

A Survey of Pediatric Dentists on the Treatment Timing and Modalities for White Spot Lesions in the United States

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Purpose: The purpose of this study was to estimate the prevalence of white spot lesions (WSLs) in various practice settings and patient populations, and to gather information about the treatment timing and modalities used by pediatric dentists in the United States. **Study design:** A fourteen question, multiple choice, electronic survey was developed and distributed to 6,092 active American Academy of Pediatric Dentistry (AAPD) members. **Results:** A total of 625 active members responded, garnering a 9.7% response rate. Before treatment, there were significantly more WSLs reported in Corporate practice than Multi-Doctor Practice ($P=0.002$), and significantly more WSLs in Academics/Hospital-Based Practices than in Multi-Doctor Practices ($P=0.002$). For WSLs after treatment, there were significantly more WSLs in Academic/Hospital-Based practices than in single-practitioner settings ($P=0.003$). Approximately 38% of pediatric dentists preferred to treat WSLs before, during or after orthodontic treatment, while 23% treat only before and 20% treat only after treatment. The three most common treatment modalities for WSLs, were prescription fluoride toothpaste (5000 ppm), fluoride varnish, and fluoride rinse. Approximately 47% of respondents reported they were “very comfortable” treating WSLs and 31.0% felt “comfortable.” **Conclusions:** The prevalence of WSLs differed across types of practice. There is no agreement among pediatric dentist as to timing and treatment modalities for WSLs.

Keywords: White spot lesions, treatment modalities, demineralization

INTRODUCTION

The development of white spot lesions (WSLs) is one of the biggest challenges and most common complications orthodontists face. Orthodontists strive to finish patients with a functional, esthetic and stable result but the presence of WSLs can undermine their efforts. The incidence of WSLs in orthodontic treatment has been estimated to range from 2%-97%.^{1,2} One study showed that nearly half of all patients receiving orthodontic treatment experienced one or more lesions.³ Tufeki *et al* reported a rapid spike in WSLs during the first six months of treatment followed by a much lower prevalence until 12 months.⁴

Studies show that there is a rapid increase in the amount of dental plaque and a decrease in pH in patients with fixed orthodontic appliances compared to non-orthodontic patients.^{5,6} The increased plaque retention results in an increase in cariogenic bacteria around orthodontic appliances.^{7,8} There are many factors that impact the development of WSLs including diet, medications, saliva, genetic susceptibility and dental and medical history.^{9,10} Unfortunately, even with the advent of new treatment modalities, WSLs are an ongoing concern for both patients and dentists. Even when patients have excellent oral hygiene, they may need to employ additional measures such as prescription fluoride toothpaste, fluoride varnish or rinse, chlorhexidine, or xylitol to help minimize the formation of WSLs.¹² Due to the iatrogenic effects of orthodontics and other risk factors, WSLs are inevitable, so additional measures are needed to prevent them. A number of studies have examined different treatment modalities for WSLs; however, none have provided comprehensive recommendations for treatment timing and modalities for WSLs. Communication between pediatric dentists and orthodontists along with a standard treatment protocol is imperative to provide the optimal treatment plan for WSLs. It is critical to keep up on current evidence-based research for treatment of WSLs. The purpose of this study was to estimate the prevalence of WSLs in various practice settings and patient populations, and to gather information about the timing and modalities used by pediatric dentists in the United States to treat WSLs.

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METHOD

After receiving approval from the A.T. Still University Institutional Review Board, Mesa, Ariz., USA, the proposed survey was submitted to the American Academy of Pediatric Dentistry (AAPD) for approval before distribution. The electronic survey was implemented using SurveyMonkey (Palo Alto, Calif., USA) and distributed to the AAPD registry of active US members in the form of a web link. Clicking on the link led users to an online survey consisting of 14 questions written in a multiple-choice and ranking format. The survey was divided into four sections: (1) demographics; (2) confidence and training; (3) treatment modalities and their timing before, during and after orthodontics, and (4) patient household income. Respondents were asked to characterize their confidence in treating WSLs on a scale ranging from one (very uncomfortable) to five (very comfortable). Another section of the survey compared mean household income of the pediatric practice to the presence of WSLs before and after treatment. Respondents were provided a list from which they were asked to choose the most appropriate response(s) for each question. In addition, participants were given the option of adding their own comments. Participation was voluntary and anonymous.

