Improving Soft Tissue Form Around Implants via Forced Eruption

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Integration of a single-tooth implant in the esthetic zone can be one of the most difficult treatment options because of the numerous biologic and esthetic requirements. Of critical importance is the soft tissue integration of the implant-supported restoration relative to the rest of the anterior teeth. Failure to mimic the natural gingival form from both the cervical contour and the papillary form can create an esthetic dilemma. The need to preserve the gingival form has led to the trend of immediate implant placement. After anterior tooth loss, the normal course of wound healing will cause the facial bone and soft tissue to recede both facially and palatally.[1-4] Without support, this recession may be compounded by the loss of the interdental papilla.[5] This creates a narrower residual ridge that may impede placement of an implant in an ideal, restoratively driven position without additional surgical procedures, even if the soft tissue form looks acceptable.[6] Although surgical procedures to rebuild the residual ridge can be performed with generally good results, rebuilding the papilla to its proper form can be much more of a challenge. Forced eruption via orthodontics can be a critical adjunct to regenerating papillae adjacent to an implant, especially when papillary regeneration via a surgical procedure may not achieve the desired result.

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CASE 1

A 40-year-old woman was referred to the office by an orthodontist who questioned the integrity of an existing anterior restoration made 18 years earlier.

At age 18, the patient had had an accident in which she lost tooth 6(13) and fractured the remaining incisors, with a resultant need for endodontic treatment. The patient was rehabilitated with a fixed partial denture from teeth 3(16) through 8(11) (tooth 5[14] was extracted for or-

CASE 1

Fig 1 Initial radiographs at presentation.

Fig 2 Lips at rest during initial evaluation.

Fig 3 Smile during initial evaluation. Note the papillary levels from right to left; the papillae on the right side are shorter.

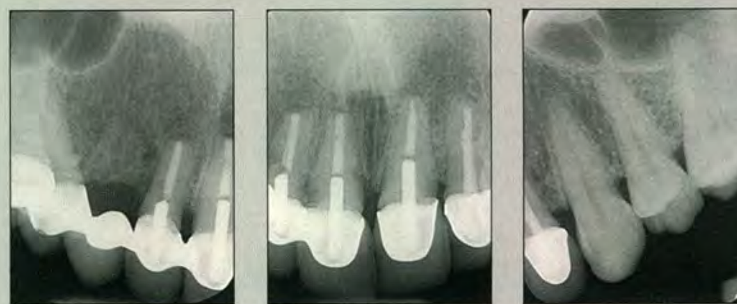

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Fig 4 Intraoral frontal at presentation. Note the discrepancy in the level of the gingiva, which is higher on the right side.

Fig 5 Initial preparations. Note the short preparations and form of the pontic area.

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thodontic purposes, 6[13] because of trauma), with single units (full-coverage crowns) on teeth 9(21) and 10(22).

Implants were not readily available at the time of the injury, so the patient opted for a fixed partial denture to replace the missing canine. Radiographic evaluation revealed fairly short roots on the anterior teeth, with good residual height of bone in the area of tooth 6(13), although there had been both vertical and horizontal bone loss (Fig 1).

Clinical evaluation of the incisal edge at rest position revealed approximately 5 mm of tooth exposure (Fig 2). Assessment during smiling showed more papilla on the left side than the right (Fig 3).

At the time of examination the patient was already in mandibular orthodontic appliances for the correction of crowding (Figs 4 and 5). After intraoral evaluation, it was determined that the marginal integrity of the restorations was compromised by washout of the cement and the resultant decay.

Evaluation of the pontic area 6(13) revealed fair to good remaining soft tissue form, although deficient in the horizontal aspect and the papillae (Figs 4 and 5). The soft tissue margin was positioned more cervically around tooth 7(12) and more coronally around tooth 11(23) than around the other remaining anterior teeth. The marginal tissue contours on the central incisors were not symmetrical or level. The papillary heights were not level; the papillae on the left side were more coronal than on the right (see Figs 3 and 4).

Treatment Plan

The patient wanted to have single-tooth prostheses rather than bridgework. To determine if this was possible, the teeth would be evaluated periodontally at the time of provisionalization to determine whether they could be maintained as single units. Once the determination was made that the teeth could be made into single units from the standpoints of function, mechanics, and biology, the marginal heights of the soft tissue would be corrected with crown lengthening along with an implant placed in the area of tooth 6(13). The soft tissue around tooth 7(12) would be coronally positioned to cover the exposed root and help to level the soft tissue. Shortening of the incisal edges and cervical positioning of the soft tissue would maintain the proportions of the teeth.

The final restorations would be fabricated with Procera crowns (Nobel Biocare, Göteborg, Sweden) to replace teeth 3(16), 5(14), 7(12), 8(11), 9(21), and 10(22), with a porcelain-fused-to-metal crown and a gold custom abutment replacing tooth 6(13) and a feldspathic veneer tooth replacing tooth 11(23).

