Original article

A survey of oral hygiene status (OHI-S) and its association with white spot lesions among University of Medicine and Pharmacy, Hue University students wearing fixed orthodontic appliances

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Abstract

Background: Fixed orthodontic appliances hinder oral hygiene maintenance, promote the development of white spot lesions (WSLs), and impose a significant risk on the dentition.

Objective: to evaluate the prevalence and association of oral hygiene status and WSLs among orthodontic patients attending orthodontic departments at Hue University.

Methods: A cross-sectional study was conducted in 2024 on 100 students from the University of Medicine and Pharmacy, Hue University, undergoing fixed orthodontic treatment. Data were collected through clinical assessment of patients' enamel damage index (WSLs) (International Caries Detection and Assessment System, ICDAS) and oral hygiene status (Simple Oral Hygiene Index, OHI-S).

Results: Among 100 orthodontic patients (mean OHI-S: 1.32 ± 1.39), 48% had fair, 30% had poor, 22% had good hygiene, with no cases of excellent hygiene. The prevalence of WSLs was 44.0%. Female had lower OHI-S scores (1.28 ± 1.38 vs. 1.45 ± 1.43) and a lower of WSLs prevalence (40.79% vs. 54.17%) than males. There were moderate positive correlations of OHI-S and WSLs ($r = 0.27$, $p = 0.0053$) and treatment duration ($r = 0.35$, $p = 0.03$). Treatment duration had a strong, positive correlation with WSLs ($r = 0.72$, $p = 0.0000$).

Conclusions: Among orthodontic patients, there were high prevalence of poor to fair oral hygiene with high occurrent of WSLs. Female had better oral health status and lower occurrence of WSLs. Poor oral hygiene and longer treatment duration was associated with a higher prevalence of WSLs.

Keywords: *Oral hygiene status; fixed orthodontic treatment; white spot lesion.*

1. INTRODUCTION

Oral hygiene is vital in maintaining oral health and preventing dental diseases. In cases involving orthodontic treatment, especially with fixed appliances, maintaining proper oral hygiene status becomes more challenging due to the structure of these appliances, which can facilitate plaque accumulation and bacterial growth. If not cleaned properly, this plaque can lead to severe issues such as dental caries, gingivitis, and particularly white spot lesion (WSLs) – a common complication during orthodontic treatment. WSLs occur due to demineralization of the enamel in areas in contact with orthodontic appliances, affecting aesthetics and potentially causing long-term oral health problems for patients [1],[2]. According to Gorelick et al. (1982), up to 50% of patients develop at least one white spot lesion during orthodontic treatment [3]. In a study by Celjana Toti et al. (2022), after three months of treatment fixed appliances, 59.5% of patients showed the appearance of WSLs, with this percentage increasing to 60.8% after six months [4].

Numerous studies have indicated that oral hygiene status is closely associated with developing WSLs during orthodontic treatment. Factors such as the level of oral hygiene, duration of treatment fixed appliances, and personal hygiene habits can significantly affect the formation of these lesions [4]. Specifically, the Simplified Oral Hygiene Index (OHI-S) is a widely used tool for assessing the level of oral hygiene in patients, helping to identify risk factors related to the development of WSLs [5].

In Vietnam, studies on the relationship between oral hygiene and WSLs in orthodontic patients are limited. Therefore, investigating the oral hygiene status and its correlation with WSLs is necessary to provide scientific data that can improve preventive and treatment methods in orthodontic care and enhance the effectiveness of oral health care for patients. The current study aims at determining the prevalence and association of oral hygiene and WSLs in orthodontics patients.

2. MATERIAL AND METHODS

2.1. Subjects

A cross-sectional descriptive study was conducted among students enrolled at the University of Medicine and Pharmacy, Hue University, who were undergoing orthodontic treatment with fixed appliances.

Inclusion criteria: Students undergoing fixed orthodontic treatment who agree to participate in the study.

Exclusion criteria:

+ Students with a history of previous fixed orthodontic treatment who are no longer receiving treatment.

+ Students who have been diagnosed with white spot lesions before wearing orthodontic braces.

+ Students who have been diagnosed with fluorosis or enamel hypoplasia.

The sample size was determined using the formula: $n = Z^2_{1-\alpha/2}\frac{p(1-p)}{d^2}$

n = Sample size

p = Proportion of WSLs in orthodontic patients, derived from the study by Fida and Khan (2010), with p = 0.75 [6].

d = Desired margin of error between the sample and population proportions, where d = 0.09.

