Avoiding Osseous Grafting in the Atrophic Posterior Mandible for Implant-Supported Fixed Partial Dentures: A Report of 2 Cases

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Bone atrophy occurs after tooth extraction in the posterior mandible, placing the mandibular canal and its neural, arterial, and venous contents closer to the osseous facial aspect and the coronal crest. This proximity places the structure in danger of damage when dental implants are surgically placed to support fixed or removable prostheses. Several options are available to treat these areas for implant-supported fixed and removable complete or partial dentures. Osseous grafting and ridge expansion are surgical options that enable acceptance of standard sized dental implants but have serious morbidities. Additionally, vertical osseous augmentation is not predictable at this time. Narrow diameter dental implants can be placed to avoid the mandibular canal, but some bone volume situations preclude this. Very wide and very short (6.5 × 5 mm) dental implants may be placed at an angle in atrophic sites to successfully support fixed partial dentures. An anterior guidance occlusal scheme may be used in maxillary dentate patients or group function in maxillary complete denture patients. A 100 micron occlusal relief in fixed partial dentures in dentate patients may be required to account for natural tooth intrusion and to prevent occlusal overload of the implant-supported partial denture.

Key Words: atrophic bone, mandibular canal, nerve damage, dental implant, occlusion

INTRODUCTION

After a tooth is extracted, the bone in that site undergoes edentulous remodeling. As time passes, bone volume continues to be lost and bone becomes atrophic, typically at the expense of the facial and crestal aspects (Figure 1). In the past, the partially edentulous posterior mandible was traditionally treated with a unilateral or bilateral free-end removable partial denture. This treatment does not inhibit osseous atrophy and in fact may encourage it.[1] Additionally, patients who wear a bilateral free-end removable partial denture opposed by a removable complete maxillary denture can develop combination syndrome.[2,3] Signs include posterior mandible atrophy, hypertrophic maxillary tuberosities, atrophic fibrous replacement in the anterior maxilla, and super-erupted mandibular anterior teeth. This condition creates an unstable base for the removable maxillary complete denture, so the denture has poor support and retention. Many of these patients present for implant treatment. Nevertheless, the atrophic edentulous posterior mandibular ridge may preclude placement of standard sized dental implants for

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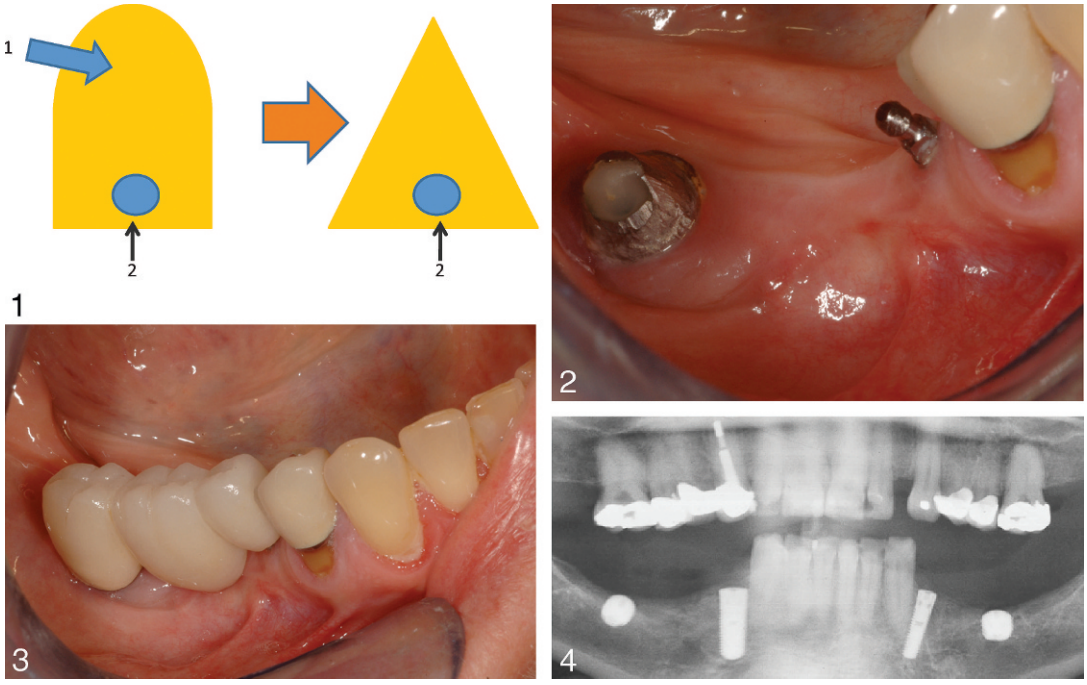


