Small-Diameter Implant Placement: A Case Report

Managing the Thin Knife-Edged Mandibular Ridge With Bone Grafting

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INTRODUCTION

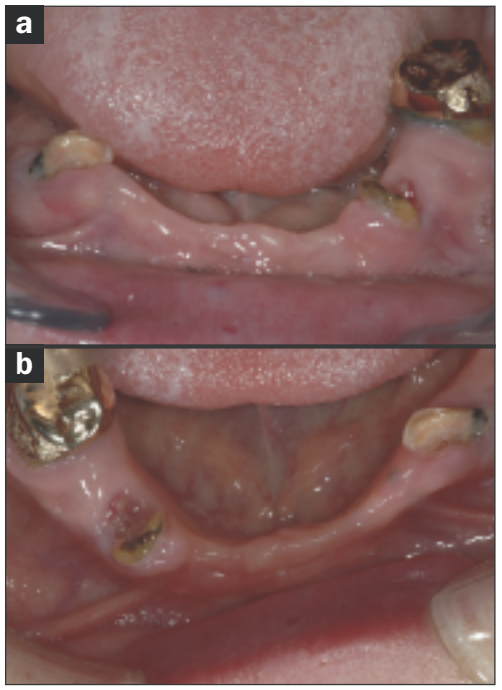
How often do patients arrive at your office so dissatisfied with their lower denture that they are carrying it in their purse or shirt pocket? Whether it is a full or partial denture, a poorly fitting mandibular prosthetic can generate a variety of quality-of-life concerns. Fear of the denture becoming loose or falling out may lead to avoidance of certain foods as well as insecurities about laughing, smiling, or even talking. These issues can lead to changes in diet, avoidance of social situations, and isolation among this patient population. Treatment plans that call for implant-supported prosthetics (ISP) can address the quality-of-life concerns that stem from a poorly fitting denture, while providing patients the self-confidence and security they are seeking.

Traditional implants can be a suitable choice for prosthetic retention; however, the use of small-diameter implants (SDIs) has expanded the patient base that is eligible for implant-retained prosthetic treatment. Importantly, studies demonstrate that survival rates between SDIs and their standard-width counterparts are similar, and that SDIs can be a suitable choice for prosthetic retention.[1] In an ideal situation, patients who present with denture-related concerns will have existing anatomy to facilitate the successful SDI osseointegration that can lead to a well-supported prosthetic. However, fully or partially edentulous patients often do not demonstrate the bone width or quality that is needed.[2,3] Augmentation of existing bone is often necessary. In these cases, ridge augmentation via bone grafting can help generate additional high-quality bone structure.

Background

As documented in the dental literature, traditional implants generally require approximately 6 mm of mandibular bone facial-lingually for successful osseointegration as well as 10 mm of bone height in the coronal-apical direction.[2,3] Small-diameter implants can be placed in as little as 3 to 4 mm of facial-lingual bone width with one mm of surrounding bone, as well as 10 mm of bone height in the coronal-apical direction.[2,3] However, when a patient presents with a knife-edged mandibular ridge, as well as concurrent insufficient bone to support even SDIs, a well-structured treatment plan is needed that takes into account mandibular ridge alteration as well as bone augmentation. As demonstrated in the case report below, a combination of autologous harvested bone with allograft or xenograft bone granules can be used with a supporting resorbable membrane to supplement existing bone structure. Surgically flattening the knife-edged ridge creates a platform, providing sufficient bone width and surrounding bone structure to successfully maintain SDIs and their accompanying overdenture.

Figure 1. Preoperative photo.



Figures 2a and 2b. Patient presented with a knife-edged mandibular ridge.

The article to follow is the second in a series of 7 articles to appear in *Dentistry Today*; the first article, "Improving Existing Dentures With Mini Implants: Idealizing a Knife-Edged Mandibular Ridge," was published in the magazine's February 2013 issue. Future articles will address: (1) extraction of mandibular anterior teeth, modifying the interproximal bone, then immediate placement of SDIs in the interproximal bone followed by bone grafting/membrane placement, then fabrication of a lower denture; (2) placement of SDIs in a mandibular ridge with minimum vertical bone height; (3) SDI denture stabilization in the maxillary arch; (4) technique for relining dentures that contain implant housings; and (5) SDI utilization for removable partial stabilization.

