The prerequisites for long-term success of endosseous implants under functional load include sufficient bone height, width, and volume in the edentulous span. When the bone is insufficient in any dimension, ridge augmentation may be considered as a means of enhancing the morphology of the existing defect. Surgical procedures to improve the morphology of the anticipated emergence profile include guided tissue regeneration (GTR), guided bone regeneration (GBR), onlay grafts, and free gingival grafts.

Autogenous bone grafts originate from the patient and are considered to be the optimal choice for augmentation. Various anatomic locations have been utilized as donor sites, and the techniques are well described in the literature. Bone has been harvested successfully from local areas of the mandible and maxilla and distant sites.

Conventional dentistry has provided acceptable treatment alternatives for the partially or fully edentulous patient for decades. Recent innovations have provided clinicians with an assortment of new techniques to restore the function of these patients. Established treatment alternatives have been significantly enhanced, resulting in increased acceptance of predictable dental implant restorations. However, implant dentistry cannot be successfully utilized in all edentulous patients, and augmentation measures are often necessary to enhance the alveolar bone, requiring autogenous donor sites. While bone tissue has been harvested from numerous sites, the mandibular tori may provide sufficient graft material. The teaching objective of this article is to describe a clinical implant placement procedure, utilizing bilateral tori as the donor sites of the autogenous grafting material. A clinical case is utilized to document the tori removal and the augmentation procedures.

Figure 1. Illustration of the bilateral mandibular tori, defined as hyperostoses or enlargements of the lingual aspect of the mandible.

Figure 2. Preoperative intraoral view of patient’s mandible reveals the presence of large bilateral mandibular tori.
such as the ilium,7,10 tibia,11,12 scapula,13 clavicle,14 and calvarium.15-17 Due to the location and complexity of the harvesting procedure, most of these techniques require a comprehensive surgical protocol. Grafts from the local sites provide advantages that may include an in-office outpatient procedure, reduced operative period, and decreased morbidity for the patient. Mandibular symphysis bone has been utilized successfully for various augmentation procedures. However, numerous patients object to harvesting bone from this site due to fear of compromising the natural contours of the chin, and mandibular ramus bone has been reported as a successful alternative.18

One region that has not been previously described as a potential donor site is the mandibular torus, defined as hyperostosis or enlargement of the lingual aspect of the mandible (Figure 1). The literature reveals three major hypotheses for the etiology of tori mandibularis: Heredity, functional reaction to masticatory stresses, and environment.19 The tori are found primarily among the populations in the extreme northern regions, and the prevalence ranges from 6% among American and European whites to 64% among Canadian Eskimos, to 100% among Greenland Eskimos. The mandibular tori generally occur bilaterally in the premolar region, but the hyperostoses may extend distally to the third molar and mesially to the lateral incisor. The lingual tori are unnecessary bony extensions, which may limit tongue space and create phonetic difficulties. When considering any type of prosthetic reconstruction, the tori can become an obstacle. This article presents a technique for utilizing mandibular tori as a source for onlay bone augmentation, with advantages to the clinician and the patient.

**CLINICAL PROCEDURE**

**Diagnostic Phase**

A 55-year-old female patient presented with bilateral distal edentulous spans in the mandibular arch. The patient had been wearing a removable partial denture for 12 years but had recently expressed an interest in implant-supported fixed dentures. The preoperative study cast illustrates the outlines of bilateral tori and the 6 proposed implant sites (Figure 3). The axial CT scan image with 6 proposed implant sites in the posterior mandible, simulated with diagnostic software (Figure 4) reveals the extent of the tori and the potential implant sites. The tori can limit tongue space and create phonetic difficulties, making them a potential obstacle to prosthetic reconstruction. This article presents a technique for utilizing mandibular tori as a source for onlay bone augmentation, with advantages to the clinician and the patient.

**Figure 3.** Preoperative study cast illustrates the outlines of bilateral tori and the 6 proposed implant sites.

**Figure 4.** The axial CT scan image with 6 proposed implant sites in the posterior mandible, simulated with diagnostic software.

