GBR and Autogenous Cortical Bone Particulate by Bone Scraper for Alveolar Ridge Augmentation: A 2-Case Report

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Scientific literature describes autogenous bone as the gold standard among graft materials for alveolar reconstructive procedures. Alveolar ridge augmentation has been clinically achieved with different forms of autogenous bone, including autogenous cortical bone particulate (ACBP). However, few histologic studies demonstrating the biologic potential and healing dynamics following the use of ACBP are currently available. This case report presents 2 patients in whom atrophic edentulous alveolar crests were submitted to a vertical/lateral ridge augmentation prior to implant placement. The technique was performed through the use of a titanium-reinforced expanded polytetrafluoroethylene (e-PTFE) membrane with an ACBP graft obtained from the retromolar region with a specially designed bone scraper. Bone biopsy specimens were harvested at 9 months after graft placement. Analysis of the reconstructed bone revealed bone with a lamellar quality characterized by a mature osteonic structure. Sparse particles of grafted bone were evident in direct contact with the regenerated bone. Marrow spaces showed a normal stromal component with limited grafted particles. Int J Oral Maxillofac Implants 2008;23:111–116

Key words: *alveolar ridge augmentation, autogenous cortical bone particulate, guided bone regeneration*

A prerequisite for implant placement is the availability of sufficient alveolar bone to support and retain the endosseous implant. Factors such as infection, cystic lesions, tooth/alveolar trauma, or congenital tooth agenesis can cause a reduction of the alveolar ridge dimensions. A variety of reconstructive procedures have demonstrated efficacy in ridge reconstruction,[1,2] and implant survival in reconstructed bone mimics survival in native bone.[2–5]

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Surgical protocols for alveolar ridge augmentation include the use of resorbable and nonresorbable membranes,[6] graft biomaterials,[7,8] and bone morphogenetic proteins.[9] Among grafting procedures, the use of autogenous bone is considered the first choice because of its osteogenic, osteoinductive, and osteoconductive properties.[10–17] Autogenous bone can be harvested from intraoral donor sites (mandibular symphysis and ramus, maxillary tuberosity) or extraoral sites (iliac crest, tibia, calvaria).[18] Although a number of donor sites have been described, there is no clear preference indicated in the literature for any specific donor site.

The efficacy of autogenous cortical bone particulate (ACBP) has been reported for both periodontal and alveolar reconstruction; however, few histologic studies showing the biologic potential and the healing dynamics following the use of ACBP are currently available.[19,20] Therefore, the present report histologically evaluates an alveolar reconstructive procedure based on the combined use of ACBP (obtained by means of a specially designed bone scraper) and an expanded polytetrafluoroethylene (e-PTFE) membrane in 2 cases where vertical and lateral alveolar ridge augmentation was to be achieved.

Fig 1a Case 1. Space was provided by an e-PTFE membrane and a screw left exposed above the alveolar crest.

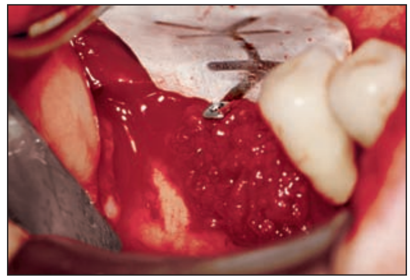


Fig 1b Case 1. Particles of autogenous bone were used to fill the osseous defect and cover the additional screw.

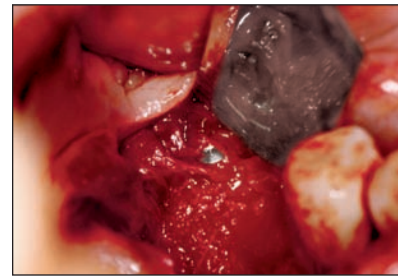


Fig 1c Case 1. 9-month surgical re-entry. The screw is submerged by newly formed bone.

