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Literature Review

Effect of Bleaching Gel Concentration on Tooth Color and Sensitivity: A Systematic Review and Meta-analysis

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Clinical Relevance

The use of low-concentration bleaching gels will promote in the patient a favorable whitening effect compared to high concentrations while at the same time being responsible for a lower dental sensitivity, promoting patient comfort.

SUMMARY

Objective: The aim of this systematic review and meta-analysis was to evaluate a high concentration of hydrogen peroxide (35%) regarding tooth sensitivity and color change in tooth bleaching in comparison to low concentrations (6% to 20%).

Methods and Materials: This review was conducted using the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and is registered on the Prospective Register of Systematic Reviews (CRD42017064493). The PICO question was "Does a concentration of hydrogen peroxide ≥35% using in-office bleaching procedure contribute to greater tooth sensitivity?" A search was made in PubMed/MEDLINE, Scopus, and the Cochrane Library.

Results: Fourteen studies were selected for the qualitative analysis and seven for quantitative analysis. A total of 649 patients were evaluated (mean age: 36.32 years; range: 13.9 to 31 years),

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and the follow-up period ranged from one week to 12 months. The meta-analysis demonstrated that tooth sensitivity was higher in the patients submitted to treatment involving a high concentration of hydrogen peroxide (0.67; 95% confidence interval [CI]: 0.44 to 1.03; p=0.04; I^2: 56%), and a significant difference was found regarding objective color ΔE (1.53; 95% CI: 2.99 to 0.08; p<0.0001; I^2: 82%) but no significant difference was found regarding subjective color ΔSGU (0.24; CI: 0.75 to 1.23; p<0.00001; I^2: 89%).

Conclusions: This study indicated that a lower concentration of hydrogen peroxide causes less tooth sensitivity and better effectiveness in objective color change (ΔE); however, there is no difference between them related to subjective color (ΔSGU).

INTRODUCTION

In-office bleaching is a treatment that offers excellent color stability; moreover, since the procedure is under the control of a dental surgeon, there is less risk of exposure to soft tissue.[1] Hydrogen peroxide (HP) is used in this treatment as a dental oxidizing agent, resulting in effective color change.[2] However, the concentration of HP and the duration of its application can influence its absorption into dental tissues, causing tooth sensitivity.[3]

High concentrations of HP promote evident color change at the first application session.[4,5] The mechanism of bleaching can generate a greater number of by-products capable of causing cell stress, clinically reflected as sensitivity.[6-9] Moreover, the clinical protocols for these products require, on average, 30 to 50 minutes of contact of the bleaching gel with the tooth for each clinical session.[10-12]

To maintain efficacy in color as well as alleviate sensitivity, bleaching gels with lower concentrations of HP[13] are used for in-office bleaching. However, low concentrations may require a greater number of sessions to achieve effective bleaching.[14] The efficacy of low-concentration bleaching gels is also affected by the addition of a semiconductor agent. Nanoparticles of titanium dioxide doped with nitrogen have been introduced with the aim of enhancing safety, providing less damage to the dental structure and tooth sensitivity.[14-16]

Considering the variety of products available on the market, it is challenging for dentists to identify a bleaching gel that is efficient and does not cause discomfort or sensitivity to patients.[17,18] Therefore, the aim of the present study was to conduct a systematic review of the literature to evaluate whether high concentrations of HP (≥35%) used in an in-office bleaching procedure can influence tooth sensitivity and color change in comparison to low concentrations (6%, 15%, and 20%). The first and second null hypotheses, in relation to tooth sensitivity and change in tooth color, respectively, were that there is no difference between high concentrations (≥35%) and lower concentrations (6%, 15%, and 20%) of HP.

METHODS AND MATERIALS

Registry of Protocol

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses[19] as well as some systematic reviews of the literature.[20,21] The review is also registered with the Prospective Register of Systematic Reviews (CRD42017064493).

Eligibility Criteria

Studies considered eligible for the present review needed to meet the following criteria: 1) randomized clinical trials, 2) prospective studies, 3) in-office bleaching protocol, and 4) studies published in English. The exclusion criteria were 1) retrospective studies, 2) clinical cases, 3) case series, 4) *in vitro* studies, and 5) *in vivo* (animal) studies.

The guiding question was "Does a concentration of hydrogen peroxide ≥35% using an in-office bleaching procedure contribute to greater tooth sensitivity?" The PICO question was employed: Population: individuals submitted to in-office bleaching; Intervention: the use of ≥35% hydrogen peroxide bleaching gel; Comparison: use of <35% hydrogen peroxide bleaching gel; and Outcomes: tooth sensitivity (primary outcome) and color change (secondary outcome).

