Research Article

Inside-Outside Bleaching of Endodontically Treated Teeth: An *In Vivo* Study

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ARTICLE INFO

Received Date: October 12, 2017
Accepted Date: October 25, 2020
Published Date: October 28, 2020

KEYWORDS

Tooth whitening
Endodontically-treated teeth
Discolored teeth

Citation for this article: Maryam Khoroushi, Amineh Hasankhani and Hesam Mirmohammadi. Inside-Outside Bleaching of Endodontically Treated Teeth: An in Vivo Study. SL Dentistry, Oral Disorders And Therapy. 2020; 3(1):116

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INTRODUCTION

A number of phenomena related to optical properties and light determine tooth color. In fact, tooth color is under the influence of dentin color and intrinsic and extrinsic colorations [1]. Structural changes of enamel, dentin, or coronal pulp might result in the alteration of tooth structure light-transmitting properties [2]. Dental practitioners and patients have always been concerned about beautiful and charming smile. As a result, cosmetic dental procedures have a great role in building high self-esteem; thus such procedures are ever-increasingly requested by patients and spurred on by mass media by emphasizing that good health is associated with an esthetic appearance. Therefore, intrinsic tooth discoloration has given rise to the introduction of bleaching techniques [3].

The most common cause of discoloration in non-vital teeth is the presence of pulpal haemorrhagic products, and commonly follows trauma [4]. However, degradation of proteins during necrosis of the pulp [5], restorative and root canal filling materials can lead to such chromatic alterations [1-5]. In addition calcification of the pulp is considered another form of intrinsic discolouration [4]. Correct diagnosis of the etiologic factors of tooth discoloration is very important because it profoundly affects the treatment outcome.

Internal bleaching technique is a conservative method to manage discolored endodontically treated teeth. The bleaching of endodontically treated teeth was first reported by Garretson in 1895, with the use of chlorine as a bleaching agent [6]. Nonetheless, hydrogen peroxide wasnot used as a bleaching agent for non-vital teeth until 1951 [7]. At present, bleaching of non-vital teeth which have been discolored yields acceptable esthetic results and virtually no significant risks are involved [3]. There are large number of studies demonstrating the clinical efficacy of bleaching [8-11], but it should be noted that in general multiple applications of the bleaching agent are required for good esthetic results [12,13]. Previous studies have been reported in relation to color stability subsequent to bleaching procedures [4,14-17].

Three most commonly used techniques for bleaching of root treated teeth ,which are considered cost-effective and simple [4,18], are the 1) walking, 2) conventional in-office, 3) inside-outside bleaching techniques. The walking bleaching technique is

rather reliable and fairly simple for dental practitioners and patients. In-office bleaching is considered a short-term technique and its effects are attributed to tooth dehydration for endodotically-treated and discolored teeth, outcome of this technique is unpredictable [3]. Settembrini et al [19] introduced the inside-outside bleaching technique, in which bleaching occurs simultaneously with in the tooth structure and on tooth external surface. In this technique, generally 10% carbamide peroxide gel applied to tooth structure internally and externally in root-filled, discolored teeth and refreshed on a regular basis. This bleaching agent ($CH_4N_2O \cdot H_2O_2$) has undergone extensive research. An in vitro study showed that carbamide peroxide has a bleaching capacity comparable to that of hydrogen peroxide [20]. Inside-outside technique is a fast technique because the oxygen reactive species released from the hydrogen peroxide freely diffuse inside and outside of the tooth structure to effect tooth whitening. Plotino et al in their review article reported that: There is a deficiency of evidence-based science in the literature that addresses the prognosis of bleached non vital teeth. Therefore, it is important to always be aware of the possible complications and risks that are associated with the different bleaching techniques [21]. At present, little information is available on the relationship between the clinical outcomes of inside-outside bleaching technique with trays and the discoloration and its causes. Therefore, the aim of this in vivo study was to assess the initial outcomes of inside-outside bleaching technique relative to the control tooth color, the etiology and severity of discoloration.

