In-office and walking bleach treatment of non-vital teeth with 10% carbamide peroxide: a 21-year retrospective evaluation

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Abstract

Objectives: The present study is aimed at evaluating the long-term color stability of endodontically-treated teeth which have been subjected to in-office and the walking bleach treatment with carbamide peroxide. **Methods and Materials:** Sixty patients in need of dental bleaching following endodontic treatment were selected for the study. After endodontic treatment, the patients were subjected to in-office dental bleaching and the walking bleach technique with 10% carbamide peroxide. A color shade score was given to each patient before and after the bleaching procedures and at the final follow-up. Data were statistically analyzed. **Results:** At the 21-year follow-up, 42 out of 60 patients were eligible for the retrospective evaluation. Failures were noticed in 9 patients showing a color mismatch of two or more shades in comparison with adjacent teeth. A success rate of 78.6% was reported. The statistical analyses showed significant differences between Baseline vs End of Treatment and Baseline vs Follow-Up ($p<0.0001$) while no statistically significant differences were noticed between End of Treatment vs Follow-Up ($p>0.05$). The endodontic treatment failed in 3 patients. **Discussion:** The null hypothesis was rejected. The bleaching effect of carbamide peroxide in non vital teeth proved to be stable and reliable in the long-term. The clinical observations performed in the present investigation are consistent with the results of previous studies. No chronic sensitivity was observed in any patient. Although no root resorption was observed, few root fractures were noticed and the detrimental effects of peroxide on dental hard tissue may have contributed to such failures. **Conclusions:** Carbamide peroxide proved to be an effective dental whitening agent in the long-term for endodontically-treated teeth with both in-office and walking bleach techniques. Moreover, the vertical condensation technique of warm guttapercha did not seem to be affected by the intra-coronal application of carbamide peroxide.

Clinical Significance: Carbamide peroxide can be considered a safe and effective bleaching agent to maintain color stability of non vital teeth in the long term.

Short title: 21-year retrospective clinical study on dental bleaching
Key words: dental bleaching, endodntic treatment, vertical condensation, carbamide peroxide, color stability

Introduction

Tooth discoloration may affect different areas of teeth, with appearance and severity correlated to different etiology.[1,2] The optical properties of dental pulp tissue contribute to the determination of tooth color. Consequently, the removal of pulp tissues due to endodontic treatment may often lead to intrinsic staining. In such cases, cleaning procedures utilized to remove surface pigmentations are not effective and chemical bleaching is required to recover the original color. Nowadays, dental bleaching has been recognized as the most conservative treatment for discolored teeth.[1, 2]

In recent years, several products and techniques have been developed to achieve reliable dental bleaching. Different studies have demonstrated the effectiveness and safety of carbamide peroxide in removing intrinsic staining.[1-5] Furthermore, if properly used, carbamide peroxide was proved to contribute to smooth enamel, leading to reduced plaque accumulation and improved periodontal tissue health.[2, 4-6]

Home bleaching by means of individual trays containing

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Table 1: Anatomical distribution of treated teeth

TOOTH	N	%
11	18	30
21	22	36,7
22	7	11,7
41	3	5
42	2	3,3
31	2	3,3
32	6	10
Total	*60*	*100*

Table 2: Baseline teeth colors

BASELINE COLOR	N	%
A4	8	13,3
A3	18	30
A3,5	12	20
B4	5	8,3
C4	2	3,3
D3	9	15
D4	6	10
Total	*60*	*100*

whitening agents to be applied during night for 2 to 4 weeks was introduced as an easy procedure, less time consuming and cheaper than professional treatments.[4, 5] Nonetheless, different studies showed a lack of patients' compliance, since the dentist cannot monitor the proper application of such trays.[1, 2] In order to achieve better control, in-office and intra-coronal bleaching procedures were introduced in clinical practice. Both proved to be operator- and patient-friendly as well as acceptably time-consuming procedures. Such techniques usually use higher whitening agent concentrations activated by means of heat or light sources, resulting in improved color stability in the long term.[1, 2, 3, 7-9]

The main drawback of dental bleaching was reported to be dental sensitivity. However, such a condition usually disappears after the end of the treatment and can be easily solved using desensitizing agents, such as toothpastes and varnishes.[1, 2, 6] In certain structural analyses, enamel porosity was described after both home and in-office dental bleaching. Nonetheless, minor surface alterations can be restored by means of polishing procedures as well as the application of fluoride, calcium and phosphate.[6] According to most authors, roughness and micro-hardness alterations can be considered negligible.[1, 2, 6]