Search Strategy

The selection of studies was performed by two independent researchers (MMAP and JMLG), with the involvement of a third researcher to resolve cases of a divergence of opinion between the first two. Electronic searches were performed in the PubMed/MEDLINE, Scopus, and Cochrane Library databases for articles published up to September 2017 based on the eligibility criteria. The key words were *tooth bleaching and in office OR tooth bleaching and hydrogen peroxide and concentration OR dental bleaching and in office OR dental bleaching and hydrogen peroxide and concentration OR tooth*

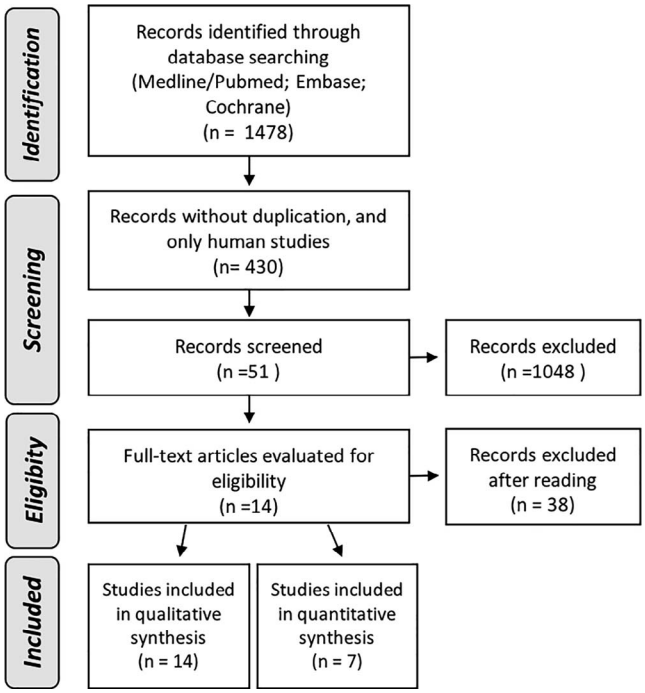

Figure 1. *Flowchart.*

whitening and in office OR tooth whitening and hydrogen peroxide and concentration OR dental whitening and in office OR dental whitening and hydrogen peroxide and concentration. A hand search was also performed in periodicals of major impact in the fields of dentistry and dental materials: *Journal of Dentistry*, *Operative Dentistry*, *Materials Science*, *Journal of Esthetic and Restorative Dentistry*, *Journal of Prosthetic Dentistry*, *American Journal of Dentistry*, *Journal of Dental Research and Dental Materials*.

Summary Measures

One researcher (MMAP) collected the relevant data from the articles, which were checked by two other researchers (BCEV and SLDM). The meta-analysis was based on the inverse variance and Mantel-Haenszel methods. Tooth sensitivity (absolute risk of tooth sensitivity) related to the dichotomous outcomes evaluated using the odds ratio, while subjective (ΔSGU) and objective (ΔE) color changes were considered the continuous outcome and evaluated using mean difference evaluated by inverse variance with a 95% confidence interval (CI). The odds ratio and mean difference values were considered significant when $p < 0.05$. In case of statistical significance ($p<0.10$) for heterogeneity, a random-effects model was used to assess the significance of treatment effects. Where no statistically significant heterogeneity was found, analysis was performed using a fixed-effects model.[22,23] The software Reviewer Manager 5 (Cochrane Group) was used for the meta-analyses.

The kappa statistic was calculated for the determination of the level of agreement between the researchers (MMAP and JMLG) regarding the selection of the studies from the PubMed/MEDLINE, Scopus, and Cochrane Library databases.

Risk of Bias

Two researchers (CAAL and RSL) performed the analysis of the risk of bias using the Cochrane scale for the appraisal of the methodological quality of the randomized clinical trials selected for the present systematic review and meta-analysis.

RESULTS

The search of the databases led to the retrieval of 1478 articles: 722 in Scopus, 597 in PubMed/MEDLINE, and 159 in the Cochrane Library. After the removal of duplicate references, the titles and abstracts of the articles were analyzed regarding the eligibility criteria, and 51 articles were preselected for the reading of the full texts. After the full-text analysis, 14 studies were selected for the qualitative analysis,[2,12-15,24-32] and seven of these were selected for the quantitative analysis[12-15,27,29,31] (Figure 1).

