Case Report: Forced eruption and implant site development

Theo Mantzikos, DMD; Ilan Shamus, DDS

Modern orthodontic therapy continues to advance, leading to improvements in the quality of care. The use of implants to replace missing teeth and to provide anchorage sites in compromised orthodontic patients is a significant part of this change. The limits of orthodontic treatment are being pushed outward, and it becomes increasingly necessary to rely on supporting specialities.[1]

The increased use of implants in dentistry has stimulated interest in augmenting bone in patients who have deficient alveolar ridges that preclude ideal implant placement.[2-7] Orthodontic tooth movement has been suggested as a method by which osseous defects may be eliminated or altered to provide a base from which surgical procedures may be performed.[8-12] Clinical studies on tooth movement and its effects on periodontal lesions have produced encouraging results.[8,13-17]

A basic tenet of osteophysiology is that the fibers of the periodontal membrane are secured to the bone by the formation of new bone around the ends of the fibers.[18,13] Bone is in a constant state of transition. As elsewhere in the body, the bone of the alveolus is constantly being resorbed and rebuilt. Therefore, when tension is applied to the periodontal ligament, periodontal fiber bundles are elongated and osteoblasts are induced to deposit new bone in the areas of the alveolus where periodontal attachment exists.[11,19] The same effects on alveolar bone height are seen when orthodontic treatment is carried out with reasonable force levels and reasonable speed of tooth movement. In other words, a tooth moved into the dental arch by extrusive orthodontic forces will bring alveolar bone with it. The height of the fiber attachments should remain constant during tooth movement.[20,21]

A nonsurgical technique for increasing the amount of available bone for implant site development and fixture placement is orthodontic ex-

Abstract

It is now possible to use the orthodontic extrusion of periodontally compromised teeth to facilitate the development of a future implant site in an area where the amount of bone in the inciso-apical dimension would otherwise have been inadequate. The purpose of this case report was to analyze the hard and soft tissue changes when forced eruption is used for implant site development.

Key Words

Forced eruption • Implants

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trusion, or forced eruption. Forced eruption is an excellent way of using teeth that might otherwise have been hopeless. Alteration of osseous defects by forced eruption is based upon sound orthodontic and orthopedic principles. Brown suggested that there is a potential for reduction in pocket depth, increase in attachment apparatus, and change in the architecture of both hard and soft tissues of the periodontium.[11] Reitan demonstrated that eruptive tooth movement results in a stretching of the gingival and periodontal fibers, which produces a coronal shift of bone and gingiva.[13,18,22,23] Elongation of the tooth in its alveolus causes a stretching of the gingival and periodontal ligament fibers. This results in a coronal shift of the bone at the base of the defect as the tooth moves occlusally. Ingber showed that teeth could be erupted for the purpose of lengthening the clinical crown, altering the gingival margins, and leveling osseous defects. He noted that as teeth were extruded using light forces, both the bone and gingiva migrated coronally.[8,9,24,25]

Recently, Salama and Salama[10] reported on the use of forced eruption prior to extraction for the purpose of site development for implant placement. They termed this procedure *orthodontic extrusive remodeling,* whereby hopeless teeth were extruded over the course of 6 weeks and then stabilized for the same period of time. We prefer the term *orthodontic extraction,* i.e., orthodontic extrusion to the point of extraction. This takes advantage of orthodontic and orthopedic principles by improving the three-dimensional topography of the recipient implant site prior to extraction. Subsequently, implant placement would follow a stabilization period. Noting that hopeless teeth are not useless teeth, their research showed that the attachment apparatus can be used to develop the bone and gingiva in an incisal or occlusal direction for the development of a potential implant site.

The contemporary purpose of forced eruption is to enhance an extraction site for implant placement. Likewise, the prosthetic-driven implant and restoration should be indistinguishable from adjacent natural teeth. Consequently, implant site development guided by forced eruption enhances two specific areas: the hard tissue component and the soft tissue component. Both these areas are essential to the success of the restoration. The volume of the osseous structure must allow for implant placement in an ideal situation for the restoration, while the anatomic topography of the soft tissue must mimic that of the adjacent teeth.[24,26]

During implant site development, forced eruption also contributes to the emergence profile of the implant and the restoration by: (1) increasing tissue depth as measured from tissue crest to seating surface of the implant; (2) improving implant angulation placement in relation to the adjacent dentition; and (3) improving the interarch distance as measured from the implant seating surface to the opposing dentition.[27]

An important consideration is the timing of the implant placement into the postextraction site of an existing hopeless tooth. Initially, the application of the Branemark technique recommended a healing period of approximately 1 year following the extraction of a hopeless tooth. This exhibited a collapse of the alveolar ridge due to significant resorption of the thin labial plate of bone.[28,29] The procedure was very time consuming, rendering the treatment plan unacceptable to many patients. While regenerative procedures exist that can successfully restore ridge height, they necessitate additional surgery, which carries the potential for unnecessary negative sequelae.[2-7,17,30,31,32] Therefore, the enhancement of the implant site with orthodontic therapy further improves the stability of the adjunctive surgical procedure in the mesiodistal, buccolingual, and apico-coronal dimensions.

