

Review Article

An update of tooth whitening procedure: A narrative review

Abstract:

Objective: Besides the prevention of caries and periodontitis, an increasing number of oral care products focus on teeth whitening. Nowadays, teeth whitening is considered as one of the most common and inexpensive method for treating discoloration of teeth. Dental esthetics has become a great importance to majority of the people; and discoloration of even a single tooth can negatively influence the quality of life. The aim of this review is to summarize the frequently used whitening procedures.

Data: Data was obtained using the following keywords: tooth whitening, tooth bleaching, color, whitening concentration, and success rates.

Sources: In formulating this review, only English-language articles available electronically were selected. A comprehensive literature search was conducted on PubMed and Scopus databases. A separate search was made on a Google Search Engine. The references from the reviewed material were used to locate other relevant publications.

Study Selection: A total of 50 articles were included in this review after reviewing the literature that resulted from the initial search.

Conclusion: Tooth whitening procedures have proven to be a conservative and viable option for improving dental esthetics.

Clinical Significance: It is crucial for dentists to have a solid awareness of tooth whitening methods, their unique indications, potential side effects, and restrictions given the rising demand for aesthetic treatment among dental patients. These procedures offer a substantially less invasive method of enhancing dental aesthetics.

Keywords: Discoloration, Peroxide, Stain, Tooth whitening

Introduction:

Today, many people are becoming more conscious of and interested in dental esthetics^[1]. "The teeth' color is frequently affected by stains caused by wine, tea, coffee, smoking, and other substances".^[2] "Tooth whitening procedures are a low-cost method to improve the esthetic of the smile. These whitening methods can be used alone or in conjunction with other restorative procedures. Regardless of the method used, tooth whitening is the process that results in a substance being similar in color to a preferred or standard white. Tooth bleaching is defined as chemically induced whitening caused mostly by the actions of carbamide peroxide, which emits approximately one-third of its content as hydrogen peroxide".^[1] "As the public becomes more aware of dental esthetics, there may be a rise in demand for esthetic procedures as well as higher expectations for treatment outcomes. It is also necessary for dentists to know tooth whitening techniques, their specific indications, success rates, rates of success and failure, potential side effects, and limitations".^[3] The aim of this research is to provide a summary of the existing information, and literature about teeth whitening procedures, their specific indications, limitations as well as side effects.

Etiology of tooth discoloration:

"Discoloration of a tooth surface or surfaces as a result of ingested materials, bacterial action, tobacco, and/or other substances is the definition of teeth stain. This could be intrinsic, extrinsic, acquired, or developmental in nature. Stains can be extrinsic or intrinsic in nature". [4] "Intrinsic stains are found inside the tooth, either in the enamel or in the dentin. They can be caused by high fluoride consumption during tooth formation (fluorosis), tetracycline incorporation, and a variety of metabolic illnesses and systemic causes. For example, the severity of fluorosis can be assessed using Dean's index, which goes from questionable to very light, mild, moderate, and severe". [5] "Extrinsic staining usually comes from the medium and are associated with dye pigments such as food, tobacco and coffee. The use of some types of medications and the accumulation of bacterial plaque, being surface stains and that leave more easily after prophylaxis". [6]

"It is visible on the tooth surface, including exposed dentin and enamel, particularly on hard-to-clean areas and surfaces with a thick pellicle layer. These stains are made up of organic and inorganic chromophores that are either directly adsorbed to the tooth (particularly if it has a rough surface) or (more frequently) absorbed into calculus, biofilm, and/or pellicle". [7]

Tooth whitening methods:

1-Dental Prophylaxis:

"Using an abrasive paste and a rubber cup on slow-speed rotary equipment, professional hygiene procedures and polishing are carried out to remove extrinsic stains. Extrinsic stains can affect how tooth color is assessed, and it has been demonstrated that dental prophylaxis procedures improve patients' perceptions of how white their teeth are" [8]

2-Microabrasion:

For treating superficial enamel stains or flaws, microabrasion is a safe, conservative, and non-traumatic procedure for teeth whitening. Microabrasion is used for treating intrinsic discoloration or enamel surfaces changes as a result of fluorosis, amelogenesis imperfecta, or enamel hypoplasia. It eliminates the outer layer of enamel by combining the erosive and abrasive effects of acid and abrasive gel by using a micro-motor with a low speed. With older formulations containing as much as 36% hydrochloric acid, the acceptable acid concentration has changed over time [9]

3- Whitening toothpaste:

Bleaching toothpaste, which gives bleaching results in 2 to 4 weeks and is marketed as an alternative to at-home and/or dental whitening procedures, has been developed by different companies. Thus, patients looking for whiter teeth have more accessible and affordable whitening options due to these types of toothpaste. While some of these bleaching toothpastes have abrasives that aid in removing extrinsic stains, others frequently contain hydrogen peroxide. [10] The most important component in toothpaste formulas for extrinsic stain removal is abrasives. Whitening toothpaste frequently (though not always) contains a high amount of abrasives than regular toothpaste to effectively remove surface stains. The toothpaste with a high abrasive content will remove the enamel's outer layer, along with any adhered or integrated stains. [11] "The removal of flaws from the outer surfaces by these abrasives may give rise to the perception that changes in tooth discoloration have taken place, which is frequently used by companies to

demonstrate that teeth are healthy. The effectiveness of these bleaching dentifrices in comparison to traditional (nonbleaching) dentifrices and their effects/alterations on discolored teeth regardless of origin are, however, not well understood until now". ^[12]

4- Over the Counter (OTC):

There are various over-the-counter (OTC) teeth whitening materials available that patients can buy and use on their own. The percentage of bleaching agents in a product determines whether it may be purchased over the counter. Different companies in each country set limits on the permitted concentration according to regulatory bodies. The formulas for over-the-counter teeth whitening products include, among others, dentifrices, mouthwashes, intraoral strips, varnishes, gels, and toothbrushes. ^[13] *A total of 24 papers were included in a systematic assessment of over-the-counter whitening treatments, and it concluded that dentifrices were the most effective OTC agent for changing color but less successful than whitening strips.* ^[14]

5- In Office teeth whitening using Peroxides:

The oxidizing chemicals in dental bleaches, which typically have hydrogen peroxide (H₂O₂) concentrations between 3 and 40%, penetrate dental enamel to remove coloring substances. Since hydrogen peroxide (H₂O₂) has a lower molecular weight than water, it can pass through dentinal tubules. It can discharge oxygen-free radicals that are able to penetrate the enamel and dentinal structures and ultimately oxidize organic pigments and chromogenic substances. ^[15] *The principal bleaching agent for use at home is carbamide peroxide (CH₆N₂O₃: 10% to 20%). It breaks down into hydrogen peroxide and urea when it meets water, ultimately releasing free oxygen. The benefit of carbamide peroxide is that it produces effective results while having a lower tendency to cause adverse effects such as sensitivity, gingival inflammation, and changes in surface microhardness after treatment.* ^[16] *Bleaching is frequently related to post-treatment tooth sensitivity being strongly dependent on the pH of the chemical, although it is a conservative treatment strategy. Additionally, the authors claim that this process has a high failure rate for tooth shade, necessitating re-treatment.* ^[17] *Some authors claim that the hydroxyl radical (•OH), which breaks the double bonds in chromophores, causes these molecules to reflect less light, which results in a whitening effect. The exact process by which bleaching teeth works is not fully understood. According to some reports, using light sources while bleaching increases the effectiveness of whitening. To describe how UV light and peroxide work together to whiten teeth, three basic mechanisms are typically put out in the literature. Due to the high radiation energy (3.5 eV for the employed wavelength), UV cleaves the C-O, H-O, and HO-OH bonds of chromophore molecules. The generation of free radicals as a result of peroxide's photon absorption causes the cleavage of the chromophore molecules. Additionally, the energy of the C=O, C=C, and C=C-C=C bonds in chromophore molecules increases with photon absorption, increasing their reactivity to peroxide.* ^[18] *Some in-office bleaching systems are recommended for use in conjunction with an activating light source that, according to the marketing, improves the whitening result. Theoretically, heat generated by the light source speeds up the bleaching agent's catalytic breakdown into free oxygen radicals. Halogen lamps, lasers, plasma arc lamps, and light-emitting diodes (LEDs) are some of the several types of lighting. To determine whether there were variations in the bleaching effectiveness and tooth sensitivity of bleaching protocols*

carried out with or without light using low and high hydrogen peroxide concentrations, a systematic review and metanalysis were done and they concluded that light did not considerably affect color change in delta E or Shade Guide Units. The two test groups did report significant data heterogeneity, but there was no difference in tooth sensitivity between them. ^[19]

6- Walking bleaching:

The teeth that have undergone endodontic treatment and are intrinsically discolored should undergo this procedure. Urea and hydrogen peroxide are both components of carbamide peroxide ($\text{CH}_4\text{N}_2\text{O} \cdot \text{H}_2\text{O}_2$). In an *in vitro* experiment, carbamide peroxide demonstrated bleaching power on par with hydrogen peroxide. In comparison to a 16% concentration, a 35% concentration offers noticeably more whitening effects with no additional side effects. ^[20] After about 10 days, oxidizing ions will be released; after that point, the bleaching mixture's effectiveness is rather limited, and it must be replaced with new material. After three to six procedures, a satisfactory reduction in tooth discoloration should be attained. ^[21]

