Residual root preparation for socket-shield procedures: a facial window approach

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Abstract

Two common complications that occur following immediate implant placement and provisionalization procedures in the anterior maxilla are changes to the facial periimplant soft tissue levels and the facial contours. To counteract these changes, different techniques and treatments have been recommended. The recently introduced socket-shield technique (SST) appears to be a viable treatment option for stabilizing the facial osseous and gingival architecture; however, preparation of the root fragment can present challenges. This article describes a surgical approach designed to facilitate preparation of the facial root fragment.

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Introduction

The primary challenge with anterior implant esthetics is the clinician's ability to recreate and/or maintain a periimplant soft tissue architecture in harmony with the adjacent dentition.[1,2] For anterior immediate implant placement and provisionalization (IIPP) procedures, the two primary esthetic concerns following treatment are facial periimplant soft tissue recession and changes to the facial contour.[3-11] Studies have reported that approximately 1 mm of facial periimplant soft tissue recession can be expected following the first year of treatment,[3-9] and may continue as time progresses.[10] This was corroborated by a cone beam computed tomography (CBCT) study by Roe et al, which quantified both horizontal and vertical dimensional changes to the facial bone following IIPP procedures, with the greatest changes occurring at the coronal aspect of the socket.[11]

In an attempt to minimize these dimensional changes to the facial contour, guidelines have been established and techniques have been advocated. These include implant placement toward the palatal aspect of the socket,[1,2,6-8,10,12,13] the incorporation of bone graft materials into the implant–socket gap,[6-8,11-13] subepithelial connective tissue grafts,[6-8,12] and/or bone grafting on the facial aspect of the extraction socket.[14] Root retention has been suggested as a method for preserving the ridge dimensions in pontic sites for tooth-borne and for implant-supported fixed partial dentures.[15,16] In 2010, Hurzeler et al[17] introduced the socket-shield technique (SST), involving the retention of the facial root fragment (FRF) to preserve the facial bone after immediate implant placement. Although preliminary clinical and histologic findings appear to be promising,[17,18] the procedure is technique sensitive. The purpose of this clinical report is to describe a modified surgical approach for the SST technique.

Case presentation

A 56-year-old male presented with a fractured right central incisor that extended below the gingival level on the facial half of the tooth (Figs 1 and 2). Orthodontic extrusion was ruled out, as this would have resulted in an unfavorable crown-to-root ratio (Fig 3). The patient was presented with various options and decided to proceed with an implant-supported restoration. Bone sounding revealed an intact labial bone plate and a normal bone-to-gingiva relationship on the facial aspect (~ 3 mm) of the fractured tooth as well as on the interproximal aspects (~ 4.5 mm) of the adjacent teeth. Prior to reattaching the fractured clinical crown, similar facial gingival levels were noted on both the left and right maxillary central incisors (Fig 4). CBCT confirmed a Class I sagittal root position (SRP),[19] and an overall root length of 13.5 mm (Fig 5).

Clinical procedure

After administering local anesthesia, the coronal structure of the failing tooth was carefully removed using a diamond bur (KS4, Brasseler) until the remaining root structure was 2 mm below the predetermined gingival margin (Fig 6).

Fig 1 Frontal pretreatment view of the failing maxillary right central incisor.

Fig 2 Occlusal pretreatment view of the failing maxillary right central incisor.

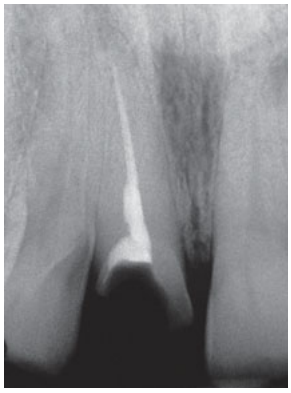


Fig 3 Pretreatment periapical radiograph of the right central incisor showing endodontic treatment.

Fig 4 Reattached clinical crown immediately after bonding.

Fig 5 Right central incisor with SRP Class I.

