A Wide-Body Implant as an Alternative for Sinus Lift or Bone Grafting

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Purpose: The aim was to evaluate the outcome of a short wide-body implant in the atrophic posterior jaw without a grafting procedure.

Materials and Methods: Patients treated with a tapered wide-body implant measuring 8 to 9 mm in width and 7 to 9 mm in length (Max implant; Southern Implants, Irene, South Africa) were recalled to scrutinize implant survival. Preoperative cone beam computed tomography images were analyzed to measure bone height in reference to the mandibular canal and sinus floor.

Results: There were 57 implants inserted in 18 men and 24 women after a 2-stage procedure and delayed loading. The mean follow-up was 15 months (SD, 10; range, 1-32 months), with 63.2% of the implants having at least 1 year of follow-up and 26.3% having at least 2 years' follow-up. Forty-six implants were inserted in the posterior maxilla and eleven in the mandible. Fifteen were placed in an extraction socket and forty-two in healed bone. Thirteen implants were supporting a single crown. Two implants failed, resulting in a survival rate of 96.5%, with rates of 90.9% and 97.8% for mandible and maxilla, respectively. This was not affected by gender, jaw, immediate or delayed placement, implant diameter and length, or the use of a bone substitute. The mean preoperative bone height was 7.21 mm in maxilla and 8.76 mm in mandible. In 41 cases implant length surpassed available bone height.

Conclusions: Despite the compromised bone condition and height, the survival rate of 96.5% is comparable to normal implants and, therefore, placing a wide-body implant may be an alternative to avoid grafting procedures. This is probably related to the enlarged implant surface area and the good primary stability.

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Good short- and long-term results have been reported with dental implants.[1-3] However, the posterior maxilla and mandible were considered to be "risk" zones because of the higher occlusal forces, the inferior bone quality, and the often-limited amount of bone.[4,5] In addition, the positioning of the maxillary sinus and the mandibular nerve often limits the available bone height for implant placement.

The first generation of implants—turned titanium implants—were dependent on their length to achieve enhanced stability and sufficient bone-to-implant contact. This was not always possible, especially in the posterior jaw, and thus short implants were related to an increased failure rate. The wide-diameter implant was introduced to increase the available contact surface for osseointegration and enhanced primary stability.[6-8] Unfortunately, the first results were disappointing, with failure rates of 9% to 24% being reported within 5 years.[9-12] Later studies, using an improved implant design with modified implant sur-

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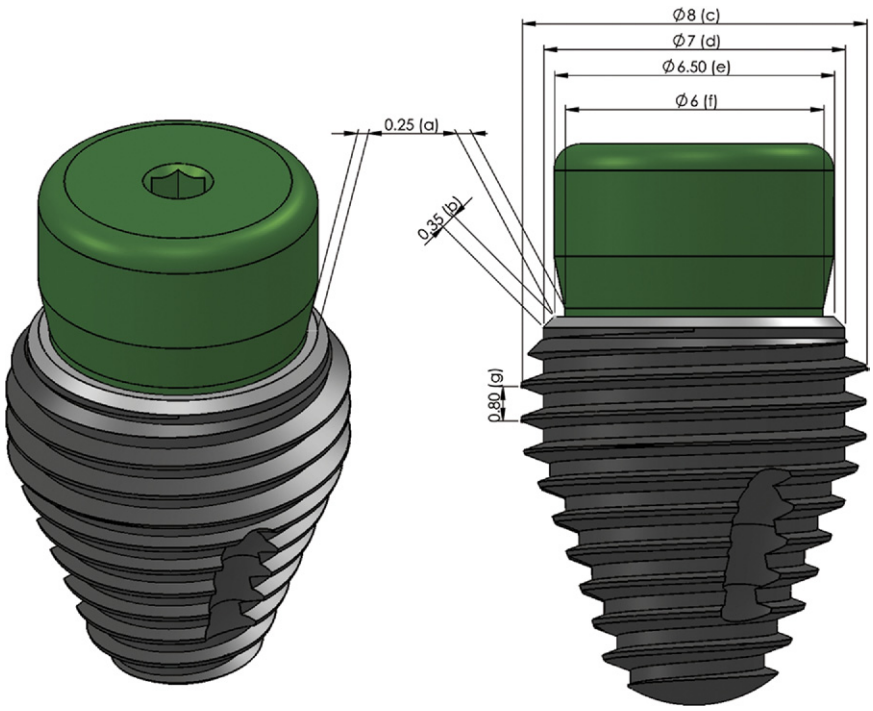

