

How to Cite:

Jandial, M., Mahajan, S., & Singh, G. (2021). Temporary anchorage devices in orthodontics. *International Journal of Health Sciences*, 5(S2), 333–343.
<https://doi.org/10.53730/ijhs.v5nS2.5854>

Temporary anchorage devices in orthodontics

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Abstract---During orthodontic treatment it is crucial to prevent the unintentional movement of the anchorage unit whilst causing movement of other teeth. Conventional methods of anchorage control came along with many shortcomings. The introduction of skeletal anchorage in the form of temporary anchorage devices (TADs) or miniscrews has greatly benefited orthodontists in finding a way of anchorage control with minimum patient compliance and without a complicated clinical insertion and removal procedures. This review article outlines about the types of TADs, parts, techniques of insertion, removal and its clinical applications in orthodontics.

Keywords---temporary, anchorage devices, orthodontics.

Introduction

For more than 100 years, orthodontists have searched for ideal anchorage that fits two criteria: absolute resistance to unwanted tooth movement and independence from patient compliance. Conventional intra- and extraoral anchorage systems often fall short of providing absolute anchorage¹. The extraoral forces cannot be used on 24 × 7 basis to resist the continuous tooth moving forces and are also taxing on patient's compliance. On the other hand, strict reliance on intra oral areas, usually dental units does not offer any significant advantage, except the fact that patient cooperation is less critical; therefore, it is important to have absolute anchorage to avoid reactive forces which might produce undesirable tooth movements^{2,3}. This deficiency has spurred interest in skeletal anchorage systems, which appeal to practitioners because they have the

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2021.

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Manuscript submitted: 18 Sept 2021, Manuscript revised: 9 Nov 2021, Accepted for publication: 12 Dec 2021

potential to provide absolute anchorage and do not depend on patient compliance. Skeletal anchorage has been the subject of study for more than 60 years in orthodontics.

Definition: 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 prosthesis, regardless of the fact that they may be used for orthodontic anchorage, are not. Considered temporary anchorage devices since they are 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 forces⁴. Mini-screws are also known as TAD'S Temporary Anchorage Device or Micro-implants or Ortho-implant which has brought about the significant revolution in the field of clinical Orthodontics.

Historical outlook

Evolution of orthodontic implants was followed the development of dental implants and orthognathic fixation methods. These techniques were combined with basic biological and biomechanical principles of osseointegration. Earliest record of idea for skeletal anchorage was given by Gainsforth and Higley (1945) who proposed possibilities of orthodontic anchorage in the basal bone by inserting Vitallium screws into a dog's ramus for the purpose of distalising a maxillary canine.⁶ The concept of osseointegration and use of titanium implants for replacement of teeth was introduced by Per Ingvar Branemark.^{7,8} Creekmore and Eklund (1983) gave the first clinical report of TAD usage in the anterior nasal spine for intrusion of upper incisors in a patient with severe deep bite.⁹ Kanomi (1997) was the first to describe that mini implant of 1.2 mm diameter and 6 mm length can be explicitly used for orthodontic purpose.¹⁰ Abso-Anchor Screw was developed in 1999 by a group of Korean clinicians, Aarhus Mini-Implant was created by a Scandinavian group and an Italian group developed The Spider Screw in 2003. Lately, palatal onplants, mid palatal screws and miniplate implants are being researched and reported.¹¹

Classification

- According to shape and size
 - Conical (cylindrical)- miniscrew implants - Palatal implants - Prosthodontic implants
 - Miniplate implants
 - Disk implants (onplants)

- According to implant bone contact
 - Osseointegrated
 - Non osseointegrated
- According to the application
 - Orthodontic implants
 - Prosthodontic implants¹⁰
- Based on the Location
 - Subperiosteal: Implant body lies over the bony ridge.
 - Transosseous: Implant body penetrates the mandible completely.
 - Endosseous: Partially submerged and anchored within the bone- endosseous implants are most commonly used for orthodontic purposes.
- 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: Flatter and can be used in resorbed and knife-edge ridges.
- According to the Composition
 - Stainless steel
 - Cobalt-chromium-molybdenum (Co-Cr-Mo)
 - Titanium
 - Ceramic implants
 - Miscellaneous, such as vitreous carbon and composites.
- According to the Surface Structure
 - 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 Nonporous: The screw type implants are usually nonporous, whereas the plate or blade implants (nonthreaded) 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.

