

# The effect of in-office vital bleaching and patients' perception of the shade change

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## ABSTRACT

**Objectives:** This study aimed to evaluate the degree of colour change after an in-office vital tooth bleaching procedure with a 35% hydrogen peroxide gel using a spectrophotometer. The study also determined the patients' perceptions of the colour change and assessed the post operative sensitivity during the first week of the intervention.

**Methods:** The maxillary teeth (from 15 to 25) of 22 patients comprising of 11 males and 11 females were bleached with a 35% hydrogen peroxide (HP) gel in a single visit treatment procedure (Yotuel® Special, Biocosmetics Laboratories, Spain). Colour readings of the two maxillary central incisors were obtained using a spectrophotometer (CM-2600d Konica, Minolta) before and after the bleaching procedure. All the patients were requested to complete a form regarding post-operative tooth sensitivity and to record their perceptions toward the success of the bleaching treatment.

**Results:** The quantitative effect of the bleaching material on tooth colour showed an increase in the L\* values and a decrease in the a\* and b\* values. The changes were significant (Wilcoxon Signed Rank Sum Test;  $p < 0.05$ ) from baseline until one month, except for the b\* values one month after the bleaching procedure which were only significant at  $p \leq 0.1$ . The median overall colour change ( $\Delta E$ ) between baseline and after the bleaching procedure was 3.56. The mean value of the patients' colour perception was found to be 2.14 immediately after bleaching on a 3 point visual analogue scale. A Spearman correlation test showed a positive relationship between the  $\Delta E$  values immediately and one week after bleaching and a weak relationship one week and one month after the bleaching procedure. There was a significant consistency in the patients' colour perception data immediately and one week after the bleaching process and a weak relationship between the  $\Delta E$  values and the patients' colour perception one month after bleaching. Ten out of the twenty two patients experienced tooth sensitivity on the first day, immediately after the bleaching procedure. However only five patients experienced sensitivity on the second day, four patients on the third day and only one patient experienced sensitivity on the fourth and the fifth days after bleaching which was described as mild.

**Conclusions:** Yotuel® Special 35% HP was able to bleach the patients' teeth with a perceptive colour change noticeable by the

patients; however colour regression was evident quantitatively from the first week. Tooth sensitivity was a temporary side effect. The material cost is reasonable, it was easy to use and the procedure is not dependant on light activation.

**Clinical implications:** A single application of this product may not be sufficient to give patients the bright smile they desire. However it is important to monitor the rebound effect after this procedure. Patients may experience some tooth sensitivity after the use of this bleaching material but the sensitivity is of a transient nature.

**Key words:** Colour Change, Vital bleaching, Hydrogen peroxide, Spectrophotometer, Tooth sensitivity.

## INTRODUCTION

An increased number of patients are demanding aesthetic treatment to lighten the colour of their teeth. An accurate diagnosis of the original cause of the discoloration needs to be made to determine the best treatment options.<sup>1</sup> There are many treatment modalities for discolored teeth and these vary from bleaching, microabrasion of enamel using abrasive materials, veneers, all ceramic crowns and a combination of treatment options depending on the degree of staining.<sup>2</sup> Bleaching is considered a conservative form of aesthetic treatment for discolored teeth, unlike laminate veneers or all ceramic crowns which require an irreversible tooth preparation.<sup>3</sup>

There are numerous bleaching methods that can be used to achieve the desired results. Vital bleaching techniques include dentist supervised nightguard bleaching, in-office bleaching and over the counter bleaching products.<sup>4</sup> Due to a busy lifestyle; patients usually prefer to have quick results in a relatively short time and with minimal effort. Therefore most patients consider in-office vital bleaching to be the quickest way to get lighter teeth. The whitening effect can be achieved after only one visit<sup>5</sup> but may sometimes need multiple visits.<sup>6</sup>

In-office bleaching systems use a high concentration of hydrogen peroxide<sup>7</sup> that can be activated using a light source such as quartz-tungsten-halogen (QTH) lamps, plasma arc lamps (xenon short arc lamps), laser sources and light emitting diodes (LED).<sup>8</sup>

Recently, chemically activated systems which do not need light activation have been introduced commercially. Opalescence Xtra-Boost (Ultradent Products, South Jordan, Utah, USA) is a





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chemically activated in-office bleaching material which is a two syringe system activated by mixing both syringes.<sup>6</sup> Ultradent has recently replaced this material with Opalescence Boost, which is also a chemically activated double syringe system.

