Horizontal Ridge Augmentation Utilizing a Composite Graft of Demineralized Freeze-Dried Allograft, Mineralized Cortical Cancellous Chips, and a Biologically Degradable Thermoplastic Carrier Combined With a Resorbable Membrane: A Retrospective Evaluation of 73 Consecutively Treated Cases From Private Practices

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Ridge deficiency is an unfortunate obstacle in the field of implant dentistry. Many techniques are available to rebuild the deficient ridge. Some of these techniques are associated with significant morbidity and often require a second surgical site. With the advent of guided bone regeneration (GBR), one may now graft the deficient ridge with decreased morbidity and without a second surgical site. The purpose of this retrospective consecutive case series from 5 private practices is to report on the outcomes of a composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier (Regenaform RT) when combined with a resorbable

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membrane for GBR of lateral ridge defects in human patients. The specific aim was to quantify clinical results through direct measurement. Data were obtained from 73 consecutively treated lateral ridge augmentations performed on 67 partial and/or completely edentate patients. Clinical data (presurgical ridge width, ridge width at implant placement, and bone density at implant placement) were obtained retrospectively from 5 private practices via an exhaustive retrospective chart review, which was pooled and averaged for analysis. The average gain in horizontal ridge width was 3.5 mm (range, 3–6 mm). The density of the bone was noted to be type 2 to 3, with type 3 being the predominant finding. This retrospective case series from 5 clinical private practices suggests that the use of a composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier, when covered by a resorbable collagen membrane for GBR, is an effective means of horizontal ridge augmentation.

**Key Words:** ridge augmentation, bone graft, particulate graft, dental implant

**INTRODUCTION**

Advances in surgical and implant technology have enabled dentists to meet the treatment needs of an esthetically demanding patient population. Historically, Albrektsson’s criteria have served as the benchmark by which dental implant success has been measured. Although these criteria have remained the gold standard, with a strict focus on osseointegration and function, they do not address contemporary concerns such as esthetics or restorability secondary to implant positioning. For example, implants may be suboptimally placed because of anatomic limitations, developmental defects, pathology, bone resorption, and long-standing ridge deficiencies, which when restored may satisfy all of Albrektsson’s criteria for success. Yet the implant may be a failure, as seen in an undesirable esthetic outcome.

Implant malpositioning has been an unfortunate complication of our profession. The consequence of this can be off-axial loading, which may result in biomechanical problems, loosening, and/or fracturing of the cover screw, implant, or implant collar. Implant malpositioning can adversely affect clinical and prosthetic outcomes by creating a suboptimal emergence profile, fracture of the restoration, poor screw-hole positioning, occlusal discrepancies, and compromised esthetics and phonetics.

An ideal volume of bone is essential for proper implant placement in the buccal/palatal, apical/coronal, or mesial/distal dimension. Studies have demonstrated that bone resorption will occur secondary to tooth extraction (Figure 1). This tends to occur over a 12 month period, most notably in the first 4 months following extraction and, depending upon location, may range up to 5–7 mm buccolingually. In addition, 2–4 mm of vertical height loss frequently accompanies the horizontal loss and usually is seen when multiple adjacent extraction sites are combined. To combat this dimensional loss of bone volume, ridge preservation techniques have been used to maintain the alveolar ridge secondary to tooth extraction. However, even with current techniques, postextraction resorption may occur, mandating surgical management of the ridge deficiency.

Ridge splitting and expansion techniques concurrent with bone grafting have been well documented for treating horizontal deficiencies. Included in these categories are ridge splitting and expansion, guided bone regeneration (GBR), distraction osteogenesis, and block graft-
The purpose of this retrospective consecutive case series from 5 private practices is to report on the outcomes of a composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier (Regenaform RT, Exactech Dental Biologics, Gainesville, Fla) when combined with a resorbable membrane for GBR of lateral ridge defects in human patients. The specific aim was to quantify the clinical results through direct measurement.

