



## Major clinical results on the dental bleaching: a systematic review

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### Abstract

**Introduction:** It is lived in a society where the media induces our patient's standards of aesthetics and beauty. Patients are seeking more and more offices for a completely aesthetic smile. Toothpaste whiteners consist of surfactants, polyphosphates, enzymes, peroxides, citrate, pyrophosphate, hexametaphosphate, blue covarine, and abrasive agents. **Objective:** It was to conduct a systematic review to present the main considerations and outcomes of clinical studies on dental bleaching. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from July to August 2025 in the Scopus, Embase, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument, and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 175 articles were found, and 40 articles were evaluated in full, and 30 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 30 studies with a high risk of bias and 25 that did not meet the GRADE and AMSTAR-2 criteria. According to the GRADE instrument, most studies presented homogeneity in their results, with  $X^2=94.7\%>50\%$ . It was concluded that after analyzing and comparing the literature results obtained before and after the use of toothpastes and mouthwashes, it can be observed that the products did not promote teeth bleaching. Also, external root resorption in internal tooth whitening is one of the disadvantages of whitening; the etiology is unknown. External cervical resorption is the loss of hard tissue of the dental structure, such as cementum and dentin, resulting in an odontoclastic action, its onset usually occurring in the cervical region of the root surface, and is asymptomatic.

**Keywords:** Dental aesthetic. Toothpastes. Mouthwashes. Tooth whitening. Dental bleaching.

### Introduction

It is lived in a society where the media induces our patient's standards of aesthetics and beauty. Patients are seeking more and more offices for a completely aesthetic smile. White, symmetrical, well-aligned teeth are known to be standards of beauty, economic status, and self-esteem [1]. Alteration in the color of the dentin can affect esthetics, even more, when they affect anterior teeth, and very commonly occur after trauma, endodontic treatments, among others occurred. The technology came to help us with several techniques, chemicals, and a laser that promise to reestablish the aesthetics of the element [1-3].

Cosmetic dentistry has as main objective the search for aesthetic excellence of dental elements, with the growing interest among dentists [3-7]. Thus, the aesthetics of a smile is determined by sociocultural values and individual preferences [8-10]. This event occurs by chromophores (pigments) impregnated in the dental structure for a variety of reasons, such as trauma, intracanal medication, bleeding in the internal structure of the teeth, among other causes. When these pigments form a molecule capable of reflecting light at wavelength visible by the human eye and whose intensity is greater than the light reflected by the dental structure, then the pigment color predominates and the darkened tooth is observed [11-15].

Also, patients are increasingly searching for whiter teeth, since it is synonymous with aesthetics and health. The rapid growth of tooth whitening over the past decade is due to the desire for whiter teeth by society and it made were developing various techniques and products for this purpose [16]. Among the

techniques indicated to obtain tooth bleaching are the following: bleaching techniques that can be performed in the office by the dentist and bleaching performed at home using individual trays [17]. However, in addition to these techniques indicated by the dentist, there is an increase in the availability of products promising to bleach teeth, known as over-the-counter. This name is because they are products marketed in bulk and easily accessible as toothpastes and mouthwashes [18,19].

Toothpaste whiteners consist of surfactants, polyphosphates, enzymes, peroxides, citrate, pyrophosphate, hexametaphosphate, blue covarine, and abrasive agents. The whiter appearance of the teeth after the use of these toothpastes has been related to the abrasive action of some components of their formulation. Among these components are the following: hydrated silica, calcium carbonate, aluminum oxide, dicalcium phosphate dihydrate, perlite and sodium bicarbonate [20,21].

Studies have demonstrated that effective removal of dental pigmentation is It occurs through chemical reaction and not by mechanical abrasion. chemical bleaching. Furthermore, abrasive agents may cause erosion and increase in surface roughness on tooth enamel. The mouthwashes have been developed to support the chemical control of bacterial plaque [22,23]. However, some trademarks also indicate these products for teeth bleaching, because in their composition there may be low concentrations (usually 1.0 to 2.0 %) of hydrogen peroxide, responsible for the cleavage of pigments that promote teeth darkening, which promotes the bleaching action [24].

Therefore, this study conducted a systematic review to present the main considerations and outcomes of clinical studies on dental bleaching.

## Methods

### Eligibility and Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: <http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1>. Accessed on: 08/18/2025. The AMSTAR 2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: <https://amstar.ca/>. Accessed on: 08/18/2025.

### Search Strategy and Search Sources

The literature search process was carried out from July to August 2025 and developed based on Web of Science, Scopus, Embase, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from

various periods to the present day. The following descriptors (DeCS /MeSH Terms) were used "Dental aesthetic. Toothpastes. Mouthwashes. Tooth whitening. Dental bleaching", and using the Boolean "and" between MeSH terms and "or" between historical findings.

### Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using Cohen's d test.

