Short Implants with Oxidized Surface in Posterior Areas of Atrophic Jaws: 3- to 5-Year Results of a Multicenter Study

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ABSTRACT

Background: The loss of one or more teeth has always been a reason for bone resorption and it can lead to a condition of "alveolar atrophy" that could make implant rehabilitation difficult.

Purpose: The aim of this prospective study was to observe crestal bone loss and implant success of short implants with oxidized surfaces in patients with partially edentulous jaws after a 3- to 5-year follow-up.

Materials and Methods: Forty-six patients with single or partial edentulism were treated consecutively from 2006 to 2008 using 107 short implants with oxidized surfaces, which were restored with a single crown or a partial fixed denture. Clinical and radiographic examinations were scheduled after functional loading of implants according to a well-established protocol generally applied to determine implant success rates and crestal bone levels. Statistical analysis was used to determine significant differences or correlations between variables ($p = .05$).

Results: After a 3- to 5-year follow-up, 44 patients with 102 implants were still followed up according to previously established study protocol, because two patients with five implants dropped out. Ninety-eight out of 102 implants are still functioning: four implants have been lost, with a survival rate of 96.1%. Moreover, a total of seven implants failed to meet the success criteria, resulting in a success rate of 93.1%. The mean bone loss was 0.9 ± 0.6 mm.

Conclusions: Many authors had recently demonstrated the predictability of short implants in different clinical conditions after a short-term follow-up. After 3 to 5 years of functional loading, short implants used to restore posterior teeth seems to be a viable solution in order to simplify and shorten the treatment of patients with partial edentulous jaws. Long-term follow-up is recommended to definitively establish the predictability and efficiency of this kind of implant-supported rehabilitation.

KEY WORDS: 7 and 8.5 mm length, oxidized surface, posterior teeth, short implant

INTRODUCTION

The loss of one or more teeth has always been a reason for bone resorption, which can be influenced by many factors such as age, gender, osteoporosis, diabetes, smoking, previous lost implants, kind of prosthetic rehabilitation, time elapsing before implant rehabilitation, and others.[1] The loss of teeth determines the loss of the functional stimulus for the alveolar bone. Consequently, it undergoes a constant and predictable resorption, which is different depending on location: it is mainly horizontal and centripetal in the maxillary jaw, with early resorption of the buccal bone; while in the mandibular jaw, it is mainly horizontal and centripetal in interforaminal regions, but it is vertical and centrifugal in retroforaminal ones.[2,3] A moderate or severe resorption of alveolar bone due to tooth loss make a condition of "alveolar atrophy" that could make difficult or impossible an adequate implant-supported rehabilitation.[4,5]

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The greater osseointegration due to advances in surface and design enables implant length to be shortened, as proposed by Brånemark and colleagues[6] and Albrektsson and colleagues[7]: short implants can be used in regions with alveolar atrophy, giving high implant success and survival rates (95.5–100%),[8–13] comparable to those of longer implants after bone grafting (94.5–100%).[14–17]

Recently, some authors demonstrated in randomized clinical trials (RCTs) that 1 year after loading short implants achieve similar if not better results than longer implants placed in augmented bone.[18–25]

Although short implants might be a preferable choice to bone augmentation since the treatment is faster, cheaper, easier, and more comfortable for patient, their results after a long-term follow-up are unknown because today, there are few prospective studies on the use of short implants with follow-up more than 3 years.[26–28]

Recently, Monje and colleagues[29] observed in a systematic review that short dental implants had an estimated survival rate of 88.1% at 168 months when standard dental implants had a similar estimated survival rate of 86.7%. However, the peak failure rate of short dental implants was found to occur between 4–6 years of function. This occurred at an earlier time point compared to standard dental implants, where the peak failure rate occurred between 6–8 years of function. Therefore, this prospective study is aimed to provide data about success rates and crestal bone loss of 7- and 8.5-mm implants with oxidized surface used to restore posterior teeth in atrophic maxilla and mandible after a follow-up of 3 to 5 years.

MATERIALS AND METHODS

Patients

The patients chosen for treatment with short implants were referred between October 2006 and July 2007 for single or partial implant-supported rehabilitation in posterior areas in three different centers.