A semilunar incision was created 5 mm from the predetermined facial gingival margin, and a full thickness flap was reflected to expose the facial bone. The same diamond bur (KS4) was then used to remove the facial bone and expose the root apex. The coronal boundary of the window was created 8 to 9 mm from the predetermined margin to ensure that approximately 5 to 6 mm of the FRF would be in contact with the facial bone. The apical segment of the root was sectioned horizontally using a surgical carbide bur (H254LE, Komet) and removed using an elevator (Fig 7). The same surgical carbide bur (H254LE) was

then used to section the root mesial to distal (Fig 8). The palatal root fragment was removed and the socket was debrided (Fig 9). The remaining FRF was prepared using diamond burs to form a C-shape, and the coronal portion of the fragment was beveled. A slurry mixture of tetracycline and 0.12% chlorhexidine gluconate (Peridex, Procter & Gamble) was used to clean the dentin surface of the prepared root fragment as well as the residual socket.[13]

Immediate implant placement and provisionalization

Sequential implant osteotomy was performed without contacting the FRF to achieve the appropriate three-dimensional implant position.[13] A 3.5 x 13 mm implant was placed (NobelActive, Nobel Biocare).

- *Apicocoronal:* The implant platform was placed 3 mm apical to the predetermined facial gingival margin. This resulted in the implant platform being positioned more apical to the most coronal aspect of the FRF.
- *Mesiodistal:* The implant was placed at the center of the mesiodistal width of the definitive restoration, leaving a minimum distance of 2.0 mm between the implant and the root of the adjacent teeth.
- *Facial-palatal:* The implant was placed along the palatal wall of the extraction socket for primary stability, leaving a gap between the implant and the FRF (Fig 10).

Bone graft material (Puros, Zimmer Dental) was placed in the gap between the implant and the FRF, as well as in the apical aspect of the socket where the facial window was created. A resorbable collagen membrane (Bio-Gide, Geistlich Pharma) was used to cover the bone graft material on the facial aspect. The flap was repositioned, and primary closure was achieved using a nonresorbable suture material (6-0 Polypropylene, Hu-Friedy) (Fig 11). In preparation for the immediate provisionalization procedure, the titanium temporary abutment (Temporary Abutment Engaging Conical Connection NP, Nobel Biocare) was adjusted to the proper dimensions and hand tightened to the implant. The provisional shell was relined with composite resin (Filtek Supreme, 3M ESPE), light polymerized, and adjusted to clear all centric and eccentric functional contacts. The temporary abutment with the provisional restoration was then removed, and additional composite resin (Filtek Supreme) was placed and shaped to develop the desired submergence profile. The provisional restoration was polished and cleaned using a laboratory steam cleaner. Connective tissue harvested from the tuberosity area was trimmed and placed in the facial aspect of the submergence area (Fig 12). The finished provisional restoration was placed and hand tightened. Vinyl polysiloxane (VPS) (Exafast NDS, GC) material and composite resin (Filtek Supreme) was placed to seal the screw access hole (Figs 13 and 14). The CBCT image immediately following surgery confirmed the sagittal position of the implant in relation to the FRF (Fig 15).

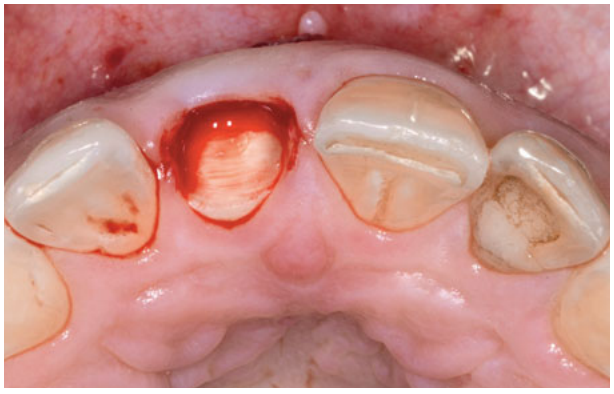
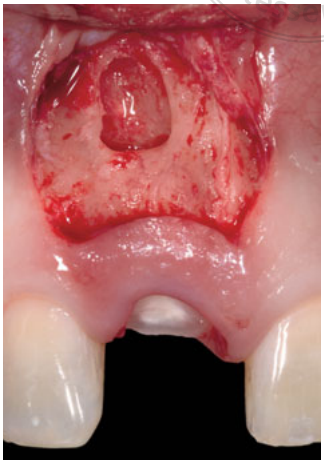


Fig 6 Decoronation 2 mm below the predetermined facial gingival margin.