During fiscal year 2017, there were 6,092 active AAPD members. After initial survey distribution, two reminder emails were sent one month apart (February-April 2017). No incentive was offered.

It might be difficult for a dentist to be objective about their level of expertise in treating WSLs, but we wanted to determine if dentists who considered themselves to be experts in treating WSLs differed in their approach from those who were not experts. Two questions asked, “How comfortable are you with treating white spot lesions?” and “How would you rate your clinical background on WSLs?” Responses were given on a 5-point Likert scale; for the first question, “not comfortable” to “very comfortable,” and for the second, “very weak” to “very strong.” Based on responses to these questions, we created two somewhat arbitrary categories: “experts” and “non-experts.” In this study, experts included those who were both “very comfortable” working with WSLs and whose clinical background was “very strong.” All other respondents were classified as non-experts. Three stepwise logistic regression analyses were used to identify treatment choices which were differentially endorsed by the two groups of respondents —experts and non-experts — one each for pre-treatment, during treatment, and post-treatment.

Data are summarized using means and standard deviations, or counts and percentages, as appropriate. Chi-square, Kruskal-Wallis and Mann-Whitney tests were used to evaluate differences in responses across different types of practices, treatment modalities, timing of treatment and patient socioeconomic status. A P-value of 0.05 (two-tailed) was used as a cutoff for statistical significance. No adjustments were made for multiplicity. SPSS statistical software ver. 24 (IBM Corp., Armonk, NY, USA) was used for analysis.

RESULTS

A total of 625 active members responded, which translated to a 9.7% response rate.

Demographics

Years of practice ranged from zero to more than 30, with those in practice zero to ten years being the most prevalent followed by members with more than 30 years of practice. All geographic regions in the US were well represented (Northeastern, 27%; Southeastern, 22%; North Central, 15%; Southwestern, 19%; and Western, 17%). Forty-four percent of all respondents were part of a multi-specialty practice and 42% of pediatric dentists reported that patient annual household income (AHI) was \$25,000-\$74,999.

Confidence and training

Survey participants expressed a range in confidence in treating WSLs. Forty-seven percent rated themselves as “very comfortable,” 31% “somewhat comfortable,” 16% were “neutral,” while 4% said they were “somewhat uncomfortable” and 2% were “not comfortable.” Twenty-nine percent of respondents rated their clinical background as “very strong,” 40%, “strong,” 22%, “neutral,” 7%, “weak,” and 0.8%, “very weak.”

Treatment modalities and timing

Thirty-eight percent of respondents indicated that they treat WSLs at the beginning and after treatment while 23% preferred before only and 20% selected after only (Figure 1). Before, during, and after orthodontic treatment, prescription fluoride toothpaste was the most common modality endorsed, followed by fluoride varnish and then fluoride rinse (Figure 2).

One hundred and sixty-four respondents (26.5%) qualified as “experts,” and 454 (73.5%) as “non-experts. Experts (88.4%) were more likely to address management of WSLs before treatment than non-experts (63.4%), $P<0.001$. Experts (59.1%) were also more aggressive in managing WSLs during treatment than non-experts (50.0%), $P=0.045$. However, post-treatment, experts (64.6%) were slightly less likely than non-experts (67.2%) to manage WSLs, $P=0.564$. Treatment modalities used to treat WSLs before, during, and after orthodontic treatment that differed in frequency across expert/non-expert categories are provided in Table 1.

Income

Patients from the lowest income households were reported as having significantly more WSLs before orthodontic treatment than those from all other groups (all pairwise comparisons, $P<0.001$). In addition, there were significantly more WSLs reported after treatment from patients from the lowest income households (Figure 3).

Employment Status and WSLs

The presence of WSLs before and after orthodontic treatment differed across types of practice. Before treatment, there were significantly more WSLs in Corporate practice than in Multi-Doctor Practices ($P=0.002$), and significantly more WSLs in Academics/Hospital-Based Practices than in Multi-Doctor Practices ($P=0.002$). After treatment, there were significantly more WSLs reported in Academics/Hospital-Based Practices than by Single Practitioners ($P=0.003$) (Figure 4).