CASE REPORT

Diagnosis and Treatment Planning

A 65-year-old woman in excellent health with an unremarkable medical history presented to our office carrying her mandibular, 7-unit, anterior fixed partial denture (FPD) in her hand. She was mostly edentulous in the mandibular arch except for the abutment teeth that had retained the FPD as well as the remains of her left canine (Figure 1). Following a thorough clinical and radiographic examination, it was determined that the aforementioned teeth could not be saved. The patient, who coordinated prison ministries for a living with her husband, engaged frequently in public speaking and needed a prosthetic solution that prioritized function and stability. She was terrified of having a nonimplant-supported lower denture because of stories she had heard about lower denture instability; specifically, a friend of hers whose denture had fallen out of her mouth while she was laughing!

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Figure 3. Lower arch, following extraction of teeth and roots.

Figure 4. Periodontal flap reflected and mandibular alveolar ridge exposed.

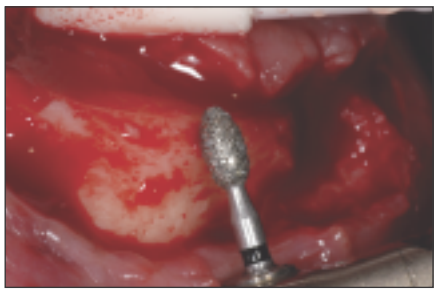


Figure 5. A coarse football diamond bur (No. 379-023 [Brasseler USA]) was used to flatten the knife-edged ridge.

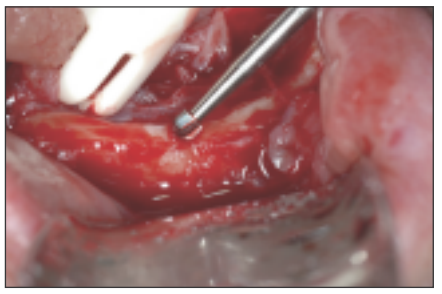


Figure 6. A No. 4 round bur was utilized to make small indentations in the cortical bone to create "stops" for the pilot drill.

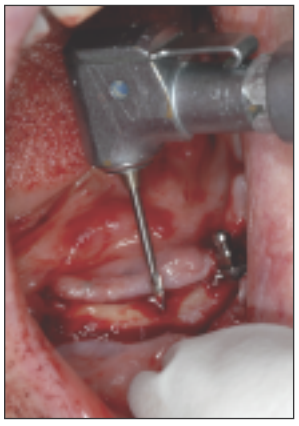
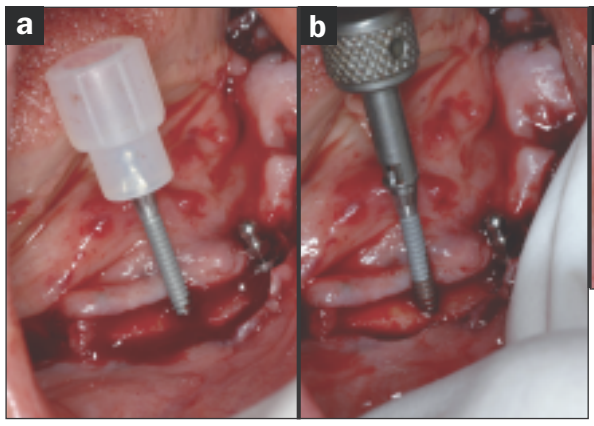
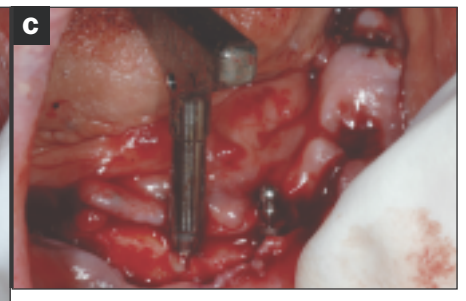


Figure 7. Pilot holes were drilled through the cortical plate.





