Splinted wide-short implants in the posterior region of an atrophic mandible opposed by an edentulous maxilla: immediate loading and 1-year follow-up

Fernanda Faot, DDS, MSc, PhD ■ Raissa Micaella Marcello-Machado, MSc, PhD ■ Caio Hermann, DDS, MSc, PhD
Flávia Noemy Gasparini Kiatake Fontão, DDS, MSc, PhD

The generally recommended treatment for patients with mandibular bone atrophy involves extensive bone reconstruction to enable the use of standard dental implants. In posterior areas with limited height and thickness, a combination of wide-short dental implants and long implants has also been recommended. This alternative treatment improves the biomechanical resistance to stress from occlusal forces during mastication and has achieved success rates comparable to those of standard implants. In most cases, this treatment option allows immediate loading, simplifying the oral rehabilitation and decreasing the morbidity rate. The purpose of this case report is to discuss clinical treatment of a patient with bilateral bone atrophy in the posterior regions of the mandible. Two wide-short implants splinted to 1 standard implant were used for rehabilitation on the right side. The mandibular left hemiarch had a greater amount of bone, and 3 standard implants were placed on the right side. One year after implant placement, the treatment outcomes were found to be similar on both sides. In this patient, the use of wide-short implants splinted to a standard implant improved mandibular occlusal stability in an area of reduced bone height.

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Treatment of partial and total edentulism with dental implants has achieved predictable success, resulting in high levels of patient satisfaction. When dental implants were introduced, the favorable prognosis and success were restricted to implants measuring 3.75 ×10.00 mm, which became known as *standard implants*.[1] Short implants (3.75 × 7.00 mm) were first used in 1979, either alone or in conjunction with standard implants. However, because of their low initial success rates, short implants were used only occasionally to treat partial edentulism, mainly in patients with atrophic maxillae.[1] However, technological advances in the 1990s resulted in a wide-short implant (5.00 × 7.00 mm) designed for areas with inadequate bone height.[2,3]

Short implants (7.00-8.50 mm) still are not recommended frequently because of the low initial success rates and poor predictability of short implants. The low success rates were attributed to biomechanical aspects, including poor bone quality, heavy occlusal forces, and excessive crown-implant ratios.[2,4-7] However, the development of surface treatments, the simplification of surgical techniques, and the availability of new implant designs prompted reevaluation of these previously reported cases.[8-10] The recent introduction of short and extrashort implants presents an appealing therapeutic alternative, particularly for atrophic posterior regions, where limited access and visibility, reduced space, and poor bone quality are present alongside the risks of damaging the inferior alveolar nerve or penetrating the maxillary sinus during implant placement.[11-14]

The latest studies and systematic reviews suggest that short implants have survival rates similar to those of standard implants.[15-17] A review of horizontal and vertical bone augmentation techniques concluded that short implants represent a better alternative to vertical bone grafting.[18] A recent randomized clinical trial of 5.00 × 5.00-mm dental implants with a nanostructured calcium-incorporated titanium surface reported that the wide-short implants achieved results similar to those of longer implants placed in augmented bone.[19]

This evidence has been corroborated by several biomechanical studies suggesting that maximum bone stress is independent of implant length.[20-22] Pierrisnard et al used a finite element method to assess implants ranging between 6 and 12 mm.[20] The results showed that tension is concentrated 2-3 mm from the coronal portion of the implant, which is the portion that transfers most of the load to the bone. In addition, the implant width is more important than additional length for optimizing loading stress distribution.[21]

Fig 1. Clinical overview of the mandibular arch prior to treatment.

