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Effects of a fluoride-releasing orthodontic cement on preventing the development of white spot lesions

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Abstract

Objective: This study aimed to evaluate the efficacy of "Embrace WetBond", a fluoride-releasing self-adhesive resin cement in preventing the development of white spot lesions (WSLs) during orthodontic treatment.

Methods: This retrospective cross-sectional study was conducted on the dental records of 140 patients treated with fixed orthodontic appliances in a private orthodontic clinic in Tehran, Iran. Patients were divided into two equal groups based on the type of adhesive used for bonding orthodontic attachments: Group 1 (control), Transbond XT and Group 2, Embrace wetBond. The prevalence and severity of WSLs were assessed in all teeth from the first molar to the first molar of both jaws using post-treatment photographs. The data were analyzed by chi-square and Mann-Whitney U test and a P-value<0.05 was considered statistically significant.

Results: The prevalence and severity of WSLs were significantly lower in the Embrace WetBond group compared to the Transbond XT group (P=0.02 and P=0.003). The difference in WSL prevalence between the maxilla and mandible was insignificant within each group (P>0.05). The highest prevalence of WSLs was in maxillary lateral incisors (21.4%) and mandibular first molars (15.7%) in the Transbond XT group and maxillary lateral incisors (7.1%) in the WetBond group.

Conclusions: The findings of this study suggest that Embrace WetBond adhesive may effectively reduce the risk of WSL development in patients treated with fixed orthodontic appliances. This fluoride-releasing self-adhesive resin cement can be considered a suitable alternative to traditional cement in orthodontic practice.

Keywords: Dental caries, Fluoride, Orthodontic brackets, Orthodontic treatment, Resin cement, White spot lesions

Introduction

Orthodontic treatment corrects dentoskeletal relationships, improves esthetics, and enhances masticatory function (1). However, enamel demineralization or white spot lesions (WSLs) frequently occur around orthodontic attachments, compromising the esthetic outcome of therapy (2). Food retention around orthodontic attachments, inadequate oral hygiene practices, and decreased cleaning efficacy of saliva and muscles increase the prevalence of WSLs in patients with fixed orthodontic appliances (3, 4).

During orthodontic treatment, the accumulation of dental plaque around orthodontic brackets decreases the pH of the oral cavity. Acidic pH leads to the dissolution of calcium and phosphorus from the tooth structure, causing enamel demineralization. This process can be reversed if pH normalizes. Prolonged low pH levels lead to further enamel demineralization, creating a matte white appearance known as WSLs. The prevalence of WSLs ranges from 26% to 89% in orthodontic patients (5).

Fluoride application is an important measure for caries prevention. Fluoride inhibits cariogenic bacteria, increases calcium hydroxide and fluorapatite formation, and improves enamel resistance to acid attacks (6). Fluoride can be administered via toothpastes, mouthwashes, varnishes, or gels. However, less than

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15% of orthodontic patients adhere to daily use of prescribed mouthwashes (7).

Poor patient adherence to fluoride use led researchers to develop fluoride-releasing orthodontic adhesives as an alternative strategy. However, the practical use of these adhesives depends on their adequate bond strength and sufficient fluoride release (8). Traditionally, resin-modified glass-ionomer cement has been recommended for bonding orthodontic attachments, but it is not preferred in areas subjected to high masticatory forces (4). Self-adhesive resin cements have fewer procedural steps (9). Manufacturers claim that these adhesives release fluoride, which can reduce enamel demineralization and formation of WSLs around orthodontic brackets (10). They are easy to mix, time-saving, and suitable for indirect bonding, combining the advantages of glass ionomers with the superior mechanical properties of composite resins (11).

This study aimed to assess the effect of orthodontic bracket bonding with fluoride-releasing self-adhesive resin cement (Embrace WetBond) on the prevalence and severity of WSLs compared to Transbond XT.