Different subjective and objective methods were designed to evaluate dental discoloration as well as bleaching effects.[1, 2,9] Although spectrophotometers may offer reliable assessments, most studies were performed by means of subjective comparison methods using acrylic resin shade guides. Such techniques were proved to be effective when used by skilled operators in standardized light conditions.[2,9]

The present clinical study is aimed at evaluating the long-term color stability of endodontically-treated teeth subjected to in-office and walking bleach dental treatments with carbamide peroxide. The following null hypothesis was tested: there is no correlation between the use of 10% carbamide peroxide in non vital teeth and tooth color stability in the long-term.

As secondary outcomes, the stability of the vertical condensation endodontic technique over time and the influence of carbamide peroxide application on root resorption were evaluated.

Materials And Methods

Sample collection

Patients in need of a single endodontic treatment on front teeth were recruited in the Department of Oral and Maxillofacial Sciences of the University "Federico II" of Naples between September 1991 and March 1992. The patients eligible for the study had to fulfill the following inclusion criteria: 18 to 35 years old, good general health, presence of at least all front teeth, no smoking and available for follow-up recall. Patients allergic to peroxides, presenting tetracycline stained teeth, who had used bleaching agents within 12 months and pregnant or lactating women were excluded. A total of 60 patients (38 males, 22 females) were recruited for the experiment and all underwent etiological periodontal treatment to eliminate gingival inflammation.

In Tables 1 and 2 the distribution of treated teeth and the baseline tooth color were reported respectively. For each tooth, the etiology of discoloration was carefully established by means of accurate anamnesis and clinical inspection. The most frequent causes of intrinsic pigmentations were the following:

- severe caries affecting pulp tissues (65%), resulting in decomposition products just like colored proteins;
- dental traumas (30%), breaking pulp blood vessels and

Table 3: Absolute and relative frequency of discoloration etiological factors

DISCOLORATION ETIOLOGY	N	%
Caries	39	65
Generic trauma	18	30
Orthodontic trauma	2	3,3
Impaction trauma	1	1,7
Total	*60*	*100*

Table 4: Restorative conditions at baseline

RESTORATIVE CONDITION	N	%
Trauma	8	13,3
Composite restoration	18	30
Endodontic treatment	34	56,7
Total	*60*	*100*

allowing iron sulfide to diffuse into dentinal tubules;

- necrosis secondary to orthodontic treatment (3.3%), due to uneven force application making the vascular peduncle being interrupted;
- impaction trauma (1.7%), due to uneven pressure exerted by included teeth on the vascular peduncle of erupted teeth.

The absolute and relative frequency of such etiological factors were reported in Table 3.

Each case was documented by means of both standardized radiographs and photographs, in order to study the endodontic anatomy and record the baseline tooth color.

Eight teeth presented no evidence of any previous treatment, 18 teeth showed minor composite restorations and 34 teeth presented with incongruous endodontic treatments, showing pain, fistulas and/or periapical osteolysis (Table 4).

All endodontic treatment was performed according to the vertical condensation technique of warm guttapercha.

Bleaching procedures

Each patient was examined by two operators skilled in tooth color evaluation. In the event of a disagreement, a third trained operator was called as referee. The color shade match was performed in standardized conditions using the same light source and shade guide (Vita Lumin Vacuum Shade Guide, Vita Zahnfabrik, Spitalgasse, Bad Sackingen, Germany).

All the teeth selected for the study were subjected to both in-office intra-coronal dental bleaching and walking bleach technique.

