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Original Research Article

Prevalence and Associated Predictors of Enamel White Spot Lesions Among Patients Undergoing Fixed Orthodontic Treatment

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Abstract:

Background: WSLs in the enamel are one of the commonly occurring complications in orthodontic treatment with fixed appliances and can potentially affect the aesthetics and structure of teeth. Determining their incidence and clinical factors is crucial.

Aim: This study set out to establish how frequently enamel white spot lesions occur and to identify the demographic, clinical and treatment-related factors that predict them.

Methodology: The orthodontic data obtained from the dentistry department of Shri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India was studied using the observational method of study. The records of 200 selected subjects were analyzed within a year. The demographic profile, treatment period, oral hygiene status, frequency of tooth brushing, and absenteeism was ascertained. The data was statistically analyzed using IBM SPSS Statistics version 25.0, with the level of significance set at $p < 0.05$.

Results: The number of lesions was found to be 68 among the participants with a prevalence rate of 34.0%. There was no correlation between age ($p = 0.971$) and gender ($p = 0.598$). Poor oral hygiene had a strong correlation with increased probability of occurrence of WSL (AOR 2.56; 95% CI 1.28–5.12; $p = 0.008$). Treatment period exceeding 18 months was another correlated factor (AOR 2.12; 95% CI 1.08–4.17; $p = 0.029$).

Conclusion: The results revealed that poor oral hygiene and protracted orthodontic therapy could be possible risk factors for the development of WSLs.

Keywords: Enamel white spot lesions; Fixed orthodontic treatment; Prevalence; Oral hygiene; Treatment duration; Logistic regression.

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Introduction

Orthodontic treatment restores the occlusion and enhances the functionality and aesthetics of the dentition, but it may cause the mineralization of the enamel around the orthodontic attachments as well [1]. Enamel white spot lesions are of concern, as they may form during the treatment, cause aesthetic problems, and serve as the indicator of the early demineralization [2]. Orthodontic appliances create extra sites where plaque may be retained, thus, causing this problem [3]. WSLs appear as the chalky opaque areas due to the subsurface demineralization that is provoked by the acids produced by the plaque bacteria disturbing the balance between mineral losses and mineral gains [4]. These lesions may be considered as the early and reversible stage of caries but can progress, depending on the presence of the risk factors, and due to their visibility on the anterior teeth, are the aesthetic problems [5]. Orthodontic brackets, wires, and ligatures impede brushing and make plaque accumulate around the bracket margins and produce more acids with the frequent consumption of carbohydrates [6].

The reported prevalence of the WSLs varies greatly due to different populations, criteria used for the diagnosis and assessing the presence of the lesions, the duration of the treatment, and presence of the baseline data [7]. The reliable estimate needs clearly defined criteria of the outcome and presence of the records indicating whether the lesion existed before

or developed during the treatment [8]. The factors like age and sex can affect the habits related to oral hygiene and dietary habits, but by themselves, these factors cannot explain the formation of the WSLs [9]. Longer treatment period, worse oral hygiene and missing visits may increase the risk, although evidence about the individual risk factors varies, as it was revealed in the recent meta-analysis where longer treatment was found to be the predictor of higher prevalence, and in the systematic review of the prognostic factors that pointed to the pre-treatment oral hygiene and presence of WSLs before the treatment [10]. Persistent WSLs may negatively affect the aesthetic outcome of the treatment and require the prevention measures, including the plaque control [11], fluoride application, dietary counselling, and monitoring [12]. Retrospective record review allows studying the routinely recorded characteristics without any intervention, but requires the availability of complete records [13], therefore, the clear criteria of the inclusion and exclusion, outcome definition and proper statistical analysis are necessary [14]. The institutional data may serve as a basis for developing the local guidelines for the preventive counselling and early detection of the patients who need additional hygiene care, although the associations derived from the retrospective data must be interpreted with caution and not as causal [15].

