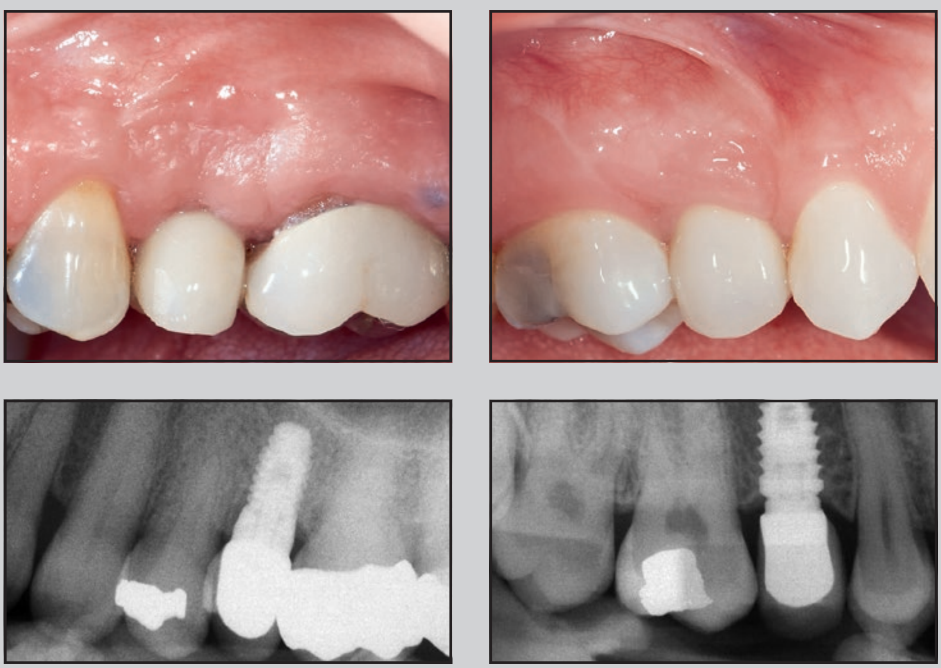

The Effect of Platform-Switching Plus Laser Grooving on Peri-implant Hard and Soft Tissue Level: A Randomized, Controlled, Blinded Clinical Trial

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Twenty patients were randomly assigned to receive either a platform-switched or platform-matched implant to replace a single maxillary anterior tooth. Primary outcome variables were the implant interproximal bone loss, facial recession, and papilla fill at 12 months. The platform-switched group showed crestal bone loss of 0.1 ± 0.3 (mesial) and 0 mm (distal) while the platform-matched group showed losses of 0.6 ± 0.5 mm (mesial) and 0.7 ± 0.7 mm (distal) (P < .05). Facial recessions for the platform-switched and platform-matched groups were 0.1 ± 0.3 mm and 0.4 ± 0.8 mm, respectively. Int J Periodontics Restorative Dent 2019;39:669–674. doi: 10.11607/prd.4243

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Osseointegration of dental implants is a predictable procedure, but it does not always translate to esthetic success. Loss of interdental papillary height and facial recession are often the sequelae of implant placement, which creates esthetic and hygienic concerns for patients. Lazzara and Porter introduced the concept of "platform switching" in 2006.[1] It was observed over the years that the mismatch between a wide-diameter implant and a standard-size abutment showed less vertical loss in crestal bone height.[1]

The biologic and biomechanical concept of platform switching is not fully understood. The biomechanical theory proposed that platform switching shifts a majority of stress away from the bone-implant interface and directs it along the long axis of the implant.[2] One theory proposed that platform switching medializes the location of the biologic width and minimizes crestal bone resorption by moving the implant-abutment junction (IAJ) away from the osseous crest.[1] This was based on a previous study that showed that placing the IAJ at or below the crestal bone level can cause vertical bone resorption to reestablish the biologic width.[3] The presence of microbiota and inflammatory cell infiltrate within the microgap was suggested to cause crestal bone loss.[4,5] Platform switching by medializing the microgap may limit crestal bone resorption by moving the inflammatory cell infiltrate away from the crestal bone.