Study Characteristics

Design of the Studies—Table 1 lists the characteristics of the studies. Fourteen randomized controlled trials were selected; four of these studies used a split-mouth design.[14,24,25,31] A total of 649 patients were submitted to bleaching treatment (mean age: 36.32 years; range: 13.9 to 31 years). The most common patient's inclusion criteria in the studies were being caries free,[2,12,15] good oral hygiene,[2,26] absence of periodontal disease,[2] absence of anterior teeth restorations,[12-15,26,28,32] and teeth without bleaching experience.[18,22,26,28,29,31] Three[14,26,31] reported loss of the patient during the follow-ups; this means that 15% of the patients in the included studies dropped out.

The most common patient exclusion criteria in the studies were systemic diseases,[2,26,32] change in tooth structure,[2] smoking,[2] bruxism,[2,12,28] presence of dental sensitivity,[2] poor oral hygiene,[2,12] presence of fluorosis or tetracycline stains,[12-15,28,29,31,32] use of orthodontic treatment,[2,13-15,26,31] taking analgesic or anti-inflammatory drugs,[13,14,31] and pregnancy or breast-feeding.[2,12-15,25,26,32] The follow-up period

Table 1: *Characteristics of the Studies Included*

Reference	Type of Study	Study Design (n per Group)	Patients (n)/ Dropouts (n)	Mean Age (y)	Follow-Up
Bacaksiz and others[2]	RCT	G1: 25% HP with UV light (n=14) G2: 36% HP with LED light (n=14)	28/3	13.9	12 mo
Bezerra Dias and others[24]	RCT	G1: 35% HP (n=3) G2: 6% HP/N-doped TiO_2 (n=3)	6/0	31	1 wk
Bortolatto and others[15]	RCT	G1: 15% HP+TiO_N (n=20) G2: 35% H_2O_2 (n=20)	40/15	G1: 20.7 G2: 21.5	3 wk
Bortolatto and others[13]	RCT	G1: 6% HP+TiO_N (n=24) G2: 35% H_2O_2 (n=24)	48/0	G1: 24.3 G2: 24.0	2 wk
Fernandez and others[25]	RCT (split-mouth)	G1: 6% HP+TiO_N (n=32) G2: 35% HP (n=32)	32/5	24.1	9 mo
Martín and others[26]	RCT	G1: 15%HP+TiO_2+light (n=25) G2: 35% HP+light (n=27) G3: 35% HP (n=36)	88/46	23.03	1 mo
Martín and others[14]	RCT (split-mouth)	G1: 35% HP G2: 6% HP+TiO_N (split-mouth; n=30)	31/1	24.5	1 mo
Martín and others[26]	RCT	G1: 15% H_2O_2 N_TiO2 G2: 35% H_2O_2	70	23.6	1 mo
Mena-Serrano and others[27]	RCT	G1: 20% HP+LED light (n=19) G2: 20% HP (n=19) G3: 35% HP+LED light (n=20) G4: 35% HP (n=19)	77/0	G1: 22.9 G2: 22.0 G3: 23.0 G4: 22.0	1 mo
Moncada and others[28]	RCT	G1: 15% HP+TiO_N+light (n=25) G2: 35% HP+light (n=27) G3: 35% HP (n=35)	87	23.15	1 wk
Reis and others[12]	RCT	G1: 35% HP (n=30) G2: 20% HP (n=30)	60	G1: 29 G2: 25.0	2 wk
Rezende and others[29]	RCT	G1: 20% HP (n=15) G2: 35% HP (n=15) G3: 10% HP (at-home bleaching)	30	G1: 25.9 G2: 24.0	12 mo
Gallagher and others[30]	RCT	G1: 25% HP (n=20) G2: 38% HP (n=20)	21/1	≥18 y	1 wk
Vildsóla and others[31]	RCT (split -mouth)	G1: 6% HP (n=31) G2: 35% HP (n=31)	31/3	24.7 y	12 mo

Abbreviations: ΔE, objective color; ΔSGU, subjective color; RCT, randomized controlled trial; G1, group 1; G2, group 2; G3, group 3; G4, group 4; hydrogen peroxide; N.R., nonreported; TiO_2, titanium dioxide; VAS, visual analog scale; TiO_N, nitrogen-doped titanium dioxide; ARR, absolute risk rate. P1: patient 1; P2: patient 2; P3: patient 3.

ranged from one week to 12 months. The studies compared a higher concentration of HP (35%) to lower concentrations (6% to 20%). Two studies[2,30] performed a comparison of high-concentration HP bleaching gels.

