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SKELETAL ANCHORAGE SYSTEM : A REVIEW

Dental Science

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ABSTRACT

The selection of a proper anchorage is an essential factor for successful orthodontic treatment. Starting from the miniplates for correction of class malocclusion. Presently the SAS (skeletal anchorage system) are using for correction malocclusion .this review article,discussing the current status and future prospects for SAS for the treatment and management of dental and skeletal malocclusions.

KEYWORDS

Skeletal Anchorage System ,malocclusion

Introduction

The selection of a proper anchorage is an essential factor for successful orthodontic treatment. Orthodontists have long searched for the perfect anchorage to minimize undesired tooth movements. Traditionally, orthodontists have used teeth, intraoral appliances and extraoral appliances to control anchorage.However, the main drawback was that most relied on patient compliance to be successful. The need for skeletal anchorage in orthodontics increased with the growing number of adult patients. In addition, complex treatment goals, patients with missing teeth, non-compliance with extra-oral anchorage all added to the same. Thus, the skeletal anchorage system (SAS) is a new means to an end, not defined previously and represents an important paradigm shift in orthodontics.[1,2]

History

Jenner and Fitzpatrick first reported on the use of miniplates to retract mandibular molars in 1985.[3] In 1992, Sugawara et al. first applied a titanium mini-plate as orthodontic anchorage to correct a severe crossbite in view of the lack of molar anchorage in the lower arch.[4] Sugawara in 1998subsequently developed the SAS for correction of class III malocclusions by lower molar distalization.[5]In 1999, Umemoridescribed a technique for open bite correction by intruding lower molars with SAS.[6]Recently, Sugawara and Nagasaka[7] have used SAS in cases treated by surgery first approach to correct the intentionally created class III or class II malocclusion by moving posterior teeth to achieve final class I relationship.

At present, patients with both dental and skeletal discrepancies benefit from SAS mechanics to compensate for malocclusions that cannot be corrected using traditional orthodontics.This review article, thus discusses the current status and future prospects for SAS for the treatment and management of dental and skeletal malocclusions.

Structure of miniplates

An orthodontic miniplate consists of three components: the head,arm and body (Fig.1). The head is exposedintraorallyand has three continuous hooks for the application of various orthodontic force vectors by connecting wires, springs, and elastics.Orthodontic tubes or brackets can be bondedontotheheadwhenmorecomplicatedmechanics are required.The head comes in a variety of shapes: circular, hooked and tubular.

The arm is transmucosal and is available in three different lengths to accommodate theindividual differences.

The body is positioned subperiosteally and is available in three different configurations T,Y and I. The T-plate can be converted to the L-plate by cutting off one side of the bodyportion.

The fixation miniscrews, 2.0 mm in diameter and5.0 or 7.0 mm in length, are monocortically inserted through the holes in the miniplate. The surgical site requires at least 2 mm of cortical bone thickness to fix the miniplate.

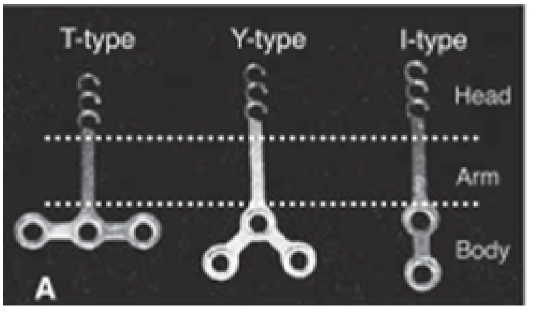

Fig.1 Orthodontic miniplates

Sites for miniplate placement

Inthemaxilla,theanteriorsinuswallistoothintofix the miniplateand hencethe placement sites allowing screw fixation are limited to the piriform rim and zygomatic buttress. The cortical bone of these regions is almost always thick enough to secure the miniplate with multiple fixation screws. At the piriform rim, the I-plate is usually placed for the intrusion and protraction of the molars(Fig.2) .Atthezygomaticbuttress, the Y-plate is usually placed to intrude and distalize the molars (Fig.2). Predrillingcanresult in minor perforations of the sinus membrane, which may not be a concern. To increase the primary stability offixationscrewsinthemaxilla,theuseofaself-drilling screw without creating a pilot hole is advantageous[8].