Figure 1. Respondent preference regarding when to treat white spot lesions (WSLs); before, during or after orthodontic treatment.

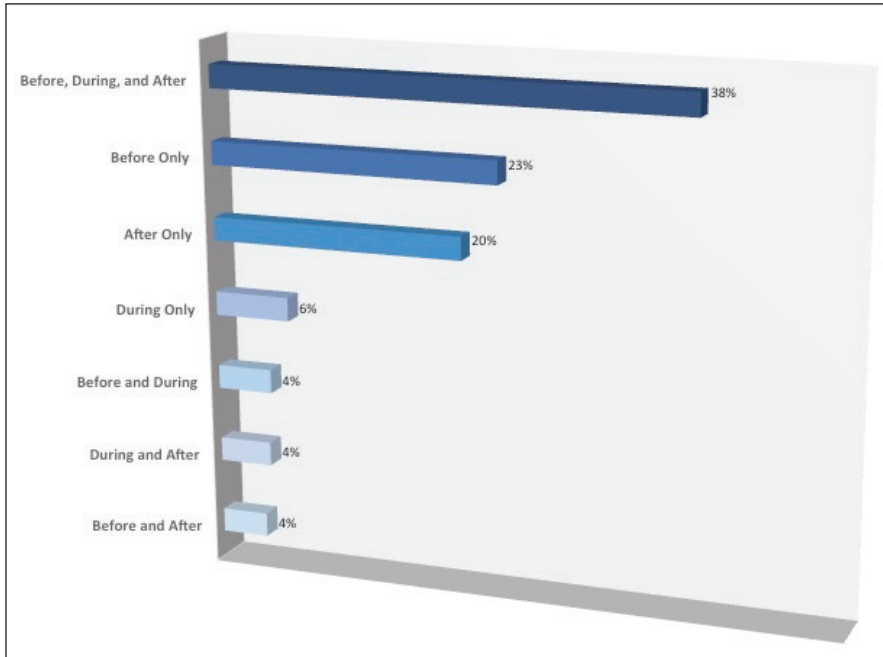


Figure 2. Treatment modalities used by pediatric dental specialists for managing WSLs before, during and after orthodontic treatment.

