# **Original Article**

# A practice-based evaluation of the prevalence and predisposing etiology of white spot lesions

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# ABSTRACT

**Objective:** To use an alumni-centered, practice-based research network to evaluate white spot lesions (WSLs) among treated orthodontic patients.

**Materials and Methods:** An initial survey was conducted to ascertain whether orthodontic alumni from Texas A&M University Baylor College of Dentistry were willing to participate. Twenty randomly selected alumni participated, providing 158 treated cases. Each alumnus (1) obtained internal review board consent; (2) submitted pre- and posttreatment photographs of 10 consecutively finished cases; (3) completed a treatment survey; and (4) had the patient/parent complete the American Dental Association (ADA) Caries Risk Assessment.

**Results:** Almost 90% of the alumni surveyed were willing to participate in the practice-based research, primarily because a fellow alumnus asked them to. Approximately 28% of the patients developed WSLs. The average patient developed 2.4 white spots, affecting 12.7% of the teeth examined. WSLs were significantly (P < .001) more (2.3–3.2 times) likely for patients who were identified on the ADA Caries Risk Assessment. The risk of developing WSLs during treatment was also increased for those with fair (2.7 times) or poor (3.5 times) oral hygiene, poor gingival health (2.3 times), and extended treatment times (2.1 times).

**Conclusions:** There is a substantial risk of developing WSLs among private practice patients, depending partially on the length of treatment. Patients at greatest risk can be identified prior to treatment based on the ADA Caries Risk Assessment, oral hygiene, and gingival health. (*Angle Orthod.* 2016;86:181–186.)

KEY WORDS: White spot lesions; PBRN; Risk factors

#### INTRODUCTION

Research designed to promote evidence-based practices and optimize patient care must extend beyond traditional academic clinics to private practice

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settings.<sup>1</sup> For over 20 years, medicine has been using practice-based research networks (PBRNs) to perform various types of research.<sup>2</sup> PBRNs are well suited for studying the development of white spot lesions (WSLs), which occur in 2% to 96% of patients, depending on the assessment methods used.<sup>3–7</sup> WSLs can create dissatisfaction at the end of treatment for patients, parents, referring dentists, and orthodontists and can possibly precipitate litigious proceedings.<sup>8</sup>

WSLs are preventable with proper oral hygiene, but orthodontic appliances cause plaque retention, and patients with poor compliance complicate the problem. Various methods have been proposed to prevent the development of WSLs during treatment, including oral hygiene instruction, fluoride varnish, fluoride rinses, glass ionomer cements, fluoride-releasing cements, antibacterial rinses, antibacterial cements, resinsealants, and argon lasers.<sup>9–18</sup> Orthodontists might also consider shifting toward risk-based prevention of WSLs, as general dentistry and periodontics have done for dental caries and periodontal disease.<sup>19</sup> The risk factors associated with WSLs in private practice

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settings have not been previously investigated. A PBRN would make it possible to more efficiently and effectively determine which patients are at greatest risk of developing WSLs.

The primary aims of the present study were to enlist multiple alumni from the Orthodontic Department of Texas A&M University Baylor College of Dentistry to prospectively evaluate the prevalence of WSLs and to determine risk factors associated with the development of WSLs among patients in private practice. Using alumni from the same alma mater is important because it fosters a sense of community and makes it easier to recognize the clinicians for their participation; the absence of these benefits is a well-recognized barrier to the implementation of a research network.<sup>20</sup> Using patient records from multiple practices is important to ensure the external validity of the results.

# MATERIALS AND METHODS

This study was approved by the Texas A&M University Baylor College of Dentistry Institutional Review Board in Dallas (IRB Protocol #2012-06). Informed consent was obtained from all of the participating patients.

#### **Data Collection**

Fifty-seven alumni of Texas A&M University Baylor College of Dentistry returned surveys sent to determine whether they qualified and were willing to participate. To qualify, they had to be currently taking high-quality pre- and posttreatment intraoral photos. The orthodontists also had to have been using the same measures to prevent WSLs for at least the three previous years. In addition to participating in the present study, each orthodontist was also asked about his willingness to participate based on who was conducting the clinical research.

