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Mini Implants And Its Application In Orthodontics: A Review

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Abstract

Recently, the use of miniscrews to achieve absolute anchorage has gained popularity in clinical orthodontics as rigid anchorage procedure. Miniscrew implants contributes many advantages when used as temporary anchorage devices like, providing absolute anchorage, convenient placement and removal, can be placed in different sites and requires less patient compliance. This makes them an indispensable treatment option in cases with critical anchorage that would have otherwise resulted in anchorage loss if treated with regular means of anchorage. The aim of this broad review is to focus on the progressive evolution, clinical applications, indications and complications of the miniscrew implants when used to achieve a temporary but absolute skeletal anchorage for orthodontic applications.

Keywords: Anchorage, Temporary Anchorage Devices, Mini-Implant, Orthodontics.

Introduction

Ensuring adequate anchorage is often a prime concern in Orthodontics. While progressing through the orthodontic treatment ,teeth are exposed to various forces & moments. All these forces bring about reciprocal forces in opposite direction. This statement can be correlated to Newton's third Law, ie , for every action there is an equal and opposite reaction. The forces need to be well controlled to achieve desired treatment objectives and to evade undesirable tooth movements. Understanding the basic concepts of anchorage management methods are an important factor for the success of any orthodontic treatment. Stable anchorage is a necessary requirement for orthodontic treatment with fixed appliances. Traditional appliances for reinforcement of anchorage includes headgear and intraoral elastics.

The patients wearing these bulky appliances must be co-operative to achieve the desired treatment outcomes. It becomes challenging when the techniques developed for reinforcing anchorage, depends on patient compliance. The introduction of mini- screws in orthodontics have expanded the boundary of tooth movement without patient compliance. Mini-screws works on the basic principle of absolute anchorage. Absolute or infinite anchorage is defined as no movement of the anchorage unit as a consequence to the reaction forces applied to move teeth. Mini-screws are also known as TAD's - Temporary Anchorage Device or Micro-implants or Ortho-implant which has brought about momentous transformation in the field of clinical Orthodontics.

History

Skeletal anchorage was suggested more than 75 years ago when Grainsforth and Higley[1] placed vitallium screws in ramus of the mandible in 6 dogs to distalize the maxillary canine. But the application of force resulted in screw loss within 16 to 31days. Years later, Creekmore and Eklund [2] evaluated that a small sized vitallium bone screw could withstand a constant force of adequate magnitude over a long period of time for retraction of the entire anterior maxillary dentition and it could be inserted just below the anterior nasal spine to treat a patient with a deep impinging overbite. Roberts et al [3] evaluated the osseous adaptations of rigid endosseous implants to continuous loading of 100 gms in rabbit femurs. Results suggested that the titanium implants contributed firm osseous anchorage for orthodontics and dentofacial orthopaedics. Roberts et al [4] further conducted considerable research on the use of retromolar implants for orthodontic anchorage. Onplant, a subperiosteal implant consisting of a thin circular titanium disc was introduced by Block and Hoffman in the year 1995 [5].In 1996,Bosquet et al [6] introduced a variant of interdental implants, that were endosseous implants but of smaller diameter. Ryuzo Kanomi [7] reported that 1.2mm diameter and 6-7 mm length titanium mini-implants, could be used effectively for anterior intrusion and retraction, and molar intrusion. Costa et al [8] introduced, the Aarhus Anchorage System, a miniscrew with a bracket like head which aided the insertion of a full sized wire. Melsen and Costa[9] through their extensive studies outlined primary stability as an important factor for mini implant success. They suggested that primary stability is important during the healing and remodelling period, especially when the implant is immediately loaded. Ohmae et al[10] reported the results of a clinical and histological evaluation of titanium mini-implants used as anchors for orthodontic intrusion in beagle dogs. Park et al[11] suggested that 1.2mm diameter microscrews could be inserted between the roots of the teeth to retract the six anterior teeth en mass and intrude mandibular molars at the same time.

