Bleaching Teeth Treated Endodontically: Long-Term Evaluation of a Case Series

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Abstract

The chromatic stability of nonvital discolored teeth, subjected to the combined intracoronal bleaching technique and to endodontic treatment, was evaluated at a distance of 16 yr (1989-2005). The series comprised 50 patients (age range 7-30 yr) selected from among those attending the Dental Clinic at "Federico II" University, Naples, between 1987 and 1989. After 16 yr, only 35 cases could be evaluated: in 22 of these cases (62.9%) the color had remained stable and was similar to that of adjacent teeth, indicating a successful outcome of the combined bleaching technique. There were 13 cases (37.1%) classified as failures because of marked color relapse. Radiology showed none of the cases re-examined to have undergone internal or external root resorption. These results confirm the validity of the combined intracoronal bleaching technique in terms of efficacy, rapid esthetic result, and safety. *(J Endod 2006;32:376–378)*

Key Words

Bleaching technique, efficacy, endodontic treatment, tooth resorption

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Over recent years, esthetic dentistry has become more prevalent because of increasing demand from patients for this type of treatment (1). One of the commonest practices in esthetic dentistry is bleaching, which entails the use of chemical substances, in general hydrogen peroxide or carbamide peroxide. On contact with the tooth, these compounds release active principles that diffuse through the enamel and dentin and oxidize the pigments responsible for discoloration. This procedure is simpler and less invasive than restorative, prosthetic, or both, treatment as a means to eliminate discoloration and improve the smile.

Since the 1960s, hydrogen peroxide at a concentration of approximately 30%, alone or in association with sodium perborate, has been used to bleach nonvital teeth. The various techniques are based on a common action mechanism: the bleaching agent releases active oxygen inside the pulp chamber, from where it diffuses into the dentinal tubules (2). It oxidizes and bleaches the iron sulfide and other pigments present in the dentinal tubules (3).

One frequently used technique is the thermocatalytic technique (4), which consists of applying heat or UV light to activate the bleaching agent placed inside the pulp chamber, and increase its efficacy. The treatment is repeated twice or more, for a number of sessions until the desired esthetic result has been achieved, The walking bleach technique is also in widespread use (5): a mixture of 30% hydrogen peroxide and sodium perborate is placed inside the pulp chamber, sealed in place and left to act for 3 to 7 days while the patient continues normal day-to-day life. The mixture is renewed weekly until the desired result has been achieved. The combined technique is also in widespread use (6): this is a combination of the above two techniques that uses the same bleaching agents and the same catalyst. To our knowledge, few studies have yet been published indicating the long-term results of the combined bleaching technique, although it is currently the most widely employed.

The study determined, at a distance of 16 yr (1989-2005) the chromatic stability of 50 nonvital discolored teeth subjected to the combined intracoronal bleaching technique and, at the same time, evaluated the outcome of endodontic treatment performed before bleaching. The goal was to determine whether root resorption could be activated by the use of the bleaching agent.

Materials and Methods

Patients

A group of patients selected from among those attending the Department of Dental Science at "Federico II" University, Naples, between 1987 and 1989 were evaluated clinically. Selection was based on request for treatment and absence of gingival inflammation. Patients with the following characteristics were excluded: extensive restoration in the anterior sector; insufficient residual crown structure to guarantee successful application of the composite materials used for crown reconstruction; enamel cracked or with severely undermined areas; discoloration because of tetracycline or deeply rooted pigmentation (7).

Of 540 patients examined for whom such treatment was necessary, 50 patients met the above criteria (31 male, 19 female; age range 7-30; mean age = 13.2; SD = 6.4). Teeth involved are indicated in Table 1.

For each tooth, the etiology of the discoloration was established by taking a detailed medical history and through careful clinical and radiographic observation. The following were the most frequent etiologic factors:

TABLE 1. Type of teeth involved in the 50 cases in the series

Type of tooth involved	*n*	%
Right maxillary central incisor	16	32.0
Left maxillary central incisor	20	40.0
Left maxillary lateral incisor	4	8.0
Right mandibular central incisor	3	6.0
Right mandibular lateral incisor	2	4.0
Left mandibular central incisor	1	2.0
Left mandibular lateral incisor	4	8.0
Total	50	100

- Caries advanced until it compromises the pulp tissue with formation of numerous decay products in the form of pigmented proteins (8).
- Direct trauma to dental tissue. This causes breakage of coronal blood vessels and subsequent diffusion into the dentinal tubules of red blood cells that release iron on hemolysis and decay. The iron combines with hydrogen sulfide of bacterial origin, giving rise to iron sulfide, responsible for the tooth pigmentation (3).
- Necrosis because of orthodontic treatment, involving inappropriate application of force that can cause amputation of the vascular pedicle (9, 10).
- Necrosis because of tooth impaction. We observed one case of pulp necrosis because of compression of the blood and nerve supply in an impacted maxillary canine, with pulp necrosis of a homolateral maxillary lateral incisor erupted in the arch and with no reported trauma.

