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ORIGINAL ARTICLE

Influence of treatment duration on the efficacy of at-home bleaching with daytime application: a randomized clinical trial

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Abstract

Objective The aim of this study is to determine whether prolonging the daytime at-home bleaching treatment by 1 week increases the bleaching effect without causing more side effects.

Materials and methods Fifty participants were randomly divided into two groups, (A) with a 14-day treatment and (B) with a 21-day treatment. A gel with 10% carbamide peroxide was applied for 2 h a day in custom trays. Color measurement was performed using a dental spectrophotometer on the right maxillary central incisor and the canine at baseline, at the end of treatment, and 1 and 6 months afterwards. Daily, participants recorded their tooth sensitivity and gingival irritation.

Results At the end of the treatment, the ΔE^{00} of group B (5.77 ± 2.15) was significantly higher than the ΔE^{00} of group A (4.74 ± 1.94) ($p = 0.005$ (95% CI: − 2.13 to − 0.39)). After 6 months, tooth color was more stable in group B. The ΔSGU values between the different appointment times were higher in the 3-week group. Participants from group B reported more side effects, but statistically, there were no differences compared with group A ($p = 0.225$ for tooth sensitivity and $p = 0.758$ for gingival irritation).

Conclusions Daytime application of at-home bleaching for 3 weeks achieves greater bleaching results than for 2 weeks, immediately after treatment and 1 and 6 months afterwards. However, slightly more side effects could occur.

Clinical relevance When daytime application of at-home bleaching is required, the treatment duration should be prolonged from 2 to 3 weeks to achieve greater and more stable results.

Keywords At-home bleaching · Tooth bleaching · Tooth whitening · Carbamide peroxide · Tooth sensitivity · Esthetic dentistry

Introduction

The importance of tooth whitening for patients has led to a significant rise in tooth whitening products and procedures, and consequently an increase in scientific publications about this field [1]. In 1989, Haywood and Heymann first described nightguard vital bleaching [2], which consisted of the overnight application of 10% carbamide peroxide (CP) in custom trays [2].

Since then, manufacturers have introduced different concentrations of CP and hydrogen peroxide (HP) for at-home whitening, which are effective and safe [1]. However, the European and Spanish legislations only allow the use of products with a concentration of between 0.1 and 6% of HP for at-home bleaching [3, 4], which are equivalent to 0.3% and 17% of CP respectively. Additionally, the American Dental Association (ADA) recommends using 10% CP because it is the concentration that has the most available scientific evidence supporting its efficacy and safety [5].

Besides this, different application times have been proposed according to patients' preferences [6]. Satisfactory results can be achieved with different protocols, provided that the use of short times, such as daytime application, is compensated by prolonging the number of days of treatment [7]. This is due to the fact that bleaching gel is in contact with teeth

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for fewer hours. However, most studies with daytime application follow a 2-week treatment [8–10], which is the usual duration of at-home bleaching treatment; there are few studies that continue the treatment for an additional week [11–14]. Prolonging treatment may lead to greater bleaching results, but there have been no articles published evaluating the efficacy of extending the application time.

Thus, the aim of this study is to determine whether prolonging the at-home bleaching treatment by 1 week (from 2 to 3 weeks), employing 10% CP, increases the bleaching effect without causing more side effects. The null hypothesis is that 10% CP applied 2 h a day for 3 weeks is no more effective and causes more side effects than the same protocol applied for 2 weeks.