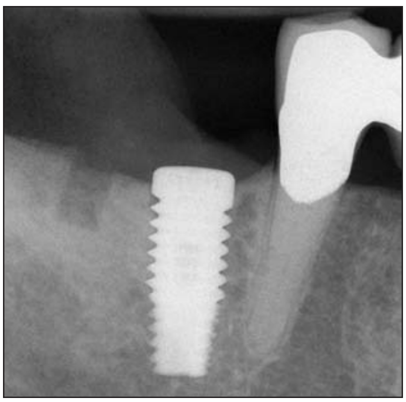


Fig 1d Case 1. 9-month re-entry. Radiographic appearance immediately after implant placement. Note the radiotransparent region of the bone biopsy.

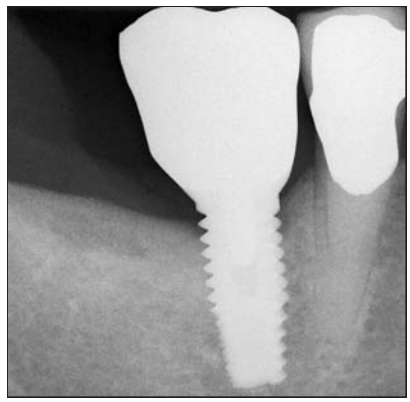


Fig 1e Case 1. Stability of the reconstructed bone 3 years after implant loading.

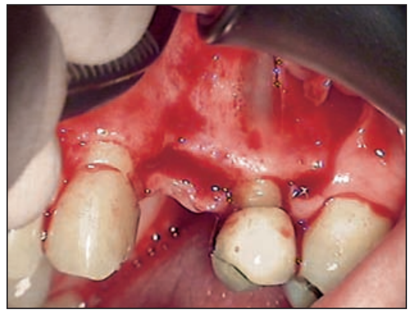
MATERIALS AND METHODS

Case 1

A 55-year-old woman presented with an atrophic edentulous alveolar crest in the mandibular right molar region. The clinical and radiographic examination revealed reduced lateral (5 mm) and vertical (7 mm) dimensions in the area of missing mandibular right molars. Patient medical and dental history included no systemic or local contraindications for surgical therapy.

After periodontal management, reconstruction of the edentulous crest was initiated. A full-thickness flap was elevated, and the buccal cortical plate was perforated. An adequate amount of ACBP was collected from the buccal cortical bone of the ipsilateral retromolar region using a specially designed bone scraper (Safescraper; META, Reggio Emilia, Italy). The harvested bone was positioned to augment the vertical and horizontal dimensions in the region of the mandibular right molars. A titanium-reinforced e-PTFE membrane (Gore-Tex Periodontal Material, W. L. Gore & Associates, Flagstaff, AZ) was positioned to cover the graft.[21–25] The membrane was fixed by a mini-screw on the buccal cortical plate. The space-making effect was enhanced using an additional screw inserted perpendicular (vertical) to the bone crest and left exposed above the alveolar crest. This screw created an additional 6 mm of space for site development (Fig 1a). The exposed portion of this screw was entirely covered with the bone particles and submerged by the membrane; thus, the screw provided a reference point for assessment of the vertical augmentation of the bone crest at the surgical re-entry (Fig 1b). The flap was sutured with 5-0 and 6-0 e-PTFE interrupted sutures, and internal mattress sutures were used to ensure membrane coverage.

After an uneventful healing period of 9 months, a full-thickness flap was elevated to place an implant in the mandibular right first molar region. The membrane-supporting screw was completely submerged by newly formed bone (Fig 1c). After membrane and screw removal, a cylindric implant 5 mm in diameter and 13 mm long (Biomet/3i, Palm Beach Gardens, FL) was placed. A biopsy specimen was collected with a trephine bur (internal diameter: 2 mm; depth of the sample: 5 mm) from the reconstructed alveolar crest (Fig 1d). Radiographic assessment demonstrates stability of the reconstructed bone contour 3 years after implant loading (Fig 1e).



