(International Print/Online Journal)

SJIF IMPACT FACTOR: 4.617
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume2, Issue 6, Page No: 235-239
November-December 2019

Mechanical Consideration of Mini-Implants - A Short Review

Dr. Aishwarya.K[1], Dr. Ashwin.K.S[2], Dr. Poorna Devadoss[3]
[1]Senior lecturer, [2]Post Graduate, [3]Professor
Department of orthodontics, Thai Moogambigai Dental College and Hospital, Mugappair, Chennai- 600107

***Corresponding Author:**

Dr. Aishwarya.K
Department of orthodontics, Thai Moogambigai Dental College and Hospital, Mugappair, Chennai- 600107

Type of Publication: Original Research Paper
Conflicts of Interest: Nil

ABSTRACT
Anchorage control has always been a challenge in the field of Orthodontics, adding to this is the patient'scompliance towards removable anchorage systems like headgears and face masks. Intra orally the teeth also cannot be used as absolute anchorage in various situations due to unwanted side effects. In the recent times, the use of Mini implants in Orthodontics is gaining popularity due to their advantages, ease of use and ability to control tooth movement in various planes of space. This article reviews the various aspects of Mini implants like advantages, disadvantages, placement, and compliance etc. in the field of Orthodontics

Keywords: Mini-implants, Screw, Anchorage, Torque

INTRODUCTION

Orthodontic tooth movements follow the principle of Newtons Third Law of Motion which states that "Every action has an equal and Opposite Reaction". Tooth movement happens when forces are applied which is counteracted by equal and opposite force. Generally orthodontic treatment causes unplanned tooth movements which need to be controlled from the beginning. Anchorage control is an important consideration for achieving optimal treatment results in orthodontic practice. To reinforce anchorage and achieve the desired tooth movements, there are several options such as interarch elastics, headgears, bonded intraoral anchorage devices, miniplates, dental implants, and miniimplants. These mechanics and appliances have specific advantages anddisadvantages, mainly depending on the specific properties of the individual case. Unfortunately, all types of conventional intra-oral anchorage reinforcement are associated with anchorage loss. Throughout the twentieth century headgear was regarded as the 'gold standard' for anchorage reinforcement, principally because it was the only source of anchorage not dependent on the dentition. Headgear, however, is often associated with compliance problems, in that insufficient wear by the patient results in anchorage loss [1].

The use of absolute anchorage dates back to the 1700's where John Hunter, Scottish Surgeon explored the chances of transplanting human teeth[2].In 1911, Greenfield described the fabrication & insertion of an endosseous implant[3]. The first published case of an implant for orthodontic anchorage was introduced by Gainsforth & Higleyin 1945[4]. In 1969, Branemark et al reported that titanium implants remained stable for 5 years without sign of tissue injury or rejection showing that the implant became firmly osseointegrated with the bone [5]. In 1984, Robert & fellow researchers collaborated with Branemark in a study which concluded that titanium endosseous implants provides firm osseous anchorage for orthodontics & dentofacial orthopedics[6].In 1988, Shapiro & kokich described

the use of Dental implants for anchorage during orthodontic treatment prior to being used for prosthodontic purposes[7]. Also in the same year, Creekmore used Vitallium implant for anchorage for intruding upper anterior teeth[8].Orthodontic mini-implants have been in clinical practice since Kanomi first mentioned them as an anchorage device in 1997[9].Spider screw system implant for skeletal anchorage was introduced by Maino et al[10]and C micro implant system was introduced by Kyu Rhim Chung[11].

The start of the twenty-first century has seen the emergence of a new form of orthodontic anchorage, utilising orthodontic mini-implants (OMIs), also known as mini-screw implants and temporary anchorage devices (TADs). These are modified bone screws with typical body (endosseous) dimensions of 1.5–2 mm diameter and 6–10 mm length. Their surfaces are polished and smooth compared to tooth implants. Hence they rely on mechanical retention within the alveolar and palatal bones, especially their cortical layers, rather than osseointegration.

Contemporarily, mini-implants have a multitude of indications in orthodontic practice with a wide range of size and design options. Mini-implant anchorage is reported to be used in many cases, such as the upper third molar alignment, correction of a canted occlusal plane, alignment of dental midlines, correction of deep overbites, closure of extraction spaces, extrusion of impacted canines, extrusion and uprighting of impacted molars, molar intrusion, maxillary and mandibular molar mesialisation and distalization, intermaxillary anchorage for the correction of sagittal discrepancies,en masse retraction of anterior teeth, and correction of vertical skeletal discrepancies.

Although there are various advantages there are many frequently encountered problems such as loosening, pain, tissue overgrowth, discomfort of the mini-implants. Their stability is determined by implant design, surgical technique, loading conditions and bone strength. This review evaluates the clinical usefulness, success rates, and analyzes the various factors associated with them.