α = Significance level, where α = 0.05.

The Z value was obtained from the Z table, with α = 0.05, so $Z^2_{(1-\frac{\alpha}{2})}Z^2_{(1-\frac{\alpha}{2})}$ = $(1.96)^2$.

Using the formula, we calculated the sample size will be 89 patients. In this study, 100 patients were included. Convenience sampling technique was used.

2.2. Data collection

We obtained class rosters of students, then contacted and screened those who were undergoing orthodontic treatment and invited them to participate in the study. Accordingly, eligible participants were students enrolled at the University of Medicine and Pharmacy, Hue University, who were receiving orthodontic treatment with fixed appliances from August 2024 to December 2024 and met the predefined inclusion criteria.

Eligible participants were interviewed to collect personal and demographic variables, including name, sex, date of birth, and duration of fixed appliance use. The Oral Hygiene Index–Simplified (OHI-S) and white spot lesions (WSLs) were assessed directly through clinical examination.

Oral hygiene status assessment

The oral hygiene status was evaluated using the OHI-S of Greene and Vermillion based on numerical determinations representing the amount of debris or calculus on index tooth surfaces [7]. The OHI-S index for selected tooth surfaces (16, 11, 26, 36, 31, 46) is calculated using the formula: OHI-S = DI-S + CI-S, where DI-S represents the plaque index, and CI-S represents the calculus index. The OHI-S for a tooth is the average score of the index calculated for the selected surfaces, and the OHI-S for an individual is the average of the OHI-S scores across all teeth of that individual. The index of each tooth surface according to DI-S and CI-S were calculated (**Table 1**). The individual OHI-S index ranges from a minimum value of 0 to a maximum value of 6. Based on the classification levels and the formula for calculating the OHI-S index, the OHS can be assessed as follows: excellent if the OHI-S is 0; good if the OHI-S ranges from 0.1 to 1.2; fair if the OHI-S ranges from 1.3 to 3.0; and poor if the OHI-S ranges from 3.1 to 6.

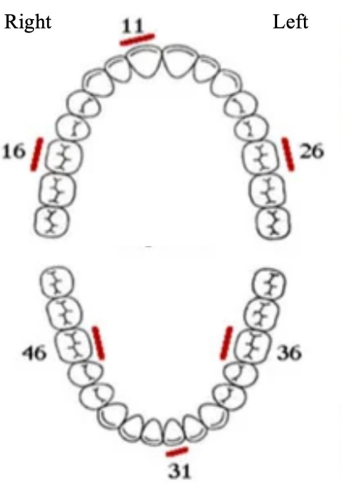

Figure 1. Teeth and tooth surfaces examined in OHI-S [8]

Table 1. Classification of levels according to DI-S index and CI-S index

Score	DI-S Index	CI-S Index
0	No debris or stains present	No calculus present
1	Soft debris covering not more than 1/3rd the tooth surface or presence of extrinsic stains without other debris regardless of the area covered.	Supragingival calculus covering not more than 1/3rd of the exposed tooth surface.
2	Soft debris covering more than 1/3rd, but not more than 2/3rd of the exposed tooth surface.	Supragingival calculus covering more than 1/3rd but not more than 2/3rd of the exposed tooth surface or presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both.
3	Soft debris covering more than 2/3rd of the exposed tooth surface.	Supragingival calculus covering more than 2/3rd of the exposed tooth surface or a continuous heavy band of the subgingival calculus around the cervical portion of the tooth or both.

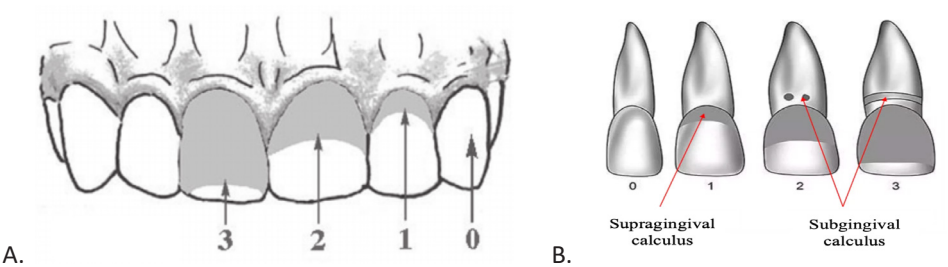

Figure 2. A. How to record plaque index; B. How to record calculus index [8]