There has been no clinical study of hopeless teeth extruded over the course of several months to the point that they are virtually extracted. The osteophysiology supporting this practice would indicate that following the orthodontic extrusion, a stabilization period of approximately 4 to 6 months is required. Subsequently, sufficient volume of soft tissue to develop the restorative emergence profile with osseous support allows for a three-dimensional configuration of the prosthesis. Whether orthodontically developed or not, the implant must be anchored in pre-existing bone. The regenerative bone is not to be relied on to provide primary support to the implant, but merely to obtain coverage. The procedures of bone grafting, e.g., freeze-dried or autogenous bone with guided tissue regeneration (GTR) and miniscrews following implant site development, have the advantage of optimizing augmentation of the ridge and soft tissue.[2-7,33,34] Likewise, adjunctive reconstruction with implant placement will lead to improved implant stability. Therefore, the orthodontic, periodontal, implant, and restorative needs of the patient are addressed through an interdisciplinary team approach.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 1
Localized horizontal and vertical bone loss mesial and distal to maxillary central incisor.

Figure 2
Panoramic radiograph reveals normal trabecular bony pattern with periapical pathosis of the maxillary right and left central incisors

Figure 3
Pretreatment frontal view shows proclined maxillary central incisors with 4 to 6 mm gingival recession

Figure 4
Palatal view of central incisors shows proclination and tissue recession

Figure 5
Maxillary incisors were proclined and mandibular plane angle was 37 degrees

Case report

The patient was a Caucasian male, 34 years old, presenting for multidisciplinary treatment at New York University, College of Dentistry. His chief complaints were "my two front teeth are loose and I would like to improve my smile." He appeared cooperative and intelligent. There were no medical contraindications to orthodontic treatment. His dental history included restorative care, extractions, and periodic prophylaxis. He received the majority of his restorative dentistry in Ireland. He related a recent history of purulent discharge from between the two central incisors. Upon periodontal evaluation, pocket probing ranged from 2 mm to 10 mm generalized with the maxillary central incisors having the greatest involvement.

The intraoral radiographic survey showed a mutilated adult dentition with the mandibular right and left first molars having been previously extracted. Generalized horizontal bone loss, and localized vertical bone loss on the mesial and distal of the maxillary right and left central incisors were evident clinically and radiographically (Figure 1). The panoramic radiograph revealed a normal trabecular bony pattern with periapical pathosis of the maxillary right and left central incisors (Figure 2).

The patient had a retrognathic facial profile with moderate facial convexity, accompanied by an anterior openbite and proclined maxillary central incisors. The facial appearance was a Class II skeletal pattern with sagittal mandibular deficiency. The lips were strained upon closure. No crepitus was noted; nor was there any history of pain, discomfort, or tenderness in the temporomandibular joint or associated muscles. Lower anterior facial height was increased with respect to upper anterior facial height (41.0%:59.0%).

There was a 10 mm overjet and 2 mm openbite (Figsures 3 and 4).

Cephalometric evaluation revealed a convex skeletal profile with Class II characteristics, such as maxillary denture base protrusion (SNA: 87°); anteroposterior denture base discrepancy (ANB) of 8°; and a Wits analysis of 6.0 mm. The maxillary incisors were proclined (1:SN: 121), and the mandibular plane angle was high (37°, Figure 5).

The soft tissue profile revealed a convex profile with an acute nasolabial angle accompanied by a protrusive upper lip and a retrognathic mandible. The severe Class II malocclusion was accompanied by a skeletal mandibular deficiency in a patient whose facial growth is essentially complete. Orthodontic treatment alone for this type of case seldom provides a stable occlusion and improved facial esthetics. The patient was advised to consider adjunctive orthognathic surgery to correct the Class II skeletal disharmony. He declined this avenue of treatment.

