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Implants: An aid to anchorage

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Abstract

Successful orthodontic treatment has always required intraoral anchorage with a high resistance to displacement of unwanted tooth movement.

Orthodontic anchorage is usually achieved by using a tooth (or) a group of teeth to effect the movement of other malpositioned teeth. Adequate anchorage becomes difficult when the key teeth that might be used for anchorage are missing.

Conservation of anchorage in totality has been a perennial problem to the traditional orthodontist. Conventional means of supporting anchorage have been using either intra oral or by extra oral means. Both of these have their limitations. The extra oral forces resist the continuous tooth moving forces but are also taxing on patient's compliance.

Because of this limited anchorage potential and acceptance problem of conventional intra oral and extra oral aids, implants as a means of orthodontic anchorage are gaining increased importance in orthodontic treatment. Implants for the purpose of conserving anchorage are welcome additions to the armamentarium of the clinical orthodontist to overcome the challenge of unwanted reciprocal tooth movement.

When maximal anchorage is required during orthodontic treatment, additional aids are often needed to support the anchoring teeth. Implant systems have been proposed to reinforce orthodontic anchorage without the need for extra-oral appliance.

Keywords: anchorage, mini implants, micro implants, fixed orthodontic treatment

Introduction

Successful orthodontic treatment has always required intraoral anchorage with a high resistance to displacement of unwanted tooth movement.

Orthodontic anchorage is usually achieved by using a tooth (or) a group of teeth to effect the movement of other malpositioned teeth. Adequate anchorage becomes difficult when the key teeth that might be used for anchorage are missing.

This necessitates an anchorage unit that could be placed in mouth to receive forces of magnitude sufficient to effect tooth movement without getting displaced by the applied force. Sometimes it is impossible to correct a class II malocclusion with inter maxillary elastics, when the patient lacks mandibular posterior teeth in such situations the orthodontist has to rely upon the use of extra oral head gears.

Samuel surveyed 1117 dentists in the UK, regarding the headgear use in their clinical practice and injuries sustained by their patients. Thirty three injuries to the face and surrounding areas were reported. Three of these involved ocular damage, with one patient losing the sight in one eye. In a further study, there were 17 reports of ocular damage worldwide. Patients wear their headgear for less than half the time that is actually prescribed by the clinician.

Conservation of anchorage in totality has been a perennial problem to the traditional orthodontist. Conventional means of supporting anchorage have been using either intra oral or by extra oral means. Both of these have their limitations. The extra oral forces resist the continuous tooth moving forces but are also taxing on patient's compliance.

Because of this limited anchorage potential and acceptance problem of conventional intra oral and extra oral aids, implants as a means of orthodontic anchorage are gaining increased importance in orthodontic treatment. Implants for the purpose of conserving anchorage are welcome additions to the armamentarium of the clinical orthodontist to overcome the challenge of unwanted reciprocal tooth movement.

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When maximal anchorage is required during orthodontic treatment, additional aids are often needed to support the anchoring teeth. Implant systems have been proposed to reinforce orthodontic anchorage without the need for extra oral appliance.

An Implant is "A mechanical device made from one or more biomaterials that is intentionally placed within the body, either totally or partially buried beneath an epithelial surface"

As defined by Boucher "Implants are alloplastic devices which are surgically inserted in to or on to jaw bone".

Osseointegration: An intimate structural contact at the implant surface and adjacent vital bone, devoid of any intervening fibrous tissue' – Branemark (1983).

The use of dental implants has greatly increased over the last three decades, largely as a consequence of their successful long term osseointegration. This has led to increased orthodontic use, with appropriate modifications in the design when required. The ability of osseointegrated implants to remain stable under occlusal loading has led orthodontics to use them as anchorage units without patient compliance.

An implant used to enhance orthodontic anchorage should be biocompatible, inexpensive, easily inserted and removed under local anaesthesia, and should be smaller enough to be placed in multiple sites in the mouth. It should also osseointegrate in few days, and should be stable to orthodontic loading in all planes of space. Continuing development of orthodontic implants has led to the production of smaller designs which are easy to insert and remove, and do not require a long healing period prior to loading. Recently developed Orthodontic mini screws and micro screws are efficient, inexpensive, and simple to place and remove. Since the primary means of retention of most micro implants is a mechanical lock within the bone.

Skeletal anchorage using miniscrews and micro screws provides an absolute anchorage for tooth movement. Miniscrew or microscrew implants have many benefits such as ease of placement, removal and they are inexpensive. Because of their small size, they can be placed in the intra arch alveolar bone without discernable damage to tooth roots. In addition, Orthodontic force applications can begin almost immediately after placement, in contrast to dental implants. Therefore, these advantages have expanded the use of mini and microscrew implants for various orthodontic applications.