Fig 7 Semilunar flap to access the apical portion of the root.



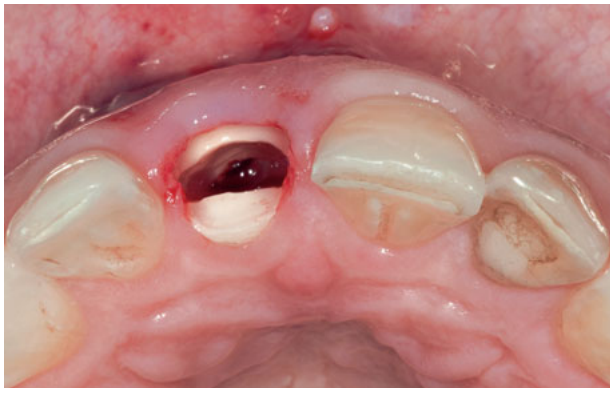


Fig 8 Mesial to distal sectioning of the residual root.

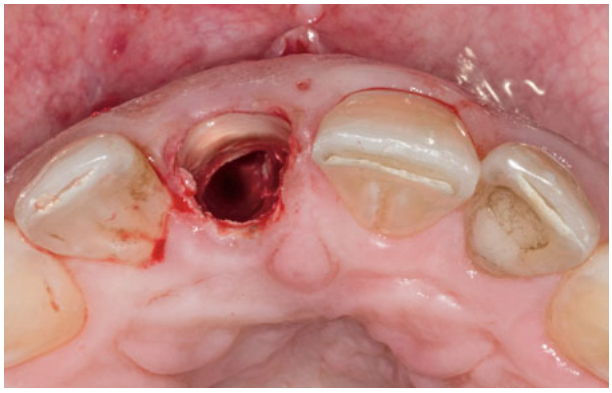


Fig 9 The prepared facial root fragment.

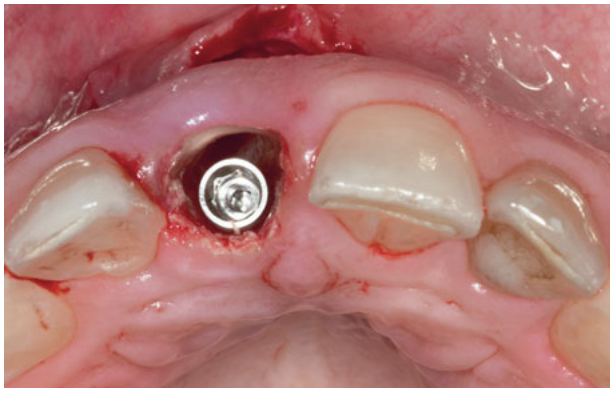


Fig 10 Final implant position. Note the gap between the implant and the facial root fragment.

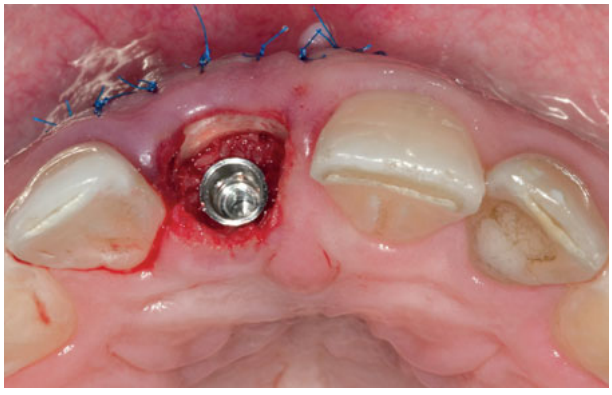


Fig 11 Bone graft material placed into the gap between the implant and facial root fragment, as well as the apex.

