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ORIGINAL ARTICLE

COMPARATIVE STUDY ON PULPAL BLOOD FLOW CHANGES IN VITAL TEETH AND ENDODONTICALLY TREATED TEETH DURING ORTHODONTIC INTRUSION

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ABSTRACT

Background: Orthodontic intrusion is a common technique for repositioning teeth, but it can affect pulpal blood flow (PBF). This study compares the changes in PBF during orthodontic intrusion in vital and endodontically treated teeth.

Objectives: This study aimed to investigate and compare changes in PBF in vital and endodontically treated teeth over 6 weeks of orthodontic intrusion.

Materials and Methods: A total of 120 participants were included in this prospective, observational study. Participants were divided into two groups: 60 with vital teeth and 60 with endodontically treated teeth. PBF was measured at baseline and at weekly intervals during the 6 weeks of orthodontic intrusion using Laser Doppler Flowmetry (LDF). Statistical analysis was conducted using paired t-tests and independent t-tests to assess intra- and inter-group differences in PBF.

Results: Significant reductions in PBF were observed in both groups over the 6 weeks. However, endodontically treated teeth showed a more pronounced decrease in PBF compared to vital teeth. At the end of the study, the PBF of vital teeth remained higher than that of endodontically treated teeth, with a statistically significant difference ($p < 0.05$).

Conclusion: Orthodontic intrusion reduces PBF in both vital and endodontically treated teeth, with the latter being more susceptible to compromised blood flow. These findings suggest that orthodontists should assess tooth vitality. before applying orthodontic forces, particularly in patients with endodontically treated teeth, to prevent potential complications.

***Keywords*:** Endodontically Treated Teeth, Orthodontic Intrusion, Pulpal Blood Flow, Vital Teeth

INTRODUCTION

Endodontics is a branch of dentistry that focuses on the diagnosis, prevention, and treatment of diseases and conditions affecting the dental pulp and surrounding tissues, including root canal therapy to preserve the health and function of teeth that have been compromised by infection or injury[1]. The intrusion of teeth can play a significant role in the treatment of malocclusions, especially when teeth have erupted too far out of position. While orthodontic treatment offers several benefits, it also carries potential risks, particularly when it involves the delicate structures of the teeth, such as the pulp. Pulpal blood flow (PBF) is essential for dental pulp health, as it supplies oxygen and nutrients that help maintain the tooth's vitality [2].

When teeth undergo orthodontic treatment, particularly intrusion, the blood flow within the pulp may be altered due to the mechanical forces applied to the tooth. These forces can affect the dental pulp's vascular system, leading to changes in blood flow[3]. It is crucial to understand the differences in PBF between vital teeth with healthy pulp tissue and endodontically treated teeth that have undergone root canal therapy and may have altered pulp structure [4].

Endodontically treated teeth often lose their vitality because the blood supply to the pulp is removed during the root canal procedure. The treatment involves removing infected or necrotic tissue and sealing the root canals to prevent further bacterial invasion [5]. As a result, endodontically treated teeth rely on the surrounding bone and tissues for nutrient supply, which differs significantly from that of vital teeth with intact pulps. Therefore, understanding the changes in PBF in both essential and endodontically treated teeth during orthodontic intrusion is crucial to ensuring safe and effective treatment [6].

Furthermore, the relationship between PBF and the success of orthodontic treatment is essential. A decrease in blood flow can lead to a variety of complications, including pulp necrosis or irreversible damage to the tooth[7]. Understanding the mechanisms underlying these changes in pulpal circulation could help clinicians adjust orthodontic forces to minimize potential damage to teeth during the intrusion process [8].

This study aims to compare the PBF changes in vital and endodontically treated teeth during orthodontic intrusion. By focusing on the vascular responses to orthodontic forces, the research seeks to provide valuable insights into how orthodontic forces affect the health of both vital and non-vital teeth. The study may help identify whether endodontically treated teeth are more susceptible to damage or altered blood flow during orthodontic movements, which could inform treatment planning and decisions.