The patient began treatment as described. At the time of provisionalization, it became evident that the patient needed crown lengthening, not only for esthetic reasons but also for form retention and resistance of the preparations because of the inadequate height (see Fig 5). The mobility of the teeth was negligible; therefore, an implant was deemed appropriate for replacement of tooth 6(13). Once the functional and esthetic requirements were fulfilled in the provisional phase (Fig 6), the patient was sent to a periodontist for esthetic crown lengthening and an implant to replace the missing maxillary right canine. The patient was anesthetized with Xylocaine (AstraZeneca, London, United Kingdom) 1:100,000 epinephrine. A sulcular incision was made around tooth 7(12) and continued into an inverse bevel incision at the new marginal levels of the remaining maxillary anterior teeth, sparing the papilla from the mesial of tooth 7(12) to the distal of tooth 12(24). In the area of teeth 3(16) through 5(14), facial and palatal flaps were reflected to enable circumferential ostectomy for resistance and retention form of the preparations. Vertical incisions were made on the mesial of tooth 5(14) and the distal of tooth 7(12) internal to the papilla on either side to enable coronal positioning of the soft tissue over the implant site 6(13). In the area of the residual ridge, the flap was extended slightly palatal of the center of the ridge to obtain extra tissue. Upon reflection of the flap, the bone was reshaped on all teeth slightly coronal to the bony level of tooth 7(12), as it was the limiting factor because of its bony dehiscence, short root, and minimal bony support. No bone was removed around tooth 7(12) at all. A narrow-diameter standard neck dental implant (Straumann, Waldenburg, Switzerland) was placed in the area of tooth 6(13) with the head of the implant 3.0 mm cervical to the desired gingival margin of the future implant crown as dictated by the surgical stent (Figs 7 and 8). The soft tissue was sutured in place with the flap over the implant coronally positioned to gain vertical height (Fig 9). The soft tissue around tooth 7(12) was also coronally positioned to level the gingival margins (Fig 10).

At 5.5 months, the biologic width had re-established itself, and the patient was ready to begin relining of the provisionals and soft tissue manipulation in the area of the implant. Verification of maturation was made by sounding to bone and comparing the biologic width in the implant area to areas that were not surgically modified. The mass of the papilla on the mesial of the implant (distal of 7[12]) was almost negligible, with only the palatal aspect remaining (Figs 11 and 12). The marginal ridge remained very flat, with an angular transition from the marginal ridge to the papilla rather than a nice scallop (Fig 12). The gingival margin around

Fig 6 First set of provisionals.

Fig 7 Implant placement from an occlusal view. Note the reflection of the papilla on the distal of tooth 7(12).

Fig 8 Implant placement from a facial perspective with the provisional in place.

Fig 9 Coronal positioning of the flap over the implant and healing abutment.

Fig 10 Facial view of suturing after implant placement in the area of tooth 6(13), crown lengthening of the anteriors (except tooth 7[12]), and coronal positioning of the soft tissue over tooth 7(12).


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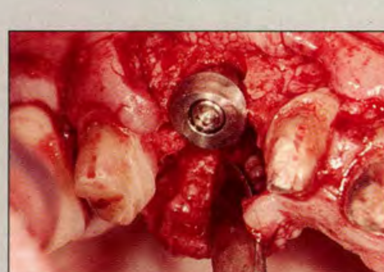
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tooth 7(12) ended up in a more cervical position than the remaining anterior teeth (Fig 11). The teeth were prepared again to the gingival level, except for tooth 7(12), which was left slightly coronal to the margin (Fig 11). An octa-abutment was torqued into the implant, followed by modification of a titanium temporary abutment with addition of acrylic resin to create a root form to support and mold the soft tissue (Figs 13 and 14). The provisionals were relined, and the patient was told to return in 3 months.

After 3 months, the soft tissue form around the implant was still unacceptable. Not only was the facial half of the papilla almost nonexistent, with only the palatal aspect remaining, but the marginal ridge form around the implant was too flat and an-

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Fig 11 Soft tissue form after full healing and reformation of the biologic width. Note the defect around the implant at site 6(13).

Fig 12 Lateral view of the soft tissue around the implant at site 6(13).

Fig 13 Placement of an octa-abutment prior to fabrication of a temporary abutment.

Fig 14 Temporary abutment in place after being modified with a bur and acrylic resin. Note the flat gingival form and deficient papilla on the mesial of the implant.

Fig 15 Provisional relined over the temporary abutment. Note the short papilla on the mesial of the canine compared to the other teeth.

gular, creating a defect on the mesial of the canine (Fig 15). The marginal ridge height of tooth 7(12) remained more cervical than the remaining teeth.

At the time of the initial evaluation it seemed that there was adequate soft tissue and bony topography to adequately restore tooth 6(13) with an implant without bone augmentation prior to placement. In hindsight, it may have been appropriate in this case to augment at least the soft tissue component in this area. The patient had fairly thin soft tissue, especially in the papillary area distal to tooth 7(12) (see Fig 5). Evaluation of the preoperative photographs reveals that the papillary heights on the right side of the maxilla were at least 1.5 mm shorter than those on the left side (see Figs 4 and 5). Without augmentation, the two sides would never be at the same levels.