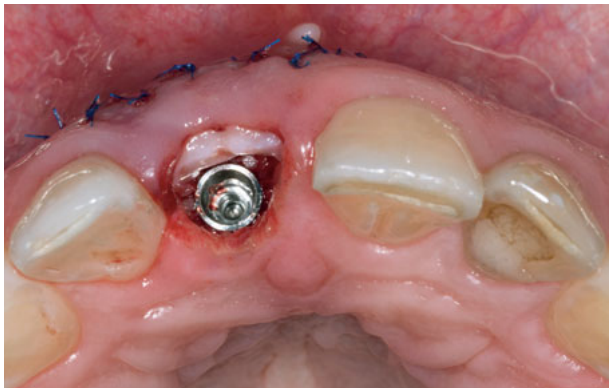


Fig 12 Connective tissue harvested from the tuberosity and placed in the submergence area.

Fig 13 Provisional screw-retained restoration in place, with the access hole sealed with composite resin.

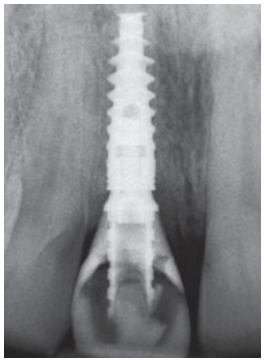


Fig 14 Periapical radiograph of the implant immediately following surgery.

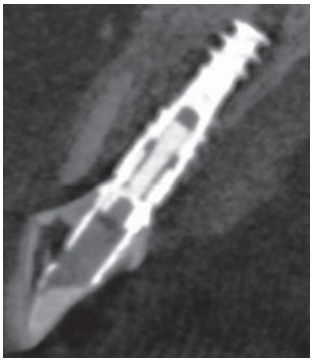


Fig 15 CBCT image of the implant immediately following surgery.

Appropriate antibiotics and analgesics were prescribed. The patient was instructed not to brush the surgical site, but to rinse gently with 0.12% chlorhexidine gluconate (Peridex) and remain on a soft diet for 2 weeks. The patient was advised against functioning activities to the implant site for the duration of the implant healing phase (6 months).

Definitive restoration

At 6 months, the gingival architecture appeared stable and had responded favorably to the provisional restoration (Fig 16). The provisional restoration was removed, and healthy periimplant tissue was noted, with no signs of root fragment exposure (Fig 17). A customized impression coping was fabricated by duplicating the submergence profile of the provisional restoration. An implant-level impression was made using VPS (Exafast NDS) in preparation for the definitive restoration. A customized abutment was fabricated using metal-ceramic alloy to allow for the addition of ceramic on the facial aspect of the abutment (Fig 18). The custom abutment was torqued to 35 Ncm, and the screw access hole was sealed with Teflon tape, followed by a flowable composite resin (Titan, Apex). The definitive metal-ceramic restoration was cemented using a resin-modified glass ionomer (GC FujiCEM 2, GC). At 12 months, the clinical evaluation demonstrated stable periimplant architecture, no indications of facial gingival recession or changes to the facial topography, and the absence of inflammation (Figs 19 and 20). Radiographic evaluations demonstrated

Fig 16 Provisional restoration at 6 months.

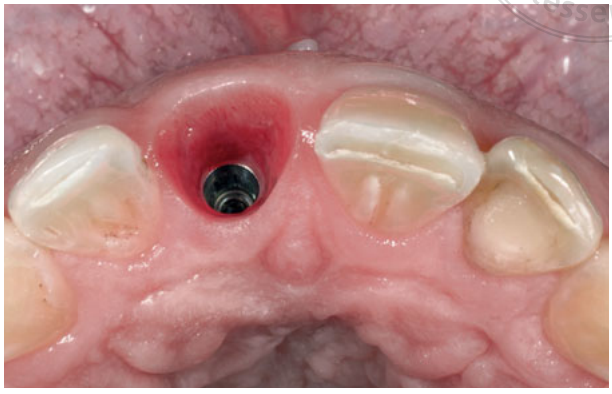


Fig 17 Condition of the periimplant soft tissue at the first disconnection.

Fig 18 Placement of the custom metal-ceramic abutment.