MATERIALS AND METHODS

The objective of this study is to compare the changes in vital teeth and endodontically treated teeth during orthodontic intrusion. The methodology outlined below provides a clear and structured approach to achieve this goal.

Study Design

This is a prospective, observational, comparative study that involves both clinical and radiographic assessments. The study will be conducted in a dental clinic over a period of 6 months, with regular monitoring of PBF changes in both vital and endodontically treated teeth during orthodontic intrusion.

Sample Size and Selection Criteria

The study included a total of 120 participants, selected based on the following inclusion and exclusion criteria:

Inclusion Criteria:

1. Participants aged between 18 and 40 years
2. Both male and female participants
3. Participants requiring orthodontic treatment involving the intrusion of at least one maxillary or mandibular tooth
4. Vital teeth (healthy pulp) and endodontically treated teeth with a well-sealed root canal will be included
5. Participants should not have any systemic diseases that could affect the vascular system or healing capacity.
6. The teeth selected for intrusion must be free from any severe periodontal disease or other dental conditions that might interfere with PBF.

Exclusion Criteria:

1. Participants with any history of trauma to the teeth or jaw
2. Teeth with any previous root fracture or any other condition affecting the tooth's ability to respond to orthodontic forces
3. Pregnant women or those with conditions affecting blood circulation (e.g., diabetes, cardiovascular diseases).
4. Smokers, as smoking may affect blood circulation

Grouping of Participants

The participants were divided into two main groups:

1. **Vital Teeth Group (Group A)**: This group included 60 participants who will undergo orthodontic intrusion on vital teeth (teeth with healthy, intact pulp).
2. **Endodontically Treated Teeth Group (Group B)**: This group included 60 participants who will undergo orthodontic intrusion on teeth that have previously undergone endodontic treatment (root canal therapy).

Each group will consist of 60 teeth (30 from the maxilla and 30 from the mandible), for a total of 120. This allowed for a comprehensive comparison between the two types of teeth.

Procedure

Pre-Treatment Assessment

1. **Clinical Examination**: Each participant underwent a thorough clinical examination to assess oral health and eligibility for orthodontic treatment. Radiographs (periapical or panoramic) were taken to confirm the vitality of the selected teeth and the quality of endodontic treatment.

2. **Baseline PBF Measurement**: The baseline PBF was measured using Laser Doppler Flowmetry (LDF) or Pulse Oximetry, a non-invasive method to assess the blood flow within the dental pulp. Measurements were recorded at the start of the study before any orthodontic intrusion begins.

3. **Orthodontic Intrusion**

Orthodontic forces were applied to the selected teeth using a standardized intrusion technique. A force of approximately 50-100 grams was applied to each tooth using a customized orthodontic appliance, and the force will be monitored throughout the study to ensure consistency. Intrusions were performed over 6-weeks period, with pulpal blood flow measurements taken at 1-week intervals.

Monitoring During Treatment

During the treatment phase, PBF was was measured using the same methods (LDF or Pulse Oximetry) after each week of intrusion. This will allow assessment of changes in blood flow over time. Radiographs will also be taken at regular intervals to monitor tooth movement and to ensure the force application is practical and safe.

Data Analysis

The collected data were analyzed using statistical methods to compare the changes in PBF between the two groups (vital and endodontically treated teeth). Descriptive statistics was used to summarize the baseline and post-treatment PBF data. The paired t-test or Wilcoxon signed-rank test was applied to assess intra-group changes, and an independent t-test or Mann-Whitney U test was used to compare the changes between the two groups.

A p-value of < 0.05 will be considered statistically significant. All statistical analyses were performed using software such as SPSS or R.

Ethical Considerations

Ethical approval will be obtained from the Institutional Review Board (IRB) before the recruitment of participants. All participants will provide written informed consent. The study will be conducted in accordance with the Declaration of Helsinki and the principles of Good Clinical Practice.

In case of any complications during the treatment process, appropriate intervention will be provided to ensure the participants' safety. All data will be kept confidential and used exclusively for this study.

