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CLINICAL AND RADIOGRAPHICAL ASSESSMENT OF THE ROLE OF PLATELET RICH FIBRIN WITH DELAYED SHORT DENTAL IMPLANTS PLACEMENT (COMPARATIVE CLINICAL STUDY)

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ABSTRACT

Purpose: Assessment the efficacy of platelet rich fibrin (PRF) with delayed short dental implants placement clinically and radiographically.

Methods: This study was a comparative clinical study, with 16 short dental implants were used in the posterior edentulous region. Cases were distributed into two groups, the study group who had lost posterior teeth to be restored with short dental implant, while the the control group who were looking for missed molar restoration also. The study group patients have received short dental implant with PRF membrane surrounding it. On the other hand, the control group patients received short dental implants without PRF placement. Prosthetic procedures started after three months, with the assessment of different clinical indices including; modified plaque index (mPI), Osstell device to assess osseointegration, peri-implant probing depth index (PPDI) and the crestal bone loss (CBL). Also the crestal bone surrounding short implants was assessed after placement immediately (T0) using periapical digital x-ray with parallel technique and re-evaluated at the time of the prosthetic phase (T3) again. Later on, all of these indices were re-evaluated for second time after three months (T6).

Results: At recent clinical study it was found that the study group patients with PRF around the placed short dental implant got better clinical and radiographical parameters than that of the control group patients without PRF surrounding the short dental implants.

Conclusions: PRF can be used around the short dental implants to decrease the crestal bone loss and enhance soft and hard tissue healing surrounding short dental implants.

KEYWORDS: PRF, Short dental implants, crestal bone loss.

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INTRODUCTION

In cases of severe alveolar resorption, placing standard-length implants (≥10mm) is challenging without additional surgical steps such as distraction osteogenesis, bone grafting, mandibular nerve transposition, sinus floor elevation and zygomatic implant placement. These interventions are linked to extended treatment times, increased surgical morbidity and higher costs [1]. Over time, different strategies have been presented to overcome dimensional shortages for implant placement[2]. Short dental fixtures have been suggested as an substitute for prosthetic solution of atrophic alveolar bone, offering surgical advantages such as reduced morbidity, treatment time, and costs [2, 3]. Biomechanically, short dental implants are justified by the idea that the coronal part of the dental implant fixture bears most of the load, with minimal stress transferred to the apical portion [2]. Biomechanical studies have indicated that highest magnitude of bone stress is essentially without considering of implant height, emphasizing the importance of implant width over additional length [4].

Usage of short implants represents a significant advancement in implantology and serves for patients with severe alveolar bone resorption as a new therapeutic option. Despite initial controversy regarding the predictability of short dental implants due to less bone-to-implant contact, different researches have declared similar success rates for short dental implants compared to conventional fixtures [1, 5]. Short implants are generally defined as five to eight mm long implants and exhibit high success rates and stability, particularly with advancements in material surface treatment technology and titanium surface structural modifications. The survival rates of single crown in the posterior region are comparable between short and long implant groups [6].

Platelet derivatives, such as platelet-rich fibrin and platelet-rich plasma (PRP), have emerged as potential regenerative materials. These blood derivatives contain growth factors crucial for tissue healing and regeneration, making them valuable in dental treatments. This concept further fuels the increasing interest in these biomaterials within the realm of regenerative medicine. The diversity of platelet-rich types opens up numerous possibilities for their application[7]. Enveloping implants with platelet-rich fibrin accelerates the healing process, promotes tissue regeneration, and reduces and repairs small osseous defects. PRF is cost-effective and prepared from the patient's blood, offering advantages in terms of money saving, shorter treatment interval, easiness, and reduced risk of drawbacks when used in combination with short dental implants [4].

SUBJECTS AND METHODS

Study population: A total of 16 short implant (length = 6-8 mm) were placed in periodontally healthy patients, with missing posterior molar teeth, in need of implant placement. Participants were chosen from the outpatient diagnostic clinic in Oral Medicine and Periodontology department, Faculty of Dentistry, Mansoura University. All participants had thorough clinical examination and a preoperative Cone Beam Computed Tomography (CBCT).This research was conducted to help in the assessment of the effectiveness of platelet rich fibrin with delayed short dental fixtures placement from the clinical and radiographical points of view. All patients were given written informed consents. They were told about the risks, complications, benefits, and feedback times before procedures. Study protocol was checked by the ethical committee, Faculty of Dentistry, Mansoura University with approval number M07060722.

