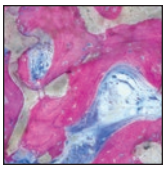
Feasibility of Alloplasts in Extraction-Socket and Sinus Augmentation Procedures



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Thirty-eight patients (aged 25 to 74) requesting extraction-socket and sinus augmentation procedures (27 and 11 patients, respectively) prior to implant placement volunteered to participate in this case series protocol. Surgical sites were grafted with either biphasic calcium phosphate (BCP) + collagen (for extraction-socket augmentation) or BCP with a collagen barrier membrane (for maxillary sinus augmentation). All patients completed the 1-year postloading follow-up, which consisted of clinical and radiographic evaluations. No implants were lost, and both healthy soft tissue support and good radiographic evidence of supporting bone were found around implants. The result of this short-term evaluation of implants placed in areas grafted with alloplasts seemed to be favorable and promising.
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Dental implants can be placed into both naturally healed alveolar ridges or augmented ridges with similar success and survival rates.[1–6] Different types of bone grafts ranging from allografts, xenografts, and alloplasts have been utilized over the years in implant dentistry for different indications.[1–6] Both preclinical and clinical studies support alloplast use in a wide range of clinical situations requiring bone augmentation procedures prior to implant placement.[6,7–12] For example, biphasic calcium phosphate (BCP) composed of hydroxyapatite (HA) and β-tricalcium phosphate (β-TCP) has been shown to form an amount of new bone that is clinically and histologically adequate to support dental implants.[7–10] One of the goals of this clinical case series was to evaluate the efficacy of BCP's ability to form bone in both augmented extraction sockets and maxillary sinuses in order to support dental implant restoration up to 1 year postloading.

Materials and Methods

Twenty-seven patients requiring implants to replace failing teeth and 11 patients requiring sinus augmentation to improve mastication volunteered to participate. The patients' ages ranged from 25 to 74 years old, and each signed an informed