At the time of surgery, a vertical incision was made through the distal papilla of tooth 7(12) to allow coronal repositioning of the flap over the healing abutment so that the soft tissue could gain vertical height. Close observation of the surgical procedure shows that the incision was placed very close to tooth 7(12), leaving very little bulk or mass of papilla (see Figs 8 and 9). As a result, the blood flow to the area was compromised, and the facial aspect of the papilla sloughed over time, leaving only the palatal aspect. Both a loss in vertical and horizontal mass of the papilla was evident (see Figs 11 and 12). A better approach may have been to include the papilla in the flap by making the vertical incision at the distal line angle of the central incisor rather than through the papilla. This would have allowed even greater freedom to coronally position the flap and possibly get root coverage over the lateral incisor.

Options for Redevelopment of the Papilla and Marginal Tissue

One option for regeneration of the papilla and mesial marginal ridge of the implant was to wait for the biologic width to regenerate. The dentogingival complex was described in 1961 by Garguilo et al[7] in a study in which they measured the distance from the free gingival margin to the underlying bone. This complex comprises the connective tissue attachment, the epithelial attachment (junctional epithelium), and the gingival sulcus. They reported measurements of 2.04 mm for the depth of the connective tissue and epithelial attachments and 0.69 mm for the depth of the sulcus. Kois[8] described a similar biologic width of 3 to 4 mm on the facial aspect of central incisors, with 85% of the subjects within the 3-mm range. Interproximally, a measurement of 4.5 mm was observed. This coincides with the study done by Tarnow and associates in which they measured the distance from the cervical contact to the underlying bone and evaluated the presence or absence of a papilla.[9] There was complete presence of a papilla when the distance was less than 5 mm. Both of these studies evaluated the papilla between two adjacent intact teeth. Between two teeth, the papillary height is actually controlled by the shape and volume of the gingival embrasure, which is determined by the contours of the adjacent roots and teeth and the level of interseptal bone. When one of the contacts is eliminated via tooth loss, as was the case with the missing canine, the papilla will generally collapse to a normal biologic dimension of 3 mm. The connective tissue attachment and junctional epithelium in the papillary area still compose only 2 mm of the total length of the papilla, as they do at the free gingival margin. Between a tooth and an implant, bony support of the soft tissue papilla comes from the attachment level at the tooth side, not the bone level of the implant.[10] Waiting for the regeneration of the papilla could take up to 1 year, and there would still remain a vertical and horizontal deficiency in comparison with the adjacent papilla. This would also not address the marginal discrepancy of tooth 7(12). The second option for redeveloping the papilla was to surgically rebuild the papilla. Several techniques have been proposed for rebuilding the papilla around single-tooth implants,[11,12] although they are difficult to perform, predictability has not been documented, and there are no data regarding long-term stability. These surgical techniques also rely solely on thickening of the overlying soft tissue without augmentation of the underlying supporting bone. The most biologically sound and predictable method for altering gingival levels and papillary levels was to forcibly erupt tooth 7(12).

Forced Eruption

Forced eruption is defined as an orthodontic process whereby a tooth is intentionally moved in a coronal direction through the application of gentle, continuous force in order to effect changes in the soft tissue and bone.[13,14] Because forced eruption modifies the gingival and alveolar crest, it has been used to alter gingival discrepancies and osseous defects of periodontally involved teeth.[15–19] The fibers of the periodontal ligament are attached to the bone by fibers, with formation of new bone around the ends of the fibers.[20,21] Bone is dynamic in nature and hence is constantly being resorbed and rebuilt. When tension is applied to the periodontal ligament, periodontal fibers are elongated, and osteoblasts are induced to deposit new bone in the alveolus, where the attachment is.[22,23] When a tooth is erupted, the bone comes with it and the height of the fiber attachment remains constant.[24] If a tooth is forcibly erupted and, following the movement, held in its new position for 4 to 6 months, the bone and soft tissue should re-establish themselves in this new 3-dimensional position.

