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EVALUATION OF DENTAL WHITENING TREATMENT TO MOTIVATE USE BY PERCEIVED EFFICACY

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ABSTRACT

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Introduction This study assesses the effectiveness of a whitening treatment by analyzing the variations in the color of the tooth surface using a spectro-photometer that employs the CIE "L*a*b*" system.

Methodology A Professional Motivational Kit containing 6% hydrogen peroxide whitening gel and blue covarine toothpaste was used on a sample of 30 subjects. Six applications were performed, two per day, and at the end time-point two (T2) was taken. The results of the treatment were analyzed with a spectrophotometer. After an initial detection using the L*a*b*, executed at baseline (T0), the whitening product was applied for 10 minutes. The L*a*b* values were then detected at time one (T1). Six applications were performed, two per day, and at the end time-point two (T2) was taken. A statistical analysis was carried out.

Results The results showed a positive ΔE (> +2) after the sixth application. A statistically significant variation in the colorimetric parameters L*, a*, b* with Test T < 0,05 was observed for all the parameters (p<0,05).

Conclusion Our study demonstrated that the whitening treatment with 6% hydrogen peroxide whitening gel and blue covarine toothpaste has immediate positive effects.

KEYWORDS

Dental; Dental Care; Dental Equipment; Esthetic Dentistry; Vital Tooth Bleaching.

1. INTRODUCTION

Smiling plays a decisive role in social interactions. Given that smiling entails revealing one's teeth, the whiteness of the teeth and their good state of health are essential for self-esteem and self-confidence [1,2]. A smile should also communicate strength and confidence. Consequently, a 'perfect' smile is thus not only sought after by adolescents and young people as part of their social media requirements, but also by leaders and those who work in the public domain. In fact, the literature highlights how a strong clear color of the teeth gains greater social appeal than smiles that show teeth with a more natural color [3]. In particular it is reported that physical appearance has a very important role in human social interactions. The face is usually considered the social card presentation, even if in some cases a severe body disfigurement can be an important obstacle. Considering the face, the eyes and mouth are the most important elements. People's smiles are thought to be the major components determining the attractiveness of the facial aesthetics. This is why in the dental field, whitening is in very high demand, with a market growing by 15% every year [4].

The color of the teeth is determined by the intrinsic feature and by extrinsic elements like stains that can form on the external surface of the teeth. The intrinsic color of teeth is influenced by how light is scattered and absorbed at the surface and within the structure of the teeth. The perception of teeth color is determined by the enamel which is a scattering trans-lucent material. In some cases enamel is not able to cover the underlying dentine enough; this can influence the overall perception of the color of the teeth.

Whitening can be performed with various methods: the most commonly used one are those used by professional dental clinics and in-home whitening kits. There are also numerous options on the choice

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of product and application times, which is why it is necessary to choose the one most suited to the individual and to the dentist's clinical experience [5]. Tooth whitening products help to improve the aesthetic and whiteness of the elements by improving the intrinsic color of teeth and in some cases removing the extrinsic stains. These can be even taken off by the abrasive and polishing action of dental prevention.

Home whitening products treat discolored teeth in a discreet and non-invasive way, but which is also effective, thanks to the use of hydrogen peroxide-based products (HP) and carbamide peroxide (CP). Although the action of hydrogen peroxide and its effect on enamel and dentin have not been fully understood yet [6], it permeates these tissues and produces free radicals that break down the pigmented molecules and create a whitening effect. A whitening agent based on low hydrogen peroxide concentration has a positive aesthetical impact [7] and also gives good clinical results, with fewer side effects than those products at high concentrations [8]. Carbamide peroxide's activation depends on a reaction with water that determines the production of active components that permit the whitening process. When performing home whitening with peroxide of hydrogen, the only documented side effect is a slight and transient hypersensitivity, which ceases at the end of the procedure [9-11]. In relation to the use of whitening products, the use of products containing bleaching agents with concentrations of less than 0.1% peroxide of hydrogen, as adjuvants to therapy is widely used.

The effectiveness of toothpaste whiteners is still under debate. However, recent studies have shown that toothpaste whiteners containing blue covarine show a whitening effect from the first use, with a statistically reduced yellowing of the teeth [12]. Thus although there are numerous techniques, products and whitening agents for improving the aesthetics of patients, not all whitening treatments are suitable for everyone [13] and they should only be used as part of a comprehensive treatment plan developed by a dentist after a thorough oral examination [14].