Figures 8a to 8c. Small-diameter implants (SDIs) (MDI Mini Dental Implants [3M ESPE]) were inserted with the plastic lid of the implant **(a)**, followed by a finger driver **(b)**, and finally with a winged thumb wrench **(c)**.

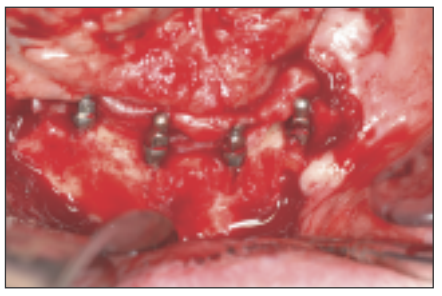


Figure 9. Four SDIs solidly in place but with inadequate facial-coronal bone for long-term stability.

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Finances were also a major concern. In addition to these concerns, the patient also presented the clinical challenge of a thin, knife-edged mandibular ridge (Figures 2a and 2b) with what was deemed to be insufficient bone to support an implant.

The recommendation to the patient was a solution that addressed both functionality as well as financial concerns: extraction of the remaining mandibular teeth and roots followed by fabrication and placement of an SDI-stabilized removable denture. Due to the thin facial-lingual condition of the mandibular bone, however, the patient was advised that bone grafting could be required in order to provide adequate long-term support for the SDIs and prosthetic. The patient, who was satisfied with the condition of her maxillary teeth and restorations, eagerly agreed and consented to the presented treatment plan for the mandibular arch.

Clinical Protocol

At the patient's next visit, the remaining lower teeth and roots were extracted (Figure 3). Using a 15 Bard-Parker blade, an incision was made from cuspid to cuspid to expose the mandibular ridge at the crest of the knife-edged bone. The incision was extended apically in the first bicuspid area (Figure 4). Avoiding the inferior alveolar nerve exiting the mental foramen, the alveolar bone was exposed by reflecting a full thickness gingival flap apically along the complete anterior arch. The knife-edged ridge was flattened with a coarse football diamond bur (No. 379-023 [Brasseler USA]) (Figure 5) and rongiers. This bony ridge adjustment created a flat platform for SDI placement. The football diamond can be used safely with either high- or low-speed handpieces. High water volume and very light pressure should be applied if a high-speed device is used.

The SDIs do not have to align exactly with each other upon placement, as their housings are designed to allow up to 30° of alignment variation. A surgical guide is not necessary, but if the clinician is uncomfortable visualizing implant alignment, a vacuum-formed shim with surgical pilot drill guide holes may be used to guide SDI placement. It is sometimes difficult to utilize a surgical guide following gingival flap reflection and ridge modification. The reflected flap makes it difficult to seat the surgical guide, and the bony ridge morphology has been changed following ridge modification.

As supported in the dental literature, four 1.8 x 13 mm SDIs were placed (MDI Mini Dental Implants [3M ESPE]) in the flattened ridge to support the patient's denture, staying anterior to the identified mental foramen and leaving at least 7 mm of separation between implants to accommodate housings.[2-5] Prior to insertion, small indentations were made in the cortical bone at the implant sites with a No. 4 round bur (Figure 6). These indentations serve as "stops" to prevent the pilot drill from sliding. Pilot holes were then drilled through the cortical plate approximately one quarter the length of the threaded implants (Figure 7). On a slow-speed contra angle handpiece connected to an electric motor (AEU 7000 [Aseptico], 0.9% sterile NaCl IV bag [Baxter]), the pilot drill was moved up and down at slow-to-moderate speed with high water flow to avoid burning the bone.

