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Healing after tooth extraction and alveolar ridge preservation using demineralized cortical allograft particles in a dehiscence type defect: clinical, radiographic and histomorphometric case report

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ABSTRACT

Aim The present article reports clinical, radiographic, and histological healing of a case of alveolar ridge preservation treated with a cortical bone allograft and a bioabsorbable collagen wound dressing membrane for the reconstruction of a damaged extraction socket with a buccal bone dehiscence.
Case report In the case reported, alveolar ridge preservation technique was applied in an extraction site with a buccal dehiscence type defect, using an allograft bone substitute and a bioabsorbable collagen wound dressing membrane followed by a successful implant placement at a later stage.
Conclusion This case report showed that alveolar ridge preservation technique in a damaged socket with buccal dehiscence, using a freeze dried bone allograft covered with a fast resorption collagen membrane, can lead to new bone formation, of up to 53.53%, and ultimately allow safe implant placement.

KEYWORDS Alveolar ridge preservation, allograft, histomorphometry, socket preservation

INTRODUCTION

Dental implants have been widely accepted as a predictable treatment option for the replacement of missing teeth (1). Sufficient bone width at the implant site is a major prerequisite for a predictable, long-term prognosis in implant dentistry (2). Following tooth extraction, significant changes in ridge dimension, both horizontally and vertically, occur in a short period of time (3). When assessing the magnitude of dimensional changes of both the hard and soft tissues of the alveolar ridge following tooth extraction in humans, Tan et al. found in a systematic review a mean horizontal bone reduction of 29 to 63% mm and a mean vertical bone reduction of 11 to 22% at 6 months (4). More interestingly, *in vitro* and *in vivo* studies have found more pronounced hard tissue loss on the buccal and marginal portions than on the lingual/palatal portions of the edentulous ridge, leading to a triangular shape alveolar crest (5–7). In the scope of those events, dental implant placement in a restoratively driven position, in reduced alveolar ridges becomes a challenging and undesirable situation for clinicians.
Alveolar ridge preservation (ARP) after extraction has been shown to be effective and predictable in reducing the postoperative buccolingual and vertical bone loss (8–10). Most of the published studies concerning ARP are related to extraction sites with no description of existing or occurring buccal bone dehiscence (11–15). However, a damaged extraction socket is commonly encountered clinically, since most teeth extractions are performed as a result of vertical root fracture, uncontrolled endodontic/periodontal infections, usually associated with severe loss of the surrounding bone (16). When left untreated, a damaged extraction socket will present more significant bone volume reduction along the entire length of the socket when compared to undamaged extraction sites (17,18), thus demonstrating the need for alveolar bone reconstruction before implant placement. Fortunately, the application of ARP in extraction sockets with buccal dehiscence reduces the dimensional changes compared to the non-grafted control sites (18–22). To our knowledge, only few *in vivo* studies have been published on the application of the ARP in sockets with three or less remaining walls before the placement of an implant in a second surgery (23–25).
The aim of this article is to report the clinical, radiographic, and histological healing of ARP surgery using a cortical bone allograft and a bioabsorbable collagen wound

dressing membrane for the reconstruction of a damaged extraction socket with a buccal bone dehiscence.

CASE REPORT

Case description

A 62 years old male patient was referred to the department of Periodontology at Saint Joseph University (Beirut, Lebanon) for the extraction of the two upper left molars and the placement of an implant at first molar site. Clinical examination revealed 2 ill-adapted crowns on the two molars showing fracture of the ceramic from the metallic infrastructure (Fig. 1). Periapical radiographs revealed deep caries, and possible periapical lesions. Cone beam computed tomography (CBCT) showed a clear buccal bone dehiscence at the first molar 's mesial root. Based on the clinical and radiographic examination, we opted for an ARP, followed by the placement of an implant four months later.

