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Color stability, psychosocial impact, and effect on self-perception of esthetics of tooth whitening using low-concentration (6%) hydrogen peroxide

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Objective: The aim of this study was to assess the bleaching efficacy and impact on psychosocial and esthetics self-perception of a low-concentration (6%) hydrogen peroxide (H₂O₂) gel compared with a conventional (37.5%) H₂O₂ gel when used as an in-office treatment. **Method and Materials:** In total, 35 participants received two sessions of three 12-minute applications of treatment with 37.5% H₂O₂ on one side of the mouth and 6% H₂O₂ on the other. Color changes were measured objectively using total variation in color (ΔE) and subjectively using Vita Classical scale (ΔS_{GU}). The Psychosocial Impact of Dental Aesthetic Questionnaire (PIDAQ) and Oral Health Impact Profile (OHIP-14) esthetic questionnaires were administered to measure self-perception and the psychosocial impact

of the whitening procedure. **Results:** Both gels produced significant changes in tooth color at 1 and 3 months post-whitening. The objective efficacy (ΔE) of 37.5% H₂O₂ (9.06 ± 2.96) was significantly higher than that of 6% H₂O₂ (5.69 ± 3.06). The results of the subjective assessment were not statistically different. There was a positive impact on esthetic auto perception (OHIP-14, $P < .05$) and psychosocial impact (PIDAQ, $P < .05$) at the 3-month time point. **Conclusion:** Low concentration of H₂O₂ (6%) achieved effective bleaching ($\Delta E > 5$ units) with good stability at 3 months accompanied by a positive psychosocial impact and enhanced self-perception. However, the traditional 35% concentration was objectively more effective. (*Quintessence Int* 2018;49:557–566; doi: 10.3290/j.qi.a40468)

Key words: low concentration, OHIP, PIDAQ, quality of life, tooth bleaching

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Although dental whitening is a common procedure frequently requested by patients, concerns have been raised about the possible toxic effects of the procedure on pulp cells and its potential for tissue damage.¹ To address this issue the use of low-concentration bleaching gels has been proposed, and these have shown effective whitening power with very low post-bleach sensitivity. These reported systems need LED/laser activation and inclusion of nitrogenous Ti nanoparticles.^{2,3}



There are also a few reports evaluating the stability of tooth whitening, whose results are inconclusive because of the variability of subjective measurements.^{4,5} Similarly, there are only a few studies that discuss tooth whitening with respect to patients' quality of life.^{6,7} One of them concluded that tooth whitening produced positive psychologic effects in all patients evaluated.⁷

Because of the increased demand for cosmetic procedures, especially those relating to dental appearances, it is critical to evaluate patients' self-perceptions and the psychosocial impact of tooth whitening.⁸ Additionally, bearing in mind that the effect of whitening lasts up to or more than 1 year,⁹ it is important to assess the psychosocial effects beyond the first few weeks after whitening. Recent studies suggest that extracoronary tooth whitening can produce positive psychosocial effects and increase patients' self-perceptions.^{7,8} However, there are currently no reports of the medium-term psychosocial effects of using low concentration (6% hydrogen peroxide [H₂O₂]) gels or the effect on patients' self-perception.

This study evaluated the efficacy of a low-concentration (6% H₂O₂) gel in an in-office whitening procedure compared to a conventional 35% system using a split-mouth design; color stability was evaluated by regression at 1 and 3 months. Additionally, the psychosocial effects and effects on the patients' self-perception were evaluated immediately after whitening and compared to those at the 3-month follow-up.

This study tests two null hypotheses. Firstly, there will be no rebound of color after 3 months for patients treated with either the 6% or the 35% H₂O₂ gel. Secondly, there will be no psychosocial effects or change in patients' self-perceptions as a result of tooth whitening.

