

Tissue preservation through socket-shield technique and platelet-rich fibrin in immediate implant placement

A case report

Tianqi Guo, DDS, Ran Nie, MS, Xirui Xin, MS, Hanchi Wang, MS, Manlin Qi, MS, Kaixuan Yu, MS, Yao Wang, BS, Liuyi Du, BS, Yanmin Zhou, DDS, PhD*

Abstract

Rationale: In this report, a combination of socket-shield technique (SST) and platelet-rich fibrin (PRF) technique was used for immediate implant placement on a fractured central incisor. During the follow-up visit, cone beam computed tomography (CBCT) and clinical observation were used to evaluate the preservation outcome of peri-implant bone and gingiva.

Patient concerns: The patient was a 28-year-old healthy female patient who desired her fractured 21 to be replaced with an implant-supported single crown; the fractured 21 comprised a post-core crown with insufficient residual bone at the labial site.

Diagnosis: The root of 21 exhibited a complex root fracture; the labial portion of the alveolar ridge was thin (<1 mm) and partial ankylosis of the residual root was observed.

Interventions: Modified SST was applied to the labial portion of the residual root. The implant was placed immediately at the lingual site of the retained socket-shield root fragment; PRF was placed in the gap between the root fragment and the implant. Final prosthodontic treatment was performed at 24 weeks after implant placement.

Outcomes: Clinical examination and CBCT scanning at various follow-up visits time showed that the periodontal tissue was well-preserved. At 6 months after surgery, the average horizontal and vertical peri-implant bone resorption was 0.4 mm; a follow-up visit at 18 months post-loading indicated that peri-implant tissue was well preserved by the shield-technique and no significant peri-implant tissue resorption was displayed.

Lesson Subsections: In cases of anterior teeth with intact but insufficient residual alveolar ridge, the SST with PRF may be effective for preservation and maintenance of stable peri-implant tissue.

Abbreviations: CBCT = cone-beam computer tomography, GBR = guided bone regeneration, PDGF = platelet-derived growth factor, PDL = periodontal ligament, PRF = platelet-rich fibrin, RST = root submerged technique, SST = socket-shield technique, VEGF = vascular endothelial growth factor.

Keywords: immediate implant placement, platelet-rich fibrin, socket-shield technique, tissue preservation

1. Introduction

Resorption of alveolar bone is unavoidable after tooth extraction,^[1] as a result of surgical trauma of tooth extraction and the absence of the periodontal ligament that offers vascular supply to the alveolar ridge.^[2] The extent of bone resorption can be up to 3.8 and 1.24 mm in the horizontal and vertical directions.^[3] Resorption on the labial

site of the postextracted sockets is aggravated on the labial side,^[4] which can then cause severe gingival margin recession and damage the pink aesthetic of peri-implant tissue.^[5]

Reduction of blood supply is a critical reason for alveolar bone resorption. The endosseous marrow in cancellous bone, periodontal ligament, and labial periosteum are the 3 main sources of blood supply to the alveolar ridge^[6]; bone plates on the anterior region of maxillary arch are thin and primarily composed of cortical bone lacking vascular supply. Thus, postextracted alveolar ridges in aesthetic areas are more vulnerable to resorption. Upon extraction of the tooth, blood supply from the periodontal ligament is destroyed.^[7]

For cases treated with socket-shield technique (SST), the labial part of the periodontal ligaments can be preserved and residual labial periodontal ligaments can connect dental cementum with peri-implant bone; thus, peri-implant tissue can become more like normal periodontal tissues, and can better protect against soft tissue retreat.^[8] This report describes a case of fractured residual root with insufficient alveolar ridge at the labial site. To minimize therapeutic trauma, increase patient satisfaction, and reduce post-surgical bone resorption, SST was applied to the residual labial site of the tooth fragment, and platelet-rich fibrin (PRF) was used around the shield to promote bone healing.

