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Miniscrews in Orthodontics- Review

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ABSTRACT *Anchorage control is an important factor in the success of orthodontic treatment. There have been many attempts to devise suitable anchorage methods, including intra-oral and extra-oral appliances. These conventional methods do not provide reliable anchorage without patient compliance and anchor loss. When using skeletal anchorage such as osseous dental implants, miniplates, or microscrews, the clinician can expect reliable anchorage without patient compliance. Among these anchorage devices, mini implants have been increasingly used in orthodontic anchorage because of their absolute anchorage, low cost, easy placement, and removal.*

KEYWORDS : – Mini implant anchorage, orthodontic implants, Temporary anchorage device

Osseointegrated implants are considered reliable sources of anchorage for orthodontists.[1-6] However, the large size of these implants limits their usage. To overcome this problem, mini-implants were developed.[7-13] Their advantages, in addition to size, include minimal anatomic limitations, minor surgery, increased patient comfort, immediate loading, and lower costs.[11-15]

The inclusion of implants for skeletal anchorage in our armamentarium is changing not only how far orthodontists can move a tooth without the use of headgear, but also their approach to managing different orofacial deformities, malocclusions, or space problems before the prosthetic replacement of missing teeth. For example, case reports have described how implants can be used as anchorage for facemask protraction in adolescent patients with maxillary hypoplasia and obligodontia.[2,3] Several studies have also been conducted on the use of implants to correct open bite of different severities.[16-19] In addition, intrusion of overerupted teeth before prosthetic replacement of missing teeth in the opposing arch can be achieved with skeletal anchorage.[20] The use of skeletal anchorage not only changed how far teeth can be moved, but also offered more treatment options to patients. Orthodontic camou- flage of malocclusion, which needs surgical correction, becomes possible to achieve without surgery by skeletal anchorage.

REVIEW OF LITERATURE

In 1983, Creekmore and Eklund[21] placed a vitallium screw in the anterior nasal spine of a patient with a deep impinging overbite to intrude the maxillary incisor. Although the clinical results were exciting, the technique did not gain immediate acceptance because it was premature to be used clinically without an adequate understanding of reliability or pathology. In 1997, Kanomi[22] reported a successful case with a mini-screw (diameter, 1.2 mm; length, 6 mm), with the mandibular incisors intruded 6 mm with no root resorption or periodontal pathologic evidence. Park[23] then presented a case using 1-stage surgical microscrews with healing in an open method in 1999, generating serious interest in mini-implants as a source of skeletal anchorage because of their superiority for few anatomic limitations, simple placement, and versatile applications.[24] Surgical microscrews have been substituted for specially designed orthodontic mini-implants that are more suitable as conventional orthodontic anchorage fixtures[25]

The different uses of miniscrews in orthodontic and orthopedic management of malocclusion will be discussed with respect to the 3 spatial planes of movement—namely, sagittal, vertical, and transverse

SAGITTAL PLANE

RETRACTION OF ANTERIOR TEETH

Palatal Implants

Wehrbein et al[26] prospectively studied 9 patients with Class II malocclusion in whom anchorage was indirectly reinforced by connection of a transpalatal bar to a palatal implant after extraction of the upper first premolars. The loading force applied was 200 g over 11 months and the reduction of overjet ranged from 5.1 to 7.8 mm (mean, 6.22 mm). The loss of anchorage ranged from 0.2 to 1.6 mm, and was attributed to the deformation of the transpalatal bar.

Miniscrews

Most of the published studies on the retraction of anterior teeth with miniscrews are case reports. [20,27-29] In the cases presented, the miniscrews were applied directly to the hooks on the archwire to retract all upper 6 anterior teeth simultaneously with a loading force of about 150 g. Furthermore, the extraction space was fully utilized in the retraction of anterior teeth without anchorage loss. The posterior teeth even moved distally slightly in some cases.[19-28,29] One of the advantages of the mechanics involved in these cases was the direct application of load to the vertical hooks on the archwire: in this setup, the point of force application was close to the center of resistance of the anterior segment, thereby allowing bodily sliding of the whole segment with minimal tipping, and in turn, shortening the treatment time.[29]

Park et al[30] described a case of anterior retraction in which an innovative miniscrew technique circumvented the need for brackets during retraction. First, maxillary miniscrews were placed between the first molar and second premolar. Second, a segmental hard acrylic splint with 2 lever arms distal to the canines was fabricated on the 6 anterior teeth. Elastics were then attached from the miniscrews to the lever arm. The 6 anterior teeth that were embedded in the clear splint were thus retracted without a bracket during the 6 months of retraction. Brackets were needed only in the finishing stage in the last 6 months.

In a prospective split-mouth study, Thiruvenkatachari et al[31] measured anchorage loss during canine retraction in 10 patients in whom only 1 side of the mouth received miniscrew treatment. The canines were retracted in 4 to 6 months, with no anchorage loss on the implant side but with 1 to 2 mm of anchorage loss on the nonimplant side

RETRACTION OF WHOLE DENTITION OR DISTALIZATION OF MOLARS

In general, 3 kinds of implants— bone plates, palatal implants, and miniscrews— have been used to retract the whole dentition or to distalize the molars. The anchorage provided by the implant can be direct or indirect.

