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Effectiveness of Dental Bleaching With 37.5% and 6% Hydrogen Peroxide and Its Effect on Quality of Life

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Clinical Relevance

A gel with a low concentration of hydrogen peroxide (6%) achieves effective whitening with a low occurrence and intensity of sensitivity. It also generates a positive effect on psychosocial impact and esthetic self-perception among patients.

SUMMARY

Objective: This study investigated whether it is possible to achieve equally satisfactory results between 37.5% hydrogen peroxide (HP) gel and 6% HP gel. We also assessed the psychosocial impact and self-perception of esthetics generated by extracoronal tooth whitening.

Methods and Materials: A prospective, double-blind, randomized clinical trial was carried out. A total of 33 patients were selected from the clinic of the Faculty of Dentistry at the University of Chile. The patients included men and women over 18 years old without prior tooth whitening treatments, tooth decay, or restorations of the maxillary anterior teeth. The patients had tooth colors of A3 or less according to the Vita Classical scale, which was determined with a Vita Easy Shade spectrophotometer. The study was carried out with a "split-mouth" design. One side of each mouth was randomly treated with 37.5% HP, and the other side was bleached with 6% HP. Each group received 3 to 12 minutes of treatment with the respective gel applications. Two sessions of bleaching were carried out each week. A spectrophotometer was used to measure the total variation of color (ΔE), and a subjective evaluation was made with Vita Classical scale (ΔSGU) between the baseline (session 1) and different measurement times. We compared ΔE

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and ΔSGU for both agents using the Mann-Whitney test (α=0.05).

Results: In both groups, there was variation among the initial color and the color in the different measurement times. In the month after the treatment was completed, ΔE was 9.06 in the 37.5% HP group and 5.69 in the 6% HP group. The difference between the two groups was statistically significant starting in the second session (p=0.000).

Conclusion: There was a significant difference between the effectiveness of the bleaching gel concentrations of 37.5% and 6% HP according to spectrophotometer measurements and subjective evaluations. There was also a positive effect on psychosocial impact and esthetic self-perception among patients.

INTRODUCTION

Hydrogen peroxide (HP) is commonly used to treat the discoloration of teeth. It is a powerful oxidizer that separates the molecules of chromophores that remain on the teeth. The molecules become smaller molecules that reflect less light, which creates a whitening effect.[1] Evidence suggests that tooth whitening is safe and minimally invasive. However, some researchers believe that whitening could potentially lead to structural changes in the teeth tissues.[2]

The effects caused by whitening are controversial, especially for gels with high concentrations.[3] The effects and the diffusion of HP on hard tooth tissues depend on the concentration and contact time.[4] This has led some manufacturers to produce gels with lower concentrations of HP. The European Union banned the use of whitening agents at concentrations above 6%.[5] Despite this, patients continue to demand these treatments. Therefore, it is necessary to investigate bleaching agents to confirm their efficacy and safety under the new requirements.

Efforts are currently focused on achieving effectiveness with low concentrations of peroxide while minimizing the contact time between the tooth and bleaching gel to reduce the adverse effects.[6-8] This could be performed using low concentrations of dental whitening agents. However, it must be confirmed that the effectiveness does not differ significantly from that of the high concentrations that are usually used.[9,10] A recent study followed a cohort of patients treated with a low concentration HP gel. The study showed acceptable results and a low rebound of color at nine months and at one year.[6,8] However, the gel was catalyzed by light-emitting-diode or laser light. There are no reports on low concentrations of HP gels without light assistance that demonstrate the effectiveness of tooth bleaching.

There has been a large increase in the demand for improving cosmetic appearance, especially dental appearance. New reports link personality factors with choosing tooth whitening.[11,12] Thus, it is important to assess the possible changes in esthetic self-perception and the psychosocial impact among patients undergoing clinical tooth whitening using validated instruments. The effects of whitening can last for one year or more.[13] Thus, it seems relevant to consider whether possible psychosocial changes occur beyond the first few weeks after bleaching. Patients who undergo extracoronal tooth whitening experience a positive impact on psychosocial quality of life and self-perception.[6]

Therefore, the present study investigated whether it is possible to achieve equally satisfactory results between 37.5% HP gel and 6% HP gel in a split-mouth model. We also assessed the psychosocial impact and self-perception of esthetics generated by extracoronaral tooth whitening. The first null hypothesis was that there would be no difference in the effectiveness of the whitening gels at one month follow-up. The second null hypothesis was that the whitening would not affect the quality of life of patients.