Figures 1–4. Figure 1. As demonstrated in this schematic drawing, edentulism results in osseous atrophy (1) that proceeds mainly from the facial and crestal aspects, resulting in a narrow ridge at the crest and making implant placement problematic in avoiding the mandibular canal (2). **Figure 2.** Stock abutments are prepared for parallelism and standard crown and bridge impressions and laboratory procedures. **Figure 3.** The final fixed partial denture in place. **Figure 4.** Radiographically, short wide implants can appear spherical when placed at an angle. Standard diameter implants were used in the more anterior sites.

support of a lower fixed partial denture. These sites generally require extraosseous grafting or ridge expansion to increase site width, if bone height is sufficient, to accept standard sized implants. Loss of bone height exacerbates the condition. Patients who present for dental implant treatment after many years of edentulism in this area typically have lost most of the alveolar bone height that would have been available for implant placement.

Several implant treatment options are available for these cases, such as vertical osseous augmentation with bone blocks or vertical ridge expansion for standard sized implant placement. Vertical bone augmentation does not yield predictable results at this time.

Another option is to place narrow diameter implants into the narrow ridge when height is sufficient.[4] Yet another option is surgical nerve repositioning.[5] This option can be expensive, may be impractical, and has serious morbidities. In the end, the clinician is left with few alternatives.

As a final option, very short and very wide dental implants may be used to support prostheses in highly selected atrophic osseous conditions (Rescue, MegaGen, Los Angeles, Calif). Implants are available in 6.0, 6.5, 7.0, 7.5, and 8.0 mm diameters and in 5, 6, and 7 mm lengths with internal or external hex. When these implants are placed at an angle in the atrophic ridge, they typically do not penetrate the lingual cortex, thus avoiding the mandibular canal and reducing the potential for submental arterial damage, and additionally avoiding the mandibular canal.

The object of this article is to present 2 cases of restored edentulous atrophic posterior mandible and to discuss the selection of these case types for appropriate treatment using short wide dental implants to support fixed partial dentures.