FIGURE 1. Image of Max implant.

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face and adapted drilling protocol, reported fewer than 5% failures after 5 years.[13-16]

Short implants are defined as being 10 mm or shorter.[17-19] Their advantage lies in the fact that they can be inserted in limited bone height, thereby avoiding sinus lifting, nerve repositioning, or onlay grafts. This decreases morbidity and complications linked with these extra surgical procedures, reduces the total treatment time, lowers costs, and improves patient satisfaction.[19] However, the initial results when short implants were used were rather disappointing, with failure rates of 17% to 25%.[20-23] This was explained by the lower bone quality of the posterior area.[24] The introduction of the moderately rough implants increased these survival rates from 95.1% to 100%.[14,18,25]

The implant used for this study was the Max implant (Southern Implants, Irene, South Africa), a wide-diameter implant intended for the posterior jaw. Good results have been reported for this implant under various conditions.[26] The aim of this study was to evaluate the outcome of short wide-diameter implants in the posterior area as an alternative for bone grafting or sinus lifting.

Materials and Methods

IMPLANT DESIGN

The commercially available Max implants measure 7, 8, 9, or 10 mm in width and 7 to 13 mm in length, with a 0.8-mm thread pitch (Fig 1). They have an external hex and a moderately rough surface created by sandblasting and chemical conditioning with solvents of a grade 4 commercially pure titanium, with a surface area roughness (Sa) of 1.34 μm.[27,28] Because of the wide diameter, there is a platform shifting of 0.25 mm on the horizontal plane and a further 0.35 mm when the 45° bevel is included.

DATA COLLECTION AND PATIENT SELECTION

All patients were consecutively treated in the past with at least 1 short Max implant (7-9 mm) by 1 maxillofacial surgeon (A.T.). Patients were encouraged to participate in the study and asked to undergo a clinical examination by an independent multidisciplinary team of researchers at the University of Ghent, Belgium. All patients were personally contacted to be invited to undergo a clinical examination. Thus patients were included depending on their availability at the time of the clinical examination by the visiting research team. This study was approved by the Ethical Comité of the University Hospital Ghent, Belgium, and was in accordance with the CONSORT (Consolidated Standards of Reporting Trials) statement on clinical research design and the Declaration of Helsinki on medical protocols and ethics.

Implant data were collected from patient files and clinical examination. Parameters were time of placement, time of loading, 1- or 2-stage surgery, additional use of a grafting material, implant position and dimen-

