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Narrow Diameter Implants Compared to Regular Diameter Implants Installed in the Posterior Region of the Jaws-Results from One-Year Follow Up

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Abstract

Purpose: The aim of this prospective clinical study was to analyze marginal bone loss around Narrow Diameter Implants (NDIs) in comparison with that of Regular Diameter Implants (RDIs) installed in the posterior region of the jaws after one year of loading with single prostheses.

Material and Methods: A total of 21 patients with a mean age of 57.2 years were included in the study. The patients received one implant of each diameter in the maxilla or in the mandible. Panoramic radiographs were realized immediately after prostheses installation (T0) and one year after loading (T1). Measurements were performed from implant shoulder to the first point of bone/implant contact. The differences in marginal bone change between the groups were analyzed by Student t-test for paired samples. A level of 95% of significance was adopted.

Results: A total of 42 implants were installed (21 RDIs and 21 NDIs). At the end of the follow-up period (12 months of loading), implant success and survival rates of 100% were observed. The bone loss around implants at T0 was 0.41 (± 0.45) mm for NDIs and 0.47 (± 0.60) mm for RDIs and at T1 was 1.3 (± 0.3) mm for NDIs and 1.24 (± 0.3) mm for RDIs. No statistically significant differences between the groups were found (p>0.05).

Conclusion: This study demonstrated that RDIs and NDIs produced similar marginal bone alterations patterns after one year of loading, regardless the implant location, indicating that NDIs may be used in the posterior region of the jaws with single unit prostheses in selected patients.

Keywords: Narrow diameter; Dental implants; Bone resorption; Radiography

Introduction

Nowadays, dental implants have become an important treatment option to support different types of prosthetic restorations. However, when implantology was taking its first steps, implants were only used to treat fully edentulous patients. With the evolution of dental materials and techniques, they started to be used to treat partially edentulous patients until, finally, being used to rehabilitate patients that required single-tooth replacement. Nonetheless, in some specific cases, space constraints were sometimes present in situations where, for example, lower incisors and upper lateral incisors, needed to be replaced. These situations have been particularly challenging to clinicians not only from an esthetic point of view, but also in relation to the tooth's emergence profile [1-4].

Reduced mesio-distal prosthetic space, tooth agenesis, severe alveolar ridge reduction after extractions, or considerable bone resorption resulting from periodontal diseases or trauma, may result in insufficient bone, preventing the use of regular-diameter implants (RDIs). When the buccolingual dimension is reduced and the amount of available bone is less than 5 mm wide, the placement of an RDI often leads to the exposure of implant threads. This exposure may not only compromise the stability of the implant, but also the esthetic results of the future restoration [5-8]. In an attempt to overcome some of these challenges, narrow-diameter implants (NDIs; < 3.75 mm) were introduced into the clinical practice [9]. In addition to allowing implant placement in a reduced mesio-distal space, their use may also prevent further surgical procedures for bone augmentation, which are not only more traumatic, but also more costly and time consuming to the patient.

After implant placement, a significant marginal peri-implant bone loss is normally observed during the healing and remodeling period within the first year of prostheses installation [10,11]. Therefore, according to the current literature, both RDIs and NDIs produce similar marginal bone loss patterns, which are within the parameters of success. However, so far, no clinical trials have been carried out to specifically compare marginal bone loss around those two different types of implants. Therefore, the objective of this prospective clinical study was to analyze marginal bone loss around NDIs in comparison with that of RDIs placed in the posterior region of the jaws after one year of loading with single prostheses.

Material and Methods

Patients and Study Site

The present prospective clinical study was approved by the Ethic Committee for Research in Humans at Federal University of Sergipe, Brazil, and all patients signed a written informed consent before taking part in the study. Twenty one healthy patients, scheduled for single unit prosthetic rehabilitation supported by implant in the posterior region of the jaws were included in the study, those patients constituted a convenience sample. The implants and the prosthesis were delivered in a private practice clinic.

The inclusion criteria for all participants were: (i) to sign voluntary informed consent for using his/her data, (ii) age ≥ 18 years-old, (iii) to require 2 implants in either the posterior maxilla or mandible (one NDI and one RDI) to be restore with a single crown and (iv) to exhibit an alveolar ridge 5-6 mm wide. The exclusion criteria were the following: (i) previous bone augmentation procedure at implant site, (ii) presence of untreated periodontitis, (iii) soft and/or hard tissues alterations, (iv) use of any drug that could affect bone metabolism, (v) alcohol or tobacco abuse (> 10 cigarettes/day), (vi) presence of immunocompromising conditions (HIV-positive, or under therapy with immunosuppressive drugs), (vii) pregnancy, (viii) presence of parafunctional habits; and (ix) history of radiotherapy of the head/neck region.