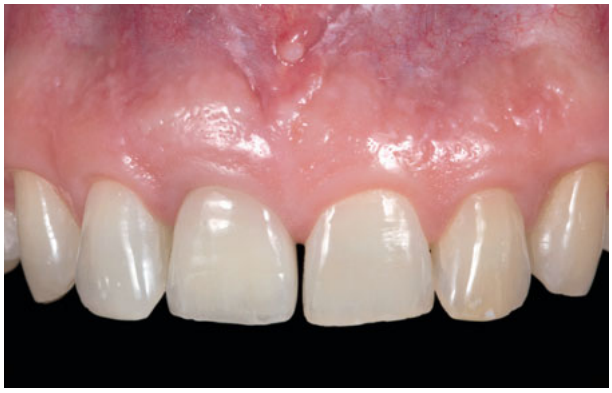


Fig 19 Definitive restoration at 12 months. Note the harmonious gingival architecture.

Fig 20 Profile view of the definitive restoration at 12 months. Note the preserved facial contours.

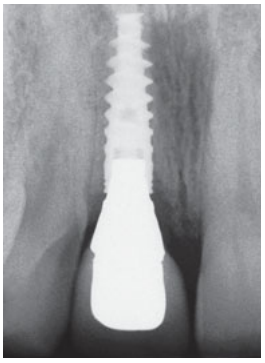


Fig 21 Periapical radiograph of the definitive restoration at 12 months.

Fig 22 CBCT image of the definitive restoration at 12 months.

Fig 23 Definitive restoration at 24 months.

Fig 24 Profile view of the definitive restoration at 24 months.

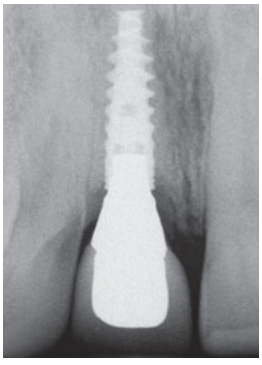


Fig 25 Periapical radiograph of the definitive restoration at 24 months.

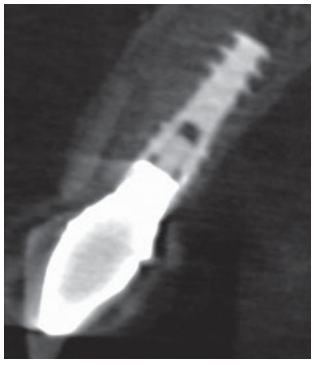


Fig 26 CBCT image of the definitive restoration at 24 months.

stable proximal bone levels, along with the absence of pathology between the FRF and the implant surface (Figs 21 and 22). At 24 months, the clinical and radiographic evaluations demonstrated continued stability (Figs 23 to 26).

Discussion

When a tooth is removed from its alveolar socket, the blood supply to the facial bone is partially disrupted.[20] In addition, the bundle bone undergoes resorption shortly after the periodontal ligament is displaced.[21,22] These factors, along with the lack of support from the root, contribute to the dimensional changes to the alveolar socket. Retaining a FRF can eliminate trauma to the facial bone, thereby preserving the bundle bone and maintaining the local vasculature.

Preliminary data suggest that root shielding can be beneficial for maintaining the facial gingival contour in anterior maxillary implants; however, this increases the difficulty of an already complex procedure. Initial reports have described decoronation of the failing tooth, and the use of implant osteotomy drills in a sequential fashion to carefully remove the palatal aspect of the root until the desired size of the osteotomy has been achieved, while preserving the FRF.[17,18] The residual root fragments on the palatal, mesial, and distal aspects are removed, and the implant is placed. Although this is a viable technique, this approach should be used with caution. Implant drills are designed for cutting into bone. Since dentin is structurally denser than palatal bone, a reduction in cutting efficiency should be expected

when the implant drills come into contact with dentin. This may result in the osteotomy drills drifting toward the path of least resistance (palatal bone), which could result in implant placement in an undesired position. Vibration (chatter) from the implant drill could also weaken the root-to-bone interface and/or damage the facial bone. Furthermore, this also results in partial engagement of the implant with the root fragment. Although the root-to-implant contact is not contraindicated,[17,18] it is not necessarily desired, and should be kept to a minimal since the insertion of the implant can apply unnecessary compressive forces to the FRF on insertion, and the long-term integration of this interface has not been documented.

