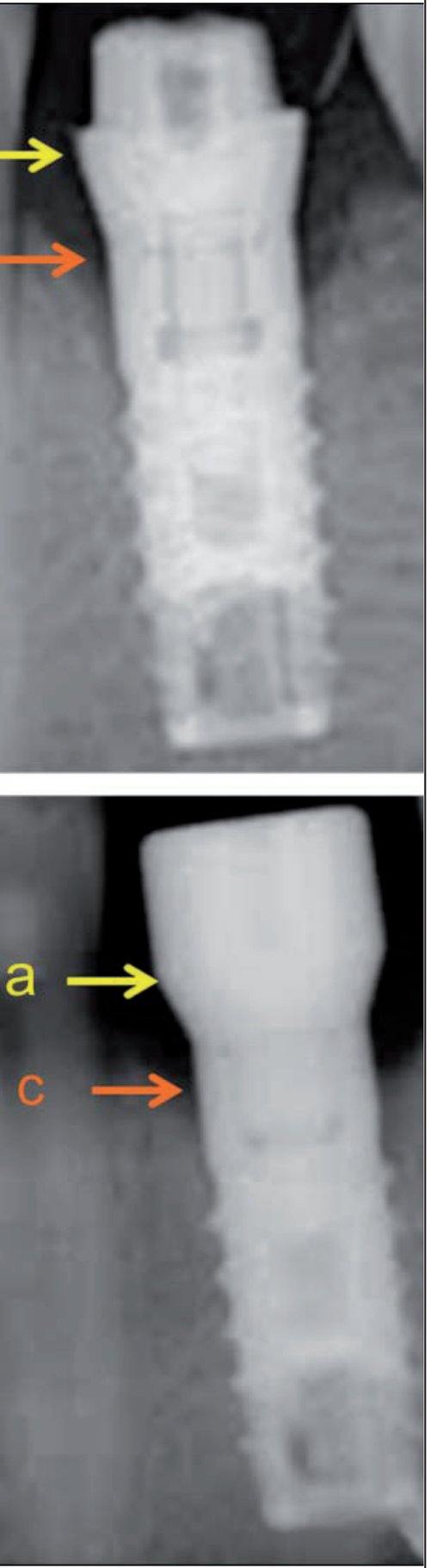

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Radiographic Comparison of Periimplant Bone Resorption and Assessment of Survival Rates of 2 Implant Systems: A 10-Year Prospective Multicenter Study

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Index

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Radiographic Comparison of Periimplant Bone Resorption and Assessment of Survival Rates of 2 Implant Systems: A 10-Year Prospective Multicenter Study

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Purpose: *The aim of this multicenter human clinical trial was to radiographically evaluate the marginal bone loss and to assess implant survival rate in patients treated using 2 different implant systems (Bio-Plant and Tuber-Plant) after 10 years of loading.*

Methods: *Ninety-seven patients were selected, and 160 implants were inserted (72 Bio-Plant and 88 Tuber-Plant). Ten years later, 20 patients were lost at follow-up and 77 patients (126 implants; 67 Bio-Plant and 59 Tuber-Plant) were recalled. After 10-year, the periimplant bone resorption was significantly lower (P = 0.0039) for Tuber-Plant (0.74 ± 0.12 mm) than for Bio-Plant (1.31 ± 0.09 mm). The cumulative survival rate was 99.11%.*

Conclusion: *Both implant systems demonstrated to be suitable for a long-term successful rehabilitation because of stable marginal bone levels and high survival rates after 10 years of functional loading. (Implant Dent 2015;24:77–82)*

Key Words: 10-year follow-up, radiographic evaluation, periimplant bone resorption, survival rates

The preservation of the marginal bone level safeguards the functional and esthetic long-term success of dental implant restorations.[1] In literature, the periimplant bone loss is frequently described when the long-term evaluation of dental implants stability is investigated.[2] Albrektsson et al[1] demonstrated that in a successful implant treatment, a marginal bone loss within 1 to 1.5 mm, during the first year of functional load and <0.2 mm in subsequent years should be registered. Marginal bone remodeling, after implant placement, is more sustained within 6 months from the insertion time, and it would be assumed that the early establishment of osseointegration may prevent periimplant bone level from resorption.[3]