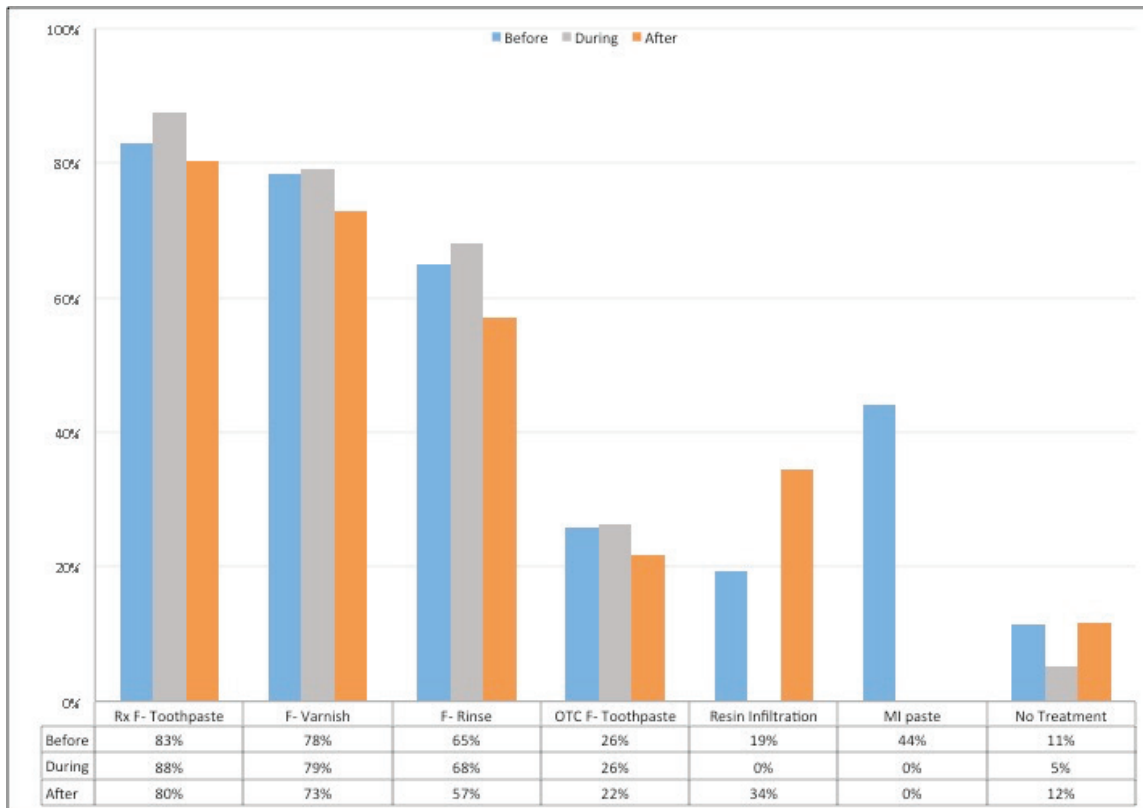


Figure 3. Mean household income of pediatric practice compared to the presence of WSLs before and after orthodontic treatment. (Income ranges based on the US Census Bureau.)

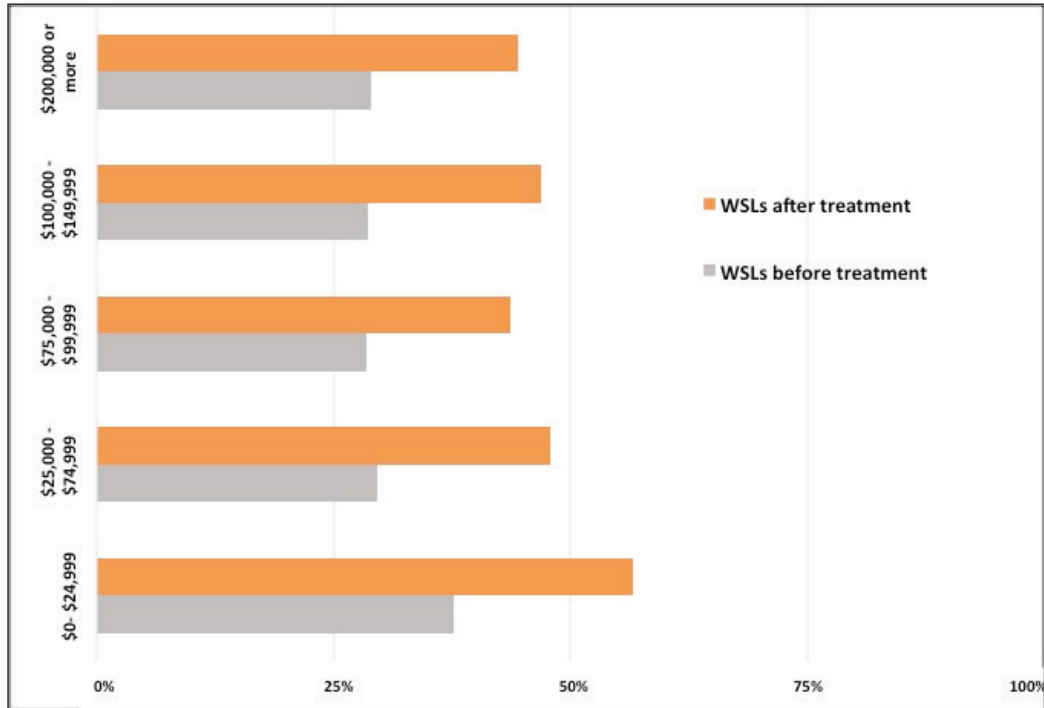


Figure 4. Respondent employment status compared to the presence of white spot lesions before and after orthodontic treatment.

