DOI: https://doi.org/10.53350/pjmhs2023176566

ORIGINAL ARTICLE

Histo-Pathological Evaluation of Gingival Changes in Patients Undergoing Orthodontic Treatment

FARHAN ALI[1], ZUBAIR AHMED[2], SUMAN MUHAMMAD WAZIR[3], USMAN YOUSAF[4], ABID HUSSAIN KANJU[5], TAIMUR KHAN[6]
[1]*Assistant Professor, Dept of Orthodontics, Multan Medical & Dental College, Multan, Pakistan.*
[2]*Associate Professor, Dept of Orthodontics, CIMS Dental College, Multan,Pakistan.*
[3]*Lecturer, Department of Oral Pathology, IPDM, Khyber Medical University, Peshawar*
[4]*Assistant Professor, Dept of Orthodontics, University College of Medicine & Dentistry, The University of Lahore, Lahore, Pakistan.*
[5]*Assistant Professor, Dept of Orthodontics Nishtar Institute of Dentistry, Multan,Pakistan.*
[6]*Associate Professor Dept of Orthodontics Frontier Medical And Dental College, Abbottabad*
Correspondence to: Farhan Ali, farhanali9994@gmail.com

ABSTRACT

Background: To evaluate histopathological alterations in gingival tissue, particularly chronic inflammatory changes and any signs of epithelial dysplasia, in patients undergoing fixed orthodontic treatment.

Methods: This cross-sectional study included 71 patients receiving fixed orthodontic therapy at a dental teaching hospital. Gingival tissue biopsies were collected from areas of clinical inflammation. Histological assessment included analysis of epithelial hyperplasia, inflammatory cell infiltration, fibrosis, vascular changes, and dysplasia. Data were analyzed using SPSS, and associations were examined with chi-square tests.

Results: Chronic inflammatory features were commonly observed. Epithelial hyperplasia was present in 70.4% of samples, while severe inflammatory infiltrates were seen in 52.1%. Fibrosis, hyperkeratosis, and vascular proliferation were also frequent findings. Importantly, no epithelial dysplasia was identified. A significant association was noted between duration of treatment and severity of inflammation ($p = 0.018$).

Conclusion: Fixed orthodontic appliances are associated with significant chronic gingival inflammation and epithelial remodeling. However, no evidence of precancerous epithelial dysplasia was observed. Regular monitoring and improved oral hygiene practices are recommended to minimize periodontal complications during orthodontic care.

Keywords: Orthodontic treatment, gingival inflammation, epithelial hyperplasia, epithelial dysplasia, histopathology, fixed appliances, chronic inflammation.

INTRODUCTION

Orthodontic therapy is an essential component of modern dental care, addressing malocclusion and improving both function and esthetics. However, the use of fixed appliances introduces new challenges for maintaining periodontal health. Brackets, wires, and bands create additional surfaces for plaque retention, often resulting in gingival inflammation, enlargement, and altered tissue architecture over the course of treatment[1-3].

The response of the gingival tissues to orthodontic mechanical forces is multilayered, spanning both biomechanical and biological dimensions. Although inflammatory responses are typically managed and reversed following the removal of appliances, chronic irritation results in progressive deeper tissue remodeling. Some of the features routinely observed include the thickening of epithelium, fibrotic changes, and the presence of inflammatory cells. Despite this, the potential for these changes to advance to epithelial dysplasia, a precursory form to malignant conditions, raises concern, particularly for individuals with prolonged use of appliances[4-6].

Evaluating the histopathology of gingival tissues profoundly deepens our understanding of the changes that occur within them, particularly their types and levels. Determining whether these changes are solely response mechanisms or possibly pre-neoplastic alterations is important for risk evaluation and management of the patient[7-9].

This study was designed to investigate the histopathological changes in gingival biopsies from patients undergoing fixed orthodontic treatment, with a particular focus on detecting chronic inflammation and any evidence of epithelial dysplasia.

METHODOLOGY

This cross-sectional study was conducted at the Department of Oral Pathology, Frontier Medical and Dental College, over a period of one year, from January 2022 to January 2023. The objective was to assess histopathological changes, particularly chronic inflammation and any evidence of epithelial dysplasia, in gingival tissues of patients undergoing orthodontic treatment. Ethical approval for the study was obtained from the Institutional Review Board of Frontier Medical and Dental College prior to data collection. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki.

A total of 71 patients were enrolled in the study using non-probability purposive sampling. All participants were undergoing fixed orthodontic treatment at the time of recruitment. Inclusion criteria required participants to be between 15 and 35 years of age, with a minimum of three months of continuous appliance use. Patients with systemic diseases, on medications affecting periodontal health, or with a history of tobacco use were excluded to eliminate confounding factors.

