Published online: 2019-10-01

Original Article

The clinical evaluation of platelet-rich plasma on free gingival graft's donor site wound healing

Mahmoud Khosravi Samani[1], Bardia Vadiati Saberi[2], S. M. Ali Tabatabaei[3], Mahdjoube Goldani Moghadam[4]

[1]Department of Periodontology, Oral Health Research Center, Faculty of Dentistry, Babol University of Medical Sciences, Babol, Iran,
[2]Department of Periodontology, Faculty of Dentistry, Guilan University of Medical Sciences, Guilan, Iran,
[3]Department of Periodontology, Faculty of Dentistry, Birjand University of Medical Sciences, Birjand, Iran,
[4]Department of Orthodontics, Faculty of Dentistry, Birjand University of Medical Sciences, Birjand, Iran

Correspondence: Dr. Mahdjoube Goldani Moghadam
Email: mahdjoube.gm@gmail.com

ABSTRACT

Objective: It has been proved that platelet-rich plasma (PRP) can promote wound healing. In this way, PRP can be advantageous in periodontal plastic surgeries, free gingival graft (FGG) being one such surgery. **Materials and Methods:** In this randomized split-mouth controlled trial, 10 patients who needed bilateral FGG were selected, and two donor sites were randomly assigned to experience either natural healing or healing-assisted with PRP. The outcome was assessed based on the comparison of the extent of wound closure, Manchester scale, Landry healing scale, visual analog scale, and tissue thickness between the study groups at different time intervals. **Statistical Analysis Used:** Repeated measurements of analysis of variance and paired *t*-test were used. Statistical significance was $P \leq 0.05$. **Results:** Significant differences between the study groups and also across different time intervals were seen in all parameters except for the changes in tissue thickness. **Conclusion:** PRP accelerates the healing process of wounds and reduces the healing time.

Key words: Free gingival graft, platelet-rich plasma, wound healing

INTRODUCTION

Platelet-rich plasma (PRP) is an adjuvant to enhance healing in many procedures, including the healing of oral wounds, first described in 1997 and well-documented in the medical and dental literature.[1] This autologous platelet concentrate contains several growth factors[2] which are beneficial for reducing bleeding, enhancing wound healing, and bone regeneration by increasing the concentration of autologous platelet and growth factors in surgical procedures.[3] It has been reported that the use of PRP improved soft tissue healing in the alveolar socket following tooth extraction, and has proven successful outcomes when used in combination with bone curettage in the treatment of refractory bisphosphonate-related osteonecrosis of the jaw. It has also shown promising results in periodontal and implant surgeries.[4] The employment of PRP positively modified the bone formation around dental implants.[5] The use of PRP in combination with bone grafts yielded positive results in terms of improving

Access this article online

Quick Response Code:

Website: www.eurjdent.com

How to cite this article: Samani MK, Saberi BV, Ali Tabatabaei SM, Moghadam MG. The clinical evaluation of platelet-rich plasma on free gingival graft's donor site wound healing. Eur J Dent 2017;11:447-54.

DOI: 10.4103/ejd.ejd_76_17

the handling properties of the grafts and enhancing the quantity and quality of the newly formed bone.[6] In patients with an alveolar cleft, repairing the cleft with autologous bone graft in combination with the use of PRP enhanced the bone healing and led to earlier resuming of orthodontic treatment.[7] In cases of complete cleft palate repair, the use of PRP significantly improved the velopharyngeal closure and nasality.[8] The injection of PRP after a mandibular odontogenic cystectomy has led to faster healing and yielded promising results as a minimally invasive method to support the wound healing process in oral soft tissue defects.[9] It has been found that the periodontal health distal to the second molar following third molar removal could be enhanced using platelet-rich fibrin (PRF), which was significantly better compared to PRP in this regard.[10]

Free gingival graft (FGG) is one of the most common periodontal plastic surgeries to increase or establish the attached gingiva around teeth and implants. Inadequate keratinized gingiva (≤2 mm) around implants can compromise the treatment outcomes in the long-term.[11] The grafts harvested from palatal tissue are preferred to synthetic or allogenic grafts due to their adequate thickness and autologous nature.[12] Despite its safety and efficacy, FGG from palatal tissue leaves an open wound in the donor site and causes a postoperative pain and morbidity. A case series study has shown that PRF was an effective wound dressing which enhanced the healing of the palatal donor site and reduced the postoperative morbidity.[13,14] Despite the excellent observations in the mentioned study, the authors suggested conducting well-designed and controlled studies to further support the findings. They had evaluated the results in terms of wound healing and postoperative morbidity. The evaluation of tissue thickness was suggested for future studies to assess if the blood concentrates provide additional bulk to the donor site.[14] Regarding the limitations of the previous investigations, the aim of the present study was to evaluate the effect PRP has on the extent of wound closure, color, contour, and distortion of the wound, soft tissue healing, tissue thickness at the donor site, and the perceived pain.