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School and Hospital of Stomatology, Jilin University, Department of Dental Implantology, Jilin Provincial Key Laboratory of Tooth Development and Bone remodeling, Changchun, Jilin Province, China.

* Correspondence: Yanmin Zhou, 1500 Qinghua Road, Changchun, 130021, Jilin, China (e-mail: zhouyanmin62@126.com).

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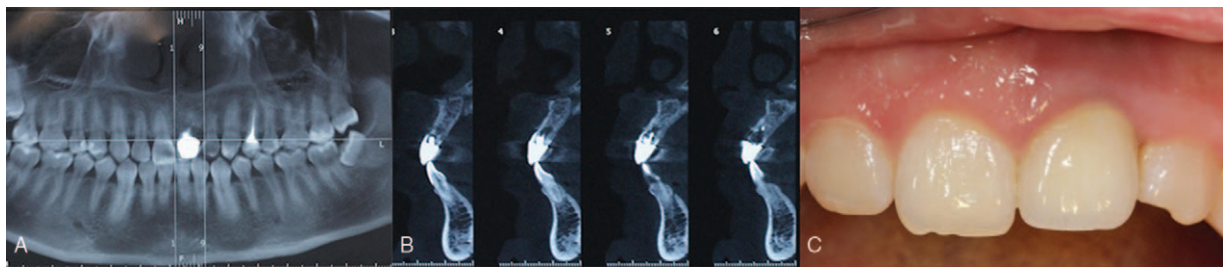


Figure 1. Clinical and radiograph examination before surgery.



Figure 2. Labial shield preservation and immediate implant placement.

2. Case report

A 28-year-old, healthy, nonsmoking female patient consulted the Department of Oral Implantology, School and Stomatology Hospital of Jilin University with 21 root fracture caused by crush injury (tooth numbered by “FDI World Dental Federation notation”). Panoramic radiography revealed that 21 had been restored with a bad prosthesis post-core crown; moreover, the labial bone plate was thinner than 1 mm. The fracture line extended 3 mm apical to the alveolar ridge crest (Fig. 1A, B). The patient’s periodontal ligament was healthy, except for minor calculus and debris. Frontal view indicated that the gingival contour of 21 exhibited 1 mm of recession, compared with adjacent teeth (Fig. 1C); furthermore, the patient had thin gingiva that were vulnerable to recess.

Because the fracture line was lower than the alveolar crest, as shown by panoramic radiography, we initially planned to completely extract the residual root and place an implant-supported single crown to replace 21.

Before surgery, informed written consent was obtained from the patient for publication of this case report and its accompanying images. Mouth rinsing was performed 3 times with 0.2%

chlorhexidine solution. Under local infiltration anesthesia with articaine, the crown of 21 was removed by dental forceps; we then noted that the post-core had caused a side perforation on the root of 21. Furthermore, the fracture line on labial side of 21 was parallel to the alveolar crest; on the palatal side, it was 3 to 4 mm apical to the alveolar crest, and the residual root had several minor leakages (Fig. 2A). We attempted to extract the residual root with a minimally invasive periosteal elevator; however, the root fractured into 2 parts, and we then extracted the palatal portion of the residual root, leaving the labial portion inside the alveolar socket. The top of the remaining root was located parallel to the alveolar crest, and the root fragment was shaped and prepared with a coarse-grained diamond bur into a C-shaped, 1 mm thick shield (Fig. 2B). The socket was then debrided slightly and irrigated with normal saline. Implant bed preparation was drilled step by step in the alveolar socket, and a Straumann SLActive bone level implant (3.3 × 12 mm) was placed in the alveolar socket (Fig. 2C). The cover screw was then installed on the implant (Fig. 3A), and 2 pieces of PRF were made and used to fill the gap between the implant and the socket shield (Fig. 3B). The surgical area was then tightly sewn (Fig. 3C).



Figure 3. Applying PRF for guided bone regeneration.