Palatal Implants

There are several different ways of using palatal implants for distalization. These include indirect distalization by way of a transpalatal arch with a spring, and direct distalization by way of a transpalatal bar or other appliance.

Indirect distalization.

Mannchen[32] performed 2 cases of indirect distalization using a transpalatal arch supported by a palatal implant on which a yokeshaped bar was attached. A push coil was then used to distalize an upper molar that had a bracket welded on its palatal side. In a study of 25 patients aged 11.3 to 16.5 years using palatal implants to distalize maxillary molars, Gelgor et al[33] placed a miniscrew of 1.8-mm diameter in the palate and connected a transpalatal arch to 1 premolar on either side through the implant. An open-coil spring of 250-g loading force was then fitted between the first molars and the anchorage-reinforced premolars to push the molars distally. In this configuration, the implants served as indirect anchorage. The upper first molars were distalized by a mean of 3.9 mm according to cephalograms and 5.0 mm according to dental casts. A mild protrusion of the upper central incisors, of 0.5 mm, was also noted.

Direct distalization

Kyung et al[34] developed a direct method to distalize Class II molars after facemask treatment for an 11-year-old boy and a 10-year- old girl. The 2 upper first molars were splinted together by a transpalatal bar, and a miniscrew was placed distally and directly pulled by a powerchain connected to the bar. The upper first molars were distalized by 3.5 mm from the apices and 5 mm from the crowns, in 3 months for the boy and 5 months for the girl. On the other hand, Byloff et al[35] secured a surgical bone plate with 4 miniscrews and attached a pendulum appliance to the plate to directly distalize the upper molars with 250 g of loading force. The whole system was named the Graz implant-supported pendulum. Similar designs were subsequently developed, as reviewed by Kinzinger et al[36]—namely, the Aachen miniscrew-supported distal jet, Mainz implant pendulum, and Aachen implant pendulum.

LINGUAL ORTHODONTICS

One of the difficulties of lingual orthodontics is the control of anchorage and torque of the anterior teeth. Several case reports have focused on using miniscrews for anchorage in lingual appliances.[28,37-39] In a report of 2 cases, Hong et al[40] stressed the importance of the insertion of miniscrews with a lever arm to reinforce anchorage and torque control of the anterior teeth.

PROTRACTION OF MOLARS OR WHOLE DENTITION

The use of implants to protract molars or the whole dentition was first described in 1990.[41] The 2 main ways of protracting the lower molars are the insertion of small-sized miniscrews between the roots[42,43] or the placement of conventionally sized implants in the retromolar area.[41,44-46] Freudenthaler et al[42] studied the effectiveness of miniscrews in protracting the lower molars of 8 patients aged from 13 to 46 years. Either the lower first permanent molars or the deciduous second molars were first extracted owing to agenesis of the second bicuspids. Miniscrews of 2-mm diameter were then inserted in either the area between the 2 premolars at the level of the apical thirds or in the mesial side of a molar extraction socket. With both methods, the immediate loading force of 150 g was maintained for 7 to 20 months during active treatment. A prospective study conducted by Higuchi and Slack[43] demonstrated the successful protraction of the whole lower dentition in 6 of 7 adults receiving push-coil treatment with direct anchorage from conventional implants. The 400-g loading force on each side resulted in 2 to 6 mm of movement for the lower second molars and 3 to 5 mm of movement for the lower incisors. Roberts et al[44] also used retromolar implants to protract the lower second molars in 5 adults to close first molar extraction sites. The implants provided indirect anchorage because the premolars were connected to the implants with archwires. The rate of mesial translation of the second molars was approximately 0.60 mm per month during the first 8 months. Thereafter, the rate was approximately 0.34 mm per month until space closure was complete.

ORTHOPEDICS

The use of implants for orthopedic purposes was first reported in 1999 by Henry et al.[45] The patient was a 13-year-old girl with maxillary growth retardation following the repair of a unilateral cleft and palate defect. Two implants of 7-mm diameter were placed in the zygomatic buttress of the maxilla, which was allowed to heal for 5 months. Following traction with 800 g of loading force by way of a face mask for 8 months (14 hours per day), the maxilla was advanced anteriorly and inferiorly by 4 mm. In 2003, Enacar et al[46] described a 10-year-old girl with Class III skeletal relationship, maxillary hypoplasia, and severe oligodontia. Owing to the lack of adequate teeth to anchor a facemask, a titanium screw was placed in the processus pterygoideus of the maxilla. After 3 weeks of healing, 800 g of loading force was applied to the facemask for 16 hours a day for 7 months. The maxilla was advanced forward and convexity improved from 4 mm to 3 mm. In 2006, Kircelli et al[47]reported on a 11-year-old girl with severe maxillary hypoplasia and hypodontia. Miniplates were fixed onto the lateral nasal wall of the maxilla as anchorage for face mask protraction. The technique achieved 8 mm of maxillary advancement with 350 g of loading force.

