ORIGINAL RESEARCH

The Impact of Injectable Platelet-rich Fibrin on Orthodontic Tooth Movement during Retraction: A Randomized Controlled Trial

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Abstract

Aim: This study intended to comprehend the effects of injectable platelet-rich fibrin (i-PRF) on anchor loss and space closure rates during the retraction phase of orthodontic treatment.

Materials and methods: Twenty-four participants with malocclusion, necessitating extractions and space closure during orthodontic treatment, were enrolled and divided into two groups (n = 12 participants) group A: the experimental group was administered i-PRF on the maxilla/mandible, while group B: the control group did not. Measurements of the rate of space closure, anchor loss, and salivary enzyme activity were done before retraction (T0), after three weeks (T1), after six weeks (T2), and after nine weeks (T3). The Mann–Whitney and the independent Student's *t*-test were used to compare continuous variables among groups.

Results: Four participants were lost to follow-up in each group with eight participants remaining in the respective groups. The rate of space closure in the maxillary arch was 1.4 ± 1.9 mm at T3 intervals with the baseline value (T0) 10.8 ± 3.01 mm, and the rate of anchor loss was 0.57 mm at T3 intervals for group A. In group B, space closure at T0 was 11.1 ± 2.0 mm and 4.9 ± 1.5 mm at T3 while anchor loss of 0.57 mm at T3 intervals, respectively. In the mandibular arch, the rate of space closure was 2.6 ± 2.0 mm at T3 intervals, with the baseline value (T0) 9.5 ± 2.5 mm, and the rate of anchor loss was 0.325 mm at T3 for group A. In group B, space closure at T0 (baseline) were 10.0 ± 2.7 mm and 4.7 ± 2.3 at T3 mm, and anchor loss was 0.37 mm at T3 intervals, respectively. Space closure rate in the maxilla is significant statistically at intervals T2 and T3 and in the mandible is significant statistically at intervals T2, the anchor loss in both the arch is statistically insignificant.

Conclusion: In both maxillary and mandibular arches, the experimental group showed accelerated tooth movement compared to the control group, although statistical significance was not achieved in the mandible. There were no apparent differences in anchor loss between the two groups.

Clinical significance: The use of i-PRF in orthodontic treatment significantly enhances the rate of space closure and reduces the overall treatment. Injectable platelet-rich fibrin can be a safe adjunct to orthodontic treatment, providing benefits without compromising anchorage stability and aiming to optimize orthodontic treatment efficiency.

Keywords: Anchor loss, Injectable platelet-rich fibrin, Regional accelerating phenomenon, Space closure.

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Introduction

In recent years, accelerated orthodontics has gained significant importance due to the growing demand for shorter treatment durations and improved patient comfort. Numerous techniques have been proposed in clinical practice to accelerate orthodontic tooth movement (OTM), falling into three categories: invasive, minimally invasive, and noninvasive methods.[1] One invasive approach involves corticotomy, which necessitates the reflection of mucoperiosteal flaps on buccal and lingual sides, followed by corticotomy incision.[2] However, this method is highly invasive and poses a significant risk of morbidity. To mitigate the morbidity associated with corticotomy, Dibart et al.[3] introduced a minimally invasive, flapless corticotomy technique using a piezotome. Yet, this approach risks root damage due to blind incisions. To further reduce bone surgery's invasiveness, Propel Orthodontics introduced a less technique-sensitive device compared to other surgical methods in accelerating tooth movement.[4]

On the non-invasive front, techniques include low-dose laser therapy (LLLT), vibration, photobiomodulation, direct electric current stimulation, and pharmacological approaches like the local administration of prostaglandin (PGE2), vitamin D, and relaxin.[5]

