

Research Article

Oral Mucosal Pathology and Systemic Toxicity of Bleaching Agents and Amalgam Restoration in Patients with Gastrointestinal Disorders

Syeda Tehreem Zahra Bukhari¹, Moezza Sameen^{2*}, Hafiza Sara Sahar³, Bushra Ghani⁴, Zaryab Shaukat⁵, Sadia Tabassum⁶

^{1,2*}BDS, Dental Surgeon, Department of Operative Dentistry, CMH Institute of Medical Sciences and Dental College, Multan, Pakistan.

³BDS, Dental Surgeon, Department of Operative Dentistry, Peshawar Dental College, Peshawar, Pakistan.

⁴BDS, FCPS-II (Operative Dentistry and Endodontics), Certification in Dental Implantology, Certification in Orthodontics (Clear Path Certified Provider), Senior Dental Surgeon, Department of Dentistry, Dr. Ruth K.M. Pfau Civil Hospital, Karachi, Pakistan.

⁵BDS, Dental Surgeon, Department of Endodontics, CMH Institute of Medical Sciences & Dental College, Multan, Pakistan.

⁶BDS, FCPS, MSc, Assistant Professor, Pediatric Dentistry, Jinnah Medical and Dental College, Karachi, Pakistan.

Corresponding Author: Moezza Sameen

BDS, Dental Surgeon, Department of Operative Dentistry, CMH Institute of Medical Sciences and Dental College, Multan, Pakistan.

Email: sameenmoezza@gmail.com

Received: 10.07.2026, Revised: 08.09.2026, Accepted: 16.09.2026

ABSTRACT

Background: Dental bleaching agents and amalgam restorations are widely used in clinical dentistry, but their potential effects on oral mucosal tissues and systemic health remain a matter of clinical interest. Patients with gastrointestinal disease may be more prone to oral mucosal changes as a result of changes in saliva, reflux irritation, medications and nutritional changes.

Objective: To assess oral mucosal pathology and selected systemic toxicity indicators associated with bleaching-agent exposure and amalgam restorations in patients with gastrointestinal disorders.

Methodology: This descriptive analytical cross-sectional study was conducted at Peshawar Dental College, Peshawar from January 2025 to June 2025. Non-probability consecutive sampling was used to select a total number of 77 patients with gastrointestinal disorders. Demographic Data, Gastrointestinal Disease Profile, Exposure to Dental Bleaching Agents, Presence and Duration of Amalgam Restorations and Orofacial Mucosal Findings were documented. Selected biochemical parameters such as liver and renal function tests, systemic symptoms, were also measured when available. The associations of dental exposure and oral mucosal pathology were assessed by chi-square or Fisher's exact test with adjustment for potential dental exposure confounders by using multivariable logistic regression. All p-values were interpreted as being statistically significant at the p-value <0.05 level.

Results: Oral mucosal pathology was identified in 39 (50.6%) participants. Burning sensation, mucosal erythema, xerostomia, pigmentation, and lichenoid changes were the most commonly observed abnormalities. Mucosal pathology was more frequent among participants exposed to bleaching agents than among non-exposed patients (66.7% vs 43.4%, p=0.049) and among those with amalgam restorations compared with those without restorations (63.2% vs 38.5%, p=0.030). The highest frequency was observed among participants exposed to both bleaching agents and amalgam restorations (73.3%). Combined exposure was also associated with modest differences in alanine aminotransferase and serum creatinine levels.

Conclusion: Bleaching-agent exposure and amalgam restorations were associated with a higher frequency of oral mucosal abnormalities in patients with gastrointestinal disorders, particularly when both exposures were present. Although modest systemic biochemical variations were observed, the findings do not establish direct systemic toxicity. Larger prospective studies are required to clarify the clinical significance of these associations.

Keywords: Dental Bleaching, Amalgam Restoration, Oral Mucosal Pathology, Gastrointestinal Disorders, Systemic Toxicity, Oral Lesions.