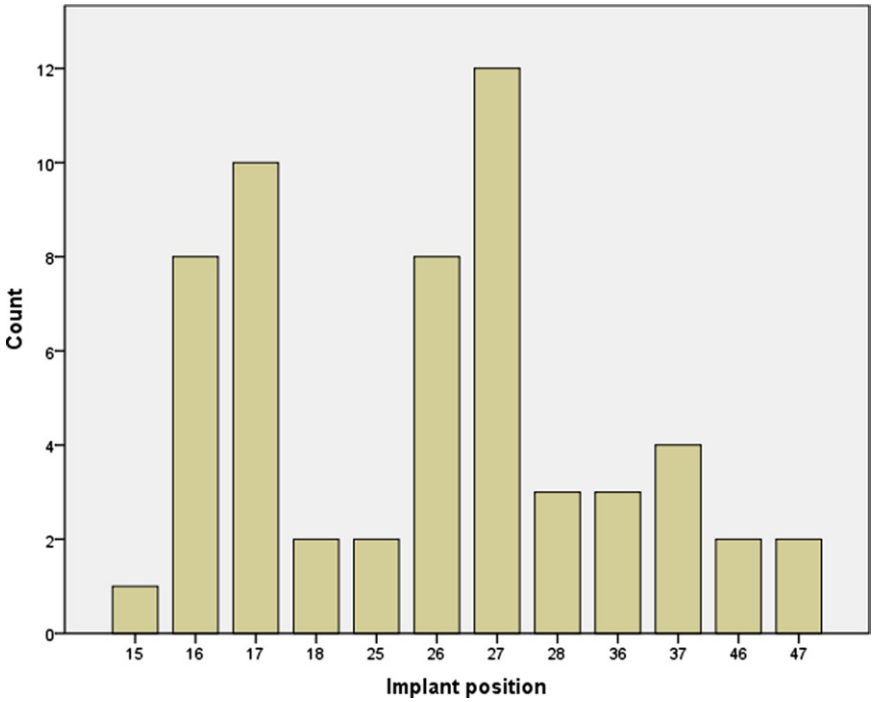

FIGURE 2. Overview of implant positions.

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sions, type of prosthetic reconstruction, and gender. Delayed placement was defined as implant placement at least 6 months after tooth extraction. Preoperative cone beam computed tomography scans (I-Cat; Imaging Sciences, Hatfield, PA) were analyzed, and the available bone height was measured. In the maxilla, the distance from the bone crest to the sinus floor was measured, and in the mandible, the distance from the crest to the mandibular nerve was measured.

Statistical analyses were done by use of PASW, version 18 (IBM Corp, Somers, NY). The Fisher exact test was used to compare implant survival between groups. The level of significance was set at $P = .05$.

Results

Up to the time of examination, 94 implants corresponding to the selection criteria had been placed in 84 patients. In total, 3 implants had failed, resulting in an overall survival rate of 96.8%.

In total, 42 patients (18 men and 24 women), representing 57 implants, presented for detailed clinical examination. The mean age was 59 years (SD, 13; range, 28-84 years). The mean follow-up time was 15 months (SD, 10; range, 1-32 months), with 63.2% of the implants having at least 1 year of follow-up and 26.3% having at least 2 years' follow-up. Forty-six implants were inserted in the posterior maxilla and eleven in the mandible (Fig 2). Fifteen were immediate placements in an extraction socket and forty-two in healed bone. All implants were placed with a 2-stage procedure and delayed loaded after 3 to 6 months. Implant dimensions are shown in Table 1. A bone substitute was used around 13 implants (22.8%), of which 3 were extraction cases. Of the implants, 13 (22.8%) were supporting a single crown; 35 (61.4%), a fixed partial prosthesis; 7 (12.3%), a fixed full prosthesis; and 2 (3.5%), a full removable prosthesis.

Of 57 implants, 2 failed, resulting in an overall survival rate of 96.5%, with rates of 90.9% and 97.8% for mandible and maxilla, respectively. The survival rate was not affected by gender ($P = .499$), jaw ($P = .352$), immediate or healed bone ($P > .999$), implant diameter ($P > .999$), implant length ($P = .119$), the use of a bone substitute (Cerasorb; Curasan AG, Kleinostheim, Germany) ($P > .999$), or the type of

Table 1. IMPLANT DISTRIBUTION ACCORDING TO IMPLANT LENGTH AND DIAMETER

	Implant Diameter		
	8.0 mm	9.0 mm	Total
Implant length			
7.0 mm	19	1	20
9.0 mm	30	7	37
Total	49	8	57

