

## Original Research

### The influence of platelet-rich plasma on the healing of extraction socket

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#### ABSTRACT:

**Aim:** To evaluate the role of platelet-rich plasma on the healing of extraction socket. **Methods:** 40 patients with an unremarkable medical history, subjects with at least one site bordered by minimum of one tooth, nonsmokers, teeth with root fracture, patients having teeth with hopeless periodontal prognosis, teeth with failed endodontic therapy or advanced carious lesion. The patients fulfilling the criteria were randomly allocated into two groups: Group I (test group-n = 20): Extraction sockets which received platelet rich fibrin. Group II (control group-n = 20): 10 extraction sockets left for normal healing (blood clot). **Result:** 40 patients aged between 22 and 52 (mean 36.8) years, including 25 females and 15 males completed the study. Each patient had single tooth extraction. The width of the alveolar ridge was measured after extraction (at baseline) as well as 1 week, 4 weeks, and 8 weeks in both the control and the test groups. The test group presented with a mean horizontal ridge width of  $12.94 \pm 3.33$  mm after extraction, which reduced to  $12.70 \pm 3.37$ ,  $12.33 \pm 3.30$  and  $11.97 \pm 3.33$  mm at 1, 4 and 8 weeks respectively. For the control group the mean horizontal ridge width was  $14.46 \pm 4.13$  mm after extraction, which reduced to  $14.01 \pm 4.00$  mm,  $13.04 \pm 3.50$  mm and  $12.54 \pm 3.42$  mm at 1, 4 and 8 weeks respectively. The mean radiographic bone fill (RBF) percentage in the control group at 1, 4 and 8 weeks was  $69.82 \pm 2.07\%$ ,  $75.03 \pm 2.22\%$  and  $81.35 \pm 3.61\%$  respectively. While in the test group, the mean radiographic bone fill percentage was  $75.05 \pm 2.66\%$ ,  $82.54 \pm 4.33\%$  and  $89.81 \pm 2.53\%$  at 1, 4 and 8 weeks respectively. **Conclusion:** We concluded that the use of PRP accelerates socket wound healing after tooth extraction as noticed by increased bone fill and reduced alveolar bone width resorption using clinical and radiographic methods.

**Keywords:** PRP, Extraction socket.

Received: 25 August, 2021

Accepted: 29 September, 2021

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**This article may be cited as:** Singh A, Singh R, Gautam G. The influence of platelet-rich plasma on the healing of extraction socket. Int J Res Health Allied Sci 2021; 7(5): 57-62.

#### INTRODUCTION

PRP is a blood derivative in which platelets are concentrated in a small plasma volume. The use of PRP is based on the fact that platelets constitute a reservoir of critical growth factors that may positively regulate the wound healing process once released.<sup>1</sup> It has now been more than 50 years since the use of PRP was originally reported in haematological and immunological research.<sup>2</sup> PRP was principally introduced to the oral and maxillofacial surgery field by Whitman et al<sup>3</sup> and Marx et al.<sup>4</sup> Since that time, PRP has been used in jaw reconstructive procedures and in conjunction with dental implants.

The efficiency of PRP to promote hard and soft tissue healing has been extensively investigated; however, studies often yielded conflicting results and conclusions. The role of platelets in wound healing has been comprehensively reviewed by Anitua et al.<sup>5</sup> Further reviews on the subject are also available: while a few are enthusiastic<sup>6-8</sup>, others are rather critical.<sup>9-12</sup> In a systematic review of the literature<sup>13</sup>, the authors aimed to analyse the reported effects of PRP on bone regeneration in humans. For this purpose, all clinical PRP applications in the field of dentistry were considered. It was concluded that there was evidence of beneficial effects of PRP in the treatment of periodontal defects, and that there was

weak evidence of beneficial effects of PRP for maxillary sinus augmentation, although this was disputed in a recent Cochrane review<sup>12</sup> on maxillary sinus augmentation procedures which suggested that PRP treatment may not improve the outcome of maxillary sinus augmentation procedures for implant rehabilitation. Moreover, no conclusions were drawn about other applications of PRP in dentistry owing to insufficient data.<sup>13</sup>

There are some trials and reviews on the use of PRP as an adjunctive treatment to the surgical repair of intrabony periodontal defects<sup>14</sup>, or to the maxillary sinus augmentation procedures<sup>12</sup>. However, there is a lack of studies evaluating the influence of PRP alone on the hard and soft tissue healing of extraction sockets in patients contemplating implant treatment. New techniques and materials are being developed to enhance healing and to minimise complications that may occur after tooth extraction. Furthermore, little has been published on patient-centred outcomes such as patient satisfaction and quality of life after PRP application in extraction sockets.

