CASE REPORT

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Alveolar Ridge Preservation after Tooth Extraction and Replacement with Fibre-reinforced Composite Bridge in a Young Patient: A Case Report

Zi Hui Cheng*, Ei Leen Lim

Periodontology Unit, Jerantut Government Dental Clinic, Ministry of Health Malaysia, 27000 Jerantut, Pahang, Malaysia

*Corresponding author: drchengzihui@gmail.com

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ABSTRACT

Alveolar ridge preservation is a surgical procedure aimed to preserve the alveolar bone after tooth extraction to eliminate or reduce the need for bone augmentation during implant placement. It includes the use of membrane that is either being used alone or in combination with a bone replacement graft. This case report describes the technique of alveolar ridge preservation after tooth extraction using a xenogenic bone graft combined with a resorbable collagen membrane, and the fabrication of an anterior fibre-reinforced composite (FRC) bridge in an 18-year-old male patient. This treatment allows him to have a good preservation of the volume and architecture of the alveolar ridge as well as soft tissues and temporarily replace a missing anterior tooth until a definitive restoration can be achieved.

Keywords: *Alveolar ridge preservation; bone regeneration; fibre-reinforced composite bridge; socket preservation; tooth extraction*

INTRODUCTION

Tooth extraction is commonly indicated when a tooth cannot be restored due to gross caries, root fracture, advanced periodontal disease, as part of an orthodontic treatment plan, or when it is severely affecting aesthetics. After a tooth is being extracted, a series of biological events that result in significant local anatomic changes is initiated (Van der Weijden *et al.*, 2009). Various research has demonstrated that alveolar ridge resorption after extraction is irreversible and will result in dimensional loss of both horizontal and vertical alveolar process (Schropp *et al.*, 2003; Araújo & Lindhe, 2009). Alveolar ridge preservation (ARP) is an effective therapy to reduce the resorption of the alveolar ridge following tooth extraction, as compared to spontaneous healing (Avila-Ortiz *et al.*, 2019). In clinical scenarios in which minimising alveolar ridge resorption is the primary concern, the technique of atraumatic tooth removal followed by ARP should always be considered (Avila-Ortiz *et al.*, 2019).

Various surgical techniques and graft materials have been used for ARP, which includes allogenic grafts (Brownfield & Weltman, 2012), in the form of cortical mineralised freeze-dried bone allograft

(Eskow & Mealey, 2014) and cortical demineralised freeze-dried bone allograft (Becker *et al.*, 1994; Froum *et al.*, 2002), alloplastic bone grafts such as medical-grade calcium sulphate (Aimetti *et al.*, 2009), hydroxyapatite (Checchi *et al.*, 2011), beta-tricalcium phosphate (Brkovic *et al.*, 2012), and xenogenic grafts which includes porcine or bovine bone (Kim *et al.*, 2011; Calasans-Maia *et al.*, 2014). Grafting materials have been used in post-extraction sockets either alone or covered by barrier membranes (Barone *et al.* 2008; Poulias *et al.* 2013; Arbab *et al.* 2016).

For replacement of missing teeth, various treatment options can be considered including removable partial dentures (RPD), conventional or resin-bonded fixed dental prostheses (FDP), and implant-supported prostheses. Implants are often the treatment of choice; however, it may not always be feasible due to patient's age, inadequate volume of bone, frequent number of visits and its high cost (Kermanshah & Motevasselian, 2010). Therefore, other alternatives which is functional, more cost-friendly with acceptable aesthetics should be regarded for the replacement of missing teeth, as a definitive or long-term provisional restoration before implant therapy (Pankratz *et al.*, 2018).

Fibre-reinforced composite (FRC) bridge represents an interesting alternative to conventional FDP or implants. It is minimally invasive with minimal or no loss of dental hard tissues, cheaper, reversible, easy to perform and can be completed in a single visit (Heo *et al.*, 2019). This technique is usually performed using a direct or indirect composite build-up splinted with a fibreglass ribbon to the adjacent teeth. Extracted, avulsed or artificial tooth can also be used.