All patients had advanced alveolar bone resorption in the posterior areas of the maxilla or mandible to be treated by implant placement; they had been advised that they were not candidates for long implants without bone grafting procedures because of insufficient alveolar ridge height. However, all sites had a sufficient alveolar ridge width to receive at least 3.75 mm diameter implants.

The decision to use short implants was made after discussion with the patients and after obtaining informed written consent. The following criteria were used to select the patients in whom this kind of implant could achieve successful results.

The inclusion criteria of the study were highly controlled oral hygiene, absence of acute infection in the oral cavity, residual bone volume at least 3.5 mm in width and 5 mm in height (for the maxilla) or 3.5 mm in width and 8 mm in height (for the mandible), willingness to participate in an oral hygiene maintenance program. While, the exclusion criteria of the study were insufficient bone volume, bruxism, smoking more than 20 cigarettes/day, abuse of alcohol, radiotherapy in the maxillofacial district, chemotherapy, liver diseases, blood diseases, kidney diseases, inflammatory and autoimmune diseases, immunodepression, corticosteroid therapy, pregnancy, and insufficient oral hygiene.

On the basis of pre-established inclusion and exclusion criteria, 55 out of a cohort of 60 patients were selected and enrolled for implant-prosthetic rehabilitation using short implants. The 55 patients selected for the study were treated consecutively in three different centers with implants restored with a single crown or partial fixed bridge.

A total of 120 implants were inserted according to standardized surgical and prosthetic protocols, which were pre-established at the beginning of the prospective study. All implants that were not restored with a fixed prosthesis according to prosthetic protocol, or were not properly evaluated according to the data collection protocol, or were not completely followed up according to the follow-up protocol for various reasons (lack of patient compliance, relocation abroad, disease with an unfavorable prognosis, death) were not considered in the statistical analysis because they were excluded from this prospective study.

Treatment was done in three centers – the Department of Morphological and Biomedical Sciences, Section of Dentistry and Maxillofacial Surgery, University of Verona, and two private offices. All centers provided details of all short implants with oxidized surfaces that had been used in rehabilitated patients.

Implant System

All implants used were short implants (Brånemark System® Mk III Shorty, Nobel Biocare AB, Göteborg,

Sweden; NobelSpeedy™ Shorty, Nobel Biocare AB) with a length of 7 or 8.5 mm and with an oxidized surface (TiUnite®, Nobel Biocare AB). They were provided by the manufacturer and purchased by the clinicians.

The implants are short versions of long implants with oxidized surfaces, which are available in the following platforms and implant diameters: the implant diameter is 3.75 or 4.0 mm for regular platform implants (platform diameter: 4.1 mm), and 5.0 mm for wide platform implants (platform diameter: 5.1 mm).

They were machined from titanium alloy (Ti-6Al-4V) as a parallel design, with a designed intrabony length of 6.3 or 7.8 mm, and a standard 0.7 mm high external hex connection. All implant length featured the oxidized surface described by Hall and colleagues.[30]

Surgical Protocol

Each patient was evaluated clinically and radiographically to choose the correct treatment planning: orthopantomography and periapical X-rays were used as a primary radiographic examination to basically evaluate bone height available for implant surgery, while computed tomography, in the DentaScan mode, was requested in all cases of alveolar atrophy in order to accurately evaluate bone height and width.

Antibiotic prophylaxis was prescribed to reduce the risk of infections: it consisted of amoxicillin + clavulanic acid 2 g a day for 6 days, starting with 2 g 1 hour before surgery; or clindamycin 600 mg a day for 6 days in penicillin-allergic patients. Anti-inflammatory therapy with non-steroidal anti-inflammatory drugs was also recommended, consisting in nimesulide 200 mg a day for 3 days, starting with 200 mg 1 hour before surgery. Local anesthesia was administered with articaine + adrenalin 1:50.000, in the site of intervention; and articaine + adrenalin 1:100.000, in other sites.

Short implants were used according to a "two-stage function" approach, as described by the manufacturer. The surgical technique adopted for all patients was previously described by the same authors.[31]

A flap technique is necessary to observe the underlying alveolar bone and adjacent anatomical structures and to place implants exactly in the correct position.