METHODS AND MATERIALS

Study Design

This study was a double-blind, randomized, prospective clinical trial. The study was conducted according to the recommendations of CONSORT (Consolidated Standards of Reporting Trials),[14] as shown in Figure 1, as well as the principles of the Helsinki Convention.[15] The study was approved by the ethics local committee (approval number 15/001), and the trial was registered (NCT03217994).

Sample Description

Sample Selection—A total of 35 patients were selected from the clinic of the Faculty of Dentistry at the University of Chile. The patients had been seeking whitening treatment and volunteered to participate in the study. The selected patients had to meet all the inclusion criteria and signed informed consent forms adopted by the Ethics Committee of Faculty of Dentistry. The inclusion criteria were as follows:

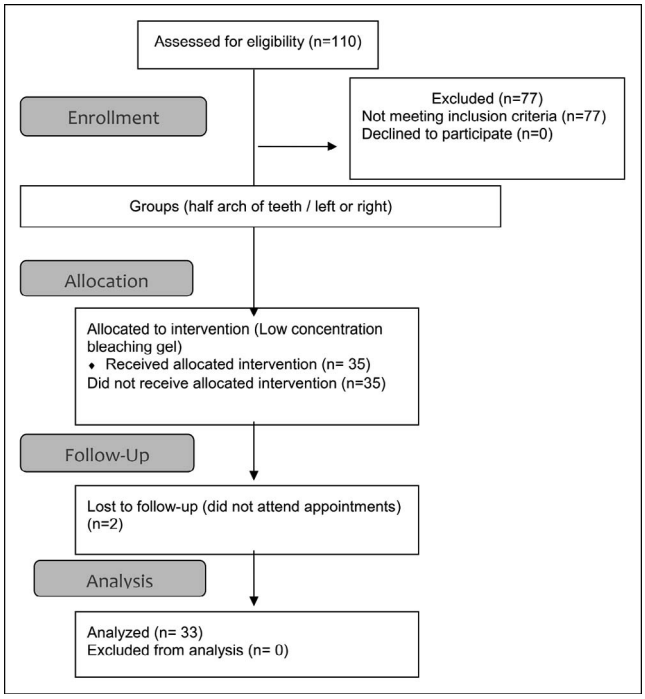

Figure 1. *Flow diagram of the clinical trial.*

- Age over 18 years (both sexes)
- Six present maxillary anterior teeth
- No caries
- No restorations (in the maxillary anterior teeth)
- No previous whitening treatments
- Tooth color value of A3 or darker (Vita Classical scale, Vita Zahnfabrik, Bad Säckingen, Germany), which was determined with a spectrophotometer (Vita Easy Shade Compact, Vita Zahnfabrik, Bad Säckingen, Germany) on the middle third of the vestibular surface of the maxillary central incisors

Patients were excluded based on the following criteria:

- Pregnant or nursing mothers
- In pharmacologic treatment
- Bruxism and patients who reported prior tooth sensitivity
- Previous tooth whitening (either at home or professionally)
- Visible dental cracks, developmental defects, or teeth stained by tetracycline or fluorosis in the maxillary anterior teeth
- Treatment with fixed appliances
- Periodontal disease or cancer
- Presence of noncarious cervical lesions or endodontics in the maxillary anterior teeth

Patients who experienced any pathologies that prevented them from entering the study (such as caries, periodontal disease, or dental sensitivity) were directed for treatment to the dental clinic of the Faculty of Dentistry of the University of Chile.

Sample Size—The sample size (n) was determined based on similar studies.[6] A minimum n of 25 patients per group was determined. A significance level of 5% was considered at (1-"β) 0.84 with a dropout rate of 5%, resulting in 35 patients.

Study Location—Treatments were carried out at the clinic of the Faculty of Dentistry of the University of Chile. During this period, volunteers were supervised by the researchers.