METHOD AND MATERIALS

Study design

This study utilized a double-blind, randomized, prospective clinical trial approach. The study was conducted as shown in Fig 1 according to the recommendations of CONSORT (Consolidated Standards of

Reporting Trials),¹⁰ and the principles of the Helsinki Convention. The study was approved by the ethics local committee (approval number 15/001) and registered with ClinicalTrials.gov (NCT03217994).

Sample selection

A total of 35 patients was selected from the clinic associated with the Faculty of Dentistry at the University of Chile. All patients had been seeking whitening treatment and volunteered to participate in the study. The selected patients met the inclusion criteria and signed informed consent forms adopted by the Ethics Committee of the Faculty of Dentistry. To be included in the study, all participants must have been older than 18 years (both sexes) and have:

- at least 6 maxillary anterior teeth
- no caries
- no restorations (specifically relating to the sample teeth to be whitened)
- a tooth color value of A3 or less (using the Vita Classical scale) as determined using a spectrophotometer (Vita Easy Shade Compact, Vita Zahnfabrik) on the middle third of the vestibular surface of the maxillary lateral incisors.

The following exclusion criteria were used:

- pregnancy or nursing mothers
- current pharmacologic treatment
- bruxism or a report of prior tooth sensitivity
- previous tooth whitening (either at home or professionally)
- visible dental cracks, developmental defects, or teeth that are stained by tetracycline or fluorosis
- treatment with fixed appliances
- periodontal disease or cancer
- presence of non-caries cervical lesions or endodontics in the sample teeth to be whitened.

