



SCIENTIFIC ARTICLE

Treatment Considerations for Bleaching and Bonding White Lesions in the Anterior Dentition

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White lesions occur commonly on the anterior teeth. There are numerous reasons why these lesions appear in the anterior dentition, and these reasons will be discussed in detail. For some patients, these white lesions may be considered unsightly and the patients may seek treatment to have them removed; other patients are not concerned about their presence on their anterior teeth. Some of the white lesions are caused by demineralization and occur because of poor oral hygiene. For the purpose of this article, developmental white lesions will be discussed in detail, along with the options for treatment of these lesions.

One of the simplest ways to disguise white lesions is by whitening the background of the tooth. Some patients have faint white lesions present on their teeth. When their teeth are whitened, these lesions can become more obvious. Therefore, when patients prepare to whiten their teeth, it is important for the supervising dentist to warn patients that the white lesions can appear to become whiter during the bleaching treatment. Dentists need to be able to detect these white lesions on the teeth and be able to discuss the occurrences and management of these lesions and the likely consequences during the bleaching process. It is essential to discuss this before bleaching. This article discusses the etiology of white lesions, their occurrence, and the treatment considerations for bleaching and bonding these lesions (Table 1).^{1,2}

WHY DO WHITE AREAS OCCUR ON TEETH?

Many patients want to understand why a white lesion has occurred on their teeth (Tables 1 and 2). Mothers are often also concerned when their child's new dentition erupts with a large white lesion on the central incisor.

ETIOLOGY OF WHITE LESIONS Chemical Disturbances in Enamel Maturation

Tooth Decay: Caries

Dental caries is an infectious disease that affects up to 90% of adolescent and young adults in the United States.³ Dental caries is a complex disease that occurs along the interface between the dental biofilm and the enamel surface. The primary causative organism is *Streptococcus mutans* bacteria. The resulting lesion can begin as white line on the smooth surfaces of a tooth.

Demineralization Around Orthodontic Brackets

On occasion, white demineralized lesions become visible after the removal of the orthodontic brackets.⁴ Some lesions have black edges around them. This is related to poor oral hygiene around the brackets and the consumption of a high cariogenic diet during orthodontic treatment. These lesions are amenable to the use of topical fluoride⁴ to reduce their size and to bleaching and microabrasion treatments to remove the appearance of the white lesion.

This demineralization can occur within 4 weeks of placement of direct bonded orthodontic brackets.⁵ This can affect up to a third of orthodontic patients. The most commonly affected teeth are the maxillary lateral incisors and the mandibular canines.⁶ The distogingival area of the labial enamel surface is the most commonly affected. Remineralization occurs rapidly during the first few weeks after the removal of appliances to reduce the size of the lesion.⁶ About half of the original lesions had remineralized after 6 months with no specific treatment.

Treatment options vary from doing nothing and monitoring the situation to the application of fluoride and amorphous calcium phosphate and microabrasion treatment using 5% hydrochloric acid (Table 3).

In a 26-patient study by Wilcott,⁷ the author noted that in the period after removal of orthodontic appliances there was a wide variation in the response of postorthodontic demineralized white lesions to a low fluoride toothpaste, but lesions were consistently reduced in size with time. On average, in all participants studied, the difference in percentage reduction showed a reduction in lesion area of about one-third after 12 weeks and one half

after 26 weeks. The postorthodontic white lesions can be distinguished from developmental white lesions by their shape.⁸ Developmental white lesions are more rounded, opaque, and whiter than the postorthodontic markings.

Fluorosis: Overexposure to Fluoride

Fluorosis is a developmental condition that can occur as a result of having ingested too much fluoride (Figure 1). This can be caused by the ingestion of too much fluoride in the water supply, too much toothpaste, or the use of fluoride tablets. Dental fluorosis is a developmental disturbance of dental enamel that is caused by successive exposures to high concentrations of fluoride during tooth development, leading to enamel with lower mineral content and increased porosity. The severity of dental fluorosis depends on the length and timing of the overexposure to fluoride. The risk period for aesthetic changes in permanent teeth is between 20 and 30 months of age.⁹ The recommended level for daily fluoride intake is 0.05 to 0.07 mg F/Kg/day, which can prevent dental caries by remineralisation of lesions. A daily intake above this level leads to an increased risk of dental fluorosis. Currently recommended procedures for diag-



Figure 1. Case 1. Discoloration that is probably caused by fluorosis. This patient sought to have conservative treatment before getting married. All options were discussed with the patient before commencing treatment.

nosis of fluorosis should discriminate between symmetrical and asymmetrical and/or discrete patterns of opaque defects (Figures 1 and 2).