Materials and methods

Study design and participants

The protocol of this study was approved by the ethics committee of Shahed University of Medical Sciences (IR.SU.DENTISTRY.REC.1397.301). This retrospective cross-sectional study was conducted on the dental records of patients treated with fixed orthodontic appliances in a private orthodontic clinic in Tehran, Iran, from January 2019 to March 2021. The patients were 11-17 years of age with no missing teeth or congenital tooth anomalies, and their appliances were bonded with either a conventional composite resin or a fluoride-releasing self-adhesive cement. The baseline dental photographs were evaluated to exclude patients showing WSLs, caries, or restorations on the buccal surface of maxillary and mandibular teeth. All patients were treated without tooth extraction in a treatment period between 15 to 18 months. Patients with systemic diseases, oral cysts, or long-term medication intake due to chronic conditions were excluded. Written consent was obtained from patients concerning the anonymous use of their records in future examinations.

Study procedure

The dental records of 140 patients were selected according to the inclusion and exclusion criteria. Participants were selected by convenience sampling method. All patients underwent fixed orthodontic therapy with metal brackets (3M Unitek, Monrovia, CA, USA).

The patients were divided into two groups based on the type of cement used for bracket bonding. In group 1 (control), brackets were bonded with Transbond XT adhesive (3M Unitek). The metal brackets in group 2 were bonded by fluoride-releasing dual-cure self-adhesive resin cement (Embrace WetBond; Pulpdent, Watertown, MA, USA) (12, 13). The same clinician explained standardized oral hygiene to all patients. The patients were advised to use fluoride-containing toothpaste and no other fluoridated products.

Assessing the prevalence and severity of WSLs

In post-orthodontic photographs of each patient, teeth from the first molar to the first molar were evaluated in both jaws. The frequency and severity of WSLs were recorded by an experienced orthodontist (M.M.) in the bonded teeth of all patients (14, 15). For assessing the lesions' severity, the classification proposed by Gorelick et al. (5) was employed as follows:

Score 0: No WSL is observed on the tooth surface (no enamel demineralization).

Score 1: Less than one-third of the tooth surface showed WSL (mild enamel demineralization).

Score 2: Over one-third of the tooth surface had WSL (moderate enamel demineralization).

Score 3: Cavitation of the tooth surface is visible (severe enamel demineralization).

In patients with multiple WSLs, the highest severity of WSLs was recorded and included in the statistical analysis.

Statistical analysis

Data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL, USA). The chi-square and Mann-Whitney U tests were used for data analysis. The level of significance was set at $P < 0.05$.

Results

A total of 140 records were retrospectively reviewed. Patients in the Transbond XT and Embrace WetBond group had a mean age of 14 ± 3.4 and 13 ± 3.9 years, respectively ($P = 0.11$).

Table 1 presents the frequency of WSLs in the two groups. The chi-square test revealed a significantly higher overall prevalence of WSLs in the Transbond XT group compared to the Embrace WetBond group ($P=0.02$; Table 1). Table 2 presents the severity of WSLs

Table 1. Frequency and percentage of patients with white spot lesions (WSLs) in the study groups

Group	Absence of WSLs	Presence of WSLs
Transbond XT	51 (72.85 %)	19 (27.14 %)
Embrace WetBond	64 (91.4 %)	6 (8.5 %)
P-value	0.02	

Table 2. The distribution of white spot lesions (WSLs) scores in the study groups

Group	Score 0	Score 1	Score 2	Score 3
Transbond XT	51 (72.85 %)	11 (15.7 %)	8 (11.4 %)	0 (0 %)
Embrace WetBond	64 (91.4 %)	6 (8.5 %)	0 (0 %)	0 (0 %)
P-value	0.003			

in the study groups. Mann-Whitney U test revealed that there was a statistically significant difference between the two study groups in terms of the severity of WSLs (P=0.003; Table 2).

Table 3 presents the prevalence of WSLs around each bonded tooth in both jaws of the study groups. In the Trasnbond XT group, the highest and lowest prevalence of WSLs was around the maxillary lateral incisors (21.4%) and mandibular central incisors (2.8%), respectively. In the Embrace WetBond group, WSLs were again most frequently observed around maxillary lateral incisors (7.1%). None of the maxillary premolars, mandibular central incisors or mandibular canines in the Embrace WetBond group, showed any WSLs.

There was no significant difference in the prevalence of WSLs between the maxilla and mandible in the Transbond XT group (P=0.9; Table 4) and the Embrace WetBond group (P=0.8; Table 4). Moreover, the prevalence of WSLs in the participants' teeth in the Transbond XT groups (4.6%) was significantly higher than in the Embrace WetBond group (1.1%; p<0.001; Table 4).

