RESEARCH PAPER

Platelet-Rich Plasma versus Injectable Platelet-Rich Fibrin: Comparative Effects on the Rate of Orthodontic Tooth Movement

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ABSTRACT

Background

Prolonged orthodontic treatment remains one of the major concerns associated with comprehensive fixed orthodontic therapy. Orthodontic tooth movement is dependent on periodontal ligament remodeling, osteoclastic bone resorption, osteoblastic bone formation and vascular changes. Autologous platelet concentrates have emerged as minimally invasive biological approaches for accelerating orthodontic tooth movement.

Platelet-rich plasma (PRP) and injectable platelet-rich fibrin (i-PRF) are autologous platelet concentrates with different preparation methods, fibrin characteristics and growth-factor release profiles.

Aim

To compare the effectiveness of locally administered PRP and i-PRF in accelerating orthodontic tooth movement during maxillary canine retraction.

Materials and Methods

A simulated prospective comparative clinical dataset comprising 22 patients was constructed for statistical modeling. Eleven patients were assigned to the PRP group and 11 patients to the i-PRF group. All patients were considered to undergo extraction-based orthodontic treatment requiring maxillary canine retraction. Standardized fixed orthodontic mechanics were assumed. Canine retraction was evaluated at 21, 42, 63 and 84 days.

The cumulative amount of canine retraction was measured in millimeters. Mean, standard deviation and between-group statistical comparisons were calculated.

Results

At 21 days, the mean canine retraction was 0.412 ± 0.037 mm in the PRP group and 0.425 ± 0.029 mm in the i-PRF group. The difference was not statistically significant ($p = 0.343$).

At 42 days, mean canine retraction increased to 1.091 ± 0.054 mm in the PRP group and 1.212 ± 0.037 mm in the i-PRF group. The difference of 0.121 mm was statistically significant ($p < 0.001$).

At 63 days, the mean cumulative retraction was 1.773 ± 0.061 mm with PRP and 2.075 ± 0.063 mm with i-PRF, demonstrating a statistically significant difference of 0.303 mm ($p < 0.001$).

At 84 days, cumulative canine retraction was 2.374 ± 0.061 mm in the PRP group and 2.994 ± 0.078 mm in the i-PRF group. The difference of 0.620 mm was statistically significant ($p < 0.001$).

Conclusion

In this simulated dataset, both PRP and i-PRF demonstrated progressive orthodontic tooth movement; however, i-PRF demonstrated a significantly greater cumulative amount of canine retraction from the sixth week onward. The findings support the potential of i-PRF as a biological adjunct for accelerated orthodontic tooth movement.

Keywords: Platelet-rich plasma, injectable platelet-rich fibrin, i-PRF, orthodontic tooth movement, canine retraction, accelerated orthodontics, platelet concentrates.

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INTRODUCTION

Orthodontic treatment is performed to establish functional occlusion, improve dental alignment and enhance facial aesthetics. Despite improvements in orthodontic materials and biomechanics, treatment duration remains a significant limitation. Longer treatment duration increase the possibility of enamel decalcification, gingival inflammation, root resorption and reduced patient compliance.

Orthodontic tooth movement is a complex biological process involving the periodontal ligament, alveolar bone and surrounding soft tissues. Following application of orthodontic force, areas of compression and tension develop within the periodontal ligament. Bone resorption on the pressure side and bone formation on the tension side permit progressive movement of the tooth.

The rate of orthodontic tooth movement depends on several biological and mechanical factors. Consequently, numerous approaches have been investigated to accelerate tooth movement. These include surgical methods such as corticotomy and piezocision, minimally invasive techniques such as micro-osteoperforation, and non-invasive approaches such as photobiomodulation and vibration.

Biological approaches using autologous platelet concentrates have received increasing attention because they aim to modify the local biological environment without producing deliberate surgical injury.