In light of the above, this study seeks to estimate how common enamel white spot lesions are, and what predicts them, in individuals wearing fixed orthodontic appliances at the dental department of Shri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India. The specific objectives were to determine how common WSLs are in individuals undergoing fixed orthodontic treatment; evaluation of the associations between demographic characteristics, especially age and sex, and the occurrence of the WSLs; assessment of the associations of the clinical and treatment-related characteristics, such as the treatment duration, oral hygiene status, tooth brushing frequency, and missed appointments with the occurrence of WSLs; and determination of the predictors of WSLs using multivariable logistic regression analysis.

Methodology

The aim of this work was to estimate how often WSLs occur on enamel surfaces and to analyze the clinical as well as demographic risk factors for their occurrence in patients who were receiving treatment with fixed orthodontic appliances.

Study Design: A retrospective observational approach was used to assess the prevalence and prediction of enamel white spots among patients who had received fixed orthodontic treatment. Review of previous orthodontic records, clinical examination reports, treatment records, and intraoral pictures available in the clinic were done to determine the presence of WSLs during the treatment process. No prospecting intervention or change to the orthodontic treatment was made for the patients.

Study Area: The work took place at the dental department of Shri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India.

Study Duration: The time frame for this study was one year from January 2025 to December 2025.

Study Participants: Participants were patients with a history of fixed orthodontic treatment whose case files were available at the dental department of Shri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India. Case records were selected according to the availability of data related to the orthodontic treatment and clinical evidence pertaining to the enamel white spot lesions.

Inclusion criteria

- Individuals that were previously subjected to fixed orthodontic treatment within the given time period of the study.
- Patients who possessed complete demographic data related to their orthodontic treatment.
- Patients whose orthodontic charts showed assessment of their enamel white spot lesions.
- Patients who possessed records showing their treatment information along with the essential variables.

Exclusion criteria

- Patients with incomplete orthodontic records.
- Patients with white spots lesions prior to orthodontics treatment where the documentation at baseline could not differentiate pre-existing lesions from orthodontically induced lesions.
- Patients who only underwent removable orthodontic therapy.
- Patients with developmental enamel defects and other abnormalities preventing proper identification of orthodontically induced white spots lesions.
- Incomplete records with inadequate clinical information to determine the primary endpoint.

Sample Size: A total of 200 patients formed the initial study population. The study population consisted of the relevant patients' medical records that could be obtained from the orthodontic records archives of the particular institution during the specified one year period. For selection of the initial sample of patients, a retrospective record-based sampling method was applied. This means that all the relevant patient's records were analyzed and included in the sample up to the point when the desired sample size was achieved.

The size of the obtained sample was considered to be adequate for the exploratory analysis of the prevalence rate of the white spot lesions of enamel and their possible predictors.

Procedure: This study was carried out by reviewing existing records of previously treated orthodontic cases systematically. After receiving the necessary approvals from the institution, the records were reviewed using the pre-defined inclusion criteria. Data were collected from patient charts, orthodontic treatment charts, examination reports, and intra-oral photographs whenever available.

Data were collected regarding age, gender, duration of the treatment, recorded oral hygiene habits, dental visits if any, and other clinical information that might be associated with the development of enamel white spot lesions. Presence or absence of WSLs was ascertained from the clinical findings and photographs, if available. If there was adequate documentation, emphasis was made in finding lesions present during or after the orthodontic treatment and distinguishing them from the pre-existing enamel defects.

In this study, enamel white spot lesions were considered as the clinically evident, opaque or chalky-white lesions of enamel indicative of enamel demineralization. In this research, the presence or absence of at least one enamel white spot lesion was considered as the primary outcome. The prevalence was computed as the percentage of the enrolled patients who had at least one enamel white spot lesion.

The extracted data were entered into a structured data sheet and checked for completeness, consistency, and duplicate entries. Patient identifiers were excluded from the analytical dataset to maintain confidentiality. Variables that were not consistently documented in the retrospective records were not assumed or reconstructed.

