Iran J Orthod. 2022 December; 17(2):e1027. doi:10.22034/IJO.2022.546834.1027.
Published online 2022 December 1 Research Article

A Comparative Evaluation of Space Closing Rate between Platelet Rich Plasma Injection and Conventional Method: A Preliminary Study

Kalashri K.K[1]*; Goutham B Reddy[1]; Sunil Muddaiah[1]; Sanju Somaiah[1]; Balakrishnak K Shetty[1]; Namitha Nanu[1]

[1] Department of Orthodontics, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India.

***Corresponding author:** Kalashri K K. Department of Orthodontics, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India.

Email: kalashrikk@gmail.com

Received: 2022 January 19; **Revised:** 2022 March 11; **Accepted:** 2022 March 12

Abstract

Aim: Orthodontists and patients prefer minimal time for orthodontic treatment. The submucosal injection of platelet-rich plasma (PRP) helps to provide tooth movement without surgery or alveolar bone loss. The purpose of this research was to assess the rate of space closure using PRP injection with the conventional method.

Methods: In this preliminary study, 10 patients aged 14-20 years, requiring first premolar extractions in both arches using MBT technique were included. This was a split-mouth study wherein, on one side (experimental), space closure was done using a submucosal injection of 0.7 ml PRP, and the other side (control) was subjected to conventional space closure using an active tie back with a constant force of 200 gm. Statistical analysis was performed using a paired t-test. P-value <0.05 was set for statistical significance.

Results: The findings of the research showed no significant difference in the rate of space closure between the case and control groups in the maxilla (P=0.073); however, there was a significant difference between the experimental and control groups in the mandible (P=0.04).

Conclusion: Analyzing space closure rate between the control and experimental side showed that PRP injection did affect the acceleration of space closure in the mandible.

Keywords: Platelet-Rich Plasma (PRP), Submucosal Injection, MBT Brackets, Active Tieback.

1. Background

Non-invasive techniques have been suggested experimentally and clinically to accelerate orthodontic tooth movement, for example, (a) biomechanical approaches including self-ligation brackets, (b) physiological approaches including low-level laser therapy, direct electric current stimulation, vibration or photo-biomodulation, and (c) the pharmacological approach including relaxing or prostaglandin injection (1). During tooth movement, there is a pressure area where the periodontal ligament (PDL) is compressed by the mechanical load force of the orthodontic appliances (2). At the site of compression of the periodontal ligament, resorption occurs, activating progenitor cells to differentiate into osteoclasts. By contrast, the tension zone in the PDL and osteocytes in the alveolar bone respond to deformation by stimulating fibroblasts and osteoblasts (3).

Many studies have been done on the practicality of different bioactive grafts to accelerate orthodontic tooth movement (OTM). Sufficient volume of alveolar bone is a prerequisite for achieving efficient tooth movement during space closure (4). The term platelet-rich plasma (PRP) refers to a limited volume of plasma with an autologous concentration of platelets that is a beneficial resource of autologous growth factors. Cellular processes such as tissue repair and regeneration are regulated by growth factors,

which are natural biologic mediators (5). A localized acceleration of tooth movement occurs with PRP depending on its concentration. Injection of PRP during the stages of orthodontic procedures would enhance treatment outcomes by improving bone quality and increasing the rate of OTM (6,7).

Dental PRP consists of calcium chloride and thrombin, which coagulates the platelets to create a gel-like substance. The growth factors also need to be stimulated prior to application on the targeted area via a full-thickness flap operation. In the CaCl2 and thrombin reaction, all the growth factors of PRP are stimulated simultaneously, resulting in a short PRP action time. Ideal PRP for orthodontic use should have a long-lasting effect. Hence, in order to produce injectable PRP that has a prolonged impact upon the desired tissue, a straightforward scheme is to prepare the PRP minus the thrombin and CaCl2, allowing the PRP to stay in a liquid injectable form (8,9). So, the purpose of this preliminary research was to analyze the rate of space closure between two groups who underwent induced PRP–injection or the conventional method.

