

ALL ABOUT DENTAL STAINS: A REVIEW (PART I)

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Abstract

Dental Stains are pigmented deposit on the tooth surface. They can be either extrinsic or intrinsic stains. A dental stain compromises the aesthetic of an individual. Dental stains have always been matter of concern for the patients and the clinician. Their prevalence may vary through geographic location, age, sex, habit and diet of an individual. Since there is a lot of variation between different types of stains there is a need to classify them for easy identification. As clinicians we should be able to diagnose the type of stains and help these patients with choices to pick the most conservative treatment plan with an aesthetic outcome that is acceptable to the patient and the dental practitioner. This article aims to give an insight into the prevalence, etiology and classifications of dental stains.

Key words: - Discoloration, Extrinsic Stains, Intrinsic Stains.

Introduction

Dental stains, the pigmented deposits on the tooth surface are the first dental variation noticeable in a person causing an aesthetic problem for the patients. They differ in etiology, appearance, composition, location, severity and degree of adherence to the tooth.¹

In the present generation, cosmetic appearance of teeth has become a matter of prime importance. The number of people seeking treatment for dental stains has substantially increased. Hence; the dentist must be ready to manage these patients. He should be able to identify the type of stains and its etiology because it dictates how to manage the condition.² The purpose of this article is to review the literature about various types of stains and their etiology for better understanding and treating it.

Discoloration of the teeth has been divided according to the origin of the stain into extrinsic or intrinsic staining (Gorlin and Goldman, 1970). The extrinsic as the name suggests, is found on the outer surface of the tooth while intrinsic stain is found within the tooth structure. Extrinsic and intrinsic stains can also exist in combination.^{1,3}

EXTRINSIC STAINS

These staining occur on the outer aspect of the tooth. They may penetrating the enamel defects or when dentin is exposed and become internalised (Figure 1) due to the porosity of dentin that helps in penetration of chromogenic material to variable depths into the dentin.³

Prevalence

It has been observed that the prevalence of extrinsic stains increases with age and is found higher among the men (Ness *et al.* 1977). A significant variation is seen among children with respect to extrinsic stain. Sutcliffe (1967) found 25 % children had extrinsic staining and reported brown stains to be most predominant. Gerdin (1970) in a study on Swedish school children found that 15 % of them showed discolorations on their teeth and yellow/ green

deposits were most frequently colour of the stains present.⁴ Leung (1950) found that 85 % of a group of children had discolorations on their teeth, with green deposits being the most predominant.⁵ These discrepancies in data reflects variation in extrinsic staining among different population and groups.



Figure 1: Internalised tobacco stains

Predisposing factor

There are various factors that can modify the occurrence of extrinsic stains like enamel defects, salivary dysfunction, poor oral hygiene, microscopic pits and fissures on the enamel that make the subject susceptible to the accumulation of stain producing beverages, tobacco, and other topical agents.

Saliva plays an important role in removing the food debris hence reduction in flow of saliva in conditions like Sjogren's syndrome, cancer therapy, anticholinergic medication, predispose the accumulation of plaque leading to stain deposition.⁶

Etiology and Classification

The formation of extrinsic stain can be because of any of the three reasons;

- a) **Chromogenic bacteria:** These bacteria that are present in plaque, deposits coloured substances onto the tooth surface. Colour of the stains varies from one strain of bacteria to other like green, yellow, blue, black, orange etc. They tend to reoccur after removal.⁴
- b) **Direct staining by food:** It occurs by food substance having a strong colouring characteristic like tea, coffee, berries etc.⁴
- c) **Chemical transformation of pellicle:** The pellicle may be exposed to a variety of denaturing agents under normal conditions like tannic acid that is a natural constituent of various fruit, wines, tea and coffee. Undisturbed adsorption and apposition of glycoproteins forming an extraordinary thick "consolidated" pellicle may also increase the possibilities for extrinsic discoloration.⁴ Various metabolites in oral cavity like aldehyde and ketone groups are known to react with amino groups to form brown organic complexes. Furfural is an aldehyde that occurs in a variety of baked products and fruit and may also be formed in the oral cavity by normal digestion of pentoses (a normal constituent of the pellicle) and certain polysaccharides. The interaction of protein and furfural produces a brown stain (Berk 1976).⁸

The causes of extrinsic staining can also be divided into two categories; those substances that get incorporated in the pellicle and produce a stain because of its own basic colour, and those which stain by the chemical interaction at the tooth surface.³ they are:

