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Effectiveness and Impact of the Walking Bleach Technique on Esthetic Self-perception and Psychosocial Factors: A Randomized Double-blind Clinical Trial

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Clinical Relevance

Nonvital bleaching produces positive and immediate impact on esthetic perception and psychosocial factors.

SUMMARY

Objective: This trial evaluates the impact of psychosocial and esthetic self-perceptions of patients undergoing nonvital tooth bleaching using the walking bleach technique. We also assessed the clinical effectiveness of bleaching tooth discoloration.

Methods: Fifty volunteers with nonvital tooth discoloration were enrolled. Teeth were randomized into two groups: 35% hydrogen peroxide (n=25) and 37% carbamide peroxide (n=25). Intracoronal bleaching was performed over four sessions using the walking bleach technique. Tooth color was evaluated at each session to measure total color variation. The shade guide was arranged from highest (B1) to lowest (C4) values to assess the color and calculate the color change in the number of shade guide units. Subjective and objective assessments were compared with the tooth counterpart.

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Esthetic self-perception and psychosocial factors were assessed before and after treatment.

Results: Color change was 15.48<5.17 for hydrogen peroxide and 14.02<4.85 for carbamide peroxide. There was no significant difference at any time point ($p>0.05$) except at sessions 3 and 4 ($p<0.05$). Overall, whitened teeth values were similar to those of counterpart teeth ($p>0.05$). There was a decrease in Oral Health Impact Profile and Psychosocial Impact of Dental Esthetics questionnaire scores after treatment compared with baseline ($p<0.05$).

Conclusion: The walking bleach technique was highly effective on nonvital teeth and had a positive effect on self-esthetic perception and psychological impact for the patients.

INTRODUCTION

Tooth color is one of the most important factors in achieving an esthetically pleasing smile in some cultures of the world.[1] It also substantially influences esthetic self-perception and has a psychosocial impact on people.[2] Thus, when a single tooth is darkened, the negative effect may be more pronounced because the color does not match the rest of the teeth.[3] However, there is no information on the impact of intracoronal bleaching on patient self-perception or on psychosocial impact.[4] Some authors have shown that alterations in cosmetic dentistry can cause psychosocial consequences that could have more of an impact on the person than the biological problems caused by caries lesions do.[5]

Intracoronal bleaching is a minimally invasive method of whitening discolored endodontically treated teeth. In most patients, intracoronal whitening requires more than one appointment to achieve a white smile and to repair or match the dark color of a single tooth to the rest of their teeth.[6] Therefore, it should be considered a color rehabilitation treatment.[7] There are only a small number of clinical studies on the intracoronal whitening technique, and most are difficult to compare with each other, as their conclusions are based on subjective records.[8-10] They are also considered to have low precision.

The most commonly used chemical agents include hydrogen peroxide (>35%) and carbamide peroxide (>37%).[6] Even though these agents are popular, no clinical studies have used objective methodologies that are highly reproducible or that explain the effectiveness of these agents in the whitening treatment of nonvital teeth.

The null hypothesis of this study was that there will be no difference in treatment effectiveness or in the esthetic perception and psychosocial impact of patients treated with 35% hydrogen peroxide or 37% carbamide peroxide. The main objective of this study was to evaluate the psychosocial impact and esthetic self-perceptions of patients undergoing nonvital tooth bleaching with 35% hydrogen peroxide and 37% carbamide peroxide gels using the walking bleach technique and to assess the clinical effectiveness of bleaching for discoloration.

METHODS AND MATERIALS

This randomized clinical study was approved by the Ethics Committee of the Faculty of Dentistry of the University of Chile (2016/04) and was performed according to the Consolidated Standards of Reporting Trials Statement[11] and the Declaration of Helsinki[12] (1975; revised 2000).

Study Design

This trial was a randomized double-blind (patient and evaluator) study. The study groups were randomized using Excel 2013 software (Microsoft, Seattle, WA, USA). Patients were recruited via flyers within the local Faculty of Dentistry and through social networks such as Facebook and Twitter.

Sample Size

The sample size was determined using GPower 3.1[13] software, with a 5% level of significance, 90% statistical power, and a dropout of 25%, based in a previous studies. This study corresponds to a therapeutic equivalence type in which a color variation of ΔE tones in the range of 7-10 or more, based on the original color, was considered significant. This indicated a sample size of 20. To compensate for the dropout rate reported in previous studies, we used a sample size of 25 per group.

