Enhancement of Immediate Implant Stability and Recovery Using Platelet-Rich Fibrin

Elif Öncü, PhD, DDS1
Ahmet Afsin Erbeyoğlu, PhD, DDS1

The objective of this study was to evaluate the effect of leukocyte platelet-rich fibrin (L-PRF) on immediate implant stability and recovery. A total of 60 immediate implants were evaluated. After the extraction, using split-mouth design, test sockets were coated with L-PRF (L-PRF+) and control sockets were not (L-PRF−). All the implants were followed for 12 months. Results showed a statistically significant difference between the stability of L-PRF+ and L-PRF− implants at 1 week and at 1 month. Mean marginal bone resorption was higher in the control group at 1 year. Int J Periodontics Restorative Dent 2019;39:e58–e63. doi: 10.11607/prd.2505

Immediate implant placement has gained popularity because it can reduce treatment time, number of surgeries, and postextraction bone loss.1,2 After tooth extraction, the socket area undergoes a series of physiologic processes. The majority of the bone resorption and gingival remodeling is confirmed, which is usually the cause of biologic, esthetic, and functional damage.3 As a result, immediate and early implant placement was proposed as a way to maintain the osseous complex of the surgical area.1,3 Immediate implant placement refers to the placement of an implant into a tooth socket concurrently with the extraction.1,3,4 Remodeling of the alveolar ridge continues after the implant placement.5 The peri-implant bone healing starts with the formation of a fibrin scaffold. The platelets attach to this fibrin and are activated through the implant surface. These activated platelets locally release growth factors (bone morphogenetic proteins [BMP], platelet-derived growth factor [PDGF], insulin-like growth factor [IG], vascular endothelial growth factor [VEGF], transforming growth factor-β1 [TGF-β1], and transforming growth factor-β2 [TGF-β2]) that accelerate the wound healing process by attracting undifferentiated mesenchymal cells to the injured site. Therapeutic applications of platelet-rich products have demonstrated bone regeneration and faster titanium implant osseointegration,
which improve the stability and maintenance of dental implants by increasing bone-to-implant contact (BIC). Studies have demonstrated that the use of these leukocyte platelet-rich fibrin (L-PRF) membranes for the stimulation of bone and gingival healing around the implant is particularly significant.6–8

Adequate implant stability is important for long-term clinical success. Compared with other methods of measuring implant stability, resonance frequency analysis (RFA) has high clinical practicability for monitoring the osseointegration process because of its ease of application and repeatability.9

The objective of this study was to evaluate the effect of L-PRF on immediate implant stability by RFA on the early healing period and to evaluate the effect of L-PRF on the crestal bone level and the gingival margin level around the implants.

Materials and Methods

Patient Selection

The clinical and radiographic outcomes evaluated in 26 patients (16 men, 10 women), who were treated at the Department of Periodontology, School of Dentistry, University of Necmettin Erbakan, Konya, Turkey, between September and December 2013, with two or more adjacent or contralateral premolar and molar teeth were screened for eligibility to participate in this study. All of the selected patients gave full written informed consent in accordance with the Helsinki Declaration. The Ethics Committee of Turkey approved the study protocol.

Patients who met the eligibility requirements did not have any systemic health problems; did not need sinus floor augmentation, distraction osteogenesis, or bone grafting; and had at least two adjacent or contralateral premolar or molar teeth that needed extraction in the mandible and maxilla. The exclusion criteria were insufficient bone volume, parafunctional habits, smoking more than 10 cigarettes per day, systemic disorders, and poor oral hygiene.

The 26 included patients had undergone extraction and surgical preparation of the implant sockets. One or two of the sockets was selected randomly, and the selected sockets were covered with a part of the preoperatively prepared L-PRF (n = 30). No L-PRF was applied to the other sockets (n = 30). Implants (4.1-mm width and 12-mm length ITI SLActive surface, Straumann) were then placed. The resonance frequency measurements were made with Osstell ISQ (Osstell) intraoperatively and at 7 days, 1 month, and 3 months postoperative. All of the implants had at least 12 months of follow-up. All the patients had given written consent to the therapy plan and follow-up procedures prior to treatment. All the treatment steps were part of the routine procedures at the clinic, and no extra measures were taken for this study.