Absolute and relative frequencies of these etiologic factors are given in Table 2.

Each of the selected cases was then documented radiographically, to determine whether the tooth had been subjected to endodontic treatment, and if so whether the treatment had been correctly performed. When possible the case was also documented photographically to record the initial color. Of the 50 teeth subjected to observation, 31 had never undergone any form of treatment, eight had undergone only restorative treatment, and 11 had undergone inadequate endodontic treatment (of which two for closure of the apical portals of exit, one for incomplete apexification and the remaining eight for other causes including pain, fistula, presence or nondisappearance of areas of peri- and/or latero-radicular lysis revealed radiographically).

Endodontic re-treatment was performed with the lateral condensation technique in the 11 devitalized teeth for which prior endodontic treatment had been inadequate. Table 3 indicates the initial endodontic situation for the 50 cases.

Procedure

All subjects were examined initially by two professionals trained in chromatic evaluation, in the same room and using the same dental unit, so that all patients were examined under the same lighting conditions to standardize color evaluation. During this first examination, each tooth scheduled for bleaching was evaluated chromatically using a Vita color scale for porcelain (Vita Lumin Vacuum Shade Guide, Vita Zahnfabrik, Spitalgasse, Bad Sackingen, Germany) with colors ordered from lighter to darker.

TABLE 2. Etiology of discoloration in the 50 cases in the series

Etiology of the discoloration	*n*	%
Trauma	42	84.0
Caries	6	12.0
Orthodontic treatment	1	2.0
Necrosis due to canine impaction	1	2.0
Total	50	100

TABLE 3. Initial situation of the 50 cases in the series

Initial situation	*n*	%
No prior treatment	31	62
Restorative treatment alone	8	16
Inadequate endodontic treatment	11	22
Total	50	100

The combined intracoronal bleaching technique was then applied to all selected teeth by the following *procedure*: for protective purposes, the surrounding soft tissues were covered with Vaseline; each discolored tooth was placed under rubber dam and tied with wax thread so that the sheet perfectly sealed the neck of the tooth, to prevent the bleaching agent from reaching periodontal tissues. The pulp chamber was then opened and cleansed. The endodontic filling was removed to a distance of 2 to 3 mm apically to the gengival margin with Gates Glidden burs mounted on a contra-angle hand-piece at 10,000 rpm. This exposed to bleaching the tubules that depart from that point; they run in an apical-coronal direction following an *S*-shaped path and terminate at the cervical enamel (3).

A layer of approximately 2 mm of zinc oxyphosphate cement (De Trey Zinc, Dentsply, Konstanz, Germany) was then placed coronal to the canal gutta-percha and the bleaching mixture was inserted in the pulp chamber. The mixture comprised sodium perborate and 120 volume hydrogen peroxide mixed to a paste on a sheet of glass (11, 12) and was photocatalyzed in situ with a lamp (Illuminator, Union Broach, York, PA) used at 50% heat intensity. In all cases bleaching was accompanied by frequent washing with 5% sodium hypochlorite to potentiate the bleaching effect by liberating nascent oxygen. The procedure was repeated consecutively three times, each time using fresh bleaching mixture. The entire cycle was repeated at each appointment.

At the end of the session, which in general lasted between 35 and 40 min, the access cavity was sealed with temporary cement providing adequate marginal adhesion (Coltosol, Colténe AG, Altstätten, Switzerland), the bleaching material being left in situ without photoactivation. Bleaching sessions were performed regularly once a week for 4 weeks, until the tooth was slightly lighter in color than its neighbors (13). The long-term success of bleaching treatment depends on its being carried out gradually (14). Some weeks after the last bleaching session, when the color appeared stable, the final restoration work was completed by placing photoactivated composite resin in the pulp chamber (Prodigy TM, Kerr Co., West Collins Orange, CA) of a lighter color than that of the tooth, so as to obtain a more lasting esthetic result and reduce the risk of relapse.