MATERIALS AND METHODS

The sample for this clinical trial comprised of 10 subjects (20 surgical sites) who were selected from the patients in the Department of Periodontology at Babol University of Medical Sciences. Patients who were in the age range of 20–45 years and were candidates for a bilateral FGG to manage their gingival recession were included in the study. The subjects with compromised systemic health condition and those suffering from diseases or lifestyle factors influencing the healing process such as uncontrolled diabetes mellitus, immune system disorders, positive history of alcoholism, addiction, current smoking as well as the uncooperative patients and the subjects with abnormal bleeding time or abnormal findings in the complete blood count were excluded from the clinical trial. Similar oral hygiene instructions were delivered to all subjects. They were asked to brush twice daily, clean between the teeth with floss once a day, and to refrain from any other oral hygiene adjunct. The patients were adequately informed about the study design and represented their willingness to participate in the research by signing the informed consent form.

Study design

A randomized split-mouth controlled design was used in this study. With this study design, each of the two treatments—natural healing at one donor site (control group) and healing enhanced with PRP at the other donor site (experimental group)—was randomly assigned either to the right or left sides of the mouth of each subject. The treatment interval for performing the operation was 6 weeks.

Surgical procedure

Local anesthetizing (with 2% lidocaine containing epinephrine at a concentration of 1:100,000) both the recipient and donor sites (palate) was the first step, after which, a gingival graft was harvested from the palate to cover the recession defect at the recipient site. The FGG was dissected using a mucotome (A. DOPPLER made in SWISS) to have the same size grafts (thickness 1.5 mm, width 9 mm, length 15 mm) in all subjects [Figures 1-3].

Platelet-rich plasma preparation

A few minutes before the surgery, 10 ml of blood was drawn from each subject and was then transferred to sterile test tubes containing 3.8% anticoagulant sodium citrate. Centrifugation, using a digital machine (PRGF bti system IV, Spain) at 4000 rpm for 8 min, was done to separate and concentrate the platelets. Following the centrifugation, the plasma was divided into distinct fragments including PRP, platelet average plasma, and platelet poor plasma. To prepare PRP for use in the procedure, it was carefully pipetted out in a test tube (500 µl per each tube) and subsequently,