VERTICAL PLANE

INTRUSION OF DENTITION

Intrusion of posterior or anterior dentition is always difficult to achieve without the side effect of extrusion of the anchorage teeth, and the placement of mini-implants for skeletal anchorage may provide the solution. For example, intrusion of posterior teeth is essential in the correction of open bite, and case reports have shown that miniplates can lead to the intrusion of upper and lower molars by 3 to 5 mm, while also achieving counterclockwise mandibular rotation.[48-51] Sugawara et al[52] investigated the amount of intrusion of mandibular molars among 9 patients after miniplate treatment, and found that 1.7 mm and 2.8 mm of intrusion was achieved in first and second molars, respectively, although there was about 30% relapse. Erverdi et al[53] also reported using miniplates to intrude upper molars by 2.6 mm in 10 patients. Even as early as 1983, Creekmore et al[54] demonstrated the use of miniscrews to intrude maxillary central incisors by 6 mm. In 2005, Ohnishi et al[55] described a case of gummy smile correction with intrusion of the upper incisors by 3.5 mm.

In 2006, DeVincenzo[56] used a new appliance, called a vertical adjustable corrector, to treat extreme dolichocephalic malocclusion.. Intrusion of posterior or anterior teeth can change the occlusal plane and correct open bite or gummy smile, as demonstrated in 5 cases,[57] showing that this method represents an alternative to the surgical option.

INTRUSION OF INDIVIDUAL TEETH

In the management of overeruption of unopposed teeth, molar intrusion is a common indication for orthodontic treatment before prosthodontic replacement of missing teeth. Two cases have been reported in which overerupted lower and upper molars were intruded with miniscrews but without any braces on other teeth.[27,58] Upper molars can also be intruded with miniscrews on buccal and palatal sides before the prosthetic restoration of the lower missing teeth is commenced.[59,60]In 1 case, overerupted upper left first and second molars were intruded by the fixation of a miniplate on buccal bone and a miniscrew on palatal bone, with a loading force of 150 to 200 g delivered by a powerchain.[61]

EXTRUSION OF INDIVIDUAL TEETH

A miniscrew has been used for forced tooth extrusion in a 51-year-old woman who presented with a bridge that replaced a missing upper right incisor with the central incisor and canine as abutments. Because the gingiva at the central incisor and canine had receded by 3 to 4 mm, both of them required extrusion to match the gingival level of the contralateral side before a new bridge could be constructed. To do this, a miniscrew was placed into the alveolus of the missing upper lateral incisor and an open coil was applied perpendicularly to an orthodontic wire connecting the central incisor and canine.[62] In another case,[63] a patient had a mandibular left first premolar that displayed radicular perforation and biological width invasion slightly below the bone crest. To restore the biological distance, rapid extrusion of the premolar was done using adjacent prosthetic implants for skeletal anchorage.

TRANSVERSE PLANE

EXPANSION

Titanium screws were used in a pilot study to provide skeletal anchor-

age for a rapid maxillary expander after surgical splitting of the maxilla.[64] For the 2 women studied, who were aged 21 and 23 years, 8 mm of expansion was achieved after 21 and 45 days, respectively. The authors concluded that a skeletally supported rapid maxillary expander provided better anchorage and caused less buccal tilting of the posterior teeth than conventional expander.

OTHER USES OF MINI-IMPLANTS

INSUFFICIENT TOOTH ANCHORAGE

In an investigation conducted by Odman et al,[65] 9 patients with 7 to 20 missing teeth who underwent orthodontic treatment were aided with endosseous implants. All the implants served their purpose as anchorage units, remained stable, and were used as abutments for permanent prostheses. In addition, Fukunaga et al[66] demonstrated that malocclusion in a patient with periodontal disease could be successfully treated with the aid of a miniplate. Preoperatively, the patient had generalized horizontal bone loss, vertical bone loss in the posterior segment, 5 mm of space in the upper anterior teeth, and 7.5 mm of overjet.

UPRIGHTING MOLARS AND DISIMPACTION

When conventional orthodontic methods are employed to upright ectopically positioned molars, undesirable side effects include extrusion of the target molars and reciprocal forces exerted on anchorage units. The application of mini-implants for skeletal anchorage has eliminated such side effects because orthodontic brackets are not required, and no forces are applied to other teeth during anchorage. In 1996, Kokich[67]published a case report illustrating how an endosseous prosthetic implant could upright and intrude the mandibular molars. As the popularity of mini-implants increased, Park et al[68,69]reported in 2002 and 2004 that mini-implants could upright mesially inclined molars in mandibular and maxillary second molars. In the mandible, microimplants that were inserted in the retromolar area distal to the second molars allowed the application of an uprighting force (50-70 g) through an elastic thread to the lower second molars. As a result, the mesially angulated mandibular second molar was uprighted after 6 to 8 months Furthermore, the same researchers[70] disimpacted upper canines of 2 patients and brought the canines into the arch orthodontically with miniscrew instead of brackets and wire.

CONCLUSION

The introduction of miniscrews and miniplates into orthodontics has had a revolutionary impact on the specialty. Skeletal anchorage with mini-implants offers more options for patients and dentists to achieve better results than ever before. Future studies should explore further applications of skeletal anchorage in the correction of malocclusions and skeletal discrepancies

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