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COULD INJECTABLE PRF (i-PRF) HOLD A HIDDEN ROLE IN PRESERVING PERIODONTAL HEALTH DURING TWO-STEP CANINE RETRACTION? A RANDOMIZED SPLIT-MOUTH CLINICAL TRIAL

Mohamed M Alkhawaga*, Fady H Fahim** *and* Sally Magdi***

ABSTRACT

Aim: To evaluate the efficacy of i-PRF in periodontal health preservation around canines during two-step retraction.

Material and Methods: A randomized split-mouth controlled trial was conducted on 19 patients (mean age: 18 ± 3.85 years) undergoing fixed orthodontic treatment for bimaxillary protrusion or Class II Division 1 malocclusion, all requiring bilateral maxillary first premolar extractions. In each patient, one quadrant was randomly allocated to receive i-PRF injections (intervention), while the contralateral side served as control with no injections. After leveling and alignment, canine retraction was performed using Niti closed-coil springs, applying a standardized 150 g of force. Autologous i-PRF was injected at four intervals. Each application targeted the buccal and palatal aspects of the canine at two vertical levels, plus a distal intraligamentary site. Periodontal health was assessed using a UNC-15 probe.

Results: At baseline (T0), probing depth was significantly greater in the control group (2.35 ± 0.51 mm) compared to the intervention group (2.21 ± 0.51 mm; P = 0.0001). However, no statistically significant intergroup differences were observed at any subsequent time point (T1–T5 P > 0.05). The overall mean probing depth across all time points was slightly higher in the control group (2.28 ± 0.23 mm) than in the intervention group (2.20 ± 0.23 mm), with this difference reaching statistical significance (P = 0.008) but with no clinical significance. Intragroup comparisons showed significant changes over time in both groups (P = 0.001 for intervention, P = 0.0003 for control), though all values remained within the clinically normal range. Marginal tissue loss from T0 to T5 was minimal and statistically non-significant between groups: 0.06 ± 0.15 mm in the intervention group vs. 0.11 ± 0.17 mm in the control group (P = 0.14).

Conclusion: i-PRF injections led to a statistically significant yet clinically negligible reduction, with all values remaining within the healthy range (≤ 3 mm) in probing depth, with no effect on marginal tissue loss. Thus, i-PRF offers limited clinical benefit in preserving periodontal health during orthodontic canine retraction.

KEYWORDS: Injectable platelet-rich fibrin (i-PRF), University of North Carolina No. 15 Probe (UNC-15), probing depth (PD), Marginal tissue loss.

* MSc, Department of Orthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt.
** Ass. Prof, Department of Orthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt.
*** Lecturer, Department of Orthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt.

INTRODUCTION

Orthodontic tooth movement (OTM) is fundamentally driven by the biological remodeling of the periodontal tissues in response to applied mechanical forces. Over the years, accelerating OTM has been a focal point of research due to its numerous clinical advantages, namely reduced treatment duration, minimized risks of adverse effects such as root resorption, oral hygiene challenges, and black triangle formation, and potentially enhanced post-treatment stability **Huang, Williams and Kyrkanides (2014)**.

Various strategies have been explored to expedite tooth movement. Invasive techniques such as micro-osteoperforations and bone decortication have demonstrated some efficacy; however, their routine clinical application remains limited due to the associated risks of alveolar bone loss and gingival recession **Zeitounlouian et al. (2021a)**. Although micro-osteoperforations did not significantly increase the rate of canine retraction, they showed potential in facilitating root movement **Aboalnaga et al. (2019)**.

On the other hand, non-invasive approaches such as low-level laser therapy (LLLT) have shown limited success in enhancing tooth movement **Abd-El-Ghafour Omar et al. (2017)**. More recently, biological agents like platelet-rich plasma (PRP) have demonstrated promising effects when administered during the early stages of treatment **El-Timamy et al. (2020).** Among these biological adjuncts, injectable platelet-rich fibrin (i-PRF) has garnered growing attention due to its simplicity, autologous nature, low cost, and repeatability. i-PRF represents a minimally invasive method with the potential to enhance orthodontic biomechanics **Erdur et al. (2021)**.

Platelet concentrates were first introduced by **Kingsley (1954)** and later developed into PRP, which gained clinical relevance following its successful application in surgical wound healing by **Marx (2004)**. As the first generation of platelet concentrates used in dentistry, PRP opened the door for biological enhancement in orthodontics. However, due to limitations such as rapid release of growth factors and the need for anticoagulants, its use has declined in favor of platelet-rich fibrin (PRF), which offers more sustained biological activity **He et al. (2009)**.