Classification

Skeletal anchorage devices can be classified into two categories, based on their origin.[12]The first category has its origins in Osseo integrated dental implants and consists of orthodontic mini-implants, the retromolar implants, and the palatal implants. The second category finds its origin in the surgical mini-implants, such as the one used by Creekmore and Eklund[2] and those specified later by Kanomi[7] and Costa et al.[8] The variation between the 2 categories are that devices of the second category are smaller in diameter, have smooth surfaces, and are designed to be loaded shortly after insertion.[12]

Cope Classification [13]

- Biocompatible- TADS
- Biologic -Ankylosed and dilacerated teeth

Labanauskaite etal.[14]suggested the following classification:

- According to the shape and size
  - conical (cylindrical)
    - Miniscrew implants
    - palatal implants
    - prosthodontic implants
  - miniplate implants
  - disc implants (onplants);
- According to the implant bone contact
  - osseointegrated
  - nonosseointegrated;
- According to the application
  - used only for orthodontic purposes (orthodontic implants)
  - used for prosthodontic and orthodontic purposes (prosthodontic implants).

Ideal Characteristics

The major difference between the presently available miniscrews relate to their composition, size, and design and include: (1) alloy or metal used for their manufacturing (2) diameter of threaded portion, (3) length of the implant, and (4) design of the head. An ideal miniscrew implant used for orthodontic anchorage should satisfy a broad set of requirements, which includes :

- Biocompatibility;
- Availability in different diameters and length sizes, and different designs (i.e., button or bracket head);
- Simple and easy to insert
- Capable of immediate loading
- Removal without the need for complicated accessory equipment; and low cost.

Biocompatibility

Most of the available systems are made up of medical type IV or type V titanium alloy.

Osseointegration

Complete osseointegration of screws used in orthodontic applications complicates the removal process. So most of these devices are fabricated with a smooth surface, thereby diminishing the development of bone ingrowth and promoting soft tissue attachment at the typical conditions and in the absence of special surface treatment regimens.[15]

Types of anchorage

The miniscrew implants administers 2 different types of anchorage: direct and indirect. While using for Indirect anchorage, the miniscrews are connected through bars or wires to the reactive unit , whereas when used for direct anchorage, the miniscrews directly receive the reactive forces by acting as an anchor unit. [16]

Head design

Most of the currently available miniscrew implant systems are available in different designs to facilitate both direct and indirect anchorage and to avoid tissue irritation. The most common is the buttonlike design with a sphere or a double sphere like shape or a hexagonal shape. Miniscrew implants available with this design include the Aarhus Anchorage System, the Abso Anchor System, the Dual-Top Anchor System etc. This design with a hole through the head or the

neck of the screw, generally 0.8 mm in diameter is mostly used for direct anchorage. A bracketlike design is also available, which can be used for either direct or indirect anchorage as manufactured by the Aarhus Anchorage System, the AbsoAnchor System, the Dual-Top Anchor System, the Spider Screw Anchorage System etc. A hook design was used by the TOMAS miniscrew implant.

The pitch of the screw threads

Screw with tight pitch should be used in areas of dense bone. The layer of cortical bone is thin in the dental alveolus, thus a tighter pitch of the threads near the head of the screw will provide considerable contact with the cortical bone, higher pull out strength, and improved primary stability [17].

Length of the screw

Studies suggest that short screws performs as comparable to the longer ones. This is because the amount of contact with cortical bone is the major factor in stability. Amount of contact with medullary bone doesn't make a major difference. Screws extending to the base of zygomatic process needs to be longer to reach the cortical bone. A long screw which passes through the alveolus to reach cortical bone on the other side does provide greater stability but it is not recommended due to its invasiveness [18].

