CLINICAL APPLICATIONS OF MINI IMPLANTS IN ORTHODONTICS: A REVIEW

Review Article

Dwijesh Goswami*, Sonali Mahadevia, Neha Assudani***, Arth Patel******

ABSTRACT

Among the various types of implants, orthodonticmicroscrews are widely used as they have a unique property of providing absolute anchorage and also increasing the range of biomechanical therapy by converting surgical case into a nonsurgical case, which is a boon to any orthodontist. And above all they provide skeletal anchorage without requiring patient cooperation or compromising esthetics. Mini implants are here to stay and will be an integrated part of the armamentarium as they make treatment outcome more predictable and satisfy both patient and orthodontist.

KEYWORDS: Periodontal therapy, risk factors, failures.

Received: 17-01-2017; **Review Completed:** 17-04-2017; **Accepted:** 12-05-2017

INTRODUCTION:

Orthodontics involves desired movement of teeth and this is brought about by a variety of appliances. In planning the biomechanical aspects of orthodontic treatment for a specific patient, it is imperative that the orthodontists consider not only the forces required for the necessary tooth movement to achieve the patient's objectives, but also the undesired tooth movement that may occur in response to these forces. One of the concerns of Orthodontists is to provide adequate anchorage for selective movement of individual tooth or a group of teeth in order to eliminate unwanted tooth movement. Maintaining maximum or absolute anchorage has always been an onerous goal for the practicing orthodontist.

Absolute anchorage is defined as no or minimal movement of the anchorage unit (zero anchorage loss) as a consequence to the reaction of forces applied to move teeth.[1] Such an anchorage can only be obtained by using ankylosedteeth or dental implants as anchors, both relying on bone to inhibit movement.[2] Anchorage provided by devices, such as implants or miniscrew implants fixed to bone, may be obtained by enhancing the support to the reactive unit (indirect anchorage) or by fixing the anchor units (direct anchorage), thus facilitating skeletal anchorage.

DEFINITION

Implants, as defined by Boucher[1] are: 'Alloplastic devices which are surgically inserted into or onto jaws. Terms such as mini-implants, miniscrews, microimplants, and microscrews have been used to describe devices of temporary anchorage. The term "Mini-screw" is more appropriate than "micro-implant" from the perspective of scientific nomenclature since "micro" means < 10^{-6}. Also, the shape and design indicate that "screw" is more appropriate than 'implant'. However since 2004 it was agreed on that the word mini-implant should be applied both to palatal implants, to mini-implants, to miniscrews, and to microscrews.[3] Intraoral extradental anchorage systems[4] and temporary anchorage devices[5] are other terms that have also been suggested to describe devices such as mini-implants.

HISTORICAL BACKGROUND

In 1945, Gainesforth and Highley[6] mentioned the use of implant supported anchorage; they used vitallium screws in six dogs. Creekmore8 1983 used vitallium implant for anchorage for intruding upper anterior teeth.

In 1997, Kanomi[9] described a mini-implant specifically made for orthodontic use, and in 1998, Costa et al.[10] presented a screw with a bracketlike head. Several other miniscrew implants have been introduced since then, each presenting different designs and features. Further, during the last decade, other means of bone anchorage have also been proposed, including zygoma wires[11], miniplates,[12,13] and zygoma anchors.[14]

CLASSIFICATION

Labanauskaiteet al.[15] suggested the following classification in 2005 which is widely accepted

- According to the shape and size

1) Conical (cylindrical)

* Post Graduate, **Professor & Head, ***Senior Lecturer, ****Senior Lecturer

DEPARTMENT OF ORTHODONTICS AND DENTOFACIALORTHOPAEDICS
AHMEDABAD DENTAL COLLEGE AND HOSPITAL, TA. KALOL, DIST: GANDHINAGAR, GUJARAT, INDIA.

ADDRESS FOR AUTHOR CORROSPONDENCE : DR. DWIJESH GOSWAMI, TEL: +91 9662476389

- miniscrew implants
- palatal implants
- prosthodontic implants

2) Miniplate implants

3) Disc implants (onplants);

● According to the implant bone contact

1) Osseointegrated

2) Nonosseointegrated;

● According to the application

1) used only for orthodontic purposes (orthodontic implants)

2) used for prosthodontic and orthodontic purposes (prosthodontic implants)