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Table 2. DIFFERENT VARIABLES WITH CORRESPONDING IMPLANT NUMBER, IMPLANT SURVIVAL, AND *P* VALUE

	No. of Implants	Survival	*P* Value
Gender			
Male	25	100%	.499
Female	32	93.8%	
Jaw			
Maxilla	46	97.8%	.352
Mandible	11	90.9%	
Implant length			
7 mm	20	90.0%	.119
9 mm	37	100%	
Implant diameter			
8 mm	49	95.9%	>.999
9 mm	8	100%	
Time of placement			
Immediate	15	100%	>.999
Delayed	42	95.2%	
Bone substitute			
Yes	13	100%	>.999
No	44	95.5%	
Type of prosthetic reconstruction			
Single crown	13	92.3%	.220
Fixed partial prosthesis	35	100%	
Fixed full prosthesis	7	85.7%	
Full removable prosthesis	2	100%	

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prosthetic reconstruction (P = .220) (Table 2). In addition, there was no significant difference in failure rate between the splinted (2.3%) and non-splinted (7.7%) implants (P = .351).

In the maxilla, the mean preoperative bone height was 7.21 mm (SD, 1.78; range, 4.30-12.13 mm) for a mean implant length of 8.39 mm (SD, 0.93; range, 7.00-9.00 mm). In the mandible, 8.76 mm (SD, 1.98; range, 7.00-12.74 mm) of bone height was available for a mean implant length of 7.91 mm (SD, 1.04; range, 7.00-9.00 mm).

In 41 cases (71.9%), the implant length surpassed the available bone height. Of these, 39 were in the maxilla and 2 in the mandible. Thirteen implants had a length of 7 mm, whereas 28 had a length of 9 mm (Fig 3).

Discussion

This study is based on a cohort of 42 clinically examined patients out of a total group of 84 consecutively treated patients. This selection was not biased, but it relied on the availability of the patients during the time of visit with the external examiners. The study by Herrmann et al[29] indicates that with this approach, even a 50% dropout rate does not alter the outcome. Hence, the outcome of the cohort can be considered representative for the whole population. With a 96.5% survival rate, the outcome of the Max implant is comparable to other studies using a similar treatment protocol, reporting survival rates of 73.8% to 100%.[9,10,12,13,16,30-34] However, some of these include turned implants, which may be responsible for some of the lower results. Although only a limited number of 15 implants were followed up for over 2 years, implant failure occurred only during the first months after surgery, suggesting a stable condition over time.

Although some authors reported better results in the maxilla compared with the mandible,[10,11,31,35] this was not observed in our study. The wide diameter of the implants allowed good primary stability when placed in molar extraction sites. In this study no difference was found between immediate and delayed placement, which confirms earlier reports in the literature.[36-42] Immediate placement can be a predictable procedure if primary stability is achieved.

Neither implant length nor diameter had any effect on implant survival. This confirms the conclusion of an extensive review that found no correlation between implant length or diameter and implant failure.[43] Although all implants were shorter than 10 mm, the 96.5% survival rate is still better than most other short-implant studies, reporting survival rates of 79.7% to 100%.[14,18,21-23,25,44-56] This is possibly because of the wide diameter, which increases the contact surface.

However, to be clinically relevant and honest, one should compare the outcome of short/wide implants with those implants placed in combination with sinus graft or nerve transposition. Implant survival rates in combination with sinus graft range between 84% and 100%.[57-75] Although some studies report results comparable to short implants, one should not forget the additional costs and time that sinus grafting entails.