Each of the 4 SDIs was screwed in sequentially before proceeding to the next one. They were inserted first with the plastic lid of the implant, followed by a finger driver, and finally with a winged thumb wrench (Figures 8a to 8c). Figure 9 shows the 4 SDIs solidly in place but with inadequate facial-coronal bone for long-term stability. If the SDI can be placed completely with the finger driver, it likely will not osseointegrate and will be lost. In cases where only the finger driver is needed to completely insert the SDI, the best course of action is to remove the implant and choose an alternate site. Implant success rates are very high when the winged thumb wrench or torque wrench is required to securely screw the SDI into place. Sometimes there is insufficient vertical space for the winged thumb wrench, and the torque wrench, which requires less space, may be used to very slowly screw the SDI to place. Once placed, an SDI should "ting" and not "thud" when tapped with the handle end of a mouth mirror.

The laboratory technician uses the housings on the stone model to verify spacing and fit.

As was determined during the initial clinical examination, bone augmentation would be necessary in the facial-coronal region of the lower alveolar ridge. This augmentation would facilitate successful SDI osseointegration and support for the mandibular prosthesis. A recent literature review by Clementini et al[6] of 8 studies during the last 17 years demonstrates comparable success rates of implants placed in regenerated bone versus pristine bone. Also, a study by van der Meij et al[7] indicates that an ISP will predictably succeed in mandibular bone that has underdone augmentation procedures. For this patient, augmenta-

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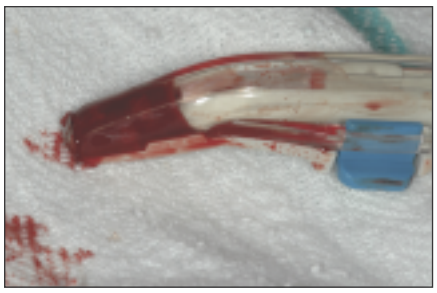
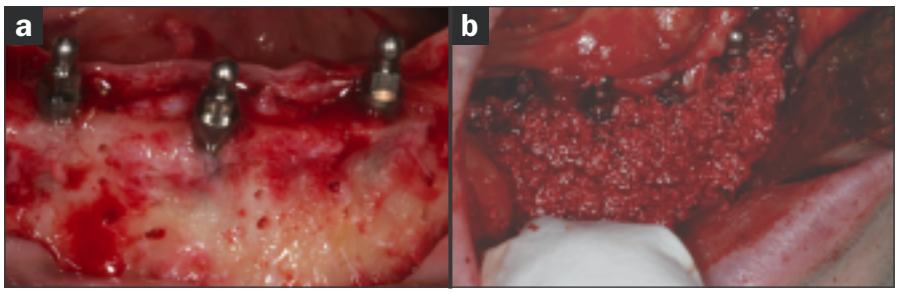


Figure 10. Bone and blood harvested with a (sterile disposable) curved cortical bone collector (Safescraper Twist [Osteogenics Biomedical]).



Figures 11a and 11b. Cortical plate perforations followed by a mixture of autologous and xenograft bone graduals.

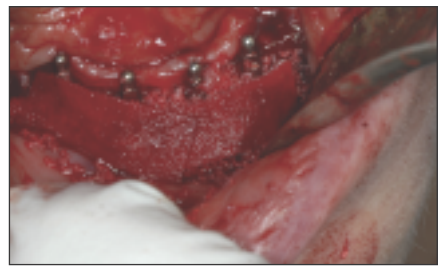
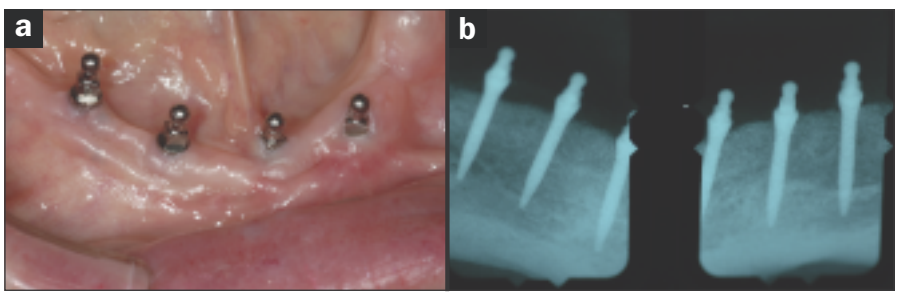