Parts of implant

- Implant head – It serves as the abutment and in the case of an Orthodontic implant, could be the source of attachment for elastics/ coil-springs.
- Implant body- It is the part embedded inside bone. This may be a screw type or a plate type. The screw and plate design that has been used in Orthodontics as the skeletal anchorage system varies from these conventional plate implants.
- Implant Neck- It is the part of the implant which connects the Head and the Body. (fig.1)

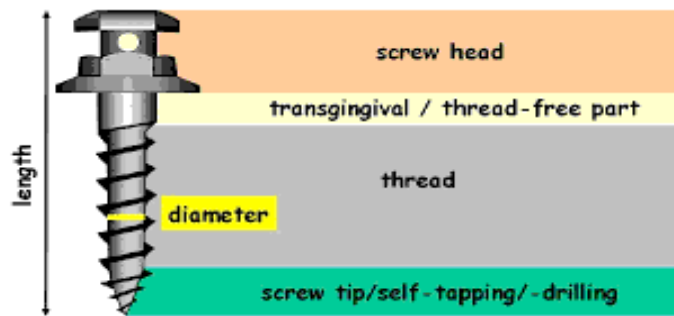


Fig.1. Implant design

Device design

Miniscrews or TADs are generally made of titanium or titanium alloy to ensure they are bioinert (i.e., they will not elicit an inflammatory tissue response or discharge corrosive by-products into the bone or surrounding tissue)¹². Ranging from 4 to 20 mm in length (6 to 12 mm being the most common) and 1.0 to 2.3 mm in width, TADs will have a male-type head that fits into a female socket on a hand held driver for insertion. Almost all miniscrews commercially available are both self-drilling (no pilot hole necessary) and self-tapping (meaning, they produce the space for their threads by compression or cutting as they are inserted)¹³. Two thread types are utilized in TADs. The first is a cutting-type thread outline that is used on screws of larger diameter and length for placement into dense cortical bone. These threads will cut and remove small amounts of bone as the screw is inserted. The second type has a thread-forming outline which compresses less-dense bone as it is inserted through a smaller amount of cortical bone during TAD placement.

Placement sites

In Maxilla: (fig.2)

Most commonly used sites are –

- Between second premolar and first permanent molar.
- Between the first and second permanent molar.
- Between the two central incisors, which is particularly good for intrusion.
- Infrazygomatic region – zygomatic buttress Palatal areas where the thickness and quality of cortical bone are excellent.
- Maxillary tuberosity region
- Mid palatal area

In Mandible: (fig.2)

Most common sites are –

- Between second premolar and first permanent molar
- Between first and second permanent molar
- Between two central incisors'

- Between mandibular canine and premolar buccally
- Retromolar area
- Mandibular symphysis facially

