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Original article

Value of Platelet Rich Fibrin as Surgical Adjuvant in Management of Mandibular Fracture

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Abstract:

Objectives: The aim of this study is to evaluate the effect of Platelet Rich Fibrin (PRF) in bone regeneration and healing in cases of fracture mandible. **Patients and Methods**: Forty patients diagnosed clinically and radiographically with mandibular fracture treated with open reduction and rigid internal fixation, they were randomly divided into two groups (n=20): Group A; the study group (Fixation with plates and screws with PRF membrane along the fracture line) and Group B; the control group (Fixation with platelet and screws only). Mean Bone Density was assessed via Computed tomography at 1week, 3 months, 6 months postoperative. The pain was assessed using numerical rating scale (NRS) during 1st, 3rd day and 1 week postoperatively, as well as maximum mouth opening. **Results:** Increased mean bone density was observed in the study group which was statistically significant. The mean bone density for the study group at 1week, 3 months and 6 months were 270.80±79.60, 575.40±83.49 and 890.10±130.55 respectively. In contrast to control group, the mean bone density was of 223.00±53.53, 408.80±76.59 and 635.80±94.58 for 1 week, 3months and 6 months respectively. There was no statistically significant difference as regard pain and maximum mouth opening between both groups. **Conclusion:** PRF application as a biologic surgical additive at the fracture line in mandibular fractures promotes early bone regeneration and soft tissue healing due to the presence of growth factors.

Keywords: Fracture Mandible, Platelet Rich Fibrin, Bone healing.

Introduction

Mandible fractures account for a significant portion of maxillofacial injuries and the evaluation, diagnosis, and management of these fractures remain challenging, despite improved imaging technology and fixation techniques. Understanding appropriate surgical management can prevent complications such as malocclusion, pain, and revision procedures. Depending on the type and location of the fractures, various open and closed surgical reduction techniques can be utilized (1).

The healing of hard and soft tissues is mediated by a wide range of intra and extra-cellular events that are regulated by protein signals. Elsisy et al, suggested that chitosan is very effective in bone formation (2). Also, It is known that platelets are involved in the process of healing through blood clot formation and release of growth factors that promote and maintain healing (3). Therefore one of the great challenges of clinical research has been the development of bioactive surgical additives, which help to regulate inflammation and increase the speed of healing process (4).

Platelet-rich fibrin (PRF) is a second-generation platelet concentrate developed by ***Choukroun et al***., PRF contains platelets, leukocytes, cytokines and adhesive proteins. The presence of white blood cells (WBCs), that secrete a large quantity of growth factors (5). PRF is simpler and less expensive to prepare, as well as being less risky to the patients. Owing to its dense fibrin matrix, PRF takes longer to be resorbed by the host, which results in slower and sustained release of platelet and leukocyte derived growth factors in to the wound area (6,7).

Several methods are available for the assessment of bone healing including densitometry, direct digital radiography, and bone biopsy. Computed tomography (CT) is an imaging modality that is widely used for maxillofacial imaging, as it provides accurate two and three-dimensional radiographic images of an anatomical structure with an increased precision, lower doses of radiation, and lower costs (8). Assessment of bone union after a fracture is an important clinical consideration. Wrong assessment of bone healing can have major negative consequences for a patient. Especially if bone union is doubtful, an objective and accurate assessment tool can be helpful in clinical decision making (9).

PRF showed promising effect on bone regeneration either alone or combined with other osteogenic materials. Recent studies reported that PRF showed safe and promising results, without contradictory findings, and showed several advantages and possible indications for PRF to be used (10).

The aim of this study is to evaluate the effect of PRF in bone regeneration and healing in cases of fracture mandible.

Subjects and Methods

This study was designed as a prospective comparative study where patients were selected from the Emergency Room of Benha University Hospital and from the Outpatient Clinic of Oral and Maxillofacial Surgery, Otorhinolaryngology department Benha

University from January 2020 to January 2022.

The study was approved by the medical ethical committee of Benha Faculty of medicine (Code number: MD 21-11-2019) and written informed consents from the patients were obtained after detailed explanation of all the procedures.

Patient Selection

Forty patients diagnosed with mandibular fracture were selected for the study, divided into two groups, each with 20 patients:

Group A (Study Group): The mandibular fracture was treated by open reduction and direct fixation using the conventional 2.0 mm miniplates and screws with placement of PRF membrane.