The Yotuel® (Spain) bleaching system involves a mixing process that results in a thick hydrogen peroxide gel that can be applied onto the tooth surface to achieve the bleaching effect.<sup>9</sup>

The Yotuel® Special material was recently launched commercially in South Africa with no scientific clinical research to evaluate the efficacy and the possible side effects of the product.

The efficacy of a bleaching treatment can be determined through measuring the colour change over time by using shade guides, digital image capturing devices, colorimeters or a spectrophotometer.<sup>10-14</sup> The Vita Classical Shade Guide was one of the methods previously used to identify tooth colour in which tooth shades were arranged depending on their lightness (B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, C4) where B1 is considered the lightest and C4 the darkest of the shade tabs.<sup>10</sup> An error in determining the exact tooth shade can occur due to the limitations in colour selection based on the available shade guide compared to the wide variety of natural tooth colours possible.<sup>11</sup> Visual assessments using shade guides are highly subjective and prone to observer bias.<sup>12</sup> The use of a shade guide in evaluating the shade change after a bleaching procedure is considered to be the most subjective method used in shade assessment studies.<sup>13</sup>

Digital photography after being processed and analyzed using computer software was also utilized to assess bleaching efficacy. The creation of a reproducible brightness index was developed from computer analysis of these photographs and this was used to monitor the brightness effect of the vital bleaching procedure.<sup>12</sup> However there is difficulty according to some authors in using the software to evaluate the shade change as digital systems with controlled lighting are subjective and expensive.<sup>13</sup>

Colorimeters have been designed for flat surfaces, which can be a challenge to get the proper shade of the human teeth which are normally curved.<sup>13</sup> Reflectance colorimetry is considered as cumbersome, labor-intensive and an expensive procedure.<sup>12</sup>

The spectrophotometer has been used to measure light absorption, but is now designed to measure spectral reflectance, transmission or relative emission by utilizing a high sensor which collects the reflected light from an object and processes it using a built-in micro-computer.<sup>15,16</sup> The light source in a spectrophotometer can be filtered or unfiltered. Different light sources have been used for object illumination including tungsten halogen bulbs and xenon flash tubes.<sup>14</sup> The reflectance spectrophotometer is considered an accurate instrument in determining tooth shade clinically; however an error could be recorded on curved posterior teeth and on the labial surfaces of the lower anterior

teeth during the colour measurement recording process due to the curvature of these teeth.<sup>17</sup> The spectrophotometer is regarded by many researchers as an objective method in clinical shade evaluation of bleaching materials and techniques.<sup>18,19</sup>

Another major problem facing in-office vital bleaching is colour rebound. Some authors reported colour rebound after two weeks of finishing the bleaching treatment<sup>20</sup>, while others only reported the colour regression a few months after the procedure.<sup>21</sup> Bello and Jarvis<sup>3</sup>, considered the bleaching effect reversible especially in patients that smoked and drank fluids that stained teeth. Swift *et al*<sup>22</sup> examined the effects of 10% carbamide peroxide over a two year follow-up period and found that 83% had a two unit shade change using the Vita shade guide, and that most of the regression occurred during the first six months after bleaching.