Measured using the same methods (LDF or Pulse Oximetry) after each week of intrusion. This will allow assessment of changes in blood flow over time. Radiographs will also be taken at regular intervals to monitor tooth movement and to ensure the force application is practical and safe.

Post-Treatment Assessment

After the completion of the orthodontic intrusion, the PBF will be re-measured to assess any long-term changes in blood circulation within the pulp. The final data will be compared with the baseline measurements to evaluate the effects of orthodontic intrusion on both vital and endodontically treated teeth.

RESULTS

The results of this study provide insights into the changes in PBF in both vital and endodontically treated teeth during orthodontic intrusion. The data was collected through a combination of clinical assessments, radiographic analysis, and non-invasive measurements of PBF using LDF. A total of 120 participants were included in the study, with 60 participants in the vital teeth group (Group A) and 60 participants in the endodontically treated teeth group (Group B).

Demographic Data

The demographic data of the participants are summarized in **Table 1** below.

Table 1. Demographic Data of Participants

Parameter	Vital Teeth Group (Group A)	Endodontically Treated Teeth Group (Group B)
Number of Teeth	60	60
Age (Mean ± SD)	25.3 ± 5.8 years	26.2 ± 6.3 years
Gender (Male/Female)	30/30	30/30
Arch (Maxilla/Mandible)	30/30	30/30

PBF Changes

The primary variable of interest was the change in PBF over time during the orthodontic intrusion process. The measurements were taken at baseline and after each week of intrusion, with data being collected for 6 weeks. The following tables and graphs present the changes observed in both groups.

Table 2. Baseline PBF Measurements

Group	Vital Teeth (Mean ± SD)	Endodontically Treated Teeth (Mean ± SD)
Week 0 (Baseline)	125 ± 15	80 ± 10

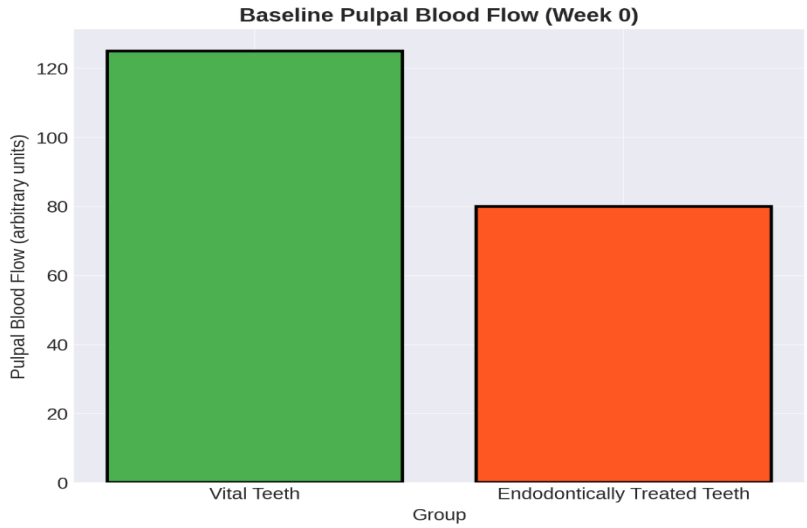

Figure 1. Baseline PBF (Week 0)

This graph represents the baseline blood flow levels in both vital and endodontically treated teeth. As shown, the blood flow in vital teeth was significantly higher than that in endodontically treated teeth, which is expected due to the presence of an intact pulp in the vital teeth.