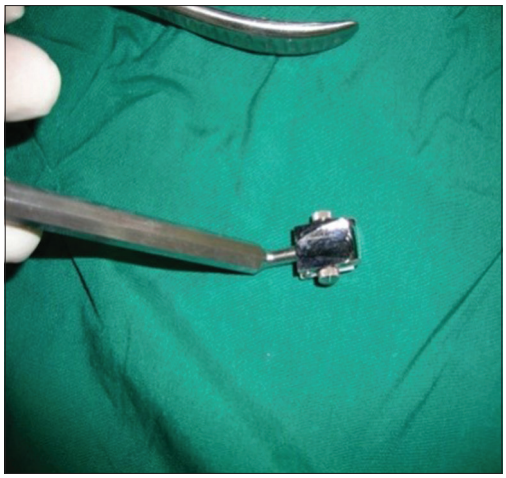

Figure 1: Periodontal mucotome to harvest the graft from the palate

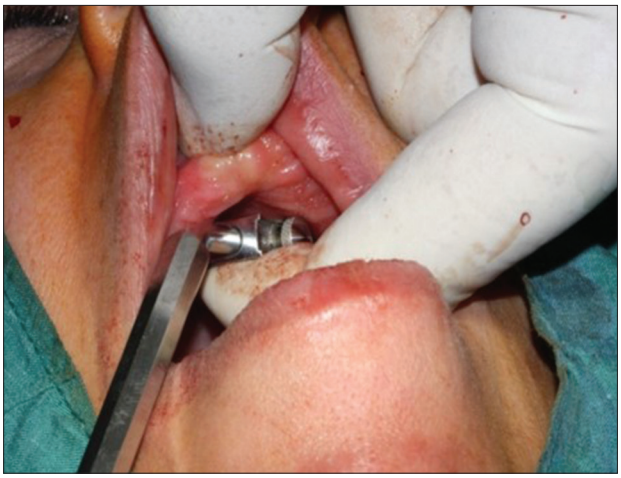

Figure 2: Graft harvesting using mucotome

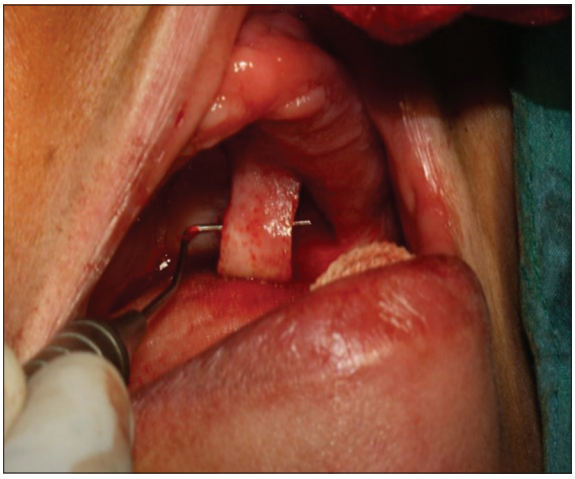

Figure 3: Free gingival graft harvested from the palate

injected to the submucosa of donor site and also, placed over the defect with a collagen sponge at the experimental side (which was randomly assigned) in each subject.

Postoperative care

Analgesics (Acetaminophen 325 mg four times daily for 5 days) and antibiotics (Amoxicillin 500 mg three times a day for a week) were prescribed. The patients were asked to use 0.2% Chlorhexidine Gluconate mouthwash twice daily for 2 weeks. The stitches were removed after 10 days.

Data collection

The patients were examined on days 2, 4, 7, 10, 14 after surgery and photographs were uniformly taken from the wounds in all subjects using a Canon EOS 450D digital camera held at a 30-cm-distance from the surgical sites while the subjects were seated in the dental chair. The tissue thickness at the donor site was recorded before and 2 months after the surgery. Certain parameters were blindly recorded by three observers who were unaware of the study protocol. The following clinical parameters were recorded:

1. Wound closure
2. Modified Manchester Scar Pro forma scale (to evaluate color, contour, and distortion of the wound)
3. Landry, Turnbull, Howley Index (to assess the soft tissue healing)
4. Tissue thickness at the donor site
5. Visual analog scale (VAS) (to record the pain level).

Wound closure

A standard periodontal probe was used to evaluate the extent of wound closure and calculate the actual size of the photographed wounds. The extent of wound closure was determined according to its margin using the Adobe Photoshop CS4 software and reported in the form of the percentage of initial surface area.

Modified Manchester scar pro forma

The Modified Manchester Scar Proforma scale was used to assess color, contour, and distortion of the wound.[15] The color of the wound in comparison with adjacent mucosa was classified as a perfect match (score 0), slight mismatch (score 1), or obvious mismatch (score 2). The contour of the wound was evaluated as similar (score 0), slightly proud or indented (score 1), and hypertrophic (score 2) compared to the surrounding tissues. The wound distortion was considered to be no distortion (score 0), slight distortion (score 1), and obvious distortion (score 2). Accordingly, the overall score for each wound ranged from 0 to 6 in which the lower scores corresponded to the well-repaired wounds.

Landry, Turnbull, Howley index

The healing progress was evaluated using the Landry, Turnbull, Howley Index,[16] which classifies healing on the basis of redness, the presence of bleeding, granulation tissue, epithelialization, and suppuration and rates it from score 1 (very poor healing) to 5 (excellent healing) accordingly.

Tissue thickness at the donor site

Tissue thickness at the donor site was measured using a periodontal probe held perpendicular to the anesthetized tissue at three specific points (2 mm distal, 2 mm mesial, and at the center of future soft tissue window) and was averaged to represent the presurgical tissue thickness at the donor site. The same procedure was repeated 2 months after the surgery and was recorded as the postsurgical tissue thickness at the donor site.

Visual analogue scale

The patients' pain level was recorded in the form of a VAS. In this method, the patients were asked to rate their pain at an examination in form of a score between 0 (no pain) and 10 (the most pain which he/she has ever experienced). In addition, the patients' pain level was also recorded in response to thermal stimulation (normal saline which was stored in a refrigerator at a temperature of 4°C). A volume of 1 ml of normal saline was released from a syringe at distance of 1 cm from the surgical site and the pain level was recorded in the form of a VAS.

