DENTAL IMPLANTS IN ORTHODONTIC

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Abstract: The purpose of this article is to review and update current concepts involving the use of dental implants for orthodontic anchorage. Topics to be discussed include indications, implant requirements (eg, materials, size, designs of dental implants), surgery and healing time, biomechanics and forces, loading time, implant maintenance, post-treatment considerations, and disadvantages.

Key words: Implants, Anchorage;

INTRODUCTION

Compared with the past, more patients receive orthodontic treatment because of the demands of esthetics or function. In the Center for Disease Control’s Third National Health and Nutrition Examination Survey (NHANES III), only 35% of adults were considered as having well-aligned mandibular incisors; 15% had severe irregularities that could affect social life or function; about 60% of the entire population might benefit from orthodontic treatment.1 However, not everyone has adequate dentition for orthodontic anchorage, eg, partially edentulous patients and those with congenital dentofacial anomalies.2,3 Therefore, supplementary alternatives have been sought.

In 1960s, Brånemark et al4 noticed the biocompatibility of titanium screws in bone tissue. Light microscopic examinations showed bone-to-implant contact; thus, the concept of “osseointegration” developed.5 After this, many studies were conducted to investigate the application of titanium implants in dentistry. An implant success rate of over 90% has been reported in edentulous patients.6,7 Decades before, the idea of using dental implants to reinforce orthodontic anchorage showed encouraging results.8,9 The purpose of this article is to review and update current concepts of using dental implants for orthodontic anchorage.

HISTORICAL PERSPECTIVE

In 1945, Gainsforth and Higley11 used vitallium screws and stainless steel wires in dog mandibles to apply orthodontic forces. However, the initiation of force resulted in screw loss. In 1969, Linkow8 placed blade implants to anchor rubber bands to retract teeth, but he never presented long-term results.8 In 1964, Brånemark et al8 observed a firm anchorage of titanium to bone with no adverse tissue response. In 1969, they demonstrated that titanium implants were stable over 5 years and osseointegrated in bone under light microscopic view.5 Since then, dental implants have been used to reconstruct human jaws or as abutments for dental prostheses.5,6 The success has been attributed to the material, surgical techniques, and the manner that implants are loaded. In 1984, Roberts et al9 corroborated the use of implants in orthodontic anchorage. Six to 12 weeks after placing titanium screws in rabbit femurs, a 100-g force was loaded for 4 to 8 weeks by stretching a spring between the screws. All but 1 of 20 implants remained rigid. Titanium implants developed
osseous contact, and continuously loaded implants remained stable. The results indicated that titanium implants provided firm osseous anchorage for orthodontics and dentofacial orthopedics.

INDICATIONS
In orthodontic treatment, anchorage control is essential for success. Dental implants, due to the stability in bone, can serve as firm anchorage. They have been applied in the following situations.

**Intrude/extrude teeth.** It is difficult to intrude or extrude teeth, particularly molars. Implant anchorage greatly facilitates these movements. However, conventional implants are 3.5 to 5.5 mm in diameter and 7 to 15 mm long; these dimensions create limitations for usage. Therefore, mini-implants (1.2 mm in diameter, 6 mm in length), which can be placed between roots or apical to a tooth, are more feasible. Pure intrusion or extrusion cannot be achieved. If the implant is at the facial side for intrusion, only intrusion plus protrusion can be accomplished. Also, care should be taken not to involve the periodontal ligament and prevent postoperative peri-implant mucositis, which is often observed when an implant is placed in mobile mucosa. Mini-implants are too small to cause irreversible damage. Removal of these implants should result in uneventful healing.

**Close edentulous spaces.** Missing first molars or congenital missing teeth are common. Because of reduced anchorage, implants in retromolar areas have been used to translate teeth into edentulous areas. Titanium screws were placed to protract molars and close the spaces of congenital missing premolars. This treatment is superior to others when adjacent teeth are intact or have large pulp chambers, making preparation undesirable. Plaque control is more complicated with fixed partial dentures, which increase the risk of caries and endodontic or periodontal disease. The soft tissue around implants should be cared for during treatment. If the translated tooth is tipped, it should be uprighted to prevent a mesial angular bony defect. Tight contact points are preferred to minimize food impaction and future caries or periodontal tissue breakdown.

**Reposition malposed teeth.** Preprosthetic corrections of tilted abutments are not unusual. Adequate anchorage for tooth movement is often impossible when there are several missing teeth. Realignment of molars by using the remaining teeth is complicated because of limited support. Implants facilitate uprighting the abutment teeth at the end of a long edentulous ridge. If carefully planned, dental implants used to upright teeth can be restored as implant-supported prostheses in edentulous areas.