Case Reports

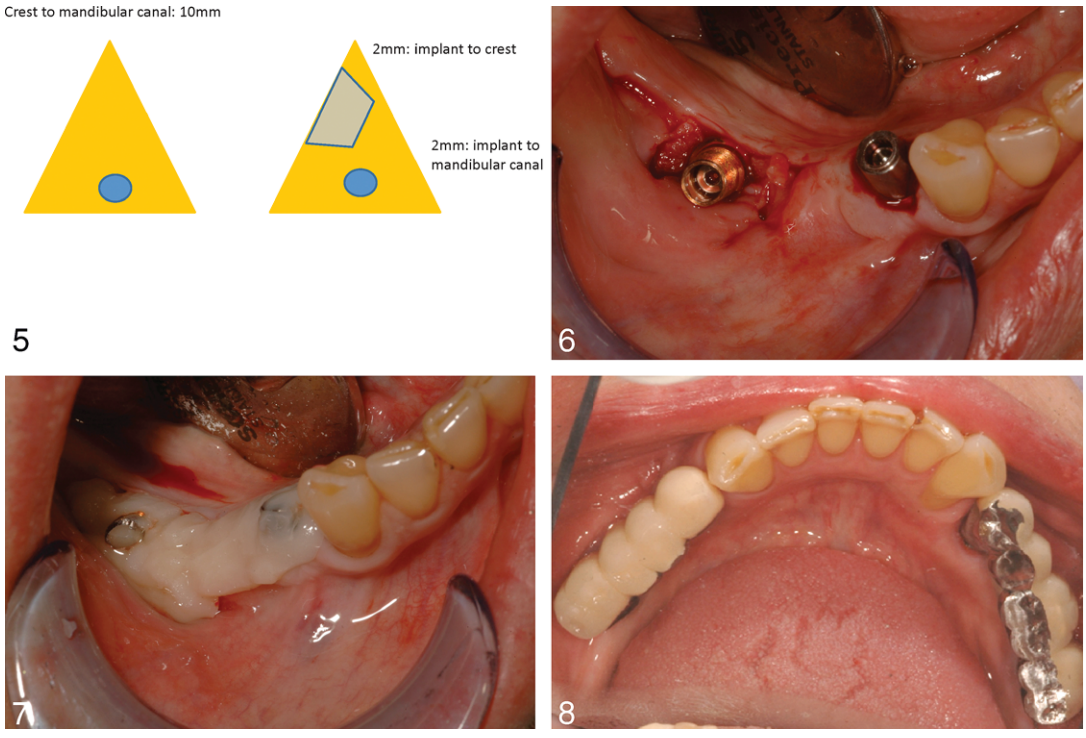
Case #1

A 65-year-old female presented for implant treatment of her severely atrophic Kennedy Class II partially edentulous mandible. Her medical history was insignificant for dental implant treatment. She wore a complete removable maxillary denture, and the posterior mandibular teeth were missing. She was developing combination syndrome. After clinical and radiographic examination was performed, and after treatment options were reviewed, she accepted a treatment plan that included bilateral fixed partial dentures supported by short wide implants in conjunction with narrow diameter implants. The right mandible was locally anesthetized by facial and lingual infiltration with 1.8 mL of articaine (Septocaine). A full-thickness facial flap was raised. Because of a narrow atrophic ridge but adequate height at the #28 site, the mandibular right first premolar, a 2.5 × 13 mm (IntraLock) narrow diameter implant was placed. At site #30, the mandibular right first molar, sequential osseous drilling was performed, and a 6.5 × 5 mm dental implant was placed at a facial angle, so that the implant platform was flush with the osseous facial surface. To augment the attached gingiva, an apically positioned flap relocated the crestal attached gingival to facial. This was sutured with 4-0 polyglycolic acid (Vicryl). The patient healed uneventfully. After 4 months, she presented for prosthetic treatment of the osseointegrated implants. The narrow diameter implant was slightly prepared for parallelism with a diamond burr. The stock abutment for the wide diameter implant was prepared for parallelism with the narrow diameter implant and was torqued into place (Figure 2). The abutment access hole was filled with a compomer (Dyract) and was light cured. A standard fixed partial denture impression was made with polyvinyl siloxane (Imprint). A centric relation record was made with fast-set polyvinyl siloxane (Futar). A 3-unit porcelain-fused-to-noble metal-fixed partial denture was constructed. To ensure a passive fit, the laboratory technician was instructed to apply an extra layer of die separator to each die and to make a narrow occlusal table. The finished fixed partial denture was luted with resin-modified glass ionomer cement (Figure 3). A new complete denture was concomitantly constructed, and the occlusion was refined for group function. This patient has been in function for 1 year with no complications. The left side recently underwent the same treatment.

Case #2

A 60-year-old female presented for replacement of missing bilateral Kennedy Class II mandibular posterior teeth. Her medical history was unremarkable for dental implant treatment. Her teeth had been removed many years prior and the residual ridges had atrophied, reducing the available bone volume and contour. Natural maxillary dentition opposed the mandibular sites. Ridge mapping demonstrated a narrow ridge contour.[8] Radiographically, at the first molar sites, the mandibular canal was in close proximity to the crest, leaving approximately 10 mm from the osseous crest to the superior radiographic rim of the canal. Because adequate bone was present, standard sized implants (3.7 × 10 mm and 4.7 × 10 mm) were placed in sites #21 and #28, respectively, while 6.5 × 5 mm implants were bilaterally placed at an angle in the second molar sites (Figure 4). Because the wide implant at the right side was placed at a severe facial angle, the anterior abutment required 15 degrees of facially angled abutment to ensure parallelism. The path of insertion therefore would extend from the facial-occlusal direction. All abutments were stock and were prepared for parallelism for a passive prosthetic fit (Figures 5 and 6).

A standard impression technique (Imprint) and a fast set polyvinyl siloxane (Futar)



Figures 5–8. Figure 5. When an atrophic ridge presents with little bone volume, a short (5 mm) and wide (6.5 mm) implant may be placed at an angle to avoid the mandibular canal. A 2 mm radiographic margin should be observed at the crest and at the inferior aspect. The abutment has a wide diameter and can be prepared for parallelism for a fixed partial denture. **Figure 6.** The short wide implant was placed at a severe angle toward the facial. Abutment #28 was replaced with a 15 degree stock abutment placed angled toward the facial. Each abutment was then prepared for parallelism and subsequent impression. **Figure 7.** After the abutments were prepared and impressed, a free gingival graft was performed and the site covered with a bis-acryl stent, applied free-hand. No sutures were placed. The stent was removed after 1 week of healing.

centric relation record were used to construct mounted working casts. Bilateral porcelain fused to metal fixed partial dentures was constructed with minimal cusp height, and the laboratory technician was instructed to apply an additional layer of die separator during the waxing procedure to ensure passivity.

