Original Article

The effect of platelet-rich fibrin (PRF) on maxillary incisor retraction rate

Kuter Karakasli[a]; Emire Aybuke Erdur[b]

ABSTRACT

Objective: To investigate the efficiency of platelet-rich fibrin (PRF) injection on maxillary incisor retraction rate.

Materials and Methods: The study included 40 patients (23 women and 17 men; mean age; 20.7 ± 1.45) with Class II Division 1 malocclusion. The treatment plan for all patients was extraction of the maxillary first premolars and canine distalization, followed by retraction of the maxillary incisors. Patients were randomly divided into two groups. The study group received injectable platelet-rich fibrin (i-PRF) two times with an interval of 2 weeks; the control group did not receive i-PRF. In both groups, the measurements were bilaterally assessed as the distances between the lateral and canine teeth on the plaster models at five time points. The rate of incisor movement was evaluated by Student's *t*-test, analysis of variance, and Tukey honestly significant difference tests. Statistical significance was set as $P < .05$.

Results: The average movements of incisors were significantly higher in the study group than the control group at all time points ($P < .05$). According to the within-group comparison, none of the measurements showed any significant differences between the right and left sides in both groups at all time points ($P > .05$). While the movement of incisors was significantly higher in the study group in the week following the PRF injection compared to the other weeks ($P < .05$), there were no significant differences in the control group at all-time points ($P > .05$).

Conclusions: Applying i-PRF significantly increased the rate of maxillary incisor retraction at all time intervals. Platelet-rich fibrin injection can be an effective method for shortening treatment duration. (*Angle Orthod.* 2021;91:213–219.)

KEY WORDS: i-PRF; Incisor retraction rate; Injectable platelet-rich fibrin; Rate of tooth movement

INTRODUCTION

The average duration of orthodontic treatment varies between 18 and 24 months. The period is especially prolonged depending on particular malocclusion characteristics, treatment modality, patient cooperation, and patient age.[1–4] Prolonged orthodontic treatment can lead to complications such as poor oral hygiene, gingival problems, white spot lesions, root resorption, and possibly loss of teeth.[4,5]

The biological responses of periodontal and bone tissue are limiting factors in orthodontic tooth movement. Many experimental and clinical studies have aimed to accelerate tooth movement by modifying the biological response of tissue using surgical, pharmaceutical, physical, and other methods.[3,6–11] However, none of these procedures is routinely used in orthodontic practice.

Platelet-based preparations are acquired from the patient's blood and classified according to their contents and method as platelet-rich plasma (PRP) and platelet-rich fibrin (PRF). Platelet-based concentrations have a wide variety of proteins and growth factors and are used in different fields of medicine, dentistry, and veterinary medicine to accelerate tissue healing and regeneration.[12,13] PRF, a completely autologous fibrin matrix, was developed as a second-generation platelet concentrate without the addition of anticoagulants and additives at lower centrifugation speeds.[13,14] PRF is easily applied, minimally invasive, repeatable, autogenous, low cost, and a complication-avoiding procedure.[13,14]

[a] Research Assistant, Department of Orthodontics, Faculty of Dentistry, Necmettin Erbakan University, Konya, Turkey.

[b] Assistant Professor, Department of Orthodontics, Faculty of Dentistry, Necmettin Erbakan University, Konya, Turkey.

Corresponding author: Emire Aybuke Erdur, DDS, MS, Necmettin Erbakan University, Faculty of Dentistry, Department of Orthodontics, Konya 42050, Turkey
(e-mail: dtaybuke@gmail.com)

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In the literature, animal-based studies have addressed the effects of platelet-based concentrations on tooth movement. The results of some studies have shown accelerated tooth movement with the application of PRP.[15–17] No clinical studies evaluating the efficacy of PRF injection on incisor retraction have been published previously. The purpose of this study was to investigate the efficiency of injectable PRF (i-PRF) on the maxillary incisor retraction rate. We hypothesized that i-PRF application would accelerate the rate of tooth movement and could decrease the duration of orthodontic treatment.

