



The Effectiveness of Different Clinical Methods of Application for In-office Bleaching Materials with Hydrogen Peroxide: A Systematic Review

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Authors' contributions

This work was carried out in collaboration among all authors. Author KA helped in conceptualization of study. Authors AAA and OAA managed the literature search and reviewed the manuscript. Author AZBM extracted the relevant data, reviewed and wrote. Author AAA reviewed wrote and prepared the final draft of the manuscript. Author MAA managed statistics application. All authors read and approved the final manuscript.

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ABSTRACT

Background: In the past few years, there has been an increase in demand for esthetic dental treatment. Vital tooth-bleaching is one of the most popular cosmetic procedures requested by patients in daily dental practice. There are various materials and protocols for treating discolored teeth since the introduction of vital tooth-bleaching to dental practice. In-office bleaching can be performed clinically using hydrogen peroxide alone or it can be combined with carbamide peroxide as a home bleaching technique. Hence the aim of this systematic review was to evaluate the

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effectiveness of different application protocols.

Methodology: A comprehensive search was performed using online databases (PubMed and ADA Center for Evidence-Based Dentistry) to obtain clinical trials relevant to the research question. The readers validated the studies that met the inclusion criteria. The included studies were evaluated using the risk of bias assessment instrument. In addition, the strength of recommendation of clinical trials was evaluated using Ex-GRADE.

Results: After reviewing 89 studies, duplicates were removed and inclusion and exclusion criteria were applied. Finally 10 clinical studies were accepted in this review. Acceptable sampling was performed to obtain the clinical trials with strong evidence.

Conclusion: A qualitative assessment for the included studies proved the hypothesis of the research in that the best clinical outcomes of in-office bleaching is achieved with a single application of hydrogen peroxide.

Keywords: Vital tooth bleaching; dental bleaching; light teeth bleaching; bleaching; whitening; carbamide peroxide; hydrogen peroxide.

1. INTRODUCTION

Non-invasive dental procedures are becoming more commonly requested by patients in daily dental practice. There has been an increase in demand for the esthetic dental procedures. Tooth whitening is an effective way for individuals to lighten the color of their teeth without affecting any part of the tooth surface. One of the most demanded procedures is the whitening or the bleaching of vital teeth [1]. The objective of bleaching is to treat discolored teeth and reach a clinical result of a lighter color of the teeth [2]. Teeth whitening is one of the most requested esthetic dental procedures by patients and, according to Carey et al. [3] when an individual follows the instructions, tooth whitening will show noticeable, safe, and effective results.

Vital bleaching of teeth was first used in the middle of 19th century where it was introduced using heat- and light-activated agents [4]. The first documentation of teeth bleaching procedures in modern dentistry was in 1848 with the use of chloride of lime. In 1864, a new effective procedure was documented using chlorine from a solution of calcium hydrochlorite and acetic acid. The aim of the procedure was to treat discolored non-vital teeth. Hydrogen peroxide was introduced in 1911 for vital tooth bleaching using a source of light or heated instruments [5].

A proper examination should be performed to carefully determine the cases most suitable for bleaching [2]. Several studies have recommended to have cases clinically evaluated by a dentist before starting an in-office bleaching in order to find out whether the procedure will

favor or affect them [6]. Hydrogen peroxide, sodium perborate, and carbamide peroxide are the most commonly used materials for vital bleaching today [7]. Hydrogen peroxide was found by many clinical studies to be an effective in-office bleaching technique where the oxygenating agents within this bleaching compound are absorbed by the enamel and dentin [8]. In-office bleaching can be performed clinically using 30% to 35% hydrogen peroxide alone or it can be combined with 10% to 15% carbamide peroxide as a home bleaching technique [4,8]. However, there are many other over-the-counter agents which contain lower concentrations of carbamide peroxide or hydrogen peroxide [5].

Vital tooth bleaching is indicated for cases diagnosed with intrinsic discoloration, trauma, or aging factors [4]. Aging is the most common reason for discoloration [5]. These cases might be treated by a combination of in-office bleaching and home bleaching [9]. Several studies have looked into the effect of using light curing in in-office bleaching [9]. A systematic review by Ajaj et al. concluded that after 1 week, there were no noticeable differences of whether a light cure was used or not [10].

The side effects found to be associated with vital bleaching may vary from patient to patient, ranging from mild discomfort to severe sensitivity and gingival irritation. Due to the high concentration of the materials used in bleaching, it is contraindicated for children and patients with exposed root surfaces. It has also been suggested to not use these materials for women during pregnancy [2].

The purpose of this comparative effectiveness review was to construct a consensus for in-office

vital tooth bleaching and to conclude the best materials and application protocols for achieving enhanced clinical outcomes.

2. MATERIALS AND METHODS

A comprehensive search was performed using two online databases during June and July of 2019. The search engines used for this study were PubMed and ADA Center for Evidence-Based Dentistry. The components of the research (PICO) question in this study are:

Population: Adult male and female patients with vital discolored permanent teeth.