In the mandible, screw fixation is possible on the lateral cortical bone in most locations except for thearea adjacent to the mental foramen. The T-plate orthe L-plate is usually placed in the mandibular body to intrude, protract, or distalize the molars (Fig.2）. Placementofthe L-plate at theanteriorborder of the mandibular ramus can assist the extrusion of impacted molars (Fig.2）.In caseswhere the miniplateis positioned directly over the mandibular canal or near the mental foramen, monocortical screws should be used to avoid injury to the inferior alveolar neurovascular bundle. The density and thickness of the mandibular cortical bone may cause the screw to fracture when usingaself-drilling screw[9]. Therefore, it is essential to create a pilot hole for use with both self-tapping and self-drilling fixation screws.

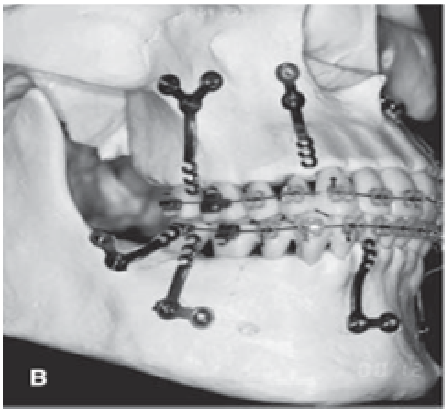

Fig.2. Sites for orthodonticminiplates

Miniplate Placement Procedure

1. The surgical procedure is performed under local anesthesia.
2. Initially, a mucoperiosteal incision is performed in the vestibule.
3. Thenmucoperiosteal flap is elevated to expose the bony cortex.
4. Appropriate shape and length anchor plate is selected.
5. The plate is contoured to the bone surface and placed in its final position.
6. Then a pilot hole is drilled, and a self-tapping monocortical screw is placed.
7. Last, the surgical site is closed with resorbable sutures.
8. The surgery takes approximately 10 to 15 minutes for each anchor plate.

Post-operative Management

Analgesics and antibiotics are prescribed for 3-5 days after surgery. Ice packs should be applied during the first 24 hours on the side where surgery was performed.The patient is instructed to gently clean the transmucosal portions of the miniplateswith a soft single-tuft brush and to use a chlorhexidine oral rinse for two weeks after surgery.

Although it is possible to start loading the SAS immediately, orthodontic force application is usually delayed for 3 weeks to allow for resolution of postoperative facial swelling, soft tissue healing10.

Complications

The following complications may occur after miniplate placement:
1. Mild to moderate facial swelling for several days after surgery.
2. Infection may occur in about 10% of the patients.
3. Plate loosening or fracture can occur.
4. Mucosal dehiscence around the plate.

Advantages

1. Greater stability.
2. Do not rely on patient cooperation.
3. Screw insertion is performed beyond tooth apices, which allows adjacent teeth to be moved in all the three dimensions.

Disadvantages

1. Invasive insertion and removal surgeries.
2. Increased likelihood of infection
3. Higher costs

Clinical applications of SAS

1) Molar Intrusion

Because it is wasextremely difficult to intrude the molars with traditional orthodontic mechanics the treatment of choice for open bite for a long time was orthognathic surgery. Impaction of the posterior mandibular alveolar segment was impossible because of the high risk of injuring the inferior alveolar neurovascular bundle. Orthodontic intrusion of the molars is now possible using SAS placed at thezygomaticbuttress(Fig. 3B) or at the posterior mandibular body(Fig. 3F).

Umemori and Sugawara[11]evaluated the results of treatment in two severe open-bite cases.The lower molars were intruded about 3 to 5 mm, and open-bite was significantly improved.Kuroda et al12compared treatment outcomes in patients with severe anterior openbite treated with molar intrusion by using skeletal anchorage and with orthognathic surgery.Molars were intruded 3.6mm.These results suggest that molar intrusion with skeletal anchorage is simpler and more useful than surgery.