## MATERIAL AND METHODS

A total of 40 subjects who required tooth extraction and future implant therapy were included in the study. Inclusion criteria consisted of patients with an unremarkable medical history, subjects with at least one site bordered by minimum of one tooth, nonsmokers, teeth with root fracture, patients having teeth with hopeless periodontal prognosis, teeth with failed endodontic therapy or advanced carious lesion. Patients with systemic diseases, with presence or history of osteonecrosis of the jaws, with use of bisphosphonates, exposure to head and neck radiation, chemotherapy, and patients with distinct peri-apical pathology were excluded. A sample size of minimum of 20 subjects in each group was identified using power calculation, incorporating means and standard deviations from previous studies.<sup>15</sup> The patients fulfilling the criteria were randomly allocated into two groups:

Group I (test group-n = 20): Extraction sockets which received platelet rich fibrin.

Group II (control group-n = 20): 10 extraction sockets left for normal healing (blood clot).

## PRP PREPARATION

Immediately after surgical procedure, 20 ml of blood was drawn from each patient in test group without adding anticoagulant. Following blood collection each sample was centrifuged at 3000 rpm (approximately 400 g) for 10 min using compact centrifuge. This results in a fibrin clot formation, containing platelets located in the middle of the tube, just between the red blood cell layer at the bottom and acellular plasma at the top. This clot is removed from the tube using sterilized tweezers and the attached red blood cells scraped off and discarded. The PRP clot was then placed on the grid in the PRP Box, and covered with

the compressor and lid. This produces an inexpensive autogenous fibrin membrane.

## CLINICAL PROCEDURE

All patients were given buccal and lingual/palatal infiltration anesthesia of lidocaine HCl 2% with epinephrine 1:100,000. The teeth were extracted with minimal trauma and without flap elevation, using periostomes by single experienced periodontist. The periostome was inserted around as much of the circumference of the root and the socket was dilated. The final delivery of the tooth was performed with forceps. For molars, root separation was performed using surgical bur before the use of periostomes.

The PRP treatment sites (group I) were treated immediately post extraction by placement of PRP, pressure application and figure-8 suture (3-0 chromic gut). After removal of the tooth, the control group (II) extraction sites were treated immediately by pressure application and figure-8 suture. Post operative instructions included prevention of wound disturbance. Avoid excessive rinsing and spitting for 48 h. Tongue and fingers should not be used to apply pressure at wound site. No smoking and pulling or lifting of lips.

## CAST ANALYSIS

Patients were seen for postoperative appointments at 1 week, 4 weeks and 8 weeks. Alginate impression for study cast construction was taken after extraction and at each interval. Rigid acrylic stents were made of 3 mm thick light cured resin, based on the cast model prepared after surgical procedure. Two holes at 5 mm from mid-buccal and mid-lingual sites apical to crest were made in the acrylic to create reference points to ensure that the follow-up measurements would be standardized and reproducible. Reference marks were made on the cast at the point of these holes. A digital caliper (accuracy to 1/1000 of an inch) was used to measure alveolar ridge width at these points after each appointment.

## RADIOGRAPHIC ANALYSIS

The surface area of the extraction sockets was measured using computer graphic software program (Adobe Photoshop version 11, adobe system incorporation, 345 Park Avenue, san Joe, 95/10). The size of the extraction sockets were calculated by the technique described by Chiapasco and Rossi<sup>16</sup>. The radiographic images were transferred to software and converted to grayscale tonalities of 256. Auto-tracing of the size of the residual cavity using a magnetic tool was done for each defect. The area marked was converted into a histogram, which gave the number of pixels in the residual cavity. The surface area was calculated in millimeters. The decreasing number of millimeter in the surgical defect overtime gave us the relative bone filling in the area of the lesion. The percentage of radiographic bone fill (RBF) was then calculated. The residual cavity defect and

regenerated bone density in both the test group and control group were also calculated using Radio Visio-Graphs to rule out bias.

Bone regeneration results of the participants on test group and control group at 1 week, 4 weeks and 8 weeks follow up were compared and statistically analyzed. The radiographic and clinical measurements at the 1st week, 4th week and 8th week follow up appointments were compared for changes in bone fill and alveolar ridge width changes. Means and standard deviations were identified with descriptive statistics and compared using ANOVA and Mann-Whitney U Test (Graphpad-Instat).

## RESULT

40 patients aged between 22 and 52 (mean 36.8) years, including 25 females and 15 males completed the study. Each patient had single tooth extraction.