## Results and Discussion

### Summary of Findings

As a corollary of the literature search system, a total of 175 articles were found that were submitted to eligibility analysis, 40 articles were evaluated in full and 30 final studies were selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational studies. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with  $X^2=94.7\%>50\%$ . Considering the Cochrane tool for risk of bias, the overall assessment resulted in 30 studies with a high risk of bias and 25 studies that did not meet GRADE and AMSTAR-2.

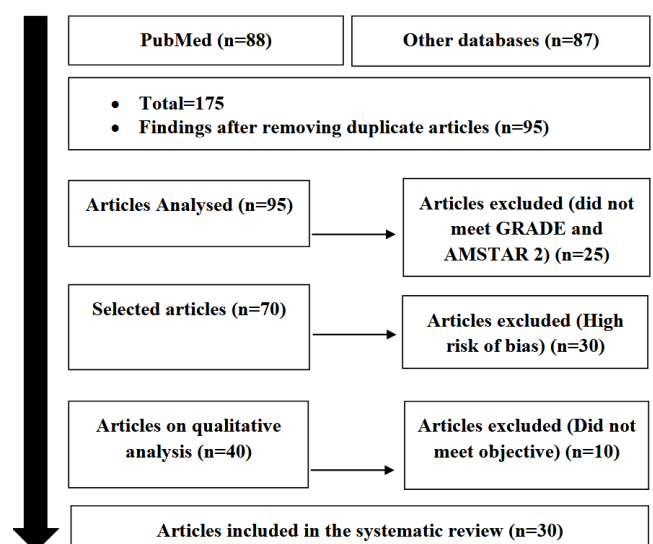


Figure 1. Flowchart showing the article selection process. Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) that are shown at the base of the graph and in studies with large sample sizes that are shown at the top.

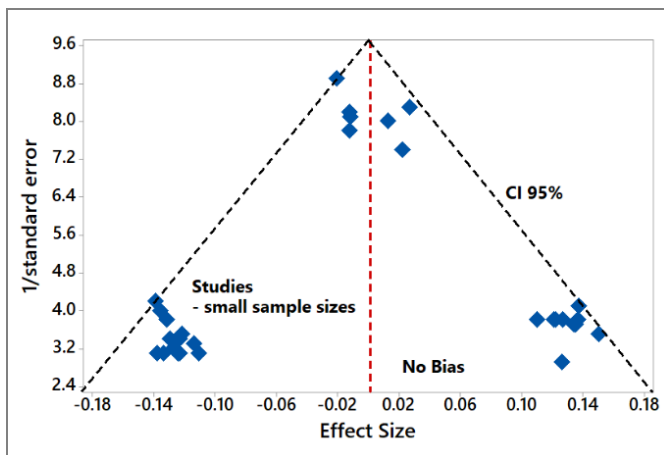


Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. Studies with high confidence and high recommendation are shown above the graph (n=30 studies). Source: Own Authorship.

## Major Results

### Dental enamel

The dental structure is composed of dentin, enamel and dental pulp [1-3]. The pulp is a portion rich in blood vessels and nerves that is formed by connective tissue and is located in the center of the tooth. The dentin is similar in composition to the bone and involves the portion of the pulp. Finally, enamel is observed, an extremely resistant substance formed mainly by calcium phosphate, which involves the dentin [3].

The chemical composition of the mineral (hydroxyapatite) is 96%, organic (proteins) + water = 4%. Due to the high mineral content the dental enamel is hard and friable (brittle) being translucent under normal conditions. Thus, the color of the tooth is dentin, because the enamel is translucent [4]. The etiology of the darkening of devitalized teeth is well known. Among the main causes of this chromatic alteration we can highlight the presence of restorative materials in the crown, hemorrhage inside the pulp chamber, decomposition of tissues or debris inside the pulp chamber, intracanal medication and root canal filling materials [2,3].

Also, the etiology of the chromatic alteration in the pulp teeth can be due to the contents of the pulp cavity or the operative procedures. In the first case, the causes of hemorrhagic origin and tissue decomposition are included, and the second, inadequate access to the pulp chamber, incomplete removal of cavity contents and use of drugs and fillers [1,2].

Authors studied the darkening of teeth due to hemorrhage. Samples of whole blood, erythrocytes, plasma, concentrated blood platelets and saline were individually inserted into the pulp chamber of five groups of teeth which were centrifuged for 25 minutes twice daily for 3 consecutive days. They confirmed that the pigment of the blood responsible for darkening was found only in samples containing erythrocytes. The teeth were then prepared for histological analysis and histochemical tests. They observed that after hemolysis of erythrocytes, hemoglobin was found intact inside the dentin, and there was no evidence of iron or hemosiderin ions [1-3].

