Marginal bone level around conical connection tapered implants with platform switching: A multicenter retrospective study at 14 months follow-up

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ABSTRACT

Aim The long-term success of dental implants mainly depends on marginal bone stability around the fixtures. The development of prosthetic abutments with reduced width in relation to the implant prosthetic platform (platform switching) and/or tighter implant/abutment connections seem to have a potential in reducing crestal bone resorption. The aim of the present study was to examine the effect of platform switching and conical connection design, on marginal bone loss around newly designed dental implants.

Materials and Methods Subjects who underwent implant therapy in three different centers, were enrolled in the present retrospective study. Patients were rehabilitated with tapered platform-switched dental implants. To evaluate marginal bone level changes over time, the mesial and distal bone height was radiographically evaluated on the day of implant placement (baseline) and 14 months post-implantation.

Results One hundred and twelve conical tapered platform-switched implants were placed in three different centers in 37 patients, with mean age of 53 years. The survival rate was 100% after an average follow-up of 14 months. During the first year, marginal bone loss was 0.67±0.45mm. No statistically significant differences were recorded between the different centers.

Conclusions Within the limitations of the present retrospective study, limited marginal bone loss and 100% implant survival rate were observed over 14 months of follow-up. The results showed high crestal bone stability around the newly designed conical tapered platform-switched implants.

KEYWORDS Bone loss; conical connection; platform switching; tapered implants.

INTRODUCTION

The successful replacement of lost natural teeth by osseointegrated implants is a major advance in clinical dental treatment. Implant therapy has made a substantial improvement in terms of survival rate. Nowadays, dental implants report a high survival rate: on average, only 2.5% of all implants placed are lost before loading, and after the prosthetic reconstruction the failure rate varies between 0.5 – 1.3% per year (1). Therefore, the main focus of the dental community today is on the success rate of the dental implant and the stability of the results. The long-term success of endosseous implants depends mainly on the preservation of bone support. Indeed, maintenance of osseointegration and stability in marginal bone level are imperative to this success.

Peri-implant marginal bone loss is influenced by many factors and by multiple phenomena (2). Those might include the surgical technique (3), implant positioning (4), tissue thickness (5), the presence of a micro-gap (6) at the implant-abutment interface (7), and the implant design (8). All of them can also influence the stability of the marginal bone crest.

The criteria to define success in implant dentistry are under constant debate, but the achievement and maintenance of osseointegration are recognized as crucial factors, and marginal bone loss (MBL) is therefore a key consideration.

The ubiquitous loss of up to 2 mm of bone around implant neck during the first year after functional loading has widely been considered acceptable by the dental community and has even been considered a successful outcome in some classifications and consensus statements (9,10). However, tissue stability is expected at one year after placement, and a loss of more than 0.2 mm per year is regarded as undesirable (9). Other Authors have claimed that a marginal bone loss of 1.5 mm in the first year (11), 1.8 mm (12), or 1.5–2 mm (13) represents a good outcome. A MBL of less

than three threads has also been proposed as a success criterion (14,15), despite the variability in inter-thread distances among different implant systems.
Implant design concepts to diminish crestal bone loss have been developed and embedded in dental implant structure. The development of prosthetic abutments with reduced width in relation to the implant prosthetic platform (platform switching concept), and an internal conical implant-abutment connection, seem to have a potential in reducing crestal bone resorption. Implants with platform switching show a lesser crestal bone loss, improved crestal bone preservation and lead to controlled biological space reposition and to stable aesthetic outcomes (16). A recent meta-analysis revealed significantly less bone loss around implants with a platform switching configuration compared with the standard platform matching implant-abutment design (17).
The aim of the present retrospective study was to examine the effect of a newly designed conical tapered platform-switched implant on the marginal bone level over 14 months of follow-up.

MATERIALS AND METHODS

Data collection

In the present retrospective observational study were enrolled patients who underwent implant therapy in three different centers: one in Jerusalem (Israel) (LS-research supervisor), one in Barcelona (Spain) (JN research supervisor) and one in Murcia (Spain) (JG research supervisor). All subjects were treated with tapered dental implants, with internal conical implant-abutment connection and a built-in platform switching (MIS C1 Conical Connection, MIS, Israel).

Inclusion and exclusion criteria

Patients were included in the study according to the following criteria:

1. implant placement performed at least three months after tooth extraction;
2. medical history without any contraindications to implant therapy;
3. pre-existing bone, radiographically examined by a CT scan, adequate to allow the placement of at least 3.75-mm-diameter and 10-mm-long implants with a potential minor horizontal bone augmentation.

