

A) Heading: Orthodontics

B) Title: "A Spot of Bother" – Orthodontic Associated White Spot Lesions

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“A Spot of Bother”

Orthodontic associated White Spot Lesions

Abstract:

White spot lesions (WSL) are a commonly reported risk of fixed appliance orthodontic treatment. This article reviews the incidence, aetiology, and effectiveness of prevention and management of WSLs with a relevant case report. An adolescent male had fixed appliance treatment and developed WSLs, despite prevention advice and careful monitoring, the WSLs progressed and ultimately led to the need for early removal of his orthodontic appliances. Removal of appliances prevented further damage and allowed partial resolution of the WSLs.

Clinical Relevance:

Careful monitoring of a patient's dental health during orthodontic treatment is essential, both the orthodontist and the patient's general dentist have a responsibility in this regard. If oral health deteriorates and demineralisation occurs, rapid decisive action is necessary to limit irreversible damage.

Objectives:

To provide an overview of the aetiology, prevention and management of white spot lesions.

Prevalence and aetiology

Decalcification, or demineralization, is the first clinically recognizable stage of enamel caries. The co-existence of plaque bacteria (mutans streptococci and lactobacilli), substrate, susceptible tooth surface and time are necessary for decalcification.¹ Its incidence among patients undergoing fixed appliance treatment varies greatly with sociodemographic areas and individual risk factors but a commonly accepted incidence is that WSLs occur in up to half of orthodontic patients.² The labio-gingival aspect of the maxillary lateral incisors has the highest incidence followed by mandibular buccal segment teeth and the lowest is in the maxillary posterior region.³ These sites are most likely affected due to reduced salivary flow to these regions⁴. They may also have increased number of attachments which, along with the length of orthodontic treatment, are risk factors.^{5,6} WSLs are commonly graded via the index of Gorelick et al. 1982¹ see **Figures 1**.

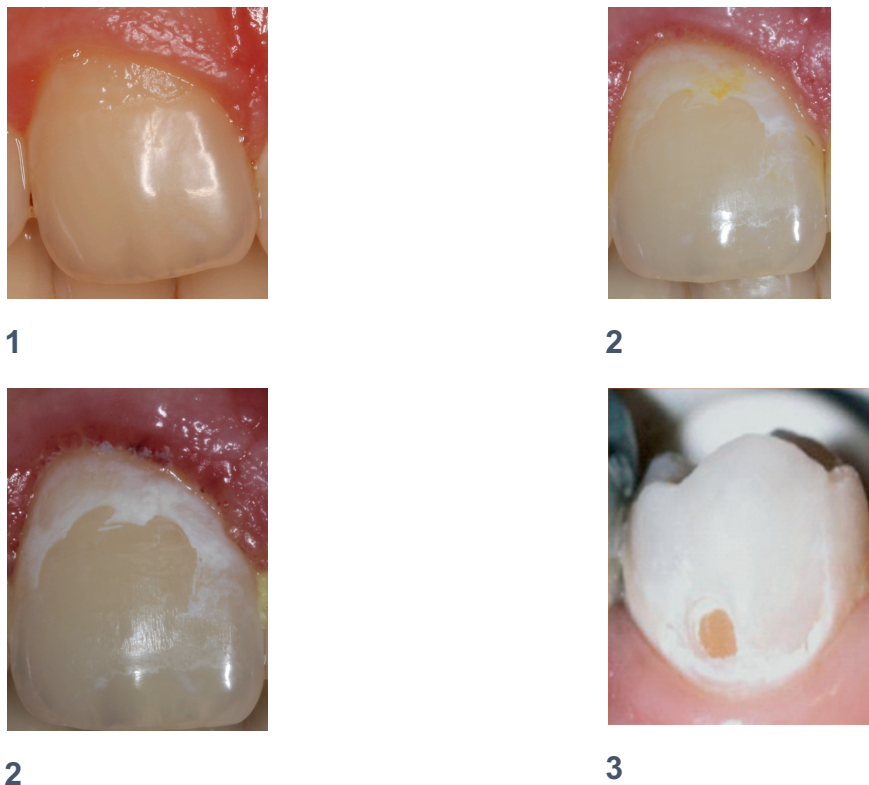


Figure 1 White spot lesion index. 1 No white spot, 2 Slight white spot formation, 3 Excessive white spot formation and 4 White spot with cavitation. Permission to publish these photos was granted by the publisher.⁷

The opaque appearance is due to subsurface mineral loss with increased porosity and optical changes in enamel. The lesion is developed via repeated mineral loss and is a dynamic process of repair and destruction. The pH and fluoride concentration of the oral environment directly affects diffusion of calcium and phosphate ions. Salivary flow rate may explain why in some patients there is minimal decalcification despite high plaque scores.^{8,9} While the surface is unchanged, arrest and reversal is still possible however if there is continued mineral loss then a point will be reached where the surface can't be reconstituted by remineralisation and cavitation may occur. Forceful probing may also hasten cavitation.¹⁰