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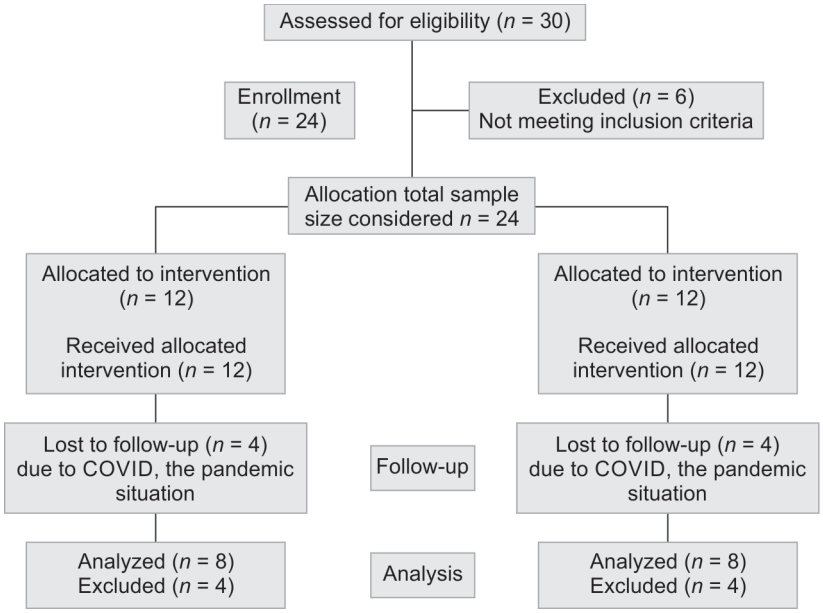

Fig. 1: CONSORT flowchart of the study

However, none of these non-invasive procedures are routine in orthodontic practice.

Recently, one local agent that has gained attention for accelerating various OTMs is platelet-rich plasma (PRP). Platelet-rich plasma is extracted from a patient's blood and offers a safe alternative to commercially available bioactive material.[6,7] Platelet-rich plasma is essentially a small volume of plasma with an autologous concentration of platelets. It contains many proteins, including chemokines and growth factors. These elements are essential to both wound healing and initial hemostasis.[8] The highly concentrated platelet fractions in PRP increase platelet function in physiological processes. Notably, current studies have shown that PRP and bone morphogenetic protein are equally effective at encouraging bone regeneration.[9] Platelet-rich plasma has also been demonstrated to improve mesenchymal stem cell motility, viability, and proliferation, which supports angiogenesis, osteogenesis, and bone regeneration.[10]

Traditionally, space closure in orthodontics can take several months, prolonging overall treatment time. However, accelerated orthodontic techniques, such as platelet-rich fibrin (PRF), enhance the movement of teeth, allowing for faster closure of extraction spaces. Platelet-rich fibrin stimulates the bone remodeling process, taking advantage of the body's natural healing mechanisms to increase the efficiency of tooth movement.[11] Patients benefit from reduced treatment times, fewer office visits, and potentially less discomfort, making the orthodontic process more patient-friendly.

The movement of the tooth at every stage of orthodontic treatment can be assessed by various salivary enzyme activities. Lactate dehydrogenase (LDH) has the potential to serve as a molecular marker to monitor the progression of orthodontic treatment, with its activities successfully measured in saliva.[12] During OTM, two processes occur simultaneously, leading to the recruitment of osteoblasts and osteoblast progenitors. Alkaline phosphatase (ALP) activity signifies osteoblastic activities, and aspartate transaminases (AST) signifies osteoclastic activities, making ALP and AST useful biomarkers during bone deposition and resorption.[13] Hence these enzymatic activities can be used to assess the rate of space closure during the tooth retraction.

The use of PRF in expediting OTM has been a subject of debate in clinical studies. Therefore, the purpose of this study was to find out how injectable platelet-rich fibrin (i-PRF) affected anchor loss and space closure rates. Additionally, the study sought to examine levels of salivary enzyme activity, specifically ALP, AST, and LDH, during the retraction phase of orthodontic treatment. Moreover, the research aimed to test the null hypothesis that i-PRF does not affect the acceleration of tooth movement.

Materials and Methods

This prospective, randomized, single-center, parallel-arm randomized controlled clinical trial follows the CONSORT statement reporting guidelines (Fig. 1). It was conducted at the orthodontic outpatient department, Chettinad Dental College and Research Institute, Tamil Nadu, India, during the period 2020–2022 and is approved by the Institutional Ethical Committee (Proposal No. 679/IHEC/12-19). Using G Power version 3.1.9.4, sample size estimation was carried out, yielding a sample size of 15, a statistical test power of 80%, and a permitted (α) error of 5%. Anticipating potential dropouts during the study, a total sample size of 24 was recruited for the study. The inclusion criteria for the study were patients between the ages of 15 and 25, Angle's Class I malocclusion with either crowding, proclination, or both, requiring first premolar extracted as part of their therapy; patients with a minimum of 3 mm extraction space left during the retraction phase of OTM; no history of previous orthodontic treatment, acceptable periodontal health required for treatment, no missing permanent teeth in the maxillary or mandibular arch (except third molars), and no history of systemic diseases or long-term medication use.

