A novel approach for implant site development through root tipping

Flavio Uribe, a Thomas Taylor, b David Shafer, c and Ravindra Nanda d
Farmington, Conn

Implant site development through orthodontic extrusion can regenerate hard and soft tissue volumes lost to periodontal disease. This extrusive procedure is indicated especially when a maxillary incisor is severely compromised and the esthetic demands are high. This article describes a novel approach to alveolar bone development that enhanced the volume of the implant site. The technique involves tipping the maxillary incisor in the direction of the angular defect to increase alveolar bone volume in the implant site; simultaneous improvement of the interproximal papillary height can also be expected. With this procedure, immediate loading of the endosseous implant is possible due to the quality of the bone developed. (Am J Orthod Dentofacial Orthop 2010;138:649-55)

A lveolar bone development before the placement of an endosseous implant can be accomplished through the slow orthodontic eruption or “extraction” of a severely periodontally compromised tooth.1,2 This procedure is particularly useful when a maxillary incisor is compromised. Because the maxillary incisor is in an important esthetic zone, this method generates tissues that are sufficient to mimic the contralateral incisor and maximizes the development of hard and soft tissue contours. With a light, continuous orthodontic force applied, the tooth is slowly brought incisally along with its gingival attachment and alveolar bone, improving the surrounding bony architecture.4-8

The success of an endosseous implant depends on adequate soft and hard tissue volumes in the recipient site.2 As the compromised tooth is erupted, the cross-sectional area of the root is reduced because of its conical shape. As a result, bone fill is deficient, since the root’s capacity of regenerating bone is limited in the mesiodistal and buccolingual directions. To circumvent this problem, Zuccati and Bocchieri3 described a procedure to increase the buccolingual width of the ridge development by purposely torquing the root labially as the orthodontic eruption is advanced. An alternative to this method is tipping the incisor to maintain adequate buccolingual and mesiodistal widths of the remnant root. In addition, the tipped root fragment might have the potential of developing the papilla lost to periodontal disease. This case report describes the forced eruption concurrent with tipping of the remaining root fragment of a maxillary left central incisor with a severe alveolar bone defect in the mesial aspect. The full treatment plan included replacement of this tooth with an endosseous implant.

CASE REPORT

A 30-year-old woman was referred by a periodontist for an orthodontic consultation, and a significant angular defect was found on the maxillary left central incisor. A significant deepbite was noted during the intraoral examination, as well as a Class II end-on molar occlusion on the right and a Class I occlusion on the left. From the frontal view, the patient displayed uneven gingival heights in the anterior region with mild recession on the maxillary left central incisor and open gingival embrasures in the anterior maxillary region (Fig 1).

The periodontal examination with the periapical full-mouth series (Fig 2) showed generalized moderate periodontal disease. Angular bone defects were limited to the mandibular first molars and the maxillary central incisors. The magnitude of the bony defects of the mandibular molars was mild; however, the angular defect in the mesial aspect of the maxillary left central incisor was severe, extending to the apex. The severity of the
osseous angular defect in the maxillary left incisor was of concern but not directly related to the microbial plaque observed, suggesting that a genetic predisposition might have contributed to the progression of the disease.

The distal aspect of the maxillary left central incisor and the mesial and distal aspects of the maxillary right incisor had lost approximately 60% of the angular bone. The clinical examination also showed mild to moderate crowding in both arches and increased mobility in the maxillary left incisor.

Cephalometric analysis confirmed a straight soft and hard tissue profile with short lower facial height and a reduced mandibular plane angle. Maxillary incisor display at smile was 100%, and the maxillary incisors were slightly retroclined.

The primary treatment objective for this patient was the regeneration of adequate height and width of the alveolar bone and gingival tissue lost to periodontal disease in the maxillary anterior region. The site would be used for an ideal 3-dimensional placement of an endosseous implant to support a prosthetic restoration for the maxillary left central incisor.

The specific orthodontic objectives were to maintain the maxillary incisal edges and relieve the crowding by
distalizing the maxillary right canine, thereby finishing
in a full-cusp Class II molar occlusion on the right and
a Class I on the left. The mandibular arch was to be
aligned through approximately 2 mm of incisor flaring.
In the vertical dimension, the objective was to abso-
lutely intrude the anterior teeth from canine to canine
to correct the overbite. The incisal edges of the maxil-
lary incisors were to be maintained as well as the
patient’s skeletofacial and soft-tissue drape.

The treatment alternatives for the localized peri-
odontal problem were the following.

1. A thorough debridement with gingival tissue regen-
eration procedures. This would address the disease
and result in possible bone deposition and attach-
ment gain. Although some alveolar bone gain
would be expected, the extent of regeneration
would be limited and most likely result in approxi-
amately 50% of root coverage. Additionally, the gain
in gingival tissue height, with the obvious esthetic
benefits, would probably be negligible.