Surgical, PRF and prosthetic protocol: Each subject underwent a comprehensive review of their medical and dental history, accompanied by the acquisition of preoperative photographs and radiographs. Clinical evaluation of the chosen surgical site for dental implant placement included an assessment of width and the identification of any significant undercuts. Cone Beam Computed Tomography (CBCT) was utilized to precisely gauge the volume of available bone and its proximity to vital structures for each patient. A solution containing Articaine HCL 4% and 1:100,000 adrenaline was employed for infiltration anesthesia. Before the procedure, it was recommended to conduct a 1- to 2-minute rinse with chlorhexidine gluconate to minimize the bacterial load at the surgical site. The surgical approach involved a midcrestal incision made mesio-distally at the edentulous area along the crest of the edentulous area. A full mucoperiosteal flap was raised buccally, and any narrow, sharp ridges present were surgically reduced or contoured using a large round bur to create a reasonably flat ridge. The intended inclination was determined by the angulation of neighboring teeth and the pre-operative radiographs, as the implant was properly positioned with the help of these guidelines.

In the course of the surgical operation, into a plain glass tube, 10 ml of blood was taken from the patient (study group). The collected blood was promptly centrifuged at 3000 rpm for 10-12 minutes at normal room climate, using a centrifugal machine without any delay [(8)]. The upper layer was then extracted, and the middle section, identified as the PRF, was collected 2 mm below the lower separating line [(9)]. It was transferred to a PRF box. Using the PRF Box, a slow and uniform compression process of the membrane within the clots was conducted, ensuring that the formed membrane consistently remained uniformly wet and soaked in serum. Subsequently, after the preparation of the osteotomy site, the gelatinous PRF membrane was inserted into it. To insert the implant, a torque wrench and an implant fixture driver were utilized.

A smart peg was screwed to the fixture to record stability, and the implant stability quotient (ISQ) value was documented in the chart. The surgical site underwent thorough irrigation with sterile saline to remove debris and cleanse the wound. Subsequently, the flap was carefully approximated and sutured using 4/0 non-absorbable monofilament polypropylene suture. A digital periapical radiograph was then captured to evaluate the implant's position, its placement to vital structures, and the relationship between the implant's collar and the bone crest.

Post-surgery, patients were prescribed a seven-day course of the antibiotic, having 125mg of clavulanic acid and 875mg of amoxicillin. Additionally, Patients were also advised to use mouthwash three times daily, 0.12% chlorhexidine di-gluconate, for two weeks to serve as an antiseptic and aid in plaque management, especially in the initial post-surgery days when oral hygiene may be compromised. Patients were informed to apply ice packs for the first 2 days to minimize expected swelling. They were also educated on maintaining optimal oral hygiene, adopting a soft diet for at least two days, and gradually transitioning back to a normal diet. A follow-up appointment was scheduled for 7-10 days after implant placement for suture removal. Three months after implant placement, local anesthesia was administered, a mid-crestal incision was made, followed by cover screw removal. A healing abutment of suitable size and length was placed to achieve the desired emergence profile through the soft tissue.

The rigidity of the implants in both groups was evaluated again through Resonance Frequency Analysis (RFA) utilizing the Osstell device. The implant immobility values were noted in Implant Stability Quotient (ISQ) units on a calibration ranging from 1 to 100 [(10)]. Intra-oral digital scan impressions for the dental implants were conducted two weeks post 2nd stage surgery for both groups, utilizing the intraoral scanner. The digital scan data was transmitted to the dental lab. The dental lab then selected the appropriate Ti-base abutment with the best gingival height from the implant company's library for dental prosthesis fabrication. The lab proceeded to design the final crown with a screw channel. The screw-retained prosthesis was examined and placed in position using a torque wrench after the removal of the healing abutment following manufacture's instruction.

