

Treatment of tetracycline-stained teeth: A narrative review

Yue Lin ¹, Mohong Deng ², Yusi Huang ³, Xiaoqing Liu ^{4, *}

¹ Stomatology college of Guangzhou Medical University, Guangzhou, China

² Wuhan University Stomatological Hospital, Wuhan, China

³ The second clinical medical college of Kunming Medical University, Kunming, China

⁴ Radiotherapy department of Affiliated Cancer Hospital, Shantou University Medical College, Shantou City, China

* Corresponding author: 271084388@qq.com

Abstract. Tetracycline teeth are caused by the use of tetracycline antibiotics during the growth period, and the clinical manifestation is tooth staining. Aesthetic restoration can be carried out by bleaching, cold light whitening, all ceramic veneer restoration, all ceramic crown restoration, and light cured resin restoration. In the current research, researchers focus on new veneers and resin materials, and whether other tetracycline antibiotics induce tetracycline teeth or not.

Keywords: Tetracycline-stained teeth, Discolored teeth, Aesthetics of anterior teeth, Tooth bleaching.

1. Introduction

Tetracycline stained teeth is an oral disease caused by the unregulated use of tetracycline during the patient's early childhood, and this disease can have a certain degree of physical and psychological impact on the patient. As the usage of tetracycline drugs gradually decreases, the incidence of tetracycline stained teeth is decreasing year by year. The article would try to provides a narrative review of the causes of tetracycline stained teeth, its treatment options, and current research advances on the disease.

2. Causes and clinical manifestations of tetracycline teeth

Tetracycline is a type of antibiotic that is effective against rickettsia, chlamydia and mycoplasma [1], its clinical use began as early as 1948. However, it also has side effects, which include tooth staining. The first report of tooth discoloration caused by tetracycline in children occurred in 1956, and other similar cases were subsequently reported [2, 3]. Studies have shown that the use of tetracycline in children under 8 years of age may cause permanent staining of the teeth, ranging from yellow, gray to brown; and that teeth affected by tetracycline fluoresce yellow when exposed to ultraviolet light in a dark environment [4]. The staining effect of tetracycline on teeth is influenced by the dose, application regimen, duration and the degree of activity of the mineralization stage of the teeth [5]. Although the usage of any dose of tetracycline drugs can cause tooth staining, daily doses of more than 3 grams, or longer treatment periods are considered the most relevant risk factors for the side effect.

When a tooth is mineralizing, if it comes into contact with tetracycline, the tetracycline will bind to the calcium ions in the tooth. When the tooth is exposed to sunlight, the tetracycline oxidizes and discolors [6]. Therefore, the tooth color will change from fluorescent yellow to non-fluorescent brown over time [7]. The location of tooth discoloration is closely related to the developmental stage of the tooth at the time of exposure to tetracycline. Primary tooth staining may be due to exposure in children 10-14 months of age. And anterior permanent tooth staining is due to tetracycline exposure in children 6 months to 6 years of age, while the posterior permanent tooth staining is due to that in children 8 years of age [8]. Studies have shown that the overall prevalence of tetracycline-induced staining is 3-4% [9].

3. Traditional treatment

Treatment options for tetracycline stained teeth includes microwear, bleaching, ceramic veneers, full coverage crowns, and even combinations of these techniques[10, 11]. The main direction of its aesthetic restoration is minimally invasive treatment. Its principle is to remove as little tooth structure as possible, while obtaining as much aesthetic result as possible.

3.1. Decolorization and bleaching

Decolorization and bleaching is the most conservative treatment method, which does not destroy healthy dental tissue and has a high level of satisfaction and oral health-related quality of life improvement in patients after bleaching[12]. The main principle of this method is to use some bleaching substances to make the enamel less transparent and make the tooth white. This method is suitable for moderate to severe tetracycline stained teeth and the affected teeth should be vital. The advantages of the decolorization and bleaching is that this will not cause permanent trauma to the teeth and that the bleaching substances based on urea peroxide and hydrogen peroxide are clinically safe and do not have irreversible side effects[13]. Its use is also quite convenient, it can be used by professionals[14], or by patients at home[15]. Its disadvantage is that the treatment period is longer and the enamel may remineralize over time, resulting in a deeper shade, so regular follow-ups are needed to consolidate the treatment. For patients suffering from various bleeding diseases, some acute infectious diseases, inflammation of oral soft and hard tissues in the acute stage, malignant tumors in the gums and heart diseases, the use of decolorization and bleaching is not recommended[16].