PARTS OF MINI IMPLANT

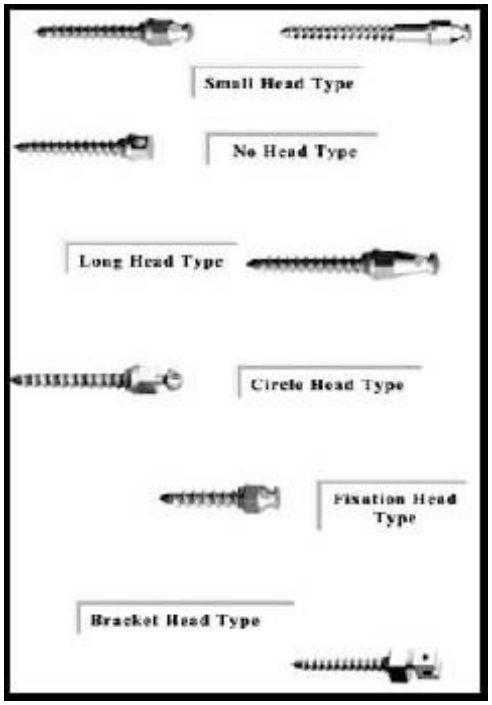
Fig.1

Implant head:It serves as the abutment and in the case of an orthodontic implant, it is the source of attachment ofelastics or coil springs.

Implant neck:It serves as an attachment of the body and the neck.

Implant body:It is the part embedded inside bone. This may be a screw type or a plate type.

TYPES OF MINI IMPLANT



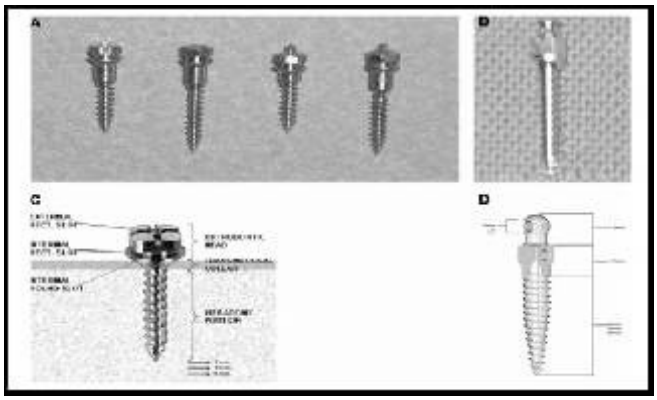


Fig. 2 Various miniscrew implants.
A, The Aarhus Anchorage System.
B, The AbsoAnchor. C, The Spider Screw Anchorage System. D, The IMTEC Mini Ortho Implant