Group B (Control Group): The mandibular fracture was treated by open reduction and direct fixation using the conventional 2.0 mm miniplates and screws.

Standardized preoperative panoramic radiographs and CT scans axial, coronal and 3D reconstruction views to assess the number and location of line or lines of fracture, localize the inferior alveolar canal and any teeth in the fracture line. Patients were admitted to the hospital and routine laboratory investigations were performed before surgery. ECG, and chest radiograph were performed for patients older than 40 years of age.

Preparation of Platelet rich fibrin (PRF)

Twenty milliliters of the patient's whole venous blood were collected in 2 sterile 10 ml glass test tubes without anticoagulant. Then the test tubes were placed in a table centrifuge machine at 3000 rotations per minute (rpm) for 10 minutes. The resultant product consisted of the following three layers: the top-most layer consisting of acellular platelet poor plasma (PPP), platelet rich fibrin layer (PRF) in the middle and red blood cells (RBCs) at the bottom. The PRF was then separated from PPP and RBC layer. Dental PRF box device developed for PRF membrane preparation to secure the PRF and to drain the excess fluid when compressed (Fig. 1).

Fig. (1): steps of PRF preparation, A) after centrifugation and separation into 3 layers, B) PRF membrane, C) after compression in dental PRF box.

Operative procedures

All procedures were performed under general anesthesia and strict aseptic conditions. The oral cavity was first disinfected with povidone-iodine, as well as extra-orally. Intermaxillary fixation (IMF) was used temporarily to adjust the occlusion. After exposing all the fracture lines through an intraoral incision, the fractures were mobilized, and any soft tissue entrapped within the fracture lines were removed, and the bone reduction was done.

Fixation of the fractures was done as follows: (Study Group A) as in (Fig. 2 A): The fracture was treated by reduction and fixation using conventional 2.0 mm miniplates and screws with placement of PRF membrane. (Control Group): as in (Fig. 2 B): The fracture was treated by reduction and fixation using conventional 2.0 mm miniplates and screws.

After checking the correct reduction of the fracture and the stability of the internal fixation, the IMF was removed and the wound was closed in layers using polyglycolic polylactic 3-0 suture material (Vicryl, Ethicon, Cornelia, GA, USA).

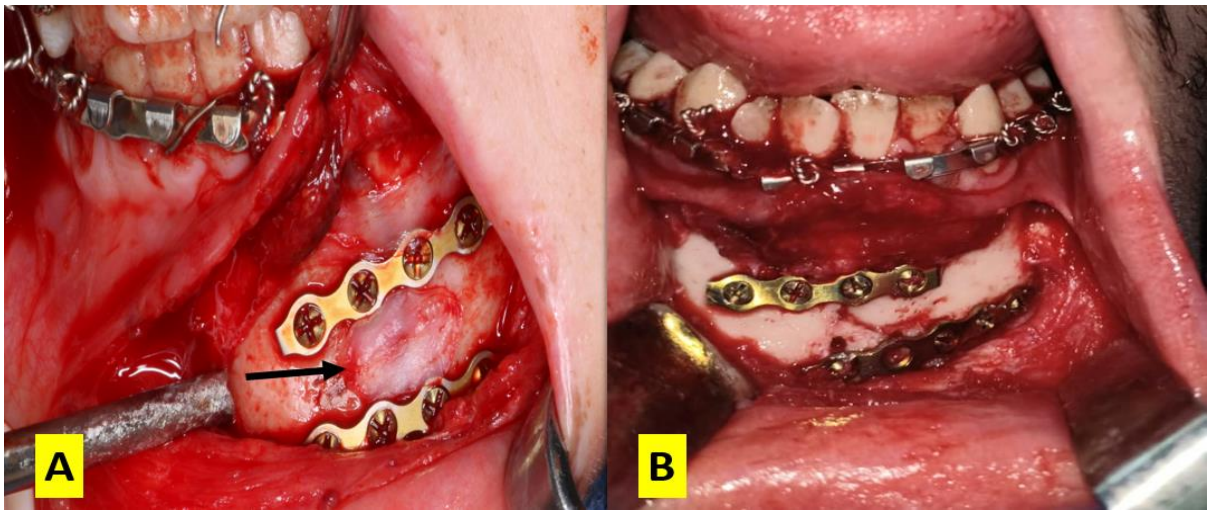

Fig. (2): A) Study case showing fixation of fracture using miniplates and screws with PRF membrane (black arrow) overlying the fracture line. **B)** Control case showing Fixation of fracture using miniplates and screws.