Following informed consent, clinical examination was conducted to assess gingival status, including presence of gingival enlargement, bleeding on probing, and plaque accumulation. Oral hygiene status was recorded using the Plaque Index and Gingival Index. Based on clinical assessment, gingival tissue samples were obtained from the labial interdental papillae, particularly in areas showing visible inflammation or hypertrophy.

Biopsy specimens were fixed in 10% buffered formalin and processed using standard paraffin embedding techniques. Sections of 4–5 micrometers thickness were cut and stained with hematoxylin and eosin (H&E). Histopathological examination was performed under light microscopy by an experienced oral pathologist who was blinded to the clinical status of the patients.

The tissue samples were evaluated for specific histological parameters, including: Epithelial hyperplasia, Inflammatory cell infiltrate (graded as mild, moderate, or severe), Connective tissue fibrosis, Keratinization patterns (normal or hyperkeratosis), Vascular proliferation and Epithelial dysplasia

The presence or absence of these changes was noted for each sample. Particular attention was given to detecting any dysplastic features, including nuclear pleomorphism, hyperchromatism, increased mitotic activity, and disordered epithelial stratification.

Data were entered and analyzed using SPSS version 25. Categorical variables were expressed as frequencies and percentages. The chi-square test was used to assess the association between duration of orthodontic treatment and severity of histopathological changes. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Among the 71 patients undergoing orthodontic treatment, the majority were aged between 19 and 25 years (52.1%), followed by those ≤18 years (28.2%) and >25 years (19.7%). There was a nearly equal gender distribution with 36 males (50.7%) and 35 females (49.3%). Most patients had been receiving orthodontic treatment for 6–12 months (43.7%), while 32.4% had undergone treatment for less than 6 months.

Table 1: Demographic Characteristics of Patients (n=71)

Variable	Category	Frequency (n)	Percentage (%)
Age Group	≤18 years	20	28.2%
	19–25 years	37	52.1%
	>25 years	14	19.7%
Gender	Male	36	50.7%
	Female	35	49.3%
Duration of Treatment	<6 months	23	32.4%
	6–12 months	31	43.7%
	>12 months	17	23.9%

Gingival enlargement was present in 54 patients (76.1%), while bleeding on probing was noted in 61 participants (85.9%). Most patients showed a moderate gingival index score (57.7%) and a fair oral hygiene status (66.2%).

Table 2: Clinical Findings Related to Gingival Status

Variable	Category	Frequency (n)	Percentage (%)
Gingival Enlargement	Yes	54	76.1%
	No	17	23.9%
Bleeding on Probing	Present	61	85.9%
	Absent	10	14.1%
Gingival Index	Mild	15	21.1%
	Moderate	41	57.7%
	Severe	15	21.1%
Oral Hygiene	Good	9	12.7%
	Fair	47	66.2%
	Poor	15	21.1%

Histopathological evaluation revealed that epithelial hyperplasia was observed in 70.4% of samples, indicating increased epithelial cell turnover possibly due to chronic mechanical stimulation from orthodontic appliances. Inflammatory infiltrates were highly prevalent, with 52.1% showing severe inflammation and 36.6% moderate, confirming the chronic inflammatory nature of gingival changes in this population. Connective tissue fibrosis was seen in 40.8% of cases, while hyperkeratosis and vascular proliferation were found in 38% and 56.3% of samples respectively, all consistent with chronic inflammatory responses.

Importantly, no epithelial dysplasia was detected in any of the 71 biopsies, even among patients with long-term appliance use exceeding 12 months. This finding suggests that although long-standing orthodontic treatment induces chronic gingival inflammation and epithelial remodeling, it does not appear to promote precancerous dysplastic changes in gingival tissues.

Table 3: Histopathological Findings in Gingival Biopsies (n = 71)

Parameter	Finding	Frequency (n)	Percentage (%)
Epithelial Hyperplasia	Present	50	70.4%
	Absent	21	29.6%
Inflammatory Infiltrate	Mild	8	11.3%
	Moderate	26	36.6%
	Severe	37	52.1%
Connective Tissue Fibrosis	Present	29	40.8%
	Absent	42	59.2%
Keratinization Pattern	Normal	44	62.0%
	Hyperkeratosis	27	38.0%
Vascular Proliferation	Present	40	56.3%
	Absent	31	43.7%
Epithelial Dysplasia	Present	0	0.0%
	Absent	71	100.0%

A statistically significant association was observed between the duration of orthodontic treatment and severity of inflammatory infiltrate ($p = 0.018$). Patients undergoing treatment for more than 12 months showed a higher frequency of severe inflammation compared to those treated for shorter durations.

