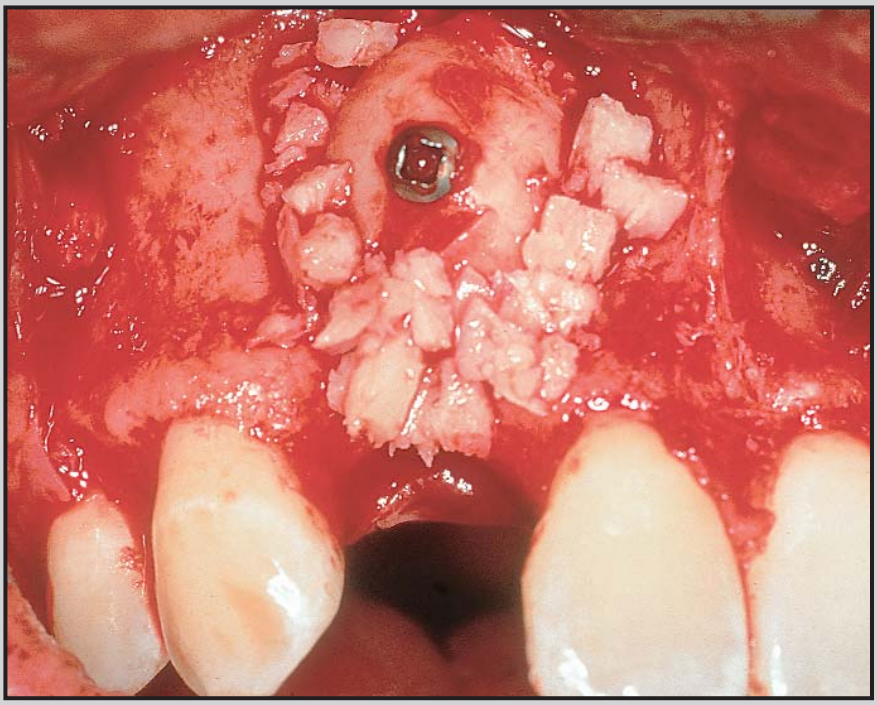
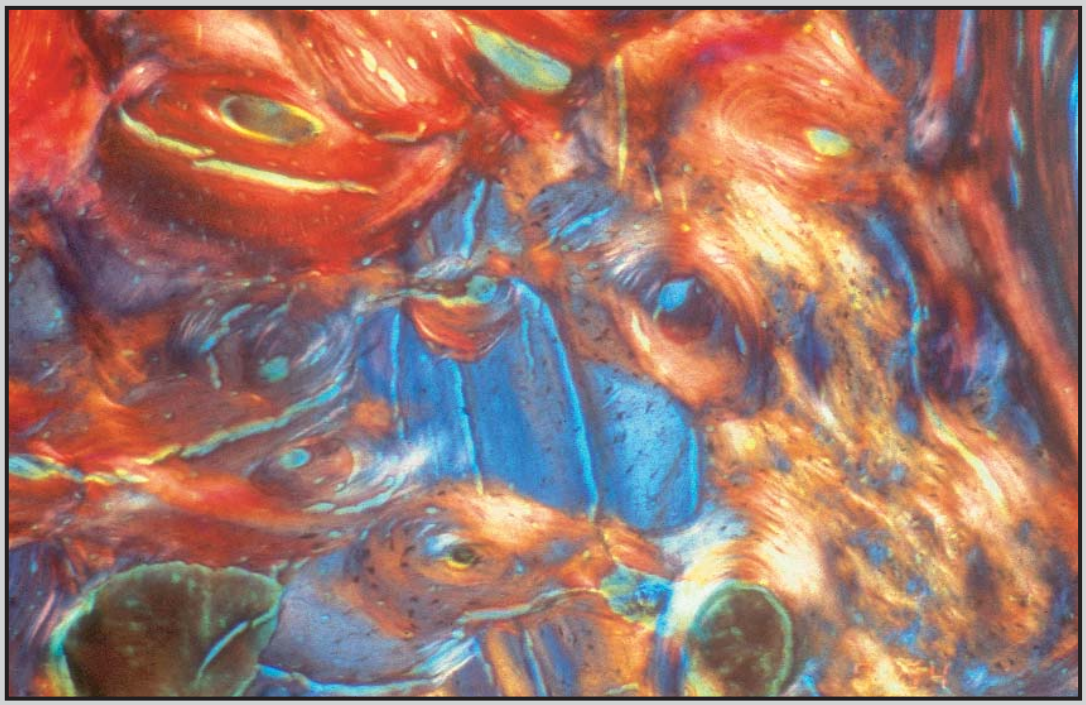
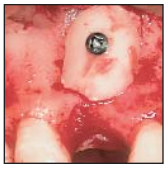