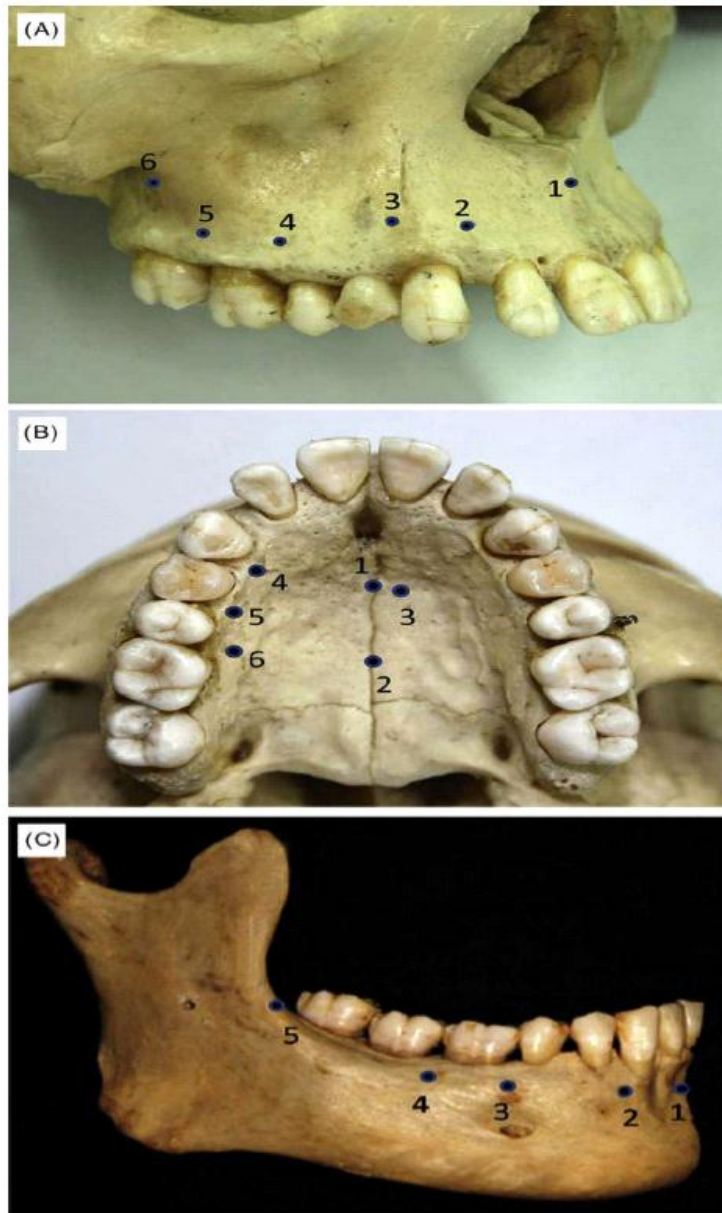


Fig.2. Various sites for miniscrew placement

Buccal sites on maxilla. (B) Palatal sites on maxilla. (C) Buccal sites on mandible. The sites that should be avoided are: Some of the anatomical and vital structures that should be kept care of during micro-implant placement include-inferior alveolar nerve, artery, vein, mental foramen, maxillary sinus and nasal cavity. As

these implant sites are reasonably close to archwire plane, the force applied to move the teeth and control of resultant counter forces are much easier. The screws used for orthodontics anchorage purpose must be thin (1.3mm to 1.5mm) and tapered to prevent accidental root contact.(fig.3). Generally, for maxilla length should be 8mm to 10mm and for mandible length should be 6mm to 8mm because of dense bone ¹⁴.

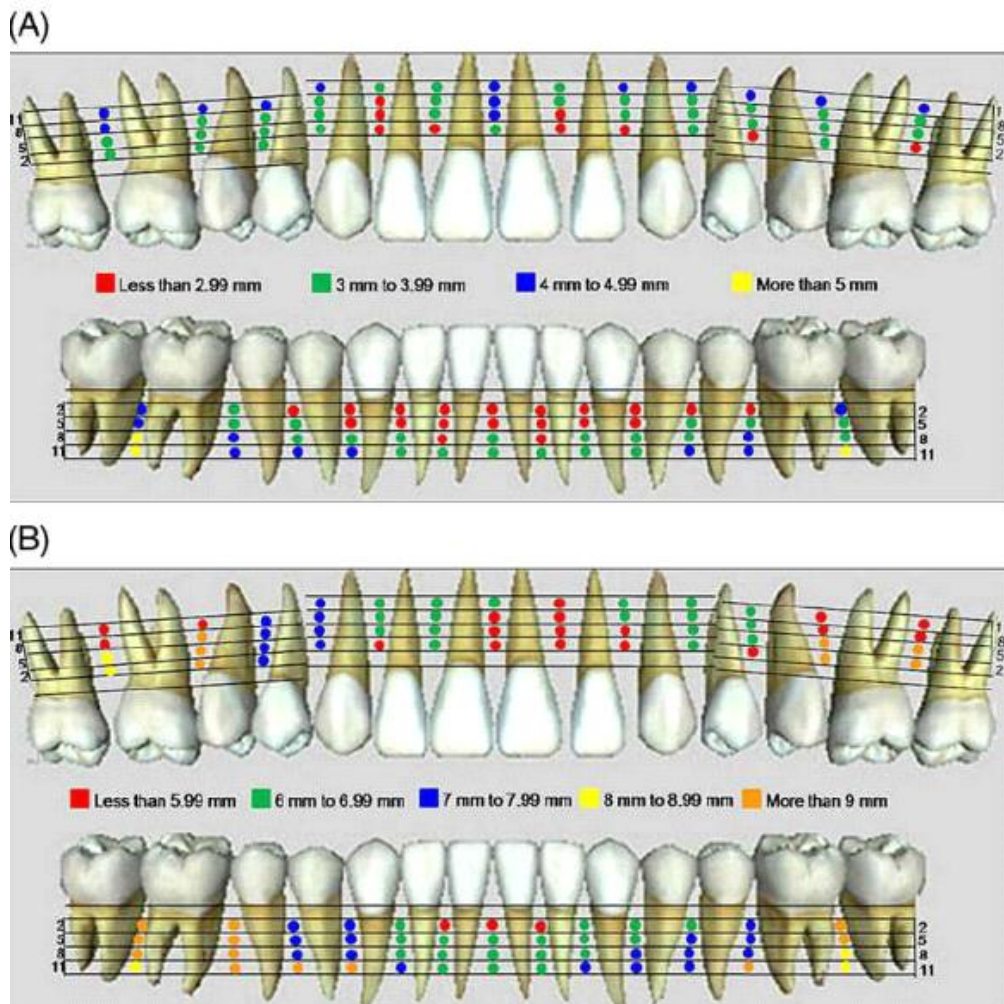
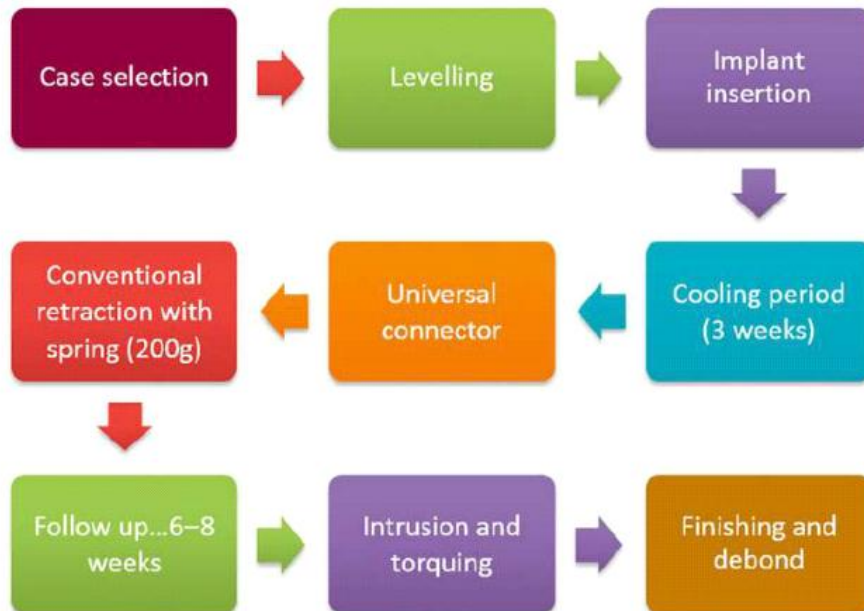