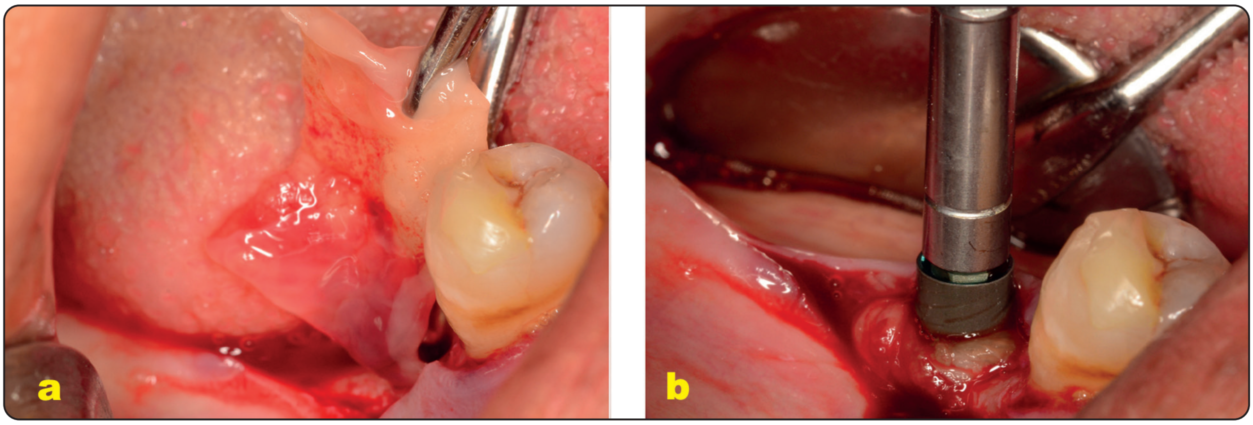

Fig. (1): (a) Showing PRF membrane placement and (b) implant insertion surrounded by PRF membrane at the osteotomy.

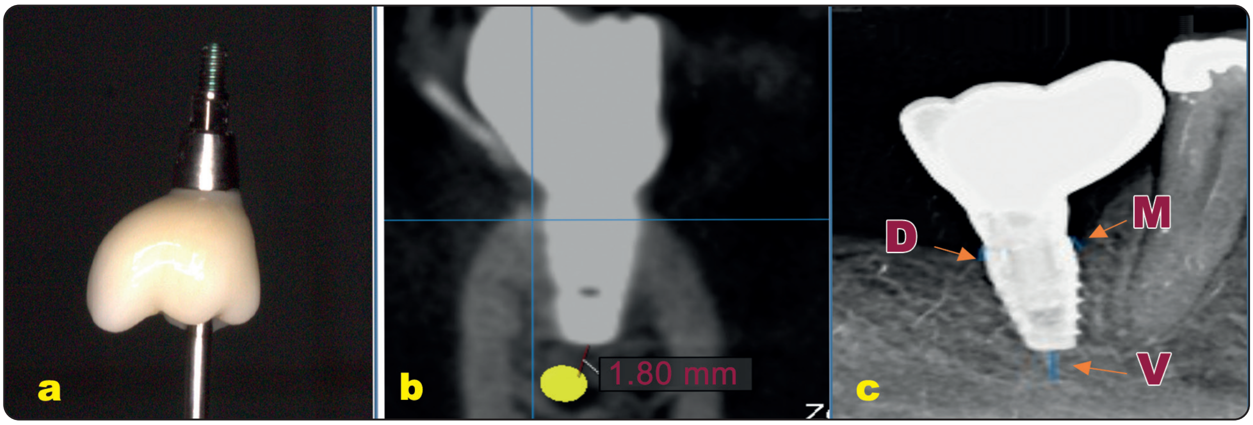

Fig. (2) Showing (a) Screw retained prosthesis with Ti-base abutment (b) 3 months post-operative CBCT showing relation of implant to vital structure and bone implant relation. (c) periapical radiograph showing (M) distance between implant platform and first bone contact mesially (D) distance between implant platform and first bone contact distally (V) distance between implant apex and inferior alveolar canal.