Clinical and Histologic Evaluation of the Use of Mandibular Tori As Donor Site for Mandibular Block Autografts: Report of Three Cases



*Periklis Proussaefs, DDS, MS**

The present paper reports on three patients who underwent localized alveolar ridge augmentation using block autografts harvested from the mandibular tori. Autogenous particulate bone graft was placed at the periphery of the block. Resorbable collagen membrane was placed above the graft material. Implant placement surgery followed at 6 to 16 months after bone grafting. During implant surgery, a biopsy was taken from the block autograft. Clinical evaluation revealed incorporation of the graft material at the recipient site. No donor site complication was noted. Histologic evaluation suggested that the block autograft was vital and in an active remodeling phase at the time of implant placement. Impressions were made intraorally before and 6 months after bone grafting. Laboratory measurements revealed 13% resorption at 6 months after bone grafting while 0.53 mL of ridge augmentation was achieved 6 months after bone grafting. Linear tomographs indicated 4.33 mm of lateral alveolar ridge augmentation. This report suggests that block autografts harvested from the mandibular tori may have the potential to maintain their vitality after bone grafting, while they may demonstrate resorption rates similar to those of autografts harvested from other intraoral donor sites. (Int J Periodontics Restorative Dent 2006;26:43–51.)

*Assistant Professor, Graduate Program in Implant Dentistry, Loma Linda University, Loma Linda, California; and Private Practice in Implant and Prosthetic Dentistry, Encino, California.

Correspondence to: Periklis Proussaefs, 16133 Ventura Blvd #1100, Encino, California 91436; fax: 818-906-2597; e-mail: pProussaef@hotmail.com.

With the widespread acceptance of dental implants as a valid treatment modality for the totally[1,2] or partially[3,4] edentulous patient, bone grafting has been proposed before[5–15] or simultaneous to[16,17] the placement of dental implants in patients lacking adequate bone volume.

While xenografts,[12,15,18,19] alloplastic bone grafts,[20,21] and allografts[11,22,23] have been proposed and studied for alveolar ridge augmentation, the use of autogenous bone graft represents the gold standard for bone augmentation procedures. Autogenous bone has been used as a block,[5,7–10,12,14,15] in particulate form,[11,13,24,25] or in combination of block and particulate form.[7,12,14,15] Block autografts can be secured at the recipient site with fixation screws[5,8–10,12,14,15] or dental implants.[16,17] Regarding the source of the autogenous bone, both extraoral[6,8,16,17] and intraoral[5,7–15,24–26] donor sites have been proposed. Several studies have demonstrated that intraorally harvested intramembranous bone grafts, in comparison to extraorally harvested endochondral bone grafts, may demonstrate mini-

Table 1 Patient distribution

Patient	Age	Sex	Recipient site	Healing period (mo)	No. of implants	No. of fixation screws	Bone quality*
1	25	M	Maxillary right lateral incisor	9	1	1	2
2	53	F	Maxillary left first and second premolars	16	2	2	2
3	50	F	Maxillary left central incisor	6	1	1	3

*As assessed during implant placement, according to Lekholm and Zarb.[42]

mal resorption,[27–30] enhanced revascularization,[28] and better incorporation at the donor site.[29] Intraoral donor sites include the symphysis area,[5,7–10,13,15] the ascending ramus area,[9,12–15] the tuberosity,[31] the coronoid process,[32] or the zygomatic bone.[33]

Harvesting of autogenous bone from the mandibular tori area has also been proposed.[34] No histologic evaluation has determined the potential of block autografts harvested from the mandibular tori area to maintain their vitality after bone grafting. It has been shown that autogenous block grafts, when comprising mainly cortical bone (as is the case for the mandibular tori), have reduced osteogenic activity[35] and slow revascularization.[36,37] The current report provides a clinical, laboratory, and histologic evaluation of three clinical situations where localized alveolar ridge augmentation was performed using the mandibular tori as donor sites.

