Special Article

White spot lesions in orthodontics: consensus statements for prevention and management

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ABSTRACT

Objective: To establish consensus recommendations for clinicians to manage white spot lesions (WSLs) during orthodontic treatment.

Materials and Methods: Three task force members reviewed the literature to identify best practices for minimizing WSLs during orthodontic treatment. Each draft statement was read to the task force members by a facilitator, followed by voting, accepting, or editing if necessary. The statements were then sent electronically by an independent third party (Magellan Medical Technology Consultants Inc, Minneapolis, Minn) to a previously formed content validation panel consisting of 20 independent private practitioners and clinical academicians for validation.

Results: Twenty-one statements were developed and sent for content validation. While 19 statements achieved a content validation index (CVI) of 0.78, two items did not. These items were edited by the task force members based on qualitative feedback from content validation participants. Each of these revised statements did achieve a CVI of 0.78 on second evaluation from the content validation panelists and therefore were included in this document.

Conclusion: To reduce the risk of WSLs, it is essential to implement individualized caries management measures based on a comprehensive assessment of the patient's oral and systemic health. Effective at-home and professional mechanical and chemical plaque control should be implemented for high-risk orthodontic patients. Fluoride to support prevention and materials such as orthodontic sealants should also be used to provide a physical barrier around the brackets in high-risk patients. By following these guidelines, orthodontic professionals can help promote oral health and minimize the need for restorative treatment. (*Angle Orthod*. 2023;93:621–628.)

KEY WORDS: White spot lesion; Demineralization; Prevention; Management; Restoration; Orthodontics

INTRODUCTION

Demineralization of enamel as part of the caries process is a common occurrence in orthodontic patients and initially manifests clinically as white spot lesions (WSLs).[1–4] The prevailing view on demineralization caused by caries is based on the ecological plaque hypothesis, which suggests that the microbial makeup of the biofilm remains stable until external factors such as diet (specifically, free sugars), oral hygiene, and saliva disrupt the bacterial balance, leading to dysbiosis.[5,6] With continuous and repeated availability of free sugars, a dysbiotic biofilm eventually generates sufficient amounts of organic acids, which decrease the pH of the biofilm at the tooth surface. The biofilm then becomes undersaturated with respect to tooth minerals, and the dissolution of enamel occurs.[7] Based on this concept, demineralization and the caries process can be controlled by modifying the patient's risk and susceptibility by rebalancing the dysbiosis within the tooth surface biofilm or restoring the balance

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Table 1. Task Force Members Who Worked on the Development of Consensus Statements for the Prevention and Management of WSLs During Orthodontic Treatment

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between demineralization and remineralization. Such management of the caries process aims at avoiding the placement of restorations and the initiation of the "restorative death spiral."[8,9]

The prevalence of WSLs during orthodontic treatment varies depending on factors such as oral hygiene and treatment duration.[10] Studies have reported an incidence of WSLs ranging from 23.4% to 75.6%[11,12] and a prevalence ranging from 33.8% to 97%.[13,14] Pooled estimates from a meta-analysis indicated that the incidence of WSLs during orthodontic treatment was approximately 45.8%, with a prevalence of 68.4%.[15] If left untreated, WSLs can progress to cavitated carious lesions, leading to poor esthetics and requiring restorative intervention. The high incidence and rapid onset of WSLs during orthodontic treatment highlight the importance of prevention for patients and clinicians. This underscores the need for guidelines to manage demineralization and WSLs. Numerous systematic reviews[16–20] and meta-analyses have provided evidence on different modalities of preventing and managing WSLs during orthodontic treatment; however, there is a lack of guidance on how orthodontists should manage WSLs during and after treatment, including primary prevention (prevention) and secondary or tertiary prevention (treatment). Expert consensus can help support decision making, especially when the existing evidence is limited or of narrow scope. Recent efforts in dentistry have aimed to provide expert consensus on clinical decision making for dental caries but did not address WSLs during orthodontic treatment.[21,22] Therefore, the present study aimed to establish consensus recommendations for clinicians to manage WSLs during orthodontic treatment.