Intervention: 30-40% of hydrogen peroxide (single application for 40 minutes).

Comparator: Alternative materials and protocol of application.

Outcome: The change in tooth color and reduction of discoloration.

Timing: One week of follow-up.

Setting: Dental clinic.

The search engines were refined for relevant articles based on the following inclusion criteria:

- Clinical trials
- Adult patients
- Permanent teeth only
- Only sound teeth with discoloration
- Papers in English
- One week of follow-up

The exclusion criteria were:

- Systematic reviews and observational studies
- Studies on primary teeth
- Clinical trials with participants under 18 years old
- In vitro studies
- Less than one week follow-up evaluation

Five readers were standardized to evaluate the articles for risk of bias and strength of recommendation. The process was accomplished using the revised risk of bias instrument [11] and the Ex-GRADE [12]. The standardization method was performed on a pilot clinical trial.

3. RESULTS

The initial search result was 102 studies obtained from the two different databases. After duplicate removals and applying the inclusion/exclusion criteria, thirty-five studies were screened and the total number of studies that matched the PICOTS question was 10, as shown in Fig. 1.

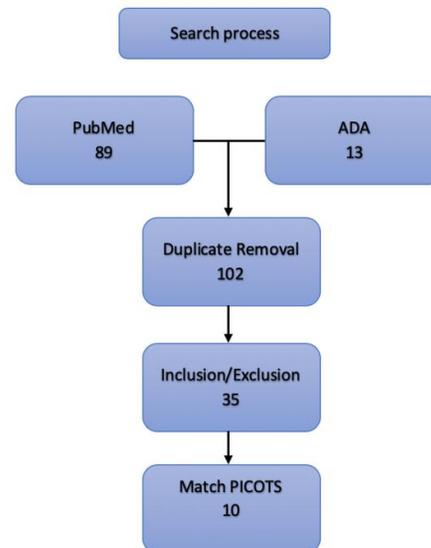


Fig. 1. The Flowchart for the search process

The ten studies were then evaluated for quality of the evidence and strength of recommendation, and an average score was calculated by all the readers (Table 1). Of all the included studies a high-quality and no risk of bias clinical trials were emphasized.

- a) High-concentration carbamide peroxide can reduce the sensitivity caused by in-office tooth bleaching: a single-blinded randomized controlled trial [13].
- b) Tooth bleaching with hydrogen peroxide and nano-hydroxyapatite: a 9-month follow-up randomized clinical trial [14].
- c) Evaluation of several clinical parameters after bleaching with hydrogen peroxide at different concentrations: A randomized clinical trial [15].
- d) Clinical Comparative Study of the Effectiveness of and Tooth Sensitivity to 10% and 20% Carbamide Peroxide Home-use and 35% and 38% Hydrogen Peroxide In-office Bleaching Materials Containing Desensitizing Agents [16].

Table 1. Ten studies were evaluated for quality of the evidence and strength of recommendation, and an average score was calculated by all the readers

No	Author	Title	Score
1	Peixoto, A.C. et al. 2018	High-concentration carbamide peroxide can reduce the sensitivity caused by in-office tooth bleaching: a single-blinded randomized controlled trial.	34.6
2	Martins, I. et al. 2018	Effectiveness of In-office Hydrogen Peroxide with Two Different Protocols: A Two-center Randomized Clinical Trial.	33.6
3	Angel, P. et al. 2018	Color stability, psychosocial impact, and effect on self-perception of esthetics of tooth whitening using low-concentration (6%) hydrogen peroxide.	28.8
4	Lima, S.N.L. et al. 2017	Evaluation of several clinical parameters after bleaching with hydrogen peroxide at different concentrations: A randomized clinical trial.	34.4
5	Vildósola, P. et al. 2017	Comparison of Effectiveness and Sensitivity Using Two In-Office Bleaching Protocols for a 6% Hydrogen Peroxide Gel in a Randomized Clinical Trial.	31.4
6	Fernández, E. et al. 2017	Longevity, Esthetic Perception, and Psychosocial Impact of Teeth Bleaching by Low (6%) Hydrogen Peroxide Concentration for In-office Treatment: A Randomized Clinical Trial.	30.4
7	Rezende, M. et al. 2016	Combined Bleaching Technique Using Low and High Hydrogen Peroxide In-Office Bleaching Gel.	33.2
8	Martín, J. et al. 2015	Effectiveness of 6% hydrogen peroxide concentration for tooth bleaching—A double-blind, randomized clinical trial.	33
9	Vano, M. et al. 2015	Tooth bleaching with hydrogen peroxide and nano-hydroxyapatite: a 9-month follow-up randomized clinical trial.	33.6
10	Basting, R.T. et al. 2012	Clinical comparative study of the effectiveness of and tooth sensitivity to 10% and 20% carbamide peroxide home-use and 35% and 38% hydrogen peroxide in-office bleaching materials containing desensitizing agents.	34

e) Effectiveness of In-office Hydrogen Peroxide With Two Different Protocols: A Two-center Randomized Clinical Trial [17].