Clinical cases

All patients were treated at the Center for Prosthodontics and Implant Dentistry, Loma Linda University, by postgraduate students. All patients signed the corresponding informed consent regarding bone grafting procedures and implant placement. All surgeries were done with local anesthesia.

Case 1

A 25-year-old male Caucasian patient sought treatment for his edentulism at the area of the maxillary right lateral incisor (Fig 1a) (Table 1). The tooth was congenitally missing. After being offered different treatment options, the patient decided to proceed with implant placement at the area of the missing tooth. Linear tomographs were taken, and bone volume for placement of a threaded root-form implant was inadequate. Therefore, it was decided to perform bone grafting before implant placement. The patient had mandibular tori (Fig 1b), and the clinician decided to use the mandibular tori as the donor sites for bone grafting.

Bone grafting was done in April 1998 under local anesthesia. A full-thickness flap was reflected on the lingual side, and the mandibular tori were exposed (Fig 1c). Harvesting of the tori was done with a surgical fissure bur (ACE Surgical Supply) according to a technique that has been described before.[34] A chisel was used to detach the tori. One of the tori was used in the form of a block. The recipient site was perforated with the fissure bur to induce bleeding and promote incorporation and vascularization of the graft material (Fig 1d).[38,39] A fixation screw (Osteomed) was used to secure the block autograft in place (Fig 1e). The other torus was particulated and placed around the block graft (Fig 1f). A collagen membrane (Bio-Gide, Osteohealth) was placed above the graft material,[15] and the area was sutured (Fig 1g). Periosteal fenestration[40,41] was performed to facilitate suturing and primary closure.

Figure 1h shows the 6-month postoperative appearance of the recipient site. Implant surgery was performed 9 months after bone grafting. Full-thickness labial and palatal flaps were reflected. The autogenous block graft appeared incorporated at the recipient site (Fig 1i). The fixation screw was removed. With a 2-mm internal-diameter trephine bur (ACE Surgical Supply) a biopsy was harvested from the block autograft. One threaded hydroxyapatite-coated root-form implant (Steri-Oss, Nobel Biocare) was placed. The grafted site appeared to have type 2 bone quality, as assessed during implant surgery.[42] The area was