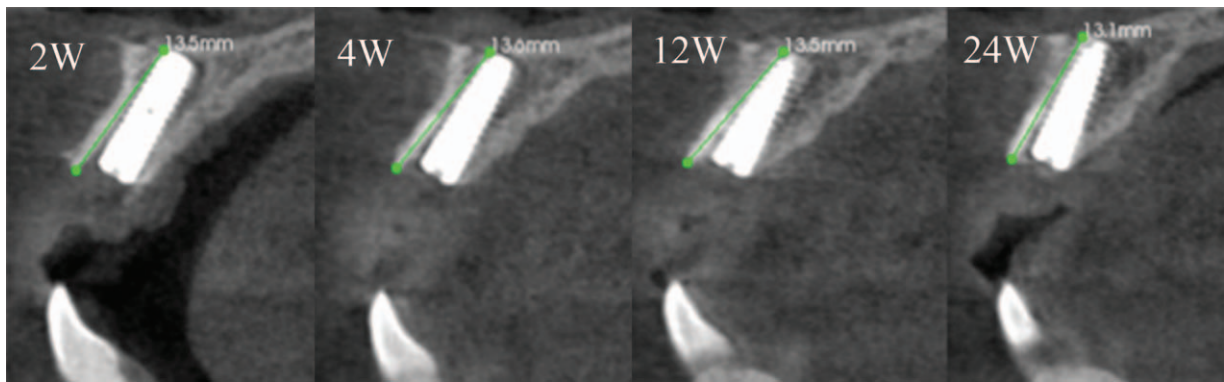


Figure 4. CBCT scanning at 2,6,12,24 weeks after implant placement.

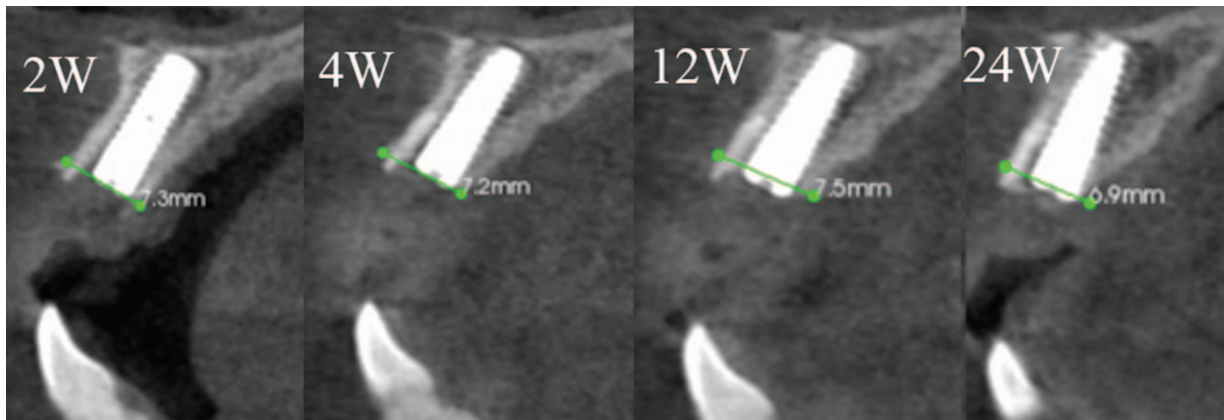


Figure 5. CBCT scanning at 2,6,12,24 weeks after implant placement.

The patient was asked to attend follow-up visits at 2, 6, 12, and 24 weeks after surgery. Clinical examination indicated that no inflammation was present at the implant site. We performed the second stage of surgery at 24 weeks postsurgery, when cone beam computed tomography (CBCT) scanning indicated a mean vertical resorption of 0.4mm and horizontal resorption of 0.4 mm (Figs. 4 and 5).

After flap elevation, we found that the preserved labial shield remained intact with no bone resorption at the implant site; the minor gap between the implant and socket shield was filled with newly regenerated bone that overlapped a portion of the cover screw (Fig. 6A, B). We then carefully replaced the cover screw with healing abutment, and tightly sewed the surgical site (Fig. 6C).