Materials and methods

Study design and patient selection

This randomized parallel clinical trial was developed at the Faculty of Dentistry of the University of Santiago de Compostela, Spain. The protocol of this study was approved by the Ethics Committee of the SERGAS (2015-581), and a EudraCT (European Clinical Trials Database) number (2016-002896-92) was issued to it. Figure 1 shows the CONSORT flow chart of the study design and the number of subjects at each phase of the study. Consecutive patients coming to our University asking for tooth whitening were informed about this study and were invited to participate. Patients fulfilling selection criteria were enrolled in the study. The following inclusion criteria were used: patients at least 18 years of age, with a minimum of 24 natural teeth (including incisors, canines, and premolars in both arches), good oral hygiene (Sillness and Löe plaque index [15] ≤ 1), and availability for the study appointments. Subjects were not included if any of the following criteria was present: restorations in the six anterior teeth of either arch, active caries, structural alterations of teeth, staining by tetracycline or fluorosis, general hypersensitivity, periodontal disease, and gingival recession. Also, patients with systemic disease, under analgesic and/or anti-inflammatory therapy, smokers, pregnant or lactating women, and people who had done a prior bleaching treatment were excluded.

Sample size calculation

Sample size was calculated from the data of a pilot study. With a significant level of 5%, statistic power of 80%, and a minimum of effect size of 2, the sample size was calculated as 22 participants for each group. The sample size was increased to 25 participants per group to compensate for the potential loss of participants or their refusal to participate.

Randomization

Fifty patients were included and randomly divided in 2 groups, group A with a 14-day treatment and group B with a 21-day treatment. The statistical software SPSS 21 (SPSS Inc., Chicago, IL) was used for randomization by an independent statistician.

Material

A 10% CP whitening gel (Vivastyle Vivadent, Ivoclar Vivadent, Schaan, Liechtenstein) was applied for 2 h a day in custom trays on both arches. This whitening gel included potassium nitrate as additional component.

Experimental procedure

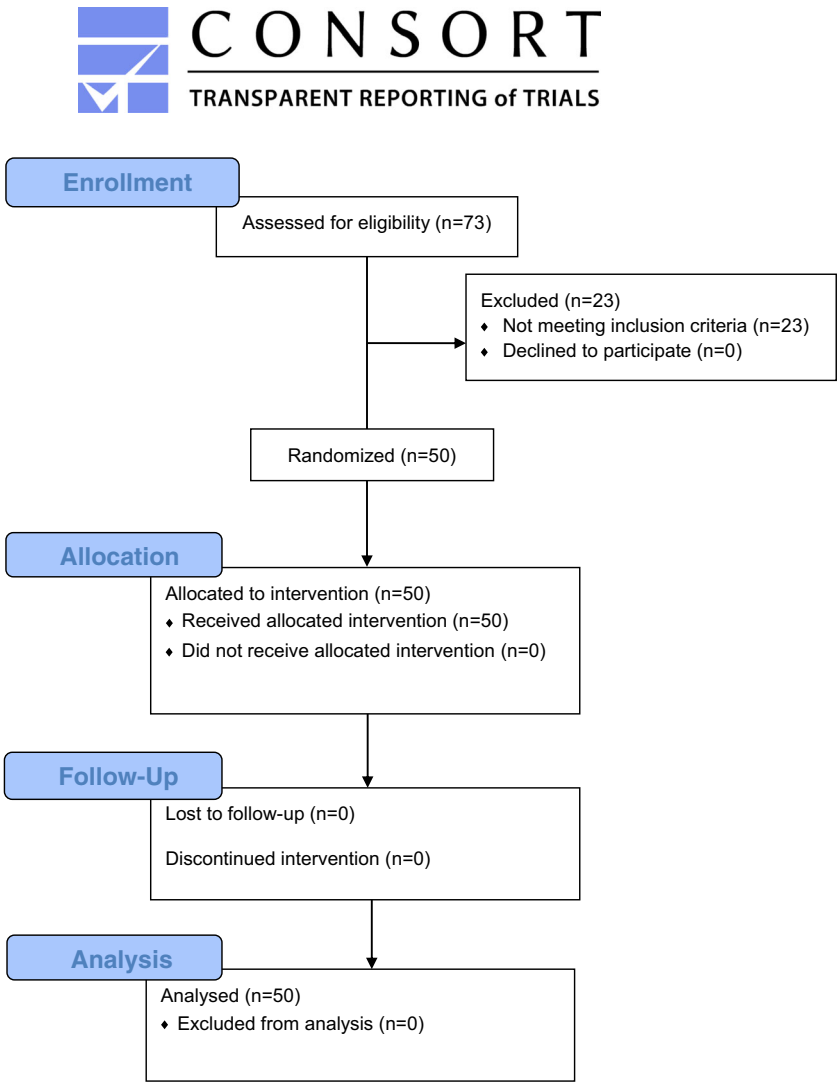
Two weeks before the beginning of the study, subjects signed an informed consent form. After that, all participants underwent a professional prophylaxis to remove extrinsic stains. Alginate impressions of both arches were taken to customize maxillary and mandibular trays. A maxillary custom positioning guide was also prepared to provide a repeatable area for the placement of the spectrophotometer sensor. Trays were fabricated using an Econo-Vac machine (Buffalo Dental Manufacturing, Syosset, NY) and 1-mm soft sheets (Vivastyle Vivadent, Ivoclar Vivadent, Schaan, Liechtenstein), without reservoirs and were scalloped and trimmed 1-mm above the gingival margin. For the positioning guide, 4-mm clear sheets (Clear-Mouthguard, Henry Schein Inc., Melville, NY) were used. Four orifices were made in the center of the middle third of the upper central incisors and the canines, with a 6-mm external diameter trephine which coincides with the diameter of the spectrophotometer sensor.