Forty-seven alumni qualified and indicated a willingness to participate in the study. Those willing to participate were contacted and asked to submit information pertaining to 10 consecutively finished cases, including (1) pre- and posttreatment intraoral photos, (2) a treatment survey (Table 1) completed by the orthodontist, and (3) an American Dental Association (ADA) Caries Risk Assessment<sup>21</sup> completed by the patient/guardian, with help from clinical staff as needed. The treatment survey was used to identify treatment conditions that might contribute to lesion development, including the length of treatment, hygiene during treatment, and patient cooperation during treatment. The pretreatment photos made it possible to determine initial enamel condition, including preexisting lesions, as well as the pretreatment gingival health and oral hygiene status.

Table 1.	Treatment Survey	Questions
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Questions	Answer Options
1. The total active treatment duration (in	<12 months
brackets) for this patient was:	12–18 months
	18–24 months
	24-30 months
	30-30 months
0. Llow did total tractment duration relate to	>30 MONUNE Charter then eveneted
2. How did total treatment duration relate to	Shorter than expected
expected treatment duration?	As expected
	no specific reason
	Longer than expected
	due to lack of patient
	compliance
3. The patient's overall cooperation	Excellent
(keeping appointments, elastic wear,	Good
appliance breakage, etc) can best be	Fair
described as:	Poor
	0–1
	2–3
	4–5
	>5
5. Patient's overall oral hygiene during	Excellent
treatment can best be described as:	Good
	Fair
	Poor
6. The patient had to be reinstructed on	0–1
oral hygiene how many times during	2–3
treatment?	4–5
	>5
7. How would you best describe the	Healthy
patient's gingival health?	Mild gingivitis
	Moderate gingivitis
	Severe gingivitis
	Gingival hyperplasia

Each orthodontist was provided with complete sets of forms for each patient and a ledger to record the patients included in the study. The treatment surveys, caries risk assessments, forms, and flash drive with photos were returned in prepaid envelopes.

Of the 47 who indicated a willingness to participate, 20 (42.6%) returned the records of 10 consecutive cases. The final sample size included 158 patients, with some cases excluded as a result of incomplete or poor record quality.

#### Methods

Photographs were used to identify lesions that developed during the course of orthodontic treatment. Photographic analysis of WSLs associated with orthodontic treatment has been shown to be effective<sup>22</sup> and comparable to intraoral<sup>23</sup> and quantitative light-induced fluorescence (QLF)<sup>24,25</sup> assessments. Pre-treatment photos were necessary because preexisting developmental enamel defects can be mistaken for WSLs.<sup>26</sup> The maxillary and mandibular second pre-molars to second premolars were scored by one

Table 2.	Percentage (%) of Alumni Willing	to Participate in Clinical Research	n Based on Who Research Is Conducted By

	Very Willing	Moderately	Slightly	Not Willing
Fellow alumni	66.7	26.3	5.3	1.8
Orthodontic organizations	28.8	38.6	26.3	5.3
Nonalumni orthodontists	12.3	42.1	29.8	15.8
Nonorthodontist	7.0	12.3	47.4	33.3

calibrated dentist using a modified Ogaard score,<sup>6</sup> with scores ranging from 0 to 4. A score of 0 indicated that there was no white spot present, 1 was given for incipient white spot lesions that had no distinct border (ie, diffuse demineralization), 2 indicated that the lesion covered less than one-third of the buccal surface of the tooth, 3 indicated the lesion covered more than one-third of the buccal surface, and a score of 4 was given if a cavitation was present.

All records were labeled with unique identification numbers, and all assessments were blinded. The photos were loaded into Dolphin Imaging 11.0<sup>®</sup> (Chatsworth, Calif) software and viewed on a high definition LCD monitor in a darkened room. Photos were viewed individually; if a question about lesion development or progression was present the photos were viewed side by side.

#### Analysis

The lesion severity score was calculated by totaling the modified Ogaard scores for each subject and dividing by the total number of teeth with lesions present ([Total Tooth Scores]/No. of teeth with lesions). The total mouth severity score was calculated by totaling the Ogaard scores and dividing by the total number of teeth scored ([Tooth Scores]/No. of teeth scored). The scores were totaled for each patient, and final scores were recorded. The lesion development rates were compared to risk factors recorded in the ADA Caries Risk Assessment. Orthodontic appliances were assumed to be a moderate risk factor for all patients. Patients were designated low risk if all factors were classified as low risk. If a patient had two or more moderate risk factors, they were classified as moderate risk. Patients were classified as high risk if they had any factors deemed "high risk." In addition to overall risk designation, total risk scores were tabulated for each category, with each low-risk answer given a score of 0, moderate-risk answers given a score 1, and highrisk answers given a score of 2.