**Figure 5.** CT scan image of cross-sectional images 109 through 112. A simulated implant has been placed to support a terminal abutment. Buccal defect and the tori are indicated by arrows.
comprehensive restorations. A thorough medical and dental history was completed along with a clinical examination, a full-mouth radiographic series, preoperative diagnostic casts, and a panoramic radiograph. Clinical examination revealed the presence of eight remaining mandibular anterior teeth, which were splinted together by a fixed ceramic-metal restoration. The existing semiprecious removable partial denture fit into two lingual attachments. Bilateral mandibular tori (i.e., extensive lingual bony exostoses) were present (Figure 2). Radiographic evaluation revealed large radiolucent areas on the mandibular right and left quadrants as a result of recent tooth extractions. Using panoramic radiographs to evaluate bone height, it was determined that 3 endosseous implants could be used to support the desired posterior fixed restoration of the right and left mandibular arch. A diagnostic waxup was completed, and the position of each implant was determined (Figure 3).

The panoramic radiograph has an inherent distortion factor that can reduce accuracy when planning implant restorations in the posterior mandible. While this distortion occurs primarily in bone height, the two-dimensional radiograph reveals no information about bone width and little about the quality of bone available. Therefore, a three-dimensional computerized tomography (CT) scan (Sim/Plant, Columbia Scientific, Columbia, MD) was taken, revealing 6 potential implant sites for the bilateral edentulous spans (Figure 4).

Utilizing the panoramic view from the CT scan, the residual extraction sites were reinspected to determine the extent of the radiolucent areas. It became evident that, due to loss of buccal plate, areas of exposed implant fixture would be revealed as illustrated in the cross-sectional CT scan images 109 through 112 (Figure 5). These sectional slices are 1 mm apart, as reformatted by the CT scan software, and are free from distortion.

A simulated implant was placed to support a terminal abutment, revealing the amount of potential fixture exposure. The extent of the tori was manifested...
by the dense cortical appearance of the lingual bony exostosis. Since the second bicuspid area was a potential implant site, options were considered for improving the existing bone morphology. The patient was informed, benefits were explained, and a color computer printout of the cross sectional views of the mandibular tori was explained. Through digital enhancement imaging, it was further demonstrated how the tori could be removed, sculpted, and moved from the lingual to the buccal surface of the alveolar ridge in the defect area (Figure 6).

The size of the tori was considerable and impinged upon lateral and anterior tongue space; removal would provide more space for the tongue and improve phonetics (Figure 7). A surgical template was subsequently designed to guide implant placement in relation to the existing mandibular tori. Utilizing the tori as augmentation material requires only one mutually inclusive incision along each mandibular ridge to gain access to the donor bone on the lingual aspect and the recipient site on the buccal aspect. The patient heals in a normal manner, as if undergoing only the tori removal. The procedure offered little risk other than the possible formation of lingual hematoma. The patient reviewed the benefits and risks and agreed to the procedure.

**Surgical Technique**

A local anesthetic agent (lidocaine 1:100,000 epinephrine solution) was administered during the in-office procedure. A full-thickness mucoperiosteal incision was initiated in the sulcus of the mandibular right cuspid and extended over the midcrestal region of the alveolar ridge to the retromolar pad. Two Y-shaped releasing incisions were included at the retromolar pad to allow full access to the proposed implant sites. Utilizing a periosteal elevator in an anterior to posterior direction, the lingual aspect of the flap was carefully dissected to expose the multitubercled tori (Figure 8). Due to the cohesive nature of the lingual soft tissue covering, tears are possible, especially when the tori are irregular in shape. These tears are generally the result of a direct

Figure 9. The torus is scored and sectioned with a chisel. Once removed, it will be recontoured to fit the defect site.

Figure 10. Illustration of the superior bone cut. The cut is sufficiently deep to permit the chisel to engage the tori for removal.