Entry Criteria

A total of 74 patients were examined to assess whether they met the entry criteria for this study (Figure 1). Inclusion criteria were as follows: patients over the age of 18 years, with one or more nonvital discolored teeth, whose restoration did not include the vestibular surface, with the root canal in good condition, without apical lesions, with no previous tooth whitening experiences, and with a tooth shade of A2 or higher, according to the Vita Classical scale. Exclusion criteria were as follows: pregnant or breast-feeding, patients with enamel

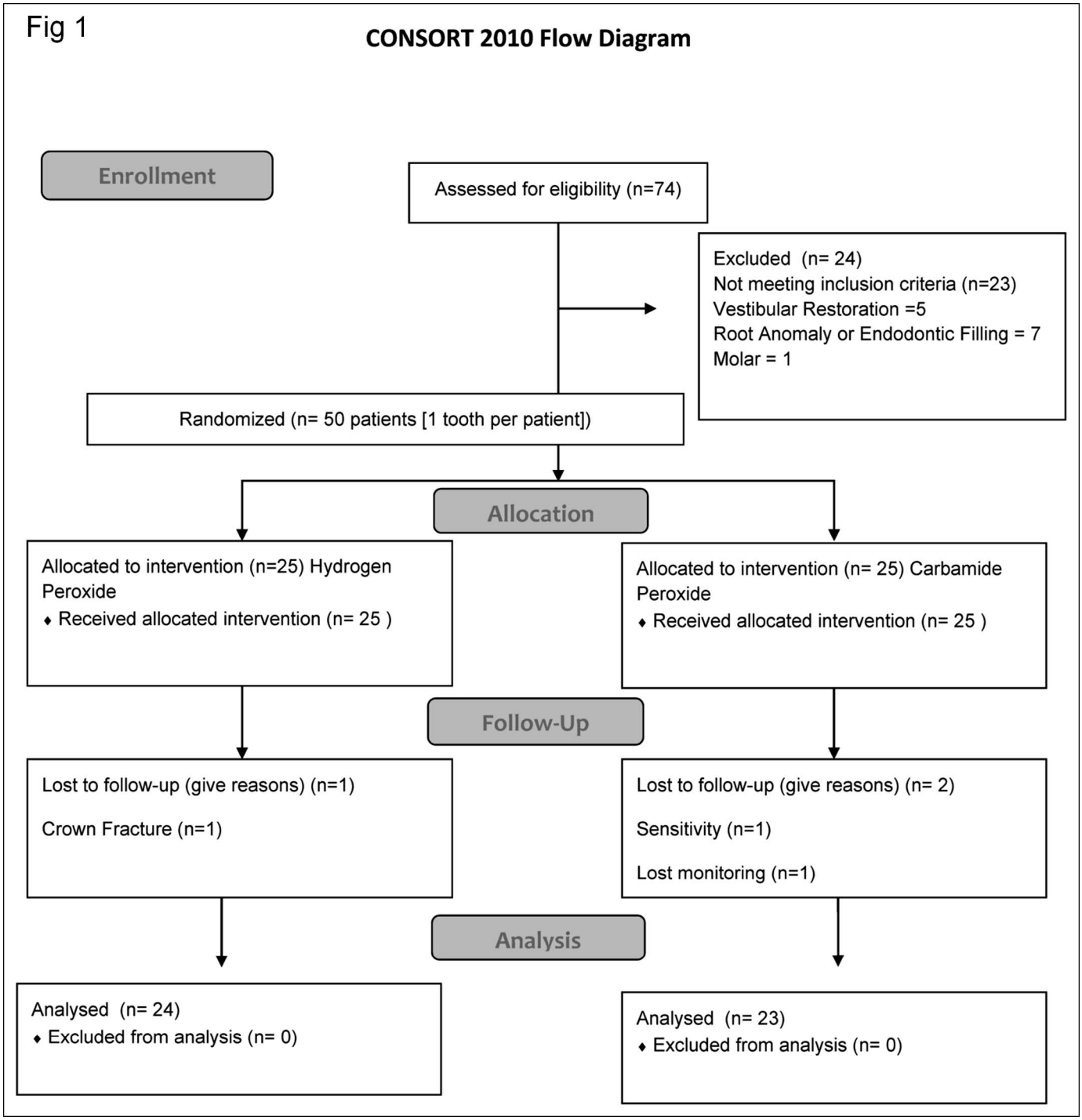

Figure 1. *CONSORT flow diagram.*

hypoplasia, teeth stained by tetracycline or fluorosis, patients receiving orthodontic treatment with fixed devices, patients with cancer, and patients with periodontal pathologies. Volunteers with clinically or radiographically identified caries, periapical lesions, external or internal tooth resorption, and/or periodontal disease were excluded, and these patients were referred to specialty clinics for treatment.

Patients agreed to use the bleaching agents and were randomized into two groups, each with 25 patients, as follows: In group 1, teeth were bleached with 35% hydrogen peroxide (Opalescence Endo,

Ultradent, South Jordan,Utah, USA); and in group 2, teeth were bleached with 37% carbamide peroxide (Whiteness Superendo, FGM, Joinville, Brazil). The bleaching agents were applied according to the manufacturer's instructions over four sessions, using an ambulatory (walking bleach) technique. There was one week between each session.