MATERIALS AND METHODS

To develop consensus statements for managing WSLs during orthodontic treatment, a task force was formed composed of three academicians (Dr Sardana, Dr Schwendicke, Dr Tüfekçi) with expertise in cariology, pediatric dentistry, and orthodontics (Table 1). The task force reviewed the relevant literature to identify best practices for preventing or reducing the occurrence and progression of WSLs during orthodontic treatment. The recommendations developed by the task force, and later validated by the Consensus Panel, were intended to guide clinicians in managing WSLs during and after orthodontic treatment.

A comprehensive literature search was conducted using PubMed based on clinical questions and objectives associated with developing appropriate guidelines. An initial literature search was performed on November 7, 2022, with subsequent searches on December 6, 2022, and December 13, 2022. Available literature was assessed based on the following keyword search terms: ortho* (orthodontic, orthodontic appliances), white spot*, car* (caries, carious), aligner*, and demineralization. Results were limited to the last 10 years and the English language.

Data extraction was performed by members of the task force, each assessing 23 or 24 publications. The following variables were extracted:

1. Study design (parallel group or split mouth)
2. The mean age of the study participants
3. Sample size
4. Interventions and co-interventions, including dosage and frequency
5. Control group
6. Method of outcome assessment
7. Follow-up duration
8. Key results

A narrative synthesis of the results was performed to formulate the consensus statements; meta-analysis was not attempted, given the heterogeneity in settings, comparators, and outcomes.

Draft statements were created by the task force based on the literature review described above. To achieve agreement on each draft statement among the task force members, a structured process was used that adhered to the principles outlined by Murphy et al.[23] The process involved a knowledgeable facilitator with expertise in the process, who presented each draft statement to the task force. The facilitator then asked questions about the statement's purpose and its alignment with the overarching goals of the best

Table 2. Content Validation Panel Who Voted on the Consensus Statements Drafted by the Task Force for the Prevention and Management of WSLs During Orthodontic Treatment

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practice guidelines. After addressing preliminary questions, the task force conducted an initial vote to determine if the statement was acceptable or if modifications were necessary before its inclusion in the final consensus-based guideline document. The minimum level of agreement required to achieve consensus was 80% agreement. If agreement was not reached on the first vote, the statement was edited based on the input by the task force members and was guided by the facilitator, who ensured opinions from all three task force members were discussed and considered. If agreement could not be reached after this initial round of discussion, an additional round of discussion was undertaken if necessary to achieve consensus. If the statement did not achieve agreement after two rounds of debate, the statement was removed from further discussion and identified as not having reached a consensus.

After considering the draft statements, the facilitator expedited a debate to identify any additional statements addressing aspects of best practices in preventing and managing WSLs in patients undergoing orthodontic treatment. In addition to consensus building using the structured technique described above, all statements underwent a rigorous content validation process using methods originally proposed by Lynn[24] and Waltz and Bausell[25] and modified by Grant and Davis.[26] Subsequently, the 21 statements developed by the task force were then sent in an e-mail by an independent third party (Magellan Medical Technology Consultants Inc, Minneapolis, Minn) to a previously formed content validation panel (Table 2).

The content validation panel, composed of private practitioners and clinical academicians with expertise in the prevention and management of WSLs in orthodontic patients, was created to rank the content validity of each consensus-based statement developed by the task force. The panelists were chosen from different regions of Canada and the United States and represented various dental fields, including orthodontics, general dentistry, periodontology, operative dentistry, and cariology.

Each of the 21 consensus statements was ranked by the Consent Validation Panelists based on a relevance scale of 1 to 4:

1. The statement is not relevant to oral health in patients with fixed orthodontic appliances.
2. The statement is somewhat relevant.
3. The statement is quite relevant.
4. The statement is highly relevant to oral health in patients with fixed orthodontic appliances.