Study Design

The patients were selected to receive one NDI (3.3 mm) and one RDI (4.1 mm) Straumann® Standard Plus implants with a SLA-surface and a platform diameter of 4.8 mm (Straumann® Dental Implant System, Basel, Switzerland). Twenty-one healthy patients (10 males and 11 females) with a mean age of 57.2 years were selected for the study. A total of 42 implants were placed (21 RDIs and 21 NDIs). Fourteen implants were placed in the maxilla (7 NDIs and 7 RDIs) while the remaining 28 implants were placed in the mandible, (14 NDIs and 14 RDIs). The implants ranged from 6 to 10 mm in length. The region of the implant's placement was randomly assigned following simple randomization procedures (computerized random numbers).

The surgical procedures were performed under anesthesia with mepivacaine 2% and epinephrine (Noraepinephrine 1:100,000). After local anesthesia, a crestal incision was made and a full-thickness flap was elevated. Subsequently, the implants were placed according to manufacturer's instructions and healing caps were placed on each implant. The flap was repositioned and stabilized with interrupted sutures around the healing caps in such a way to allow a semi-submerged healing. The sutures were removed 10 days after implant placement. Medical prescription was given to patients that included potassium diclofenac (50 mg), one pill every eight hours for three days, amoxicillin (500 mg), one capsule every eight hours for seven days and mouthwash with chlorhexidine digluconate 0.12%, twice a day for 15 days. All surgical procedures were performed by the same clinician. After 6 weeks of healing, impression of the implant sites were taken and 2 weeks later, screwed-retained single metal-ceramic crowns were delivered. The patients were included in a plaque control regimen, which consisted of oral hygiene instruction and professional plaque control that took place during follow-up appointments at 3, 6, 9 and 12 months after prosthetic rehabilitation had been delivered. The presence of occlusal contact on the ceramic crowns was confirmed with the aid of occlusal marking films.

Primary Outcome Measurements

The primary outcome measurements were the change of peri-implant marginal bone level and success and survival rates of the narrow diameter implants. Panoramic radiographs were performed immediately after prostheses installation (T0) and one year after loading (T1). All panoramic radiographs were performed in the same radiological clinic and with the same apparatus (Planmeca ProMax®, Planmeca, Helsinque, Finland). At mesial and distal aspects of each implant, the distance between the implant shoulder to the first point of bone/implant contact was measured with the aid of a computer program (Image J®, National Institutes of Health, Maryland, USA in ImageJ library [Rasband (1997-2006)] and an average data was obtained for each fixture. A periapical radiograph after implant placement to know the per-implant bone level insertion of this implant was also realized.

Implant survival was defined in this study as the implant being still in place at the 12-month follow-up. Implant success was defined according to Karoussis et al. (2003) [12] as absence of (i) persistent pain, foreign body sensation and/or dysesthesia; (ii) recurrent peri-implant infection with suppuration; (iii) implant mobility (M); (iv) continuous radiolucency around the implant; (v) clinical probing depth (CPD) ≥ 5 mm associated with bleeding on probing (BoP). The peri-implant suppuration (S), bleeding on probing (BoP) and clinical probing depth (CPD) were obtained with use of a manual periodontal probe (William's probe, Hu-Friedy®, Chicago, United States). Implant mobility (M), S and BoP were recorded as absent or present. Furthermore, the percentage of visible bacterial plaque present on the different crown aspects was also determined. All variables described above, except M, were measured at the four implants aspects (mesial, distal, buccal and lingual sites) at six weeks after fixture installation, 3, 6, 9 and 12 months after loading. A calibrated examiner who was not involved in the surgical procedure performed all measurements.

Secondary Outcome Measurement

The secondary outcome measurement was represented by the success rate of the implant-supported prosthesis. Prosthesis success according to Pjetursson et al. (2012) [13] was defined as (i) absence of prosthesis (crown or abutment) mobility and (ii) lack of necessity of prosthesis repair at the 1-year follow-up examination.

Calibration

Calibration of the clinical and radiographic examinations was performed to ensure consistent evaluation of the implant sites. In order to calibrate the examiner prior to actual measurements, intra-observer error was determined by measuring soft tissue characteristics (CPD and BoP) and measuring bone marginal level around 10 implants, five of each group, on patients randomly chosen. Each measurement was performed twice over 2 days, with an interval of at least 24 hours, in patients included in this clinical protocol. The Kappa correlation coefficient was 0.9.

The error associated with the radiographic technique was also calculated using the same program used for peri-implant bone loss measurements. Measurements obtained from radiographs were compared to the actual dimensions of implants [14,15]. An RDI has a real width (excluding the threads) of 3.5 mm, while an NDI has an actual width (excluding the threads) of 2.8 mm. The difference between the mean variability found on the radiologic images and the real size of implants (3.5 mm and 2.8 mm) was calculated. The calculation employed confirmed that the distortion observed in the radiographic images obtained with panoramic technique was the same as that established by the radiographic equipment's manufacturer (25%) used for correction.