MATERIALS AND METHODS

This prospective, randomized, single-center study was approved by the Ethical Committee of the Ministry of Health and the Local Ethical Committee of the Necmettin Erbakan University, Faculty of Dentistry. The study was performed in the Department of Orthodontics of the Necmettin Erbakan University. G*Power (version 3.1.10, Franz Faul Universität, Kiel, Germany) based on a 1:1 ratio between the groups, with a significance level of .05 and a sample size of 20 in each group, was found to give the power of more than 80% (actual power; 0.856) to detect significant differences. The study materials consisted of cephalometric radiographs and plaster models obtained at the beginning of the treatment, during incisor retraction, and after 4 weeks of the retraction.

All patients fulfilled the following criteria: systemically healthy condition, age $\geq$18 years, Class II division 1 malocclusion requiring maxillary incisor retraction, permanent dentition, no history of orthodontic treatment, no history of trauma to the anterior teeth, no smoking, no bleeding on probing, gingival index $\leq$1, plaque index $\leq$1, probing depth values $<$3 mm, no use of anti-inflammatory drugs for at least 6 months before or during the study. The treatment protocol was explained in detail to the patients, and patients who met the selection criteria and completed an informed consent form were included in the study.

All records (periodontal, radiographic, intraoral/extraoral photographs, and plaster models) were taken before orthodontic treatment. The treatment plans were made by the same orthodontist. After leveling and alignment procedures for the 40 patients receiving treatment with a straight wire 0.022-in slot bracket system, patients were referred for extraction of maxillary first premolars. Bilateral canine distalization was completed upon reaching a Class I canine relationship, and recording procedures were repeated. After canine distalization, a 0.019-in $\times$ 0.025-in stainless steel wire was tied back, and temporary anchorage devices were placed bilaterally between the maxillary second premolar and the first molar for incisor retraction.

As an anchorage unit, posterior teeth were ligated together to the canine, and the anchorage of the posterior teeth was increased by using the transpalatal arch. Then, the patients were equally divided into two groups on a random basis: the study group (12 women, 8 men; mean age 21 $\pm$ 1.35 years) received i-PRF two times with an interval of 2 weeks and maxillary incisor retraction. The control group (11 women, 9 men; mean age 20.4 $\pm$ 1.56 years) did not receive i-PRF with maxillary incisor retraction. Randomization was performed with a coin toss to prevent selection bias.

Maxillary incisor retraction was conducted using bilaterally calibrated 150-g nickel-titanium closing coil springs (GAC International Inc, Bohemia, NY, USA) connected from a temporary anchorage device to a hook (Tomas-crimp hook, upper left/right, Dentaurum, Ispringen, Germany) placed in front of the lateral incisor brackets. The force produced with the coil was calibrated with a gauge (Dentaurum, Ispringen, Germany) for readjustment each week. The total follow-up period started after canine distalization and was concluded at the fourth week of incisor retraction. All patients continued treatment, and routine final records were repeated at the end of the treatment. A schematic drawing and an intraoral clinical view of the study design are shown in Figures 1 and 2, respectively.

Preparation of i-PRF

An aseptic environment was established to prepare the i-PRF. After the proper injector and region for drawing blood were determined, the area was disinfected with a 70% alcohol solution. A 10-mL syringe was used to draw blood from the brachial vein of patients in the study group. The collected blood samples were promptly placed in centrifuge tubes without anticoagulants and then centrifuged. The centrifuge parameter was set to 700 rpm for 3 minutes at room temperature with Choukroun PRF Duo Centrifuge (Process for PRF, Nice, France). The centrifuged blood was divided into two components, and approximately 2–3 mL of i-PRF obtained from the upper liquid layer was placed in dental injectors.

The study group received i-PRF in the periodontal ligament space of the incisors two times, just before incisor retraction (T0) and at the second week (T2) of the retraction. Before the injection of PRF, an anesthetic solution was administered for pain control.