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Osseointegration is affected by different factors,[4–7] but the most important are the implant surface and the neck design.[8,9] Indeed, to improve osseointegration and to limit marginal bone loss implant systems have been modified over time.[10,11] Several studies suggested that rough surfaces showed better bone responses than turned ones,[12–15] because the roughness enhanced cell attachment on implant surfaces and cells differentiation into osteoblasts.[16,17] In addition, a human study reported that rough-surfaced implants improved bone contact and preserve marginal bone level.[18]

Regarding the neck design, in a radiographic study on microthreaded implants, it was concluded that the implant-abutment interface design (microgap) was crucial for the maintenance of periimplant marginal bone level after a 4-year follow-up.[19] Long-term studies showed that the most significant bone loss occurred before the placement of the final restoration and that it might be related to the creation of a microgap between fixtures and abutments.[20–22] Furthermore, the roughness of the neck also affects crestal bone resorption. In a 18-month randomized clinical trial, den Hartog et al[23] demonstrated that implants with smooth or moderately rough necks showed a significantly less radiographic marginal bone resorption compared with implants with rough neck with grooves.

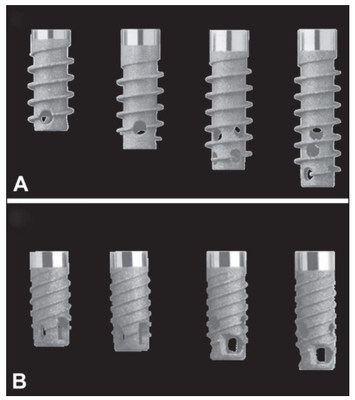

Fig. 1. A and **B**, Outlook of both implant systems. A, Bio-plant implants. B, Tuber-plant implants.

Table 1. Distribution of Patients, Characteristics, and Position of Implants After 1-y Follow-up

Patients' Age and Gender (2001–2002)			
Subjects	Mean Age (y)	Male	Female
97	46	34	63

Implant Distribution (2001–2002)				
No. Implants	Mandible	Maxilla	Bio-Plant	Tuber-Plant
160	94 (58.75%)	66 (41.25%)	72 (45%)	88 (55%)

One year after implant insertion, 97 patients, 34 men and 63 women were recalled. The average age of patients was 46 years. A total of 160 implants were evaluated of which 94 placed in the mandible and 66 in the maxilla; 45% of the implants were Bio-Plant and 55% Tuber-Plant.

The aim of this multicenter human clinical trial was to compare 2 implant systems (Bio-Plant and Tuber-Plant) by radiographically evaluating marginal bone resorption and assessing implant survival rates after 10 years of loading.

Materials and Methods

Study Design

During the years 2000–2010, 19 private dentists with certificated implant technique of Oralplant (Cordenons, Pordenone, Italy) participated to this multicenter longitudinal study. Between January 2001 and November 2002, 97 healthy patients (63 women and 34 men, range from 24 to 78 years, mean age, 46 years), who needed an implant rehabilitation, were selected for this study.

Patients affected by severe systemic diseases, uncompensated diabetes, uncontrolled periodontal disease, and smoking more than 10 cigarettes per day were excluded from this study. All patients were older than 18 and showed a good oral hygiene and a sufficient bone volume to allow dental implant insertion. Subjects were completely or partially edentulous both in the maxilla and mandible 1 to 3 years before starting the treatment. All patients signed an informed written consent, and the protocol of the study was approved by the Ethical Committee of the University of Guarulhos, Sao Paulo, Brasil. This multicenter clinical trial was carried out in accordance with the Declaration of Helsinki.

In all patients, a total of 160 implants (Oralplant, Cordenons, Pordenone, Italy) were placed and divided in 2 groups: 72 implants were Bio-Plant (group A) and 88 Tuber-Plant (group B) implant system (Fig. 1, A and B); 66 implants were inserted in the maxilla, and 94 implants were placed in the mandible (Table 1).