WSLs assessment

The presence of WSLs was recorded through clinical examination under standard light conditions on the dental chair. Teeth were isolated with cotton rolls and air-dried for 5 seconds before examination. The facial surfaces of maxillary and mandibular teeth from the first molar on the right to the first molar on the left were examined. Only surfaces beneath the arch-wire were examined for the presence of WSLs. WSLs were identified and classified based on ICDAS using a three-level scale [9]: (Score 0) Sound tooth surface: no evidence of caries after five-second air drying; (Score 1) First visual change in enamel: opacity or discoloration (white or brown) is visible after prolonged air drying; (Score 2) Distinct visual change in enamel: opacity or discoloration distinctly when wet, lesion must still be visible when dry. WSLs were recorded when the score was 1 or 2.

2.3. Statistical analysis

Data analysis was performed using STATA 14.0 software. Group comparisons for categorical variables were conducted using Fisher's Exact Test, with p considered significant when $p < 0.05$.

The T-test for independent samples was used to compare the mean DI-S, CI-S, and OHI-S between genders. The Kruskal-Wallis test was used to compare the mean DI-S, CI-S, and OHI-S across different stages of orthodontic treatment, with a significance threshold of $\alpha = 0.05$. Spearman's rank correlation test was used to assess the correlation between variables.

3. RESULTS

This cross-sectional study involved 100 patients aged 18 to 24, 76% female. Patients in treatment for more than 24 months accounted for 30%, 6-12 months and 13 - 18 months each comprised 23%, less than 6 months accounted for 14%, and 19-24 months made up 10%.

3.1. Oral hygiene status in patients undergoing orthodontic treatment with fixed appliances.

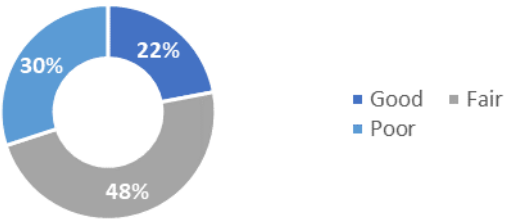

Figure 3. Oral hygiene status in patients undergoing orthodontic treatment with fixed appliances

Table 2. Oral hygiene status in patients undergoing orthodontic treatment with fixed appliances (N=100)

		Excellent	Good	Fair	Poor	Total
Gender	Male	0 (0.00)	7 (12.50)	13 (54.17)	8 (33.33)	24 (24.00)
	Female	0 (0.00)	19 (25.00)	35 (46.05)	22 (28.95)	76 (76.00)
	p			0.46		
Treatment duration	Under 6 months	0 (0.00)	7 (50.00)	6 (42.86)	1 (7.14)	14 (14.00)
	6 - 12 months	0 (0.00)	11 (47.83)	12 (52.17)	0 (0.00)	23 (23.00)
	13 - 18 months	0 (0.00)	4 (17.39)	16 (69.57)	3 (13.04)	23 (23.00)
	19 - 24 months	0 (0.00)	0 (0.00)	3 (30.00)	7 (70.00)	10 (10.00)
	Over 24 months	0 (0.00)	0 (0.00)	11 (36.67)	19 (63.33)	30 (30.00)
	p			p < 0.001		

Using test Fisher's Exact

Nearly half of the patients had average oral hygiene (48%), 30% had poor oral hygiene, 22% had good oral hygiene, and no patients had excellent oral hygiene. The results presented in Table 2 illustrate the oral hygiene status among patients undergoing orthodontic treatment with fixed appliances. In both male and female patients, the majority of the OHI-S scores fell within the "fair" category, followed by the "poor" category, and then the "good" category. No patients achieved a "very good" rating. Among male patients, a higher percentage (54.17%) fell into the "fair" category compared to female patients (46.05%). A higher proportion of female patients (25.0%) achieved a "good" rating, which was twice the rate of male patients (12.5%). However, this difference was not statistically significant with a p-value > 0.05.

With regards to treatment duration, students who had worn braces for less than 6 months and between 6 - 12 months demonstrated higher rates of "good" (50.0% in the < 6 months group, 47.83% in the 6 - 12 months group) and "average" oral hygiene (42.86% in the < 6 months group, 52.17% in the 6 - 12 months group) compared to other groups. Notably, no cases of "poor" oral hygiene were observed in the 6 - 12 months group. Meanwhile, as the treatment duration increased (over 18 months), oral hygiene status tended to deteriorate: in the 19 - 24 months group, 70% had "poor" oral hygiene, and in the group treated for more than 24 months, 63.33% showed "poor" oral hygiene. The differences in OHI-S (Oral Hygiene Index - Simplified) across different orthodontic treatment durations were statistically significant with p < 0.001.