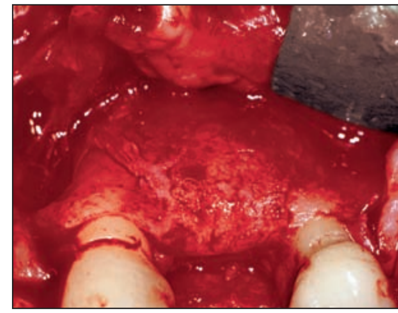
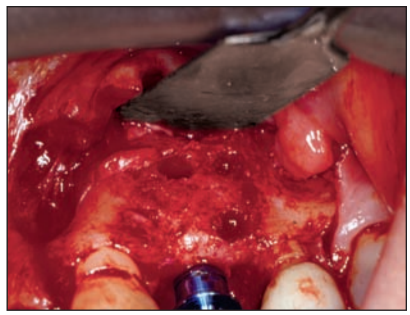


Fig 2a Case 2. Vertical and transversal collapse of the alveolar ridge associated with a 10-mm bone dehiscence on the buccal cortical plate of the maxillary second premolar.

Fig 2b Case 2. At 9-month re-entry the dimensions of the alveolar crest were increased. The buccal dehiscence was completely reconstructed.



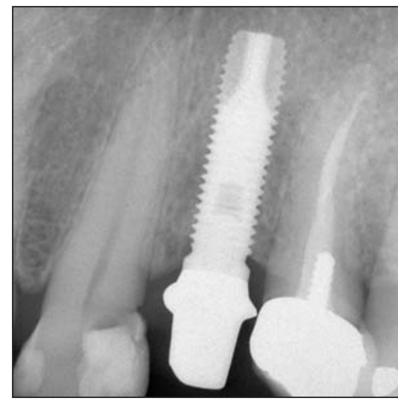


Fig 2c Case 2. 9-month re-entry. Implant placement and collection of 3 specimens from the reconstructed alveolar ridge (2 from the buccal plate, 1 from the alveolar crest).

Fig 2d Case 2. 9-month re-entry. Radiographic view of the implant immediately after its placement in the reconstructed alveolar crest.

Case 2

A 50-year-old woman presented with a transversal and vertical collapse of the edentulous alveolar crest in the maxillary left first premolar region. No systemic or local contraindications for surgical therapy or implant placement were identified. A 2-step approach, bone reconstruction followed by implant placement, was selected.

After full-thickness flap elevation, a 2-mm thin alveolar ridge was evident in the area of the missing first premolar. There was also a 10-mm bone dehiscence on the buccal cortical plate of the second premolar (Fig 2a). After bone perforation, autogenous cortical bone particulate was harvested by a bone scraper (Safescraper) from the left retromolar region and positioned to augment vertically and horizontally the edentulous ridge and bone dehiscence. The bone graft was covered by means of a titanium-reinforced e-PTFE membrane (Gore-Tex). Primary closure of the flaps was ensured by 6-0 polypropylene interrupted and 5-0 e-PTFE internal mattress sutures.

After an uneventful healing period of 9 months, the site was re-entered for implant placement. Vertical and lateral augmentation of the alveolar crest was compatible with the insertion of a cylindric implant 4 mm wide and 13 mm long (Biomet/3i). The buccal cortical dehiscence of the second premolar was completely reconstructed (Fig 2b). Three biopsy specimens of the reconstructed bone were collected with a trephine bur with an internal diameter of 2 mm during implant site preparation: 2 specimens from the buccal cortical plate, 1 from the alveolar crest (Figs 2c and 2d).

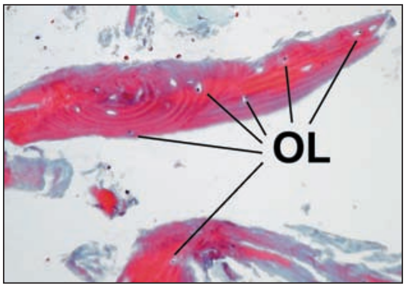
Histologic Analysis

The collected samples were immediately fixed in a 10% formalin solution in neutral pH. Sections 5 to 8 µm thick were cut along the long axis of each specimen. The specimens were stained with hematoxylin-eosin (H&E), Masson's trichrome stain, and periodic acid-Schiff stain (PAS).