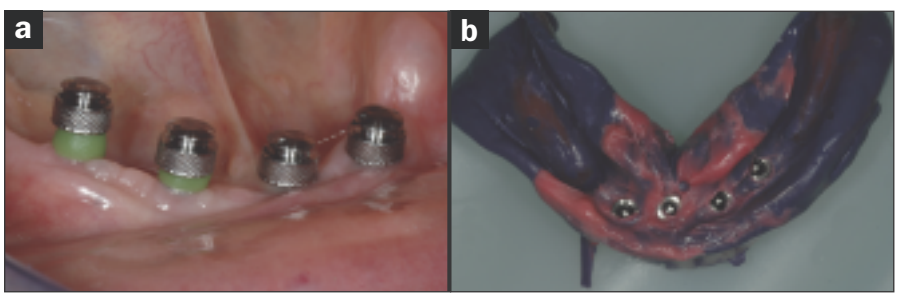
Figure 12. Resorbable membrane (BioCellect [IMTEC, a 3M Company]) in place to cover the bone graft.

Figure 13. Gingival tissue sutured passively back into place.



Figures 14a and 14b. Clinical **(a)** and radiographic **(b)** examination revealed healthy tissue and bone structure as well as implant osseointegration at the 4-month follow-up visit.

...this step ensures there is adequate space in the denture base to accommodate the housings when they are seated on the SDIs....



Figures 15a and 15b. Micrometal housings with spacers were placed on the SDIs **(a)** and pulled with polyether impression material that had been placed in the custom tray **(b)**.

Figure 16. Final mandibular denture.

Figure 17. Denture with housings and o-rings.

Figure 18. The patient was pleased with the final outcome.

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tion was best accomplished utilizing a combination of autogenous bone harvested from the patient's chin and freeze-dried xenograft bone granules.

Using a sterile, disposable curved cortical bone collector (Safescraper Twist [Osteogenics Biomedical]), cancellous bone was carefully harvested from the chin. The collected shavings produced are collected with coagulated blood, and together they demonstrate the low density and porosity needed for angiogenesis and integration with existing bone (Figure 10).[8] The collected autologous bone and blood was supplemented with sterile xenograft bone granules (Bio-Oss [Geistlich Biomaterials]), a material derived from the mineral portion of bovine bone.[9,10] After making multiple facial surface cortical plate perforations with a No. 1 round bur to establish bleeding points into the trabecular bone, the bone graft mixture was applied to the mandibular alveolar ridge (Figures 11a and 11b). A resorbable membrane (BioCellect [IMTEC, a 3M Company]) covered the graft (Figure 12). It is important that the resorbable membrane have no memory so it adheres to the shape of the bone graft. If the membrane is stiff, suturing the reflected flap over the membrane will be difficult.

The gingival tissue was sutured passively back into place to cover and protect the bone graft and membrane (Figure 13). It is important the gingival flap be deeply reflected apically to facilitate passive suturing. Either 3-0 chromic gut (Angiotech) or 5-0 polypropylene suture (Prolene [Ethicon 360]) can be used. Prolene is not dissolvable and must be removed one to 2 weeks postplacement. If prolene is left in place much over one week the tissue will grow over the suture, making it difficult to remove, even requiring local anesthesia. Chromic gut suture dissolves in 1.5 to 2 weeks, versus plain gut which dissolves in 4 to 7 days.