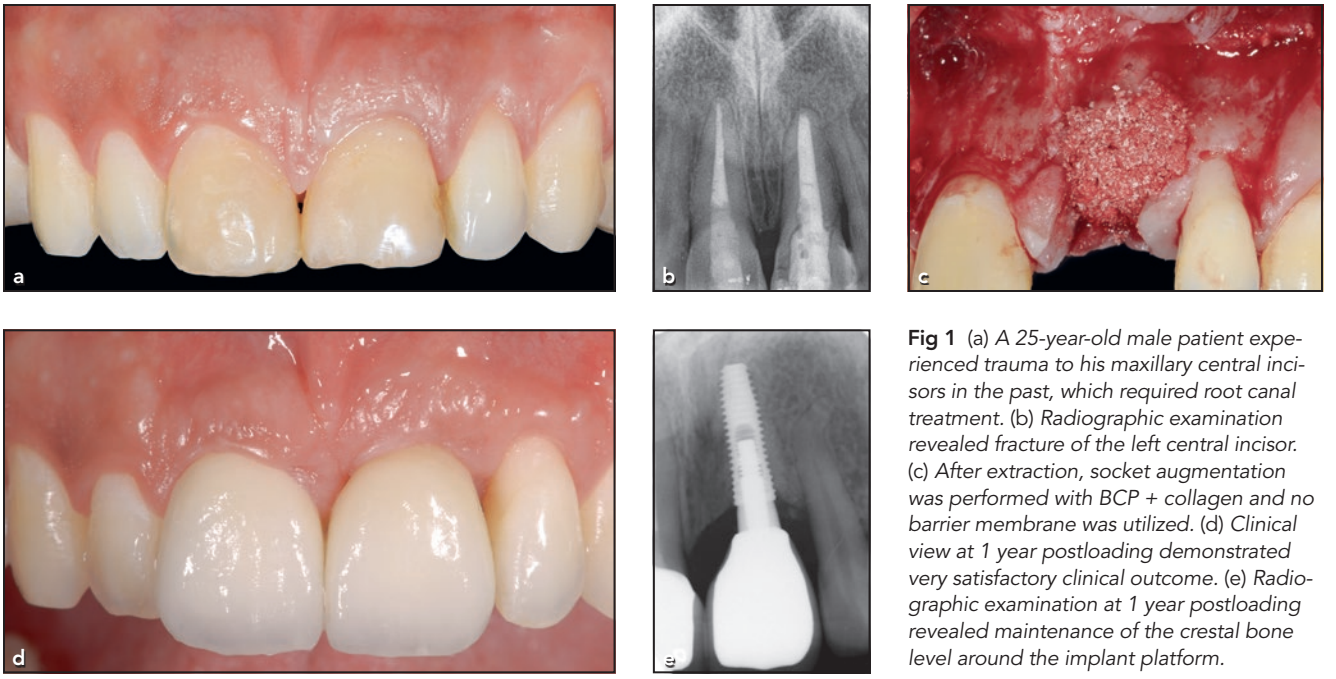

Fig 1 (a) *A 25-year-old male patient experienced trauma to his maxillary central incisors in the past, which required root canal treatment.* (b) *Radiographic examination revealed fracture of the left central incisor.* (c) *After extraction, socket augmentation was performed with BCP + collagen and no barrier membrane was utilized.* (d) *Clinical view at 1 year postloading demonstrated very satisfactory clinical outcome.* (e) *Radiographic examination at 1 year postloading revealed maintenance of the crestal bone level around the implant platform.*

consent form based on the Helsinki Declaration of 1975, as revised in 2000. These patients required placement of either a single or multiple implants into grafted areas, resulting in a total of 53 implants (31 implants for socket augmentation patients and 22 implants for sinus augmentation patients). Each participant was thoroughly informed regarding the nature of the protocol and understood that they had to return for follow-ups on a regular basis until final analysis at 1 year after implant loading.

The extraction-socket augmentation group (Figs 1 to 3) received BCP composed of 30% HA and 70% β-TCP with collagen (Osteon II Collagen, Genoss) and the sinus augmentation group (Fig 4) received BCP composed of 30% HA and 70% β-TCP (Osteon II, Genoss). Since the handling property was optimal as a socket grafting material, it was hypothesized that BCP + collagen by itself (without a barrier membrane) was sufficient to induce hard tissue regeneration in extraction sockets.

Twenty-seven patients requiring a socket preservation procedure following extraction of maxillary and mandibular teeth (anterior teeth and/or premolars) were enrolled and prepared for surgery in accordance with accepted dental practice guidelines (including informed consent). The appropriate demographics and medical history were recorded, and radiographs (periapical radiograph and computed tomography scan as needed) were performed (Figs 1a, 1b, 2a, 2b, and 3a). The surgical procedures were performed on an outpatient basis. The tooth scheduled for extraction and socket preservation procedure was anesthetized with local anesthesia.

Full-thickness flaps were produced with a horizontal incision so that they could be elevated to reveal the bone surface. Vertical incisions were to be used as necessary for visibility. After atraumatic extraction to make sure that there was an intact buccal plate, extraction sockets were grafted with BCP + collagen, and the mucoperiosteal flap was repositioned and sutured (Figs 1c and 2c). Some surgical sites achieved primary flap closure, while remaining surgical sites were allowed to heal by secondary intention (Fig 2d). Routine postsurgical visits (including oral hygiene instruction) occurred on a regular basis until implant placement at 6 months