Statistical analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 18 for Windows (SPSS, Inc., Chicago, Illinois, USA) and were represented as mean ± standard deviation. Repeated measures analysis of variance has been used to find the significance of the study parameters at different time intervals (two, four, seven, 10, and 14 days following the surgery). Paired *t*-test was used to reveal the significance of differences between the two groups (with or without PRP) at each time point. Statistical significance was considered at $P \leq 0.05$.

RESULTS

The average value for the measured parameters (wound closure, Modified Manchester Scar Pro forma scale, Landry, Turnbull, Howley Index, and VAS), as well as the results of the statistical tests are shown in Table 1. Table 2 presents data on tissue thickness at the donor site along with the results of the statistical test.

As can be seen from Table 1, the changes in the extent of wound closure, Manchester scale, VAS, and stimulated VAS were all significantly different at various time intervals in each study group. The differences between the study groups were significant for the extent of wound closure and the Manchester scale at each time interval [Figures 4 and 5]. Regarding the VAS, the differences between two groups were significant up to the 10th day following the surgery; but at days 10 and 14 the differences between the control and experimental groups were insignificant. Similarly, the stimulated VAS scores were significantly different between the two groups for all examination intervals except for the 14th day, when the differences were insignificant. The changes in tissue thickness from the baseline to 2 months after the surgery, as can be seen from Table 2, revealed no significant difference between the control and the experimental groups.

DISCUSSION

It is a continuous search for finding new treatment methods which are less invasive and are capable

Table 1: Measured parameters and results of statistical analysis

Measured parameters	Groups	Days following surgery					Statistical tests	
		2	4	7	10	14	Repeated measures ANOVA (*P*)	Paired *t*-test (*P*)
Wound closure	Control	13.69±6.33	38.17±8.00	63.15±3.17	82.91±5.42	95.12±3.95	*P*<0.001 *F* (5,2.757)=59.3	*P*<0.0 *F* (5,2.757)=47.33
	Experimental	36.08±7.44	70.67±3.71	91.30±3.41	99.69±0.98	1.00±0.00		
Manchester scale	Control	5.70±0.48	4.80±0.42	3.90±0.31	2.80±0.42	1.70±0.48	*P*<0.001 *F* (5,3.16)=12.47	*P*<0.001 *F* (5,3.16)=24.94
	Experimental	4.80±0.78	3.10±0.56	1.60±0.51	1.10±0.31	1.00±0.00		
Landry index	Control	1.00±0.00	1.70±0.48	2.50±0.70	3.10±0.31	4.00±0.00	*P*<0.001 *F* (5)=10.65	*P*<0.001 *F* (5)=28.08
	Experimental	2.20±0.42	3.70±0.48	4.40±0.51	4.90±0.31	5.00±0.00		
VAS	Control	7.00±1.05	4.10±1.37	1.30±1.25	0.10±0.31	0	*P*<0.001 *F* (4,2.18)=9.86	*P*<0.001 *F* (4,2.18)=32.003
	Experimental	3.20±1.13	0.90±0.87	0	0	0		
Stimulated VAS	Control	9.50±0.52	6.70±1.33	3.90±1.37	2.00±0.66	0.10±0.31	*P*<0.001 *F* (4)=13.255	*P*<0.001 *F* (4)=28.08
	Experimental	4.90±1.28	2.50±0.84	0.80±0.78	0	0		