SITES FOR MINI IMPLANT PLACEMENT

In Maxillary zone

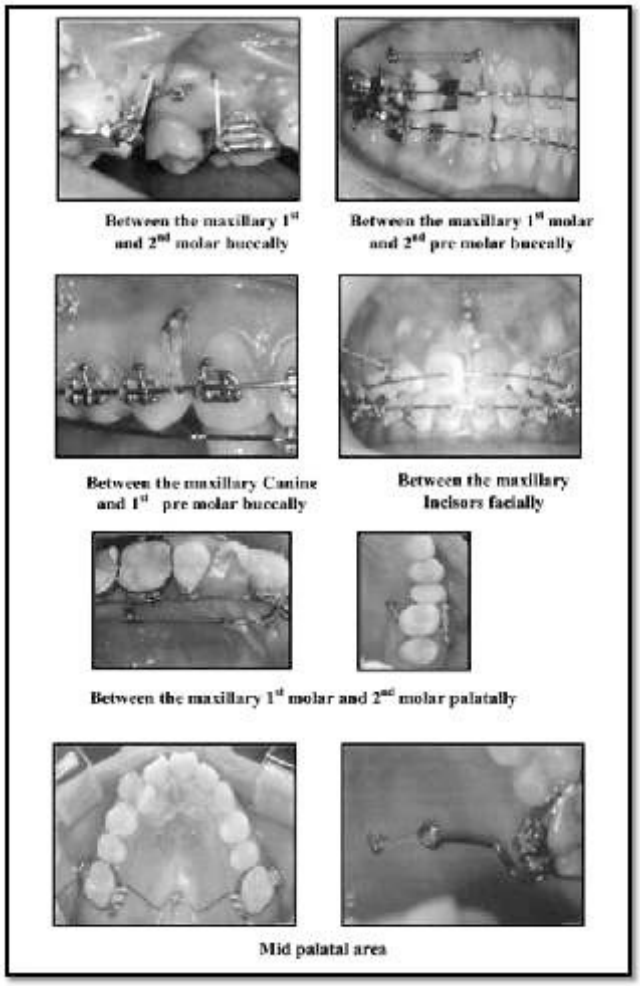


Fig 3 Sites for mini implant placement in maxillary arch

In Mandibular zone

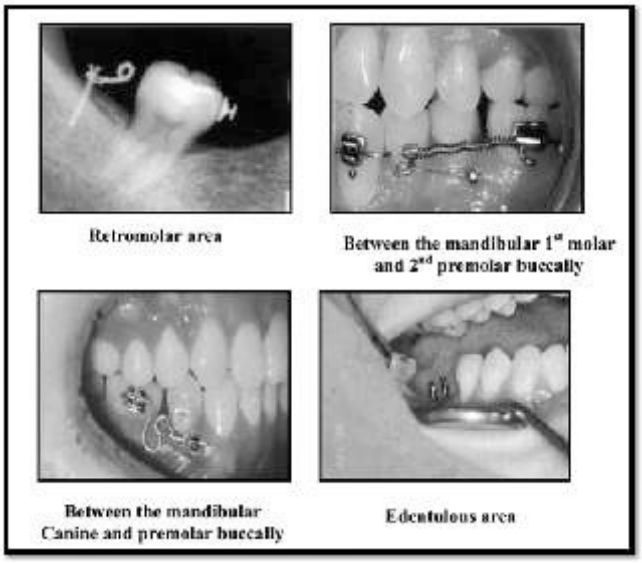


Fig 4 Sites for mini implant placement in Mandibular arch

CLINICAL APPLICATION OF MINI IMPLANTS IN ORTHODONTICS

1. Mini implant for Retraction
2. Molar uprighting
3. Lingual Orthodontics
4. Forced eruption of impacted canines
5. Intrusion
6. Non Extraction Treatment
7. Molar Distalization
8. Molar Protraction

1. Mini implant for Retraction

En masse retraction of anterior may require heavy anchorage. Hyo-Sang Park[16] used microscrew implants for retraction of six anterior teeth and concluded that treatment time can be reduced effectively and clinicians can move teeth without patient compliance for anchorage devices.

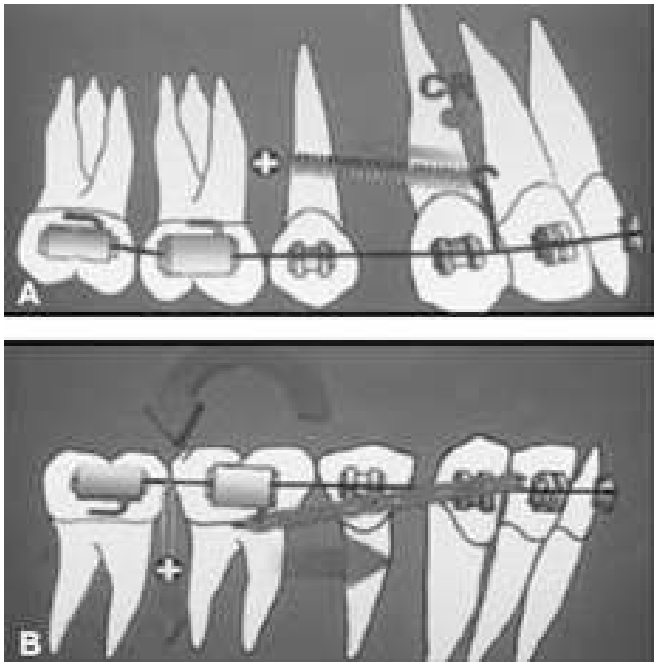


Fig 5

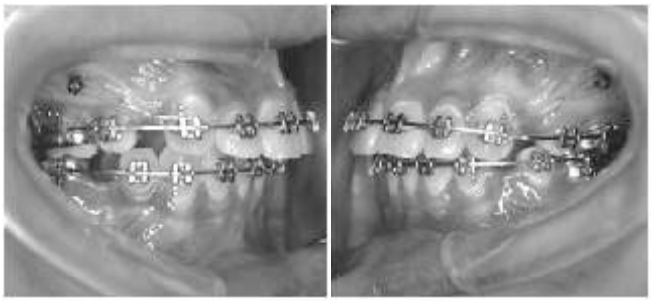


Fig 6 Clinical photograph of retraction using mini implants

By using an upward and backward force passing near the center of resistance, the maxillary anterior teeth showed bodily intrusion and retraction. For bodily retraction of the anterior teeth with a slight intrusion, the position of the maxillary microscrew implants should be 8-10 mm apical to the bracket slot with the anterior hooks 5-6 mm gingival to the bracket slot (Fig 5A). With this configuration, the force will pass just under the center of resistance and induce bodily retraction with only slight linguoversion and intrusion. The mandibular microscrew implants provide vertical intrusive force to the archwire distal to the first molars. The mesial movement of the mandibular posterior teeth could move a fulcrum forward and as a result close the mandibular plane in high angle cases. (Fig 5B)

