A Prospective Study Comparing the Effect of L-PRF and Porous Titanium Granules on the Preservation of the Buccal Bone Plate Following Immediate Implant Placement

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The aim of this study was to compare the effect of an autogenous blood concentrate (L-PRF) with the effect of white porous titanium granules (WPTG) on buccal bone remodeling. These materials were used to graft the void between the implant and the buccal bone following immediate implant placement. Clinical measurements were made at two time points, and the mean buccal bone horizontal dimension at placement was 2.94 ± 0.59 mm for L-PRF and 3.49 ± 0.99 mm for WPTG. At reentry, the values were 1.19 ± 0.90 mm and 2.12 ± 0.87 mm, respectively. Overall, there was no difference observed in the performance of the two materials regarding buccal bone resorption. Int J Periodontics Restorative Dent 2020;40:767–774. doi: 10.11607/prd.4299

In recent years, immediate implant placement has become a commonly used technique for replacing a compromised tooth. The benefits include reduction in the overall treatment time and number of surgical procedures.1 High 1- and 2-year survival rates for immediate implants have been consistently reported, but a recent systematic review demonstrated lower overall survival rates when compared to implants placed following healing of the socket.2–4 All failures were identified as early (≤ 1 year), and, interestingly, postoperative antibiotics had a positive effect on the survival of immediate implants.4

The dimensional changes occurring following tooth extraction have been well documented.5 Most of the changes occur in the buccolingual dimension, with up to 56% bone resorption buccally and 30% lingually.6 Additionally, buccal vertical resorption is greater than the lingual resorption following loss of the tooth-dependent bundle bone. The majority of the bone remodeling occurs in the first three months and it was initially suggested that immediate implants might counteract postextraction ridge alterations.7,8 However, later animal and human studies refuted this theory6,9,10

Both buccal bone thickness and height are instrumental in the prevention of bone resorption.11

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Grafting of the void between the implant and the buccal bone using a biomaterial with a low substitution rate may compensate, to a degree, for the resorption of the bundle bone even when the void is narrower than 1 mm. It is also widely accepted that the implant should not be in contact with the buccal bone, as pressure can induce resorption. Dimensional alterations after immediate implant placement were summarized in a recent systematic review, where the authors reported a weighted mean horizontal buccal bone resorption of 1.07 mm, whereas a subgroup analysis of grafted sites only showed a resorption of 0.79 mm.

This study was designed as a prospective clinical study with two cohorts of patients. The aim was to evaluate and compare the effects of white porous titanium granules (WPTGs; Natix, Tigran Technologies), placed in the first cohort of patients, with the effects of leukocyte- and platelet-rich fibrin (L-PRF), placed in the second cohort of patients, on hard tissue modeling following immediate implant placement in the anterior maxilla. Buccal bone horizontal dimension (BBHD) reduction was the primary outcome.

Materials and Methods

The WPTG used were commercially pure titanium grade 1 with a diameter of 0.7 to 1.0 mm. Their porosity (around 80%) increases their surface area to around 2 cm². L-PRF is an autologous platelet concentrate that has been utilized to enhance healing in a variety of indications and it may offer some putative advantages as a regenerative material.

To process the L-PRF, centrifugation at a relative force of 408 g RCF (2,700 rpm) with IntraSpin centrifuge (Intra-Lock International) was used. An Xpression Fabrication Kit (Intra-Lock International) was used to compress the L-PRF clots into L-PRF membranes and plugs. Prior to commencement of the study, ethical approval was obtained from the SJH/AMNCH Research Ethics Committee (REC Ref: 141013 and 160205). All suitable patients who agreed to participate between 2013 and 2015 were treated with WPTG, and those who participated between 2016 and 2018 were treated with L-PRF (Fig 1).

Subjects were recruited from a population of patients requiring one or more implants in the anterior maxilla (incisors, canines, or premolars), providing the following inclusion criteria were met: > 18 years of age; the nonrestorable tooth had to be abutted by two adjacent teeth; all teeth had to be free from any active infection; and the site had to be suitable for an immediate implant. Periodontal disease control was performed and good periodontal health evidenced by full-mouth plaque and bleeding scores < 25% and < 10%, respectively, were required prior to inclusion. Patients had to be in good general health, be able to tolerate minor dental surgeries, and had to be able to give consent to participate in the study. Pregnant women, heavy smokers (> 10 cigarettes/day), and patients with uncontrolled diabetes mellitus, active drug addiction, or undergoing chemo/radiation therapy were excluded. A total of 33 patients were included in the study, requiring a total of 35 implants.

Amoxicillin (3 g) or clindamycin (600 mg) was given to each patient 1 hour preoperatively. The nonrestor-
Only two measurements were taken (Fig 3). A healing abutment was placed, and flaps were closed with resorbable sutures.