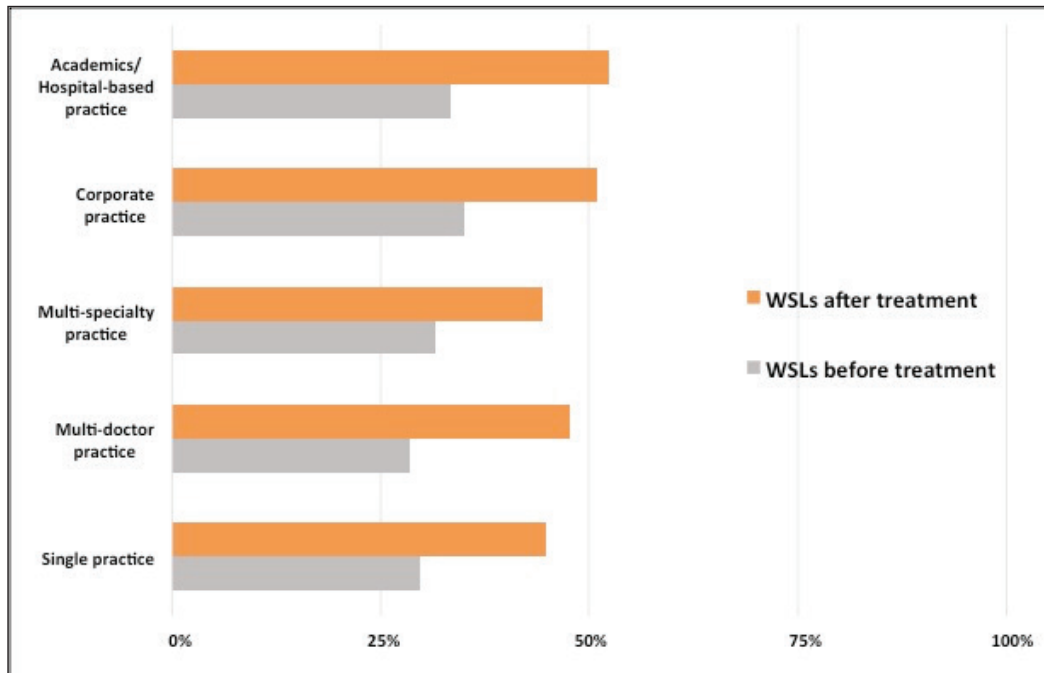


Table 1. Counts and percentages of treatment modalities that differed in frequency of use across experts and non-experts.

| Treatment Modality | Experts (n=164) | Non-Experts (n=454) | P-value |
|-------------------------------------|-----------------|---------------------|---------|
| Pre-orthodontic treatment | | | |
| Fluoride Rinse | 127 (77.4) | 275 (60.6) | <0.001 |
| OTC Toothpaste | 63 (38.4) | 96 (21.1) | <0.001 |
| Prescription Fluoride Toothpaste | 146 (89.0) | 367 (80.8) | 0.016 |
| Fluoride Varnish | 147 (89.6) | 337 (74.2) | <0.001 |
| Resin Infiltration | 44 (26.8) | 76 (16.7) | 0.008 |
| During orthodontic treatment | | | |
| OTC Toothpaste | 54 (32.9) | 108 (23.8) | 0.029 |
| Prescription Fluoride Toothpaste | 153 (93.3) | 388 (85.5) | 0.009 |
| Fluoride Varnish | 149 (90.9) | 354 (78.0) | <0.001 |
| Post-orthodontic treatment | | | |
| Fluoride Varnish | 131 (79.9) | 320 (70.5) | 0.024 |
| Resin Infiltration | 68 (41.5) | 145 (31.9) | 0.035 |

*OTC-Over the counter

DISCUSSION

The prevalence of WSLs is one of the most frequent complications in orthodontic treatment. It is critical to develop a protocol that pediatric dentists and orthodontists can follow to help re-mineralize and prevent further WSLs. This study aims to help standardize a treatment protocol for WSLs. Figure 3 indicates there was a significant difference in the WSL level between the lowest income group (\$0- \$24,999) and that of the other income levels both before and after orthodontic treatment. Data from the National Health and Nutrition Examination Survey found significantly fewer caries in patients from the higher socioeconomic levels (SES).¹³ WSLs are classified as an early carious lesion that has the potential to develop into cavities. In addition, it has been widely documented that minority groups, especially Blacks and Hispanics, have the highest risk for both early childhood and dental caries due to poor access to dentists and fewer dental visits.¹⁴ When compared to adolescents in high socioeconomic position (SEP) groups, adolescents in low SEP groups were less likely to achieve successful orthodontic treatment at the end of one year of active treatment. This may be due to a combination of poor oral hygiene and lack of compliance.¹⁵