MATERIALS AND METHODS

In this retrospective study 39 consecutive teeth in 31 patients, bleached by one operator, were followed for up to six months by two calibrated operators. All the subjects signed an informed written consent form and the study was approved by the Institutional Ethics Committee. The bleach technique described by Leith [22] as used. The tooth color was recorded along with the etiologic agent involved in discoloration before the procedure. Radiographic techniques were used to confirm proper root canal therapy. Each patient's medical history was reviewed for any medical conditions that might preclude bleaching procedures, including enzymatic disorders and allergies to H_2O_2 and plastics [23]. Patients with oral conditions that might preclude application of bleaching agents such as poor oral hygiene, xerostomia, un-restored carious lesions and severe erosive lesions of the enamel were excluded [23]. The treatment protocol consisted of inside-outside bleaching procedure with 15% carbamide peroxide gel (Opalescence Ultradent Products Inc, South Jordan, UT, USA). The patients were given information on the putative etiologic factors involved in discoloration, the technique to be applied, the expected outcomes and the possibility re-discoloration in future.

An alginate impression was used to fabricate a study model. A thin layer of nail varnish was applied to the model of the teeth planned to be bleached in order to produce a reservoir in a vacuum-processed plastic mouth guard, with a thickness of 0.50–0.90 mm. The mouth guard was trimmed to and adjusted on the cervical margins on the labial and lingual aspects. Excess gutta-percha was eliminated from the access cavities almost 2 mm below CEJ [22], followed by irrigation of the access cavities with normal saline solution. A light-curing glass-ionomer(Fuji II LC, GC, USA) barrier(~2mm thick) was placed over gutta-percha and light-cured for 40 seconds at a light intensity of 600 m W/cm^2 using an LED light-curing unit (Dr's Light, Good Doctors Co Ltd, Seoul, Korea). The barrier reduces diffusion of the bleaching agent from the tooth into the periodontal ligament and the periapical region [24,25].

The patients were given instructions as to the place of 15% carbamide peroxide gel into the coronal orifices and the mouth guard, simultaneously. Apiece of cotton wool was used to remove excess bleaching gel on the margins after the mouth guard is inserted.

The patients were asked to place the mouth guard with the bleaching gel in the oral cavity for 2 hours [26]. After each treatment session, the subjects were instructed to rinse their mouth and then place small pieces of cotton pellets in the coronal orifices that food particles would not penetrate into them. During the course of treatment, the patients refrained from pigmented foods and drinks with the capacity to stain teeth. Furthermore, they refrained from biting with the teeth being bleached. All the patients were examined at two-day, one-week and two-week intervals. After satisfactory color modification was achieved, the pulp chambers were rinsed with copious water to remove the remnants of the bleaching agent; then each pulp chamber was sealed with a small piece of

Inside-Outside Bleaching of Endodontically Treated Teeth: An in Vivo Study. SL Dentistry, Oral Disorders And Therapy. 2020; 3(1):116.

cotton wool and GI. Each access cavity was restored, after a minimum of one week, with a carefully selected shade of a composite resin (Point 4, Kerr, Orange CA, USA) incrementally using an etch-and-rinse adhesive (Optibond FL, Kerr, Orange CA, USA). Re-evaluation was carried out at one-, three- and six-month postoperative intervals and color regression and External Root Resorption (ERR) were assessed radiographically. Following variables were evaluated in this study: age and gender, tooth type, causes of discoloration, original tooth color, initial outcome of the inside-outside bleaching technique, the required duration of treatment with bleaching gel, color stability at follow-ups, factors related to subsequent color changes and the incidence of ERR.