RESULTS

Histologic Observations

Histologic analysis of the autogenous cortical bone, as processed immediately after harvesting, revealed the narrow and lengthened macroscopic structure of the particles, which were about 3 to 4 mm long. These



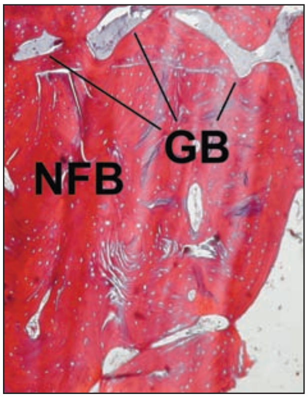


Fig 3 Bone particles (as processed immediately after harvesting). Note the lamellar structure and osteocytic lacunae (OL; Masson's trichrome stain; original magnification ×40).

Fig 4 Alveolar crest, newly formed bone (case 1). Overview of the specimen. The reconstructed bone revealed a lamellar quality, characterized by a mature osteonic structure. Only sparse particles of grafted bone (GB) characterized by a lamellar structure with empty osteocyte lacunae are present, embedded, and integrated with the newly formed bone (NFB; Masson's trichrome stain; original magnification ×5).

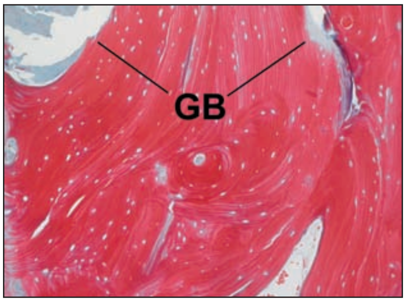


Fig 5 Reconstructed alveolar crest (case 1). Mature lamellar structure. Residual graft particle (GB) is evident. (Masson's trichrome; original magnification ×20).

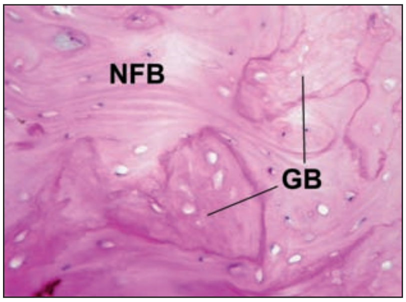


Fig 6 Reconstructed buccal cortical plate (case 2). Grafted cortical bone particles (GB) surrounded by newly formed bone (NFB; PAS; original magnification ×40).

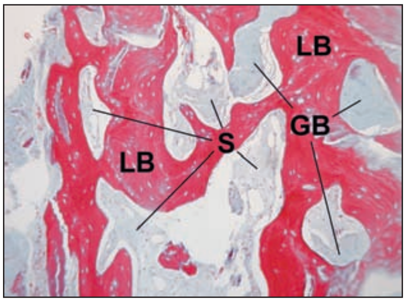


Fig 7 Reconstructed trabecular bone (case 1). A grafted particle (GB) surrounded by lamellar bone (LB) and in direct contact with a normal stromal component (S) is evident in marrow spaces (Masson's trichrome; original magnification ×10).

particles had the appearance of bone shavings. Higher magnifications highlighted the lamellar quality of the bone particles, with vital osteocytes included in lacunae (Fig 3).

In specimens harvested from the alveolar crest and the buccal cortical plate, the reconstructed bone revealed a lamellar quality, characterized by a mature osteonic structure (Figs 4 and 5). Only sparse particles of grafted bone (characterized by a lamellar structure with empty osteocyte lacunae) were evident in direct contact with the regenerated bone (Fig 6). In marrow spaces, grafted particles were surrounded by lamellar bone and in direct contact with a normal stromal component (Fig 7).

DISCUSSION

The present 2-case report illustrates the reconstructive potential of ACBP obtained by means of a bone scraper in conjunction with an e-PTFE membrane when used for vertical and lateral ridge augmentation. Both presented cases showed substantial reconstruction of the alveolar crest deficiency, which allowed for successful implant placement. At 9 months following the grafting surgery, histologic assessment revealed almost complete replacement of the grafted cortical bone particles with newly formed mature lamellar bone.