Nevins et al reported in a human histology study that platform-switched implant showed high bone-implant contact with no epithelial downgrowth and hence no crestal bone loss around the switched implant.[6] One additional innovation was introduced with the implants with a laser-grooved implant collar: Nevins et al reported that histologic analysis of these implants showed functionally oriented connective tissue fibers in the microgrooved zone.[7] This histologic evidence plus other research confirms that both phenomena (platform switching and the laser-grooved implant collar) individually function as intended in terms of establishing a zone of connective tissue attachment, which prevents apical migration of junctional epithelium and crestal bone loss.[7,8] However, there is little research regarding platform-switched implants that have a laser-grooved collar. The primary purpose of this clinical study was to compare peri-implant hard and soft tissue healing around esthetic zone of platform-switched vs platform-matched implants, both with a laser-grooved collar, at 12 months after implant placement. The primary outcome variable was radiographic interproximal bone loss on the implant, and secondary outcomes included gingival recession and the papilla index. As a secondary aim, the objective and subjective esthetic results for the two treatment groups were compared using Pink and White Esthetic Scores (PES and WES, respectively) and a visual analog scale (VAS).

Materials and Methods

Study Design

The overall study design was a prospective, randomized, blinded, controlled clinical trial. Subjects were recruited from a patient population needing replacement of a single missing tooth with an implant-supported restoration in the maxillary esthetic zone. Twenty-four patients were recruited for this 12-month study. By random selection (coin toss), 12 positive control patients were selected to each receive a delayed-placement laser-grooved platform-matched implant (PMLG; Internal, BioHorizons). The test group consisted of 12 patients, each receiving a delayed-placement laser-grooved platform-switched implant (PSLG; Tapered Internal Plus, BioHorizons).

Inclusion/Exclusion Criteria

Subjects met the eligibility criteria if they were at least 18 years of age with a single anterior (from second premolar to second premolar) maxillary edentulous site bordered by two adjacent teeth. Exclusion criteria included: *(1)* patients with systemic factors that significantly affect the periodontium; *(2)* previous head and neck radiation; *(3)* patients who have been on intravenous or oral bisphosphonates for greater than 3 years; *(4)* smokers; *(5)* patients needing prophylactic antibiotics prior to dental procedures; *(6)* allergy to any medication or material used in the study; *(7)* chemotherapy in the previous 12 months; *(8)* severe psychologic problems; and *(9)* pregnancy. Postsurgical exclusion criteria were: *(1)* patient failure to comply with postoperative follow-up appointments or treatment protocol; and *(2)* failure of implant to osseointegrate.

Clinical and Radiographic Parameters

At baseline and 2, 4, 6, and 12 months, the indices evaluated on teeth adjacent to edentulous site were: Plaque Index, Gingival Index, mobility, probing depth, keratinized tissue width, and bleeding on probing. All radiographic measurements were standardized using a stent. Clinical measurements included: *(1)* periodontal biotype: thick or thin; *(2)* soft tissue thickness, measured at the crest and 5 mm apical to the crest (an endodontic file with a rubber stopper was used and the distance from file tip to stopper was measured with a digital caliper); *(3)* facial recession, measured relative to adjacent gingival margin; *(4)* papilla harmony; *(5)* gingival margin harmony; *(6)* facial horizontal osseous crest thickness; *(7)* bone quality at implant placement; and *(8)* papilla fill (Jemt's Papilla Index)[9], which was measured at two locations per implant. Radiographic measurements included determining mesial and distal vertical distances from *(1)* the implant platform to the mesial and distal osseous margins; *(2)* the osseous crest to contact point;

and *(3)* the osseous crest to adjacent interproximal cementoenamel junction (CEJ). As a secondary goal, *(4)* the objective and subjective esthetic results (PES, WES, and VAS scores) for both treatment groups were recorded and compared.

Surgical Treatment

Papilla-preserving incisions were made with the paracrestal incision, and a full-thickness flap was elevated. Based on a coin toss, either a PMLG or PSLG implant was placed in an ideal three-dimensional position with the implant platform at crestal level.