INTRODUCTION

Dental restorative and aesthetic procedures have become increasingly common, with tooth bleaching and amalgam restorations remaining important components of dental care. Tooth whitening involves the use of bleaching agents such as hydrogen peroxide, carbamide peroxide, and others for the purpose of bleaching (1). Hydrogen peroxide and carbamide peroxide are used for the purpose of bleaching due to its ability to oxidize organic pigments present within the dental tissue (2, 3). These agents are generally effective, but may result in a transient gingival or oral mucosal irritation if used at inappropriate concentrations, if the length of exposure is excessive, or because of contact with soft tissues. These effects may be burning, erythema, sensitivity and epithelial changes, particularly if the bleaching product is not adequately separated from adjacent oral tissues (4).

The use of dental amalgam has been in existence for many decades due to its mechanical strength, cost effectiveness and resistance to occlusal forces (5). Amalgam, however, is a mixture of metals, including mercury, and it is sometimes suggested that there are local mucous effects and that there is a possible systemic exposure to mercury (6). Oral lichenoid reactions, mucosal discoloration, metallic taste and localized irritation have been reported for amalgam restorations in susceptible individuals. There is continuous debate about the clinical relevance of mercury exposure that occurs systemically from dental amalgam, as it depends on the dose, duration of exposure, individual susceptibility and health status (7, 8).

The population of patients with gastrointestinal diseases might be a clinically significant cohort to examine during the study of oral mucosal diseases. Recurrent episodes of acid contact to the oral cavity, changes in salivary flow, dehydration, use of medications, and altered nutrient absorption due to gastroesophageal reflux disease, gastritis, peptic ulcer disease, and other chronic gastrointestinal disease can have an impact on the oral cavity (9). These can compromise the mucosal barrier function and lead to susceptibility of burning, ulceration, dryness and inflammatory lesions. Like vomiting, refluxed material can also decrease the pH of the mouth, thereby creating a more corrosive environment for dental restorations and contributing to soft tissue damage (10).

The possibility of systemic effects related to dental material exposure is particularly relevant in patients with underlying gastrointestinal disease because symptoms such as nausea, fatigue, abdominal discomfort, headache, and metallic taste may overlap with manifestations of both gastrointestinal disorders and dental material exposure (11). Of course, the same applies to liver and renal function parameters - there may be several reasons for their deviations, and they can certainly not be blamed on the dental materials. Therefore, the evaluation of local oral changes and some selected systemic parameters can give a better idea of the possible biological effects of bleaching agents and amalgam restorations (12, 13).

Despite extensive use of dental bleaching materials and amalgam restorations, limited clinical data are available regarding their combined association with oral mucosal pathology and systemic toxicity indicators specifically among patients with gastrointestinal disorders. Most available evidence has examined bleaching-related sensitivity, isolated oral reactions, or amalgam-associated mucosal changes separately. Therefore, the present study was conducted to assess the frequency and pattern of oral mucosal pathology and evaluate selected systemic toxicity indicators associated with bleaching-agent exposure, amalgam restorations, and combined exposure in patients with gastrointestinal disorders.

METHODOLOGY

This descriptive analytical cross-sectional study was conducted at Peshawar Dental College, Peshawar from January 2025 to June 2025. A total of 77 patients with diagnosed gastrointestinal disorders were enrolled during the study period. The study was designed to evaluate the association of exposure to dental bleaching agents and amalgam restorations with oral mucosal pathology and selected indicators of systemic toxicity. Patients attending the relevant dental and medical outpatient departments during the study period were screened for eligibility. Ethical approval was obtained from the institutional review committee before commencement of the study, and written informed consent was taken from all participants before data collection.

The non-probability consecutive sampling technique was used for the selection of the participants. Eligible patients were adults (18 years or older) with a clinically defined gastrointestinal disorder such as gastritis,

gastroesophageal reflux disease, peptic ulcer disease or chronic gastrointestinal disease. Patients were eligible to be included if they had a history of dental bleaching exposure, one or more amalgam restorations, both exposure and amalgam restorations or neither for comparison. To minimize any potential confounding factors, patients with a known oral malignancy, an active oral infection not related to the dental materials, autoimmune mucocutaneous disorders, severe hepatic or renal disease, recent chemotherapy or radiotherapy, or use of medications known to cause prominent oral mucosal lesions were excluded.