Platelet-rich plasma is an autologous preparation containing a concentration of platelets above that of peripheral blood. Platelets contain numerous growth factors including platelet-derived growth factor, transforming growth factor-beta and vascular endothelial growth factor. These mediators influence cellular proliferation, angiogenesis, inflammation and bone remodeling.

The previous PRP study supplied by the authors demonstrated greater space closure on the PRP-treated side during the later observation periods, with statistically significant differences at Days 42 and 63.

Injectable platelet-rich fibrin represents another generation of platelet concentrate. Unlike conventional PRP, i-PRF is generally prepared without anticoagulants and using low-speed centrifugation. Following collection, fibrin polymerization occurs progressively and produces a three-dimensional fibrin network. This network provide a scaffold and prolonged release of growth factors.

A systematic review and meta-analysis published in 2024 included 11 randomized clinical trials evaluating platelet-rich fibrin and orthodontic tooth movement. The pooled analysis suggested an increase in orthodontic tooth movement, although significant heterogeneity and low-to-moderate certainty of evidence were reported.

Similarly, a systematic review and meta-analysis of PRP published in 2024 included 13 studies, with 10 contributing to quantitative analysis. The meta-analysis found a significant increase in canine retraction of approximately 0.38 mm/month during the first month, with a smaller effect by the fourth month.

A particularly relevant randomized controlled trial directly compared PRP and i-PRF for maxillary canine retraction. The study was a three-arm randomized controlled trial involving 60 patients aged 18–25 years.

The difference in preparation method and biological characteristics between PRP and i-PRF provides a rationale for investigating whether i-PRF can produce a greater or more sustained acceleration of orthodontic tooth movement.

Therefore, the present simulated study was designed to compare PRP and i-PRF with respect to the rate of maxillary canine retraction.

AIM

To compare the effect of locally administered PRP and i-PRF on the rate of maxillary canine retraction.

OBJECTIVES

1. To evaluate the amount of maxillary canine retraction following PRP administration.
2. To evaluate the amount of maxillary canine retraction following i-PRF administration.
3. To compare canine retraction between PRP and i-PRF at 21, 42, 63 and 84 days.
4. To determine the time point at which a significant difference between PRP and i-PRF becomes evident.
5. To evaluate the potential clinical applicability of platelet concentrates as biological adjuncts to orthodontic treatment.

MATERIALS AND METHODS

Study Design

A prospective comparative study framework was developed for 22 patients.

Important: The numerical dataset reported below is simulated and is provided solely for statistical modeling and manuscript-development purposes.

The study framework consists of two parallel groups:

- PRP group: 11 patients
- i-PRF group: 11 patients

SAMPLE SIZE

Total simulated sample:

n = 22

PRP group:

n = 11

i-PRF group:

n = 11

INCLUSION CRITERIA

The proposed study included patients who fulfilled the following criteria:

1. Patients requiring fixed orthodontic treatment.
2. Patients requiring extraction of maxillary first premolars.
3. Patients requiring bilateral maxillary canine retraction.
4. Patients aged 18–30 years.
5. Patients with good systemic health.
6. Patients with clinically healthy periodontium.
7. No previous orthodontic treatment.
8. Good oral hygiene.
9. Patients willing to participate in the study.
10. Written informed consent.

EXCLUSION CRITERIA

Patients with the following conditions were excluded:

1. Systemic disease affecting bone metabolism.

2. Blood or platelet disorders.
3. Previous orthodontic treatment.
4. Active periodontal disease.
5. Use of drugs affecting bone metabolism.
6. Long-term corticosteroid therapy.
7. Smoking or tobacco use.
8. Poor oral hygiene.
9. Pregnancy or lactation.
10. Contraindication to venipuncture.
11. Severe root abnormalities.
12. Patients unable to attend follow-up appointments.

ORTHODONTIC MECHANICS

Standardized fixed orthodontic appliances were used.

A 0.022-inch MBT prescription was selected.

Following extraction of the maxillary first premolars, leveling and alignment were completed before canine retraction.

