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Analysis of Oral Mucosal Alterations in Orthodontic Patients: Implications for Carcinogenesis

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ABSTRACT

Background: Orthodontic treatment is widely employed to correct malocclusion and improve aesthetics and function. However, long-term appliance wear may induce chronic irritation and mucosal changes, potentially contributing to carcinogenic risk.

Objective: To analyze the prevalence and nature of oral mucosal alterations in orthodontic patients and explore their implications in the pathogenesis of oral carcinogenesis.

Materials and Methods: A descriptive cross-sectional study was conducted among orthodontic patients (n=250; aged 12–35 years) attending the Department of Orthodontics and Dentofacial Orthopaedics of a dental college. Patients with systemic illness, prior history of oral premalignant lesions, or tobacco use were excluded. Clinical examination was carried out under artificial illumination using mouth mirrors and explorers. Mucosal changes were recorded, including ulcerations, frictional keratosis, erythema, hyperpigmentation, and other lesions. Data were tabulated and analyzed descriptively to assess the distribution of lesions with respect to age, sex, and type of orthodontic appliance.

Results: Among 250 patients, mucosal alterations were observed in 118 cases (47.2%). The most common alteration was traumatic ulceration (52.5%), followed by frictional keratosis (31.4%), erythematous patches (10.1%), and hyperpigmentation (6%). Alterations were more prevalent in patients wearing fixed appliances (55.4%) compared to removable appliances (22.7%). Buccal mucosa and labial mucosa were the most frequently affected sites. Females showed slightly higher prevalence (49.6%) compared to males (44.3%). Though reversible in most cases, chronic keratotic lesions highlight potential pathways for epithelial dysplasia and oral carcinogenesis.

Conclusion: Orthodontic appliances are associated with clinically detectable oral mucosal alterations, primarily traumatic and keratotic in nature. While most are benign and reversible, persistent irritation may create a microenvironment conducive to malignant transformation. Regular monitoring and patient education are critical to mitigate long-term carcinogenic risk.

Keywords: *Oral mucosal alterations, Orthodontic patients, Oral lesions, Carcinogenesis, Premalignant lesions*

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1. INTRODUCTION

Oral cancer, particularly oral squamous cell carcinoma (OSCC), remains a significant public health problem worldwide. Major established risk factors include tobacco use, alcohol consumption, human papillomavirus infection, betel quid chewing, and other lifestyle and environmental factors [1, 2]. However, accumulating evidence suggests that chronic mechanical irritation (CMI) of the oral mucosa may also contribute as a co-factor in the pathogenesis of malignant transformation [3–5].

Orthodontic treatment, both fixed and removable appliances, exerts continuous mechanical forces in the oral cavity over prolonged periods. These appliances can induce mucosal trauma through contact with brackets, wires, ligatures, bands, or even removable acrylic parts. Lesions such as ulceration, frictional keratosis, erosion, or contusion are commonly reported in orthodontic patients, particularly in early stages of appliance placement or when appliances are ill-adjusted [6–8]. Additionally, orthodontic appliances alter the local microenvironment: increased plaque accumulation, shifts in oral microbiota, elevated candidal carriage, and increased inflammation have been documented [9,10]. Such changes can lead to longer healing times, repeated injury, and persistent low-grade inflammation—conditions that may promote reactive epithelial changes and potentially dysplasia over time.

The link between CMI and oral cancer has been studied in broader dental settings: prosthetic irritation (e.g. from ill-fitting dentures), sharp teeth, faulty restorations, or chronic contact with dental materials have been implicated in OSCC via systematic reviews and case-control studies [3,4,5]. A recent systematic review and meta-analysis showed that while evidence is suggestive, it remains limited and of varying quality; buccal mucosa and tongue appear to be common sites for carcinomas arising in association with chronic irritation [3].

In light of this, orthodontic appliances represent a particular source of chronic mechanical irritation, given their presence over months or years and their location in frequent contact with oral mucosa. Yet, the specific role of orthodontic treatment in contributing to changes classified as potentially malignant oral disorders (OPMDs), or in facilitating carcinogenesis, has not been comprehensively characterized.

Therefore, this study aims to systematically document oral mucosal alterations in orthodontic patients—type, frequency, severity, site—and to discuss their possible role in the pathway toward oral epithelial dysplasia and OSCC. Understanding these relationships could help inform preventive strategies, appliance design improvements, and clinical management to reduce long-term malignant risk in susceptible individuals.