Clinical and radiographical evaluation and periodontal assessment: Pain has been measured using visual analogue scale (VAS) on the first post-operative day, third day, one week and two weeks [(11)]. ISQ values for implants with successful osseointegration are reported between 57 and 82. It is commonly acknowledged that ISQ scales exceeding 70 indicate very high stability, scales ranging between 60-69 indicate medium stability, while scales below 60 indicate low stability [(12)]. Modified Gingival index (mGI): The mGI applies a rating score between zero and four, with zero demonstrate a tooth with sound gingiva and four the most serious inflammation with continuous bleeding. Modified gingival index was recorded at T3 (at the prosthetic phase) and T6 (3 months after the prosthetic phase) according to Mombelli et al [(13)]. Also plaque was assessed according to modified plaque index and was recorded described by Mombelli et al[(13)] Measuring the Probing depth of the sulcus around the short implant is a critical clinical measure in evaluating implant health and stability. A color coded plastic probe is recommended for use when assessing dental fixtures. Implant probing entails inserting the probe implant-abutment interface area and the oral mucosal tissues surrounding it [14].

Post-operative digital periapical radiograph with parallel technique was taken immediately then at follow up at 3 months later and at 6 months of implant placement to assess the crestal bone amount changes mesio-distally. The vertical marginal bone level was calculated from the implant-abutment interface to the initial bone-implant contact. CBCT was taken for the site of implant placement after 6 months from implant insertion to evaluate accurate placement of dental implant related to surrounding vital structures and neighboring teeth and amount of crestal bone loss mesio-distally and bucco-lingually.

Statistical analysis

Data was fed to the computer and analyzed using GraphPad Prism 8 (GraphPad Software). Patients' age, and crestal bone measurements were normally distributed, while the other assessed parameters were not normally distributed as evident by using test of normality (Shapiro-Wilk tests). Data were provided as mean, and standard deviation (SD) values except for gender that was presented as frequencies and percentages. Student unpaired T test was used to analyze between the two groups and Repeated measures. One way ANOVA followed by post hoc Tukey's multiple comparison test were used to compare between the time points within the same group in normally distributed data. The Mann Whitney test was used to compare between the two groups and the Kruskal-Wallis test followed by post hoc Dunn's multiple comparisons test were used to compare between the time points within the same group in not normally distributed data. Binary categorical data (gender) was analyzed by Fisher exact test. Significance of the collected results was judged at the (0.05) level.

RESULTS

Sixteen short implants were used in this study. Patients' age range was from 20 to 60 years. They were included into two classes. Group 1 (study group) (which included eight short dental implants surrounded by PRF membrane at the site of molar area with bone height ≤ 10 mm. Group 2 (control group) which included eight short dental implants without PRF membrane surrounding it at the site of molar area with bone height ≤ 10 mm.

Table (1): Shows the resonance frequency analysis (RFA), bucco-lingual (BL) and mesio-distal (MD), of the study groups at (T0) (directly after implant placement), and at (T3) (3 months of implant insertion). There were statistically no significant difference between the study groups at (T0) BL ($P = 0.0688$) and MD ($P=0.1675$) but there were statistically significant differences between the study groups at (T3) BL ($P = 0.0002$*) and MD ($P=0.0005$*). There was also statistically significant difference between T0 and T1 in control group BL ($P= 0.0002$*) and MD ($P= 0.0002$*) and in study group BL ($P= 0.0002$*) and MD ($P= 0.0002$*).

Table (2): Shows the crestal bone margin at (T0) (immediately after implant insertion) and amount of crestal bone loss at (T3) (immediately after prosthetic phase) and at (T6) (3 month of prosthesis insertion) in the study groups at the mesial (M) and distal (D) sides. There was statistically no significant differences between the study groups at (T0) at (M) ($P>0.9999$) or (D) ($P=0.8891$). There was statistically significant difference between the study groups at (T3) at (M) ($P=0.0011$*) and (D) ($P=0.0035$*). Also there was statistically significant difference between study groups at (T6) at (M) ($P<0.0001$*) and (D) ($P<0.0001$*). In control group there was statistically significant difference in comparison between (T0-T3) at (M) ($P=0.0266$*) but no statistically significant difference at (D) ($P=0.067$). In study group there was statistically significant difference in comparison between (T0-

T3) at (M) (P=0.0003*) and (D) (P<0.0001*). Additionally, in control group there was statistically significant difference in comparison between (T0-T6) at (M) (P< 0.05[a]) but no statistically significant difference in comparison between (T0-T6) at (D) (P ≥ 0.05). In study group there were statistically significant differences in comparison between (T0-T6) at (M) and (D) (P< 0.05[a]).