The optimal implant site was marked by perforating the bony cortex using a 2.3 mm (Ø) round bur at 15,000–20,000 rpm with profuse external sterile irrigation. A twist drill was used at a drill speed of 10,000–15,000 rpm with profuse internal and external sterile irrigation in order to create a site of the appropriate depth for the chosen implant length, and a paralleling pin (occlusal guide pin) was used to verify the appropriate alignment with adjacent teeth, opposing occlusion, or other implants. When the final depth was reached with the twist drill and the paralleling pin confirmed the proper angulation, the site was gradually expanded with implant burs of appropriate size at a drill speed of 10,000 rpm with copious internal and external sterile irrigation. The shoulder of the cone-shaped portion of the gage should be flush with or just below the crestal bone level. In cases of two or more implants, the trial-fit gage could be left in the first site as a guide to help achieve parallelism with other implants. It was important to ensure that the edge-to-edge inter-implant distance was at least 2 to 3 mm to ensure optimal bone and soft tissue healing.

After opening the implant packaging and removing the sterile inner vial, it is necessary to connect an appropriate implant driver to the hand piece and to pick up the implant by applying light pressure on the implant driver.

It is then necessary to install the implant in the osteotomy site using low speed (25 rpm) and 30–45 Ncm torque, turning the implant until it is fully inserted. At this point, the driver can be removed with an easy upward motion.

A cover screw is positioned on the implant using a screwdriver manual unigrip (Nobel Biocare AB), and a tissue flap suture is performed to ensure a first intention submerged healing.

During the first 15 days, patients were instructed to observe a fluid diet, while for the next 15 days, patients were instructed to observe a soft diet and good oral hygiene. Chlorhexidine 0.2% three times daily was recommended. Patients used no removable prostheses with mucosal support in the operation site.

Prosthetic Protocol

All implants were submerged at the time of first surgery and the healing period of short implants was maintained at around 3 months in the mandible and 4 months in the maxilla. After exposure of the implant head, the healing screw was manually tightened using a 1.25 mm hex driver, avoiding excessive torque at the bone-implant interface. Impression was performed 1 or 2 weeks after reentry surgery, where a provisional prosthesis was required, and 3 or 4 weeks later, in cases where the definitive prosthesis was created directly.

A master model was made in the laboratory in order to produce custom abutments, provisional prostheses and/or definitive prostheses. Provisional prostheses were made in the laboratory and re-based directly in the mouth, using flowable acrylic resin. The occlusion was also checked to eliminate pre-contact and interference during centric and eccentric movements. After 3 months, the provisional prosthesis was removed and the definitive impression was taken in order to produce a definitive prosthesis, which was positioned on the implants after 1 or 2 weeks, thus concluding the treatment.

A biomechanical approach was used to decrease stresses to implant-bone interface, as suggested by Misch et al.[13] The forces to the implants were reduced by eliminating lateral contacts in mandibular excursions and eliminating cantilevers on the prosthesis when possible. The area of forces applied to the prosthesis was increased by increasing the implant number, increasing the implant diameter, increasing the implant design surface area, and splinting the implants together, as suggested by Misch and colleagues.[13]

The definitive rehabilitation included single crowns or fixed partial dentures that were placed in occlusion, where the occlusal surface was thoroughly modeled so that it was in contact with reduced areas during lateral and protrusive excursions to reduce the dislocating vectorial components. Several contacts were maintained in maximum intercuspation.

Data Collection and Success Assessment

A database was created from patient records enrolled in the three centers. Data recorded at baseline included name and surname of patient (initials), age, sex, health status, medical therapy, smoking habits, bruxism habits, implant site, implant size, kind of prosthesis, C/I ratio, and crestal bone level. Data recorded after follow-up period included implant success and crestal bone level.

For each implant, the crestal bone loss were measured by examination of periapical X-rays, which were performed at the time of implant surgery, at the time of functional loading (baseline), and at the periodic control (follow-up).