3.2. Cold light tooth whitening

Cold light whitening is to transmit the high intensity blue light with wavelength between 480-520nm through fiber optic, and then pass through two pieces of special optical lenses with more than 30 layers of coating, then special optical treatment will be used to isolate all the harmful ultraviolet and infrared rays, so that the blue light is transformed into cold light[17]. The blue light can make the main whitening agent such as hydrogen peroxide and silica pass through the dental tubules, so that the whitening agent can quickly produce oxidation reduction reaction on the surface and deep layer of teeth to remove the attached pigment, thus achieving the whitening effect[18]. Compared with the traditional home whitening method, this method is less stimulating to the gums, has a shorter whitening time, a more significant whitening effect, and significantly reduces treatment discomfort. In addition to the above-mentioned advantages, the greatest excellence of this method is that it effectively avoids the patient's tooth sensitivity caused by peroxide in traditional decolorization and bleaching therapy[19]. For patients with more serious periodontal disease and decay, as well as patients with artificial restorative materials to cover the tooth surface, cold light whitening method is not recommended.

3.3. Porcelain veneer restoration

Porcelain veneer restoration refers to the use of bonding technology to restore the normal shape and color of the tooth surface, this restoration method has a high success rate. The porcelain veneer restoration technique involves grinding away the tooth surface to a depth of about 1 to 2 mm and bonding the porcelain veneer to the tooth surface[20]. This type of restoration has become one of the main means of restoring tetracycline teeth.

However, there are three main disadvantages: the need to remove a lot of dental tissue; whether veneers will fall off or not by external factors; if the veneer is chipped, it is usually needed to be removed and re-fabricated [21]. However, with the advancement of technology, ultra-thin porcelain veneers have been introduced [22]. These new porcelain veneers, also known as minimally invasive veneers, have reduced thickness and increased strength compared to conventional porcelain veneers, reducing the amount of tissue that needs to be removed to a greater extent. The method is suitable for lightly stained anterior teeth, but the effect is not good for darkly stained teeth, therefore the method

is mainly used in the incisal edge, lip, adjacent incisal surface restoration. Porcelain veneer restorations are not suitable for patients with severe misalignment, tilted maxillary teeth, and severe nocturnal molars. Patients who are prone to allergies and patients with severe periodontitis are also not suitable for this method[23].

3.4. All-Ceramic Crown Restoration

An all-ceramic crown restoration involves making a ceramic crown on the root of the treated tooth, which is then bonded to the tooth[24]. This method involves grinding away the lingual, labial and adjacent surfaces of the patient's tooth to increase its abutment, and then attaching the completed all-ceramic crown[25]. The advantage of this method is that it is more beautiful and realistic. The disadvantage is similar to porcelain veneer restoration, which is the need to remove more healthy dental tissue. All-ceramic crowns are often used for more severely stained tetracycline teeth because of their relatively large thickness and enhanced shading ability[26]. Some patients with a large amount of tissue to be cut, or patients prone to pulp exposure, or patients with short temporary crowns are not suitable for this method.

3.5. Light-cured resin restoration

Light-cured resin restoration is a method of treating chipped, decayed or stained teeth with light-curing. First, a portion of the patient's tooth that is heavily infested with tetracycline is abraded, then a composite resin is placed on the surface of the tooth that has just been abraded, and finally the composite resin is cured with an ultraviolet pen[27]. The light-cured resin restoration method is one of the mainstream restorative methods, which has the following advantages: low cost; less damage to the dental tissue; and ease of operation[28]. The disadvantage is that it may not be durable enough, with the possibility of breakage, veneer loosening and allergy. In clinical practice, this method is widely used and has very good therapeutic effect on mild to moderate tetracycline stained teeth. If the patient's treatment area cannot be effectively isolated when using this method, or if the patient has more severe grinding, other treatment methods should be used instead.

4. New treatment methods

More new technologies have emerged in the bleaching treatment of tetracycline teeth. Photo-Fenton Bleaching is a method that has been used in recent years to treat age-related tooth discoloration caused by dentin sclerosis[29]. However, this method opened up ideas for other scholars. Zackary B et al. showed by their study that the method can be used for the treatment of tetracycline teeth[30]. The procedure is to apply a gel to the surface of the tooth, which has 25% hydrogen peroxide, and then irradiate it with a strong visible blue light emitted by an LED array. In addition to light-assisted Fenton bleaching, Sodium Perborate Bleaching is also a new bleaching method that operates in the same way as conventional decolorization bleaching. This method has a good whitening effect on the surface of the teeth[31, 32].