At 2 months after implant placement, the implants were uncovered and a provisional restoration was placed. The final crown was fused to the Laser-Lok Titanium Base Abutment (BioHorizons) provided to the lab. The final crown was placed at about 4 months post–implant placement. All final restorations were screw-retained. The final examination was completed at 12 months post–implant placement.

Statistical Analyses

Data for 20 patients (10 in each group) were analyzed at 12 months. Means and standard deviations were calculated for all parameters. Paired *t* test was used to evaluate the statistical significance of the differences between initial and final data, and unpaired *t* test was used to evaluate statistical differences between the test and control groups. A sample size of 10 gave 85% statistical power to detect a difference of 1 mm of implant bone loss between groups.

Results

A total of 12 males and 12 females with a mean age of 59 years (range: 22 to 81 years) were enrolled in this study, and 4 patients (2 per group) dropped out at the 12-month follow-up and were excluded from the study. The PSLG group consisted of 3 central incisors, 1 canine, and 6 premolars at study end. The PMLG group consisted of 1 central incisor, 1 lateral incisor, 1 canine, and 7 premolars at study end. Subjective assessment at implant placement indicated that for the PSLG group, 4 implants were placed in Type II bone and 5 were placed in Type III bone, and 1 was placed in Type IV bone; for the PMLG group, 4 implants were placed in Type II bone, 5 were placed in Type III bone, and 1 was placed in Type IV bone. There were no postsurgical exclusions due to implant failure.

Radiographic Implant Platform to Mesial and Distal Osseous Crest

Both implants groups showed crestal bone loss. The PSLG group had a mean difference of –0.1 ± 0.3 mm (mesial) and 0 mm (distal) ($P > .05$). The PMLG group had a mean difference of –0.6 ± 0.5 mm (mesial) and –0.7 ± 0.7 mm (distal) ($P < .05$). The PMLG group had significantly more crestal bone loss compared to the PSLG group ($P < .05$).

Clinical Indices

In both groups, the Plaque Index, Gingival Index, bleeding on probing index, and probing depths were low initially and remained low at 12 months ($P > .05$).[10,11] Mean keratinized tissue width at 12 months was 3.8 ± 1.8 mm and 4.0 ± 1.0 mm for the PSLG and PMLG groups, respectively ($P > .05$).

Soft Tissue Thickness

At 12 months, the PSLG group had soft tissue thickness of 2.9 ± 1.0 mm at the crest and 2.2 ± 0.7 mm at 5 mm apical to the crest. The PMLG group had soft tissue thickness of 2.8 ± 0.6 mm at the crest and 2.1 ± 0.5 mm at 5 mm apical to the crest. There were no significant differences within or between groups ($P > .05$).

Radiographic Osseous Crest to Adjacent CEJ

At 12 months, for both groups, there was a mean bone loss of ≤ 0.3 mm from the osseous crest to the CEJ ($P > .05$), and there were no statistically significant differences between groups ($P > .05$).

Facial Recession Data

The PSLG sites presented with a mean of 0.2 ± 0.6 mm of facial recession relative to adjacent teeth at 4 months, which decreased to 0.1 ± 0.3 mm at 12 months, for a mean change of 0.1 ± 0.7 mm ($P > .05$). PMLG sites presented with a mean recession of 0.9 ± 0.8 mm at 4 months, which decreased to 0.4 ± 0.8 mm at 12 months, for a mean change of 0.5 ± 0.9 mm ($P > .05$). There were no statistically significant differences between the PSLG and PMLG groups ($P > .05$).

Papilla Fill and Papilla Harmony

Using the Jemt index, PSLG cases had ≥ 50% papilla present in 85% (17/20) of cases vs 90% (18/20) for PMLG cases.[9] Complete papilla fill was seen in 30% (6/20) of cases in both groups. Papilla harmony was achieved in 20% (2/10) of cases in PSLG and 20% (2/10) of cases in PMLG groups.