This case describes the technique of ARP after extraction of a fractured non-conservable mandibular left central incisor and its replacement via a FRC bridge in an adolescent.

CASE REPORT

An 18-year-old male patient, non-smoker, with no known medical illness, presented with a non-conservable mandibular left central incisor due to complicated crown-root fracture after a motor vehicle accident. Detailed clinical and radiographical examination (Fig. 1) were carried out. The root was submerged, fully covered by gingiva, with a visible soft tissue cleft. Buccolingual width of the alveolar ridge was measured to be 6 mm. The adjacent teeth #32 and #41 were presented with uncomplicated fracture confining to the incisal edges. Both teeth showed positive response to sensibility tests. The patient had a Class I incisor relationship.

Treatment options were discussed with patient which includes surgical extraction of the submerged root #31 followed by ARP, and replacement of the tooth with a RPD, FRC bridge, resin bonded bridge (RBB) or dental implant. Patient was not keen for removable prosthesis and had decided for FRC bridge as an interim replacement due to financial constraint. The options of RBB and implant are still available to patient in the future. A written informed consent was obtained from the patient.

Prior to surgery, meticulous oral hygiene instructions were given to the patient. Full mouth scaling and polishing was also done. Tooth extraction was performed under local anaesthesia. Full mucoperiosteum flap was elevated (Fig. 2A) buccally and lingually after performing intracrevicular incision from tooth #32 to #42 with crestal incision at #31 area. Deepithelialisation was done at the soft tissue fold over the retained root site. Intraoperatively, it was found that root #31 had fractured below the crestal level with no grip to extract the root. The buccal wall was also very thin (< 1 mm).

In order to minimise surgical trauma, minimal bone guttering was done at the mesial aspect under copious irrigation with sterile saline. Root #31 was mobilised and carefully elevated using periotome

(A) (B)

Fig. 1 Pre-operative examination. (A) Labial view showing fractured root #31 fully covered by gingiva; (B) Periapical radiograph showing root #31 below crestal level.

and elevators, finally delivered using an endodontic hand file #80 (Fig. 2B). Labial bone was preserved intact and extraction socket was thoroughly debrided using bone curettes and rinsed with sterile saline.

The extraction socket was then grafted with a natural bovine bone grafting material (Cerabone® Granulate, Botiss Biomaterials GmbH) mixed with patient's blood. The bone graft was gently packed into the socket and also placed buccally to the labial bone. The site was then covered with a resorbable collagen membrane (Biocollagen®, Bioteck) shaped to the post-extraction site (Fig. 2C). Tension-free full closure was achieved via flap approximation with a non-absorbable synthetic monofilament 5/0 suture (Dafilon®, B.Braun) using Laurell and simple interrupted suturing technique (Fig. 2D). Haemostasis was achieved and finally, the surgical site was applied with 1% hyaluronic acid and covered with a eugenol-free periodontal dressing (Coe-Pak™, GC). Post-operative instructions were given, and patient was prescribed with 500 mg amoxicillin every 8 h for 5 days, and 400 mg ibuprofen every 8 h for 3 days. The suture was removed one week postoperatively.

The postoperative healing was uneventful. There was no exposure of membrane with no loss of bone graft particles (Fig. 2E). Healing at two weeks (Fig. 2F) showed well preserved soft tissues with keratinised epithelium. Buccolingual width of alveolar ridge maintains at 6 mm.