The effects of fluoride on enamel formation causing dental fluorosis are cumulative rather than requiring a specific threshold dose,¹⁰ being dependent on both the total fluoride intake from all sources and the duration of fluoride exposure. Enamel mineralization is highly sensitive to free fluoride ions, which uniquely promote the hydrolysis of acidic precursors, such as octacalcium phosphate, and the precipitation of fluoridated apatite crystals.¹⁰ Once fluoride is incorporated into enamel crystals, the solubility of the mineral is reduced. This modulates the ionic composition in the fluid surrounding the mineral.

Trauma to the Primary Dentition

The prevalence of this type of injury can vary from 12% to 69% according to Danish studies¹¹ (Figure 3). It was estimated that enamel hypoplasia of traumatic origin is common. In a clinical study,¹¹ it was estimated that 10% of all



Figure 2. Case 1. Teeth after prolonged whitening treatment. The prolonged whitening treatment took about 8 to 10 weeks to remove the yellow and brown discoloration. Home bleaching every night with 10% carbamide peroxide in bleaching trays was undertaken. This was followed by two sessions of microabrasion treatment on the remaining white lesions. Composite bonding was not necessary to achieve this result.

Table 1. Etiology and occurrence of developmental white lesions

Type of white lesions	Etiology
Isolated single white spots	Natural developmental occurrence with diameter <0.5 mm maxillary incisors
White speckled lesions: mottled enamel	Fever during development
Multiple lesions: chalky white hypocalcification	Fluorosis brown and white discolorations
White line/stripes	More severe developmental disturbances along the enamel maturation layers; higher luminance and more circular boundaries
White patches	Trauma to the primary dentition
White spots covered with yellow layer	Bleeding had occurred during the traumatic injury and seeped into areas of mineralization
Faint white lesions, some black edges	Orthodontics bracket demineralization lesions after removal of orthodontic brackets Enamel defects and white lesions in deciduous celiac disease Enamel defects related to hypermineralization; decay to incisors and molars Premature birth
White marks on the enamel (where parents and children have the same lesions)	Hereditary enamel hypoplasia ¹

Adapted from Greenwall.²

enamel hypoplasias affecting anterior teeth in school children in Copenhagen were related to trauma in the primary dentition. The type of dental trauma sustained will determine the type of developmental disturbance.

In these cases, the trauma interferes with enamel mineralization. These enamel changes are confined to the site of coronal mineralization at the time of injury.¹² It is assumed that the displacement trauma to the primary dentition causes damage to the adjacent tooth germ and possibly the odontogenic epithelium, thereby interfering with the final mineralization of enamel. The lesions are normally white. However, the bleeding that can occur causes the blood breakdown products to seep into the layers of mineralization during the enamel formation. This could explain why yellow brown areas are located exclusively apical to the white lesions. Surface defects in the

enamel most probably reflect direct injury to the enamel matrix before mineralization has been completed.

Process of Enamel Maturation

There is a disturbance in the formation of the enamel caused by an illness accompanied by a high fever. Premature birth can result in the development of white lines on the primary as well as the permanent dentition. Patients should be questioned about this on the medical questionnaire (Figures 4 and 5).

The prevalence of enamel defects in celiac disease can be high. A recent study¹³ of 30 children with celiac disease (with a mean age 3.5 years) detected that 83.3% of patients with celiac disease had enamel defects compared to the control of 53.3%. Symmetric defects were noted in 73.3% of patients. Dental enamel defects were detected in deciduous molars (45.1%) and the deciduous incisors.