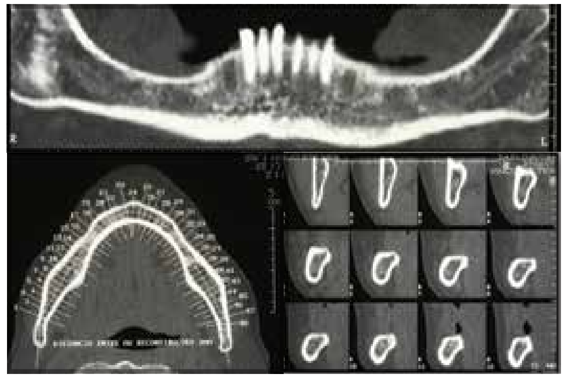

Fig 2. Tomographic visualization of the mandibular arch.

Fig 3. Abutments for multiple screwed implant-supported prostheses.

A finite element study by Sotto-Maior et al assessed the contributions of several prosthetic factors to stress concentrations in single posterior crowns supported by short implants.[22] They examined the influence of crown-implant ratio, restorative material, retention system, and occlusal loading and observed that traumatic occlusion was the main factor responsible for stress concentration. The crown-implant ratio was responsible for 11.45% of the stress in the cortical bone, and occlusal loading contributed 70.92% of the stress in the implant.[22] Finally, eliminating or minimizing the lateral force on the prosthesis and force distribution by splinting multiple implants may significantly reduce stress on implants, especially shorter ones.[23-26]

Although these in vitro or "in silico" (computer-simulated) biomechanical studies do not provide direct clinical evidence, they help to clarify the biomechanical forces involved under an established and accepted 3-dimensional mesh and thus help to predict what can happen in clinical practice. The aforementioned studies suggest that treatment with short implants is feasible, provided that the implants attain proper bone anchorage, which is based on the bone quality and achievement of primary stability.[3,27] Therefore, this clinical case report aims to show the viability of using wide-short implants in the posterior areas of atrophic mandibles and describes the simple surgical technique that is involved.

Case report

History and diagnosis

A 52-year-old patient with an edentulous maxilla and a partially edentulous mandibular arch presented for prosthodontic treatment at ILAPEO (Latin American Institute of Dental Research and Education) (Fig 1). She reported wearing a maxillary complete denture and a mandibular removable partial prosthesis for 25 years. During the anamnesis, the patient had complaints related to oral comfort and impaired mastication and expressed the desire to replace the removable partial prosthesis with fixed implant-supported prostheses. However, she did not want to undergo any bone augmentation procedures.

The patient was diagnosed with severe maxillary and mandibular bone resorption, resulting in limited space for the placement of dental implants (Fig 2). Nonetheless, the posterior region of the mandible presented satisfactory remaining bone in the buccolingual dimension, despite its low height. The latter condition is an indication for treatment with wide-platform implants. The patient was briefed about this treatment option, agreed to the terms, and was invited to sign an informed consent form.

Surgical and prosthetic treatment

During the prosthetic phase, the maxillomandibular relationship was established through wax occlusal rims to reestablish the plane of occlusion commonly used in removable prosthesis construction. The surgical planning for the mandibular arch indicated that 2 wide-short implants (WS Titamax Cortical, 5.00 × 5.00 mm, Neodent) should be placed in the right hemiarch and a long implant should be placed in the region anterior to the mental foramen (CM Titamax, 3.75 × 15.00 mm, Neodent). The mandibular left hemiarch had a greater vertical amount of bone than did the right side, and 3 standard implants (3.75 × 15.00 mm, 3.75 × 11.00 mm, and 4.00 × 9.00 mm) were chosen for the left side. In effect, this clinical case adopted a split-mouth design in the mandibular arch, with wide-short implants on the right side and standard implants on the left side.

The area intended for placement of the short implants had cortical bone tissue (types 1 and 2), and thus the surgical procedure required a low drilling speed (200-300 rpm) and abundant irrigation. Surgery for short implants must be performed with extreme care, because the implant length may limit repositioning. However, repositioning sometimes is necessary when primary stability is not achieved at the time of placement.