Bleaching Protocol—In-office bleaching was performed in all included studies.[12,13,15,25,26,28,29,31] The bleaching protocol varied according to the concentration of the bleaching gel, and all bleaching protocols are described in Table 1. Some studies mentioned the use of gingival isolation[2,13-15,28] and lip retractor[2,29] and previous prophylaxis before the treatment.[13-15,24,26,27,29,33] The whitening gel was applied on the vestibular surface of the teeth (1 to 2 mm thick) or according to the manufacturer's instructions.[13,15,24] Also, other studies used the LED light associated with two low-level lasers at red (660 nm) or infrared (780 nm) wavelengths,[24] laser of low intensity (808 nm/infrared light),[18] LED light (470 nm),[13,26-28] LED/laser hybrid cold-light,[13,14,31] or infrared laser diodes (830 nm).[26] Only two studies[2,12,30,32] did not report the use of light.

Table 1: *Characteristics of the Studies Included (ext.)*

Reference	In-Office Bleaching Protocol	Outcomes		
		Color Change, ΔE±SD (Spectrophotometer)	Color Change, ΔSGU (Shade Guide Units)	Tooth Sensitivity
Bacaksiz and others[2]	G1: 3×15 min single visit+UV light G2: 3×15 min single visit+LED light	G1: 10.9±4.04 G2: 15.1±2.73	N.R.	Five-Step Scale events: G1: 3; G2: 3
Bezerra Dias and others[24]	G1: 2×12 min in the same session G2: 3×12 min in the same session	G1: P_1: 6.7; P_2: 6.1; P_3: 6.6 G2: P_1: 7.1; P_2: 5.7; P_3: 3.6	G1: $P_{1\text{-}2}$: 0.8; P_3: 1.0 G2: $P_{1:\ 1.5}$; P_2: 0.8; P_3: 4.5	VAS
Bortolatto and others[15]	G1: 3×16 min in three sessions and LED four times/arch per session G2: 3×15 min in three sessions	G1: 8.92±2.36 G2: 6.66±2.73	N.R.	VAS ARR: 52%
Bortolatto and others[13]	G1/G2: 2×12 min in two sessions +LED/laser light (1 min)	G1: 3.03±1.36 G2: 4.96±2.36	N.R.	Verbal scale ARR: 33.4%
Fernandez and others[25]	G1: 2×12 min+LED light in the same session G2: 2×12 min+LED light in the same session	G1: 5.14±3.49 G2: 7.81±2.32	G1: 6.81±2.22 G2: 6.93±2.25	N.R.
Martín and others[26]	G1: 3×15 min+LED light G2: 3×10 min+LED light G3: 1×45 min All groups were treated in the same session	N.R.	N.R.	VAS
Martín and others[14]	G1/G2: 2×12 min+LED laser hybrid light in three sessions	G1: 7.98±2.45 G2: 5.57±3.71	G1: 5.03±2.30 G2: 4.83±2.28	VAS ARR: G1: 36%; G2: 50%
Martín and others[26]	G1: 3×15 min in one session of 45 min G2: 3×12 min one session of 36 min	N.R.	N.R.	VAS
Mena-Serrano and others[27]	G1/G3: 3×15 min in two sessions G2/G4: 3×15 min in two sessions+LED light	G1: 13.2 ±4.1 G2: 11.8±4.0 G3: 12.4±3.7 G4: 14.1±2.9	G1: 6.1±2.6 G2: 8.2±1.3 G3: 8.2±2.5 G4: 8.4±1.4	Five-Point Verbal Scale and VAS ARR: G1: 63%; G2: 73%; G3: 80%; G4: 85%
Moncada and others[28]	G1: 3×15 min per session+30 s light G2: 3×10 min per session+light G3: 3×15 min per session	N.R.	N.R.	VAS
Reis and others[12]	G1: 1×40 min per session G2: 1×50 min per session	N.R.	G1: 1.6±0.7 G2: 3.5±1.0	Five-Point Verbal Scale ARR: G1: 26.7%; G2: 16.7%
Rezende and others[29]	G1: 1×50 min per session G2:1×40 min per session G3: 1×120 min per session (at-home bleaching)	N.R.	G1: 3.1±1.0 G2: 3.2±1.0	Five-Point Verbal Scale Events: G1: 7—ARR: 85% G2: 17—ARR: 47%
Gallagher and others[30]	G1/G2: 3× in one session	G1: 3.23±2.22 G2: 1.46±0.53	N.R.	Questionnaire: 0 to 3 (not sensitive to severely sensitive) Events: 10 (G1 and G2)
Vildsóla and others[31]	G1/G2: 3×12 min per session+LED laser hybrid light in three sessions	G1: 5.1±3.7 G2: 7.3±2.6	G1: 6.8±2.2 G2: 6.9±2.3	N.R.