TABLE (1): Shows the resonance frequency analysis (RFA) bucco-lingual (BL) and mesio-distal (MD) of the study groups:

Groups		**RFA**	**Mean±SD**	**Comparison between T0-T3**
		T0	T3	
Control N=8	BL	57.88±1.13	63.75±1.6	P=0.0002*
	MD	58.13±1.36	66.75±1.4	P=0.0002*
Study N=8	BL	59.50±2.20	69.50±1.0	P=0.0002*
	MD	60.13±2.85	70.25±1.4	P=0.0002*
P value	BL	P=0.0688	P=0.0002*	
MD	P=0.1675	P=0.0005*		

Data provided as mean±SD, Used test: Mann Whitney test.*p value is significant at level ≤0.05

TABLE (2): Shows the amount of crestal bone loss in the study groups mesial and distal:

Groups		**Crestal bone loss**	**Mean±SD**		**Comparison between T0-T3**
		T0	T3	T6	
Control N=8	M	0.98±0.21	0.83±0.14	0.71±0.08[a]	P=0.0266*
	D	0.93±0.17	0.84±0.13	0.75±0.12	P= 0.067
Study N=8	M	0.98±0.31	0.49±0.19[a]	0.36±0.14[a]	P=0.0003*
	D	0.94±0.18	0.58±0.17[a]	0.38±0.15[a]	P<0.0001*
P value	M	P>0.9999	P=0.0011*	P<0.0001*	
D	P=0.8891	P=0.0035*	P<0.0001*		

Data presented as mean±SD, Used test: Unpaired t test to compare between groups within the same time point and repeated measures ANOVA test followed by post hoc Tukey's multiple comparison test to compare between time points within the same group.*p value is significant at level ≤0.05. a: Significance Vs. T0 at p < 0.05

DISCUSSION

In spite of the insipidity of short implants was firstly a subject of debate due to reduced bone-implant contact, many studies have demonstrated that short dental fixtures exhibit similar prognostic rates to standard-length implants [15].

In this research it was constructed that there was enhancement in the periodontal indices around the short dental implants inserted with PRF more than that in the control group patients without PRF. Therefore, as per PRF's application; The study by Pradeep et al. has demonstrated a similar reduction in probing depth, gain in clinical attachment level, and bone fill in areas treated with PRF or PRF with open flap debridement. Yet, because of PRF is not very tricky technique, it can be offered as an improved treatment choice [16]. The positive outcomes accompanied by usage of Platelet-Rich Fibrin (PRF) in dental operations can be considered to its rich content of soluble growth factors and cytokines. These include transforming growth factor beta-1 (TGF-β1), insulin-like growth factor 1 and 2 (IGF-1 and IGF-2), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and interleukins such as IL-1, IL-4, and IL-6.

These growth factors and cytokines play crucial roles in tissue regeneration, wound healing, and the modulation of the inflammatory response. For example, TGF-β1 is known for its involvement in tissue repair and collagen synthesis, while PDGF stimulates cell proliferation and angiogenesis. VEGF promotes angiogenesis, supporting tissue vitality, but after 10 days showed a slight increase in levels of tissue MMP-1 inhibitor, promoting healing of periodontal wounds in the early stages[17]. Moreover, PRF has been shown to reduce levels of matrix metalloproteinase-8 (MMP-8) and interleukin beta (IL-1β). MMP-8 is an enzyme associated with tissue degradation, and its reduction suggests a potential anti-inflammatory effect. IL-1β is a pro-inflammatory cytokine, and modulation of its levels by PRF may contribute to a more controlled inflammatory response, promoting optimal healing conditions.

Additionally, this study also showed that there were higher ISQ values detected in the PRF group than in the control group during the insertion of the dental implants (T0) and after 3 months at the second stage surgery (T3). This means that PRF can increase primary stability of the implant in the initial phase of osseointegration. Two randomized trials examining the effect of PRF before implantation (Öncü and Alaaddinoglu, 2015; Tabrizi et al., 2017) showed comparable results. The use of PRF increased implant stability during the initial healing phase, as evidenced by higher ISQ values. It seems that the ease of use of this material guarantees faster osseointegration [18, 19]. This can be attributed to the influence of growth factors on the promotion of bone healing around implants. The well-established osteo-inductive impact of TGF-β and bone morphogenetic proteins (BMPs) in the context of dental implant-related bone healing is widely acknowledged [20, 21]. Platelet-rich fibrin (PRF) serves as an autologous cicatricial matrix, akin to fibrin glue. PRF comprises a polymerized matrix of fibrin arranged in a tetra-molecular structure, encompassing platelets, cytokines, leukocytes and circulating stem cells [22].