2) Distalization

Since the introduction of SAS it is possible to predictably move the maxillary molars and the whole maxillary dentition distally in nongrowing patients without having to extract the premolars and depending on the patient's compliance.

Sugawara et al[13]achieved 3.78mm of distalization in 25 nongrowing patients with the SAS.Therefore, this new noncompliance technique is particularly useful for correcting Class II malocclusions, decompensation for Class III surgical patients and malocclusions characterized by maxillary anterior crowding.

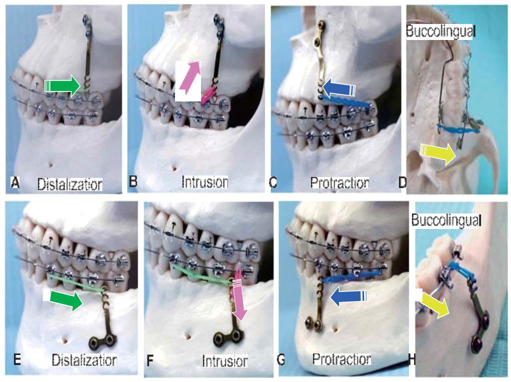

Fig.3 Orthodontic biomechanics with the SAS.

3) Molar protraction

Protraction of the molars is easy using miniplates placed at the piriformrim (Fig. 3C)or at the anterior mandibular body (Fig.3G).

Upper molar protraction is indicated in cases ofanterior crossbite, congenitallymissingupperteeth(particularly lateral incisors or second bicuspids), asymmetrical upper dentition, or Class III molar relationship. On the other hand, lower molar protraction is usually needed in patientswithdiastemaoflowerdentition,congenitally missing lower second bicuspids, asymmetrical lower dentition, Class II molar relationship, or decompensationof the lower incisors in skeletal Class III patients requiring orthognathicsurgery.

4) Anterior retraction

The use of miniplates to provide absolute anchorage, therby enabling the premolar extraction spaces to be fully utilized for the retraction of maxillary anteriors so as to reduce lip protrusion and correct the overjet.

De Clerck[14]used zygoma anchorage system for maximum retraction of anterior teeth.

5) Maxillary orthopedic traction

Face mask (FM) is the preferred appliance for the treatment of skeletal Class III patients with maxillary deficiency. However, there are many disadvantages associated with FM therapy including a lack of aesthetics,discomfort and its dependency on patient compliance. Many investigators have also reported that the vertical dimension increases after FM treatment. In recent years, in order to avoid these undesirable effects, some clinicians and researchers have utilized SAS. **De Clerk**[15]treated21 Class III patients before the pubertal growth spurt with SAS and achieved 4 mmof maxillary advancement. Recently,**Yilmazet al**[16] evaluated corticotomy-assisted maxillary protraction with skeletal anchorage in patients with Class III malocclusions.Sagittal measurements of maxilla showed significant improvements (3.59 mm) during the protraction period (3.85 months).

6) Non-surgical camouflagetreatment

SAS has been used in combination with multibracketappliances to move individual teeth or the entire dentition in three dimensions. The use of miniplate anchorage subsequently involved a number of camouflage or compensation techniques for a variety of skeletal problems that traditionally would have required orthognathicsurgery, such as class III deformity and anterior open bite[5-7].

Miniplates can provide continuous anchorage support required for large tooth movements beyond the limit of traditional orthodontic mechanics alone. Also, they have a greater success rate than other temporary anchorage devices. As a result, predictable orthodontic treatment outcomes based on a goal-oriented approach can be achieved.

7) Surgery first approach

Nagasakaet al[7]reported a new treatment approach for"Surgery First"orthognathics with the SAS for the correction of skeletal Class III deformity. The principle of"Surgery First"is to first correct theskeletal disharmony and then decompensate the dentition. Due to the applicationofSAS,astableandfunctionalocclusioncan be obtained without bicuspid extraction or segmental maxillary osteotomy. **Sugawara et al**[17-18] uses SAS to correct the intentionally created class III or class II malocclusion by moving posterior teeth to achieve final class I relationship. This technique may well represent a paradigm shift in surgicalorthodontics.