**Reinforce anchorage.** Palatal implants have been developed to reinforce anchorage. An endosseous orthodontic implant anchor system (Orthosystem, Straumann, Waldenburg, Switzerland) was designed and used in Angle Class II malocclusion patients in whom extraction of maxillary first premolars and retraction of anterior teeth were planned. Implants were placed in anterior palatal areas and attached to posterior teeth. Maximum anchorage was achieved without compliance-dependent aids (headgear, elastics). When palatal implants were used to reinforce anchorage, they showed no mobility, and they did not cause soft tissue complications, posterior teeth movement, or retraction of anterior teeth. This application in molar distalization successfully stabilizes teeth against rotational movement.

**Treat partial edentulism.** Treatment is complicated in patients with malocclusion and many missing and periodontally compromised teeth. Fortunately, implants
in edentulous areas to provide orthodontic anchorage and later serve as prosthetic abutments have been considered a proper interdisciplinary approach. To improve lip profile, anterior teeth can be repositioned with implants at the ramus or tuberosity. Implants are particularly helpful when many posterior teeth are missing and the teeth must be moved in 1 direction. Transitional implants have been applied in these situations. The relatively low cost, user-friendly protocol, immediate loading potential, and adaptability to orthodontic mechanics make them worth further investigation. The benefit of implants is that when several teeth are missing, the reciprocal effects of conventional methods can be minimized.

Correct undesirable occlusion. Correcting Class III anterior crossbite with conventional methods is not always satisfactory. Retracting the entire mandibular arch with dental implants is possible. Localized crossbite can be treated by bonding implants and teeth to avoid full-mouth treatment. Protracting maxillary arches can be achieved by using implant anchorage. A patient with anterior open bite, bilateral crossbite, and missing mandibular anterior teeth was reported. Three implants, placed in the edentulous area to improve anchorage, later served as abutments for fixed partial denture. Open bite correction is significantly enhanced by permitting intrusive forces to be applied posteriorly. Patients with compromised occlusions benefit tremendously if implants are used to provide rigid and superior anchorage.

Provide orthopedic anchorage. Palatal implants can be used to elicit palatal expansion. This applies to partially edentulous patients or children with congenital diseases that result in facial developmental defects or missing teeth. Implants in congenital anomalies can promote orthodontic and orthopedic therapy and accelerate jaw movement by sutural distraction.

IMPLANT CRITERIA

Implant materials. The material must be nontoxic and biocompatible, possess excellent mechanical properties, and provide resistance to stress, strain, and corrosion. Commonly used materials can be divided into 3 categories: biotolerant (stainless steel, chromium-cobalt alloy), bioinert (titanium, carbon), and bioactive (hydroxyapatite, ceramic oxidized aluminum). Because of titanium’s characteristics (no allergic and immunological reactions and no neoplasm formation), it is considered an ideal material and is widely used. Bone grows along the titanium oxide surface, which is formed after contact with air or tissue fluid. However, pure titanium has less fatigue strength than titanium alloys. A titanium alloy—titanium-6 aluminum-4 vanadium—is used to overcome this disadvantage.

Implant sizes. Implant fixtures must achieve primary stability and withstand mechanical forces. The maximum load is proportional to the total bone-implant contact surface. Factors that determine the contact area are length, diameter, shape, and surface design (rough vs smooth surface, thread configuration). The ideal fixture size for orthodontic anchorage remains to be determined. Various sizes of implants, from “miniimplants” (6 mm long, 1.2 mm in diameter) to standard dental implants (6-15 mm long, 3-5 mm in diameter), have proved to effectively improve anchorage. Therefore, the dimension of implants should be congruent with the bone available at the surgical site and the treatment plan.

Implant shape. This determines the bone-implant
contact area available for stress transfer and initial stability. The design must limit surgical trauma and allow good primary stability. It is difficult to identify the “perfect” implant shape. The most commonly used is cylindrical or cylindrical-conical, with a smooth or threaded surface. Studies have shown that the degree of surface roughness is related to the degree of osseointegration. Most implants used for orthodontic anchorage are similar to conventional designs. Specially designed implants are discussed next.

CONCLUSIONS
Currently, dental implants have become predictable and reliable adjuncts for oral rehabilitation. Osseointegration can be used to provide rigid orthodontic or orthopedic anchorage. Although initial results are encouraging, the risks and benefits must be thoroughly evaluated. Further investigations are needed to standardize the treatment protocol.

REFERENCES
15. Freudenthaler JW, Haas R, Bantleon HP. Bicortical titanium screws for critical orthodontic anchorage in the mandible: a