Surgical technique

Presurgical antibiotics consisting of 1 g amoxicillin-clavulanic acid taken twice daily (Augmentin, GlaxoSmithKline, Brentford, United Kingdom), starting one day prior to surgery, were provided and were continued for 7 days. After administration of local anesthesia, 4% articaine with epinephrine 1:100,000 (Septanest, Septodont, Saint Maur des Fosses, France), an atraumatic flapless extraction of the two upper molars was performed (Fig. 2). Sockets were thoroughly degranulated and debrided with Lucas curettes (Osung URCL84, USA) under copious irrigation with saline solution. Full thickness envelope flaps were elevated on the buccal and palatal aspect of the crest and a bioabsorbable collagen wound dressing (CollaTape, Zimmer Biomet, USA) was inserted buccally in order to create a buccal support for the future bone graft, especially on the mesial root of the first molar. Hydrated demineralized freeze-dried cortical human bone allograft (DFDBA) (AlloOss, Ace, USA) was lightly packed into the sockets. The sockets were filled to the crest of the ridge. The collagen membrane was folded on top of the graft, in order to insert it deep below the palatal flap and secured with 5/0 sutures (Novosym, B-Braun, Melsungen, Germany) with a cross-mattress suturing technique. Primary closure was not attempted. Customary postoperative instructions were provided, and the patient was prescribed NSAIDs drugs every 6 hours (ibuprofen 400 mg, Abbott Laboratories, Illinois, CHI, USA) and 0.12% chlorhexidine mouthrinse three times daily for 2 weeks. An extra-oral cold pressure icepack was applied to minimize postoperative swelling the same day. Sutures were removed after 2 weeks.

Healing was uneventful.

At re-entry, four months after surgery, the patient was recalled for a clinical and radiographic examination. A CBCT scan of the area was done in order to evaluate the site for future implant placement (Fig. 3). At the time of implant placement, a mid-crestal incision and an intra-sulcular incision on the premolar was performed. The buccal and palatal flap were elevated in full thickness, and the site degranulated. When a needle tip was pushed into the site, it bent, leading to the assumption of a good bone density. At the first molar site, a hollow trephine drill with 2 mm internal diameter was used to obtain a hard tissue biopsy of 6 mm in length. The biopsy was then placed in 10% neutral buffered formalin for histomorphometric analysis. A classical series of drilling was performed and a 4 mm diameter x 10 mm length implant (3I, Zimmer Biomet, USA) with high primary stability was inserted. Flaps were sutured with 5/0 sutures (Novosym, B-Braun, Melsugen, Germany). Postoperatively, patient was given the same instructions and medication as previously described.

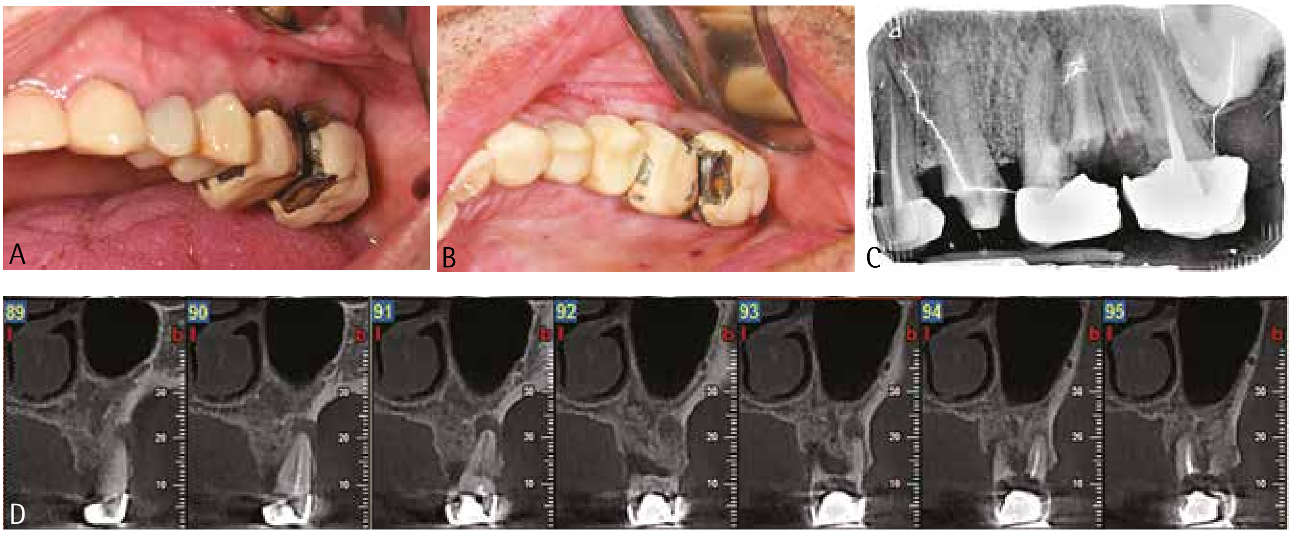


FIG. 1 Clinical examination (A, B). Periapical radiograph (C). CBCT (D).