2. Methods

The subjects enrolled in current study were seeking fixed orthodontic treatment at the Department of Orthodontics and Dentofacial Orthopedics, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India. The sample size for this study comprised of 10 patients, aged between 14-20 years old, who had their first premolars extracted as a requirement for their fixed orthodontic treatment. Prior to the start of the study, all subjects were encouraged to adopt sound oral hygiene habits and routinely check for any periodontal problems. They were given oral prophylaxis one week prior to the study. Every patient was briefed about the purpose of the study, and before undertaking the study, the patients/guardians signed an informed consent form.

This split-mouth study was carried out on one side (experimental) in which the space closing was carried out using PRP injected submucosally, and on the other side (control), the retraction was done. At first, an impression was taken from both jaws, and study models were prepared.

The experimental side received an injection of PRP submucosally after alignment and leveling, followed by conventional MBT space closing using active tie backs on both sides. A single dose of 0.7 ml PRP was injected into each target site under local anesthesia by the same operator to minimize inter-operator errors and to increase accuracy (Fig. 1).

The autologous PRP was produced under sterile conditions. Whole blood (60 ml) was taken from the patients' median cubital vein by way of three syringes of 30ml, each containing 3 ml of the anticoagulant solution of 10% sodium citrate. Since heparin has systemic effects and may induce alveolar bone resorption, it was not selected as the anticoagulant of choice. The next step was to test the

Figure 1. PRP injection administered in the maxilla and mandible

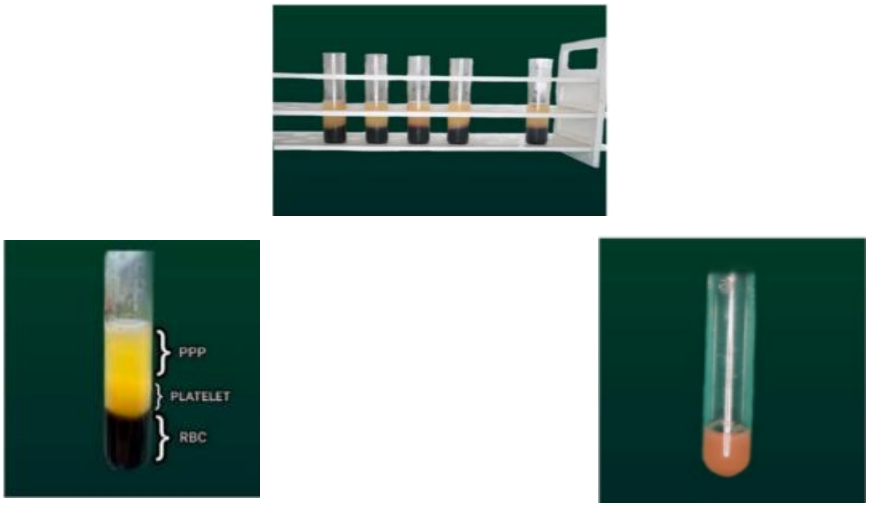

Figure 2. Differentiation of whole blood to PRP

platelet count of 1 ml of blood, then centrifuge 59 ml of the entire blood using 1000 rpm at room temperature for 12 minutes. Then the blood was divided into three elementary parts: the platelet-poor plasma (PPP) lies on the top, the buffy coat (platelets) in the middle, and the RBCs at the bottom. The RBCs were disposed of, and the PPP and buffy coat were collected and centrifuged again for 8 minutes at 3000 rpm. Following the subsequent centrifugation, only 4 ml of the PPP was kept, and it was combined with the buffy coat to form PRP. The platelet count of the 1 ml of PRP that was initially kept was analyzed (Fig. 2).

All patients reported mild post-injection pain that was controlled by acetaminophen. Other adverse effects like mucosal swelling and itching at the injection site were not reported as only 0.7 ml was injected. Studies have reported that higher PRP concentrations can cause greater post-injection unpleasantness, and other adverse effects will also be more frequent (1). No analysis was done for confounding factors since PRP has been established to have no adverse effects at low concentrations (10, 11).