Tooth discoloration was categorized according to the etiologic agent and color changes. The causes were classified as trauma (T), Pulp Necrosis (PN), Pulp Canal Calcification (PCC) or history of Previous Dental Treatment (PDT). Discolorations were categorized as grey, black, light yellow and dark yellow [4,6]. Data were analyzed with IBM SPSS Statistics version 22using Scheffé's post hoc and spearman tests and one-way ANOVA. Statistical significance was set at P<5%.

RESULTS

There were 31 patients with a total of 39 teeth in this study. Of the 31 patients, 10% were male and 90% were female; in other words, 8% of bleached teeth belonged to men and 92% to women (Table 1). In 25 patients only one tooth was bleached, two teeth in 4 patients and three teeth in 2 patients (Table 1). Patients were 15–46 years of age, with a mean age of 27. The most prevalent age range was 21–30 (Table 2). Age was not significantly related to the cause of discoloration, while the color or the duration of treatment was significant (p<0.001).

Table 1: Number of patients and number of teeth entered in the study.

	1 tooth	2 teeth	3 teeth	Total No. of teeth
Males	3	0	0	3 (8%)
Females	22	4	2	36 (92%)
Total No. of Patients	25	4	2	31(patients), 39 (teeth)

Table 2: Age distribution of the patients in the study.

Age range (years)	Number of patients	Percent of patients
<10	0	0
11-20	9	29
21-30	12	39
31-40	7	22
41-50	3	10
51-60	0	0
Total	31	100

Of the teeth requiring a bleaching procedure, 97% were maxillary teeth, predominantly central (90%) and lateral (5%) incisors (Table 3). Only 2.5% of the teeth were mandibular teeth.

Table 3: Tooth types bleached.

Tooth	Maxillary	Mandibular
Central incisor	35 (90%)	1 (2.5%)
Lateral incisor	2 (5%)	0 (0%)
Canine	1 (2.5%)	0 (0%)
Total	38 (97%)	1 (2.5%)

There were no significant differences between the initial color of the teeth and the cause of the discoloration (P=0.351). The most prevalent discoloration was grey (59%), followed by dark yellow (18%). Table 4 shows that trauma and previous PDT were more likely to cause grey discoloration. The most prevalent cause of discoloration was PDT which had led to grey discoloration in 13 teeth, dark yellow in 5 teeth and black in 3 teeth. Three discolored teeth due to PCC were light yellow. PN had resulted in grey and light yellow discoloration.

Table 4: Initial color of the discolored teeth and the cause of the discoloration.

Pre-operative discoloration	Cause of the discoloration								Total	
	Trauma		Previous dental treatment		Pulp canal calcification		Pulp necrosis			
	No	%	No	%	No	%	No	%	No	%
Dark yellow	2	5.12	5	12.82	0	0	0	0	7	17.94
Light yellow	1	2.56	0	0	3	7.69	1	2.56	5	12.82
Grey	8	2o.51	13	33.33	0	0	2	5.12	23	58.97
Black	1	2.56	3	7.69	0	0	0	0	4	10.25
Total	12	30.7	21	53.84	3	7.69	3	7.69	39	100

Inside-Outside Bleaching of Endodontically Treated Teeth: An in Vivo Study. SL Dentistry, Oral Disorders And Therapy. 2020; 3(1):116.

Spearman's rho analysis did not reveal any correlation between initial tooth color and the treatment outcome (r=0.036 , p=0.827) (Table 5). Treatment outcome in 67% of the teeth was good, with 25% of acceptable and 8% of little change categories. The treatment outcome of light yellow teeth was either good or acceptable.

One-way ANOVA indicated that treatment course duration had no significant difference in the initial tooth color (P=0.792). 23% of the teeth required only 2 days for treatment, 31% required one week and almost half the teeth needed 2 weeks to achieve good or acceptable esthetic results (Table 6).

Table 5: The outcome of the bleaching procedure to the pre-operative discoloration.