THE AESTHETIC MANAGEMENT OF WHITE LESIONS OF DEVELOPMENTAL ORIGIN

Medical History

If possible, a detailed medical history should be taken from the parent regarding any prolonged illness that has occurred during childhood. Questions regarding multiple ear or chest infections at an early stage of the child's development that lead to the prolonged use of antibiotics may give a clue to the etiology of the occurrence of the white spots (Figures 6 and 7). The age at which the infection occurred is relevant, because in patients less than 2 years of age there is an increasing chance of damage to the permanent dentition (Figure 8). Many of the lesions are chronological in that the incisal tip, if it is affected, would indicate that the fever causing the damage occurred very early on in the child's life, such as 1 to 2 years old.

The past administration of topical fluoride, toothpaste, and the indigenous location where the patient grew up can give an indication of the likely chance of fluorosis being a cause of the discoloration. Under 6 years of age, the swallowing reflex is not well developed, and children can swallow between 25% and 33% of fluoridated toothpaste with each brushing.¹⁴

Radiographs

Radiographs will not reveal the presence of these white lesions. It is therefore not necessary to irradiate a young patient to gain much further clinical information. However, teeth with other forms of discoloration

Table 2. Rare diseases that may cause white lesions and enamel hypoplasia

Hypoparathyroidism
Exanthemous fevers
Celiac disease
Acidosis

TREATMENT CONSIDERATIONS FOR BLEACHING AND BONDING

Table 3. Treatment options for white lesions teeth with increasing intervention

Treatment option	Intervention
Do nothing	If the patient or parent is not concerned about the appearance of the teeth Professional cleaning of the enamel surface
Bleaching	Usually home bleaching Prolonged home bleaching if the lesions are severely discolored or multicoloured, such as severe fluorosis Power bleaching (may not be efficient and may cause further rehydration of the enamel, giving the appearance of further visible white lesions)
Microabrasion to the affected areas Megabrasion	Using hydrochloric acid Remove the white area, partially or fully with a handpiece before composite bonding
Direct composite bonding to mask the white spots directly over the area Indirect porcelain veneers	Placed directly over the white area To cover the entire surface of the buccal enamel
Crowns (if the lesions are severe)	Requires destruction of areas of healthy tooth as well in the preparation
Combinations of treatment in a sequential manner	Home bleaching is often started, followed by microabrasion; the need for composite bonding may be less

should have a periapical radiograph to examine the periapical status of the tooth.

Photographs and Digital Intraoral Photography

It is essential to take detailed photographs and, in particular, digital photographs, because these would provide more information about the nature and location of the white spots. Photographs of the labiolingual area are also useful. Occasionally, some of the white lesions are associated with hypoplastic enamel pits and defects, and it is important to photograph these because there may be defective enamel present.

Bleaching Treatments (Table 3)

There are several options that can be undertaken depending on the severity of the white spots that are present on the teeth and also the severity and the multiple shades of discoloration which is commonly seen in fluorosis. Bleaching is nor-

mally the first part of the treatment plan. The bleaching treatments will remove any orange-brown or yellow lesions from the surface of the enamel, particularly from the maxillary anterior teeth. The general background color of the tooth can then be lightened so that the white lesions start to fade.

Bleaching teeth that have inactive white spot lesions after fixed braces can be undertaken effectively. In a study of 10 patients with inactive white spot lesions,¹⁵ bleaching treatments were effective in disguising the effect of the lesion and in whitening the background color of the tooth.

Why Do White Spots Get Whiter During the Initial Whitening Treatment?

It is important to note that when bleaching treatments are undertaken—particularly home bleaching treatments—the white spots

initially seem to get whiter and brighter. It is essential to warn the patient of this phenomenon so that patients do not get alarmed when they see this occurrence. It is thought that the presence of oxygen inside the enamel during the initial bleaching stages is the cause of the bright appearance of the white spots. Another factor may be the partial dehydration of the tooth during the initial whitening treatment. The dehydration of the enamel is more rapid and more evident when the teeth are whitened using power bleaching techniques. These techniques often use higher concentrations of hydrogen peroxide in combination with a light or heat at the chairside.

Sometimes patients panic when they see this occurring. They mistakenly think that the bleaching material has caused this damage to the tooth surface. Written documentation is essential when discussing this information for patients before commencing treatments so that patients can be fully aware of the risks and benefits of these treatments together with the expected side effects when bleaching teeth with white lesions present.