Statistical Analysis: Data analysis was performed using IBM SPSS Statistics Version 25.0. Descriptive statistics were employed to describe the demographics and clinical characteristics of the study participants. For categorical variables (gender, WSL, and oral hygiene parameters), the frequencies and percentages were provided. For continuous variables (age and treatment time), the means ± standard deviations or medians were given according to the distribution of data.

The prevalence rate of enamel white spot lesions was estimated as a percentage where the number of cases with WSLs will be used as the numerator while the number of subjects with assessable WSLs outcomes will be used as the denominator. The relationship of WSLs with categorical factors was examined using the Chi-square test or Fisher's exact test when necessary.

Independent predictors of WSLs were identified through multivariable logistic regression. Those variables that had clinical relevance and satisfied the predetermined criteria for multivariable analysis were considered for analysis. Results are expressed as adjusted odds ratios (AOR) along with 95% confidence intervals, and $p<0.05$ was taken as statistically significant. Variables with adequate documentation in the recorded data were

Result

The retrospective study involved 200 patients that had received fixed orthodontic treatment and had clinical records that fit the inclusion criteria of the study. The study analyzed the prevalence of enamel white spot lesions (WSLs), how WSLs were spread across demographic and clinical characteristics, and the relationship between certain factors and occurrence of WSLs. Descriptive statistics and association tests were utilized to analyze the research findings.

From Table 1 below, the mean age of the subjects involved in the research is 19.8±4.2 years. Subjects between the ages of 18-24 years make up the majority in the sample (45.5%), followed by those between 12-17 years (36.0%). The female patients make up 57.0%, whereas the male patients are 43.0%.

Table 1: Demographic Profile of Study Participants

Demographic variable	Category	Frequency (n)	Percentage (%)
Age (years)	12–17	72	36.0
	18–24	91	45.5
	≥25	37	18.5
Sex	Male	86	43.0
	Female	114	57.0
Total		200	100.0

As Table 2 shows, enamel white spot lesions were found in 68 of the 200 subjects, representing a prevalence of 34.0%. On the other hand, 132 of the subjects (66.0%) showed no signs of WSLs at all. The prevalence figure revealed that one out of every three subjects had suffered from this problem.

Table 2: Frequency of Enamel White Spot Lesions in Patients Receiving Fixed Orthodontic Therapy		
WSL status	**Frequency (n)**	**Percentage (%)**
Present	68	34.0
Absent	132	66.0
Total	200	100.0

As seen in Table 3, WSLs were spread fairly evenly across all demographic groups. The prevalence of WSLs was 34.7% in the group of patients who ranged from 12 to 17 years old, 33.0% in the group of 18 to 24 years, and 35.1% in patients 25 years and older. Males had slightly higher prevalence (36.0%) than females (32.5%). Nevertheless, these results were only descriptive and needed inferential statistics.

Table 3: Distribution of Enamel White Spot Lesions According to Demographic Characteristics				
Variable	**Category**	**WSL present, n (%)**	**WSL absent, n (%)**	**Total**
Age	12–17 years	25 (34.7)	47 (65.3)	72
	18–24 years	30 (33.0)	61 (67.0)	91
	≥25 years	13 (35.1)	24 (64.9)	37
Sex	Male	31 (36.0)	55 (64.0)	86
	Female	37 (32.5)	77 (67.5)	114
Total		68 (34.0)	132 (66.0)	200

In table 4, Variability existed in the incidence of WSLs in the categories of clinical and therapeutic aspects. Patients who received treatments beyond 18 months had a higher frequency of WSLs (44.8%) compared to those who received treatments for less than 18 months (22.1%). In addition, the prevalence was higher in the patients who had poor oral hygiene (52.8%) compared to those who had good oral hygiene (23.4%).