Demographic, clinical, gastrointestinal and dental exposure characteristics were documented on a structured form of data collection. Demographic information was obtained including Age, Sex, Residence, Smoking or Tobacco use, Socioeconomic status. Gastrointestinal variables consisted of diagnosis, disease duration, severity of symptoms and their current treatment. Previous use of a bleaching agent, number and frequency of bleaching procedures, interval since last bleaching, amalgam restorations, number of amalgam-restored teeth, and approximate duration of exposure to amalgam were recorded as part of dental exposure assessment. The participants were then grouped by bleaching exposure, amalgam restoration status and combined exposure.

A comprehensive oral examination was conducted under good lighting with dental examination instruments. Systematic assessment of the oral mucosa, gingiva, tongue, buccal mucosa, palate, floor of mouth and other visible oral structures was performed. The main outcome were oral mucosal changes such as erythema, burning sensation, ulceration, lichenoid changes, desquamation, pigmentation and xerostomia. Mucosal involvement was assessed as mild, moderate or severe based on the extent and clinical

appearance of the lesions. Other systemic symptoms possibly related to exposure were also noted such as fatigue, headache, nausea, metallic taste, dizziness, and abdominal discomfort. Biochemical parameters included in the study protocol were serum alanine aminotransferase, aspartate aminotransferase, creatinine, and blood urea, which are indicators of hepatic and renal function, where laboratory testing was performed.

The IBM SPSS Statistics version 26.0 software was used to enter and analyze the data. Continuous variables were summarised as mean $\pm$ standard deviation while categorical variables were summarised as frequencies and percentages. Data for continuous variables were compared as appropriate by independent-samples t-test or one-way analysis of variance, whereas categorical variables were compared by a Fisher's exact test or a chi-square test for association. The association between bleaching exposure, amalgam restorations, and combined dental exposure and oral mucosal pathology was presented as odds ratios and 95% confidence interval. To account for possible confounding factors, age, sex, smoking history and time of gastrointestinal disease were included in the multivariable binary logistic regression. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 77 patients with gastrointestinal disorders were included in the study. The age range of the participants was 20 to 65 years and the mean age was 41.8 ± 11.6 years. Of the total participants, 43 (55.8%) were females and 34 (44.2%) were males. The most common gastrointestinal conditions reported were: gastritis (29, 37.7%), gastroesophageal reflux disease (21, 27.3%), peptic ulcer disease (15, 19.5%), and other gastrointestinal conditions (12, 15.6%). The mean length of gastrointestinal illness was about 4 years.

Table 1. Demographic and Gastrointestinal Characteristics of Participants (n = 77)

Variable	n (%) / Mean $\pm$ SD
Age, years	41.8 $\pm$ 11.6
Male	34 (44.2)
Female	43 (55.8)
Gastritis	29 (37.7)
Gastroesophageal reflux disease	21 (27.3)
Peptic ulcer disease	15 (19.5)
Other gastrointestinal disorders	12 (15.6)
Current smoker/tobacco user	18 (23.4)

Duration of GI disorder, years	4.6 ± 2.8
--------------------------------	-----------

Regarding dental exposure, 24 (31.2%) participants had a history of bleaching-agent use, while 38 (49.4%) had one or more amalgam restorations. Fifteen of the participants (19.5%) had a dual exposure to both bleaching products and amalgam

restorations. Twenty-one (55.3%) of the patients had two or more amalgam-restored teeth and 17 (44.7%) had only one amalgam-restored tooth. The mean time for the amalgam restoration was 6.2 ± 3.4 years.

Table 2. Dental Exposure Characteristics of Study Participants

Dental exposure variable	N (%)
History of bleaching-agent use	24 (31.2)
Presence of amalgam restoration	38 (49.4)
Exposure to both bleaching and amalgam	15 (19.5)
≥2 amalgam-restored teeth*	21 (55.3)
One amalgam-restored tooth*	17 (44.7)
Repeated bleaching exposure**	14 (58.3)
Single/occasional bleaching exposure**	10 (41.7)

*Calculated among 38 patients with amalgam restorations.