Prolonged Bleaching Treatments

Sometimes home bleaching treatments need to be prolonged because of the severity of the discoloration on the tooth. The normal time period for home whitening of upper and lower teeth is about 2 weeks for the upper teeth and 3 weeks for the lower teeth. These treatment times may vary depending on the degree of discoloration. Prolonged times for bleaching are undertaken to effectively remove the deep discolorations within the tooth. The first shade that will be removed is the brown discoloration. This is followed by the



Figure 3. Case 3. The appearance of the central incisors before whitening. This 12-year-old was concerned about the discoloration of the central incisors and requested that her mother take her to the dentist.

range of orange and yellow shades. The underlying tooth begins to whiten, and it is then that the white spots that will become evident. Extending the whitening even further will allow the white spots to fade into the white background of the tooth. Treatment is terminated once it becomes apparent that no further whitening is possible. Normally, extended bleaching will allow the shade of the teeth to reach beyond the B1 shade range (Figures 1 and 2.)

Microabrasion (Table 3)

Microabrasion is a technique that uses a chemical compound to simultaneously erode and abrade the enamel surface of a tooth¹⁶ to remove the brown and white spot enamel lesions on permanent teeth (Figure 9). This is normally undertaken after a course of bleaching treatment. Microabrasion on its own is used for very young children with a single isolated lesion (at ap-



Figure 4. Case 2. Defective enamel with orange and brown and white lesions. Treatment involved home bleaching for 7 weeks followed by microabrasion.

proximately 8 years old) to microreduce the effect of the white patch. This would be followed later with full home bleaching when the child is about 12 years old (Figures 3, 6, 7, 10, 11).

A modification of this technique has been suggested by Ardu et al¹⁷ using a combination of the microabrasion paste (hydrochloric acid) followed by daily home application of casein phosphopeptide-amorphous calcium phosphate complexes (CCP-ACP). The proposed technique is based on reactivation of the enamel by elimination of its hypermineralized external layer through the microabrasion and the daily long-term home use of ACP.

Very deep extensive lesions can be treated by abrading the surface with a fast handpiece (a fine, flame-shaped diamond) by first undertaking microreduction¹⁸ of the enamel lesion. This is followed by chemical microabrasion using a 5% hydrochloric acid and pumice treatment (Figures 3 and 4).

The materials used for the microabrasion technique include compound of hydrochloric acid and flour of pumice.¹⁹ A generic form consisting of 18% hydrochloric acid and pumice can be used on the surfaces of the teeth. There are two specific proprietary products available. The first is a combination of 5% hydrochloric acid and silica to form a purple paste (Opalustre; Ultradent Products, Inc., South Jordan, UT; Figure 9). Another product is 10% hydrochloric acid in combination with pumice, and this is a green paste (Prema Paste; Premier Dental Products Co., Plymouth Meeting, PA).

Application Technique

The teeth need to be isolated with a rubber dam or a light cure dam to protect the gingiva during the proce-



Figure 5. Case 2. The appearance after bleaching, microabrasion, and bonding.

sure (Figure 9). Because this type of treatment is normally undertaken on a young patient, dehydration of the teeth can occur rapidly. The material is directly applied to the teeth¹⁹ using a special cup with hard bristles. The material is gently massaged over the white lesion several times. Intermittent rinsing and rehydration in combination with observation are undertaken during this procedure. This is repeated several times. As the teeth dehydrate, more of the white lesions may become visible,²⁰ but it is only necessary to remove those lesions that are visible when the tooth is fully hydrated. The abrasion times are very quick. Only a few seconds of application time are required, and then the paste should be rinsed and the process reviewed. Fluoride, in the form of a gel, is applied at the



Figure 6. Case 3. Before bleaching, the teeth are colored; note the presence of white lesions with brown discoloration in the middle. The lower incisors have fractured enamel. Because of the patient's young age, a decision was made to wait 1 year before beginning a whitening treatment. A temporary composite restoration was placed on the lower incisor.