Table 3. Mean OHI-S scores distributed by gender, and treatment duration (N = 100)

	Mean ± SD		
	DI-S	**CI-S**	**OHI-S**
All	0.75 ± 0.76	0.56 ± 0.62	1.32 ± 1.39
Gender			
Female	0.73 ± 0.77	0.52 ± 0.59	1.28 ± 1.38
Male	0.79 ± 0.74	0.71 ± 0.68	1.45 ± 1.43
p*	0.72	0.18	0.60

Treatment duration			
Under 6 months	0.57 ± 0.61	0.35 ± 0.49	0.88 ± 1.26
6 - 12 months	0.56 ± 0.51	0.47 ± 0.54	1.11 ± 0.85
13 - 18 months	0.60 ± 0.65	0.58 ± 0.51	1.19 ± 1.21
19 - 24 months	1.55 ± 0.59	0.90 ± 0.78	1.60 ± 1.76
Over 24 months	0.82 ± 0.94	0.61 ± 0.71	1.70 ± 1.71
p**	0.006	0.06	0.10

**Use of Independent Samples T-test, DI-S: Simplified Debris Index; CI-S: Simplified Calculus Index; OHI-S: Simplified Oral Hygiene Index.*

***Kruskal-Wallis Test*

The results from Table 3 show that the oral hygiene status of the patients was generally at an average or moderately good level. The average scores for DI-S, CI-S, and OHI-S were lower for female patients than for male patients, but this difference was not statistically significant ($p > 0.05$). The average scores of the Debris Index (DI-S), Calculus Index (CI-S), and Simplified Oral Hygiene Index (OHI-S) showed variation across different treatment timeframes.

The average DI-S score exhibited an increasing trend corresponding to the duration of orthodontic treatment, rising from 0.57 ± 0.61 in patients treated for less than 6 months to 1.55 ± 0.59 in those treated for 19–24 months, and a decrease was observed in patients treated for more than 24 months (0.82 ± 0.94). The difference in the average DI-S scores across treatment duration groups was statistically significant ($p < 0.05$).

Similarly, the average CI-S score increased from 0.35 ± 0.49 in the <6-month group to 0.90 ± 0.78 in the 19–24-months and then declined slightly to 0.61 ± 0.71 in the >24 months. However, this difference in CI-S scores was not statistically significant ($p > 0.05$).

The overall average OHI-S score also showed an upward trend with treatment duration. Patients treated for less than 6 months recorded the lowest average OHI-S score (0.88 ± 1.26), whereas those treated for over 24 months exhibited the highest average score (1.70 ± 1.71). Nevertheless, differences in CI-S and OHI-S average scores across the treatment periods did not reach statistical significance ($p > 0.05$).

3.2. WSLs in patients undergoing orthodontic treatment with fixed appliances.

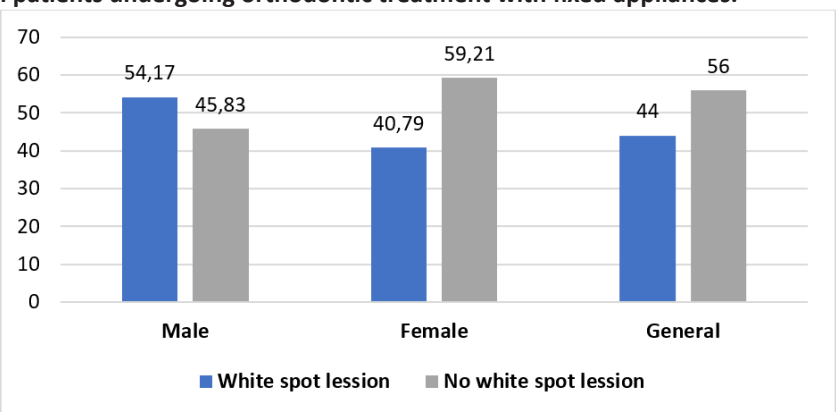

Figure 4. Distribution of white spot lesions on teeth in patients undergoing orthodontic treatment with fixed appliances by gender (N=100)

Figure 4 represents the distribution of white spot lesions on teeth in patients undergoing orthodontic treatment with fixed appliances by gender. Of 100 patients undergoing orthodontic treatment with fixed appliances, 44 (44.0%) had white spot lesions. Of which, the proportion of male patients with white spot lesions on their teeth (54.17%) was higher than that of female patients (40.79%).