The periapical X-rays were always taken using customized occlusal templates associated to customized Rinn holder devices and standard long-cone paralleling techniques. Each periapical radiograph was evaluated using a software for image analysis (Image J, National Institutes of Health, Bethesda, MD, USA): analogic radiographs were digitalized by means a scanner; digital images were calibrated based on the implant length; and crestal bone levels were measured using a ruler tool. In particular, the measurements were rounded off to the nearest 0.1 mm and were carried out mesially and distally to each implant, calculating the distance between first bone-implant contact point and implant shoulder.

Each implant was considered successful if it met all the success criteria proposed by Buser and colleagues[32] and modified by Albrektsson and Zarb,[33] including universally accepted: absence of any complaint such as pain, dysesthesia, or paresthesia in the implanted area; absence of recurring peri-implant infection and/or suppuration; absence of perceptible mobility of the implant; absence of radiolucency at the implant-bone junction; absence of persistent peri-implant bone resorption greater than 1.5 mm during the first year of loading, and 0.2 mm per year during the following years. The implants were considered successful in the absence of all of the above-mentioned complaints at the most recent recall appointments.

Clinical complications such as pain, dysesthesia, or paresthesia were assessed by interviewing the patients; peri-implant infection with or without suppuration and implant mobility were assessed by clinical observation and pressure. Radiographic complications such as excessive peri-implant bone resorption or radiolucencies were assessed by means of periapical X-rays, which were taken using customized templates associated to Rinn holder devices and standard long-cone paralleling techniques.

Statistical Analysis

Since more than one implant was used in the same patient, to take into account within-subject correlations between implants univariate and multiple linear generalized estimating equation models with robust standard error were used to analyze the relationship between peri-implant bone loss (in mm) and implant failure/success (%) and other designated variables. Statistical analyses were performed with a dedicated analysis software (Stata 12 software, StataCorp LP, College Station, TX, USA), according with a 0.05 significance cut-off ($p = .05$), for example, a p value <0.05 was considered statistically significant.

RESULTS

At the beginning of the prospective study, 120 implants were inserted in 55 patients. All implants were successfully osseointegrated at the end of the submerged healing period, and no implants failed to achieve complete osseointegration. 113 of 120 implants were functionally loaded and were successfully restored with a definitive fixed prosthesis, according to prosthetic protocol; six implants were merely restored with provisional fixed prostheses for patient-related reasons and were excluded from the study. 107 of 120 implants were properly followed up according to the pre-established protocol until the 3-year follow-up visit; but only 102 implants were correctly evaluated at the time of data collection for this report because two patients with five implants dropped out after 3 years of follow-up.

Consequently, a total of 102 short implants with oxidized surface in 44 patients were evaluated in the statistical analysis of this prospective study. In total, records included 44 subjects (mean age: 56 ± 11 years; 23 females and 21 males), who received 102 short implants in order to rehabilitate the posterior areas of maxilla and mandible.

The university center contributed 51 implants in 21 subjects and had the highest number of patients (36 to 60 months' functioning; mean follow-up: 47.7 ± 7.9 months). Private office 1 (Verona, Italy) contributed 27 implants in 13 subjects and had the longest mean follow-up times (36 to 60 months' functioning; mean follow-up 50.6 ± 11.1), performed by an oral maxillofacial surgeon; and private office 2 (Mantua, Italy) contributed 24 implants in 10 subjects (36 to 60 months' functioning; mean follow-up: 45.9 ± 7.5 months), performed by a dentist. Patient information was reported in a previous article; also characteristics of implants, such as implant size, implant site, and kind of prosthesis (single crown, partial fixed bridge, cantilevered prosthesis), were described in the article reporting 1- to 3-year results.[31]

No surgical complication associated with implant placement occurred at the time of surgery, but prosthetic complications were observed during follow-up time, which included five screw loosening (4.9%), three screw fracture (2.9%), and two porcelain veneer fractures (2.0%).

At the time of this report, implants had been functioning for a mean follow-up of 46.8 ± 19.1 months (median: 48 months; range: 36–60 months). All 102 implants were followed for at least 3 years, 49 for at least 4 years, and 20 implants had a follow-up period of 5 years. Details are reported in Table 1.