Post-operative sensitivity is another common side effect in patients treated with vital bleaching techniques.<sup>23</sup> Tooth sensitivity after the application of the bleaching material has been reported by many authors especially in patients diagnosed with gingival recession<sup>24</sup> even when a low concentration of carbamide peroxide (10%) was utilized.<sup>25</sup> The sensitivity that has been reported is of a temporary nature. Schulte *et al* reported sensitivity for four days after the procedure.<sup>26</sup> The sensitivity mechanism is not fully understood. An in-vitro study conducted by Thitinanthapan *et al*<sup>27</sup>, showed that peroxide can reach the pulp after penetrating the enamel and dentin and may be the cause of the sensitivity. In the power bleaching technique the use of a quartz-tungsten-halogen (QTH) and plasma arc lamps increased the intra-pulpal temperature which may have affected the pulp and caused tooth sensitivity,<sup>28</sup> however; Bernardon *et al*<sup>19</sup>, concluded that the in-office vital bleaching procedure resulted in higher sensitivity regardless of the presence of a light source.

Therefore the purpose of this clinical study was to assess the outcome of an in-office vital bleaching procedure using a 35% hydrogen peroxide gel (Yotuel® Special, Biocosmetics Laboratories, Spain); to ascertain the patient's perception of the colour change after the treatment and to record any post operative sensitivity that may have accompanied the procedure.

## MATERIALS AND METHODS

Twenty two healthy patients (11 males and 11 females) ranging in age from 18 to 40 years and requested bleaching of their sound maxillary anterior teeth formed the study sample. All the patients had maxillary central incisors of a shade of A2 or darker based on the visual assessment with a Vita Lumin-Vacuum shade guide. Shade evaluation was standardized in the same dental clinic and under the same lighting conditions to ensure a reproducible environment for all the patients (Figure 1). Patients that experienced initial hypersensitivity during the pre-treatment clinical examination or with a history of having previously



Figure 1: Patient tooth shade selection.



Figure 2: Spectrophotometer readings of the tooth colour shade.



Figure 3: Application of bleaching gel after silicone protective barrier was applied.

**Oral-B**





Figure 4: Before bleaching.



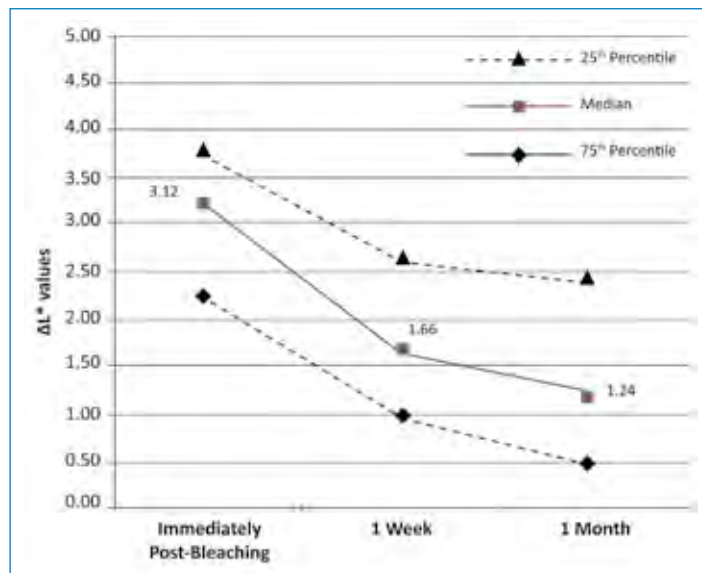
Figure 5: After bleaching.



Figure 6: One month after bleaching.

bleached their maxillary incisors were excluded from the study. A photographic record of the teeth prior to the treatment was obtained. The first reading of the shade of the teeth was taken using the spectrophotometer (CM-2600d Konica, Minolta) prior to any intervention (Figure 2). Three readings of one area at the centre of the crown of the two maxillary central incisors were obtained. The spectrophotometer has a built-in light to control the light reaching the object and to provide standard illumination. Spectrophotometric results are displayed as quantitative (CIE) colorimetric numerical values expressed as  $L^*$ ,  $a^*$  and  $b^*$ . The data were recorded on an Excel spreadsheet. A thorough scaling using an ultrasonic scaler and professional prophylaxis was performed of the patient's teeth to remove any existing extrinsic staining and a second reading of the shade of the teeth was taken. Patients were asked to use a toothpaste without any whitening agents during the study period.