VAS: Visual analogue scale

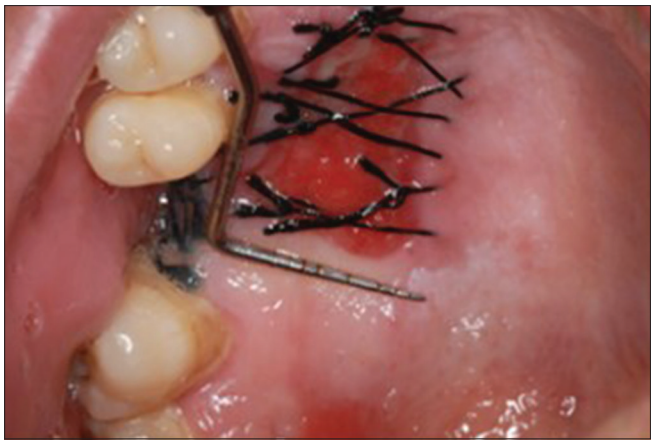

Figure 4: Wound closure at the donor site on day 7 without PRP

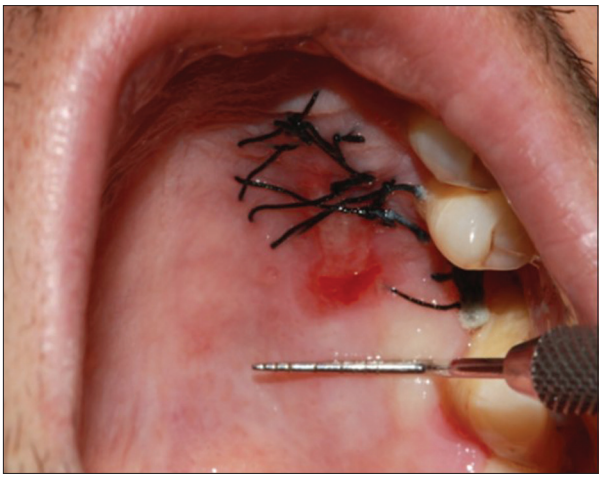

Figure 5: Wound closure at the donor site on day 7 with PRP

Table 2: Changes in tissue thickness from presurgical period to 2 months following surgery measured as postsurgical thickness subtracted from initial thickness

Groups	Tissue thickness change	Result of statistical test
Control	−0.13±0.38	*P*=0.158
Experimental	0.13±0.4	

of reducing the side effects besides accelerating the healing process. One of the major problems of the FGG procedure is that it causes a large defect in the donor site, which needs excessive time for healing. Recently, attempts have been made to enhance the healing process in the grafts' donor sites, and the growth factors have been the focus of many debates in this regard. PRP is a blood product which contains an enormous amount of growth factors. It can positively affect cell proliferation, chemotaxis, differentiation, and the matrix synthesis and plays a role in the initial events of healing and tissue regeneration.[17]

Regarding the aforementioned facts about PRP, so far, however, there have been few papers on the topic of the effect of PRP effect on periodontal wound healing. Based on the findings of this study, PRP significantly reduces the time needed for wound closure and accelerates the healing process. On an average, more than 90% of wound closure in the experimental group was achieved in 1 week compared to the 2-week period needed for the same amount of wound closure in the control group. Kulkarni *et al*. had also reported that on the 7th day after the surgery, the donor site in the PRF group showed normal appearance and no sign of inflammation, whereas in the non-PRF group, the wound had a raw appearance and a layer of slough could be seen on the surface. On day 14 following the surgery, complete wound closure in the PRF group was observed, whereas the non-PRF group showed and some inflammation and incomplete closure.[14] This finding is also in line with the observation by Rozman *et al*.[18] who pointed out that PRP caused more rapid healing and lesser complications.[17] The positive effect of PRP on the healing process, especially in the 1st week, is further supported by the research done by Hung-Wen Lee, who also showed that epithelialization, wound closure, and the fibroblastic count were higher in the PRP group.[19] However, the findings by Keceli, who used a combination of PRP and connective tissue graft for root coverage, revealed no significant difference between the experimental and control groups, which can be attributed to the different incisions used in their study groups (using full thickness flaps in the PRP group and partial thickness flaps in the control group).[20]

In contrast to the first two papers cited above (Rozman's study and Keceli's), there are studies which do not support the positive effect that PRP has on wound healing. In the study done by Lawlor *et al*.,[21] to evaluate the effect of PRP on inguinal wound healing in vascular surgery patients, it was shown that the incidence of groin wound complications was not decreased. The explanation for this difference from our findings can be attributed to the differences in methodological aspects or the various indices used to evaluate the healing rate.[20] Powell *et al*.,[22] who assessed periodontal wound healing with and without PRP, found no significant contribution of PRP to greater flap strength at any postsurgical time point or any histologic differences in wound healing in the Yucatan minipig model. This contradictory result was attributed to the time points chosen for evaluation as well as the inappropriate environment for healing

in that animal model.[21] Camargo *et al*. investigated the effect of incorporating PRP into a bovine porous bone mineral and guided tissue regeneration (GTR) in the treatment of intrabony defects. They found that PRP was not a significantly effective adjunct in the healing of intrabony defects. This observation can be explained on the basis of the small sample size used in that study and the interference of PRP incorporation into the GTR protocol.[17]

In the present study, the healing process was assessed according to the Modified Manchester Scar Pro forma scale and the Landry index. Based on the scores rated with regard to the Manchester scale, it can be seen that the healing score was significantly better in the PRP groups at all-time points, especially in the 1st week. In the 2nd week (day 14), both groups showed a good healing score, and the difference between the two groups was more obvious on the 1st day of the 2nd week.