The SAS can be helpful in postsurgical correction of any relapse tendencies or slight discrepancies between the planned and actual surgical outcomes.The percentage of nonextraction cases has increased significantly because the SAS permits distalization of the entire dentition, taking advantage of the spaces created by third-molar extractions during surgery[19].

Miniplate Removal procedure

Initially, a short mucoperiosteal incision is made to expose the miniplatebody and fixation screws. It is not uncommon for bone to overgrow the miniplate due to increased osseointegrationwith time[20]. Bony overgrowthoften complicates access to the screws, but resistance of the screwsthemselvesisnotaproblem[21]. Aftercarefulremoval of the excess bone, the screws can be turned in reverse with a hand driver. The miniplate and residual bony overgrowth can be easily removed from the bone surface with a periosteal elevator. Lastly, the surgical wound is closed with resorbable sutures. Analgesics, antibiotics and oral rinse solution are prescribed as necessary.

StressDistribution on the miniplate

Vezirogluet al[22]concluded that, inadequate design and non-homogeneous force distribution along the anchorage system can cause stress directly effecting on the screws and may impair screw stability. **Nalbantgil et al**[23]designed a new miniplate structure featuring spikes placed on the surface facing the cortical bone and compared the force distribution along the conventional miniplate-screw system and the newly designed spiky miniplates.The newly designed miniplate that has spikes was found effective in reducing the stress on and around the screws and the force was distributed more equivalently.

Huang et al[24] have shown stress values were highest with the I-type plates followed by the L-type, Y-type, and T-type plates. Bone stress decreased as the screw numbers increased but was not related to screw length.

Success/failure of miniplates

Nagasaka et al[25] have shown In 210 consecutive patient, 551 miniplates (Dentsply-Sankin K.K.,Japan) were implanted. A total of nine miniplateswere removed prematurely and replaced. Failure criteria included miniplate mobility in 7 and fractureof the head in 2. The failure rate was 1.7%.The failure rate due to miniplate mobility in the mandible was 2.8% (6miniplates) , which was much higherthan that inthemaxilla (0.3%,1miniplate) .**Chen et al**[26]also shown increased incidence of failures in themandible. In contrast, **De clercket al**[27]

shown majority of failures occur in maxilla. They have also shown Younger age increases the risk of failure because of lower bone density, thin cortical bone and their relations to poor primary stability of the fixation screws.

Conclusion

Control of dental anchorage has often been the most difficult and critical component of orthodontic therapy. The success of miniplatesbeing used as anchors has widened the horizons of the orthodontist and are welcome additions to the armamentarium of a clinical orthodontist, which should be explored to the best possible advantage for treating patients. This could help in providing the aesthetically conscious adult patient orthodontic care, which was once compromised or denied altogether due to the lack of posterior teeth, which serve as anchors during orthodontic treatment.