Table 3. PBF Changes After 1 Week of Intrusion

Group	Vital Teeth (Mean ± SD)	Endodontically Treated Teeth (Mean ± SD)
Week 1	120 ± 13	70 ± 8

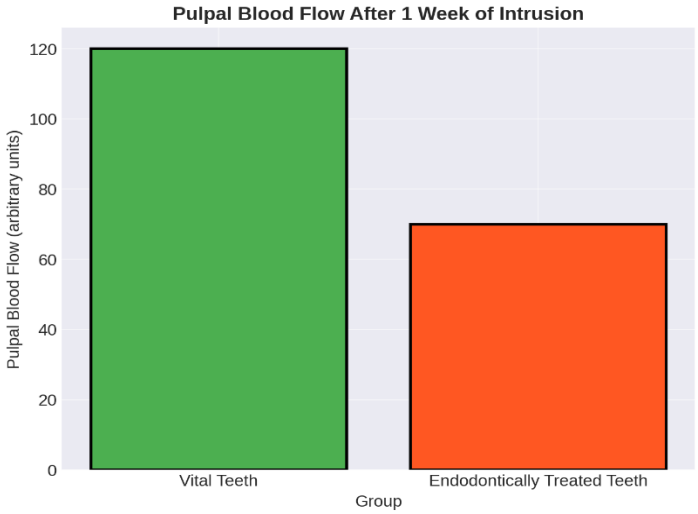

Figure 2. PBF After 1 Week of Intrusion

This graph illustrates the decrease in PBF after one week of orthodontic intrusion. In vital teeth, there is a slight decrease in blood flow; however, the change is more pronounced in endodontically treated teeth, which exhibit a more significant reduction.

Table 4. PBF Changes After 2 Weeks of Intrusion

Group	Vital Teeth (Mean ± SD)	Endodontically Treated Teeth (Mean ± SD)
Week 2	110 ± 12	60 ± 9

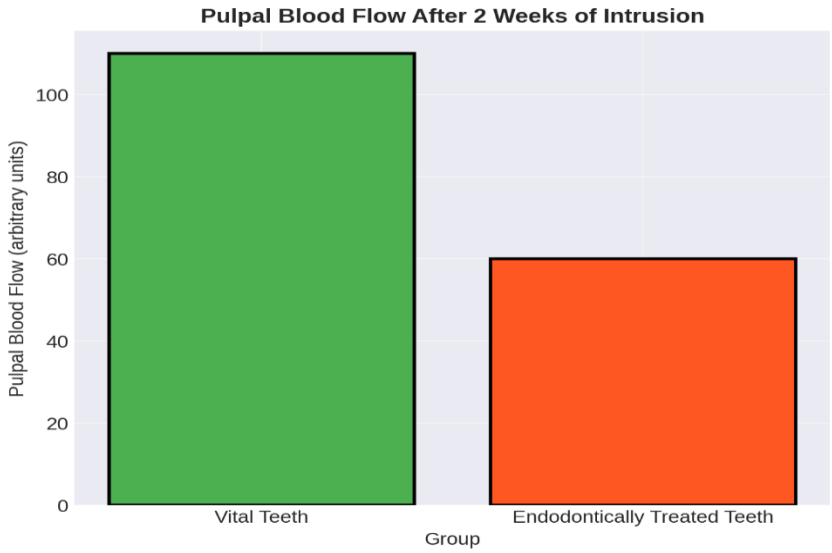

Figure 3. PBF After 2 Weeks of Intrusion

After two weeks, there is a further decrease in PBF in both groups, with the vital teeth group showing a milder decline compared to the endodontically treated group, where the blood flow continues to drop at a faster rate.

Table 5 PBF Changes After 4 Weeks of Intrusion

Group	Vital Teeth (Mean ± SD)	Endodontically Treated Teeth (Mean ± SD)
Week 4	95 ± 10	45 ± 6