An alternate approach that could eliminate the aforementioned potential complications involves sectioning the root in a mesiodistal direction, removing the palatal half of the root, and then preparing the root shield. This can be effective in situations where teeth have either short roots or a Class III SRP. However, if the residual root is long, and/or the SRP is unfavorable (Class I and II), this can be problematic with respect to access during root preparation, since the heads of most rotary instruments are larger than the mesiodistal space of a single tooth, and their respective burs are limited in length.

The facial bone crest in this case was approximately 3 mm from the facial gingival margin. Since the greatest horizontal dimensional changes start at the facial bone crest and extend approximately 6 mm apical to the implant platform, in the authors' opinion, only about 5 to 6 mm of the FRF in direct contact with the facial bony plate is needed to effectively preserve the gingival and bone contour.[11] Due to this, the horizontal incision for the facial window should start at least 5 mm from the free gingival margins of the surgical site, with vertical releasing incisions toward the vestibule to allow for complete access. With the flap reflected, the facial bone covering the apical segment of the root is carefully removed, and the exposed root is sectioned horizontally, approximately 8 to 9 mm from the predetermined margin, and is then removed. This addresses the limitations of the rotary instruments when sectioning the root in a mesiodistal direction, and improves visualization when preparing the FRF, since the facial window allows light to illuminate the apex of the socket. Nevertheless, flap reflection can increase the risk of bone remodeling and soft tissue scarring. Therefore, the treating clinician should evaluate the degree of gingival exposure when the patient smiles, and should only extend the incisions where they are absolutely necessary. Once the palatal portion of the root has been removed, the FRF should then be prepared with the surgical carbide (H254LE) creating uniform thickness (1.5 to 2.0 mm) to ensure strength. It should, however, be thin enough not to interfere with implant placement.[13] The coronal portion of the FRF should be beveled approximately 2 mm below the predetermined facial gingival margin (1 mm above the bony crest). This will create sufficient space to develop a proper prosthetic submergence profile while ensuring complete soft tissue coverage of the root fragment. Furthermore, the FRF above the facial bony crest may help to maintain the supracrestal gingi-

val fibers, and help to stabilize the gingival levels. The use of tapered implants may also be beneficial when performing the SST procedure to minimize contact with the root fragment while increasing primary implant stability.[13]

The SST is a technique-sensitive procedure that requires proper case selection and meticulous execution. The mode of failure, its location, and the extent should be considered in order to avoid potential complications with the retained root fragment. The tooth and periodontal apparatus on the SST side of the failing tooth should be healthy, with no evidence of pathology (eg, internal/external root resorption, mobility, perforation, infection, or extensive fracture). This is extremely important, as reports have documented unfavorable biologic responses of implants in contact with pathologic root fragments eventually leading to catastrophic failures.[23] In addition to the aforementioned criteria, careful attention to root dimensions and the SRP in the alveolar housing is critical. Roots that are narrow facial-palatally (< 6.0 mm) may not provide adequate space for the root fragment while placing the implant in the correct prosthetic position. These situations can be seen in patients who have microdontia or have undergone orthodontic extrusion. The facial window approach was designed for SRP Class I and II situations. An SRP Class III is not indicated for the facial window approach, since the bone available for implant stability is located on the facial aspect of the extraction socket and can typically be sectioned mesiodistally due to the angulation of the root. The incorporation of a subepithelial connective tissue graft in the submergence area is not necessary with the SST. However, it may be beneficial, as it will help to thicken the periimplant soft tissue that is not supported by the FRF.

Conclusions

The ability to maintain the facial periimplant soft tissue level(s) and topography following IIPP procedures is essential to the overall esthetic outcome. This case report demonstrates the benefits of the SST procedure with IIPP to maintain the osseous and gingival architecture. Furthermore, the described facial window surgical approach should improve access to the residual root, thereby allowing the clinician to manage teeth with longer roots while minimizing implant-to-root contact.

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