2. Molar uprighting

Numerous approaches are used for uprightingmesially tipped mandibular molars after loss of 1st molars. They cause molar extrusion and movement of anchor unit. Hee Moon Kyung and Hyo Sang Park[17] used mini implants to obtain absolute anchorage with no side effects on anterior teeth or extrusion of molars. In maxilla mini implants are placed in the tuberosity. In the mandible micro implant are placed in the retromolar area, distobuccal to the second molar. Hyo Sang Park[18] has reported the use of micro implants placed in the alveolar bone palatal to the upper 2nd molar and buccal to the lower 2nd molar which gives palatal and intrusive forces on the upper molar and buccal and intrusive forces on the lower molar. (Fig 7)

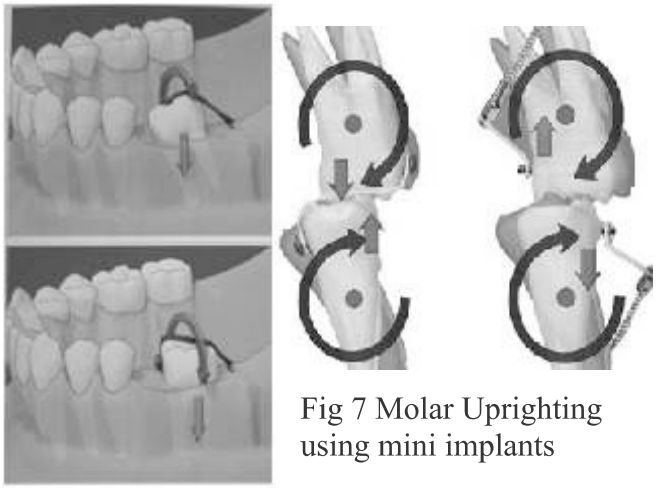


Fig 7 Molar Uprighting using mini implants

3. Lingual orthodontics

Anchorage requirements are even more critical in lingual orthodontics than in labial treatment because of the anatomical relationship between the tongue and cortical bone. The best position forplacement of the microscrew implants in the maxilla arch is the palatal interradicular alveolar bone between it and second molars. Jang Seop Lee19reported that mini screw (1.2mm-1.3mm diameter and 10mm-12mm length) can be placed in the palatal alveolar bone in maxillary 1stand 2nd molar at an angle of 300 – 400to the bone for controlling anchorage in lingual sliding mechanics.

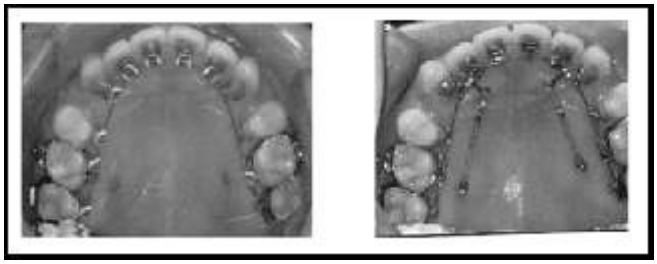


Fig 8 Retraction using mini implants in lingual orthodontics

4. Forced eruption of impacted canines

In labial treatment the force required to move a palatally impacted canine into arch causes distortion of arch form and in lingual treatment small arch wires with short inter bracket span and smaller bracket slots may be unable to resist such distortion. To overcome these mini implants can play a key role. Hyo Sang Park et al[20] reported that micro implant can be used for eruption of impacted canines.

A small implant (1.2mm diameter and 8mm long) should be used due to lack of alveolar bone &should be placed in the labial cortical alveolar bone on this line of force at an angle of 10^0 – 20^0 to the bone surface andparallel to the long axis of tooth as possible. This keeps the apex of screw from contacting the root. The head of the implant should be located as incisally as possible to maximize the vertical component of force. (Fig 9)

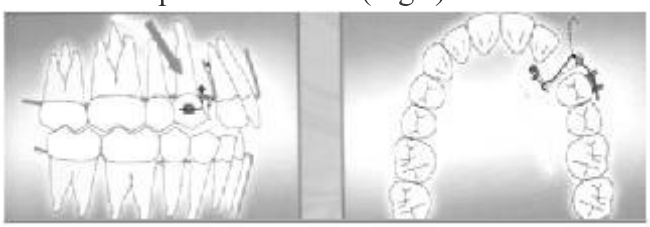


Fig 9 Forced eruption on impacted canine using mini implants

5. Intrusion

Yeon-Joo Chang[21] has suggested use mini implants for molar intrusion without side effects in which two mini implants are placed one on the buccal side and another on palatal side and force is applied on to the molar. In another method 2 mini implants are used buccally and one implant in palate to prevent the buccal faring.(Fig 10)