Lesions which develop in a high fluoridated environment can become "sealed" with fluoroapatite on the surface. This arrests the lesion but doesn't reverse it, as repair of the subsurface doesn't occur i.e.: the surface layer is well-mineralised while the subsurface is hypo-mineralised so the opaque lesion remains. These lesions can persist for years after treatment and are an aesthetic concern.^{3,10} Therefore, the opacity of an advanced lesion will not respond to fluoride supplements. Initial surface lesions can, however, re-mineralize and the opaque surface regress completely once the main cause of decalcification, fixed appliances, are removed and good oral hygiene practiced.^{11,12} Regression of the lesion is primarily from surface abrasion along with some re-deposition of minerals.¹³

Prevention:

Firstly, any patient commencing fixed orthodontic appliance treatment must have an up to date assessment with their dentist, with excellent oral hygiene a prerequisite.¹⁴ Oral hygiene and anti-cariogenic dietary habits are necessary to prevent WSLs and the evidence on these are covered comprehensively in the *Delivering better oral health: an evidence-based toolkit for prevention* and SDCEP Management of Dental Caries in Children.^{14,15} Fluoride supplements can also be used as an adjunct.

Fluoride

Fluoride ions adsorb onto the surface of enamel and stop dissolution as well as increasing re-mineralization of the enamel. It is most effective when applied topically and present at low concentrations in the mouth.¹⁶ Side-effects include skeletal and dental fluorosis caused by excessive fluoride intake. Skeletal fluorosis is a rare bone disease resulting in joint and bone pain, it may exist where fluoride is unusually high in the drinking water, 8mg/l, or very high levels of toothpaste consumption. Dental fluorosis occurs as opaque white areas to stained yellow dark brown pitted surfaces. There is no threshold dose but its greatest risk is at early maturation while the dentition is developing, therefore, patients 6 years and up are not generally at risk of dental fluorosis.¹⁷

There are numerous means of fluoride application, with evidence for WSL reduction summarised in **Table 1**. It's important to remember that fluoride supplements can only act as an adjunct and the emphasis should be on good oral hygiene and dietary habits.

Fluoride Applications in addition to standard tooth paste.

- **Topical Varnish**

10,000PPM fluoride varnish applied to the teeth every 6 weeks at the fixed appliance adjustment appointment can have a significant reduction in WSL incidence.¹⁸

- **Foam**

Similar to varnish, 12,300PPM (1.23%) fluoride foam applied every 2 months to the teeth can have a significant reduction WSL incidence.¹⁹

- **High Fluoride Tooth Paste**

SDCEP 2018 and Public Health England 2017 guidance advises high strength fluoride tooth paste for those in fixed appliances – 2,800PPM for over 10 years and 5,000PPM for over 16 years.^{14,15}

5000PPM instead of 1450PPM tooth paste can significantly reduce WSL incidence.²⁰

- **Mouth Rinse**

Fluoride mouth-rinse (0.05% / 225PPM) may be prescribed although, compared with a placebo, there is no significant difference in WSL incidence.²¹ If it is prescribed as an additive measure it must be used at a different time to brushing as the rinsing will clear away the tooth paste, which has a higher level of fluoride content of 1450PPM.

- **Fluoride releasing materials**

Fluoride releasing materials may be used for bonding orthodontic brackets however a multi-centre RCT has found no difference in WSL incidence between standard composite bonding and resin modified glass ionomer cement (RMGIC) in orthodontic patients.²²

- **Fluoride Gel**

Gels are cheaper than varnish but tend to wash away easily and offer no significant reduction in WSL incidence in orthodontic patients.²³

- **Amine and Stannous Fluoride (AmF/SnF₂)**

Tooth paste containing both amine fluoride (AmF) and stannous fluoride (SnF₂) has reported cariostatic potential.¹⁶ Although the evidence that it reduces WSL incidence in orthodontic patients compared to sodium fluoride is limited.²⁴

Cochrane Review: Benson 2019²⁵

Overall, there is not enough evidence to support a significant difference from: amine fluoride (AmF) and stannous fluoride (SnF₂), fluoride releasing materials, fluoride mouth-rinse or varnish application.

There's a low level of certainty that 12,300PPM fluoride foam or high fluoridated tooth paste 5,000PPM may reduce WSL incidence.