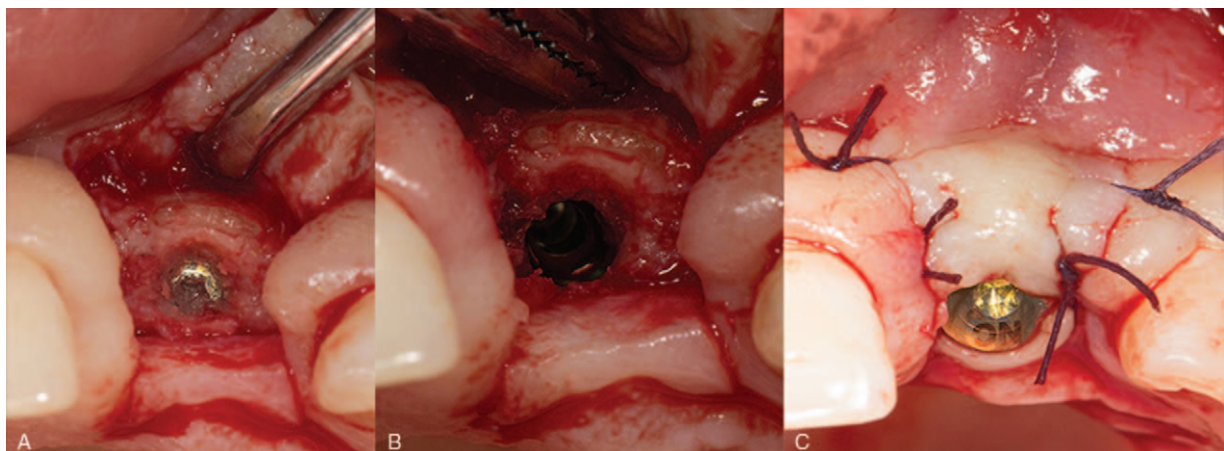


Figure 6. Twenty-four weeks after implant placement, second-stage surgery.