Procedure

Determination of Study Group—The study was carried out with a "split-mouth" design. Bleaching agents (HP) were randomly (pararell groups) calculated and assigned (SPSS 21, IBM, New York, NY, USA) to each hemiarch. The two operators were unaware of the product being used. To achieve this, auto-mix syringes from a Polaoffice+ whitening kit were used (SDI Limited, Bayswater, Australia). The syringes contained HP in the form of a thixotropic gel at a concentration determined by the manufacturer and marked properly. Each gel syringe was relabeled with a key number depending on the concentration of the agent, which was determined by an operator who was unaware of the procedures.

All color measurements were performed on the maxillary central incisors by different operators from those mentioned. In one group, the hemiarch (canine, lateral, and central incisors) was bleached with 37.5% HP (Polaoffice + 37.5% SDI Limited). In the other group, the hemiarch was bleached using 6% HP (Polaoffice + 6% SDI Limited).

Preliminary Phase—The procedures to be performed were verbally explained, and then each volunteer read and signed an informed consent form. In each case, a heavy silicone matrix (Speedex Putty, Coltene Whaledent, Altstätten, Switzerland) was prepared for both maxillary central incisors. These matrices were perforated at the height of the union of the cervical third and the middle third of the vestibular tooth face to standardize the color measurements with the spectrophotometer (Easyshade compact, Vita Zahnfabrik, Bad Säckingen, Germany). Another reason was to create a perfect fit with the nozzle of the spectrophotometer to help control the passage of light to the measurement site. The color of each maxillary central incisor was measured using

the spectrophotometer, which was previously calibrated according to the manufacturer's instructions.

Bleaching Protocol—Two whitening sessions were carried out with intervals of one week. At the beginning of each session, dental prophylaxis was done with a brush at low speed. Stone pumice and water were used on the maxillary anterior to remove the surface layer from the enamel so that it would not alter the effectiveness of the gels. We used a plastic lip separator and a light-cured blue resin gingival barrier (Gingival Barrier, SDI Limited) to protect the soft tissue. We homogeneously applied the different gels on the vestibular surfaces of each hemiarch. One hemiarch was treated with 37.5% HP, and the other was treated with 6% HP (Polaoffice+, SDI Limited).

The protocol included two sessions of treatment with three applications of 12 minutes of whitening gel each session (72 minutes of total contact). The gels were in full contact with the tooth surface and then were removed between each application with cotton rolls, which were moistened with water and dried carefully. At the end of the third application, we removed the gels, washed off all the excess with copious water, and removed the gingival barrier.

After Bleaching—All patients were instructed to avoid consuming foods with a high content of pigments, such as coffee, tea, wine, and beets during the study period.

Controls—At the end of the first session, we measured the tooth color with the calibrated spectrophotometer (Vita Easy Shade Compact), which has high reliability.[16] One week later, the same protocol was repeated. The time to control sessions (one week and one month post whitening) was considered.

Tabulation of Data—Data obtained in each period were tabulated according to the three axes of the CIELAB (CIEL*a*b* 1976 color space) system (L*, a*, and b*). We also calculated ΔE using the Pythagorean Theorem as follows:

$$\Delta E = \left[(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2\right]^{1/2}$$

The variation of each parameter at different times was always calculated in relation to the initial values (the color measurement prior to the first session of whitening).

Subjective Evaluation—For the subjective evaluation, we used the Vita Classical shade guide (Vita Classic, Vita Zahnfabrik), which ranges from lightest (B1) to darkest (C4) according to the color. Although the Vita Classical scale is not linear in the truest sense, we treated the changes as continuous with a linear ranking as in previous clinical trials of dental bleaching.[17] Two calibrated evaluators with a κ value of 0.85 recorded the shades of both central incisors at baseline, at each session, one week after treatment, and one month after. The perceptibility threshold considered was 2.7 ΔE units.[18] The color was registered over the middle third of the labial surface as established by the American Dental Association (ADA) guidelines.[19] The color difference was calculated as the number of shade guide units that the tooth changed toward the lighter end of the shade guide (ΔSGU). At the one-month control, the evaluation was done after dental prophylaxis and after waiting 15 minutes for rehydration of the teeth before color assessment.

