Management of Root Sensitivity following Socket Shield Technique with Anterior Single Immediate Implant Placement and Provisionalization


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Abstract
It is challenging for implants in the esthetic zone to maintain the facial soft tissue contour and interimplant papillae. To counteract the inevitable hard and soft tissue changes after tooth extraction, the socket shield technique (SST) has been advocated as means to maintain the facial and/or interproximal osseous and gingival architecture. As SST is a technique-sensitive procedure, various complications related to SST have been reported. This article presents a unique complication after a socket shield procedure and a novel management of the complication. *Int J Periodontics Restorative Dent* 2022. doi: 10.11607/prd.5426

Introduction

Alveolar ridge remodeling after maxillary anterior tooth extraction often results in buccal bony plate resorption1-3 compromising esthetics.2 Therefore, in anterior single immediate implant situations, techniques such as grafting the implant-socket gap,4 connective tissue grafts,5 contour bone grafts,6 dual-zone grafting7 or their combinations have been advocated to minimize buccal contour change. In 2010, Hurzuler et al introduced the socket shield technique (SST),8 which aimed to preserve the buccal bone by retaining facial portion of the root fragment of the failing tooth. This technique, along with immediate implant placement and provisionalization (IIPP),9 has been shown to maintain peri-implant buccal contour and gingival architecture for optimal implant esthetics.8 In 2013, Kan and Rungcharassaeng expanded the concept by including the proximal root fragment that proved beneficial in inter-implant papilla preservation.10 Since then, several short-term studies and case reports have shown good initial success with this procedure.11-14

Despite high implant success rates, socket shield (SS) complications are not uncommon. Gluckman et al, in an up to 4 years retrospective study on 128 socket shield cases, reported a complication rate of 19.6% (12.8% shield exposure, 3.9% implant failure, 2.3% infection and 0.7% shield migration) in spite of achieving a 96.1% implant survival rate.15 Recently, a systematic review
on SST compiled an average of 6.96% SST complications in human clinical studies. This case report presents how to manage a unique complication after SST in conjunction with IIPP.

Case Report

Socket Shield with Immediate Implant placement and Provisionalization

A 78-year-old healthy female patient presented with a horizontally fractured left central incisor (#9) at gingival level (Figs 1a and 1b). Clinical bone sounding revealed intact buccal bone with normal gingiva to underlying bone relationship of 3 mm facially and 4 mm interproximally. The residual root exhibited no mobility nor periodontal attachment loss. Patient presented with no pain on percussion and palpation. Radiographic examination showed no bone loss and revealed an implant at left lateral incisor (#10) position, which was restored 11 years ago (Fig 2). Cone-beam computed tomographic (CBCT) image (Fig 3) revealed a Class I (root leaning towards buccal bony plate on sagittal CBCT images) sagittal root position (SRP). After being provided with benefits and risks of different treatment options, the patient, who had a high smile line and whose main concerns were esthetics and papilla loss, consented to SST with IIPP.

The maxillary left central incisor was first sectioned mesiodistally (H254, Komet) and the palatal half of the root was removed. The remaining facial root fragment was then adjusted to 3 mm below facial gingival margin (at level of facial crestal bone) to form a 1.5-mm thick C-shaped SS encompassing mesial, facial and distal aspects of the socket (Fig 4). An internal bevel was created (843 KRA, Komet) at coronal aspect of the SS to provide space for prosthetic facial emergence profile. Following sequential osteotomy, a 3.5 x 13 mm implant (Nobel Active, Nobel Biocare) was placed with 35Ncm insertion torque (manufacturer’s recommendation) (Fig 5). The implant platform was placed 4 mm apical to the facial gingival margin (1 mm apical to buccal bone and SS) with minimal contact to the SS. Allograft (Puros, Zimmer Dental) was placed into the gaps between implant and SS, as well as surrounding bony socket. A screw retained immediate provisional was fabricated by
relining (Protemp Plus, 3M ESPE) a pre-made provisional shell onto an adjusted titanium temporary abutment (Temporary Snap Abutment Engaging Conical Connection NP, Nobel Biocare). Besides removing all occlusal centric and eccentric contacts, adjustment was made to leave at least 1 mm space between the subcritical19,20 emergence profile of provisional and SS for soft tissue development. The patient was instructed to be on a soft diet and to avoid masticatory function to the implant site. Final polyvinyl siloxane impression (Exafast NDS, GC) was made 8 months following SST and IIPP. A definitive cement retained implant metal-ceramic crown was fabricated and cemented onto a customized alloy abutment (GoldAdapt Engaging Conical Connection NP, NobelBiocare) with negative die technique21 to minimize the need for excess cement removal.