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

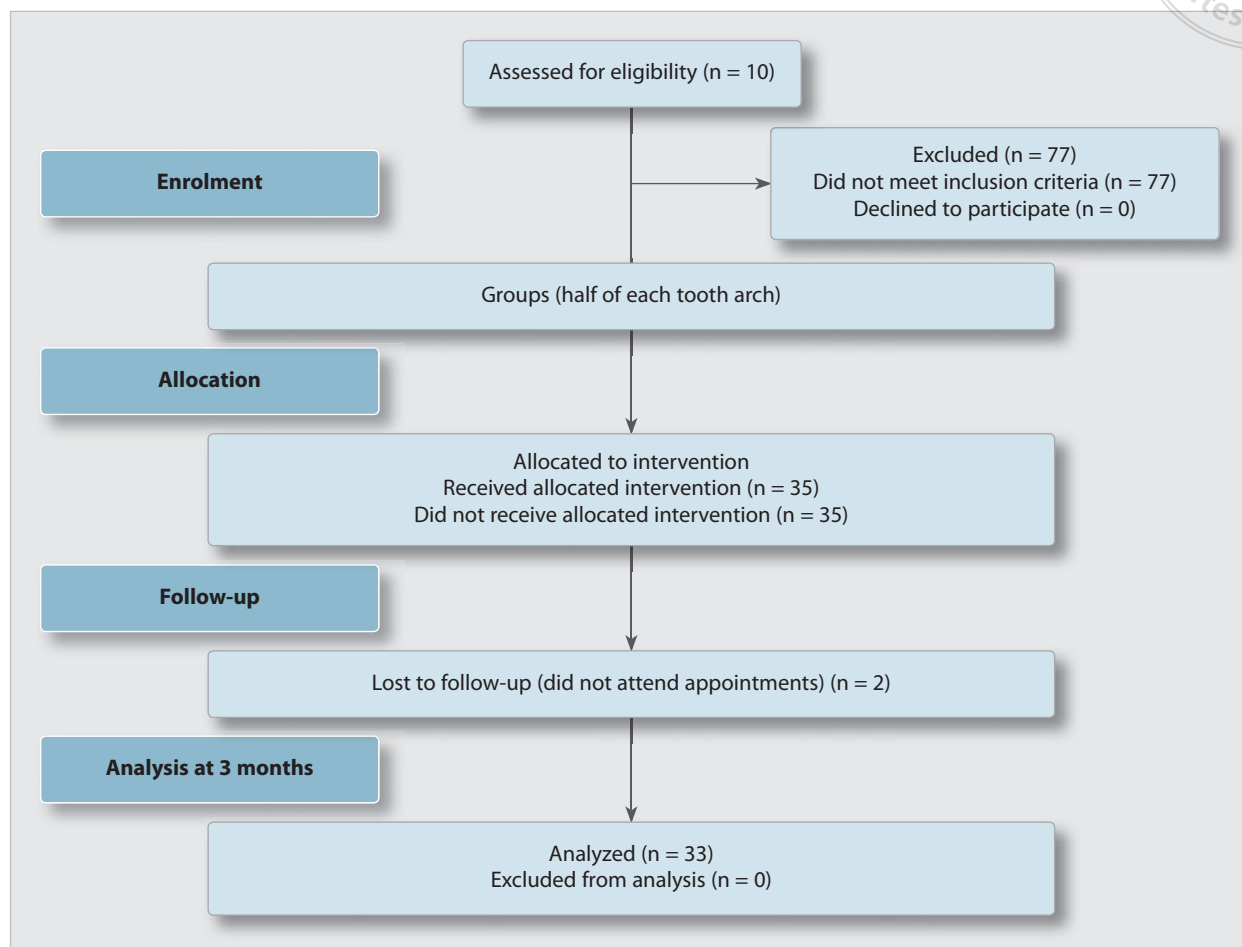


Fig 1 Flow diagram of the clinical trial.

Study location

Treatments were carried out at the clinic of the Faculty of Dentistry of the University of Chile where participants were supervised by the research team.

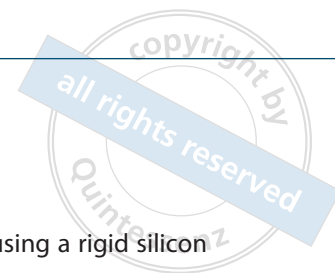
Determination of study group

The study was carried out using a split-mouth design,¹¹ with 37.5% H₂O₂ (Polaoffice+ 37.5%, SDI Limited) and 6% H₂O₂ (Polaoffice+ 6%, SDI Limited) as bleaching agents. Bleaching agents were randomly (parallel groups) calculated and assigned (SPSS 21, IBM) to each half arch (canine, lateral and central incisors) of each participant. The operators (two) were unaware of the product being used. To achieve this, auto-mix syringes from a Polaoffice+ in-office tooth

whitening system were used (SDI Limited). The syringes contained H₂O₂ (at a concentration of either 37.5% or 6%) in the form of a thixotropic gel. Each gel syringe was re-labeled with a key number depending on the H₂O₂ concentration of the gel by a third operator who was unaware of the protocol. All color measurements were performed on the maxillary central incisors by different operators than those who performed the whitening procedure.

Preliminary phase

All procedures were verbally explained to each participant, who then read and signed an informed consent form. For each participant, a heavy silicone matrix (Speedex Putty, Coltene Whaledent) was prepared for



both maxillary central incisors. These matrices were perforated at the height of the union between the cervical third and middle third of the vestibular tooth face; perforations helped to standardize color measurements and 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 a spectrophotometer (Vita Easy Shade Compact, Vita Zahnfabrik), which was previously calibrated according to the manufacturer's instructions.

Whitening protocol

For each participant, two whitening sessions were performed, separated by a 1-week interval. At the beginning of each session, dental prophylaxis was performed with a brush at low speed. A stone pumice and water were used to remove the surface layer from the enamel of the maxillary anterior teeth so that it would not alter the efficacy of the bleaching gel. A plastic lip separator and a light-cured blue resin gingival barrier (Gingival Barrier, SDI Limited) were used to protect the soft tissue. The bleaching gels were applied homogeneously to the vestibular surfaces of each half arch.