PRF, a second-generation platelet concentrate, is derived from centrifuged autologous blood and contains high concentrations of platelets, stem cells, and growth factors, up to seven times more than PRP **Dohan Ehrenfest et al. (2010)**. Unlike PRP, PRF preparation does not require biochemical additives or anticoagulants, which can interfere with wound healing **Dohan et al., (2006)**. This makes PRF not only simpler to produce but also more biocompatible.

PRF releases an array of regenerative growth factors, including platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF). These molecules play critical roles in angiogenesis, collagen synthesis, and bone remodeling, thereby supporting tissue regeneration **(Del Corso *et al.*, 2012; Preeja and Arun, 2014).** Moreover, PRF has been shown to reduce post-extraction complications such as alveolar bone loss and gingival invaginations, which could compromise orthodontic treatment outcomes **(Che *et al.*, 2017; Reichert *et al.*, 2017).**

A distinguishing feature of i-PRF is its immunomodulatory capacity. Evidence from **Nasirzade et al. (2019)** indicates that i-PRF can induce a phenotypic shift in macrophages from the M1 (pro-inflammatory) to the M2 (pro-regenerative) state. Given the central role of macrophages in regulating tissue inflammation and healing, this shift highlights i-PRF's dual potential as both a regenerative and anti-inflammatory agent.

Clinically, the therapeutic potential of i-PRF extends beyond orthodontics. A noteworthy trial by **Kapa et al. (2022)** utilized i-PRF in the formulation of "sticky bone" for the treatment of

Miller Class I and II gingival recessions. The results demonstrated consistent improvements in gingival thickness, keratinized tissue width, and reductions in pocket depth and recession, underscoring the broader applicability of i-PRF in periodontal and regenerative therapies.

MATERIALS AND METHODS

This split-mouth, randomized controlled single-center trial was conducted with a 1:1 allocation ratio following approval by the Ethical Review Committee of Cairo University with identification number: 91222. Patients were randomly selected from the outpatient clinic at the Department of Orthodontics, Faculty of Dentistry, Cairo University. The sample size was calculated based on a previous study by **El-Timamy et al. (2020)**. According to their finding and based on a power analysis (80% power, $\alpha = 0.05$), a minimum sample of 19 subjects was determined. The calculation was performed using G*Power 3.1 software for a paired-samples t-test (dependent t-test). Participants aged between 18 and 30 years (mean age: 21.85 ± 3.85 years), (12 females, 7 males). All participants provided written informed consent before inclusion in the study. The inclusion criteria included adult patients with bimaxillary protrusion or Class II Division 1 malocclusion requiring bilateral maxillary first premolar extraction with maximum anchorage, a full permanent dentition (excluding third molars), and good oral hygiene. Exclusion criteria included a history of orthodontic treatment, systemic diseases or medications affecting tooth movement, smoking, poor oral health (e.g., caries, white spot lesions, or periodontal disease), and severe crowding with ectopically erupted canines.

Randomization and Blinding

This study followed a split-mouth randomized controlled design, where the right and left quadrants of each participant's maxillary arch were randomly assigned to either the experimental or control side in a 1:1 ratio. A block randomization list was computer-generated using Random.org by an independent coordinator who had no role in treatment or assessment. Allocation was concealed using opaque, sealed, and sequentially numbered envelopes, prepared by a third party and opened only after participant enrollment. Blinding of participants and the operator was not feasible due to the nature of the intervention, as the control side received no treatment. However, the outcome assessor was blinded to group allocation throughout the study. Group identities were also coded during statistical analysis to maintain blinding of the data analyst.