Preparation Session

The root canal was prepared with absolute isolation and an endodontic seal clearance of 3 mm from the enamel-cement limit. A 2-mm mechanical seal was placed using a glass ionomer reinforced with composite resin (Riva light cure, SDI, Bayswater. Victoria, Australia), and it was cured for 60 seconds at a distance of 1 cm with a 1200 mW intensity lamp (Raddi Cal, SDI). A radiographic control seal of the root canal was then performed. Once the proper seal was confirmed, clinical and radiographic intracoronal bleaching was performed.

Four Whitening Sessions

Application of the whitening agent was performed according to the manufacturer's instructions. The correct amount of bleaching gel for each group was placed into the pulp cavity with the presence of mild moisture (using the walking bleach technique), which allowed a close and optimum cavity seal. Cavity closure was performed using a temporary cement (Fermin, Detax, Ettlingen, Germany) until the next session in seven days. This procedure was repeated at each of the next four sessions. The same amount of gel was used and changed for both products and the same number of times.

Final Session

After the cavity access well was washed with water, a temporary restoration was placed for seven days until the final restoration with composite resin was made. Patients were cautioned not to eat or drink foods that could dye their teeth, such as coffee, tea, or red wine, during the study period. They were given these directions in writing and provided with contact information if they had any questions or experienced adverse events.

Color Evaluation

Objective Evaluation—Two calibrated evaluators (Kappa=0.85) were used to measure tooth color for the baseline immediately after each of the four sessions and again at one week and at one month after the last session. Color evaluation was obtained from a 6-mm area located in the middle third of the labial surface of the left and right central incisors. To standardize this evaluation, an impression of the maxillary arch was taken to make a guide using high-putty silicone (Zetaplus, Zhermack, Badia Polesine, Rovigo, Italy). A window was created on the labial surface in the middle third of the central incisor using a device with well-formed borders and a 3-mm radius corresponding to the reflectance of the spectrophotometer (Vita EasyShade Compact, VITA Zahnfabrik, Bad Säckingen, Germany), which has good reliability.[14] The shade was determined using the obtained parameters L*, a*, and b*. Color alteration after each session was indicated by the differences between the values obtained at the session and the baseline (ΔE). The ΔE was calculated using the following formula: $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$. The evaluators considered the color of the tooth counterpart (treated tooth: upper right central incisor; tooth counterpart: left central incisor), and the same area (middle) of each tooth was evaluated to compare color matching.

Subjective Evaluation—For the subjective evaluation, the 16 tabs of the shade guide (Vita Classic, Vita Zahnfabrik) were arranged from the highest (B1) to the lowest (C4) value to assess the color. Two calibrated evaluators (Kappa=0.85) recorded the shade of the upper central left and right incisors at baseline and at the same time points as for the objective evaluation. The investigators checked the color in the middle third area of the labial surface on the anterior central incisor, according to the American Dental Association guidelines.[15] The color changes from the beginning of the active phase through the individual recall times were calculated using the change in the number of shade guide units (ΔSGU). The color of the counterpart tooth was also recorded subjectively and compared to that of the treated tooth.

Oral Health Impact Profile Questionnaire

Satisfaction was measured using the Oral Health Impact Profile (OHIP-Esthetics) questionnaire validated in Chilean Spanish.[16] The questionnaire was administered by a research operator at baseline, one week, and one month after bleaching.

Psychosocial Impact of Dental Esthetics Questionnaire

The Psychosocial Impact of Dental Esthetics questionnaire (PIDAQ) consisted of 23 items that were grouped into four components using factor analysis:

Table 1: *Participant Baseline Characteristics*

Baseline Features	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide
Age (years; mean±SD)	30.88±11.58	30.83±11.25
Minimum age (y)	19	20
Maximum age (y)	65	65
Male (%)	50	39.13
Trauma (%)	58.33	39.13
Caries (%)	41.67	60.87
SGU baseline median (min;max) Vita Classic	15 (5; 16)	12 (7; 16)
L* (mean±SD)	73.55±8.54	75.91±6.81
a* (mean±SD)	4.48±3.45	4.85±3.39
b* (mean±SD)	29.14±3.87	31.79±6. 60

Abbreviation: max, maximum; min, minimum; SD, standard deviation.

1) dental self-confidence, 2) social impact, 3) psychosocial impact, and 4) esthetic concern.[17]

Statistical Analysis

After verifying the normality of data distribution and the homogeneity of the variance-covariance matrix, the treatment efficacy was evaluated with respect to color alteration (ΔE and ΔSGU) and analyzed using the Wilcoxon test for within-group comparisons and the Mann-Whitney test for between-group comparisons. The statistical analyses were performed using SPSS 23.0 (SPSS Inc, Chicago, IL, USA) with $\alpha=0.05$. For comparison of OHIP-Esthetics and PIDAQ questionnaire scores, the Wilcoxon test was used.[18]

RESULTS

Participant characteristics are shown in Table 1. There were no statistically significant differences between the participants' characteristics in the different groups (Mann Whitney test $p>0.05$). Results for ΔSGU differed over time, as shown in Table 2, with more effectiveness in group 1 ($p<0.05$). However, at the final measurement one month after bleaching, values were not significantly different ($p=0.59$). The color change determined using ΔL*, Δa*, and Δb* is shown in Table 3. The ΔL* was different at all measurement times, with values higher for group 1 ($p<0.05$). The values of Δa* and Δb* were similar for both groups ($p>0.05$). The ΔE color difference is shown in Table 4. The effectiveness was similar to baseline ($p>0.05$) at all-time points except that a significant difference from baseline ($p<0.05$) was observed for both groups at sessions 3 and 4. These two groups showed high effectiveness, with an average change of 14 color units.