Discussion

This study evaluated the development of WSLs around orthodontic brackets bonded with a fluoride-releasing self-adhesive resin cement (Embrace WetBond) compared with a conventional orthodontic composite (Transbond XT). Multiple methods exist for assessing enamel demineralization. This study evaluated pre- and post-treatment photographs to assess the development of WSLs. Sardana et al. (16) stated that clinical photographs are more valid than DIAGNOdent™ pen in diagnosing WSLs during fixed orthodontic treatment.

The present study showed that bracket bonding with Embrace WetBond was associated with a lower prevalence of post-orthodontic WSLs (27.14%) than that of Transbond XT (8.5%) in orthodontic patients. The severity of WSLs and the overall number of teeth with WSLs were also significantly lower in the Embrace WetBond than in the Transbond XT group. The efficacy of Embrace WetBond in reducing WSLs is attributed to its fluoride release, which promotes the formation of high-quality hydroxyapatite and enamel remineralization.

The findings of this study align with prior research showing the efficacy of fluoride-releasing agents in reducing WSL development. Nascimento et al. (17) indicated that applying fluoride-releasing agents decreased WSLs around orthodontic brackets by 58%, especially when a fluoride-releasing adhesive was used. This effect was less profound with fluoride-releasing

Table 3. Frequency of white spot lesions (WSLs) around brackets based on tooth type in the two groups

Group		Tooth number					
		1	2	3	4	5	6
Transbond XT	Maxilla	7	15	5	3	4	5
		10%	21.4%	7.1%	4.2%	5.7%	7.1%
	Mandible	2	5	4	8	8	11
		2.8%	7.1%	5.7%	11.4%	11.4%	15.7%
Embrace WetBond	Maxilla	1	5	2	0	0	2
		1.4%	7.1%	2.8%	0	0	2.8%
	Mandible	0	2	0	1	3	3
		0	2.8%	0	1.4%	4.2%	4.2%

Table 4. Frequency and percentage of white spot lesions (WSLs) around brackets in bonded teeth of both jaws in the study groups

Orthodontic cement	Jaw	Absence of WSLs	Presence of WSLs	P-value
Transbond XT	Maxilla	801 (95.4)	39 (4.6)	
	Mandible	802 (95.5)	38 (4.5)	
	Total	1603 (95.4)	77 (4.6)	
	P-value	0.9		<0.001
Embrace Wet Bond	Maxilla	830 (98.8)	10 (1.2)	
	Mandible	831 (98.9)	9 (1.1)	
	Total	1661 (98.9)	19 (1.1)	
	P-value	0.8		

varnishes and unsatisfactory when using fluoride-releasing sealants. Wang et al. (18) recommended using fluoride-releasing adhesives and the use of fluoridated mouthwashes for high caries-risk patients, which aligns with the present findings. Ramazanzadeh et al. (19) compared Embrace WetBond self-adhesive resin cement with Transbond XT and concluded that fluoride release from Embrace WetBond was significantly greater than Transbond XT. Studies on glass ionomer cement also support the benefits of fluoride in reducing demineralization around brackets (3, 10, 20).

In contrast to the findings of this study, Banks et al. (14) compared two composite adhesives and stated that adding fluoride to adhesives did not decrease the incidence of enamel demineralization. The difference between the results of Banks et al. (14) and the present findings may be attributed to different types of cement used or different methodologies adopted for the assessment of demineralization. They used a split-mouth design and employed the EDI index to measure the extent of WSLs, which differs from Gorelick's classification (5) used in the present study. The adoption of a split-mouth design may create a significant confounding effect. It is possible that the fluoride released from the fluoride-releasing adhesive enters the saliva and affects the teeth in the other quadrant. Thus, the difference between the two groups may be falsely minimized. A similar design was also adopted by Alabdullah et al. (21), with the difference that they measured the extent of lesions visually and using DIAGNOdent and digital photography. They concluded that fluoride-containing adhesive resin had no preventive effect on the development of WSLs.