The concentration of the bleaching agent, the amount of exposure time, and the type of intrinsic stain are just a few of the variables that influence how quickly teeth whiten. The effectiveness of tooth whitening increases with bleaching agent concentration and exposure time. ^[15] Severe tetracycline stains respond to chemical bleaching more slowly depending on the type of staining. The length of the tooth whitening process increases with the initial shade of the teeth. Yellow staining is more bleachable than gray or blue staining. ^[22]

"A common side effect that initiates immediately after bleaching procedures is teeth sensitivity and many factors contribute to the etiology and progression of teeth sensitivity. The patients suffer from sudden, spontaneous, sever pain in single or multiple teeth and might be forced to stop bleaching in some cases". ^[23] "This side effect has been documented frequently in the literature and the incidence ratio varies between 37 and 90%, according to previous investigations". ^[24] "Tooth sensitivity after in-office bleaching has been reported in up to 50% of cases. Most of the time, the tooth sensitivity followed by in-office bleaching is transient and lasts for 2 to 3 days. Even if it is transient, this may discourage patients from completing the treatment". ^[25]

*"In recent developments in tooth whitening, sweet potato enzymes have been added to hydrogen peroxide because they contain a number of antioxidant molecules that, in theory, target chromogens by scavenging free radicals. The *in vitro* research on these enzymes is encouraging".*

*^[26] "Other developments involve adding chemical, bioactive, and natural organic additives to hydrogen peroxide in an effort to raise pH levels and thereby postpone hydrogen peroxide's decomposition. These materials have also shown promise in *in vitro* studies, which open the way for more clinical trials". ^[27]*

Conclusion:

Different procedures for tooth whitening offer a conservative way to enhance aesthetics. They are risk-free and efficient procedures The dental market has a large competition between manufacturers, and not all claims are based on solid scientific evidence. In general, dentists should be aware of the composition and mode of action of each individual product, and more clinical

studies in the field of teeth whitening are recommended as teeth staining is strongly correlated to diet and other factors like smoking, and chlorhexidine.

References:

1. Irusa K, Abd Alrahaem I, Ngoc C, Donovan T. Tooth whitening procedures: A narrative review. *Dentistry Review* 2022;2:100055. <https://doi.org/10.1016/j.dentre.2022.100055>.
2. Joiner, A. Whitening toothpastes: A review of the literature. *J. Dent.* 2010, 38 (Suppl. 2), e17–e24. <https://doi.org/10.1016/j.jdent.2010.05.017>
3. Pereira R, Corado D, Silveira J, Alves R, Mata A, Marques D. Dental prophylaxis influence in tooth color assessment —Clinical study. *J Esthet Restor Dent.* 2020;32(6):586–92. <https://doi.org/10.1111/jerd.12593>
4. Kapadia Y, Jain V. Tooth Staining: A Review of Etiology and Treatment Modalities. *Acta Scientific Dental Science*, 2018; (2):6. <https://www.researchgate.net/publication/322509199>
5. Fejerskov O, Kidd E. *Dental Caries: The Disease and its Clinical Management*; Wiley: Hoboken, NJ, USA, 2009. ISBN: 978-1-118-93582-8
6. Andrew J. The bleaching of teeth: a review of the literature. *J Dent.* 2006 Aug;34(7):412-9. doi: [10.1016/j.jdent.2006.02.002](https://doi.org/10.1016/j.jdent.2006.02.002)
7. Viscio, D, Gaar, A, Fakhry S, Xu T. Present and future technologies of tooth whitening. *Compend. Contin. Educ. Dent. Suppl.* 2000, 21, S36–S43. PMID: 11908346
8. Pereira R, Corado D, Silveira J, Alves R, Mata A, Marques D. Dental prophylaxis influence in tooth color assessment —Clinical study. *J Esthet Restor Dent* 2020;32(6):586–92. <https://doi.org/10.1111/jerd.12593>
9. Sundfeld R, Franco L, Gonçalves S, de Alexandre R, Machado L, Neto D. Accomplishing esthetics using enamel microabrasion and bleaching —A case report. *Oper Dent* 2014;39(3):223–7. <https://doi.org/10.2341/13-002-s>
10. Pintado-Palomino K, Vasconcelos C, Silva R. Effect of whitening dentifrices: a double-blind randomized controlled trial. *Braz Oral Res.* 30(1): 82, 2016. <https://doi.org/10.1590/1807-3107bor-2016.vol30.0082>
11. Epple M, Meyer F, Enax J. Efficacy of Dental Bleaching with Whitening Dentifrices: A Systematic Review. *Int. J Dent.* 2018, 7868531. <https://doi.org/10.1155/2018/7868531>
12. Casado B, Moraes S, Souza G, Guerra C, Souto-Maior J, Lemos C, Vasconcelos B, Pellizzer E. Efficacy of Dental Bleaching with Whitening Dentifrices: A Systematic Review. *Int J Dent.* 2018 Oct 30;2018: 7868531 <https://doi.org/10.1155/2018/7868531>
13. Casado B, Moraes S, Souza G, Guerra C, Souto-Maior J, Lemos C. Efficacy of dental bleaching with whitening dentifrices: a systematic review. *Int J Dent.* 2018. <https://doi.org/10.1155/2018/7868531>