2. Extraction of the maxillary left central incisor and
extensive debridement and grafting to gain alveolar
bone height and width. The advantage of this pro-
dure would be that the site could be ready for im-
plant placement in a shorter time, compared with
an orthodontic forced-eruption approach. However,
the occlusal relationship in the form of a deepbite
was not favorable to receive an implant, and its
placement would need to be delayed until intrusion
of the mandibular incisors was accomplished. Two
other disadvantages of this tripartite approach were
the unpredictability of soft-tissue gain and the need
for additional surgical procedures before the
endosseous implant placement.

3. Eruption of the maxillary left central incisor after
debridement of the anterior region in conjunction
with periodontal maintenance visits every 3
months. The advantages of this option were both
esthetic and functional. Functionally, a greater
amount of bone could be obtained in both height
and width for an ideal implant site. Esthetically,
the gingival tissue would follow coronally, thereby
matching the contralateral tooth and achieving op-
timal soft-tissue contours. Furthermore, tipping
the root apex of the maxillary left central incisor
in a mesial direction toward the right central incisor
would have the added benefit of potentially restor-
ing the papilla lost to periodontal disease in the me-
sial aspect. A larger surface area of the periodontal
ligament would remain with this method, and, as
a result, increases in bone width and height would
be achieved. In contrast, the direct vertical eruption
of the incisor limited the beneficial influence of the
periodontal ligament because of the reduced sur-
face area.

The periodontist who referred the patient had per-
formed a thorough scaling and root planing procedure
by quadrants before the orthodontic consultation. The
patient had also been placed on a 3-month recall sched-
ule. The treatment was divided into 2 phases: the first
phase involved eruption of the maxillary left central in-
cisor and intrusion of the mandibular anterior segment.
The second phase involved extraction of the maxillary
right first premolar and space closure. An endosseous
dental implant was to be immediately placed after
orthodontic treatment.
The first phase started with two 0.022-in preadjusted double tubes bonded to the maxillary first molars and a bracket bonded to the maxillary left central incisor. An 0.018-in stainless steel archwire with an extrusive activation force of approximately 20 g was extended to the central incisor from the molar tubes. A 0.022-in slot preadjusted appliance was bonded to the mandibular first molars and premolars. A 0.020-in stainless steel wire segment was bonded directly, without brackets, from the right lateral incisor to the mandibular left canine (Fig 3). Brackets were not placed in this region to prevent potential occlusal interference with the maxillary incisors, particularly in this patient, whose maxillary left incisor was being extruded as the mandibular incisors were being intruded.

Two 0.017 × 0.025-in stainless steel segments were placed in the mandibular buccal segments from the first molar to the first premolar. An intrusion arch made of .020-in titanium-molybdenum alloy was extended from the auxiliary tubes of the first molars to the mandibular anterior segment and tied mesially to the lateral incisors.

As extrusion in the maxillary left incisor was accomplished, the incisal edge was adjusted for esthetic reasons. After significant tooth eruption, elective endodontic treatment with calcium hydroxide was performed on this tooth to continue the eruptive process (Fig 4). Incisal and lingual tooth structure reduction was needed as the tooth erupted.

After the root was extruded approximately 4 mm, the maxillary right premolar was extracted. The maxillary teeth from the left second premolar to the right second premolar were bonded, and the teeth were aligned and leveled. En-masse space closure was started, bypassing the left central incisor. The mandibular anterior segment of a wire was removed after the intrusion of this segment reached the level of the buccal segments; then brackets were bonded to these teeth and a continuous archwire placed.

As space closure continued, the bracket on the maxillary incisor was bonded more gingivally, and this tooth was tipped mesially to develop extra bone and achieve a papilla in the mesial aspect. The forced eruption continued, and, as the tooth started to tip significantly, composite was added to the mesial aspect of the crown for esthetics (Fig 5).

Space closure was completed, and the patient was finished and debonded. On the same day as appliance removal, the root fragment was extracted (Fig 6), and an immediate bone-level SLActive endosseous dental implant (Straumann, Basel, Switzerland; height, 10 mm; width, 4.1 mm) was placed and torqued to greater than 35 N per centimeter, with good primary stability obtained. At the time of surgery, the alveolar bone completely filled the defect. This surgery was performed through a flapless procedure. Notably, the crestal bone in the extraction site needed to be reduced for placement of the implant 3 mm below the gingival level. A tooth-colored provisional abutment was hand tightened and prepared to receive a temporary acrylic crown. As a protective measure, the occlusion was relieved from contact with the mandibular incisors. Also, at this same visit, a plastic vacuum-formed retainer was delivered.
to ensure no contact with the endosseous implant. Eight weeks later, the final restoration was complete (Fig 7).