**Calculated among 24 participants with bleaching exposure.

Thirty-nine (50.6%) participants had oral mucosal abnormalities. Most common were oral burning sensation (23, 29.9%), mucosal erythema (20, 26.0%), xerostomia (18, 23.4%) and mucosal pigmentation (14, 18.2%) patients. The 11 (14.3%) patients had lichenoid

mucosal changes, whereas ulceration and mucosal desquamation were less common. Twenty-one (27.3%) of the participants showed mild mucosal pathology, 12 (15.6%) moderate, and 6 (7.8%) severe mucosal abnormalities.

Table 3. Oral Mucosal Pathological Findings among Participants

Oral mucosal finding	N (%)
Any oral mucosal pathology	39 (50.6)
Burning sensation	23 (29.9)
Mucosal erythema	20 (26.0)
Xerostomia	18 (23.4)
Mucosal pigmentation	14 (18.2)
Lichenoid lesion/change	11 (14.3)
Oral ulceration	8 (10.4)
Mucosal desquamation	7 (9.1)
Mild mucosal pathology	21 (27.3)
Moderate mucosal pathology	12 (15.6)
Severe mucosal pathology	6 (7.8)

A higher proportion of oral mucosal abnormalities were seen in those who had been exposed to bleaching agents compared to those who had not been exposed to bleach (66.7% vs 43.4%, $p = 0.049$). Likewise, the prevalence of mucosal pathology was higher among those with amalgam restorations than without

amalgam restorations (63.2% vs 38.5%, $p = 0.030$). The patients that had been exposed to both bleaching agents and amalgam restorations alone had the greatest amount of oral mucosal pathology, with 11/15 (73.3%) having at least one mucosal abnormality.

Table 4. Association of Dental Exposure with Oral Mucosal Pathology

Exposure	Mucosal pathology n (%)	No pathology n (%)	p-Value
Bleaching exposure (n=24)	16 (66.7)	8 (33.3)	0.049
No bleaching exposure (n=53)	23 (43.4)	30 (56.6)	
Amalgam restoration (n=38)	24 (63.2)	14 (36.8)	0.030

No amalgam restoration (n=39)	15 (38.5)	24 (61.5)	
Both bleaching + amalgam (n=15)	11 (73.3)	4 (26.7)	0.041
No combined exposure (n=62)	28 (45.2)	34 (54.8)	

Other systemic conditions possibly related to dental material exposure were also noted. The most frequently reported symptoms were fatigue in 24 (31.2%), nausea in 20 (26.0%), metallic taste in 17 (22.1%), headache in 16 (20.8%), and abdominal discomfort in 15 (19.5%) participants. There were more systemic symptoms in amalgam patients than

non-amalgam patients. Among patients, the presence of amalgam, the presence of dental caries, and the presence of fresh amalgam had more patients reporting metallic taste than the other groups, respectively (31.6% vs 12.8%, $p = 0.047$; 18.3% vs 12.8%, $p = 0.18$; and 17.6% vs 12.8%, $p = 0.19$).

Table 5. Systemic Symptoms according to Amalgam Restoration Status

Symptom	Amalgam present (n=38)	Amalgam absent (n=39)	p-value
Fatigue	16 (42.1)	8 (20.5)	0.041
Nausea	13 (34.2)	7 (17.9)	0.103
Metallic taste	12 (31.6)	5 (12.8)	0.047
Headache	10 (26.3)	6 (15.4)	0.236
Abdominal discomfort	10 (26.3)	5 (12.8)	0.134

Biochemical tests showed that liver enzyme and renal function mean values were higher in the subjects exposed to both bleaching and amalgam products, but were in the clinically acceptable range. In those with combined exposure, mean ALT was 31.6 ± 10.4 U/L and in those without, 26.3 ± 8.7 U/L ($p = 0.041$). Mean serum creatinine was also modestly

higher in the combined-exposure group (0.98 ± 0.19 vs 0.87 ± 0.17 mg/dL, $p = 0.030$). The differences between these indicated a possible relationship between cumulative dental-material exposure and systemic biochemical changes but no cases of overt hepatic or renal failure were found.