The preventive conditions were added to the data set after all the data had been collected. The data were then loaded in to IBM SPSS Statistics software Version 19 (Armonk, NY) for analysis.

### **Statistical Analysis**

Risk ratios and significance were determined using Chi-square analyses. Risk score totals were compared to lesion severity scores using nonparametric Spearman correlations. Lesion development was also compared to reported adverse treatment conditions (extended treatment times, poor oral hygiene, poor patient cooperation), and risk ratios were calculated (% positive for risk factor who developed lesions divided by the % negative for the risk factor who developed lesions), and the significance of these relationships was determined using Chi-square analysis.

# RESULTS

The 57 orthodontists initially surveyed indicated that they were much more willing to participate if a fellow alumnus conducted the study than if others, even orthodontic associations, conducted the study (Table 2).

Twenty-eight percent of patients developed WSLs during treatment, and another 14% exhibited diffuse demineralization (modified Ogaard score of 1). The average patient developed 2.4 white spots, affecting 12.7% of the teeth examined. The patients who developed WSLs developed an average of 5.6 lesions each.

Patients with contributing and clinical condition risk factors were 2.3 and 3.2 times more likely, respectively, to develop WSLs than were those without the same risk factors (Table 3). General health condition risk factors did not have a significant effect on lesion development. Patients who exhibited moderate or high overall risks of developing caries were 3.2 times more likely to develop WSLs during treatment than were those who had a low caries risk. Contributing (R = .345, P = .001) and clinical (R = .387, P < .001) condition risk scores were both positively correlated with increasing lesion severity score.

Patients with extended treatment times (>30 months) were also more likely (2.1 times) to develop lesions than were those with shorter treatment times (Table 4). In addition, patients with fair and/or poor oral hygiene during treatment were 2.7 and 3.5 times more likely, respectively, to develop WSLs than were other patients. Patients who required repeated oral hygiene instruction were 2.3 times more likely to develop WSLs than were those who did not. Finally, patients with moderate or severe gingivitis were 2.3 times more likely to develop WSLs than were those who did not. Finally, patients with moderate or severe gingivitis were 2.3 times more likely to develop WSLs than were other patients.

As oral hygiene worsened, lesion severity scores increased (r = .343, P = .001). Longer treatment times

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					95% Confide	% Confidence Interval	
Risk Factors	% Individual with Trait	% Individuals without Trait	Probability (P)	Risk Ratio	Lower	Upper	
Contributing condition	44	19	=.001	2.33	1.371	3.960	
General health	33	29	=.093	1.17	0.446	3.054	
Clinical condition	51	16	<.001	3.24	1.871	5.606	
Moderate to high risk	44	14	<.001	3.19	1.694	6.001	

Table 3. Risk Ratios Associated with Reported Risk Factor, Based on American Dental Association (ADA) Caries Risk Assessment

were also related to increased lesion severity scores (r = .287, P = .005), as were the number of times oral hygiene instruction had to be repeated (r = .341, P = .001). As gingival health decreased, lesion severity scores increased (r = .370, P < .001).

There were no statistically significant differences in WSLs between the patients who did and did not use preventive methods (42.6% smooth surface sealants, 30.9% varnish, 10.6% both). However, the lesions on unsealed teeth began at the interface of the bracket and enamel, whereas the lesions on sealed teeth were usually located at the gingival margin.

#### DISCUSSION

The initial group of orthodontists surveyed was most willing to participate in practice-based research conducted by an alumnus researcher. This is important because clinician participation in practice-based research depends in large part on the sense of community among the clinicians involved.<sup>20</sup> Initiating a research network through an alumni community utilizes an established community.

