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Unusual Indelible Enamel Staining Following Fixed Appliance Treatment

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Abstract. *Two cases are described of indelible enamel staining following fixed appliance therapy. The acquired pigmentation occurred in patients with an identifiable enamel defect prior to treatment. The interaction of factors to cause the staining is discussed and it's prevention in future cases highlighted. Subsequent restoration of the affected teeth is shown.*

Index words: Complications of fixed appliance treatment, Enamel staining, Micro-abrasion.

Introduction

Severe enamel staining as a consequence of fixed appliance treatment is, fortunately, a rare occurrence. Mild decalcification and white spot lesions are not uncommon findings following removal of orthodontic bands and brackets in previously healthy, unmarked teeth. These have been reported as occurring most frequently on the upper lateral incisors and first permanent molars (Artun and Brobakken, 1986). Bishara *et al*. (1987) described the process of microabrasion, a simple treatment to remove these areas of mild decalcification and also those stains caused by extrinsic agents. Extrinsic stains may be caused by diet, smoking, chromogenic bacteria, and drugs such as iron supplements, chlorhexidine and minocycline. It has also been suggested that corrosion products from orthodontic bands and brackets may be responsible for tooth discolouration (Gwinnett, 1982). There have been few reports of extrinsic enamel staining post-orthodontic treatment on teeth that already have an identifiable enamel defect, whether this is a discrete area of hypomineralization or more widespread, such as amelogenesis imperfecta. Ceen and Gwinnett (1980) reported a case of greenish-black staining beneath an orthodontic bracket on a central incisor corresponding to the area where a diffuse white lesion was noted on the pretreatment photographs.

Two cases of unusual staining are reported, one occurring at the periphery of an anterior bracket producing a green-black stain and the other occurring underneath anterior bands producing a red-brown stain. Both patients were noted to have generalized hypomineralization of their enamel prior to orthodontic treatment.

Case 1

Orthodontic Treatment

AK, a 10-year-old female, was referred by her general dental practitioner for orthodontic management of her malocclusion. Clinical examination revealed a Class II division 1 malocclusion. The lips were incompetent at rest with the upper incisors lying outside lower lip control. The patient was in the mixed dentition, with generalized brownish white enamel mottling of the permanent teeth, suggestive of fluorosis or hypomature amelogenesis imperfecta (Figure 1). Upper and lower arches were mildly crowded. In occlusion the overjet was increased to 11 mm, the overbite was average and incomplete, and the molar relationship was Class II bilaterally. The panoramic radiograph confirmed the presence of all permanent teeth with the exception of upper second premolars and all third molars. A lateral cephalogram confirmed the moderate Class II skeletal pattern and reduced vertical proportions.

The patient was physically small for her age and had not entered her growth spurt. She was kept under regular review until 12 years of age when treatment was started with an Andreasen functional appliance, with the aim of improvement of the anteroposterior skeletal pattern and overjet reduction. The overjet reduced from 11 to 2 mm over 9 months of full-time wear of the appliance.

The patient declined to undergo further orthodontic treatment after the functional phase. She was re-referred at 16 years of age, complaining of the alignment of the upper incisors and the palatal position of the upper canines. The overjet had relapsed to 6 mm, and the overbite was increased and complete.

Lower second premolars and retained upper deciduous second molars were extracted, and upper and lower pre-adjusted edgewise fixed appliances were placed together with a transpalatal arch for anchorage support. The teeth were etched with 30 per cent phosphoric acid for 1 minute and Concise™ (3M Unitek, Bradford, U.K.) composite, a chemically-cured composite, was used to attach stainless steel brackets (Dentaurum, Ispringen, Germany). Repeated bond failures of the upper incisor brackets occurred as a result of the hypomineralization and the same standard process of bracket placement was followed each time. Shortly prior to debond, green-black staining became evident on the upper left central incisor, extending from the apical aspect of the bracket base to the gingival margin

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(Figures 2 and 3). No extrinsic factors could be identified which may have caused the tooth discolouration and the staining could not be removed by polishing. The tooth was vital to pulp testing and a peri-apical radiograph revealed no obvious pathology.

Restorative Treatment

As an initial measure the stained enamel was removed while retaining as much of the underlying enamel as possible to optimise bonding. Dark striations were observed through the thickness of the affected enamel rather than uniform discoloration (Figure 4). A composite resin veneer was placed, but an acceptable shade match was not achieved due to the very high value of the patient's natural tooth shade. In addition, the mottling of the other incisors was still a cause for concern to the patient (Figure 5). It was decided to carry out micro-abrasion to 21|2 and to place a porcelain veneer |1. Micro-abrasion using 18 per cent hydrochloric acid-pumice slurry was performed, as well as external bleaching using Opalesence® (Optident Dental Solutions, Skipton, U.K.), applied nightly over the course of 3 weeks, in order to further improve the mottling and to lighten the remaining stained cervical margin of |1. It was important to retain this marginal enamel in order to achieve an optimal seal with the resin luting cement. The definitive restoration achieved a satisfactory aesthetic result (Figure 6).

FIG. 1 Case 1: anterior view showing pretreatment enamel mottling.

FIG. 2 Case 1: green-black staining evident around bracket base.

FIG. 3 Case 1: green-black staining after bebond.

