
Potential Remineralization of Postorthodontic Demineralized Enamel and the Use of Enamel Microabrasion and Bleaching for Esthetics

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Orthodontic care increases the difficulty in maintaining good oral hygiene. For this reason demineralized enamel areas, termed "white spot lesions," frequently occur. White spot lesions can be remineralized, which is much more desirable than having to progress to restorative dental care. Enamel can be remineralized with meticulous toothbrushing, twice per day, with fluoridated dentifrice. Additional fluoride can further enhance the remineralization process. This would include higher dose fluoridated dentifrice, over-the-counter 0.05% sodium fluoride rinses, topical fluoride gels, fluoride varnishes, and professionally applied topical fluoride such as 2% sodium fluoride, 8% stannous fluoride, and 1.23% acidulated phosphate fluoride. Enamel can also be remineralized with casein phosphopeptide-amorphous calcium phosphate preparations. Chewing gums and pastes are available that contain casein phosphopeptide-amorphous calcium phosphate. When white spot lesions are remineralized, the white appearance of the remineralized lesion may remain. Bleaching can successfully camouflage these white enamel areas. If bleaching alone does not camouflage the white appearance of the remineralized areas, enamel microabrasion can be performed. Enamel microabrasion abrades the enamel surface, leaving a highly polished surface with calcium phosphate packed into the interprismatic enamel surface space. This highly polished enamel surface can then be bleached. This technique has been demonstrated to improve the appearance of enamel surfaces that had white spots. (Semin Orthod 2008;14:220-225.) © 2008 Elsevier Inc. All rights reserved.

The literature documents that orthodontic care complicates daily oral hygiene maintenance and increases the risk for subsequent enamel demineralization.¹⁻⁷ Although great efforts are placed on enamel demineralization prevention, including toothbrushing instruc-

tions, topical fluorides and newer hygiene devices (ie, oral irrigation systems, electric toothbrushes, sonic and ultrasonic toothbrushes), early enamel demineralization, which appears as "white spot lesions," still occurs.⁴⁻⁷ This article will discuss the remineralization of demineralized enamel, as well as present recommendations on how enamel microabrasion and vital tooth bleaching can aid in achieving optimal esthetics following the enamel remineralization process.

Remineralization

There is long-standing research evidence available that has demonstrated the effectiveness of topical fluoride to remineralize early (incipient)

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demineralized enamel.⁸⁻¹³ Good oral hygiene with a standard fluoridated dentifrice, utilized daily, is the foundation of prevention.¹⁴⁻¹⁸ The addition of the daily use of over-the-counter 0.05% sodium fluoride rinses can be effective in remineralizing demineralized enamel.¹⁹⁻²¹ These low-dose fluoride rinses are safe for children receiving orthodontic care (an expected 8- to 16-year-old range). The concern that children will swallow the rinse is anticipated to be low for this age of children and adolescents.²²

When children are receiving orthodontic care, professional preventive dental care should continue to be provided by the dentist who is responsible for comprehensive dental care for the patient. This may include professionally applied topical fluoride such as 1.23% acidulated phosphate fluoride (APF), 2% sodium fluoride, and 8% stannous fluoride.²³⁻²⁷ A relatively new topical fluoride to the United States marketplace is 5% sodium fluoride varnish. This can be professionally applied. There is excellent data available that demonstrate the effectiveness of these fluoride varnishes to prevent enamel demineralization.^{25,28-32} There is minimal information available on the remineralization effectiveness of fluoride varnish, however. The data that are available indicate the potential enamel remineralization these fluoride varnishes may offer.³³⁻⁴⁰

Another agent that can have a remineralization effect is casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). Research has demonstrated the demineralization inhibition, as well as enhancement of remineralization, with solutions and chewing gum containing CPP-ACP.⁴¹⁻⁴⁴ Presently, there is also a paste containing CPP-ACP available in the marketplace. Placing this agent in areas where salivary control is compromised can make calcium and phosphate available for precipitation. The addition of fluoride to this paste should further enhance the precipitation of mineral into subsurface incipient lesions.

Another factor that plays a role in remineralization, as well as inhibition of demineralization, is fluoride-releasing cementing agents. There are fluoride-releasing resin bonding and cementing agents that have demonstrated inhibition of enamel demineralization and some effectiveness in remineralization of demineralized enamel adjacent to orthodontic bands and

brackets.⁴⁵⁻⁴⁸ Although this research is predominantly *in vitro*, data can be extrapolated for potential *in vivo* benefit.

Glass ionomer cements and resin-modified glass ionomer cements have also demonstrated remineralization effects on demineralized enamel adjacent to orthodontic bands and brackets.⁴⁹⁻⁵¹ *In vitro* data suggest the glass ionomer and resin-modified glass ionomer cements are more effective at inhibiting enamel demineralization than fluoride-releasing resins.^{52,53} This is attributed to the higher fluoride release associated with the glass ionomer cements shortly following the chemical cure of the cement. It could be extrapolated that the glass ionomer cements would also be more effective in remineralization, compared with fluoride-releasing resins.