After 16 yr, two professionals trained in chromatic evaluation (the same persons who had make the initial chromatic evaluation at the start of treatment) blindly examined the patients who had been recalled for follow-up; failure was defined as a color change of two or more units. This final re-examination was only possible in 35 cases. Seven patients were contacted but did not present to follow-up, and of the 43 who did present, 14 had required prosthetic work after crown fracture, and one case had suffered crown or root fracture with resulting loss of the treated tooth.

Results

At re-evaluation 16 yr after treatment, in 2004 and 2005, the results may be summarized as follows.

Result of Bleaching Treatment

At 16 yr, it was only possible to evaluate the outcome of the bleaching treatment in 35 cases. Of these, 22 cases (62.9%) had maintained a stable color similar to that of adjacent teeth and were thus classified as

successful. The other 13 cases (37.1%) were classified as failures since the color had relapsed by two or more units.

Evaluation of Endodontic Work

Of the 11 cases subjected to endodontic re-treatment we were only able, at 16 yr, to observe nine cases, because two did not respond to recall. Seven (77.8%) of the nine cases re-examined showed an excellent radiographic picture with no fistula and no clinical symptoms. The remaining two cases (22.2%) showed fistula, pain and a peri-radicular and/or latero-radicular bone lysis area that had failed to disappear or had reappeared.

Discussion

At 16 yr, only 43 cases returned for follow-up. In 15 of those that did return it was not possible to evaluate the outcome of bleaching treatment; 14 teeth had since been replaced by prostheses and one had been extracted because of crown or root fracture, probably ascribable to weakening of the dentin caused by bleaching (15–17): hydrogen peroxide has been shown to cause morphologic and structural changes in enamel, dentin, and cementum in vitro (17–19), and these changes may make the hard tissues more susceptible to decay (20). It was thus possible to make a long-term evaluation in only 35 cases. Of these, 22 had maintained a stable color similar to that of adjacent teeth, and were thus classified as successes. There were 13 classified as failures, by the criteria outlined in the *Procedure* section.

However, it is of interest that the 13 cases we classified as failures had not, during the intervening 16 yr, felt the need to seek further bleaching treatment. They were re-contacted and asked whether they were satisfied with the previous treatment. If they were not they were asked whether they intended to seek further bleaching treatment. They replied as follows: 6/13 (46.2 %) said they were satisfied and did not intend to seek further bleaching treatment. There were 7/13 (53.8 %) that said they were not satisfied and had noticed the color change, but that they did not intend to seek further bleaching treatment for various reasons. This points up the marked difference between clinical evaluation and that of the patient: clearly, what the clinician considers a failure may not be so for the patient, and sometimes the reverse may also hold. Thus, purely technical evaluation gives a success rate of 22 out of 35 cases (62.9%) whereas subjective evaluation by the patient increases this rate to 28/35 (80.0%). However, the study only evaluated success by professional parameters.

The scientific literature reports few long-term clinical data on the duration of efficacy and post-treatment side effects of nonvital bleaching. Our results may be compared with those of one of the few reports that have been published: an investigation conducted by Feiglin (21) on a group of 20 adults showed that the use of the intracoronal bleaching technique with sodium perborate and with a mixture of three-quarters water and one quarter 130 volume hydrogen peroxide gave a success rate of 45%. However, the patients were evaluated after a much shorter time lapse than in the present study. Furthermore, Feiglin investigated only adult patients, who are generally more compliant to treatment than children (22). There are also some differences in the bleaching technique applied in the two studies: 130 volume hydrogen peroxide versus 120 volume in the present study; accompanying the bleaching agent with heat and photocatalyzing with a lamp operating at 50% of its power for three times in our case, versus inserting a heated metal instrument into the pulp chamber approximately 10 times in the Feiglin study.

With regard to the outcome of the endodontic treatment, of the 9/11 cases re-treated with the lateral condensation technique who returned for follow-up, we classified seven (77.8%) as successful and two (22.2%) as failures. From the radiological investigation, none of the cases examined showed signs of internal or external root resorption.

The zinc oxyphosphate cement bottom placed at the beginning of treatment in the root canal after removing the canal obturation to 2 to 3 mm apically to the gingival margin, which remained in place during treatment, may in our opinion explain why there were no cases of root resorption, which is a rather frequent complication in bleaching procedures (23–27).