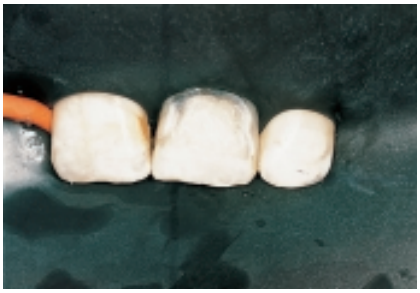

FIG. 4 Case 1: appearance of |1 following initial removal of the most darkly stained enamel under rubber dam. Some stain remains at the cervical margin.

FIG. 5 Case 1: initial composite resin restoration |1.

FIG. 6 Case 1: finished result showing porcelain veneer |1 and microabrasion 21|2.

Case 2

Orthodontic Treatment

LH was referred by her general dental practitioner for orthodontic treatment. She presented at age 12 years with a Class II division 1 malocclusion in the late mixed dentition. The enamel of all permanent teeth was noted to be hypomineralized with hypoplastic areas affecting the incisal edges of the permanent first molars and maxillary central incisors, and occlusal tooth surface loss on the permanent first molars (Figure 7). A diagnosis of hypomature amelogenesis imperfecta was made. The upper and lower arches

were crowded, with severe shortage of space in the upper arch for the eruption of upper canines which could be palpated buccally. In occlusion, the overjet was 9 mm, the overbite was increased and incomplete, and the molar relationship was Class II bilaterally. The panoramic radiograph showed all permanent teeth developing and the lateral cephalogram confirmed the underlying Class II skeletal relationship.

Upper first and lower second premolars were extracted, and a Medium Opening Activator functional appliance placed to correct the Class II relationship. After 8 months, the molar relationship had corrected to Class I and the overjet reduced to 3 mm. Maxillary and mandibular preadjusted edgewise fixed appliances were placed with stainless steel brackets (Dentaurum, Ispringen, Germany), initially on the anterior teeth. These were cemented using routine bonding procedures, etching with 30 per cent phosphoric acid for 1 minute and using a chemically cured composite, Concise™ (3M Unitek, Bradford, U.K.), to cement the brackets. Repeated bond failure occurred and the anterior brackets were replaced with stainless steel anterior bands, cemented with glass ionomer cement. It was not possible to identify the manufacturer of the bands. Bands were in place between 15 and 24 months, and treatment was completed after 26 months. At debond, a red-brown staining of the central portion of the anterior teeth was evident. This was unusual in being confined to the area under the brackets or bands and was noticeably worse on |12 (Figure 8). Interestingly, the bands on these teeth had been in place for a shorter time than those on the contralateral teeth which were less severely affected.

FIG. 7 Case 2: anterior view showing pretreatment enamel mottling.

FIG. 8 Case 2: red-brown staining visible after debond.

FIG. 9 Case 2: reduction in staining intensity after micro-abrasion.

Restorative Treatment

Microabrasion was carried out using 18 per cent hydrochloric acid-pumice slurry which reduced the staining in intensity, but did not eradicate it completely (Figure 9). 321|123 were then prepared for porcelain veneers and it was noted that the stain was less intense again after the enamel surface was removed (Figure 10). Porcelain veneers were placed 321|123 and a satisfactory aesthetic result obtained (Figures 11 and 12).

Discussion

Indelible staining of enamel following orthodontic treatment has been reported and the effect of this in patients where enamel is already compromised may be severe. Ceen and Gwinnett (1980) demonstrated post-orthodontic discolouration of an area that had previously been noted as a diffuse white lesion, suggestive of hypomineralization. Kostlan and Plackova (1962) have shown that zones of developmental hypomineralization, which appear as subsurface white spot lesions, possess a relatively greater volume of space than normal enamel. Acid etching of the more porous lesion may open pathways to allow the resin sealant to penetrate the area, carrying stains into the subsurface

FIG. 10 Case 1: 321|123 prepared for porcelain veneers.

FIG. 11 Case 2: anterior view showing porcelain veneers 321|123.

FIG. 12 Case 2: facial view showing porcelain veneers 321|123.

spaces. It is thought that the majority of pigments arise from metal ions released by corrosion of the metallic attachments (Maijer and Smith, 1982). Gwinnett (1982) postulated that, in certain patients, conditions favouring bracket corrosion existed. A combination of accumulated plaque at an acidic pH and the presence of saliva rich in chloride can potentiate conditions favourable to corrosion. Cracks in the resin attached to the bracket base, and between the resin and the metal base at the site of discolouration were seen under the scanning electron microscope. These cracks may have given rise to the phenomenon of crevice corrosion and the subsequent release of stainless steel breakdown products.

The colour of the stain may give some clue to it's origin. Black deposits are associated with corrosion of stainless steel, especially in relation to welds or soldered joints, nickel oxide, nickel sulphide and chromium sulphide. The green aspect of the stain may have been due to hydrated chromium oxide, chromium fluoride, nickel fluoride and nickel phosphate. The greenish-black discolouration seen in Case 1 is likely to be due to a combination of these compounds. In contrast, the reddish-brown stain of Case 2 is typical of iron oxide and may have been due to a localized loss of the luting cement underneath the band as well as crevice corrosion.

In order to prevent such stains occurring, Gwinnett (1982) recommended that the clinician should be alert to early colour changes, loss of luting cement or resin, and dissolution of metal from the bracket periphery. Care should be exercised with recycled brackets, particularly those made from Type 304 stainless steel alloys. This alloy is prone to corrosion when new and the recycling process may further reduce it's corrosion resistance. The use of metal alloys with increased corrosion resistance, such as Type 316L, and non-metallic attachments should be considered. Developmental anomalies of the enamel, whether localized or generalized, must also be thought of as a risk factor for indelible enamel staining after fixed appliance treatment.

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