The protocol included three applications of bleaching gel for 12 minutes each (72 minutes of total contact). The gel was in full contact with the surface of the teeth during treatment; between each application, the gel was removed with cotton rolls moistened with water and the teeth were dried carefully. At the end of the third application, the gel was removed, using plenty of water to wash off excess gel, and the gingival barrier was removed.

Controls

At the end of the first session, tooth color was measured using a calibrated spectrophotometer (Vita Easy Shade Compact, Vita Zahnfabrik), which has been shown to have high reliability.¹² Reproducibility was verified by measuring the tooth color three times. If the readings were similar, the value was registered as definitive. In the case of any difference, the procedure was repeated, verifying the right position of the spectro-

photometer, which was stabilized using a rigid silicon matrix.

To assure the validity, before each use the spectrophotometer was calibrated to a block of white ceramic, according to the protocol indicated by its manufacturer.

The same protocol of measurement was repeated 1 week, 1 month, and 3 months after the last whitening session.

Tabulation of data

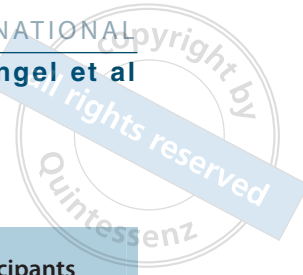
Data obtained at each time point were tabulated according to the three axes of the CIELAB system (L*, a*, and b*). ΔE was also calculated using the Pythagorean theorem as follows:

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

Variation of each parameter at different time points was calculated in relation to the initial value (ie, the color measurement prior to the first session of whitening).

Subjective evaluation

The Vita Classical shade guide (Vita Classic, Vita Zahnfabrik), which measures the color of a tooth ranging from lightest (B1) to darkest (C4), was used as a subjective evaluation. Although the Vita Classical scale is not linear in the truest sense, the changes were treated as if they represented a continuous and linear ranking as in previous clinical trials evaluating dental whitening.¹³ The perceptibility threshold considered was 2.7 ΔE tones to initial selection of evaluators (determined previously).¹⁴ Two selected observers were calibrated using ten permanent teeth (central incisors) from five patients. Evaluation of color was performed separately. The procedure was repeated until they reached a Kappa value of .85. They recorded the shades of both central incisors for each participant at baseline, at each session, 1 week after treatment, and 3 months after treatment. The color was registered over the middle third of the labial surface as established by the American Dental Association guidelines.¹³ The difference in tooth color was calculated as the number of shade guide units that the tooth changed towards the lighter end of the guide (ΔSGU). At the 1-month time point, tooth color was evaluated after dental prophylaxis and a waiting period of 15 minutes for rehydration of the teeth.



Assessment of the psychosocial impact and self-perception

Before the tooth whitening procedure, participants completed two questionnaires: the Psychosocial Impact of Dental Aesthetic Questionnaire (PIDAQ)¹⁵ and the Oral Health Impact Profile (OHIP-14)¹⁶ for dental esthetics. The questionnaires were completed under the supervision of an examiner who was available to answer any participant questions.

Sample size calculation and data analysis

The sample size (N) was based on a similar study considering ΔE changes as the main outcome, where 6% and 35% H₂O₂ concentrations were used, but with other catalyzed chemical reaction systems (LED/laser), and using a split-mouth design.¹⁷ A minimum N of 25 patients was used. A significance level of 5% was considered at (1-β) .90 with a drop-out rate of 30% considering a long-term follow-up, resulting in a final N of 35 patients.

Data were tabulated and the Shapiro-Wilk test was conducted to analyze data distribution. The Shapiro-Wilk test identified a non-normal distribution for both the PIDAQ and the OHIP-14 data, obtained both before whitening and at both time points subsequent to treatment (*P* < .05). For this reason, nonparametric statistics were used to analyze the data. Mann-Whitney test was used to compare the efficacy and sensitivity of the results in each group. Descriptive statistics of the PIDAQ and OHIP-14 esthetic survey scores were determined, and the results for each time point were compared using the Wilcoxon test. With the exception of selected demographic variables such as age and sex, the data were coded and treated anonymously. Data were analyzed statistically using SPSS 25.0 (Lead Technologies). The data were considered statistically significant when *P* < .05.