In the present clinical case, the implants were placed at the bone level. The wide-short implants were placed with the following drilling sequence: initial twist drill, drill 2.0; pilot 2/3; drill 3.0; pilot CM 3/3.75; drill 3.8; pilot CM 3.8/4.3; drill 4.3; and

Fig 4. Occlusal records taken in centric occlusion after placement of brass 1-step hybrid copings.

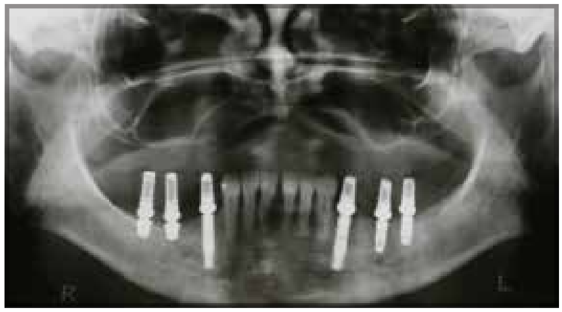

Fig 5. Panoramic radiograph after the placement of temporary implant-supported prostheses in the mandibular arch.

Fig 6. Placement of fixed metal-ceramic prostheses.

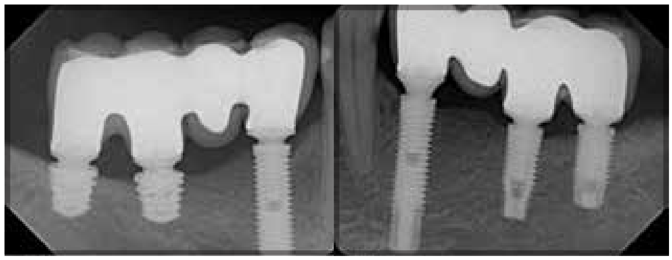

Fig 7. Radiographic examination 1 year after implant placement.

pilot 4.3/5.0 (Titamax drills, Neodent). The implant placement speed was 30 rpm. Immediate loading of the prostheses was possible because adequate primary stability was achieved, as indicated by a torque of 60 N/cm.

The standard Morse taper implants were installed 1.0 mm below the bone crest. The ideal height for the transmucosal level was determined to be 1.5 mm using the CM Prosthetic Selection kit (Neodent), and the prosthetic abutments (CM Mini conical abutment, Neodent) were subsequently connected (Fig 3). An open prosthetic mold and elastomeric material (Speedex, Coltene) were used to capture the mini conical abutment impression copings during impression taking. While the patient's dentition was in centric occlusion, an occlusal registration was obtained using a brass 1-step hybrid coping and an autopolymerizing pattern acrylic resin (GC Pattern Resin LS, GC America) (Fig 4). The temporary implant-supported prostheses in the mandibular arch were placed simultaneously with the maxillary complete denture, and a panoramic radiograph was taken (Fig 5).

Outcome and follow-up

The final multiple-implant–supported prostheses were placed 3 months after implant surgery (Fig 6). All the implants on each side of the mouth were splinted to facilitate the prosthetic design and establish favorable biomechanics. The marginal bone level and loss were examined via periapical radiographs taken immediately and 6 months after placement of the prostheses. Follow-up periapical radiographs were taken 1 year after placement (Fig 7).

Discussion

The posterior areas of the dental arches are usually considered less favorable for dental implants because they generally present limited bone height and worse bone quality and are exposed to greater occlusal loads than are the anterior regions of the mouth.[28,29] Moreover, patients with partial edentulism in the posterior region of the mandible tend to face more discomfort because of its proximity to the inferior alveolar nerve and surgical risks such as temporary paresthesia.[2,30]

The use of short implants (less than 10.00 mm long) was intensively debated and criticized throughout the last decade because of the large number of failures reported.[31] However, some studies analyzing long-term behavior of short implants have shown encouraging results. In particular, the retrospective clinical analysis of implants with various dimensions by Renouard & Nisand has encouraged other authors to advocate the use of short implants (6.00, 7.00, and 8.50 mm), as these can achieve greater long-term success rates than standard length implants in some cases.[32] High clinical success rates of 80%-100% have been reported in prospective, retrospective, and case report follow-up studies of short implants placed in atrophic posterior mandibles.[4,6,15-17,33] Furthermore, no differences in outcomes have been observed between short implants and other modalities of prosthetic rehabilitation for severely resorbed mandibles.[15,16,33] These studies indicate that short implants can adequately support most prosthetic restorations and encourage reevaluation of the results obtained by previous studies.