TABLE 1 Distribution of Implants according to Time in Function

Follow-Up (Months)	No. of Patients	No. of Implants
36.1–42.0	15	33 (32.4%)
42.1–48.0	7	16 (15.7%)
48.1–54.0	10	24 (23.5%)
54.1–60.0	12	25 (24.5%)

After the follow-up period, 98 out of 102 implants are still functioning: four implants have been lost, with an overall survival rate of 96.1%. Moreover, a total of seven implants failed to meet the success criteria, resulting in an overall success rate of 93.1%. It is understandable that overall values were rather similar to cumulative ones since cumulative survival and success rates were respectively 95.5% and 92.5%, as reported in Table 2. The characteristics of failed/loss implants, such as implant size, implant site, prosthesis type, or failure/loss timing, were described in Table 3.

The radiographs taken at baseline and follow-up revealed a mean marginal bone loss during functional loading of 0.9 ± 0.6 mm (range: 0.4–2.4 mm). Most implants ($n = 54$; 52.9%) had a bone resorption ranging from 0.6 to 1.0 mm; 11 implants (10.8%) showed bone loss between 0.1 and 0.5 mm; 23 implants (22.5%) between 1.1 and 1.5; and only seven implants (6.8%) experienced bone loss up to 1.6 at the moment of maximum follow-up. None of the osseointegrated implants showed a marginal bone loss more than 2.5 mm, excluding seven failed implants (Table 4).

DISCUSSION

Renourd and Nisand[34] defined the concept of "short" implant as an implant with "designed intrabony length" (e.g., length of implant required to achieve and maintain osseointegration) of <8 mm. This definition was used in the present report. The implants used here had a designed intrabony length of 6 or 7 mm because they have a standard 1 mm high external hex connection, and therefore were considered as short implants by the authors. They are characterized by an oxidized surface, which has repeatedly been found to induce an enhanced bone response compared to machined implant surfaces.[35,36]

TABLE 2 Cumulative Survival and Success Rates of Short Implants

Time in Function (Months)	Implants at Beginning of Interval	Implants Loss during Interval	Interval Loss Rate (%)	Cumulative Survival Rate (%)	Implants Failed during Interval	Interval Failure Rate (%)	Cumulative Success Rate (%)
0.1–6.0	102	0	0.0	100.0	0	0.0	100.0
6.1–12.0	102	0	0.0	100.0	0	0.0	100.0
12.1–18.0	102	0	0.0	100.0	0	0.0	100.0
18.1–24.0	102	1	1.0	99.0	2	2.0	98.0
24.1–30.0	101	0	0.0	99.0	1	1.0	97.0
30.1–36.0	101	1	1.0	98.0	1	1.0	96.0
36.1–42.0	100	1	1.0	97.0	2	2.0	94.0
42.1–48.0	66	1	1.5	95.5	1	1.5	92.5
48.1–54.0	49	0	0.0	95.5	0	0.0	92.5
54.1–60.0	25	0	0.0	95.5	0	0.0	92.5

Several retrospective studies demonstrated predictability of short implants with oxidized surface after short- and long-term follow-up, reporting success rates between 95.5% and 97.1%.[8,31,37] De Santis and colleagues[31] published preliminary results of a prospective study, giving an implant success rate of 96.3% after a 1- to 3-year follow-up. Despite the limited number of cases treated and the short-term follow-up, we report data from different clinical situations: mandible and maxillary sites; implant restorations with single crowns, crowns supporting a cantilever, and fixed prostheses; patients enrolled from three different treatment centers; and the use of 7- and 8 mm-long implants (Figures 1, 2, and 3). The data acquired support the possibility of using this kind of implant in the treatment of partially edentulous patients.

In the present study, the results were updated after a 3- to 5-year follow-up in order to confirm reliability of short implants for restoration of posterior teeth in single or partial edentulism.