Orthodontic Procedure

At baseline, full-mouth scaling was performed, and oral hygiene instructions were provided. Leveling and alignment were completed using 0.022-inch slot brackets with the MBT prescription. Progression was made to a 0.017 × 0.025-inch stainless steel arch wire in preparation for canine retraction. Before extractions, two miniscrews were inserted interradicular between the upper second premolars and first molars bilaterally. Anchorage was reinforced by connecting the first molars to the miniscrews with a 0.019 × 0.025-inch stainless steel wire; screw heads were covered with flowable composite. Following extraction, NiTi closed-coil springs delivering 150 g of force were attached between the canine hooks and first molar hooks on both sides. Force magnitude was verified with a force gauge, and adjustments were made as needed. Canine retraction was maintained for five months, with monthly follow-ups to assess appliance integrity, force levels, mini-implant stability, and oral hygiene.

i-PRF Preparation and Application:

A total of 9 ml of venous blood was drawn from each patient and centrifuged at 600 rpm (44 g) for 8 minutes, following the protocol by **Choukroun and Ghanaati. (2018)** to prepare injectable platelet-rich fibrin (i-PRF). The i-PRF was administered at four time points: three weeks prior to premolar extraction (initial dose), immediately before canine retrac-

tion T0, and again at T2 and T4. Using an insulin syringe, injections were delivered to both the buccal and palatal aspects at two vertical levels along the distal surface of the canine root (25 units per injection, totaling 50 units per surface). Additionally, 50 units were injected intraligamentarily distal to the canine on the experimental side to ensure optimal distribution of the concentrate.

Periodontal Assessment

Periodontal health was monitored using the **UNC** periodontal probe. Probing depths were recorded around the canine (Mesiolabial, Mesiopalatal, Distolabial, Distopalatal, Mid-labial, and Mid-palatal surfaces) according to **Chapple et al. (2018)** in the intervention and control sides at each monthly follow-up. Marginal tissue loss was assessed by measuring the apical displacement of the gingival margin relative to the cemento-enamel junction (CEJ) at labial and palatal surfaces according to the modification of **Kumar and Masamatti (2013)**. at pre-retraction (T0) and post-retraction (T5) intervals.

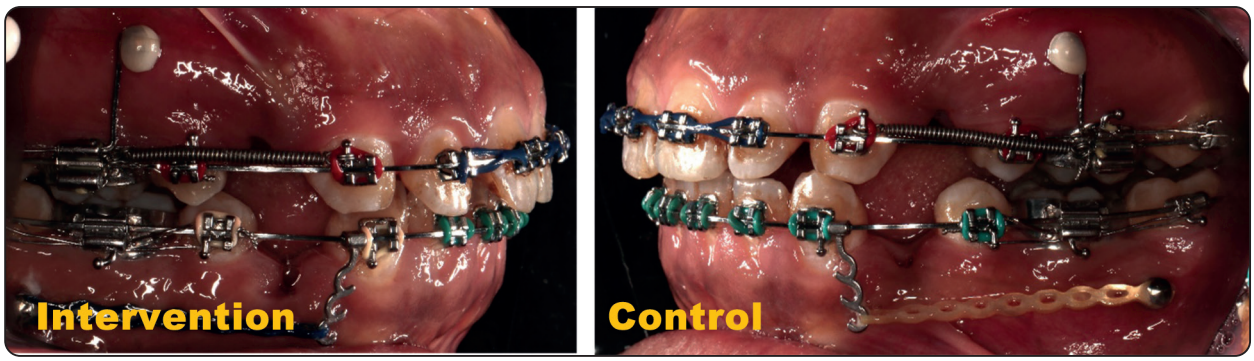

Fig. (1) Indirect intra-oral photos for the retraction process.

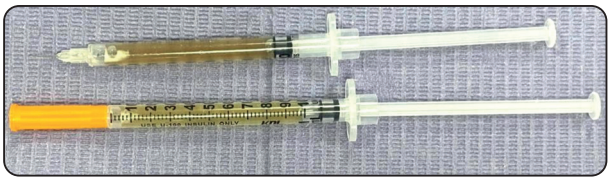

Fig. (2) Insulin syringe contains (i-PRF) ready for injection.

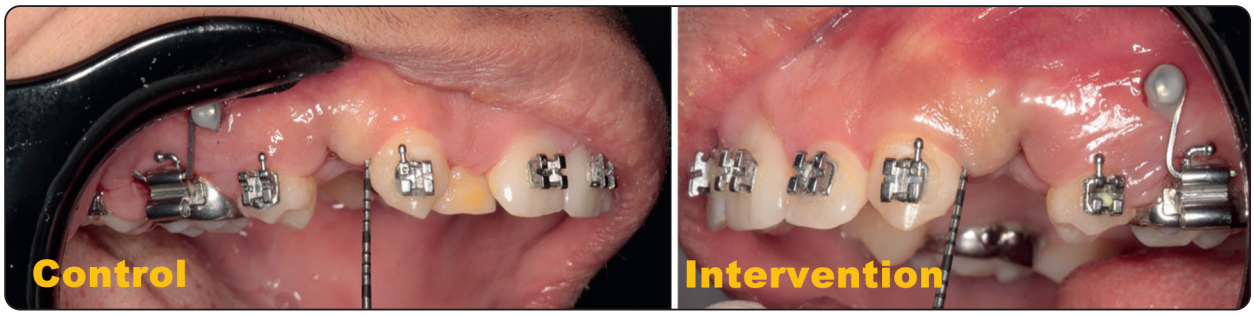

Fig. (3) Direct intra-oral photos showing the Process of measuring probing depth at one surface.