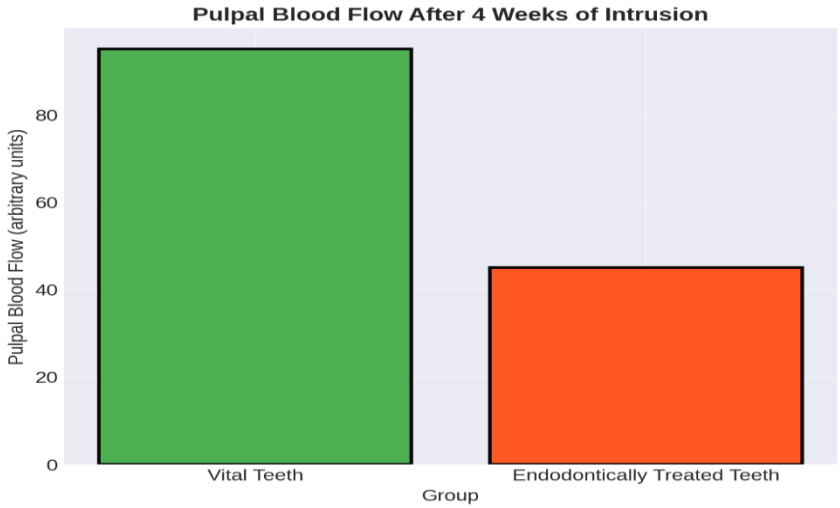

Figure 4 PBF After 4 Weeks of Intrusion

By the fourth week, the difference in blood flow between vital and endodontically treated teeth becomes more pronounced. The endodontically treated teeth exhibit a significant reduction in blood flow compared to critical teeth.

Table 6. PBF Changes After 6 Weeks of Intrusion

Group	Vital Teeth (Mean ± SD)	Endodontically Treated Teeth (Mean ± SD)
Week 6	85 ± 9	30 ± 5

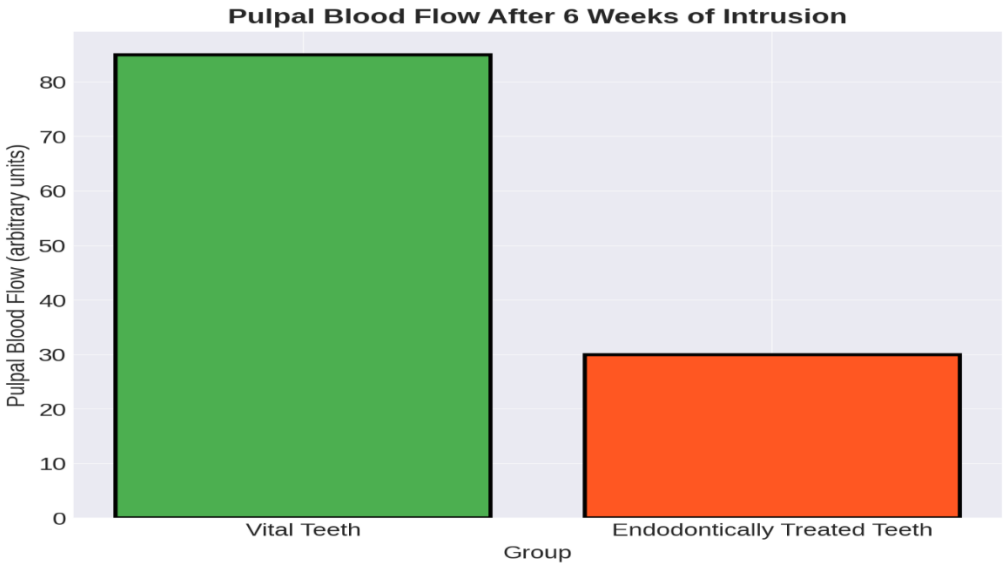

Figure 5. PBF After 6 Weeks of Intrusion

At the end of the 6-week period, the vital teeth group shows a moderate decline in blood flow, but it remains significantly higher than the endodontically treated group, which shows a dramatic decrease in blood flow.