An implant success rate of 93.1% was found after a mean follow-up of 46.8 months, which compares predictably with other recent studies with shorter follow-up periods.[26,38–41] Moreover, the mean peri-implant bone loss (PBL) was 0.9 mm, which is similar to the values reported by other authors using short implants (Figures 4, 5, and 6).[26–28] If 0.3 mm is considered to be the inherent error in reading standardized periapical radiographs,[42] then the vast majority of measurements (about 85% at 3 years) fall within this range of error, suggesting minimal if any change from zero, that is, that the majority of sites demonstrated stable PBLs. The value of 0.9 ± 0.6 mm for peri-implant bone loss seems to be greater than those reported for standard long implants. A possible reason could be higher crown-implant ratio of short implants, as recently suggested by Malchiodi and colleagues (Figure 7).[43] Those authors demonstrated a statistically significant correlation between crown-implant ratio and bone loss around short implants. Other reason could be external hex connection of implants

TABLE 3 Characteristics of Failed Implants

Implant	Site	Ø	Length	Prosthesis	Failure Timing	Loss Timing	Reason
1	16	4.1	7.0	Cantilever	–	18th month	Peri-implantitis (poor oral hygiene; smoking habit)
2	35	5.0	8.5	Fixed bridge	18th month	–	Peri-implantitis (periodontal disease)
3	47	4.1	7.0	Single crown	24th month	–	Occlusal overloading (bruxism habit)
4	36	4.1	7.0	Single Crown	–	32nd month	Occlusal overloading (oversized crown)
5	27	5.0	7.0	Fixed bridge	–	40th month	Undeterminable (bruxism habit; smoking habit)
6	15	4.1	7.0	Single crown	–	46th month	Peri-implantitis (periodontal disease; smoking habit)
7	26	4.1	8.5	Cantilever	48th month	–	Peri-implantitis (poor oral hygiene)

TABLE 4 Distribution of Implants according to Crestal Bone Loss during Follow-Up Period

Mean Bone Loss (mm)	Implants
0.1–0.5	11 (10.8%)
0.6–1.0	54 (52.9%)
1.1–1.5	23 (22.5%)
1.6–2.0	4 (3.9%)
2.1–2.5	3 (2.9%)
>2.5	7 (6.9%)
Total	102 (100.0%)

used in the present study, which is characterized by higher bone loss compared to internal conical/tapered connection and platform switching.[44–46]

Many authors have confirmed that not only 8.5-mm-long but also 7-mm-long implants constitute a reliable procedure in severely resorbed jaws[8,37,47,48]; and others have even proposed the use of short implants with lengths <7 mm.[49,50] Obviously, different authors investigate and attempt different implant designs and surfaces, but many of them have validated the use of short implants as a predictable procedure.

Using short implants, ridge height is no longer a surgical limitation for implant-supported prostheses; although it could be a prosthetic limitation because a reduced ridge height leads to an unfavorable crown/implant ratio. The C/I ratio has been considered one of the load prosthetic factors that may increase the risk of biomechanical complications because unfavorable occlusal forces, such as overload or non-axial loading, have been reported to be one of the possible explanations for these complications.[51–53]

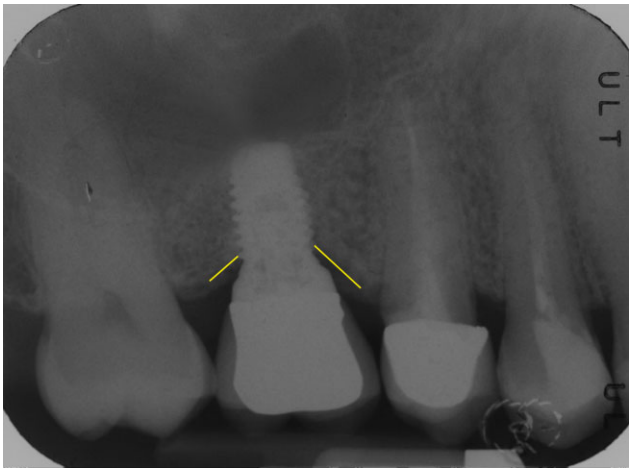

Figure 1 Single crown supported by 7-mm implant in site #16.