According to the recommendations of Polit and Beck,[27] items achieving a mean ranking of 3 or 4 demonstrated strong content validity. Yusoff[28] introduced the item-level content validation index (I-CVI) as the proportion of content experts who rated an item as relevant with a score of 3 or 4. Therefore, a recommended I-CVI cutoff point of 0.782 is considered

Table 3. Consensus Statements and the Value of the Item-Level Content Validation Index (I-CVI)

	I-CVI
A. Assessment and Planning	
1. Prior to orthodontic treatment, an initial comprehensive assessment should be performed to evaluate systemic and oral health.	100%
2. Caries risk assessment should be performed before and routinely during orthodontic treatment and should consider caries history, current oral hygiene, fluoride use, diet, and systemic risk factors.	100%
3. Patients receiving orthodontic treatment with fixed appliances should be considered at elevated caries risk.	90%
4. Based on the initial assessment of the patient and orthodontic treatment–related factors, individualized caries management measures should be implemented.	95%
B. Management	
5. Orthodontic treatment modality should be selected and carried out based on principles of caries management.	85%
6. While placing brackets, buttons, and attachments, excessive bonding material should be removed before curing to prevent plaque formation.	95%
7. Effective at-home mechanical plaque control should be implemented and regularly reinforced throughout orthodontic treatment.	100%
8. At-home chemical plaque control should be considered to support mechanical plaque control with patients who are considered high-risk.	85%
9. Professional mechanical and chemical plaque control should be considered with high-risk patients.	95%
10. Regular toothbrushing should be performed with over-the-counter fluoridated toothpaste at a concentration of 1350–1500 ppm.	90%
11. Prescription fluoride toothpaste in a higher concentration should be considered for high-risk patients.	80%
12. For high-risk patients, additional topical fluoride regimens (rinses and gels) should be recommended for at-home use.	95%
13. Professional topical fluoride applications (varnishes, foams, gels) should be considered according to caries risk at individualized intervals.	85%
14. Sustained fluoride-releasing orthodontic materials or devices should not be relied on for caries management.	85%
15. Mineral-delivering systems such as casein phosphopeptide–amorphous calcium phosphate (CPP-ACP) should not be relied on solely for white spot management due to conflicting evidence.	100%
16. Materials (eg, orthodontic sealants) to provide a physical barrier around the brackets should be considered in high-risk patients and reapplied as needed.	89%
17. Digital/electronic reminders may promote adherence to orthodontic treatment and caries management.	85%
18. Tooth surfaces should be reassessed throughout orthodontic treatment for the incidence and severity of white spot lesions via visual examination.	95%
19. The findings of the visual examination should be recorded in sufficient detail to allow comparisons over time; standardized photography may be used to support these comparisons.	100%
C. Transitional care	
20. After the conclusion of orthodontic treatment, dental and periodontal health should be reassessed to determine the transition of care.	100%
21. Following orthodontic treatment, patients should be referred to their general dentist for supportive care.	95%

acceptable in a panel with 10 or more individuals, and this value was applied in the development of the current consensus-based guidelines.

RESULTS

A total of 349 articles were reviewed based on title and abstract by an independent reviewer for relevancy. Results were refined to include only randomized or comparative controlled trials. The remaining 127 articles were assessed by the task force members for inclusion. Articles were considered in this guideline if all three task force members rated the articles for inclusion based on their individual assessments. This resulted in a total of 71 articles that the task force reviewed in their entirety for consideration as part of these guidelines. Twenty-one statements were developed by the task force and were later sent via e-mail to the content validation panel. While 19 statements achieved an I-CVI $\geq$0.78, 2 did not. Statement 15, "If not containing a sufficient concentration of fluoride, mineral delivering materials such as casein phosphopeptide–amorphous calcium phosphate (CPP-ACP) should not be relied on for white spots management," was revised by the task force as "Mineral delivery systems such as calcium-containing materials should not be relied on solely for white spots management due to conflicting evidence." Similarly, statement 16, "Preventive sealing around the brackets should be considered in high-risk patients and should be reapplied as needed," was revised as "Materials (e.g., orthodontic sealants) to provide a physical barrier around the brackets should be considered in high-risk patients and reapplied as needed." These two statements were revised by the task force based on the qualitative feedback from content validation panelists and resent to the same individuals for validation. On the second attempt, revised statements 15 and 16 reached an I-CVI $>$0.78 from content validation panelists. In the end, all 21 recommendations were successfully validated (Table 3).