- 1) **Direct stains:** It has multi-factorial aetiology with chromogen derived from dietary sources or those that are habitually placed in the mouth. The colour seen on the tooth might occur due to polyphenolic compounds which gives colour to the food. These organic chromogen are taken up by the pellicle, hence; colour of the chromogen determines the colour of the stain. Tobacco smoking and chewing are known to cause direct staining and so do tea and coffee.^{3,9}
- 2) **Indirect stains** are caused by chemical interaction at the tooth surface by cationic antiseptics and metal salts. These agents are colourless or of a different colour from the stain they produce on the tooth surface. Flotra *et al* in 1971 observed that tooth staining increases with the use of chlorhexidine.³ Though chlorhexidine is considered a gold standard in treating gingivitis and prevention of plaque, it is associated with formation of extrinsic yellowish brown staining of the teeth and tongue on long term use. The theory that it is caused due to degradation of the chlorhexidine molecule to release parachloroaniline is no more accepted. The newer proposed mechanism involves Non enzymatic browning reactions that take place in the acquired

pellicle which causes condensation and polymerisation of proteins and carbohydrate in it leading to discolouration of the acquired pellicle and catalyse steps in Millard's reaction (Yates *et al.*, 1993).⁹ One of the other theory is that chlorhexidine denatures the acquired pellicle to expose sulphur radicals. The exposed radicals react with dietary chromogen to form the metal sulphide that is seen as staining.¹⁰

With respect to the elements of origin causing extrinsic staining of tooth, it is divided into:

- 1) **Non-metallic stain:** The non-metallic extrinsic stains are adsorbed onto the tooth surface deposits such as plaque or the acquired pellicle. The aetiological agents include.^{2,9}
 - i. Diet: tea, coffee, other beverage causing brown to black staining.
 - ii. Habit: tobacco and pan causing reddish to brown staining.
 - iii. Poor Oral hygiene: plaque and calculus causes yellow to brown staining, and chromogenic bacteria produces various colour of staining depending upon the strains.
- 2) **Metallic stains:** It is mainly associated with industrial workers or people consuming drugs based on metal salts. Some metals like copper, iron, fluoride, manganese, silicon, silver, and tin produces characteristic tooth staining because their sulphides are brown or black, and in the oral cavity there exists ample opportunity for the production of these sulfides from food and saliva.¹¹

There is a characteristic black staining of teeth reported in people working in iron factories (Nordbo *et al.*, 1982). Green stain is produced due to mouthrinses that contains copper salts (Waerhag *et al.*, 1984) and in industrial workers who remain in contact with copper metal (Dayan *et al.*, 1983).⁹

Elingsen *et al* demonstrated the formation of yellowish brown staining due to use of stannous fluoride mouthwash for 2-3 weeks. This staining is accelerated on having oxidising food. A number of other metals have characteristic colours such as potassium permanganate producing a violet to black colour and silver nitrate causes a grey colour on the tooth surface.¹² Table-1 enumerates various metals along with the characteristic colour of stains they produce on the tooth surface.

Metal	Colour of stains produced
Iron	Black
Copper , nickel, mercury , lead	Green, blue
Manganese	Violet ,black
Tin	Golden brown
Silver	Grey

Table-1: Stains produced by various metals.