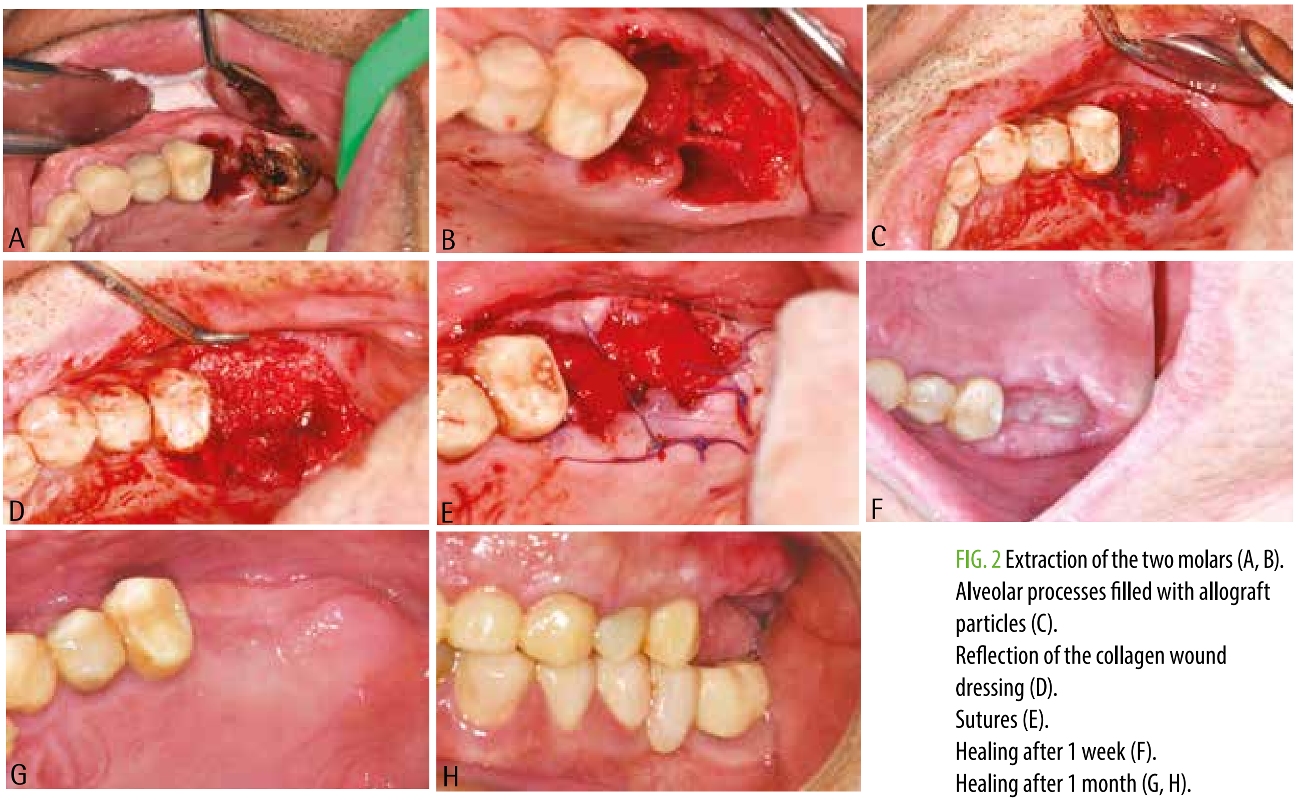


FIG. 2 Extraction of the two molars (A, B).
Alveolar processes filled with allograft particles (C).
Reflection of the collagen wound dressing (D).
Sutures (E).
Healing after 1 week (F).
Healing after 1 month (G, H).