To standardize the time interval for all the patients, pre-bleaching readings of the shade of the maxillary central incisors was recorded one week later (Baseline reading) which served as a control reading for comparative purposes. The Yotuel gingival protector product was applied to seal the inter-proximal spaces and the barrier material was extended to one tooth beyond the last tooth to be bleached. Yotuel® Special, (Biocosmetics Laboratories, Spain) contains 35% hydrogen peroxide (the non-sensitivity whitening system). The bleaching material was prepared according to the manufacturer's instructions. A layer of bleaching gel approximately 1.0mm thick was applied over the labial surfaces of the teeth to be bleached for 10 minutes (Figure 3). The applied gel was agitated over the teeth with a brush dipped in the activator. The gel was left undisturbed for a further 10 minutes. The gel was then removed and the teeth cleaned and rinsed with water being directed toward the incisal edge, while using a high-volume suction to remove the water. The gel application was repeated two more times in the same session with material reactivation before each application. After completing one hour of bleaching, the bleaching gel was removed using a high-volume suction and the teeth were rinsed with water in the presence of the high volume suction. Patients were asked about their perception of the colour change if any immediately after the bleaching procedure. Data were recorded in a separate sheet. Spectrophotometer readings were taken immediately after finishing the bleaching treatment. Post-bleaching photographs were also taken which provided a record for colour change, although their colour accuracy can be affected with the change of lighting conditions and with the camera technology being used. Photographs without a reproducible brightness index or without the use of special software should not be used to evaluate the colour change after bleaching. The patients were asked to record any changes to their teeth as regards sensitivity experienced for seven days in the sensitivity form supplied.



Graph 1: The 25<sup>th</sup> percentile, median and 75<sup>th</sup> percentile differences in the  $L^*$  values between the baseline (before bleaching) and after treatment.

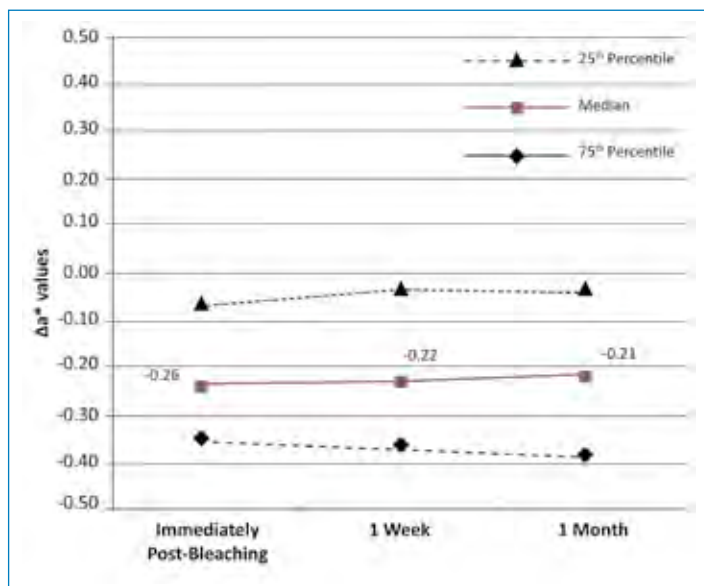
A four point visual analog scale form recording no sensitivity, mild, moderate or severe sensitivity, based on the work of Jorgensen and Carroll<sup>24</sup> was used. Tooth shade readings were obtained with the spectrophotometer one week after finishing the bleaching treatment. At that stage the sensitivity forms were also collected and the patient's perception about the colour change was also recorded. The patients were recalled after four weeks when the tooth shade readings were again repeated using the spectrophotometer. The patient's perception about the colour change was also recorded. Photographs were obtained after each reading.

The Wilcoxon Signed Rank Sum Test (a non parametric test) was used to test for statistically significant differences between the baseline values and those obtained immediately after bleaching and those obtained four weeks after bleaching. A Spearman correlation test was used to correlate the values of colour change obtained numerically and expressed as  $\Delta E$  and the patients' perception of colour change.