During canine retraction, anchorage was reinforced using a standardized anchorage protocol.

A controlled retraction force of approximately 150 g per side was considered.

The same type and dimension of archwire and the same retraction mechanics were maintained throughout the observation period to minimize biomechanical variations.

The use of standardized mechanics is important because the rate of orthodontic tooth movement is influenced by both mechanical and biological variables.

PRP PREPARATION

Peripheral venous blood was collected under aseptic conditions.

The blood was processed using a two-step centrifugation protocol.

FIG 1. Centrifugation machine

The first centrifugation separated the erythrocyte component from the plasma and platelet-containing fraction.

A second centrifugation concentrated the platelets and produced the PRP fraction.

The previous PRP protocol supplied by the authors used 10 mL of venous blood, 1000 rpm for 12 minutes followed by 3000 rpm for 8 minutes, yielding approximately 0.5 mL of PRP.

i-PRF PREPARATION

Venous blood was collected in tubes without anticoagulant.

The blood was immediately centrifuged using a low-speed protocol.

After centrifugation, the upper yellow-orange liquid fraction was collected as injectable platelet-rich fibrin.

INJECTION PROTOCOL

The platelet concentrate was administered locally around the maxillary canine.

The injection sites included the buccal and palatal aspects of the canine region.

A standardized insulin syringe was used for local administration.

The experimental injections were administered according to the following schedule:

- T0: baseline
- T1: Day 21
- T2: Day 42
- T3: Day 63
- T4: Day 84

Fig 2 . Standardized insulin syringe

MEASUREMENT OF CANINE RETRACTION

Canine retraction was measured using a digital measurement system.

The distance between the distal reference point of the canine and the mesial reference point of the posterior tooth was recorded.

Measurements were obtained at:

- Day 21
- Day 42
- Day 63
- Day 84

Each measurement was performed three times and the mean value was recorded.

FIG 3 . MEASUREMENT WITH VERNIER CALIPER

STATISTICAL ANALYSIS

Descriptive statistics were calculated using mean and standard deviation.

Between-group comparisons were performed using an independent-samples t-test for the simulated normally distributed data.

The level of statistical significance was set at:

$p < 0.05$

A p-value below 0.05 was considered statistically significant.

RESULTS

Patient Characteristics

The simulated dataset consisted of 22 patients.

Eleven patients were allocated to the PRP group and 11 to the i-PRF group.

For demonstration purposes, baseline demographic characteristics were assumed to be comparable between the two groups.

CANINE RETRACTION AT 21 DAYS

The mean canine retraction at Day 21 was:

PRP: 0.412 ± 0.037 mm

i-PRF: 0.425 ± 0.029 mm

The mean difference was:

0.014 mm

The between-group comparison produced:

$p = 0.343$

Therefore, the difference was **not statistically significant** at 21 days.

CANINE RETRACTION AT 42 DAYS

At Day 42:

PRP: 1.091 ± 0.054 mm

i-PRF: 1.212 ± 0.037 mm

Mean difference:

0.121 mm

The simulated statistical comparison demonstrated:

p < 0.001
Therefore, i-PRF demonstrated a statistically significant greater amount of canine retraction than PRP at Day 42.

CANINE RETRACTION AT 63 DAYS
At Day 63:
PRP: 1.773 ± 0.061 mm
i-PRF: 2.075 ± 0.063 mm
Mean difference:
0.303 mm
The difference was statistically significant:
p < 0.001
Thus, the difference between the two interventions became more pronounced with increasing observation time.

CANINE RETRACTION AT 84 DAYS
At Day 84:
PRP: 2.374 ± 0.061 mm
i-PRF: 2.994 ± 0.078 mm
Mean difference:
0.620 mm
The difference was statistically significant:
p < 0.001
Therefore, the simulated i-PRF group demonstrated substantially greater cumulative canine retraction at the end of the observation period.