Exclusion criteria were:

1. subjects with systemic diseases such as diabetes;
2. pregnant and lactating subjects;
3. subjects with habit of severe bruxism or clenching;
4. subjects treated with radiation to the head within the past 12 months;
5. subjects treated with bisphosphonate within the past 12 months;
6. subjects smoking more than 10 cigarettes/day.

Surgical procedure

All surgeries were performed by three practitioners: 2 periodontists (LS and JN) and one oral surgeon (JG). All surgeries were performed under local anesthesia, and with antibiotic premedication of 2 g of amoxicillin (Moxypen, Teva, Israel and Actimoxi, Clariana, Spain). The antibiotic medication was continued, 500 mg 3 times a day, for up to 5 days. In cases where bone was missing around the implant's neck, a GBR (Guided Bone Regeneration) procedure was performed using a xenograft bone substitute (Osteobiol® Gen-Os, Tecnoss, Torino, Italy) and a collagen membrane (Osteobiol® Evolution, Tecnoss, Torino, Italy). The patients were instructed with oral hygiene, and rinsing with 0.2% chlorhexidine solution twice a day until suture removal, starting the day of surgery. Patients were instructed with analgesic medications post-surgery as needed. Suture removal took place 7-10 days post-surgery. All implants were placed in a submerged protocol; they were reentered and exposed by elevating a mini full-thickness flap 2-4 months after implant installation. At least 2 weeks later, the implants were loaded. Following the prosthetic reconstruction, the patients were seen at least every 6 months for professional plaque control by a dental hygienist and for follow-up appointments by the prosthodontist.

Radiographic examination and evaluation

All implants were examined by means of radiographs taken immediately after implants placement (time point 0: T0, baseline) and radiographs obtained on average fourteen months post-implantation (time point 1: T1). The radiographs were both intraoral periapical ones, obtained using the parallel technique with film holders, or panoramics (Gendex, Hatfield, PA, USA); a digital intraoral imaging system was used (Digora phosphor plate reader, Soredex Tuusula, Finland). All the X-rays were scanned and uploaded into the computer in order to assess marginal bone level changes over time. The measurements were taken on the computer screen using the "ImageJ" software (http://rsbweb.nih.gov/ij/download.html). Only the vertical peri-implant bone level was assessed; this was defined as the vertical distance between a reference point at the implant shoulder and the most coronal bone-implant contact (Fig. 1).

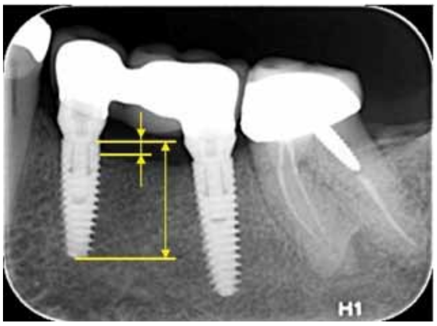

FIG. 1 Measurement of the vertical peri-implant bone level, obtained as the vertical distance between a reference point at the implant shoulder and the most coronal bone-implant contact.

Changes in marginal bone level were expressed as differences in the measured values on radiographs (T1-T0=ΔIBL). Marginal bone loss was calculated by multiplying the actual implant length with the bone loss from a constant referral point of the implant-abutment connection (ΔIBL), all divided with the implant length measured on the x-rays.
The calculating equation was as follows:

$$\text{Marginal bone loss} = \frac{\text{Actual implant length X } (\Delta\text{IBL})}{\text{Implant length on x-ray}}$$

The radiographic measurements were independently performed by a blinded periodontist, experienced with oral radiology (MT).

Statistical methods

The primary outcome variable was ΔIBL. The hypothesis tested was that the average ΔIBL values would be significantly smaller than those accepted in the literature.
For statistical analysis STATISTICA v7.0 software (StatSoft, Inc.; Tulsa, OK) was used. Descriptive statistics were used to explore the demographic data of the patients. Bi-nominal patient and implant descriptive variables were defined (such as smoking, center of treatment, follow-up x-ray, etc.).
T-test was utilized to describe the amount of MBL found between groups of each describing variable. Data analysis was done based on the patient mean MBL and on each implant MBL.
For all statistical analysis, a P value of <0.05 indicated statistical significance.