Statistical Analysis and Error of the Method

Statistical analysis was performed with SPSS 27®, GraphPad Prism®, and Microsoft Excel 2016. All quantitative data were explored for normality by using Shapiro Wilk Normality test and Kolmogorov test, which revealed that probing depth was normally distributed. Accordingly, comparison between different groups was performed by using Paired t test, while comparison between different time points was performed by using Repeated Measures ANOVA test followed by Tukey`s Post Hoc test for multiple comparison. In marginal tissue loss all data were nonparametric; accordingly, comparison between groups was performed by using Wilcoxon signed rank test. The significant level was set at $P \leq 0.05$.

RESULTS

Probing depth

Mean and standard deviation of probing depth of both groups at different time points were presented in Table 1 and Figure 4.

1. Intergroup comparison (comparison between groups using Paired t test)

Comparison between groups was performed by using Wilcoxon signed rank test which revealed that: **At baseline (T0),** the Intervention group recorded a mean probing depth of 2.21 ± 0.51 mm, while the Control group showed a mean of 2.35 ± 0.51 mm. This difference was statistically significant (P = 0.0001), favoring higher baseline probing depth in the Control group. **At T1**, no significant difference was observed between the Intervention group (2.03 ± 0.40 mm) and the Control group (2.01 ± 0.38 mm), with a P value of 0.687. **Similarly, at T2, T3, T4, and T5**, no statistically significant differences were detected, with P values of 0.110, 0.101, 0.093, and 0.330, respectively. When considering the **overall mean probing depth** across all time points, the Intervention group had a mean of 2.20 ± 0.23 mm, while the Control group recorded a mean of 2.28 ± 0.23 mm, with this difference reaching statistical significance (P = 0.008), Table 1 and Figure (4).

TABLE (1) Descriptive results of PD in both groups at different time points:

	Group				Paired Differences					P value
	Intervention group		control group		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
	Mean	Standard Deviation	Mean	Standard Deviation				Lower	Upper	
T0	2.21 [a]	0.51	2.35 [ac]	0.51	-0.14	0.14	0.03	-0.21	-0.07	0.0001*
T1	2.03 [ab]	0.40	2.01 [b]	0.38	0.02	0.20	0.05	-0.08	0.12	0.687
T2	1.99 [b]	0.39	2.05 [ab]	0.41	-0.06	0.15	0.03	-0.13	0.01	0.110
T3	2.18 [ab]	0.31	2.25 [abc]	0.35	-0.07	0.19	0.04	-0.16	0.02	0.101
T4	2.32 [ab]	0.32	2.45 [ac]	0.31	-0.13	0.32	0.07	-0.28	0.02	0.093
T5	2.49 [a]	0.33	2.56 [c]	0.39	-0.08	0.33	0.08	-0.23	0.08	0.330
Overall	2.20	.23	2.28	.23	-0.08	0.11	0.03	-0.13	-0.02	0.008*
P value	0.001*		0.0003*							

Significant difference as P ≤ 0.05.

Means with different superscript letters per column were significantly different as P ≤ 0.05.

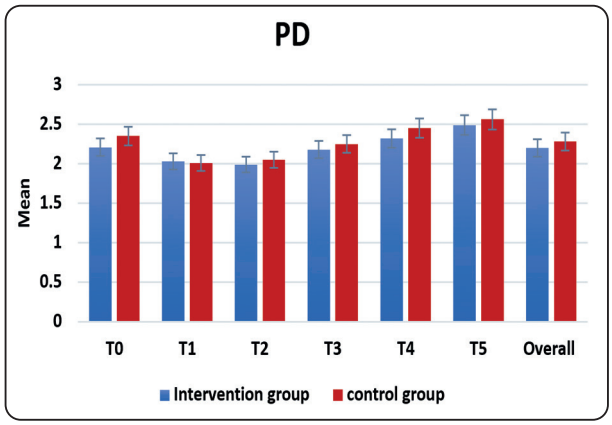

Fig. (4) Bar chart showing PD in both groups at different time points.