### CAST ANALYSIS RESULTS

The width of the alveolar ridge was measured after extraction (at baseline) as well as 1 week, 4 weeks, and 8 weeks in both the control and the test groups. The test group presented with a mean horizontal ridge width of  $12.94 \pm 3.33$  mm after extraction, which reduced to  $12.70 \pm 3.37$ ,  $12.33 \pm 3.30$  and  $11.97 \pm 3.33$  mm at 1, 4 and 8 weeks respectively. For the control group the mean horizontal ridge width

was  $14.46 \pm 4.13$  mm after extraction, which reduced to  $14.01 \pm 4.00$  mm,  $13.04 \pm 3.50$  mm and  $12.54 \pm 3.42$  mm at 1, 4 and 8 weeks respectively. (table 1)

The mean difference in proportion of alveolar ridge width in control and test groups with regards to the time intervals (baseline, 1 week, 4 weeks and 8 weeks) are presented in table 2. Significant differences were observed in alveolar ridge width proportions among test and control groups for observations between baseline to 4 and 8 weeks respectively. Similarly significant ridge width proportion difference was also observed among test and control groups for intervals between 1 week as compared to 4 and 8 weeks respectively (Mann-Whitney U test). (table 2)

### RADIOGRAPHIC ANALYSIS

The mean radiographic bone fill (RBF) percentage in the control group at 1, 4 and 8 weeks was  $69.82 \pm 2.07\%$ ,  $75.03 \pm 2.22\%$  and  $81.35 \pm 3.61\%$  respectively. While in the test group, the mean radiographic bone fill percentage was  $75.05 \pm 2.66\%$ ,  $82.54 \pm 4.33\%$  and  $89.81 \pm 2.53\%$  at 1, 4 and 8 weeks respectively. (table 3.)

The mean RBF was significantly higher in the test group than control group at all time intervals (1, 4 and 8 weeks). (table 4)

**Table 1 Mean  $\pm$  standard deviation of alveolar ridge width for control and test group right after extraction, 1, 4 and 8 weeks two after extraction in mm**

	Group	Test group	Control group
After extraction	Mean	14.46	12.94
	Std. deviation	4.13	3.33
One week	Mean	14.01	12.70
	Std. deviation	4.00	3.37
Four weeks	Mean	13.04	12.33
	Std. deviation	3.50	3.30
Eight weeks	Mean	12.54	11.97
	Std. deviation	3.42	3.23

**Table 2: Mean (SD) difference in proportion and P value of alveolar ridge width for control and test group 1, 4 and 8 weeks after extraction**

	Extraction to one week	Extraction to four weeks	Extraction to eight weeks	One week to four weeks	One week to eight weeks	Four weeks to eight weeks
Control group (mean difference)	$3.26 \pm 2.21$	$9.79 \pm 6.02$	$13.54 \pm 6.57$	$6.72 \pm 5.25$	$11.08 \pm 6.78$	$4.20 \pm 1.47$
Test group (mean difference)	$2.09 \pm 0.84$	$5.22 \pm 0.80$	$8.58 \pm 1.73$	$3.19 \pm 0.77$	$6.33 \pm 1.35$	$3.24 \pm 1.21$
P value	0.13	0.014	0.039	0.014	0.039	0.38

\*The mean difference is significant at the  $P < 0.05$ .

**Table 3: Mean  $\pm$  standard deviation of bone fill percentage for control and test group at 1, 4 and 8 weeks**

	Control group			Test group		
	One week	Four weeks	Eight weeks	One week	Four weeks	Eight weeks
Mean	69.82	75.03	81.34	75.05	82.54	89.81
Std. deviation	2.07	2.2	3.6	2.66	4.33	2.53
Minimum	68.30	73.24	77.98	72.37	78.99	87.09
Maximum	71.11	76.76	85.96	77.44	87.93	91.32

**Table 4.**

	One week		Four weeks		Eight weeks	
	Control	Test	Control	Test	Control	Test
Mean P value	69.82 0.014	75.05	75.03 0.0	82.54	81.35 0.019	89.81

## DISCUSSION

The aim of the study was to evaluate extraction socket healing using autologous platelet rich fibrin (PRP) both clinically and radiographically. The hypothesis that PRP will accelerate socket wound healing after tooth extraction, appreciated by increased bone fill and reduced bone resorption was accepted. The mean loss of alveolar ridge width in the test groups (PRP-0.99 mm–8.68%) was significantly less as compared to the control group (No PRP-1.97 mm–14.54%). In addition, comparison between the proportions of the ridge width among the test and control groups showed that there was a statistically significant difference from tooth extraction to 4 weeks and 8 weeks among the two groups, again signifying the impact of using PRP. It is suggested that incorporation of PRP increases the efficiency of cell proliferation. In addition, platelets in the PRP undergo degranulation,<sup>17</sup> providing a sustained release of growth factors [platelet derived growth factors (PDGF), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), thrombospondin-1 (TSP-1), transforming growth factor-beta (TGF-β)] influencing angiogenesis, epithelialization, stem cell trapping and immune control.<sup>18-20</sup> This provides major elements for accelerated bone healing in the presence of PRP.