References

1. Gokay O, Mujdeci A, Algn E. Peroxide penetration into the pulp from whitening strips. J Endod 2004;30:887–9.
2. Kawamoto K, Tsujimoto Y. Effects of the hydroxyl radical and hydrogen peroxide on tooth bleaching. J Endod 2004;30:45–50.
3. Castellucci A. Lo sbiancamento dei denti trattati endodonticamente. Endodonzia. Edizioni Martina Bologna, 1996:643–4.
4. Caldwell CB. Bleaching vital or non vital teeth. J Calif Dent Assoc 1966;42:234–5.
5. Nutting EB, Poe GS. Chemical bleaching of discolored endodontically treated teeth. Dent Clin North Am 1967:655–62.
6. Freccia WF, Peters DD, Lorton L, Bernier WE. An in vitro comparison of nonvital bleaching techniques in the discolored tooth. J Endod 1982;8:70–7.
7. Baratieri LN, Ritter AV, Monteiro S Jr, Caldeira de Andrada MA, Cardoso Vieira LC. Nonvital tooth bleaching: guidelines for the clinician. Quintessence Int 1995;26:597–608.
8. Castellucci A. Patologia Pulpare. Endodonzia. Edizioni Martina Bologna, 1996:132.
9. Anstendig HS, Kronman JH. A histologic study of pulpal reaction to orthodontic tooth movement in dogs. Angle Orthod 1972;42:50–5.
10. Proffit WR, Fields HW. The biologic basis of orthodontic therapy. Contemporary orthodontics, 1st ed. St. Louis, MO: C.V. Mosby Company, 1986,238.
11. Rotstein I, Zalkind M, Mor C, Tarabeah A, Friedman S. In vitro efficacy of sodium perborate preparations used for intracoronal bleaching of discolored non vital teeth. Endod Dent Traumatol 1991;7:177–80.
12. Haywood VB. History, safety, and effectiveness of current bleaching techniques and applications of the nightguard vital bleaching technique. Quintessence Int 1992;23:471–88.
13. Rosenstiel SF, Gegauff AG, Johnston WM. Duration of tooth color change after bleaching. J Am Dent Assoc 1991;122:54–9.
14. Castellucci A. Lo sbiancamento dei denti trattati endodonticamente. Endodonzia. Edizioni Martina Bologna, 1996:651.
15. Chng HK, Palamara JE, Messer HH. Effect of hydrogen peroxide and sodium perborate on biomechanical properties of human dentin. J Endod 2002;28:62–7.
16. Lewinstein I, Hirschfeld Z, Stabholz A, Rotstein I. Effect of hydrogen peroxide and sodium perborate on the microhardness of human enamel and dentin. J Endod 1994;20:61–3.
17. Rotstein I, Dankner E, Goldman A, Heling I, Stabholz A, Zalkind M. Histochemical analysis of dental hard tissues following bleaching. J Endod 1996;22:23–5.
18. Rotstein I, Lehr Z, Gedalia I. Effect of bleaching agents on inorganic components of human dentin and cementum. J Endod 1992;18:290–3.
19. Zalkind M, Arwaz JR, Goldman A, Rotstein I. Surface morphology changes in human enamel, dentin and cementum following bleaching: a scanning electron microscopy study. Endod Dent Traumatol 1996;12:82–8.
20. Rotstein I. Bleaching nonvital and vital discoloured teeth. In: Cohen S, Burns RC, eds. Pathways of the pulp, 8th ed. St. Louis: Mosby, 2002:685.
21. Feiglin B. A 6-year recall study of clinically chemically bleached teeth. Oral Surg Oral Med Oral Pathol 1987;63:610–13.
22. Waterhouse PJ, Nunn JH. Intracoronal bleaching of nonvital teeth in children and adolescents: interim results. Quintessence Int 1996;27:447–53.
23. Lado EA, Stanley HR, Weisman MI. Cervical resorption in bleached teeth. Oral Surg Oral Med Oral Pathol 1983;55:78–80.
24. Heller D, Skriber J, Lin LM. Effect of intracoronal bleaching on external cervical root resorption. J Endod 1992;18:145–8.
25. Montgomery S. External cervical resorption after bleaching a pulpless tooth. Oral Surg Oral Med Oral Pathol 1984;57:203–6.
26. Madison S, Walton R. Cervical root resorption following bleaching of endodontically treated teeth. J Endod 1990;16:570–4.
27. Cvek M, Lindvall AM. External root resorption following bleaching of pulpless teeth with oxygen peroxide. Endod Dent Traumatol 1985;1:56–60.