Table 6. Biochemical Toxicity Parameters according to Combined Dental Exposure

Laboratory parameter	Bleaching + amalgam (n=15)	Other participants (n=62)	p-value
ALT, U/L	31.6 ± 10.4	26.3 ± 8.7	0.041
AST, U/L	29.4 ± 8.8	25.8 ± 7.5	0.110
Serum creatinine, mg/dL	0.98 ± 0.19	0.87 ± 0.17	0.030
Blood urea, mg/dL	29.8 ± 7.2	26.7 ± 6.8	0.119

On multivariable analysis, the presence of amalgam restorations remained independently associated with oral mucosal pathology (adjusted OR = 2.54, 95% CI: 1.03–6.26, $p = 0.043$). Repeated bleaching exposure was also associated with an increased likelihood of mucosal pathology (adjusted OR = 2.78, 95% CI: 1.01–7.65, $p = 0.048$). Patients with both exposures demonstrated the greatest risk (adjusted OR = 3.41, 95% CI: 1.07–10.88, $p =$

0.038), after adjustment for age, sex, smoking status, and duration of gastrointestinal disease. Overall, the findings demonstrated that oral mucosal abnormalities were common among patients with gastrointestinal disorders and occurred more frequently in individuals exposed to bleaching agents, amalgam restorations, or both. Combined exposure was associated with the greatest frequency of mucosal pathology and modest alterations in selected biochemical parameters.

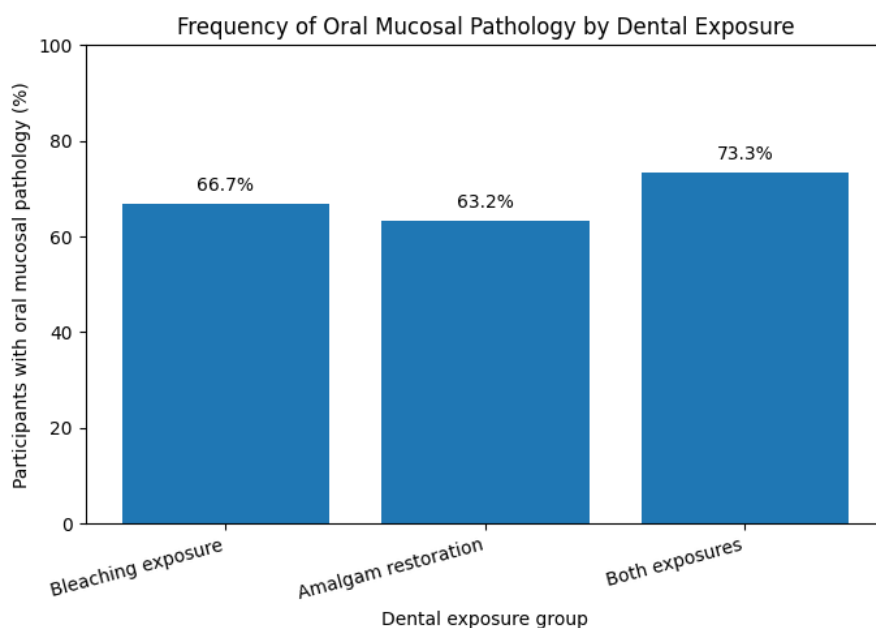


Figure 1. Frequency of Oral Mucosal Pathology according to Dental Exposure Status among Patients with Gastrointestinal Disorders. The Highest Proportion of Mucosal Pathology was Observed in participants Exposed to both Bleaching agents and Amalgam Restorations (**73.3%**), followed by Bleaching Exposure alone (**66.7%**) and Amalgam Restoration (**63.2%**).

