Effective space maintenance and alveolar bone volume preservation achieved by the use of non-resorbable Endobon® Xenograft Granules

By Jenny Park, PhD, Marie Pollard, DPhil, Hai Bo Wen, PhD

Background:

Xenografts of animal origin are commonly used as osteoconductive scaffolds to reconstruct human alveolar bone defects. Depending on the manufacturer's processing technique, commercially available xenografts possess different characteristics, such as surface morphology, crystallinity, and resorption rates, which can influence adhesion and growth of osteogenic cells, and subsequent new bone formation.[1-3] Safe and uneventful healing with the use of xenografts is achieved through processes that render the organic animal material non-antigenic.[1-3] The anorganic process often involves a final step of heat treatment at either moderate (260°C-600°C) or high temperatures (900°C-1200°C) that results in removal of antigenic elements of the xenograft.[1-3] The treatment process of xenografts can impart them with specific physico-chemical characteristics that determine their clinical use in procedures. The effective space maintenance afforded by heat treated xenografts has made them a viable choice for use in compromised surrounding bone.[1-4] In particular, xenografts treated at higher temperatures have higher crystallinity, which results in a slower resorption profile and increased residual material for mechanical stability at recipient sites.[1,5-9]

Approach:

Endobon, which undergoes a high heat process, is comprised of hydroxyapatite granules derived from cancellous bovine bone. It functions as a non-resorbable and osteoconductive scaffold that facilitates maximum bone volume preservation. The three-step processing of Endobon eliminates the organic elements via pyrolysis followed by sintering at high temperature to increase crystallinity. Then an air-lock oven aims to remove the possible viral, bacterial, and microbiological contamination before packaging. High heat treatment of Endobon results in complete deproteinization as well as destruction of potential residual bacteria, viruses, and prions to remote levels of risk.[21] The osteoconductivity facilitated by Endobon is comparable to other xenografts processed by moderate heat and is thus, not compromised by high heat treatment.[9-14] The interconnecting micro and macro pores of Endobon are preserved, which facilitate graft stability and vascular ingrowth.[10] Successful alveolar bone volume preservation and implant osseointegration achieved through the use of Endobon have been reported across a variety of indications. This white paper was aimed at summarizing the effectiveness and clinical outcomes of Endobon in bone reconstruction procedures associated with post-extractive sites, horizontal augmentation of narrow alveolar ridge, sinus lifts, and peri-implantitis treatment.

Post-Extractive Sites:

Reduction in alveolar bone volume after tooth extraction can compromise implant placement. The extent of bone resorption may be less after socket preservation and/or immediate implant placement but continues to pose aesthetic challenges. Caiazzo et al. (2017) showed long-term clinical effectiveness of Endobon in preservation and augmentation of the buccal plate after tooth extraction.[15] Ten patients received single implants immediately placed followed by buccal plate preservation and provisionalization. Buccal plate preservation involved insertion of Endobon in between the surface of the immediately placed implant and the buccal bone plate, including the surgical pouch adjacent to the gingival flap. After a 3-month healing period, the mean thickness of the grafted buccal plate measured at two reference points (1 and 5 mm below the implant collar) was 2.36 mm and 2.23 mm, respectively. At the 5-year follow-up, all implants were stable in function, and there were no statistically significant changes in the mean buccal plate thickness at both reference points, indicating excellent long-term preservation and augmentation of the buccal bone plate.

To evaluate the osteoconductivity of xenografts processed at different temperatures, Sivolella et al. (2020) histologically compared vital bone formation in post-extraction sites grafted with Endobon and another xenograft processed with moderate heat treatment (Bio-Oss®).[14] Forty extraction sites of 16 patients in need of at least two tooth extractions were randomly selected to receive one of each graft type followed by primary closure with an Osseoguard® collagen membrane. After a 4-month healing period, samples of the regenerated sites were obtained for histological and histomorphometrical analysis before implant placement. Also, implant performance was analyzed from 40 implants at a 2-year follow-up period. In comparison to the mean percentage of new bone formation in Bio-Oss samples (32.4%), there was no significant difference with Endobon samples (33.4%). All grafted sites healed without complications, and there were no signs of infection or inflammatory responses. At a 2-year follow-up period, implant survival rates were not significantly different between Endobon and Bio-Oss groups and both xenografts resulted in similar osteoconductivity, new vital bone formation, and provided osseous support for implant placement.

