

CASE REPORT

## Tetracycline induced tooth discoloration

Venkateswarlu M<sup>1</sup> and Naga Sailaja R<sup>2</sup>

Department of Oral Medicine & Radiology  
Kamineni Institute of Dental Sciences,  
Narketpally.

Professor & HOD<sup>1</sup>  
PG Student<sup>2</sup>

### Article Info

Received: October 11, 2010

Review Completed: November 14, 2010

Accepted: December 17, 2010

Available Online: April, 2011

© NAD, 2011 - All rights reserved

### ABSTRACT:

Teeth can get discolored due to various factors, both intrinsic and extrinsic. Many chemical substances have the potential to cross the placental barrier and affect the mineralization of teeth during their formative stage. Tetracyclines are a group of drugs which can discolor teeth permanently. Due to global awareness among health professionals, prescription of tetracyclines and subsequent discoloration has become rare and one such case of discoloration of teeth due to administration of tetracyclines is reported here and discussed in detail.

**Key words:** Staining of teeth, Tetracyclines, Intrinsic and extrinsic staining, Drug induced discoloration

### Introduction:

Tetracycline is a broad spectrum bacteriostatic antibiotic (*vander bijl and pitgoi — Aron 1995*) which is used in the treatment of many common infections in children and adults.<sup>1</sup> The tetracycline antibiotics are a group of related compounds that are effective against gram negative and gram positive bacteria. Systemic administration of tetracyclines during development is associated with deposition of tetracycline within bone and the dental hard tissue.

These tetracyclines during odontogenesis cause unsightly discoloration of both primary and secondary dentitions.<sup>2</sup> The staining effects are as a

result of chelation of tetracycline molecule with calcium ions in hydroxyapatite crystals primarily in the dentine (*swift 1988*).<sup>3</sup> The tetracycline is incorporated into the enamel and dentine and the chelated molecule arrives at the mineralizing predentin dentin junction via the terminal capillaries of pulp (*patel et al 1998*).<sup>4</sup> The brown discoloration is due to photo oxidation which occurs on exposure of tooth to the light.

With reports of potential illeffects of tetracycline on mineralization of teeth, during last several decades, prescription of tetracyclines to pregnant women and feeding mothers as well as in the early years of infants is being avoided by dentists and physicians and reports of cases of staining of teeth

Email for correspondence:  
saila21june@gmail.com

due to tetracyclines have become very rare and one such rare case of tetracycline staining of teeth is being reported here.

### Report of a case:

A 25 year old male patient reported to our department of oral medicine and radiology, with a complaint of discoloration of teeth since childhood. History revealed that the patient used tetracyclines for a period of 1 to 2 years for pain in the stomach as prescribed by a physician during his early childhood. No positive history of consanguineous marriage between his parents or familial history elicited.

Clinical examination revealed grayish to yellow brown discoloration involving the cervical middle and incisal regions of maxillary and mandibular teeth except lower second premolars, upper premolars and 2<sup>nd</sup> molars. The discoloration of teeth was not scrapable by dental explorer. No pigmentation was observed on the oral mucosa and other soft tissues.

A symmetrical linear grey stained band of hypoplastic enamel is seen involving the labial surfaces of all the incisors at the cervical 1/3<sup>rd</sup> of the crowns of the teeth except 14, 15, 24, 25, 35, 37, 44, 45, 47. Later the patient was subjected to wood lamp test that showed yellowish fluorescence on exposure to UV light.

In the present case the hypoplastic and stained bands involving the permanent incisors, canines, and first molars may be due to disturbance in enamel formation from birth to 6 years of age

The history of extensive tetracycline therapy for stomach ache during his early childhood indicates that the most likely cause of disturbance in enamel formation was administration of high doses of tetracycline (> 35 mg/kg of body weight/day), because there is no history of any prolonged fever (> 104° F) concurrent with the illness for which the drug was administered.

The Clinical examination and relevant investigations suggest that in the present case the discoloration of teeth may be due to tetracycline staining

### Discussion:

Tooth discolouration is classified as either intrinsic or extrinsic.<sup>5</sup>

**Extrinsic Discoloration may be due to:** caffeine and its related products, smoking and tobacco chewing, certain drugs like liquid iron supplements in excessive dosage and few mouth washes

### Intrinsic Discolouration

Intrinsic discolouration occurs following a change to the structural composition or thickness of the dental hard tissues. The normal colour of teeth is determined by the blue, green and pink tints of the enamel and is reinforced by the yellow to brown shades of dentine beneath.

