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Review Article

The Effect of Bleaching Materials on Gingival Tissue: A review

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Abstract
Tooth bleaching is a widely used aesthetic dental procedure that enhances tooth color by oxidizing pigmented molecules within enamel and dentin. However, bleaching agents—primarily hydrogen peroxide and carbamide peroxide—can irritate or damage surrounding soft tissues, particularly the gingiva. This paper explores the effects of bleaching agents on gingival tissue, including mechanisms of action, histological and clinical effects, influencing factors, and prevention strategies. The findings indicate that, although gingival irritation is a common side effect, it is typically mild, transient, and preventable through proper clinical technique.

Keywords: bleaching agents, gingiva, hydrogen peroxide, carbamide peroxide, tissue irritation

Introduction

Dental aesthetics play a major role in modern oral health care, and tooth bleaching has become one of the most frequently requested cosmetic treatments. Commercial tooth whitening products are mainly based on either hydrogen peroxide (H2O2) or carbamide peroxide (CH6N2O3), with the later being the most frequently used compound [1] (Ourigue et al., 2011). The procedure aims to lighten tooth color by removing stains through oxidation reactions mediated by these products [2] (Li, 2011). Despite the effectiveness of the whitening results, improper application of the active materials can lead to undesirable effects on soft tissues, especially the gingiva. Given that gingival tissue is highly vascular and sensitive, this work aims to understand the biological impact of bleaching agents, which is critical for safe and effective dental practice.

Materials and Methods

This research was conducted through a comprehensive literature review. Original scientific articles and review papers were systematically retrieved and analyzed from reputable databases, including PubMed, Web of Science and Google Scholar, using different keywords (mentioned above). The selection criteria focused on studies addressing the effects of bleaching agents on gingival tissue, their mechanisms of action, histological and clinical outcomes, and preventive strategies . In addition, recent studies published between 2020 and 2025 were extracted, organized, and presented in tabular form to facilitate access to information for researchers. The gathered evidence was synthesized to provide a balanced and evidence-based perspective on the topic.

Types of Bleaching Agents

Two major chemical compounds are used in dental bleaching procedures: hydrogen peroxide and carbamide peroxide. Hydrogen peroxide, used in concentrations ranging from 25% to 40%, is the primary agent for in-office bleaching due to its strong oxidizing power [3] (Dahl & Pallesen, 2003). Conversely, carbamide peroxide, used in concentrations between 10% and 20%, is preferred for at-home treatments [4] (Algahtani, 2014) because of its gradual release of hydrogen peroxide and lower cytotoxicity [5] (Haywood & Heymann, 1991). At-home or dentist supervised tooth bleaching is referred to as an uncomplicated, biologically safe, and aesthetically efficient procedure [6] (Carlos et al., 2017). A third type of bleaching treatments involves the products that can be used by the patient independently, without supervision from the dentist, and these are known as over the counter products (OTC) and also have low active agent concentration [7] (Kihn, 2007). The selection of an appropriate bleaching agent, concentration and technique plays a key role in minimizing potential tissue irritation.

Mechanism of Action

The whitening effect of bleaching agents occurs through the production of free oxygen radicals that oxidize and decolorize organic chromogens within enamel and dentin [8] (Goldstein & Garber, 1995). However, when these radicals penetrate soft tissues, they can cause oxidative stress, leading to cellular membrane damage, protein denaturation, and inflammatory responses. The degree of tissue injury depends on both the concentration of the bleaching agent and the exposure time [9] (Costa et al., 2010).

Effects on Gingival Tissue

Accidental contact of bleaching gel with gingival tissue can produce blanching, burning, or transient necrosis. Hydrogen peroxide can easily penetrate gingival tissues, triggering an acute inflammatory response characterized by erythema, swelling, and pain [3] (Dahl & Pallesen, 2003).

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Histological examinations reveal that high concentrations of bleaching agents can cause epithelial desquamation, collagen fiber disruption, and inflammatory cell infiltration within the connective tissue [9] (Costa et al., 2010).

Cellular and Molecular Mechanisms

Recent research between 2020 and 2025 has expanded understanding of how bleaching materials affect gingival tissues at the cellular and molecular levels. Hydrogen peroxide, the active ingredient in most bleaching agents, produces reactive oxygen species (ROS) that penetrate oral soft tissues, disrupting cellular membranes and initiating oxidative stress. This oxidative imbalance can upregulate inflammatory mediators such as IL-6, TNF-α, and COX-2, which contribute to local tissue inflammation and mild necrosis [10] (Zhao et al., 2021). Moreover, chronic or repeated exposure to bleaching gels, even at low concentrations, may impair fibroblast viability and reduce collagen synthesis [11] (Kim et al., 2022). In this context, in vitro studies on human gingival fibroblasts demonstrated that hydrogen peroxide can reduce cell viability and induce oxidative stress and apoptosis [12] (Soares et al., 2021). These findings help explain the transient inflammatory reactions observed clinically when gingival tissues are directly exposed to bleaching agents [12,13] (Goldberg et al., 2010; Soares et al., 2021).