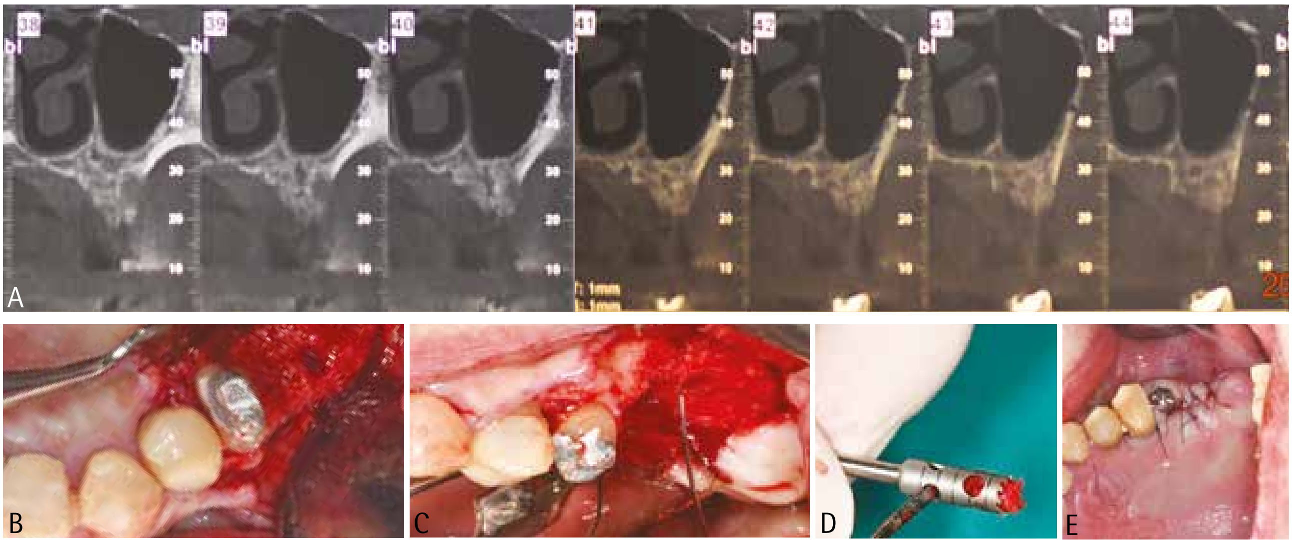


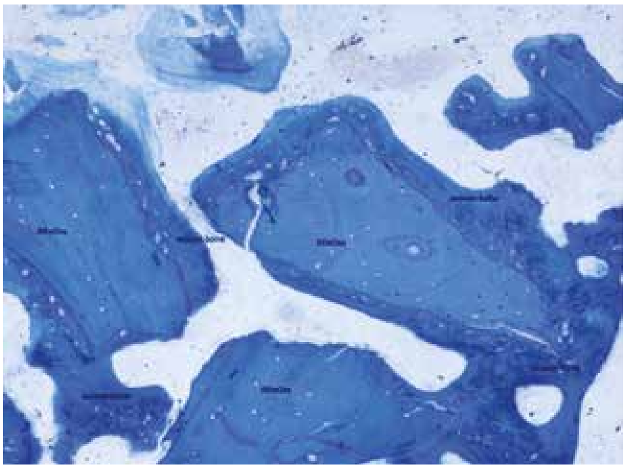
FIG. 3 CBCT 4 months after ARP (A). Flap elevation (B). Bending of the needle as inserted on the bone crest (C). Trephine with the bone biopsy (D). Implant placement with healing abutment (E).