Both implants had a titanium pull spray superficial (TPSS) surface in the endo-osseous portion, and a half smooth (upper side) and half TPSS surface (lower side, ie, 1 mm below the implant shoulder) in the neck portion. In the Tuber-Plant, the threads were made of 3 little spirals with a trapezoidal section and a rounded end, whereas in the Bio-Plant, the threads were made of 1 little spiral with a trapezoidal section and a rounded end; the screw pitch was shorter in Bio-Plant than in Tuber-Plant.

Between January 2011 and March 2012, at 10-year follow-up, patients included in this study were recalled. Twenty patients were lost at follow-up and 77 patients (45 women and 32 men, range from 48 to 83 years, mean age, 59 years) were evaluated for implant survival rates and marginal bone loss. One hundred twenty-six implants (67 Bio-Plant and 59 Tuber-Plant) were present in 77 subjects; 80 fixtures were located in the mandible and 46 in the maxilla (Table 2).

Surgical Procedures

Panoramic orthopantomography and calibrated x-rays were performed before surgery for the examination of each clinical case. All the patients underwent oral hygiene before surgery. Antimicrobial prophylaxis was obtained with 2 g amoxicillin-clavulanic acid 1 hour before surgery and 1 g twice per day for 6 days. Patient's mouths were rinsed with a chlorhexidine digluconate solution (0.12%) for 1 minute.

Table 2. Distribution of Patients, Characteristics, and Position of Implants After 10-year Follow-up

Patients' Age and Gender (2011/2012)			
Subjects	Mean Age (y)	Male	Female
77	59	32	45

Implant Distribution (2011/2012)				
No. Implants	Mandible	Maxilla	Bio-Plant	Tuber-Plant
126	80 (63.49%)	46 (36.51%)	67 (53.17%)	59 (46.83%)

Ten years after implant insertion, 77 patients, 32 men and 45 women, were recalled. The average age of patients was 59 years. A total of 126 implants were evaluated, 80 placed in the mandible and 46 in the maxilla; 53.17% of the implants were Bio-Plant and 46.83% Tuber-Plant.

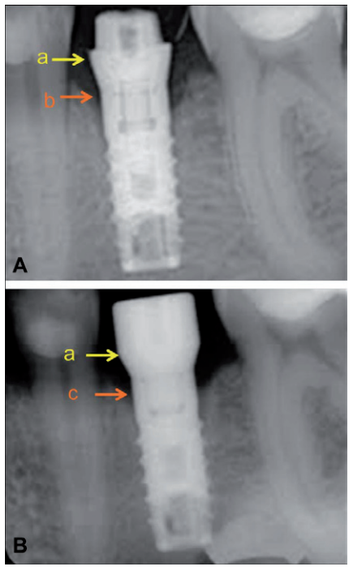

Fig. 2. **A** and **B**, Radiograph measurement of marginal bone level: (**A**) a: implant shoulder, b: most coronal bone to implant contact at baseline; (**B**) a: implant shoulder, c: most coronal bone to implant contact at follow-up.

Local anesthesia was induced by infiltration with articaine-epinephrine 1:100.000 (Ubistesin 4%; ESPE Dental AG, Seefeld, Germany). Implants were inserted after the manufacturer's instructions, and surgeons used 3 different procedures: a 2-stage procedure, a 1-stage technique, and immediate loading procedure. The 2-stage technique was performed in 90 patients (148 fixtures). In these patients, implants were submerged for a healing time of 3 months for the mandible and 6 months for the maxilla, then provisional restorations were provided, and after an additional month, the final restorations were delivered. The 1-stage procedure was performed in 6 subjects (11 implants) and consisted in the insertion of transmucosal implants. After 3 to 6 months, provisional restorations were provided and after an additional month, final restorations were delivered. The immediate loading procedure was performed in 1 patient (1 implant). In this subject, after the placement of the fixture, a transmucosal abutment was inserted and a temporary resin prosthesis was supplied. After 1 month, the final restoration was provided. Sutures were removed 12 days after surgery. Temporary prostheses were made with resin, whereas final restorations were made with gold-ceramic crowns.