Figure 11. Illustration depicts the removal of the torus for use as donor graft. The donor bone was wrapped in sterile gauze soaked in saline.
downward and lingual motion, and can create potential compromise in the primary closure over the newly grafted areas. Slow, careful movements of the periosteal elevator are advised; a wide periosteal elevator was utilized to provide the lingual soft tissue retraction required for optimal visibility of the donor bone site.

A small fissure bur in a high-speed handpiece was used under copious irrigation to score the superior aspect of the cortical bone (Figure 9). This incision was prepared medial to the tori, along a line extending from the anterior aspect to the posterior aspect of the tori. With smaller tori, it may be possible to use the fissure bur to cut through the entire bony exostosis. Tori of greater size should be removed with a combination of depth cuts, followed by a final chisel fracture. As the present tori exhibited greater tissue volume, the initial penetration was made to allow the chisel or osteotome to engage the bone in the desired direction of separation (Figure 10).

Placing the chisel firmly within the channel created by the fissure, several deliberate, gentle taps of a surgical mallet were delivered to the bone, the tori were released cleanly from the mandible (Figure 11), and the lingual topography was examined for the presence of sharp bony spicula. Using a bone file and a football-shaped diamond bur, the area was shaped and smoothed. By repositioning the lingual flap over the bone, any sharp areas can be detected. Moist gauze was packed against the lingual aspect of the donor site to minimize swelling and hematoma formation. The donor bone was wrapped in sterile gauze soaked in saline, pending utilization.

Using the CT data, it was determined that the maximum diameter for this implant should be 3.7 mm to fit the site morphology and prevent perforation through the lingual cortical plate. Following the predesigned surgical template, the first implant (Screw-Vent, Paragon, Encino, CA) was placed into the extraction site of the mandibular right second premolar (in the same position as the simulation), so that the lingual aspect of the implant was at the crest of the higher lingual cortical plate.

Figure 12. The first implant is placed in the bicuspid extraction site with loss of buccal plate evident.

Figure 13. Three implants are placed according to preoperative simulated CT scan plan.

Figure 14. Illustration of the donor bone graft fixated with a titanium pin to the buccal surface of the mandibular ridge.
of bone (Slice 111 in Figure 5). The extent of the buccal exposure of the implant head and screw threads was a result of the loss of buccal plate (Figure 12). The implant fixture was placed to bisect the “triangle of bone,” as described by Ganz,21 and fixated against the cortical bone. Two hydroxyapatite (HA)-coated wide-body 4.7-mm implants (Selective Surface, Screw-Vent, Paragon, Encino, CA) were placed in the distal sites (Figure 13). The design of these implants was selected for this particular site to compensate for the anatomic limitations in the posterior mandible. The fixture is characterized by an acid-etched, micro-pitted titanium neck, and a self-tapping acid-etched surface at the apical portion of the implant. The bioactive potential in the area of trabecular bone is increased by the HA-coating of the implant body.22-24 These features match the implant to the bone anatomy of the site and may improve the initial stabilization.25

The bone from the donor site was carefully trimmed and sculpted to fit the dimensions of the recipient site. Through trial and error, the graft is shaped to match the contour of the underlying bone; a more intimate adaptation of the donor graft improves the prognosis of successful union. A single hole was subsequently predrilled for the fixation screw required to secure the recontoured graft. A rosette-type round bur was used to remove any surface tissue and remaining periosteal tags from the surface of the recipient site, and small penetrations were made through the cortical plates to establish bleeding points prior to delivering the graft. Adequate vascularity is an important requisite in the healing process of any graft procedure. The recontoured graft was carefully positioned onto the recipient site and fixated with a 1.2-mm titanium screw (Figures 14 and 15). Since even slight movement can result in nonunion, it is essential to ensure the stability of the graft. A new buccal plate of bone was established (Figure 16), leaving a small 3-wall defect around the exposed implant. Autogenous bone, previously collected from the osteotomy sites, was mixed with an allograft of osteoconductive resorbable

Figure 15. Recontoured donor bone is carefully positioned and securely fixated to the buccal aspect of the ridge with a titanium screw.