Tooth Sensitivity Evaluation—The tooth sensitivity (TS) after whitening was assessed by the variables of occurrence and intensity. These data were obtained using a self-completed form as well as clinical evaluations during the sessions and immediately after by a visual analogue scale (VAS). For the VAS, we instructed the participants to place a line perpendicular to a 100-mm-long line, with a zero at one end indicating "no TS" and the other end indicating "unbearable TS."

Quality of Life

Before tooth whitening, as well as one week and one month after, all patients answered two questionnaires: (1) the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) and (2) the Oral Health Impact Profile for dental esthetics (OHIP-14). The questionnaires were answered under supervision of an examiner, who could answer the patients' questions.

PIDAQ[20] is used for psychometric assessment of the impact of psychosocial aspects of dental esthetics. It consists of 23 items rated on a five-point Likert scale (0 for total disagreement and 4 for full agreement). The items are divided into four subscales consisting of six questions on positive dental self-confidence, eight questions on three negative dimensions of psychological impact, three questions concerning esthetics, and eight questions on social impact. The total score is between 0 and 72 points. In addition, an analysis was done according to the subscales. A greater dental self-confidence subscale score indicated greater self-confidence. However, high scores on the subscales of psychological and social impact indicated adverse effects of esthetics.

Table 1: *Baseline Participant Characteristics*

Baseline Features	Groups (Hydrogren Peroxide Percentage)	
	37.5%	6%
Age (y; mean ± SD)	27.36 ± 9.28	
Minimum age (y)	20	
Maximum age (y)	53	
Male (%)	51.5	
L* (mean ± SD) ($p>0.05$)	85.85 ± 3.12	85.43 ± 3.21*
a* (mean ± SD)	0.22 ± 1.23	0.33 ± 1.50*
b* (mean ± SD)	28.06 ±3.39	28.64 ± 3.88*
Baseline Vita Classical SGU median (min:max)	9 (9:12)	9 (9:12)

Abbreviation: SD, standard deviation.
* $p>0.05$ *between groups.*

OHIP-14[21] is an instrument for evaluating esthetic self-perception. The questions are also answered on a five-point Likert scale indicating "very often" (4); "quite often" (3); "occasionally" (2); "almost never" (1); and "never or unknown" (0). A greater score indicated a worse patient self-perception of the cosmetic dentistry. To calculate the OHIP-14 score for each patient, the scores of the 14 questions were added to generate overall scores ranging between 0 and 56 points.

Statistical Analysis

The Shapiro-Wilk test was used to determine the normality of the dataset. The data distribution was not normal, so the Mann-Whitney test was used to compare the efficacy and sensitivity results in both groups. The Wilcoxon test was used to compare the variations between different measurement times. The statistical tests were performed using the software SPSS 21.0 (IBM, New York, NY, USA). Descriptive statistics of the scores on the scales of the PIDAQ and OHIP-14 esthetic surveys were determined, and the results were compared for different evaluation time points using the Wilcoxon test. Besides the selected demographic variables such as age and sex, the data were coded and treated anonymously.

RESULTS

Description of the Sample

This study evaluated 110 patients who voluntarily came to the local Faculty of Dentistry clinic. Using a "split-mouth" design, each group (37.5% and 6% HP) comprised n=35 patients (selected according to the inclusion criteria). However, two patients left the study due to noncompliance with the appointments, so only 33 patients were considered in the analysis (Figure 1). The average age of the sample was 24 years old, with a range of 20 to 47 years. Their baseline features are presented in Table 1.

Effectiveness of Whitening

Objective Evaluation—Both groups achieved effectiveness ($\Delta E > 5$) with differences of more than 3 ΔE units at one month after bleaching ($p<0.001$; Table 2).

Subjective Assessment—Both groups had a whitening effectiveness of more than 5 SGU units at one month after whitening, but there was a statistically significant difference between groups ($p<0.05$; Table 3).

Sensitivity—Only four patients noticed sensitivity, and the mean sensitivities after the first session according to VAS were 0.48 ± 1.20 in the 37.5% group and 0.41 ± 1.31 in the 6% group. However, differences between groups were not statistically significant ($p=0.531$). The mean sensitivity after the second session was 0.41 ± 1.20 in the 37.5% group and 0.35 ± 1.37 in the 6% group, but again the differences were not statistically significant ($p=0.450$).