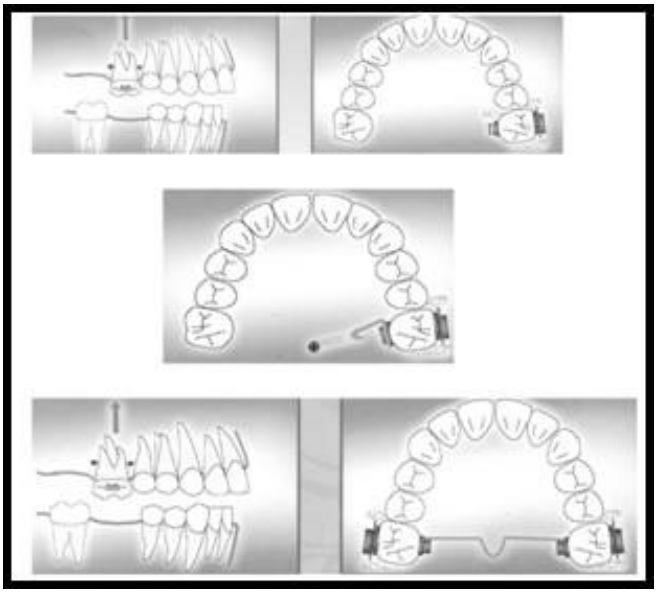


Fig 10 Molar intrusion

INCISORS INTRUSION

It can be carried out by placing 2 mini implants between lateral incisor and canine and applying force on to the bracket or on to the wire (Fig11)

Fig 11. A) Pre Intrusion

Fig 11. B) Post Intrusion

6. Non Extraction Treatment

Hyosang park[22] reported that with the use of Microscrew implants one can retract whole dentitions and can eliminate the adverse reciprocal movement andmaximize the efficiency of the treatment.

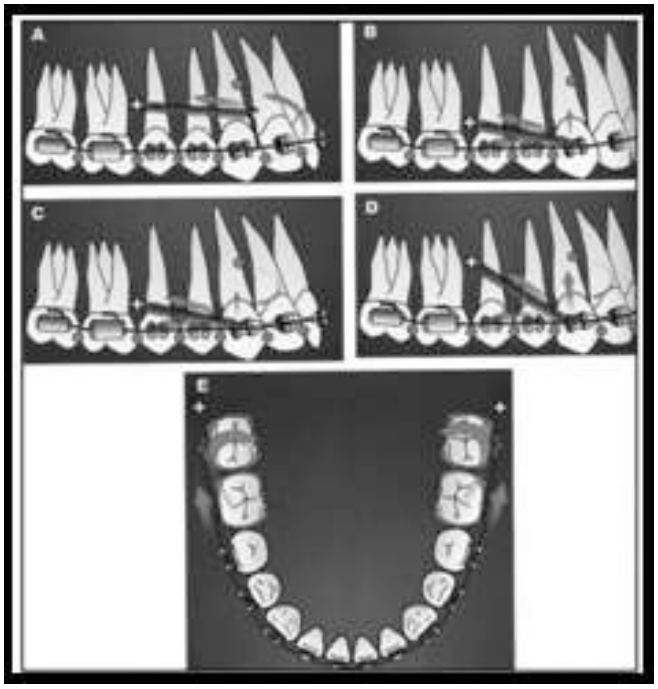


Fig 12

In non-extraction treatment, the biomechanics of anterior teeth retraction invovles the contact of the teeth on the crown which act as a resistance to movement, whichcreates a counterclockwise moment on the anterior teeth. (Fig12.A) These movements are acceptable in the case of retracting lingually tipped upper anterior teeth.

When retracting the upper anterior teeth showing labial tipping or normal inclination in non extraction treatment, the counterclockwise moment on the upper anterior teeth should be eliminated. By applying distal force to the crown of the teeth, the distal force was transmitted through the crown. After creating space by moving the posterior teeth distally against the microscrew implants, the anterior crowding could be resolved without flaring of the maxillary incisors.(Fig 12.B. C)

The microscrew implants, placed deep to the vestibule sulcus, could not produce a sufficient horizontal component of force to retract the anterior teeth. This is because the higher the microscrew implants were placed the more vertical was the vector of the force. (Fig 12.D) The occlusogingival position of the microscrew implants therefore should be lower in non extraction treatment than in extraction, which will contribute to the increased horizontal-vector of the force.