Table 1 Clinical effectiveness of the use of Fluoride supplements in WSL prevention

Treatment of WSLs:

Treatment of WSLs involves a step-wise approach i.e.: the treatment of choice should be the least invasive that satisfies the aesthetic and functional needs of the patient. This will range from no treatment to more invasive restorative methods such as composite restorations and veneers. It should be remembered that bleaching of teeth is well established for management of non-cariou enamel defects however, bleaching decalcification will only improve the shade of the surrounding tooth and not the lesion itself, making it appear worse.

- **No treatment:**

Most lesions undergo at least partial regression following the removal of fixed appliances and appropriate oral hygiene instruction.²⁶

Therefore, a watchful waiting approach of 3-6 months before any intervention is sound.

- **CPP-ACP**

Casein phosphopeptide – amorphous calcium phosphate (GC *Tooth Mousse*) is derived from dairy products and can remineralize demineralized lesions.²⁷ Exposing white spot lesions to fluoride can create a hypermineralized surface layer of fluoroapatite preventing ionic ingress of calcium and phosphate into the body of the lesion so the opacity persists.²⁸

CPP-ACP can deliver high concentrations of calcium and phosphate ions to promote remineralization and eliminate the opacity.²⁹ It is available in tooth mouse and often administered via vacuum-formed retainers.

However, the evidence is still equivocal and further studies are required before remineralisation agents can be routinely recommended for treatment of white spot lesions.³⁰

- **Micro-abrasion**

Micro-abrasion involves removal of the superficial layer of enamel by applying an acid slurry to the tooth, and repeating this until the opacity has improved. 18% hydrochloric acid is normally used in orthodontics but 37% phosphoric has similar results.³¹

Aesthetics improve via surface abrasion of discoloured enamel and creation of a lustrous sheen to significantly improve the white spot lesion.^{32,33}

After micro-abrasion, vital bleaching may be done if there is a yellow shine through from the underlying dentine.

- **Resin infiltration**

This is a minimally invasive unfilled resin infiltration system for treating white spots by optical manipulation and little, if any, tooth removal. The ICON (Infiltration CONcept) kit is commonly used and is a low viscosity resin developed by DMG.³⁴ It involves applying 15% hydrochloric acid gel for 2 minutes, washing and drying, applying ethanol and air drying for 30 seconds – this may be repeated until the patient is satisfied, and finally unfilled resin is applied, light cured and polished.

It's effective in treating WSLs^{35,36} as well as other white spots like fluorosis, hypomineralisation and amelogenesis imperfecta, **Figure 2.**



Figure 2

Figure 2 Is a case of hypomature amelogenesis imperfecta. The ICON treatment was carried out on UR2 to UL2. Five rounds of etching was carried out before the resin infiltration to achieve the desired result.

Case Report:

A 14-year-old boy presented with a Class II division 1 incisor relationship on a Class II base. This was associated with restored 1st molars, supernumeraries palatal to UR1 and UL1, severe upper arch crowding, upper centreline shift to the left and mesially impacted LR7 and LL7, **Figures 3 and 4.**



Figure 3 Pre-Treatment orthodontic photos of the Class II div 1 incisor relationship with severe upper arch crowding, upper centreline shift to the left and restored first molars.



Figure 4 Pre-Treatment OPT illustrating the restored 1st molars, supernumeraries palatal to UR1 and UL1, and mesially impacted LR7 and LL7

The patient underwent a general anaesthetic for surgical removal of supernumeraries, LR8, and LL8 and extraction of UR6 and UL6. This was followed by orthodontic treatment which included a trans-palatal arch and upper and lower fixed appliances.

Oral hygiene at commencement of treatment was excellent. Fifteen months, 12 visits, into fixed appliance treatment it was noted that oral hygiene had deteriorated and early signs of decalcification were evident. This was despite reinforcement of diet and oral hygiene instruction at every visit, this included tooth brushing and interdental brushing instructions, the use of 1450PPM fluoride toothpaste and a fluoride mouth-rinse 225PPM. Additionally, the patient attended his general dentist regularly for check-ups. The patient and his parents were advised of the clinical findings and the consequences if oral hygiene did not improve including the risk of irreversible damage to the dentition and the requirement to remove appliances to prevent further damage. Patient specific diet and oral hygiene advice was provided. A diet diary was not used but may have been beneficial. Photographs were obtained

to act as a baseline and to monitor the decalcification progression **Figure 5**. The patient's social history was also updated at this stage to investigate any potential child safeguarding issues.

