

Mini-Screws in Orthodontics- A Review

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Abstract: Anchorage plays an important role in orthodontics. Miniscrews as a temporary anchorage device have gained popularity because of its small size, ease of insertion and removal, low cost, immediate loading and ability to be inserted in different locations of the alveolar bone. The aim of this review article is to discuss the historical development, clinical applications, risk factors, advantages, clinical applications and complications of miniscrews implants during its usage.

Keywords: Temporary Anchorage Devices, Miniscrews.

INTRODUCTION

A temporary anchorage device (TAD) is a device that is temporarily fixed to bone for the purpose of enhancing orthodontic anchorage either by supporting the teeth of the reactive unit or by obviating the need for the reactive unit altogether, and which is subsequently removed after use.

They can be located transosteally, subperiosteally, or endosteally; and they can be fixed to bone either mechanically (cortically stabilized) or biochemically (osseointegrated). It should also be pointed out that dental implants placed for the ultimate purpose of supporting a prosthesis, regardless of the fact that they may be used for orthodontic anchorage, are not considered temporary anchorage devices since they are not removed and discarded after orthodontic treatment. Importantly, the incorporation of dental implants and TADs into orthodontic treatment made possible *infinite anchorage*, which has been defined in terms of implants as showing no movement (zero anchorage loss) as a consequence of reaction forces [1-3].

HISTORICAL DEVELOPMENT

The evolution of temporary anchorage devices was based on the development and improvement of traditional orthodontic anchorage, dental implants, and orthognathic fixation methods. Later, modifications of these techniques were unified with basic biologic and biomechanical principles of osseointegration into orthodontic mechanics that were finally improved based on experiences with interdisciplinary dentistry.

CLASSIFICATION

Based on the location [4-5]

Subperiosteal: The implant body lies over the bony ridge.

Transosseous: The implant body penetrates the mandible completely.

Endosseous

These are partially submerged and anchored within bone, and have been the most popular and the widely used ones in orthodontics.

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

Blade / Plate implants

According to the composition

Stainless steel, Cobalt-Chromium, Molybdenum, titanium, Ceramic Implants. Miscellaneous such as Vitreous carbon and composites

**According to the insertion
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 Non Porous

The screw type implants are usually non porous, 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.

According to mode of insertion

Pre-tapped screws: Used in harder, less compressible materials, such as in metal or in cortical bone.

Self- tapping screws: Used in softer, less compressible materials and forms threads by compressing and cutting the surrounding materials.

Self-drilling screws: Referred as drill-free screws have a corkscrew like tip, therefore, neither predrilling nor tapping procedures are needed.

Based on their origin [6]

- Osseointegrated dental implants
- Surgical mini implants

Cope classification [7]

Biocompatible: Temporary anchorage device

Biologic in nature: Ankylosed teeth and dilacerate teeth

In a more thorough classification of implants used for orthodontic anchorage, Labanauskaite *et al.*, suggested the following classification:

According to the shape and size

- Conical (Cylindrical)
- Miniscrew Implants
- Palatal Implants
- Prosthodontic Implants
- Miniplate Implants
- Disc Implants (Onplants)

According to implant and bone contact

Osseointegrated, Non-osseointegrated.

According to the application

- Used only for orthodontic purposes (orthodontic implants)
- Used for prosthodontic and orthodontic purposes (prosthodontic implants).

APPLICATIONS [8, 9]

The anchorage derived from implants is categorized into:

(A) Direct anchorage in which an endosseous implant used as an anchorage site

(B) Indirect anchorage in which implants are used for preserving anchorage.