CT was performed immediately postoperative, at 3 months and at 6 months consequently to evaluate the adequacy of the reduction of the fractured segment, the progress of the healing process and measurement of the mean bone density at the site of the fracture line by using 3 points at each region of interest [ROI]. These 3 points were distributed inside the fracture line then taking their mean value to determine the mean bone density (Fig.3). The pain was assessed using

numerical rating scale (NRS) during 1st, 3rd day and 1 week postoperatively, as well as maximum mouth opening.

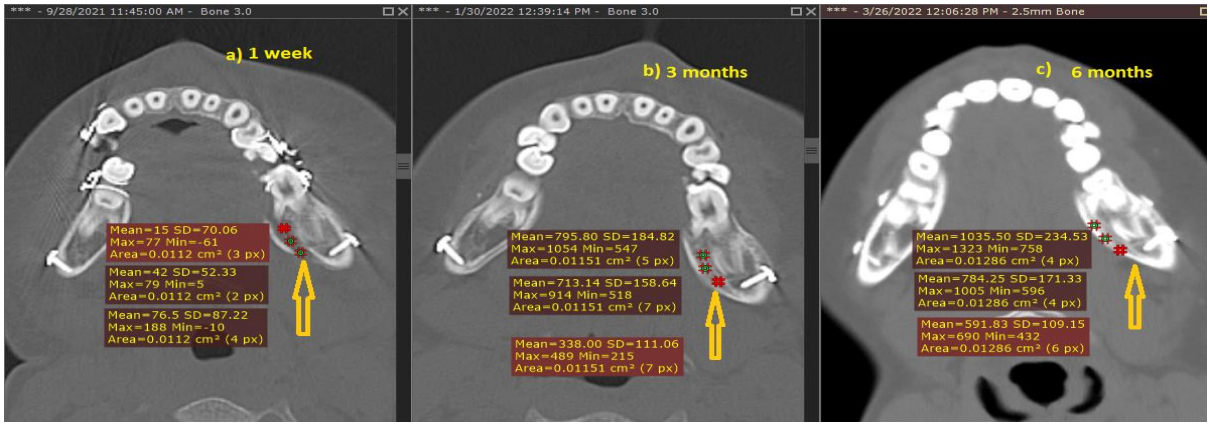

Fig. (3): 3 points are taken along ROI on left angle of mandible, a) Evidence of linear fracture line along the left mandibular angle, b) reaction denoting progress of bone healing with decreased bone gap at fracture line, c) Increased bone density with barely perceived fracture line.

Statistical analysis

The data were recorded on an "Investigation report form". These data were tabulated, coded then analyzed using the computer program SPSS (Statistical package for social science) version 26. Descriptive statistics were calculated for the data in the form of Mean and Standard deviation (±SD) or Number and percent. In the statistical comparison between the different groups, the significance of difference was tested using Student's t-test to compare between mean of two groups of numerical (parametric) data, for continuous non- parametric data, Mann-Whitney U- test was used for inter-group analysis, ANOVA test to compare between more than two groups of numerical (parametric) data, for continuous non-parametric data, Friedman test was used, post-hoc analysis was used for in between group analysis. Inter-group comparison of categorical data was performed by using chi square test (X2-value). P value <0.05 was considered statistically significant (S) in all analyses.

Results

In the present study, there were 35 males and 5 females, age ranging from 18 to 50 years with a mean age of 25.8±8.3. The main cause of mandibular fracture was a road traffic accident in 25 patients. While 8 patients were due to fall from a height and 7 patients were due to violence. Results showed that mean bone density for study group at 1week, 3 months and 6 months were 270.80±79.60, 575.40±83.49 and 890.10±130.55 respectively. In contrast to control group, the mean bone density was 223.00±53.53, 408.80±76.59 and 635.80±94.58 for 1 week, 3months and 6 months respectively. The difference

between both groups was found to be statistically significant (Table,1). Also, there was an observable significant increase in bone density for 3 months and 6 months follow up period compared to 1 week in both groups.