Osseous Crest to Contact Distance

At 12 months, the mean distance from adjacent tooth's osseous crest to the bone-to-implant contact point for PSLG sites was 4.8 ± 0.8 mm and 4.6 ± 0.8 mm on the mesial and distal aspects, respectively, and for PMLG sites was 4.6 ± 1.1 mm and 3.8 ± 1.1 mm on the mesial and distal aspects, respectively. There were no statistically significant differences between groups for either mesial or distal measurements ($P > .05$).

Implant to Tooth Distance

At 12 months, the mean implant-to-tooth distance at mesial and distal measurement sites was 2.3 ± 0.6 mm and 2.8 ± 0.4 mm, respectively, for PSLG implants and was 2.1 ± 0.6 mm and 2.5 ± 0.6 mm, respectively, for PMLG implants. There were no statistically significant differences between groups for either mesial or distal measurements ($P > .05$).

Objective and Subjective Evaluations

Objective PES and WES and subjective VAS scores were high for both groups with minimal differences between the groups. This indicates that, from both the clinician's and patients' standpoints, a high esthetic outcome was achieved.

Discussion

The primary outcome of this study was to radiographically assess crestal bone loss with respect to each implant shoulder. At 12 months, the mean bone loss on mesial and distal aspects for the PSLG group was approximately 0.1 mm ($P > .05$), while that for the PMLG group was about 0.7 mm ($P < .05$). The PSLG group had less crestal bone loss than the PMLG group on both mesial and distal aspects ($P < .05$) (Figs 1 and 2). However, the minimal difference between both groups could be due to the presence of additional laser grooving, which may have prevented crestal bone loss for both groups, limiting the between-group difference.[12,13]

At 12 months, the mean recession relative to the adjacent gingival margin was 0.1 mm for the PSLG and 0.4 mm for the PMLG implant groups. One factor in preventing recession is an ideal three-dimensional implant placement, with at least 2 mm of facial bone thickness.[14–16] In this study, the mean facial bone thickness was similar for both groups: 1.8 mm for the PSLG group and 1.7 mm for the PMLG group. Another factor to consider is the soft tissue thickness and keratinized tissue width. Thin tissue and lack of keratinized tissue have shown increased susceptibility to recession.[17,18] In this study, soft tissue thickness for both groups was approximately 2.8 mm at the crest, and both groups had approximately 4 mm of keratinized tissue at 12 months. Thus, with similar values for facial bone thickness, soft tissue thickness, and width of keratinized tissue, there was no statistically significant difference for recession between both groups ($P > .05$). Several studies show that, as a general rule, up to 1 mm of facial recession can be anticipated at 1 year from the time of abutment connection.[19–21] In this study, the difference in facial recession between groups, although minimal, could be clinically significant in the esthetic zone, as recession around an implant could lead to potential complications.

The presence of a papilla that completely fills a normal-sized interproximal space apical to a properly sized and located contact area is an important esthetic outcome. Papilla fill, however, can be achieved by decreasing the vertical height of the embrasure through the use of a long contact area. Thus, papilla esthetics are best assessed using the dual measures of papilla fill and papilla harmony. Papilla harmony can be measured as the papilla height being harmonious with the papillae on adjacent teeth. In this study, papilla fill was assessed using the Jemt score,[9] stratified by percentage papilla fill, and by evaluating papilla harmony.

An important indicator for the potential of papilla fill is the distance between interproximal osseous crest and the contact point. Previous studies have shown that an osseous crest–to-contact distance of about 4 to 5 mm is a good predictor for papilla fill between an implant and tooth.[22,23] In this study, the osseous crest–to-contact distance for both groups ranged between 3.8 and 4.8 mm and was thus on target with the aforementioned measurements. Papilla is a three-dimensional structure, and the horizontal distance from implant to tooth must also be considered. Previous studies have shown that a horizontal distance of about 2 to 4 mm favors the best papilla result.[24–26] In this study, the horizontal distance from tooth to implant was about 2.3 to 2.8 mm for both groups (Figs 1c and 2c). The combination of these vertical and horizontal distances resulted in ≥ 50% papilla fill at 85% of the PSLG sites and at 90% of PMLG sites. These numbers compare well with previous studies that have shown improved papilla fill at 1 or more years after crown insertion.[21,27,28]