CONSENSUS RECOMMENDATIONS

Assessment and Planning

1. Prior to orthodontic treatment, an initial comprehensive assessment should be performed to evaluate systemic and oral health.

2. Caries risk assessment should be performed before and routinely during orthodontic treatment and should consider caries history, current oral hygiene, fluoride use, diet, and systemic risk factors.
3. Patients receiving orthodontic treatment with fixed appliances should be considered at elevated caries risk.
4. Based on the initial assessment of the patient and orthodontic treatment–related factors, individualized caries management measures should be implemented.

Management

5. Orthodontic treatment modality should be selected and carried out based on principles of caries management.
6. While placing brackets, buttons, and attachments, excessive bonding material should be removed before curing to prevent plaque formation.
7. Effective at-home mechanical plaque control should be implemented and regularly reinforced throughout orthodontic treatment.
8. At-home chemical plaque control should be considered to support mechanical plaque control with patients who are considered high risk.
9. Professional mechanical and chemical plaque control should be considered with high-risk patients.
10. Regular toothbrushing should be performed with over-the-counter fluoridated toothpaste at a concentration of 1350–1500 ppm.
11. Prescription fluoride toothpaste in a higher concentration should be considered for high-risk patients.
12. For high-risk patients, additional topical fluoride regimens (rinses and gels) should be recommended for at-home use.
13. Professional topical fluoride applications (varnishes, foams, gels) should be considered according to caries risk at individualized intervals.
14. Sustained fluoride-releasing orthodontic materials or devices should not be relied on for caries management.
15. Mineral-delivering systems such as casein phosphopeptide–amorphous calcium phosphate (CPP-ACP) should not be relied on solely for white spot management due to conflicting evidence.
16. Materials (eg, orthodontic sealants) to provide a physical barrier around the brackets should be considered in high-risk patients and reapplied as needed.
17. Digital/electronic reminders may promote adherence to orthodontic treatment and caries management.
18. Tooth surfaces should be reassessed throughout orthodontic treatment for the incidence and severity of white spot lesions via visual examination.
19. The findings of the visual examination should be recorded in sufficient detail to allow comparisons over time; standardized photography may be used to support these comparisons.

Transitional Care

20. After the conclusion of orthodontic treatment, dental and periodontal health should be reassessed to determine the transition of care.
21. Following orthodontic treatment, patients should be referred to their general dentist for supportive care.

DISCUSSION

The above consensus was drafted to address the issue of WSLs during orthodontic treatment and provide recommendations for their prevention and management. Each of the statements was carefully developed by three experts (task force members) and validated by academicians and private practitioners with expertise in orthodontics and general dentistry (content validation panelists). These statements serve as a brief summary of the best practices and recommendations for reducing the risk of WSLs and caries in patients undergoing orthodontic treatment. By following these guidelines, orthodontic professionals can help promote oral health and minimize the need for restorative treatment.