Table (1): Comparison between the two studied groups according to bone density.

	Group A (n=20)		Group B (n=20)		Test of significance. (t-test)	p-value
	Mean	S. D	Mean	S. D		
1 week	**270.80**	**79.60**	**223.00**	**53.53**	**2.2**	**0.02***
3 months	**575.40**	**83.49**	**408.80**	**76.59**	**6.6**	**<0.001***
6 Months	**890.10**	**130.55**	**635.80**	**94.58**	**7.1**	**<0.001***

Indicate significance at p ≤ 0.05

Results showed an observable significant decrease in NRS pain scores during Day 3 and 1 week compared to Day 1 NRS scores in each group. However, there was no statistically significant difference in pain level between both groups in the NRS scores (Fig. 4) at the different observation times. For mouth opening in both groups, there was improvement during the overall follow up periods (3rd day ,1 week, first month and 6 months post operatively) and it was statistically significant for all (p≤ 0.001, p < 0.05), but there was no significant difference between both groups at each follow up periods (Fig. 5). In both groups, edema was limited to the area of operation and resolved completely in all cases by the end of 2-3rd week postoperatively and no infection nor wound dehiscence were detected.

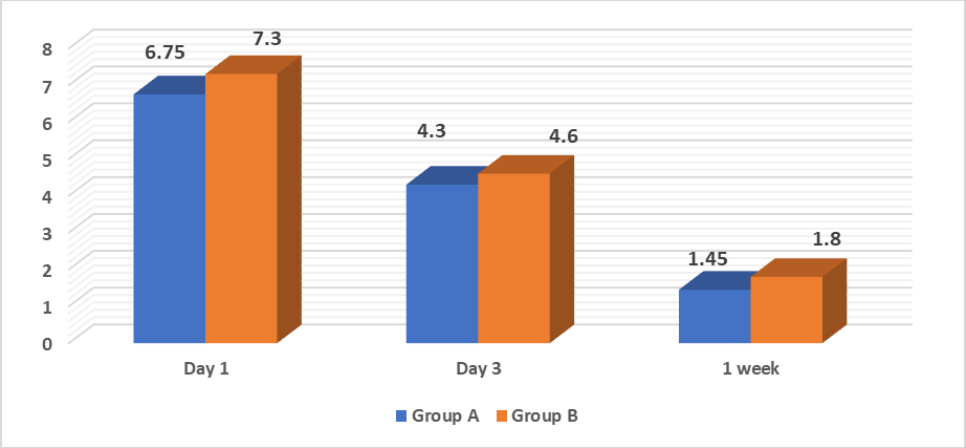

Fig. (4): Group A and Group B regarding Post-operative NRS pain score assessment.

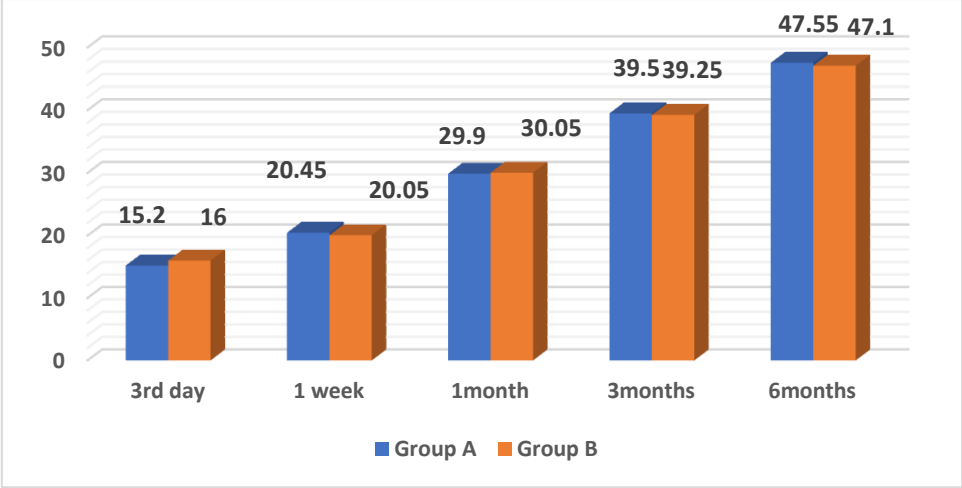

Fig. (5): Group A and Group B regarding Post-operative maximum mouth opening.