This study showed no significant difference in the prevalence of WSLs between the maxilla and mandible within each group. Maxillary lateral incisors were the teeth most affected teeth in both study groups. This suggests that this area may experience higher plaque accumulation and inadequate plaque removal, leading to a higher incidence of WSLs. Similar to the present findings, Chapman et al. (22) reported a high prevalence of WSLs on the buccal surface of maxillary lateral incisors after fixed orthodontic therapy. Kumar Jena et al. (20) also reported that the highest WSL prevalence was observed around brackets bonded to the maxillary lateral incisors. Contrary to present findings, Tufekci et al. (15) reported an equal prevalence of WSLs across all teeth. Their focus on the maxillary anterior teeth and the gingival tooth third might explain this finding. Ong et al. (23) found the highest WSL prevalence in the mandibular premolars and first molars. The discrepancies between the findings of these studies may be due to differences in sample size and the type of adhesive used.

Bond strength is a crucial factor in orthodontic treatments to ensure that brackets remain securely attached throughout the treatment period. Several studies have shown that self-adhesive resin cement like Embrace WetBond provides sufficient bond strength, comparable to traditional adhesives while offering the advantage of fluoride release to reduce the risk of WSLs (9, 10, 11). Self-adhesive resin cements are also valued for their simplified application process, which reduces chair time and procedural complexity (9). However, some studies suggest that self-adhesive cement may have lower shear bond strength than conventional adhesives, potentially leading to a higher incidence of bracket debonding (24). This aspect was not measured in the present study. Future investigations should consider the trade-offs between fluoride release benefits and the mechanical performance of orthodontic adhesives. From a cost-effectiveness perspective, while self-adhesive cements like Embrace WetBond may be more expensive than conventional adhesives, their potential to significantly reduce WSLs could result in long-term savings by decreasing the need for treatment of tooth demineralization and its associated complications. Therefore, improving patient

outcomes and satisfaction and reducing treatment time may justify the higher initial costs.

The present study has some limitations. Several factors could affect the results, such as the bias in sample selection, the misdiagnosis of WSLs in digital photographs, inter-individual differences in oral microflora, and variations in saliva quantity and oral hygiene measures between patients. Future studies with a larger sample size are suggested to assess the efficacy of fluoride-releasing adhesives in preventing enamel caries in orthodontic patients.

Conclusions

This study demonstrated a significantly lower prevalence and severity of WSLs in orthodontic patients when Embrace WetBond was used for bonding brackets compared to Transbond XT adhesive. Thus, integrating Embrace WetBond fluoride-releasing cement into clinical orthodontic practice could be an effective approach to mitigate the development of WSLs, potentially improving patient outcomes and satisfaction.

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Conflict of Interests

There is no conflict of interest to declare.

Authors contributions

MM: Designed, managed, supervised the project, and conducted the study. BS: collected and analyzed the data, wrote the original draft and corrected the manuscript. All authors read and approved the final manuscript.

Ethical approval

The protocol of this study was approved by the ethics committee of Shahed University of Medical Sciences (IR.SU.DENTISTRY.REC.1397.301).