The patient complained of sensitivity and tenderness upon palpation and tooth brushing on the facial aspect on the implant at 1 month recall appointment (Figs 6a and 6b). Periapical radiographs (Fig 7) and clinical evaluations did not detect infection nor residual cement at the implant site. The symptoms persisted over the subsequent 2 months. A CBCT scan was then taken and the sagittal view of implant #9 revealed an incomplete SS preparation leaving a 7 mm long root with intact root canal, but without periapical pathology (Fig 8). After discussing treatment options, which included SS removal or endodontic intervention, the patient opted for exploratory surgery involving microsurgical endodontic treatment.

Root-End Resection and Microsurgical Endodontic Intervention

Endodontic surgical procedures were performed with an operating microscope (A-SeriesTM Dental Microscope [Global Surgical Corporation, USA]). After administering local anesthesia, a scalloped horizontal incision (Ochsenbein-Luebke) was made 4 mm apical from #9 facial gingival margin with two accompanying vertical incisions and a full thickness flap reflected (Fig 9). A small buccal bony window was created (H7S, Komet) to reveal the apical portion of the SS (Fig 10). The apical 3 mm of the SS was sectioned with a horizontal facial bevel cut (S5856, Komet) and removed, exposing the pulp canal (Fig 11). Hemostasis was achieved (Racellet #2, Pascal) and inverse
mechanical instrumentation (K-Files #15- #30, Kerr, SybronEndo) was executed in an apico-coronal direction with irrigation (normal saline solution) (Fig 12). The piezo ultrasonic unit (Acteon Satelec P5 Newton Ultrasonic scaler, Acteon) with a periapical diamond coated retro-tip 3 mm (Apical Surgery Tip AS3D, Acteon) was used to prepare the inverse canal for root-end retrofill (Fig 13). The canal was then dried (Absorbent Points, Dentsply Sirona) and filled with grey mineral trioxide aggregate (MTA [ProRoot, Dentsply/Tulsa Dental]) using micro plugger/condenser (3 Abou-Rass Angled Apical Plugger, Hu-Friedy) (Fig 14). The root-end resection site was filled with allograft (Puros, Zimmer Dental) and covered with resorbable collagen membrane (Bio-Gide, Geistlich Pharma) (Figs 15 and 16). Primary closure was achieved using resorbable (5-0 Chromic-Gut, Hu-Friedy) and nonresorbable (6-0 Polypropylene, Hu-Friedy) suture materials (Fig 17). Root-end retrofill was verified with CBCT (Fig 18). The sutures were removed after 2 weeks. The patient was symptom free after the microsurgical endodontic treatment, and did not report any further sensitivity or discomfort up to 6 months at the SST and IIPP site (Figs 19, 20a, 20b).

