Mini implants in orthodontics

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Introduction of mini implants to the field of orthodontics has allowed the orthodontist to treat a wide range of malocclusion than those could be treated by conventional anchorage system. As the force could directly be applied from the anchor unit for the required tooth movement, the chances of anchor loss could be minimized. Therefore, mini-screws not only enable the orthodontists to have good control over tooth movement in all three dimensions but also help them to provide the best of the treatment result . This review will illustrate the versatility of biomechanics provided by orthodontic mini-implants for the correction of the malocclusion along with the advantages, disadvantages and the complications due to the use of the mini implants.

Key word: Mini-implant, Anchorage, Orthodontics

According to **GRABER**[1], Anchorage in orthodontics is defined as **"**The nature and degree of resistance offered by an anatomic unit for the purpose of effective tooth movement".

Achieving absolute anchorage is very critical for the practicing orthodontists. Anchorage control throughout orthodontic treatment is essential for an uncompromised treatment result. Conventional methods of providing anchorage used either tooth borne or an extra oral anchorage method. One of the greatest limitations in orthodontic practice is the tooth borne anchorage due to the movement of the anchor unit in response to orthodontic forces which is called anchor loss[2].

Extra oral anchorage can be used to provide anchorage during orthodontic treatment but requires patient co-operation to be effective.

This lead to the introduction of Skeletal anchorage which expanded the range of tooth movement by enhancing the biomechanical possibilities. This system is anchored to the jaws and the force are applied directly from the implant to produce desired tooth movement in any direction without any anchor loss[2].

Kanomi and Costa et al[3] introduced mini implant. They used mini implant for orthodontic anchorage to intrude mandibular incisors in a patient with deep bite and partially edentulous arch. It is small enough to be placed in any area of alveolar bone even in the apical bone. A surgical procedure is easy enough and provides rapid healing and are easily removable after orthodontic traction.

The mini implant is only 1.2mm in diameter and 6mm in length which makes it more useful in orthodontic applications compared to the Conventional dental implants.

Mini implants are small enough to be used between the roots, placed in palate for molar distalization, molar intrusion and other tooth movements. Oral hygiene is easier to maintain and can be easily removed after treatment.

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MINI IMPLANT SCREW DESIGN (FIG:1)

Orthodontic mini implants are made up of pure titanium. It is available in different diameter and length to be used for orthodontic anchorage. The various diameter and length of the mini implant are 1.5mm, 2.0mm, 2.7mm and 7mm, 10mm, 12mm, 14mm, and 17mm respectively.

Orthodontic mini implant various parts. Such as:

·Head – This part of the mini implant is exposed to the oral environment. Sometimes it has a slot of 0.022" x 0.28" for placement of the orthodontic archwire.

·Isthmus: This is the connection between the head and platform of the mini implant. It helps in the attachment of any orthodontic accessory like elastics, nickel titanium coil spring etc to the implant head. Sometimes it has a round hole of 8mm diameter which serves as an auxiliary tube for an the archwire placement.

·Platform – It is of three different heights such as 1mm, 2mm and 3mm for accommodating different soft- tissue thickness at different implants sites. Its smooth surface improves peri-implant wound healing and prevents slippage and displacement of an elastic or coil spring, thus avoiding gingival irritation and keeping the screw head from becoming embedded in the soft tissue.

Body of the implant is parallel. It is either of self drilling or self tapping type. It has threads and grooves for better interlocking of the mini implant to the bone.

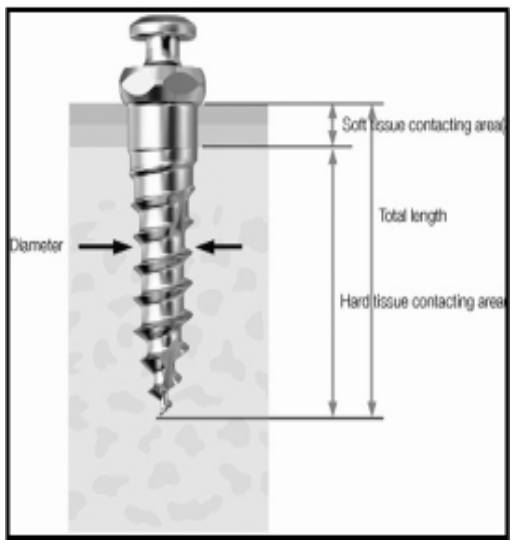

Fig 1. Parts Of An Orthodontic Mini-Implant

MINI-SCREW SELECTION

The Orthodontic mini implant anchorage has a wide range of application in orthodontics.