A number of metabolic diseases and systemic factors are known to affect the developing dentition and cause discolouration. Conditions which cause intrinsic staining of teeth are:

1. Alkaptonuria
2. Congenital erythropoietic porphyria
3. Congenital hyperbilirubinaemia
4. Amelogenesis imperfecta
5. Dentinogenesis imperfecta
6. Tetracycline staining
7. Fluorosis
8. Enamel hypoplasia
9. Pulpal haemorrhagic products
10. Root resorption
11. Ageing

Tetracyclines are broad spectrum bacteriostatic antibiotics which are introduced in the year 1950 and usually prescribed for respiratory and middle ear infections as well as some of the infections caused by penicillin resistant organism. Minocycline, chlortetracycline, oxytetracycline are other drugs which belong to the same group as tetracycline and result in tooth discoloration.

In recent years, reports have been published regarding the discolouration of teeth resulting from the administration of tetracyclines during the period of tooth formation. Concern was expressed in some of these reports that tetracyclines might also disturb enamel formation, leading to malformed, hypoplastic teeth. When these conditions occur in the primary teeth, the problem will be resolved by their natural exfoliation. If, however, the secondary teeth are so affected the condition is permanent.

As a result of these observations, the Food and Drug Administration of the United States issued an official statement in April 1963 that tetracyclines could discolour children's teeth if administered to the mother during the last trimester of pregnancy or to the child in the neonatal period, infancy or early childhood.

As tetracycline can cross the placental barrier its administration should be avoided from 29 weeks in utero until full term to prevent incorporation into the dental tissues.<sup>6</sup> Since the permanent teeth continue to develop in the infant and young child until 12 years of age, tetracycline administration should be avoided in children below this age and in breast-feeding and expectant mothers.<sup>7</sup>

In June 1963 the Council on Dental Therapeutics of the American Dental Association issued a report on "The Significance of Dental Changes Induced by Tetracycline". Since no threshold dosage had yet been determined, it was emphasized in the report that all physicians and dentist should be aware of these facts, and that where possible, alternative antibiotics should be employed.

The coronal portion of the tooth consists of enamel, dentine and pulp. Any change to these structures is likely to cause an alteration in the outward appearance of the tooth caused by its light transmitting and reflecting properties. The appearance of tooth colour is dependent on the quality of the reflected light and is also, as a consequence, dependent on the incident light.

### **Mechanism of tetracycline staining:**

The precise mechanism whereby tetracyclines are incorporated into the teeth and bones is not clearly understood. The formation of intrinsically discoloured teeth occurs during tooth development and results in an alteration of the light transmitting properties of the tooth structure.

However, it is the result of chelation of tetracycline with calcium ions in the molecular structure. This phenomenon occurs only during the period of the calcification process, and for this reason such an effect on the teeth occurs only during the last trimester of pregnancy and in childhood. *Urist and Ibsen* suggested that tetracycline and its homologues have the ability to form complexes with calcium ions on the surface of hydroxy apatite crystals within bone and dental tissues.<sup>8</sup> Dentine has been shown to be more heavily stained than enamel.<sup>9</sup> Minocycline a semisynthetic tetracycline derivative causing tooth discoloration is controversial and still under investigation.

Currently, there are four possible theories: first, the 'extrinsic theory' (Berger *et al.*, 1989), where it is thought that tetracycline attaches to the glycoproteins in acquired pellicles.<sup>10</sup> This in turn etches the enamel, and demineralization/remineralization cycles occur. It oxidizes on exposure to air or as a result of bacterial activity, and so causes degradation of the aromatic ring, forming insoluble black quinone.

The second is the 'intrinsic theory' (*Bowles and Bokmeyer, 1997; Bowles, 1998*), where the tetracycline bound to plasma proteins is deposited in collagen-rich tissues, such as teeth. This complex oxidizes slowly over time with exposure to light. This deposition in teeth occurs solely within the dentin matrix as secondary and reparative dentin is formed

As it has been postulated by *Cohen and Parkin's* that tetracycline incorporated into hydroxyapatite, when oxidized by light produces the red quinone product 4a, 12a anhydro-4-oxo-4-dimethylamino tetracycline (AODTC) and this could be the reason

why labial surfaces of the incisors darken while the molars remain yellow for a longer period of time.