WSLs commonly develop on the buccogingival surfaces of teeth with orthodontic appliances due to plaque accumulation around brackets because of the difficulty of maintaining good oral hygiene in the presence of brackets, bands, wires, and elastomeric ligatures.[1,13–15] A patient's diet, including the frequent consumption of fermentable carbohydrates, and oral hygiene practices can significantly affect the risk of developing early enamel caries.[29,30] A plethora of research shows a significant increase in acidogenic bacteria in orthodontic patients, namely *Streptococcus mutans* and Lactobacilli.[31–34] A substantial increase in cariogenic species in the saliva of patients undergoing orthodontic treatment with fixed appliances was observed in a previous study.[35] Similarly, another study reported a significant increase in *S mutans* and Lactobacilli bacterial load during orthodontic treatment with fixed appliances and clear aligners.[36] Thus, the prevention and management of WSLs during orthodontic treatment start at the assessment and planning stage.

The patient's past caries experience might be a future indicator of dental caries and possible enamel demineralization during orthodontic treatment.[37,38] Similarly, oral hygiene, duration of orthodontic treatment, type of orthodontic appliances to be placed (springs, wires, ligatures), systemic and topical fluorides, dietary habits, and so forth should be considered

in the assessment and planning stage of the orthodontic treatment to foresee WSLs and provide tailor-made plans for prevention and management.

Orthodontic treatment creates an oral environment for plaque retention and subsequent development of WSLs; thus, the excess bonding materials around the brackets should be removed and regular home care with mechanical plaque control should be encouraged and supplemented with reminders to promote adherence. Toothbrushing should be encouraged with over-the-counter fluoride toothpaste, and additional self-applied fluoride should be recommended for high-risk patients.[20] Professional fluorides and plaque control should be considered for patients at high risk of WSLs during orthodontic treatment.[39] Similarly, physical barriers such as sealants can be placed around the brackets to ward off acid attacks and prevent WSLs during orthodontic treatment.[19,40] Since orthodontic treatment involves multiple visits over a few years, frequent reminders from the general dentist or the orthodontist can improve adherence to the appointment schedule and the patient's motivation to maintain good oral hygiene and prevent WSLs.[41] Finally, after the conclusion of the orthodontic treatment, WSLs should be assessed after the removal of the brackets. In addition, appropriate referral should be made to provide treatment of WSLs, as these lesions might last for 5 years without any intervention and be a cause of esthetic concern.[42]

The strengths of this study included the rigorous methodology in developing the consensus and its validation by private practitioners and clinical academicians from different specialties. However, a minor limitation is that only North American members were included in validating the consensus statements. This may be a minor limitation, as the spectrum of interventions and evidence available to manage WSLs during orthodontic treatment was thoroughly discussed and elaborated.

CONCLUSIONS

- Content validation panelists were in agreement that the development of WSLs is a significant problem in orthodontic patients with poor oral hygiene. Clinicians should take necessary precautions to prevent and reduce the incidence and severity of these lesions. Patients and caregivers should be educated by clinicians and motivated to maintain oral hygiene and follow healthy diets. All stakeholders (patients, caregivers, orthodontists, and general dentists) should anticipate and thus be equipped with the tools necessary for preventing and managing WSLs during orthodontic treatment.
- To reduce the risk of WSLs, it is essential to implement individualized caries management measures based on a comprehensive assessment of the patient's oral and systemic health. This should include an evaluation of caries risk factors such as caries history, current oral hygiene, fluoride use, diet, and systemic factors. Effective at-home mechanical and chemical plaque control should be implemented and regularly reinforced throughout orthodontic treatment, and professional mechanical and chemical plaque control should be considered for high-risk patients. Fluoride should also be used to support caries prevention, including regular toothbrushing with fluoridated toothpaste, prescription fluoride toothpaste for high-risk patients, additional topical fluoride regimens for at-home use, and professional topical fluoride applications. Materials such as orthodontic sealants can also be used to provide a physical barrier around the brackets in high-risk patients, and digital/electronic reminders may promote adherence to orthodontic treatment and caries management. It is also essential to reassess tooth surfaces for the incidence and severity of white spot lesions throughout orthodontic treatment via visual examination and record the findings in detail to allow for comparisons over time. Finally, after orthodontic treatment, dental and periodontal health should be reassessed to determine the transition of care, and patients should be referred to their general dentist for supportive care.

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