The use of an osseointegrated dental implant for single tooth replacement in the anterior region is one of the greatest challenges in esthetic dentistry.[35-40] From the patient's perspective, dentistry is evolving from the necessities of pain

Figure 6

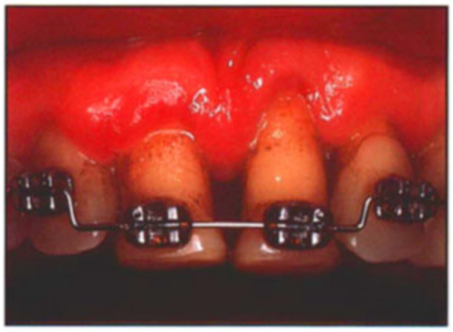

Figure 7

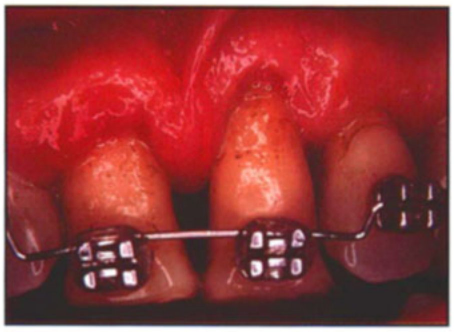

Figure 8

Figure 9

Figure 10

Figure 6
Frontal view following initial bracket placement with initial .0175 Wildcat archwire

Figure 7
Frontal view shows .018 stainless steel arch-wire with step-down bends. Mild chlorhexidine staining is present. Note initial redness at gingival area of maxillary right central incisors and incisal equilibration

Figure 8
Progressive redness of gingival margins

Figure 9
Occlusal view shows incisal reduction and calcification of pulp chambers

Figure 10
Maxillary central incisors 16 weeks into treatment, with 5 mm extrusion and vertical bone improved relative to lateral incisors

management to procedures designed more for esthetic gratification. The art of orthodontics plays an integral role in the final outcome. For this patient, consideration was given to implant placement for the area of the maxillary right and left central incisors. However, because of labiolingual and incisogingival defects, the prognosis was poor. Other possibilities considered were a conventional three-unit bridge, a Maryland bridge, or other bonded bridges. The patient had a very strong desire to maintain the adjacent teeth. As a result, multidisciplinary dental treatment was recommended to assist in the complex rehabilitation.

Initially, the patient was referred for periodontal surgery in both arches. Surgery was performed on the maxillary right and left quadrants, followed by surgery on the maxillary anterior sextant. Mandibular surgery was completed after the maxillary arch had healed. The maxillary and mandibular arches were to be treated as separate entities, with orthodontic treatment focusing primarily on the maxillary right and left central incisors. There is no contraindication to treating adult patients who have periodontal disease, as long as the disease has been brought under control. The periodontal situation must receive major attention in planning and executing orthodontic treatment for adults. As a result, the patient was placed on chlorhexidine mouthrinse during the course of orthodontic treatment.

Orthodontic treatment was initiated in the maxillary arch with bonding of 0.022-inch pretorqued and preangulated edgewise brackets from maxillary right to maxillary left canine, and an 0.0175 Wildcat archwire was placed (Figure 6). The brackets on the maxillary central incisors were moved apically to the cementoenamel junction in order to provide an extrusive component, and a retractive component was incorporated into the archwire. The combination of these two components allowed for manipulating the hard and soft tissues of the labial aspects of the maxillary central incisors. Also, when the appliance is used, the patient must be seen every 2 weeks to reduce the incisal edge of the tooth being extruded, control inflammation, and monitor progress (Figure 7).

At the next appointment, it was necessary to equilibrate the incisal edges of the maxillary central incisors (Figure 8). Root canal therapy is generally performed on these significantly extruded and incisally reduced teeth. However, since the patient did not experience sensitivity following

