EFFECT OF DISTANCE BETWEEN ONE PIECE IMPLANTS ON CRESTAL BONE RESORPTION

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One-piece implants became incorporate the trans-mucosal abutment facing the soft tissues as an integral part of the implant. The interface between the trans-mucosal component and the implant is generally located in the neighbourhood of the alveolar bone level. One-piece implant are usually welded together and immediately loaded. Since no report is available on the effect of distance between implants on clinical outcome, a retrospective study was performed. Nineteen patients (10 females and 9 males) with a median age of 62 years (min-max 43-80) were enrolled. The mean follow-up was 7 months. A total of 176 one-piece implants (Diamond, BIOIMPLANT, Milan, Italy) were inserted. Among them 11 failed (i.e. survival rate – SVR = 93.75). The remaining 165 were studied as regard peri-implant bone resorption. Since 4 fixtures have a crestal bone resorption higher than 1.5 mm, the success rate (SCR) was 97.57. Log rank testing was used to compare success curves. Statistical analysis demonstrated that an average distance between fixtures of about 2 mm does not determine an higher crestal bone resorption when one-piece implants are used. In conclusion one-piece implants are reliable devices for oral rehabilitation and distance between fixtures of about 2 mm does not determine an higher crestal bone resorption.

Soft tissue esthetics, along with osseointegration, are important factors for successful implant treatment. During the treatment procedure, minimal soft tissue intervention has been advocated for obtaining optimal soft tissue integration. Thus, it would be desirable not to manipulate the soft tissue at the implants during and after initial healing, as such intervention may disrupt the soft tissue seal. Abutment connection in the 2-stage treatment procedure requires a second surgical intervention involving the soft tissue and, in addition, the procedure generally involves use of healing abutments that are removed after soft tissue healing. The replacement of healing abutments with definitive abutments may result in disruption of the tissue at the implant-soft tissue interface (1).

The presence of a trans-mucosal component at two-piece implant systems can lead to intentional or unintentional disconnections of this abutment. Based on Hermann et al. (2) results, an unintentional abutment loosening will lead to a disruption of the soft tissue integration and to increased bone remodeling. It has also been shown that repeated intentional abutment disconnections and reconnections after alcoholic disinfection induces an apical repositioning of the soft tissues and marginal bone resorption (3). In contrast, a single shift of a healing abutment and replacement by a final abutment proved to induce no marginal bone remodeling (4).

Unavoidable issues of bone resorption and soft tissue remodeling following tooth extraction (5) have been proposed with the most significant bone resorption occurring in the first 3 months (6). This has been attributed to be predominantly due to the loss of bundle bone around the socket and the resorption of the external cortical plate in response to surgical trauma (5). Immediate implant placement in fresh extraction sockets have shown to limit this extent of the anticipated hard and soft tissue remodeling therefore, avoiding the need for augmentation procedures (7). Single implant crowns as immediate restorations both in and out of occlusion on implants placed in fresh extraction sockets have shown acceptable

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prosthodontic and patient-satisfaction outcomes (8, 9).

Using experimental implants with either a one-piece or a two-piece design, Hermann et al. (10) showed significantly higher apical migration of the soft tissues and marginal bone resorption with two-piece implants, suggesting a role of the sub-gingival position of the abutment/implant interface (so-called microgap) on tissue remodeling in strong opposition with several animal studies (2, 3, 11) in which a soft tissue integration occurs at the abutment level. In another experiment of the same group (2) it was demonstrated that the size of the microgap between implants and abutments has little influence on marginal bone remodeling, whereas micromovements of the abutments induce a significant bone loss, independent of the microgap's size. This strongly suggests that the mechanical disruption of the soft tissue interface is of importance.

Another important variable for the aesthetic outcome is the distance between implants. Around dental fixtures exists a ''biologic width'' of few millimeters that have to be preserved in order to not have adverse effect on soft and hard tissues around implant (12).

Since one-piece implants became more and more popular and no report is available on the effect of the distance between implants on clinical outcome we perform a retrospective study.

MATERIALS AND METHODS

A) Study design/sample

To address the research purpose, the investigators designed a retrospective cohort study. The study population was composed of patients at the Dental Clinic, University of Chieti, Italy for evaluation and implant treatment by S.F. between January and December 2010.