Table 5 shows the subjective comparison of the treated teeth and their counterparts using Vita Classical SGU. There were no statistically significant differences ($p>0.05$) between treated teeth and controls in the first week. However, in the monthly monitoring of group 2 there were differences in color between treated teeth and counterpart teeth ($p<0.05$). Table 6 shows the objective comparison of the treated teeth and their counterparts from the L*, a*, and b* measured by the spectrophotometer. The L* values from one week after bleaching were not statistically significant ($p>0.05$), and the values

Table 2: *Comparison of ΔSGU Values at Different Times Using the Vita Classic Scale*[a]

Assessment Points	Color Change by ΔSGU		Mann-Whitney Test
	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	
Baseline vs 1-wk bleaching	3.5 (0, 10)	3 (0, 9)	**0.04**
Baseline vs 2-wk bleaching	8 (0, 14)	4 (0, 11)	**0.04**
Baseline vs 3-wk bleaching	9.5 (0, 14)	7 (0, 13)	**0.02**
Baseline vs 4-wk bleaching	11 (1, 15)	7 (1, 14)	**0.02**
Baseline vs 1-wk after bleaching (before restoration)	10 (−1, 14)	7 (1, 13)	**0.04**
Baseline vs 1-wk after bleaching (after restoration)	9.5 (1, 14)	7 (2, 13)	**0.04**
Baseline vs 1-mo after bleaching	8.5 (1, 13)	7 (1, 13)	**0.59**

[a] *Bold indicates statistical difference between groups at indicated time point. Expressed in median (min, max).*

Table 3: *Color Change by ΔL, Δa, and Δb (Means and Standard Deviations) at All Time Points*[a]

Assessment Times	Color Change by ΔL			Color Change by Δa			Color Change by Δb		
	Hydrogen Peroxide	Carbamide Peroxide	Mann-Whitney Test	Hydrogen Peroxide	Carbamide Peroxide	Mann-Whitney Test	Hydrogen Peroxide	Carbamide Peroxide	Mann-Whitney Test
Baseline vs 1-wk bleaching	8.13±4.73	4.33±4.31	**0.006**	–2.88±2.14	–2.63±2.32	.709	–1.22±3.82	–3.18±4.18	.100
Baseline vs 2-wk bleaching	10.26±7.06	5.98±4.70	**0.019**	–4.20±2.82	–3.96±2.97	.782	–3.11±4.70	–5.70±5.97	.105
Baseline vs 3-wk bleaching	11.78±6.55	7.98±4.26	**0.023**	–5.03±2.72	–4.51±2.69	.516	–5.68±5.95	–5.38±5.96	.865
Baseline vs 4-wk bleaching	13.07±7.43	8.64±3.53	**0.013**	–5.70±2.99	–5.20±2.85	.561	–6.18±5.93	–6.63±5.85	.796
Baseline vs 1 w k after bleaching (before restoration)	11.54±8.23	7.64±3.93	**0.045**	–5.52±3.58	–5.45±2.88	.939	–6.60±5.95	–8.00±7.43	.480
Baseline vs 1 w k after bleaching (after restoration)	10.85±7.20	7.25±4.53	**0.047**	–6.32±3.04	–5.67±2.75	.452	–7.24±5.99	–7.92±7.75	.737
Baseline vs 1 mo after bleaching	7.75±6.03	4.41±4.63	**0.039**	–6.53±2.92	–6.07±2.50	.569	–9.52±5.49	–9.97±6.21	.796

[a] *Bold indicates statistical difference between groups at indicated time point.*

from one month after bleaching were statistically significantly different ($p<0.05$) from the L* values of the homologous teeth.

Regarding the a* values in group 1, the comparison of one week after restoration and one month after restoration was statistically significant ($p<0.05$). In group 2 there were no statistically significant differences ($p>0.05$).

Regarding the b* values, there was a statistically significant difference in group 2 at the one week recall, and there was no statistically significant difference after one month ($p>0.05$).

Oral Health Impact Profile

There was a statistically significant difference in the OHIP-Esthetics score for the baseline compared with the sessions and one month after treatment ($p<0.05$; Wilcoxon test, Table 7). The factors of functional limitation and psychological disability were statistically significant compared to the baseline values ($p<0.05$). In group 1, the psychological discomfort and handicap factors were statistically significant at one week and one month compared with baseline ($p<0.05$), and the handicap factor at the one-month assessment was statistically significant in group 2 ($p<0.05$).