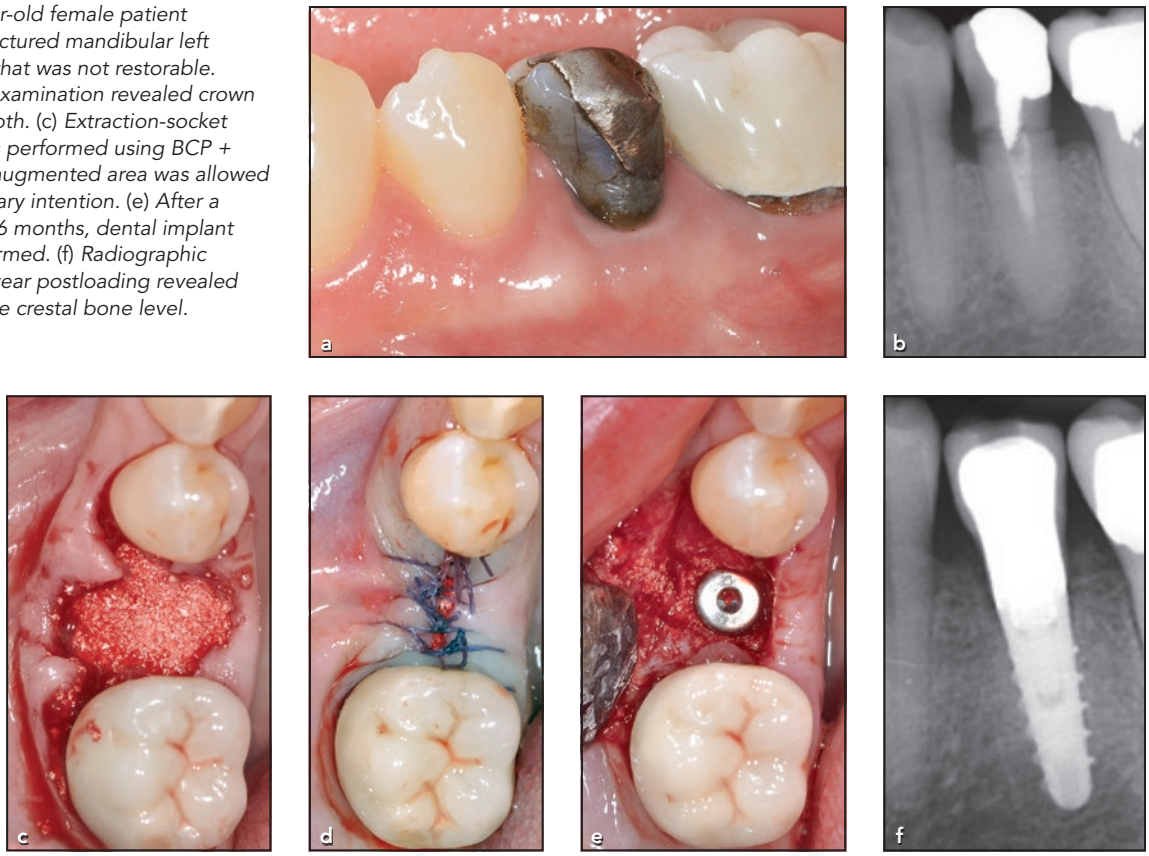

Fig 2 (a) *A 46-year-old female patient presented with fractured mandibular left second premolar that was not restorable.* (b) *Radiographic examination revealed crown fracture for the tooth.* (c) *Extraction-socket augmentation was performed using BCP + collagen.* (d) *The augmented area was allowed to heal by secondary intention.* (e) *After a healing period of 6 months, dental implant surgery was performed.* (f) *Radiographic examination at 1 year postloading revealed maintenance of the crestal bone level.*