Corporate practices see significantly more WSLs before treatment than Multi-Doctor Practices do. In addition, Academic/Hospital-Based institutions see significantly more WSLs before treatment than Multi-Doctor Practices do. Both corporate and Academic/Hospital-Based practices typically see patients with lower AHL, and

Table 2. Recommended treatment protocol for white spot lesions before during and after orthodontic treatment.^{12-15, 24-27, 35}

| | |
|-------------------------------------|---|
| Pre-orthodontic treatment | <ul style="list-style-type: none"> -Prescription fluoride toothpaste: twice daily -Fluoride Varnish: 2-3 times/yr -0.12% chlorhexidine rinse -Re-evaluate for orthodontic treatment in 3 months |
| During orthodontic treatment | <ul style="list-style-type: none"> -Fluoride varnish: every 6 weeks to 3 months depending on severity -Prescription fluoride toothpaste: twice daily OR -0.05% Fluoride mouth rinse: twice daily -Chlorhexidine rinse before bed for 30 seconds for 14 days -Rechargeable fluoride-containing sealant -Recommend xylitol gum/mints |
| Post-orthodontic treatment | <ol style="list-style-type: none"> 1. OTC fluoride toothpaste: up to 6 months after debond for natural remineralization 2. If not remineralized after 6 months: <ol style="list-style-type: none"> a. Bleach b. Microabrasion c. Resin Filler d. Restorative treatment |

thus they see more WSLs. In an academic setting, there is more emphasis on diagnosis and treatment so a higher prevalence of WSLs is noted in patients. Figure 4 shows that single practitioners have significantly fewer WSLs after orthodontic treatment, which suggests that they have more control over mitigating the causes of WSLs. Mascarenhas and Vig found orthodontic treatment time was approximately 5.5 +/- 6.7 months longer with academic treatment than in private practice thus increasing the susceptibility to WSLs.¹⁶

Overall, there was little agreement among pediatric dentist regarding how to treat WSLs before, during, and after orthodontic treatment (Figure 1). Failure to diagnose and chart WSLs can become a legal issue for the orthodontist and possibly the dentist. Without intervention, it is unlikely that WSLs will disappear.¹⁷ Maxfield *et al* reported that when parents acknowledged that they had received proper instruction on the process of WSL formation, they attributed the development of WSLs to inadequate oral hygiene.¹⁸ Although some education is evident, the prevalence of WSLs continues to remain high.

If a WSL develops during orthodontic treatment, 87% of all respondents say they would treat the lesion with prescription fluoride toothpaste, 79% would recommend fluoride varnish, and 68% would use fluoride rinse (Figure 2). Gieger *et al* reported that 52% of orthodontists prescribe fluoride mouth rinse. However, fewer than 15% of the patients admitted to very little or no compliance.¹⁹ This same trend was evident both before and after treatment as well. However, studies have shown that administering high concentrations of fluoride prevents deep penetration of the fluoride and prevents remineralization, thus lower concentrations are recommended to produce a more esthetic result. MI Paste was selected by 44% of respondents before treatment but 0% during or after treatment. Due to a lack of meaningful clinical studies on MI paste there is insufficient evidence to recommend it for the treatment of WSLs;^{20,21} in fact, several studies have shown there is no advantage to using MI Paste compared to normal oral hygiene.^{22,23}

There is a wide variance among pediatric dentists concerning how WSLs should be treated. Continuity and communication of treatment of WSLs between the pediatric dentist and orthodontist are extremely important to ensure the highest quality of patient care. Based on a careful review of literature, the following WSL treatment protocol is recommended (Table 2).