Active tie backs were engaged from the canine and lateral incisor hooks to the maxillary first molar hook. (Fig. 3). Space closure was carried

Figure 3. Beginning of space closure with active tie backs

out on 0.019"×0.025" SS wires via a constant force of 200 gm measured with the Dontrix gauge on both sides by the same operator. After 90 days, a second impression was taken, and study models were prepared. Next, a digital vernier caliper (±0.001 mm) was employed to measure the distance between the contact points of the maxillary canines and second premolars on days 1 and 90 of space closure on the study models. Space closure rate was also calculated by the distance at the beginning of the study minus distance after 90 days divided by 90. All measurements were recorded by the same operator to minimize inter-operator errors. At the end of the study, the data were evaluated by applying paired t-test. P-value<0.05 is considered statistically significant.

3. Results

The present study compared the rate of space closure between PRP administered on the experimental side and the conventional space closure methods applied on the control side. According to Table 1, no significant difference existed in the extraction space at the beginning of the investigation (P-value>0.05). This table also indicates that there was not a significant difference in the amount of space in all groups after 90 days (P-value>0.05).

Table 1. Comparison of the amount of space between the experimental and control side

			Mean	Standard Deviation	T	P-value
Maxilla	Initiation	E0	5.5990	1.02367	-0.055	0.957 (NS)
		C0	5.6240	1.01844		
	After 90 days	E1	2.4360	0.84202	-0.500	0.623 (NS)
		C1	2.6780	1.27883		
Mandible	Initiation	E0	4.9870	0.65325	-0.655	0.520 (NS)
		C0	5.1660	0.56479		
	After 90 days	E1	2.7170	0.83754	-0.210	0.836 (NS)
		C1	2.8310	1.49899		

E0:Experimental side at the Initiation of the study
C0: Control side at the Initiation of the study
E1: Experimental side after 90 days
C1: Control side after 90 days

Table 2. Comparison the rate of space closure between control and experimental groups in the maxilla and mandible

Rate of Retraction		Mean	Standard Deviation	T	P-value
Maxilla	Experimental	0.0351	0.01	0.349	0.731 (NS)
	Control	0.0327	0.01		
Mandible	Experimental	0.0252	0.008	-0.131	0.048 (S)
	Control	0.0259	0.01		

Table 2 shows a comparison of space closure between the control group and experimental group in the maxilla and mandible. A notable difference was not observed between the case and control groups in the maxilla, as shown in the table (P-value=0.073). However, space closure between the control and experimental groups in the mandible indicated a significant difference (P-value=0.048).

4. Discussion

Platelet Rich Plasma was introduced to dentistry by Marx et al (12) in 1998 to supplement mandibular reconstructive procedures and improve graft's radiographic maturation rate. PRP is rich in many growth factors like IL-1β, TGF, EGF, VEGF, TGF-β, PDGF, etc. (13), and it is made by concentrating autologous human platelets in a minimal volume of plasma. Thus, PRP is preferred over plasma-rich growth factors (PRGFs), autologous platelet gel, and autologous platelet concentrate. Furthermore, PRP is a readily available source of growth factors that aid the restoration of soft and bone tissue. These growth factors accelerate matrix formation, cellular proliferation, connective tissue healing, osteoid production, collagen synthesis, and angiogenesis (14).

Orthodontic tooth movement needs some amount of mechanical stress to stimulate osteoclastic and osteoblastic activities and alter bone metabolism. Moreover, bone metabolism may be affected by other factors that regulate osteoblastic and osteoclastic activity (e.g., growth factors, hormones, and inflammatory or pro-inflammatory cytokines) (15). As a result of the numerous growth factors in PRP, it could possibly be used in orthodontic tooth movement, as the literature indicates.

