Introduction

Anchorage preparation has always been a challenge in fixed orthodontic treatment and attempts were frequently made in developing an anchorage system that will offer absolute anchorage. The concept of metal components being screwed into the maxilla and mandible to enhance orthodontic anchorage was first published by Linkow in 1945 with the use of Vitallium Screws. In 1969, Branemark developed Titanium endosseous implants with long term success, which became a major influence in field of oral implantology and prosthodontics Since then Implants made of titanium have been widely used by several orthodontists to obtain absolute Anchorage. Among several implant types available endosseous Mini-implants of screw were frequently used in orthodontics because of their reduced size.

The major disadvantage of using Titanium endosseous Implants to obtain orthodontic anchorage was the difficulty in removing the implant after orthodontic treatment due to the osseoingeration. Osseointegeration is not required in Orthodontic Mini-Implants when used exclusively for anchorage purpose as these Implants are meant to be removed at the end of fixed orthodontic treatment. Osseointegeration of the implants to the bone may render removal difficult or impossible.[1] Hence stainless Implants or titanium Implants surface treated to disencourage Osseointegeration and Mini plates were developed and recommended for orthodontic use. These Orthodontic Mini-implants offered absolute anchorage with a low cost and a comparatively simpler technique for easy placement, and removal.

Absolute anchorage during orthodontic treatment may be obtained with these Mini-implants and Miniplates placed in various intraoral sites with thick cortical bone and dense trabecular bone. The use of Mini implants have increased the scope of corrections that can be achieved by orthodontics in all three planes of space from simple anterior intrusion or retraction to protraction or retraction of posterior teeth, molar distalisation, uprighting and intrusion.[2]

The success of the mini implant anchorage is dependent on understanding the mini-implant system, the anatomical structures of the sites in which they are being placed, indications and contraindications, the placement technique , the factors affecting the stability and biomechanical principles involved in construction of a precise force system to obtain the necessary changes.

Classification of Implants

Implants used in orthodontics can be broadly classified based on the location and area in which they are placed, their morphology, surface characteristics and methods used for placement of the implants. (Table 1, 2, 3 4 &5) of the various types present endosseous screw type, non porous implants made of stainless steel or titanium is the most commonly used implant in orthodontics.[3]

Table 1. Classification of Implants based their location in the bone

Subperiosteal Implants	Subperiosteal implants lie below the periosteum over the bony ridge. These type of implants have reduced long-term success rate, due to the fact that they lie above the cortical plates and are not threaded to the bone. The chances of getting dislodged are high and the stability is dependent on the surface area and the osseointegeration of the implant to the underlying cortical bone. The Subperiosteal design currently in use for orthodontic purposes is the Palatal Onplant primarily used along with TPA for obtaining indirect anchorage.
Transosseous Implants	Transosseous implants penetrate the bone through and through encaging both the cortices completely. These implants enjoy good success rate however they are not widely in orthodontics because of the possible damage to the vital structures like the nerves, vessels, dental roots and maxillary sinus.
Endosseous Implants	These are partially submerged and anchored within bone encaging the cortex and the cancellous bone. These have been the most popular and the widely used implants in orthodontics. Various designs, sizes and composition are available for usage in specific conditions.

Table 2. Classification of Implants based on their configuration

Root form Implants	These are the screw type endosseous implants with the head, neck and an endosseous portion with threads. The name root form has been derived due to their cylindrical structure.
Blade /plate Type Implants	The mini plate type Implants are derived from the blade type prosthod0ntic implants and the miniplates used in oral surgery for bone platings. The miniplates used in orthodontic have hooks for the engagement of power elements.

Table 3. Classification of Implants based on their composition

1.	Vitallium
2.	Stainless steel
3.	Cobalt Chromiun Molybdenum (Co Cr Mo)
4.	Titanium -Alpha -Beta -Alpha- Beta phase -Ti -6Al -4V
5.	Ceramic Implants
6.	Vitreous carbon & composites

Table 4. Classification of Implants based on their surface charectistics

Threaded	The root form implants are generally threaded as this provides for a greater surface area and stability of the implant.
Non threaded	Non threaded implants are limited to their use in prosthetic dentistry, not used in orthodontics.
Porous	Porous Implants have vents in the implant body to aid in growth of bone and thus a better interlocking between n the metal structure and the surrounding bone during osseointegeration. They are not commonly used in orthodontics, Palatal onplants and retromolar implants are the only systems in orthodontics that are dependent on osseointegeration for stability.
Non porous	Most of the orthodontic implants are non porous, and are surface treated by elecropolisning to disencourage osseointegeration.