The mini implant of 1.5mm diameter is used in the interseptal bone of tooth bearing areas. It provides better mechanical retention than the previously used bone screws of 1.2mm diameter due to its extra thickness. These types of mini implants are place near the root apex of the two teeth to avoid any possible damage to the roots during placement.

The mini implants of 2.0mm and 2.7mm diameter are mainly used in the non- tooth bearing areas like the zygomatic buttress, the midpalatal region and buccal shelf region of the mandible. These screws can bear forces as high as 500-600gms to achieve effective tooth movement. They can provide an headgear like effect for enmasse retraction of anterior, canine retraction or for the distalisation or protraction of molars.

When the length of the mini implant is considered the implant of smaller length like 7mm, 10mm and 12mm are used in the interdental region where as the mini implants of 14mm and 17mm are used in the zygomatic buttress region.

Mini-implants can be classified according to their morphology & site of placement. **(FIG:2&3)**

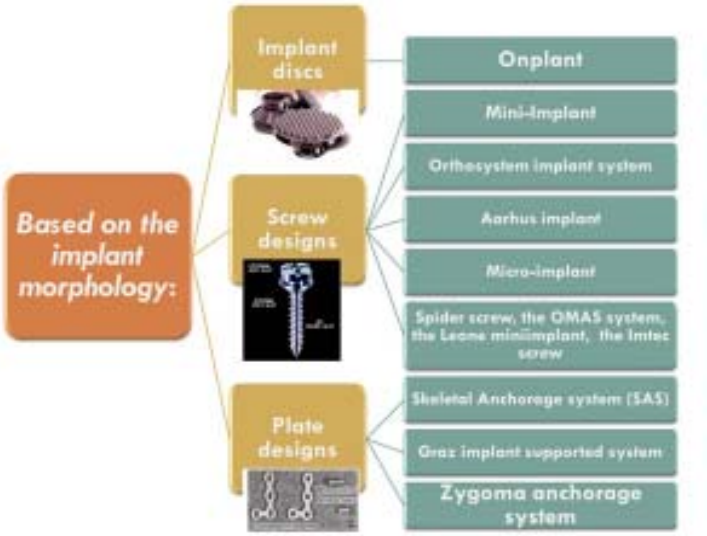

Fig 2. Classification of mini-implants according to implant morphology.

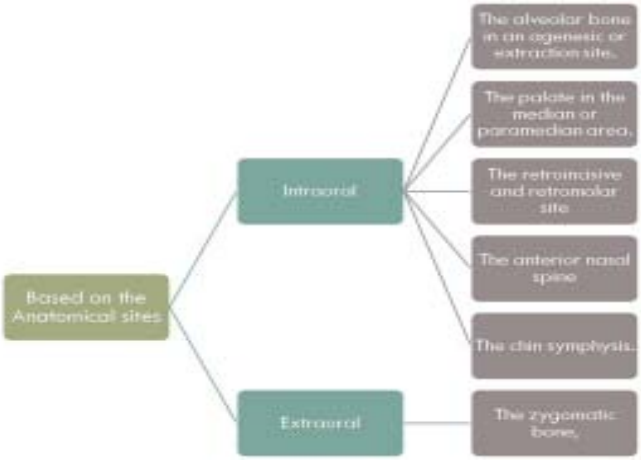

Fig 3. Classification of mini-implants according to implant placement site.

PLACEMENT SITES

Anchorage control with self-taping mini-screws suggest that maxillary alveolar bone has the highest bone thickness in mesiodistal dimension between first molar and second premolar on both the buccal and palatal side and is the best sites for implants placement.