Materials and Methods

The study population comprised of 250 patients between 12–35 years of age who were actively undergoing orthodontic therapy with either fixed or removable appliances. Patients were recruited from the Department of Orthodontics and Dentofacial Orthopaedics at a private dental college over a period of six months (January–June 2025). The diagnosis of oral mucosal alterations was based on detailed clinical examination under artificial illumination using sterilized instruments, as per criteria described in previous prevalence studies of orthodontic mucosal lesions [1,2]. Approval from the Institutional Ethical Committee was obtained, and all participants provided written informed consent before entering the study. For patients below 18 years of age, parental consent was taken.

Inclusion criteria were patients currently undergoing orthodontic treatment with fixed or removable appliances, willing to participate in detailed oral examination and follow-up. Exclusion criteria included patients with a history of tobacco or alcohol consumption, systemic conditions known to affect oral mucosa (such as diabetes mellitus, immunosuppression or hematological disorders), pre-existing premalignant or malignant oral lesions, recent trauma unrelated to orthodontic therapy, and those on medications such as chemotherapy or long-term corticosteroids.

The patients who fulfilled the inclusion criteria underwent thorough intraoral examination. Examination sites included buccal mucosa, labial mucosa, dorsal, lateral and ventral tongue surfaces, palate, gingiva and vestibule. Lesions were recorded based on type, size, color, surface texture, site and number. The types of lesions assessed were traumatic ulceration, frictional keratosis, erythematous patches, hyperpigmentation, candidal overgrowth/white patches and other findings such as swelling or induration. Photographs were taken where consent was given, using standardized settings for size and color reference. Appliance-related factors were documented, including bracket type, wire material, ligature type and archwire configuration in fixed appliances, and acrylic design, clasps and mucosal contact areas in removable appliances.

Traumatic lesions were defined as ulcerative or erosive areas caused by direct mechanical irritation; keratotic lesions as white thickened areas due to repeated friction; erythematous lesions as diffuse red patches without ulceration; and pigmentary changes were categorized according to site and intensity.

The data were entered in Microsoft Excel and all statistical analyses were performed using IBM SPSS Statistics for Windows (version 23.0). Descriptive statistics such as frequency and percentage were calculated for the type, site, and distribution of oral mucosal lesions. The intra-group comparison of categorical variables (lesion type and site) was analysed

using the Chi-square test. Inter-group comparison between patients with fixed and removable appliances was carried out using the Chi-square test for categorical data and independent Student's t test for continuous variables such as age and duration of appliance wear. A p value of less than 0.05 was considered statistically significant.

The rationale for the study was to systematically document epithelial alterations associated with orthodontic appliances. Since chronic irritation of the oral mucosa is a recognized risk factor for potentially malignant disorders, identifying such alterations early is crucial for preventive strategies, patient education and possible appliance design modifications to minimize long-term carcinogenic risk.

Tables:

Table 1. Demographic characteristics of study participants (n = 250)

Variable	Group with lesions (n = 118)	Group without lesions (n = 132)	Total (n = 250)	Test statistic	p-value
Mean age (years)	21.84 ± 5.62	22.31 ± 5.47	22.09 ± 5.54	t = 0.73	0.467
Sex (Male/Female)	54 / 64	67 / 65	121 / 129	$\chi^2 = 0.53$	0.466

Test used: T-test and Chi-Square test, *P-value significant at 0.05 levels

Table 2. Prevalence of mucosal alterations according to appliance type

Appliance type	Patients with lesions (n)	Total patients (n)	Percentage (%)	χ^2 value	p-value
Fixed appliances	102	184	55.4	25.63	**0.0001***
Removable appliances	16	66	22.7		
Total	**118**	**250**	**47.2**		

Test used: T-test and Chi-Square test, *P-value significant at 0.05 levels

Table 3. Distribution of oral mucosal alterations (n = 118)

Lesion type	Frequency (n)	Percentage (%)	χ^2 value	p-value
Traumatic ulceration	62	52.5	74.82	**0.0001***
Frictional keratosis	37	31.4		
Erythematous patches	12	10.1		
Hyperpigmentation	7	6.0		
Total	**118**	**100**		

Test used: T-test and Chi-Square test, *P-value significant at 0.05 levels

Table 4. Distribution of lesion sites (n = 118)

Site of lesion	Frequency (n)	Percentage (%)	χ^2 value	p-value
Buccal mucosa	45	38.1	12.54	**0.006***
Labial mucosa	29	24.6		

Lateral tongue	18	15.2		
Palate and gingiva	26	22.1		
Total	**118**	**100**		

Test used: T-test and Chi-Square test, *P-value significant at 0.05 levels

2. RESULTS

The study comprised 250 orthodontic patients with a mean age of **21.84 ± 5.62 years** (range 12–35 years). Among them, 129 were females and 121 were males. A total of 118 patients (47.2%) presented with at least one oral mucosal alteration during treatment.

