

Socket grafting with bioactive self-hardening synthetic graft materials

# Ridge preservation and regeneration

JONATHAN COCHRANE, BDS, MSC, BRISTOL, UK

The preservation of the alveolar ridge after dental extractions is an important concept to retain the host bone for future placement of implants. It is well-researched that after the removal of teeth or retained roots, the sockets and the ridge will model and reduce in size with time generally starting just a few weeks post-removal. The use of novel bioactive self-hardening synthetic graft materials composed of beta tri-calcium phosphate ( $\beta$ -TCP) and calcium sulfate (CS) for socket grafting may not only aid the preservation of the architecture of the ridge, but also will up-regulate host hard and soft tissue regeneration to improve the ridge quantity (volume) and quality.

## Case report

A 79-year-old female patient presented with mobility of the lower central incisors. The patient suffered from localised periodontitis affecting all lower incisors (Fig. 1). Clinically, tooth 41 was splinted with composite to the neighbouring tooth 42. The patient was a regular dental attender and the periodontal health of the rest of her teeth was well-managed. Medically, she was generally well, only taking low dose medication for acid reflux, hypercholesterolemia and moderately high blood pressure. Radiographic examination of her lower incisors with periapical x-rays showed severe bone loss of between 60–100%, affecting her low-

er four incisors; providing for a hopeless prognosis. The patient opted to remove the four failing, grade 2 mobile, lower incisor teeth and have an implant bridge replacement.

The treatment plan consisted of simple extractions, socket/ridge preservation, and subsequently the placement of two dental implants ten weeks post-op, with loading of the implants a further fifteen weeks later. The patient used an immediate acrylic partial denture as a provisional prosthesis during the whole healing period, but without applying pressure on the surgical site.

Under local anaesthesia, the hopeless prognosis four lower incisors were 'atrau-

matically' removed with forceps without raising a flap. Attention was given not to damage the surrounding soft and hard tissues. Then a crestal incision was made to fully expose the extraction sockets, and periosteal relieving incisions were made under the lingual and buccal flaps to allow for later tension-free closure. It is very important that at this stage any bleeding arising from the incised periosteum must be thoroughly managed with the appropriate haemostatic measures. Usually application of pressure with a sterile gauze for a few minutes is sufficient. In this way, the clinician can operate in a clean surgical site with no bleeding, and the periosteum is already released, so that there is



1 | Initial periapical x-ray.



2 | Clinical view immediately after extractions and socket curettage, flap raised and released both lingually and buccally.



3 | Intraoperative situation after the application and setting of EthOss in situ. No barrier membranes were used.



4 | Surgical wound sutured with Vicryl Rapide—primary closure almost achieved but not completely as can be seen.



5 | Re-entry 10 weeks later, single crestal incision made.

no need to perform this after grating and risk initiating bleeding then, that could wash out the placed biomaterial. Stability to control bleeding at any stage of the socket grafting procedure will result in poor setting of the graft in situ. The sites were then thoroughly curetted using hand instruments (Lucas hand bone curettes) followed by rinsing with sterile saline (Fig. 2), and subsequently grafted with a self-hardening resorbable synthetic bone substitute (EthOss; EthOss Regeneration Ltd, Silsden, UK), consisting of 65 %  $\beta$ -TCP and 35 % CS. The grafting material comes in a delivery syringe where the piston is drawn back and sterile saline is added to the powder. It is allowed to seep through the particles and then the excess is discarded by compression into a sterile gauze. The hydrated material is now taken to the surgical site and extruded into the defect, then compressed with another sterile gauze using an instrument to pack the material into any cavities. The gauze is then held over the graft for three to five minutes until the CS element sets, making sure to restrict and control any bleeding, as blood from the surgical site may inhibit the proper setting of the biomaterial in situ. It is also important not to overfill the augmented area for tension-free closure. No barrier membranes were used (Fig. 3). The flaps were then repositioned, slightly advanced and sutured without tension with 4-0 resorbable sutures (Vicryl Rapide, Ethicon, Johnson & Johnson) (Fig. 4). Single interrupted sutures were used. Antibiotic therapy consisting of 500 mg amoxicillin every eight hours for five days, and mouth rinsing with 0.2% chlorhexidine every eight hours for ten days were prescribed. The sutures were removed one week post-op.

The post-operative healing was uneventful. After ten weeks, the architecture and the dimensions of the ridge were adequately preserved, and the site was covered with thick keratinised epithelium. Under local anaesthesia, a site-specific full thickness flap was raised using a linear crestal incision, without any vertical incisions, revealing a well regenerated bony volume (Fig. 5). Two 3.6 mm X 11 mm implants (Astra-Tech EV, Dentsply Sirona) were placed



6a and b | Freehand placements with the initial twist drills in the lateral positions, no surgical guide used – occlusal and buccal views.



7 | Immediately after placing the implants in the optimal three-dimensional position – occlusal view.



8a and b | Healing abutments placed, – occlusal and buccal views.



9a and b | Surgical site suture closed – occlusal and buccal views.



10 | Periapical x-ray immediately post-op.



11 | Restoration phase, 10 weeks later, showing nicely healed, regenerated keratinised soft tissues.