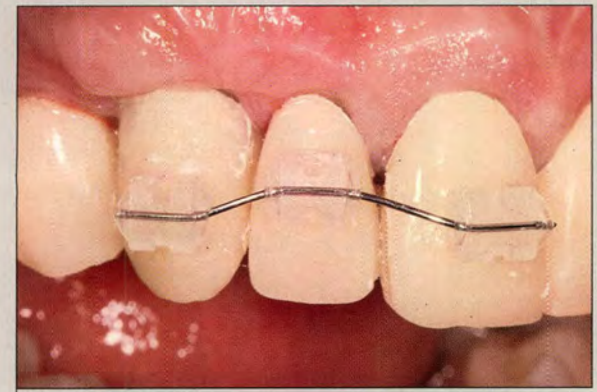
Technique

The provisional restorations were sectioned, leaving the restoration at 7(12) as a single unit. This unit was cemented with a final cement (RelyX ARC, 3M ESPE, St Paul, MN) to prevent loosening during the forced eruption. Only three brackets were used for the eruptive process (Fig 16): one on the maxillary right canine, one on the maxillary right lateral incisor, and one on the maxillary right central incisor. Because the canine was an implant and the right central incisor was splinted to the other central incisor and the left lateral incisor medially, there was no mobility and hence no reason to add more brackets posteriorly. The bracket on the lateral incisor was placed more cervical in relation to the brackets on the canine and central incisor to create a coronal force on the lateral incisor for eruptive purposes (Fig 16). Once the brackets were placed and the acrylic resin was set, nickel titanium wire was placed in the brackets and held with ties. A small-diameter 0.016-mm wire was used to create a slow force during eruption to bring down the bone and soft tissue with the maxillary right lateral incisor. The forced eruption process in this case took only 2 weeks (Fig 17). This was most likely because of the limited bony support around the root of the lateral incisor (Fig 19). Once the lateral incisor was erupted to its correct position, it was luted back together with the remaining provisionals and the brackets were removed. The incisal edge was shortened to compensate for the eruption. Generally, a 4- to 6-month stabilization period is advocated to allow for proper reorganization of the soft tissue and bone and for prevention of relapse (intrusion).[25] In this case, a 4-month stabilization period was chosen to allow redevelopment of the papilla and the gingival margin around the implant. Not only was the gingival margin around the lateral incisor brought more coronal, but the papillary height was increased by approximately 1.5 mm (Figs 18 and 20). Although there was good improvement in the papillary form and the gingival margin of both the canine and lateral incisor, the thickness and bulk of the papilla prevented achievement of an ideal form on the mesial aspect of the marginal ridge of the canine (Figs 20 and 21). Once the tissue was healthy, final impressions were taken (Fig 22).

All of the restorations other than the implant crown and the veneer were fabricated from all-ceramic Procera crowns (Nobel Biocare). For the implant crown, a castable custom gold abutment was fabricated (Fig 23). It was decided to use gold rather than a ceramic abutment because the crown for the implant was going to be made of porcelain fused to metal, allowing the same type of porcelain to be used for the porcelain veneers for the purpose of color matching. If a Procera crown had been made for the implant, the porcelain used for the veneer would have to have been made of a different type of porcelain than the overlay porcelain for the Procera. This in turn would have been difficult to match.

The final results were good considering the original soft tissue defect following surgery (Figs 24 through 26). Radiographs showed that the implant was well integrated, and the new bone apical to the root of tooth 7(12) filled in nicely (Figs 19 and 27).

FORCED ERUPTION—CASE 1



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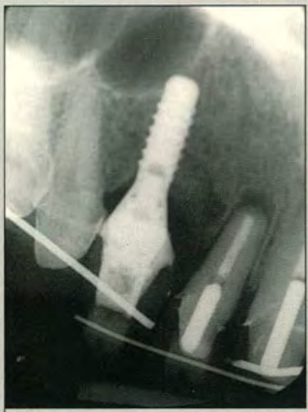

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Fig 16 Beginning of the eruptive process on tooth 7(12) to coronally position the margin and grow the papilla.

Fig 17 Tooth 7(12) erupted into place after 2 weeks of orthodontics.

Fig 18 Soft tissue form around the mesial of the implant improved tremendously, including the marginal configuration and the papillary form and height.

Fig 19 Radiograph after eruption of the lateral incisor. Note the space at the apex of the root.

Fig 20 New provisionals relined over the teeth and the temporary implant abutment.

Fig 21 Facial view of the provisionals after orthodontics, prior to making the final impression. The papilla and soft tissue on the mesial of the canine are still not ideal.

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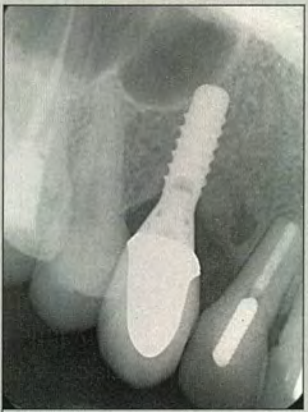

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Fig 22 Final preparations with chord and implant transfer coping on implant 6(13). Note the improved clinical crown length on the teeth.

Fig 23 Final gold abutment on implant 6(13).

Fig 24 Intraoral frontal view of the final case.

Fig 25 Final smile.

Fig 26 Lateral view of final crowns.

Fig 27 Final radiograph of implant 6(13).

CASE 2

A 55-year-old man presented with a porcelain-fused-to-metal crown on tooth 7(12) in his hand. The crown had come loose the previous day (Fig 28); the post had remained within the crown. This is a classic example of the failure associated with a lack of ferrule in which the cement seal breaks, the cement washes out, and the post comes out with the crown, leaving decay in the canal and a broken-down tooth.[26] There was approximately 0.5 mm of remaining tooth structure above the gingival line with decay into the canal space (Fig 28). For long-term predictability, there needs to be at least 1.5 mm of tooth structure beyond the core to create a "ferrule effect."[26]

Evaluation of the gingival levels revealed an ideal gingival margin location, and the patient desired an ideal esthetic result. The patient was given three options, although there were only two options (options 1 and 2) for treatment that would maintain the same gingival levels:

- Option 1: Forced eruption of tooth 7(12) along with supracrestal fiberotomy
- Option 2: Extraction of the tooth and immediate implant placement
- Option 3: Crown lengthening, which would create a "long tooth" relative to the adjacent teeth and disturb the esthetic balance

The patient refused to wear braces due to vanity reasons and therefore chose option 2. Alginates were taken, and a removable provisional was fabricated to replace tooth 7(12). The patient was referred to an oral surgeon for extraction of the tooth and immediate implant placement. Periotomes were used to extract tooth 7(12) with no trauma to the surrounding bone and soft tissue. A 4.1×3.8-mm implant (Straumann) was placed in the extraction socket with the head of the implant placed 3 mm apical to the desired marginal ridge (Fig 29). An implant design that decreases in diameter apically (ie, a tapered implant) is ideal to prevent perforation or stress to the thin labial plate. The surgeon modified a plastic healing abutment to create the proper anatomical emergence form (Figs 30 and 31). The healing abutment was left above the gingival margin to allow full support for the papilla. The removable provisional was inserted as a temporary prosthesis (Fig 31).