According to Landry index, better healing score was seen for the PRP groups at days 2, 4, and 7. This observation is corroborated by a previous study which used the same index for evaluating the rate of healing.[21]

There are several reports which support the positive role of PRP in the healing of the extraction socket.[21-25] For example, Alissa *et al*. studied the effect of PRP on the healing of extraction socket in terms of pain level, analgesic consumption, oral function (such as the ability to eat food, and swallowing), patient satisfaction, soft and hard tissue healing, and other factors. They used the Landry scale for the assessment of the healing rate and demonstrated that PRP caused an improved healing of the soft tissue of the extraction sockets.[23]

Lindeboom *et al*.[26] have shown that PRP has a strong stimulatory effect on wound healing and capillary regeneration, especially during the first 7 days after the surgery.[25] These findings are proved by the investigations of Pierce[27] and Pierce and Mustoe.[28] Monica Caceres also reported that PRP causes several cell responses that have a potential role in wound healing. This article shows that PRP accelerates the healing.[29] It is enriched with growth factors such as PDGF (platelet-derived growth factor) and the epidermal growth factor, and it has been claimed that healing time is twice or thrice as fast using this method.[30] Furthermore, it has been shown that PRP contains hepatocyte growth factor which has a strong anti-fibrinolytic effect, prevents the scar formation, and accelerates the epidermal regeneration.[31,32] The results of the present study show similar findings along the line of these investigations.

One of the side effects of the conventional FGGs is the large wound in the donor site which needs a long time to heal and causes a long-lasting pain and discomfort. The patients' satisfaction and convenience are important issues which are influenced by several things including personal and social factors. To assess the effect of PRP on reducing pain and discomfort, we evaluated the perceived pain in this study. Using the VAS which was recorded from the 1st day after surgery, it was found that the patients expressed less pain in the PRP-treated sites and it was significantly lower compared to the control sites. After 7 days, the patients felt no pain in the PRP-treated sites while this took 14 days to occur in the control sites. Alissa *et al*. assessed the effect of PRP on the extraction socket in terms of healing time and perceived pain. Their findings too showed more pain in the control sites during the first few days following the surgery.[23] This is also in accordance with the observations by Kulkarni *et al*. who found relative comfort reported by the subjects in the PRF group during the 1st week after surgery.[14]

Regarding the definition of healing, it can be claimed that the more a wound heals, the less pain is expected.[33] In this study, the result of stimulated pain on days 10 and 14 showed significantly less stimulated pain in the experimental sites. Hence, it can be argued that PRP improves the patient's convenience and comfort and reduces the side effects. Monteleone *et al*. assessed the potential of PRP to accelerate soft tissue wound healing and epithelialization of a split-thickness graft donor site of skin. They concluded that PRP accelerated the wound healing in the early stages, which led to earlier epithelialization[34] and less pain perception in the donor site. These findings are also in accordance with our observations. It seems that the healing process in skin and oral mucosa have many aspects in common.

Several studies claimed that PRP could increase the thickness of the repaired tissue.[25,26] The results of the current study revealed an insignificant difference between the study groups in this regard. Huang *et al*. surveyed the effect of PRP on the coronally advanced flap root coverage procedure. They observed that PRP provided no clinically measurable effect on the gingival thickness, which correlated to the small sample size used in their pilot study.[35]

The anesthetizing injection have some influence on the actual tissue thickness and this limited us in assessing the tissue thickness in the present study. Although attempts were made to inject at a site as far as possible from the site of graft harvesting, it is possible that the limited access to harvested tissue led to insignificant differences between the two study groups regarding the changes in tissue thickness.

Taken together, the results of this study suggest that PRP accelerates the healing process in the surgical site and causes patients to be more satisfied. In general, it can be claimed that the earlier researches on the topic unanimously have concluded that PRP plays a positive role in the various stages of treatment. However, with passing time and more studies in this field, literature has emerged that offers contradictory findings about the role of PRP as an adjunct in the healing process.[35,36] A possible explanation for the disappointing function of PRP when used in addition to the synthetic bone materials can be traced to the acceleration of remodeling and consequently, the resorption of synthetic bone materials which should remain longer to serve as a scaffold containing osteoconductive agents to induce bone formation. However, this explanation needs further research to become scientifically accepted.