The efficacy of PRP on orthodontic tooth movement has been tested on experimental animals prior to its use on humans, including dogs by Rashid et al. (13), rats by Gulec et al. (15) and Akbulut et al. (14), and rabbits by Nakarnoi et al. (16). In humans, the studies on PRP have been done by Alomari et al. (17), Mahmood et al. (18), and El-Timamy et al. (19).

In present study, the results revealed no significant differences in the rate of space closure in the maxilla. Although there was a statistically significant difference in the rate of space closure between the experimental and control side in the mandible, it does not seem to be of clinical significance.

Liou et al. (20) evaluated tooth movement rate influenced by platelet-rich plasma. They showed that clinical effects of one submucosal injection of PRP could continue for as long as about six months, and the quickest rate of acceleration was observed post-injection between the second and fourth months. Alveolar bone loss was not observed on the side that received single-dose PRP, so it was dose-dependent. In our study, PRP injection was administered at the initiation of space closure .

In this regard, Gulec et al. (15) analyzed the rate of OTM histomorphometrically in rats when submucosal injections with large and moderate concentrations of PRP were performed. PRP injection was administered to the right side of each molar buccal sulcus prior to the mesialization of the maxillary first molars (experimental groups) and to the left side (control groups). On day 21, the high-dose experimental group experienced 1.7 times more tooth movement than the high-dose control group, while the moderate-dose experimental group experienced 1.4 times more tooth movement (P=0.001).

Sufarnap et al. also studied the effectiveness of PRP on OTM in guinea pigs. OTM was measured on days 6, 9, 12, and 24 of the study. The groups did not differ statistically significantly at any of the measurement times (4).

In this regard, Nakornnoi et al. evaluated the effects of leukocyte-platelet rich plasma for accelerated OTM among rabbits via a local injection of leukocyte-platelet rich plasma. On days 0, 3, 7, 14, 21, and 28, three-dimensional digital models were used to study tooth movement. In the first seven days and the seventh to fourteenth days of the study, the OTM rate was significantly higher (16).

This preliminary study had some limitations including small sample size and short research period. As a result, future studies should investigate the effect of PRP on orthodontic tooth movement.

Conclusion

Administration of PRP did not seem to have a clinical significant effect on the rate of orthodontic tooth movement.

References

1. Liou EW. The development of submucosal injection of platelet rich plasma for accelerating orthodontic tooth movement and preserving pressure side alveolar bone. APOS Trends Orthod. 2016;6(1):5-11. doi: 10.4103/2321-1407.173725.
2. Ali Mahmood TM, Chawshli OF. The Effect of Submucosal Injection of Plasma-Rich Platelets on Blood Inflammatory Markers for Patients with Bimaxillary Protrusion Undergoing Orthodontic Treatment. Int J Inflam. 2019;2019:1–10. doi: 10.1155/2019/6715871.
3. Güleç A, Bakkalbaşı BÇ, Cumbul A, Uslu Ü, Alev B, Yarat A. Effects of local platelet-rich plasma injection on the rate of orthodontic tooth movement in a rat model: A histomorphometric study. Am J Orthod Dentofac Orthop. 2017;151(1):92–104. doi: 10.1016/j.ajodo.2016.05.016. PMID: 28024792.
4. Sufarnap E, Sofyanti E, Ilyas S. The Effect of Platelet-Rich Plasma to Orthodontic Tooth Movement.2017;8:80-83. doi: 10.2991/idcsu-17.2018.22.
5. Mangal U. Influence of platelet rich plasma on orthodontic tooth movement: A review. Biomed Pharmacol J. 2017;10(3):1463–8. doi: 10.13005/bpj/1253.
6. Singh P, Namarach K, Rashed Salem W, Shahzadi K. The current and potential future uses of platelet rich plasma in orthodontics. Ann Dent Oral Heal. 2018;1(1):1-5.
7. Lana JFSD, Purita J, Paulus C, Huber SC, Rodrigues BL, Rodrigues AA, et al. Contributions for classification of platelet rich plasma - Proposal of a new classification: MARSPILL. Regen Med. 2017;12(5):565–74. doi: 10.2217/rme-2017-0042.
8. Vaidya M, H J, N. R. Accelerated Orthodontics: an Answer To Fast Paced Life. Int J Adv Res. 2017;5(6):75–81. doi: 10.21474/IJAR01/4383 .
9. Akbulut S, Yagci A, Yay AH, Yalcin B. Experimental investigation of effects of platelet-rich plasma on early phases of orthodontic tooth movement. Am J Orthod Dentofac Orthop . 2019;155(1):71–9. doi:10.1016/j.ajodo.2018.03.015.
10. Nakornnoi T, Leethanakul C, Samruajbenjakun B. The influence of leukocyte-platelet-rich plasma on accelerated orthodontic tooth movement in rabbits. Korean J Orthod. 2019;49(6):372–80. doi: 10.4041/kjod.2019.49.6.372. PMID: 31815105.
11. Soma S, Matsumoto S, Higuchi Y, Takano-Yamamoto T, Yamashita K, Kurisu K, et al. Local and chronic application of PTH accelerates tooth movement in rats. J Dent Res. 2000;79(9):1717–24. doi: 10.1177/00220345000790091301. PMID: 11023269.
12. Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR,