After 6 months of healing, the patient was ready for restoration. A titanium temporary abutment was modified with acrylic resin to create the proper emergence profile (Fig 32). The acrylic resin was applied with a salt-and-pepper technique directly into the sulcus form created by the healing abutment. Once set, the temporary abutment was prepared directly in the mouth. The provisional was relined over the abutment, and the tissue was allowed to heal for 1 month prior to the final impression (Fig 33). Even with meticulous surgical technique, there was slight recession on the distal aspect of the central incisor papilla.

At the time of the final impression, acrylic resin was added to the transfer coping to register the emergence profile to the final model. A polyvinyl siloxane impression was taken and poured in stone.

A custom abutment was fabricated using a castable abutment. Porcelain was baked on the abutment to create the emergence form and to cover the metal of the abutment so that an all-ceramic crown could be used (Fig 34). An Inceram crown (Vita, Bad Sackingen, Germany) was fabricated to match the existing porcelain Dicor crowns (Dentsply, York, PA) (Fig 35). After torquing the abutment and cementing the final crown, the patient was told to return in 1 week for photographs.

Emergency Visit

Six days after delivery of the implant crown, tooth 8(11) had fractured down to the gingival line. The patient again presented to the office with a crown in his hand, although this time, the preparation was broken within the crown (Fig 36).

Intraoral evaluation revealed that the gingival margin of tooth 8(11) was in the ideal position. The tooth had fractured to the gum line with no remaining ferrule effect, but radiographically, there was enough root length to restore the tooth if the

CASE 2

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Fig 28 Tooth fracture down to the gum line.

Fig 29 Implant placed immediately at the site of tooth 7(12).

Fig 30 Healing abutment supporting the soft tissue around the implant.

Fig 31 Flipper in place with soft tissue, supported by the healing abutment.

Fig 32 Temporary abutment prepped and modified with acrylic resin to create the proper emergence form.

Fig 33 Placement of the provisional.

Fig 34 Final porcelain-fused-to-metal abutment. Porcelain was baked on the abutment to cover the metal and create a tooth-colored margin and post.

Fig 35 Final crown at try-in.

Fig 36 Tooth 8(11) fractured to the gumline 1 week after delivery of an implant-supported crown at site 7(12).

Fig 37 Radiograph of the fractured tooth. Note the angular peaks of bone around the root.

crown was lengthened or the tooth erupted (Fig 37). The root taper was fairly significant, so a narrower marginal diameter would be created if the tooth was crown lengthened or erupted. The interproximal bone surrounding the root of tooth 8(11) was angular, not horizontal, with the peaks more coronal than the adjacent bone. The root was actually supporting the two peaks of interseptal bone.

Taking the aforementioned into consideration, the patient was given two options for treatment. Only option 1 would ensure an ideal gingival marginal relationship; however, option 2 was more sound biomechanically:

- Option 1: Forced eruption with supracrestal fiberotomy and restoration with a crown
- Option 2: Implant placement immediately post-extraction and restoration with a single crown

Even though it would take much longer to forcibly erupt tooth 8(11), and even with the biomechanical compromise of maintaining the tooth versus placing an implant, the patient chose to maintain his tooth for esthetic reasons and felt he could always have an implant placed if the tooth failed over time.

There were many reasons why forcibly erupting the central would create a more esthetic result. Radiographically, it was evident that the root of tooth 8(11) was supporting the angular interproximal peaks of bone surrounding the root (Fig 36). Extraction of the root, even with immediate implant placement, would inevitably have resulted in the loss of the interseptal bony peaks. After extraction and immediate implant placement, there is generally up to 1 mm of apical migration of the free gingival margin.[27,28] Interproximally, the ideal bone width is approximately 1.5 mm at the crest to minimize lateral resorption of the osseous crest and biologic width violation after implant placement with resultant bone loss.[29] The bone on the distal of the root of tooth 8(11) adjacent to the implant was thin (less than 1.5 mm), especially in the coronal portion (Fig 37). Because the interproximal bone was angular, in order to maintain the peaks of bone, the implant would need to have been placed more coronal than the adjacent implant and tooth 9(21). This would have created a very short distance from the implant head to the free gingival margin, which would have made creating a smooth emergence profile very difficult. Placement of the implant in the correct depth for creation of a smooth emergence profile would have necessitated obliteration of the angular peaks of interseptal bone. The last disadvantage of placing an implant adjacent to another implant is that when 2 adjacent implants are placed, the biologic width around flat implants does not support the papilla interproximally.[30] In fact, only 3 to 4 mm of interproximal soft tissue height is routinely possible, even with a 3-mm distance between implants, as advocated by Tarnow et al.[29] Because the biologic width is apical to the crest of interproximal bone between implants, the connective tissue attachment and the epithelial attachment will not support the papilla. Findings by Tarnow et al[31] indicated that the height of the soft tissue covering the inter-implant bony crest is 2 to 4 mm as compared to the 5 mm found around teeth. Kois and Kan[32] also found comparable measurements of 3 to 4 mm of peri-implant mucosa for anterior single implants.