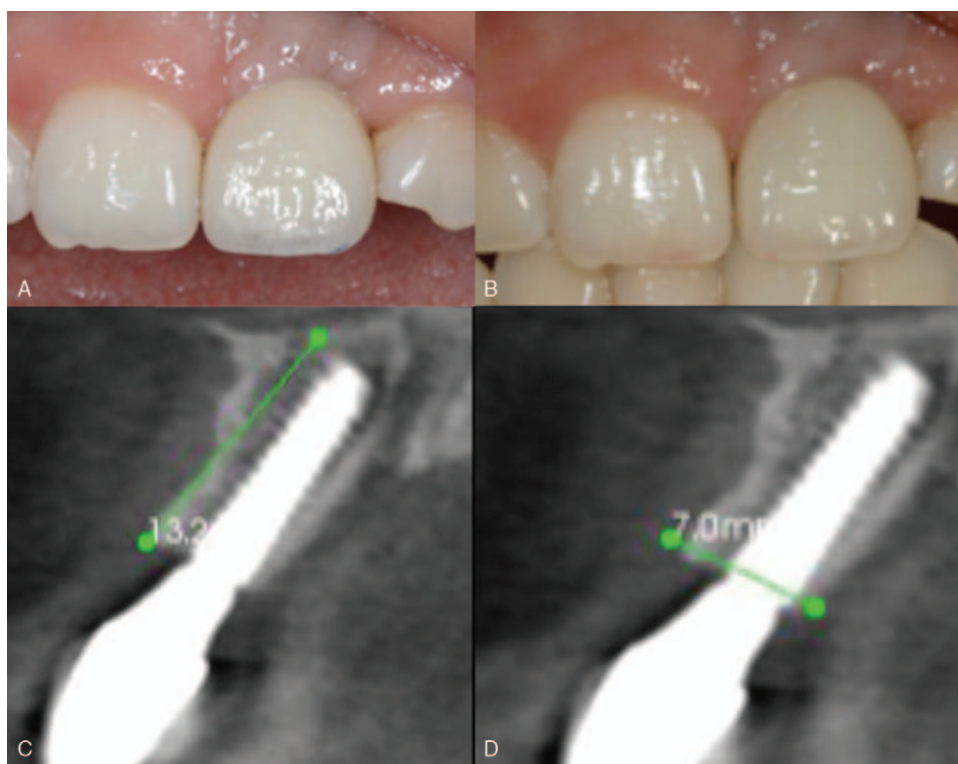


Figure 7. The gingiva contour at 5 months (A) and 18 months (B) after final restoration, and the CBCT scanning at 18 months after final restoration (C, D).

Impressions were taken 15 days after the second stage of surgery; final prosthodontic treatment was finished by a porcelain-fused-to-metal crown. The follow-up visit at 5 months after final restoration (Fig. 7A) indicated that the gingival contour was well-preserved by the labial Socket-Shield, and no significant gingival recession was present at 21. In contrast, the gingiva papillae, which were not supported by a Socket-shield, showed slight recession with the presence of a black triangle. There was no inflammation on the periodontal tissue of 21 (Fig. 7B). At the 18-month follow-up after final rehabilitation, 21 gingiva was stable and no contour recession occurred, CBCT indicated that the marginal bone level around the implant (Fig. 7C,D) was stable in both vertical (13.2 mm) and horizontal (7.0 mm) directions. The patient was satisfied with the final restoration.

3. Discussion

At immediate implant sites, the functionally loaded periodontal ligament can be destroyed during tooth extraction, which could lead to severe gingival recession. In order to compensate for the tissue resorption, various types of guided bone regeneration (GBR) were applied in the immediate implant site.^[9,10] Because of unavoidable peri-implant tissue resorption and postoperative complications, GBR always results in unsatisfactory outcomes^[9,11]; at aesthetic areas, the space for bone regeneration is hard to maintain and blood supply is always insufficient with respect to the lack of cancellous bone. Due to such restrictions, the subsequent tissue shrinkage after GBR made it difficult for clinicians to predict the pink aesthetic outcomes after horizontal and vertical bone augmentation at the anterior region.^[11,12] Although overbuilding of labial bone could not guarantee a

satisfactory aesthetic outcome,^[13] some *in vivo* tests indicated that ridge preservation solely by heterogenous bone substitution was inefficient for preserving labial bone at the immediate implant site.^[14]

On the basis of the Root Submergence Technique (RST), which was first documented in 1960s,^[15] the SST was first reported by Hürzeler et al^[8]; this provided an alternative idea for immediate implant sites at anterior aesthetic regions. With the goal of preserving, rather than augmenting, peri-implant tissue, SST indicated that the root should be sectioned in its mesial-distal direction, after atraumatic removal of the palatal root segment; thus, the labial part of the root segment is shaped and remains in the alveolar socket, while the remaining labial root should be 1 mm above the alveolar crest, and shaped carefully to approximately 2 mm. The root section, together with the attached periodontal ligaments, was used as a socket shield. In this process, the alveolar bone and periodontal ligament were protected, the implants were able to contact with the residual labial root directly, and the periodontal root-PDL system was retained in the labial portion of the implant site. Compared with alveolar bone, the residual root was more resistant to resorption, and the functional PDL could connect the residual root with the gingival margin; this connection was much more rigid than the implant-gingival interface of normal peri-implant tissue. Thus, the implant-root-PDL-gingiva system could help prevent the retreat of peri-implant gingiva. In a histology study, Gray and Vernino^[16] indicated that cementum-like calcified materials would form around the implants without inflammation; a cementum-like structure would be formed at the implant-root interface and act in a manner similar to the osseointegration process. This discovery provided the theoretical foundation for SST.^[16]