The exclusion criteria include young adults with facial asymmetry, adolescents with poor periodontal health, and patients with partially erupted teeth or teeth with reduced clinical crown height/diminutive teeth.

Orthodontic treatment involved the Extraction of the first premolar followed by bonding MBT 0.022 brackets for all participants, anchorage was reinforced using a transpalatal arch, lingual arch, as well as second molar banding. Leveling and alignment were completed and a 0.019*0.025-inch stainless steel archwire was reached for space closure during the retraction to be commenced. The Levelling and alignment were carried out for about 6–9 months approximately. Before the retraction phase of OTM upper and lower alginate impressions were taken as initial records (T0) for both experimental and control groups. Throughout the study, oral hygiene measures were reinforced.

The sample size (n = 24) during the retraction phase of OTM was divided into two groups: the experimental group (Group A, n = 12) and the control group (Group B, n = 12). Randomization was performed using a simple randomization method, with patients assigned to either group based on numbering (even numbers for group A, odd numbers for group B). Blinding of patients or operators was not implemented, and all patients were treated orthodontically by the same operator to standardize monthly activations.

The retraction stage of OTM was initiated after the injection of i-PRF for group A, using NiTi closed coil springs activated and attached from the molar tube to the power hooks soldered to a 19 × 25 SS wire. Using a Dontrix gauge, the force generated by the coil was calibrated and readjusted to roughly 150 gm at each visit. The study population was reviewed every three weeks for activation of space closure.

Preparation and Application of i-PRF

Patients in the study group had their brachial veins pierced using a 10-mL syringe. After blood samples were taken, they were centrifuged for three minutes at 700 rpm. After the blood was centrifuged, it was separated into two parts. Using insulin syringes, about 4–5 mL of i-PRF were extracted from the upper liquid layer. This resulted in the obtainment of 4–5 mL of PRF. Injectable platelet-rich fibrin was then injected submucosally in the extraction site, both buccally and palatally, and intraligamentary in the distobuccal region of all anterior teeth (Incisors and canines). In the experimental group (Group A), 0.25 mL (25 units) was injected at the extraction site. Before injection, topical anesthetic was delivered to every location, and to help i-PRF disperse throughout the alveolar mucosa, a finger massage was performed at the injection site. Patients were warned to report to the hospital in the event of any acute discomfort and were not to take any painkillers or antibiotics unless they were experiencing substantial discomfort.

Determination of Rate of Tooth Movement

Following the retraction, models were acquired at four time frames on every recall visit: before retraction (T0), after three weeks (T1), after six weeks (T2), and after nine weeks (T3). Measurements were taken on the models using a digital Vernier caliper. The change in the horizontal linear distance between the neighboring teeth's mid-marginal ridges was compared every three weeks for a total of three months to figure out the amount of OTM.

Determining Anchorage Loss

An acrylic button and extended wire fixtures were created for both maxilla and mandible models. The acrylic button, fabricated with guiding wires (0.019 × 0.025-inch SS) implanted in acrylic, extended to the central fossa of the first molars. The progressive models acquired at T1–T3 were mounted to the acrylic button that was made from the original model. Using a digital Vernier caliper, the amount of anchoring loss may be directly observed owing to this superimposition.[14]

Enzyme Estimation

A total of 2–4 mL of unstimulated whole saliva was collected from participants using a passive drooling method. The saliva was collected in a sterile container and was centrifuged for 5 minutes at 2500 rpm to eliminate insoluble components. After being moved to a sterile container, the supernatant was kept at –20°C until enzyme quantification. Saliva samples were collected on day 0 (before initiating retraction), 7th day, 14th day, 21st day, sixth week, and ninth week. Alkaline phosphatase, AST, and LDH levels were estimated using Photometer 5010 V5+. The supernatant saliva sample was added to specific ALP, AST, and LDH reagents used as substrates, and the values were determined and expressed as International units per liter (IU/L).