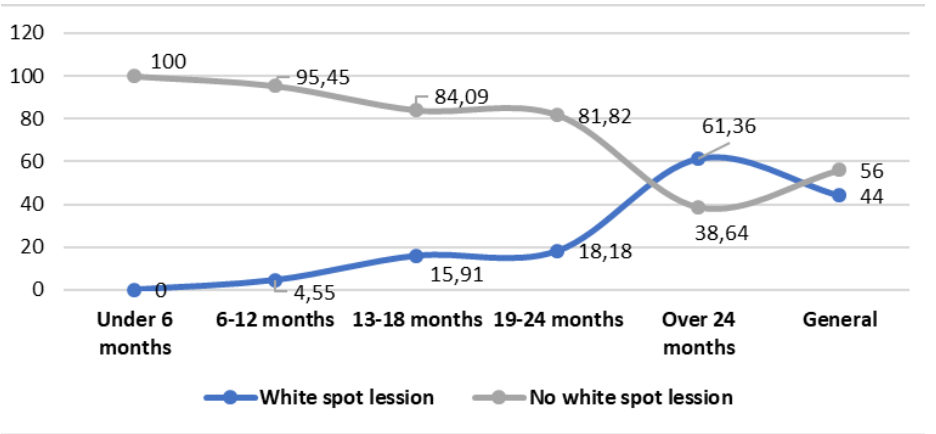

Figure 5. Distribution of white spot lesions on teeth in patients undergoing orthodontic treatment with fixed appliances according to treatment time (N = 100)

In general, the rate of white spot lesions on teeth in patients undergoing orthodontic treatment with fixed appliances was distributed in most treatment periods, except for the period under 6 months when there were no cases of white spot lesions. The group of patients treated for more than 24 months had the highest rate of white spot lesions (61.36%), 18.18% of patients had white spot lesions in the treatment period from 19 - 24 months, and 15.91% of patients had white spot lesions in the treatment period from 13 - 18 months, and 4.55% in the 6 - 12 months group.

These findings suggest a potential association between longer orthodontic treatment duration and an increased risk of developing white spot lesions.

3.3. Oral hygiene status and the occurrence of WSLs

Table 4. Spearman's correlation of oral hygiene status and related factors

	OHI-S r (p value)	**White spot lessions** r (p value)	**Treatment duration** r (p value)
OHI-S	1.00		
White spot lessions	0.27 (0.0053)	1.00	
Treatment duration	0.35 (0.03)	0.72 (0.0000)	1.00

Use Spearman's rank correlation coefficient

Oral hygiene status and WSLs had a moderate, positive correlation (r = 0.27); OHI-S and treatment duration had a moderate, positive correlation (r = 0.21). A strong, positive correlation between treatment duration and WSLs (r = 0.72). The correlations were statistically significant with $p < 0.05$.

4. DISCUSSION

Oral hygiene status

Generally, the oral hygiene status of patients undergoing orthodontic treatment with fixed appliances is suboptimal. Specifically, the OHI-S was predominantly at a moderate level, accounting for the highest percentage (48%), followed by a poor level (30%), with only 22% at a reasonable level, and no patients achieved an excellent level. These results show a discrepancy and are lower compared to the study by Do Hoang Viet et al. (2022) in which the OHI-S at a reasonable level accounted for the highest proportion (49.6%), followed by a moderate level (44%). Both poor and excellent levels were at 3.2% [10].

The proportion of patients with a good OHI-S was higher in females (25.0%) than males (12.5%), while males scored higher in all other levels. Both genders showed no cases with an excellent OHI-S. Additionally, the average OHI-S score for females (1.28 ± 1.38) was lower than that for males (1.45 ± 1.43). This finding is consistent with the study by Nguyen et al. (2015), which reported an average OHI-S score of 1.33 ± 0.10 for females, lower than the male score of 1.55 ± 0.09. [11] This could be attributed to better oral hygiene awareness and more meticulous oral care practices among females than males.