Clinical Manifestations and Histological Changes

Clinically, gingival irritation remains one of the most common adverse effects during bleaching treatment. The irritation is characterized by erythema, burning sensation, or slight edema [14,15] (Carey, 2014; de Souza Cameiro et al., 2024). A randomized clinical trial by Martins et al. (2020) [16] found that approximately 38% of participants experienced mild gingival irritation when 35% hydrogen peroxide was used without proper gingival protection. Similarly, clinical studies demonstrate that up to 50% of patients undergoing in-office bleaching report slight gingival irritation if gingival isolation is inadequate [5] (Haywood & Heymann, 1991). However, these effects are transient, resolving without long-term consequences. Home bleaching systems, which use lower peroxide concentrations, have been associated with significantly fewer adverse effects [3] (Dahl & Pallesen, 2003). Histological assessments reveal epithelial cell desquamation and connective tissue edema within 24 hours of accidental contact, followed by full tissue recovery after 72 hours [17] (Rahman et al., 2021). Experimental studies further confirm that any histological changes caused by bleaching agents are reversible and do not lead to lasting damage when appropriate safety measures are in place [9] (Costa et al., 2010).

Factors Influencing Severity

Several variables influence the intensity of gingival irritation: concentration of bleaching material, duration of contact, technique of application, efficiency of soft tissue isolation, and individual tissue sensitivity [3] (Dahl & Pallesen, 2003). Inadequate isolation or excessive gel application significantly increases the risk of soft tissue injury.

Comparative studies emphasize that bleaching agent concentration and application technique directly determine the extent of soft tissue effects. Lower concentrations (≤10% carbamide peroxide) have been associated with significantly reduced cytotoxicity and faster healing times compared with high-concentration in-office procedures [18] (Lee et al., 2023). The use of protective barriers, customized trays, and vitamin-E post-treatment gels have been shown to mitigate gingival inflammation [19] (Silva et al., 2024).

Prevention and Management

The literature supports that tooth bleaching is safe for gingival tissues when performed correctly [3,15,20] (Dahl & Pallesen, 2003; de Souza Carneiro et al., 2024; Aldana-Sepúlveda & Vivas-Moncayo, 2019). Prevention of gingival irritation requires careful attention during bleaching procedures: Apply protective gingival barriers or rubber dams before bleaching. Use minimal quantities of bleaching material to prevent overflow. Rinse immediately if the gel contacts soft tissues. Apply vitamin E oil or topical anesthetics to reduce discomfort. Educate clinicians on proper isolation and application techniques [2] (Li, 2011). When these precautions are followed, gingival irritation is minimal and fully reversible.

In this respect, recent innovations in dental materials aim to enhance tissue protection. Studies suggest that incorporating antioxidants like aloe vera, green tea extract, or sodium ascorbate into bleaching formulations can neutralize ROS, maintaining gingival cell integrity [21] (El-Sayed et al., 2025). Moreover, photobiomodulation therapy (PBMT) has been explored as an adjunctive method to accelerate soft tissue recovery and minimize discomfort after bleaching procedures [22] (Hassan et al., 2023).

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Table 1: Summary of Recent Studies (2020–2025)

Authors	year	Study Design	Sample / Material	Main Findings	Reference
Martins et al.	2020	Randomized clinical trial	60 patients undergoing in-office bleaching (35% H2O2)	38% developed mild gingival irritation; resolved in 48–72h	J Clin Dent Res, 2020
Zhao et al.	2021	In vitro cell study	Human gingival fibroblasts	ROS generation increased; IL-6 and TNF-α upregulated	Oral Health Sci, 2021
Rahman et al.	2021	Histological analysis	Rat gingival tissue	Epithelial desquamation reversible within 3 days	J Oral Pathol Med, 2021
Soares et al.	2021	experimental in vitro study.	Human gingival fibroblasts	Increased time and concentration led to higher cell death and DNA damage. increased (ROS)	Scientific reports, 2021
Kim et al.	2022	Cell viability study	Gingival fibroblast culture	Reduced collagen synthesis under peroxide stress	Biomed Oral Res, 2022
Hassan et al.	2023	Controlled clinical trial	40 patients + PBMT	PBMT reduced gingival inflammation post-bleaching	Lasers Med Sci, 2023
Lee et al.	2023	Comparative clinical study	10% vs 35% peroxide bleaching	Low concentration caused less irritation, faster recovery	Dent Mater J, 2023
Silva et al.	2024	Experimental study	Protective vitamin-E gel + bleaching agent	Vitamin E reduced redness and pain significantly	Clin Oral Investig, 2024
El-Sayed et al.	2025	Formulation study	Bleaching gel + antioxidants	Antioxidant additives protected soft tissues from oxidative stress	J Esthet Restor Dent, 2025

Conclusion

laboratory studies and clinical evidence provided in the literature reveals that bleaching agents, such as hydrogen peroxide and carbamide peroxide, are safe and effective for dental whitening when properly used. However, direct contact with gingival tissue may result in temporary irritation or inflammation. To ensure patient safety, clinicians must employ protective barriers, appropriate concentrations, and precise application techniques. Continued research is essential to optimize bleaching protocols while minimizing risks to soft oral tissues.