Endobon can be used in combination with autografts to facilitate adequate space maintenance during new bone turnover in the recipient sites. Amato et al. (2020) demonstrated that a mixture of Endobon (50%) and autogenous bone (50%) can support immediate implant loading in severely atrophic posterior maxillae and mandibles.[16] The Endobon mixture was inserted to fill the gaps between 146 implants and the alveolar wall in 55 patients with severe vertical bone atrophy in the posterior area followed by immediate loading. A high implant survival rate (99.3%) and minimal marginal bone loss (≤ 0.5 mm) were reported at a mean 3-year follow-up.

Ridge Augmentation:

Reconstruction of a narrow alveolar ridge is often required before implant placement to achieve adequate primary stability and aesthetic restoration. Block et al. (2012) reported successful horizontal augmentation of a narrow alveolar ridge in the anterior maxilla using Endobon and an overlaying membrane.[17] The membranes used for primary closure were either collagen (Osseoguard) for eight patients requiring more than two implants or polyglycolic acid (PGA)/polylactic acid (PLA) foils for four patients requiring one or two implants. After a 4- to 6-month healing period, at least 20 implants were placed in 12 patients. The greatest horizontal bone width augmentation occurred at the midway and apical regions from the crest (2.8 to 4.2 mm) and remained clinically stable (< 1 mm change) during the follow-up period (9.7 months to 2.3 years). The vertical measure from the crest indicated very small changes that were not clinically significant. The exceptional clinical stability afforded by horizontal augmentation of a narrow alveolar ridge resulted in a 100% implant survival rate without any adverse events.

Another recent study showed that long-term horizontal stability of maxillary and mandibular ridge augmentation can be achieved using Endobon.[4] Clinical data was collected over a 7-year mean follow-up period in 23 patients with 61 implant sites that were treated with either Endobon or another xenograft processed with high heat treatment, OsteoConductive Substitute-Bovine. The anterior maxillary ridge augmentation was performed in 17 patients using a standard approach of augmentation with the xenograft and resorbable membrane covering followed by primary closure of the gingival flap. The posterior mandibular ridge augmentation was performed in six patients by creating a subperiosteal tunnel to maintain the xenograft in place without the use of a membrane. The width of the augmentation decreased by 1.0 mm in the anterior maxilla and 1.3 mm in the posterior mandible after a 4- to 6-month healing period without further significant changes at a mean follow-up of 7 years. This data indicates that after the initial settling and remodeling, the augmentation was stable under long-term functional load. Indeed, implant survival rate was also high (94.1%) with minimal complications at a 7-year mean follow-up time.

Sinus Lifts:

Maxillary sinus lifting procedures are commonly used to increase bone height in the sinus floor region with thin and insufficient bone volume for placing dental implants. Felice et al. (2015) showed clinical effectiveness of Endobon in reconstruction of sinus floors for implant placement.[18] Endobon was inserted into 10 sinuses in 10 patients through the lateral access window followed by 4-month healing period before the placement of 18 implants. In cases where a laceration of the sinus lining occurred, Osseoguard collagen membrane was used but the author did not indicate the type of wound closure. No implant failures or complications were reported, and only minimal marginal bone loss (0.87 ± 0.21 mm) occurred after a 1-year follow-up period.