Depending upon the colours extrinsic stains can be classified as: -

COLOUR	CHARACTERISTICS	LOCATION	ETIOLOGY
Brown Stain	Stain is thin and bacteria free.	Most commonly found on the Buccal surface of the maxillary molars and the lingual surface of the Mandibular incisors, and least on the labial surfaces of maxillary anterior teeth.	Found in individuals with poor oral hygiene due the deposition of tannin found in tea, coffee, and other beverages and those who use a dentifrice with inadequate cleaning and polishing action. (Hattab et al; 1999)
Black Stain	Thin or wide black line firmly attached to the tooth surface that is difficult to remove with a toothbrush and dentifrice. It mostly tends to recur after removal.	Found on the facial and lingual surfaces of the teeth near the gingival margin and extends on the proximal surfaces	It is caused by colour producing (chromogenic) bacteria, primarily <i>Actinomyces</i> . The black stain is due to ferric sulphide formed by the reaction between hydrogen sulphide produced by bacteria and iron found in saliva and gingival exudates. (Hattab et al; 1999)
Green Stain	These are tenacious and thick stains common in children.	Found on the facial surface of the maxillary anterior teeth near the gingival third.	It is considered to be remnants of the primary enamel cuticle that has been stained. The discoloration is considered to be due to fluorescent bacteria and fungi like <i>Penicillium</i> and <i>Aspergillus</i> . (Hattab et al; 1999) It has also been seen in people exposed to copper salts in mouthwashes. (Manuel et al; 2010)
Orange Stain	These are easily removable. It is rare and found in only 3% of the population.	Usually occurs on the labial surface of Maxillary and Mandibular anterior teeth at the gingival third.	Found in individuals with poor oral hygiene. Chromogenic bacteria of orange stain, such as <i>Serratia marcescens</i> and <i>Flavobacterium lutescens</i> are considered the main cause. (Hattab et al; 1999)
Metallic Stains	This type of staining evident in industrial workers exposed to metal.	This staining is mostly evident in exposed tooth surface or outer environment.	The metals combine with acquired pellicle to produce a surface stain, or penetrate the tooth substance to cause permanent discoloration. Different metal produces a different colour of staining. (Manuel et al; 2010)
Yellow	Stains easily removed by proper brushing	Mostly found on the cervical interproximal areas of teeth, dorsum of the tongue	Caused by use of essential oil and phenolic mouthrinses (Manuel et al; 2010)
Red- Black	Thick, hard staining not easy to remove.	Found on the facial, lingual and occlusal surface of both anterior and posterior teeth.	Found in people who are habitual betel palm leaf and nut chewer. (Sruthy et al; 2013)
Violet Black	Easily removable by proper brushing	Found on the cervical interproximal areas of teeth, dorsum of the tongue	Due to the presence of potassium permanganate in mouthrinses. (Sruthy et al; 2013)

Table 2: - Classification of extrinsic stains on the basis of colour.

Nathoo propose a new classification based on the chemistry of dental discolorations that explains the mechanism of discoloration and variable extent of staining (Table 3).¹³

NATHOO'S CLASSIFICATION OF EXTRINSIC DENTAL STAINS		
Type	Characteristic	Example
N1- Dental Stain or Direct Dental Stain	Coloured material (chromogen) binds to the tooth surface to cause discoloration. The colour of the chromogen is same as that of the dental stain.	Tea, coffee, iron suppliments, metals, chromogenic bacteria
N2- Dental Stain or Direct Dental Stain	Coloured material changes colour after binding to the tooth.	These are N1 stains that get darker with age
N3- Dental Stain or Indirect Dental Stain	Colourless prechromogen binds to the tooth surface and undergoes a chemical change to form chromogenic material.	Chlorhexidine, stannous fluoride, carbohydrate rich food(apples, potatoes)

Table-3: Nathoo's classification of extrinsic stains.

INTRINSIC STAINS

These are stains that occurs inside the tooth structure that may occur due to incorporation of chromogenic materials into enamel and dentin either before eruption i.e. during odontogenesis (pre eruptive) or after eruption (post eruptive).¹ There are several causes of intrinsic tooth staining which have either an endogenous or exogenous origin.³ The normal with the yellow shade of the dentine beneath it. A number of metabolic diseases and systemic factors are known to affect the developing dentition and cause staining.¹⁴

Etiology and Classification

Intrinsic dental stain has been broadly classified into pre eruptive cause and post eruptive cause.²

1) Pre eruptive cause

The teeth may become discoloured from the changes in the quality or quantity of enamel or dentin, or due to deposition of discolouring agent into the hard tissues during odontogenesis.

a) *Disturbance in tooth germ formation*

It can either affect single tooth (localised) or can be generalised. Example of localised stain is *turner's tooth* that is caused by trauma to the tooth during development.² Molar incisor hypomineralisation is a condition causing severe hypomineralisation of enamel that affects incisors and permanent first molars. The generalised disturbance in tooth

development is seen in case of infections like cytomegalovirus, morbilli virus (measles), varicella zoster (chicken pox), streptococcal infections etc. The nutritional deficiency like vitamins C and D, calcium, and phosphate that are required for healthy tooth formation lead to enamel hypoplasia.¹⁵

In all the above conditions the colour of the tooth vary from white to yellow to brownish areas and they always show a sharp demarcation between sound and affected enamel.²

b) *Genetic disorder*

It consists of hereditary diseases like Amelogenesis imperfecta (affecting formation of enamel), Dentinogenesis imperfect (defect in dentin formation) and dentin dysplasia. Other hereditary diseases include erythropoietic porphyria and Epidermolysis bullosa. Erythropoietic porphyria is a rare disease of porphyrin metabolism. It is characterised by high levels of reddish brown porphyrin pigments that have an affinity for calcium phosphate and are incorporated into mineralised tooth structure during tooth formation.⁶