References

1. Nanda R, Uribe FA. Temporary Anchorage Devices in Orthodontics.1st edition, Mosby Elsevier, 2009.
2. Cope JB. Temporary Anchorage Devices in Orthodontics: A Paradigm Shift. SeminOrthod 11:3-9 © 2005.
3. Jenner JD, Fitzpatrick BN. Skeletal anchorage utilising bone plates. AustOrthod J. 1985 Oct;9(2):231-3.
4. Sugawara J. Dr. Junji Sugawara on the skeletal anchorage system. Interview by Dr. Larry W. White.J ClinOrthod. 1999 Dec;33(12):689-96.
5. Sugawara et al. Orthodontic treatment system for class III malocclusion using a titanium miniplates as an anchorage. Ortho waves, 57 : 25-35,1998.
6. Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal anchorage system for open-bite correction. Am J OrthodDentofacialOrthop. 1999 Feb;115(2):166-74
7. Nagasaka H, Sugawara J, Kawamura H, Nanda R. "Surgery first" skeletal Class III correction using the Skeletal Anchorage System. J ClinOrthod. 2009 Feb;43(2):97-105.
8. Hibi,H.,etal.:Orthodonticanchoragesystemusing a locking plate and self-drilling screws, J Oral MaxillofacSurg, 64 ： 1173-1175,2006.
9. Chen, Y.J., et al. : A retrospective analysis of the failure rate of three different orthodontic skeletal anchorage systems, Clin Oral Implants Res, 18 ： 768-775,2007.
10. MinibonePlates:The Skeletal Anchorage System. Junji Sugawara and Makoto Nishimura.SeminOrthod 11:47-56 © 2005
11. Umemori M, Sugawara J, Mitani H, NagasakaH, Kawamura H. Skeletal anchorage system for open-bite correction. Am J OrthodDentofacialOrthop. 1999 Feb;115(2):166-74.
12. Kuroda S, Sakai Y, Tamamura N, Deguchi T, Takano-Yamamoto T. Treatment of severe anterior open bite with skeletal anchorage in adults: comparison with orthognathic surgery outcomes. Am J OrthodDentofacialOrthop. 2007 Nov;132(5):599-605.
13. Sugawara J, Kanzaki R, Takahashi I, Nagasaka H, Nanda R. Distal movement of maxillary molars in nongrowing patients with the skeletal anchorage system. Am J OrthodDentofacialOrthop. 2006 Jun;129(6):723-33.
14. De Clerck H, Geerinckx V, Siciliano S. The Zygoma Anchorage System.J ClinOrthod. 2002 Aug;36(8):455-9.
15. De Clerck H, Cevidanes L, Baccetti T. Dentofacial effects of bone-anchored maxillary protraction: a controlled study of consecutively treated Class III patients. Am J OrthodDentofacialOrthop. 2010 Nov;138(5):577-81.
16. Yilmaz HN, Garip H, Satilmis T, Kucukkeles N. Corticotomy-assisted maxillary protraction with skeletal anchorage and Class III elastics. Angle Orthod. 2015 Jan;85(1):48-57.
17. Villegas C, Uribe F, Sugawara J, Nanda R. Expedited correction of significant dentofacial asymmetry using a "surgery first" approach. J ClinOrthod. 2010 Feb;44(2):97-103;
18. Sugawara J, Aymach Z, Nagasaka DH, Kawamura H, Nanda R. "Surgery first“ orthognathics to correct a skeletal class II malocclusion with an impinging bite. J ClinOrthod. 2010 Jul;44(7):429-38.
19. Aymach Z, Sugawara J, Goto S, Nagasaka H, Nanda R. Nonextraction "surgery first" treatment of a skeletal Class III patient with severe maxillary crowding. J ClinOrthod. 2013 May;47(5):297-304
20. Sugawara, J., et al. :Skeletal Anchorage System Using Orthodontic Miniplates, In Nanda, R. and Uribe, F.A., ed. Temporary Anchorage Devices in ORTHODONTIC, Mosby Elsevier, St. Louis, 2009, p317-341.
21. Cornelis, M.A, et al. :Modified miniplatesfor temporary skeletal anchorage in orthodontics : Placement and removal surgeries, J Oral MaxillofacSurg, 66 ： 1439-1445,2008.
22. Veziroglu F, Uckan S, Ozden UA, Arman. A Stability of Zygomatic Plate-Screw Orthodontic Anchorage System. Angle Orthod 2008;78:902-907.
23. Nalbantgil D, Tozlu M, Ozdemir F, Oztoprak MO, Arun T. FEM analysis of a new miniplate: stress distribution on the plate, screws and the bone. Eur J Dent. 2012 Jan;6(1):9-15.
24. Huang YW, Chang CH, Wong TY, Liu JK. Bone stress when miniplates are used for orthodontic anchorage: finite element analysis. Am J OrthodDentofacialOrthop. 2012 Oct;142(4):466-72.
25. HiroshiNagasaka.The present and future of skeletal anchorage syatem(SAS) using mini-plates. Jpn. J. jaw Deform. 22(Suppl) : 35-44, Deccember 2012.
26. Chang HH, Chang JZ, Lai HH, Lu SC, Chen YJ. Revisiting the stability of mini-implants used for orthodontic anchorage. J Formos Med Assoc. 2015 Nov;114(11):1122-8.
27. DeClerck EE, Swennen GR. Success rate of miniplate anchorage for bone anchored maxillary protraction. Angle Orthod. 2011 Nov;81(6):1010-3.