DISCUSSION

The present study evaluated oral mucosal pathology and selected systemic toxicity indicators associated with bleaching-agent exposure and amalgam restorations among patients with gastrointestinal disorders. Oral mucosal abnormalities were observed in approximately half of the participants, with burning sensation, erythema, xerostomia, pigmentation, and lichenoid changes being the most frequent findings. The prevalence of mucosal pathology was higher among participants with a history of bleaching exposure and among those with amalgam restorations, while the highest frequency was seen in individuals exposed to both. These findings suggest that dental material exposure may contribute to local mucosal irritation, particularly in patients who already have gastrointestinal disease and may possess altered oral environments due to reflux, medications, nutritional deficiencies, or changes in salivary composition (14-16). Dental bleaching agents generally contain hydrogen peroxide or carbamide peroxide, both of which may temporarily irritate oral soft tissues when they come into direct or repeated contact with the mucosa. The number of mucosal abnormalities was higher in the bleaching history group than in the non-bleaching history group in the present study. Repeated exposure was also more strongly associated with mucosal pathology. This

observation can be attributed to the oxidant effects of peroxide-based agents that can cause an increase in epithelial permeability, induce inflammation, and cause a short-term sensitivity of the mucosa. These effects may be more apparent in patients who have gastrointestinal diseases since chronic reflux, changes in oral tissue pH, dehydration, medication, and pre-existing sensitivity of oral tissue may decrease the ability of the oral tissues to adhere (17, 18).

Oral mucosal pathology was also a significant association with the amalgam restorations in the current study. The mucosal lesion frequency of participants with amalgam restorations was significantly higher than the others, specifically for mucosal pigmentation, lichenoid changes, burning sensation and metallic taste. Although clinical experience has shown that dental amalgam is a long-lasting material, local reactions can be experienced in some susceptible individuals, especially around restorations. Localized oral lichenoid reactions and muco-cutaneous discoloration have been suggested to be the result of corrosion products or trace metal exposures. The present findings do not prove the direct toxicity of amalgam, but rather highlight the need to make a careful clinical assessment in patients with higher or longer exposure levels if there is an unexplained mucosal abnormality (19-21). Participants who reported exposure to dental materials also reported higher frequencies of

systemic symptoms including fatigue, nausea, headache, and abdominal discomfort, especially those with amalgam restorations and/or combined exposure. Furthermore, small variations were seen in certain biochemical markers, such as alanine aminotransferase and serum creatinine, among those who had combined exposure (22-24). These were, however, generally within clinically acceptable limits and there was no evidence of overt hepatic or renal failure. Thus, caution should be exercised in interpreting the biochemical results. These differences observed may be due to a variety of factors besides the dental materials, such as underlying gastrointestinal disease, the use of other medications, nutrition, smoking, hydration, and other systemic diseases (25).

There are several limitations of the study. The relatively small sample size of 77 participants and the single-center design may limit the generalizability of the findings. The cross-sectional design of the study also does not allow one to ascertain definite temporal or causal relationships between the exposure to dental materials and oral or systemic manifestations. However, some exposure factors such as the frequency and duration of bleaching were recalled by the participants, which could lead to recall bias. In addition, the biochemical parameters (liver and renal function tests) are not specific markers of toxicity associated with dental materials. In order to understand the biological and clinical relevance of these associations, future multicenter prospective studies with larger cohorts, well-defined exposure groups, direct measurement of exposure-related biomarkers (metals or peroxides) and harmonization of oral mucosal scoring systems are recommended.

CONCLUSION

Oral mucosal abnormalities were common among patients with gastrointestinal disorders and occurred more frequently in individuals exposed to bleaching agents, amalgam restorations, or both. Combined exposure was associated with the highest frequency of mucosal pathology, while systemic symptoms and modest biochemical variations were also more evident in exposed participants. These findings suggest a possible relationship between dental material exposure and oral mucosal changes; however, they do not confirm direct systemic toxicity. Careful oral examination, detailed exposure history, and appropriate clinical monitoring may be useful in

gastrointestinal patients presenting with unexplained oral mucosal symptoms.