Psychosocial Impact of Dental Esthetics Questionnaire

The PIDAQ score was significantly different at baseline compared with one week and one month after treatment ($p<0.05$; Wilcoxon test, Table 8) except for the psychological assessment and total PIDAQ sum for group 2 at one month after treatment. When the one-week and one-month

Table 4: *Color Change Expressed in Units (ΔE; Means and Standard Deviations) at All Time Points*[a]

Assessment Times	Color Change by ΔE		Mann-Whitney Test
	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	
Baseline vs 1-wk bleaching	9.67±4.79	7.40±4.64	.11
Baseline vs 2-wk bleaching	13.24±5.94	11.04±5.19	.18
Baseline vs 3-wk bleaching	15.69±5.79	12.17±4.93	**.03**
Baseline vs 4-wk bleaching	17.19±6.55	13.31±4.67	**.02**
Baseline vs 1 w k after bleaching (before restoration)	16.44±7.10	14.36±4.74	.25
Baseline vs 1 w k after bleaching (after restoration)	16.22±6.46	14.45±4.88	.30
Baseline vs 1 mo after bleaching	15.48±5.17	14.02±4.85	.32

[a] *Bold indicates statistical difference between groups at indicated time point.*

Table 5: *Comparison of SGU Values at Different Times Using the Vita Classical Scale, Median (Minimum:Maximum)*

Assessment Times	Color Value	
	G1	G2
Homologous teeth	5 (1:9)	3 (2:10)
Baseline	15 (5:16)[a]	12 (7:16)[a]
1-wk bleaching	10.5 (2:16)[a]	9 (5:16)[a]
2-wk bleaching	5 (1:15)	7 (1:15)[a]
3-wk bleaching	4 (1:15)	5 (2:15)[a]
4-wk bleaching	2 (1:12)[a]	5 (1:15)
1 wk after bleaching (before restoration)	4.5 (1:13)	5 (1:15)
1 wk after bleaching (after restoration)	3.5 (1:12)	4 (1:14)
1 mo after bleaching	5 (1:13)	6 (1:14)[a]

[a] *Statistically significant difference intragroup (Wilcoxon test,* $p<0.05$*) versus Homologous teeth (counterpart).*

posttreatment time points are compared, the only statistically significant differences were found in the field of self-confidence ($p<0.05$) for group 1 and the esthetic concern factor for both groups ($p<0.05$).

DISCUSSION

This randomized clinical study showed that the effectiveness of two bleaching agents (35% hydrogen peroxide and 37% carbamide peroxide) can be measured objectively and subjectively, and both agents can be applied using the walking bleach technique for bleaching nonvital intracoronal teeth. Both products showed high effectiveness, and the results were similar and highly reproducible one month after whitening. Our results showed that the treatment had a positive influence on esthetic self-perception and psychosocial impact at one month after treatment, after color improvement in only one tooth in most volunteers in this trial. Therefore, the null hypothesis is accepted, as the two gels were widely effective according to objective and subjective measurements, and they had similar positive effects on the esthetic perception and psychosocial impact of patients in this clinical trial.

Several studies showed that bleaching can be considered effective when there is a change of at least 5 ΔE units.[19] Our results showed that in four sessions using the walking bleach technique and up to one month after treatment, there was a change of 15.48 ± 5.17 of ΔE for group 1 and 14.02 ± 4.85 of ΔE for group 2, which was highly effective. The first session achieved a considerable change of approximately 50% of the final result. There was no difference between the agents in the final results ($p>0.05$), although there was a trend for color to recur at one month after treatment. Statistical significance in ΔE was found only at the second and third sessions during treatment, even though ΔL* was different at all times, with higher values for hydrogen peroxide. However, ΔE was similar in both groups, which suggests that there is a different chemical mechanism for both gels in the respective groups; hydrogen peroxide gel has a lower molecular weight and a quicker and more direct action, so it probably spreads faster than carbamide peroxide.[20] Carbamide peroxide degrades at a lower concentration of hydrogen peroxide,[21] which results in a slower process and no difference in effectiveness one month after bleaching. Subjective evaluation of the change in coloration also indicates a highly effective treatment. When comparing both products using subjective measurement, a statistically significant difference was found at all time points until one week after treatment, while differences in the objective measurement were only found at the second and third sessions of whitening. Luminosity

Table 6: *Color by L*, a*, and b* (Means and Standard Deviations) at All Time Points and Color of the Homologous Teeth*