Measurement of Tooth Movement

Plaster models were obtained at five time points: before incisor retraction (T0) and in the first (T1), second (T2), third (T3), and fourth (T4) weeks of

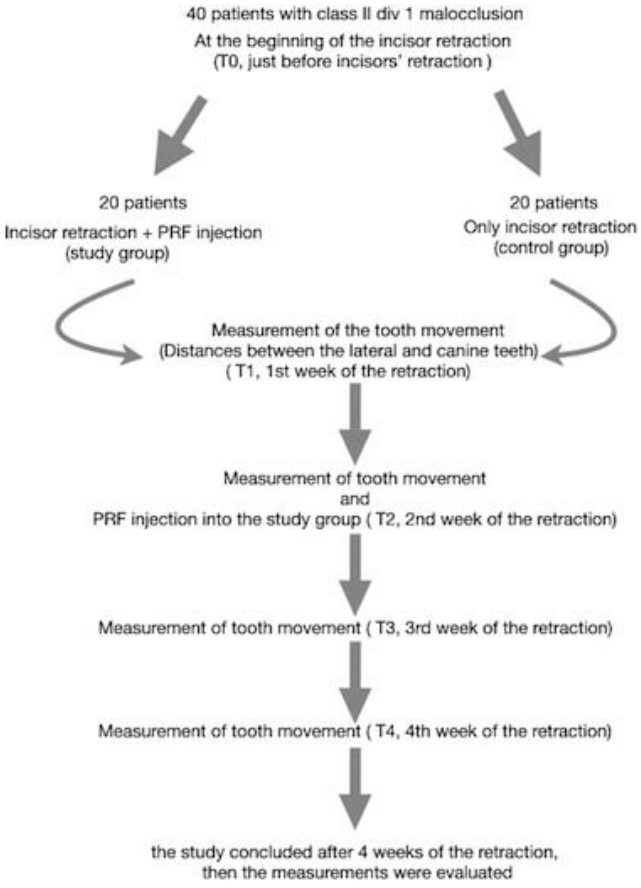

Figure 1. Schematic drawing of the study design.

retraction. The models were labeled with the patient's name and the date and then stored. In both groups, the measurements were bilaterally assessed as the distances between the lateral and canine teeth on the plaster models. Using these reference points, two linear measurements were obtained and recorded as right and left values with a digital caliper (Absolute Digimatic & Vernier Caliper, Mitutoyo, Illinois, USA) (Figure 3). The average movements of the incisors were determined by measuring the movement differences between the weeks.

Statistical Analysis

To assess the method error of measurements, 20 plaster models were randomly selected and measurements were repeated by the same examiner with a 3-week interval. For the interobserver error, another clinician measured the same set of models twice, and the mean values of the two measurements by each investigator were compared. The reliability of the measurements was evaluated using the formula described by Dahlberg,[18] and systematic error was calculated by paired-sample *t*-tests at $P < .05$. Both errors were found to have insignificant, confirming reliability.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 21.0, SPSS, Chicago, Ill). All of the data were normally distributed with a homogeneous variance; therefore, parametric tests were used. The rate of incisor movement was evaluated by the Student's *t*-test within and between comparisons. One-way analysis of variance was performed for within-group comparisons according to the side at different time points. Pairwise multiple comparison analysis was performed with the Tukey honestly significant difference test. Statistical significance was set as $P < .05$.

RESULTS

Forty patients were included and completed the study with no loss to follow-up. Both groups received

Figure 2. Intraoral clinical view of the study design.