Discussion

Since SST was first advocated, many studies, case reports, and systematic reviews over the past decade have suggested that this technique can effectively maintain the facial as well as the interproximal soft and hard tissue. However, it is clear that beside comprehensive training, proficient skill and extensive experience of the clinician, this technique sensitive procedure also requires proper diagnosis and case selection. Step-by-step protocols have been developed in exploring proper ways to handle the procedure and navigate its corresponding difficulties. Nevertheless, questions such as remain regarding ideal SS dimension, necessity and type of bone graft material between SS and implant, apicocoronal position of SS to buccal bone level, and proximity between SS and implant are still worthy of discussion.
Calcific metamorphosis (CM) is defined as “a pulpal response to trauma characterized by rapid deposition of hard tissue within the canal space.”24 CM is most commonly seen after traumatic injuries of teeth and can be detected clinically as early as 3 months, while in most situations it is not recognized up to 1 year.25,26 CM is generally asymptomatic and endodontic intervention may not be needed when obliterated pulp canal shows no symptoms of periapical pathosis.27 The incidence of a tooth with CM developing pulpal pathology is low, between 1-16%, therefore, routine follow ups and observation are recommended unless signs of infection develop.28-30 The patient’s history of trauma causing fracture of #9 more than 10 years ago accompanied with the obliteration of pulp chamber and coronal portion of root canal (Figs 1a and 1b) suggested a diagnosis of CM on #9. Before SST, the patient did not experience pain or discomfort on #9, and did not receive endodontic treatment. However, after SST and IIPP, the patient complained about the sensitivity and tenderness upon palpation and tooth brushing on facial of #9. This could be due to the exposure and incomplete removal pulp tissue in root canal during SS preparation (Fig 4). Possible introduction of bacteria into the exposed pulp tissue in root canal could lead to pain, sensitivity and/or infection.31

It is interesting to note that several authors recently mentioned using root canal as a directional guide for SS preparation. Staehler et al22 advocated using a small Lindemann bur to remove the endodontic post and follow the root canal to the apex. Gluckman et al23 recommended the use of Gates Glidden burs to widen the canal and drill to the apex. Besides, Gluckman et al32 suggested clinician could use endodontic instrument to orientate root canal, which might help section root into labial and palatal halves. However, it becomes challenging for clinicians to identify the path of canal when partial or total obliteration of the pulp chamber/canal is encountered, thus confounding their ability to completely remove the vital pulp. Moreover, as in the described case, Class I SRP17 (root tilting towards the buccal bone plate) with significant angular deviation between root and implant long axis (Fig 3) could lead to inadequate SS preparation and thus incomplete clearance of the pulp canal. It can be noted from post SST and IIPP CBCT (Fig 8) that only coronal palatal portion of root was
removed during SS preparation, thereby, leaving a completely intact root canal within the SS. Therefore, to avoid this issue, SRP and the angular deviation between crown and root (Collum Angle) of the failing tooth must be identified from the available CBCT. If SST is to be performed on a non-endodontically treated tooth, it is advisable to follow the path of the root canal with the initial drill to ensure complete pulp tissue removal and that the root is sectioned into buccal and palatal halves.23,32 In an endodontically treated tooth, the clinician can simply follow the path of the endodontic post and/or endodontic filling material such as gutta percha to achieve similar results.22,23 Regardless, clinician must be cautious with this approach, as buccal bone perforation, though not detrimental, can occur especially in class I SRP.17

In the presented case, the treatment of symptoms (sensitivity) could entail surgical removal of the SS or with microsurgical endodontic intervention. Surgical SS removal, however, may result in an adverse change in hard and soft tissue architecture compromising esthetics.33 While endodontic intervention was more conservative, the unique situation presented demanded an unconventional approach. As SS in the presented case was already completely covered by soft tissue coronally, the implant was integrated, and already restored with definitive cement retained restoration, accessing root canal from coronal aspect proved to be a challenge. In addition, completely calcified and obliterated coronal pulp canal and close proximity between SS and implant made it virtually impossible to perform traditional coronal approach endodontic treatment.

Therefore, a novel conservative root-end resection with root-end filling approach was undertaken. When the apical 3 mm of SS was removed after being resected with external bevel, the visibility of the root canal for inverse endodontic treatment were significantly improved (Fig 11). Majority of root ramifications were also eliminated since lateral canals usually exist within 3 mm from root apex.34 Furthermore, the remaining SS (~4 mm) was sufficient to maintain the stability and esthetics of peri-implant facial contour. However, due to the location of the apical entrance, visibility did not translate to accessibility. Inverse mechanical instrumentation using regular endodontic files could be extremely
difficult and time consuming. The use of the piezo ultrasonic unit with the tip that has an appropriate angle and length (Fig 13), on the other hand, could substantially enhance the accessibility. It has been shown that the vibration created by the ultrasonic tip produces the effectiveness in cleaning and removing remaining pulpal tissue comparable to mechanical instrumentation. MTA was the material of choice for root-end filling in this case due to its superior biocompatibility, long term compressive strength and marginal adaptation and leakage.