Role of implants in orthodontics

The use of implants during orthodontics

- Implants as a source of absolute anchorage
- Implants used for anchorage and as abutments for restorations
- Application of Implants in osteogenic distraction.

Various applications of implants in orthodontics

- As a source of Anchorage alone (Indirect anchorage)
 - Implants for Orthopedic and Orthodontic Anchorage
- i) Maxillary Protraction
 - ii) Maxillary expansion

Headgear like effects

- Dental Anchorage
- Space closure

- Intrusion
 - of anterior teeth
 - of posterior teeth
- Distalization
- In conjunction with prosthetic rehabilitation (Direct anchorage)

Implant-based anchorage can be of particular benefit in treating certain aspects of malocclusions

- Retracting and realigning teeth with no posterior support.
- Closing edentulous spaces in first molar extraction sites.
- Mid line correction when missing posterior teeth.
- Intruding or extruding teeth.
- Protraction or retraction of one arch.
- Stabilization of teeth with reduced bone support.
- Distalization of molars
- In conjunction with prosthodontic rehabilitation

Disadvantages

One of the obvious disadvantages of dental implants for orthodontic anchorage is the need for a long healing period of 6 months for osseointegration, which adds significantly to the treatment time. The bone height required for traditional dental implants may also restrict the locations available for implant placement. Dental implants are expensive, cannot be easily inserted and removed under local anaesthesia, and are large enough to be located in multiple sites in the mouth. As a result of these problems, implants have been designed specifically for orthodontic purposes.

Important Limitations

- Bulkiness of the implant
- Involves a two stage procedure hence a long waiting period before loading the implant
- Anatomic limitations such as erupting teeth, nerve canal.
- Cost of implants very expensive factors that need to be considered include the bone quality and the extent of ridge resorption.

The age of the patient is an important consideration, as implants are problematic if inserted in growing children.

1. The use of implants in the anterior maxilla is contraindicated due to the possibility of the mid-palatal suture being opened.
2. Resorption in the posterior part of the maxilla, resulting from growth changes, could lead to the exposure of the implant in to the sinus.
3. Posterior aspect of the mandible continues to undergo growth changes in all three planes of space and as such, definitive implant placement in this area would be difficult to estimate.

These factors made it imperative that newer implants adapted specially for orthodontic usage be developed.

Mini implants

Dental implants are troublesome for patients because of the severity of the surgery, the discomfort of initial healing, and the difficulty of oral hygiene maintenance

Disadvantages of endosseous implants are its cost, a limited number of potential implant sites, complex design and

relatively large size, the difficulty of surgical implantation and removal, a long waiting period for osseointegration before orthodontic traction can be applied.

Kanomi and Costa *et al.* introduced the mini implants that were more suitable for orthodontic purposes. Mini implant for orthodontic anchorage are small enough to be placed in any area of alveolar bone, even the apical bone. The surgical procedure was easy enough for an orthodontist or general dentist to perform and it permitted rapid healing. The implant was easily removable after orthodontic traction.

Conventional dental implants are 3.5-5.5mm in diameter and 11-21mm long. The mini implant is only 1.2mm in diameter and 6mm long, making it much more useful in orthodontic applications. A new bone screw called the Orthodontic Mini Anchor System was introduced recently.

Clinical application of mini screws

1. Closure of the extractions space
2. Symmetric intrusion of the incisors
3. Correction of the cant of the plane of occlusion and of the dental midline
4. Molar intrusion of one or two teeth
5. Molar distalization with the Distal Jet and miniscrews
6. Molar mesialization
7. Intermaxillary anchorage

Advantages of miniscrews

- a) Independence from the number or position of the present teeth
- b) Optimal use of the pulling forces
- c) Independent from patient cooperation
- d) Patient comfort
- e) Shorter treatment time
- f) Easy and fast screw insertion
- g) Possible application even in interceptive therapy More sizes for different applications.
- h) Easier access for oral hygiene and placement of orthodontic accessories.
- i) Stronger body and deeper thread pitches for better mechanical retention and loading of heavier forces.

With its upgraded design, the orthodontic mini anchorage system can be applied with confidence to the most complex and difficult anchorage cases.

Use of the miniscrews for inter maxillary fixation offers the following advantages

- No preparation is necessary to secure a location for a stable, rigid fixture.
- The miniscrews are easily placed and removed and inter maxillary wires and elastics can be tied immediately after insertion.
- Oral hygiene is much easier to maintain than with conventional methods of inter maxillary fixation.
- Chairtime is drastically reduced.