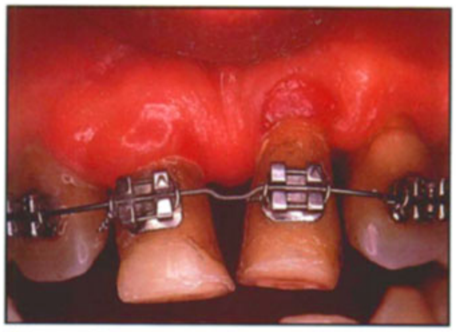

Figure 11

Figure 12

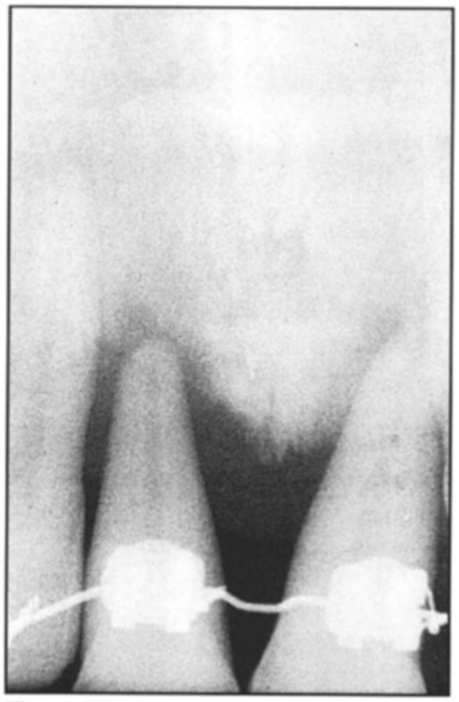

Figure 13

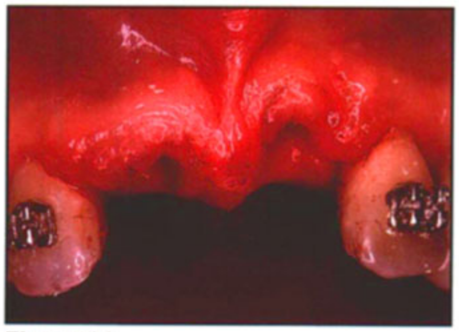

Figure 14

Figure 15

Figure 11
Frontal view shows keratinized gingiva of maxillary right central incisor and progressive redness of gingival margin of maxillary left central incisor. Incisal equilibration and chlor-hexidine staining evident

Figure 12
Note keratinized sulcular epithelium on on right central incisor and nonkeratinized sulcular epithelium on left following bracket placement

Figure 13
Maxillary right and left central incisors outside alveolar housing. Vertical bone improved relative to lateral incisors. Stabilization period

Figure 14
Frontal view of extraction sockets. Note improved gingival margin heights

Figure 15
Occlusal view of extraction sockets showing buccolingual topography of soft tissue

the reduction, this was not necessary (Figure 9). Periapical radiographs were taken at monthly intervals as orthodontic extrusion progressed (Figure 10).

During extrusion of the maxillary central incisors, a red patch on the facial aspect of the gingiva appeared. It was observed initially on the maxillary right central incisor; several weeks later a similar patch appeared on the maxillary left central incisor. The red patch was everted nonkeratinized sulcular epithelium that had peeled off the surface of the teeth. The timing of the appearance of the red patch is in direct relation to the pocket depth; the greater pocket depth on the maxillary left central incisor meant the red patch appeard later in the orthodontic extrusion procedure.[14,15] Keratinization of the everted epithelium takes approximately 28 days (Figure 11).

After 16 weeks of orthodontic extrusion accompanied by incisal equilibration, the central incisor brackets were rebonded more apically on the root surface (Figure 12). The remaining brackets maintained their original positions, and an 0.016 nickel titanium archwire was placed. Additional extrusion was accomplished by simultaneous occlusal reduction. The patient continued to be free of sensitivity that would warrant root canal therapy.

At this time it was recognized radiographically that the maxillary central incisors were no longer within the confines of the alveolus, and the remaining extrusive component generated an actual orthodontic extraction (Figure 13). By manipulating the extrusion of the tooth with orthodontic treatment, there is a potential for continued relocation of the osseous crest and soft tissue. This will further enhance the osseous profile in the vertical dimension and improve the emergence profile of the final restoration.

Following an additional 8 weeks of orthodontic extraction, 4 to 6 months of stabilization is recommended. Stabilization allows for proper reorganization of the soft tissue, and allows bone to remodel, thus discouraging relapse. Subsequently, the two central incisors were extracted (Figures 14 and 15) and the provisional removable appliance inserted. The provisional appliance was relieved on the tissue surface so that the extraction site remained free of any loading pressure preventing resorption. Consequently, the alveolar ridge was allowed to heal for 4 weeks prior to implant placement (Stage I surgery, Figures 16 and 17).