At the next appointment (baseline data), bleaching trays and the positioning guide were tried for accuracy and fit. Patients received customized trays, application protocol, bleaching agent, and a questionnaire in order to record the side effects every day. Furthermore, oral hygiene instructions, a toothbrush (GUM Technique Toothbrush, Sunstar Americas Inc., Chicago, IL), and toothpaste (Colgate Total Toothpaste, Colgate Oral Pharmaceuticals, New York, NY) were provided to participants to ensure standardized oral hygiene procedures during the study.

Clinical variables

Color (primary outcome) was measured objectively with an Easyshade dental spectrophotometer (Vita Zahnfabrik, BadSackingen, Germany) at the upper central incisors and the canines. This dental spectrophotometer records the color reflected by the Vita Classical, Vita 3-D Master, and the CIE L^*, a^*, b^*, C^*, and h^* values. Color was measured before the

Fig. 1 CONSORT flow diagram



beginning of the treatment (baseline, D0), at the end of the treatment (2 weeks later for group A and 3 weeks later for group B, D1), and 1 and 6 months after the end of the treatment (D2 and D3 respectively). Before color measurement in each participant, the spectrophotometer was calibrated following the manufacturer's instructions.

Side effects were the secondary outcomes. Participants were asked to record the daily tooth sensitivity using a 4-point scale (0 = none, 1 = mild, 2 = moderate, and 3 = severe) [16, 17]. They were also requested to indicate whether or not any gingival irritation was present. Gingival irritation was defined as a white layer on the gingiva caused by the desquamation of the outer layers of the gingival epithelium [9].

To determine the efficacy of both protocols, intragroup comparisons between the CIE $L^*C^*h^*$ parameters and the Vita shade guide units (SGU), recorded on the different appointments, were made. The differences between the groups were analyzed using the differences in color (ΔE^{00}) [18], lightness (ΔL^*), chroma (ΔC^*), and value (Δh^*) as well as those in the Vita shade guide units (ΔSGU) between the different appointment times. Additionally, the side effects for both groups were compared. The SGU were converted into established numeric values ranging from 1 (B1) to 16 (C4) in order of lightness: B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, and C4 [14, 19, 20], so as to enable their comparison.