In this study the available bone height was very limited. Forty-one implants exceeded the available bone height in length, which means that these perforated the sinus floor or were positioned above the crest. As shown in Table 3, the contact surface is still large when the implant is placed 2 mm above the crest or 3 mm above the sinus floor. The Max implant largely surpasses the contact surface of standard implants. A standard-diameter implant (Ø3.75 mm) with a length of 7 or 13 mm has a maximal contact surface of 95.3 or 193.1 mm^2. Gabbert et al[76] reported no difference when implants were placed in normal bone or when implants were placed in limited bone height, without

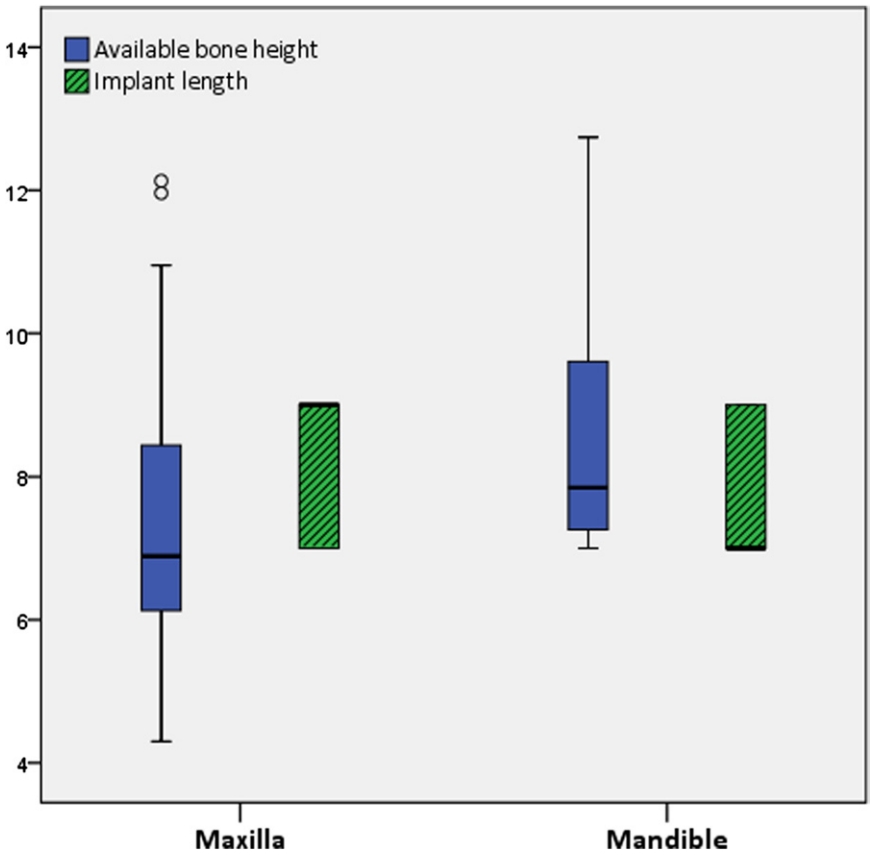

FIGURE 3. Box plot representing preoperative available bone height and actual implant length for maxilla and mandible.
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the use of a graft material. In 30% of the cases, additional bone formation was observed by lifting the membrane alone without the use of a bone substitute. Although it was not the aim of the study to perform cone beam evaluations for reasons of radiation protection rules, some images were available. On those images, bone formation around the apex of the implant when the membrane was lifted was likely to have occurred (Fig 4). The interpretation of these cone beam images remains questionable, however, and further long-term research seems mandatory to support this conclusion.

Table 3. AVAILABLE CONTACT SURFACE FOR OSSEOINTEGRATION WHEN IMPLANT IS FULLY IN BONE, 2 MM ABOVE CREST, OR 3 MM INTO SINUS

	Area in Bone (mm^2)		
Implant	Fully in Bone	2 mm Supra-Crestal	3 mm Apically Lifting Sinus Floor
Max-8-7	224.4	151.5	150.0
Max-8-9	282.5	208.4	218.4
Max-9-7	258.4	172.3	174.4
Max-9-9	326.7	313.1	249.4

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The results of the cross-sectional study showed that implants were often inserted in bone with limited width. Often, the available crest was smaller than the used implant diameter. Consequently, the implant was not always completely surrounded by bone, and some threads were exposed in a supra-crestally manner. Whether this affects the peri-implant health in the long-term remains to be investigated. In the meantime, it seems advisable to introduce a 7-mm-diameter implant of the same design to overcome the vast majority of these cases and to facilitate inclusion of patients.