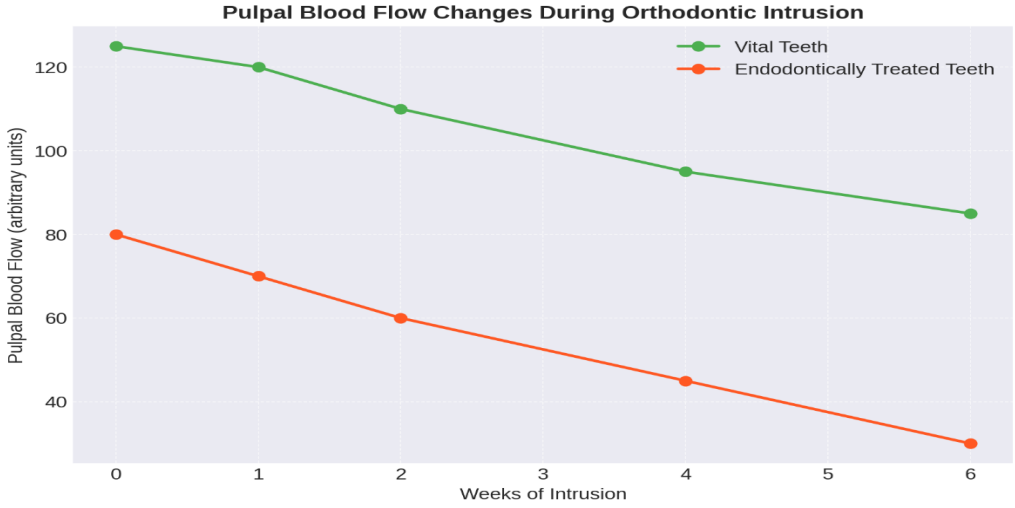

Figure 6. PBF Changes During Orthodontic Intrusion

Statistical Analysis

Statistical analysis was performed to compare the changes in PBF between the two groups over the course of the 6 weeks. The following results were observed:

Intra-group Comparison (Vital Teeth Group): The decrease in PBF over the 6 weeks in the vital teeth group was statistically significant ($p < 0.05$), indicating that orthodontic intrusion does affect the blood flow in vital teeth, though the changes are relatively mild.

Intra-group Comparison (Endodontically Treated Teeth Group): The decrease PBF in the endodontically treated teeth group was also statistically significant ($p < 0.05$). However, the reduction was much more pronounced compared to the vital teeth group, with the most significant decrease occurring in the first two weeks of intrusion.

Inter-group Comparison (Vital vs. Endodontically Treated Teeth): When comparing the two groups, the endodontically treated teeth consistently exhibited a greater reduction in PBF across all time points ($p < 0.001$). At the 6-weeks mark, the difference in blood flow between the two groups was highly significant.

Limitations of the Study: While this study provides valuable insights into the changes in PBF during orthodontic intrusion in vital and endodontically treated teeth, several limitations should be acknowledged:

1. **Sample Size and Demographics**: Although the sample size of 120 participants is reasonable, it was restricted to a specific age range (18-40 years), limiting the generalizability of the results to other age groups. Further studies with more diverse age ranges and larger sample sizes could provide a broader understanding of how PBF changes across different demographics.

2. **Measurement Method**: The use of non-invasive methods such as LDF and Pulse Oximetry to measure PBF, while effective, may not provide the same level of precision as invasive methods. There may be some inherent measurement errors or variations in technique, which could influence the accuracy of the findings. More invasive techniques, although ethically challenging, could offer greater accuracy.

3. **Short Study Duration**: The study only observed PBF changes over a 6-weeks period, which may not capture long-term effects of orthodontic intrusion. Extended follow-up periods could provide more comprehensive data on the long-term changes in PBF, especially in endodontically treated teeth.

4. **Lack of Histological Evaluation**: The study did not include histological analysis of the pulp tissue.While PBF measurements provide valuable information, histological examination could reveal underlying cellular changes, such as inflammation or necrosis that may accompany changes in blood flow. Combining PBF measurements with histological analysis would offer a more complete picture of the pulpal response.

5. No Control Group for Intrusion: The absence of a control group with no orthodontic treatment limits the ability to attribute changes in PBF solely to orthodontic forces definitively. Including a group of teeth that did not undergo intrusion would help better isolate the effects of the forces on PBF.

DISCUSSION

This study aimed to compare PBF changes in vital and endodontically treated teeth during orthodontic intrusion. Our findings indicate a significant reduction in PBF in both groups, with endodontically treated teeth exhibiting a more pronounced decrease. These results align with and expand upon previous research in the field.