Statistical analysis

The data records were checked for normal distribution using the Kolmogorow Smirnov test. CIE $L^*C^*h^*$ values, ΔE^{00}, ΔL^*, ΔC^*, and Δh^* records showed a normal distribution, and they were compared with a mixed-design ANOVA followed by Bonferroni post-hoc test. ΔSGU values between groups were compared with the Mann-Whitney U test, due to the fact that they did not follow a normal distribution and were

continuous independent variables. SGU intragroup values were compared with the Wilcoxon test (continuous dependent variables with no normal distribution). The Chi-Square test was used to compare side effects between groups. Differences were considered statistically significant when $p < 0.05$. The statistician was blinded, so she did not know the identification of the groups until the study was finished. Statistical analysis was performed using the SPSS 20.0 (SPSS Inc., Chicago, IL).

Results

Fifty subjects were enrolled and completed the study, 17 (34%) men and 33 (66%) women, with a mean age of 26.81 ± 11.67 years.

Bleaching efficacy

The mean CIE $L^*C^*h^*$ values of each group obtained at the different appointments are shown in Fig. 2. There were statistically significant differences between the absolute values of CIE L^*, C^*, and h^* of the incisors and the canines and both teeth combined, between the end of the treatment (D1) and baseline (D0) for both groups (intragroup analyses) ($p \leq 0.001$), as well as between the follow-up appointments (D2 and D3) and baseline (D0) ($p < 0.005$).

Assessing SGU between D0 and D1, D2, and D3, there were also statistically significant differences ($p = 0.000$) for both groups. The evolution of the SGU during the observed period is shown in Fig. 3.

Likewise, the color change (ΔE^{00}) was statistically significant between D0 and D1, D2, and D3 in both groups ($p < 0.05$). The average ΔE^{00} of the incisors, the canines, and both teeth combined for the three measurement periods are given in Table 1.

Long-term efficacy/color stability

Between the end of the treatment and the 6-month appointment, there were no statistically significant differences in CIE $L^*C^*h^*$ values in either group ($p > 0.05$). However, some variations in CIE $L^*C^*h^*$ values occurred differently between the groups during the post-treatment. For the 2-week group, during the first-month post-treatment, C^* and h^* continue varying significantly with the same trend as during bleaching ($p = 0.021$ (95% CI: 0.12–2.12) and $p = 0.006$ (95% CI: −1.88 to −0.23), and L^* did not change significantly ($p = 0.998$ (95% CI: −0.57–1.74). However, between D2 and D3, L^* increased reaching similar values to those obtained at D1, and C^* and h^* suffered a slight regression but there were no statistically significant differences ($p = 0.132$ (95% CI: −1.21 to −0.09), $p = 1.000$ (95% CI: −0.54–0.59) and $p = 1.000$ (95% CI: −0.79–0.67), respectively). On the other hand, the 3-week group remained more stable, since there were no statistically significant differences in CIE $L^*C^*h^*$ values between D0 and D1 nor between the follow-up appointments (D2 and D3) ($p > 0.05$).

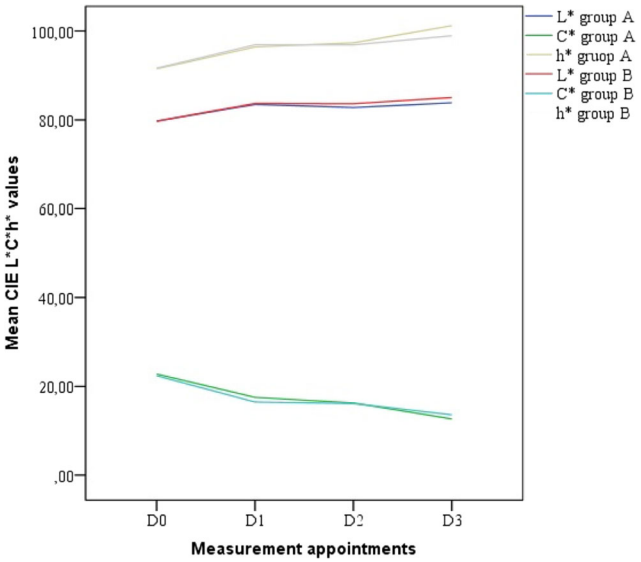


Fig. 2 Mean CIE $L^*C^*h^*$ values of each group obtained at the different appointments. D0, baseline; D1, end of treatment; D2, 1-month follow-up; and D3, 6-month follow-up