Taking the aforementioned into consideration, placement of an implant in the area of tooth 8(11) would most likely have created an esthetic nightmare due to loss of papilla, especially between the two implants, as compared to forced eruption with a supracrestal fiberotomy of the remaining root of tooth 8(11). Again, the patient chose to maintain his natural root.

Forced Eruption with Supracrestal Fiberotomy

It is advantageous to erupt a tooth for the purpose of crown lengthening when there is need for sound tooth structure and the gingival height and contour is ideal. Given that surgery would create an imbalance in the marginal levels and increase the crown-to-root ratio, orthodontic eruption with a fiberotomy is the treatment of choice. Kozlovsky et al[33] used forced eruption combined with an incision of the supracrestal gingival attachment. The intrasulcular incisions were performed in conjunction with root-surface curettage at 2-week intervals. This technique prevented coronal displacement of the attachment apparatus, eliminating the need for surgery. Pontoriero et al[34] indicated that the fiberotomy eliminated tensile stress on the alveolar bone and allowed more rapid tooth movement. Bone and soft tissue were left behind, although they recommended weekly fiberotomies.

Technique

The patient was sent to an endodontist for root canal treatment of the maxillary right central incisor. Once week later, a GC post pattern (GC Dental, Tokyo, Japan) was fabricated and cast in type III gold alloy. After cementation with zinc phosphate cement, the preparation was refined with a diamond bur, and an acrylic resin provisional was fabricated. The provisional was cemented with RelyX ARC cement to ensure retention during the eruption process.

Five brackets were placed; one on the implant crown at site 7(12), one on the provisional, and three on the contralateral central incisor, lateral incisor, and canine for anchorage (Fig 38).

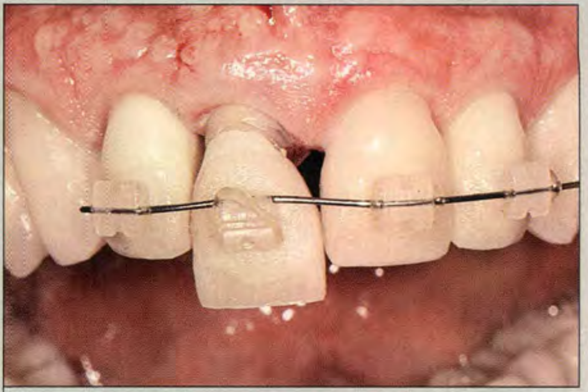
The bracket on tooth 8(11) was placed 2.5 mm cervical to the remaining brackets to create a coronal force after wire placement. Prior to placing the wire, the patient was anesthetized on both the facial and palatal aspects of the soft tissue surrounding tooth 8(11). A no. 15C blade was placed directly into the sulcus until contact with bone occurred. The blade was pulled against the root surface and moved around the full circumference of the root to ensure severing of the supracrestal gingival fibers. The root was planed to the level of the bony crest as described by Kozlovsky et al.[33] A 0.018 nickel titanium round wire was used to rapidly extrude the right central incisor. Even though the tooth reached its final position after only 2 weeks, the patient returned for a fiberotomy every week for 5 weeks to ensure that the fibers would not reattach. The brackets remained

FORCED ERUPTION—CASE 2

Fig 38 Orthodontic forced eruption of tooth 8(11) after a supracrestal fiberotomy.

Fig 39 Final positioning of tooth 8(11) after forced eruption.

Fig 40 Radiographic view of tooth 8(11) in its final position following forced eruption.



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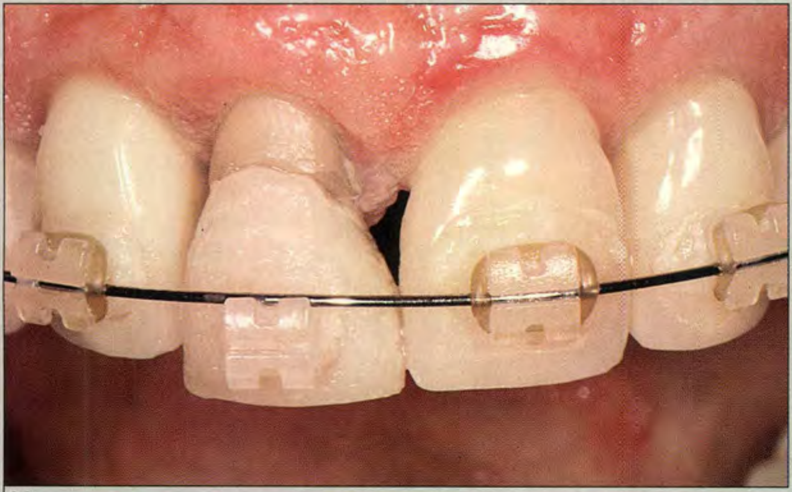

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in place for 4 months to allow reformation of the biologic width and for bone deposition apical to the root (Figs 39 and 40). At this point, there was no movement of the gingival margin.