RESULTS

Descriptive sample statistics

The total number of participants analyzed at 3 months was 33, and the average age of each participant was 27.11 years (range 20–54 years, standard deviation

Baseline features	Groups	
	H ₂ O ₂ 37.5%	H ₂ O ₂ 6%
Age (years; mean ± SD)	27.36 ± 9.28	
Minimum age (y)	20	
Maximum age (y)	53	
Male (%)	51.5	
*L (mean ± SD)	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 (mean ± SD)	9.55 ± 1.06	9.52 ± 1.06

SD, standard deviation.
*Statistically significant between groups (*P* < .05).

[SD] 9.33). The participants consisted of 17 men and 16 women; other participant characteristics are summarized in Table 1.

Efficacy values

Significant changes in tooth color were noted for both H₂O₂ concentrations at 1 and 3 months posttreatment compared to baseline. The values measured for both subjective and objective measurements (ΔSGU and ΔE) were similar; however, 37.5% H₂O₂ gel whitened the teeth significantly lighter than the 6% H₂O₂ gel. The difference between groups in ΔL, Δa, and Δb was statistically significant, and that significance was maintained up to 3 months post-whitening (Table 2).

PIDAQ values

Dental self-confidence improved significantly between baseline and 1 week (*P* < .001), 1 month (*P* < .001), and 3 months (*P* < .001) after treatment. Social impact decreased significantly between baseline and 1 week (*P* = .019), 1 month (*P* < .001), and 3 months (*P* = .019) after treatment. There were also significant differences in social impact between assessments made at 1-week post-whitening and those made at 1 month (*P* = .036) and 3 months (*P* = .031) post-whitening. Similarly, the psychologic impact decreased between baseline and 1



Table 2 Comparison of ΔSGU, ΔE, ΔL, Δa, and Δb values at different time points (mean ± SD)

Assessment points	Color change by ΔSGU			Color change by ΔE			Color change by ΔL			Color change by Δa			Color change by Δb		
	37.5% H ₂ O ₂	6% H ₂ O ₂	Mann-Whitney test	37.5% H ₂ O ₂	6% H ₂ O ₂	Mann-Whitney test	37.5% H ₂ O ₂	6% H ₂ O ₂	Mann-Whitney test	37.5% H ₂ O ₂	6% H ₂ O ₂	Mann-Whitney test	37.5% H ₂ O ₂	6% H ₂ O ₂	Mann-Whitney test
Baseline vs. 1 month after bleaching	6.71 ± 1.83	5.87 ± 1.84	.037	9.06 ± 2.96	5.69 ± 3.06	<.001	4.76 ± 3.61	2.92 ± 3.19	.026	-2.03 ± 1.30	-1.10 ± 0.85	.001	-6.30 ± 3.18	-3.40 ± 3.14	<.001
Baseline vs. 3 months after bleaching	6.14 ± 1.86	5.55 ± 1.93	.043	9.11 ± 4.89	5.47 ± 3.27	<.001	4.33 ± 3.30	1.76 ± 3.20	.003	-1.24 ± 3.78	-1.15 ± 1.10	.007	-0.31 ± 4.72	-3.66 ± 3.43	.002

week ($P < .001$), 1 month ($P < .001$), and 3 months ($P < .001$) posttreatment. Finally, esthetic concern decreased significantly between baseline and 1 week ($P = .002$), 1 month ($P = .001$), and 3 months ($P = .009$) post-whitening (Table 3).