Outcome of bleaching	Pre-operative discoloration								Total	
	Dark yellow		Light yellow		Grey		Black			
	No	%	No	%	No	%	No	%	No	%
Good	5	12.82	2	5.12	18	46.15	1	2.56	26	66.66
Acceptable	1	2.56	3	7.69	4	10.25	2	5.12	10	25.64
Little change	1	2.56	0	0	1	2.56	1	2.56	3	7.69
Total	7	17.94	5	12.82	23	58.97	4	10.25	39	100

According One-way ANOVA the mean difference was significant at the .05 level.

Table 6: Duration of treatment with required bleaching agent to modify the various discolorations.

Duration of treatment	Pre-operative discoloration								Total	
	Dark yellow		Light yellow		Grey		Black			
	No	%	No	%	No	%	No	%	No	%
2days	2	5.12	1	2.56	5	12.82	1	2.56	9	23
1week	2	5.12	1	2.56	9	23	0	0	12	30.76
2weeks	3	7.69	3	7.69	9	23	3	7.69	18	46.15
Total	7	17.94	5	12.82	23	58.97	4	10.25	39	100

Table 7: Duration of treatment with required bleaching mixture related to the cause of the discoloration.

No. of applications required	Cause of the discoloration								Total	
	Trauma		Previous dental treatment		Pulp canal calcification		Pulp necrosis			
	No	%	No	%	No	%	No	%	No	%
2days	7	17.94	0	0	0	0	2	5.12	9	23
1week	4	10.25	7	17.94	0	0	1	2.56	12	30.76
2week	1	2.56	14	10.25	3	7.69	0	0	18	46.15
Total	12	30.7	21	53.84	3	7.69	3	7.69	39	100

There were significant differences between the duration of treatment and the etiologic factors involved in discoloration according to ANOVA (P<0.001). Post hoc LSD indicated that the duration of treatment was not significant between PCC and PDT also between truma and PN. Teeth discolored by trauma required significantly shorter treatment courses (only 2 days) compared to those discolored by other causes (Table 7). No teeth discolored by PDT exhibited any changes during the first 2 days; of course, some of the teeth discolored due to PDT exhibited improvements after removing the previous treatment. Teeth discolored due to PCC required longer duration of treatment (2 weeks). However, teeth discolored due to PN achieved good or acceptable esthetic results in 2 days or a maximum of one week, of course after received root canal treatment. The patients were re-evaluated at intervals ranging from one month up to six months, depending on the clinical need and patient availability (Table 8). One-month recall attendance was 78%; however, only 39%of patients attended 6-month recall visits. No cases of invasive external resorption were found at recall appointments for 6 months.

Table 8: Number of patients who attended recall appointments plus the number of teeth actually reviewed.

Recall interval	Number of patients/ teeth reviewed			
	No. of patients %		No. of teeth %	
1 month	24	77.41	27	69.23
3 months	20	64.51	17	43.58
6 months	12	38.70	14	35.89

DISCUSSION

The esthetic appearance of the smile and teeth, including tooth color, is of great significance to patients and has led to increased demands for tooth bleaching. There exists several products and techniques for bleaching of non-vital teeth, with various concentrations of bleaching agents, application times and methods, and the kind of accelerators used with bleaching agents, including chemical activation or photo activation [27]. This article presents an alternative to the traditional walking bleach and thermocatalytic techniques. The active bleaching material interacts with a non-vital tooth both intra-coronally

and extra-coronally. It preserves tooth structure and maintains the natural contour, occlusion, form and function of the tooth. Potential problems associated with dental prostheses are avoided, such as periodontal problems, changes in occlusion, root fractures, opposing tooth wear, and esthetic concerns.[4] The procedure is safe on the condition that care is exercised [26]. A thorough understanding of the chemistry of the agents used and the procedure is of utmost importance to ensure patient and staff safety due to the caustic nature of the materials [4]. One of the advantages of the inside-outside bleaching technique is the higher surface area available internally and externally for the bleaching agent, which might shorten the treatment duration [28].