CONCLUSION

The evidence from this study suggests that PRP is capable of accelerating the healing process of gingival tissue wounds and it can be extrapolated to the soft tissue defects in the whole body. However, further research is needed to settle the issue conclusively.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Marques FP, Ingham SJ, Forgas A, Franciozi CE, Sasaki PH, Abdalla RJ, *et al.* A manual method to obtain platelet rich plasma. Acta Ortop Bras 2014;22:75-7.
2. Moghe S, Saini N, Moghe A. Platelet-rich plasma in periodontal defect treatment after extraction of impacted mandibular third molars. Natl J Maxillofac Surg 2012;3:139-43.
3. Albanese A, Licata ME, Polizzi B, Campisi G. Platelet-rich plasma (PRP) in dental and oral surgery: From the wound healing to bone regeneration. Immun Ageing 2013;10:23.
4. Longo F, Guida A, Aversa C, Pavone E, Di Costanzo G, Ramaglia L, *et al.* Platelet rich plasma in the treatment of bisphosphonate-related osteonecrosis of the jaw: Personal experience and review of the literature. Int J Dent 2014;2014:298945.
5. Georgakopoulos I, Tsantis S, Georgakopoulos P, Korfiatis P, Fanti E, Martelli M, *et al.* The impact of Platelet Rich Plasma (PRP) in osseointegration of oral implants in dental panoramic radiography: Texture based evaluation. Clin Cases Miner Bone Metab 2014;11:59-66.
6. Kumar KA, Rao JB, Pavan Kumar B, Mohan AP, Patil K, Parimala K, *et al.* A prospective study involving the use of platelet rich plasma in enhancing the uptake of bone grafts in the oral and maxillofacial region. J Maxillofac Oral Surg 2013;12:387-94.
7. Giudice G, Cutrignelli DA, Leuzzi S, Robusto F, Sportelli P, Nacchiero E, *et al.* Autologous bone grafting with platelet-rich plasma for alveolar cleft repair in patient with cleft and palate. Ann Ital Chir 2016;87:5-12.
8. El-Anwar MW, Nofal AA, Khalifa M, Quriba AS. Use of autologous platelet-rich plasma in complete cleft palate repair. Laryngoscope 2016;126:1524-8.
9. Cieślik-Bielecka A, Glik J, Skowroński R, Bielecki T. Benefit of leukocyte- and platelet-rich plasma in operative wound closure in oral and maxillofacial surgery. Biomed Res Int 2016;2016:7649206.
10. Doiphode AM, Hegde P, Mahindra U, Santhosh Kumar SM, Tenglikar PD, Tripathi V, *et al.* Evaluation of the efficacy of platelet-rich plasma and platelet-rich fibrin in alveolar defects after removal of impacted bilateral mandibular third molars. J Int Soc Prev Community Dent 2016;6:S47-52.
11. Park JB. Widening keratinized tissue using modified free gingival graft. J Oral Implantol 2016;42:114-6.
12. Cortellini P, Pini Prato G. Coronally advanced flap and combination therapy for root coverage. Clinical strategies based on scientific evidence and clinical experience. Periodontol 2000 2012;59:158-84.
13. Baltacıoğlu E, Bağış B, Korkmaz FM, Aydın G, Yuva P, Korkmaz YT, *et al.* Peri-implant plastic surgical approaches to increasing keratinized mucosa width. J Oral Implantol 2015;41:e73-81.
14. Kulkarni MR, Thomas BS, Varghese JM, Bhat GS. Platelet-rich fibrin as an adjunct to palatal wound healing after harvesting a free gingival graft: A case series. J Indian Soc Periodontol 2014;18:399-402.
15. Wessel JR, Tatakis DN. Patient outcomes following subepithelial connective tissue graft and free gingival graft procedures. J Periodontol 2008;79:425-30.
16. Beausang E, Floyd H, Dunn KW, Orton CI, Ferguson MW. A new quantitative scale for clinical scar assessment. Plast Reconstr Surg 1998;102:1954-61.
17. Camargo PM, Lekovic V, Weinlaender M, Divnic-Resnik T, Pavlovic M, Kenney EB, *et al.* A surgical reentry study on the influence of platelet-rich plasma in enhancing the regenerative effects of bovine porous bone mineral and guided tissue regeneration in the treatment of intrabony defects in humans. J Periodontol 2009;80:915-23.
18. Rozman P, Bolta Z. Use of platelet growth factors in treating wounds and soft-tissue injuries. Acta Dermatovenerol Alp Pannonica Adriat 2007;16:156-65.
19. Lee HW, Reddy MS, Geurs N, Palcanis KG, Lemons JE, Rahemtulla FG, *et al.* Efficacy of platelet-rich plasma on wound healing in rabbits. J Periodontol 2008;79:691-6.
20. Keceli HG, Sengun D, Berberoğlu A, Karabulut E. Use of platelet gel with connective tissue grafts for root coverage: A randomized-controlled trial. J Clin Periodontol 2008;35:255-62.
21. Lawlor DK, Derose G, Harris KA, Lovell MB, Novick TV, Forbes TL, *et al.* The role of platelet-rich plasma in inguinal wound healing in vascular surgery patients. Vasc Endovascular Surg 2011;45:241-5.
22. Powell CA, Bannister SR, Mackey SA, Maller SC, McDonnell HT, Deas DE, *et al.* Periodontal wound healing with and without platelet-rich plasma: Histologic observations and assessment of flap tensile strength. J Periodontol 2009;80:985-92.
23. Alissa R, Esposito M, Horner K, Oliver R. The influence of platelet-rich plasma on the healing of extraction sockets: An explorative randomised clinical trial. Eur J Oral Implantol 2010;3:121-34.
24. Sammartino G, Tia M, Gentile E, Marenzi G, Claudio PP. Platelet-rich plasma and resorbable membrane for prevention of periodontal defects after deeply impacted lower third molar extraction. J Oral Maxillofac Surg 2009;67:2369-73.
25. Sammartino G, Tia M, Marenzi G, di Lauro AE, D'Agostino E, Claudio PP, *et al.* Use of autologous platelet-rich plasma (PRP) in periodontal defect treatment after extraction of impacted mandibular third molars. J Oral Maxillofac Surg 2005;63:766-70.
26. Lindeboom JA, Mathura KR, Aartman IH, Kroon FH, Milstein DM, Ince C, *et al.* Influence of the application of platelet-enriched plasma