Statistical Analysis

The Statistical Package for Social Science (SPSS, version 17) for Microsoft Windows was used to perform all statistical analyses. In light of the non-normal distribution of the data, non-parametric tests were run. Data were expressed as the median and standard deviation, and descriptive statistics were shown as numbers and percentages. To compare continuous variables between the two groups, an independent Student's t-test/Mann–Whitney test was employed; a p-value of less than 0.05 was deemed statistically significant.

Results

The total sample size allocated for the study during the retraction phase of OTM is 24 participants, however, only 16 patients completed the study while others dropped out due to the lack of follow-up during the COVID-19 pandemic. The descriptive information of the study population is 16 participants with an equal no: of male and female participants and a mean age group of 20 ± 5 years.

In the maxillary dentition, the baseline value (extraction space) for group A at the T0 interval was 10.8 ± 3.01 mm. The rate of space closure was 6.9 ± 3.3, 3.5 ± 2.2, and 1.4 ± 1.9 mm at T1, T2, and T3 intervals, respectively. In group B, the baseline values at the T0 interval were 11.1 ± 2.0 mm, and the rate of space closure was 8.9 ± 2.3, 6.7 ± 1.9, and 4.9 ± 1.5 mm at T1, T2, and T3 intervals, respectively. The rate of tooth movement in group A increased at all intervals compared to group B and was significant statistically at intervals T2 and T3. In group A, the rate of anchor loss was 0.11, 0.27, and 0.57 mm at T1, T2, and T3 intervals, respectively. In group B, the rate of anchor loss was 0.11, 0.27, and 0.57 mm (Table 1). There was no statistically significant difference between both groups (Fig. 2).

In the mandibular dentition, the baseline values for group A at the T0 interval were 9.5 ± 2.5 mm. The rate of space closure was 7.7 ± 3.1, 5.1 ± 2.4, and 2.6 ± 2.0 mm at T1, T2, and T3 intervals, respectively. In group B, the baseline values at the T0 interval were 10.0 ± 2.7 mm, and the rate of space closure was 9.3 ± 2.6, 6.9 ± 2.5, and 4.7 ± 2.3 mm at T1, T2, and T3 intervals, respectively. The rate of tooth movement in group A increased at all intervals compared to group B and was significant statistically at interval T2.

Table 1: Comparison of rate of space closure and anchor loss between two groups at varying time intervals in the maxillary arch

		Rate of space closure				*Rate of anchor loss*	
Time interval	*Group*	*n*	*Median*	*SD*	*p-value*	*Median*	*SD*	*p-value*
T0	A	8	10.8	3.013	0.818	0	0.0000[a]	–
	B	8	11.1	2.0181	–	0	0.0000[a]	–
T1	A	8	6.9	3.3018	0.187	0.11	0.1126	
	B	8	8.9	2.309	–	0.11	0.1246	1
T2	A	8	3.5	2.2258	0.02	0.27	0.1165	–
	B	8	6.7	1.9939	–	0.27	0.1389	1
T3	A	8	1.3	1.8574	0.006	0.57	0.2816	1
	B	8	4.9	1.5824		0.57	0.2915	–

[a]indicates statistically significant difference between the groups

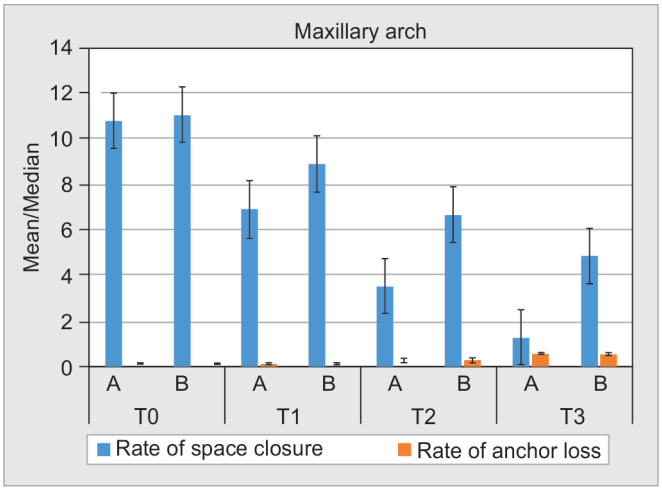

Fig. 2: Comparison of rate of space closure and anchor loss between two groups at varying time intervals in the maxillary arch

In group A, the rate of anchor loss was 0.063, 0.13, and 0.325 mm at T1, T2, and T3 intervals, respectively. In group B, the rate of anchor loss was 0.088, 0.2, and 0.37 mm at T1, T2, and T3 intervals, respectively (Table 2). The rate of anchor loss was slightly higher in group B compared with group A but was not statistically significant (Fig. 3).