As indicated by He et al.'s research, PRF demonstrates the ability to gradually release autologous growth factors, exhibiting a more robust and enduring impact on the proliferation and differentiation of osteoblasts compared to PRP in vitro. The utilization of PRF has proven to be among the most dependable approaches for augmenting bone healing [23]. PRF elevates the concentration of platelet-derived growth factor (PDGF) and manifests a potent chemotactic effect on osteoblasts and other connective tissue cells. Furthermore, it possesses the capacity to mobilize mesenchymal cells during both bone formation and remodeling processes. PDGF has the capacity to impact alterations in bone directly and indirectly by elevating the transcription of collagen and enhancing the expression of interleukin 6 in osteoblastss [(24)].

Moreover, in this investigation, a noticeable reduction in postoperative pain was observed in the PRF group during the initial healing phases, as assessed through the visual analog scale up to the 14th day, in comparison to the control group. Plausible explanations for this phenomenon include a great impact on the immunity, attributed to the stimulation of defense mechanisms as suggested by Gassling et al. 2009[(25)]. fibrin network facilitated the safeguarding of growth factors from proteolysis the fibrin network, leading to release of substantial amounts of platelet-derived growth factor AB (PDGF-AB), transforming growth factor Beta-1 (TGF beta-1), vascular endothelial growth factor (VEGF), and thrombospondin-1, which stimulate various biological tasks such as chemotaxis, angiogenesis, proliferation, differentiation, and modulation, as highlighted by Choukroun et al. 2001, Singh et al. 2012, and Kumar et al. 2015a [(25-27)].

These findings align with results from two researches employing patient-reported outcomes measured through the VAS. Temmerman et al. (2016) concluded that substantially reduced pain sensations by PRF after three to five days, and Marenzi et al. (2015) observed quite reduced pain in the PRF group up to three weeks [(28, 29)]. However, important considering that both researches did not specify if the patients were ***sufficiently*** blinded. While numerous studies have evaluated the effect of PRF on pain in mandibular third molar extraction [(30)], only a few employed a blinded protocol [(31, 32)]. Conversely, a report by Meschi et al., which included the use of platelet-rich fibrin contain leukocytes (L-PRF) and an occlusive cover in endodontic surgery, resulted in no statistically quite differences in terms of enhancement in life quality during the first seven days post-surgery [(33)].Consequently, patient-reported verbal results, such as pain, should be interpreted cautiously.

Finally, in this study, the marginal bone surrounding the short dental implants at the PRF application site showed significant improvement compared to the control group, as assessed by CBCT and digital periapical radiograph 3 months after the prosthetic phase (T6). These results parallel those obtained in a randomized controlled trial by Boora et al. (2015), demonstrating statistically significant crestal bone loss within three months in the PRF group [(34)]. In the same study, the control group also exhibited statistically crestal bone level significant changes within three months, but the amount of crestal bone level changes in the study group had a statistically significant fewer value than the control group [(34)]. Typically, bone loss before loading is connected with factors such as poor surgical protocols[(35)], infection[(36)], or inadequate oral hygiene [(37)]. Additional bone loss was recorded after a 3-month follow-up in both groups, possibly due to ongoing restorative procedures including many healing abutment separations. It has been demonstrated that the disarranging of the peri-implant tightness during abutment unscrewing may come up with bone loss [(38)]. This phenomenon can be attributed to the protective nature of the original fibrin framework, which shields growth factors from lysis of protein, allowing them to remain active for an extended event (up to 28 days) [(23)]. This gives effective neovascularization and better wound closure with reduced post-operative morbidity [(39)]. While PRF has been successfully tested in surgical procedures related to osseous tissue augmentation (sinus elevation, socket preservation) [(40)] and in the area of periodontal regeneration [(41)], publications on PRF usage in conjunction with short dental implants are scarce, providing limited grounds for conclusive statements at this point.

CONCLUSION

PRF in conjunction with short dental implants in the molar area is a successful treatment and associated with improved soft and hard tissue and improve implant primary stability during the early phase of osseointegration.

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