Stage I implant surgery consisted of the place-

Figure 16

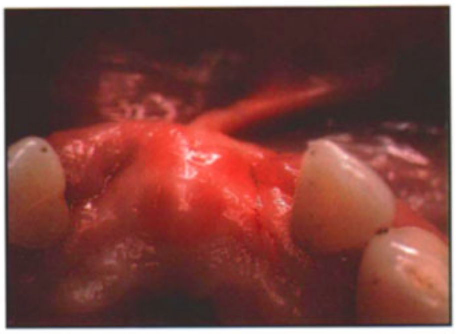

Figure 17

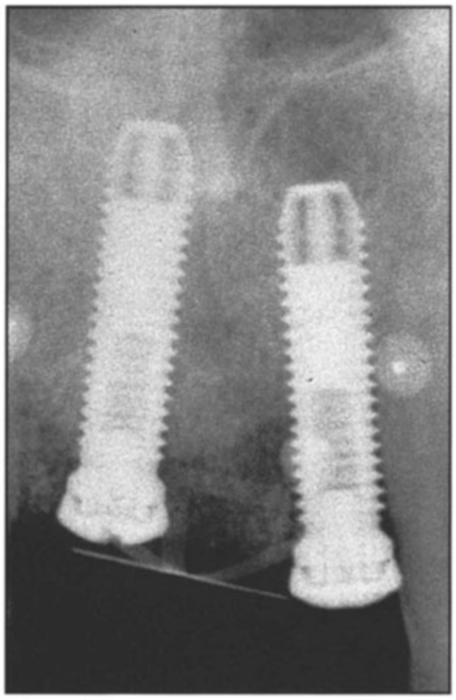

Figure 20

Figure 18

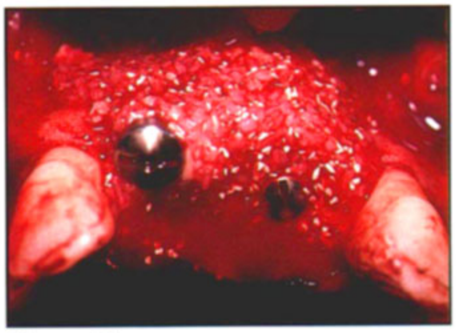

Figure 19

Figure 16
Alveolar ridge 4 weeks after extractions and prior to implant surgery

Figure 17
Occlusal view of alveolar ridge 4 weeks after extractions

Figure 18
Stage 1 implant surgery. Two titanium fixutres placed. Labial dehiscences and three buccal threads visible upon placement

Figure 19
Dehiscences grafted with demineralized freeze-dried cortical bone

Figure 20
Radiograph of maxillary anterior region with 7 to 8 mm vertical bone augmentation

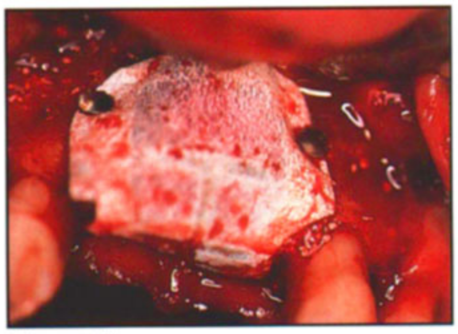

Figure 21

Figure 21
Bone graft in place secured with Goretex membrane and two miniscrews

ment of two titanium fixtures, 3.75 x 15 mm in dimension. Labial dehiscences and crestal threads of the implant were evident upon implant placement (Figure 18). Dehiscences that occur in close proximity to the marginal bone limit the extent to which osseous correction could be made. It is difficult to know whether the defect was present prior to treatment, result of accidental trauma, "contoured trauma" from orthodontic therapy, or merely anatomic variations. As a result, these areas were grafted with demineralized freeze-dried cortical bone and primary closure was attained (Figure 19). This technique involves placing a Gore-tex membrane so that a secluded space is created into which cell populations from surrounding bone tissue can proliferate (Figure 20). The provisional temporary was replaced and re-evaluated to prevent any unnecessary loading pressure. The patient was placed on chlorhexidine mouthrinse and antibiotic coverage was initiated.

It was determined radiographically that 7 to 8 mm of bone was formed; five millimeters of soft tissue was relocated as a result of the forced eruption (Figure 21). Consequently, the dental implants will remain unloaded for a minimum of 6 months to allow for bone maturation and healing. Afterward, the osseointegrated dental implant can be loaded, and the final esthetic restoration completed.

Discussion

The osseointegrated implant is one of the most exciting and evolving areas of clinical dentistry. Many disciplines are potentially involved. In addition to procedures associated with diagnosis, treatment planning, and posttreatment maintenance, a multidisciplinary team approach involving orthodontic treatment is recognized. With new techniques and increased focus on combining different cosmetic modalities, orthodontists become more creative and provide patients with improved treatment options and superior esthetic results.

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Author Address

Theo Mantzikos, DMD
279 Sound Beach Ave.
Old Greenwich, CT 06870

Dr. Theo Mantzikos, assistant clinical professor, Department of Orthodontics, Division of Growth and Developmental Sciences, New York University College of Dentistry.

Dr. Ilan Shamus, assistant clinical professor, Department of Orthodontics, Division of Growth and Developmental Sciences, New York University College of Dentistry.

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