Figure 16. Illustration exhibiting the anticipated appearance of the buccal plate utilizing the mandibular tori donor graft.

Figure 17. Particulate bone graft mixture (OsteoGen, Implantec, Holliswood, NY) covers the implants and the bone graft site.
synthetic bone graft material (OsteoGen, Implanent, Holliswood, NY). The highly porous hydrophilic particulate graft mixture was placed in the site to fill any remaining voids, flowing distally to cover all 3 implants (Figure 17).

To maintain the position of the particulate graft, a collagen matrix (CollaCote, Sulzer Calcitek, Carlsbad, CA) saturated with sterile saline was placed over the entire treatment site and gently tucked under the soft tissue margins. It has been hypothesized by the author that the collagen “barrier” absorbs the platelets and red blood cells, which maintain a blood clot serving as a nutrient base for the graft.26,27 The excess lingual tissue that previously covered the tori was utilized to achieve the primary soft tissue closure and to maintain the graft (Figure 18). The entire site was gently compressed for 5 minutes, and moist gauze was packed against the lingual aspect of the site to avoid additional swelling. A postoperative radiograph was taken to verify the position of the implant fixtures in the grafted site (Figure 19). Once the right side was completed, the patient underwent a similar procedure on the left side; the smaller torus was removed and 3 posterior fixtures were placed during the same appointment.

The in-office procedure was well tolerated, and the postoperative phase was uneventful. The sutures were removed 2 weeks postoperatively, and the site exhibited excellent healing (Figure 20). The patient was satisfied with the removal of the bilateral tori, amazed that this procedure had not been offered previously to provide more space for the tongue. Four months postoperatively, the graft site was exposed to facilitate evaluation of the integration process (Figures 21 through 24), and the site is expected to be suitable for prosthetic restoration within the next 4 to 6 weeks (Figures 25 and 26).

**DISCUSSION**

Implant dentistry has been recently redefined, acknowledging the definitive tooth replacement as its ultimate objective, not the implant itself.28 The purpose is to replace the missing anatomic
structures, eg, lost bone and soft tissue, in addition to the lost tooth. The focus of implant dentistry has been reoriented to ridge preservation, site preparation, and augmentation to enhance implant placement and the supporting structures. Enhancement of the site with onlay grafting procedures has created additional treatment alternatives for previously unacceptable edentulous spaces.

However, numerous procedures described in the literature require invasive surgical techniques for harvesting bone from distant sites, such as the hip, which require hospitalization and have inherent morbidity factors. The use of bone material from local sites, such as the mandibular symphysis and the ramus, offers several advantages over more distant sites, yet requires that existing structural bone be removed. The author postulates that an ideal site to harvest bone for augmentation procedures would be a local area of excess bone (exostosis) that offers no structural or aesthetic benefits to the patient. The mandibular torus, defined as a hyperostosis or an enlargement of the lingual aspect of the mandible, exhibits such characteristics.

The delicate tissue that covers the lingual surface of the tori is often traumatized during the impression phase of the prosthetic procedure, causing discomfort to the patient. Without removal, the tori may interfere with the design of a removable partial denture or become irritated when a prosthesis is worn. Pynn et al suggested five indications for tori removal: Traumatic ulcers from mastication, prostodontic considerations, cancer phobia, interference with tongue function during mastication, and interference with normal speech.\(^9\) When implant placement is considered for posterior mandibular reconstruction and tori are present, the same considerations apply.

When local bone augmentation is required, and the mandibular tori are present, they can be considered as excellent potential donor sites. As previously discussed, however, these hyperostoses will be exhibited by only a minute segment

Figure 21. Upon reentry 4 months postoperatively, the regeneration of the buccal plate was demonstrated.

Figure 22. Zone of keratinized tissue is evident surrounding the healing collars.