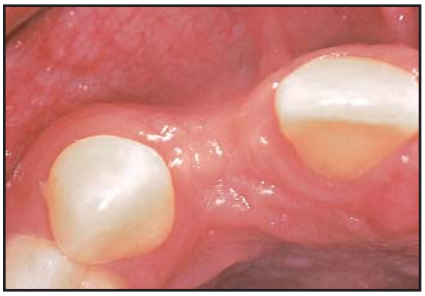


Fig 1a *Preoperative view of edentulous site in patient #1.*

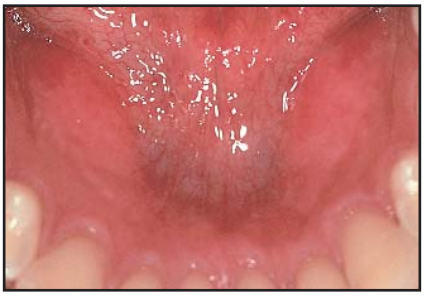


Fig 1b *Preoperative view of donor sites (mandibular tori).*

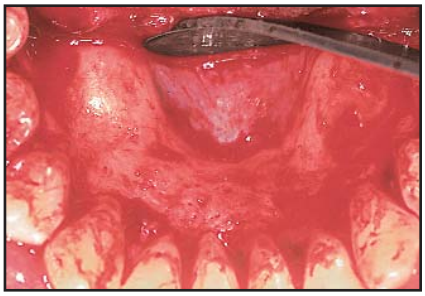


Fig 1c *Mandibular tori after full-thickness flap reflection.*

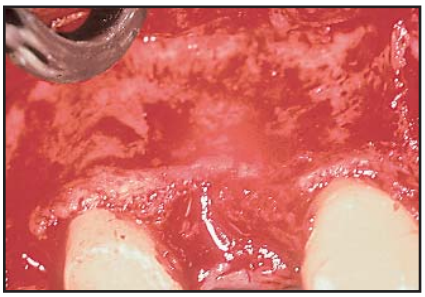


Fig 1d *Recipient site before placement of the block autograft.*

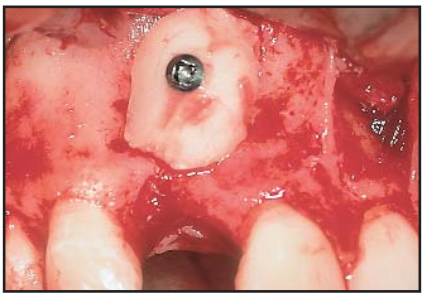


Fig 1e *The block autograft is secured at the recipient site with a fixation screw.*

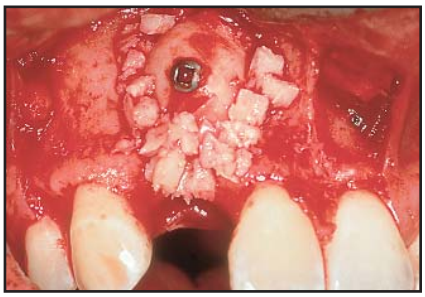


Fig 1f *The other torus is particulated and placed around the periphery of the block.*