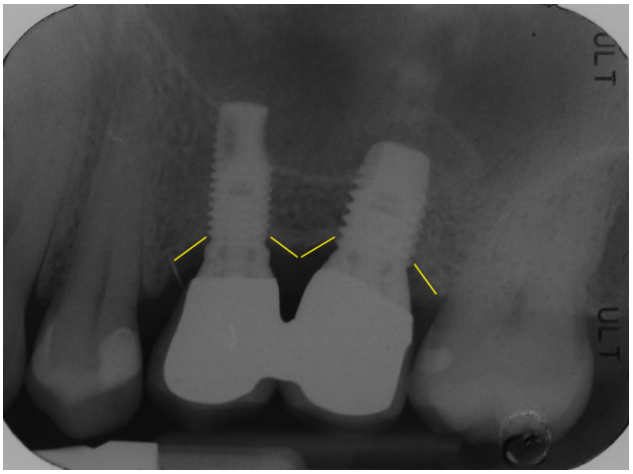

Figure 2 Unit partial fixed bridge supported by 7-mm and 8.5-mm implants in sites #25 and #26.

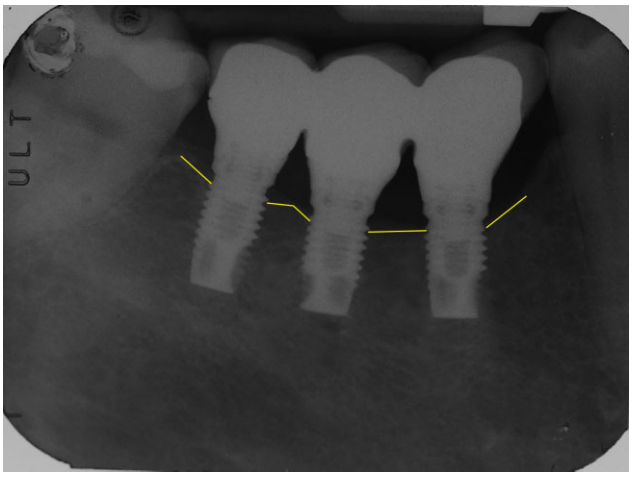

Figure 3 Unit fixed bridge supported by 7-mm implants in site #45, #46, and #47.

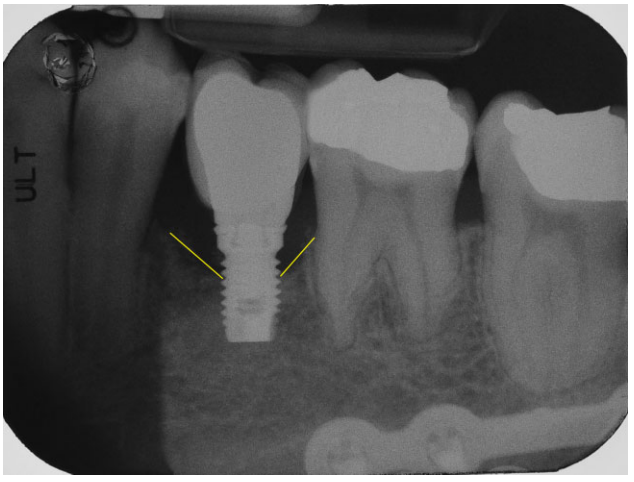

Figure 4 Single crown supported by 7-mm implant in site #35.

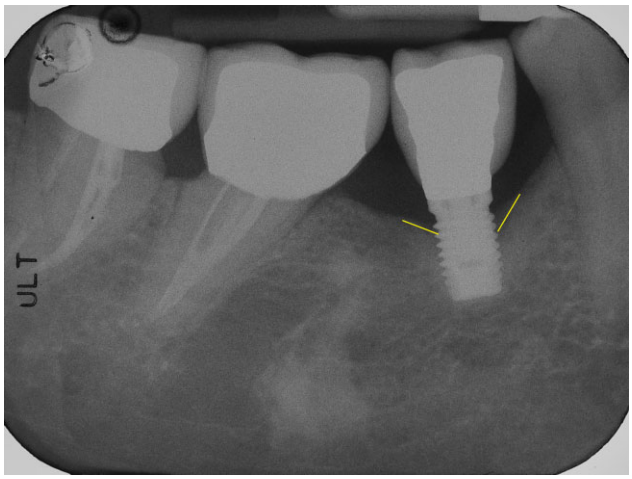

Figure 5 Single crown supported by 7-mm implant in site #45.