RESULTS

A total of 37 subjects (20 males and 17 females) were treated with 112 conical tapered platform-switched implants. The mean age of the patients was 53±13 years (range 29-79); ten of them were smokers (<10 cigarettes/day). Thirty implants were placed in 18 patients by LS, 36 in 7 patients by JG, and 36 in 12 patients by JN. Forty-nine implants were placed in the maxilla, while 63 in the mandible; 54 implants had "regular diameters" of 3.75 mm and 44 implants of 4.2 mm, whereas 14 implants were considered as "wide" implants (5 mm in diameter). Considering the implants' length, 28 were 13 mm long, 51 were 11.5 mm long, 29 were 10 mm long, and 4 were 8 mm long.
The implants were restored with porcelain crowns up to six months from the day of implantation.
None of the implants failed during the study, resulting in a survival rate of 100% after one year.
Paired t test and non-parametric signed t test for paired samples showed no difference between the MBL on the mesial and on the distal aspect of the implants.
The marginal bone loss from baseline to 14 months was 0.67±0.45 mm. There was no statistical difference in the measured MBL between the three centers (Table 1, Fig. 2). No difference was found in marginal bone loss between male and female, and between smokers and non-smokers (Table 2).

CENTER	LS	JG	JN	AVERAGE
ΔIBL	0.79±0.5	0.56±0.4	0.67±0.2	0.67±0.45

TABLE 1 The ΔIBL + SD (standard deviation) in the three different centers. No statistical difference between the three centers.
LS, Lior Shapira; JN , Jose Nart; JG, José Guirado.

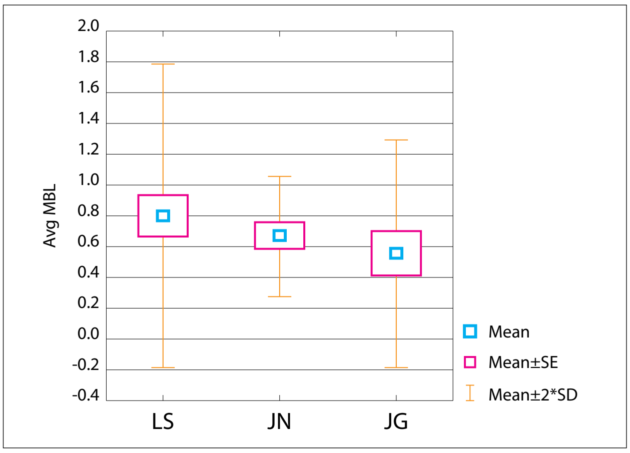

FIG. 2 Comparison between the three different centers regarding the ΔIBL. No statistical difference was found. LS, Lior Shapira; JN , Jose Nart; JG, José Guirado; SE , Standard error; SD, Standard deviation.

	MALE/FEMALE	SMOKER/NON SMOKER
ΔIBL	0.62±0.3/0.8±0.48	0.54±0.33/0.77±0.41

TABLE 2 ΔIBL+SD (standard deviation) for gender and smoking (<10 cigarettes/day). No statistical difference between the groups.

Surgical sequence and outcome

As an example, figures 3 to 10 illustrate a case treated by LS (Jerusalem center, Israel).

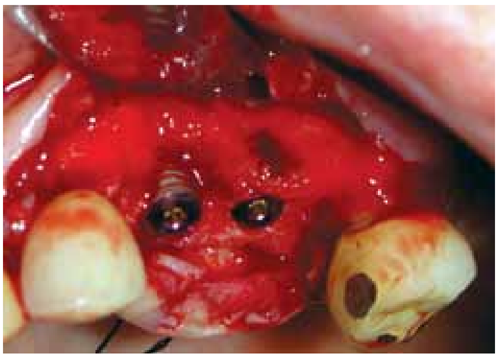

FIG. 3 Implants replacing teeth 24-25.

FIG. 4 Guided bone regeneration with a collagen membrane.

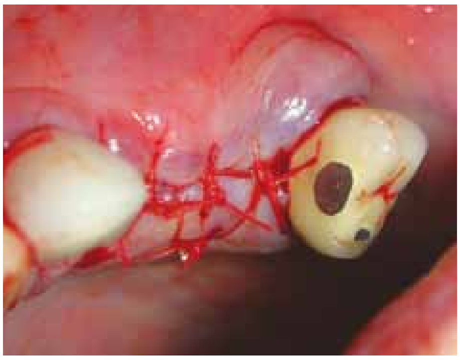

FIG. 5 Flaps are repositioned and sutured.