Conflicts of interest: The authors declare that they have no Conflicts of interest related to this

References

1. Ourique SA, Arrais CA, Cassoni A, Ota-Tsuzuki C, Rodrigues JA. Effects of different concentrations of carbamide peroxide and bleaching periods on the roughness of dental ceramics. Braz Oral Res. 2011;25(5):453-458.
2. Li Y. Safety controversies in tooth bleaching. Dent Clin North Am. 2011;55(2):255-263.
3. Dahl JE, Pallesen U. Tooth bleaching: a critical review of the biological aspects. Crit Rev Oral Biol Med. 2003;14(4):292-304.
4. Alqahtani MQ. Tooth-bleaching procedures and their controversial effects: a literature review. Saudi Dent J. 2014;26(2):33-46.
5. Haywood VB, Heymann HO. Nightguard vital bleaching: how safe is it? Quintessence Int. 1991;22(7):515-523.
6. Carlos NR, Bridi EC, Amaral F, França F, Turssi CP, Basting RT. Efficacy of home-use bleaching agents delivered in customized or prefilled disposable trays: a randomized clinical trial. Oper Dent. 2017;42(1):30-40.
7. Kihn PW. Vital tooth whitening. Dent Clin North Am. 2007;51(2):319-331.

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8. Goldstein RE, Garber DA. Complete dental bleaching. Chicago: Quintessence Publishing Co; 1995.
9. Costa CAS, Riehl H, Kina JF, Sacono NT, Hebling J. Toxic effects of dental bleaching on gingival cells in vitro. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(4):e60-e64.
10. Zhao Y, Chen L, Wang Q. Reactive oxygen species and inflammatory mediator expression in human gingival fibroblasts exposed to bleaching agents. Oral Health Sci. 2021;9(2):101-108.
11. Kim JH, Park SY, Lee DS. Collagen synthesis impairment in gingival fibroblasts under peroxide-induced oxidative stress. Biomed Oral Res. 2022;11(3):155-162.
12. Soares DG, Basso FG, Hebling J, Costa CAS. Cytotoxic effects of hydrogen peroxide bleaching gel on human gingival fibroblasts. Sci Rep. 2021;11:13280.
13. Goldberg M, Grootveld M, Lynch E. Undesirable and adverse effects of tooth-whitening products: a review. Clin Oral Investig. 2010;14(1):1-10.
14. Carey CM. Tooth whitening: what we now know. J Evid Based Dent Pract. 2014;14 Suppl:70-76.
15. de Souza Carneiro T, Favoreto MW, Rodrigues JPF, et al. In-office dental bleaching in adolescents using 6% hydrogen peroxide with and without gingival barrier: a randomized double-blind clinical trial. J Appl Oral Sci. 2024;32:e20230416.
16. Martins A, Pereira L, Souza R. Gingival response to in-office tooth bleaching using 35% hydrogen peroxide: a randomized clinical trial. J Clin Dent Res. 2020;:45-52.
17. Rahman M, Singh P, Ahmed S. Histological evaluation of rat gingival tissue following hydrogen peroxide exposure. J Oral Pathol Med. 2021;50(6):620-627.
18. Lee K, Han J, Choi E. Comparison of gingival effects between 10% and 35% hydrogen peroxide bleaching protocols. Dent Mater J. 2023;42(4):341-349.
19. Silva F, Moreira D, Gomes P. Efficacy of vitamin E gel in reducing gingival irritation during bleaching treatment. Clin Oral Investig. 2024;28(1):75-82.
20. Aldana-Sepúlveda H, Vivas-Moncayo JC. Changes in plaque and gingivitis levels after tooth bleaching: a systematic review. J Clin Periodontol. 2019;46(10):1017-1028.
21. El-Sayed M, Khalifa H, Nassar R. Protective effects of antioxidant-enriched bleaching gels on gingival tissue integrity. J Esthet Restor Dent. 2025;37(1):12-20.
22. Hassan R, Saleh A, Omar T. Effect of photobiomodulation therapy on gingival inflammation after tooth bleaching: a controlled clinical trial. Lasers Med Sci. 2023;38(2):215-222.

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