Figure 23. The preservation of the ridge and zone of attached tissue surrounding the healing collars affords an optimal foundation to complete a posterior fixed restoration.
of the patient population. When the donor site and recipient site are located within the same half of the mandibular arch, the surgical procedure is reduced to one mutually inclusive incision, which gains access to the donor bone on the lingual aspect and the recipient site on the buccal aspect. The removal of the tori can be accomplished with minimal trauma and low postoperative morbidity. The cortical and cancellous nature of the bone, with a thickened outer cortical plate of haversian bone, makes it an excellent choice as a donor site for onlay grafting procedures.

**CONCLUSION**

A technique has been described that offers substantial benefits for the clinician and the patient. Use of the mandibular tori as local donor sites for onlay graft augmentation reduces morbidity associated with other graft procedures, enhances site preparation, and aids the prosthetic phase of implant reconstruction. Despite these clinical advantages, the applicability of the technique is limited to the small segment of the patient population that exhibits mandibular tori. Advanced technology to evaluate a proposed implant site with three-dimensional accuracy has provided the means to simulate the implementation of a treatment plan that can incorporate all aspects of a complete implant-supported restoration. In the case presented, the patient had a clear concept of the procedure prior to providing informed consent, the procedure was uneventful, and the patient was satisfied with the result. Whenever a patient has mandibular tori and requires intraoral bone augmentation procedures, utilization of these anatomic exostoses as donor sites should be considered.

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REFERENCES


Learning Objectives:
This article describes a clinical implant placement procedure, utilizing bilateral tori as the donor sites of the autogenous grafting material. Upon reading and completion of this exercise, the reader will have:

- A knowledge of an additional intraoral donor site in some patients.
- Sufficient instruction to perform the clinical procedure.

1. **Mandibular tori are defined as:**
   a. Hyperostoses or enlargements of the lingual aspects of the mandible.
   b. Anatomically and functionally important bony formations.
   c. Indications of osteoporosis in females.
   d. None of the above.

2. **The etiology of tori mandibularis does NOT include:**
   a. Obesity.
   b. Functional reaction to masticatory stresses.
   c. Heredity.
   d. Environment.

3. **Mandibular tori have a significant prevalence in the populations of:**
   a. The Southern hemisphere.
   b. Eskimos in Canada and Greenland.
   c. Western United States.
   d. Middle Eastern countries.

4. **Patients with mandibular tori may exhibit the following difficulties:**
   a. Limitation of tongue space.
   b. Phonetic obstruction.
   c. Limitation of space for partial dentures.
   d. All of the above.

5. **Which of the following diagnostic measures was (were) taken?**
   a. Full-mouth radiograph.
   b. Panoramic radiograph.
   c. Computed tomography scan.
   d. All of the above.

6. **Use of CT scan technology for diagnosis and treatment planning is important, since it:**
   a. Reveals a three-dimensional picture of the bone.
   b. Provides distortion-free images.
   c. Allows simulated implant placement prior to surgery.
   d. All of the above.

7. **The surgical procedure for removal of mandibular tori requires which of these steps?**
   a. Elevation of a full-thickness mucoperiosteal flap to expose the tori.
   b. Scoring of the superior aspect of the cortical bone.
   c. Use of a surgical mallet and chisel to release the section of bone.
   d. All of the above.

8. **The utilization of mandibular tori as a donor site does NOT include:**
   a. Decreased morbidity for the patient.
   b. Antibiotic premedication.
   c. Autogenous tissue.
   d. None of the above.

9. **The excess lingual tissue that previously covered the tori was:**
   a. Utilized as part of the augmentation substance.
   b. Utilized to achieve the primary soft tissue closure.
   c. Discarded.
   d. None of the above.

10. **When the donor and recipient sites are located within the same half of the mandibular arch, the one mutually inclusive incision gains access to the:**
    a. Donor bone on the lingual aspect.
    b. Donor bone on the buccal aspect.
    c. Recipient site on the lingual aspect.
    d. None of the above.