Table 4: Association Between Treatment Duration and Inflammatory Severity

Duration of Treatment	Mild	Moderate	Severe	p-value
<6 months	5	10	8	
6–12 months	2	9	20	
>12 months	1	7	9	0.018*

*Statistically significant ($p < 0.05$)

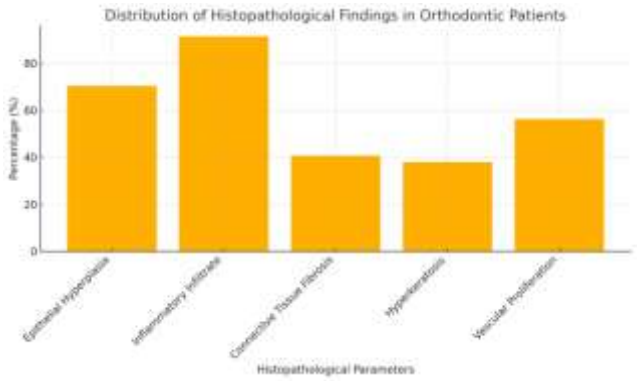

Figure 1: bar graph showing the percentage distribution of key histopathological findings in patients undergoing orthodontic treatment.

DISCUSSION

This study aimed to explore the histopathological alterations in gingival tissues of patients undergoing orthodontic treatment, with a specific focus on chronic inflammation and epithelial dysplasia. The findings confirmed that long-term use of fixed orthodontic appliances is associated with significant gingival changes, particularly chronic inflammatory responses.

The presence of epithelial hyperplasia in over 70% of cases aligns with previous observations that mechanical irritation from orthodontic brackets and wires stimulates epithelial proliferation[10-12]. This reaction can be considered a protective adaptation to persistent irritation, yet may also contribute to gingival thickening and hypertrophy frequently observed during treatment.

One of the most striking findings was the high prevalence of inflammatory cell infiltrates, with 52.1% of biopsies showing severe infiltration. This was consistent with the studies, whom demonstrated that gingival inflammation is common in orthodontic patients due to plaque retention around brackets and bands[13,14]. In a similar studies, gingival tissues exhibited chronic inflammation characterized by lymphocytic infiltration and fibrosis, findings echoed in the current study where fibrosis was detected in 40.8% of samples[15-17].

Vascular proliferation, another marker of chronic irritation, was seen in more than half the cases (56.3%). This angiogenic response supports the concept of ongoing tissue remodeling during orthodontic treatment, as reported by studies, who emphasized the role of microvascular changes in periodontal adaptation[18].

Importantly, no evidence of epithelial dysplasia was found in any of the 71 samples. This finding is reassuring and suggests that while chronic inflammation is a common outcome of prolonged appliance use, it does not appear to predispose the gingival epithelium to precancerous transformation. This is in line with the conclusions drawn by studies, who also failed to detect dysplastic changes in orthodontic-related gingival hyperplasia[19].

Furthermore, the significant association between treatment duration and severity of inflammation ($p = 0.018$) reinforces the need for ongoing periodontal monitoring during orthodontic care.

Similar patterns have been noted in research by studies, who found that patients with treatment exceeding one year had more pronounced histopathological changes compared to those with shorter durations[20].

These findings collectively highlight the inflammatory burden placed on gingival tissues during orthodontic therapy, emphasizing the importance of strict oral hygiene practices, patient education, and regular professional cleanings to mitigate potential complications.

CONCLUSION

This study demonstrated that chronic inflammatory changes such as epithelial hyperplasia, inflammatory cell infiltration, fibrosis, and vascular proliferation are common in patients undergoing fixed orthodontic treatment. However, despite prolonged appliance use, no epithelial dysplasia was observed, suggesting that while these histopathological changes reflect chronic irritation, they do not indicate malignant transformation.

These results underscore the importance of maintaining optimal oral hygiene and regular periodontal evaluations throughout orthodontic therapy to minimize inflammatory responses and preserve gingival health. Future studies with larger samples and longitudinal follow-up may help further elucidate the progression and resolution of these tissue changes post-treatment.