## RESULTS

A total of 22 patients with a mean age of 30.8 years started the study but only 20 patients completed the study. One of the patients did not return for the one week follow-up reading and the other patient did not return to complete the study; however the patients' colour perception and their responses to the sensitivity questionnaire were obtained telephonically.

There was a statistically significant difference ( $p \leq 0.05$ ) in all three coordinates ( $L^*$ ,  $a^*$  and  $b^*$ ) between (before and after bleaching) and (before bleaching and one week after bleaching). For the difference between before bleaching and one month after bleaching, there was a statistically significant difference ( $p \leq$



**Graph 2:** The 25<sup>th</sup> percentile, median and 75<sup>th</sup> percentile differences in the a\* values between the baseline (before bleaching) and after treatment.

0.05) in the L\* and a\* co-ordinates, while the b\* co-ordinate was only statistically significantly at  $p \leq 0.1$ .

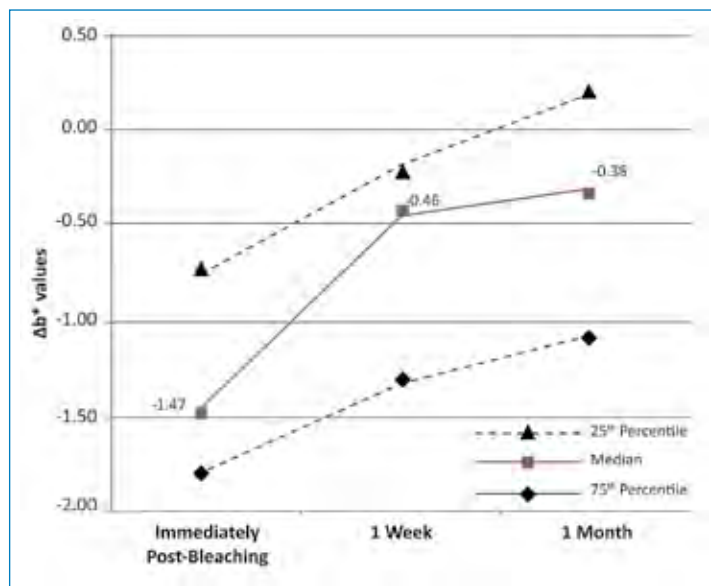
The difference in median L\* values from baseline to immediately after bleaching increased to 3.12 units, but after one week this change decreased to 1.66 units and after one month it further decreased to 1.24 units. This is represented by the area between the 75<sup>th</sup> percentile and 25<sup>th</sup> percentile 50% of the values in Graph 1. The difference in median a\* values between immediately after bleaching and baseline values decreased to “-0.26” units, however after one week this change increased to become “-0.22” units and after one month it reached “-0.21” units (Graph 2). The difference in median b\* values between immediately after bleaching and baseline values decreased to “-1.41” units but after one week this change increased to become “-0.46” units and after one month it reached “-0.38” (Graph 3).

The median  $\Delta E$  value was 3.56 units immediately after bleaching, 1.98 units after one week of the bleaching procedure and 1.67 units after one month of the bleaching procedure (Graph 4).

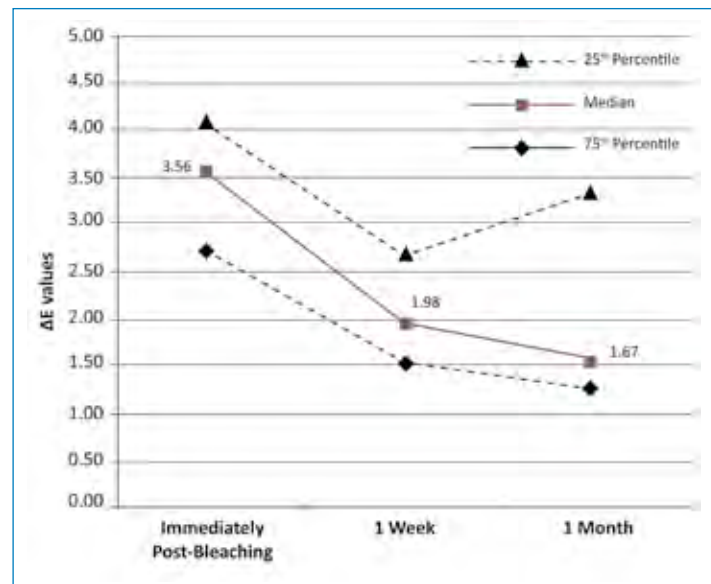
The mean value of the patients’ colour perception was found to be 2.14 immediately after bleaching; 77.3% of the patients felt a slight change immediately after the bleaching procedure but they still thought that more bleaching was needed, 18.2% of the patients were satisfied and stated that they noticed a major change in their teeth due to the bleaching effect. However 4.5% reported no change in their tooth colour due to the bleaching process.