When less than 3 mm of distal movement of the posterior teeth was needed, the microscrew implants could be placed between the maxillary second premolars and first molars. When more than 3 mm of posterior movement of the posterior teeth was required, the palatal alveolar bone between the maxillary first and second molars is a good position for microscrew implant placement because there was much more space on the lingual side.

7. Molar Distalization

Molar distalization can also be carried out by taking skeletal anchorage using mini implants. Various appliances can be fabricated which incorporates mini implants with them for anchorage. Using mini implants prevents undesirable movements of other teeth and gives control movement. Some of the implant supported molar distalizer includes Bone anchored Pendulum appliance[23], mini implant supported distal jet appliance[24], skeletal Pendulum K appliance[25](Fig 13), mini implant supported sliding jig[26](Fig 14) etc.

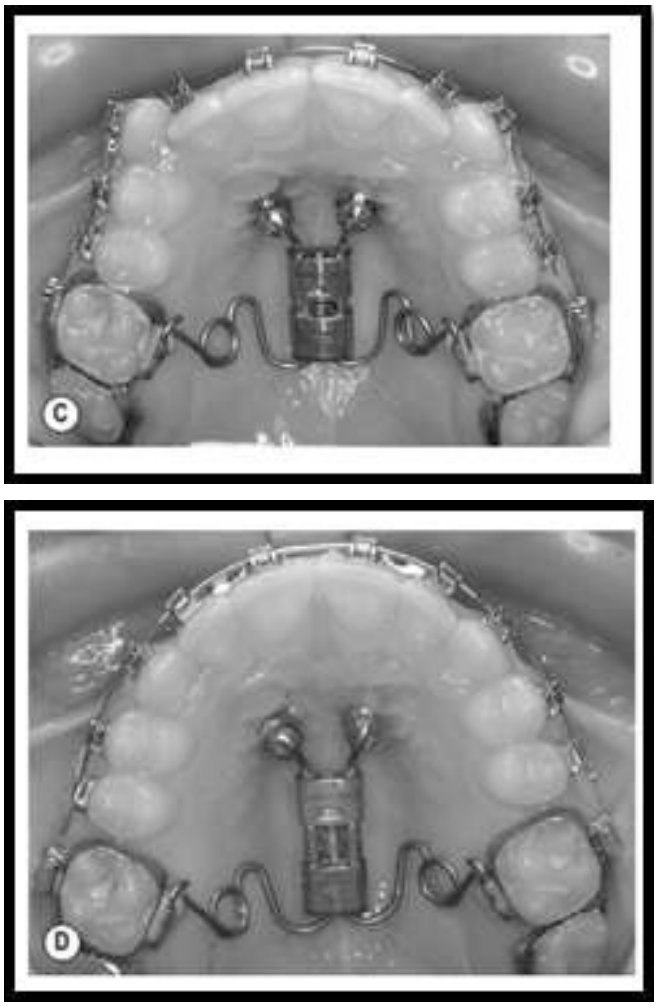


Fig 13 Skeletal K Pendulum appliance

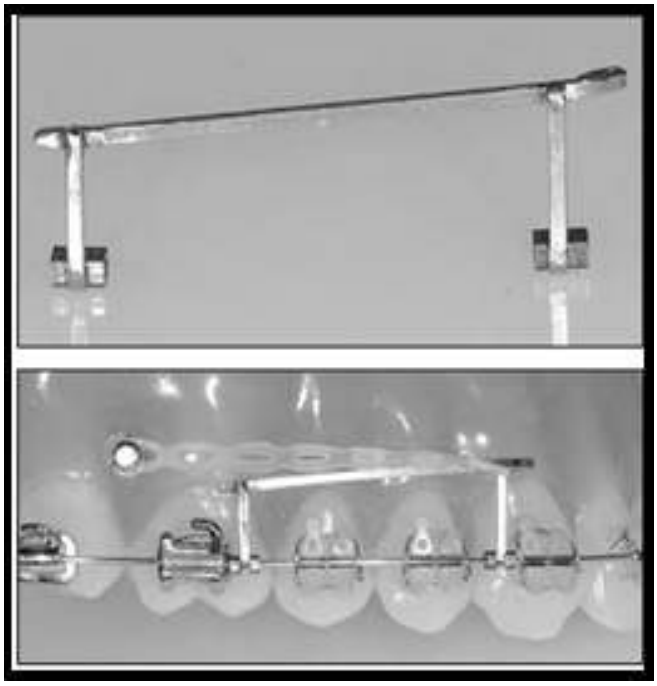


Fig 14 Mini implant supported Sliding jig

8. Molar Protraction

Mini implants can also be used to protract the molar in cases where the extraction spaces need to be closed by bring the molar forward. With use of force modules or niti coil springs on mini implants molar protraction can be carried out. (Fig 15)