A study on Computed Tomographic images from 21 patients was provided anatomic data to assist placement of the mini implants. This study suggested that the thickness of the cortical bones at the alveolar region increased from the anterior to the posterior area. The mandibular posterior region showed a thicker cortical bone. In the maxilla a greater amount of bone tissue was observed in the inter radicular spaces between roots of the second premolar and the first molar and between the roots of the first molar and the second molar in the mandible.

PAOLA MARIO[4] provided an anatomical map to assist clinician in miniscrew placement in safe location between dental roots. Volumetric tomographic images of maxilla and mandible taken with newtom system were examined. 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 of OMIs in the maxilla is as follows**(FIG:4):**

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 be-tween the second premolar and first molar,5to 8mm from the alveolar crest.

The safe sites available for implant placement in the mandible are**(FIG:5)**:

- 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.

According to **Sungami**[5] the thickness of the bone in the palate varies in different regions. The highest thickness of the bone is found within 1mm of the midpalatal suture. The thickness tends to decrease laterally and posterior. So a mini implant should be placed in the mid palatal region preferably. When it is required to place the mini implant in a posterior region, more than 1mm from the mid palatal region, it is recommended to use a shorter mini implant.

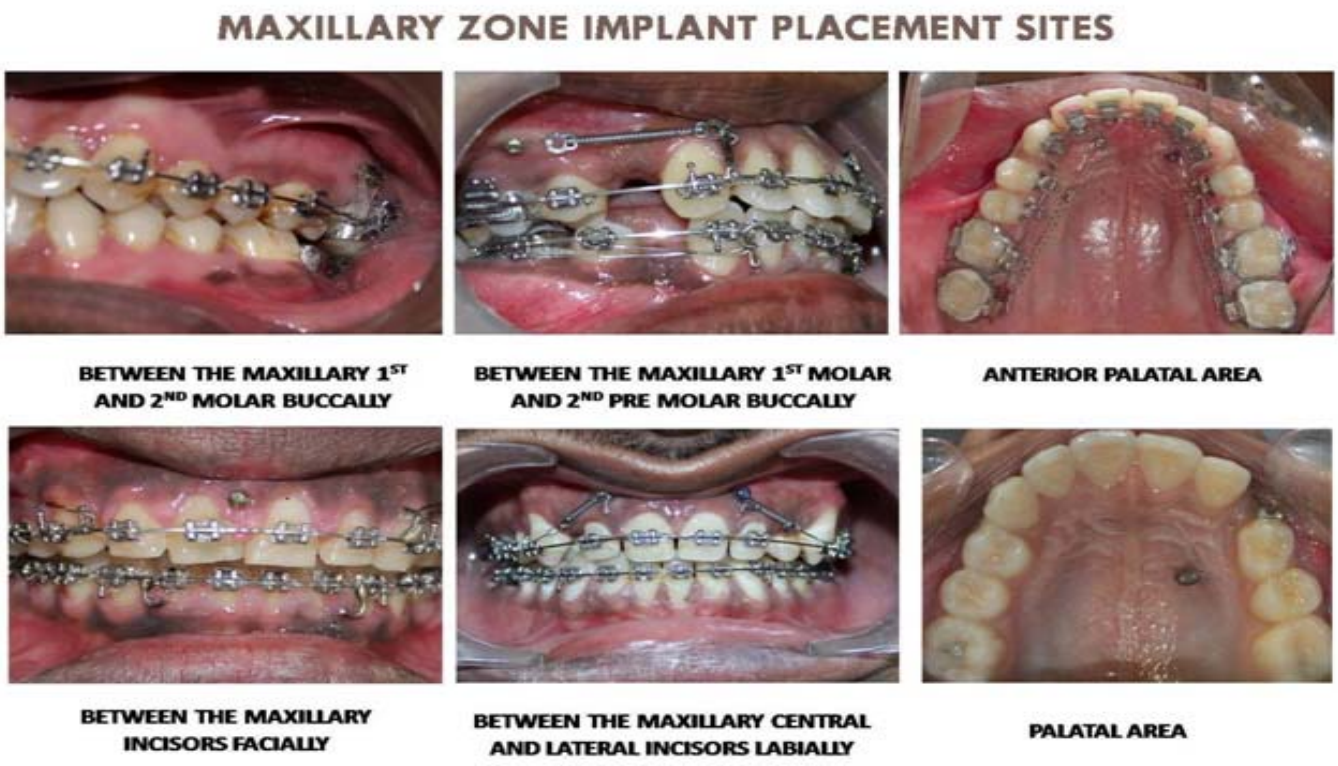

Fig 4. Sites For Mini-Implant Placement In Maxilla

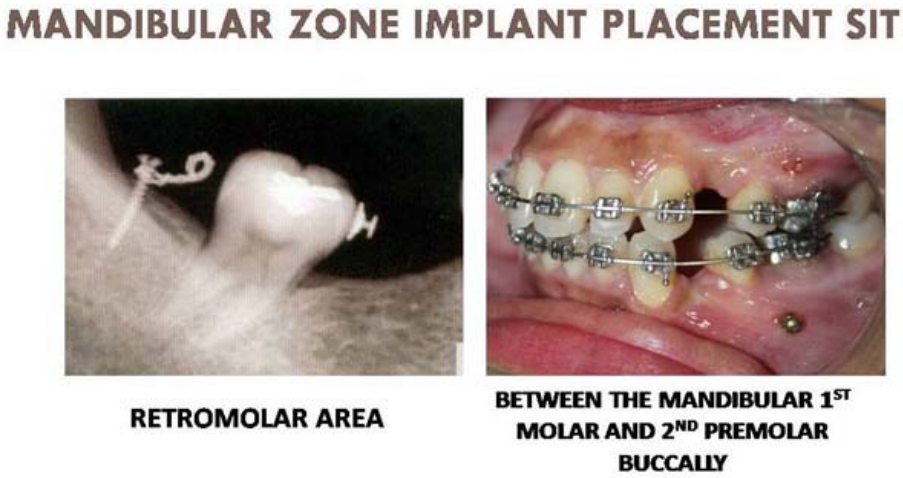

Fig:5: Sites for mini-implant placement in mandible.

The sites that should be avoided are:

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

PLACEMENT PROCEDURE:

Before surgery, the preferred implant site is evaluated carefully for bone quality and quantity, using the lateral and anteroposterior cephalometric films, panoramic X-rays, or computed tomographic scans. Depending on the implant site, one of the following two surgical procedures can be performed under local anesthesia.

Placement procedure in alveolar mucosa

For the placement of the mini implant a 3 mm horizontal incision is made in the alveolar mucosa along the mucogingival junction with a surgical blade, and the underlying bone is exposed by raising the mucoperiosteal flap. A 2mm round bur is used to drill into the cortical bone, using water coolant to make a pit about 1.5mm in diameter. A 1mm pilot drill is used to drill into the bone, using along the water cooling. The implant is inserted with the accompanying miniature screwdriver.

The implant is then covered with the flap and the wound is sutured. A periapical X- ray is then used to document the position of the implant. After healing and osseointegration,

gingival tissue covering the mini-implant is removed. Using a mucosal punch, soft tissue covering or surrounding the head of the mini-implant is removed.

The two- hole titanium bone plate is attached to the head of mini implant to act as a hook. A ligature wire or elastic chain is tied between this hook and the bracket on the tooth.

Placement procedure in attached gingiva

While placing the implant in the attached gingival the elevation of flap is not required. A high speed diamond bur is used to expose the underlying bone. Then the pilot drill is made using 1.0mm, 1.5mm or 2.0mm spiral drill depending on the screw diameter to be inserted. The speed of the drill was maintained at 500-800 rpm under constant irrigation with normal saline to avoid any overheating of the bone which might need to bone necrosis. The pilot hole is made in the cortical bone to guide the mini implant of self drilling type into the bone and for better mechanical retention.