The aim of this study was to assess the effectiveness of the motivational whitening kit named "White Beauty Professional Motivational Kit" with White Now toothpaste (Miromed - Mentadent, Unilever, Italy).

2. MATERIALS AND METHODS

The product is an athome whitening system packaged in vials containing 1ml of whitening gel, with a 6% concentration of hydrogen peroxide. Thanks to its highly viscous consistency, the whitening gel can be spread homogeneously over the entire tooth surface, thus reducing the risk of ingestion. Furthermore, it contains water, which prevents dehydration of the dental elements. The kit also contains a whitening toothpaste with blue covarine, used as adjuvant during the treatment.

Informed consent was obtained and signed by all participants, explaining all the information about the product, the procedures carried out and the possible complications, as well as the instructions for the application of the product.

The protocol was reviewed and approved by the local Ethical Committee (nº 0111335 University of Insubria, 21100 Varese VA, Italy 23/12/2022).

In order to ensure an objective evaluation of the color differences obtained after using the whitening product in question, a spectrophotometer was used (SpectroShade micro, MHT, Italy). The color variation in the vestibular surfaces of the central upper incisors was analyzed before, during and after the whitening. For the application of the product, the protocol consisted in the application of the whitening gel on the buccal surface of selected teeth, twice a day for three days.

The degree of subjective satisfaction was evaluated through an anonymous questionnaire for all participants.

The study sample consisted of 30 subjects. The inclusion criteria were as follow:

- age between 18 and 50
- periodontal Screening Record (PSR) of 1 or 2
- good state of oral health
- absence of previous whitening treatment in the past 24 months

The exclusion criteria were:

- presence of systemic diseases
- patients in pharmacological treatment
- hypersensitivity to the active ingredient contained in the product
- anomalies of dentin development or accentuated intrinsic dyschromia such as amelogenesis imperfecta, fluorosis or tetracyclines
- patients with fixed orthodontic appliances or nocturnal retainers
- patients with prosthetic elements
- smokers (>10 cigarettes/day)

For each patient, the buccal surfaces of the four upper incisors were treated twice a day for 3 days. The 6% hydrogen peroxide gel was applied on the vestibular surface for 10 minutes. The CIELAB color space (also known as L* a* b*) was then recorded using the spectrophotometer.

Three parts of each tooth were analyzed: the incisal third, the middle third and the gingival third. The measurements were recorded at three different times: before the treatment (T0), after the first application (T1), and at the end of the treatment (T2). Before starting the procedure, the subjects brushed their teeth thoroughly using the toothpaste included in the kit. A frontal digital photograph was acquired using a digital camera, and the spectrophotometer was then used to detect the parameters of value, chroma and hue for the upper incisors at incisal, middle, and gingival level [14,15]. The subjects were given all the information they needed to carry out the home treatment.

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At the end of the procedure, a satisfaction questionnaire on the treatment was carried out, to evaluate the difference between objective evaluation and subjective perception of the results.
The following questions were asked:
Did you notice a change in tooth color?
Did you experience gum irritation and dentinal hypersensitivity?
Did you feel more motivated to take care of your smile?
Would you recommend the treatment to your family, friends and acquaintances?
Did you find it difficult to follow the instructions of the treatment?
SpectroShade Downloader® and SpectroShade Database® were used to create an archive of the images.
Descriptive and statistical analysis was performed using Microsoft Excel (Microsoft Corporation, Redmond, Washington, USA), and the statistical significance was set at $p<0.05$. For the descriptive analysis, the formula $\Delta E = (\Delta L2 + \Delta a2 + \Delta b2)^{1/2}$ was applied for each tooth at incisal, middle, and gingival level. In detail, ΔL represents the difference of two L* values, Δa the difference of two values a* values and Δb the difference of two b* values. This formula represents the distance between two points in the color space and expresses the overall color difference between two samples, indicating an objective measurement. Accordingly, it was possible to calculate the color difference (ΔE) of two spectrophotometric measurements: between T0 and T1 and between T0 and T2.

3. RESULTS

The spectrophotometric results showed an overall increase in L * of +1.11, while a decrease in a * of -0.66 and a decrease in b * of - 1.52 were observed after the sixth application (T2). (Tab. 1)

Table 1. L*a*b* variations between T0-T1 and T0-T2. (* p<0,05).