Diameter of the screw:

Screw which has to be placed in to the alveolar process must be narrow enough to fit between the teeth. Bone screws with diameter1.3mm to 2mm are currently used. Success rates are low for screws with diameter less than 1.3mm.The stability and survival are more strongly related to amount of cortical bone contact rather than the diameter of the screw but a larger diameter screw does provide better primary stability when heavy force is applied [19].

The form of the tip:

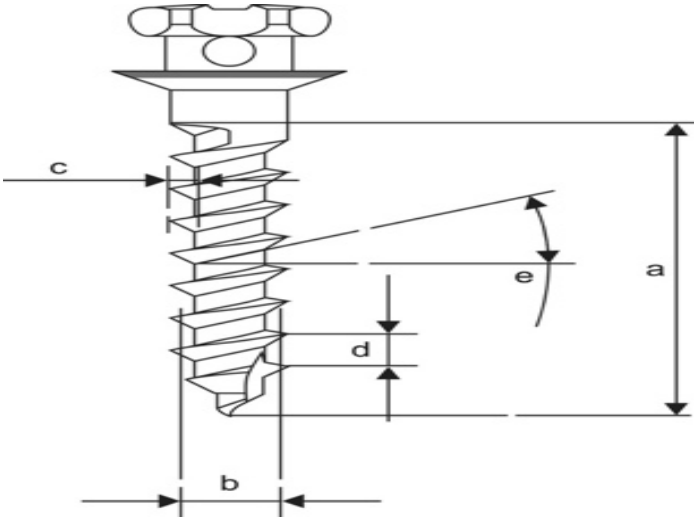

Figure 1: Parts of a miniscrew [39]: [a]Length, [b]Outerdiameter, [c]Depth, [d]Pitch, [e]Lead angle

Indications

Due to the versatility of mini-implant enhanced mechanics, some situations that could be treated using traditional mechanics might be corrected in a shorter time and with better treatment outcome. In these kind of situations, mini-implant anchorage might be indicated if the patient's desires can be better addressed and the benefits outweigh the risks. The usage of mini-implants might be beneficial for the following treatment objectives

Corrections in the anteroposterior dimension [21-24]

1) Patients with full-step Class II malocclusion and severe overjet with the need for extraction of the maxillary first or second premolars and the retraction of the maxillary anterior teeth. Absolute anchorage is indicated because anchorage loss is unfavourable in this kind of situation, and treatment time can be reduced by en-masse retraction.
2) Patients with severe bimaxillary protrusion with the complaint of unpleasant profile or lip incompetence and who are reluctant to wear headgear could be treated with mini-implants after 4 premolar extractions because they allow for maximum retraction with maximum impact on profile.
3) Patients requiring canine substitution because of agenesis of the lateral incisor may be benefitted with the use of miniscrews. Absolute anchorage allows for protraction of the posterior segments, thus making canine substitution an option even in a Class I molar relationship, a conventional contraindication for canine substitution.
4) Mini-implants can be used for the protraction of posterior segments, especially for closing extraction space, or for tooth agenesis or tooth loss if prosthetic replacement is not advised..

5) Patients who requires molar distalization for correction of Angle Class II malocclusion and to relieve the crowding.
6) Complete maxillary and mandibular arch distalization using mini screws placed in Infra zygomatic crest and buccal shelves respectively.

Corrections in the vertical dimension [25-27]

1) Anterior open bites could be corrected with the intrusion of maxillary posterior segments in patients with posterior maxillary excess
2) Mini-implants can be used for the vertical control of mandibular posterior segments in high-angle cases.
3) Anterior open bites can be corrected by a combination of the above.
4) Intrusion of Maxillary incisors in patients with deep bite and excessive gingival display.
5) Intrusion of Mandibular incisors in patients with deep bite and deep curve of Spee.
6) Deep bites can be corrected by a combination of the above.
7) Canted occlusal planes can be corrected.