REFERENCES

1. Kothari S, Jum'ah AA, Gray AR, K ML, Yap M, Brunton PA. A randomized clinical trial investigating three vital tooth bleaching protocols and associated efficacy, effectiveness and participants' satisfaction. *J Dent.* 2020;95:103322 DOI: 10.1016/j.jdent.2020.103322.
2. Chen YH, Yang S, Hong DW, Attin T, Yu H. Short-term effects of stain-causing beverages on tooth bleaching: A randomized controlled clinical trial. *J Dent.* 2020;95:103318 DOI: 10.1016/j.jdent.2020.103318.
3. Kim HJ, Jang JH, Choi D, Kim J, Shim JH, Kim DS. Bleaching toothpaste with two different concentrations of hydrogen peroxide: A randomized double-blinded clinical trial. *J Dent.* 2020;103:103508 DOI: 10.1016/j.jdent.2020.103508.
4. Martini EC, Parreiras SO, Szesz AL, Coppla FM, Loguercio AD, Reis A. Bleaching-induced tooth sensitivity with application of a desensitizing gel before and after in-office bleaching: a triple-blind randomized clinical trial. *Clin Oral Investig.* 2020;24(1):385-94 DOI: 10.1007/s00784-019-02942-9.
5. Goettems ML, Fernandez MDS, Donassollo TA, Henn Donassollo S, Demarco FF. Impact of tooth bleaching on oral health-related quality of life in adults: A triple-blind randomised clinical trial. *J Dent.* 2021;105:103564 DOI: 10.1016/j.jdent.2020.103564.
6. Santos ME, de Azevedo D, do Nascimento VGS, Rocha VFN, Meireles SS. Does a Purple Silicone Guide Can Be Used for Standardization of Tooth Color Evaluation? A Clinical Trial. *Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry [et al].* 2026;38(2):210-6 DOI: 10.1111/jerd.70058.
7. Martini EC, Favoreto MW, Coppla FM, Loguercio AD, Reis A. Evaluation of reservoirs in bleaching trays for at-home bleaching: a split-mouth single-blind randomized controlled equivalence trial. *Journal of applied oral science : revista FOB.* 2020;28:e20200332 DOI: 10.1590/1678-7757-2020-0332.
8. Surmelioglu D, Usumez A. Effectiveness of Different Laser-Assisted In-Office