	Δ1	Δ2
L*	0,317 (S.D. 0,21)*	1,11 (S.D. 0,44)*
a*	-0,364 (S.D. 0,25)*	-0,66 (S.D. 0,32)*
b*	-0,756 (S.D.0,56)*	-1,52 (S.D. 0,86)*

After the first application, an increase in L* of +0,317 was recorded, while there was a decrease in a* of -0,36 and in b* of -0,76. An ΔE of +1.87 was observed after the first application (between T0 and T1) (Fig. 1) and of +2.71 after the sixth application (between T0 and T2) (Fig. 2). The descriptive analysis (ΔE) of the experimental study showed a clinically detectable color change only after the sixth application (T2), in fact an ΔE> 2 was obtained only between T0 and T2 (Tab. 2).
The L * values showed a significant increase, while a * and b * decreased significantly after whitening. The results show a homogeneous change in tooth color throughout the sample, with few outliers.

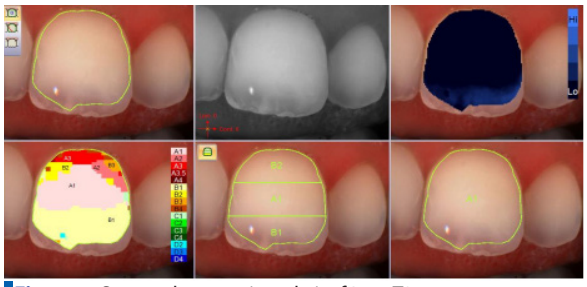

Figure 1. Spectrophotometric analysis of 2.1 at T0 .

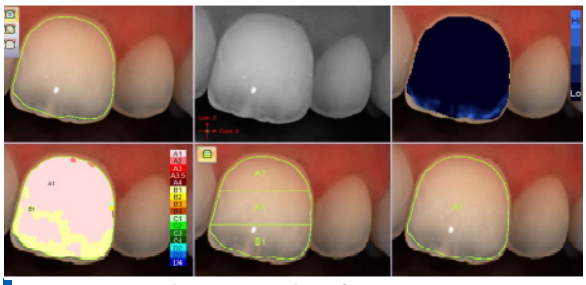

Figure 2. Spectrophotometric analysis of 2.1 at T2.

The statistical analysis was performed with a Student Test and reported that the variations of colorimetric parameters L *, a *, b *, between T0 and T1 and between T0 and T2 (Figure 3), presented a p-value not statistically significant (> 0.05). The only exception was for L * after the first application.

Table 2. ΔE variations of the L*a*b* parameters beteween T0-T1 and T0-T2.

	Δ1	Δ2
Incisal	1,94 (S.D. 0,83)	2,84 (S.D. 0,78)
Medial	1,80 (S.D. 0,76)	2,57 (S.D. 1,12)
Gingival	1,86 (S.D. 0,96)	2,71 (S.D. 1,01)
ΔE	1,87 (S.D. 0,91)	2,71 (S.D. 0,94)

The satisfaction questionnaires were filled in by all participants and gave a Likert scale from 0 (not at all) to 10 (very) in terms of satisfaction. The results were encouraging: more than 50% of the subjects noticed a change in the tooth color with an average Likert Scale of 7.36.

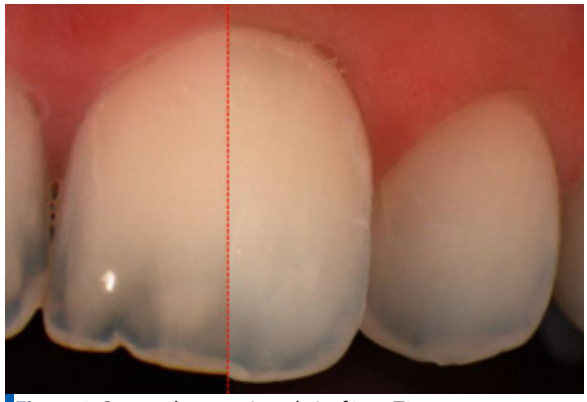

Figure 3. Spectrophotometric analysis of 2.1 at T2.

A total of 80% of the participants did not experience gum irritation and dentinal hypersensitivity and 83% said they were now much more motivated to "take care of their smile" and they would all recommend the treatment to family, friends and acquaintances.

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Almost 90% of the participants did not find it difficult to follow the directions during the treatment, which was carried out without complications. Finally, the whitening treatment was well tolerated by most of the patients.