All extractions and implant placements were performed by three operators (G.G., M.M., and I.P.). All clinical measurements and clinical pictures were taken by one operator (I.P.). A UNC 15 periodontal probe (Hu-Friedy) and a 40-mm Straight Castroviejo Bone Caliper (Hu-Friedy) were used for measuring. Measurements were performed to the nearest half millimeter. To increase the reliability of the clinical measurements, it was decided to combine/ reinforce them with photographic measurements. A photograph was taken at an angle parallel to the long axis of the implant after implant installation and again at reentry. An average of the estimated clinical and photographic measurements was calculated, and the mean score was used for the statistical analysis. Photographic measurements could only be made for GW; BBW (measured from the outer to the inner border of the buccal bone crest), 1 mm apical to the crest; BBHD (measured from the outer border of the buccal bone crest to the rim of the implant); and BBW at the second-stage surgery (Figs 2 and 3). The photographs were analyzed using ImageJ software (version 1.51s, National Institutes of Health). The known implant diameter of 4.1 mm was used to calibrate the measurements performed using the software. For all other dimensions, only the clinical measurements were used for statistical analysis.

All data was entered into an Excel spread sheet. Data analysis was performed using SPSS Statistics 25.0 (IBM) for Windows, and the analysis was done on an implant level. Demographics and other baseline characteristics were presented by means of descriptive statistics. Intergroup comparisons were made by means of paired t tests and Wilcoxon rank sum tests. A two-sided P value of ≤ .05 was considered to be statistically significant. The correlations between the different variables were determined using Pearson and Spearman correlation tests.

Results

All implant sites healed without complications in both study groups. The majority of the patients were women in both groups, and the mean age of the patients was 49.36 years and 53.14 years for the L-PRF and WPTG groups, respectively. Only three patients were light smokers, and a majority of the teeth extracted were from premolar sites.

The buccal bone plate and GW measurements were combined to calculate the overall mean BBHD. The mean BBHD reduction was 1.75 ± 0.66 mm or 61.36% (P < .0001, paired t test) for L-PRF sites and 1.37 ± 0.86 mm or 37.97% (P < .0001, paired t test) for WPTG sites. The BBHD reduction for sites grafted with L-PRF was compared to those grafted with WPTG. The mean difference in BBHD reduction was 0.38 ± 0.27 mm, which was not statistically significant (P = .166, unpaired t test).

There was no statistically significant difference in the mean values of the BBHD or the BBW between
the two groups at baseline ($P = .062$ and $P = .64$, respectively, unpaired t tests). The difference in the mean GW values between these two groups though reached statistical significance ($P = .034$, unpaired t test). The results of the measurements can be seen in Tables 1 and 2.

The reduction of BBHD was further measured according to sites that had an initial BBW of < 1 mm or > 1 mm at baseline. In the L-PRF group and when the bone was initially < 1 mm (n = 9 sites), the reduction was 68.1% (1.93 ± 0.62 mm). When the bone was > 1 mm (n = 5 sites), the reduction was 49.2% (1.42 ± 0.65 mm). In the WPTG group, there was a reduction of 35.35% (1.04 ± 0.62 mm) when < 1 mm (n = 8 sites), and 38.07% (1.51 ± 1.01 mm) when > 1 mm (n = 13 sites; Figs 4 to 7).

Loss of buccal bone height was calculated using the rim of the implant as a reference point. The level of submersion of the implant rim, measured from the top of the buccal bone crest to the submersion level, was measured at the first stage, and the first bone-to-implant contact (BIC) was measured at the second stage (from the rim of the implant to the BIC), allowing the loss of vertical buccal bone height to be calculated (Figs 2 and 3). For the L-PRF group, the mean R-BIC value was 0.86 ± 1.5 mm apical to the rim of the implant, and, in two implants, the BIC at the second-stage surgery was 1 mm coronal to the rim of the implant. The mean R-BIC value for the WPTG group was 0.16 ± 0.36 mm apical to the rim of the implant.

For the L-PRF group, there was moderate correlation ($r = 0.515$) between buccal bone thickness at implant placement and residual bone at the second stage, which did not reach statistical significance ($P = .60$). A summary of significant correlations for WPTG are presented in Table 3.
## Table 1 Most Notable Average Measurements for the L-PRF Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First-stage surgery</strong></td>
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<td></td>
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<tr>
<td>PWC</td>
<td>0.50</td>
<td>2.00</td>
<td>1.32</td>
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<tr>
<td>GW</td>
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<tr>
<td>BBW–C</td>
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<tr>
<td>BBHD</td>
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<td>4.25</td>
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</tr>
<tr>
<td>SM</td>
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<td>0.00</td>
<td>–0.68</td>
<td>0.47</td>
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<tr>
<td><strong>Second-stage surgery</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBW–PO</td>
<td>0.00</td>
<td>3.76</td>
<td>1.19</td>
<td>0.90</td>
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</table>

First BIC = first bone-to-implant contact measured from the rim of the implant to the most coronal buccal bone.

Measurements are given in millimeters.