One week after the bleaching process only 72.7% of the patients felt a slight change but they still thought that more bleaching was needed, 18.2% of the patients were satisfied and reported a major change in the colour of their teeth due to the bleaching effect, while 9.1% reported no change in the colour of their teeth.

One month after the bleaching 68.2% of the patients felt a slight change but they still thought that more bleaching was needed, 13.6% of the patients were satisfied and they reported a major change in the colour of their teeth due to the bleaching effect while 18.2% of the patients reported no change in the colour of their teeth.



**Graph 3:** The 25<sup>th</sup> percentile, median and 75<sup>th</sup> percentile differences in the b\* values between the baseline (before bleaching) and after treatment.



**Graph 4:** The 25<sup>th</sup> percentile, median and 75<sup>th</sup> percentile differences in the  $\Delta E$  values between the baseline (before bleaching) and after treatment.

Patient’s perception to colour change ranged from there was no change at all, there was some change but the teeth still needed bleaching or there was a major colour change.

A Spearman correlation test showed a positive relationship between  $\Delta E$  values immediately and one week after the bleaching procedure. Values were greater after the bleaching procedure compared to those after one week and most of the values were below the quality line. Moreover, there was a weak relationship one week and one month after the bleaching procedure.

There was significant consistency in the patients’ colour perception data immediately after the procedure and one week later.

When  $\Delta E$  values are compared to the patients’ colour perception data, a weak relationship between  $\Delta E$  values and the patients’ colour perception one month after the bleaching is evident.

The mean value of the patients’ tooth sensitivity was found to be 1.73 in the first day on a 4 point visual analog scale. Ten out

of the twenty two patients (45.5%) experienced tooth sensitivity on the first day after bleaching. On the second day after bleaching only five patients (22.7%) reported some sensitivity while only four patients (18.2%) experienced sensitivity on the third day. Only one patient (4.5%) experienced mild sensitivity on the fourth and the fifth days after the bleaching procedure. Of the ten patients that experienced sensitivity on the first day after bleaching, six rated the sensitivity as mild two as moderate and another two as severe.

## DISCUSSION

The use of the spectrophotometer made it possible to quantify the colour and the change in the tooth shade after the bleaching procedure using a three-dimensional colour space<sup>19</sup>, represented by the three co-ordinates L\*, a\* and b\*, where L\* refers to the lightness co-ordinate (with 0 being perfect black and 100 being perfect white), a\* represents the red–green axis (+a red and -a green) and b\* represents the yellow–blue axis (+b yellow and -b indicates blue).<sup>29, 30</sup>

The quantitative effect of the bleaching material on tooth colour showed an increase in the L\* value and a decrease in the a\* and b\* values immediately after bleaching. When comparing the results to other in-office bleaching materials that contain high concentrations of hydrogen peroxide gel, similar findings were noted.<sup>31, 32</sup> However one week after the bleaching procedure there was a decrease in the L\* value and an increase in the a\* and b\* values which suggests a regression in colour. This regression became more obvious one month after bleaching. This rebound in colour can be due to the rehydration of the etched, bleached teeth.<sup>21</sup> Another theory suggests that the oxygen that is released from the bleaching material changes the optical quality of the tooth and the relapse in colour happens after two weeks of finishing the bleaching treatment when the oxygen is lost and subsequently the lightened colour disappears.<sup>20</sup> The bleaching effect is reduced in patients that smoke and drink fluids that can stain their teeth.<sup>3</sup>

In this study the difference in the L\* value was more than that in the b\* value (Graph 1, 3), However Ishikawa-Nagal *et al*<sup>33</sup> and Goodson *et al*<sup>34</sup> stated that the b\* value is more important in determining the bleaching effect.