Subjects were screened according to the following inclusion criteria: controlled oral hygiene and absence of any lesions in the oral cavity; in addition, the patients had to agree to participate in a post-operative check-up program.

The exclusion criteria were as follows: bruxists, smoking more than 20 cigarettes/day, consumption of alcohol higher than 2 glasses of wine per day, localized radiation therapy of the oral cavity, antitumor chemotherapy, liver, blood and kidney diseases, immunosupressed patients, patients taking corticosteroids, pregnant women, inflammatory and autoimmune diseases of the oral cavity.

B) Variables

Several variables are investigated: demographic (age and gender), anatomic (tooth site, distance between implants), implant (length and diameter), and prosthetic (welding procedure) variables.

The predictor of outcome is the peri-implant bone resorption. It is defined as implant success rate (SCR) and it is evaluated according to the absence of persisting peri-implant bone resorption greater than 1.5 mm during the first year of loading and 0.2 mm/years during the following years (13).

C) Data collection methods

Before surgery, radiographic examinations were done with the use of orthopantomographs and CT scans.

Peri-implant crestal bone levels were evaluated by the calibrated examination of orthopantomograph x-rays after surgery and at the end of the follow-up period. The measurements were carried out medially and distally to each implant, calculating the distance between the implant' neck and the most coronal point of contact between the bone and the implant. The bone level recorded just after the surgical insertion of the implant was the reference point for the following measurements. The measurement was rounded off to the nearest 0.1 mm. The radiographs were performed with a computer system (Gendex, KaVo ITALIA srl, Genova, Italia) and saved in uncompressed TIFF format for classification. Each file was processed with the Windows XP Professional operating system using Photoshop 7.0 (Adobe, San Jose, CA), and shown on a 17" SXGA TFT LCD display with a NVIDIA GÈ Force FX GO 5600, 64 MB video card (Acer Aspire 1703 SM-2.6). By knowing dimensions of the implant, it was possible to establish the distance from the medial and distal edges of the implant platform to the point of bone-implant contact (expressed in tenths of a millimeter) by doing a proportion.

The difference between the implant-abutment junction and the bone crestal level was defined as the Implant Abutment Junction (IAJ) and calculated at the time of operation and at the end of the follow-up. The delta IAJ is the difference between the IAJ at the last check-up and the IAJ recorded just after the operation. Delta IAJ medians were stratified according to the variables of interest.

D) Surgical protocol

All patients underwent the same surgical protocol. An antimicrobial prophylaxis was administered with 1g Amoxycillin twice daily for 5 days starting 1 hour before surgery. Local anesthesia was induced by infiltration with articaine/epinephrine and post-surgical analgesic treatment was performed with 100 mg Nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

One-piece implants (Diamond, BIOIMPLANT, Milan, Italy) were inserted with a trans-mucosal approach. The implant neck was positioned at the alveolar crest level. Welding procedure was performed by using an intra-oral welding machine Dent Weld (Swiss & Wegman S.r.l., Ponte San Nicolò (PD) Italy) (fig 1 and 2). A provisional prosthesis was immediately provided and the final restoration was usually delivered within 8 weeks (fig 3). All patients were included in a strict hygiene recall.

E) Data analysis

Disease-specific survival curves were calculated according to the product-limit method (Kaplan-Meier algorithm) (14). Time zero was defined as the date of the implant's insertion. Implants which have a crestal bone resorption value lower then the cut-off value were included in the total number at risk of loss only up to the time of their last follow-up. Therefore, the SCR only changed when crestal bone resorption higher than the cut-off value occurred. The calculated SCR was the maximum

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estimate of the true success curve. Log rank testing was used to compare success curves, generated by stratifications for a variable of interest.

RESULTS

Nineteen patients (10 females and 9 males) with a median age of 62 years (min-max 43-80) have the inclusion criteria and were enrolled in the present study. The mean follow-up was 7 months.

