Cylindrical Ringbone Allograft to Restore Atrophic Implant Sites: A Pilot Study

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Atrophic or severely deficient edentulous single tooth dental implant sites require osseous augmentation before any dental implant surgery. This may be accomplished by several procedures, allowing for several months of healing in order to achieve osteogenesis. After the initial site preparation, an implant may be placed and then allowed to heal for 3–6 months before the prosthetics are placed. This entire procedure may take several months to a year to complete. With the technique described herein, these cases were treated with an allograft ring or cylinder of bone that allowed for immediate placement of an implant. The allograft augmentation and implant placement are done at the same appointment. This technique shortens treatment time and may be valuable in treatment of failed implant sites. Further study is needed to refine and improve this technique.

Key Words: osseous grafting, atrophic, failed osseointegration, revision treatment, osteogenesis

INTRODUCTION

Dental implant patients present with varying osseous site conditions. Many sites are atrophic or have previously failed implant placements. These sites usually require osseous development and augmentation that may prolong treatment. A missing facial cortex may compromise a supportive or esthetic outcome, and this should be addressed for an appropriate outcome. Augmenting these sites can be time consuming and have complications. This cylindrical ringbone technique is not new. Previous reports have used autogenous cylinders of bone.1–3 This technique is functionally the same as those previously reported but uses an allograft cylinder of bone to augment an atrophic site. Allograft material has been shown to be very appropriate for osseous augmentation.4 Essentially, a trephine-cut cylinder of allograft bone is placed in a trephine-prepared site and the allograft cylinder is then drilled to accept a single implant; the implant is placed and allowed to heal for 4–6 months. A crown is then fabricated to restore the site. Multiple sites have not yet been studied.

A 1.8–mm thickness of facial supporting bone may be needed for a long-term functional and esthetic result.5 The allograft can encourage this bone to form from adjacent vital bone. The primary purpose of graft material is to maintain space for osteogenesis. Trabecular allograft is substantial, a few millimeters thick, and can maintain space for new bone to form.

The object of this pilot work is to present several cases in which a cylindrical ring allograft bone was used to functionally restore single tooth atrophic edentulous sites with single crown restorations.

MATERIALS AND METHODS

All patients were treated in a single private dental office. Eight patients with single tooth partial edentulism with atrophic facial cortices were treated (Figures 1 through 3). All sites were locally anesthetized with approximately 0.8 cc articaine (Septocaine) and 0.8 cc bupivicaine (Marcaine). A chlorhexidine oral rinse was administered preoperatively. All the sites required osseous augmentation for an appropriate outcome and were treated with an allograft cylindrical ring of bone cut with a trephine from a trabecular block (Rocky Mountain Bone Bank, Aurora, Colo) (Figures 4 through 6). The sites were prepared with a smaller trephine that would accept the bone cylinder. The smaller trephine slid easily into the larger trephine (Figure 4). The outside diameter of the small trephine is equal to the inside diameter of the large trephine, therefore the site diameter equals the inside diameter of the larger trephine and produces a cylinder of bone cut from the allograft block. The allograft cylinder was then placed into the osteotomy that was prepared with the corresponding trephine and then wedged and slightly compressed into the osteotomy and seated into place. The top of the allograft was placed at the level of or just below the adjacent bone crest. The seated allograft bone cylinder was then drilled through the coronal into the apical residual bone, held steady by a gloved index finger. A 3.7 × 13 mm diameter implant (Implant Direct, Ventura, Calif) was immediately placed in all cases (Figures 7 and 8). The implants engaged the apical bone and the prepared allograft cylinder for stability. The seated implant also helps to stabilize the allograft cylinder. All implants were placed with 35–45 Ncm seating torque with satisfactory initial stability. Each platform was placed about 2 mm below the top of the allograft. Each site was then covered with a 50/50 mix of particulate allograft (Puros, Zimmer Dental, Warsaw, Ind) and calcium sulfate (Alvelogro, Snoqualmie, Wash), and then covered with a collagen barrier membrane (Cytoplast, Osteogenics Biomedical, Lubbock, Tex) (Figures 9 and 10). All sites were subsequently primarily closed.
with 3-0 black silk suture (Figure 11). Postoperative radiographs were taken (Figure 8). Postoperative oral amoxicillin or azithromycin was prescribed with a loading dose administered immediately postoperatively. Sutures were removed at approximately 1 week and the site evaluated. Patients were again seen at the eighth postoperative week to evaluate healing. All patients healed uneventfully. After 4 months, each patient was infiltrated facially and palatally with articaine (Septocaine) and a fold-over facial flap raised and sutured with 3-0 or 4-0 black silk suture (Figure 12). An open tray analogue impression was made and a healing cap placed. After 1 week these sutures were removed, and after 2–3 weeks the crown was placed and evaluated for fit and appearance (Figures 13 through 15). After appropriate acceptances by the patient and the clinician (DF), the crowns were cemented with resin modified glass ionomer (RMGI) (RelyX, 3M, Minneapolis, Minn).