Corrections in the Transverse Dimensions

1) The use of MARPE appliances such as MSE can be used to correct transverse maxillary deficiency in adolescent patients with minimal dentoalveolar side effects.[28]

Single tooth movement, mutilated dentition and preprosthetic orthodontics [29,30]

1) Mini-implants can be used for single-tooth intrusion in patients with extruded antagonists, uprighting of the molars and space management
2) In patients with mutilated dentition desirable anchorage can be achieved.

Complications

Inflammation, infection, and tissue irritation

Inflammation and infection of the tissues around the implant site might occur.[31-33] Thorough oral hygiene is necessary, and the use of 0.2% chlorhexidine mouth rinses or dental floss dipped in 2% chlorhexidine can be recommended to evade and control any inflammation or infection that might develop.[33]

At situations where the patient has purulence, pallor, or inflammation, management with an appropriate antibiotic is recommended.[32] An essential factor to help avoid tissue inflammation is the determination of the best site for miniscrew implant insertion.[34] It is recommended that the miniscrew implants should be inserted in keratinized gingiva when possible[12] and that frenum and muscle tissue should be avoided.[35] Hypertrophy of the mucosa covering the implant might appear as a complication of placing it in nonkeratinized gingiva. In such situations the placement of a healing cap abutment is advised at the time of insertion,[32] or the clinician could allow the mucosa to cover the miniscrew implant, with only a wire or an attachment on it passing through the mucosa.[12]

Injury to adjacent structures

Injury to the adjacent roots, periodontal ligaments, nerves, and blood vessels is a major concern in miniscrew implant insertion.[33] In such circumstances, the patient usually shows pain on percussion and mastication in cases of periodontal injury, and sensitivity to hot and cold in case of root injury.[33] In these situations, the miniscrew implant should be immediately removed.[31] The prognosis of the injured tooth depends on whether the pulp has been injured or not.

Failure

Failure of the miniscrew implants occur if there is lack of stability at insertion time due to inadequate thickness of the cortical bone.[31] If this complication appears, an alternate site should be adopted to insert the miniscrew implant. The miniscrew implant may be lost or become

loose as a result of various factors, such as inflammation of the peri-implant tissues or improper placement.[31] In a study by Miyawaki et al.,[34] it was reported that instability and failure of titanium miniscrew implants inserted in the buccal alveolar bone of the posterior region were associated with an implant thread diameter of 1.0 mm or less. The same study also reported that patients with high mandibular plane angles may not be a suitable candidate for miniscrew implantation, because they often display thin cortical bone, which may lead to implant failure.

Recent advancements

In 2010, Lee et al introduced an RPE reinforced by orthodontic miniscrews (MARPE) positioned on the palatal bone. To avoid multiple surgeries, nonsurgical maxillary expansion was performed with the MARPE to achieve both skeletal and dentoalveolar expansion for transverse correction. [36]

In 2016, Suzuki et al[37] changed the rapid maxillary expansion appliance, securing it by means of miniscrews (MARPE); however, with a different design (Peclab, Belo Horizonte, Brazil) MARPE's new design has been used in a number of patients with atrophic maxilla, both young, growing patients and adult ones. Park and Hwang, Moon and MacGinnis et al developed the maxillary skeletal expander (MSE, Biomaterial Korea, Seoul, South Korea) with four miniscrews installed into the expansion screw body, parallel to the midpalatal suture and to itself.[38]Maxillary Skeletal Expander (MSE) is a unique MARPE, with posterior force loading and bi-cortical engagements of implants, and the expansion force is concentrated near the suture according to the FEM study. This approach reduced bone bending and dental tipping, and assisted in disarticulating the premaxillary sutures connecting the maxilla to the skull. MSE can effectively cause non-surgical mid-facial expansion in mature patients, disarticulating all sutures associated with maxillary complex.