Throughout the following 4 months, the patient returned for brief follow-up visits to check the condition of the graft, implants, and surrounding soft tissues. A chlorhexidine gluconate antimicrobial oral rinse (PerioGard [Colgate-Palmolive]) was prescribed for patient use between visits to help keep the implants and tissue plaque free. Bone regeneration, osseointegration, and soft-tissue healing continued without incident. At the patient's 4-month visit, radiographic and clinical examination revealed healthy tissue and bone structure, as well as implants that had fully integrated with the regenerated bone (Figures 14a and 14b). When the integrated SDIs were tapped with a mouth mirror handle the sound was "ting" and not "thud." A custom acrylic tray was fabricated for a final impression of the patient's lower arch. Micrometal housings with spacers were placed on the SDIs and pulled in the custom tray with polyether impression material (Impregum Penta Soft [3M ESPE] (Figures 15a and 15b). An arbitrary face-bow record and centric relation occlusal registration record at the estimated vertical dimension were taken for the lab.

Finalizing Denture Placement and Alignment

The laboratory technician uses the housings on the stone model to verify spacing and fit. Specifically, this step ensures there is adequate space in the denture base to accommodate the housings when they are seated on the SDIs and pulled in the mouth with hard acrylic pick-up material at the final denture delivery appointment. The laboratory sends the housings back to the dentist once final laboratory processing of the denture has taken place.

It is indeed more trouble to "pull" the housings in the mouth at the final

denture delivery appointment versus processing the housings into the denture base in the laboratory prior to delivery. The concern is that if the housings are not pulled at the final appointment and the denture is not relined in the mouth, one cannot be certain all the housings/o-rings are completely seated on the SDIs or that the denture is in intimate contact with and supported by the mandibular ridge. It is essential for the denture base to be in intimate contact with the mandibular ridge rather than vertically supported by the SDIs, which could lead to fracturing of the prosthetic. The SDIs are intended to prevent horizontal and coronal movement of the prosthetic, not support apical load. If the denture "pivots" on an implant/housing and is not apically supported by the mandibular/maxillary ridge, then the denture may fracture across the implant.

Following a "teeth in wax" appointment to verify teeth placement, the final mandibular denture with housings and o-rings is pictured in Figures 16 and 17. *Note: The patient in this case declined treatment for her maxillary arch, and issues associated with natural teeth opposing a denture, especially with implants, will be discussed in a forthcoming article.*

DISCUSSION

Small-diameter implants were chosen for this case because of the limited presenting horizontal bone, ease of SDI placement, and cost concerns. Prior experience as well as an examination of the dental literature assured us the SDIs would adequately support the patient's prosthetic. As part of our bone augmentation procedure, we supplemented the patient's harvested bone with xenograft granules due to their demonstrated biocompatibility and long-term success in dental procedures that require augmentation.[9,10]

As with all dental procedures, it is important to present to patients a full treatment plan and obtain informed written consent prior to the start of therapy. Due to the longer-term nature of dental therapies such as the aforementioned that involve implant osseointegration, bone augmentation, and tissue healing, patients should demonstrate the ability to physically and psychologically tolerate in-office procedures and follow-up treatment, as well as suggested at-home regimens to support a successful outcome.

CLOSING COMMENTS

For patients presenting with a fully edentulous lower arch, an SDI-retained removable denture can be a secure and functional prosthetic solution. Knife-edged ridges pose an additional clinical challenge, but can be easily altered, creating a flat "platform" appropriate for SDI placement using the technique presented in this article. When an edentulous patient presents with a knife-edged ridge as well as insufficient bone to support an SDI, bone augmentation procedures may be necessary and can be accomplished via autologous bone harvesting, use of a bone substitute, or a combination of both along with a resorbable membrane barrier.

Through use of the above procedures, the patient in this article was provided a solution that restored excellent functionality, addressed quality-of-life concerns, and restored the self-confidence to continue with a successful career centered on ministry and public speaking. She is very pleased with the final results (Figure 18) of her treatment. After 2 years, she remains confident and satisfied, saying that she is able to eat the foods she enjoys, never worries about talking or laughing, and never even thinks about her lower denture rising up or falling out of her mouth. The implants are still fully viable: radiographically bone appears to cover the implant threads completely, and they still "ting" versus "thud" when tapped by a metal mirror handle.✦

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