Assessment Times	L* Values		a* Values		b* Values	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Homologous teeth	84.39±2.62	84.77±4.91	–0.91±0.55	–1.16±0.82	20.10±3.47	19.43±3.21
Baseline	73.55±8.54[a]	75.91±6.81[a]	4.48±3.45[a]	4.85±3.39[a]	29.14±3.87[a]	31.79±6.60[a]
1-wk bleaching	81.68±7.20	80.24±7.51[a]	1.60±3.57[a]	2.22±4.02[a]	27.93±4.54[a]	28.61±5.51[a]
2-wk bleaching	83.81±6.47	81.89±6.95	0.28±3.38	0.89±4.35	26.03±4.31[a]	26.10±5.49[a]
3-wk bleaching	85.34±5.64	83.89±6.55	–0.55±3.24	0.34±3.98	23.46±5.10[a]	26.41±5.80[a]
4-wk bleaching	86.63±5.80	84.56±6.30	–1.23±3.01	–0.36±3.73	22.96±5.08[a]	25.17±5.30[a]
1 w k after bleaching (before restoration)	85.10±7.08	83.55±5.96	–1.04±3.42	–0.60±3.92	22.54±4.83	23.79±5.99[a]
1 w k after bleaching (after restoration)	84.41±5.64	83.16±7.32	–1.84±2.51[a]	–0.83±3.77	21.90±4.83	23.87±6.08[a]
1 mo after bleaching	81.31±5.73[a]	80.33±5.38[a]	–2.05±2.33[a]	–1.22±3.03	19.62±4.84	21.83±5.29

[a] *Statistically significant difference intragroup (Wilcoxon test,* $p<0.05$*) vs homologous teeth (counterpart).*

Table 7: *Effect of Intracoronal Bleaching on Esthetic Self-Perception Evaluated With the Oral Health Impact Profile Questionnaire*

Dimension	Baseline			1 Wk After Bleaching			1 Mo After Bleaching		
	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test
Functional limitation	5 (2:8)	5 (2:8)	0.754	3 (0:6)[a]	4 (1:6)[a]	0.357	2.5 (0:7)[a]	4 (0:8)[a]	0.435
Physical pain	3.5 (0:6)	3 (0:5)	0.366	3 (1:6)	3 (1:6)	0.575	2.5 (0:6)	2 (0:8)	0.829
Psychological discomfort	5 (2:6)	5 (0:7)	0.670	4 (0:6)[a]	3 (2:7)	0.974	4 (0:6)[a]	4 (0:8)	0.754
Physical disability	1.5 (0:6)	2 (0:5)	0.710	1.5 (0.4)	1 (0:6)	0.893	1 (0:5)	0 (0:6)	0.672
Psychological disability	2.5 (0:6)	3 (0:8)	0.257	2 (0:6)[a]	2 (0.7)[a]	0.905	1.5 (0:5)[a]	2 (0:6)[a]	0.533
Social disability	0 (0:5)	1 (0:6)	0.854	0 (0:4)[a]	0 (0:6)	0.921	0 (0:6)	0 (0:4)	0.950
Handicap	1 (0:6)	1 (0:6)	0.718	0 (0:5)[a]	0 (0:6)	0.690	0 (0:6)[a]	0 (0:4)[a]	0.933
Sum	18 (5:38)	19 (5:42)	0.873	13 (3:33)[a]	15 (4:41)[a]	0.529	14 (2:31)[a]	13 (5:41)[a]	0.983

[a] *Statistically significant difference (Wilcoxon test, $p<0.05$) versus baseline.*

can explain the differences (Table 3) because it is a parameter with more power to determine color than the human eye.[19] At the one month recall, there was a slight rebound of color, which can be explained by the rehydration of the tooth subjected to high concentrations of peroxide for several sessions. This may suggest that clinicians should aim to overbleach by at least a tone to compensate for this rebound.

Few clinical studies have evaluated the effectiveness of nonvital bleaching, and the most commonly used bleaching agent is sodium perborate.[7] An *in vitro* study conducted by Lim and others[22] concluded that 35% carbamide peroxide and 35% hydrogen peroxide are more effective than sodium perborate. In this study, the color of each tooth was evaluated using the Vita Lumin shade guide; after seven days, there was change of eight SGU, and the color changed by two additional units after 14 days for carbamide and hydrogen peroxide.[22]

Regarding comparing subjective and objective evaluations of tooth color with an untreated counterpart, we can say that the color of the treated tooth resembled that of the counterpart according to the subjective evaluation; however, it is not possible to perfectly match the color of all teeth. This represents a difficulty of the technique, and perhaps the clinician should apply a custom technique for each patient based on the tones that should be whitened.