Quality of Life

Psychosocial Impact (PIDAQ)—At one week and one month, there were statistically significant differences from the baseline values of PIDAQ, which indicate a positive impact on the factors (Table 4).

Esthetic Self-Perception (OHIP)—All factors except functional limitation had significantly lower

Table 2: *Comparison of ΔE Values at Different Times*

Assessment Points	Color Change by ΔE		
	37.5% Hydrogen Peroxide	6% Hydrogen Peroxide	Mann-Whitney Test
Baseline vs one week during bleaching	3.79 ± 4.43	3.53 ± 3.04	0.493
Baseline vs two weeks during bleaching	6.95 ± 3.33	4.37 ± 2.34	0.001
Baseline vs one week after bleaching	8.94 ± 3.07	6.34 ± 3.82	0.001
Baseline vs one month after bleaching	9.06 ± 2.96	5.69 ± 3.06	0.000

Table 3: *Comparison of ΔSGU Values at Different Times*

Assessment Points	Color Change by ΔE		
	37.5% Hydrogen Peroxide	6% Hydrogen Peroxide	Mann-Whitney Test
Baseline vs one-week bleaching	3.90 ± 1.90	3.52 ± 1.90	0.345
Baseline vs before two-week bleaching	4.77 ± 2.10	4.29 ± 2.10	0.325
Baseline vs two-week bleaching	6.68 ± 1.60	6.26 ± 1.60	0.196
Baseline vs one week after bleaching	6.68 ± 1.60	6.10 ± 1.7	0.106
Baseline vs one month after bleaching	6.71 ± 1.80	5.87 ± 1.8	0.019

values compared with the baseline. At one month, all factors measured had a statistically significant difference compared with the baseline. In the overall score, the difference was also significant at one week and one month (Table 5).

DISCUSSION

This study compared the effectiveness of tooth whitening with gels containing 6% and 37.5% HP without light treatment. Tooth color was measured up to the one month after whitening using a spectrophotometer and a subjective assessment. Based on the results, we rejected the null hypothesis that bleaching with 6% HP was as effective as that with 37.5% HP.

Prior to the intervention, the spectrophotometer measurements showed that there was no significant difference between the initial parameters of the two groups (Table 1) on any of the three axes of the color system. This is an advantage of the split-mouth design, because there is greater variability between the characteristics of each hemiarch in the same patient.[7,22,23] Bleaching was considered effective in both groups because they presented a ΔE of at least five units during the control month (G [6%]: ΔE = 5.69). In the 37.5% group, the highest value of ΔE occurred in the monthly control (ΔE = 9.06).

Table 4: *PIDAQ Results at Different Time Points*

Dimension	Time Points		
	Baseline	1 Week After Bleaching	1 Month After Bleaching
Dental self-confidence	18 (10:63)	23 (15:68)[a]	23 (16:30)[a]
Social impact	17 (9:34)	16 (8:34)[a]	13 (8:29)[a]
Psychological impact	19 (8:28)	15 (6:26)[a]	13 (6:23)[ab]
Esthetic concern	7 (3:15)	6 (3:10)[a]	5 (3:10)[a]
Sum	60(44:86)	59 (38:92)	55 (36:75)[ab]

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

From the measurements at the start of the second session, we began to see a separation between the values of each group, with a difference of more than two units in ΔE that increased over time (Table 2). Despite the differences between the final values, only one patient noticed a difference between both hemiarches (was retreated). Prior to bleaching, we told the patients that we would work to match the colors of the different hemiarches if they were unhappy with the esthetic results. This probably occurred because the difference between the colors of both groups was not significant enough due to the thresholds of each person.

Related to the objective effectiveness, dental in-office whitening systems can be categorized into groups of high or low concentration of HP (>35% or <20%, respectively). Highly concentrated groups traditionally show a high effectiveness, with more than eight units of ΔE in color change, in treatments of around 100 minutes of segmented contact in different sessions using different protocols.[24,25] In contrast, low concentrated agents traditionally have been less effective, with ΔE of around five units.[10,26,27] In our study we obtained color changes

Table 5: *Effect of Bleaching in the Esthetic Self-perception Evaluated With the OHIP Questionnaire*