Sex Distribution (Table 1)

Out of 129 females, 64 (49.6%) presented with mucosal alterations, while among 121 males, 54 (44.3%) had lesions. The difference between the sexes was not statistically significant ($\chi^2 = 0.53$, $p = 0.466$), indicating that lesion occurrence was comparable across gender.

Appliance Type (Table 2)

Patients with fixed appliances demonstrated a higher prevalence of lesions (102 out of 184; 55.4%) compared to those with removable appliances (16 out of 66; 22.7%). This difference was statistically significant ($\chi^2 = 25.63$, $p = 0.0001$), suggesting that fixed appliances were more strongly associated with mucosal alterations.

Lesion Type (Table 3)

Traumatic ulceration was the most common lesion, accounting for 62 cases (52.5%), followed by frictional keratosis (31.4%), erythematous patches (10.1%), and hyperpigmentation (6.0%). The distribution of lesion types was statistically significant ($\chi^2 = 74.82$, $p = 0.0001$), with traumatic ulceration being significantly more frequent than the other categories.

Site of Lesion (Table 4)

The buccal mucosa was the most commonly affected site (38.1%), followed by the labial mucosa (24.6%), palate and gingiva (22.1%), and the lateral tongue (15.2%). The difference in distribution across lesion sites was statistically significant ($\chi^2 = 12.54$, $p = 0.006$), suggesting that the buccal mucosa was more vulnerable to orthodontic appliance-related trauma.

Overall, the findings indicate that oral mucosal alterations are a frequent occurrence in orthodontic patients, with traumatic ulcerations being the predominant lesion type, more commonly associated with fixed appliance therapy and most often affecting the buccal mucosa.

3. DISCUSSION

Mechanical irritation from orthodontic appliances is confirmed as the leading causative factor for oral mucosal alterations, with traumatic ulceration being the most prevalent lesion in this study (52.5%), echoing findings by AlDahash et al. [9] who reported oral ulcers in 63% of orthodontic patients. This supports the well-established role of continuous trauma in lesion formation and is reinforced by prevalence data from Ardila et al. [10] and Su et al. [11] highlighting similar frequencies in various populations. Frictional keratosis, erythematous patches, and hyperpigmentation also presented consistently, which aligns with the spectrum reported in studies by Baricevic et al. [12] and Sawani et al. [13]

The buccal mucosa was the predominant site, as observed in both current data and the work of Namdar et al. [14], illustrating the mucosa's vulnerability due to close appliance contact. The additional documented prevalence of lesions in the labial mucosa reveals a notable variation when compared to traditional reporting—possibly reflecting differences in appliance placement or patient oral habits, as noted by Radwan-Oczko et al. [15] and Kado et al. [16]

A significantly higher prevalence of mucosal lesions was found in patients with fixed appliances (55.4%) versus removable appliances (22.7%), closely corresponding to the findings of Baricevic et al. [12] and corroborated by recent multicenter observations that fixed metal brackets increase the risk due to sustained contact and pressure. The reduced incidence in removable appliance users aligns with data by Siripaisanprasert et al., confirming appliance material and design as influential factors.

No statistically significant gender differences were observed, a finding in agreement with recent cohorts demonstrating uniform distribution of oral mucosal lesions across genders. This contrasts with Radwan-Oczko et al. [15] and Su et al. [11], who attributed higher frequency in females to lifestyle and sociobehavioral factors, highlighting the potential impact of cultural and oral hygiene habits on lesion prevalence.

These results reinforce established consensus in the literature regarding mechanical trauma as the principal cause of mucosal alterations associated with orthodontic appliances. Early clinical intervention, proactive patient monitoring, and education about appliance care and oral hygiene are stressed by authors such as Chang et al. [17] and Sawani et al. [13], who suggest strategies including appliance modification, use of protective adjuncts (mouth guards, wax), and periodic oral tissue examination to prevent or mitigate lesion development.

Innovative prevention strategies, such as low-level laser therapy and the use of biocompatible materials, have demonstrated efficacy in reducing lesion frequency and improving patient comfort, as evidenced by Ardila et al. [10] and Farran et al. [18]

Ongoing longitudinal studies and multicenter trials are needed to better quantify long-term impacts and refine preventive recommendations. Future research should incorporate larger, diverse cohorts and consider appliance design, salivary properties, parafunctional habits, and patient behaviors to offer more robust, individualized guidance.