In addition, results from a prospective multicenter study by Slotte et al, who placed 4-mm-long titanium implants with SLActive surfaces (Straumann), showed a 92.2% implant survival rate and a mean marginal bone loss (MBL) of 0.53 mm at the 5-year follow-up.[13] This favorable result was attributed to the surgical and prosthetic handling and to favorable biologic and biomechanical factors. After long-term (10- to 12-year) retrospective evaluation of short implants placed in posterior areas, Anitua el al reported high success rates of 98.9% and

98.2% for implant- and patient-based analyses, respectively.[10] No relationship was observed between the studied variables and the MBL. The single implant failure in that study was attributed mainly to a case of peri-implantitis, which probably resulted from the patient's very thin gingival biotype, poor hygiene, and excessive accumulation of plaque.[10] No association was found between any of the investigated prosthetic-, implant-, or patient-dependent variables and MBL.

It has been suggested that wide-diameter implants increase the tolerance to occlusal forces in bone sites of poor quality and less quantity, preventing initial instability and achieving a more favorable stress balance around the bone.[8] It has been reported that wide-diameter implants achieve good results, especially those placed in the posterior region of the mandible.[5] Theoretically, wide-diameter implants can achieve superior stability relative to their diameter when anchored in cortical bone, because this enables anchorage into either the lingual or buccal cortical bone.[34] The reduced height is partially compensated for by an increase in implant diameter, producing a larger superficial contact area between the bone and titanium. According to Langer et al, the latter translates into a lower rate of loss for short implants, mainly in posterior atrophic mandibles.[2]

The downside of the wide implants is that a larger volume of bone is replaced by titanium, which can result in a large bone volume decrease around the implant. In addition, the bone microarchitecture found in the posterior region of the mandible usually consists of dense cortical bone with low vascularization and low metabolic capability, suggesting a reduced risk of initial stability loss during bone remodeling.[17] However, this larger surface area can also be considered a disadvantage, as such systems have a lower resistance to occlusal forces. Finally, there is a limited availability of short implant designs with wider diameter.

The clinical failure of these implants is attributed to many causes, but the most frequently described cause is the type 1 bone found in atrophic mandibles. This type of bone predisposes overheating of the area while the bone niche is being prepared, mainly for the placement of large diameter implants, resulting in early losses.[3,15,31] In addition, treatment planning using wide-short implants can be affected by several functional factors, such as the magnitude of occlusal forces during normal function and parafunction, and the locus of the force in relation to the implant axis and antagonist arch.[6,14]

Edentulous patients rehabilitated with complete dentures present bite forces that are approximately 75% lower than those of a dentate individual.[35] In addition, complete denture wearers exhibit decreased masticatory function.[35] The latter finding could be associated with the individual patient's degree of neuromuscular control and oral stereognosis, which influence chewing load transfer.[36] Masticatory efficiency and bite force in complete denture wearers may also be impaired due to the lack of mucosal support. During mastication, the supporting tissues are subject to compression, prosthesis displacement, and pain.[35-37] Melo et al observed extremely low bite forces of 4 kgf (39.22 N) in edentulous patients wearing complete dentures, irrespective of their facial pattern.[37] After rehabilitation with mandibular fixed implant–supported prostheses, the bite force roughly doubled to 9.4 kgf (92.18 N), which is still biomechanically insufficient to damage the masticatory system or the implants.