- Bleaching Techniques: 1-Year Follow-Up. Photobiomodulation, Photomedicine, and Laser Surgery. 2020;38(10):632-9 DOI: 10.1089/photob.2019.4741.
9. Donassollo SH, Donassollo TA, Coser S, Wilde S, Uehara JLS, Chisini LA, et al. Triple-blinded randomized clinical trial comparing efficacy and tooth sensitivity of in-office and at-home bleaching techniques. Journal of applied oral science : revista FOB. 2021;29:e20200794 DOI: 10.1590/1678-7757-2020-0794.
10. Terra R, da Silva KL, Vochikovski L, Sutil E, Rezende M, Loguercio AD, et al. Effect of Daily Usage Time of 4% Hydrogen Peroxide on the Efficacy and Bleaching-induced Tooth Sensitivity: A Single-blind Randomized Clinical Trial. Operative dentistry. 2021;46(4):395-405 DOI: 10.2341/20-058-c.
11. Gupta P, Mallishery S, Bajaj N, Banga K, Mehra A, Desai R. Low Prevalence of Amalgam-Associated Lichenoid Lesions in the Oral Cavity: A Prospective Study. Cureus. 2022;14(2):e22696 DOI: 10.7759/cureus.22696.
12. Mailart MC, Sakasagawa PA, Santos KC, Torres CRG, Palo RM, Borges AB. One-year follow-up comparing at-home bleaching systems outcomes and the impact on patient's satisfaction: Randomized clinical trial. Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry [et al]. 2021;33(8):1175-85 DOI: 10.1111/jerd.12814.
13. de Araújo IDT, de Sousa Santos K, das Neves Peixoto TVO, Costa MJF, de Assunção IV, Borges BCD. The combined use of systemic analgesic/anti-inflammatory drugs and a bioactive topical desensitizer for reduced in-office bleaching sensitivity without jeopardizing the hydrogen peroxide efficacy: a randomized, triple blinded, split-mouth clinical trial. Clin Oral Investig. 2021;25(12):6623-32 DOI: 10.1007/s00784-021-03948-y.
14. Sutil E, da Silva KL, Terra RMO, Burey A, Rezende M, Reis A, et al. Effectiveness and adverse effects of at-home dental bleaching with 37% versus 10% carbamide peroxide: A randomized, blind clinical trial. Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry [et al]. 2022;34(2):313-21 DOI: 10.1111/jerd.12677.
15. Carneiro TS, Favoreto MW, Bernardi LG, Sutil E, Wendlinger M, Centenaro GG, et al. Gingival irritation in patients submitted to at-home bleaching with different cutouts of the bleaching tray: a randomized, single-blind clinical trial. Clin Oral Investig. 2022;26(6):4381-90 DOI: 10.1007/s00784-022-04401-4.
16. Pereira R, Silveira J, Dias S, Cardoso A, Mata A, Marques D. Bleaching efficacy and quality of life of different bleaching techniques - randomized controlled trial. Clin Oral Investig. 2022;26(12):7167-77 DOI: 10.1007/s00784-022-04678-5.
17. Oliveira Barros AP, da Silva Pompeu D, Takeuchi EV, de Melo Alencar C, Alves EB, Silva CM. Effect of 1.5% potassium oxalate on sensitivity control, color change, and quality of life after at-home tooth whitening: A randomized, placebo-controlled clinical trial. PLoS One. 2022;17(11):e0277346 DOI: 10.1371/journal.pone.0277346.
18. Meireles SS, de Oliveira RDB, Barbosa MTG, da Silva KL, Loguercio AD. Efficacy and tooth sensitivity of at-home bleaching in patients with esthetic restorations: a randomized clinical trial. Clin Oral Investig. 2022;26(1):565-73 DOI: 10.1007/s00784-021-04035-y.
19. Carneiro TS, Favoreto MW, Centenaro GG, Carneiro OS, Crovador CJ, Stanislawczuk R, et al. Does simultaneous versus individual-arch at-home dental bleaching regimen influence patient satisfaction? A randomized clinical trial. Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry [et al]. 2022;34(8):1263-71 DOI: 10.1111/jerd.12962.
20. Geier DA, Geier MR. Dental amalgam fillings and mercury vapor safety limits in American adults. Human & experimental toxicology. 2022;41:9603271221106341 DOI: 10.1177/09603271221106341.
21. Park SB, Kim EK, Sakong J, Park EY. Association between dental amalgam restoration and urine mercury concentrations among young women: a cross-sectional study. Journal of Yeungnam medical science.

- 2023;40(4):373-80 DOI: 10.12701/jyms.2022.00955.
22. Zhong BJ, Yang S, Hong DW, Cheng YL, Attin T, Yu H. The Efficacy of At-home, In-office, and Combined Bleaching Regimens: A Randomized Controlled Clinical Trial. *Operative dentistry*. 2023;48(3):E71-e80 DOI: 10.2341/22-099-c.
 23. Paula AM, Hanzen TA, de Oliveira M, Loguercio AD, Reis A. Evaluation of Different Protocols with 4% Hydrogen Peroxide in Bleaching Efficacy and Tooth Sensitivity - A Single-blind, Randomized Clinical Trial. *Operative dentistry*. 2023;48(3):268-76 DOI: 10.2341/22-051-c.
 24. Krayem E, Banerjee A, Milly H. Evaluating the efficiency of two different over-the-counter tooth whitening systems: a randomised controlled clinical trial. *BDJ Open*. 2024;10(1):41 DOI: 10.1038/s41405-024-00227-2.
 25. Bin Hassan SA. Tooth Sensitivity Following Hydrogen Peroxide Bleaching With and Without Ozone: A Randomized Controlled Trial: Tooth Sensitivity Following H₂O₂ Versus H₂O₂/Ozone Bleaching. Pain research & management. 2024;2024:2695533 DOI: 10.1155/2024/2695533.