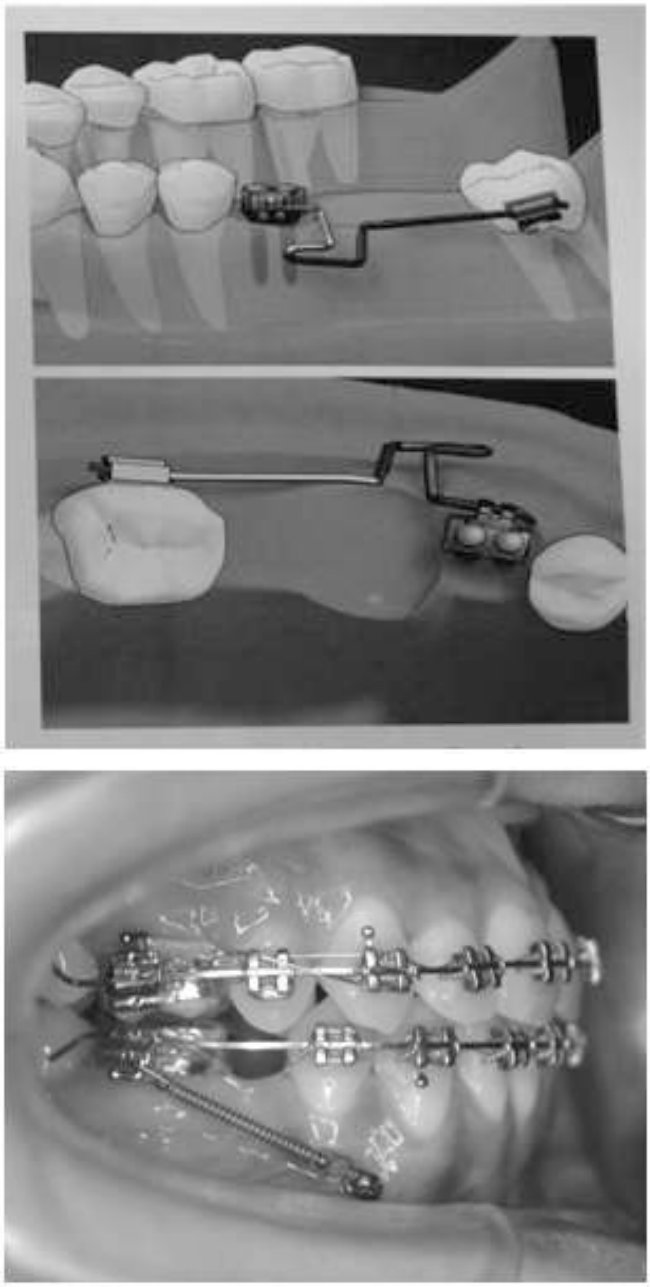


Fig 15 Molar Protraction

ADVANTAGES OF MINI IMPLANT

- Insertion and removal is easy as it is a less invasive surgical procedure
- Miniscrew implants can be easily inserted chair side in one appointment, even by the orthodontist.
- There is no need for complicated clinical and laboratory procedures (i.e., fabrication of acrylic splints by taking imprints with additional implant copying systems to accurately transfer the implant position to cast models) to facilitate safe and precise implant insertion.
- Miniscrew implants can be immediate loaded (there is no need for a waiting period for osseointegration, in contrast to orthodontic implants), reducing the total treatment time.
- Miniscrew implants can be inserted at safe location without damaging vital anatomic structures.
- The provided absolute anchorage eliminates undesirable effects on the teeth that otherwise would have been normally used as anchorage.
- Patient cooperation is limited to maintaining immaculate oral hygiene.

DISADVANTAGES OF MINI IMPLANT

- Damage of the adjacent tissues or root injuries might occur as a result of improper insertion.
- Irritation or inflammation of peri-implant tissues and consequent failure of the miniscrew implant is also possible, especially by patients with poor oral hygiene.

CONCLUSION

Considering Newton's Third Law, it is virtually impossible to achieve absolute anchorage condition with intraoral anchorage thus making it extremely difficult to achieve excellent result without compromising treatment. With skeletal anchorage, orthodontic tooth movements beyond the realm of the conventional orthodontic practice can the accomplished successfully. It can be considered as an exceptional method to control anchorage, thus it is a boon to orthodontist.