Regarding SGU values between D1 and D2, there were statistically significant differences in both groups ($p = 0.000$ and $p = 0.025$, in the 2 and 3-week groups respectively). Between D1 and D3, as well as between D2 and D3, there were no statistically significant differences in either group ($p > 0.05$). The median and the mode of ΔSGU during these periods were 0.

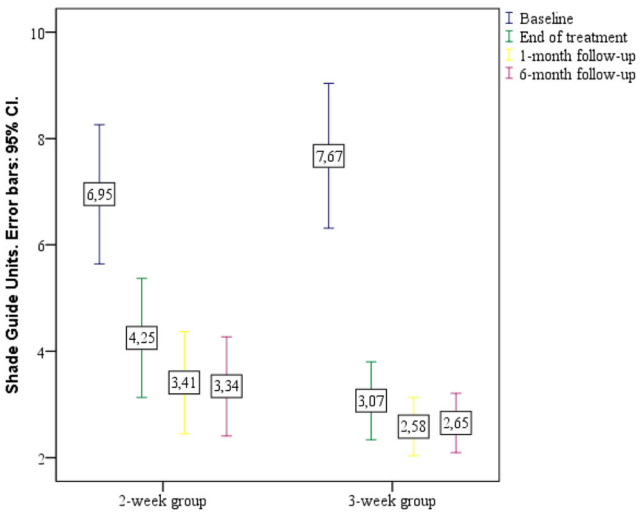


Fig. 3 Mean values of the Vita shade guide units of both teeth combined at the different appointments of measurement. CI, confidence interval

Table 1 ΔE^{00} values (mean ± standard deviation) of both groups for the three measurement periods (end of treatment (D1)–baseline (D0), 1-month follow-up (D2)–baseline (D0), and 6-month follow-up (D3)–baseline (D0))

Measurement periods	Group	ΔE^{00} values		
		Central incisors	Canines	Both teeth combined
D1–D0	2-week group	4.24 ± 1.86	5.24 ± 1.92	4.74 ± 1.94
	3-week group	4.59 ± 1.59	6.94 ± 2.00	5.77 ± 2.15
D2–D0	2-week group	3.79 ± 1.48	5.44 ± 1.83	5.62 ± 1.85
	3-week group	4.34 ± 1.80	6.90 ± 1.70	5.62 ± 2.16
D3–D0	2-week group	4.05 ± 1.69	5.56 ± 2.40	4.81 ± 2.19
	3-week group	4.40 ± 1.60	6.71 ± 1.89	5.56 ± 2.09

Differences between groups

The ΔC^* of the central incisors, the canines, and both teeth combined for group B was significantly higher than for group A at D1 (compared with D0) ($p < 0.05$), as well as the Δh^* of the canines ($p = 0.000$ (95% CI: 1.55–4.66)) and of both teeth combined ($p = 0.001$ (95% CI: 1.59–5.62)), and the ΔL^* of both teeth combined ($p = 0.014$ (95% CI: 0.50–4.16)). One month after treatment (D0-D2), these differences remained statistically significant ($p < 0.05$). However, between D0 and D3, there were only differences between groups in ΔC^* for both teeth combined ($p = 0.002$ (95% CI: − 5.95 to − 1.41)) and Δh^* for the canines ($p = 0.001$ (95% CI: − 3.15 to − 0.95)). Between the end of the treatment (D1) and 1 month after (D2), the ΔC^* and Δh^* of the canines for group B were significantly higher than for group A ($p = 0.010$ (95% CI: − 4.40 to − 0.65), $p = 0.003$ (95% CI: 0.66–2.99), respectively). Between D1 and D3, there were statistically significant differences between groups in ΔL^* and Δh^* of both teeth combined, in ΔC^* and Δh^* of the central incisors, and in ΔC^* of the canines ($p < 0.05$). The Δh^* of both teeth combined and the central incisors for the 3-week group were significantly higher than for the 2-week group between D2 and D3 ($p = 0.011$ (95% CI: − 2.33 to − 0.32), $p = 0.039$ (95% CI: − 2.75 to − 0.09), respectively).