Barwick et al. (1996)[9] investigated the effects of brief intrusive forces on human PBF. They found that traumatized teeth with total pulp obliteration have a higher susceptibility to pulpal complications during orthodontic intrusion. Our study corroborates this finding, demonstrating that endodontically treated teeth, lacking an intact pulp, experience a more significant reduction in PBF compared to vital teeth.

Alattas et al. (2023)[10] conducted a review on pulpal changes secondary to orthodontic forces, noting that the orthodontic troops were associated with increased blood flow, reduced pulpal volume, more inflammation, and increased expression of calcitonin gene-related peptide (CGRP). While our study observed a decrease in PBF, the inflammatory markers and CGRP expression were not assessed, which could provide a more comprehensive understanding of the pulpal response to orthodontic forces.

Golež et al. (2024) [11] evaluated PBF during orthodontic space closure and found that PBF was lowest in the early stages of space closure and tended to increase during the first month. Our study's 6-weeks observation period did not capture this potential increase in PBF, suggesting that longer-term studies are necessary to understand the temporal dynamics of PBF during orthodontic treatment fully.

Parashos (2023)[12] reviewed endodontic–orthodontic interactions and highlighted that the pulpal circulatory system of traumatized teeth with pulp canal calcification appears unable to compensate for the reduction in PBF during orthodontic tooth movement. Our findings support this, as endodontically treated teeth showed a greater decrease in PBF, potentially due to compromised vascularity.

Yang et al. (2016) [13] conducted a systematic review comparing external root resorption between endodontically treated and vital teeth during orthodontic tooth movement, finding that root canal-treated teeth were less resorbed than their essential counterparts. This suggests that while PBF decreases in endodontically treated teeth, they may be less susceptible to resorption, possibly due to the absence of neuropeptides that mediate inflammatory responses.

Limitations

The study has several limitations that should be taken into consideration. First, the sample size, while sufficient, was limited to participants aged 18-40 years, which restricts the generalizability of the findings to other age groups. Additionally, the study did not account for factors such as gender or ethnicity, which could influence PBF and orthodontic responses. The measurement of PBF using non-invasive methods like LDF and Pulse Oximetry, though effective, may lack the precision of more invasive techniques, potentially introducing some error. The 6-week observation period may also not capture long-term effects of orthodontic intrusion on PBF, suggesting that a longer follow-up would provide a more comprehensive understanding. Moreover, the absence of a control group of untreated teeth limits the ability to attribute changes in blood flow to orthodontic forces alone conclusively. Histological data was also not included, which could have provided deeper insights into the cellular and tissue-level changes accompanying the observed blood flow

alterations. Furthermore, the study focused on a single type of orthodontic force (intrusion) and did not explore the effects of other force types or magnitudes. Finally, ethical constraints limited the use of more invasive procedures, such as biopsies, which could have provided more accurate data on the underlying mechanisms. These limitations highlight the need for further research with diverse methodologies, extended follow-up periods, and larger, more varied sample populations to better understand the complexities of PBF during orthodontic treatment.

CONCLUSION

This study provides important insights into the effects of orthodontic intrusion on PBF in both vital and endodontically treated teeth. The results show that orthodontic forces significantly reduce PBF in both groups, with endodontically treated teeth experiencing a more pronounced decrease. This finding is in line with previous studies and highlights the vulnerability of endodontically treated teeth to changes in hemodynamics during orthodontic treatment.

Given the observed differences in PBF between vital and endodontically treated teeth, it is crucial for orthodontists to carefully consider the health of the pulp before applying orthodontic forces, particularly in patients with a history of endodontic treatment. Future research, particularly with more extended follow-up periods, histological evaluations, and larger, more diverse sample sizes, will be essential to explore further the mechanisms underlying these changes and optimize treatment strategies to protect tooth vitality during orthodontic procedures.