Amelogenesis imperfect appears bluish brown in colour while dentinogenesis imperfecta, dentin dysplasia and epidermolysis bullosa has a yellowish tinge on the tooth.⁶

c) *Metabolic disorders*

It signifies any abnormal chemical reactions in the body that alters the normal metabolic process. In case of neonatal jaundice, there is increased level of bilirubin in body leading to deposition of bilirubin in the developing tooth enamel and dentin. This gives a yellowish discoloration to the tooth.¹⁶ Phenylketonuria is disease in which the body lacks ability to metabolise tyrosin and phenylalanine causing a build-up of homogenistic acid. This result in a brownish discoloration of the permanent dentition.²⁰ In Congenital erythropoietic porphyria, there is increased formation and excretion of porphyrins. Porphyrin pigments have an affinity for calcium phosphate and are incorporated into teeth during odontogenesis that causes a characteristic reddish-brown discoloration of the teeth, called erythrodontia. Alkaptonuria is a defective metabolism of tyrosine and phenylalanine that increases the level of homogentisic acid in the body. It causes a brownish discoloration of permanent dentition.¹⁷

d) *Medication*

Drugs from the tetracycline family have been associated with intrinsic tooth discoloration since the 1950s.⁶ Tetracycline chelates with the calcium ions on the surface of the hydroxyl apatite crystals forming a stable orthophosphate complex. Teeth appear yellowish to brown and also fluoresce under ultraviolet light, giving off a bright yellow colour.

Minocycline is a semisynthetic derivative of tetracycline that causes green–grey or blue grey intrinsic staining.¹⁸ Ciprofloxacin an antibiotic that is used to treat Klebsiella infection in infants has shown to cause greenish discoloration of the teeth.¹⁹

e) *Dental fluorosis*

It is the environmental cause for staining characterized by enamel discoloration resulting from subsurface hypomineralisation due to the excessive intake of fluoride during the early maturation stage of enamel formation. Clinically mild fluorosis can be identified as faint white lines or streaks on the enamel. Moderate fluorosis shows prominent opaque regions known as enamel mottling, whereas in severe fluorosis extensive mottling that easily chips and stains and leads to pitting and brown discoloration is seen.^{6,21} A daily fluoride intake of more than the optimum of 0.05-0.07 mg fluoride/kg body weight/day is thought to cause dental fluorosis. The fluoride sources can be naturally or artificially fluoridated drinking water, commercially formulated beverages, and oral health care products.^{2,22}

2) **Post eruptive cause**

It is a type of intrinsic staining that occurs after eruption of tooth. It is also called acquired defect.⁷

a) *Dental condition*

The carious lesions can be identified by changes in colour as the disease progresses. The initial carious lesion appears as an opaque, white spot that differs in colour from the adjacent enamel due to increased porosity. It can be identified by air drying the lesion. The hard arrested carious lesion is black due to staining by exogenous sources.^{2,7,23}

Tooth abrasion, attrition, erosion and recession cause thinning of tooth enamel causing the tooth colour to become yellowish because the colour of dentin becomes evident.⁶

b) *Pulpal condition*

Damage of pulp due to Bacterial, mechanical or chemical irritant causes its necrosis which lead to release of disintegration products that penetrates the dentinal tubules that causes staining. Acute trauma to pulp causes haemorrhage that gives a reddish tinge to the tooth that later turn grey-brown.²

Trauma to the tooth may also lead to internal resorption presents as a pink lesion in an otherwise healthy tooth, known as the 'Pink tooth of Mummy'.⁷

c) *Dental material*

Various restorative materials used in dentistry also lead to staining of the tooth. Eugenol, phenolic and polyantibiotic based materials used during endodontics therapy contain pigments which may stain dentin.⁷ The most common restorative stains which a dentist comes across in his life is amalgam stains that appears as a bluish tinge around the

restoration (amalgam blue). Previously it was thought that the staining is caused due to reaction of mercury with sulphide in dentinal tubules but recently it was discovered that the staining is due to penetration of tin into the tubules.²⁴ Ledermix that contains triamcinolone acetonide and demethylchlortetracycline and is used within the tooth for endodontic therapy has also reportedly caused dark grey-brown discolorations.²⁵

Conclusion

The understanding of the pathological process involved in stain formation can help the dentist to explain the cause to the concerned patients. The dentist should analyse the expectation of every patient and treat them for discoloration accordingly. The knowledge shall help the clinician to decide if he will be able to manage the stains or he should refer it to the specialist.

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