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Radiographic evaluation of marginal bone levels around dental implants with different designs after 1 year

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Abstract

Objective. The aim of this study was to use intra-oral radiographs to evaluate changes in marginal bone levels around three different implant designs after 1 year. ***Materials and methods.*** Three implant designs; two with a straight and one with a conical design, were placed adjacent to each other in the partially edentulous areas of 25 patients. The patients received 46 implants with a straight design (All fit SSO and SPI-element) and 29 implants with a conical design (SPI-contact). Two-way repeated analysis of variance (ANOVA) was used to evaluate the marginal bone changes in each group at 12 months follow-up ($p < 0.05$). ***Results.*** None of the implants had failed by the end of this study. After 12 months, significant differences were noted in the amount of alveolar bone loss recorded between the All fit SSO and SPI implants ($p < 0.05$). Mean crestal bone loss was 0.88 ± 0.43 mm for the All fit, 0.61 ± 0.34 mm for the SPI contact and 0.54 ± 0.27 mm for the SPI element implants. ***Conclusions.*** The results of this study demonstrate that straight (cylindrical) implants with shorter high polish surface displayed less bone resorption.

Key Words: *dental implant, macro design, bone loss, rough surface*

Introduction

Nowadays, treatment planning for oral rehabilitation is mainly based on using dental implants, the function of which is to transfer loads to the surrounding biological tissue. One of the criteria for evaluating implant success is the bone levels surrounding dental implants [1].

Marginal bone loss up to the first coronal thread of a dental implant is commonly observed after attachment of the abutment [2]. In a 15-year study by Adell et al. [3], 1.2 mm of bone loss was reported during the first year of the study. There are many factors that can accelerate bone loss; they can be categorized into systemic factors (such as systemic diseases) and local factors (such as design and surface treatment of the dental implant).

Various types of dental implants with macroscopic and microscopic design components are available. Review of the literature has revealed different implant survival rates and marginal bone loss values for various implant designs [4–9].

Variation in component designs among dental implant systems may lead to different stress/strain distributions, thus altering the transmission of forces to the surrounding bone [10]. Smooth-sided, cylindrical and tapered implants have a component of compressive load to be delivered to the implant–bone interface which depends on the degree of taper [11]. However, there are limitations in the amount of implant tapering [12]. The aim of this study was to use intra-oral radiographs to evaluate changes in marginal bone levels around three different implant designs after 1 year.

Materials and methods

In total, 25 patients (19 male, six female; age range: 16–55 years) were included in this clinical study. Inclusion criteria were: residual bone volume

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sufficient to receive at least three implants (4/10 mm) in the premolar and/or first molar regions of the mandible/maxilla, sufficient keratinized tissue, absence of systemic diseases that would prevent surgery and good oral hygiene.

Exclusion criteria were: history of radiotherapy in the head and neck region, bruxism and/or clenching, smoking habit, immuno-compromising diseases, partial/full denture prosthesis in an opposing position to the implants, local inflammation and oral mucosal diseases, requirement for bone graft surgery/GTR prior to implantation and immediate implant placement.

Patients provided informed consent to participate in this clinical trial and the follow-up consultations. The consent form and experimental protocol were approved by the Ethical Committee of Hamadan University of Medical Sciences.

The optimal locations for the implants were determined using intra-oral parallel radiographs and computed tomography. Three implant designs; two with a straight and one with a conical design, were placed adjacent to each other in the partially edentulous areas of 25 patients. The patients received 46 implants with a straight design: the All fit SSO (Dr Ihde Dental Co, Eching, Germany) and SPI-element (Thommen Medical, Waldenburg, Switzerland); and 29 implants with a conical design: SPI-contact (Thommen Medical). Altogether 75 implants were placed; diameters of the implants used in this study were 4 and 4.1 mm and lengths of the implants were between 10–11 mm. All of the implants were randomly assigned for each patient. The surgical and prosthetic procedures were conducted according to manufacturer guidelines and one stage implant surgeries were performed under local anesthesia. A specialist dental surgeon and prosthodontist participated in this study. Single crowns were placed after 2 months in the mandible and 3 months in the maxilla.

Post-surgical medications included 400 mg ibuprofen 4-times a day for 2 days, 500 mg amoxicillin 3-times a day for 7 days and oral rinsing with 0.12% chlorhexidine gluconate (1 min) twice a day for 7 days.