Even though the CBCT image (Fig 18) showing a filled canal and the absence of persistent symptom suggest a successful operation, there are caveats to this technique sensitive procedure. Since the partially sectioned SS was in a very close proximity with the implant, great care must be taken during root end resection to avoid damaging the implant. When creating external bevel, one must be aware that large bevel can subsequently increase the risk of leakage of the root-end fill. Material overfill is also a major concern with apical root end fill in this situation. Fortunately, in the presented case, the coronal portion of the SS was calcified minimizing the chance of overfill. Furthermore, hard tissue could have developed between SS and implant minimizing the chance of MTA overflowing into the implant SS gap. Regardless, cautions must still be exercised and long-term follow-up observed.

Conclusions

Post-surgical sensitivity can occur in socket shield technique case when a calcified and/or obliterated pulp canal with no previous symptoms has not been completely removed. Inverse endodontic treatment with root-end fill can be performed to resolve the issue. Nevertheless, CBCT to identify the sagittal root position in conjunction with complete vital pulp removal by sectioning the root while following the root canal chamber is essential during socket shield preparation to minimize complications.

Acknowledgments
The authors reported no conflicts of interest related to this case report.

References


Figure Legends
Fig 1 a) Frontal and b) Occlusal views of fractured maxillary left central incisor (#9). Note the calcified root canal on #9.

Fig 2 Periapical radiograph of horizontally fractured tooth #9 with adjacent maxillary left lateral incisor implant crown (#10).

Fig 3 Cone-beam computed tomographic (CBCT) sagittal image of tooth #9 with radiographic template displays a Class I sagittal root position (SRP) of #9 with significant bone concavity apical to its apex. Note a substantial angular deviation between crown and root of #9.

Fig 4 Preparation of a 1.5-mm thick C-shaped socket shield (SS) encompassing mesial, facial and distal aspects of socket.

Fig 5 Occlusal view of the immediately placed implant #9. Note minimal contact between implant and C-shaped SS.

Fig 6 a) Frontal and b) Occlusal views of definitive cement-retained implant metal-ceramic crown #9 11 months after SS and immediate implant placement and provisionalization (IIPP).

Fig 7 Periapical radiograph of cement retained implant metal-ceramic crown #9 11 months after SS and IIPP. Note the presence of root fragment mesial and distal to the implant.

Fig 8 A CBCT sagittal image showing SS and implant #9 at 11 months. Note the intact root canal within the inadequately prepared SS.

Fig 9 An Ochsenbein-Luebke flap was used for visualization of the surgical site and subsequent tensionless flap closure.

Fig 10 A facial bony window was created exposing the apical 3 mm of the SS.

Fig 11 A 3-mm root-end resection with slightly facial bevel of SS was made for endodontic access. Note the bleeding point as a result of vital radicular pulpal exposure.

Fig 12 K file was used to remove vital pulp, trace the canal, determine the working length and initiate the inverse mechanical instrumentation.
Fig 13 The 3-mm piezoelectric ultrasonic retro-tip was used to complete the inverse mechanical instrumentation and root-end preparation.

Fig 14 Root-end cavity filled with grey mineral trioxide aggregate (MTA).

Fig 15 Allograft was placed in the root-end resection site.

Fig 16 A resorbable collagen membrane was placed over the bone graft material.

Fig 17 Primary closure was achieved with resorbable and non-resorbable suture materials.

Fig 18 Post-operative CBCT sagittal image shows satisfactory root-end resection and MTA-filled root-end cavity.

Fig 19 Periapical radiograph of #9 6 months after root-end resection and microsurgical endodontic intervention, and 20 months after SS and IIPP.

Fig 20 a) Frontal and b) Occlusal view 6 months after root-end resection and microsurgical endodontic intervention, and 20 months after SS and IIPP. Note the well-maintained facial contour after SS and IIPP on #9.
Figures 5426

Fig 1a

Fig 1b

Fig 2

Fig 3

Fig 4

Fig 5