REFERENCES

1. Kumar V, Singh P, Arora VK, Kaur S, Sarin S, Singh H. Assessment of effect of fixed orthodontic treatment on gingival health: An observational study. Journal of Pharmacy and Bioallied Sciences. 2021;13(Suppl 1):S425-S8.
2. Katta M, Cumpătă CN, Ţuculină MJ, Lazăr AC, Manolea HO, Mocanu H, et al. Clinical, histopathological and immunohistochemical changes of the superficial marginal periodontium caused by orthodontic treatment with fixed metallic orthodontic appliances. Romanian Journal of Morphology and Embryology. 2022;63(2):431.
3. Zigante M, Spalj S, Prpic J, Pavlic A, Katic V, Matusan Ilijas K. Immunohistochemical and histopathological features of persistent gingival enlargement in relation to metal allergic sensitisation during orthodontic treatment. Materials. 2022;16(1):81.
4. Alkan Ö, Kaya Y, Tunca M, Keskin S. Changes in the gingival thickness and keratinized gingival width of maxillary and mandibular anterior teeth after orthodontic treatment. The Angle Orthodontist. 2021;91(4):459-67.
5. Alzoman H, Abalkhail KA, Alomran WK, Almudhi A, Bindayel NA. Changes of Periodontal Tissues Because of Orthodontic Treatment: A Retrospective Study. Journal of Advanced Oral Research. 2021;12(2):296-303.
6. Mustafa MN. The histopathological change of oral mucosa in patient with orthodontic appliance. World Bulletin of Public Health. 2022;13:176-81.
7. Gehlot M, Sharma R, Tewari S, Kumar D, Gupta A. Effect of orthodontic treatment on periodontal health of periodontally compromised patients. The Angle Orthodontist. 2022;92(3):324-32.
8. Simancas-Escorcia V, Leal-Betancur J, Díaz-Caballero A. Expression of type III collagen in hypertrophic gingival tissue of patients with orthodontic treatment: a pilot study. Revista Facultad de Odontología Universidad de Antioquia. 2020;32(2):53-63.
9. Shirozaki MU, da Silva RAB, Romano FL, da Silva LAB, De Rossi A, Lucisano MP, et al. Clinical, microbiological, and immunological evaluation of patients in corrective orthodontic treatment. Progress in Orthodontics. 2020;21(1):6.
10. Bud E, Vlasa A, Pacurar M, Matei A, Bud A, Szoke A-R, et al. A retrospective histological study on palatal and gingival mucosa changes during a rapid palatal expansion procedure. Biomedicines. 2023;11(12):3246.
11. Ashfaq M, Sadiq A, Sukhia RH, Fida M. Association of hard and soft tissue factors with gingival recession in orthodontically treated patients: a retrospective study. International Orthodontics. 2021;19(1):60-6.
12. Orsini M, Benlloch D, Aranda Macera JJ, Flores K, Ríos-Santos J-V, Pedruelo FJ, et al. Improvement of periodontal parameters with the sole use of free gingival grafts in orthodontic patients: correlation with periodontal indices. A 15-month clinical study. International Journal of Environmental Research and Public Health. 2020;17(18):6578.
13. Gopalasamy K, Ramamurthy J, Pradeep D. Prevalence of gingivitis in patients undergoing orthodontic treatment of ages 18-25 years-a retrospective study. International Journal of Dentistry and Oral Science. 2020;7(12):1231-5.
14. da Silva VC, de Molon RS, Martins RP, Ribeiro FS, Pontes AEF, Zandim-Barcelos DL, et al. Effects of orthodontic tooth extrusion produced by different techniques, on the periodontal tissues: a histological study in dogs. Archives of Oral Biology. 2020;116:104768.
15. Simon CP, Motoc AGM, Simon GA, Brezovan D, Muselin F, Cristina RT, et al. Gingival proliferative growth–stress and cytoarchitecture related with fixed and mobile orthodontic therapy. Romanian Journal of Morphology and Embryology. 2021;61(4):1287.
16. Nagy P, Molnar B, Nemes B, Schupbach P, Windisch P. Histologic Evaluation of Human Intrabony Periodontal Defects Treated with Deproteinized Bovine Bone Mineral in Combination with Orthodontic Tooth Movement: A Case Series. International Journal of Periodontics & Restorative Dentistry. 2020;40(3).
17. Mohammed RE, Al Qassar SSS, Taqa GA. Clinical and histological evaluation of the effect of magnesium oxide administration on relapse after orthodontic teeth movement (Rabbit Model Study). Journal of Orthodontic Science. 2023;12(1):19.
18. Calniceanu H, Stratul S-I, Rusu D, Jianu A, Boariu M, Nica L, et al. Changes in clinical and microbiological parameters of the periodontium during initial stages of orthodontic movement in patients with treated severe periodontitis: A longitudinal site-level analysis. Experimental and Therapeutic Medicine. 2020;20(6):199.
19. Nanu S, Goriuc A, Bejan O, Vata I, Martu MA, Testa S, et al. A comparative study between periodontal status before and after orthodontic treatment. Romanian Journal of Oral Rehabilitation. 2022;14(4).
20. Wang CW, Yu SH, Mandelaris GA, Wang HL. Is periodontal phenotype modification therapy beneficial for patients receiving orthodontic treatment? An American Academy of Periodontology best evidence review. Journal of periodontology. 2020;91(3):299-310.