Advantages when compared with other Osseo integrated implants

- Versality in the insertion sites
- Easy insertion and removal
- Immediate loading
- Application in growing patients
- Low cost

Some potential complications common to other implant procedure are

- Lesions of some anatomic structures like nerves, vessels, dental roots.
- Inflammation around the implant site.

Breakage of the screw within the bone during insertion or removal. This complication has probably be due to the use of screws with a small diameter.

Micro implants

Standard dental implants, have been used for orthodontic anchorage, that had drawbacks such as the difficulty of selecting proper implant sites in most orthodontic patients due to their bulkier size and the need to wait for osseointegration before force loading and its invasive surgical placement procedure

The size, bulk, cost, and invasiveness of endosseous implants have limited their orthodontic application, the screw head fail to protect the gingiva from impingement of ligatures or attaching elastics and also makes it difficult to attach coil springs.

Kanomi and Costa *et al.* introduced the use of titanium microscrews for orthodontic anchorage. Controlling anchorage in orthodontic treatment using microimplants have been successful. Microimplants are inexpensive which are small in diameter and comes in several lengths, which can be inserted in any desired location, including interradicular space and can be loaded immediately to withstand typical orthodontic forces of 200-300g for the entire length of treatment and no waiting period for osseointegration hence immediate force application can be done and it can easily be removed by the orthodontist

Orthodontic force application

It is better to wait about 2 weeks for soft tissue healing before applying orthodontic force when we use stab incision for implantation. We can commence immediate loading after implantation if needed. Actually, there was no clinical difference in failure rate between immediate loading and delayed loading, if we keep the applied force less than 300gm. We infer that the mechanical stability is far more important than osseointegration in microimplant anchorage systems. Light continual forces as generated by NiTi coils are more favored over elastomers that often have excessive initial forces.

Advantages

- Does not depend on patient compliance with extraoral appliances.
- Produces an early profile improvement, giving the patient even more incentive to cooperate.
- Ease of placement and removal and it is inexpensiveness.
- Smaller size, can be placed in the intra-arch alveolar bone without discernable damage to tooth roots
- Orthodontic force applications can begin almost immediately after placement, in contrast to dental implants.
- Correction of Class II and Class III dental relationships efficiently in a shorter treatment time by moving quadrants of the dentition distally or mesially.
- The midline discrepancy can also be controlled easily.

- Intrusion of the incisors and molars can be achieved easily. Shortens treatment by retracting the six anterior teeth simultaneously
- Reduces chairtime

Therefore, these advantages have expanded the use of micro screw implants for various orthodontic applications.

Various Applications

Sliding Mechanics with Microscrew implant Anchorage

When micro screw implants are used, clinicians can retract six anterior teeth altogether without anchorage loss. Maxillary anterior teeth were bodily retracted against micro screw implants. The centre of resistance of the six anterior teeth was estimated to be halfway between the center of resistance of the four incisors and canines. By using upward and backward force passing near the center of resistance, the maxillary anterior teeth showed bodily intrusion and retraction.

Occlusogingival position of micro screw implants determines the force direction so that the retraction of the anterior teeth can be controlled. A second factor capable of changing the direction of force is the vertical position of the anterior hooks. For example, the use of short anterior hook would increase the vertical component and decrease the horizontal component of the force. For bodily retraction of the anterior teeth with a slight intrusion, the proper position of the maxillary micro screw implants was 8-10mm apical to the bracket slot with the anterior hooks 5-6mm gingival to the bracket slot. So that the force will pass just under the center of resistance and induce bodily retraction with only slight linguoversion and intrusion. Enmasse retraction of the six anterior teeth, instead of step-by-step retraction of the canine and four incisors can reduce treatment time and allow an early change of the facial profile.

The mandibular micro screw implants provided vertical intrusive force to the archwire distal to the first molars. This exerted uprighting forces on the first molars and an intrusive force on the second molars.

Inter maxillary elastics to correct Class II canine and molar relationships cause the extrusion of the posterior teeth and opening of the mandibular plane, which results in a deleterious effect on the facial profile. In sliding mechanics with micro screw implant anchorage, the need for inter maxillary elastics is usually eliminated. This prevents extrusion of the posterior teeth and opening of the mandibular plane.

Molar Uprighting With Micro Implant Anchorage

Micro implant placed in the alveolar bone palatal to the upper second molar and buccal to the lower second molar generate palatal and intrusive forces on the upper molar and buccal and intrusive forces on the lower molar without any orthodontic appliances on the anchorage unit.