The various applications of implants in orthodontic perspective includes-

As a source of anchorage alone (indirect anchorage)

Orthodontic anchorage

- Maxillary expansion
- Maxillary protraction
- Head gear like effects

Dental anchorage

- Space closure (Fig-1)



Fig-1: Retraction with miniscrews



Fig-2: Intrusion of Anterior teeth



Fig-3: Intrusion of posterior teeth

In conjunction with prosthetic rehabilitation (Direct anchorage)

ADVANTAGES OF MINISCREWS [10, 11]

- Does not depend on the number or the position of the present teeth
- Optimal use of the orthodontic forces
- Patient cooperation not required
- Shorter treatment time
- Easy and fast insertion of the mini screw.
- Wide range of application due to the availability of different sizes.
- Does not affect in the maintenance of oral hygiene
- Easier for the attachment of orthodontic accessories.
- Sharper and deeper thread pitches for better mechanical retention
- Immediate loading of heavier forces is possible

IMPLANT CRITERIA [12]

Implant materials

The material must be nontoxic and biocompatible, possess excellent mechanical properties, and provide resistance to stress, strain, and corrosion. Because of titanium's characteristics (no allergic and immunologic reactions and no neoplasm formation), it is considered an ideal material and is widely used.

Bone grows along the titanium oxide surface, which is formed after contact with air or tissue fluid. However, pure titanium has less fatigue strength than

titanium alloys. A titanium alloy—titanium-6 aluminum-4 vanadium—is used to overcome this disadvantage.

Implant sizes

Various sizes of implants, from “mini implants” (6 mm long, 1.2 mm in diameter) to standard dental implants (6–15 mm long, 3–5 mm in diameter), have proved to effectively improve anchorage. Therefore, the dimension of implants should be congruent with the bone available at the surgical site and the treatment plan.

Implant shape

This determines the bone–implant contact area available for stress transfer and initial stability. The most commonly used is cylindrical or cylindrical-conical, with a smooth or threaded surface.

IMPLANT DRIVING METHOD

There are two methods of placement of mini-implants.:

- 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.

PLACEMENT SITES [13]

PAOLA MARIO provided an anatomical map to assist clinician in miniscrew placement in safe location between dental roots. In each interradicular space the mesiodistal and buccolingual distances were measured at 2, 5, 8, 11mm from the alveolar crest.

The safe sites for the placement in the maxilla is as follows:

On the palatal side

- The interradicular space between the maxillary second premolar and first molar, 2mm to 8mm from the alveolar crest.
- The interradicular space between the maxillary first and second molar, 2-5mm from the alveolar crest.

Both on buccal or palatal sides:

- Between the first and second premolar, 5 to 11mm from the alveolar crest.
- Between the canine and first pre-molar, 5 to 11mm from the alveolar crest.

On the buccal side

- Interradicular space between the second premolar and first molar, 5 to 8mm from the alveolar crest.

The safe sites available for implant placement in the mandible are:

- Interradicular space between the first and second molar.
- Interradicular space between the first and second premolar.
- Interradicular space between the second premolar and first molar, 11mm from alveolar crest.
- Interradicular spaces between the canine and first premolar, 11 mm from the alveolar crest.

The sites that should be avoided are

The maxillary tubercosity area especially in case of the unerupted third molars should be avoided for the implant placement.

Risk Factors for Dental Implants Placement [14]

- Tobacco smoking (more than 10 cigarettes a day): A higher failure rate and greater marginal bone loss occurs in patients who smoke. Cessation of smoking at least one week before and eight weeks after dental implant surgery is recommended.
- Age: As many Temporary Anchorage Device (TAD) are small, they should not influence the bone growth. Age restriction is for insertion of TADs in the median region of palate. It should be delayed until adulthood or at least until the midpalatal suture has calcified.
- Risk of infective endocarditis: Placement of TADs causes an insult to oral mucosa and underlying bone, a prophylactic antibiotic has been recommended.

- Diabetes: Placement of TADs and orthodontic treatment should be avoided in patients with poorly controlled insulin dependent diabetes, because these patients are susceptible to periodontal breakdown and have poor wound healing.
- Juvenile idiopathic arthritis: There is no contraindication for the use of TADs in these cases. The clinician should however assess whether wrist joint is affected as these patients find difficulty in tooth brushing and flossing.
- Medication: Any medication likely to hinder wound healing, gingival health and tooth movement should be taken into account prior to placement of a TAD. Examples: Bisphosphonates, immune modulators, anti-epileptics, anti-aggregation medication and anticoagulants.