OHIP-14

Significantly lower scores were measured for all OHIP-14 dimensions at both 1 and 3 months post-whitening compared to baseline ($P = .001$). When summed, OHIP-14 scores were significantly lower at 1 week ($P < .05$), 1 month ($P < .05$), and 3 months ($P = .001$) post-whitening compared to baseline. There were no significant differences between the values measured at 1 and 3 months post-whitening ($P > .05$). Regarding each dimension, psychologic discomfort ($P = .026$) and physical ($P = .03$), psychologic ($P = .02$), and social disability ($P = .017$) scores were significantly lower at 3 months post-whitening, whereas physical pain ($P = .02$), handicap ($P = .03$), and functional limitations were significantly lower at 3 months post-whitening (Table 4).

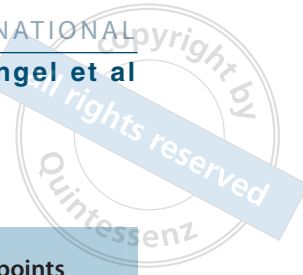
DISCUSSION

This study aimed to evaluate the efficacy of a low-concentration (6%) H₂O₂ gel in a compromised split-mouth design compared to the standard 37.5% H₂O₂ gel. Both gels achieved good color change that was stable after

3 months, increased participants’ esthetic self-perception, and had positive psychosocial effects.

Both the low and standard concentrations of H₂O₂ gel showed good stability without significant rebound of the dental color at 3 months’ follow-up. Therefore, the first null hypothesis was not rejected. These results indicate that there was no influence of H₂O₂ concentration on the rebound of the color during the follow-up period. Although there were color differences detected by the spectrophotometer, there were no differences detected by the operators using the Vita Classical scale. In addition, participants were promised that if there were differences between the half arches after treatment, the research team would match the colors. Only one participant requested a re-whitening treatment, indicating that although the spectrophotometer identified a change in color, there was not a perceived color change by the participant, even when comparing adjacent teeth. These observations are likely due to the perceptibility threshold of the operators and participants, which can contribute to difficulty and lack of precision when making measurements.¹⁸

The relevance of this study relies on the evidence it provides to support the affirmation that it is possible to use lower concentrations of gel (6% H₂O₂), applying a standard protocol, to obtain an effective teeth whitening. The variation in whiteness was not directly proportional to the concentration of gel used, a precept



employed as the basis for the design of traditional whitening systems.¹⁹

The methodology of treating patients with a split-mouth arrangement was risky but represents the best way to compare a traditional whitening system versus an innovative one.⁷ In this case, the design allowed demonstration of objective but not clinical differences, reaffirming the statement that apparently it is enough to use a system of low concentration H₂O₂ to achieve effective teeth whitening with a positive psychologic impact.

Given the results of the present study, and despite the better whitening effect achieved by the gel of higher concentration of H₂O₂ using a standard protocol, it is reasonable to expect that modifying the protocol of use by increasing the time of action, would allow the lower concentration gel to reach similar whitening efficacy.

Furthermore, the use of a H₂O₂ gel of low concentration will provide a safer biologic choice, since a growing number of studies warn of potential dental injury caused by higher concentration gels.¹

Even though the sensitivity report was not an objective of this manuscript, it can be reported that only four patients experienced this discomfort (8.25% of absolute risk), and that the mean sensitivity after the first session according to visual analog scale (1 to 10 scale) was 0.4 in the 37.5% group and 0.4 in the 6% group. The difference between groups was not statistically significant ($P > .05$). The sensitivity of this cohort of patients was low in both intensity and incidence. It is surprising that the sensitivity is similar for both groups, and this could be related to the strict criteria used for the selection of patients, which are not always applicable to all patients requesting teeth whitening. These results are in agreement with those of a recent systematic review, which concluded that the sensitivity induced by bleaching is an unsolved problem.²⁰

The positive psychologic effect shown in the present study definitively reveals the welfare improvement experienced by patients after tooth whitening. Historically, esthetic treatments were considered nonessential by the World Health Organization. However, considering that these treatments have a definite impact on

Table 3 PIDAQ results at different time points [expressed in median values (minimum/maximum)]

Dimension	Time points		
	Baseline	1 mo after bleaching	3 mo after bleaching
Dental self-confidence	18 (10/63)	23 (16/30)*	23 (13/27)*
Social impact	17 (9/34)	13 (8/29)*	14 (8/26)*
Psychologic impact	19 (8/28)	13 (6/23)*	12 (6/22)*
Esthetic concern	7 (3/15)	5 (3/10)*	6 (3/12)*
Sum	60 (44/86)	55 (36/75)*	54 (36/71)*

*Statistically significant difference (Wilcoxon test, $P < .05$) versus baseline.

