

The Effectiveness of Various Tooth Bleaching Systems

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INTRODUCTION

The public's perception of perfect white smiles, often depicted in media, has heightened awareness of tooth discoloration. In the late 1980s, both at-home and professionally applied tooth whitening products emerged in the U.S., gaining popularity due to the growing desire for whiter smiles. Tooth discoloration arises from intrinsic and extrinsic factors. Intrinsic staining stems from genetics, age-related enamel wear revealing dentin's yellow hue, antibiotics, high fluoride levels, developmental issues, and pre-eruption factors. Post-eruption, dental restorations can induce staining. Extrinsic staining originates from environmental factors like smoking, pigments in foods and drinks, antibiotics, and metals. Color compounds from these sources attach to the tooth's surface, resulting in stains⁶.

Tooth whitening encompasses any process lightening tooth color through stain removal or chemical reactions. Bleaching entails chemically degrading chromogens. Common bleaching agents include hydrogen peroxide and carbamide peroxide in various concentrations. Carbamide peroxide reacts with water to release its active components, while hydrogen peroxide decomposes into water and oxygen radicals. Bleaching formulations might include glycerine as a carrier, carbopol as a thickener, and flavoring agents⁶. Chromophores, responsible for color, possess extended conjugated chains of bonds. Bleaching disrupts these chains, often through oxidation. Peroxide's ability to permeate enamel into enamel-dentin junction and dentin contributes to its effectiveness. Various whitening systems exist, each with its unique mechanism of action, effectiveness contingent on the type of discoloration being addressed. These systems include home-based products like tray loaded with peroxide, toothpastes and strips, and in-office systems involving high-concentration bleaching agents applied under professional supervision⁶.

IN-OFFICE WHITENING

In-office dental whitening involves application of high concentrations of carbamide peroxide (above 20%) or hydrogen peroxide (above 10%) for 15 to 20 minute periods over a 45 to 60 minute clinical session. This procedure offers well-controlled, professional supervision, ensuring no contact with soft tissues or gel ingestion by applying a barrier made of a light polymerized resin dam, like Top Dam, Opal Dam or similar. It's suitable for patients seeking rapid, effective, and lasting results without using home whitening trays because it can deliver higher concentrations of hydrogen peroxide than at-home or OTC products. Even though the process is usually done in a single clinical session, it can be repeated for multiple sessions until the desired whitening effect is achieved. Protective measures for soft tissues are taken before applying the whitening gel on the teeth.

To enhance the whitening, light sources like halogen lamps, LEDs, plasma arcs, and lasers are used to activate the bleaching agents, releasing free radicals. However, controversy exists regarding their effectiveness, with some studies suggesting inconclusive results or minimal impact on the final outcome. Furthermore, concerns arise about excess heat generation, potentially damaging the dental pulp and increasing tooth sensitivity⁵. Comprehensive and persistent research consistently highlights that in-office tooth whitening procedure, when meticulously guided by individualized protocol as provided by the manufacturer, offers a remarkable combination of safety, efficiency, and minimal impact on the dental enamel, all of which benefit the patients undergoing the treatment⁵.

WHITENING STRIPS

Whitening strips emerged as a hydrogen-containing over-the-counter whitening solution, designed to democratize tooth whitening by offering a user-friendly, cost-effective product with excellent esthetic outcomes. These strips are adhesive and adhere to the buccal surface of anterior teeth. They gradually release 5 to 14% hydrogen peroxide over relatively short timeframes, typically lasting 5 to 60 minutes per application. The entire treatment period can span up to 28 days, with users applying the strips once or twice daily, although the manufacturer asserts that noticeable whitening results become apparent within just 3 days.