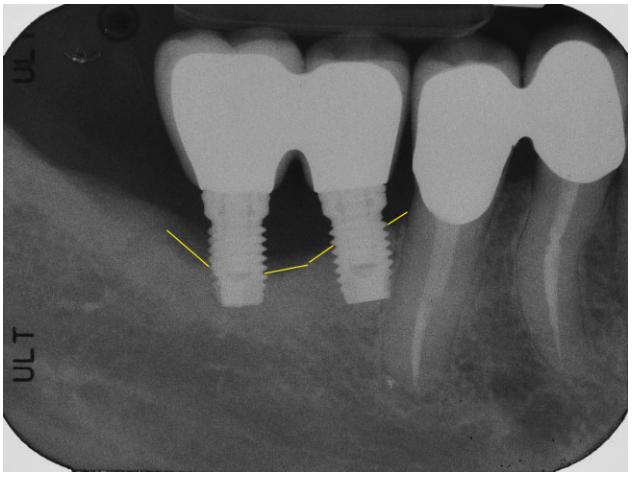

Figure 7 Unit fixed bridge supported by 7-mm implants in site #46 and #47.

However, Tawil and colleagues[39] demonstrated that it did not prove to be a major complicating factor, although it was found to be increased by 2 to 3 times in nearly 87% of cases: peri-implant bone resorption was similar in implants with high C/I ratio.

Many recent randomized clinical trials compared short implants placed in residual bone with longer implants placed in surgically augmented bone[18–25]: although 1-year results showed no statistically significant differences, more implant failures and more serious biological complications occurred in the long-implant group compared with the short-implant group. While some obvious differences exist among those RCTs (e.g., use of different types of implants and bone grafts, the timing of implant placement and loading, and how "short" implants are defined), the results of all these studies are substantially consistent, suggesting that short implants may be a preferable solution over a sinus augmentation procedure placing longer implants in the short-term period.

The main question is whether the 1-year advantage of short implants reported in the above-mentioned studies is maintained over time. In fact, after many years of loading, short implants could fail more often due to progressive marginal bone loss or overloading or peri-implantitis through the high crown-to-implant ratio.[40,43,54,55]

Only longer follow-up evaluations will provide an answer to this question: the present should give an answer to it, reporting outcomes of short implants after a 3- to 5-year follow-up.

In conclusion, data from this treatment indicate that short implants with oxidized surface for the rehabilitation of atrophic posterior regions achieved successful outcomes after 3 to 5 years of function, although implant success rate and peri-implant bone loss reported in the present study appear slightly worse than those reported in other studies due probably to longer follow-up period. Nevertheless, short implants permit to have a considerably lower operation time with decreased surgical complications and post-operative patient discomfort compared with longer implants after bone augmentation surgery, and they may be preferable to easy and fast implant-supported rehabilitation in atrophic regions. However, RCTs with longer follow-up times and larger sample sizes are necessary to validate this alternative treatment solution.

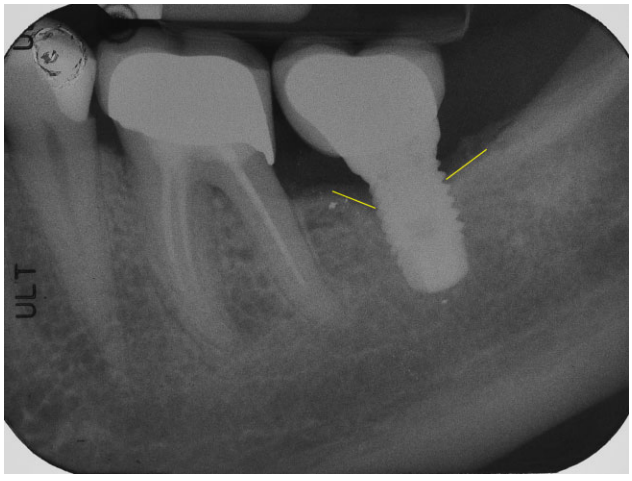

Figure 6 Single crown supported by 7-mm implant in site #37.

CONCLUSION

After 3 to 5 years of functional loading, short implants used to restore posterior teeth seems to be a viable solution in order to simplify and shorten the treatment of patients with partial edentulous jaws. Long-term follow-up is recommended to definitively establish the predictability and efficiency of this kind of implant-supported rehabilitation.

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