Objective PES and WES scores and subjective VAS scores had minimal differences between both groups, indicating that both the

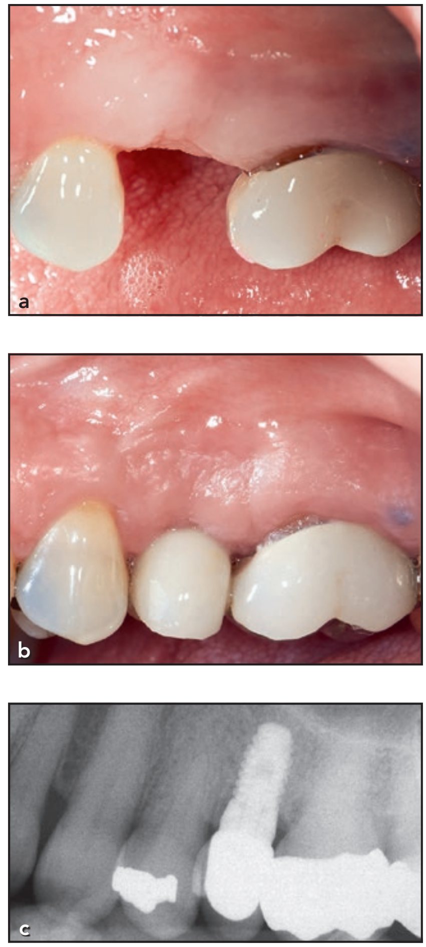

Fig 1 *Patient in the PMLG group.* (a) *Initial, preoperative presentation of an edentulous maxillary left second premolar.* (b) *Clinical 12-month postoperative results. Note the partial papilla fill and black triangle on the distal aspect of the implant.* (c) *Crestal bone loss is shown at the distal aspect in the radiograph taken at 12 months.*

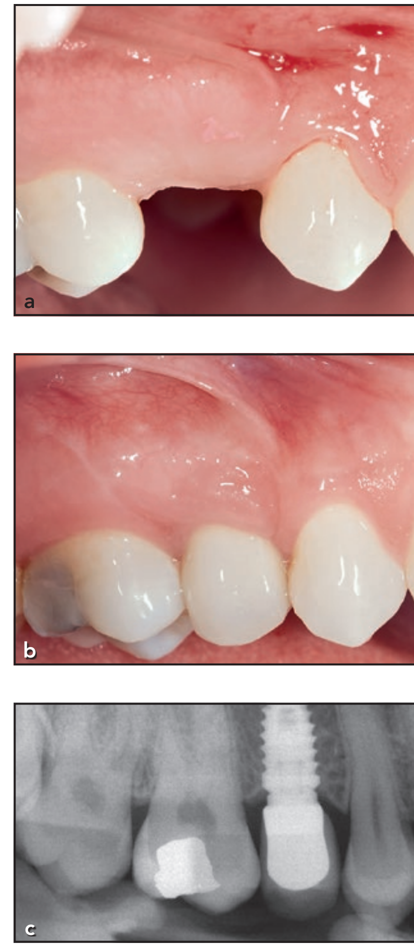

Fig 2 *Patient in the PSLG group.* (a) *Initial, preoperative presentation of an edentulous maxillary right second premolar.* (b) *Papilla fill is seen at the clinical 12-month postoperative results.* (c) *The 12-month radiograph shows crestal bone stability around the implant.*

clinician and the patients believed a good esthetic result was achieved for both treatments.[29,30]

Conclusions

Within the limitations of this study design and duration, it was concluded that: *(1)* bone loss after abutment connection was minimal; however, the PSLG group had significantly less crestal bone loss ($P < .05$) than the PMLG group; *(2)* there was a similar amount of recession for both groups, but the PSLG group had less facial recession, which may be clinically significant; and *(3)* there was a similar amount of papilla fill and harmony for both implant groups. Given that many of the parameters assessed were similar for both groups, it is possible the laser-grooved surface on both the implant and abutment allowed for more coronal connective tissue and osseous attachment and contributed to the good results in both groups. Further studies are needed to determine the long-term stability of the soft and hard tissue results for both groups.

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