4. DISCUSSION

A qualitative analysis was performed for the included clinical trial papers. The data was extracted from all five studies and summarized in a table for further assessment. Interpretation of the results focused on the protocol of application and outcome measurements.

i. **Peixoto, A.C. et al. [13]**

40 patients participated in this clinical trial. The patients were divided into two groups and both received two sessions of in-office bleaching. One group received 35% hydrogen peroxide and the other group was treated with 37% carbamide peroxide. The results showed better clinical outcomes for color-changing with 35% hydrogen peroxide. The group that received carbamide peroxide reported less sensitivity.

ii. **Vano, M. et al. [14]**

The study was conducted to compare the application of 6% hydrogen peroxide with or without 2% nanohydroxyapatite. 60 patients were enrolled in this study and the assessment of color changes was measured with Vita classic shade guide. The color changes showed no differences between the two groups but reduction of sensitivity was significant with the use of nano-hydroxyapatite.

iii. **Lima, S.N.L. et al. [15]**

This clinical trial was conducted on 25 volunteers with teeth darker than shade A3. The volunteers were assigned to two groups: one group received 15% hydrogen peroxide and the other one received 35% Hp. Vita Easy shades spectrophotometer was used for the assessment of color change. The study showed that the higher concentration had better whitening of the teeth but increased risk of post-operative sensitivity.

iv. **Basting, R.T. et al.[16]**

Participants were enrolled in this clinical trial to compare in-office bleaching to home bleaching: "25 volunteers for 20% carbamide peroxide, 24 volunteers for 10% carbamide peroxide, 24 volunteers for 35% hydrogen peroxide, and 21 volunteers for 38% hydrogen peroxide." The results showed that all the techniques showed similar effectiveness of bleaching but the group that received 20% carbamide peroxide showed a higher prevalence of sensitivity.

v. **Martins, I. et al. [17]**

This is a multicenter clinical trial with a total of 129 patients examined and 44 of them were enrolled in the study. Color evaluation was performed using spectrophotometer and Vita classic shade guide. Moreover, they evaluated teeth sensitivity using a visual analog scale. The study concluded that a single 40-minute in-office bleaching agent had similar results and similar teeth sensitivity levels as two 20-minute applications.

vi. **Bianca Medeiros Maran et al. [18]**

There were few Randomized controlled trials done (5 in number) that compared the low/medium vs. high concentrate Hydrogen Peroxide. Low and medium hydrogen peroxide concentrate products for in-office bleaching were found to have a reduced risk and intensity of bleaching sensitivity than high concentration hydrogen peroxide, with no difference in color change performance.

vii. **Marta Peydro-Herrero et al. [19]**

The 40 patients in this clinical research were separated into four groups based on the concentration of the hydrogen peroxide-based (HP) product utilized. Regardless of the bleaching substance used, a single in-office whitening session efficiently changes tooth color. For moderate and severe dental discoloration, in-office whitening with high concentration hydrogen-peroxide-based solutions was proven to be a successful treatment.

viii. **Vicente Faus-Matoses et al. [20]**

The goal of this study was to verify that teeth treated with combination bleaching will whiten more than teeth treated with clinical bleaching, as well as to assess the efficacy of clinical treatment in circumstances when the home phase is not possible or desired. 66 removed anterior human teeth were used in the investigation, which were split into two groups. On the one hand, the clinical group (CIG) included 33 teeth that were treated according to a clinical guideline with 37.5 percent hydrogen peroxide in a single session of four 8-minute treatments. The combine group (CoG), on the other hand, consisted of 33 teeth that were treated with a combined guideline, apex locator, and apex locator. The color of the tooth was measured before and after each treatment using a spectrophotometer and a customized whitening splint. The authors concluded that the combined therapy bleached the teeth more than the clinical therapy, yet both were effective. Furthermore, it is said that the clinical phase may be used as an alternative in circumstances where the home phase is not feasible or desired.

5. CONCLUSION

Qualitative analysis of this research confirmed the hypothesis that the best clinical outcomes of in-office bleaching can be achieved with 30-40% hydrogen peroxide. The inconsistency of study designs did not allow the performance of a meta-analysis and statistical interpretation. It was also determined that an increase in the percentage of hydrogen peroxide was associated with increased risk of post-operative sensitivity.

RESEARCH RECOMMENDATIONS

More clinical trials are needed for the assessment of in-office bleaching application protocols and materials concentration. There is a need to investigate if the use of home trays with 10% carbamide peroxide in addition to the in-office bleaching with hydrogen peroxide can reduce the sensitivity and improve the clinical outcomes.

CLINICAL RECOMMENDATIONS

Comprehensive clinical examinations and assessments of each individual case must be performed prior to selecting the type of vital bleaching and the concentration of the material. Alternative protocols to in-office bleaching with 30-40% of hydrogen peroxide might be more suitable for patients who show signs of teeth sensitivity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Ethical approval for the current study was obtained from the research center at Riyadh Elm University (RC/IRB/2019/149).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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