Due to these anatomical and biomechanical factors, the success of rehabilitation in this case report is also directly related to the rehabilitation of the opposing maxilla as well as the decision to splint the wide-short implants to a standard implant to increase the predictability of immediate loading. A recent systematic review by Anitua et al analyzed the clinical effectiveness of 2 extrashort implants (6.50 mm long) to support fixed prostheses in the premolar-molar region and found that the immediate loading of these extrashort implants did not jeopardize their survival.[38] In addition, prostheses supported by 2 implants had the same clinical effectiveness whether the extrashort implant was splinted to another extrashort implant or a longer implant. However, the meta-analysis showed that the distal bone loss around the splinted implants was significantly greater in the short-long splinted group.[38] Mean bone loss was 0.37 (SD 0.55) mm in the short-short splinted group and 0.94 (SD 0.66) mm in the short-long splinted group.

Furthermore, although prosthetic aspects such as the crown-implant ratio and the size and morphology of the prosthetic crown do not seem to be a major risk factor, they must be carefully monitored and controlled.[6] Prosthetic rehabilitations that use short implants often lead to imbalances between the lengths of the crowns and the implants. Disproportionate prosthetic restorations could induce poor biomechanical behavior, potentially having an impact on MBL and reducing the implant survival rate.[39] The retrospective study by Anitua et al found no associations between the crown-implant ratio of implant-supported prostheses on short implants in posterior regions and MBL at any observation time.[12] The effect of implant diameter on stress distribution in bone is more significant than the effect of the implant's length or geometry. In addition, the use of cantilevers in their study was related to increased MBL during the first year after loading.

Other relevant parameters that should be evaluated include the width of the occlusal table, mesial and distal cantilevers, occlusal patterns, the mesiodistal length of the edentulous area, the combination of short implants with longer implants for better biomechanical resistance to stress and strain, the existing maxillomandibular relationship, and bruxism.[6,8] Bone quality appears to be a more critical factor for determining implant survival than bone quantity.[4]

Short implants have a number of advantages. They reduce the need for expensive imaging procedures, such as tomography and prototyping, to accurately determine the height and thickness of the available bone.[4] They eliminate the need for complex surgical procedures such as sinus lifting, bone grafting, osteogenic distraction, and transposition of the mandibular nerve. They can be placed in restricted prosthetic spaces. They can circumvent the use of cantilevers in posterior regions.[6] Finally, eliminating the need for advanced surgical procedures can enable dentists to provide restorations for patients who present a more challenging prognosis, such as individuals who exhibit bruxism, a smoking habit, or a serious medical condition.[5]

Conclusion

This case report showcases the use of wide-short implants in the posterior area of an atrophic mandible, demonstrating their applicability and the simple surgical technique involved. In this patient, a split-mouth approach to rehabilitating the mandibular arch, with splinted wide-short implants in the right posterior region and standard implants in the left, resulted in similar success. Wide-short implants have a great potential to rehabilitate areas that have bone of poor quality and insufficient quantity, because the geometry associated with splinting the short implant to a longer standard implant increases the tolerance to occlusal forces. It is necessary to perform a treatment planning of each individual case in order to choose the appropriate dimensions of implants and select the right abutments. In these cases, splinting of the implants in this region is still necessary to guarantee the biomechanical security. Finally, longitudinal radiographic follow-ups are essential to successfully monitor short implants.

Author information

Dr Faot is an associate professor, Federal University of Pelotas (UFPEL), School of Dentistry, Pelotas, Brazil. Dr Marcello-Machado is a postdoctoral fellow, Department of Prosthodontics and Periodontology, Piracicaba Dental School, University of Campinas, Piracicaba, Brazil. Drs Hermann and Fontão are professors, Latin American Institute of Research and Education in Dentistry (ILAPEO), Curitiba, Brazil.

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The authors report no conflicts of interest pertaining to any of the products or companies discussed in this article.

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