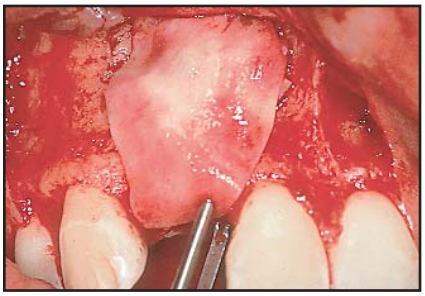


Fig 1g *A resorbable collagen membrane is placed over the graft material.*

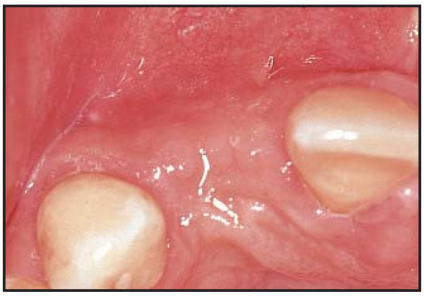


Fig 1h *Six-month postoperative view.*

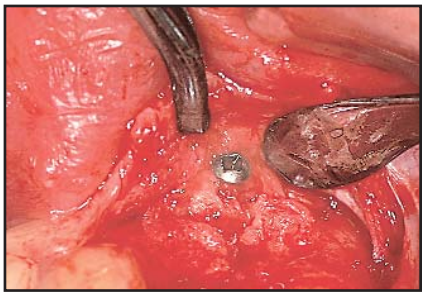


Fig 1i *Nine months after bone grafting, the fixation screw is removed.*

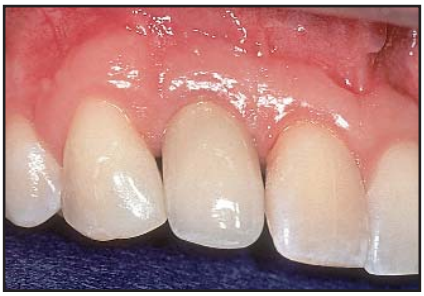


Fig 1j *Definitive prosthesis with custom abutment.*

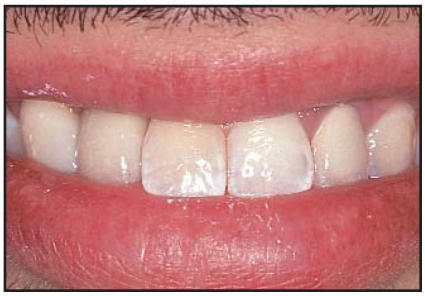


Fig 1k *Posttreatment facial view.*

sutured, and the implant was kept submerged for 6 months before second-stage surgery. A provisional acrylic resin crown was placed 2 weeks after second-stage surgery to allow soft tissue healing around the provisional restoration.[43–46] The definitive cement-retained prosthesis was placed 3 months later (Figs 1j and 1k). The patient has been recalled annually for 3 years after loading of the implant with the definitive prosthesis. At each recall appointment, standardized periapical radiographs were taken using an occlusal jig made of vinyl polysiloxane (Exabite, GC America) attached to the film holder, as described elsewhere.[46] Peri-implant probing was performed and mobility was tested using the Periotest unit (Siemens).[47,48] No clinical signs of pathosis (ie, probing depth > 3 mm, Periotest measurement < 1, bone loss < 0.2 mm annually, or gingival recession) were noticed at any of the recall exams.

Case 2

A 53-year-old female patient was treatment-planned for implant placement at the area of the maxillary left first and second premolars (see Table 1). Preoperative radiographic examination (periapical and panoramic radiographs, plus tomographs) revealed inadequate bone volume at the lateral aspect of the edentulous area. Bone grafting was performed in October 2000 with the mandibular tori as the donor sites. One torus was used as a block and the other was particulated and applied around the block. The patient was unable to proceed with implant placement in 6 months as designated by the investigators for personal reasons. Implant placement was performed in February 2002. The surgical procedures and follow-up were similar to that described for the first patient. The prosthesis was placed 6 months after implant surgery. No clinical signs of pathosis were noted 1 year after loading.

Case 3

A 50-year-old female patient underwent bone grafting at the area of the maxillary left central incisor (see Table 1). As in the previous cases, preoperative clinical and radiographic examination revealed inadequate bone volume along the labial area of the edentulous alveolar ridge for placement of a root-form implant. The mandibular tori were used as the donor sites. As for previous patients, one torus was used as a block and the other was used in particulate form. After 6 months of healing, one threaded hydroxyapatite-coated implant was placed. Bone quality at the grafted area was type 3. The surgical protocol used was similar to that described for the first patient. Implant was loaded 6 months later. No clinical signs of pathosis were seen.

Laboratory evaluation

The volume of localized alveolar ridge augmentation was assessed with a technique that has been developed by the Graduate Program in Implant Dentistry, Loma Linda University.[49] Briefly, impressions were made around the grafted area with a custom tray made from photopolymerized acrylic resin (Triad, Dentsply International), with irreversible hydrocolloid as the impression material (Coe Alginate, GC America). The impressions were made preoperatively, at 1 and 6 months after the bone grafting procedure. The impressions were poured with Type III dental stone (Microstone, Whip-Mix).

Table 2 Laboratory volumetric measurements

Patient	Volume after 1 mo (mL)	Volume after 6 mo (mL)
1	0.55	0.49
2	0.82	0.72
3	0.46	0.38
Average	0.61	0.53

Table 3 Linear laboratory measurements of lateral augmentation

Patient	Augmentation after 1 mo (mm)	Augmentation after 6 mo (mm)
1	5	4
2	6	5
3	4	4
Average	5.00	4.33

An impression was made from the postoperative stone casts using the custom tray and silicone (Lab-putty, Coltene/Whaledent). Polyvinylsiloxane bite registration material (Exabite II NDS, GC America) was then loaded into the tray, which was then placed on the preoperative stone cast; the bite registration material was allowed to polymerize. The bite registration material was then removed from the tray. The excess material was trimmed. The weight of the material was assessed, and by considering the material's density (provided by the manufacturer), it was possible to calculate the volume of alveolar ridge augmentation. In addition, linear measurements were made by evaluating the width of the bite registration material. Linear measurements were made with a caliper (Derby Dental Supply). Linear measurements were made at the location of maximum bone deficiency, as determined by preoperative clinical and radiographic evaluation. This method for laboratory evaluation of alveolar ridge resorption has been used in previous clinical studies involving localized alveolar ridge augmentation.[12,13,15] In this report, a mean of 0.61 and 0.53 mL of alveolar ridge augmentation was achieved 1 and 6 months after bone grafting (Table 2). This indicated 13% resorption between months 1 and 6. Linear laboratory measurements indicated 5.00 and 4.33 mm of lateral augmentation at 1 and 6 months, respectively (Table 3).