Teeth affected by tetracyclines have a yellowish or brown gray appearance which is worse on eruption and diminishes with time. Exposure to light changes the colour to brown, the anterior teeth are particularly susceptible to light induced colour changes. Various analogues of tetracycline produces different colour changes, for instance chlortetracycline produces slate gray colour and oxytetracycline causes a creamy discoloration.<sup>11</sup>

*Cale et al* suggested that Minocycline, a synthetic compound of tetracycline antibiotics is also implicated in causing discoloration in an adult patient, following its long term use for treatment of acne.<sup>12</sup> The reason for the appearance of dentine following long term use of minocycline postulated that calcium- minocycline complexes were deposited in dentine

*Berger et al* suggested staining of adult dentition appear to occur in 3-6% of patients taking long term minocycline at > 100mg daily. Onset of discoloration can occur at any time from 1 month to many years after the initiation of treatment.

*Tredwin, Scully* Suggested that Severity of tooth discoloration is influenced primarily by - four factors.<sup>13</sup>.

- **Age at the time of administration:**

Anterior primary teeth are susceptible to discoloration by systemic tetracycline from 4 months in utero through 9 months post partum.

Anterior permanent teeth are susceptible from 3 months post partum to 8 years.

- **Duration of administration:** Severity is directly proportional to the length of time the medication was administered.

- **Dosage:** Severity is directly proportional to the administered dosage.

Discoloration occurs with the greatest frequency in the developing dentition when total dosage

administration is over 3 g, or treatment exceeds 10 days

- **Type of staining caused by different types of Tetracycline group of drugs:**<sup>14</sup>

- Chlortetracycline (Aureomycin): Gray brown
- Dimethylchlortetracycline (Ledermycin): Yellow stain
- Doxycycline (Vibramycin): Does not cause stain
- Oxytetracycline (Terramycin): Yellow stain
- Tetracycline (Achromycin): Yellow stain
- Minocycline: black

The staining can be classified according to the development stage, banding and colour (*Jordan and Boksmann 1984*).<sup>15</sup>

**First degree ( mild tetracycline staining):** yellow to grey, which is uniformly spread through the tooth. There is no banding.

**Second degree ( moderate staining):** yellow — brown to dark grey

**Third degree (severe staining):** blue grey or black and is accompanied by significant banding across the teeth

**Fourth degree (Intractable staining):** suggested by feinman et al 1987, designated for those stains that are so dark that bleaching is ineffective.

**Management:**

Two approaches have been used to treat tetracycline discoloration: (i) bleaching the external enamel surface and (ii) intracoronal bleaching following intentional root canal therapy.

Tooth shade depends on the type of tetracycline, dosage, duration of intake, and patient's age at the time of administration.

First and second degree staining are normally amenable to bleaching treatments (*Hay wood 1997*).<sup>16</sup> Prolonged home bleaching has been reported in the

literature to be successful for tetracycline stains. This may take between 3 and 6 months or longer. The bleaching material penetrates into the dentine structure of the tooth and cause a permanent colour change in the dentine colour.

### Conclusion:

It can be seen from foregoing discussion that an understanding of the mechanism behind tooth staining is of relevance to the general dental practitioner. In the management of patients with tooth discoloration such information is valuable in decision — making process whether or not to treat such a condition or refer to a specialist for further opinion or for treatment. Prevention of avoidable causes of tooth staining is important. An understanding of various causes for staining of teeth by the dentist creates more awareness in him to offer advice to medical colleagues to look for prescription of alternate medication to the pregnant women or to the young child during formative stages of teeth