There were statistically significant differences between the ΔSGU values of D1 and D0 between groups ($p = 0.009$), the difference being higher in the 3-week group. Separately, the canines of the 3-week group reached significantly lower SGU at the end of the treatment and at the follow-up appointments than those of the 2-week group ($p < 0.005$). The ΔSGU values of both groups for these periods are shown in Table 2.

At the end of the treatment, the 2-week group showed a $\Delta E^{00} = 4.74 \pm 1.94$ for both teeth combined, individually the central incisors presented a $\Delta E^{00} = 4.24 \pm 1.86$ and the canines a $\Delta E^{00} = 5.24 \pm 1.92$. For the 3-week group, a $\Delta E^{00} = 5.77 \pm 2.15$ was observed for both teeth combined, the central incisors presented a $\Delta E^{00} = 4.59 \pm 1.59$, and the canines a $\Delta E^{00} = 6.94 \pm 2.00$. The color change in the 3-week group was significantly higher ($p = 0.005$ (95% CI: − 2.13 to − 0.39)).

The color difference between the end of the treatment (D1) and 1 month after (D2) was 2.07 (1.29) for both teeth combined in the 2-week group and 1.55 ± 1.32 in the 3-week group. Six months after the end of the treatment, the ΔE^{00} was 2.82 ± 2.15 for group A and $\Delta E^{00} = 1.63 \pm 1.26$ for group B. Between the two groups, there were differences in ΔE^{00} between D1 and D2, and between D1 and D3 ($p = 0.031$ (95% CI: 0.10–2.15) and $p = 0.015$ (95% CI: − 1.90 to − 0.21), respectively). However, between the follow-up visits (D2 and D3), the ΔE^{00} for both groups was similar (1.32 ± 1.07 for group A and 1.32 ± 1.17 for group B), without significant differences ($p = 0.856$ (95% CI: − 0.43–0.52)).

Side effects

No participant had to have the bleaching treatment halted for severe tooth sensitivity or gingival irritation. Participants from group B reported more side effects, but statistically, there were no differences compared with group A ($p = 0.225$ for tooth sensitivity and $p = 0.758$ for gingival irritation). Gingival irritation was reported immediately after removing the trays and disappeared after a few hours. The distribution of side effects during treatment is shown in Table 3. During the post-treatment evaluation, no participant reported episodes of tooth sensitivity or gingival irritation.

Discussion

In this study, we aimed to determine whether prolonging the daytime at-home bleaching treatment by 1 week increases the bleaching effect without causing more side effects. The 10% CP whitening gel used (Vivastyle Vivadent, Ivoclar Vivadent, Schaan, Liechtenstein) was effective in both groups, since a ΔE greater than 4 has been reached. These data have also been demonstrated in the literature [9], and the ADA establishes in order to determine the bleaching efficacy [21]. In addition, the color change in the 3-week group was greater, being significant immediately after treatment, and after 1 month and 6 months post-treatment. The difference between groups in ΔE^{00} was

Table 2 Median and mean ± standard deviation (SD) of the differences of Vita shade guide units (ΔSGU) of both groups for the three measurement periods (end of treatment (D1)–baseline (D0), 1-month follow-up (D2)–baseline (D0), and 6-month follow-up (D3)–baseline (D0))