Surgical Procedure

One surgeon (E.Ö.) performed the surgical procedures. The operations were carried out with a local infiltration anesthesia (Ultracaine D-S, Hoechst). A crestal incision was made, and a mucoperiosteal flap was elevated. The remaining teeth were carefully luxated with periottes, and the teeth were extracted. The sockets were cleaned of granulation tissue and rinsed with saline. The implant sites, which were 5 mm apart, were prepared and L-PRF membrane was applied plastic tubes without anti-clotting agent (Becton Dickinson Vacutainer) and immediately centrifuged at 2,700 rpm for 12 minutes with a table centrifuge (PC-02, Process Ltd). The fibrin clot that formed in the middle part of the tube was removed, and remnants of red blood cells were scraped off with gauze. The clot was transferred to the L-PRF box (Process Ltd) and compressed, and L-PRF membranes were obtained (Fig 1).
to one of the implant sockets (Fig 2). Control implants were placed in the other socket without L-PRF application. L-PRF was limited to the test group’s implant cavity and did not have direct contact with the flap. All the implants were submerged 2 mm below the margins of the socket. No sites were grafted with bone or a bone substitute at the time of implant placement. The gaps between implant and socket walls were not grafted because they were about 1 mm. If bone grafting was necessary, the patient was excluded from the study. The muco-periodostal flaps were brought to the original position, the healing caps were not covered, and the flaps were sutured with 4/0 vicryl sutures. After 7 days, the sutures were removed. The patients received their prescribed drugs regularly. The patients had been prescribed 1,000 mg amoxicillin and clavulanic acid (Augmentin) two times a day, and chlorhexidine gluconate (Andorex) three times a day. No complications were observed during the recovery period. The healing caps were placed in the third month. Radiographs were taken at baseline (Fig 3a), on the day of surgery (Fig 3b), and at the 12-month follow-up (Fig 3c).

Evaluation and Criteria for Success

All the implants were evaluated 12 months after placement. During the clinical recalls at 1, 3, and 12 months, changes in the gingival margins were recorded using a Williams probe (Hu-Friedy), and the bone loss was evaluated using periapical radiographs. Panoramic radiographs were also taken. Patients were enrolled in an individually designed maintenance care program for professional cleaning and examinations, if needed.

The marginal bone levels were measured using the available intraoral radiographs taken at baseline (after the surgery) and after 12 months. For proper measurement, periapical radiographs were taken using long cone paralleling technique and employing a positioner (X-ray Holders, KerrHawe). Radiographic measurements were carried out using a computer and were used to determine the amount of bone loss. Vertical measurements of bone level adjacent to the implants were made using the upper corner of the coronal shoulder of the implant as a reference point. The measurements from the reference point to the first bone contact of the implant were performed using ImageJ software version 1.49m (National Institutes of Health). Formulas determined by Manz were used for calibration. The known implant actual high and the radiographic high ratio were used to find the distortion. This ratio was applied to the bone loss in
the radiograph measurement. These calibrated (ie, actual) measurements from baseline and follow-up appointments were compared for a given implant to determine vertical bone height changes.

An implant was successfully accepted when (1) there was absence of continuous radiotransparencies around the implant after loading and no loss of osseointegration, (2) no pain or symptoms of an infection were present, (3) there was ≤ 2 mm bone loss, (4) there was no soft tissue recession around the implant, and (5) the implant stability quotient (ISQ) was a minimum of 50 as determined by RFA.

**Statistical Analysis**

Statistical computations were carried out using PASW/SPSS software (version 18.0.0 2009, IBM). The implants were included in the statistical analysis as independent values. Mean values and standard deviations were calculated for each variable and group. The difference between the groups was analyzed using analysis of variance (ANOVA), and the difference within the groups was analyzed using Student t test.