In both cases, a specially designed bone scraper was used to collect cortical bone particulate in the form of ribbonlike shavings from the cortical plate at the mandibular retromolar area (ie, the *linea obliqua*). The scraper has a convex blade that enables the harvesting of cortical bone from flat, convex, and concave surfaces. It is also provided with a collecting device that enables the bone particulate to be stored and delivered to the surgical site. The scraper is available in 2 different versions of different diameters and lengths to provide access to constricted areas under the soft tissue flaps. The proposed harvesting technique may have resulted in reduced donor site morbidity[26] and reduced harvesting time compared with the standard block-harvesting procedures. The scraper-derived matrix of ribbonlike bone shavings and blood has a mortarlike consistency and can be easily adapted to the alveolar deficiency to reshape the alveolar crest profile. It can be molded with any flat surface instrument, such as a plugger or curette, and it remains where positioned.[19] This composite matrix of ribbonlike shavings, with the patient's blood occupying the interconnecting porosity, has several potential advantages for the promotion of a rapid healing response.[27] Moreover, histologic analysis of the ACBP, as processed immediately after harvesting, revealed the presence of vital osteocytes. This observation is consistent with previous reports regarding autogenous bone grafts.[28–31]

Recent studies have investigated in vitro the level of bone cell supply[32] and the proliferating capacity of osteoblasts[33] derived from a cortical bone particulate. Springer et al reported a high level of vital cells in both cortical and spongy bone particles from an extraoral site (iliac crest), although the highest cell counts were observed for transplanted bone chips of cancellous origin.[32] Cortical bone particulate harvested from the maxilla or mandible was consistently found to have similar cell viability and cell capacity to respond to mitogenic and osteogenic stimuli compared to other forms of bone graft (ie, block, dust).[33]

In the present study, the regenerated bone was histologically analyzed 9 months after the surgical reconstructive procedure. In general, biopsy specimens revealed the vital, mature lamellar structure of the newly formed bone. In some specimens, sparse residual particles of the grafted ACBP were evident; these particles were completely incorporated into the newly formed bone. These findings are in agreement with previous histologic reports in humans where a particulate bone graft was used for alveolar reconstruction with[34] and without[35,36] concomitant implant placement. Although the previous studies differed from the present report with respect to the harvesting and processing procedures used to achieve the bone particulate, the use of autogenous bone graft in particulate form consistently resulted in substantial bone regeneration with the presence of residual grafted bone particles completely embedded and integrated with the newly formed bone at 6 to 12 months following grafting.[34–36] Evidence seems to indicate that bone particulate may be incorporated into newly formed bone even after a shortened healing period.[37,38]

In the 2 reported cases, the bone graft was positioned under a barrier membrane. Whether the effectiveness of a graft material in association with guided bone regeneration (GBR) procedures has been demonstrated by previous studies is still a matter of debate. Histology has shown that both autogenous and graft materials effectively contribute to osteogenesis following surgical augmentation of alveolar defects.[34,39] Although the short-term[22,40] and long-term[4] clinical success of both autogenous bone-GBR and bone substitute-GBR combinations are well documented, no comparative randomized controlled trials are available at present.

In conclusion, this case report seems to indicate that the use of ACBP obtained with a bone scraper in conjunction with a barrier membrane represents a therapeutic option for vertical and horizontal alveolar reconstruction. The reported results are in agreement with previous studies where similar autogenous bone grafts were used in different clinical conditions, such as sinus floor elevation and bone dehiscences around implants.[19] However, previous studies comparing cortical and spongy bone grafts demonstrated that cortical grafts are characterized by lower cellular content,[32] higher resorption,[41] and longer healing times.[42] Randomized controlled trials with larger sample sizes comparing different forms of autogenous bone graft are therefore needed to validate the effectiveness of ACBP as a bone augmentation procedure.

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