Histologic processing

The specimens were fixed in 10% buffered formalin, dehydrated in alcohol, and embedded in specialized resin (Technovit 7200 VLC, Heraeus Kulzer). Initial midaxial sections of 200 µm were made by means of the cutting-grinding system (EXACT Medical Technologies). The sections were then ground to 40 to 50 µm and were stained with Stevenel blue and van Gieson picrofuchsin for light microscopy.[50,51]

Histologic analysis

The specimens from the block grafts presented a solid core comprised almost entirely of cortical bone (Figs 2a and 2b). The block autografts demonstrated histologic signs of vitality and remodeling activity. At a higher magnification (Fig 3a), different stages of remodeling activity were suggested, as indicated by the different staining qualities of the bone. Polarized microscopy emphasized the remodeling pattern (Fig 3b).

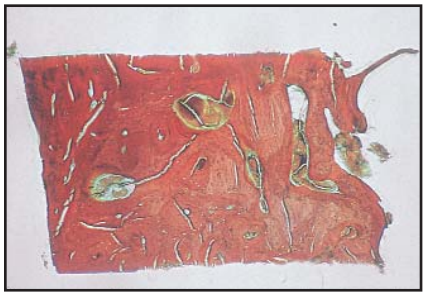
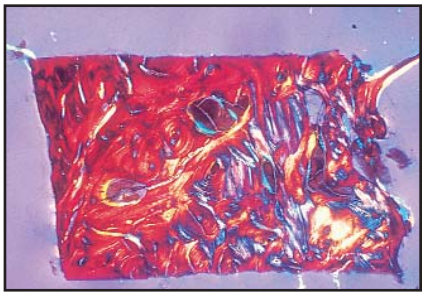


Fig 2a (left) *Histologic overview of block autograft (original magnification ×4).*

Fig 2b (right) *Polarized microscopy emphasizes remodeling pattern of block autograft (original magnification ×4).*



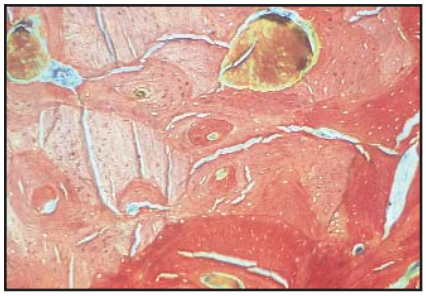


Fig 3a (left) *At a higher magnification (original magnification ×10), histologic evaluation indicates vital remodeled cortical bone. Variations in staining of the bone indicate variations in maturity. Darker staining indicates the younger bone.*

Fig 3b (right) *Under polarized microscopy, remodeling activity of the block autograft is evident (original magnification ×10).*

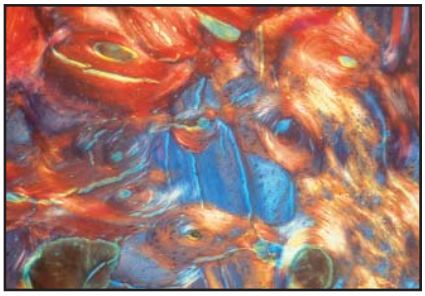


Table 4 Linear tomographic measurements obtained at 6 months after bone grafting

Patient	Lateral augmentation (mm)
1	4
2	5
3	4
Average	4.33

Radiographic evaluation

Panoramic radiographs were taken preoperatively, immediately after bone grafting, and after implant placement in all cases. Periapical radiographs were taken preoperatively, postoperatively, and during annual recall exams. Linear tomographs were taken preoperatively and 1 and 6 months after bone grafting. Linear tomographs were used to measure lateral alveolar ridge augmentation (Table 4). For the linear tomographs, the distortion rate (1.7) provided by the manufacturer of the tomographic unit (Scanora Type SBR 1C, Orion) was taken in consideration when the measurements were made. To achieve standardization and reproducibility during linear tomography, two light beams provided by the manufacturer were utilized while patients were positioning the head. On average, 4.33 mm of lateral augmentation was achieved 6 months after bone grafting (Table 4).