**Results**

The study population consisted of 26 patients (16 men, 10 women) with a mean age of 40.2 ± 11.5 years and included 60 implants (Table 1). The 60 implants healed without complication. The survival rate for the implants and restorations was 100% during the study.

All ISQ values were > 50 at 3 months after surgery (Table 2). The 1-week and 1-month stability were significantly higher for the test groups (P ≤ .002) (Table 2). At the end of the third month, the mean ISQ was 71.19 ± 10.31 for the test group and 70.08 ± 11.2 for the control group (Table 2).

The mean marginal bone resorption was 0.7 ± 0.5 mm for the test group and 1.3 ± 0.6 mm for the control group after at least 1 year in function. The difference between the groups was significant (P ≤ .05).

The mean gingival margin recession at the time of prosthesis placement was 0.22 mm in the test group and 0.25 mm in the control group. At 12 months, it was 0.49 mm in the test group and 0.51 mm in the control group. At both time points, the gingival recession values were found to be similar for each group.

---

### Table 1 Implant Distribution

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Teeth</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-PRF−</td>
<td>Maxillary first premolar</td>
<td>6</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Maxillary first molar</td>
<td>8</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>Mandibular first premolar</td>
<td>6</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Mandibular first molar</td>
<td>10</td>
<td>33.3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100.0</td>
</tr>
<tr>
<td>L-PRF+</td>
<td>Maxillary first premolar</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>Maxillary first molar</td>
<td>7</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>Mandibular first premolar</td>
<td>9</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Mandibular first molar</td>
<td>9</td>
<td>30.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### Table 2 ISQ for L-PRF+ and L-PRF− Implants

<table>
<thead>
<tr>
<th>ISQ</th>
<th>n</th>
<th>Mean ± SD</th>
<th>Minimum</th>
<th>Maximum</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-PRF−</td>
<td>30</td>
<td>24.61 ± 11.97</td>
<td>15.00</td>
<td>50.00</td>
<td>.632</td>
</tr>
<tr>
<td>L-PRF+</td>
<td>30</td>
<td>26.10 ± 12.83</td>
<td>15.00</td>
<td>50.00</td>
<td></td>
</tr>
<tr>
<td>1 wk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-PRF−</td>
<td>30</td>
<td>48.67 ± 13.61</td>
<td>30.00</td>
<td>55.00</td>
<td>.002</td>
</tr>
<tr>
<td>L-PRF+</td>
<td>30</td>
<td>54.39 ± 15.88</td>
<td>44.00</td>
<td>69.00</td>
<td></td>
</tr>
<tr>
<td>1 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-PRF−</td>
<td>30</td>
<td>61.03 ± 12.02</td>
<td>30.00</td>
<td>75.00</td>
<td>.002</td>
</tr>
<tr>
<td>L-PRF+</td>
<td>30</td>
<td>69.99 ± 11.87</td>
<td>45.00</td>
<td>83.00</td>
<td></td>
</tr>
<tr>
<td>3 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-PRF−</td>
<td>30</td>
<td>70.08 ± 11.2</td>
<td>55.00</td>
<td>83.00</td>
<td>.682</td>
</tr>
<tr>
<td>L-PRF+</td>
<td>30</td>
<td>71.19 ± 10.31</td>
<td>65.00</td>
<td>90.00</td>
<td></td>
</tr>
</tbody>
</table>

ISQ = implant stability quotient.
Discussion

Many investigations have been carried out in the interest of accelerating osseointegration and enhancing esthetics by shortening the implant healing time. In this study, the effect of L-PRF on the stability and the esthetic results of immediate implants were investigated. The results demonstrated that L-PRF application increased the stability of implants during the first month of healing. Immediate implant placement at fresh extraction sockets has become a common surgical protocol in clinical practice. This concept offers reduced exposure of patients to surgery, limited physiologic bone resorption, and better gingival esthetic outcomes.11,12 Physiologic dimensional changes in the alveolar ridge after tooth extraction usually occur within the first 3 months of socket healing.12–14 These changes may be prevented by immediately placing implants with L-PRF in fresh extraction sockets.13–15 L-PRF is preferred because it is an autologous strong fibrin membrane loaded with autologous cells (leukocytes, circulating stem cells) and enriched with growth factors and matrix proteins that are released over a span of at least 7 days.16 When L-PRF was applied to the implant surface, a protein layer involving substantial growth factors was constituted. This regeneration potential can stimulate healing of the implant on the surrounding bone with the platelet-rich layer.6–8,16