Orthodontic Mini implant is inserted using special short or long screw driver, the head and platform of the mini implant is exposed to the oral environment outside the attached gingiva. The wound site in alveolar mucosa is thoroughly irrigated with normal saline.

Post operatively antibiotic coverage is given to prevent any infection and inflammation. Mouthwash of 2% chlorhexidine is advised to maintain good oral hygiene.

When mini implant is placed in the alveolar mucosa a healing period of two weeks is allowed before loading of the mini implant to prevent any postoperative infection where as for the implants placed in the attached gingiva immediate loading can be done.

Sugawara[6] provided a guide for positioning of mini-implants based on CBCT. He suggested a new surgical guide system that uses cone-beam computed tomography (CBCT) images to replicate dental models, surgical guides for proper positioning of orthodontic mini-implants, fabricated on the replicas, and the guides were used for precise placement.

Hyewon Kim[7] **suggested a convenient method of removal of orthodontic mini-implants** by using Howe utility plier or the supplied driver, rotation of about 1 to 1.5 turns counter clockwise, loosens the screw and also removes the initial heavy torque, then gentle touching of the bur head tip to head portion removes the mini implant safely and swiftly.

APPLICATIONS OF IMPLANTS IN ORTHODONTICS[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

a. As a source of anchorage alone (indirect anchorage)

1. **Orthodontic anchorage**
   - Maxillary expansion
   - Maxillary protraction
   - Head gear like effects

2. **Dental anchorage**
   - Space closure
   - Intrusion of
     - Anterior teeth
     - Posterior teeth
   - Distalization

b. 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

Neal[12] presented the risks and complications of orthodontic miniscrews.

Complications during insertion

1) Trauma to periodontal ligament or dental root due to change in angle of insertion angle.
2) Miniscrew slippage
3) Nerve involvement
4) Air subcutaneous emphysemas
5) Nasal and maxillary sinus perforation
6) Miniscrew vending, fracture and torsional stresses.

Complications under orthodontic loading

1) Stationary anchorage failure
2) Miniscrew migration

Soft tissue complications

2) Soft tissue coverage of miniscrew head and auxiliary
3) Soft tissue inflammation, infection, and periimplantitis

Complications during removal

1) Miniscrew fracture
2) Partial osseointegration.

Potential complications related to common implant procedure are

1) Lesions of some anatomic structures like nerves, vessels, dental roots.
2) Inflammation around the implant site.
3) Breakage of the screw within the bone during insertion or removal due to the use of screws with a small diameter.

Hyo-Sang Park[13] suggested factors affecting the clinical success of screw implants used as orthodontic anchorage such as:

1) Host factors (osteoporosis, uncontrolled diabetes, smoking)
2) Improper surgical technique, lack of initial stability over heating during placement and fitness of pilot hole to the diameter of the screw implant
3) Management factors-poor home care and oral hygiene
4) Peri-implantitis
5) Mobility due to lack of osseointegration
6) Screw implants on right side of jaw had a higher failure rate, and mandible had higher failure rate. Implants placed on left side had higher success rate than placed on right side of dental arches
7) This is attributed to better hygiene on left side by right handed patients, who are most of the population

Shingo Kuroda[14] considered root proximity as a major factor for the failure of the mini implant as an orthodontic anchorage. The proximity of miniscrew to adjacent tooth root is major risk for failure of screw anchorage. This tendency is more obvious in mandible suggesting that mini implant placement near the root proximity should be avoided for better stability of mini implants as an orthodontic anchorage.

CONCLUSION

With skeletal anchorage, orthodontic tooth movement that is beyond the realm of usual orthodontic practice can be accomplished. Skeletal anchorage considerably extends the range of biomechanical therapy and decreases the need for extra oral anchorage and orthognathic surgery.[15]

The newer anchorage systems provide skeletal anchorage without requiring patient co-operation or compromising esthetics. With anchorage considerations no longer being an issue, orthodontic mechanotherapy can be greatly simplified. These skeletal fixtures would make treatment outcome more predictable satisfying both patient and the orthodontist. The concept of absolute anchorage can now be effectively explored and employed.

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