Table 4 Effect of bleaching in the esthetic self-perception evaluated with the OHIP questionnaire [expressed in median values (minimum/maximum)]

Dimension	Time points		
	Baseline	1 mo after bleaching	3 mo after bleaching
Functional limitation	3 (0/7)	2 (0/6)*	2 (0/6)*
Physical pain	3 (0/7)	2 (0/6)*	2 (0/5)
Psychologic discomfort	4 (0/7)	3 (0/5)*	3 (0/5)*
Physical disability	1 (0/6)	1 (0/2)*	0 (0/2)*
Psychologic disability	1 (0/5)	0 (0/3)*	1 (0/3)*
Social disability	0 (0/4)	0 (0/2)*	0 (0/2)*
Handicap	0 (0/4)	0 (0/3)*	0 (0/2)*
Sum	14 (6/33)	10 (0/19)*	11 (1/18)*

*Statistically significant difference (Wilcoxon test, $P < .05$) versus baseline.

psychosocial aspects and personal self-perception, it can be seen that they are in line with the new definitions of health, which include psychologic well-being, a definition recently adopted by the International Dental Federation.²¹



In this sense, tooth whitening is a treatment for achieving not only color change, but also positive improvement of a patient's psychologic aspects and confidence.

The study results showed that there were significant changes in PIDAQ and OHIP-14 scores after whitening compared to baseline, indicating that whitening had a positive psychosocial impact on participants and enhanced esthetic self-perception. Therefore, the second hypothesis was rejected.

By contrast, there were no significant differences between the posttreatment measurements, suggesting that there were no additional esthetic changes once the procedure was complete.

Dental self-reliance, the positive dimension measured by PIDAQ, measures the influence of esthetic dentistry on the self-image of an individual. The appearance of the mouth and smile play an important role in the assessment of facial attractiveness, which no doubt contributes to improving self-esteem.²² The results of this study suggest that extracoronal tooth whitening produces an increase in dental self-confidence, which is sustained 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 self image.¹⁵

The PIDAQ measures an additional three negative dimensions of psychosocial impact: social impact, psychologic impact, and esthetic concern. Social impact aims to assess potential problems that an individual may face in social situations due to a subjectively unfavorable dental appearance. Psychologic impact evaluates an individual's feelings of inferiority or unhappiness when compared with others. Esthetic concern includes data regarding the concern or disapproval that an individual's dental appearance generates when that individual faces the mirror or views photographs and/or videos.²³ In terms of these three negative dimensions, the results obtained from this study show a decrease in scores at 1 week and 1 and 2 months' post-whitening compared to baseline. Therefore, extracoronal tooth whitening generates a positive psychosocial effect, both immediately and in the medium

term. It is therefore important to keep track of these treatments.

Regarding the OHIP-14, a statistically significant decrease was observed in scores at all time points post-whitening compared to baseline. This indicates that extracoronal tooth whitening produces a substantial improvement in self-perception of patients and a noticeable decrease in the dimensions of physical, psychologic, and social disabilities; physical pain; and handicap. These values decreased significantly with treatment and provide important biopsychosocial implications, as disadvantages experienced by a person due to cosmetic dental problems may profoundly affect his/her self-esteem, interactions, environmental adaptations, personal relationships, job opportunities, and fundamental aspects affecting quality of life.²⁴