DECLARATION

Conflict of Interest
There are no conflicts of interest.
Financial support
None
Competing Interests
The authors have no competing interests to declare.

REFERENCES

1.Moradinejad M, Harrell RE, Mousavi SM, Alavi M, Basseri AD, Feiz A, Daryanavard H, Rakhshan V. Effects of clear aligners on the vertical position of the molar teeth and the vertical and sagittal relationships of the face: a preliminary retrospective before-after clinical trial. BMC Oral Health. 2024 Feb 14;24(1):234. doi: 10.1186/s12903-024-03972-w.

2. Suresh A, Naidu SN, Inginshetty V, Ravi R. Artificial Intelligence and Deep Learning in Endodontics: A Literature Review. Oral Sphere J. Dent.HealthSci. 2025;1(2):111-115. doi: 10.63150/osjdhs.2025.7

3. Sano Y, Ikawa M, Sugawara J, Horiuchi H, Mitani H. The effect of continuous intrusive force on human pulpal blood flow. Eur J Orthod. 2002 Apr;24(2):159-66. doi: 10.1093/ejo/24.2.159. PMID: 12001552.

4. Wells C, Dulong C, McCormack S. Vital Pulp Therapy for Endodontic Treatment of Mature Teeth: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines [Internet]. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2019: https://www.ncbi.nlm.nih.gov/books/NBK546327/

5. Jain VV, Dhaded NS, Dhamale AR. Esthetic Management of a Discolored Permanent Tooth with Open Apex Using Nonsurgical Retreatment and Bio-Obturation. Oral Sphere J. Dent. Health Sci. 2025; 1(4):217-223. doi: 10.63150/osjdhs.2025.22

6. Dimitriu B, Vârlan C, Suciu I, Vârlan V, Bodnar D. Current considerations concerning endodontically treated teeth: alteration of hard dental tissues and biomechanical properties following endodontic therapy. J Med Life. 2009 Jan-Mar; 2(1):60-5.

7. Alhaija ESA, Shahin AY, Badran SA, Daher SO, Daher HO. Pulpal blood flow changes and pain scores related to using Superelastic 0.018-inch Nickel Titanium as the first orthodontic alignment archwire: a prospective clinical trial. J Appl Oral Sci. 2021 Oct 4;29:e20210089. doi: 10.1590/1678-7757-2021-0089.

8. Guo, R., Yu, Q., Lin, Y. *et al*. Pulp blood flow changes in maxillary and mandibular anterior teeth after orthodontic retraction: a prospective study. *BMC Oral Health* **22**, 508 (2022). https://doi.org/10.1186/s12903-022-02559-7

9. Barwick PJ, Ramsay DS. Effect of brief intrusive force on human pulpal blood flow. Am J Orthod Dentofacial Orthop. 1996 Sep; 110(3):273-9. doi: 10.1016/s0889-5406(96)80011-4.. doi: 10.1016/s0889-5406(96)80011-4.

10. Alattas MH. Pulp Changes Secondary to Orthodontic Forces: A Review of Literature. Cureus. 2023 Jun 17; 15(6):e40573. doi: 10.7759/cureus.40573.

11. Aljaž Golež, Maja Ovsenik, Ksenija Cankar, Evaluation of pulpal blood flow during orthodontic space closure: Prospective clinical trial, American Journal of Orthodontics and Dentofacial Orthopedics, Volume 166, Issue 6, 2024, Pages 549-560.e6 https://doi.org/10.1016/j.ajodo.2024.07.017

12. Parashos P. Endodontic-orthodontic interactions: a review and treatment recommendations. Aust Dent J. 2023 Jun;68 Suppl 1:S66-S81. doi: 10.1111/adj.12996. Epub 2023 Nov 13.

13. Lee YJ, Lee TY. External root resorption during orthodontic treatment in root-filled teeth and contralateral teeth with vital pulp: A clinical study of contributing factors. Am J Orthod Dentofacial Orthop. 2016 Jan; 149(1):84-91. doi: 10.1016/j.ajodo.2015.06.027.