The same situation occurs in the objective assessment of the L* values, which are similar after one week but are different at one month because of the rebound in luminosity. In group 1, there was apparently an influence of color restoration on values a*, which remained for a month, whereas in group 2 there was no difference between the treated tooth

Table 8: Psychosocial Impact of Dental Esthetics *Results at Different Time Points*

Dimension	Baseline			1 Wk After Bleaching			1 Mo After Bleaching		
	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test	Group 1 = Hydrogen Peroxide	Group 2 = Carbamide Peroxide	Mann-Whitney Test
Dental self-confidence	16.5 (6:26)	14 (10:26)	0.386	21 (11:30)[a]	23 (12:30)[a]	0.653	19 (10:30)[ab]	22 (6:29)[a]	0.708
Social impact	24 (8:40)	23 (8:34)	0.693	17.5 (8:31)[a]	16 (8:26)[a]	0.315	15.5 (8:31)[a]	17 (8:33)[a]	0.764
Psychological impact	19.5 (8:26)	17 (6:24)	0.347	13.5 (6:24)[a]	15 (6:21)[a]	0.949	14 (6:24)[a]	14 (6:25)	0.991
Esthetic concern	9.5 (3:14)	9 (3:14)	0.604	8 (3:12)[a]	5 (3:12)[a]	0.094	5.5 (3:12)[ab]	6 (3:12)[ab]	0.320
Sum	71 (38:98)	66 (39:81)	0.365	63.5 (40:79)[a]	57 (39:74)[a]	0.287	54 (39:79)[a]	58 (40:94)	0.733

[a] *Statistically significant difference (Wilcoxon test, $p<0.05$) vs baseline.*
[b] *Statistically significant difference (Wilcoxon test, $p<0.05$) vs 1 wk after bleaching.*

and the tooth counterpart after one month. As for values b*, there was no difference between the treated tooth hand the counterpart tooth after one month.

It is likely that stronger action of agents generates color change in a darker tooth.[23] The research team was not surprised at the high degree of patient satisfaction achieved with the bleaching procedure in this trial,[24] even though, for various reasons, we were unable to completely match tooth color to the neighboring teeth using our nonvital tooth-whitening method. Findings on the perception of esthetics and psychosocial impact were positive and significant up to one month after whitening. Maintaining this positive effect over time should be confirmed in patients undergoing bleaching of vital teeth[25] and correlated with the maintenance of the effectiveness by a bleaching procedure.

The OHIP-Esthetics survey also showed a positive effect on patients' esthetic self-perception. This result is supported by other studies[2,25] that evaluated the influence on esthetic self-perception of patients undergoing extracoronal vital whitening. Our data confirm that quality of life is complex, important, and poorly reported, and multiple factors influence it. However, dental esthetics is important, even if the influence of patients' perception and the impact of psychological and social factors is unknown. The impact of perception on psychological and social factors is unknown. There were no differences in OHIP-esthetics scores between groups, but there were differences in the changes over time in each group. This resulted in a more pronounced and positive effect for group 1, which may be explained by the more rapid effect on the modification of color brightness, as shown in Table 3. This should be further investigated to assess the correlation between self-perception and esthetic changes in the brightness of the color.

The PIDAQ is not designed for patients who have undergone bleaching as it is usually used for orthodontic patients to determine their esthetic expectations; however, it fails to evaluate which areas are expected to be modified to solve a particular esthetic problem. The PIDAQ has been shown to decrease the negative impact of cosmetic dentistry for a patient and to decrease the values in the field of social impact, psychological impact and esthetic concerns. The psychosocial impact was similar in both groups ($p>0.05$). We found that there was a large impact reported by the PIDAQ data for all relevant factors, but a minimal intervention on a tooth has an important effect on people who undergo intracoronal bleaching.[25]

CONCLUSION

Both 35% hydrogen peroxide and 37% carbamide peroxide are highly effective for the walking bleach technique in nonvital teeth and achieve a high degree of color matching with the counterpart teeth. Each gel resulted in a positive impact on patients' esthetic self-perception and psychosocial self-perception after intracoronal whitening.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of CEC FOUCH. The approval code for this study is 2016/04.

Conflict of Interest

The authors of this manuscript 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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REFERENCES

1. Joiner A (2006) The bleaching of teeth: A review of the literature *Journal of Dentistry* **34(7)** 412-419, 10.1016/j.jdent.2006.02.002.
2. Martin J, Vildosola P, Bersezio C, Herrera A, Bortolatto J, Saad JRC, Oliveira OB, & Fernandez E (2015) Effectiveness of 6% hydrogen peroxide concentration for tooth bleaching—A double-blind, randomized clinical trial *Journal of Dentistry* **43(8)** 965-972, 10.1016/j.jdent.2015.05.011.
3. Samorodnitzky-Naveh GR, Geiger SB, & Levin L (2007) Patients' satisfaction with dental esthetics *Journal of the American Dental Association* **138(6)** 805-808.
4. Akarslan ZZ, Sadik B, Erten H, & Karabulut E (2009) Dental esthetic satisfaction, received and desired dental treatments for improvement of esthetics *Indian Journal of Dental Research* **20(2)** 195-200, 10.4103/0970-9290.52902.
5. Khan M, & Fida M (2008) Assessment of psychosocial impact of dental aesthetics *Journal of the College of Physicians and Surgeons—Pakistan* **18(9)** 559-564, 09.2008/jcpsp.559564.
6. Attin T, Paque F, Ajam F, & Lennon AM (2003) Review of the current status of tooth whitening with the walking

bleach technique *International Endodontic Journal* **36(5)** 313-329.