Skeletal anchorage considerably extends the range of biomechanical therapy by decreasing the need for extra oral anchorage. The newer anchorage systems provide skeletal anchorage without requiring patient co-operation or compromising esthetics. With anchorage consideration no longer an issue, orthodontic mechanotherapy can be

greatly simplified. These skeletal fixtures make treatment outcome more predictable and satisfying for both the patient and the orthodontist.

REFERENCES:

1. Daskalogiannakis J. Glossary of orthodontic terms. Leipzig: Quintessence Publishing Co.; 2000.
2. Melsen B, Garbo D. Treating the "impossible case" with the use of the Aarhus Anchorage System. Orthod 2004;1S:13-20
3. Carano A, Melsen B. Implants in orthodontics. ProgOrthod 2005;6:62-9.
4. Melsen B, Verna C. A rational approach to orthodontic anchorage. ProgOrthod 1999;1:10-22.
5. Cope J. Temporary anchorage devices in orthodontics: a paradigm shift. SeminOrthod 2005;11:3-9
6. GainsforthBl Et Al. A Study Of Orthodontic Anchorage Possibilities In The Basal Bone . Am J Orthod Oral Surg 31:406-417,1945
7. Linkow LI. Implanto- Orthodontics. J ClinOrthod 1970; 4:685-90
8. Creekmore Td, Eklund Mk. Possibility Of Skeletal Anchorage. J ClinOrthod 1983; 17:266-9.
9. Kanomi R. Mini-implant for orthodontic anchorage. J ClinOrthod 1997;31:763-7.
10. Costa A, Raffaini M, Melsen B. Miniscrews as orthodontic anchorage: a preliminary report. Int J Adult OrthodonOrthognathSurg 1998;13:201-9.
11. Melsen B, Petersen JK, Costa A. Zygoma ligatures: an alternative form of maxillary anchorage. J ClinOrthod 1998;32:154-8.
12. Nagasaka H, Sugawara J, Kawamura H, Kasahara T, Umemori M, Mitani H. A clinical evaluation on the efficacy of titanium miniplates as orthodontic anchorage. Orthod Waves 1999; 58:136-47.
13. Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal anchorage system for open-bite correction. Am J OrthodDentofacialOrthop 1999;115:166-74.
14. De Clerck H, Geerinckx V, Siciliano S. The Zygoma Anchorage System. J ClinOrthod 2002;36:455-9
15. Labanauskaite B, Jankauskas G, Vasiliauskas A, Haffar N. Implants for orthodontic anchorage. Meta-analysis. Stomatologija 2005;7:128-32
16. Park Hs, BaeSm, Kyung Hm, Sung Jh. Micro-Implant Anchorage For Treatment Of Skeletal Class I Bialveolar Protrusion, J ClinOrthod. 2001;Jul; 35(7) :4127-22
17. Park Hs, Kyung Hm, Sung Jh. A Simple Method Of Molar Uprighting With Micro-Implant Anchorage. J ClinOrthod. 2002 Oct; 36(L0):592-6
18. Park Hs, Kwon Ow, Sung Jh, Uprighting Second Molars With Microimplant Anchorage. J. ClinOrthod 2004; 38: 100- 103
19. Lee Js, Park Hs, Kyung Hm, Microimplant Anchorage For Lingual Treatment Of A Skeletal Class- II Malocclusion. J. ClinOrthod 2001; 35(10) 643- 47.
20. Park Hs, Kwon Ow, Sung Jh, Microimplant Anchorage For Forced Eruption Of Impacted Canines J. ClinOrthod. 2004; 38; 297- 302.
21. Chang Yj, Lee Hs, Chun Ys, Microscrew Anchorage For Molar Intrusion J ClinOrthod 2004; 38; 326- 330.
22. Park Hs, Kwon Tg, Sung Jh, Non Extraction Treatment With Microscrew Implants. Angle Orthod 2004; 74: 539- 549.
23. Kircelli BH, Pektaş ZO, Kircelli C. Maxillary molar distalization with a bone¬anchored pendulum appliance. Angle Orthod 2006;76:650–9.
24. Kinzinger GS, Diedrich PR, Bowman SJ. Upper molar distalization with a miniscrew-supported Distal Jet. Journal of clinical orthodontics: JCO. 2006 Nov;40(11):672.
25. Ludwig B, Glasl B, Kinzinger GS, et al. The skeletal frog appliance for maxillary molar distalization. J ClinOrthod 2011;45:77.
26. Lim JK, Jeon HJ, Kim JH. Molar distalization with a miniscrew-anchored sliding jig. Journal of clinical orthodontics: JCO. 2011 Jul;45(7):368.