

Implants in Orthodontics: Applications and Complications

Abstract

Wide range of endosseous implants for orthodontic and orthopedic anchorage have lead to great degree of success. This article will review the biomaterials used for dental implants; mechanism of osseointegration; various orthodontic implants; placement procedure and their clinical applications.

Key Words

Anchorage, Implants, Orthodontics, Osseointegration.

Introduction:

Implantation is a term used to “designate the operation of introducing either a natural or artificial tooth into an artificial socket cut into the alveolar process” (Congdon in 1915). According to Boucher, Implants are alloplastic devices which are surgically inserted into or onto jaw bone. Newton's Third Law states that there is a reaction for every action, control of which is difficult to achieve intraorally. Earlier, orthodontists used extraoral traction to reinforce intraoral anchorage. Nevertheless, patients seldom used headgears 24 hours a day -7 days a week, hence this source of anchorage was often compromised. Clinicians continue to need anchorage that displays a high resistance to displacement.

The ideal intra oral anchorage would not displace, and would require a source devoid of periodontal membrane, which tends to respond to tension and pressure allowing movement through bone. The development of small diameter titanium microimplants with specially designed heads that accept ligatures, coil springs and elastomers have helped to solve the main objections to previous implants and screws.

Biomaterials Used For Dental Implants :

Over the past several decades various biomaterials have been used for surgical implant.

Materials Mainly Used For Implant Designs Are:-^{[1],[2]}

1) Metals And Alloys :-

- a) Titanium and titanium -6 Aluminum-4 vanadium (Ti-6Al-4V)
 - b) Cobalt-Chromium-Molybdenum -Based Alloys
 - c) Iron-Chromium-Nickel-Based Alloys.
- 2) Ceramics:
- a) Aluminum, Titanium and Zirconium Oxides
 - b) Aluminum oxides
 - c) Hydroxyapatite
- 3) Carbon and carbon silicon components
- 4) Polymers and composites:
- a) Polymers.
 - b) Composites
- 5) Porous and Featured coating
- a) Titanium plasma sprayed.

Osseointegration:

Osseointegration is the most important stability. The term “Osseointegration” is made of two Latin words.

- Osseo meaning bone
- Integration meaning the state of being combined into a complete whole.

According to Branemark “Osseointegration is the direct structural and functional connection between ordered living bone and the surface of load carrying implant”.^[3]

Implants In Orthodontics

Their classification can be based on the implant morphology:

1. Implant Disc :
 - a. Onplants
2. Screw design
 - a. Orthosystem Implant System^[4]

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b. Spider Screw^[5]

c. OMAS system^[6]

d. Mini Implants^[7]

e. Micro Implants

3. Plate Design

a. Skeletal Anchorage system^[8]

b. Zygoma Anchorage System^[9]

4. Resorbable Implants / Biodegradable Implants^{[10],[11]}

Placement Procedure :^[12]

This procedure is performed under local anesthesia.

Maxillary micro-implant sites need a 30°-40° angulation to the long axis of the tooth, either buccally or lingually. Thicker mandibular cortical bone generally requires 10°-20° angulations.

When placing micro-implant in palate, the greater palatine artery and nerve must always be avoided. If micro-implant is inserted through movable soft tissue rather than attached gingival, it is preferred to use a screw without a button head, placing it completely beneath the

gingival with an emerging ligature wire hook for elastic engagement. This reduces the risk of inflammation and infection. The micro-implant depends upon mechanical retention within the bone, thus requires a tight fit. A low speed contra angle with a drill 0.2-0.3 mm narrower than micro-screw is used for initial entry into the bone.

It is safer to use a manual screwdriver so the clinician can feel resistance from roots and make adjustments to avoid them. Whenever resistance is encountered, withdraw the implant and redrill the bone with the pilot drill before reinserting the micro-implant. When the micro-implant fits tightly, orthodontic forces can be applied immediately.

Clinical Applications:

1. Closure of extraction space :

The mini screw can be placed between the roots of the first molar and the second bicuspid roots. (Figure 2)

2. Symmetric intrusion of the incisors:

To intrude the upper incisor, the best placement of miniscrew is between the upper lateral incisors and the canines. The placement of the miniscrew should be done after alignment and leveling. (Figure 3)

3. Correction of Occlusal plane and dental midline :

The miniscrews are placed between the upper laterals and the canines or in between the upper canines and the bicuspids for the maxillary arch and in between the laterals and canines for mandibular arch on opposite side for midline correction. (Figure 4)

4. Molar intrusion :^[13]

Molar intrusion can be done in the cases where simple molar intrusion is required. Miniscrews can be placed between the roots of the first and second molars. (Figure 5)

5. Molar distalization:

The ideal implant site in palate is between the roots of the first and second premolars.

Risks and Complications of Miniscrews

Complications can arise during miniscrew placement and after orthodontic loading in regard to stability and patient safety.