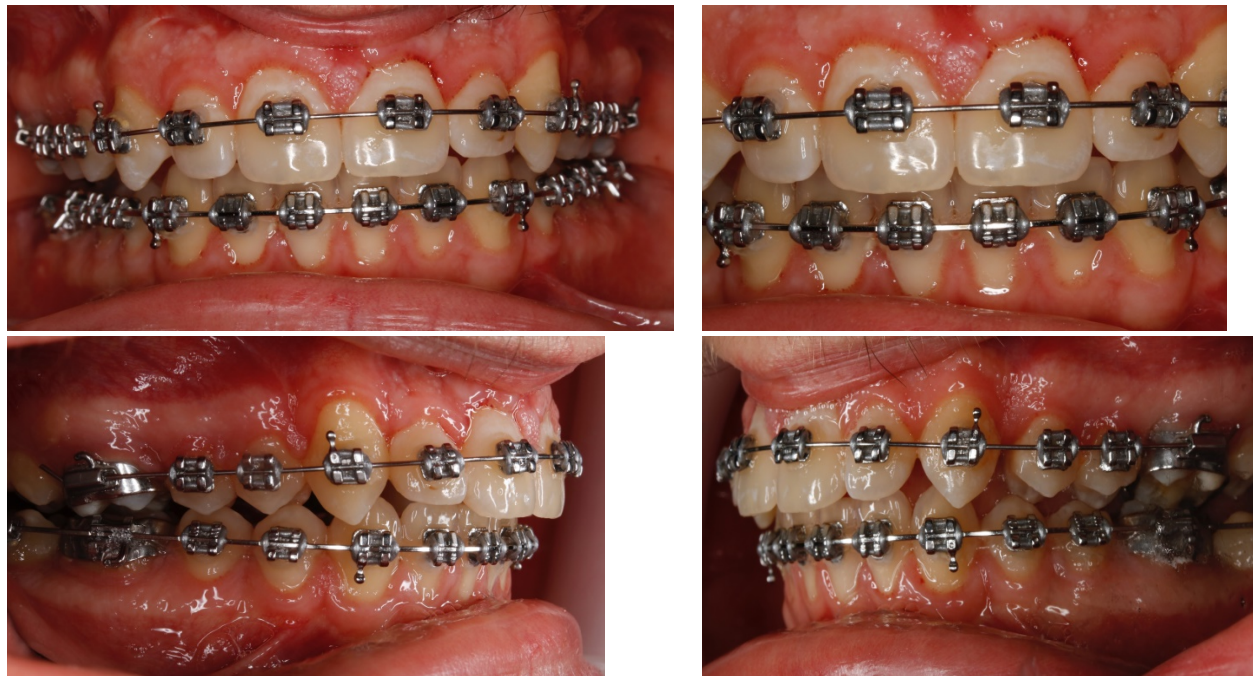


Figure 5: Initial evidence of decalcification 15 months into fixed appliance treatment.

At the following visit, decalcification had progressed and was severely affecting the labial surfaces of the maxillary incisors, predominately on the gingival aspects.

These findings were discussed with the patient and his parents. It was noted that there was still spacing in the upper right quadrant however, the patient was happy with the appearance and function of his dentition. Clinically, it was felt, the risks of further treatment would out-weigh the benefits. Both the patient, and his parents, agreed to have his appliances removed early and he was consented for “Early removal of braces”. The consent form explained the aspects of malocclusion still uncorrected and the reasons for early removal of appliances. The appliances were removed and thermoplastic retainers provided for wear on a night time basis, **Figure**

6. Oral hygiene instruction was reinforced again at this stage and an update of the orthodontic treatment was written to the GDP.



Figure 6 Debond photos of severe white spot lesions affecting the upper incisors.

Twelve weeks after removal of appliances the patient was reviewed, it was noted that the oral hygiene, WSLs and gingivitis had improved significantly **Figures 7**



Figure 7 Significant improvement of white spot lesions 12 weeks following debond.

Discussion

Prevention of WSLs is naturally better than the cure, to this end it is essential that patients have an up to date dental assessment prior to orthodontic treatment and the oral health is deemed suitable to support orthodontic treatment. Past caries experience is the biggest predictor of future caries,¹⁴ therefore it's important to identify patients as high risk for WSLs and provide appropriate tailored advice. The use of fluoride supplements is often prescribed however, compliance with oral hygiene and diet control is of paramount importance. If WSLs become established and advanced, fluoride supplements may arrest the lesion but will not improve the opacity appearance.

When advanced decalcification occurs, the benefits of continuing orthodontic treatment must be considered against the potential risks. Communication of this to the patient is important to ensure informed consent is gained for the early removal of appliances.

WSLs may regress on their own accord. Failing that, there are minimally invasive methods to improve the appearance of affected teeth as outlined in this article.

Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no conflict of interest.

Informed consent: informed consent was obtained from all individual participants included in the article.

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Figures:

Figure 1 *White spot lesion index. Left to Right; 1 No white spot, 2 minor, 3 severe and 4 white spot with cavitation. Permission to publish these photos was granted by the publisher.*

Figure 2: *Use of ICON for hypomature amelogenesis imperfecta*

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Table 2: *Clinical effectiveness of the use of Fluoride supplements in WSL prevention*