Regarding functional limitation, positive effects were measured 1 month post-whitening, but not 1 week post-whitening. This finding demonstrates that the effect of tooth whitening on functional limitation is not immediate, and that the patient requires interaction with the environment and the chance to build interpersonal relationships to accommodate this positive change.²⁵ However, once established, this positive effect is maintained for at least 3 months. The dimension with the greatest improvement as a result of tooth whitening was psychologic discomfort. This improvement was observed 1 week posttreatment and persisted throughout 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 the esthetic OHIP-14 in response to tooth whitening.⁷

The fact that all OHIP-14 dimensions improved 3 months post-whitening compared to previous whitening measurements suggests that psychosocial effects are not only immediate, but that esthetic interventions could have an effect in the medium term as well.²⁶ In a recent study, significant differences in PIDAQ subscales and a subset of OHIP-14 dimensions (functional limitation; psychologic discomfort; and physical, psychologic, and social disabilities) were observed up to 9 months post-extracoronal tooth whitening.³ These findings



indicate that the effects of tooth whitening (both psychosocial effect and effects on self-perception) may be sharper and deeper in the medium term than immediately after treatment.

It is known that comparing oneself to others can play an important role in psychosocial well-being, and feeling inferior to others and could result in dysphoric states.²⁷ This study shows that there is an increase in psychologic well-being after tooth whitening and that this persists over time. Whitening improves patients' own self-satisfaction; patients feel better and safer when they are pleased with the color of their teeth. The tools used in this study (PIDAQ and OHIP-14) demonstrate that there are positive changes in both the psychosocial well-being of patients and the self-perception of cosmetic dentistry after tooth whitening, and that they persist for up to 1 and 3 months after treatment, which corroborates the hypothesis that extracoronal tooth whitening has a positive effect on psychosocial well-being and esthetic self-perceptions. Many studies show that patients use tooth color as a factor in determining satisfaction with their dental appearance.^{28,29} Similarly, tooth discoloration can decrease a patient's self-fulfillment, resulting in harmful effects to the patient's emotional state.¹⁵ It can be concluded that the color of an individual's teeth critically influences patient satisfaction with the appearance of his/her smile. This conclusion complements the results obtained in the present study, which showed that whitening not only influences patient satisfaction with his/her appearance but also positively effects a patient's self-perception and promotes psychologic well-being.

The available literature on the self-perception of esthetics and psychosocial impact generated by tooth whitening is limited. There is more literature available in the area of orthodontics.^{23,30} Thus, more research is needed to support the present findings related to self-perception and the psychosocial impact of tooth whitening.

Future research should include studies that compare changes in tooth color, identified through spectrophotometer or color card, with changes in the psychosocial well-being of patients related to cosmetic

dentistry in both the medium and long term. It would also be interesting to evaluate the psychosocial effects of different extracoronal tooth whitening techniques (ie, in-office versus at-home) using different concentrations of bleaching gel. To isolate the effects of tooth whitening, a comparison of the psychosocial impact and effects on esthetic self-perception among patients undergoing tooth whitening versus untreated patients should be performed. Finally, the effects of tooth whitening should be further evaluated using other questionnaire types that measure, for example, improvements in a patient's quality of life.

CONCLUSION

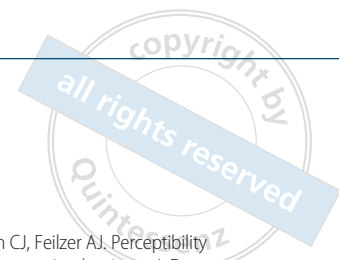
Low concentration (6%) and traditional concentration (37.5%) H₂O₂ gels were effective and stable up to 3 months post-whitening, maintaining the color difference between both half arches. A positive psychosocial effect was measured in patients undergoing extra-coronary whitening at 3 months posttreatment. Additionally, there was an increase in self-confidence and psychologic well-being at 3 months posttreatment when compared to the start of the whitening treatment.

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