Traditionally, different alveolar ridge preservation techniques have been used, most of which include the placement of graft material into extraction sockets.<sup>21,22</sup> Use of grafts for socket preservation increases the treatment cost as well as the risk of disease transmission. In addition, the graft is not totally incorporated into the newly formed bone and when compared to sites without graft, they show less vital bone formation.<sup>23</sup> In addition, in the present study socket occlusion with a PRP membrane was utilized in a flap-less manner for ridge preservation. According to Kotsakis and Chrepa<sup>24</sup>, flap advancement for primary closure in ridge preservation interventions may lead to repositioning of the mucogingival junction, displacement of the keratinized mucosa, and ridge resorption. Fickl and Zuhr<sup>25</sup> studied tissue alterations after tooth extraction with and without surgical trauma on beagle dogs at 4 months. The authors (Fickl and Zuhr)<sup>25</sup>, reported that leaving the periosteum in place decreases the resorption rate of the extraction sockets. Moreover, in a similar study,<sup>26</sup> mean values of bone density for PRP groups were significantly higher as compared to PRP groups at four months follow up.

The present study showed the efficacy of autologous PRP in the healing of extraction sockets. These results are consistent with study by Hauser and Gaydarov<sup>15</sup> who reported (0.48%) of alveolar bone loss in

extraction sockets with PRP without flap elevation compared with (3.68%) in control group at 8 weeks follow up. The authors also reported that micro computed tomographic analysis showed significantly improved microarchitecture and significantly higher bone quality in the PRP group. Similarly in the present study, radiographic data showed statistically significant difference between test and control groups at one, four and eight weeks respectively, with a significant advantage in the test (PRP) group. Interestingly in the present study, significant differences were observed in alveolar ridge width proportions among test and control groups for observations between baseline to 4 and 8 weeks respectively. Similar findings were reported in the study by Simon et al., (Simon and Gupta, 2011) showing a mean width socket resorption of 0.57 mm (7.38%) with PRP after 4 months and confirmed a significant advantage in the preservation of post extraction alveolar ridge dimensions with the use of PRP. Choukroun and Diss<sup>27</sup> indicated that when a PRP membrane is used, new blood vessels are generated and epithelialization is promoted. Consequently, this facilitates more rapid wound coverage. Also, after a cystic lesion is removed and filled with PRP, the time it takes to be replaced naturally with new bone was after 2.5 months. Similarly, in a study by Simon and Von Hagen<sup>28</sup> during morphometric tissue experiment in which they planned a socket preservation surgery showed new bone generated in only 3 weeks when the preservation procedure was conducted by using PRP only.

Recently, studies have compared the efficacy of multiple graft materials along with bioabsorbable membranes on alveolar bone healing.<sup>29</sup> A study using freeze-dried bone allografts and collagen membrane showed a mean net loss of 1.2 mm (13.04%) of preoperative alveolar width at 4 months follow up.<sup>29</sup> Similarly Lekovic and Camargo<sup>30</sup> reported 1.31 mm (17.79%) mean net loss of alveolar width after 4 months of healing when polygalactide/poly lactide membrane was used for ridge preservation. These findings are comparable to the present study findings, however the use of available bioabsorbable membranes is associated with a high rate of (upto 25%) membrane exposure, impacting the amount of bone infill within the socket. Therefore it is recommended that further studies with improved materials and techniques comparing the efficacy of PRP and bioabsorbable membranes are undertaken to assess their comparative clinical efficacy in extraction socket preservations. In addition, a possible limitation of the study was the

short follow-up of the socket healing, which was only 8 weeks. Therefore, further long-term studies with standardized methodology are warranted. From a clinical perspective, the use of autologous PRP in the healing sockets (extraction sites) and surgical sites is recommended to improve bone healing and minimize resorption.

## CONCLUSION

We concluded that the use of PRP accelerates socket wound healing after tooth extraction as noticed by increased bone fill and reduced alveolar bone width resorption using clinical and radiographic methods.

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