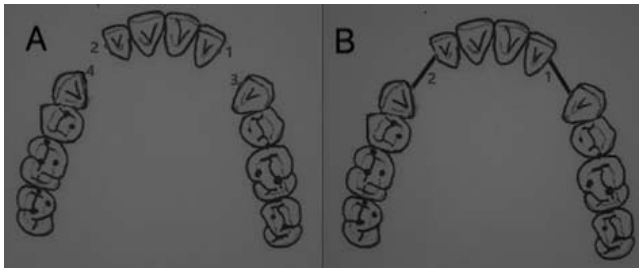

Figure 3. (A) Reference points on the plaster models: 1. Sistal contact point of the upper left lateral incisor. 2. Distal contact point of the upper right lateral incisor. 3. Mesial contact point of the upper left canine. 4. Mesial contact point of the upper right canine. (B) Measurements on the plaster models: 1. Distance between the distal contact point of the left lateral incisor and mesial contact point of the left canine. 2. Distance between the distal contact point of the right lateral incisor and mesial contact point of the right canine.

similar treatment until the beginning of incisor retraction. Gender and age distribution of both groups were statistically similar ($P > .05$). The patients were divided randomly into two groups with similar severities of malocclusion ($P > .05$) (Table 1).

A comparison of the cephalometric measurements between the groups after the study concluded is shown in Table 2. The inclination of the maxillary incisors decreased in both groups, but there was no significant difference in the U1-SN and U1-PP angle between the groups ($P > .05$). In the study group, overjet and U1-NA measurements decreased significantly compared with the control group ($P < .05$). In addition, though the U6-PP posterior angle increased in both groups there was no statistically significant difference between the groups. Measurements were assessed as the distances between the lateral and canine teeth on the right and left sides five times on the plaster models. Comparisons of incisor movement within and between groups according to the right and left sides are shown by time interval in Table 3. According to the within-group comparison, none of the measurements showed any significant differences between the right and left sides in both groups at all time points ($P > .05$). According to the between-group comparison, the average movement of incisors was significantly higher in the study group than the control group by time interval ($P < .001$) (Table 3).

In the control group, the comparison of incisor tooth movement on both the right and left sides by time interval are shown in Table 4, and no statistically significant difference was found by time intervals ($P > .05$). In the study group, the comparison of incisor tooth movement on both sides by time interval are shown in Table 4, and a significant difference was found among time intervals ($P < .05$). According to the multiple comparison tests, statistically higher values were found in the T1-T0 and T3-T2 time intervals on both sides.

Table 1. Comparison of Cephalometric Measurements Between Groups Before Treatment[a]

	Study Group[b]		Control Group[c]		
Measurements	Mean	SD	Mean	SD	*P* Value[d]
SNA (°)	86.01	0.58	85.79	0.57	NS
SNB (°)	81.42	0.46	81.34	0.77	NS
ANB (°)	4.59	0.55	4.46	0.45	NS
SN/GoGn (°)	28.38	0.66	28.75	0.91	NS
U1-SN (°)	108.9	1.89	109.2	2.16	NS
U1-NA (mm)	5.89	0.4	4.84	0.73	NS
U1-PP (°)	122.9	1.14	122.79	2.56	NS
U6-PP (mm)	21.83	0.71	21.6	1	NS
U6-PP (°)	86.06	0.68	86.29	0.62	NS
Overbite (mm)	2.67	0.23	2.61	0.22	NS
Overjet (mm)	4.84	0.26	4.70	0.29	NS

[a] NS indicates not significant; SD, standard deviation.
[b] 12 women, 8 men; mean age 21 ± 1.35 years.
[c] 11 women, 9 men; mean age 20.4 ± 1.56 years.
[d] Student's *t* test; $P > .05$.

Table 2. Comparison of Cephalometric Measurements Between Groups After Study Conclusion[a]

	Study Group		Control Group		
Measurements	Mean	SD	Mean	SD	*P* Value
SNA (°)	–0.59	0.29	–0.59	0.18	.948
SNB (°)	0.01	0.31	–0.06	0.28	.511
ANB (°)	–0.59	0.3	–0.53	0.36	.587
SN/GoGn (°)	0.36	3.32	–0.23	0.24	.477
U1-SN (°)	–0.09	1.18	–0.06	0.95	.929
U1-NA(mm)	–1.42	0.46	–1	0.36	.002*
U1-PP (°)	–0.14	1.45	–0.09	1.04	.911
U6-PP (mm)	0.05	0.38	0.3	1.37	.282
U6-PP (°)	0.25	0.51	0.06	0.26	.134
Overbite (mm)	0.12	0.19	0.14	0.11	.69
Overjet (mm)	–0.68	0.24	–0.41	0.09	<.001*

[a] NS indicates not significant; SD, standard deviation.
* Student's *t* test; significant at $P < .05$.