2. Intragroup comparison (comparison between different time points (Repeated Measures ANIOVA test):

Intragroup comparisons were conducted within each group using Repeated Measures ANOVA. **In the Intervention group**, a statistically significant change was observed across different time points (P = 0.001). The mean probing depth decreased from 2.21 ± 0.51 mm at T0 (significantly the highest) to 1.99 ± 0.39 mm at T2 (significantly the least), then increased progressively to 2.49 ± 0.33 mm at T5 (insignificantly different from T0, while T1, T3, T4 revealed insignificant differences with other time points. **Similarly, in the Control group,** Repeated Measures ANOVA revealed a statistically significant difference in probing depth over time (P = 0.0003). The mean probing depth decreased from 2.35 ± 0.51 mm at T0 to 2.01 ± 0.38 mm at T1 (significantly the least), before gradually increasing to 2.56 ± 0.39 mm at T5 (significantly the highest, with insignificant difference with T0, T3, T4) Table 1.

Marginal tissue loss:

Descriptive results of marginal tissue loss in both groups at T0 and T5 were presented in table 2 and figure 5. The comparison between the Intervention and Control groups from T0 to T5 was performed using the Wilcoxon signed-rank test. **At the buccal surface**, the mean change in bone level was 0.08 ± 0.19 mm in the Intervention group and 0.16 ± 0.29 mm in the Control group, with no statistically significant difference between them (P = 0.18). Similarly, **at the palatal surface**, the mean change was minimal, recorded at 0.04 ± 0.13 mm for the Intervention group and 0.05 ± 0.16 mm for the Control group, also without a significant difference (P = 0.32). When considering the **overall changes** across all surfaces, the mean change was 0.06 ± 0.15 mm in the Intervention group compared to 0.11 ± 0.17 mm in the Control group. This difference was not statistically significant (P = 0.14), Table 2 and Figure (5).

TABLE (2) Descriptive results of marginal tissue loss in both groups at T0 and T5, Comparison between groups using Wilcoxson signed rank test:

		Minimum	Maximum	Median	Mean	Standard Deviation	P value
Buccal	Intervention	0.00	0.50	0.00	0.08	0.19	0.18
	Control	0.00	1.00	0.00	0.16	0.29	
Palatal	Intervention	0.00	0.50	0.00	0.04	0.13	0.32
	Control	0.00	0.50	0.00	0.05	0.16	
Overall	Intervention	0.00	0.50	0.00	0.06	0.15	0.14
	Control	0.00	0.50	0.00	0.11	0.17	

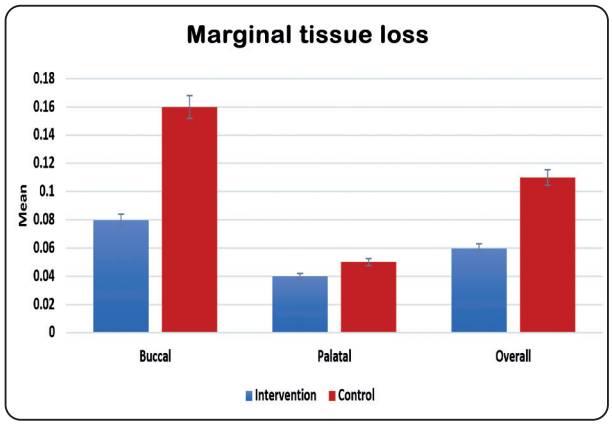

Fig. (5) Bar chart showing marginal tissue loss at different surfaces in both groups at T0 and T5.

DISCUSSION

Extended orthodontic treatment duration has been closely associated with an increased risk of periodontal complications. As treatment time lengthens, maintaining optimal oral hygiene becomes progressively more difficult, often resulting in gingival inflammation, plaque accumulation, and periodontal pocket formation(**Huang, Williams and Kyrkanides, 2014; Karakasli and Erdur, 2021**). Prolonged appliance wear can also contribute to attachment loss and alveolar bone degradation, particularly in adult patients who may already present with reduced periodontal support. These issues not only compromise periodontal health but can also negatively affect overall treatment outcomes and patient satisfaction **Nagarale et al. (2024)**. Consequently, there is growing clinical interest in accelerating orthodontic tooth movement to minimize treatment time and thereby reduce the incidence and severity of these periodontal problems.

