Acta Scientific Dental Sciences

Volume 2 Issue 6 June 2018

Review Article

Tooth Staining: A Review of Etiology and Treatment Modalities

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Received: April 12, 2018; **Published:** May 22, 2018

Abstract

Tooth staining can have a psychological and social impact on a patient. Staining has several intrinsic and extrinsic etiologic factors which can result in mild to severe staining causing an esthetic challenge for the patient and clinician. Different treatment modalities ranging from enamel microabrasion, bleaching to porcelain veneers and crowns exist and the choice depends on the underlying etiology and depth of the stain lesion. The purpose of this article is to review the etiologic factors and relevant treatment modalities for tooth staining.

Keywords: Tooth Staining; Dental Fluorosis; Enamel Microabrasion; Bleaching; Porcelain Veneers

Terminology and Classification

Tooth staining can have an adverse psychosocial effect on a patient and can create an esthetic challenge for the clinician. According to the Glossary of Prosthodontic Terms [1], 'stain' has been defined as the 'discoloration of a tooth surface or surfaces as a result of ingested materials, bacterial action, tobacco, and/or other substances. This may be intrinsic, extrinsic, acquired, or developmental'. Vogel [2] introduced two categories for tooth discoloration as extrinsic or intrinsic and later Watts [3] introduced a third category called internalized discoloration. This classification depends on specific etiologic factors. Several factors affect the color of the tooth as seen by the human eye, some of which include: tooth's physiologic components (enamel, dentin and pulp), gradation of color based on specific location on the tooth (gingival shades are darker than incisal translucency), individual teeth (central and lateral incisors are lower in value than canines), age of the patient (teeth are lighter at a younger age than at an older age due to physiologic wear of enamel, secondary dentin deposition and staining), quality of the incident and reflected light (determining how the tooth is eventually viewed) [3]. Determination of the etiologic factor causing staining plays an important role in planning a specific treatment modality and its related outcome.

Etiology

Intrinsic stains can be caused by various conditions such as: alkaptonuria [4], congenital erythropoietic porphyria [5], congenital hyperbilirubinaemia [6], amelogenesis imperfecta [7-9], dentinogenesis imperfecta [10,11], tetracycline staining [12-14], fluorosis [15-17], enamel hypoplasia [18,19], pulpal hemorrhagic products, root resorption [20] and aging. Watts [3] classified extrinsic stains as non-metallic and metallic based on whether the stain was caused by compounds being incorporated into the acquired pellicle producing a stain related to their base color or a stain produced due to a chemical interaction at the tooth surface. Non-metallic stains can be caused due to smoking [21], mouth rinses containing quaternary ammonium compounds [22] or use of chlorhexidine mouthrinses [23,24]. Metallic stains can be attributed to medications comprised of metal salts [22], use of iron supplements [25], potassium permanganate in mouthrinses [23], grey discoloration with silver nitrate salt [26] and golden-brown discoloration with stannous fluoride [27].

Internalized discoloration can be caused by structural defects which allow entry of chromogenic bacteria through the tooth surface eventually leading to staining [3]. These can be classified further into developmental defects, acquired defects and defects from restorative materials. Developmental defects include conditions causing intrinsic staining (enamel hypoplasia, fluorosis, dentinogenesis imperfecta). Acquired defects create a predisposition to staining which comprise of tooth wear (attrition, abrasion, erosion causing either physiologic or pathologic loss of tooth structure), gingival recession and dental caries [29-31]. Restorative materials like amalgam are associated with discoloration due to the migration of tin into dentinal tubules as shown by electron microscopy [32]. Root canal therapy entails use of eugenol, phenolic compounds and sometimes polyantibiotic pastes which have a propensity to stain dentin.

Treatment Modalities and Biomaterials

There are different treatment modalities for tooth discoloration such as bleaching [33], enamel microabrasion [34] and porcelain veneers [35]. These may be used individually or in combination depending on the etiology and severity of the staining. Superficial treatments like bleaching and microabrasion have been used in conjunction but controversy exists whether or not high concentration hydrogen peroxide causes morphological alterations in enamel [36-41].