The mean survival rates reported in the literature after immediate implant protocols were 98.4% after 2 years and 97.5% after 4 years.4 In the present study, the 1-year survival rate for each group was 100%.

To achieve clinical success, the implant must be stable. Multiple methods have been developed to evaluate implant stability.17–19 Many researchers have studied implant stability using RFA, and have concluded that evaluation by RFA of the stability of the implant is easy, reliable, and evidence based.9,11,17–21 The ISQ values found in this study showed that the primary and 1-week stability were higher for the test groups (P ≤ .002).

A computed tomography (CT) scan control would not have been possible due to ethical considerations related to exposure to radiation. Therefore, the change in the level of the crestal bone was measured on standardized digital panoramic and periapical radiographs. The dimensional changes occurring in alveolar crestal bone after tooth extraction and immediate implant placement have been evaluated in several clinical studies.4,7,12–15 In a similar experimental study, the vertical dimensional changes of the buccal bone wall were 2.1 ± 0.4 mm apical to the fixed landmark. After 12 weeks of healing at the lingual wall, only minor changes were observed.22 Boticelli et al23 reported 3.14 mm vertical bone resorption 4 months after placing immediate implants. In a similar study, Blanco et al24 found 1.33 mm bone resorption after 3 months. In the present study, mean marginal bone resorption was calculated at 0.7 ± 0.5 mm for the test group after at least 1 year in function, which is a more desirable result than those found in the other studies. In this study, the buccal and lingual areas were not separately evaluated. Immediate implant and bone graft allows for the maintenance and regeneration of the damaged labial bone wall.7 In this study, application of L-PRF might have provided protection to the socket. The therapeutic effects of L-PRF can be observed in bone regeneration and enhanced bone formation. In this study, all immediate implants were placed 2 mm below the crestal bone level. This method may compensate for the crestal bone loss.

The fibrin membrane of L-PRF acts as a biobarrier, protecting the implant and the oral environment. By providing growth factors, leukocytes, and a fibrin matrix for the growth of endothelial and epithelial cells, this healing material stimulates angiogenesis and accelerates gingival healing and maturation.7,16

Chen et al25 evaluated the changes in the buccal gingival recession retrospectively in immediately placed implant-supported restorations with a mean follow-up of 18 months, finding marginal tissue recession (≥ 1 mm) in one-third of the sites (33.3%). They reported that the position of the implant shoulder in relation to the buccal bone plate was significantly associated with the occurrence of marginal recession. In a similar study, gingival recessions were found to be 1.8 ± 0.83 mm in the buccally placed implants, compared with only 0.6 ± 0.55 mm in those inserted lingually.14 In the present study, the implants placed lingually had a mean gingival margin recession of 0.51 mm in the...
control group and 0.49 mm in the test group at 12 months. This result is similar to Kan et al., who reported a mean facial mucosal recession of 0.55 mm at the end of 1 year.

The results of this study demonstrated that PRF application increases implant stability during the early healing period. Based on these results, L-PRF application may provide faster bone healing around implants, allowing for early loading.

**Conclusions**

This study has shown that there is a clinically and statistically significant difference between the stability of L-PRF+ and L-PRF− implants at 1 week and at 1 month. Implant stability was enhanced by covering the implant surface with L-PRF before insertion in the extraction socket. This study looked at very few cases over a very limited period, thus long-term clinical studies are needed to validate the findings. It has shown, however, that mean marginal bone resorption was higher in the control group at 1 year.

**Acknowledgments**

The authors reported no conflicts of interest related to this study.

**References**