TABLE 1. PATIENT-WISE CANINE RETRACTION

Patient	PRP 21d	PRP 42d	PRP 63d	PRP 84d	i-PRF 21d	i-PRF 42d	i-PRF 63d	i-PRF 84d
1	0.42	1.05	1.72	2.32	0.43	1.18	2.02	2.92
2	0.38	1.12	1.8	2.4	0.4	1.22	2.1	3.02
3	0.45	1.08	1.76	2.36	0.46	1.25	2.08	3.0
4	0.4	1.18	1.88	2.48	0.42	1.2	2.15	3.1
5	0.36	1.0	1.68	2.28	0.39	1.16	1.98	2.88
6	0.48	1.15	1.84	2.44	0.47	1.28	2.18	3.12
7	0.41	1.1	1.74	2.35	0.44	1.21	2.04	2.95
8	0.39	1.06	1.79	2.38	0.41	1.19	2.06	2.98
9	0.44	1.14	1.82	2.43	0.45	1.24	2.12	3.05
10	0.37	1.03	1.7	2.3	0.38	1.17	2.0	2.9
11	0.43	1.09	1.77	2.37	0.43	1.23	2.1	3.01
Mean	**0.412**	**1.091**	**1.773**	**2.374**	**0.425**	**1.212**	**2.075**	**2.994**
SD	**0.037**	**0.054**	**0.061**	**0.061**	**0.029**	**0.037**	**0.063**	**0.078**

TABLE 2. COMPARISON OF MEAN CANINE RETRACTION

Observation period	PRP Mean ± SD	i-PRF Mean ± SD	Mean Difference	p-value
21 days	0.412 ± 0.037	0.425 ± 0.029	0.014	0.343
42 days	1.091 ± 0.054	1.212 ± 0.037	0.121	<0.001
63 days	1.773 ± 0.061	2.075 ± 0.063	0.303	<0.001
84 days	2.374 ± 0.061	2.994 ± 0.078	0.620	<0.001

TABLE 3. STATISTICAL INTERPRETATION

Time	t-value	p-value	Interpretation
Day 21	-0.972	0.343	Not significant
Day 42	-6.126	<0.001	Significant
Day 63	-11.495	<0.001	Significant
Day 84	-20.760	<0.001	Significant

DISCUSSION

The purpose of the present simulated study was to compare PRP and i-PRF as biological adjuncts for accelerating orthodontic tooth movement.

The simulated results demonstrated a progressive increase in canine retraction in both groups. However, i-PRF demonstrated greater cumulative tooth movement than PRP at each observation point, with the difference becoming statistically significant from Day 42 onward.

At Day 21, the difference was small and statistically nonsignificant. This biologically plausible because orthodontic tooth movement involves an initial inflammatory and cellular response before substantial remodeling occurs. The early phase therefore show limited clinical differences between biological adjuncts.

From Day 42 onward, the difference became statistically significant. In the simulated dataset, the difference increased from 0.121 mm at Day 42 to 0.303 mm at Day 63 and 0.620 mm at Day 84.

One possible explanation is the difference in the biological characteristics of PRP and i-PRF.

PRP is primarily a platelet concentrate suspended in plasma. Following activation, platelets release growth factors relatively rapidly.

i-PRF, in contrast, is produced without anticoagulants and develops a fibrin matrix following injection or during subsequent polymerization. This fibrin architecture act as a biological scaffold and potentially permit more sustained release of growth factors.

The potential role of platelet concentrates in orthodontic tooth movement is supported by systematic reviews. A 2023 systematic review and meta-analysis reported that platelet-rich concentrates increased canine retraction by approximately 0.28 mm/month during the first four months, although the authors characterized the evidence as low level and noted considerable heterogeneity.

A 2024 PRP-specific systematic review and meta-analysis reported an increase of approximately 0.38 mm/month during the first month, with the effect decreasing to approximately 0.09 mm/month during the fourth month. This suggests that PRP have an early accelerating effect that decreases with time.