Discussion

In this study, 87.5% of the patients were males while 12.5% were females which indicated that the male ratio was higher than female. This result was supported by *Czerwinski et al.*, , they reported that 78% of patients were male and 22% were female (11). Also, *El Shehaby et al.*, reported that males represent 88% of cases (12). Road traffic accidents were found to be the most frequent cause of fractures accounting for 62.5% of the cases, followed by falls 20.0% then violent assaults 17.5%, which was in agreement with *El Shehaby et al.*, and *Chen et al.*,(12) (13). This may be attributed to the fact that the females drive vehicles less frequently and more carefully than males. Also, due to reckless driving and badly paved routes, bad condition of the vehicles and the insufficient use of seat belts in the developing countries.

Using PRF instead of Platelet Rich Plasma (PRP) in our study coincides with another two studies in which the effect of PRP and platelet-enriched fibrin on bone formation in bone tissue engineering was compared. The results indicated that the osteogenic characteristics of platelet-enriched fibrin are superior to those of PRP in bone tissue engineering (14) (15). However, this finding was not in agreement with an in-vitro human cell culture study that aimed to examine the growth factors released from PRP and PRF. They showed that PRP application in cell cultures leads to higher levels of growth factors than PRF application (16). The difference from other results may be because most of PRF growth factors were embedded in the clot and gradually released and exerted a stronger and more durable effect than PRP which provides a sudden release of growth

factors after which the concentrations of growth factor fall.

The present study showed that the mean bone density in the study group was higher than the control group. This finding proved to be statistically significant throughout the follow-up period. A lot of studies support the PRF as a healing biomaterial because of the high levels of growth factors in the PRF which accelerates the proliferation of osteoprogenitor cells. Moreover, the fibrin seems to be a relevant matrix to support osteoblastic growth and differentiation, that is why it is used frequently during bone tissue-engineering experimentations (17).

Our result was in agreement with *Al Rayess et al.*, they conducted a split-mouth clinical trial where 12 patients suffering from bilateral mandibular fractures were included. PRF application on the fracture line was helpful in improvement and acceleration of the fracture healing (18). *Kumar et al.*, also conducted a split-mouth study to evaluate osseous regeneration in extraction sockets with and without platelet-rich fibrin to assess its effects on bone cells and soft tissue response. They concluded that platelet-rich fibrin improves healing of both soft and hard tissues. However, osseous healing did not differ significantly between the two studied groups (19). Also, *Al-Khawlani et al.* conducted a study to evaluate the validity of application of the platelet-rich fibrin versus platelet-rich plasma on the outcome of the mandibular fracture. They concluded that PRP and PRF seem to aid acceleration of bone healing in mandibular fractures, but PRF was more efficient than PRP in bone formation(15).

Regarding the postoperative pain, it was assessed using a Numeric Rating Scale (NRS), there was no significant difference between the results of post operative pain during 1st, 3rd day and 1 week in the two groups. Our results came in agree with *Al Rayess et al.* and *Esen et al.* (18)(20). In contrast to *Kumar et al.*, they assessed the effect of PRF on postoperative pain in mandibular third molar extraction sockets and found that the application of PRF decreased the severity of immediate post-operative pain and inflammation (19). The difference between our study and this one may be because of the fact that the type of incision could affect the degree of wound healing and in consequence the degree of pain.

In this study, the postoperative mouth opening measurements showed a significant difference in some periods and it was obviously decreased on the 2nd day postoperatively due to the pain related to the fracture and due to the spasm of the muscles of mastication. The mouth opening increased significantly with time,

but there was no statistically significant difference between both PRF study group and control group, which was in agreement with *Al Rayess et al.* and *Esen et al.*, (18)(20). In contrast to *Kumar et al.*, they assessed the effect of PRF on post-operative trismus after mandibular third molar extraction sockets, on the first post-operative day, it was 33.00±1.59 in the Case group and 31.07±3.19 mm in the Control group. The difference between the two groups was statistically significant, indicating that the use of PRF influenced the degree of restriction of mouth opening (19), but it was another procedure different than our study.

Conclusion

In conclusion, PRF application as a biologic surgical additive at the fracture line in mandibular fractures promotes early bone regeneration and soft tissue healing due to the presence of growth factors.

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