Conclusion

The use of miniscrew implants expands the envelope of discrepancies that are potentially correctable by orthodontic and dentofacial orthopaedic treatment. In conclusion, the incorporation of mini implants into the treatment plans has had an exceptional impact in the field of dentistry. They represent a feasible alternative for orthodontics in obtaining absolute anchorage. It not only allow to challenge the Newton's third law and carry out orthodontic actions without

reaction, which was one of the greatest woe for orthodontist but it also facilitated difficult treatments, such as molar intrusion, uprightness distalization, and protraction. Due to its reduced size, low costs and especially, lack of necessity of the patient's cooperation and the fact that they do not jeopardize aesthetics, mini-implants can be inserted in many different spots, making innumerable clinical application possible and being demanded increasingly at orthodontic clinics.

References

1. Geinforth BL, Higley LB. A study of orthodontic anchorage possibilities in basal bone. Am J Orthod Oral Surg 1945; 31: 406-417
2. Creekmore TD, Eklund MK. The possibility of skeletal anchorage. J Clin Orthod. 1983; 17: 266-269.
3. Roberts W.E., Smith R.K, Zilberman Y, Mozsary P.G, Smith R.S. Osseous adaptation to continuous loading of rigid endosseous implants. Am J Orthod 1984; 86: 95-111
4. Roberts WE, Markshall K J, Mozsary PG. Rigid endosseous implants utilised as anchorage to protract molars. Angle Orthod 1990; 60: 135-152.

5. Lock MS, Hoffman DR. A new device for absolute anchorage for orthodontics. Am J Orthod Dentofacial Orthop 1995; 107: 251-8.
6. Bousquet F, Bosquet P, Mauren G, et al. Use of an impacted post for anchorage. J Clin Orthod 1996; 30:261-265.
7. B Kanomi R. Mini-implant for orthodontic anchorage. J Clin Orthod 1997; 31(11):763-767.
8. Costa A. Raffini M, Melsen B. Microscrews as orthodontic anchorage. Int J Adult Orthod 1998; 13:201-209
9. Melsen B, Costa A. Immediate loading of implants used for orthodontic anchorage. Clin Orthod Res 2000; 3: 23-8.
10. Ohmae M, Saito S, Morohashi T, Seki K, Qu H, Kanomi R, et al. A clinical and histological evaluation of titanium mini-implants as anchors for orthodontic intrusion in the beagle dog. Am J Orthod Dentofacial Orthop 2001; 119: 489-97
11. Park S, Bae SM, Kyung HM, Sung JH. Micro-implant anchorage for treatment of skeletal class I bialveolar protrusion. J Clin Orthod 2001; 35(7): 417-422.
12. Melsen B. Mini-implants: where are we? J Clin Orthod 2005; 39:539-47.
13. Cope J. Temporary anchorage devices in orthodontics: a para- digm shift. Semin Orthod 2005;11:3-9.
14. Labanauskaite B, Jankauskas G, Vasiliauskas A, Haffar N. Im- plants for orthodontic anchorage. Meta-analysis. Stomatologija 2005;7:128-32.
15. Carano A, Melsen B. Implants in orthodontics. Prog Orthod 2005;6:62-9.
16. Costa A. Raffini M, Melsen B. Microscrews as orthodontic anchorage. Int J Adult Orthod 1998; 13:201-209
17. Brinley CL, Behrents R, Kim KB, Condoor S, Kyung HM, Buschang PH. Pitch and longitudinal fluting effects on the primary stability of miniscrew implants. The Angle Orthodontist. 2009 Nov;79(6):1156-61.
18. Chatzigianni A, Keilig L, Reimann S, Eliades T, Bourauel C. Effect of mini-implant length and diameter on primary stability under loading with two force levels. The European Journal of Orthodontics. 2011 Aug 1;33(4):381-7.
19. Ahmed VK, Krishnaswamy NR, Thavarajah R. Miniscrew implant fracture and effects of such retained tip on dentin–pulp complex: a histological report. Dental Traumatology. 2016 Apr;32(2):161-5.
20. Rodriguez JC, Suarez F, Chan HL, Padial-Molina M, Wang HL. Implants for orthodontic anchorage: success rates and reasons of failures. Implant dentistry. 2014 Apr 1;23(2):155-61.
21. Park HS, Kwon TG. Sliding mechanics with microscrew implant anchorage. Angle Orthod 2004;74:703-10.
22. Gelgor IE, Buyukyilmaz T, Karaman AI, Dolanmaz D, Kalayci A. Intraosseous screw-supported upper molar distalization. Angle Orthod 2004;74:838-50.
23. Herman RJ, Currier GF, Miyake A. Mini-implant anchorage for maxillary canine retraction: a pilot study. Am J Orthod Dentofacial Orthop 2006;130:228-35.
24. Chung KR, Cho JH, Kim SH, Kook YA, Cozzani M. Unusual extraction treatment in Class II Division 1 using C-orthodontic mini-implants. Angle Orthod 2007;77:155-66.
25. Kuroda S, Katayama A, Takano-Yamamoto T. Severe anterior open-bite case treated using titanium screw anchorage. Angle Orthod 2004;74:558-67.
26. Erverdi N, Keles A, Nanda R. The use of skeletal anchorage in open bite treatment: a cephalometric evaluation. Angle Orthod 2004;74:381-90.