Table 5: Classification of mini implants according to the type of drill used

Self-tapping method:	In this method, the miniscrew is driven into the tunnel of bone formed by drilling, making it tap during implant driving. This method is used when we use small diameter miniscrews.
Self-drilling method:	Here, the miniscrew is driven directly into bone without drilling. This method can be used when we want to use larger diameter (more than 1.5 mm) miniscrews.[4,5]

Parts of an Implant

The commonly used implant screw/plate has three parts the head, neck and the body. Implant head is the supraginival portion of the implants which serve as the source of attachment for force elements like elastics or coil-springs. Neck of the implant is the transgingival portion of the Implant which is embedded in the gingiva and the Implant body is the endosseous parts embedded inside cortical and cancellous bone. The endosseous portion is the one which is threaded into the bone and its design plays an important role in the e retention and stability of the implant.

Mini-implant site and location

Various intraoral sites are available for the placement of orthodontic mini-implants including interdental alveolar bone. In the Maxilla the possible insertion sites for placement of Implant includes the area below the nasal spine, the palate, the alveolar process, the infrazygomatic crest and the retromolar area. In the mandible the implants can be inserted in the alveolar process, retromolar area and the symphysis.

Mini-Implant size selection

The mini-implant size depends on the quality and quality of the bone and soft tissue thickness in the site in which the mini-implant is indicated to be used. The stability of the implant depends on the surface area of the implant that is in contact with the bone, greater the surface area better the stability hence longer and greater diameter implants are preferred if the quantity of bone available is adequate. The major concern is not to injure the vital structures like dental roots, neurovascular bundles and maxillary sinus during the placement of implant. A minimum of 2 mm clearance is required between the mini-implant and the vital structures as mini-implants do move under orthodontic forces. If the thickness of the cortical bone at the insertion site is less and the stability is dependent on insertion into trabecular bone a longer screw is needed, but if cortical bone thickness is adequate and will provide enough stability, a shorter screw can be chosen. Hence longer implants are preferred inn maxilla than in mandible. A mini-implant of 6mm length can provide adequate anchorage in mandible wherin a minimum of 8mm is required in most of the sites in maxilla. The thickness of the soft tissue in the insertion is another important factor in selectin the type and length of mini-implants. The thickness of mucosa is greater in palate and retromolar area hence longer implants or implants with greater neck length should be used . The length of the transmucosal part of the neck should be selected after assessing the mucosal thickness of the implant site.[6,7]

Indication of orthodontic Mini-implants

Mini-implants are used to obtain anchorage in maximum anchorage requirement cases in which conventional anchorage systems cannot be used effectively. Anchorage can be obtained for various tooth movements including retraction of anteriors, intrusion of anteriors, simultaneous intrusion and retraction of anteriors, posterior protraction, molar intrusion, molar up righting, molar distalization, posterior segmental intrusion as in correction of open bite, orthopaedic traction and osteogenic distraction.

Implant site Selection

The site in which the implant is to be placed is based on the type of tooth movement and the intented mechanics as the direction of force depends on the location of the implant to which the force element are directly attached. For posterior space closure the anterior-posterior location of the mini-implant is between roots of the first molars and the second bicuspids or between the roots of first and second molar. Vertically the mini-implant should be located at or above the mucogingival line depending on the desired line of action. Placement of mini-implant in attached gingiva is desired as the placement in movable mucosa results in gingival hyperplasia.

To intrude the upper incisors the screw is placed between the upper lateral incisors and the canines. The placement of the mini-screws should be done after leveling and alignment, in order to maximize the interadicular space at the placement site.

For intrusion of maxillary molars two implants are placed diagonally one on buccal side and one on palatal interdental area. Retromolar implants are preferred for molar distalization. Indirect anchorage can be obtained for molar distalization from palatal implants. It is very hard to place the micro-screws precisely between the roots of first and second molars without interfering with the roots of the teeth either during implantation or during the intrusive movements.Moreover, sometimes the intrusion force need to be relatively high and more than one screw might be necessary in places where there is insufficient space available for the screw placement. For the above reasons it is suggested to limit the use of the miniscrews to cases where simple molar intrusion of one or two teeth.

It is possible to distalize the mandibular molars with anchor plates placed at the anterior border of the mandibular ramus or mandibular body. Distalization of the mandibular molars enables the clinician to correct anterior crossbites, mandibular incisor crowding, and mandibular dental asymmetry without extracting premolars.

Orthodontic mini-plates or retro molar implants can be used to obtain anchorage for enmasse distalization of buccal segments. Direct retractive force is applied from the anchor plates to the first premolars to perform en masse distalization of the buccal segments.

Th mini implants are place between the roots of lateral incisor and canine for olar mesialization. The mesial movements are usually very slow especially in the lower arch so not more than 2-3 mm of mesial molar movement should be attempted.

Mini -implants placed between the roots of the first and second lower molars or between the root of the second bicuspids and lower first molars, can be used for inserting class II elastics for retraction of upper arch without any unwanted dental effects on the lower teeth.