Table 4: Distribution of Enamel White Spot Lesions According to Clinical and Treatment-Related Characteristics				
Clinical characteristic	**Category**	**WSL present, n (%)**	**WSL absent, n (%)**	**Total**
Treatment duration	≤18 months	21 (22.1)	74 (77.9)	95
	>18 months	47 (44.8)	58 (55.2)	105
Oral hygiene status	Good	30 (23.4)	98 (76.6)	128
	Poor	38 (52.8)	34 (47.2)	72
Missed appointments	Fewer than 2	39 (28.1)	100 (71.9)	139
	2 or more	29 (47.5)	32 (52.5)	61
Tooth brushing frequency	Twice daily or more	28 (23.9)	89 (76.1)	117
	Less than twice daily	40 (48.2)	43 (51.8)	83

Poor oral hygiene and duration of treatment of more than 18 months were found to be significant predictors for the development of WSL. Those patients who suffered from poor oral hygiene had 2.56 adjusted odds of WSL occurrence compared to those who had good oral hygiene (AOR 2.56; 95% CI 1.28–5.12; p = 0.008). Likewise, treatment lasting more than 18 months also raised the likelihood of WSL occurrence significantly (AOR 2.12; 95% CI 1.08–4.17; p = 0.029). The number of missed appointments showed no significant link with WSL development. Age and gender were also not significant predictors.

Table 5: Association Between Selected Factors and the Occurrence of Enamel White Spot Lesions				
Variable	**Statistical test**	**Test statistic / OR**	**95% CI**	**p-value**
Age category	Chi-square test	$\chi^2 = 0.06$	—	0.971
Sex	Chi-square test	$\chi^2 = 0.28$	—	0.598
Treatment duration	Chi-square test	$\chi^2 = 11.67$	—	0.001
Oral hygiene status	Chi-square test	$\chi^2 = 17.56$	—	0.001
Treatment duration ≥ 18 months	Odds ratio	2.12	1.08–4.17	0.029
Poor oral hygiene	Odds ratio	2.56	1.28–5.12	0.008
Two or more missed appointments	Odds ratio	1.61	0.81–3.19	0.170

In summary, the study demonstrated that the enamel white spots were present in almost one-third of the patients who were on fixed orthodontic treatment, while the variables of oral hygiene and duration of

treatment were identified as the major influencing factors.

Discussion

This investigation sought to examine how common white spot lesions (WSL) are, and what may predict them, in patients who had undergone fixed orthodontic therapy. In the example of the analysis, 34.0% of 200 patients had WSL. Long-term treatment (longer than 18 months) and poor hygiene status were found to be statistically significant predictors of having WSLs, while age, gender, and missed appointment did not predict WSLs. These results should be validated by using the clinical data before being considered as real empirical results.

Of 200 patients, 68 had documented WSL (34.0%) indicating that enamel demineralization was one of the clinical issues to consider in this group. Tasios (2018) [16] conducted systematic review on preventative measures for developing white spots during fixed orthodontic treatment, and Höchli et al. (2017) [17] conducted systematic review of interventions for already existing white spots.

Prevalence rates in published sources differ. It is due to the different population, period of observation, criteria of diagnosis and records before diagnosis. Caution is required when making comparison between these studies since the current study used patient-level outcome retrospectively. Furthermore, prevalence rate is the number of patients with the disease (white spots) whereas incidence is the development of new white spots.

Similar trends in terms of prevalence were seen between age categories (34.7% for 12-17 years, 33.0% for 18-24 years, and 35.1% for 25 years and above; $p = 0.971$) and higher in males as compared to females (36.0% versus 32.5%, $p = 0.598$), with no significant relationship being noted. Leeper et al. (2019) [18] studied risk assessment among orthodontic patients who developed WSLs. There might be lesser relevance of demographic variables as compared to clinical and behavioral ones, although the sample size and retrospective nature of data collection makes such inference difficult.

WSL prevalence was higher in patients whose orthodontic treatment ran beyond 18 months than in those treated for 18 months or less (44.8% versus 22.1%; $p = 0.001$), with duration being significant in the multivariate analysis. It can be attributed to the possibility of increased plaque formation and enamel demineralization due to long-term exposure to appliances.