The bleaching agent at the end was removed with gauze, suction, and/or water.[2] Desensitizing agent was used after the bleaching session in the studies.[2] The patients were instructed to avoid acids and food dyes[2,14,25] and the use of whitening agents.[31]

Tooth-Sensitivity Evaluation—The visual analog scale was used to measure tooth sensitivity.[14,15,24,26,28,29] The degree of tooth sensitivity was measured from 0 to 10, where 0 represents a total absence of pain, 5 moderate pain, and 10 the maximum level of pain.[24] Other measures were also used, such as the Five-Step Scale, which was applied after the bleaching, and the scores were measured with the following criteria: 0: none; 1: mild; 2: moderate; 3: considerable; 4: severe.[2,27] The Five-Point Verbal Scale[12,13,27,29] and a sensitivity questionnaire[30] were used, where four levels were considered: none, mild, moderate, or severe. Tooth sensitivity was evaluated before bleaching and after bleaching and at 24 hours, 48 hours, 72 hours, and one week, according to each study's follow-up. Also, some studies[12-15,27,29] described the absolute risk rate and the number needed to treat.

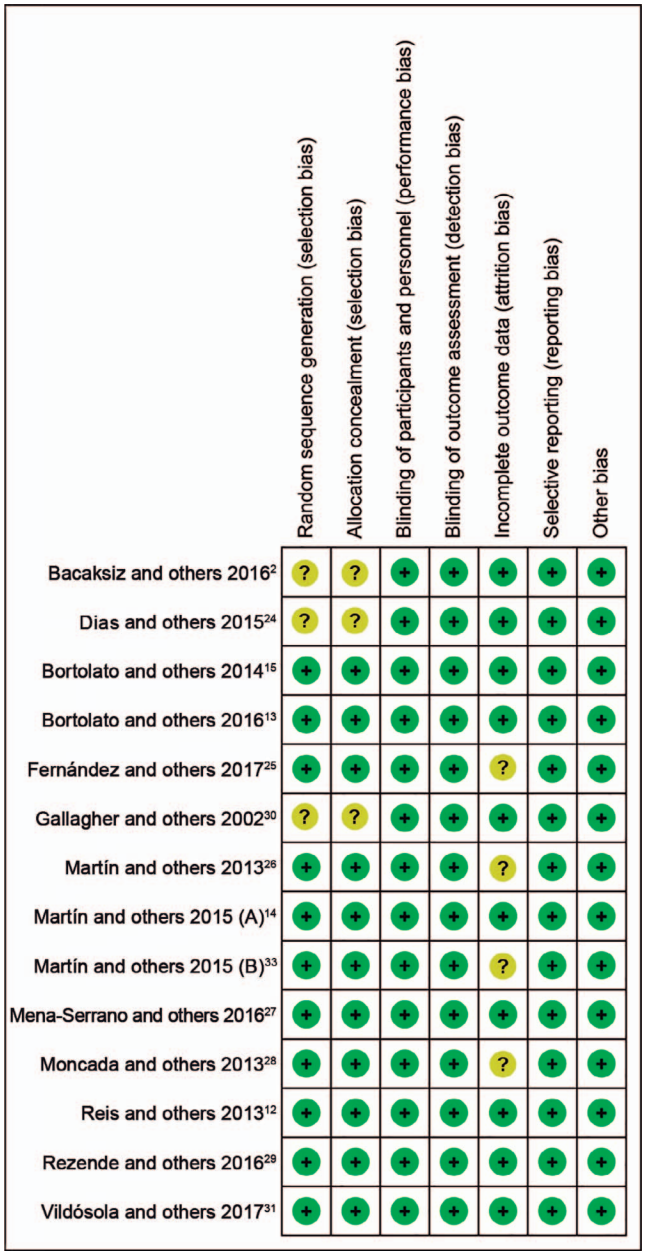

Figure 2. *Analysis of risk of bias, Cochrane scale.*

Color Evaluation—The subjective color analysis was based on shade guide units (ΔSGU), and the analysis was made from the color shade scale in some of the included studies.[12,24,25,27,29] Color was also evaluated in seven studies using an objective color analysis (ΔE) from a spectrophotometer[2,13-15,25,27,30] either by the confection of transparent soft trays with standardized markings[2] or without them in the middle third of the labial surface[24] or by a guide made with high-viscosity silicone putty[13,31] in the periods before bleaching and after bleaching and at 24 hours, 48 hours, 72 hours, one week, one month, six months, and 12 months, according to each study's follow-up. Objective color differences were calculated from the equation $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

Risk of Bias—All studies were qualified using the Cochrane Collaboration's tool for the risk of bias (Figure 2) and showed low risk of bias. Some studies were classified as "unclear" for the following items: sequence generation and allocation concealment;[2,24,30] blinding of participants, personnel, and outcome assessor;[24] and incomplete outcome data.[25,26,28]

Meta-Analysis

Tooth Sensitivity—Six studies[12-15,27,29,31] were selected for the quantitative analysis of the concentrations of bleaching gel divided into two groups: lower concentration of HP (6% to 20%) and higher concentration (35%). A significant difference between groups was found, indicating less tooth sensitivity when a lower concentration of HP (6% to 20%) was used (0.67; 95% CI: 0.44 to 1.03; $p=0.04$; I^2: 56%) (Figure 3).