In the intra-coronal technique, each discolored tooth to be treated was isolated with rubber dam to prevent contact between the bleaching agent and the soft tissue. The pulp chamber was opened and thoroughly cleaned. The guttapercha was then removed from the root canals 2-3 mm apically to the cemento-enamel junction using Gates-Glidden burs on a slow speed handpiece (10000 rpm), in order to let the bleaching agent to penetrate the cervical tubules. A 2 mm layer of zinc oxide eugenol containing cement (De Trey Zinc, Dentsply, Konstanz, Germany) was used to seal the guttapercha coronally. Subsequently, 10% carbamide peroxide gel (Opalescence, Ultradent Products Inc., USA) was applied both into the pulp chamber and in an individual vinyl tray made on the master cast and carefully cut at level of the gingival margin. The walking bleach technique was then performed. After 30 minutes, the tray was removed and the pulp chamber generously rinsed with 5% sodium hypochlorite, in order to potentiate the bleaching effect due to the formation of free oxygen. Finally, the pulp chamber was rinsed and dried, followed by a further application of 10% carbamide peroxide gel and then covered with a temporary filling material (Coltosol, Colténe AG, Altstätten, Switzerland) until the next recall appointment. Since the long-term success of a bleaching treatment was proved to be enhanced by applications of the whitening agent repeated over time, such a procedure was repeated every 7 days for a total period of 4 weeks. If necessary, the treatment was prolonged until the color of the treated tooth matched that of adjacent teeth.[10, 11]

At the end of the bleaching treatment, the color shade match procedures were performed by the same skilled operators as previously described and standardized photographs taken to record the achieved results.

The final restoration made with light-curing resin composite materials (Prodigy TM, Kerr Co, Collins West Orange, CA, USA) was performed 4 weeks after the end of the bleaching treatment, in order to verify the stability of tooth color.

The patients were recalled at follow-up every 12 months for a total observational period of 21 years. At the final follow-up, the color shade match procedures were performed by the same skilled operators who had examined the patients at the baseline. The bleaching treatment was classified as successful or unsuccessful and failure was

Figure 1 – Case 1: pre-operative view.

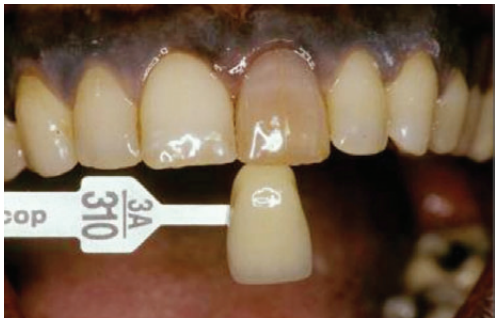

Figure 2 – Case 1: pre-operative color shade record.

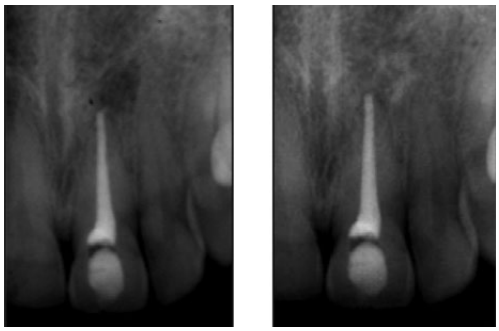

Figure 3 – Case 1: endodontic treatment at baseline (left side) and at 21-year follow-up (right side).

Figure 4 – Case 1: post-operative color shade record.

Figure 5 – Case 1: post-operative view.

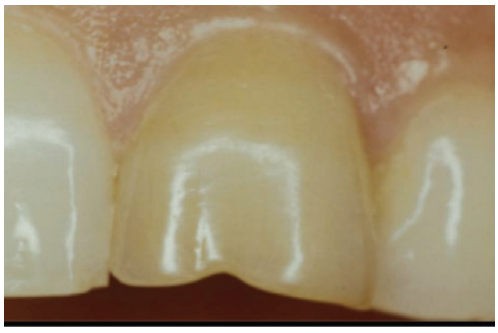

Figure 6 – Case 2: pre-operative view.

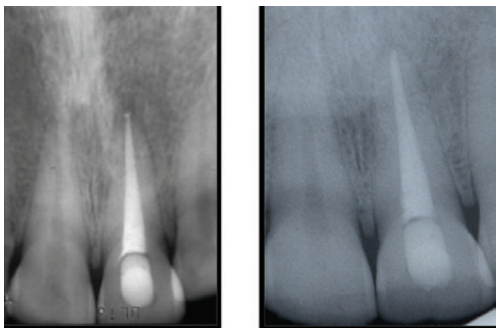

Figure 7 – Case 2: endodontic treatment at baseline (left side) and at 21-year follow-up (right side).

Figure 8 – Case 2: post-operative view.

recorded in cases where a color mismatch of two or more shades was evident. Moreover, the stability of the vertical condensation endodontic technique over time and the influence of carbamide peroxide application on root resorption were evaluated as secondary outcomes.