27. Ohnishi H, Yagi T, Yasuda Y, Takada K. A mini-implant for orthodontic anchorage in a deep overbite case. Angle Orthod 2005;75:444-52.

28. Zong C, Tang B, Hua F, He H, Ngan P. Skeletal and dentoalveolar changes in the transverse dimension using microimplant-assisted rapid palatal expansion (MARPE) appliances. InSeminars in Orthodontics 2019 Mar 1 (Vol. 25, No. 1, pp. 46-59). WB Saunders.

29. Giancotti A, Arcuri C, Barlattani A. Treatment of ectopic mandibular second molar with titanium miniscrews. Am J Orthod Dentofacial Orthop 2004;126:113-7.

30. Yao CC, Wu CB, Wu HY, Kok SH, Chang HF, Chen YJ. Intrusion of the overerupted upper left first and second molars by mini-implants with partial-fixed orthodontic appliances: a case report. Angle Orthod 2004;74:550-7.

31. Melsen B, Verna C. Miniscrew implants: the Aarhus Anchorage System. Semin Orthod 2005;11:24-31.

32. Herman R, Cope JB. Miniscrew implants: IMTEC Mini Ortho Implants. Semin Orthod 2005;11:32-9.

33. Maino BG, Mura P, Bednar J. Miniscrew implants: the Spider Screw Anchorage System. Semin Orthod 2005;11:40-6.

34. Miyawaki S, Koyama I, Inoue M, Mishima K, Sugahara T, 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.

35. Park Y, Lee SY, Kim DH, Jee SH. Intrusion of posterior teeth using miniscrew implants. Am J Orthod Dentofacial Orthop 2003;123:690-4

36. Lee KJ, Park YC, Park JY, Hwang WS. Miniscrew-assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. American Journal of Orthodontics and Dentofacial Orthopedics. 2010 Jun 1;137(6):830-9.

37. Suzuki H, Moon W, Previdente LH, Suzuki SS, Garcez AS, Consolaro A. Miniscrew-assisted rapid palatal expander (MARPE): the quest for pure orthopedic movement. Dental press journal of orthodontics. 2016 Aug;21(4):17-23.

38. Moon W. Class III treatment by combining facemask (FM) and maxillary skeletal expander (MSE). InSeminars in Orthodontics 2018 Mar 1 (Vol. 24, No. 1, pp. 95-107). WB Saunders.

39. Katić V, Kamenar E, Blažević D, Špalj S. Geometrical design characteristics of orthodontic mini-implants predicting maximum insertion torque. The korean journal of orthodontics. 2014 Jul 1;44(4):177-83.