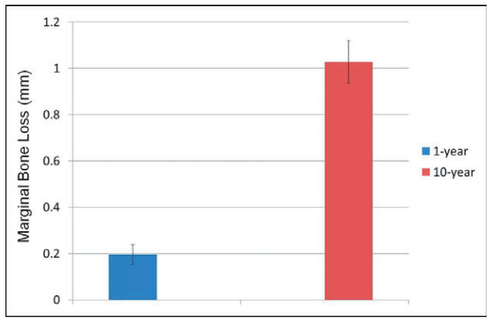

Fig. 3. Marginal bone loss evaluation of Bio-Plant implants. The 10-year follow-up values are significantly higher than the 1-year follow-up values ($P = 0.0001$).

Data Collection

Clinical and radiographic evaluations were performed at baseline (at the moment of final prosthesis delivery) and after 1 and 10 years of functional loading.

The clinical parameters evaluated for each implants were as follows:

1. Osseointegration
   - Mobility of the system: measured by applying a small transverse force with 2 handles of hand tools (mirror and explorer) opposed;
   - Presence/absence of signs of pain, inflammation, or infection;
   - Tapping the fixture evaluating the sound produced.
2. Failure of the implant (specifying the reasons for failure)

Radiographic evaluation was performed with periapical standardized x-rays. They were executed when final prosthesis were delivered and after 1 and 10 years. Measurements were assessed on the mesial/distal surface of each implant, calculating the distance between the edge of the implant shoulder and the most coronal bone to implant contact at different time points (baseline, 1 and 10 years) (Fig. 2, A and B). The bone levels, recorded when fixed final prostheses were provided, were considered as the baseline for follow-up measurements. Each measurement was rounded to the nearest 0.5-mm point.

To ensure standardization, calibrated x-rays were performed with the long cone technique, and individually fabricated film holders (XCP Instruments; Rinn

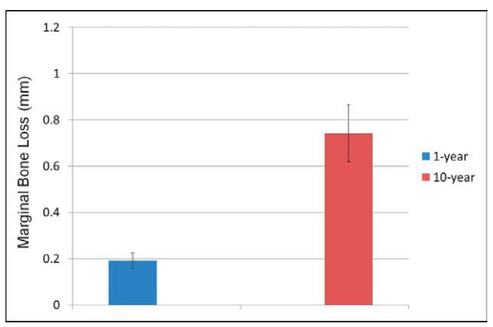

Fig. 4. Marginal bone loss evaluation of Tuber-Plant implants. The 10-year follow-up values are significantly higher than the 1-year follow-up values ($P = 0.0004$).

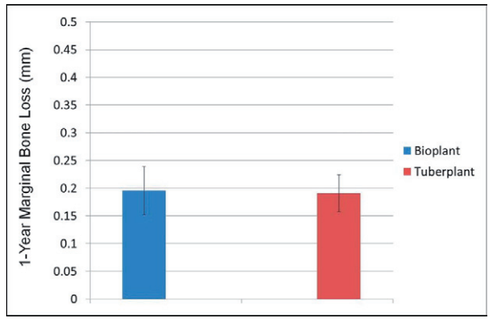

Fig. 5. Marginal bone loss evaluation at 1-year follow-up. There is no difference between Bio-Plant and Tuber-Plant resorption values ($P = 0.8809$).

Corporation Elgin, IL) were used for each subjects. This procedure allowed the reproducibility of the position of radiographs at each time during the follow-up. Subsequently, radiographs were digitized with a scanner (Epson Perfection 4870, 4800 × 9600 dpi) and analyzed using an appropriate software (Photoshop; Adobe, San Jose, CA).[25]

Values of periimplant bone loss were measured and expressed in millimeter.

Statistical Analysis

Periimplant bone loss data were statistically compared at different time points (baseline, 1 and 10 years) by means of Mann-Whitney *U* test (evaluations at 1 and 10 years) and Wilcoxon Test (evaluation between 1 and 10 years). Differences were accepted as $P < 0.05$ and, data were presented as mean values ± SE.

Results

Clinical Findings

After a 1-year follow-up period, no adverse situations occurred, and there were no signs of implant mobility, inflammation, infection, and pain. Implant survival rate was 100%.

After 10 years, 1 implant (Bio-Plant) failed in a patient with uncompensated diabetes. The implant survival rate was 98.6% for Bio-Plant and 100% for Tuber-Plant implant systems. At the 10-year follow-up, the cumulative implant survival rate was 99.21% for the 126 fixtures evaluated.