Microabrasion

Following orthodontic care, whitened enamel is frequently present, particularly in areas that were adjacent to orthodontic bands or brackets or near the free gingival margin. These are areas that are extremely difficult to keep clean during toothbrushing, making them at high risk for the development of white spot lesions. When enamel remineralizes, fluoride, calcium, and phosphate ions penetrate the surface zone and precipitate on sound enamel at the margins of the subsurface demineralized lesion.¹² The lesion becomes smaller with the center of the subsurface enamel being the final area to remineralize. The remineralization process does not recreate enamel prisms that extend from the dentin to the tooth surface, as normal enamel appears. There is merely a highly dense compaction of calcium, phosphate, and fluoride, which has more mineral content than natural enamel and is more difficult to demineralize than natural enamel.^{54,55} Due to this remineralization process, remineralized enamel is often viewed as having a whiter color than natural enamel, appearing similar to a white spot lesion. For this reason, one must assume that these whitened enamel areas could be white spot lesions. On debanding/debracketing, the presence of whitened enamel warrants the recommendation of daily topical fluoride therapy, which can include toothbrushing twice per day with a fluoridated dentifrice and an over-the-counter 0.05% sodium fluoride rinse daily.^{17,21} The over-the-

counter fluoridated dentifrice can be replaced with a higher dose (5000 ppm sodium fluoride) dentifrice that can be obtained with a prescription from the treating doctor.⁵⁶ There is evidence that a 15- to 30-day regimen of topical fluoride can minimize white spot lesions, decreasing lesion size, which increases the surface zone depth.⁵⁷ Ideally, complete remineralization would be preferable, but this is difficult to diagnose with current standard visual diagnostic techniques. The use of quantitative light fluorescence (QLF) systems have demonstrated that enamel remineralization can be followed with this type of diagnostic tool.^{58,59} However, since most dentists do not presently have these diagnostic systems, intensive topical fluoride therapy is recommended for a minimum of 15 to 30 days after orthodontic bands and brackets are removed.

At this point, if undesirable whitened enamel is still present, the patient, parent, and dentist need to decide if further esthetic treatment is desired. Whitened enamel that is very apparent compared with the remainder of natural tooth enamel can receive microabrasion treatment. Microabrasion is merely the application of an acidic and abrasive compound to the surface of the enamel.⁶⁰⁻⁶⁵ Research indicates that 1-minute applications of commercially available microabrasion compounds remove 12 μm on the first application and 26 μm on subsequent applications.⁶⁶ The explanation for why the first application removes less enamel than subsequent applications is associated with the fluoride rich enamel that is at the enamel surface. Usually, 5 to 10 applications of the microabrasion compound indicates whether the technique will be successful in adequately eliminating the undesirable discoloration. The microabrasion process removes small amounts of surface enamel, but also leaves a highly polished enamel surface. This highly polished surface does not have the typical enamel surface appearance because the microabraded enamel has no interprismatic spaces.⁶⁷ The microabrasion process abrades surface enamel while compacting calcium and phosphate into the interprismatic spaces. This polished surface reflects light differently than natural enamel. Therefore, a portion of the whitened enamel is removed and a portion is camouflaged by the highly polished surface. Research has demonstrated that although microabrasion removes small

amounts of the enamel surface, the new polished surface is less susceptible to bacterial colonization and demineralization than natural nonabraded enamel.^{68,69} Following the microabrasion technique, a 4-minute 2% sodium fluoride treatment is recommended. Should the microabrasion technique not achieve optimal esthetics and some whitened enamel is still apparent, vital tooth bleaching can be considered.

Vital Tooth Bleaching

Postorthodontic bleaching can be beneficial for some patients.⁷⁰ Patients who exhibit generalized yellowing of the teeth can experience significant whitening with tray-based whitening systems used overnight or with over-the-counter polyethylene strips that carry varying doses of hydrogen peroxide within a gel whitening system⁷¹⁻⁷⁵ (Figs 1 and 2).

Patients may also develop demineralized enamel during orthodontic treatment, which exhibits itself as white spot lesions adjacent to brackets and the free gingival margin area. As previously discussed, topical fluoride therapy is appropriate to be sure remineralization of enamel has occurred. Mild whitened enamel can often be camouflaged by bleaching with standard tray-based whitening systems used overnight or with the hydrogen peroxide-impregnated polyethylene strips⁷¹⁻⁷⁵ (Figs 3 and 4). If 2- to 4-week bleaching with these regimens is



Figure 1. The view of maxillary anterior teeth after removal of orthodontic brackets. Note that the “yellowing” of enamel makes the already present inappropriately mineralized whitened enamel more apparent. (Color version of figure is available online.)



Figure 2. View of the same maxillary anterior teeth (Fig 1) following 4 weeks of overnight vital bleaching with 10% carbamide peroxide delivered in a custom tray. (Color version of figure is available online.)

ineffective at camouflaging this whitened enamel, microabrasion followed by bleaching is recommended.⁷⁰

Summary

Prevention of enamel demineralization during orthodontic treatment is of utmost importance. Should enamel demineralization occur (white spot lesions), early diagnosis and intervention is appropriate. Improved brushing with fluoridated dentifrice and over-the-counter fluoride rinses would be the first recommended intervention. If more aggressive intervention is considered to be necessary due to the extent of demineralized enamel or expected noncompliance with oral hygiene by the patient, professionally applied and/or prescribed fluorides are recommended. Likewise, casein phosphopeptide-amor-



Figure 3. The view of maxillary anterior teeth after removal of orthodontic brackets. (Color version of figure is available online.)



Figure 4. View of the same maxillary anterior teeth (Fig 3) following 4 weeks of bleaching, 30 minutes twice per day, with a hydrogen peroxide gel impregnated on polyethylene strips. (Color version of figure is available online.)

phous calcium phosphate systems have demonstrated remineralization effects.

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