Tissue staining indicated that the periodontal ligament linked with the remaining tooth was healthy and exhibited no osteoclastic tendency at the coronal portion of the labial plate.^[18] In a series of clinical case studies, the average loss of the alveolar ridge after SST treatment was 0.88 mm in the labial direction; moreover, stable bone was present around the shield structure.^[17] Chen and Pan^[18] indicated that the maximum horizontal resorption was limited to 0.72 mm after 4 months of healing time. The implants with Socket-Shield also exhibit high survival rates; a prospective study showed that all 46 implants maintained survival at 2 to 4 years after final prosthetics, and that mesial and distal crestal bone loss were only 0.18 ± 0.09 and 0.21 ± 0.09 mm.^[19] Such results indicated the stability of alveolar crest protection by Socket-Shield.

Kan also indicated that the Socket-Shield at the mesial/distal portion of the implant site could help prevent retraction of the interpapillae^[20]; similar results were reported by Cherel and Etienne,^[20] who demonstrated that the proximal shield could successfully maintain the scalloped contour of the gingival margin. Currently, SST is considered mature and is applied in combination with other techniques, such as simultaneous GBR,^[21] template-guided implant surgery,^[22] and delayed implant placement to preserve peri-implant tissue level.^[23]

In the present patient, the initial design was to completely remove the root and process immediate implant placement with simultaneous GBR. However, the crevices inside the root caused horizontal fracture when we attempted root extraction; we then changed the surgical design to preserve the labial segment. However, the fracture line on the labial site was parallel to the alveolar crest; thus, we could not retain the labial root segment at 1 mm above the alveolar ridge, as preferred in traditional SST. The labial shield in this case was partially ankylosed with the bone plate, and played a critical role in preserving periodontal tissue by firmly connecting the bone plate with the implant. The residual periodontal ligament also maintained a connection between the tooth fragment and the labial gingiva, which was much stronger than peri-implant gingiva connections; thus, the labial shield may be effective in preventing recession of the gingival contour.

Bone plate at the labial side of 21 was thin and mainly composed of bundle bone, which lacks blood supply; in our surgery, the flap was elevated at the labial site, which also reduced blood supply from the periosteum. These 2 factors made residual alveolar ridge vulnerable to resorption, but the bone finally achieved stability in both vertical and horizontal directions within 24 months after implant placement. This result indicated that the residual alveolar ridge was well-supported and preserved by the tooth segment linked by periodontal ligament and ankylosed bone.

In our case, we made an innovation such that a small gap remained between the implant and the labial root; this gap was filled with PRF, which is effective in promoting osteogenesis, osteoconductivity, and an anti-infectious state. In this study, PRF could also have supplied growth factors, such as vascular endothelial growth factor and platelet-derived growth factor for bone regeneration and microvascular formation in the newly regenerated bone^[24,25]; moreover, it acted as an anti-inflammatory medium during the bone-healing period.^[26]

4. Conclusion

In this case, modified SST combined with PRF for tissue preservation at the implant site was successful in maintaining

peri-implant tissue. The final restoration exhibited proper function and no significant gingival contour recession was observed in this case. The Socket-Shield was effective in preserving the peri-implant tissue and contour; furthermore, PRF could promote bone regeneration in the gap between the implant and residual root segment. Because of the current location of the labial-shield, our case showed slight resorption on the interpapillae area; therefore, further studies are needed to support our conclusion, such as cases with larger labial shields that expand over the interpapillary area, in order to better protect the peri-implant soft tissue from recession.

Author contributions

Conceptualization: Ran Nie.

Data curation: Xirui Xin, Hanchi Wang.

Funding acquisition: Yanmin Zhou.

Investigation: Xirui Xin, Tianqi Guo.

Methodology: Yanmin Zhou, Tianqi Guo.

Resources: Tianqi Guo, Kaixuan Yu, Liuyi Du.

Software: Hanchi Wang, Manlin Qi, Yao Wang.

Writing – original draft: Tianqi Guo, Ran Nie.

Writing – review & editing: Yanmin Zhou.

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