As a first step of FRC bridge construction, study models were taken and build-up of the missing #31 was done with a wax-up (Fig. 3A). A silicon putty impression was then taken to establish a template for direct composite build-up. Different shades of composites (G-ænial Anterior, GC) were compared by polymerising unbonded composites on the enamel surface. Abutment teeth #32 and #41 were cleaned and polished using pumice powder, etched using 37% phosphoric acid and conditioned with XP Bond® (Dentsply Sirona Inc). After that, the silicone putty impression was applied on the buccal surfaces of the lower anterior teeth as a guide to apply a thin first layer of composite, creating the labial surface first. A preimpregnated fibreglass ribbon (everStick® C&B; GC) was then fixed onto the lingual surfaces with flowable composite (G-ænial Universal Flo, GC) (Fig. 3B). The thickness of the composite between the teeth and the fibreglass ribbon was kept as thin as possible. After completing the FRC bridge, the fractured incisal edges of #32, #41 and #42 were restored with composites. Occlusion was checked before finishing and polishing. Floss was also passed through beneath the build-up composite pontic to check if the surface is smooth.

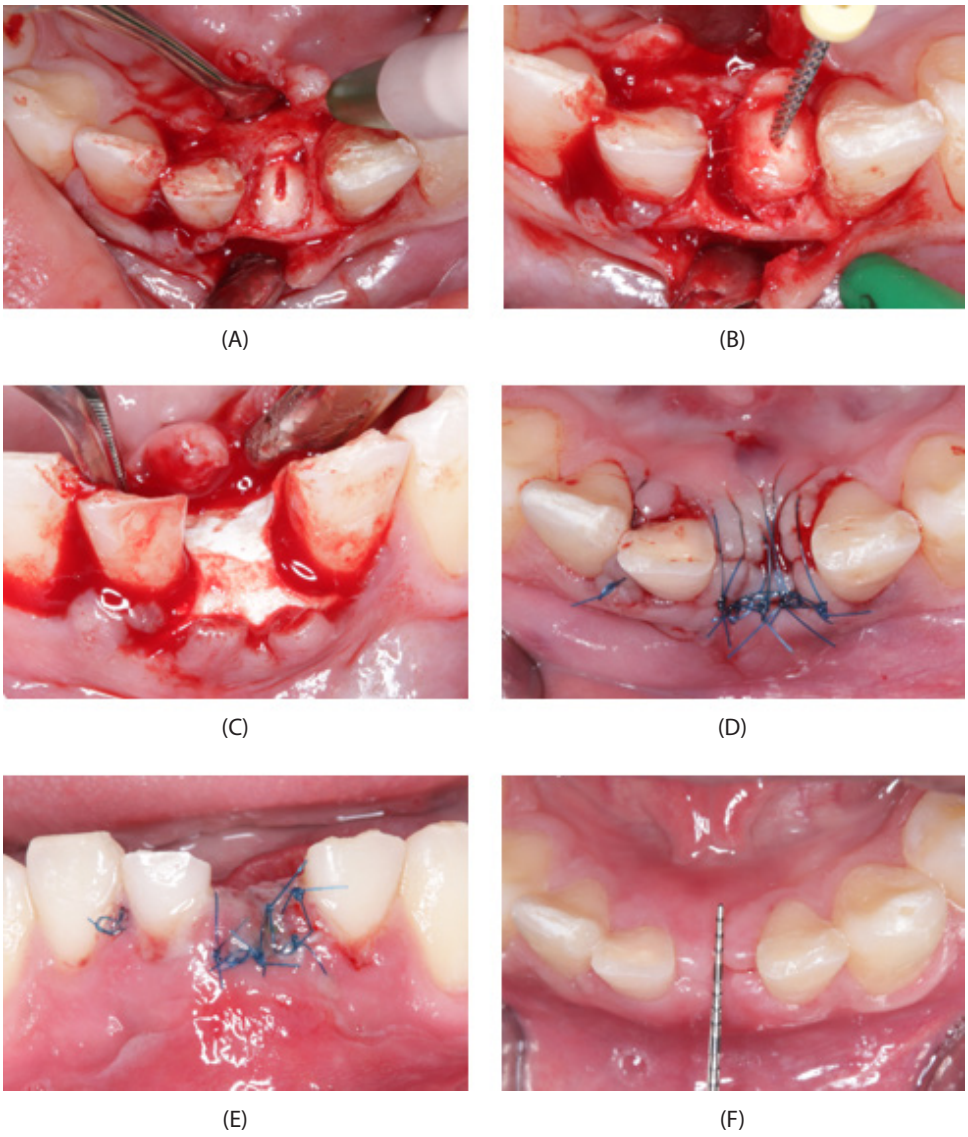

Fig. 2 Surgical procedure of ARP. (A) Full mucoperiosteum flap elevated showing retained root #31 below crestal level; (B) Root was finally delivered using an endodontic hand file to minimise surgical trauma and to preserve the buccal bone wall; (C) Extraction socket was filled with xenogenic bovine bone graft and covered with a resorbable collagen membrane; (D) Tension-free flap closure using a 5/0 non-resorbable suture; (E) Post-operative day-3 shows good healing of the soft tissues with no membrane or graft exposure; (F) Healing at two weeks showed well preserved soft tissue with keratinised epithelium. Buccolingual width of alveolar ridge maintains at 6 mm.

This is important to ensure that the area is cleansable, and no plaque retentive factor was created. Lastly, patient was instructed on the use of floss around the area. Figs. 3C and 3D showed the result of the completed restorations.

Review at six months (Fig. 3E) showed that the restoration is still intact and functional. Soft tissues were healthy, and patient has no problem cleaning around the FRC bridge. Periapical radiograph (Fig. 3F) revealed radiopacity at the graft site indicating presence of bone graft.