Fig.3. (A) Safe and danger zones based on the mesiodistal distance in the maxilla and mandible. (B) Safe and danger zones based on the buccopalatal distance in the maxilla and buccolingual distance in the mandible. The red areas indicate danger zones, and the green, blue, yellow and orange areas indicate the safe zones

Loading of Implant²¹



A schematic diagram of Dr Kharbanda protocol for MSI anchorage.

Clinical indications for use of TADs

- Insufficient number of dental elements and / or lack of occlusion drive anchor, for example patients with partial edentulism or agenesis.
- Extrusion or intrusion of individual teeth or groups of teeth without antagonists (ie in the absence of vertical opposing forces that act on them, for the need to maintain or restore proper occlusion and to avoid the establishment of functional disorders)
- Asymmetric tooth movement
- Shrinking and / or intrusion of anterior teeth with insufficient anchorage reactive unit
- Moving mesial of the molars where the front sector cannot be moved.
- Closure of spaces.
- Moving in distal direction of molars.
- Correction of an open-bite.

Since the anchoring devices have decisive role in orthodontics modern careful assessment of patient is essential to assess existence of any health conditions or factors that contraindicate use of mini-implants. Local risk factors such as bone quality and oral hygiene, general risk factors related mainly to overall health status of the patient. Best treatment plan must include the fewest number of TADS needed to deal with the case. Excessive use cannot be considered prudent

Contraindications

- Patients with metabolic bone diseases

- Patients taking suppressive therapy of the immune system
- Patients on chronic therapy with steroids or bisphosphonates
- Patients with severe neurological or psychological problems
- Patients with poor quality or quantity of bone tissue for the primary stability
- Patients with infections or circulatory problems
- Patients with allergic reactions to specific materials
- Patients receiving radiotherapy in the head and neck region or recurrent disease of the oral mucosa
- Patients with insulin-dependent diabetes, being more susceptible to infections
- Patients with poor oral hygiene
- Patients who have not completed skeletal growth^{15,19}.

Advantages

- Reduces need for patient compliance
- Eliminates need for ocular damage associated with headgear use
- Relative ease of insertion
- Good access to various placement sites
- Ease of removal
- Minimal discomfort and no residual surgical defects
- Versatile placement i.e. buccal or palatal ²⁰.