A comparison of ALP, AST, and LDH activity between the two groups at different periods (in IU/L) is shown in Table 3. In group A (experimental group), ALP and AST activity increased consistently from the seventh day to the sixth week reaching a peak in the sixth week. Later, the activity decreased in the ninth week. Lactate dehydrogenase activity gradually increased from the day of retraction (0th day) peaked in the sixth week and declined in the ninth week. In group B (the control group), a little difference in the activity of ALP and AST was observed on the seventh day compared to initial values (Figs 4 and 5). The enzyme activity was highest on the 14th day, and there was a decline from the 21st day until the sixth week, remaining the same until the ninth week. Lactate dehydrogenase activity increased from the day of retraction and peaked on the 14th day, with a rapid fall on the 21st day until the sixth week, and it continued to remain the same until the ninth week (Fig. 6).

According to the results of the statistical analysis performed the rate of OTM (space closure) is increased and the enzymatic analysis performed confirms the accelerated OTM in group A (experimental group). Hence, the null hypothesis here is rejected as i-PRF has an accelerated effect on the rate of tooth movement.

Discussion

Prolonged orthodontic treatment increases the risk of complications and patient non-compliance. Therefore, orthodontists strive to reduce treatment time, particularly for adult patients. Aging leads to biological changes in bone composition, reduced cell reactivity, and slowed metabolism, resulting in decreased bone turnover and a slower rate of OTM.

Various methods have been attempted to accelerate OTM,[15] with each claiming superiority in different studies. In recent years, the relationship between PRP and OTM has garnered attention. PRP, a platelet derivative, is extensively studied for its applications in regenerative medicine. Rashid et al. and Güleç et al.,[16,17] in their animal studies, evaluated PRP's effects on OTM and concluded that local PRP injection positively correlates with accelerated OTM, with no apparent clinical or microscopic side effects. Therefore, the present study uses an injectable form of i-PRF instead of the clot form (L-PRF) because i-PRF, obtained through a low-speed centrifugation protocol, contains higher levels of regenerative cells and growth factors. It allows for the storage and slow release of cytokines and growth factors, ensuring bioactive levels over an extended period.[18]

This study aimed to assess the impact of i-PRF on the rate of en-masse retraction in both the maxilla and mandible. Submucosal injections of i-PRF distal to the canines and intraligamentary injections in all anterior teeth were administered. Intraligamentary injections at the distobuccal surfaces of the anterior teeth were recommended in a previous study,[19] because most hyalinized areas were found lingually and buccally from the central plane, necessitating rapid bone metabolism for accelerated OTM.

Patients requiring the extraction of first premolars were recruited for the current study. Tooth extractions can elevate inflammatory markers' activity, potentially obscuring the effect of i-PRF. Hence, in this study tooth extractions were performed at the beginning of orthodontic treatment in both groups to reduce this effect. Following Rashid's protocol,[16] injections were administered every three weeks and repeated until the sixth week. Zeitounlouian's approach,[20] repeating injections after one month of canine retraction, demonstrated a "boost" effect that continued for two months, sustaining the differential in tooth movement between the control and experimental sides for four months. Therefore, in this study, i-PRF was administered only at the start of retraction (T0).

Table 2: Comparison of rate of space closure and anchor loss between two groups at varying time intervals in the mandibular arch

			Rate of space closure			*Rate of anchor loss*		
Time interval	*Group*	*n*	*Median*	*SD*	*p-value*	*Median*	*SD*	*p-value*
T0	A	8	9.4	2.5812	–	0	0.0000[a]	–
	B	8	10.0	2.7153	0.684	0	0.0000[a]	–
T1	A	8	7.7	3.108	–	0.06	0.1061	0.848
	B	8	9.3	2.678	0.3	0.08	0.1642	–
T2	A	8	4.2	2.0315	0.025	0.13	0.1061	0.331
	B	8	7.1	2.5978	–	0.2	0.1309	–
T3	A	8	2.6	2.0252	0.14	0.32	0.1753	0.656
	B	8	4.6	2.308	–	0.37	0.1165	–