FIG. 6 Four months later- prior to stage 2 surgery – implant exposure.

FIG. 7 Exposure of implants – note new bone formation.

FIG. 8 Healing abutment and suturing.

DISCUSSION

The results of the present study demonstrated limited bone level changes within the first year after implant installation. The bone loss measured around the implant neck was clinically significantly smaller than the implant success criteria of 2 mm (9, 10). The crestal bone resorption is often related to the micro-gap at the interface between the implant and the abutment, mainly when it is close to the surrounding bone (9, 18). This gap facilitates bacterial infiltration and colonization close to the crestal bone, causing an inflammatory process which results in bone resorption (19). Therefore, the prevention of microbial leakage at the implant-abutment connection is a major challenge for the construction of modern two-stage implant systems. The preservation of peri-implant bone is a major factor in the long-term prognosis of prosthetic rehabilitations supported by implants. The crestal bone loss can lead to the collapse of soft tissues and adversely affect the aesthetics of the implant-supported prosthetic elements. The adverse effects of the micro-gap are greatly reduced with thicker residual bone, as the distance between the micro-gap and the crestal bone increases. Conical connections inherently keep the implant-abutment interface away from the crestal bone (a.k.a. platform switching or platform shifting), thus promoting better biologic and aesthetic results. Implants with platform switching show lesser crestal bone loss, improved crestal bone preservation, and lead to controlled biological space reposition. All of these features lead to stable aesthetic outcomes (20) and to "complications free" survival rates up to 20 years of follow up, for fixed restorations supported by conical connection implants (21). A recent meta-analysis

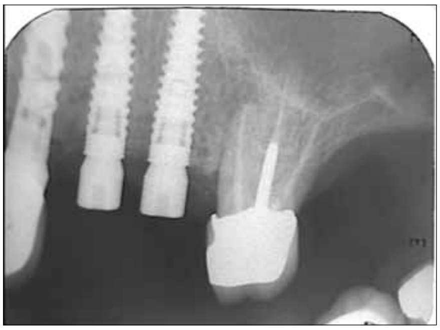

FIG. 9 Periapical X-rays – day of stage 2 surgery.

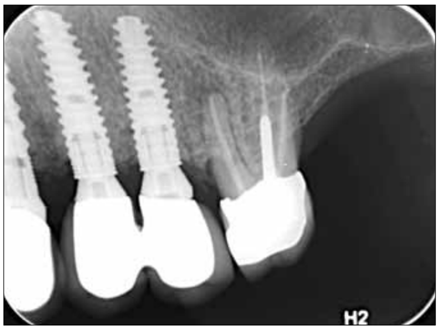

FIG. 10 Periapical X-rays – 1 year results.

revealed a significantly less mean bone loss around implants with a platform switching implant-abutment configuration compared with the standard platform matching implant-abutment design (17). The internal conical implant-abutment connection is considered to be mechanically more stable and tighter than flat-to-flat connections or tube-in-tube connections (22). By minimizing micro-movements at that junction, bone loss at the crestal level is reduced (23). Load distribution is also more favorable around implants that possess conical connections, thereby preserving the marginal bone (22, 23, 24, 25). The conical connection design simplifies maintenance and ensures reliability in all clinical situations (26). These qualities, also possessed by the implant system used in the present study, result in a higher ability to preserve bone (22, 24, 26).
Data from several implant manufacturers showed that different implant systems yielded different results with regard to bone level changes, but always better than 2 mm of bone loss, that was historically considered acceptable (27, 28, 29). A recent meta-analysis reported mean marginal bone level changes of 0.24 mm (Astra Tech Dental Implant System), 0.75 mm (Brånemark System), and 0.48 mm (Straumann Dental Implant System) after five years of follow-up, in comparison with bone levels at the time of prosthetic loading (29). These extraordinary stable results should raise the question whether or not a stricter success criteria regarding marginal bone loss should be developed, as the tested implants can provide significantly better results.
In conclusion, within the limitations of the present retrospective study, a limited marginal bone loss and 100% implant survival rate were observed over 14-months of follow-up. The results showed high crestal bone stability around the conical tapered platform-switched implants.

Disclosure

The implants and prosthetic parts were kindly provided by MIS Implants (Israel) for 3 all centers. JN, JG and LS are ad-hoc consultants for the same Company. No other financial support was given to this follow-up study.

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