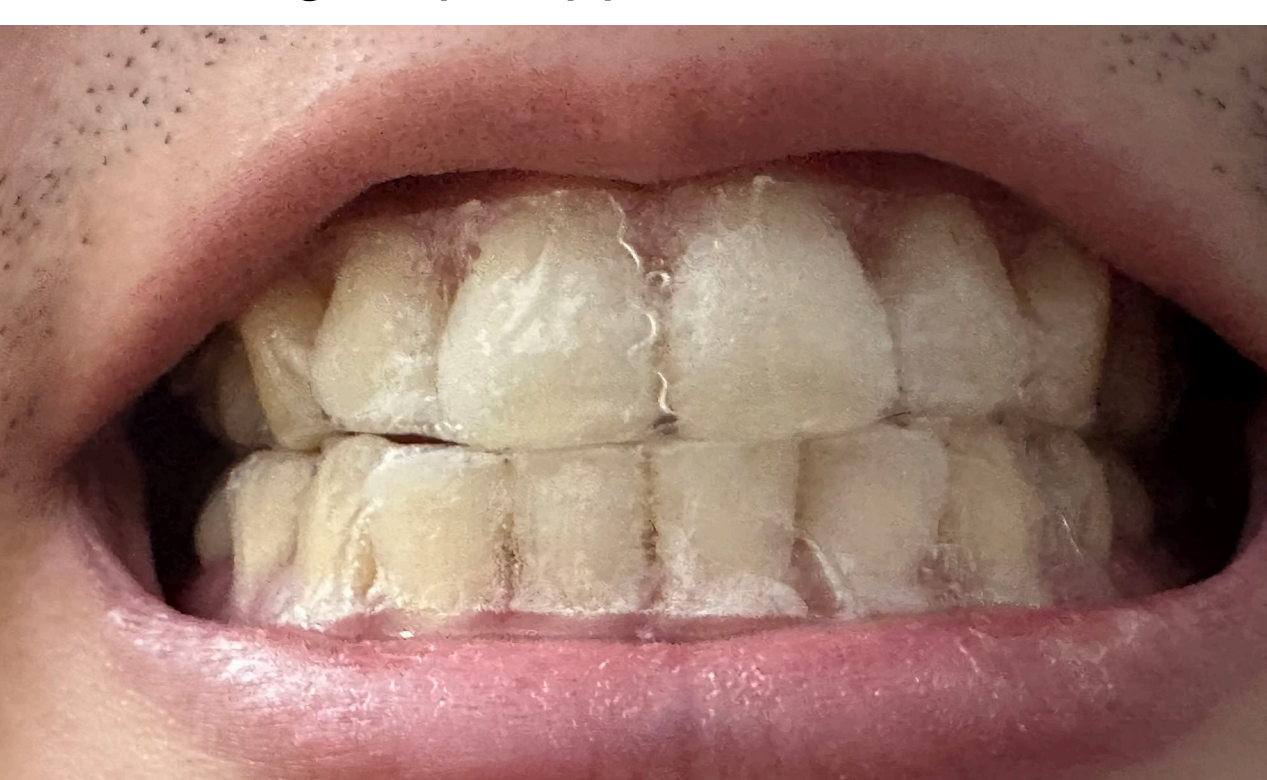
Results from clinical trials indicate that whitening strips are highly effective, yielding comparable outcomes to carbamide peroxide tray treatments. A recent meta-analysis, offering a moderate level of evidence, concluded that the perceptible color change differences between dentist-supervised at-home bleaching and the use of over-the-counter whitening strips were imperceptible to the naked human eye². Among various OTC whitening options (such as dentifrices, rinses, or paint-on gels), whitening strips emerge as the most potent choice based on many studies². These positive findings primarily stem from the extended contact duration with enamel and higher hydrogen peroxide concentrations achieved with strips. Additionally, the strip design acts as a fixed barrier, facilitating better tooth contact when compared to paint-on gels. Despite these promising outcomes, there's insufficient robust evidence to endorse whitening strips over the American Dental Association (ADA)-recommended approach involving a 10% carbamide peroxide gel applied on custom-made trays².

BEFORE & AFTER SINGLE USE OF TOOTH WHITENING STRIPS

Before applying whitening strips



Whitening strips applied for 30 minutes



After removing whitening strips



OBJECTIVES

To provide a thorough synthesis of the current literature regarding tooth whitening procedures, offering insight into the current status within the dental field and to offer an analysis of various tooth whitening techniques, their efficacy, and potential adverse outcomes

AT-HOME TRAY BASED WHITENING

Night guard vital bleaching is a popular technique for teeth whitening that offers a balance of indirect dentist supervision and patient-administered treatment at home. In this method, a customized bleaching tray is used, loaded with a low concentration of bleaching agents (10 to 20% carbamide peroxide, equivalent to 3.5 to 6.5% hydrogen peroxide). These trays are typically worn overnight or for 3 to 4 hours daily over a 2 to 6 week period. It's essential to ensure sufficient exposure time for carbamide peroxide since only 50% of it breaks down into its active components within 2 hours⁶.

The at-home approach offers advantages such as reduced chair-side time, fewer adverse effects, and lower associated costs. However, one major drawback is the high reliance on patient compliance⁶.