Contraindication of mini Implants

The predictable use of implants as a source of orthodontic anchorage requires a careful evaluation of prospective patients for osteopenia, osteoporosis, or other medical problems. An evaluation of bone metabolism is a key element of the diagnostic workup. The minimal screening procedure involves a careful medical history, evaluation of signs and symptoms of skeletal disease and an assessment of risk factors associated with negative calcium balance like Renal osteodystrophy, Hyperparathyroidism, Thyrotoxicosis, Osteomalacia and Osteoporosis. Absolute contrac Indication for orthodontic mini-implants includes severe systemic disorder affecting bone metabolism, psychiatric diseases like psychoses dysmorphobia and alcoholics drug abusers. Relative contraindication includes insufficient volume of bone poor bone quality, patients undergoing radiation therapy, Insulin dependent diabetes and Heavy smokers.

Factors affecting success of orthodontic mini-implant

Factors affecting the stability of orthodontic mini-implants can be classified under the following headings (Table 6).

Table 6. Factors affecting stability of orthodontic mini-implants

Host factor	a) Systemic factors b) Local facors c) Hard tissue factor – Amount & density of bone d) Soft tissue factors e) Hygiene
Implant factor	Size & design
Technique	Insertion torque

The primary stability of the orthodontic mini-implant is based on the cortical bone thickness, bone mineral density at the site of insertion, Implant design and placement technique where as the Late stability (2-3months) is dependent on the Targeted bone remodeling rate, Bone mineral density and Peri-implant soft-tissue inflammation. Conical shaped implants offer better stability than the cylindrical shaped implants as tighter contact between the miniimplants and tissue is ensured due to the difference in diameter between tip and the head region but Conical mini implants require high insertion torque causing over compression of the surrounding tissue which may reduce the primary mechanical stability hence predrilling is recommended when a higher diameter conical mini-implant is used to reduce the insertion torque. The length and the diameter plays an important role in the stability of the implants. Miyawaki et al found when the diameter is 1.5mm or more the success rate was 85% and Costa et al recommended mini-implants ranging between 6mm and 10mm for better primary stability.[8]

Better the bone mineral density and thicker the cortical plate greater will be the stability of the orthodontic mini-implants. A minimum bone density of 850 HU and a minimum 1mm cortical bone thickness is required for adequate primary stability if the amount of bone available in the interdental area is greater bigger size implants can be used and better would be the stability.

The implants should be placed in attached gingiva, placement of implants in unattached gingiva results soft tissue proliferation over implant head and peri implant inflammation affecting the late stability and eventually leads to implant failure. If placed in mobile mucosa a gingival punch is done before insertion and a Periodontal pack is applied after placement.

Self drilling mini-implants are more stable because of greater bone implant contact as over heating or wobbling during pre drilling affects stability. But care should be taken to minimize the insertion torque of a self drilling implant as increased torque results in more micro compression of bone in the bone–implant interface and may affect the stability. Poor oral hygiene resulting in peri–implantitis also affects the implant stability.

Predisposing medical conditions like diabetes, local factors like periodontitis also reduce the secondary stability of the mini-implant.

Complications and their management of implants

The various complications encountered during and after the placement of orthodontic implant, the method to manage the failures should be properly understood for proper execution of orthodontic mini-implant anchorage system. [9]

i. Loosening of mini-implant
a. Immediate
b. Delayed
ii. Root Damage
iii. Implant fracture during insertion

Immediate failure may occur due to Poor insertion technique like wobbling of instruments ,Abrupt change in the path of insertion ,Overheating of bone during drilling ,Site with poor cortical bone thickness and density and redundant soft tissue in the site of insertion. [10,11]

Delayed failure may be due to excessive loading, root contact of implants resulting in trauma from masticatory forces, insufficient remodelling of bone around the implants, Poor oral hygiene maintenance, Root contact may also occur during the orthodontic tooth movement when the tooth moves towards the mini-implant.Failed mini-implants should be removed and new mini-implant should be inserted in an adjacent site. If the same site is to be used the reinsertion is performed after 2-3 months and a wider mini-implant is used.

Mini-implant breakage during insertion occurs due to insertion torque higher than the torque resisting force of the implant[12,13]. If resistance is encountered during the insertion a pilot drill is recommended. Fractured mini-implants should be retrieved and a new mini-implant should be inserted in a new site. Perforation or root fracture are extremely rare, Minor injuries of the cementum will undergo spontaneous healing[14].

Conclusion

This article has highlighted the mini-implant system, the anatomical structures of the sites in which they are being placed, indications and contraindications, the placement technique, the factors affecting the stability and the potential risks and complications for clinical usage of orthodontic anchor screws with the hope of educating clinicians. The ideal implant would be one that would be simple to place as well as remove, causing minimum discomfort to the patient. Miniscrews are not a magic wand, but rather a valuable tool to enhance the quality of orthodontic treatment if they are properly used. Implants for the purpose of conserving anchorage helps the Orthodontist to overcome the challenge of unwanted reciprocal tooth movement.

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