Figure 7. Case 3. One year later, the whitening treatment was begun. Note the difference in the eruption of the upper teeth. This figure shows the appearance of the upper teeth after 1 week of home bleaching. It was necessary to review the patient because of the patient's young age. Whitening in the younger group can have results quickly. It is essential to have parental cooperation and supervision with the younger age group.

end of the treatment to restore the fluoride-rich layer that was removed with microabrasion. Only a few microns are removed, and the procedure is undertaken in a gentle manner. The patient is warned that after the first treatment, the appearance of the teeth may look worse because the teeth are dehydrated after the appointment. The following day, when the teeth are rehydrated, the enamel will appear smooth and lustrous and will not pick up stains. It is essential to review the patient 1 week after the initial treatment to fully assess the results of the micro-



Figure 8. Case 4. Teeth before bleaching. There is a large white lesion present on the upper right central incisor. Note the presence of orange and brown staining on both incisors and further evidence of white areas on other teeth.

abrasion treatment. An additional treatment session may be required to achieve the desired result.

Composite Bonding After Bleaching

The decision to bond a composite restoration over the white lesion should be undertaken after other less invasive methods have been tried, such as bleaching and microabrasion. The size of the lesion is an important consideration in the decision to bond (Figures 10 and 11).

If the lesion is confined to a small area of the tooth, a direct composite restoration can be placed. The composite bonding can be placed over the white lesion only, or the decision can be made to cover the entire surface with a direct composite bonding in order to give a smoother surface. This may give the appearance of the tooth being slightly thicker, and the patient needs to be told that they may feel the extra thickness on the labial surface in the beginning. They soon get used to this thickness (Figure 11).

The question of masking the white area with a composite or cutting out the entire area needs to be made (Figure 8). There are two different approaches depending on the size of the lesion. If a decision is made to cut out the white area, the resulting dentin and enamel shades need to be replaced in a segmental layering technique.¹ If the white area is to be masked out, the correct masking shade needs to be selected so that the white opaque area does not shine through the translucent enamel composite (Figure 12). It may be better to select more opaque dentin shades over the white lesion and then to bond enamel shades. These bondings can be challenging, and it may be necessary to do a trial run of the



Figure 9. Case 4. Microabrasion technique placement. Isolation of the dam is placed onto the gingiva and the microabrasion paste is placed directly onto the two white lesions.

shades of composite to be selected to see whether these white opacities can be effectively masked by the composite bonding.

In cases where the white lesions are extensive and the entire surface of the labial enamel is affected, restorative techniques may need to be used.

Reduction in Bond Strength Immediately After Home Bleaching

It is important to know that there is a temporary reduction in the bond strength of the enamel and dentin after home bleaching. This is related to the amount of oxygen that is still present in the tooth. The oxygen will diffuse out of the tooth over the next 1 to 2 weeks, and the bond strength will return to normal. This is not the case after power



Figure 10. Case 3. Teeth after completion of the upper and lower whitening treatments, which took approximately 2.5 weeks of bleaching. The brown lesion in the middle of the tooth faded to yellow but did not fade completely. The gingival are in much healthier state after the whitening treatment.



Figure 11. Case 3. The teeth after successful whitening and composite bonding. These were placed on the upper central incisor teeth and the lower composite repairs to the fractured teeth. The patient and her mother were delighted with the results. Further whitening will need to be undertaken following exfoliation of the deciduous canine teeth and the full eruption of the canine teeth.

bleaching; bond strengths are unaffected by power bleaching.

Therefore, it is not advisable to undertake composite bonding immediately after home bleaching is completed. It is best to wait at least 1 to 2 weeks for the remaining oxygen to diffuse before undertaking direct bonding onto the tooth.

CONCLUSION

The treatment of white lesions can be both challenging and rewarding.



Figure 12. Case 4. Teeth immediately after bonding the central incisor tooth with composite material. Note that there is the presence of other white areas on other teeth because of the dehydration of the teeth during the bonding procedure. These are not always necessary to treat. If the teeth are rehydrated, many of the white markings disappear from the teeth.

The patient needs to be fully informed as to the treatment options available and the advantages and disadvantages for each treatment option. The treatment can vary from simple home bleaching and microabrasion to bleaching and more complex direct bonding of the teeth. It is best to try the most conservative options first, because most patients will prefer a more conservative approach. The results can be rewarding for patients who have suffered with severe white lesions that have caused them embarrassment. Simple effective treatment will vary with each patient.

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