Choosing Orthodontic Brackets

There are two main types of orthodontic techniques, the standard edgewise technique and the straight-wire technique. The standard edgewise incorporates a brace with no torque and no angulation. The clinician must introduce torque and angulation by means of bending a stainless steel wire. For the general practitioner who does not understand angulation and torque, this can be confusing. A more popular technique is the easier-to-use straight wire system. This involves using a brace that has a predetermined angulation and torque. The brace itself controls the root torque and angulation of the tooth. The torque and angulation are determined by a prescription, depending on which method is used. The most popular prescription is the Roth technique. This was the technique used by the author.

Choosing a Wire

There are round and rectangular wires. When a round wire is used, only angulation can be altered; the torque of the brace is not expressed. The torque and angulation of the root can only be controlled using a rectangular wire. Torque control becomes very important when the premaxilla is thin, and it is imperative to avoid moving the root facially and possibly creating a dehiscence. Most of the time, a round wire is appropriate. The type of wire used by the author was a round, heat-sensitive, superelastic nickel titanium wire. For a slow, controlled eruption aimed at bringing the bone and soft tissue down with the tooth, a 0.014- or 0.016-size wire can be used. For fast eruption, one can use 0.018-size wire or a rectangular wire.

Provisional and Final Restoration

During the healing process, redoing the restoration on tooth 9(21) was discussed with the patient. The objective was to modify the papillary form between the centrals to close the cervical embrasure. The only way to do this was to restore both of the centrals and change the interproximal shape of the crowns. Redoing the maxillary left central crown would make matching to the maxillary right central much more predictable. Once the bone filled in apical to the root, as verified by a periapical radiograph (see Fig 40), the provisional was removed along with the old crown on the maxillary left central incisor (Fig 41). There was very little remaining tooth structure on the preparation (Fig 41); this may be why tooth 8(11) fractured. Care was taken not to touch the existing preparation. Provisionals were fabricated from a waxup of the proposed new restorations (Fig 42). Because the preparations were narrow at the margin, especially the right central incisor, a more horizontal emergence form on the interproximal had to be developed to mold and shape the papilla as well as to close the cervical embrasure (Fig 43). After 2 weeks, the papillary form was developed and final impressions were taken (Fig 44). Individual porcelain-fused-to-metal crowns were fabricated to help mask the color of the gold post of the maxillary right central incisor (Fig 45). The final crowns were cemented with RelyX ARC cement. A harmonious gingival balance and a healthy soft tissue response was achieved via forced eruption (Figs 45 and 46).

DISCUSSION

Soft tissue integration of a single-tooth implant is the most difficult and the most important esthetic aspect in creating an implant prosthesis that appears natural. Not only is the marginal level important, but the papillary form and height are critical. When the soft tissue outcome following implant placement is not as desired, a procedure such as orthodontic eruption can be a tremendous tool in your armamentarium to assist the manipulation of the soft tissue form around an implant or on a tooth adjacent to an implant. Surgically rebuilding the soft tissue can be quite unpredictable and very technique-sensitive, and no long-term data are available on the stability of rebuilt soft tissue. With orthodontics, not only can the marginal tissue of an adjacent tooth be coronally moved, but the papilla can be brought down as well. What makes this even more valuable as a procedure is the long-term predictability of moving the biologic complex 3-dimensionally to a new position rather than rebuilding one aspect of the biologic component (the soft tissue) without support by the other (the bone). Orthodontics may make it possible to save and restore teeth that previously may have been deemed hopeless because of lack of tooth structure, especially adjacent to an implant restoration. This can be critical when the soft tissue form is ideal and a soft tissue defect will be assured following extraction and placement of one implant adjacent to another.


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Fig 41 Preparations after removing old crown 9(21) and temporary crown 8(11). Note the excess soft tissue on the mesial of tooth 8(11) from the orthodontic procedure. Also note the previous overpreparation of tooth 9(21).

Fig 42 Provisionals 8(11) and 9(21)—manipulating the papillary form to close the embrasure.

Fig 43 Cervical view of provisionals. Note the cervical contour of the provisional compared to the margin of the preparation. A mesial cantilever was made to manipulate the soft tissue.

Fig 44 Soft tissue after manipulation of the soft tissue with provisionals.

Fig 45 Final crowns 7(12) through 9(21).

Fig 46 Lateral view of final crowns 7(12) through 9(21).

ACKNOWLEDGMENTS

Special thanks to Dr Isaac Garazi for his surgical work in case 1 and to Dr Stephen Rimer for his surgical work in case 2. Special thanks also to Mr Harald Heindl for the beautiful porcelain in case 1 and to Emanuele di Piazzera for the beautiful porcelain in case 2.