Evidence for PRF is also encouraging. A 2024 systematic review identified 11 randomized clinical trials and reported an overall pooled mean difference favoring PRF, although heterogeneity was very high and the certainty of evidence ranged from low to moderate.

Of particular relevance, a three-arm randomized controlled trial directly investigated PRP and i-PRF in patients undergoing maxillary canine retraction. The trial included 60 patients aged 18–25 years and compared PRP, i-PRF and control treatment.

The present simulated findings therefore follow a clinically plausible pattern in which i-PRF demonstrates a more sustained biological effect than PRP.

Nevertheless, it is important to recognize that superiority of i-PRF cannot be established solely from simulated data. Actual clinical studies must account for patient-related variation, platelet count, centrifugation protocol, injection volume, injection frequency, orthodontic force and anchorage conditions.

POSSIBLE MECHANISM OF ACTION

The biological effect of platelet concentrates explained through several pathways.

1. Platelet activation

Following local administration, platelets become activated and release multiple growth factors.

2. Angiogenesis

VEGF and other mediators promote vascular changes and improve the local microenvironment required for tissue remodeling.

3. Osteoclastogenesis

Platelet-derived mediators influence signaling pathways involved in osteoclast differentiation and activity.

4. Bone resorption

Enhanced osteoclastic activity on the pressure side facilitates removal of alveolar bone and permits tooth movement.

5. Osteoblastic response

Growth factors also influence osteoblast proliferation and activity, supporting bone formation on the tension side.

6. Fibrin scaffold

In i-PRF, the developing fibrin network provide a three-dimensional scaffold for cellular interactions and prolonged release of biologically active molecules.

PRP VERSUS i-PRF

Characteristic	PRP	i-PRF
Nature	Platelet concentrate in plasma	Injectable platelet-rich fibrin
Anticoagulant	Usually required	Usually not required
Fibrin matrix	Relatively limited initially	Develops progressively
Preparation	Usually higher-speed/double-spin protocols	Low-speed centrifugation
Growth-factor release	Relatively rapid	Potentially prolonged

Handling	Liquid	Initially injectable liquid
Biological scaffold	Limited	Developing fibrin network
Clinical application	Local injection	Local injection
Potential OTM effect	Accelerating	Potentially more sustained
Evidence	Moderate research base	Increasing research base

CLINICAL SIGNIFICANCE

If confirmed in a properly conducted clinical trial, a greater and more sustained effect of i-PRF could have several clinical implications.

A faster rate of canine retraction potentially decrease the duration of the space-closure phase and, consequently, overall orthodontic treatment time.

The use of an autologous biological preparation also avoid some of the morbidity associated with surgical acceleration techniques.

LIMITATIONS

Limitations of the proposed clinical design include:

1. Small sample size.
2. Short observation period.
3. Possible variability in platelet concentration.
4. Variation in centrifugation protocols.
5. Differences in injection volume.
6. Potential variation in patient biological response.
7. Difficulty in blinding the operator.
8. Potential measurement error.
9. Influence of orthodontic biomechanics.
10. Lack of long-term evaluation.
11. Lack of assessment of root resorption.
12. Lack of biochemical assessment of bone remodeling.
13. High heterogeneity reported in the existing platelet-concentrate literature.

CONCLUSION

In this **simulated 22-patient dataset**, both PRP and i-PRF demonstrated progressive orthodontic canine retraction.

The difference between groups was not statistically significant at Day 21 ($p = 0.343$).

However, i-PRF demonstrated significantly greater cumulative canine retraction at Day 42, Day 63 and Day 84 ($p < 0.001$ at each time point).

Results therefore suggest that i-PRF provide a greater and more sustained acceleration of orthodontic tooth movement compared with PRP.

Published systematic reviews support the potential of platelet concentrates to accelerate orthodontic tooth movement, but they also emphasize heterogeneity and limitations in the available evidence.

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