Complications During Insertion

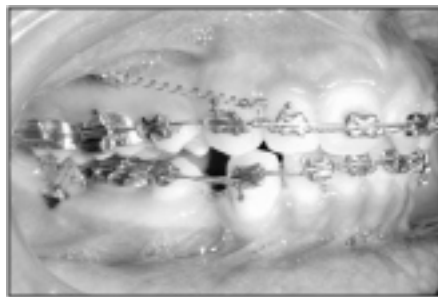


Figure 2

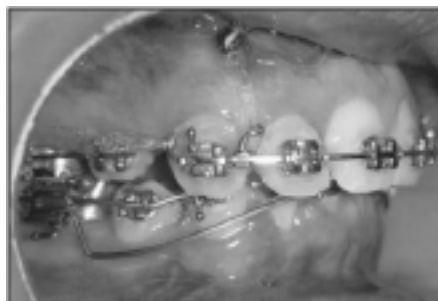


Figure 3



Figure 4



Figure 5

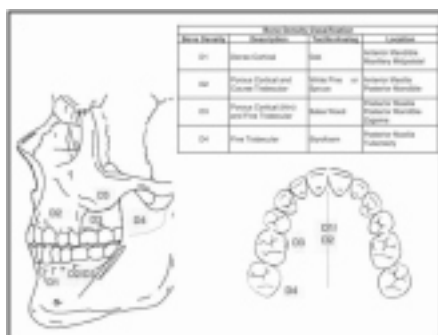


Figure 6

Trauma to the periodontal ligament or the dental root

Potential complications of root injury include loss of tooth vitality, osteosclerosis, and dentoalveolar ankylosis.^{[14],[15]} Interradicular placement requires proper radiographic planning, including surgical guide with panoramic and periapical radiographs to determine the safest site for miniscrew placement.^{[16],[17],[18],[19]}

Microscrew Slippage

Placement of miniscrews less than 30° from the occlusal plane can increase the risk of slippage. 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

Most minor nerve injuries not involving complete tears are transient, with full correction in 6 months.^[20] Long-standing sensory aberrations might require pharmacotherapy (corticosteroids), microneurosurgery, grafting, or laser therapy.

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.^{[21],[22],[23]} Self-drilling miniscrews should be inserted slowly, with minimal pressure, to assure maximum miniscrew-bone contact.

Complications Under Orthodontic Loading

Stationary anchorage failure

According to the literature, the rates of stationary anchorage failure of miniscrews under orthodontic loading vary between 11% and 30%.^{[24],[25],[26],[27]}

The key determinant for stationary anchorage is bone density.^{[28],[29],[30]}

Stationary anchorage failure is often a result of low bone density due to inadequate cortical thickness. Bone density is classified into 4 groups (D1, D2, D3, and D4) based on Hounsfield units (HU)-an x-ray attenuation unit used in computed tomography scan interpretation to characterize the density of a substance.^[31] D1 (>1250 HU) is dense

cortical bone primarily found in the anterior mandible and the maxillary midpalatal area.[32] D2 (850-1250 HU) is thick (2 mm), porous cortical bone with coarse trabeculae primarily found in the anterior maxilla and the posterior mandible. D3 (350-850 HU) is thin (1 mm), porous cortical bone with fine trabeculae primarily found in the posterior maxilla with some in the posterior mandible. D4 (150-350 HU) is fine trabecular bone primarily found in the posterior maxilla and the tuberosity region. (Figure 6)

Sevimay et al^[33] reported that osseointegrated dental implants placed in D1 and D2 bone showed lower stresses at the implant-bone interface. Placement of miniscrews in D1 and D2 bone might provide greater stationary anchorage under orthodontic loading. Placement of miniscrews in D4 bone is not recommended due to the reported high failure rate.^{[34],[35],[36]}

Miniscrew Migration

Orthodontic miniscrews can remain clinically stable but not absolutely stationary under orthodontic loading. To account for potential migration, the clinician should allow a 2mm safety clearance between the miniscrew and any anatomical structures.^[37]

Soft-Tissue Complications

Aphthous ulceration

Minor aphthous ulcerations are self-limiting and resolve within 7 to 10 days without scarring.^[38]

Soft tissue inflammation, infection, and periimplantitis

Healthy peri-implant tissue plays an important role as a biologic barrier to bacteria.^[39] Tissue inflammation, minor infection, and peri-implantitis can occur after miniscrew placement.^[40]

Complications During Removal

Miniscrew fracture

The miniscrew head could fracture from the neck of the shaft during removal. 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. The miniscrew typically can be removed without complications a few days after the first attempt of removal.^[41]

Conclusion :

The success of this type of absolute anchorage has widened the horizons of the orthodontist, which should be explored to the best possible advantage for treating cases. This should help in providing the aesthetically conscious adult patient orthodontic care which has once compromised or denied altogether due to lack of posterior teeth which serve as anchors during orthodontic treatment.

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