Statistical Analysis

Descriptive statistics were applied to data using dedicated software (SPSS 17, SPSS Inc., Chicago, IL, USA). The level of significance was set at p=0.05 for all the statistical analyses.

The Kolmogorov-Smirnov test was used to verify the

Table 5: Student's T-test for paired samples

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Color_Baseline - Color_End	7,95000	2,18178	,28167	7,38639	8,51361	28,225	59	,000
Pair 2	Color_End - Color_Follow	-,61667	3,87994	,50090	-1,61896	,38563	-1,231	59	,223
Pair 3	Color_Baseline - Color_Follow	7,33333	3,76724	,48635	6,36015	8,30651	15,078	59	,000

normality of data distribution. The Student's T-test was used to compare the color shade scores at Baseline vs End of Treatment, End of Treatment vs 21-year Follow-Up and Baseline vs 21-year Follow-Up.

Results

After 21 years of clinical service, 42 out of 60 patients were eligible for the final retrospective evaluation.

An optimal tooth color stability in relation to adjacent teeth was evidenced in 33 patients (Fig. 1-8) while 9 patients were classified as failures, since a color mismatch of two or more shades was noticed. Consequently, a success rate of 78.6% was reported after 21 years.

The Kolmogorov-Smirnov analysis confirmed the normality of data distribution ($p>0.05$). The Student's T-test for paired samples showed statistically significant differences between Baseline vs End of Treatment ($p<0.0001$) and Baseline vs Follow-Up ($p<0.0001$) while no statistically significant differences were noticed between End of Treatment vs Follow-Up ($p>0.05$) (Table 5).

The endodontic treatments proved to be radiographically stable and clinically effective in 21 patients (87.5%). Conversely, 3 patients (12.5%) experienced endodontic failure, showing pain, fistulas and/or periapical osteolysis. Consequently, the vertical condensation technique of warm guttapercha seemed not to be significantly affected by the intra-coronal application of carbamide peroxide.

Discussion

According to the results of the present study, the tested null hypothesis was rejected ($p<0.05$). Moreover, according to the statistical analysis, the bleaching effect of 10% carbamide peroxide in non vital teeth proved to be stable and reliable in the long-term.

After 21 years of clinical service, only 42 out of 60 patients were eligible for the final retrospective evaluation, since 7 were lost at follow-up and 11 no longer fulfilled the inclusion criteria of the study (6 fractured the crowns and restored them by means of prosthetic crowns, 2 underwent wider composite restorations, 3 were subjected to tooth extraction due to corono-radicular fratures). A few studies reported the risk of tooth structure weakening after dental bleaching, presumably due to a detrimental effect of oxidizing agents on dentinal tubules. In particularl, peroxides proved able to induce structural changes in enamel, dentin and cementum in vitro, leading to a higher risk of mineral decomposition of tooth hard tissues[12-15]. On this basis, the unrestorable fractures evidenced in the present investigation could be partially explained by detrimental effects of carbamide peroxide at level of the cemento-enamel junction.

According to the failure criteria established in the present clinical study, a success rate of 78.6% was reported after 21 years, since optimal tooth color stability in relation to adjacent teeth was evidenced in 33 patients, while a color mismatch of two or more shades was noticed in 9 patients. Considering the physiological ageing of tooth tissues, carbamide peroxide showed a satisfactory biomimetic behavior, since it did not macroscopically affect the chromatic changes consequent to tooth ageing.

With regard to dental sensitivity, no chronic effects due to the application of carbamide peroxide were observed in any patient. Consequently, it could be speculated that the bleaching agent did not alter the roughness and micro-hardness of enamel as well as the permeability of dentin and cementum. The clinical observations performed in the present investigation are consistent with the results of previous studies.[1-3, 7-9, 11, 13, 14]

Although 3 patients experienced endodontic failures, no

internal and/or external root resorptions were noticed radiographically. Since such phenomena have been widely described in the literature after dental bleaching, the clinical evidences of the present study were probably due to the stability of the protective layer of zinc-oxide cement used to protect the endodontic sealing materials.

Conclusions

Within the limitations of the present long-term retrospective clinical study, 10% carbamide peroxide proved to be an effective dental whitening agent in the long-term for endodontically-treated teeth with both in-office and walking bleach techniques.

The vertical condensation technique of warm guttapercha seemed to be unaffected by the intra-coronal application of carbamide peroxide.

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