Bleaching

Tooth whitening has been described by the chromophore concept [42]. The bleaching agent (hydrogen peroxide) by method of diffusion through tooth structure interacts with organic chromophores converting the latter's molecular chains to simpler units. This changes its optical properties and yields products with lower molecular weight which can be eliminated from the tooth surface. There are several bleaching agents available such as: hydrogen peroxide, carbamide peroxide, sodium perborate and chlorine dioxide. In-office bleaching is most commonly carried out with hydrogen peroxide ranging from 15 - 38% [43]. Hydrogen peroxide (H_2O_2) is able to penetrate dentinal tubules due its reduced molecular weight [44]. It has the ability to release oxygen-free radicals capable of permeating through enamel and dentinal structures and eventually oxidizing organic pigments and chromogenic compounds [45]. Carbamide peroxide ($CH_6N_2O_3$: 10 - 20%) is the agent mostly used for at-home bleaching [43]. Upon interaction with water it is broken down into hydrogen peroxide and urea eventually producing free oxygen [46]. Carbamide peroxide has the advantage of providing good results with a lesser propensity for post-treatment side effects such as sensitivity, gingival inflammation and changes in surface microhardness [47,48]. Although a conservative treatment approach, bleaching is commonly associated with post-treatment tooth sensitivity being significantly dependent on the pH of the agent [49]. Authors have also reported a significant relapse rate in tooth shade associated with this procedure necessitating a re-treatment [50-52].

Enamel microabrasion

Enamel microabrasion represents a conservative superficial approach which has been useful as definitive treatment only for mild to moderate fluorosis stains [53]. The materials used for this treatment include an abrasive paste, typically 6.6% hydrochloric acid with 20 - 160µ silicon carbide microparticles and bristle cups. Teeth are cleaned with a pumice slurry and light pressure followed by multiple 20 seconds application of the microabrasive slurry. At-home bleaching using 10% carbamide peroxide can be used in conjunction with microabrasion to remove residual staining and improve tooth shade. Mild superficial stains can be removed with this technique. The depth of the stain lesion plays an important role in determining whether microabrasion will be an effective modality. Most common vivo methods for depth determination include ultrasound, transillumination and visual assessment. Park *et al.* [54] used an in vivo method of quantitative light-induced fluorescence (QLF) to assess the level of enamel hypoplasia in order to determine the choice of treatment. Microabrasion can be used to treat: superficial enamel stains resulting from dental fluorosis, mineralized white spot lesions, surface irregularities, localized enamel hypoplasia and enamel polishing post-orthodontic treatment [34].

Porcelain Laminate Veneers or crowns

Deeper stains resulting from enamel hypoplasia or intrinsic causes cannot be treated with conservative methods like microabrasion and bleaching and need a restorative approach such as porcelain veneers and/or crowns. Veneers have long been used as a minimally invasive restorative approach for improving tooth form and shade. Reports indicate a high success rate and longevity of such restorations [35,55-59]. Materials most commonly used are feldspathic porcelain and lithium disilicate (LS2). Lithium disilicate can be fabricated with either a minimal cut-back or bi-layered technique. This is determined by the intensity of the underlying stain, amount of desired translucency and clinician's preference. Tooth preparations for veneers are conservative and remain predominantly in enamel for higher bond strength and reduced risk of post-treatment sensitivity. Severe forms of staining causing structural damage may require restoration with complete coverage crowns.

Summary

Tooth staining is one of the most common reasons for patients to seek dental treatment in order to improve their smile. It can be a complex situation for the patient as well as the clinician. Tooth staining has several etiologic factors ranging from simple enamel hypoplasia to severe dental fluorosis. An understanding of the disease process is essential in determining the appropriate treatment modalities. Mild to moderate enamel staining can be treated with conservative treatment approaches such as a combination of enamel microabrasion and bleaching. Bleaching although conservative is carries the risk of post-treatment sensitivity and relapse. More aggressive and deep staining needs a restorative approach with porcelain veneers and/or complete coverage crowns. It is imperative that the clinician have a comprehensive understanding of etiology and respective treatment options when treating a patient for tooth staining.

Conflicts of Interest

None.

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Volume 2 Issue 6 June 2018