Color Change (ΔE)—About the color change, some studies[13-15,25,27,31] found a significant difference between a high concentration of HP (35%) and a low concentration (6% to 20%) (1.53; 95% CI: 2.99 to −0.08; $p<0.0001$; I^2: 82%) (Figure 4).

Color Change (ΔSGU)—Some studies[12,14,25,27,29,31] performed a subjective evaluation of the change in color, but no significant difference was found between a low concentration (6% to 20%) and a high concentration of HP (35%) (0.24; CI: −0.75 to 1.23, $p<0.00001$; I^2: 89%) (Figure 5).

DISCUSSION

The first null hypothesis, that there is no difference with regard to tooth sensitivity between a high concentration of HP (35%)[34-36] and lower concentrations (6%, 15%, and 20%),[34-36] was rejected. This was because a meta-analysis revealed a significant difference (0.38; 95% CI: 0.16 to 0.92, $p=0.04$; I^2: 56%), revealing less tooth sensitivity for a lower concentration of HP. This agrees with the findings of Moncada and others[28] and other studies[18,26,37] reporting greater tooth sensitivity when high concentrations of HP were used. The major number of dropouts were between the first and second bleaching sections. This is in accordance with the literature[13,25,28] reporting a high level of sensitivity in the early sections.

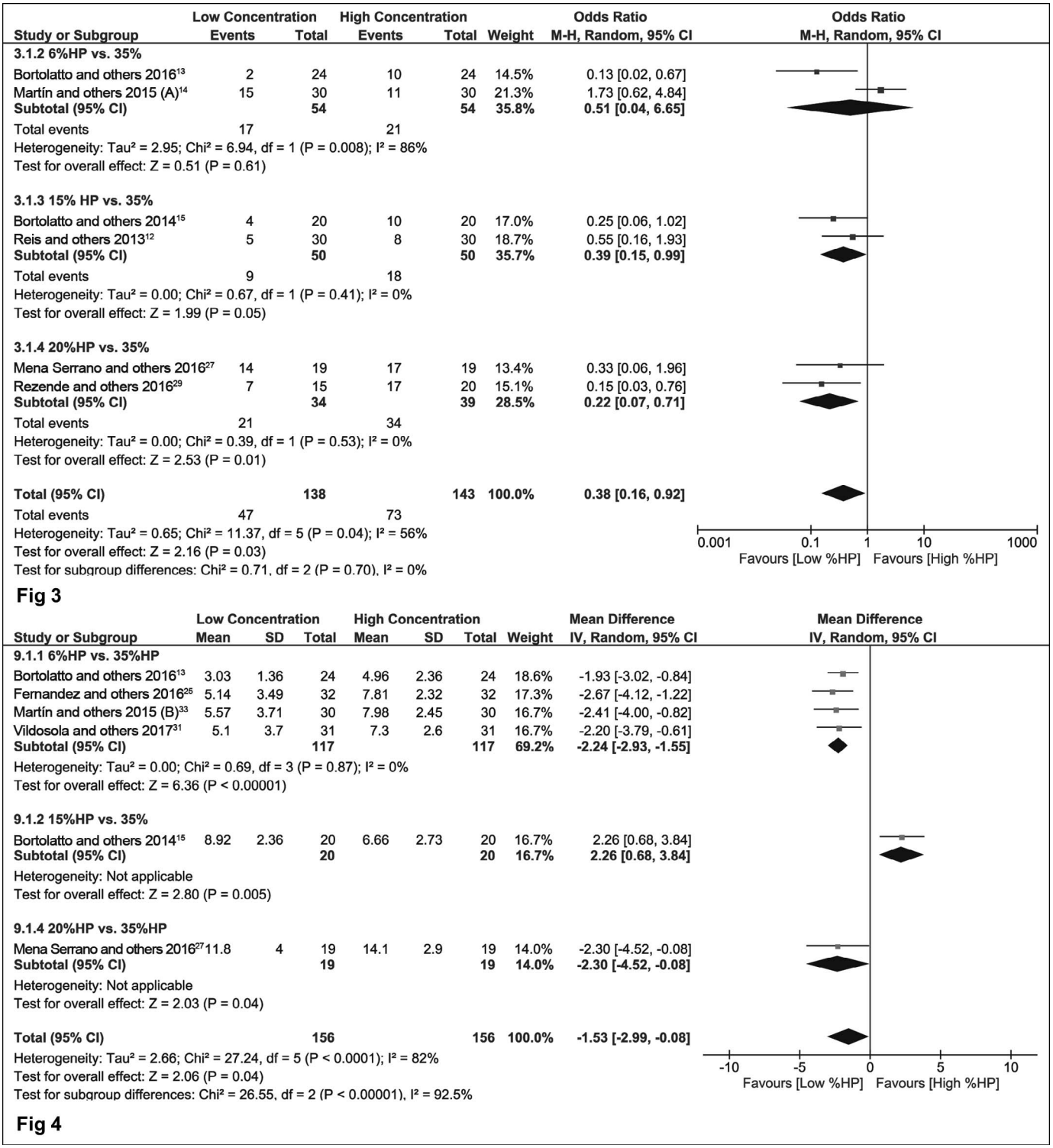

Fig 3

Fig 4

Figure 3. *Outcome: tooth sensitivity (high concentration of HP [35%] vs low concentration of HP [6% to 20%]). M-H, Mantel-Haenszel R.E., random effect.*

Figure 4. *Outcome: color change ΔE (high concentration of HP [35%] vs low concentration of HP [6% to 20%]). IV, inverse variance; R.E., random effect.*

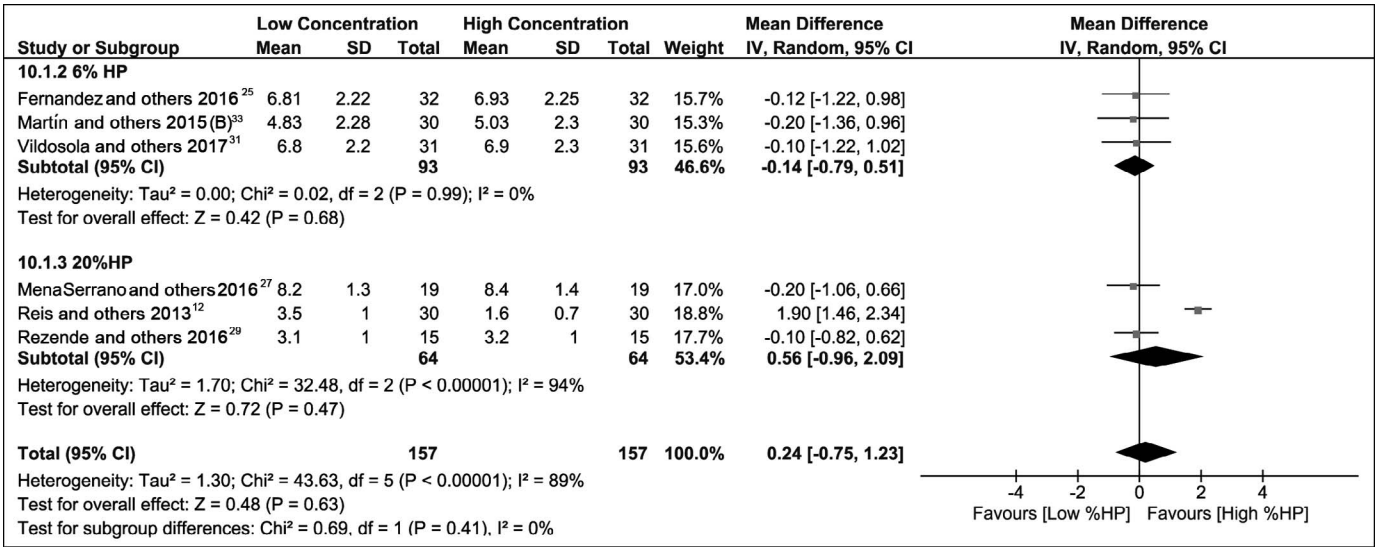

Figure 5. *Outcome: color change ΔSGU (high concentration of HP [35%] vs low concentration of HP [6% to 20%]). IV, inverse variance; R.E., random effect.*

It was not possible to carry out meta-analyses for all studies that were selected for the present systematic review due to a lack of data in some articles. In the evaluation of tooth sensitivity stemming from bleaching sessions, a reduction in sensitivity was reported one week after the procedure. This agrees with the findings of Mondelli and others,[11] who evaluated the effects of high concentrations of HP (35% and 38%) and found that sensitivity increased immediately after treatment and then diminished gradually over the course of a week.