Classification of Mini Implants used in Orthodontics:

1. Based on Dimensions:
    a. Diameter
        i. 1.2 mm
        ii. 1.5 mm
        iii. 1.8 mm
        iv. 2 mm
    b. Length
        i. 5mm
        ii. 8 mm
        iii. 10 mm
        iv. 12 mm
        v. 14 mm
2. Based on Materials:
    a. Titanium
    b. Stainless Steel
    c. Vitallium
3. Based on Location:[12]
    a. Maxilla
        i. Infrazygomatic Crest
        ii. Maxillary Tuberosity
        iii. 1st and 2nd Molar Bucally
        iv. 1st and 2nd Molar Palatally
        v. 1st molar and 2nd Premolar Bucally
        vi. Canine and Pre molar Bucally
        vii. Maxillary incisors Facially

    b. Mandible
        i. Retromolar Area
        ii. 1st and 2nd Molar buccaly
        iii. 1st Molar and 2nd Premolar Bucally
        iv. Canine and Pre Molar Bucally
        v. Mandibular Symphysis Facially
        vi. Edentulous Areas
        vii. Tori

4. Based on Head Type:[13]
    a. Small head type
    b. Long head type
    c. Circle head type
    d. Fixation head type
    e. Bracket head type

ADVANTAGES OF MINI IMPLANTS AS TEMPORARY ANCHORAGE DEVICES [14]:

- Insertion and removal does not require any particular surgical procedure.
- There is no need for complicated clinical and laboratoryprocedures (i.e., fabrication of acrylic splints.
- Miniscrew implants can be immediate loaded (there is no need for a waiting period for

Volume 2, Issue 6; November-December 2019; Page No.235-239

Osseo-integration, in contrast to orthodonticimplants), reducing thetotal treatment time.

- Miniscrew implants offer a variety of locations thatcan be inserted, unlike conventional dental implantsused for orthodontic anchorage.
- The provided absolute anchorage eliminates undesirableeffects on the teeth that otherwise would havebeen normally used as anchorage.
- Patient cooperation is limited to maintaining immaculateoral hygiene.
- Miniscrew implants can be easily removed.
- Cost is relatively low.

DISADVANTAGES OF MINI IMPLANTS AS TEMPORARY ANCHORAGE DEVICES [14]:

● 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 mini screw implant is also possible, especially by patients with poor oral hygiene.

●When the oral surgeon is involved for insertion (mainly when drilling is required), there is an additional cost to the patient.

Mini-Screw design:

The orthodontic mini- implant made up of titanium alloy grade V for anchorage. Orthodontic mini screw has 4 components [fig 1]

1. Head – Configuration of head differs based on requirement [13].
2. Neck – accessories like elastics, Niti coil springs etc. are attached here.
3. Platform – Available in three different sizes (1mm, 2mm, and 3mm) toaccommodatevaryingsoft tissue thickness at different implant site.
4. Body – It is available as cylindrical or tapered with self-drilling or self-tapping types. It provides better mechanical retention, less loosening breakage, and stronger anchorage.

Figure 1: Parts of mini-implant

Mini Screw Size:

In the maxilla, implant diameters equal to or less than 1.4 mm with 8-10 mm length are recommended for orthodontic anchorage due to the porous nature of bone.Whereas in the mandible, the choice of diameter should be larger than 1.4 mm with 6-8 mm length due to dense cortical bone.The1.5 mm tapered and 2.0 mm cylindrical versions of the mini implants achieved significantly greater primary stability than the 1.5 mm cylindrical design [15].

Tseng et al. reported a 100% success rate for a mini-implant of more than 12 mm in length and he concluded that the length of the mini-implant was related to its success rate[16]. He also reported that the success rate of the mini-implant of 8 mm in length and 2 mm in diameter was 80%.Miyawaki et al [17] reported success rates of 83.9% for 1.5-mm diameter and 85% for 2.3-mm diameter screw-type implants but the selection of size (diameter) is purely based on the jaw involved, location, and interdental bone thickness. Motoyoshi et al [18] showed higher success rates (91.9%) with 1.6 mm in diameter and 8 mm long compared to previous studies.

Mini Screw Angulation:

The buccal cortical bone is thin in maxilla from canine to the second premolar. Thus screw should be placed such that it does not touch the roots. The interdental space between the roots resembles an inverted pyramid. The Space keeps increasing in width to about 5mm as the root taper apically. The

Volume 2, Issue 6; November-December 2019; Page No.235-239

screw is placed at 30- degree to 40 -degree angle to the long axis of the teeth in the maxillato keep it in the widest space available between the roots apically. Mandible has a dense buccal cortex which requires a shorter screw with 10 degree to 20 degree angulation. To achieve the best primary stability, an insertion angle ranging from 60° to 70° is advisable. If the available space between two adjacent roots is small, a more oblique direction of insertion seems to be favourable to minimize the risk of root contact [19].

Implant Placement Torque (IPT):

IPT is the frictional force generated at the interface between the bone and screw during tightening. In a dense cortical bone, screw with larger diameter produce larger IPT and enhanced stability. A method was adopted to improve the success rate of mini-implants, by controlling the placement torque through the use of a drill size in proportion to bone density so that a recommended placement torque of (5–10 N cm) was achieved. By using this method excessive torqueing of the mini screw during insertion was reduced [7]. Motoyoshi et al[12] reported higher loss rates when the insertion torque exceeds10 Ncm (100 Nmm) for mini-implants with a diameter of 1.6 mm. This could be the reason for higher implant loss rates with mini-implants at very high insertion torques in the mandible.The placement and removal torques averaged approximately 8 and 4 N cm, respectively. A torque of 4 N cm imparts sufficient anchorage for mini-implants[15].