in oral mucosal wound healing. Clin Oral Implants Res 2007;18:133-9.
27. Pierce GF, Mustoe TA, Senior RM, Reed J, Griffin GL, Thomason A, *et al. In vivo* incisional wound healing augmented by platelet-derived growth factor and recombinant c-sis gene homodimeric proteins. J Exp Med 1988;167:974-87.
28. Mustoe TA, Purdy J, Gramates P, Deuel TF, Thomason A, Pierce GF, *et al*. Reversal of impaired wound healing in irradiated rats by platelet-derived growth factor-BB. Am J Surg 1989;158:345-50.
29. Cáceres M, Hidalgo R, Sanz A, Martínez J, Riera P, Smith PC, *et al.* Effect of platelet-rich plasma on cell adhesion, cell migration, and myofibroblastic differentiation in human gingival fibroblasts. J Periodontol 2008;79:714-20.
30. Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR, *et al.* Platelet-rich plasma: Growth factor enhancement for bone grafts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:638-46.
31. Ono I, Yamashita T, Hida T, Jin HY, Ito Y, Hamada H, *et al.* Local administration of hepatocyte growth factor gene enhances the regeneration of dermis in acute incisional wounds. J Surg Res 2004;120:47-55.
32. Ha X, Li Y, Lao M, Yuan B, Wu CT. Effect of human hepatocyte growth factor on promoting wound healing and preventing scar formation by adenovirus-mediated gene transfer. Chin Med J (Engl) 2003;116:1029-33.
33. Barbul AR. Biology of wound healing. Surgical Basic Science. St. Louis: Mosby; 1993.
34. Monteleone G, Marx R, GR. Wound Repair/Cosmetic Surgery Healing Enhancement of Skin Graft Donor Sites with Platelet-Rich Plasma (PRP). Presented at the 82nd Annual American Academy of Oral and Maxillofacial Surgery Meeting, San Francisco; 2000.
35. Huang LH, Neiva RE, Soehren SE, Giannobile WV, Wang HL. The effect of platelet-rich plasma on the coronally advanced flap root coverage procedure: A pilot human trial. J Periodontol 2005;76:1768-77.
36. Sánchez AR, Sheridan PJ, Kupp LI. Is platelet-rich plasma the perfect enhancement factor? A current review. Int J Oral Maxillofac Implants 2003;18:93-103.