Multiple attempts to accelerate orthodontic treatment can be stratified as invasive and noninvasive techniques to accelerate and shorten the treatment time and to prevent the related unwanted side effects. The injectable PRF is the 2nd generation of the blood concentrates and one of the most recently used adjunctive in the dentistry field in public and orthodontics in particular **Miron et al. (2024)**.

Our study was a randomized controlled split-mouth study. As RCTs are widely recognized as the most reliable study design for assessing the effectiveness of clinical interventions. Through the process of random allocation, RCTs help ensure that both known and unknown confounding variables are equally distributed between groups, thereby reducing selection bias and enhancing internal validity by allowing each participant to serve as their own control, this design minimizes the influence of inter-individual variability, such as differences in age, bone density, metabolism, and oral hygiene habits, thereby enhancing. The presence of a control group allows for precise comparison under uniform conditions, which strengthens the credibility of the observed outcomes **(Çağlı Karcı and Baka, 2021; Erdur et al., 2021b; Rokia, Hassan and Kalil, 2021; Zeitounlouian et al., 2021a, 2021b; Gupta et al., 2022; Naji et al., 2022; Priya et al., 2024)** were randomized controlled trials.

In the previously conducted studies, the PRF centrifugation protocols vary between 700 rpm centrifugal speed and 3 minutes centrifugal time **(Ibrahim *et al.*, 2020; Erdur *et al.*, 2021)**, 800 Rpm for 3 min **(Çağlı Karcı and Baka, 2021)** ,600 rpm for 8 minutes **(Rokia, Hassan and Kalil, 2021)**,1500 rpm for 10 min **(Naji *et al.*, 2022)**.In this study, the centrifuging protocol was 600 rpm, 8 minutes, and 44g based on **Choukroun and Ghanaati. (2018)** as it has the Highest concentration of platelets and leukocytes, the Greatest release of growth factors (VEGF and TGF-β1), and enhanced biological activity for wound healing and tissue regeneration.

The previously mentioned studies **(Ibrahim et al., 2020; Çağlı Karcı and Baka, 2021; Erdur et al., 2021b; Rokia, Hassan and Kalil, 2021; Zeitounlouian et al., 2021a, 2021b; Gupta et al., 2022; Naji et al., 2022; Priya et al., 2024)** evaluated the rate of tooth movement, canine rotations, alveolar bone dimensions, root length,

and the effect of injections on the daily performance of the patients.

To our knowledge, two studies reported the effect of PRF on the periodontal health **Çağlı Karcı and Baka (2021)** conducted a split-mouth randomized trial on 24 orthodontic patients undergoing maxillary canine distalization, in which one side received local PRF injections while the contralateral side served as the control. Similarly, of **Gupta et al. (2023)** evaluated periodontal health during canine retraction in a split-mouth trial involving 16 patients (mean age: 21.9 years). In their study, leukocyte-platelet-rich fibrin (L-PRF) plugs were inserted immediately into one extraction socket following premolar removal, while the opposite side healed naturally without intervention. Periodontal outcomes were monitored throughout the retraction phase in both studies.

In the present study, probing depth (PD) was recorded at six time points to assess periodontal health throughout orthodontic treatment. A statistically significant intergroup difference was observed at baseline (T0), with the control group showing a higher mean PD (2.35 ± 0.51 mm) than the intervention group (2.21 ± 0.51 mm; $P = 0.0001$). This initial difference may be attributed to the early i-PRF injection administered to the intervention group three weeks prior to extraction, potentially inducing early soft tissue modulation or anti-inflammatory effects that resulted in slightly shallower probing depths at baseline. However, no significant intergroup differences were found at any subsequent time point (T1–T5; $P > 0.05$), indicating that the intervention had no substantial influence on periodontal health during treatment. Despite this, the overall mean PD across all time points remained slightly higher in the control group (2.28 ± 0.23 mm) compared to the intervention group (2.20 ± 0.23 mm), and this difference reached statistical significance ($P = 0.008$). Nevertheless, the absolute difference (~0.08 mm) falls well within the ±0.5 mm range of normal variability associated with manual periodontal probing, and only changes of ≥2 mm in probing depth or attachment level can be considered biologically meaningful rather than measurement error, as noted by **Hefti (1997)**. Importantly, all PD values in both groups remained within the clinically healthy range (≤ 3 mm), suggesting that the i-PRF intervention had no meaningful clinical impact on periodontal status.