Fig. 3 Construction of FRC bridge to replace missing #31. (A) Build-up of #31 done with a wax-up; (B) A preimpregnated fibreglass ribbon was fixed onto the lingual surfaces using flowable composite; (C) Labial view of the completed restorations; (D) Occlusal view of the FRC bridge, the thickness of the composite between teeth and the fibreglass ribbon was kept as thin as possible; (E) Review at six months, FRC bridge is intact with healthy soft tissues; (F) Periapical radiograph revealed radiopacity at the graft site indicating presence of bone graft.

DISCUSSION

Alveolar ridge resorption after extraction is an irreversible process primarily mediated by local inflammatory response which involves a transient upregulation of osteoclastogenesis (Araújo & Lindhe, 2005), usually initiated immediately after extraction. However, each individual may differ in regard to the extent of bone resorption as it depends on various local and systemic factors (Van der Weijden *et al.*, 2009; Tan *et al.*, 2012). The majority of alveolar ridge resorption seems to be more evident on the buccal aspect (Pietrokovski & Massler, 1967), which was reported to involve a mean horizontal bone loss of about 4 mm and vertical loss of 1.5 mm during the first three months of healing (Johnson, 1969; Schropp *et al.*, 2003). This deficiency in the volume of alveolar ridge may cause problems to teeth replacement therapies, particularly when implant-supported restorations are

planned (Seibert & Salama, 1996). Hence, in clinical scenarios involving a hopeless tooth indicated for extraction, and considering future replacement with a FDP or implant, as in this case, adequate management of the extraction site has become a key component to be considered for a more predictable outcome in the long term, particularly in the anterior aesthetic zone.

A wide variety of bone graft materials have been suggested for grafting of the post extraction socket. For the patient in the present case, taking cost and religion factors into consideration, a xenograft of bovine origin was chosen as the grafting material, combined with a resorbable collagen membrane. This is in accordance with a recent systematic review which has concluded that the use of xenogenic or allogenic particulate graft materials in combination with resorbable collagen membrane was shown to produce the best outcome as compared to other graft materials in terms of horizontal ridge preservation (Avila-Ortiz *et al.*, 2019). The rationale behind the combination treatment is that the membrane can act as a barrier preventing epithelial down growth into the extraction socket while the bone graft serves to prevent possible membrane collapse and to enhance bone regeneration through osteoinduction and/or osteoconduction (Mardas *et al.*, 2010).