A total of 176 one-piece implants (Diamond, BIOIMPLANT, Milan, Italy) were inserted, 83 in the maxilla and 93 in the mandible. Implants were inserted to replace 55 incisors, 32 cuspids, 53 premolars and 36 molars. Implant' length was shorter than 13 mm, equal to 13 mm and longer than 13 mm in 40, 39 and 97 fixtures, respectively. Implant' diameter was narrower than 4 mm, equal to 4 mm and wider than 4 mm in 12, 97 and 67 fixtures, respectively. One hundred and thirty-eight implants were welded.

In 146 implants was calculated the distance between fixtures: the mean values was 3.9 ±1.8 mm (min/max 1.1/10 mm). Distance between fixtures was lower than 3 mm in 49 fixtures (mean value = 2.3 ± 0.4 mm, min/max 1.1/2.8 mm) and equal or wider than 3 mm the remaining 97 cases (mean value = 4.7 ± 1.7 mm, min/max 3/10 mm).

Peri-implant crestal bone resorption was recorded

Table I. *Output of Kaplan-Meier analysis calculated by using the SCR (i.e. crestal bone resorption around implant neck).*

Variable	Log Rank	Degree of freedom	Level of significance p
Implant site	1.36	3	.7154
Maxilla/Manndible	.18	1	.6743
Implant length	1.53	2	.4661
Implant diameter	5.34	2	.0691
Welding	2.37	1	.1234
Distance between implants	3.17	1	.0752

Fig. 1. *The welding procedure.*

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Fig. 2. *Welded implants.*

Fig. 3. *The final prosthetic restoration.*

in 165 implants and has a mean value of -0.1 ± 0.7 mm (min/max -1.8/+2.1 mm). There was a bone regeneration around 65 implants (positive values).

Eleven implants were lost in the post-operative period (within 3 months), survival rate = 93.75.

Then peri-implant bone resorption (i.e. delta IAJ) was

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used to investigate SCR in the remaining 165 implants.

Four fixtures have a crestal bone resorption greater than 1.5 mm (SCR = 97.57) and thus were used for statistical purpose.

Statistical analysis demonstrated that an average distance between fixtures of about 2 mm does not determine an higher crestal bone resorption when one-piece implants are used (Table 1).

DISCUSSION

The phenomenon of the establishment of a zone of ‘‘biological width’’ has been a challenging and demanding procedure for many years. In its most simplified form, biological width refers to the height of the junctional epithelium and connective tissue attachment, located between the base of the sulcus and the alveolar bone crest, and it is defined as the distance necessary for a healthy existence of bone and soft tissue from the most apical extent of a dental restoration (15-21).

Because the bone crest constitutes the base for the soft tissue, alterations in the peri-implant bone level will affect the position of the soft tissue margin, which in turn will have a significant impact on the aesthetic outcome of the implant therapy (22). The consequences of increased loss of peri-implant bone support have been reported with decreasing distance between the implant and the tooth (23). Furthermore based on the finding that the bone crest was more apically located at sites with <3 mm inter-implant distance than at sites where the implants were standing >3 mm apart, Tarnow et al. (24) suggested that not only vertical bone loss but also lateral bone loss at implants could have an effect on the level of the bone crest between two implants. The bony support between a tooth and an implant or between two implants has been shown to be an important criterion in creating or preserving the papilla (21)((25). For example, when the measurement from the interproximal coronal contact point to the crest of bone is 5 mm or less, the papilla is present almost 100% of the time (26). Tarnow et al., (1992)(24) reported a mean papillary height between two adjacent implants as 3.4 mm. One difficulty in maintaining or re-forming a papilla between two implants is that the biological width around an implant usually is located apical to the implant abutment connection. In the aesthetic zone, the distance from alveolar crest to the adjacent tooth cementoenamel junction should be 3–5 mm to achieve ideal implant localization (27) and appropriate space for the peri-implant sulcus to form.

Previously our group demonstrated that adjacent 2-piece implants inserted with a distance lower and higher than 1.8 mm have difference in crestal bone resorption (12). In addition it was demonstrated that 2-mm is a safe distance between implant and tooth if 2-piece reverse conical neck implants are used (28).

Here we demonstrated that one-piece implants are reliable devices for oral rehabilitation (since they have a SVR = 93.75 and a SCR = 97.57) and distance between fixtures of about 2 mm does not determine an higher crestal bone resorption.

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