All those who initially expressed a willingness to participate did not do so. Only 42.5% of the respondents who indicated a willingness to participate did so. This is expected because orthodontic practices are busy, and the data collection phase required collecting records, obtaining informed consent, and completing surveys. Telephone interviews showed that most of the alumni who did not participate either forgot to reply or had put off their reply, indicating that a larger numbers of alumni could have participated. In this study 28% of patients developed definitive WSLs, and another 14% exhibited diffuse demineralization. This rate is slightly (2–5%) higher than previously reported for large-scale studies,<sup>3,27</sup> likely because more teeth were included in the current study. Chapman et al.<sup>28</sup> reported a slightly higher prevalence rate of 36%.

Patients exhibiting contributing conditions of the ADA Caries Risk Assessment were more than twice as likely to develop lesions during treatment as were patients without risk factors. Sugar exposure was the only individual risk factor that proved to be significant, with a risk ratio of 2.14. Dietary sugar influences the *Mutans Streptococci* levels of dental plaque and is highly associated with early carious lesions.<sup>29</sup> A systematic review by Tanzer et al.<sup>30</sup> confirmed the central role of *Mutans Streptococci* in the initiation of smooth surface caries.

Patients with clinical condition risk factors were 3.2 times more likely to develop WSLs during treatment than were those without such risk factors. Individuals with recent history of lesions, missing teeth due to decay, and visible plaque were at greatest risk of developing WSLs. Multiple studies<sup>31-34</sup> have shown that previous caries history is one of the best predictors of dental caries in children. Visible plaque has been identified as a risk factor for caries development in multiple studies.<sup>35-38</sup>

Treatment duration of greater than 30 months more than doubled the likelihood that patients will develop lesions during treatment. Julien et al.<sup>3</sup> also found that longer treatment times increase the risk of WSLs. WSLs can develop quickly, in as few as 4 weeks,<sup>39</sup> and

Table 4. Risk Ratios Associated with Treatment Conditions Reported in Treatment Su	urvey
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					95% Confidence Interval	
Treatment Condition	Individual with Trait	Individuals without Trait	Probability (P)	Risk Ratio	Lower	Upper
>30 mo	50	24	=.009	2.07	1.254	3.421
Longer than expected	38	25	=.116	1.52	0.912	2.547
Poor cooperation	33	27	=.402	1.25	0.743	2.113
Excessive broken						
appliances	28	29	=.864	0.95	0.490	1.820
<fair hygiene<="" oral="" td=""><td>44</td><td>16</td><td>&lt;.001</td><td>2.70</td><td>1.530</td><td>4.768</td></fair>	44	16	<.001	2.70	1.530	4.768
Poor oral hygiene	75	21	<.001	3.52	2.302	5.381
Repeated oral health						
instruction	66	19	=.021	2.29	1.411	3.722
Gingival health	52	23	=.002	2.29	1.411	3.722

a large percentage of WSLs are developed in the first 6 months of treatment.<sup>40</sup> Longer treatment times allow more time for WSLs to develop and for a greater possibility of poor oral hygiene leading to increased carious attacks.

As expected, oral hygiene was a key factor in the development of lesions. Patients with fair or worse oral hygiene were nearly three times more likely to develop WSLs, and patients with poor oral hygiene were 3.5 times as likely. Orthodontic appliances increase the areas of plaque retention and make proper oral hygiene more difficult.<sup>41</sup> Without continuous plaque removal the demineralization/remineralization process shifts toward demineralization and lesions form.<sup>42</sup> Poor oral hygiene leads to poor gingival health, and an increase in gingivitis is seen in orthodontic patients.43 In addition, the patients in the present study who exhibited worse than moderate gingivitis were more than twice as likely as the others to develop lesions during treatment. Oral hygiene and gingival status are important indicators of patients at risk of developing WSLs during orthodontic treatment.

#### CONCLUSIONS

- Orthodontists are more likely to participate in research conducted by alumni from their alma mater than in research conducted by others, including orthodontists and orthodontic organizations.
- Approximately 28% of orthodontic patients in private practice settings develop WSLs.
- The risk of developing WSLs is higher (2.1–3.5 times) for patients exhibiting ADA caries risk factors as well as for those with fair or poor oral hygiene, poor gingival health, and extended treatment times.
- An alumni-centered PBRN provides an effective and efficient method of collecting high-quality data from multiple clinicians and large numbers of patients.

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