Careful treatment plan should be considered for the replacement of missing permanent incisors in young children and adolescents. Implants are often the treatment of choice for replacement of missing teeth and should be considered when general and local conditions are favourable (Strong, 2008; Hanif *et al.*, 2017). However, implant placement is generally not indicated until patients reach the age of 18–21 years old, which is the end of growth period (Hertel *et al.*, 1995; Thilander *et al.*, 2001). RPD which is often considered for very young patients as their teeth are not in a final position due to ongoing growth, are uncomfortable and frequently subjected to fracture (Pankratz *et al.*, 2018). In the present case, keeping in mind the option of implant placement in the future and considering the patient's financial status and feasibility to come for multiple appointments, a decision for ARP after surgical extraction of the retained root and its replacement with FRC bridge was made together with the patient.

This treatment modality is a minimally invasive, reversible procedure with very little or no loss of dental hard tissue. By preserving the maximum possible amount of tooth substance, further treatments in the future are possible. Compared to metal framed RBB, FRC bridge is easier to bond and repair. Furthermore, this technique presents a favourable aesthetic appearance by providing a more natural appearance to the overall restorations. It does not cast a metal shadow nor block the light passing through the very translucent dental hard tissues in young permanent teeth, as in the case of a metal framed RBB (Pankratz *et al.*, 2018). By using the layering technique to build up the tooth with different shades of enamel and dentine composites, a final restoration mimicking natural tooth can be achieved (Pankratz *et al.*, 2018). Besides, FRC bridge is less expensive, painless and easy to repair as compared to implant or FDP (Vallittu *et al.*, 2017). A 2-year follow-up period study reported high level of patient satisfaction towards FRC bridges, in regard to prosthesis appearance, colour, chewing ability and overall satisfaction (Malmstrom *et al.*, 2015). In the present case, the patient was satisfied with the treatment provided, in particular its natural appearance, cost-effectiveness and reduction in treatment time.

Regarding the longevity of FRC bridges, a systematic review (Ahmed *et al.*, 2017) which included nine studies, involving the construction of 592 FRC bridges in 463 patients, has reported that the overall survival rate was 94.4% at 4.8 years. The follow-up periods ranged between two months and eight years. This indicates that FRC bridge is a reliable option for the replacement of single missing teeth in the anterior zone.

The majority of failures of FRC bridges were due to debonding and wearing off of composite resins (Kumbuloglu & Özcan, 2015). However, these failures could be repaired in most cases, thereby prolonging the lifespan of the restoration. Unfavourable occlusion and limited vertical space may also become major risk factors that can damage and decrease the longevity of a FRC bridge (Vallittu *et al.*, 2017). Increased mobility of the abutment teeth also appears to increase the risk for debonding of the FRC splints (Heo *et al.*, 2019). Hence, the abutment teeth must be carefully examined prior to treatment planning and a proper case selection becomes mandatory (Heo *et al.*, 2019). The importance of good oral hygiene must be emphasised as there is an elevated risk for dental caries and periodontal diseases. Oral hygiene instructions, in particular the use of floss or interdental brushes to clean around the FRC bridge, must be reinforced. Furthermore, periodic review visits and supportive periodontal therapy are also required for long term maintenance of FRC bridges.

CONCLUSION

Adequate management post-extraction is pivotal and should be carefully planned prior to the extraction especially in clinical cases whereby future replacement with a FDP or implant is considered, particularly in young patients. ARP presents an effective therapy to decrease the volumetric reduction of the alveolar ridge and soft tissues that usually takes place after tooth extraction. This ensures a more predictable long-term outcome and may eliminate the need for bone augmentation should an implant is to be placed in the future. FRC bridge offers an excellent alternative for replacement of missing teeth, especially in the anterior region in young children or adolescents. It has the advantages of being minimally invasive, cost-effective, reversible, aesthetically pleasing, easy to repair, and has a relatively good longevity. However, it is important to highlight the importance of good oral hygiene compliance and periodic review visits for long term maintenance of the FRC bridge.

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