**RESULTS**

The implants healed well and were restored. All the implants and crowns were functionally successful; however, some had an unsatisfactory gingival architectural nadir. The patients have been in successful function for over 1 year without adverse events. Figure 10 shows a #4 site with a good outcome after 10 months in function (Figure 10). Esthetic outcomes were evaluated from good to unsatisfactory (Figures 13 through 15). Some outcomes had an unsatisfactory gingival nadir. All of the implants were functionally successful. All cases were not considered in the esthetic zone by the patients due to a low lip line or posterior location. No attempt was made to augment the gingival architecture with soft tissue grafting at this point.

**DISCUSSION**

After osseous atrophy or failure of an implant to integrate, the facial cortical osseous plate may be lost. This creates a problem for subsequent implant placement in terms of integration and esthetic outcome. Block graft or particulate augmentation are possible but usually require an osseous healing time before an implant can be placed. Patients are generally impatient for resolution of their partial edentulism, especially in the esthetic zone. A mortised block as opposed to a cylinder of allograft may be an alternative approach. A mortised block placement and immediate implant placement can be done, but this technique consumes operative time for fitting the block. The corresponding trephines facilitate the surgical process. This cylindrical ringbone cutting is quickly done with the pre-sized trephines and allows for immediate placement of the bone graft material and the implant, shortening operative time. Moreover, the technique promotes supportive bone formation for a functional outcome, and has the potential to generate a restoration of at least 1.8 mm of circumferential bone, which is important for long-term functional and esthetic results. Accurate CBCT radiographic evaluation of the facial cortices may be unlikely due to beam hardening.

One recent human study compared autologous bone to...
allogenic block bone for lateral ridge augmentation. This study found allogenic blocks to be an option for bone augmentation. No significant differences were found in bone-to-implant contact between the autologous and allogenic groups. Thus, an allograft may be used in place of autogenous bone.

Stevens and co-workers published a case report in which an autogenous bone ring was used to augment an atrophic site. Allograft block bone augmentation has been previously reported but not with immediate implant placement. The cases herein demonstrate that allograft bone rings may be a satisfactory material for this type of augmentation. The immediate implant placement of the implant inside the cylindrical ring reduces treatment time. Nevertheless, further study needs to be done to ensure appropriate outcomes.

Ultimately the primary, and possibly only, function of dental bone graft material is to maintain space for angiogenesis and osteogenesis. Bundle bone may form but lamellar bone may not. There are questions as to the supportive ability of bundle bone.

A fracture of the ringbone during treatment appears to be of little consequence as long as the fractured segments remain immobile. The allograft did indeed fracture during placement of 3 of the implants but did not apparently detract from healing. An adequate zone of attached gingiva should be established in order to prevent muscle tension to the implant soft tissue interface. This can be done with a free gingival graft, pedicle graft, or fold over type repositioning. Generally, a gingival augmentation procedure is best done several weeks prior to surgery, but it may be done after prosthetic insertion.

The gingival contour follows the underlying osseous contour. Grafted allograft may not consistently allow appropriate osteogenesis to support adequate gingival architecture. There may be a physiologic limit for extracortical grafting. Microvasculature must form after an inflammation phase to supply any osteogenesis. Any graft thickness beyond this distance may not form bone. The bone supports the gingival architecture, so there may be an unsatisfactory esthetic result. Grafted bone may not initially adequately support attached gingiva.

A poorly healed graft site may not provide adequate
resistance to occlusal loading and may result in a late failure from overload of the poorly mineralized osseous support. The graft material primarily provides and maintains space for the inflammation, angiogenesis, and osteogenesis to occur. Any graft thickness larger than this unknown critical distance may not form supportive bone. Additionally, this may not support gingiva and thus a poor facial gingival architecture may form. There may be a difference in intracortical bone healing as compared to extracortical bone healing (Figure 16); extracortical grafts may not receive adequate angiogenesis for adequate osteogenesis. Additionally, the displacement of the implant itself may block adequate osteogenesis. Intracortical healing can benefit from angiogenesis and subsequent osteogenesis from the surrounding walls of the osseous wound. This intraosseous intracortical type of healing may be that of a split ridge expansion technique and may offer faster healing with more supportive bone.

An insertion torque of 25 newton centimeters (Ncm) may be the minimum for appropriate initial stability. Each implant in this project was inserted to at least 32 Ncm.

Resin modified glass ionomer (RMGI) cement was used to retain all of the crowns. RMGI does not set in excessive moisture. The margins were flooded during cementation and any excess was removed after 2 minutes of setting time.

**CONCLUSIONS**

An allograft trabecular cylindrical ring of bone may be used to augment a severely deficient dental implant site where the facial cortex is absent and the lingual cortex is present. An
immediate dental implant is placed to shorten treatment time. However, gingival esthetic outcomes may be unsatisfactory. Gingival augmentation procedures may be necessary to ensure appropriate gingival architecture in the esthetic zone. Well-designed studies are needed to improve, refine, and validate the outcomes of this technique.

**ABBREVIATION**

RMGI: resin modified glass isomer

**REFERENCES**