Very little residual attached gingiva was found at the crest of these sites, so free gingival grafts were performed to restore the soft tissue architecture at the same appointment at which the abutments were placed. Keratinized tissue was taken from the palate and was placed in facially prepared sites, where mucosal flaps were apically positioned. Bis-acryl stents were placed free-hand using the newly placed abutments for retention of the stent (Figure 7). No sutures were placed to secure the gingival graft because degrading sutures may inhibit healing through the "wicking effect," creating local inflammation. The stents held the unattached gingival segments against the prepared beds, and healing occurred uneventfully.

The final prosthesis was tried in and the occlusion was refined for an anterior guidance scheme, protecting the implants from off-axial forces. Cementation was accomplished with a resin-modified glass ionomer (Fuji-Cem) (Figure 8).

Discussion

Edentulous atrophic mandibles can cause the mandibular canal to be dangerously close to a proposed implant osteotomy with the potential for surgical damage. The mandibular canal

should be preoperatively identified on a radiograph. Atrophic mandibular sites can be treated, but the position and location of this anatomic structure should be considered. The mandibular canal contains the inferior alveolar nerve, artery, and vein and can be located in relatively close proximity to the atrophic ridge crest in the atrophic posterior mandible. Avoiding this structure may prevent detrimental neural and arterial outcomes. If the mandibular canal is indeed entered, the first structure that may be encountered in the superior portion of the canal is the inferior alveolar vein.[6] The artery may be found to the lingual aspect of the canal space, so any bleeding is likely to occur in the vein or artery if canal penetration is not deep into the canal space. Because the nerve is usually found at the inferior aspect of the canal, it is likely not to have been damaged. Intraosseous bleeding will likely produce an accumulation of blood. The breakdown of blood into ferric free radicals from the porphyrin component may induce a temporary neuropathy or altered sensation.[7] The patient may experience partial or complete disruption of sensation of the distribution of the mental nerve. The implant surgeon should take preoperative steps to minimize the potential for damage to this anatomic structure through radiographic measurement and ridge mapping.[8]

Osseous contour and volume should be preoperatively determined. Computerized tomography (CT) is an excellent modality for finding the osseous volume and contour in the atrophic mandible, but this can be expensive for the economically compromised patient and may be impractical for single-implant sites. A bone sounding ridge mapping technique is simple and more cost-effective but is not as accurate as CT.[8] With the use of measurements from the ridge map and measurements from periapical radiographs, the underlying osseous contour can be determined and the mandibular canal located, allowing the surgeon to devise an appropriate treatment plan.

Awareness of implant sizes and types and of grafting procedures allows the implant dentist to create the most appropriate treatment plan, that is, the clinician chooses an implant system that fits the patient rather than surgically correcting the patient to fit the clinician's favorite implant system.

The osseous volume of some of these atrophic ridges can be surgically increased or developed by augmentation block grafting or ridge expansion or splitting. However, these procedures may be declined by the patient for fear or for economic reasons, or they just may be physiologically intolerable, so the clinician is left with few alternatives.

The mandibular lingual cortex is thicker than the facial cortex. Their close proximity after atrophy may provide facial and lingual osseous anchorage for interposed narrow diameter implants.[9] The facial and lingual cortices may even fuse into a thick deep band of bone.

These closely approximated cortices can provide the very important initial stability for a newly placed implant and, once integrated, resistance to occlusal forces. Narrow diameter implants of 1.8–3.3 mm may be used to support fixed or removable complete or partial dentures to avoid grafting and the mandibular canal. Even though these implants can be placed in very narrow ridges, they may require a site height of at least 12 mm to avoid the mandibular canal. Careful CT-guided surgery may allow placement of these mini implants to the facial or lingual aspect of the canal. Inadequate height may preclude the use of these types of implants.