## Table 2 Most Notable Average Measurements for the WPTG Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
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<tr>
<td>PWC</td>
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<tr>
<td>BBHD</td>
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<td>3.49</td>
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<td>SM</td>
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<td>3.00</td>
<td>–1.02</td>
<td>0.62</td>
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<tr>
<td><strong>Second-stage surgery</strong></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>BBW–PO</td>
<td>0.40</td>
<td>4.10</td>
<td>2.12</td>
<td>0.87</td>
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</table>

First BIC = first bone-to-implant contact measured from the rim of the implant to the most coronal buccal bone.

Measurements are given in millimeters.

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**Fig 4** Site with thick buccal bone following extraction and grafted with L-PRF.

**Fig 5** Site with thin buccal bone following extraction and grafted with L-PRF.
The objective of this trial was achieved using direct clinical measurements, a methodology which has been used in several previous studies, and results have been comparable.6,19–21 All implants placed had the same diameter, design, and surface characteristics. Additionally, the study was carried out in a single-center university setting, which allowed for a homogenous cohort of patients and good control of the patients’ appointments and attendance. Overall, though, the major limitation of the study herein is the lack of randomization.

Wider implants that fill the entire extraction socket result in more buccal bone resorption than narrower implants, which leave a wider residual gap.22,23 Despite the fact that larger gap widths result in greater bone fill, the degree of bone fill, as measured by percentage of horizontal defect resolution, has been shown to be more pronounced in smaller defects.24 The BBHD values for both groups were generally similar to those reported in earlier studies.6,19,20,25 The gap depth measured in contact with the implant surface (from the rim of the implant to the base of the defect) is a dimension of interest in existing literature. Similarly, the values recorded here

Table 3 Significant Correlations for WPTG

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Outcome variable</th>
<th>Test</th>
<th>r</th>
<th>P</th>
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<tbody>
<tr>
<td>GW</td>
<td>BBW–PO</td>
<td>Pearson</td>
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<td>.017</td>
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<tr>
<td>BBHD</td>
<td>BBW–PO</td>
<td>Spearman</td>
<td>0.51</td>
<td>.016</td>
</tr>
</tbody>
</table>

GW = gap width; BBHD = buccal bone horizontal dimension measured by combining buccal bone width measured 1 mm apical to the crest with GW; BBW–PO = postoperative (second-stage surgery) buccal bone width.

Discussion

Fig 6 Site with thick buccal bone following extraction and grafted with WPTG.

Fig 7 Site with thin buccal bone following extraction and grafted with WPTG.
are comparable to those reported in two published studies that also used direct clinical measurements but not with the values of studies that used CBCT.\(^6,19\)

The mean level of implant submersion relative to the buccal bone crest at implant placement in the study herein was 0.68 ± 0.64 mm for the L-PRF group and 1.02 ± 0.62 mm for the WPTG group. In one clinical study, slightly higher levels of submersion have been reported,\(^25\) but the levels are similar in the majority of the existing clinical studies.\(^6,19,27\) Overall, the buccal vertical bone loss where grafting protocols have been employed has not been significantly different to the nongrafted controls.\(^19,21\)

In the present study, the GW values for the WPTG group at the first-stage surgery had a moderately positive correlation with the BBW at the second stage (\(r = 0.51, P = .017\)). This suggests that the wider the initial GW at implant placement, the greater the amount of newly formed bone and the thicker the BBHD at the 4-month reentry. This finding is in agreement with similar earlier studies.\(^6,24\) The low number of participants could have been instrumental in the study’s failure to identify more statistically significant correlations between other specific socket characteristics and the dimensional changes measured at the second-stage surgery.

A potential limitation of the present study could be the raising of a mucoperiosteal flap at baseline and reentry, and the possible bone loss associated with the disruption of the vascular supply to the periodontium.\(^27,28\) However, there is limited evidence to suggest there is greater bone loss following immediate implants placed with raising a mucoperiosteal flap compared to those placed flapless.\(^29\)

In a number of cases, the superficial layer of the WPTG-grafted sites was surrounded by soft tissue. This could be attributed to the fact that primary closure was not achieved, leaving a small part of the collagen membrane exposed to the oral environment. It is likely that this exposure resulted in quick degradation of the collagen membrane, allowing soft tissue to infiltrate the most superficial layer.\(^30\)

Finally, the contribution of the added grafting materials to the initiation and progression of peri-implant diseases remains unknown. Additionally, the effect that titanium granules might have in diagnosing possible future peri-implantitis due to radiographic scatter is also a concern.

Conclusions

The BBHD seems to be influential to the remodeling of the buccal bone following tooth extraction. Grafting of the void with either WPTG or L-PRF did not prevent this remodeling process but lessened its magnitude. Overall, there was no difference observed in the performance of the two materials regarding bone resorption in either the horizontal or vertical dimension. Due to the low number of patients and the lack of randomization, no definite conclusions can be made.

Acknowledgments

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References