Measurement periods	Group	Central incisors		Canines		Both teeth combined	
		Median	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD
D1–D0	2-week group	− 1.00	− 1.78 ± 2.09	− 4.00	− 4.83 ± 3.26	− 2.00	− 3.30 ± 3.12
	3-week group	− 1.00	− 2.12 ± 2.94	− 8.00	− 7.74 ± 2.49	− 5.50	− 4.93 ± 3.91
D2–D0	2-week group	− 1.00	− 2.07 ± 2.10	− 7.00	− 5.87 ± 3.08	− 3.00	− 3.97 ± 3.24
	3-week group	− 1.00	− 2.21 ± 2.69	− 9.00	− 8.11 ± 1.79	− 6.50	− 5.16 ± 3.74
D3–D0	2-week group	− 1.00	− 1.21 ± 3.75	− 6.00	− 5.68 ± 2.97	− 3.00	− 3.45 ± 4.04
	3-week group	− 1.00	− 1.63 ± 2.41	− 8.50	− 7.96 ± 2.10	− 7.00	− 5.15 ± 4.20

between 0.5–1.0 ΔE units, which is clinically visible [22]. For other authors [23, 24], the difference detectable by visual inspection must be higher. However, they used the color difference formula named ΔE ($\Delta E\text{ab} = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$) [25] and in this article, the new color difference formula (ΔE^{00}) [18] recommended by the International Commission on Illumination (CIE) has been used. In a study that compared both formulas, Gómez-Polo et al. [26] found that the differences obtained with the formula ΔEab were between 1.15 and 2.09 times higher than those obtained with the formula ΔE^{00}. Therefore, the difference obtained in this study, ΔE^{00} close to 1, has clinical significance.

In addition, analyzing the SGU at the end of the treatment and at the follow-up visits, the difference between both groups was more than 1 unit and group B had a greater decrease in SGU, which is clinically detectable with the Vita Classical shade guide as has been determined by Chen et al. [24]. The canines of the 3-week group also achieved a lower SGU than those of the 2-week group.

Although Haywood VB recommended a treatment time of between 1 and 6 weeks with nightguard vital bleaching for teeth with normal stains [27], according to literature, the most commonly used at-home bleaching protocol is 10% CP for 2 weeks, applied for a few hours a day or overnight [8, 9, 16, 19, 20, 28–40]. However, short application times should be compensated for prolonging the number of days of treatment [7], and few studies prolong daytime application of at-home bleaching with 10% CP for 3 weeks [11–14]. Moreover, comparing the results among studies is difficult due to the variety and heterogeneity of bleaching products, duration of application, duration of treatment, teeth evaluated, and follow-up times [13]. Also, to the best of our knowledge, there is no randomized clinical trial that compares the same product applied for 2 weeks and for 3 weeks. Cardoso et al. [7], regarding the participants' satisfaction, compared a 16-day protocol with an 18-day protocol within the same group (with an application of 1 h a day), finding that if the bleaching product was applied for two more days, a higher ΔE was obtained. Similarly, the results of this study showed that prolonging bleaching treatment to 3 weeks determined significantly higher and more stable bleaching results.

Representing color-teeth three-dimensionally using L^*, C^*, and h^* is more intuitive than by L^*, a^*, and b^*; since lightness or value (L^*), chroma (C^*), and hue (h^*) are visually perceptible, and they are the main optical properties of the teeth [41–43]. Munsell was the first to separate the color into hue, value, and chroma dimensions [44]. Furthermore, the CIE uses these parameters to define color [25]. Color science is in continuous improvement, and recently, a new color difference formula named CIEDE2000 (ΔE^{00}) has been recommended [18, 45] (as we have done in this research) because it represents in a better way the color differences provided by the human eye [46]. It also uses the concepts of value, chroma, and hue, reinforcing the importance of these parameters [47].