With micro Implant Anchorage, upper and lower second molars can easily be uprighted without side effects on the anterior teeth. Simultaneous molar intrusion can be performed, eliminating the need for occlusal reduction.

Micro implant anchorage for molar distalization

Micro implants placed in the midpalatal region are very effective in bringing about molar distalization.

Non extraction treatment with micro screw implant

Maxillary and mandibular posterior teeth were retracted with micro screw implants 1.2mm in diameter and six to 10mm long that were placed into the alveolar bone and used

as anchorage. En masse movement of the posterior teeth and the whole dentition after anterior tooth alignment can reduce the treatment period and maximize the efficiency of the treatment. The efficacy and potency of the micro screw implants aid mechanics in the nonextraction treatment of both labial and lingual treatment.

Molar Intrusion With Micro Implant Anchorage

Orthodontic intrusion is a more conservative approach, it is difficult to accomplish without unwanted side effects. When an intrusive force is placed on a molar, the reactive force of extrusion, which occurs predominantly on the premolars, can virtually cancel out the molar intrusion. They require multiple teeth to be used for anchorage, increasing patient discomfort and producing unpredictable results hence implant anchorage has been suggested as an ideal force system for molar intrusion without side effects.

Micro implant Anchorage For Forced Eruption Of Impacted Canine

A small implant should be used due to the lack of alveolar bone in the canine area, especially after extraction of the primary canine. Because the force needed to extrude the tooth is less than 50g.

Micro screw should be placed in the labial cortical alveolar bone on this line of force, at an angle of 10-20° to the bone surface and as parallel to the tooth long axis as possible. This keeps the apex of the micro screw on the buccal side and reduces the likelihood of its contacting the root. Head of the micro screw should be located as incisally as possible to maximize the vertical component of force.

An attachment is bonded to the labial surface of the impacted canine to allow derotation of the tooth without over rotation. Once the canine has been moved into the arch, a lingual bracket can be bonded for more precise control.

Micro implant anchorage for treatment of skeletal class I bialveolar protrusion

Treatment of skeletal Class I bialveolar protrusion, with micro-implant anchorage used for retracting the maxillary anterior teeth and uprighting the mandibular molars.

Biomechanically, the maxillary force is applied near the center of resistance of the six anterior teeth, making it possible to achieve bodily intrusion and retraction.

To maintain or reduce the mandibular plane angle during treatment, mandibular micro screws are required. The mandibular micro-implants induce a forward and upward movement of the chin by intruding and uprighting the mandibular molars.

Micro Implant Anchorage For Lingual Treatment

Anchorage requirements are even more critical in lingual orthodontics than in labial treatment because of the anatomical relationship between the tongue and cortical bone. Microimplants of 12mm long, 1.3mm in diameter were placed in the palate between the maxillary first and second molar roots for enmasse retraction of the anterior teeth.

In the maxillary arch, extension hooks were soldered to the main archwire between the upper central and lateral incisors, and nickel titanium coil springs were attached from the extension hooks to the palatal microimplants.

Micro implants can provide reliable, absolute anchorage for lingual orthodontic treatment as well as labial treatment.

Conclusion

Clinicians continue to need anchorage during orthodontic treatment demands a high resistance to displacement. According to Newton's third law, for every action there is an equal and opposite reaction, hence control of anchorage was difficult to achieve intraorally. Earlier orthodontists used extraoral traction to reinforce intraoral anchorage. Nevertheless patient seldom used head gears 24 hours a day, hence this source of anchorage was often compromised.

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. Recently prosthetic osseointegrated implants have been used as intraoral orthodontic anchorage, but their bulky size, cost, invasiveness and long waiting period before force application have limited their orthodontic applications.

Endosseous implants was used which were much smaller in size and less bulkier than conventional dental implants, but they had drawbacks of long waiting period of 4 - 6 months, their screw head failed to protect the gingiva from the impingement of attached elastics and it was difficult to attach coil springs and other orthodontic force applications.

The newer micro implant screws introduced by Kanomi and Costa or the purpose of conserving anchorage are welcome additions to the armamentarium of clinical orthodontist.

The newer micro implant screws has the following advantages:

- Does not relies on patient cooperation.
- Micro implants are inexpensive and its smaller size permits ease of placement in various locations in the alveolar bone.
- The surgical placement procedure was less invasive so that it was easy enough to be performed by an orthodontist.
- The Micro implants almost entirely depends on mechanical retention, hence long waiting period for osseointegration is avoided and immediate loading of orthodontic forces is possible.
- Permits shorter treatment time.
- Chair side time is dramatically reduced.
- Easier access for oral hygiene maintenance and placement of orthodontic accessories.

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