Strauss JE, Georgeff KR. Platelet-rich Plasma: Growth factor enhancement for bone graft. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;85(6):638-46. doi: 10.1016/s1079-2104(98)90029-4. PMID: 9638695.

13. Rashid A, ElSharaby FA, Nassef EM, Mehanni S, Mostafa YA. Effect of platelet-rich plasma on orthodontic tooth movement in dogs. Orthod Craniofac Res. 2017;20(2):102–110. doi: 10.1111/ocr.12146. PMID: 28414871.
14. Akbulut S, Yagci A, Yay AH, Yalcin B. Experimental investigation of effects of platelet-rich plasma on early phases of orthodontic tooth movement. Am J Orthod Dentofac Orthop. 2019;155(1):71-9. doi: 10.1016/j.ajodo.2018.03.015. PMID: 30591170.
15. Gulec A, Bakkalbasi BC, Cumbul A, Usls U, Alev B, Yarat A. Effects of local platelet-rich plasma injection on the rate of orthodontic tooth movement in a rat model: A histomorphometric study. Am J Orthod Dentofac Orthop. 2017;151(1):92-104. d
16-Nakornnoi T, Leethanakul C, Samruajbenjakun B. Effects of Leukocyte-Platelet-Rich Plasma on the Alveolar Bone Changes During Orthodontic Tooth Movement in Rabbits: A Micro-CT Study. J Ind Orthod Soc. 2019;53(4):1-8. doi: 10.1177 /0301574219872608.
17. Alomari EB, Sultan K. Efficacy of injectable platelet-rich plasma in reducing alveolar bone resorption following rapid maxillary expansion: A cone-beam computed tomography assessment in a randomized split-mouth controlled trial. Angle Orthod. 2019;89(5):705-12. doi: 10.2319/091018- 661.1. PMID: 30920874.
18. Mahmood TMA, Chawshli OF. The Effect of Submucosal Injection of Plasma-Rich Platelets on Blood Inflammatory Markers for Patients with Bimaxillary Protrusion Undergoing Orthodontic Treatment. Int J Infl. 2019:1-10. doi: 10.1155/2019/6715871. PMID: 31662844.
19. El-Timamy A, El-Sharaby F, Eid F, Dakroury AE, Mostafa Y, Shakr O. Effect of platelet-rich plasma on the rate of orthodontic tooth movement: A split-mouth randomized trial. Angle Orthod. 2020; 90(3):354-61. doi: 10.2319/072119-483.1. PMID: 33378433.
20. Liou EJW.The development of submucosal injection of platelet rich plasma for accelerating orthodontic tooth movement and preserving pressure side alveolar bone. APOS Trends Orthod. 2016;6(1):5-11. doi: 10.4103/2321-1407.173725.