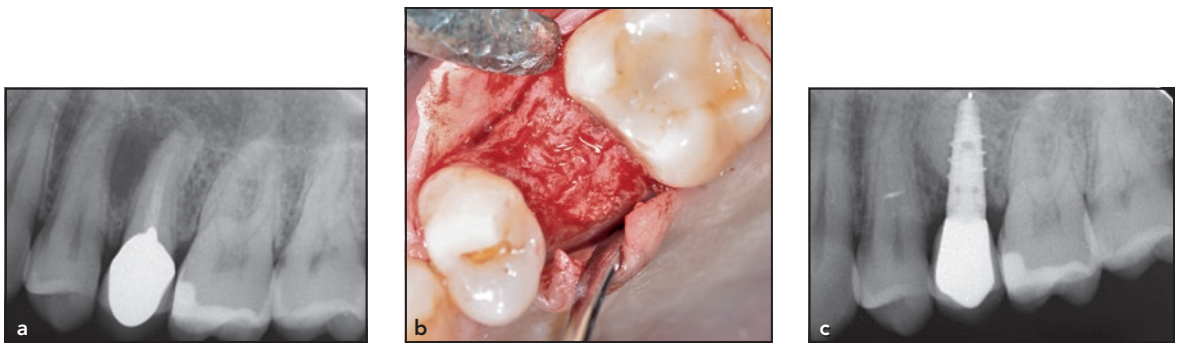

Fig 3 (a) *A 49-year-old male patient presented with buccal swelling on maxillary left second premolar area. Radiographic examination revealed possible root fracture, and the tooth was scheduled for extraction and socket augmentation.* (b) *The extraction was grafted with BCP + collagen and allowed to heal for 6 months. Maintenance of good bone ridge and shape noted at the time of dental implant placement.* (c) *Radiograph taken at 1 year postloading revealed good bone support around the dental implant.*

(Fig 2e). Bone cores were harvested for several sites at the time of implant placement and were sent to a laboratory for histologic investigation. After a routine healing period of 2 to 3 months, these implants were restored according to the manufacturer's recommendation, and patients received clinical and radiographic follow-up examinations up to 1 year after implant loading (Figs 1d, 1e, 2f, and 3c).

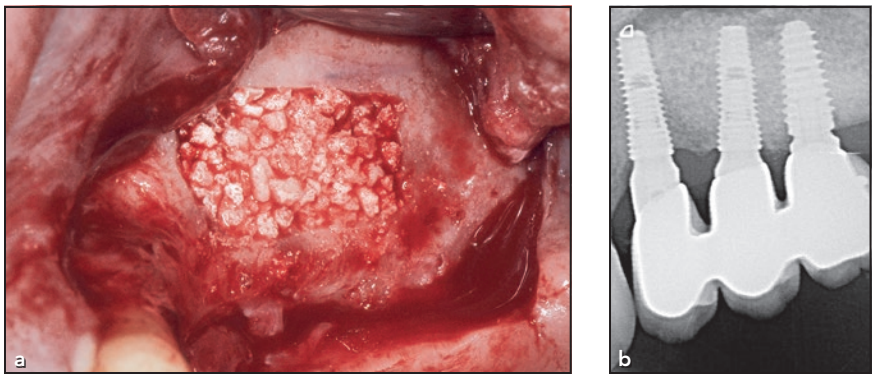

Fig 4 (a) *A 74-year-old female patient presented for maxillary sinus augmentation using BCP grafting material.* (b) *Radiograph taken at 1 year after loading revealed good bone support around the dental implants placed in the grafted area.*

For the sinus augmentation patients, similar surgical procedures were performed. The edentulous area scheduled for sinus augmentation was anesthetized with local anesthesia. With an incision made palatal to the crest of the alveolar ridge and completely through the mucoperiosteal tissue, a mucoperiosteal flap was elevated to expose the bone surface of the maxillary sinus. A mesial vertical releasing incision was made in the premolar or canine region and also in the posterior tuberosity region to reflect the flap adequately and to expose the lateral bone surface of the maxilla. An osteotomy was made through the cortical bone of the lateral wall of the maxilla by rotary and Piezosurgery instruments under copious irrigation. The cortical bone was carefully removed until the translucence of the sinus membrane was visible. The sinus membrane was gently reflected from the inner aspect of the sinus wall, with the osseous window remaining attached to the membrane. This window then was inverted to the medial wall of the sinus and superiorly positioned to become the floor of the newly created sinus cavity. With the sinus membrane elevated from its inferior and lateral position, sufficient room was created for the graft material (BCP). Small amounts of the graft were carried incrementally to the sinus recipient site and packed into position in a rather tight configuration, starting at the most medial and posterior aspect of the sinus and continuing to the most lateral and anterior position (Fig 4a). A barrier collagen membrane was trimmed and contoured to fit over the lateral window between the mucoperiosteal flap and the underlying osseous surface and bone graft.

The mucoperiosteal flap was repositioned and sutured. Postsurgical visits (including oral hygiene instructions) occurred on a regular basis until the 6-month implant placement and harvesting of bone core biopsy samples from several sites. One to two implants were placed in the sinus-augmented area (a total of 22 implants), and patients received clinical and radiographic follow-up examinations up to 1 year after implant loading (Fig 4b).