[a]indicates statistically significant difference between the groups

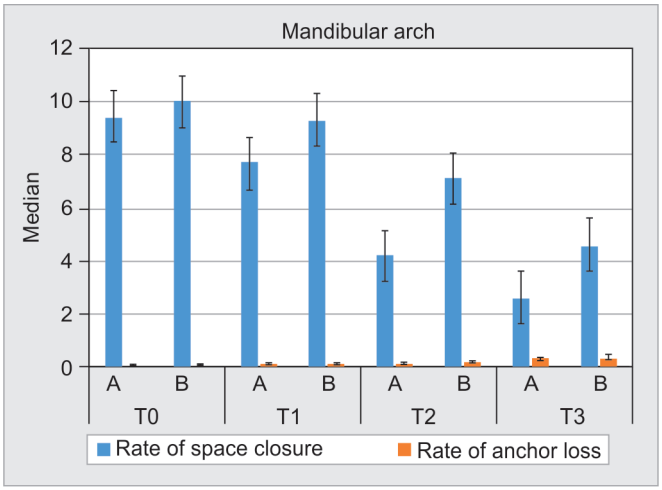

Fig. 3: Comparison of rate of space closure and anchor loss between two groups at varying time intervals in the mandibular arch

A brass hook soldered to a 0.019 × 0.025-inch stainless steel (SS) archwire to ensure that the applied force passed close to the center of resistance, achieving the desired bodily tooth movement. An en-masse retraction was performed using Nitinol closed coil springs delivering 150 gm of force. Closed coil springs were chosen because they provide a constant force throughout treatment. The rate of tooth movement and molar anchor loss were assessed at four intervals: the day of retraction (T0), the third week (T1), the sixth week (T2), and the ninth week (T3) in both the maxillary and mandibular arches for both the experimental and control groups as the study was recalled every three weeks for activation of space closure, to prevent force decay, monitor tooth movement as well as prevent any complications.[21]

In the present study, when comparing the retraction rate in the maxilla between the two groups, experimental groups showed an increased rate of tooth movement compared to controls in all three intervals, with statistical significance observed at T2 and T3. In the mandible, the experimental group exhibited increased tooth movement compared to control at all intervals, but the accelerated effect was only observed in control at the T2, which was both clinically and statistically significant. The mandible did not show an accelerated effect during T1, possibly due to differences in bone densities between the maxilla and mandible.

Anchorage reinforcement is crucial when treating orthodontic extraction patients. Anchorage was reinforced using a transpalatal arch, lingual arch, and second molar banding. The study also aimed to evaluate the amount of molar anchor loss during total retraction in both groups from T0 to T3. Anchor loss was assessed to determine whether space closure occurred due to mesial molar movement which was recorded directly on the cast. A transfer guide made from each patient's original model was used to assess the mesial migration of the first molars. Notably, there was no appreciable difference in anchorage loss between the experimental and control groups in both maxillary and mandibular arches.

It is generally agreed upon that how orthodontic forces move teeth is dependent on the bone remodeling phase, correlated with the action of inflammatory markers, the quantity and quality of bone turnover, and the ratio of osteoblastic to osteoclastic activity.[22] Limited studies in gingival crevicular fluid (GCF) and saliva have explored changes in levels of inflammatory cytokines and biomarkers during OTM.

While GCF may be a potential candidate for assessing inflammatory markers, there are limitations such as variable sampling sites in the oral cavity,[23] challenging sampling techniques, lengthy sample collection, and susceptibility to saliva contamination. Therefore, this study aimed to estimate the levels of enzymes (ALP, AST, and LDH) in saliva at every stage of treatment.