Standardized intra-oral paralleled radiographs (Kodak E DF; Eastman, Kodak Co, Rochester, NY) were taken for evaluation of marginal bone levels at the time of placement of the final restoration and at 1-year follow-up appointments. Standardized radiographs were obtained by individualizing x-ray templates with poly vinyl siloxane (Express; 3M ESPE, Seefeld, Germany).

Post-operative observations were recorded on a standardized form by two calibrated examiners. Reproducibility was greater than 90%. For both mesial and distal surfaces of each implant site, the mean of the coronal and apical measurements were calculated using a digital coulis. SPSS for Windows 10 statistical package was used for statistical analysis. Two-way repeated analysis of variance (ANOVA) was used to test the significance of marginal bone changes at the baseline and at 12 month follow-up appointments. Statistical significance for all of the tests was set at $p < 0.05$.

Table I. Crestal bone loss for different types of implant after 12 months.

Implant type	Numbers	Mean	SD	95% CI
All fit SSO	23	0.88	0.43	(0.69, 1.07)
SPI-contact	29	0.61	0.34	(0.48, 0.74)
SPI-element	23	0.54	0.27	(0.43, 0.66)
Total	75	0.66	0.37	(0.59, 0.76)

Results

None of the implants had failed by the end of this study. After 12 months, significant differences were noted in the amount of alveolar bone loss recorded between the All fit SSO and SPI implants ($p < 0.05$). Mean crestal bone loss was 0.88 ± 0.43 mm for the All fit SSO, 0.61 ± 0.34 mm for the SPI contact and 0.54 ± 0.27 mm for the SPI element implants. Marginal bone loss for each type of implant design is illustrated in Table I. In comparison, significant differences were detected between the various implants (Table II). Thirty-eight implants were placed in the maxilla and 37 implants were placed in the mandible. There was no significant difference in the mean bone loss between the two jaws ($p = 0.985$).

Discussion

Bone resorption usually occurs during the first year of prosthesis placement, decreasing considerably after occlusal loading. However, the causes of marginal bone loss around dental implants are not clearly understood. Some studies have suggested that it could be caused by interruption of blood circulation due to external injury during surgery, encroachment of the biological width, presence of a gap between the implant and the abutment, overload and poor implant design [8,13-15]. The cover screw may be covered by bone at the second-stage surgery, although bone loss has been reported after functional loading [3,16].

Table II. Comparison of marginal bone changes between different implant designs.

Implant type	Mean difference	*p*-value	95% CI
All fit and SPI-contact	0.27	0.008	(0.07, 0.46)
All fit and SPI-element	0.33	0.002	(0.13, 0.54)
SPI-element and SPI-contact	0.06	0.4	(0.06, 0.4)

$p < 0.05$.

Chang and Wennström [17] showed in a study that maximum soft and hard tissue changes around an implant occur primarily during the first 6 months after the one-stage implant installation surgery.

The implants used in this study have some differences in the macro- and micro-design components of their fixtures. There are numerous reports of the effect of implant surface roughness on bone-to-implant contact and marginal bone changes after functional loading [18-20]. In this study, two different surface roughness and three different implant body/neck designs were used. The results showed that the straight (cylindrical) implants with shorter high polished (SPI) elements displayed the least marginal bone loss after 1 year of functional loading.

After 1 year, mean bone loss values were 0.88 ± 0.43 for the All fit implants (straight or cylindrical) with double sand blast surfaces and 0.54 ± 0.27 for the SPI-element implants with sand blast and acid etch surfaces (straight or cylindrical); the results showed a significant deference between the two surfaces ($p = 0.002$). On the other hand, among SPI implants of similar surface (Sand Blast - Acid Etch) and different designs, the amount of bone resorption was greater around the SPI-contact (tapered or conical) compared to the SPI-element (straight or cylindrical) implants ($p = 0.4$).

According to previous reports, these findings may also be related to the height and design of the implant neck, fixture to abutment connection and implant thread designs. The differences between the amount of bone loss around cylindrical (element) and conical (contact) SPI implants ($p = 0.4$) may be related to the height of high polish or body designs. However, a significant difference was revealed for the All fit implants compared to the SPI implants; such marginal bone level changes are in agreement with previous reports [8,11,21,22].

We attempted to match the variables and exclude any interventional factors in this short-term study. However, more systematic long-term studies are recommended to be performed on the factors influencing bone resorption around dental implants after standardizing for a number of variables such as the type of implant, bone quality, micro/macro design and the type of restoration, etc.

Conclusion

The results of this study demonstrated that straight (cylindrical) implants with shorter high polish surface displayed the least amount of bone resorption.

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