The specific objectives of treatment were met, in terms of both implant site development and correction of the malocclusion. The bony architecture was fully developed, as demonstrated by the fact that it was even necessary to remove alveolar bone from the crest to match the gingival level of the contralateral tooth. Both alveolar height and width were obtained; this allowed for a flapless approach in the implant placement procedure. In addition, the interproximal papilla in the mesial aspect was significantly enhanced and the open gingival embrasure considerably reduced. The quality of the bone generated was adequate, allowing for immediate loading of the implant. The occlusal result was positive, since the excessive overbite improved markedly and a Class I canine occlusion was obtained. Furthermore, on the right side, a Class II molar relationship was achieved after extraction of the maxillary first premolar. The mandibular incisors were significantly intruded.

**DISCUSSION**

Generalized chronic periodontal disease can manifest clinically with sites of localized severe attachment loss. The classification of advanced severity is determined by attachment loss of more than 5 mm. In some instances, the attachment loss can extend to the apex, creating a significant angular defect. The treatment of these localized areas with significant periodontal tissue loss depends on the type of defect and usually involves resective surgical procedures such as root amputation (in the posterior teeth) or, more recently, regenerative procedures such as bone grafting and guided tissue regeneration membranes.

Treatment of an extensive angular osseous defect in the maxillary anterior zone is challenging. In these patients, function and esthetics are critical. The gingival height of a compromised incisor generally is more apical than the contralateral unaffected incisor, and bone
loss of the affected tooth, not surprisingly, increases mobility. Surgical treatment, with the objective of regaining attachment, can reduce the mobility and somewhat improve the gingival height contours, but the results might be less than optimal.

Compromised hard and soft tissue architecture in the dental arch is often best addressed with extraction of the affected tooth and a prosthetic replacement, including a bridge or an implant-supported restoration. The esthetic and long-term success of an implant-supported restoration depends on the bone characteristics (3-dimensional topography) of the implant site. Bone grafting procedures can provide height and width for the alveolar bone lost to disease; however, the soft-tissue characteristics of the contralateral incisor might be difficult to mimic. Additionally, at least 1 surgical procedure might be needed to reproduce the natural contours before the endosseous implant placement. Therefore, an alternative approach such as orthodontic forced eruption might be a better choice, since bone is regenerated from the host’s compromised attachment apparatus.

The forced eruption of teeth for implant site development has been previously reported and is based on seminal work by Ingber and Brown, who described altering bone and soft-tissue morphology through orthodontic movement. The success of this procedure depends on good plaque control, careful monitoring of the disease, and at least a third to a fourth of the apical attachment remaining intact. In this patient, minimal remnant bone and attachment were available in the distal portion, but not in the mesial aspect of the central incisor. As mentioned, this patient had an osseous angular defect in the mesial aspect that extended as far as the apex.

Zucatti and Bocchiari were the first to suggest torquing the root labially while encouraging eruption as an alternative to the traditional forced vertical eruption of the tooth to the apex. This labial root displacement was attempted to achieve better alveolar width in a patient with absent labial cortical bone and gingival tissue. Similarly, this case report describes a novel method of forced eruption that could enhance bone width and encourage the formation of interproximal papillary height. The traditional method of vertical eruption of an incisor is less effective, since bone is lost to disease; however, the soft-tissue characteristics of the contralateral incisor might be difficult to mimic. Additionally, at least 1 surgical procedure might be needed to reproduce the natural contours before the endosseous implant placement. Therefore, an alternative approach such as orthodontic forced eruption might be a better choice, since bone is regenerated from the host’s compromised attachment apparatus.

Immediate loading is becoming a more common protocol in the placement of single endosseous implants. The bone quality after bone developed through tooth eruption and tipping has not been studied. However, an animal study in dogs found improved bone quality of the developed bone compared with healed bone analyzed after tooth extraction. This patient was successfully treated with an immediately placed and loaded implant of the central incisor; this suggests that good bone quality was obtained by alveolar development with tooth movement. Additionally, this finding concurs with another case report in which immediate loading was performed after implant site development with orthodontic extrusion.

**CONCLUSIONS**

Implant site development can recreate ideal gingival architecture through tissue engineering obtained by means of slow incisal displacement of the attachment apparatus. Although the minimum amount of attachment needed for bone regeneration has not been determined, it appears that lateral tipping of a tooth might provide a means of achieving adequate bone width and interproximal papilla development. Furthermore, because the quality and quantity of bone seemed to be more than adequate, an additional benefit of this method was that immediate implant loading could be implemented after alveolar bone development.

**REFERENCES**