Lactate dehydrogenase has the potential to serve as a molecular marker to monitor the progression of orthodontic treatment, with its activities successfully measured in saliva.[12] Conversely, it is anticipated that AST will enter GCF as an inflammatory exudate from periodontal tissues. Increased concentrations of this enzyme could be a sign of OTM or inflammation-induced cell death in the periodontal tissues. The activation phase, which is characterized by inflammation and cell necrosis and produces the enzyme AST, is crucial for initiating tooth movement.[13] Two processes happen at the same time during OTM, which results in the recruitment of osteoblasts and osteoblast progenitors. Alkaline phosphatase and AST are valuable biomarkers during bone deposition and resorption because ALP activity indicates osteoblastic activities while AST activity indicates osteoclastic activities.[20] Therefore, the current study evaluates ALP, AST, and LDH activity in saliva during en-masse retraction in both groups.

In the experimental group, from day 0 to the seventh day, enzyme activity resembled pre-tooth values, coinciding with the lag phase. Alkaline phosphatase and AST activity increased from the seventh day to the sixth week, peaking at the sixth week, followed by a reduction in activity by the ninth week. These findings were supported by Kumar et al.,[23,24] who examined ALP and AST activity in GCF and saliva during canine retraction where it was noted that enzymatic activity signifies osteoclastic and osteoblastic activities, so ALP and AST from the saliva and GCF may potentially be used as biomarkers for monitoring corticotomy-assisted OTM. This study is by the findings

Table 3: Comparison of ALP, AST LDH activity between two groups at different periods (in IU/L)

Enzyme activity		*ALP*			*AST*			*LDH*		
Time interval	*Group*	*Median*	*SD*	*p-value*	*Median*	*SD*	*p-value*	*Median*	*SD*	*p-value*
0th day	A	12.5	3.891	0.81	27.2	4.743	0.334	120.3	22.213	0.654
	B	12.8	1.885		29.1	2.357		125.0	17.912	
7th day	A	12	3.586	0.331	27.1	10.855	0.424	139.0	16.169	0.898
	B	13.5	2.204		30.3	2.615		140.1	18.216	
14th day	A	15.1	4.97	0.011	34.8	4.257	0.187	161.3	18.769	0.004
	B	22.6	5.236		37.5	3.251		190.2	14.945	
21st day	A	18.3	5.097	0.781	38	3.854	0.002	188.7	15.332	0.024
	B	17.7	3.615		30.6	3.889		168.3	16.86	
6th wk	A	22.2	6.228	0.008	45.6	4.779	0	253.1	34.938	0
	B	15.1	2.1		25.8	3.399		149.0	21.321	
9th wk	A	15.2	4.234	0.544	37	4.276	0	201.7	33.986	0.001
	B	14.2	1.669		25.6	3.021		144.2	20.603	

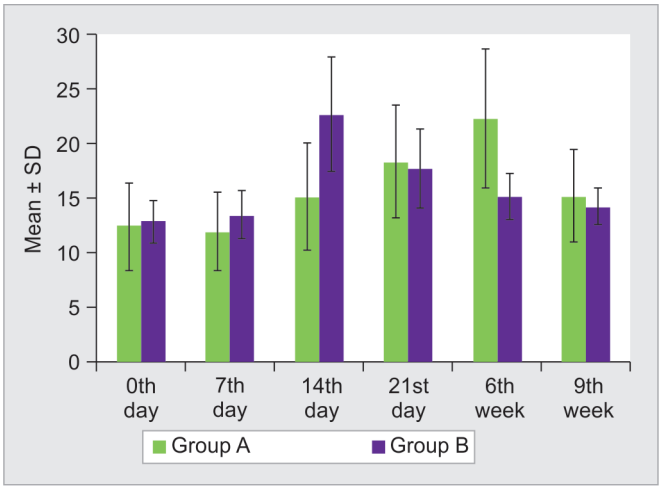

Fig. 4: Comparison of ALP activity between two groups at different periods (in IU/L)

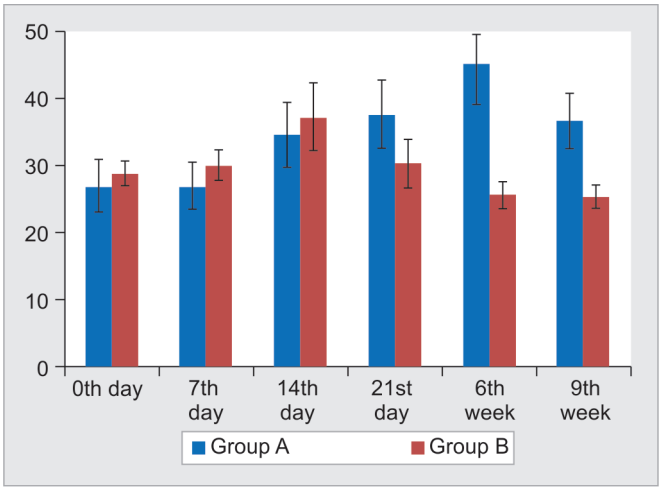

Fig. 5: Comparison of AST activity between two groups at different periods (in IU/L)

that i-PRF injection can accelerate OTM signified by the osteoclastic and osteoblastic activities evidenced by this enzymatic activity.