Loading of mini screw:

In a study using finite element analysis, it was found that immediate loading should be limited to 50 cN of force in a 2 mm diameter mini screw implant[17].In other study, no significant association was found between the success rate and immediate loading, and it was concluded that immediate loading is possible if the applied force is less than 2 N[16].

Conclusion:

Miniscrews have a high success rate of approximately 90% the same as miniplates and large titanium screws, and they provided sufficient anchorage immediately after placement surgery for any orthodontic tooth movement. In addition, miniscrews placed without a mucoperiosteal incision or flap surgery significantly reduced the patient's pain and discomfort after implantation. Miniscrews. have suitable characteristics as orthodontic anchorage devices.

References:

1. Ring Malvin E, editor. 2nd ed. Abradale Press; 1985. Dentistry: an illustrated history.
2. Asbell Milton B. Dentistry. a historical perspective: being a historical account of the history of dentistry from ancient times with emphasis upon the United States from the colonial to the present period. Bryn Mawr Pa Dorrance & Co. 1988: 1–256.
3. Greenfield EJ. Implantation of artificial crown and bridge abutments. Int J Oral Implant. 1991; 7(2):63–8.
4. Gainsforth BL, Highley LB. A study of orthodontic anchorage possibilities in basal bone. Am J Orthod 1945; 31:406-17.
5. Branemark PI, Breine U, Adell R. Intraosseous anchorage of dental prostheses. I. Experimental studies. Scand J PlastReconstrSurg 1969; 3:81-100.
6. Roberts WE, Smith RK,Y. Silberman Y, Mozsary P-G, Smith RS. Osseous adaptation to continuous loading of rigid endosseous implants. Am J Orthodont 1984; 86:95111.
7. Smalley M Ward, Shapiro A Peter, Hohl H Thomas, Kokich G Vincent, Branemark Per-lngvar; Osseointegrated titanium implants for maxillofacial protraction in monkeys; AM J ORTHOD DENTOFAC ORTHOP 1988;94:285-95.
8. Creekmore TD, Eklund MK. The possibility of skeletal anchorage.JClinOrthod 1983; 17:266-69.
9. Kanomi R. Mini-implant for orthodontic anchorage. J ClinOrthod. 1997; 31:763–767.
10. Maino, B.G.; Bednar, J.; Pagin, P.; and Mura, P.: The Spider Screw for skeletal anchorage, J. Clin. Orthod. 37:90-97, 2003.
11. Kyung, H.M.; Park, H.S.; Bae, S.M.; Sung, J.H.; and Kim, I.B.: Development of orthodontic micro-implants for intraoral anchorage, J. Clin. Orthod. 37:321-328, 2003.
12. Bae SM, Kyung HM. Clinical applications of micro implant anchorage (MIA) in orthodontics (2): Anatomic consideration and surgical procedure. Korean J clinOrthod 2002; 1: 16-29.

Volume 2, Issue 6; November-December 2019; Page No.235-239

13. Cope Jason. Temporary Anchorage devices in Orthodontics: A Paradigm shift. Seminar in orthodontics. 2005; 11: Pg. 3-9.
14. Moschos A. Papadopoulos, and Fadi Tarawneh, Thessaloniki: The use of miniscrew implants for temporary skeletal anchorage in orthodontics: A comprehensive review Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:e6-e15.
15. Lindsy Holm; Susan J. Cunningham; Aviva Petrie; Richard R.J. Cousley An in vitro study of factors affecting the primary stability of orthodontic mini-implants Angle Orthod. 2012;82:1022–1028.
16. Tseng YC, Hsieh CH, Chen CH, ShenIY, Huang IY, Chen CM. The application of mini-implants for orthodontic anchorage. Int J Oral MaxillofacSurg2006: 35: 704–707.
17. Miyawaki S, Koyama I, Inoue M, Mishima K, Sugahara T, and Takano-Yamamoto T. Factors associated with the stability of titanium screws placed in the posterior region for orthodontic anchorage. Am J Orthod Dentofacial Orthop 2003;124:373-8.
18. Mitsuru Motoyoshi, Miwa Uemura, Akiko Ono, Kumiko Okazaki, Toru Shigeeda, and Noriyoshi Shimizue Factors affecting the long-term stability of orthodontic mini-implants Am J Orthod Dentofacial Orthop 2010;137:588.e1-588.e5.
19. Benedict Wilmes, Yu-Yu Su, and Dieter Drescher (2008) Insertion Angle Impact on Primary Stability of Orthodontic Mini-Implants. The Angle Orthodontist: November 2008, Vol. 78, No. 6, pp. 1065-1070.

Volume 2, Issue 6; November-December 2019; Page No.235-239