The findings of the current study concerning probing depth are consistent with those **of Çağlı Karcı and Baka (2021)**, who examined the effects of locally administered platelet-rich fibrin (PRF) and piezocision on orthodontic tooth movement and periodontal health. In their randomized controlled split-mouth trial, no statistically significant differences in probing depth were observed among the PRF, piezocision, and control groups over a 12-week follow-up period. Similarly, our study revealed no significant differences in probing depth between the intervention and control groups at any time point following the initiation of canine retraction. Although a statistically significant difference was noted at baseline (T0), with the control group exhibiting deeper pockets, this variation may be attributed to the pre-treatment i-PRF application administered to the intervention side three weeks before extraction. Notably, in both studies, probing depth values remained within the clinically acceptable range **(≤ 3 mm)**, and the minor temporal fluctuations did not indicate pathological pocket formation or disease progression.

The findings of the present study regarding probing depth partially align with those of **Gupta et al. (2023)**, who evaluated the effects of leukocyte-platelet-rich fibrin (L-PRF) plugs during orthodontic canine retraction. In their five-month split-mouth trial, they reported no statistically significant differences between groups, with mean probing depth increasing slightly from 2.219 ± 0.655 mm to 2.234 ± 0.664 mm in the L-PRF group and from 2.328 ± 0.629 mm to 2.375 ± 0.619 mm in the control group ($p > 0.05$). Similarly, the present study found no statistically significant intergroup differences at any time point after the initiation of

canine retraction ($p > 0.05$), except at baseline (T0), where the control group recorded a significantly higher mean probing depth (2.35 ± 0.51 mm) compared to the intervention group (2.21 ± 0.51 mm; $p = 0.0001$) possibly due to the early i-PRF application administered three weeks before extraction. Notably, the overall mean probing depth across all time points was also significantly lower in the intervention group (2.20 ± 0.23 mm) than in the control group (2.28 ± 0.23 mm; $p = 0.008$). Additionally, while both groups showed statistically significant changes in probing depth over time ($p = 0.001$ for intervention, $p = 0.0003$ for control), only the intervention group maintained a significantly lower overall mean probing depth across all time points (2.35 ± 0.38 mm vs. 2.49 ± 0.41 mm; $p = 0.008$). Despite these variations, all values remained within the clinically acceptable range (≤ 3mm), indicating stable periodontal conditions.

Marginal tissue loss was assessed at two time points (T0 and T5) to evaluate the soft tissue response to orthodontic retraction. The results demonstrated minimal changes in both groups, with no statistically significant differences detected at any examined surface. On the buccal surface, the mean change was 0.08 ± 0.19 mm in the intervention group versus 0.16 ± 0.29 mm in the control group ($P = 0.18$). Palatal surface changes were similarly limited, with mean values of 0.04 ± 0.13 mm and 0.05 ± 0.16 mm for the intervention and control groups, respectively ($P = 0.32$). When evaluating total marginal tissue loss across all surfaces, the intervention group exhibited a mean of 0.06 ± 0.15 mm, compared to 0.11 ± 0.17 mm in the control group ($P = 0.14$). Clinically, these results are reassuring, as all values remained within normal limits and showed no evidence of gingival recession in either group. The subtle differences observed likely reflect physiological remodeling rather than pathological changes. Furthermore, the comparable outcomes across groups suggest that injectable PRF does not exert a significant effect, either protective or adverse, on marginal tissue stability during orthodontic retraction.

CONCLUSION

- The application of injectable platelet-rich fibrin (i-PRF) demonstrated a statistically significant reduction in mean probing depth over the treatment period compared to the control group. However, no significant differences were observed between groups at individual time points beyond baseline, and probing depth values in both groups returned to levels comparable to baseline by the end of the observation period. Importantly, all probing depth measurements remained within the clinically healthy range (≤ 3 mm), indicating no pathological pocket formation in either group.
- Despite statistical significance, the observed differences are unlikely to represent meaningful clinical improvement.
- i-PRF did not result in any statistically or clinically significant reduction in marginal tissue loss on either buccal or palatal surfaces.
- These findings suggest that while i-PRF may exert a transient influence on soft tissue response, its long-term benefits in preserving probing depth or preventing marginal tissue loss during orthodontic tooth movement remain limited. Further studies with larger sample sizes and longer follow-up periods are warranted to validate these observations

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