12 | Occlusal view of implants and peri-implant soft tissues immediately prior to fit of the final implant bridge.

at the optimal lower lateral incisor positions, well surrounded by adequate newly formed bone. After placing the healing abutments, the mucoperiosteal flap was repositioned and sutured without tension with 4-0 resorbable sutures (Vicryl Rapide, Ethicon, Johnson & Johnson) (Figs. 6 to 10). Antibiotic therapy consisting of 500 mg amoxicillin every eight hours for five days and mouth rinsing with 0.2% chlorhexidine every eight hours for ten days were again prescribed after the surgery. The sutures were removed one week post-op.

After ten further weeks of uneventful healing (Fig. 11), pick-up impressions were taken with open tray technique. Two weeks later a verification jig was used, and the bite registration was recorded. Three weeks later, the final 4-unit metal-ceramic bridge with customized Atlantis abutments (Dentsply Sirona) was placed

and torqued at 25 Ncm, resulting in a successful outcome regarding aesthetics and function (Figs. 12 to 14).

#### Discussion

Bone modelling post-extraction can be variable from case to case, dependent on several factors such as the thickness of the buccal plate, the presence of infection and host physiology [1, 2]. However, tooth removal always leads to atrophy of the alveolar ridge and clinical studies reveal horizontal bone loss of 29 to 63% and vertical bone loss of 11 to 22% during the first 6 months [3]. It is well researched that preservation of the ridge with grafting of the extraction site can be a viable option instead of allowing for spontaneous modelling, and then augmenting the ridge in a delayed case scenario [4–7]. Allografts, xenografts and synthetic biomaterials, with or without

membranes, are extensively used for socket grafting [8]. As in any bone reconstruction procedure, it is of great clinical importance that these bone substitutes vary in terms of origin, composition and biological mechanism of function regarding graft resorption and new bone formation, thus leading to different amounts and quality of regenerated bone at the extraction site where they are implanted [9]. In a systematic review, *Jambhekar et al.* [10], analyzing the outcomes of randomized controlled trials on ridge preservation with different materials, concluded that sockets filled with synthetic biomaterials had the highest amount of newly-formed bone (45.53%) compared to sites subjected to spontaneous healing with no graft material (41.07%) and xenografts (35.72%), after a minimum healing period of 12 weeks. In parallel, the amount of remnant graft particles was



13a & b | Final implant bridge immediately after fitting - occlusal and buccal views.

highest for sites treated with xenografts (19.3 %) compared to synthetic materials (13.67 %).

In the presented case, a fully resorbable self-hardening synthetic bone substitute (EthOss) was used in an attempt to preserve the architecture of the ridge after the extraction of the 4 lower incisors, and to promote the regeneration of high-quality new bone for subsequent implant placement. EthOss is a mix of  $\beta$ -TCP (65 %) and CS (35 %) where the CS helps stabilize the material as well as provide a barrier function. This allows the graft to be used without a traditional collagen membrane, for improved host blood supply to the healing site and for flap releasing to be minimized. Current medical research has confirmed that the importance of angiogenesis to host bone regeneration and the role of periosteum on bone regeneration should not be underestimated [11-14]. Here, the ability of EthOss to be used without a traditional membrane enables direct and increased access to the host periosteal blood supply and no interference with host induction of stromal cell derived factors, vital for the presence of mesenchymal cells. As the CS element dissolves in 3-5 weeks it further helps angiogenesis by increasing the graft porosity and creating space for neo-vascular ingrowth. The biphasic nature of the biomaterial means that the longer-term resorbing  $\beta$ -TCP will provide a scaffold for gradual replacement and formation of new bone in line with the body's own natural healing processes, leading to regeneration of high quality vital new bone. A growing body of literature in the medi-

cal and dental research field reveals and demonstrates the osteoinductive potential of novel calcium phosphate materials and the up-regulation of host regeneration as a result; explaining the findings of further animal and human histological analyses of these materials which show this improved osteogenic potential. Hence, it is seen that a higher quality of new host bone in a shorter period of time is regenerated [15-22].

Since the grafted area will be the site for future implant placement, it is preferable that the material fully turns over to host bone to maximize bone to implant contact [9]. Without the long-term presence of residual graft material, the new regenerated bone can turn over fully and adapt/remodel to the strains and stresses of being in function [22]. In a clinical report, Fairbairn et al. [17] used EthOss for alveolar ridge preservation. Twelve weeks after socket grafting with this biomaterial, a trephine biopsy was performed before implant placement, and the authors histologically and histomorphometrically analyzed the sample of the regenerated bone, revealing 50.28 % newly-formed bone and 12.27 % remnant biomaterial. In accordance to the above findings, in the presented case, surgical re-entry ten weeks after socket grafting with EthOss revealed pronounced regeneration of new bone, without clinical evidence of residual graft particles, allowing for the successful placement of two dental implants.

Additionally, as shown in this case, and in other recent publications [22-27], bone reconstruction with the use of  $\beta$ -TCP/CS appears to routinely improve soft tissue



14 | Periapical x-ray after fitting the final implant bridge. The grafting material is turning over, being gradually replaced by newly formed bone. The loading of the implants will lead to further consolidation and remodelling of the regenerated bony tissue.

quality, as a result of creating vital high-quality bone underneath. The regeneration of both healthy bone and attached keratinized gingivae, is an important parameter in achieving esthetic implant restorations, preventing future mucosal recessions, and improving the overall long-term implant stability [9, 28, 29]. ■

The references are available at [www.teamwork-media.de/literatur](http://www.teamwork-media.de/literatur)

#### Contact address

Dr Jonathan Cochrane  
The Bristol Dental Practice  
1 Queen Square  
Bristol, BS1 4JQ, UK