The OHI-S index varied across different treatment durations. Students who had worn braces for over 18

months exhibited a significantly higher proportion of poor OHI-S scores - 70% in the 19 - 24 months and 63.33% in the > 24 months. In contrast, students in the < 6 months had the highest proportion of "good" OHI-S scores (50%) and the lowest mean OHI-S value (0.88 ± 1.26), while those in the > 24 months had the highest mean score (1.70 ± 1.71). These findings indicate a trend of declining oral hygiene over time, which may be explained by factors such as oral hygiene fatigue, decreased motivation, or difficulties in maintaining hygiene with prolonged appliance wear.

Additionally, the variation in oral hygiene scores across treatment durations may have been influenced by uneven sample sizes among the different time groups and individual variability in oral hygiene practices. This underscores the importance of continuous oral health education and professional reinforcement throughout orthodontic treatment to ensure that patients maintain adequate hygiene and minimize complications such as plaque accumulation, gingival inflammation, and white spot lesions.

White Spot Lesions

Of the 100 patients who participated in the study, nearly half exhibited WSLs on their teeth (44%). Among them, the incidence of WSLs was significantly higher in male patients (54.17%) compared to female patients (40.79%). Our findings are consistent with those of other authors, such as Gorelick et al. (1982), who reported a white spot lesion rate of 49.6% [3]; Khalaf (2014), with a rate of 42.0% [12]; and Enaia et al. (2011), who found a rate of 40.9% [13]. Although there is no structural difference in enamel between males and females, females generally tend to maintain better oral hygiene, which could explain the difference in the incidence of WSLs between genders.

Orthodontic appliances tend to harbor plaque, which complicates the process of cleaning the teeth. As a result, plaque accumulates, bacteria proliferate, and conditions become favorable for demineralization, leading to the formation of WSLs. Ogaard et al. (1988) confirmed that WSLs can occur as early as one month after the initiation of orthodontic treatment [14].

The results of our study show that WSLs around the brackets began to appear in patients treated for 6 - 12 months, accounting for 4.55%. This rate continued to increase, reaching 15.91% in patients treated for 13 - 18 months, 18.18% in the 19 - 24 months, and 61.36% in those treated for more than 24 months. These findings suggest a strong association between treatment duration and the risk of developing WSLs.

Regarding the relationship between the duration of treatment and the development of WSLs, we observed that the longer the treatment duration, the higher the risk of developing WSLs. This result is lower than that reported by Chapman et al. (2010), who found that the incidence of WSLs increased from 36.0% to 46.0% after 6 and 12 months of treatment, respectively [15]. Similarly, Lucchese (2013) and Tufekci (2011) found that lesions developed relatively early and increased rapidly in the first 6 months of orthodontic treatment, with respective rates of 38.0% and 40.0%, and continued to rise more slowly to 43.0% and 46.0% by 12 months of treatment [16], [17]. Khalaf (2014), in a study of 45 patients, reported a 3.6-fold increased risk of developing WSLs after 12 months of treatment [12].

Oral hygiene status and WSLs in orthodontic patients

The use of fixed orthodontic appliances during treatment challenges patients in maintaining oral hygiene, providing a favorable environment for plaque adhesion and accumulation on the tooth surfaces [18]. Inadequate oral hygiene behavior during fixed orthodontic treatment can lead to gingival hyperplasia, gingivitis, enamel demineralization, and the formation of WSLs around the appliances. According to a study by Palomares NB et al. (2012), these conditions affect approximately 50 - 70% of patients with fixed appliances [19].

There is a moderate correlation (r = 0.27) between OHI-S and the presence of WSLs, with a statistically significant relationship. The OHI-S and treatment duration also show a moderate correlation (r = 0.21) with a statistically significant relationship. Furthermore, a correlation coefficient of r = 0.72 indicates a very strong, positive correlation between the duration of orthodontic treatment and the occurrence of WSLs, which is statistically significant. We observed that the longer the time gap between the two groups, the more apparent the correlation became. Additionally, the longer the treatment duration, the higher the risk of developing WSLs.

Orthodontic treatment significantly increases the risk of WSLs when associated with inadequate oral hygiene. The high prevalence of WSLs has been noted in orthodontic patients, suggesting the need for more rigorous oral hygiene practices and prevention programs before initiating orthodontic treatment.

5. CONCLUSION

Among orthodontic patients, there were high prevalence of poor to fair oral hygiene with high occurrence of WSLs. Female had better oral health status and lower occurrence of WSLs. Poor oral hygiene and longer treatment duration was associated with a higher prevalence of WSLs. Patients undergoing fixed orthodontic treatment should be warned of the high risk of WSLs and true carious lesions if proper oral hygiene measures are not followed.

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