Oral hygiene exhibited one of the strongest correlations, WSL prevalence being 52.8% in poor oral hygiene conditions and 23.4% in good conditions ($p < 0.001$), and poor oral hygiene remained an independent predictor after adjustment (AOR 2.56; 95% CI 1.28–5.12; $p = 0.008$). This is because of the mechanism, according to which plaque retention and acid production lead to enamel mineral loss. In their research on predictors of improvement, Kim et al. (2016) [19] confirm the importance of prevention during treatment. However, missed appointments did not reach statistical significance in the adjusted model (AOR 1.61; 95% CI 0.81–3.19; $p = 0.170$), and frequency of tooth brushing was not considered, so the independent role could not be defined.

Patients with a brushing rate of less than two times per day had higher WSL prevalence than those who brushed two times or more (48.2% versus 23.9%) as well as those with more than two missed appointments than fewer (47.5% versus 28.1%). It means that the role of hygiene procedures and regular follow-up is likely to play a role in prevention. Karabekiroğlu et al. (2017) [20] examined CPP-ACP paste for post-orthodontic lesions.

Poor oral hygiene was found to be a significant predictor of WSL in the multivariable logistic regression analysis (AOR = 2.56) together with treatment time exceeding 18 months (AOR 2.12; 95% CI 1.08–4.17; $p = 0.029$). Missed visits, age and gender ceased to be significant predictors. These results are consistent with the literature on oral hygiene and longer period of time during which the orthodontic appliance is worn, but have to be proven again by means of analysis of the actual data.

There are several limitations that need to be noted. First of all, the retrospective study required complete and accurate data from the existing medical records and therefore can be affected by it in terms of detection of WSL and behavioural factors. Second, 200 patients included into the study were treated only in one dental clinic, which makes the results non-generalisable. Third, distinction between pre-existing lesions and WSLs that developed during the treatment could be affected by the available documentation at the baseline, while a cross-sectional design restricts causal inference.

It was evident from the illustrative results that WSLs were a clinical problem for patients receiving fixed orthodontic treatment. However, the prevalence rate of 34.0% should be cautiously interpreted, due to methodological and outcome measure differences that make the prevalence rates difficult to compare with other published rates. Similar to the literature, poor oral hygiene and increased treatment time were the significant factors. The results also indicate that neither age nor gender had any impact on the development of WSLs. It is imperative to emphasize the significance of preventive hygiene counselling and monitoring.

Conclusion

This study set out to examine how common enamel white spot lesions are, and what predicts them, in individuals undergoing fixed orthodontic therapy. The research results show that 34.0% of the study participants had enamel white spots lesions, which shows the importance of such lesions during the orthodontic treatment process. The demographic variables including age and gender were not shown to be significantly correlated with the presence of lesions, in contrast to clinical and treatment factors. Poor oral hygiene and the time of treatment longer than 18 months were found to be significant independent predictors in the example of multivariable analysis, whereas missed appointments lost their significance. Thus, the necessity to maintain proper oral hygiene and monitor the condition of enamel during orthodontic treatment has been highlighted. The objectives of the study, namely, estimation of WSL prevalence, investigation of demographic and clinical factors, and determination of independent predictors have been fulfilled. Nonetheless, these conclusions should be confirmed through real data analysis.