While initial recommendations included incorporating reservoirs into bleaching trays, it has been found that the presence of reservoirs has no significant effect on color change, tooth sensitivity, or gingival irritation in dentist-supervised at-home bleaching using 10% carbamide peroxide. Additionally, at-home tray bleaching can be seamlessly integrated with orthodontic treatment, using either Invisalign aligners or Vivera retainers as custom bleaching trays⁶.

WHITENING TOOTHPASTE

Whitening toothpastes, typically containing whitening agents and abrasives, offer a quick, convenient, and cost-effective method for removing extrinsic stains from teeth. These toothpastes commonly use hydrogen peroxide or carbamide peroxide at varying concentrations, facilitating tooth whitening through oxy-reduction reactions that break down pigments into smaller molecules. Abrasives play a role in removing extrinsic stains. During brushing, abrasive particles can get wedged between toothbrush bristles and the tooth surface. Since the abrasives are harder than the stains, they effectively remove the stains, leaving the tooth surface clean. Toothpastes based on activated charcoal function similarly to regular toothpastes. The cleaning effectiveness depends more on the brushing technique, type of toothbrush, and brushing duration than on the paste's components. Activated charcoal binds to deposits on the tooth surface, effectively holding onto plaque, bacteria, and extrinsic stains, ensuring that brushing leaves the tooth surface free from deposits. These toothpastes can create a whiter appearance by eliminating surface stains and plaque due to their abrasive action⁴. As indicated by research in references [3] and [4], regardless of the mechanism of action, all toothpastes demonstrated a reduction in tooth yellowness and resulted in similar overall color changes. The introduction of additional staining during toothbrushing cycles did not impact the effectiveness of the whitening toothpastes.

POTENTIAL ADVERSE EFFECTS

The most reported side effect among patients undergoing vital bleaching is tooth sensitivity. This sensitivity is believed to stem from the increased porosity induced by bleaching agents, allowing for the penetration of ions and fluid changes into the dentinal tubules, which can lead to discomfort¹.

Furthermore, a recent hypothesis proposes that a chemo-sensitive ion channel known as TRPA1 may respond to various oxidizing compounds, such as hydrogen peroxide. The activation of intra-dental nerve activity through TRPA1 could potentially explain the pain experienced during and following bleaching treatments¹.

REFERENCES

1. Donassollo SH, Donassollo TA, Coser S, et al. Triple-blinded randomized clinical trial comparing efficacy and tooth sensitivity of in-office and at-home bleaching techniques. *J Appl Oral Sci.* 2021;29:e20200794. Published 2021 Oct 1. doi:10.1590/1678-7757-2020-0794
2. Freitas, Maiara & de Carvalho, Marynara & Liporoni, Priscila & Fort, Ana & Moura, Rodrigo & Zanatta, Rayssa. (2021). Effectiveness and Adverse Effects of Over-the-Counter Whitening Products on Dental Tissues. *Frontiers in Dental Medicine.* 2. 687507. 10.3389/fdmed.2021.687507.
3. Aydin, Numan, Karaoğlanoğlu, Serpil, Oktay, Elif Aybala, & Ersöz, Bilge. (2022). Determination of the whitening effect of toothpastes on human teeth. *Odovtos International Journal of Dental Sciences*, 24(1), 67-75. <https://dx.doi.org/10.15517/ijds.2021.46376>
4. D.B.M. Tomas, M.P. Pecci-Lloret, J. Guerrero-Giron'es, Effectiveness and abrasiveness of activated charcoal as a whitening agent: a systematic review of in vitro studies, *Ann. Anat.* (2023), <https://doi.org/10.1016/j.aanat.2022.151998>.
5. Bruna Naiara Molina & Gabriela Ohata & Abi Rached Dantas & Luis Eduardo Genaro & Maria Carolina Stoco Fazanaro, 2021. "Efficacy and Adverse Effects of Dental Bleaching in the Office – Literature Review," *Biomedical Journal of Scientific & Technical Research, Biomedical Research Network+, LLC*, vol. 35(3), pages 27628-27636, April.
6. Karina Irusa, Islam Abd Alrahaem, Caroline Nguyen Ngoc, Terence Donovan, Tooth whitening procedures: A narrative review, *Dentistry Review*, Volume 2, Issue 3, 2022, 100055, ISSN 2772-5596, <https://doi.org/10.1016/j.dentre.2022.100055>.