Statistical Analysis

Mean values and standard deviation (SD) were calculated for each variable. Each patient was considered as statistical unit. The differences in marginal bone change between the groups were analyzed by Student t-test for paired samples, regarding CPD, were analyzed using Mann–Whitney U-test, and the p value <0.05 was considered as the level of significance. Furthermore, the implant survival and success rate, S, M and BoP were calculated in each experimental group and expressed in mean percentage.

Results

Implants were placed in maxilla and mandible as showing in Table 1. At the end of the follow-up period (12 months of loading), implant success and survival rates of 100% were observed. The percentage values of M, BoP and S at 1-year time interval after loading (T1) are shown in Table 2. Bleeding on probing index and visible bacterial plaque were, respectively, 6% and 9% for NDIs. The corresponding values for RDIs were, respectively, 8% and 9%. No probing depths ≥ 5 mm or suppuration was identified in any of the groups. There was no statistically significant difference between the variables M, BoP and S in groups Test and Control.

	Test group (n=21)	Control group (n = 21)
Maxila pre molar	3	2
Maxilla molar	4	5
Mandible pre molar	6	7
Mandible molar	8	7

Table 1: Position of implants according to region and groups placed in maxilla and mandible (n=42)

Parameters	Test group	Control group
BoP	6	9
Mobility	0	0
Suppuration	0	0

Table 2: The frequency (%) of bleeding on probing (BoP), mobility and supurration 1 year after loading in Groups Test and Control (n = 21 implants/group)

The average CPD at 6-weeks follow-up was 3.01 mm (± 0.42) and 2.89 mm (± 0.51) in the NDIs and RDIs, respectively. At 1 year after loading the average CPD was 3.31 mm (± 0.84) and 3.27 mm (± 0.90) in the NDIs and RDIs, respectively. The bone loss around implants at T0 was 0.41 (± 0.45) mm for NDIs and 0.47 (± 0.60) mm for RDIs and at T1 was 1.3 (± 0.3) mm for NDIs and 1.24 (± 0.3) mm for RDIs. No statistically significant differences between the groups were found regarding the above clinical variables (p>0.05). The prosthesis success rate was 100% for both groups.

Discussion

The present radiographic prospective controlled study analyzed marginal vertical bone loss around narrow-diameter and regular-diameter implants placed in the posterior region of the jaws and loaded with a single crown. Regardless implant diameter (regular or narrow), no statistically significant differences in relation to bone loss were found between NDIs and RDIs placed either in the posterior maxilla or mandible. One year after loading, the implant survival and success rates as well as the prosthesis success rate were similar between the two groups. In addition, the mean values of CPD, BoP, S, and M were also similar between the groups.

Different kinds of imaging methods can be used for diagnostic and treatment plans, including conventional radiographs (periapical, panoramic, cephalometry) and computerized tomography [16]. The choice for panoramic radiography in this study was due to a number of reasons: (i) the method is more affordable; (ii) image standardization is obtained through a simple and universal positioning device; and (iii) the distortion produced by the method can be corrected with the assistance of a computer program. Despite the fact that several authors consider other radiological methods more suitable for bone loss measurements around teeth and implants [17,18], panoramic radiography is still widely used in clinical situations, and it is considered a useful imaging method in implantology [16,19,20]. As a result, recent studies have assessed per-implant bone loss by means of panoramic radiography [21,22]. The main criticism in relation to its use, however, lies in the fact that panoramic radiographs do not provide the same level of clarity and sharpness of periapical radiographs [23]. In order to circumvent this problem, all measurements were carried out by just one examiner, who was duly and thoroughly calibrated before the actual measurements were made, so that possible misreading were minimized.

The radiographic peri-implant marginal bone loss observed in the present study demonstrated no statistically significant differences when RDIs were compared to NDIs. This finding is in accordance with clinical data previously reported in the literature [11,24-28]. Such result is of particular interest since it suggests a high level of predictability for both implants in relation to the expected bone loss after one year of loading. In addition, the similar low frequency of bleeding on probing and absence of suppuration and mobility observed in both group of implants confirmed that there was no difference between the NDIs and RDIs.

The findings from the present study showed a high NDI survival rate (100%) after one year of loading, even though all implants had received single crowns. Several clinical studies [29-34], have already demonstrated high survival rates for NDIs placement. In those studies, however, NDIs were always connected to other NDIs or RDIs through partial-fixed dentures or were placed in the anterior region. The reason for this seems to be originated in the concept that NDIs are not capable of properly neutralizing and distributing the forces generated by occlusion in the posterior region when supporting single crowns [35].

Conclusion

Based on the results obtained in this 1-year prospective study, NDIs placed in posterior region of the jaws without sufficient bone thickness for placement of RDIs presented a high success and survival rate. In addition to that, NDIs presented marginal bone loss patterns similar to those for RDIs, both in the maxilla and mandible. Thus, it can be suggested that NDIs may be successfully used in the posterior regions of the jaws. More studies with longer follow-up intervals are, however, necessary to further evaluate single crowns supported by NDIs in the posterior region of the jaws.

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