Radiographic Findings

The marginal bone loss values found for Bio-Plant implant system were 0.19 ± 0.023 mm after 1 year and 1.31 ± 0.09 mm after 10 years; values for Tuber-Plant implants were 0.19 ± 0.027 mm after 1 year and 0.74 ± 0.12 mm after 10 years.

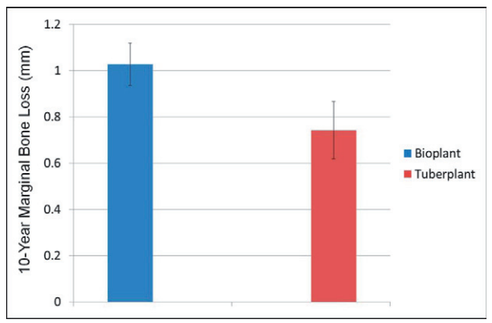

Fig. 6. Marginal bone loss evaluation at 10-year follow-up. Resorption of Tuber-Plant is significantly lower than Bio-Plant ($P = 0.0039$).

The total mean of marginal bone loss at the 1-year follow-up was 0.18 ± 0.02 mm and at the 10-year follow-up was 0.91 ± 0.08 mm.

For each implant system, the marginal bone loss values at 10-year follow-up were significantly higher than values recorded after 1 year ($P = 0.0001$ for Bio-Plant; $P = 0.0004$ for Tuber-Plant) (Figs. 3 and 4).

After 1 year, no statistically significant differences between Tuber-Plant and Bio-Plant were found ($P = 0.8809$) (Fig. 5), whereas at the 10-year follow-up, Tuber-Plant crestal bone resorption values were significantly lower than Bio-Plant values ($P = 0.0039$) (Fig. 6).

Discussion

Several studies showed that during the first year of functional load, the marginal bone loss was comprised between 0.9 and 1.6 mm.[5,9,11] Interestingly, in this multicenter study, the cumulative marginal bone loss was 0.18 ± 0.02 mm during the first year and 0.91 ± 0.08 mm at the 10-year follow-up. In a study on 192 implants, Blanes et al[26] showed that after 10 years of loading, the marginal bone loss was 4.24 ± 1.25 mm. Moreover, in a radiographic evaluation, Kim et al[27] followed 511 implants for 10 years and recorded a marginal bone loss of 3.32 ± 0.73 mm. Values showed in our investigation, after 10 years of functional loading, were lower than values reported from Blanes et al[26] and Kim et al.[27] The smooth neck design of the implants investigated in this study might minimize plaque retention and the consequent inflammation and pocket formation[28,29] at the crestal bone level. Indeed, in literature is shown how the marginal bone loss around thread retained implants with a long smooth conical neck was usually down to the first thread.[4,30] Implants included in this study presented a neck smooth surface of 1 mm below the implant shoulder. Probably, the neck design of these implants contributed to the preservation of the marginal bone level.

Both implant systems showed good clinical results, and no differences were found when 1-year bone resorption data of Bio-Plant and Tuber-Plant

were compared. However, at the 10-year follow-up, the Tuber-Plant presented a significantly lower marginal bone loss than Bio-Plant implants. Both systems had the same neck design and a similar surface, so it could be hypothesized that differences in marginal bone loss values might be influenced by the macrostructure of the implant systems. Indeed, the threads of Tuber-Plant were made of 3 little spirals, which lead to a lower stress during their insertion and to forces distribution over a larger area during function. In Bio-Plant system, the threads were made of only 1 little spiral; therefore during function, the forces distribution was concentrated on a smaller area, with higher stress on bone tissue.

In this study, only 1 implant inserted in a patient with not compensated diabetes failed at the 10-year follow-up. Diabetes can probably have a negative effect on implant survival,[31] but no definitive conclusions can be drawn because of the limited number of studies examining the issue. Indeed, systematic reviews concluded that there is limited evidence that poorly controlled diabetes is a risk factor for periimplant disease[32] and the tendency for patients with diabetes to have more failures still remains unclear.[33]

Conclusion

The results of this multicenter study indicated that both types of implants are suitable for a long-term successful implant-prosthetic rehabilitation because of low values of marginal bone loss and high survival rates after 10 years of functional loading.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

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