DISCUSSION

Researchers have prioritized the acceleration of orthodontic tooth movement and have worked on the design, structure, and material of the tools used. They have also aimed to increase tooth movement by minimizing friction coefficients. Many new materials and mechanics have been introduced into clinical practice.[19,20] While these new mechanics have had positive effects, the bone remodeling process is considered to be the limiting factor for the speed of tooth movement. To overcome this biological limit, many methods based on the regional acceleratory phenomenon have been introduced in the literature.[3,6–11,15–17,19] Surgical approaches are the most commonly used methods for accelerating tooth movement in orthodontic practice, but they are invasive, are intolerable for the patient, require the intervention of another specialist, and have higher costs.[3,9,10,21–23] They can also have such

Table 3. Amount of Initial Space Between the Incisor and Canine and Comparisons of Incisor Tooth Movement Within and Between Groups According to Sides at All Time Intervals[a]

Time Interval	Group	Right Side		Left Side		*P* (Within Group) [b]
		Mean ± SD	Minimum-Maximum	Mean ± SD	Minimum-Maximum	
IS	Control group	4.45 ± 1.23	3.15-5.95	4.65 ± 1.35	3.2-6.12	NS
	Study group	4.55 ± 1.45	3.25-6.01	4.68 ± 1.75	3.12-6.05	NS
	p (between groups)		NS		NS	
T1-T0	Control group	0.08 ± 0.02	0.05-0.12	0.08 ± 0.03	0.05-0.17	NS
	Study group	0.14 ± 0.03	0.08-0.21	0.14 ± 0.04	0.09-0.23	NS
	p (between groups)		<.001*		<.001*	
T2-T1	Control group	0.07 ± 0.02	0.03-0.12	0.07 ± 0.02	0.05-0.10	NS
	Study group	0.11 ± 0.03	0.07-0.18	0.11 ± 0.03	0.06-0.20	NS
	p (between groups)		<.001*		<.001*	
T3-T2	Control group	0.07 ± 0.02	0.04-0.11	0.06 ± 0.01	0.04-0.10	NS
	Study group	0.14 ± 0.03	0.09-0.21	0.13 ± 0.04	0.09-0.21	NS
	p (between groups)		<.001*		<.001*	
T4-T3	Control group	0.08 ± 0.02	0.04-0.14	0.07 ± 0.02	0.04-0.10	NS
	Study group	0.11 ± 0.03	0.07-0.15	0.10 ± 0.03	0.07-0.15	NS
	p (between groups)		<.001*		<.001*	
TM	Control group	0.30 ± 0.06	0.19-0.44	0.28 ± 0.17	0.22-0.41	NS
	Study group	0.50 ± 0.11	0.31-0.71	0.48 ± 0.12	0.32-0.73	NS
	p (between groups)		<.001*		<.001*	

[a] NS indicates not significant; IS; initial space, SD, standard deviation; TM; total movement.
[b] Student's *t* test; $P < .001$.
* $P > .05$.

side effects as pain, swelling, bone loss, infection, and gingival recession, so patients often do not consent to undergo surgical procedures.[3,7,10,22,23]

Platelet-based concentrations obtained from the patient's own blood provide a safe alternative to commercially available bioactive materials and are divided into two main categories that differ according to content and method.[12–16] PRP is a platelet-derived source containing high concentrations of platelets and prepared with anticoagulants to activate the contained growth factors.[12,15] Platelet-rich fibrin is a second-generation autologous platelet concentrate prepared without the addition of anticoagulants and additives at lower centrifugation speeds.[12–16,24] The lower centrifuge speed required for i-PRF allows more natural and gradual polymerization, which leads to an increase in the distribution and integrity of cytokines and other soluble molecules in the fibrin network.[13,14] As a result of controlled and prolonged secretion of cytokines, the efficiency of i-PRF also increases.[14] In addition, i-PRF is a low-cost, minimally invasive procedure that has a low risk of possible complications during application. Due to