At least 1 retrospective study has validated the use of short, 8 mm long, standard width implants in the posterior mandible.[10] Many sites require a shorter implant than 8 mm to avoid the mandibular canal without vertical bone augmentation. Another study placed implants in atrophic posterior mandibles at a tilted angle that engaged the lingual

cortex to avoid the mandibular canal.[11] No neuropathies were reported. These implants were then prosthetically loaded with fixed partial dentures. Of 196 implants, only 2 did not integrate. However, in this study, the implant apices were allowed to penetrate the lingual cortex, thus placing the submental artery in peril of instrument contact and potential laceration during the osteotomy. This creates the potential for life-threatening consequences.[12] The authors noted no failed implants, even when a lingual cortical perforation was seen.

Case #1 was treated with an opposing complete removable denture. Complete denture patients do not generate the magnitude of biting forces generated by dentate patients. Occlusal forces generated by patients are cyclical and variable in magnitude and frequency. The force maximum in dentate patients is approximately 1500 N. The force generated by patients with complete maxillary dentures is much less; thus the off-axial forces are typically less than those of dentate patients. Off-axial occlusal forces are less well tolerated by implant-supported fixed dentures, especially in less dense bone. When bone density and volume around the angular placed implant are adequate, occlusal forces will create osseous appositional conditions.[11,13]

The bone is the ultimate bearer of occlusal forces in tooth- and implant-supported prostheses. The short wide implants used in these cases were placed in residual dense cortical bone, which is very supportive for implants and resistant to associated occlusal forces. The increased surface area of these implants lessens the per square millimeter force on the supporting bone.

These implants were placed in an angled position to accommodate the atrophic osseous contour and to avoid the mandibular canal, precluding the need for bone augmentation procedures (Figure 5). Angled implants, when under occlusal load, may produce an appositional-type osseous microstrain on underlying bone in the area under the angulation.[11,14] The bone around the implant cervical bears most of the occlusal load during function. The bone under the angled implant also bears the occlusal load, but the load under the angled cervical of the implant generates force that produces an increase in bone density that is not detrimental as long as the bone is not thin or poorly calcified. If the bone is indeed thin, implant movement may occur with subsequent ingrowth of epithelium and failure of the implant. A wide diameter implant has an increased surface area and will produce less per square millimeter of force to the bone as compared with a narrower diameter implant. Thus, there is less likelihood of osseous overload and implant failure.

Maximum patient occlusal force may need to be measured to ascertain which implant system is most appropriate for any individual patient, especially when narrow diameter implants are considered. However, no quantitative relationship has been established between bite force and tolerance of implants to any magnitude of force. Narrow diameter implants can support fixed partial dentures but may fracture after an extreme number of cyclical loadings and may be best used in multiples to resist off-axial forces to prevent metal fatigue and fracture.[14]

In Case #1, the fixed partial denture was supported in the anterior by a narrow diameter implant. This implant supports the anterior section of the fixed partial denture and in the anterior area is subjected to less occlusal force; the fixed partial denture is also supported by the more posterior wide implant. Because lateral occlusal forces are a potential problem for narrow diameter implants, this implant depends on the wide implant to substantially resist lateral forces. The narrow diameter implant can well resist axially directed forces and can provide resistance to rotation of the prosthesis on the distal wide body abutment.

Because an extra layer of die separator is placed during the waxing phase of the metal substructure of the fixed partial denture to ensure a passive fit, the final prosthesis relies on the luting cement for adequate retention. Resin-modified glass ionomer and resin cements are the most retentive for these cases. The use of less retentive cement may result in loosening of one abutment and subsequent rotation of the prosthesis, causing the luted abutment/implant to rotate and lose osseous integration.

In dentate patients, an anterior guided occlusal scheme in implant-supported fixed partial dentures allows axially directed forces but dis-occludes the posterior prosthesis during working excursions. This minimizes laterally directed forces. With complete denture removable appliances, a balanced occlusal scheme encourages prosthetic stability. The off-axial forces generated in removable appliance patients are less than those noted with fixed prosthetics or dentate patients and may not create an overload.

Conclusion

In selected patients with an atrophic edentulous site, standard sized or narrow diameter implants may be used in tandem with very short, very wide dental implants placed at an angle to avoid the mandibular canal. These may be used to successfully avoid damage to the mandibular canal and to support fixed partial dentures in edentulous atrophic implant sites in the mandible.

Abbreviation

CT: computerized tomography

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