Local risk factors

- Gingivitis and periodontitis.
- Reduced mouth opening:
- Bone quality.
- Radiotherapy.

COMPLICATIONS DURING INSERTION [15]

Trauma to the periodontal ligament or the dental root

Potential complications of root injury include loss of tooth vitality, osteosclerosis, and dentoalveolar ankylosis. Dental roots damaged by orthodontic miniscrews have demonstrated complete repair of tooth and periodontium in 12 to 18 weeks after removal of the miniscrew.

Miniscrew slippage

High risk regions for miniscrew slippage include sloped bony planes in alveolar mucosa such as the zygomatic buttress, the retromolar pad, the buccal cortical shelf, and the maxillary buccal exostosis if present. To avoid this, the clinician can initially engage bone with the miniscrew at a more obtuse angle before reducing the angle of insertion after the second or third turn.

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. Long-standing sensory aberrations might require pharmacotherapy (corticosteroids), microneurosurgery, grafting, or laser therapy.

Air subcutaneous emphysema

The main symptom of air subcutaneous emphysema is immediate mucosal swelling with or without crepitus (crackling).

Upon dismissal, the patient should be instructed to apply light pressure with an ice pack for the first 24 hours. The clinician could prescribe a mild analgesic, an antibacterial rinse, such as chlorhexidine, and an antibiotic prophylaxis for a week.

Nasal and maxillary sinus perforation

A posterior atrophic maxilla is a major risk factor for sinus perforation. If the maxillary sinus has been perforated, the small diameter of the miniscrew does not warrant its immediate removal. Orthodontic therapy should continue, and the patient should be monitored for potential development of sinusitis and mucocele.

Miniscrew bending, fracture, and torsional stress

Increased torsional stress during placement can lead to implant bending or fracture, or produce small cracks in the peri-implant bone, that affect miniscrew stability. Self-drilling miniscrews should be inserted slowly, with minimal pressure, to assure maximum miniscrew-bone contact.

COMPLICATIONS UNDER ORTHODONTIC LOADING

Stationary anchorage failure

If a miniscrew loosens, it will not regain stability and will probably need to be removed and replaced. The key determinant for stationary anchorage is bone density. Stationary anchorage failure is often a result of low bone density due to inadequate cortical thickness.

Miniscrew migration

To account for potential migration, the clinician should allow a 2-mm safety clearance between the miniscrew and any anatomical structures.

SOFT-TISSUE COMPLICATIONS

Aphthous ulceration

Placement of a healing abutment, a wax pellet, or a large elastic separator over the miniscrew head, with daily use of chlorhexidine (0.12%, 10 mL), typically prevents ulceration and improves patient comfort.

Soft-tissue coverage of the miniscrew head and auxiliary

Soft-tissue overgrowth can be minimized by placement of a healing abutment cap, a wax pellet, or an elastic separator. In addition to its antibacterial properties that minimize tissue inflammation, chlorhexidine slows down epithelialization and might reduce the likelihood of soft-tissue overgrowth.

Soft tissue inflammation, infection, and periimplantitis

The clinician should be forewarned of soft-tissue irritation if the soft tissues begin twisting around the miniscrew shaft during placement. Some clinicians

advocate a 2-week soft-tissue healing period for miniscrews placed in the alveolar mucosa before orthodontic loading.

COMPLICATIONS DURING REMOVAL

Miniscrew fracture

The proper placement technique can minimize the risk of miniscrew fracture during its removal.

Partial osseointegration

Although orthodontic miniscrews achieve stationary anchorage primarily through mechanical retention, they can achieve partial osseointegration after 3 weeks, increasing the difficulty of their removal.

CONCLUSION

Using mini implants as a temporary anchorage device is a boon for orthodontist, as there is no need for complicated clinical and laboratory procedures to facilitate safe and precise implant placement and removal. These Miniscrews provide absolute anchorage, with the advantage of immediate loading of forces. Miniscrew provides an alternative to conventional mechanics, and offers a wide variety of treatment alternatives, mainly while treating challenging cases. Further studies on development of new design and miniscrew supported appliance in orthopedic field is yet to be done.

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