Despite the compromised bone condition and height, the survival rate of 96.5% is comparable to normal implants and, therefore, placing a wide-body implant may be an alternative to avoid grafting procedures. This is probably related to the enlarged implant surface area, the good primary stability, the moderately rough surface, and the bicortical anchorage obtained in the maxilla because of lifting of

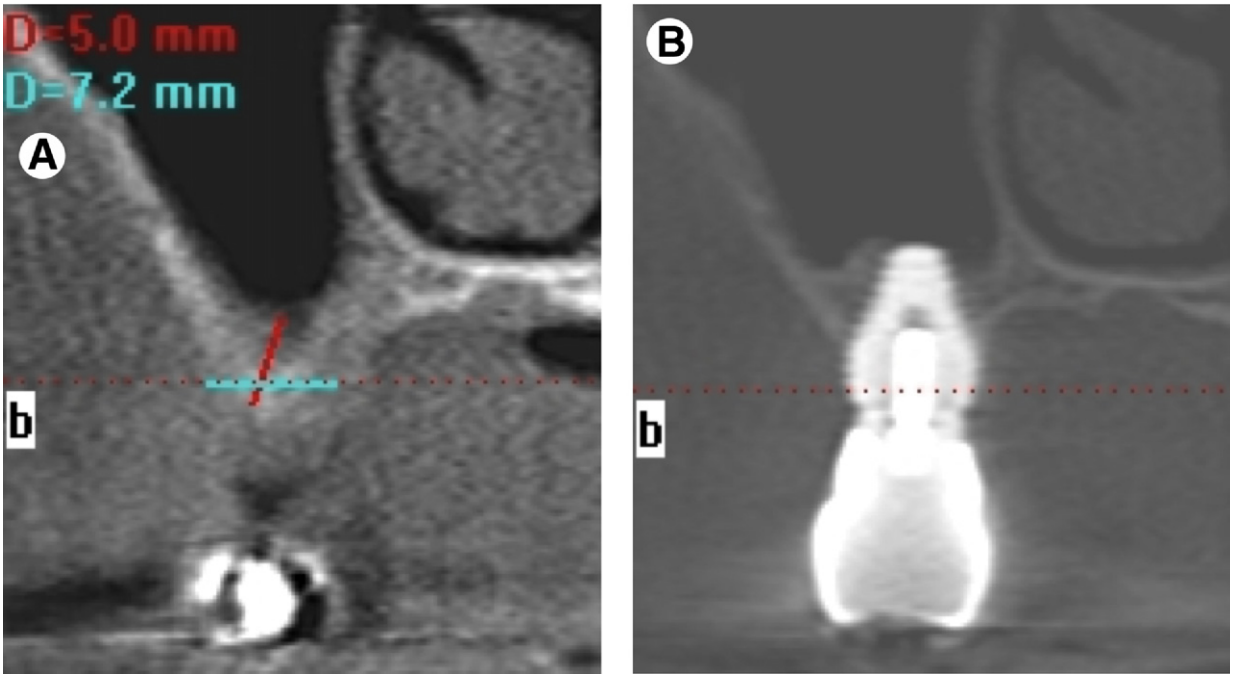

FIGURE 4. Cone beam computed tomography images preoperatively (*A*) and 1 year postoperatively (*B*) with restoration in place. The sinus lift elevation has stimulated apical bone apposition. On the other hand, buccal bone loss is visible because the original bone width was limited and the implant was obviously not completely surrounded by bone.

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the sinus floor membrane. However, more long-term survival studies on a larger patient cohort are necessary to support this treatment protocol.

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