Dimension	Time Points		
	Baseline	1 Week After Bleaching	1 Month After Bleaching
Functional limitation	3 (0:7)	3 (0:6)	2 (0:6)[a]
Physical pain	3 (0:7)	2 (0:4)[a]	2 (0:6)[a]
Psychological discomfort	4 (0:7)	3 (0:6)[a]	3 (0:5)[a]
Physical disability	1 (0:6)	1 (0:4)[a]	0.5 (0:2)[a]
Psychological disability	1 (0:5)	0.5 (0:3)[a]	0 (0:3)[a]
Social disability	0 (0:4)	0 (0:3)[a]	0 (0:2)[a]
Handicap	0 (0:4)	0 (0:3)[a]	0 (0:3)[a]
Sum	14 (6:33)	11 (3:21)[a]	10 (0:19)[ab]

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

around six units of ΔE with a low concentrated gel. However, this effectiveness is similar to low concentration gels assisted by a LED/laser light. The gel used in this study comes with the alkaline components separated in two compartments that are self-mixed at the time of application, reducing the possibility of inactivation of the HP, perhaps representing an advantage in the effectiveness of the product compared with other forms of presentation.[24]

Regarding the variations in ΔE, the results of this study are in accordance with a previous study by Martin and others,[22] who also compared the effectiveness of 6% with 37.5% hydrogen peroxide. However, they modified both agents with nitrogen titanium dioxide and activation by LED light. However, Martin and others obtained one difference in that the values of ΔE were lower in both groups in the monthly control (2.41 units). Their 37.5% group obtained lower values than our 37.5% group, and their 6% group obtained better performance than our 6% group.

In addition, although there was a statistically significant difference between the two groups according to the objective spectrophotometer measurements, the difference in ΔE was less than four units and did not show a significant difference from subjective assessments using color tablets. Furthermore, no patient was unhappy with the results based on the subjective assessments. Notably, in this clinical study, the 6% gel did not require light assistance as in the trial published by Martin and others.[22] This reduces the cost of the treatment and is advantageous for the clinician.

In vitro studies have looked at reducing the concentration of the bleaching agent. There is a significant decrease in the penetration of HP and its byproducts through the mineralized tissues of the tooth to reach the pulp.[29] Consequently, the effects on the pulp tissue can be reduced, and tooth sensitivity can be avoided. This is why efforts have focused on demonstrating the effectiveness of new bleaching protocols and agents with lower concentrations.[10] Surely, future recommendations will involve the use of low concentrations for tooth whitening.

One of the strengths of this research in comparison with previous studies is the split-mouth design, which reduces the variability between the groups studied by using every patient as their own control.[23] However, there was no previous certainty that the results of both products would be similar.

The intensity and occurrence of sensitivity were low, which could be related to the use of both gels with a more neutral pH. This coincides with the results of a recent clinical trial that used the same gel with a concentration of 37.5%.[24] That study reported lower sensitivity than when using gels with a more acidic pH. Interestingly, there was no difference between the reported sensitivity between the two gels of different concentrations, which could be due to the strict selection of patients without previous history of sensitivity.

In general, traditional highly concentrated HP gels generate higher values of sensitivity in intensity and duration.[25] The literature reports prevalence of patients with sensitivity induced by dental whitening between 45% and 90% with moderate intensity and in some cases high.[30] However, the new lower concentrations of HP (15% or 6%) definitely report very low sensitivity both in prevalence and intensity.[7,9,10] Clearly the most common adverse effect of tooth whitening is being controlled by the emergence of new whitening gel technologies.

The second hypothesis was rejected because we noticed a positive effect on the psychosocial impact and on the esthetic self-perception of the patients. The study results showed that there were significant changes in the values of the PIDAQ and OHIP-14 questionnaires after comparing the scores prior to clinical whitening with those obtained after the procedure. This difference in values showed that there was a change in patients' psychosocial aspects. Thus, by improving the dental esthetics through whitening, there was a positive change in the psychosocial impact and self-perception of these patients. There were no significant differences between the post-treatment measurements. Therefore, it can be concluded that tooth whitening is a modifier of psychosocial aspects and the self-perception of esthetic dental factors. Once the procedure was over, there were no other esthetic changes.