Complications

- Complications During Insertion–
 - Trauma to the periodontal ligament or the dental root
 - Miniscrew slippage
 - Nerve involvement
 - Air subcutaneous emphysema
 - Nasal and maxillary sinus perforation
 - Miniscrew bending, fracture, and torsional stress
- Complications Under Orthodontic Loading–
 - Stationary anchorage failure
 - Miniscrew migration
- Soft-Tissue Complications–
 - Aphthous ulceration
 - Soft-tissue coverage of the miniscrew head and Auxiliary
 - Soft tissue inflammation, infection, and peri implantitis
- Complications During Removal –
 - Miniscrew fracture
 - Partial osseointegration

Miniscrew removal²¹

Miniscrew can be removed under topical anaesthesia with the instrument used for driving, that is MSI driver with a firm yet slow anticlockwise motion, followed by anticlockwise turns by holding the head with tweezers or a similar instrument.

Miniscrew wound does not require sutures or post-removal dressings or systemic antibiotics or pain killers. The wound is seen to heal spontaneously with mucosa covering the site in 3–5 days.

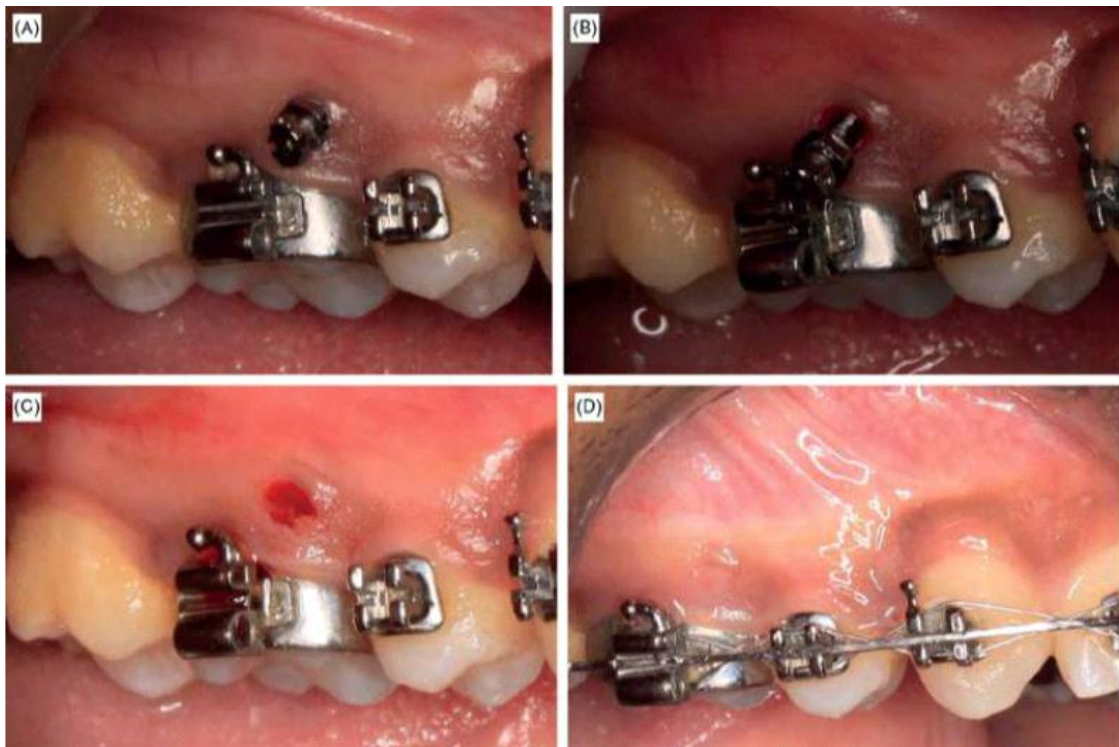


Fig 4. removal of miniscrew

Miniscrew removal is a rather simple, painless and uneventful procedure. Miniscrews are unscrewed and picked up with tweezers. The wound is dressed with sterile gauze impregnated with iodine solution. Oozing of blood, if any, stops spontaneously. The wound healing and epithelialisation occurs in 5–7 days. (fig.4)

Conclusion

Implants for the purpose of conserving anchorage are welcome additions to the armamentarium of a clinical Orthodontics. They help the Orthodontist to overcome the challenge of unwanted reciprocal tooth movement. Placed in either alveolar or extra-alveolar bone for the purpose of providing orthodontic anchorage, temporary anchorage devices (TADs) are removed once they complete their function in the treatment regimen. While they do not necessarily increase the rate of orthodontic correction. They helped converting many borderline surgical cases to nonsurgical and extraction cases to non-extraction and even bringing about esthetic impact which was difficult to achieve by conventional mechanics.

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