**Materials and Methods**

Clinical data (presurgical ridge width, ridge width at implant placement, and bone density at implant placement) were obtained retrospectively from 5 private practices via an exhaustive retrospective chart review, which was pooled and averaged for analysis. A total of 73 consecutively treated lateral ridge augmentations were performed on 67 partial and/or completely edentate patients with a composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier (Regenaform RT) that was covered by a resorbable collagen membrane (Ossix, Oropharma Inc, Warminster, Pa). All patients were free of systemic disease that might compromise the results, such as uncontrolled diabetes or thyroid disease, osteopenia or osteoporosis, and blood dyscrasias such as anemia, and all were smokers of less than 1 pack of cigarettes per day. A total of 43 augmentations were performed in the maxilla and 40 in the mandible. Three patients underwent bilateral grafts of the mandible. Patients were treated under local anesthesia using 2% lidocaine with 1:100 000 epinephrine or articaine 4% with 1:100 000 epinephrine. A beveled crestal incision was made slightly to the palate or lingual of the treatment site and was extended at least 1 tooth beyond in both mesial and distal directions. After elevation of full-thickness flaps, measurements were made near the crest of the ridge using a UNC-15 probe to record the preaugmentation ridge width. Measurements were rounded up to the nearest millimeter at pretreatment and at posttreatment. The bone defect was decorticated using a #4 round bur through the cortical plate to enhance revascularization of the site. The membrane (Ossix, Oropharma, Inc, Warminster, Pa) was soaked in sterile water or sterile saline, according to the manufacturer's instructions, and was trimmed to fit the site. Further periosteal release was performed to allow for tension-free closure of the flap over the membrane and graft. The thermoplastic composite graft was mixed according to the manufacturer's instructions and was molded to fit the ridge defect. The graft was covered with the pretrimmed resorbable collagen membrane, and tension-free closure was provided utilizing a combination of horizontal and vertical mattress sutures (Figures 2 through 6). Patients were placed on postoperative Motrin 800 mg 3 to 4 times daily for up to 10 days to provide both anti-inflammatory and analgesic benefits, as well as amoxicillin 500 mg 3 times a day or 875 mg 2 times daily for 10 days. Patients were also instructed to use 0.12% chlorhexidine rinse, starting on the day after surgery, twice daily for the first 2 weeks when the sutures were removed, and for up to 4 weeks if the membrane became exposed. Patients were subsequently seen at 1 month, 3 months, and 6 months after the implants had been placed.

All cases were allowed to heal for a minimum of 6 months before implants were placed. At this time, a second measurement was made following the elevation of a full-thickness flap. Again, a UNC-15 probe was used to record ridge width postaugmentation. This was done close to where the first measurement was made. All clinicians noted
bone density according to the Lekholm and Zarb scale at the time of implant placement.

RESULTS

Average presurgical ridge width was 4 mm, and it was noted that maxillary sites tended to have more advanced ridge defects than mandibular sites. At stage I implant placement, ridge width postaugmentation was recorded at an average of 7.5 mm. The average gain in horizontal ridge width was 3.5 mm (range, 3–6 mm). The density of the bone was noted to be type 2 to 3, with type 3 being the predominant finding. All implants were successfully placed and ultimately restored after an average 4 months of healing (Figures 7 through 12).