Discussion

This report has provided histologic evidence in humans regarding the potential of autogenous block autografts harvested from the mandibular tori to maintain their vitality until the time of implant placement surgery. Corticocancellous block grafts have been associated with a reduced rate of revascularization.[36,37] Enneking et al[37] reported that in cortical bone autografts most of the interior of such grafts is never revascularized or replaced by viable bone. As a result, they are prone to infection; if infected, they may never recover. Burchad[52] used the term "creeping substitution" to describe the dynamic reconstructive and healing process of bone transplantation. He reported that cortical bone transplants are not penetrated by blood vessels until the sixth day after transplantation and that the revascularization process may take twice as long as when particulate bone marrow is transplanted. According to his study, cancellous bone autografts are completely repaired, while with cortical bone grafts, mixtures of necrotic and viable bone are often observed.

There is a scarcity in the literature regarding histologic evidence in humans of the potential of intramembranous mandibular block grafts to heal and demonstrate signs of vitality. Shirota et al,[6] in a study that included three cases with block autografts, saw signs of devitalized bone tissue in the block grafts. Urbani et al[53] demonstrated signs of vitality of the bone transplants (block grafts) in five clinical cases. Matsumoto et al[54] demonstrated the potential of mandibular block autografts to maintain their vitality. In that study, in which biopsies were taken from 10 patients, mandibular autografts appeared to have enhanced remodeling activity and vascularity as compared to extraorally harvested endochondral bone grafts. Proussaefs et al[12,14,15] have demonstrated in human studies the potential of mandibular block autografts harvested from the ascending ramus or the symphysis area to maintain their vitality. Similar observations (histologic evidence of vital bone graft) were also made in an animal study[39] in which intramembranous bone was used in block grafts. However, no histologic evaluation has been reported regarding block autografts harvested from the mandibular tori.

Ganz[34] described a technique for harvesting block autografts from the mandibular tori. Each mandibular torus is sectioned with the fissure bur and detached with a chisel, as performed in the presented cases. Alternatively, a reciprocating saw has been proposed[55] for the removal of mandibular tori; this may result in reduced trauma during detachment of the block autograft.

In the three presented cases, the average volume of alveolar ridge augmentation was 0.53 mL at 6 months after bone grafting. This amount is smaller than that seen in grafted areas where the ascending ramus or symphysis was used as the donor site and similar volumetric methodology was applied.[12,13,15] This needs to be taken in consideration when treatment planning bone grafting procedures. In the author's experience, an edentulous alveolar ridge that is missing one or two teeth can be augmented with autogenous bone grafts harvested from the mandibular tori. In situations where more than two missing teeth are involved, alternative donor sites (ie, the ascending ramus, the symphysis, or extraoral sites) that would offer adequate volume of autogenous bone may be considered. However, it needs to be mentioned that for the laboratory analysis, impressions in this case series report were made intraorally before and after surgery. The results cannot distinguish the augmentation of hard tissue from that of soft tissue unless impressions are made during surgery and after flap reflection.

Mandibular tori removal has been associated with very low morbidity.[34] This is an advantage over other intraoral donor sites. The symphysis area has been associated with neurosensory disturbance,[9,13] while the ascending ramus has been associated with prolonged pain after surgery.[9,12]

Conclusion

Mandibular tori block autografts may have the potential to maintain their vitality when used as block autografts for localized alveolar ridge augmentation. They provide limited bone volume, as compared to block autografts harvested from the symphysis area or the ascending ramus area, but they result in low morbidity at the donor site. Larger patient samples and long-term follow-up studies are needed before definitive conclusions can be made.

Acknowledgments

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