According to Matis and others,[32] tooth sensitivity is related to the contact time of the bleaching gel and not the concentration of HP. In the analysis of bleaching gel application among the studies selected for the present systematic review, either the protocol was found to be the same for low or higher concentrations tested[13,14,25-28] or application was performed with low-concentration gels over a longer period (contact time and/or number of sessions).[15,24,29] This indicates that a longer application time does not exert an influence on tooth sensitivity but enables a low-concentration bleaching gel to perform as effectively as a high-concentration bleaching gel.[13]

The sensitivity caused by low-concentration gel (15%) is lower than that found with high-concentration (35%) gel; this may be related to the association between HP and nitrogen-doped titanium dioxide semiconductor nanoparticles (N_TiO_2). In the presence of visible light, this enables the formation of O_2 without hydroxyl (OH^-) radicals, which are a risk factor in tooth bleaching procedures. Therefore, lower-concentration gels are reported as a less irritating but equally effective tooth bleaching option.[26] However, in the subgroup analysis, when comparing a 6% HP concentration with a 35% HP concentration, there is no difference between them, even with the 6% HP concentration having the N_TiO_2, and it may be related to the use of LED/laser hybrid light in high concentrations (35%), which is reported[33] as an important factor to provide less tooth sensitivity.

In the present systematic review, meta-analysis was performed for both objective color change (ΔE) (−1.53; 95% CI: −2.99 to −0.08; $p<0.0001$, I^2: 82%) and subjective color change (ΔSGU) (0.24; 95% CI: −0.75 to 1.23; $p<0.00001$; I^2: 89%). A statistically significant difference in ΔE was found; however, there was no significant difference for ΔSGU. Hence, the second null hypothesis, which affirms that there is no difference in terms of the change in tooth color between a high concentration of HP (35%)[34-36] and lower concentrations (6% to 20%),[34-36] was partially accepted.

The results used in the meta-analysis to analyze ΔE were acquired from those for the longer follow-up period reported in each study. Researchers[14,38] believe that there is color maintenance after a longer period following bleaching, indicating that the peroxide diffuses through the tissues of the tooth and remains there.[14] Even TiO_2, when used as a catalyst at lower HP concentrations associated with

LED light, presents strong evidence of color rebound.[16,31] These results indicate that color was maintained when lower concentrations of HP were used, in comparison to previous controls (ΔE), for up to one year of follow-up.[2,14,25] Some authors[14,25] also reported that the bleaching protocol is important for color change and maintenance.[14,39,40] A protocol with 120 minutes of contact time would be ideal for complete effectiveness of a bleaching gel with a 6% concentration of HP.[41] However, the time reported in the studies cited was lower yet still presented better results.

Mena-Serrano and others[27] obtained good results by using a 20% concentration of HP with regard to ΔSGU, in comparison to that achieved with 35% HP, but found no difference when color was evaluated using a spectrophotometer (ΔE). This result was obtained in the first 30 days after the bleaching procedure and may be related to the combined use of 35% HP and light. Since 35% HP alone produces radicals in excess, light would not lead to faster bleaching due to the oxidation mechanism of the radicals.[27] Moreover, in the studies with a split-mouth design, the optical effect of the incisors exerted an influence on ΔSGU. The subjective analysis of color depends on physical and environmental variables,[28] which can lead to inconsistencies in the measurement of color. Some researchers,[40,41] when evaluating the color change by people who were not trained after bleaching or even for people who were trained,[41] reported that objective color evaluation using a spectrophotometer is more effective than using visual scales (ΔSGU). Other studies included in the present systematic review[30,42] performed comparisons of bleaching gels with high concentrations of HP (25% to 38%)[1] and demonstrated effectiveness at the 12-month follow-up evaluation.[2] In a study involving adolescent patients (mean age: 13.9 years), Bacaksiz and others[2] found no difference with regard to tooth sensitivity between gels of different concentrations, even when the pulp chambers were wider and more sensitive to irreversible pulpitis.[43]

The risk of bias among the studies included in the present review was low. However, further randomized clinical trials should be performed with uniform bleaching gel application protocols to ensure greater safety for both the operator and the patient and to minimize tooth sensitivity while maximizing the effectiveness of the treatment.

CONCLUSIONS

The findings of the present systematic review and meta-analysis indicate that a lower concentration of HP in tooth bleaching gels results in less tooth sensitivity and more efficacy of objective color (ΔE) as measured by the spectrophotometer, while the same effect between the high and low concentrations was found regarding subjective color (ΔSGU) as measured by the color shade guide.

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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