14. Naidu A, Bennani V, Brunton JM, Brunton P. Over-the-Counter tooth whitening agents: a review of the literature. *Braz Dent J* 2020; 31:221–35. <https://doi.org/10.1590/0103-6440202003227>
15. Sulieman M, Addy M, MacDonald E, Rees J. The effect of hydrogen peroxide concentration on the outcome of tooth whitening: an in vitro study. *J Dent*. 2004; 32:295–9. <https://doi.org/10.1016/j.jdent.2004.01.003>
16. Loguercio A. Effect of acidity of in-office bleaching gels on tooth sensitivity and whitening: a two-center double blind randomized clinical trial. *Clinical Oral Investigations*.2017; 21.9: 2811-2818. <https://www.researchgate.net/publication/322509199>
17. Auschill T. Randomized clinical trial of the efficacy, tolerability, and long-term color stability of two bleaching techniques: 18-month follow-up. *Quint Int*. 2012; 43.8: 683-694. <https://www.quintessence-publishing.com/deu/en/article/840556>
18. Rodrigues F, Serro A, Polido M, Ramalho A, Figueiredo C. Effect of bleaching teeth with hydrogen peroxide on the morphology, hydrophilicity, mechanical and tribological properties of enamel. <http://hdl.handle.net/10400.26/20052>
19. Maran B, Burey A, de Paris Matos T, Loguercio A, Reis A. In-office dental bleaching with light vs. without light: a systematic review and meta-analysis. *J Dent*.2018;70:1–3. <https://doi.org/10.1016/j.jdent.2017.11.007>
20. Maciel C, Oliveira R, Amorim A, Pires-De-Souza F. Efficacy of Popular Natural Dental Bleaching Products on Dental Enamel. *Dent Mat*. 2022; 38, e16. <https://doi.org/10.1590/0103-6440202204863>
21. Dietschl D. Nonvital bleaching: general considerations and report of two failure cases. *European Journal of Esthetic Dentistry*, 2006; 1(1). PMID: 19655475
22. Mahony C, Barker M, Engel T, Walden G. Peroxide degradation kinetics of a direct application percarbonate bleaching film. *Am J Dent* 2003; 16:9B–11B. PMID: 15055981
23. Rezende M, Coppla F, Chemin K, Chibinski A, Loguercio A, Reis A. Tooth sensitivity after dental bleaching with a desensitizer-containing and a desensitizer-free bleaching gel: a systematic review and meta-analysis. *Oper Dent*. 2019;44(2): E58–74. <https://doi.org/10.2341/17-253-L>.
24. Bizreh Y, Milly H. Effect of bioactive glass paste on efficacy and post-operative sensitivity associated with at-home bleaching using 20% carbamide peroxide: a randomized controlled clinical trial. *Eur J Med Res*.2022 Oct 4;27(1):194. <https://doi.org/10.1186/s40001-022-00826-5>.
25. Krishnakumar K, Tandale A, Mehta V. Post-Operative Sensitivity and Color Change Due to In-Office Bleaching with the Prior Use of Different Desensitizing Agents: A Systematic Review. *Cureus*.2022; 14(4): e24028. DOI 10.7759/cureus.24028
26. Gopinath S, James V, Vidhya S, Karthikeyan K, Kavitha S, Mahalaxmi S. Effect of bleaching with two different concentrations of hydrogen peroxide containing sweet potato extract as an additive on human enamel: An in vitro spectrophotometric and scanning electron microscopy analysis. *J Conserv Dent JCD*. 2013;16(1):45. <https://doi.org/10.4103/0972-0707.105298>

27. Hyland B, McDonald A, Lewis N, Tredwin C, Petrie A, Hall S. A new three-component formulation for the efficient whitening of teeth (Carbamide Plus). *Clin Oral Inves.* 2015;19(6):1395–404. <https://doi.org/10.1007/s00784-014-1352-9>

UNDER PEER REVIEW



UNDER PEER REVIEW