Colour change represented by  $\Delta E$  was calculated using the following formula:

$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$ . Where  $\Delta L^*$ ,  $\Delta a^*$  and  $\Delta b^*$  represent the differences between the co-ordinates for the variables L\*, a\* and b\* at different times during the study.<sup>35</sup>

The median  $\Delta E$  value immediately after bleaching was 3.56 units which according to the literature should not be clinically perceptible as a change in colour as the threshold to perceive a change in colour is a  $\Delta E$  value equal to or greater than 3.7 units.<sup>36</sup> However some authors feel that depending on the circumstances this difference in colour may be perceptible clinically to some individuals.<sup>37,38</sup> Moreover, other authors state that  $\Delta E$  values greater than 2 units can be detected by some observers as a colour difference.<sup>39,40</sup>

$\Delta E$  values decrease one week after the bleaching and decrease further one month after the bleaching procedure. Similar findings were reported by Matis *et al*<sup>41</sup> when they evaluated eight in-office bleaching systems and concluded that the  $\Delta E$  value was reduced and a rapid colour rebound occurred after one week and this reduction continued up to six weeks after the bleaching procedure. Al Shethri *et al*<sup>42</sup> reported that colour regression started after finishing the bleaching procedure and continued until the fifth week after the bleaching procedure.

The mean value of the patients' colour perception was found to be 2.14 immediately after bleaching on a 3 point visual analog scale, Auschill *et al*<sup>43</sup> reported patients' acceptance with a mean value of 3.31 when evaluated by a visual analog scale from 0 to 10 where 0 represented best acceptance and 10 no acceptance.

There were 15 patients that reported a slight change but felt more bleaching was still needed (score 2) immediately after bleaching; however the same patients reported the same colour perception one week after bleaching.

Tooth sensitivity is considered a side effect of bleaching procedures and was evaluated in this study. Ten out of the twenty two patients experienced tooth sensitivity on the first day immediately after the bleaching procedure, five patients on the second day, four patients on the third day and only one patient experienced sensitivity on the fourth and the fifth day after the bleaching procedure. As regards the type of sensitivity experienced by the ten patients, mild sensitivity on the first day was experienced by six patients while two patients had moderate sensitivity and another two patients had severe sensitivity. Tooth sensitivity is a temporary side effect associated with vital tooth bleaching.<sup>24,42</sup> Bernardon *et al*<sup>19</sup> examined the in-office vital bleaching procedure in a split-mouth study design and compared it to home bleaching systems and found that tooth sensitivity could be related to the higher hydrogen peroxide concentration in the in-office vital bleaching systems.

## CONCLUSIONS

This clinical study evaluated Yotuel® Special, (Biocosmetics Laboratories, Spain) an in-office bleaching material containing 35% hydrogen peroxide. This material was able to bleach patients' teeth with colour changes noticeable by the patients. However the bright smile (desired by patients) was not obtained for all the patients in this study. Colour regression was evident quantitatively from the first week after the treatment.

The Yotuel® Special Kit contains five vials, which can be sufficient for five patients. The manufacturer's instructions indicate a single visit treatment procedure, however; within the bounds of this study it does not seem possible to achieve optimum results in only one visit. The cost of the material is reasonable and the procedure is not dependant on light activation.

Tooth sensitivity accompanied the procedure. Of the ten cases that reported sensitivity in nine of the cases it lasted for only three days and in the one case it lasted up to the fifth day after the procedure.



## CLINICAL IMPLICATION

A single application of this product may not be sufficient to give patients the bright smile they desire. However it is important to monitor the rebound effects after this procedure. Patients may experience some tooth sensitivity after the use of this bleaching material but the sensitivity is of a temporary nature.

**Declaration:** No conflict of interest.

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