7. Plotino G, Buono L, Grande NM, Pameijer CH, & Somma F (2008) Nonvital tooth bleaching: a review of the literature and clinical procedures *Journal of Endodontics* **34(4)** 394-407, 10.1016/j.joen.2007.12.020.
8. Deliperi S (2008) Clinical evaluation of nonvital tooth whitening and composite resin restorations: Five-year results *European Journal of Esthetic Dentistry* **3(2)** 148-159.
9. de Souza-Zaroni WC, Lopes EB, Ciccone-Nogueira JC, & Silva RC (2009) Clinical comparison between the bleaching efficacy of 37% peroxide carbamide gel mixed with sodium perborate with established intracoronal bleaching agent *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **107(2)** e43-e47, 10.1016/j.tripleo.2008.09.011.
10. Bizhang M, Heiden A, Blunck U, Zimmer S, Seemann R, & Roulet JF (2003) Intracoronal bleaching of discolored non-vital teeth *Operative Dentistry* **28(4)** 334-340.
11. Lorette G, & Maruani A (2013) [The CONSORT statement (CONsolidated Standards Of Reporting Trials)] *Annales de dermatologie et de vénéréologie* **140(6-7)** 431-435, 10.1016/j.annder.2013.04.091.
12. World Medical Association (2002) World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects *Nursing Ethics* **9(1)** 105-109.
13. Faul F, Erdfelder E, Lang AG, & Buchner A (2007) G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences *Behavior Research Methods* **39(2)** 175-191.
14. Kim-Pusateri S, Brewer JD, Davis EL, & Wee AG (2009) Reliability and accuracy of four dental shade-matching devices *Journal of Prosthetic Dentistry* **101(3)** 193-199, 10.1016/s0022-3913(09)60028-7.
15. American Dental Association (2012) Tooth whitening products: ADA statement on safety and effectiveness; Retrieved online 03-01-2017 from: http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/tooth-whitening-safety-and-effectiveness.
16. Núñez L, Dreyer E, Martin J, & Moncada G (2013) "Validation of the OHIP-Aesthetic Sp Questionnaire for Chilean adults" *Journal of Dental, Oral and Craniofacial Epidemiology* **1(2)**, http://www.sharmilachatterjee.com/ojs-2.3.8/index.php/JDOCE/article/view/67.
17. Klages U, Claus N, Wehrbein H, & Zentner A (2006) Development of a questionnaire for assessment of the psychosocial impact of dental aesthetics in young adults *European Journal of Orthodontics* **28(2)** 103-111, 10.1093/ejo/cji083.
18. Hannigan A, & Lynch CD (2013) Statistical methodology in oral and dental research: Pitfalls and recommendations *Journal of Dentistry* **41(5)** 385-392, 10.1016/j.jdent.2013.02.013.
19. Bizhang M, Chun YH, Damerau K, Singh P, Raab WH, & Zimmer S (2009) Comparative clinical study of the effectiveness of three different bleaching methods *Operative Dentistry* **34(6)** 635-641, 10.2341/08-069-c.
20. Carey CM (2014) Tooth whitening: What we now know *Journal of Evidence-based Dental Practice* **14(Supplement)** 70-76, 10.1016/j.jebdp.2014.02.006.
21. Matis BA, Yousef M, Cochran MA, & Eckert GJ (2002) Degradation of bleaching gels in vivo as a function of tray design and carbamide peroxide concentration *Operative Dentistry* **27(1)** 12-18.
22. Lim MY, Lum SO, Poh RS, Lee GP, & Lim KC (2004) An in vitro comparison of the bleaching efficacy of 35% carbamide peroxide with established intracoronal bleaching agents *International Endodontic Journal* **37(7)** 483-488, 10.1111/j.1365-2591.2004.00829.x.
23. Kershaw S, Newton JT, & Williams DM (2008) The influence of tooth colour on the perceptions of personal characteristics among female dental patients: comparisons of unmodified, decayed and 'whitened' teeth *British Dental Journal* **204(5)** E9; discussion 256-257, 10.1038/bdj.2008.134.
24. Gupta SK, & Saxena P (2014) Evaluation of patient satisfaction after non-vital bleaching in traumatized discolored intact anterior teeth *Dental Traumatology* **30(5)** 396-399, 10.1111/edt.12109.
25. Fernández E, Bersezio C, Bottner J, Avalos F, Godoy I, Inda D, Vildósola P, Saad J, Oliveira OB Jr, & Martín J (2017) Longevity, esthetic perception and psychosocial impact of teeth bleaching by low (6%) hydrogen peroxide concentration for in-office treatment: Randomized clinical trial *Operative Dentistry* **42(1)** 41-52.