Results

Clinical Observations

All reconstructed areas healed uneventfully, and 53 dental implants were successfully placed and achieved clinical osseointegration without signs of adverse events. Remaining graft particles were observed at the graft site during implant placement, but they did not appear to influence the clinical outcome (Figs 2e and 3b). The clinical evaluation at 1 year after loading appeared to be within normal limits (Fig 1d). Both screw- and cement-retained restorations were delivered, and there was no clinical significance between the two.

Radiographic Observations

Radiographic evaluation (periapical radiographs) at 1-year postloading demonstrated maintenance and minimal remodeling of the crestal bone level around many dental implants (Figs 1e, 2f, 3c, and 4b).

Histologic Observations

All histologic specimens demonstrated remaining graft particles that were easily distinguishable from

the native bone and connective tissue due to differences in staining and morphology (Fig 5). The BCP particles were embedded in woven bone and dense connective tissue/marrow space. New bone growth was observed around the graft particles as well as within the cavities of the bone graft material. There was intimate contact between the graft particles and newly formed bone, and graft particles were bridged by the newly formed bone in all biopsy samples from the tested groups.

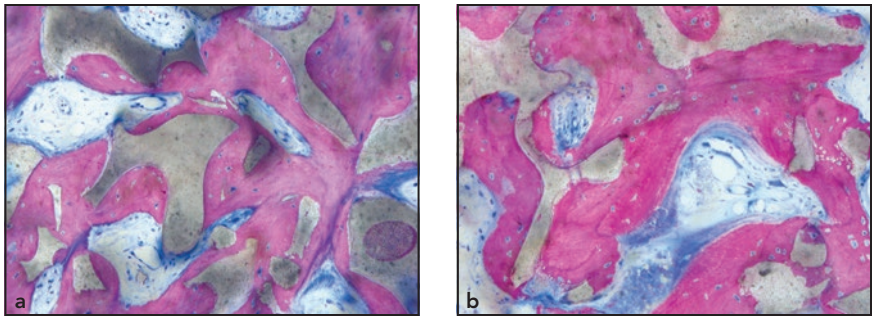

Fig 5 *All histologic specimens from both* (a) *extraction-socket and* (b) *sinus augmentations demonstrated remaining graft particles that were easily distinguishable from the native bone and connective tissue due to differences in staining and morphology. The BCP particles were embedded in woven bone and dense connective tissue/marrow space. New bone growth was observed around the graft particles and newly formed bone, and graft particles were bridged by the newly formed bone in all biopsy samples from the tested groups.*

Discussion

Alloplastic biomaterials offer an alternative to autogenous bone and its harvest, morbidity, and the nonrealized fear of disease transmission via allograft materials.[9] An alloplast with osteogenic potential will be a welcome addition to a regenerative surgeon's armamentarium for the treatment of localized alveolar ridge defects.[9] BCP composed of HA and β-TCP is a bone graft substitute that resembles the inorganic phase of human bone tissue. The insoluble HA retains its form and structure to maintain space, while the β-TCP will stimulate new bone formation by dissolving into calcium and phosphate ions.[13,14] The alteration of the HA/β-TCP ratio has been demonstrated to positively influence the substitution rate as well as the bioactivity of these materials.[13,14] Patients requiring extraction-socket augmentation or maxillary sinus augmentation prior to dental implant placement were asked to participate in this 1-year postloading case series. All patients attended their 1-year follow-up appointment. Clinical and radiographic examinations revealed promising results for BCP as an alternative grafting option. One-year postloading result may be too short to come up with a concrete conclusion regarding the biomaterial's long-term effect on dental implants. Nonetheless, the results obtained from this case series were favorable, and long-term follow-ups of these cases have been planned.

Conclusions

BCP grafting material appears to work well for forming bone in both extraction sockets as well as in maxillary sinuses. One year after implant loading, clinical and radiographic examinations revealed good tissue response as well as maintenance of bone support around dental implants. Thus, BCP grafting material seemed to be compatible and successful in forming bone in order to support dental implants.

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