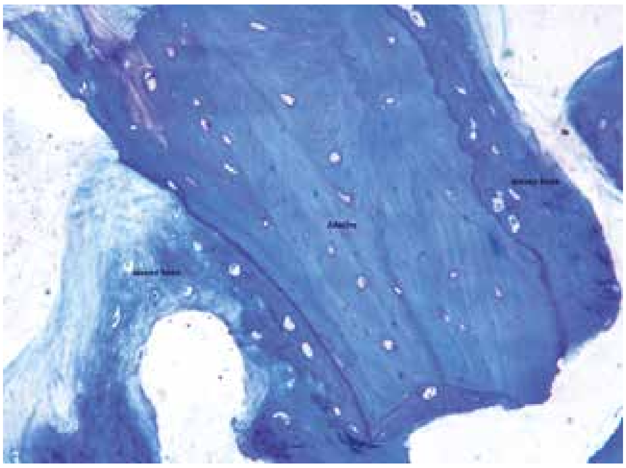
Histomorphometric processing and analysis

biopsies were sent to the HIK (Histologie Für Implantate Und Knokhen, HIK histology institute Hannover, Germany) where they were treated according to a specific protocol. In summary, biopsies were decalcified, dehydrated, embedded in paraffin, and sectioned apico-coronally. Histomorphometric analysis was made in order to calculate the percentage of woven bone and residual bone graft (Fig. 4). Measurements revealed 53.53% woven bone and 46.49% residual graft particles at 4 months (Table 1).

DISCUSSION

This article reports the case of an alveolar ridge preservation technique applied in an extraction site with a buccal dehiscence type defect, using an allograft bone





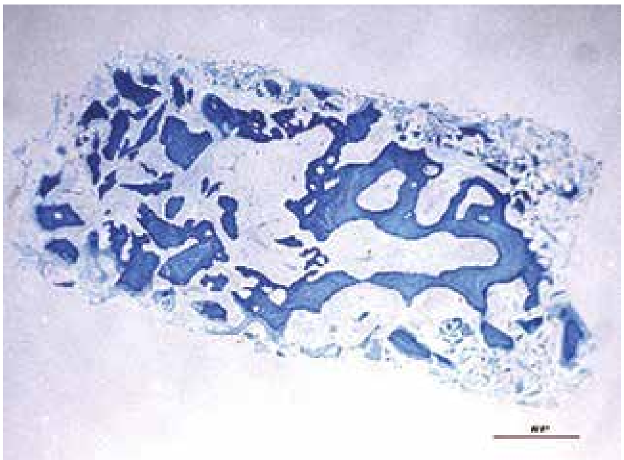


FIG. 4 Histologic section showing the bone allograft particles imbedded in woven bone (blue); connective tissue (white).

Woven bone (fibrous tissue + New bone)	53.53%
Residual graft	46.49%

TABLE 1 Percentage of woven bone and residual graft after histomorphometric analysis of the bone biopsy.