REFERENCES

1. Abrams H, Kopczyk RA, Kaplan AL. Incidence of anterior ridge deformities in partially edentulous patients. J Prosthet Dent 1987;57:191–194.
2. Abrams L. Augmentation of the deformed residual edentulous ridge for fixed prosthesis. Compend Contin Educ Dent 1980;1:205–213.
3. Tarnow DP, Eskow RN. Considerations for single-unit esthetic implant restorations. Compend Contin Educ Dent 1995;16:778–788.
4. Jansen CE, Weisgold A. Presurgical treatment planning for the anterior single-tooth implant restoration. Compend Contin Educ Dent 1995;16:746–761.
5. Weisgold AS, Amoux JP, Lu J. Single-tooth anterior implant: A word of caution. Part I. J Esthet Dent 1997;9: 225–233.
6. Garber DA. The esthetic dental implant: Letting restoration be the guide. J Am Dent Assoc 1995;126:319–325.
7. Garguilo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol 1961;32:261–267.
8. Kois JC. Altering gingival levels: The restorative connection. Part I: Biologic variables. J Esthet Dent 1994;6:3–9.
9. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol 1992;63:995–996.
10. Salama H, Salama MA, Garber D, Adar P. The interproximal height of bone: A guidepost to predictable aesthetic strategies and soft tissue contours in anterior tooth replacement. Pract Periodont Aesthet Dent 1998;10: 1131–1141.
11. Jemt T. Regeneration of gingival papillae after single-implant treatment. Int J Periodontics Restorative Dent 1997;17:326–333.
12. Azzi R, Etienne D, Takei H, Fenech P. Surgical thickening of the existing gingiva and reconstruction of interdental papillae around implant-supported restorations. Int J Periodontics Restorative Dent 2002;22:71–77.
13. Ingber JS. Forced eruption: Part I. A method of treating one and two wall infrabony osseous defects—Rationale and case report. J Periodontol 1974;45:199–206.
14. Ingber JS. Forced eruption: Part II. A method of treating nonrestorable teeth—Periodontal and restorative considerations. J Periodontol 1976;47:203–216.
15. Ingber JS. Forced eruption: Alteration of soft tissue deformities. Int J Periodontics Restorative Dent 1989;9: 416–425.
16. Potashnick SR, Rosenberg ES. Forced eruption: Principles in periodontics and restorative dentistry. J Prosthet Dent 1982;48:141–148.
17. Van Venrooy JR, Yukna RA. Orthodontic extrusion of single-rooted teeth affected with advanced periodontal disease. Am J Orthod 1985;87:67–74.
18. Brown IS. The effect of orthodontic therapy on certain types of periodontal defects. I. Clinical findings. J Periodontol 1973;44:742–745.
19. Levine RA. Forced eruption, part 1: Periodontal and orthodontic considerations for treatment of an isolated periodontal angular infrabony defect. Compendium 1988;9:10–19.
20. Reitan K. Tissue behavior during orthodontic tooth movement. Am J Orthod 1960;46:881-900.
21. Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic movement. Am J Orthod 1967;53:721–745.
22. Stern N, Becker A. Forced eruption: Biological and clinical considerations. J Oral Rehabil 1980;7:395-402.
23. Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thomsen P. The soft tissue barrier at implants and teeth. Clin Oral Implants Res 1991;2:81–90.
24. Wise RJ, Kramer GM. Predetermination of osseous changes associated with uprighting tipped molars by probing. Int J Periodontics Restorative Dent 1983;3: 68–81.
25. Mantzikos T, Shamus I. Case report: Forced eruption and implant site development. Angle Orthod 1998:68(2): 179–186.
26. Libman WJ, Nicholls JI. Load fatigue of teeth restored with cast posts and cores and complete crowns. Int J Prosthodont 1995;8:155–161.
27. Kois JC. Esthetic extraction site development: The biologic variables. Contemp Esthet Restorative Pract 1998;2:10–18.
28. Sadoun A, LeGall M, Touati B. Selection and ideal tridimensional implant position for soft tissue aesthetics. Pract Periodontics Aesthet Dent 1999;11:1063–1072.
29. Tarnow DP, Cho SC, Wallace SS. The effect of inter-implant distance on the height of inter-implant bone crest. J Periodontol 2000;71:546–549.
30. Elian N, Jalbout ZN, Cho S, Froum S, Tarnow DP. Realities and limitations in the management of the interdental papilla between implants: Three case reports. Pract Proced Aesthet Dent 2003;15:737–744.
31. Tarnow D, Elian N, Fletcher P, et al. Vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implants. J Periodontol 2003;74:1785–1788.
32. Kois JC, Kan JY. Predictable peri-implant gingival aesthetics: Surgical and prosthodontic rationales. Pract Proced Aesthet Dent 2001;13:691–698.
33. Kozlovsky A, Tal H, Lieberman M. Forced eruption combined with gingival fiberotomy. A technique for clinical crown lengthening. J Clin Periodontol 1988;15:534–538.
34. Pontoriero R, Celenza F Jr, Ricci G, Carnevale G. Rapid extrusion with fiber resection: A combined orthodontic-periodontic treatment modality. Int J Periodontics Restorative Dent 1987;7(5):30–43.