DISCUSSION

The use of autogenous iliac crest block grafts has been associated with higher rates of
Figures 7–12. Figure 7. Nonrestorable tooth #7 with endodontic lesion noted. Figure 8. A large defect is seen postremoval of tooth and lesion. Figure 9. Defect is grafted before membrane placement. Figure 10. Six months postgraft with implant placed. Figure 11. #7 showing nonrestorable of implant placed in grafted bone. Figure 12. Implant restored 8 months postgrafting.
postoperative sequelae and morbidity,\textsuperscript{29} often requiring patient hospitalization. Although iliac crest bone may present certain advantages, such as the ability to obtain a larger volume of graft material that would include osteogenic material, its value has to be questioned in light of excellent results obtained with other graft materials and techniques, and the significant costs and morbidities associated with its procurement.\textsuperscript{30} Autogenous block grafts from the mandibular symphysis or ramus may be more advantageous in that they can be procured through an in-office, outpatient procedure. Furthermore, intraoral autogenous grafts have a lower rate of resorption and better revascularization vs iliac crest grafts.\textsuperscript{31,32} Ramus and symphysial grafts have their own sets of reported postoperative complications such as pain, infection, edema, chin ptosis, incision dehiscence, paresthesia, anesthesia, and neurosensory changes.\textsuperscript{25,27,28,33,34}

When GBR is compared with block grafting techniques for ridge augmentation, little difference is seen in the horizontal bone gain that can be achieved. Studies by Buser have demonstrated that using ramus and symphysial blocks yielded an average ridge width gain of 3.53 mm (range, 1–7.5 mm).\textsuperscript{35–38} More recently, Schwartz-Arad demonstrated that the mean ridge width increase in more than 60 onlay grafts from the symphysis and ramus was 3.8 mm, and a mean success rate of 87.5% was defined as sufficient bone for implant placement.\textsuperscript{30} Additionally, Triplett (1993) reported success rates for onlay grafts at 93%.\textsuperscript{36} When this is compared with the GBR literature, bone volume gains between techniques appear similar. Buser showed that GBR procedures produced a horizontal ridge width gain of 1.5–5.5 mm.\textsuperscript{18} Studies by Feulle using GBR techniques demonstrated a mean ridge width gain of 3.2 mm (range, 2.2–4.2 mm).\textsuperscript{43} Success rates for GBR techniques have been similar to those of block grafts, with studies by Tolman, Zitmann, and Nevins reporting increases of 81% to 97%.\textsuperscript{39–41} A meta-analysis by Tolman concluded that in most areas, the success of GBR was similar to that of block grafts, with only a slight advantage favoring block grafting in the mandibular arch.\textsuperscript{39} A systematic review by Aghaloo and Moy reported findings of statistically significant reduced implant survival rates at sites grafted with autogenous bone block, compared with other regenerative techniques.\textsuperscript{35} Their meta-analysis found an implant survival rate of 74.4% for iliac crest grafts, as compared with 95.5% for GBR.

Block grafts from intraoral or extraoral sources have the advantage of allowing reentry slightly sooner for implant placement. Pikos suggested that block grafts can be reentered at 3–4 months in the mandible and at 4–5 months in the maxilla.\textsuperscript{42} However, the disadvantages of utilizing a second surgical site, along with the increased morbidity associated with the graft harvest, make GBR an attractive technique for augmentation of alveolar defects in preparation for dental implant placement.

In the current study, grafting with composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier (Regenaform RT), when combined with a resorbable membrane for GBR, resulted in average horizontal ridge augmentation of 3.5 mm. This compares favorably with Buser’s study of ramus and symphysial block grafts, resulting in an average of 3.53 mm of ridge width.\textsuperscript{37} The handling characteristic of the composite graft, its combined osteoinductive and osteoconductive nature, and the benefits of avoiding a second surgical site make it preferable over autogenous grafting techniques.

\textbf{Conclusion}

This retrospective case series from 5 clinical private practices suggests that the use of
composite material of demineralized freeze-dried allograft, mineralized cortical cancellous chips, and a biologically degradable thermoplastic carrier, when covered by a resorbable collagen membrane for GBR, is an effective means of achieving horizontal ridge augmentation (Figures 13 through 15). An average of 3.5 mm of horizontal ridge width was achieved via this technique. Additional prospective and randomized controlled clinical trials are needed to determine the efficacy of this technique and to compare it with others currently used.

**ABBREVIATION**

GBR: guided bone regeneration

**REFERENCES**


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