### Disadvantage of internal bleaching

External root resorption in internal tooth whitening is one of the drawbacks in whitening the etiology is unknown [8]. External cervical resorption is the loss of hard tissue of the dental structure, such as cementum and dentin, resulting in an odontoclastic action, its onset usually occurring in the cervical region of the root surface [12]. When this happens, it is usually asymptomatic and is usually detected through routine radiographs, in some cases it may have clinical signs such as papilla bleeding and a positive percussion test [9,13].

It is believed that the bleaching agent reaches the periodontal tissues through the dentinal tubules, denature the dentin, which is now considered as an immunologically different tissue causing an inflammatory process [9]. The inflammatory process causes loss of dental tissue [10].

### Bleaching agents

Currently, three bleaching agents are used: hydrogen peroxide, sodium perborate, and carbamide peroxide, in various concentrations and techniques, which can be enhanced by the use of lamps and heat [6]. The main techniques of bleaching for endodontically treated teeth are: WalkingBleach technique: hydrogen peroxide + sodium perborate, with weekly applications of bleaching paste, which can be associated with the use of heat; sodium perborate technique + water; technique of carbamide peroxide: preparation of a bleaching tray and daily application of the medication by the patient [13].

Greater preservation of dental structure and low cost when compared to more invasive procedures such

as total crown facets [11]. The procedure with a satisfactory aesthetic result in long-term [7]. Also, studies on toothpastes and mouthwashes that promise to bleach teeth are currently being conducted; however, the vast majority of studies show the results of abrasiveness in enamel and dentin. However, clinical evaluation of bleaching obtained by these products is rarely reported in the literature [16,19-21].

The color of teeth is changed due to the deposition of pigments arising from dietary sources such as tea, wine or acquired by habits, such as smoking. These stains are known as extrinsic stains, and abrasive agents may be useful to remove them. Another cause of dental discoloration are intrinsic stains, which may be caused by pulp bleeding or poorly conducted endodontic treatment [25,26].

The literature shows that in order to obtain dental bleaching oxidizing agents such as carbamide peroxide, hydrogen peroxide or sodium perborate are necessary [27]. Such agents act through oxido-reduction reaction, which decompose the pigments impregnated in the tooth structure [24]. The oxido-reduction reaction replaces the double bonds of chromogenic substances, making the compounds of low molecular weight colorless and providing the bleaching effect on the teeth [27]. For this reaction to occur, the oxidizing agents must have concentrations ranging between 3% and 40% (9). Some toothpastes mouthwashes and mouth may have such oxidizing agents, but their low concentration between 3% and 6%, has not been associated with the effectiveness of tooth whitening [25]. Therefore, the toothpastes used in these case reports, which commercially promise bleaching action, have no oxidizing agents, and should not be considered as products for teeth bleaching.

About 50% of toothpastes and mouthwashes commercially available on the market claim having bleaching features, but very few of them contain carbamide or hydrogen peroxide or any other type of bleaching agent and when these are present their concentration is low [26]. In this report, it can be observed that there was no clinical change in teeth coloration, which may suggest that there was only superficial removal of extrinsic stains using abrasive agents, which can provide the patient with a false feeling of bleaching [2,3].

Studies have proven that abrasive agents such as hydrated silica and sodium bicarbonate added to toothpastes can damage the tooth enamel. The toothpastes Colgate Luminous White (Colgate-Palmolive), Closeup Diamond Attraction (Unilever) and Oral-B 3D White (Procter & Gamble Manufacturing) used in this clinical case have hydrated silica in their composition [26,28].

Finally, mouthwashes are available to patients with variations in the concentration of carbamide or hydrogen peroxide, which can bleach the tooth structure, but with low maintenance of the bleaching effect because they are less concentrated. The hydrogen and carbamide peroxide can be harmful to the oral mucosa as reported in studies. It was not confirmed the presence of hydrogen or carbamide peroxide in the composition of mouthwashes used by the patients, therefore there are no bleaching substances [1-3].

## Conclusion

It was concluded that after analyzing and comparing the literature results obtained before and after the use of toothpastes and mouthwashes, it can be observed that the products did not promote teeth bleaching. Also, external root resorption in internal tooth whitening is one of the disadvantages of whitening; the etiology is unknown. External cervical resorption is the loss of hard tissue of the dental structure, such as cementum and dentin, resulting in an odontoclastic action, its onset usually occurring in the cervical region of the root surface, and is asymptomatic.

## CRedit

Author contributions: **Conceptualization; Formal Analysis; Investigation; Methodology; Project administration; Supervision; Writing - original draft and Writing-review & editing-** Bárbara Fagiani Soares, Paola Cândido Vernici, and José Augusto Pereira da Cruz.

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No additional data are available.

## Conflict of Interest

The authors declare no conflict of interest.

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It was applied by Ithenticate®.

## Application of Artificial Intelligence (AI)

Not applicable.

## Peer Review Process

It was performed.

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