Table 4. Comparison of Incisor Tooth Movement in the Study and Control Groups According to Sides Between Time Intervals

Side	Time Interval	Mean	SD	Minimum	Maximum	*P* Value	Multiple Comparison
Study group							
Right	(a) T1-T0	0.136	0.032	0.08	0.21	<.001*	(b)(d)
	(b) T2-T1	0.109	0.031	0.07	0.18		(a)(c)
	(c) T3-T2	0.138	0.030	0.09	0.21		(b)(d)
	(d) T4-T3	0.105	0.026	0.07	0.15		(a)(c)
Left	(a) T1-T0	0.138	0.036	0.09	0.23	<.001*	(b)(d)
	(b) T2-T1	0.105	0.034	0.06	0.20		(a)(c)
	(c) T3-T2	0.134	0.035	0.09	0.21		(b)(d)
	(d) T4-T3	0.098	0.026	0.07	0.15		(a)(c)
Control group							
Right	(a) T1-T0	0.081	0.018	0.05	0.12	NS	
	(b) T2-T1	0.073	0.023	0.03	0.12		
	(c) T3-T2	0.072	0.019	0.04	0.11		
	(d) T4-T3	0.077	0.024	0.04	0.14		
Left	(a) T1-T0	0.079	0.033	0.05	0.17	NS	
	(b) T2-T1	0.071	0.015	0.05	0.10		
	(c) T3-T2	0.064	0.013	0.04	0.10		
	(d) T4-T3	0.070	0.015	0.04	0.10		

* Analysis of variance, Tukey honestly significant difference; $P < .001$, NS; no significance, $P > .05$.

its advantages, the application of i-PRF was preferred in this study to increase incisor retraction rate.

Platelet-based concentrations have been used in many fields of medicine and dentistry for years; however, studies in the field of orthodontics are limited. In their study on rats, Güleç et al.[15] evaluated the dose-effect relationship of PRP and tooth movement and reported that different concentrations of PRP accelerated orthodontic tooth movement. In an animal-based study, Rashid et al.[16] evaluated the effect of PRP on the rate of tooth movement and reported that PRP accelerated orthodontic tooth movement. PRF significantly increased the rate of tooth movement, and a significant increase in the levels of inflammatory cytokine supported this result (unpublished data). In the present study, to accelerate incisor retraction, i-PRF was applied in the study group two times at an interval of 2 weeks. Analysis of the results demonstrated that i-PRF increased the rate of tooth movement. During the total follow-up period, the incisors experienced nearly twice as much movement in the study group compared with the control group; this finding was compatible with the results of similar studies in the literature.[15–17] Also, the incisor retraction rates in the first and third weeks were statistically higher than in the second and fourth weeks. Cephalometric measurements of the patients supported these results. After the study concluded, the inclination of the maxillary incisors decreased in both groups, but there was no significant difference in the U1-SN and U1-PP angles between the groups. In the study group, overjet and U1-NA measurements decreased significantly compared with the control group. In addition, the U6-PP posterior angle increased in both groups, though there was no statistically significant difference between the groups.

This was the first study examining the effect of i-PRF on the incisor retraction rate in humans. It was shown that i-PRF was an effective, comfortable, and safe procedure that significantly accelerated tooth movement and could result in shorter orthodontic treatment. Although the examiners were not blinded to study groups could have been a limitation of the study, the measurements were repeated by the same examiner, and a second clinician remeasured the same sets of models to determine interobserver error. Furthermore, both errors were found insignificant, therefore confirming reliability.

CONCLUSIONS

- The maxillary incisor retraction rate increased in the study group at all time intervals.
- Application of i-PRF can be an effective alternative treatment method for shortening treatment duration. Further studies are needed to evaluate the effectiveness of i-PRF on tooth movement.

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