In the direction of restorative treatment, the current research focuses on veneer materials and resin materials. It has been found that heat pressed ceramic veneers have more advantages than traditional ceramic veneers: good alignment with the marginal abort line of the base, simple operation, high mechanical strength, good aesthetic effect, not easy to fall off, etc[33]. Studies have also focused on the aesthetics of ceramic veneers, proving that thickening veneers is the most effective means of enhancing translucency and natural color in the restoration of porcelain veneers on discolored teeth[34]. In the field of resins, some scholars have studied the durability of resins and found that they can remain in good condition for up to 18 years[35]. The emerging resin infiltration, a material widely used for aesthetic restoration of anterior teeth, is still debatable for the treatment of tetracycline stained teeth[36].

5. Conclusion

The usage of tetracycline inevitably causes damage to the teeth of patients, especially children. Therefore, medical practitioners should inform patients about the potential damage. For patients who already have tetracycline stained teeth, practitioners should provide different treatment plans for each patient to minimize the damage to the health of dental tissues and to obtain the best whitening results.

Acknowledgements

Not applicable.

References

- [1] Grossman TH. Tetracycline Antibiotics and Resistance[J]. Cold Spring Harb Perspect Med, 2016, 6 (4): a25387.
- [2] SCHUSTER A, SHWACHMAN H. The tetracyclines; applied pharmacology [J]. Pediatr Clin North Am, 1956: 295 - 303.
- [3] WALLMAN IS, HILTON HB. Teeth pigmented by tetracycline [J]. LANCET, 1962, 1 (7234): 827 - 829.
- [4] Good ML, Hussey DL. Minocycline: stain devil?[J]. Br J Dermatol, 2003, 149 (2): 237 - 239.
- [5] Cheek CC, Heymann HO. Dental and oral discolorations associated with minocycline and other tetracycline analogs [J]. J Esthet Dent, 1999, 11 (1): 43 - 48.
- [6] Mello HS. The mechanism of tetracycline staining in primary and permanent teeth [J]. J Dent Child, 1967, 34 (6): 478 - 487.
- [7] Rosen T, Hoffmann TJ. Minocycline-induced discoloration of the permanent teeth [J]. JOURNAL OF THE AMERICAN ACADEMY OF DERMATOLOGY, 1989, 21 (3 Pt 1): 569.
- [8] Conchie JM, Munroe JD, Anderson DO. The incidence of staining of permanent teeth by the tetracyclines [J]. CANADIAN MEDICAL ASSOCIATION JOURNAL, 1970, 103 (4): 351 - 356.
- [9] Sanchez AR, Rogers RR, Sheridan PJ. Tetracycline and other tetracycline-derivative staining of the teeth and oral cavity [J]. INTERNATIONAL JOURNAL OF DERMATOLOGY, 2004, 43 (10): 709 - 715.
- [10] Faus-Matoses V, Faus-Matoses I, Ruiz-Bell E, et al. Severe tetracycline dental discoloration: Restoration with conventional feldspathic ceramic veneers. A clinical report[J]. J Clin Exp Dent, 2017, 9 (11): e1379 - e1382.
- [11] Shadman N, Kandi SG, Ebrahimi SF, et al. The minimum thickness of a multilayer porcelain restoration required for masking severe tooth discoloration [J]. Dent Res J (Isfahan), 2015, 12 (6): 562 - 568.
- [12] Martin J, Vildosola P, Bersezio C, et al. Effectiveness of 6% hydrogen peroxide concentration for tooth bleaching-A double-blind, randomized clinical trial [J]. JOURNAL OF DENTISTRY, 2015, 43 (8): 965 - 972.
- [13] Auschill TM, Hellwig E, Schmidale S, et al. Efficacy, side-effects and patients' acceptance of different bleaching techniques (OTC, in-office, at-home) [J]. OPERATIVE DENTISTRY, 2005, 30 (2): 156 - 163.
- [14] Mounika A, Mandava J, Roopesh B, et al. Clinical evaluation of color change and tooth sensitivity with in-office and home bleaching treatments [J]. Indian J Dent Res, 2018, 29 (4): 423 - 427.
- [15] Eachempati P, Kumbargere NS, Kiran KKS, et al. Home-based chemically-induced whitening (bleaching) of teeth in adults [J]. Cochrane Database Syst Rev, 2018, 12: D6202.
- [16] Iruka K, Alrahaem IA, Ngoc CN, et al. Tooth whitening procedures: A narrative review[J]. Dentistry Review, 2022, 2 (3): 100055.
- [17] Zhang B, Huo S, Liu S, et al. Effects of Cold-Light Bleaching on Enamel Surface and Adhesion of Streptococcus mutans [J]. Biomed Research International, 2021, 2021.
- [18] Sharma R, Sharma D, Bansal M. Susceptibility of repigmentation of enamel surface to red wine and brandy staining after 35% hydrogen peroxide bleaching [J]. 2022.
- [19] Demarco FF, Conde MC, Ely C, et al. Preferences on vital and nonvital tooth bleaching: a survey among dentists from a city of southern Brazil [J]. Braz Dent J, 2013, 24 (5): 527 - 531.