For patients with no pre-treatment WSLs present, a prescription fluoride toothpaste (5000 ppm) is recommended once daily.^{24,25} For patients with WSLs before treatment, prescription fluoride toothpaste at least once daily is recommended to reduce demineralization and promote remineralization.²⁴ In addition, for patients with WSLs, 0.12% chlorhexidine rinse and fluoride varnish are recommended followed by re-evaluation after three months to determine if the patient is ready for orthodontic treatment.^{12,26,27}

The American Dental Association recommends fluoride varnish application at least twice a year for moderate and high risk patients.¹² However, a study using a three month interval showed superior caries prevention than one used twice a year. Thus, applying fluoride varnish more than twice a year is advantageous.¹²

During orthodontic treatment, fluoride varnish, prescription fluoride toothpaste or high concentration prescription fluoride rinse and chlorhexidine rinse, rechargeable fluoride-containing sealant and xylitol gum/mints are recommended. During orthodontic

treatment, fluoride varnish can be applied every six weeks in severe cases according to Benson.²⁸

If compliant, fluoride rinse every other day can reduce enamel demineralization, but a study reported only 42% of orthodontic patients were compliant.¹⁹ Van deer Kaji *et al* reported that those using OTC mouth rinse without fluoride were 2.6 times more likely to get WSL than those using 0.05% fluoride rinse during orthodontic treatment.²⁹

The combination of 30% chlorhexidine varnish and fluoride varnish has resulted in a 30% reduction in WSLs.³⁰ However, chlorhexidine varnish is not available in the United States, so to inhibit demineralization,³¹ a 14 day regimen of chlorhexidine rinse (alcohol free) for 30 seconds is recommended before bed.³² In addition, the application of rechargeable fluoride-containing sealant during orthodontic bonding is beneficial to help reduce WSLs if the sealant is recharged throughout orthodontic treatment.^{33,34}

After removal of braces, the lesion must be assessed to determine if it is active, in the process of remineralization, or completely remineralized. If the lesion appears dull, pitted and irregular, demineralization has occurred. In addition, if there is plaque, the lesion is still active. In contrast, if the lesion is flat, shiny white or brown, remineralization has started or is complete.²⁶ In treating WSLs, the most conservative treatments should be considered first. If the lesion is active, over-the-counter fluoride toothpaste is recommended to allow for the deep remineralization of enamel. This should be evident after two weeks.³⁵ However, the entire process is slow and can take anywhere from three to six months.¹²

After six months, if the lesion has remineralized, external bleaching should be considered for a more esthetic result.^{26,35} Knösel *et al* showed increased lightness values in both WSLs and the adjacent enamel. However, bleaching reduces the micro-hardness of enamel, so only patients with impeccable oral hygiene should be considered.³⁶ If bleaching is inadequate for severe lesions, microabrasion should be used to eliminate the superficial hypermineralized layer.^{35,37} If the lesion still persists, aggressive restorative treatment can be done with something such as a veneer (Table 2).¹²

It is important to note the limitations of this study, which include response rate and selection bias. In addition, using a web-based survey could result in more bias toward the younger, more computer friendly generation. Also, this survey represents a subsample of the AAPD membership which might not be a representative. Future studies should be considered to learn more about how pediatric dental specialists treat white spot lesions, and to provide a more detailed survey of evaluation/treatment protocols.

CONCLUSIONS

It is extremely important to document the severity and extent of WSLs before and after orthodontic treatment and to follow a treatment protocol for WSLs to achieve remineralization and optimum esthetics. A standard treatment protocol would help simplify treatment and ease communication between pediatric dental specialists and orthodontists.

- Our survey suggests there is no standard protocol for timing and treatment modalities for pediatric dental specialist to treat WSLs.

- The prevalence of WSLs differs depending on the type of practice.
- Before orthodontic treatment, there were significantly more WSLs with Corporate practices than with Multi-Doctor Practices and significantly more WSLs in Academic/Hospital-Based Practices than in Multi-Doctor Practices.
- There were significantly more WSLs in Academic/Hospital-Based Practices after treatment than among Single Practitioners.
- Approximately 38% of pediatric dentists preferred to treat WSLs before, during and after orthodontic treatment, while 23% treat only before and 20% treat only after treatment.
- The three most common treatment modalities for WSLs were prescription fluoride toothpaste followed by fluoride varnish and then fluoride rinse before, during, and after orthodontic treatment.
- Patients with a mean household income of \$0-\$25,000 have significantly more WSLs than patients in other income groups.

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