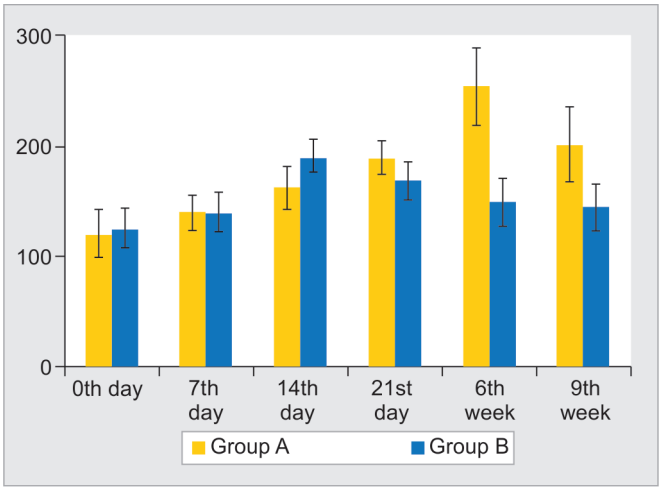

Fig. 6: Comparison of LDH activity between two groups at different periods (in IU/L)

In the control group, a little difference in the activity of ALP and AST was observed on the seventh day compared to initial values indicating the enzymatic activity during OTM.[13,22]

In the experimental group, LDH activity gradually increased from the day of retraction (0th day) peaked in the sixth week, and declined in the ninth week whereas in the control group, LDH activity increased from the day of retraction and peaked on the 14th day, with a rapid fall on the 21st day until the sixth week, and it continued to remain the same until the ninth week which shows accelerated tooth movement in the experimental group and is in line with the findings by Alfaqeeh and Anil[25] who denotes higher LDH levels on the 7th, 14th, and 21st day at the sites where orthodontic force had been applied. The levels also showed a significant increase from 0 hour to the 21st day. Peak levels were seen on the 14th and 21st day following initiation of retraction.

From the result of the present study, it is found that i-PRF can be used to accelerate OTM at all stages of treatment and is considered a minimally invasive approach. The study employed a randomized controlled trial (RCT) design, with the use of i-PRF representing a minimally invasive approach, where all participants were treated by the same operator using standardized orthodontic protocols,

reducing variability and enhancing the reliability of the results. This study assessed multiple outcomes, including the rate of space closure, anchor loss, and salivary enzyme activity (ALP, AST, LDH) offering insights into the underlying biological processes influenced by i-PRF which is considered as the strength of the study.

The final sample size was limited to 16 patients, which may reduce the statistical power of the study and the generalizability of the findings. The study followed patients for only nine weeks during the retraction phase. Longer follow-up periods are necessary to assess the sustained effects of i-PRF on tooth movement and anchorage stability over the entire course of orthodontic treatment. The lack of blinding could introduce performance and measurement biases, potentially influencing the study outcomes.

Future studies should involve a larger and more diverse patient population across multiple centers with extended follow-up periods to validate the findings and enhance their generalizability. Comparing i-PRF with other accelerated orthodontic methods, such as low-level laser therapy or vibration devices, could help determine its relative efficacy and potential synergistic effects. Exploring different concentrations and volumes of i-PRF could optimize the protocol for maximum efficacy in accelerating tooth movement while minimizing costs and potential side effects.

Conclusion

In both the maxillary and mandibular arches, the study group receiving i-PRF showed accelerated tooth movement compared to the control group, although it was not statistically significant in the mandible. The two groups' relative anchor loss wasn't affected much. The accelerated effect was observed in the sixth week of PRF injection, correlating with salivary enzyme activity, which peaked at the same time. Although the injection effect continued until the ninth week and was clinically significant.

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