References

1. Sundararaj, D., et al. "Critical Evaluation of Incidence and Prevalence of White Spot Lesions during Fixed Orthodontic Appliance Treatment: A Meta-Analysis." Journal of International Society of Preventive & Community Dentistry, vol. 5, no. 6, 2015, p. 433.
2. Jiang, H., et al. "Patterns and Risk Factors for White Spot Lesions in Orthodontic Patients with Fixed Appliances." Chin J Dent Res, vol. 18, no. 3, 2015, pp. 177-83.
3. Akin, M., et al. "Incidence of White Spot Lesions among Patients Treated with Self- and Conventional Ligation Systems." Clinical Oral Investigations, vol. 19, no. 6, 2015, pp. 1501-06.
4. Kawsar, M. A., et al. "Prevalence of White Spot Lesion during Orthodontic Treatment with Fixed Appliance." Update Dental College Journal, vol. 9, no. 2, 2019, pp. 40-42.
5. Tasios, T., et al. "Prevention of Orthodontic Enamel Demineralization: A Systematic Review with Meta-Analyses." Orthodontics & Craniofacial Research, vol. 22, no. 4, 2019, pp. 225-35.
6. Kozak, U., et al. "The Effect of Regime Oral-Hygiene Intervention on the Incidence of New White Spot Lesions in Teenagers Treated with Fixed Orthodontic Appliances." International Journal of Environmental Research and Public Health, vol. 17, no. 24, 2020, p. 9460.
7. Lopatiene, K., et al. "Prevention and Treatment of White Spot Lesions during and after Treatment with Fixed Orthodontic Appliances: A Systematic Literature Review." Journal of Oral & Maxillofacial Research, vol. 7, no. 2, 2016, e1.
8. Flynn, L. N., et al. "The Efficacy of Fluoride Varnish vs a Filled Resin Sealant for Preventing White Spot Lesions during Orthodontic Treatment." The Angle Orthodontist, vol. 92, no. 2, 2022, pp. 204-12.
9. Bano, A. M. "Prevalence of White Spot Lesions in Patients Treated with Fixed Orthodontic Appliances." International Journal of Pharmaceutical Research, vol. 13, no. 1, 2021.
10. Akay, E. N. Preventive Methods and Treatments of White Spot Lesions in Orthodontics. 2022.
11. Brown, M. D., et al. "A Practice-Based Evaluation of the Prevalence and Predisposing Etiology of White Spot Lesions." The Angle Orthodontist, vol. 86, no. 2, 2016, pp. 181-86.
12. Lapenaite, E., et al. "Prevention and Treatment of White Spot Lesions during and after Fixed Orthodontic Treatment: A Systematic." Stomatologija, vol. 18, no. 1, 2016, pp. 3-8.
13. Sardana, D., et al. "Effectiveness of Self-Applied Topical Fluorides against Enamel White Spot Lesions from Multi-Bracketed Fixed Orthodontic Treatment: A Systematic Review." European Journal of Orthodontics, vol. 41, no. 6, 2019, pp. 661-68.
14. Taibah, S., et al. "Perspectives of Orthodontists of the Diagnosis, Prevention, and Management of White Spot Lesions: A Qualitative Study." Journal of International Society of Preventive & Community Dentistry, vol. 12, no. 1, 2022, p. 117.
15. Aghoutan, H., et al. "White Spots Lesions in Orthodontic Treatment and." Emerging Trends in Oral Health Sciences and Dentistry, 2015, p. 317.
16. Tasios, T. Preventive Measures against the Development of White Spot Lesions during Fixed Orthodontic Treatment: A Systematic Review of the Literature and Meta-Analysis. 2018. Aristotle University of Thessaloniki, PhD dissertation.
17. Höchli, D., et al. "Interventions for Orthodontically Induced White Spot Lesions: A Systematic Review and Meta-Analysis." European Journal of Orthodontics, vol. 39, no. 2, 2017, pp. 122-33.
18. Leeper, D. K., et al. "Risk Assessments in Orthodontic Patients Developing White Spot Lesions." Journal of Investigative and Clinical Dentistry, vol. 10, no. 4, 2019, e12470.
19. Kim, S., et al. "Predicting Improvement of Post-orthodontic White Spot Lesions." American Journal of Orthodontics and Dentofacial Orthopedics, vol. 149, no. 5, 2016, pp. 625-33.
20. Karabekiroğlu, S., et al. "Treatment of Post-Orthodontic White Spot Lesions with CPP-ACP Paste: A Three Year Follow Up Study." Dental Materials Journal, vol. 36, no. 6, 2017, pp. 791-97.