Over the past twenty years, scientific research on teeth whitening has increased notably [13] and the use of home whitening treatments is increasing. The scientific literature claims that a hydrogen peroxide-based whitening agent in low concentrations can achieve good clinical outcomes with less adverse effects compared to treatments at high concentrations [8]. Furthermore, the application of color science in dentistry has enabled the precise description of the ideal color and whiteness of the teeth. Progress in instrumental measurement means that the reproduction of these parameters is quantifiable and reliable [16]. Other studies confirmed that color variation, evaluated as ΔE, is considered clinically significant and it is perceived by the subject only when it appears to be greater than +2.14 [17].

This evidence is also supported by our findings that revealed a clinically significant ΔE, at a rate of +2.71 after six applications of the product. Despite the minimal variation, the perception of the change was expressed by all the patients in the satisfaction questionnaire.

4. DISCUSSION

In our study we observed that this whitening product produced a significant increase in L * (+ 1.11) and an excellent reduction of parameters a * (-0.66) and b * (-1.52), leading to an increase in the clarity of the color of the teeth and a decrease in the red and the yellow rate. Indeed, the degree of satisfaction is more related to the variations of b * rather than of L * or a *, thus the reduction of yellow is of primary importance for evaluating the effectiveness of whitening products [16].

In accordance with the spectrophotometric and descriptive analysis (ΔE), which highlighted encouraging results in the clinical efficacy and in the subjective perception, the statistical analysis revealed that the whitening treatment produce statistically significant results with a p-value> 0.05 for the L * a * b * parameters at T0, T1 and T2.

These results agree with Sarrett et al. [13], who highlighted how the whitening treatment does not follow fixed rules, but is influenced by physiological and non-physiological variables, such as age, sex, quality and quantity of dental tissues, diet, bad oral hygiene, and lifestyle.

According to other studies, dental hygiene and periodontal health are fundamental prior to any whitening treatment and other dental procedures, especially for orthodontics and surgery [18].

The spread of bleaching products in commerce need to raise awareness as to their benefits and effects: the study of Basheer et al. [19] observed that over the counter bleaching agents improve teeth color in a similar way to at home bleaching but they both could leave the enamel surface slightly rough.

Estay et al. stated that 6% hydrogen peroxide is an effective bleaching agent with a valid one year follow up, and could provide a positive psychosocial impact on patients.

In conclusion, our study highlighted the effectiveness of the whitening product starting from the first application (T1), which led to an increase in the L * parameter and a decrease of a * and b *. Furthermore, all the subjects enrolled in this study were satisfied with the result obtained.

Our results highlighted that in order to increase psychophysical well being, the whitening treatment needs to be tailored to the patient, in order to achieve significant results not only at a clinical level, but also at a statistical level.

The study has some limitations: firstly, the small size of the sample, but also the fact that the starting colors of the teeth treated differed from patient to patient. Further studies are needed to confirm the findings.

5. CONCLUSION

Our study demonstrated that the whitening treatment with "White Beauty Professional Motivational Kit" has immediate positive effects.

It shows good clinical results after the sixth application, regardless of the starting color and moreover, it leads to an increase in L * (clarity) and to a decrease in the a * and b * (red and yellow, respectively).

In conclusion, the White Beauty Professional Motivational Kit, which contains 6% hydrogen peroxide, could represent an alternative to the traditional application of hydrogen peroxide at home, even though further research is needed to confirm the findings.

AUTHOR CONTRIBUTIONS

LL Conceptualization; CD methodology; RV software; SB validation; AC formal analysis; RV investigation; SS resources; RV data curation; RV writing original draft preparation; AC and SB writing review and editing; SB visualization; AC supervision; LF project administration; All authors have read and agreed to the published version of the manuscript.

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Questions

1. What is the CIELAB color space?

❑a. A method to express color using L*a*b*;
❑b. A unite of measurements for dental bleaching;
❑c. A unite of measurement for color opacity;
❑d. A scale of tooth sensibility.

2. According to the satisfaction questionnaire reported in the study:

❑a. A total of 80% of the participants did not experience gum irritation;
❑b. 90% of the participants find it difficult to follow the instructions;
❑c. 12% of the subjects noticed a change in the tooth color;
❑d. 87% of the participants would not repeat the treatment.

3. After how many applications is the "White Beauty Professional Motivational Kit" effective?

❑a. 6;
❑b. 3;
❑c. 2;
❑d. 1.

4. A fundamental factor for dental bleaching success is:

❑a. Dental hygiene and periodontal health;
❑b. The brand of the product;
❑c. The patient's nationality;
❑d. The hours the product is used.