substitute and a bioabsorbable collagen wound dressing membrane followed by a successful implant placement at a later stage. Dimensional alterations in buccal-bone-deficient extraction sockets are different from those described for intact extraction sockets. In fact, in canine model experiments, non-grafted sites in intact extraction sockets, after a healing period of 6 months, experience 35% reduction in the coronal portion, a 3% reduction in the middle portion and a 6% increase in the apical portion (11), while damaged extraction sockets heal with a 62% reduction in the buccolingual dimension in the coronal portion, and 30% and 14% reductions in the middle and apical portions respectively (17). This could be explained by the fact that healing sources in damaged extraction sockets are usually insufficient due to the destruction of socket walls, thus leading to the difference in the healing processes between damaged and intact extraction sockets (18). Furthermore, Kim et al. showed that 56.92% of extraction sockets with erratic healing presented at least one damaged wall (26). In our case the extraction site presented a buccal bone dehiscence as shown on the preoperative x-rays, thus we opted for an alveolar ridge procedure (ARP) where bone substitute materials were added to the extraction site in order to physically maintain the ridge contour (11). Experimental animal studies demonstrated that ARP using bone substitutes placed in damaged extraction sockets without a buccal bone plate reduced the horizontal ridge contraction along the entire length of the socket defect and achieved results comparable to ARP in intact extraction sockets (17–21). Furthermore, clinical studies testing ARP in damaged sockets also showed favorable results and high probability of placing implants without any augmentation procedures after a healing period (27–30,25). Koutouzis et al. failed to find statistically significant differences in the eventual frequency of implants with exposed buccal surfaces placed virtually on the CBCT scans, following treatment of compromised and non-compromised sockets with allograft bone substitute and a collagen membrane (16). Extraction sockets with damaged walls have been clinically treated with different techniques: Sisty et al., in 2012 used hydroxyapatites covered by a collagen disk in a flapless approach to treat damaged extraction sockets (27) while Barone et al., in 2015 and Lee et al., in 2018 grafted the extraction sites with demineralized bone minerals and covered them with a Bio-Guide collagen membrane without primary wound closure (30,31). An interesting retrospective study investigated the use of the open membrane technique with a high-density polytetrafluoroethylene (dPTFE) membrane and freeze-dried bone allograft (FDBA) particles in damaged extraction sockets. They found 28.48% ± 6.60% of new bone mean area, 27.68% ± 9.18% remaining graft particle mean area and 43.84% ± 6.98% of fibrous tissue at 4 months (25). To our knowledge, no study attempted the treatment of a damaged extraction socket with an allograft bone substitute covered by a collagen wound dressing membrane in a flapless approach (flapless extraction and no primary wound closure). The use of allograft bone particles has been well investigated in ARP technique (9,12,32–35). DFDBA are bone substitutes with known osteoconductive properties (36) and osteoinductive potential (37). Thus DFDBA allows for space maintenance, clot stability while inducing bone formation during healing (37). In our case report, we used a DFDBA as a bone substitute in an ARP technique, covered with a collagen membrane. Our histomorphometric results showed that we had 53.53% of woven bone 16 weeks after the application of DFDBA. This percentage was close to the one obtained by Whetman and Mealey, who found 47.41% of vital bone 18 to 20 weeks after extraction of non-molar teeth and ridge preservation using DFDBA (38). Our percentage of mean vital bone was higher to the one found by Froum et al., who reported a mean vital bone of only 34.7% in extraction sockets grafted with DFDBA (39). Moreover, when comparing DFDBA to FDBA, Wood et al. found more vital bone with the former (DFDBA 38.42%; FDBA 24.63%) (33). And when trying to compare the healing of non-molar extraction sites grafted with either mineralized FDBA or a 70:30 mineralized:demineralized (M/D) combination allograft in ARP, Borg and Mealey (32) found that the combination allograft (M/D) produced increased vital bone percentage (36.16%) compared to the FDBA group (24.69%) but with no significant difference between groups concerning dimensional changes (32). Those results when compared to ours, were somewhat comforting as to the choice of the graft. In our case report we also used a bioabsorbable collagen wound dressing membrane (CollaTape, Zimmer Biomet, USA) characterized by a fast resorption rate (40–42). The insertion of the membrane palatally, crestally, and mainly buccally in place of the missing buccal wall helped maintaining the grafted material in situ, preventing particle leakage and temporarily isolating the graft material from the oral environment. In addition, we did not attempt any primary closure leaving the membrane exposed. This could have allowed for a better outcome in terms of keratinized gingival width (43–46) and less displacement of the mucogingival junction (45). In fact, and in respect to dimensional changes and implant placement, a number of studies compared ARP with and without primary closure in non-compromised sockets: Zhao et al. using Bio-Gide membrane to cover the Bio-Oss material in molar extraction sites found no statistical difference in ridge dimensional alterations between flapped (a full thickness mucoperiosteal flap and primary soft tissue closure) and flapless (no flap elevation, no primary wound closure) ARP techniques, however, flapless technique gave better outcome in term of keratinized gingival width (44). Barone et al. also using a xenogeneic bone mineral covered by a collagen membrane found less vertical bone resorption in the flapped group, but more keratinized gingival width formation and more bone width preservation in the flapless group (43). The grafted socket in our report healed uneventfully and we were able to place an implant in a correct 3D position and obtain good primary stability. Articles comparing the outcome of implant treatment (success/survival rates) in ARP cases and non-grafted sites reported high survival rates and similar success rates between the two groups (47–49). However, no long-term studies evaluated the success and survival rates of implants placed in regenerated 'damaged' sockets.

CONCLUSION

This case report showed that applying an alveolar ridge preservation (ARP) technique in a damaged socket with buccal dehiscence, using a DFDBA covered with a fast resorption collagen membrane can lead to a new bone formation of up to 53.53% and ultimately allow for the safe placement of an implant.

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