- [20] Araujo E, Perdigão J. Anterior veneer restorations-an evidence-based minimal-intervention perspective[J]. JOURNAL OF ADHESIVE DENTISTRY, 2021, 23 (2): 91 - 110.
- [21] Gresnigt M, Özcan M. Esthetic rehabilitation of anterior teeth with porcelain laminates and sectional veneers[J]. JOURNAL OF THE CANADIAN DENTAL ASSOCIATION, 2011, 77: b143.
- [22] Chen D, Su Z, Pi Y, et al. Clinical application of fully digital self-glazed ultra-thin zirconia veneers[J]. Advances in Applied Ceramics, 2021, 120 (5-8): 275 - 280.
- [23] Hammond BD, Machowski M, Londono J, et al. Fabrication of Porcelain Veneer Provisional Restorations: A Critical Review [J]. Dentistry Review, 2022, 2 (2): 100004.
- [24] Gallucci GO, Grutter L, Nedir R, et al. Esthetic outcomes with porcelain-fused-to-ceramic and all-ceramic single-implant crowns: a randomized clinical trial[J]. Clin Oral Implants Res, 2011, 22 (1): 62 - 69.
- [25] Barnes D, Gingell JC, George D, et al. Clinical evaluation of an all-ceramic restorative system: a 36-month clinical evaluation[J]. AMERICAN JOURNAL OF DENTISTRY, 2010, 23 (2): 87 - 92.
- [26] El-Feky GS, Farouk AR, Zayed GM, et al. Mucosal co-delivery of ketorolac and lidocaine using polymeric wafers for dental application [J]. DRUG DELIVERY, 2018, 25 (1): 35 - 42.
- [27] Shi SY, Gu XY. A randomized controlled study on color stability of tetracycline teeth restored with ceramic veneer[J]. Hua Xi Kou Qiang Yi Xue Za Zhi, 2021, 39 (3): 336 - 340.
- [28] Gresnigt M, Cune MS, Jansen K, et al. Randomized clinical trial on indirect resin composite and ceramic laminate veneers: Up to 10-year findings [J]. JOURNAL OF DENTISTRY, 2019, 86: 102 - 109.
- [29] Lagori G, Rocca JP, Brulat N, et al. Comparison of two different laser wavelengths' dental bleaching results by photo-Fenton reaction: in vitro study[J]. Lasers Med Sci, 2015, 30 (3): 1001 - 1006.
- [30] Bennett ZY, Walsh LJ. Effect of Photo-Fenton Bleaching on Tetracycline-stained Dentin in vitro [J]. J Contemp Dent Pract, 2015, 16 (2): 126 - 129.
- [31] Iriboz E, Ozturk BA, Korklu S, et al. Comparison of intracoronal bleaching methods on teeth discolored by different antibiotic pastes[J]. Nigerian Journal of Clinical Practice, 2017, 20 (6): 700 - 706.
- [32] Barakah R, Alwakeel R. Non-vital Endo Treated Tooth Bleaching with Sodium Perborate [J]. Curr Health Sci J, 2019, 45 (3): 329 - 332.
- [33] Rinke S, Lange K, Ziebolz D. Retrospective study of extensive heat-pressed ceramic veneers after 36 months[J]. Journal of Esthetic and Restorative Dentistry, 2013, 25 (1): 42 - 52.
- [34] Xue SH, Wang YX, Xu TK, et al. [Study of masking ability of laminate veneers for discolored teeth][J]. Beijing Da Xue Xue Bao Yi Xue Ban, 2020, 52 (5): 943 - 947.
- [35] Mondelli RF, Soares AF, Tostes BO, et al. Direct Composite Restorations to Mask Intrinsic Staining: An Eighteen-Year Follow-Up[J]. Dent Today, 2016, 35 (3): 97 - 99.
- [36] A. BB, T. MFC, D. M, et al. Is resin infiltration an effective esthetic treatment for enamel development defects and white spot lesions? A systematic review [J]. JOURNAL OF DENTISTRY, 2017, 56.