### References:

1. Van der Bijl P, Ptitgoi- Argon G Tetracyclines and calcified tissues. *Ann Dent.* (1995); **54(1/2)**:69-72.
2. Bleaching techniques in restorative dentistry: an illustrated guide edited by Linda Greenwall
3. Swift EJ. a method for bleaching discolored vital teeth. *quintessence Int* 1988 ; **19(9)**:607-611
4. Patel K, Cheshire D, Vance A. oral and systemic effects of prolonged minocycline therapy. *Br dent J* 1988 ; **185 (11/12)**: 560-562.
5. Pindborg J J. Pathology of the dental hard tissues. p221. Copenhagen: Munksgaard, 1970.
6. Watts and M. Addy et. al: Tooth discolouration and staining: a review of the literature *British Dental Journal* March 2001; **190** no. 6 :309-316
7. British National Formulary, March 1999; **37**: 254-256, BMJ Books: London, UK.
8. Urist M R, Ibsen K H. Chemical reactivity of mineralised tissue with oxytetracycline. *Arch Pathol (Chicago)* 1963; **76**: 484-496.
9. Wallman I S, Hilton H B. Teeth pigmented by tetracycline. *Lancet* 1962; **1**:827-829
10. Berger RS, Mandel EB, Hayes TJ, Grimwood RR. Minocycline staining of the oral cavity. *J Am Acad Dermatol* 1981; **21**:1300-1301.
11. Moffitt J M, Cooley R O, Olsen N H, Hefferen J J. Prediction of tetracycline induced tooth discolouration. *J Am Dent Assoc* 1974; **88**: 547-552.
12. Cale A E, Freedman P D, Lumerman H. Pigmentation of the jawbones and teeth secondary to minocycline HCl therapy. *J Periodontol* 1988; **59**:112-114.
13. C. J. Tredwin, C. Scully, and J. -V. Bagan-Sebastian Drug-induced Disorders of Teeth. *J Dent Res* 2005; **84(7)**:596-602
14. Hayes PA, Full C, Pinkham J. The etiology and treatment of intrinsic discolorations. *J Can Dent Assoc* 1986; **52**:217-220
15. Jordan RE, Boksman L. (1984) conservative vital bleaching treatment of discolored dentition. *Compend contin educ dent* 1984; **10** : 803-807
16. Haywood VB. Extended bleaching of tetracycline- staining teeth: case report. *Contemp Esthetics Restor Pract.* 1997; **1**: 14-21
19. P. Fleming, BDentSc, FDS C. J. Witkop et al : Staining and hypoplasia of enamel caused by tetracycline: case report *pediatric dentistry* : September 1987; **9**: 243-245.
20. E Ayaslioglu, E Erkek et al: Doxycycline-induced staining of permanent adult dentition *Australian dental journal* 2005; **50**:(4):273-275
21. Jun-Ichiro Kinoshita Hamid Jafarzadeh et. al: Vital Bleaching of Tetracycline-Stained Teeth by Using KTP Laser: A Case Report *European Journal of Dentistry* July 2009 ; **3**
22. T. Attin, F. Paque et al. : Review of the current status of tooth whitening with the walking bleach technique *International Endodontic Journal*, 2003; **36**, 313-329
23. J. E. Dahl Tooth bleaching – A Critical Review of the biological aspects. *Crit Rev Oral Biol Med.* 2003; **14(4)**:292-304
24. de Wit ME, Stricker BH, Porsius AJ. Discoloration of teeth by drugs. *Ned Tijdschr Tandheelkd* 1996; **103**:3-5.
25. Siller GM, Tod MA, Savage NW. Minocycline-induced oral pigmentation. *J Am Acad Dermatol* 1994; **30**:350-354.
26. Good ML, Hussey DL. Minocycline: stain devil? *Br J Dermatol* 2003; **149**:237-239.
27. Berger RS, Mandel EB, Hayes TJ, Grimwood RR. Minocycline staining of the oral cavity. *J Am Acad Dermatol* 1989; **21**:1300-1301.
28. Addy M, Moran J. Mechanisms of stain formation on teeth, in particular associated with metal ions and antiseptics. *Adv Dent Res* 1995; **9**: 450-456.



Prominent yellowish brown staining of anteriors and permanent first molars in 24 year old male patient



Left side of arch showing tetracycline staining



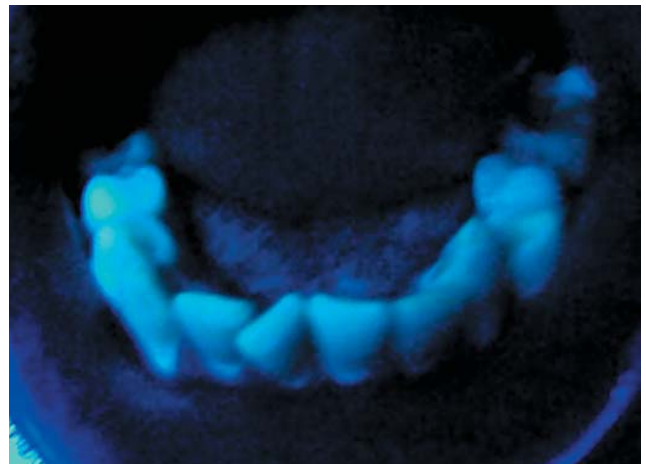
Right side of arch showing tetracycline staining



A symmetrical linear grey stained band of hypoplastic enamel involving anteriors and permanent molars.



Maxilla showing occlusal surfaces of affected teeth.



Tetracycline stains showing fluorescence under wood lamp test