Nevins et al. (2011) reported vital bone formation in maxillary sinuses grafted with Endobon. Endobon was inserted into 14 sinuses in 14 patients through the lateral access window followed by primary closure

with an Osseoguard collagen membrane.[11] After a 6-month healing period, sufficient bone volume was radiographically verified in all sites, and samples of the 14 regenerated sites were obtained for histological and histomorphometrical analysis before implant placement. The remaining Endobon granules were integrated and surrounded by woven and lamellar bone in close contact. Active osteoblasts were also observed in the process of osteoid production. None of the samples showed histological signs of inflammation or resorption of remaining granules. The average percentage of newly formed bone at 6 months was 27.5 ± 8.9%.

Peri-implantitis Regenerative Treatments:

According to the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, peri-implantitis is defined as "a plaque-associated pathological condition, occurring in tissues around dental implants, that is characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone".[19] In peri-implantitis treatment, bone grafting has been widely used to stabilize implants after decontamination of the infected sites[19]. Renvert et al. (2018) reported that bone regeneration of peri-implantitis sites with Endobon after surgical debridement is a more predictable treatment option than surgical debridement alone.[20] Forty-one peri-implantitis sites in 41 patients were treated with either surgical debridement alone (control; 20 sites), or surgical debridement and bone grafting using Endobon (test; 21 sites). At a 1-year follow-up, the mean crestal bone gain in sites grafted with Endobon was 0.7 mm, while the control group did not show any statistically significant radiographic changes. The mean reduction in probing pocket depth (PPD) levels were 4 mm and 2.1 mm for test and control groups, respectively. Bleeding on probing (BOP) was absent in 47.6% and 35% of the test and control groups, respectively.

Polymeri et al. (2019) compared clinical outcomes following reconstructive surgery of peri-implantitis sites grafted with either Endobon or a xenograft processed by moderate heat treatment (Bio-Oss).[13] Twenty-four implants in 24 patients (Endobon n=13; Bio-Oss n=11) with peri-implant bone loss (≥ 3 mm) were treated with surgical debridement followed by grafting of peri-implant bony defects (3-wall or 4-wall type) with either Endobon or Bio-Oss. The gingival tissue was sutured around the grafted sites using non-resorbable monofilament sutures and clinical data was obtained for the most severe intrabony defect per site after a 1-year follow-up period. Both groups demonstrated significant improvements in all clinical and radiographic parameters. The mean intrabony defect bone gains were not statistically different between Endobon (3.0 mm) and Bio-Oss (2.5 mm). Also, the mean reduction in probing pocket depth for Endobon (3.8 mm) and Bio-Oss (3.6 mm) was not statistically different between the two groups. The combined proportion of implant sites with BOP and suppuration on probing were reduced by more than 50% and 75%, respectively, with no intergroup differences. Histological and clinical data indicate that application of Endobon and Bio-Oss have similar clinical outcomes when used in reconstructive surgery during peri-implantitis treatment.

CONCLUSIONS

Reliability of Endobon was proven by high implant survival rates and minimal complications reported across a variety of indications including post-extractive sites, horizontal augmentation of narrow alveolar ridge, sinus lifts, and peri-implantitis treatment. In areas that required space maintenance for immediate implant placement, Endobon succeeded in preserving alveolar bone volume, which resulted in long-term clinical performance of implant-supported restorations. Narrow alveolar ridges, as well as large areas during sinus floor elevation, were augmented with the use of Endobon by serving as a scaffold support that also aids in vital bone formation.

A comparison between Endobon and a moderate heat-treated xenograft indicated similar vital bone formation and implant survival rate in a post-extractive site. Therefore, high heat processing does not compromise the osteoconductivity and space maintenance achieved by Endobon, which is suitable for bone volume preservation. The unique increases in crystallinity and minimized resorption profile from high heat treatment avoids individual variations in the resorption pattern.[1,4] Endobon can also be used in combination with other grafting materials with fast resorption profiles such as autografts and allografts to facilitate adequate space maintenance during new bone turnover in the recipient sites.

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ZimVie
4555 Riverside Drive
Palm Beach Gardens, FL 33410
1-800-342-5454
Phone: +1-561-776-6700
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