Table 3 Incidence of side effects reported by participants during bleaching treatment

Group	Sensitivity				Gingival irritation	
	None	Mild	Moderate	Severe	Yes	No
2-week group	20 (80%)	3 (12%)	2 (8%)	0	7 (28%)	18 (72%)
3-week group	15 (70%)	8 (22%)	2 (8%)	0	8 (32%)	17 (68%)

In order to be more precise and objective, the spectrophotometer measurement was preferred over the visual evaluation [48]. Besides this, a positioning guide with orifices in the center of the middle third of teeth was fabricated. This was because the middle area of teeth is generally flatter and provides a stable platform for the spectrophotometer sensor [49], the most representative area of tooth color as it reflects the light from the dentin with little influence from the enamel [43, 49].

Recently, it has been revealed that oxygen ions present in peroxide-based tooth whitening products, diffuse over enamel, and react with the transparent organic matrix of teeth promoting an opaque whiter material, causing teeth to bleach [50]. This means that tooth bleaching is controlled by the organic content and the permeability of teeth [50, 51]. Dentin is an organic-rich substrate, and its color can be considered responsible for tooth color while enamel only determines slight modifications in tooth color [52]. Therefore, it seems reasonable to state that the higher the organic content, the better the bleaching results; in consequence, yellower teeth achieve better bleaching results [10, 53–57], as demonstrated in this study. On the other hand, increasing treatment time in weeks could determine better results, as shown in this study and corroborated by the treatment plan recommended for severe-stained teeth, such as tetracycline-stained teeth, which need more time to achieve acceptable bleaching results [22, 58, 59]. In fact, in order to achieve better results, prolonging the treatment in days is more effective than increasing the time of application per day, because tooth whitening products degrade as the hours go by, leaving less than 50% of the active agent after 2 h [60, 61].

As occurs with bleaching results, the evidence regarding color rebound is confusing [29, 62–64] due to the different bleaching products concentrations, application times, and methods for monitoring color used [63]. Many authors have shown that at-home bleaching with 10% CP is stable for long periods of time, both in 2-week [9, 10] and 3-week studies [11, 12, 65, 66] with daytime use. Nonetheless, some relapse in tooth color after the end of bleaching treatment was shown. In this study, both protocols achieved stable bleaching results after 6 months, because values registered at the 6-month recall appointment were similar to those obtained at the end of the treatment. However, during the first moth post-treatment, there is some relapse, but it was not easily distinguishable, and was lower in the 3-week group. In addition, increasing the bleaching treatment by 1 week determined more stable L^*, C^*, and h^* values after 1 and 6 months. In accordance with the results obtained in terms of color stability after treatment, bleaching results must be evaluated immediately after treatment and after 6 months, but no 1-month post-treatment because some variations in tooth color are still happening.

Tooth sensitivity and gingival irritation are the most commonly observed clinical side effects in tooth bleaching [67–69]. In this study, increasing the treatment time was related with higher incidence of side effects, but not statistically significant. Similar to other studies, these events are normally mild and transient [9, 12, 40, 70, 71]. Regarding the studies with daytime application of 10% CP, the incidence of tooth sensitivity vary from 6.6 to 41.3% [7, 10, 12–14, 32]. The tooth sensitivity reported by our participants was within these percentages. The whitening gel used in this study includes potassium nitrate, which has been shown to reduce postoperative tooth sensitivity [72]. Nevertheless, gingival irritation is common in try-based systems due to mechanical compression of the papilla [58], meaning that scalloping and trimming of bleaching trays following the gingival margin are important in order to decrease gingival irritation [73].

Conclusions

When daytime application of 10% carbamide peroxide for at-home bleaching is recommended, the treatment duration should be prolonged for 2 to 3 weeks to achieve greater bleaching results. Besides this, these results are more stable after 1 and 6 months with no visible relapse on shade guide units. However, slightly more side effects could be reported, but they are transient and predominantly mild.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were in accordance with the ethical standards of the Ethics Committee of the University of Santiago de Compostela and with the 1964 Helsinki declaration. The protocol of this randomized clinical trial was approved by the Ethics Committee of the SERGAS (2015-581).

Informed consent Written informed consent was obtained from all participants included in the study.

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