Dental self-reliance measures the influence of esthetic dentistry on the self-image of an individual. The appearance of the mouth and smile play important roles in the assessment of facial attractiveness, which undoubtedly contributes to improving self-esteem.[31] The results of this study suggest that extracoronal tooth whitening produces an increase in dental self-confidence, which remains over time. This finding shows that this factor is associated with more favorable attitudes toward oral health and a higher degree of satisfaction with respect to better self-image.[32]

The measurement of social impact is aimed at assessing potential problems that an individual may face in social situations due to a subjectively unfavorable dental appearance. The third dimension of psychological impact evaluates an individual's feelings of inferiority or unhappiness in comparison to others. The fourth dimension concerns esthetics and includes data related to the concern or disapproval that an individual's dental appearance generates when they look at the mirror, photographs, or videos.[20] In terms of these three negative dimensions (social impact, psychological impact, and esthetic concerns), the results obtained show a decrease in scores when comparing data from the beginning of the treatment versus the assessments at one week and one month after whitening. Therefore, extracoronal tooth whitening generates an immediate and short-term positive psychosocial impact.

In the total scores obtained from the OHIP-14 questionnaire, there was a statistically significant decrease compared with the evaluation prior to whitening. This indicates that extracoronal whitening produces a substantial improvement in the self-perception of cosmetic dentistry in patients and a noticeable decrease in the dimensions of physical, psychological, and social disabilities, as well as physical pain and handicaps. These values decreased significantly with the treatment and show important implications in biopsychosocial health approaches, because the disadvantages experienced due to cosmetic dental problems may profoundly affect a person's self-esteem, interactions, adaptations to their environment, personal relationships, job opportunities, and fundamental aspects that affect quality of life.[32,33]

Regarding the dimension of functional limitation, the analyses showed a positive effect at just one month after treatment. No changes occurred after one week. This finding demonstrates that the effect is not immediate, and the patient requires interaction with their environment and a chance to build interpersonal relationships to accomodate this positive change.[34] This positive effect was maintained for at least three months. The dimension that had the greatest improvement was psychological discomfort. The improvement was observed at one week after completing treatment and remained constant during all subsequent evaluations. These improvements are consistent with the results obtained in a study from 2015, in which there were also improvements in the different dimensions of OHIP-14.[22]

Comparison processes play an important role in psychosocial well-being and feelings of inferiority to others, and they could result in dysphoric states.[35] This study showed that there is an increase in psychological well-being after tooth whitening, which remained steady over time. Whitening improves a patient's own self-satisfaction, and they feel better and safer when they have teeth with a color that pleases them. The PIDAQ and OHIP-14 tools demonstrated that there are positive changes in both the psychosocial well-being of patients and the self-perception of cosmetic dentistry at the end of the whitening period. These changes also remained at one and three months after treatment, which corroborates the hypothesis that the psychosocial impact and esthetic self-perceptions are positively changed by extracoronal tooth whitening.

It would be useful in future research to include comparative studies contrasting color changes after extracoronal tooth whitening (either through spectrophotometer or shadeguides) versus the changes in psychosocial aspects of cosmetic dentistry patients in the medium and long term. It would also be desirable to compare the psychosocial changes of patients in relation to the different techniques of extracoronal bleaching (in-office vs at home) and with different concentrations. The esthetic self-perception and psychosocial impact could also be compared among patients undergoing tooth whitening vs untreated patients. This would shed more light on whether the positive changes are due to bleaching and not other factors. Finally, future studies could use other questionnaires to measure whether there are improvements in the quality of life of a patient after undergoing tooth whitening. Although this study shows significant differences in quality of life measurements, it is recommended to carry out studies with controls of parallel groups of patients that are not subjected to tooth whitening to test the controlled effect on the quality of life.

CONCLUSIONS

Whitening with both 37.5% HP and 6% HP is effective according to measurements with a spectrophotometer. There was a statistically significant difference between the effectiveness of bleaching between concentrations starting from the second session of treatment.

There is a positive psychosocial impact in patients undergoing extracoronal tooth whitening when comparing the baseline measurements with those taken one week and one month after treatment. There is an increase of self-confidence and psychological well-being compared with the start of the

whitening with the measurements at one week and one month after treatment.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the approval of the Local Ethics Committee guidelines and policies of the Comité de Etica Fouch. The approval code for this study is 15/001.

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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