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References

1. Sardana D, Manchanda S, Ekambaram M, Yang Y, McGrath CP, Yiu CKY. Prevention of demineralization during multi-bracketed fixed orthodontic treatment: An overview of systematic reviews. Int J Paediatr Dent 2022;32(4):473-502.
2. Bock NC, von Bremen J, Klaus K, Schulz-Weidner N, Ganss C, Ruf S. White spot lesions after fixed appliance treatment-Can we expect spontaneous long-term (≥15 years) improvement? Eur J Orthod 2024;46(1):cjad070.
3. Shankarappa S, Burk JT, Subbaiah P, Rao RN, Doddawad VG. White spot lesions in fixed orthodontic treatment: Etiology, pathophysiology, diagnosis, treatment, and future research perspectives. J Orthod Sci 2024;13:21-30.
4. Fricker JP. Therapeutic properties of glass-ionomer cements: Their application to orthodontic treatment. Aust Dent J 2022;67(1):12-20.
5. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod 1982;81(2):93-98.
6. Parisay I, Boskabady M, Bagheri H, Babazadeh S, Hoseinzadeh M, Esmaeilzadeh F. Investigating the efficacy of a varnish containing gallic acid on remineralization of enamel lesions: an in vitro study. BMC Oral Health 2024;24(1):175.
7. Salerno C, Grazia Cagetti M, Cirio S, Esteves-Oliveira M, Wierichs RJ, Kloukos D, Campus G. Distribution of initial caries lesions in relation to fixed orthodontic therapy. A systematic review and meta-analysis. Eur J Orthod 2024;46(2):cjae008.
8. Ferreira RS, Ricomini-Filho AP, Tabchoury CP, Vale GC. Effect of high-fluoride dentifrice and bracket bonding composite material on enamel demineralization in situ. Clin Oral Investig 2020;24(9):3105-3112.
9. Swartz ML, Phillips RW, Rhodes B. Visible light-activated resins--depth of cure. J Am Dent Assoc 1983;106(5):634-637.
10. Lara-Carrillo E, Millán-Hernández XA, Salmerón-Valdéz EN, Scougall-Vilchis RJ, Medina-Solís CE, Toral-Rizo VH. Fluoride releasing dental materials used in orthodontics: Literature review. J Oral Health Oral Epidemiol 2018;7(2):52-58.
11. Dimitriadi M, Petropoulou A, Zafiropoulou M, Zinelis S, Eliades G. Degree of conversion and mechanical properties of modern self-adhesive luting agents. Appl Sci 2021;11(24):12065.
12. Aryeetey EJ, Benyahia H, Zaoui F. Oral Hygiene in the Presence of Orthodontic Therapy. J Biosci Med 2024;12(2):98-110.
13. Baumer C, Schmidtmann I, Ohlendorf D, Ferrari Peron P, Wehrbein H, Erbe C. Orthodontists' instructions for oral hygiene in patients with removable and fixed orthodontic appliances. Int J Dent Hyg 2024;22(2):329-336.
14. Banks PA, Burn A, O'Brien K. A clinical evaluation of the effectiveness of including fluoride into an orthodontic bonding adhesive. Eur J Orthod 1997;19(4):391-395.
15. Tufekci E, Dixon JS, Gunsolley JC, Lindauer SJ. Prevalence of white spot lesions during orthodontic treatment with fixed appliances. Angle Orthod 2011;81(2):206-210.
16. Sardana D, Li KY, Ekambaram M, Yang Y, McGrath CP, Yiu CK. Validation of clinical photography and a laser fluorescence device for assessment of enamel demineralization during multi-bracketed fixed

orthodontic treatment. Photodiagnosis Photodyn Ther 2022;38:102828.
17. Nascimento PL, Fernandes MT, Figueiredo FE, Faria ESAL. Fluoride-Releasing Materials to Prevent White Spot Lesions around Orthodontic Brackets: A Systematic Review. Braz Dent J 2016;27(1):101-107.
18. Wang X, Wang B, Wang Y. Antibacterial orthodontic cement to combat biofilm and white spot lesions. Am J Orthod Dentofacial Orthop 2015;148(6):974-981.
19. Ramazanzadeh BA, Merati M, Shafaee H, Dogon L, Sohrabi K. In-vitro evaluation of an experimental method for bonding of orthodontic brackets with self-adhesive resin cements. European J Gen Dent 2013;2(3):264-269.
20. Kumar Jena A, Pal Singh S, Kumar Utreja A. Efficacy of resin-modified glass ionomer cement varnish in the prevention of white spot lesions during comprehensive orthodontic treatment: a split-mouth study. J Orthod 2015;42(3):200-207.
21. Alabdullah MM, Nabawia A, Ajaj MA, Saltaji H. Effect of fluoride-releasing resin composite in white spot lesions prevention: a single-centre, split-mouth, randomized controlled trial. Eur J Orthod 2017;39(6):634-640.
22. Chapman JA, Roberts WE, Eckert GJ, Kula KS, González-Cabezas C. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. Am J Orthod Dentofacial Orthop 2010;138(2):188-194.
23. Ong V, Lim ST, Yakob M, Sah HS. Factors Associated with the Development of White Spot Lesions in Orthodontic Patients Using Fixed Appliances. Malays Dent J 2023;46(1):22.
24. Lührs AK, Guhr S, Günay H, Geurtsen W. Shear bond strength of self-adhesive resins compared to resin cements with etch and rinse adhesives to enamel and dentin in vitro. Clin Oral Investig 2010;14(2):193-199.