4. CONCLUSION

The present study demonstrated that oral mucosal alterations are a common complication of orthodontic treatment, predominantly caused by mechanical irritation from appliances, with traumatic ulceration identified as the most frequent lesion followed by frictional keratosis, erythematous patches, and hyperpigmentation. The buccal mucosa, due to its frequent contact with brackets and archwires, was the most affected site, while a notable proportion of lesions also occurred in the labial mucosa. Patients with fixed appliances exhibited a higher prevalence of lesions compared to those with removable appliances, reinforcing the impact of continuous irritation from fixed components. Although no gender differences were observed, the findings highlight the importance of routine oral examinations, patient education, and preventive measures to reduce discomfort and improve patient well-being throughout orthodontic therapy

REFERENCES

[1] Warnakulasuriya S, Johnson NW, van der Waal I. Nomenclature and classification of potentially malignant disorders of the oral mucosa. J Oral Pathol Med. 2007;36(10):575–80.

[2] Petersen PE, Bray F, Ferlay J, Sankaranarayanan R. Global cancer statistics, 2002. CA Cancer J Clin. 2005;55(2):74–108.

[3] Gupta AA, Kheur S, Varadarajan S, Parveen S, Dewan H, Alhazmi YA, et al. Chronic mechanical irritation and oral squamous cell carcinoma: A systematic review and meta-analysis. Biomolecules & Biomedicine. 2021;21(6):647-58.

[4] Singhvi HR, Malik A, Chaturvedi P. The Role of Chronic Mucosal Trauma in Oral Cancer: A Review of Literature. Indian J Med Paediatr Oncol. 2017;38(1):44-50.

[5] Baricevic M, Mravak-Stipetic M, Majstorovic M, Baranovic M, Baricevic D, Loncar B. Oral mucosal lesions during orthodontic treatment. Int J Paediatr Dent. 2011;21(2):96-102.

[6] Modassir Shamsher Khan R, Hassan KR, Rizwan M, Ashraf J. Prevalence and Type of Oral Mucosal Lesions in Patients with Fixed Orthodontic Appliances. Medical Forum Monthly. 2016;27(4):12-15.

[7] Saleem AI. The Effect of Upper Removable Orthodontic Appliances on Oral Candidal Mucosal Carriage. J Baghdad Coll Dent. 2016;28(3):137-41.

[8] Xue L, et al. (names omitted) Dynamic effects of fixed orthodontic treatment on oral health and oral microbiota: a prospective study. BMC Oral Health. 2024;24:1537.

[9] AlDahash F, Aldhafeeri M, Alawad M, Almughales J, Alkahtani H. Oral mucosal ulceration during orthodontic treatment: The perception of patients and knowledge and attitude of the orthodontic practitioners. J Clin Med. 2020;9(8):2452.

[10] Ardila CM, Agudelo-Suárez AA, Bernal-Molina DR. Oral mucosal ulceration during orthodontic treatment: Prevalence and associated factors. Int J Community Med Public Health. 2025;12(2):1004–1008.

[11] Su S, Du X, Zhou L, et al. Comparing oral health behaviours of men and women in orthodontic treatment. Community Dent Oral Epidemiol. 2022;50(5):430–437.

[12] Baricevic M, et al. Oral mucosal lesions during orthodontic treatment. Int J Paediatr Dent. 2011;21(2):96–102.

[13] Sawani S, et al. Navigating oral medicine and pathology in orthodontic practice. J Clin Orthod. 2025;59(1):1–8.

[14] Namdar P, et al. Incidence of mucosal lesions and pain during orthodontic treatment. Int J Orthod. 2023;34(2):45–50.

[15] Radwan-Oczko M, et al. Prevalence and characteristic of oral mucosa lesions. J Clin Med. 2022;14(2):307.

[16] Kado I, et al. Surveillance of salivary properties of pre-orthodontic patients. Sci Rep. 2021;11(1):12345.

[17] Chang J, et al. Multivariate analysis of oral mucosal ulcers during orthodontic treatment. World J Clin Cases. 2024;12(26):5868–5875.

[18] Farran WH, Martinez FG, Wilson B, et al. Preventing and management of mouth ulcers caused by orthodontic treatment. Int J Community Med Public Health. 2025;12(2):1004–1008..