This technique might be indicated in cases in which simultaneous bleaching of non-vital and vital teethin same arch is necessary. Since a lower concentration of the bleaching agent (15% carbamide peroxide) with a neutral pH value minimizes the risk of external cervical root resorption and gingival irritation, less chair time is required and there is no need to place a dressing in the access cavity [26,28]. During the treatment course, the coronal access cavity is open and no problems are expected to arise due to the antibacterial effect of urea. The urea increases the pH of the oral cavity and displays antibacterial properties. It has been reported that carbamide peroxide has better antibacterial effects than 0.2% chlorhexidine *in vitro* [22]. Frequent home replenishment gives rise to a smooth treatment course and there is no need for regular visits to the dental office and the patient is able to terminate the treatment when the desired esthetic appearance is achieved; therefore, the odds of over-bleaching decrease to a minimum. This technique needs no heat to activate bleaching agents, further minimizing the risk of external resorption [14]. The inside-outside bleaching technique is a superb choice in young patients and has been successfully applied in immature teeth subsequent to apexification [22].

In most circumstances it is possible to achieve a short-term improvement in tooth color. There are three possible factors involved in color regression: (1) chemical reduction of oxidative agents; (2) marginal compromise of the final restoration; and (3) permeability of the enamel and dentin to extrinsic substances [29]. In the present study the majority of patients under 20 years of age achieved good esthetic results in 2 days. Studies have shown that it is easier to bleach the teeth of young adolescents compared to adult teeth because the enamel is more permeable in young subjects [23]. Furthermore, a shorter duration of discoloration in young patients may play an important role in this respect. Since patient compliance is important, it is necessary that patients be fully informed and committed prior to bleaching procedures.

Traumas are more prevalent in the 11–20 year age group compared to other age groups [4] and tooth traumatic injuries are a common etiologic factor for tooth discoloration, necessitating internal bleaching procedures. Maxillary central incisors are usually more susceptible to traumatic injuries than other teeth. The distribution of tooth types requiring bleaching procedures in the present study was consistent with that of other studies [15,22]. In the present study the most common age group was 21–30 years and the majority of patients were female, which might be attributed to the fact that this age group, especially young women, are more concerned about their esthetic appearance. Because the operator in this study is working in a referral center for esthetic treatments, and the majority of children and young adults are referred to pediatric dentists, almost all the patients in this study were adults and adolescents. Maybe that's why the cases with tooth discoloration resulting from traumatic injuries were not frequent in this study, contrary to the results reported by Abbott et al [4], in which the majority of patients were males because of greater incidence of traumatic injuries in boys compared to girls.

According to the results of the present study, the majority of teeth had grey discoloration. The most common etiologic agent of discoloration was PDT (54%). 62% of these teeth had grey discoloration and approximately one-forth were dark yellow. Trauma had caused discoloration of about one-third of all the teeth in this study and the most common discoloration was grey. Discoloration due to traumatic injuries responded very well to the inside-outside bleaching technique. Pulp necrosis was most likely to cause grey discoloration, and pulp canal calcification had resulted in light yellow discoloration but in general these latter conditions were not a common cause of discoloration.

The outcomes of the inside-outside bleaching procedure in this study support previous reports[1,14]which have shown that inside-outside bleaching is a predictable procedure, although many in

vivo studies with this procedure have been case reports. In this study, the majority of teeth had either "good" or "acceptable" color change. Reasons for unsatisfactory results are in most cases patient compliance. Almost all of the grey and dark yellow cases had "good" outcomes. Overall, the inside-outside bleaching technique yielded encouraging and predictable results. It seems that inside-outside bleaching technique covers a greater range of colors and is an effective treatment modality.

Overall, almost 50% of the teeth required 2 weeks for treatment in order to achieve "good" or "acceptable" esthetic results. Another 30% required one week for treatment and 23% required 2 days. The majority of the teeth that had discolored due to traumatic injuries had color modification after just 2 days, similar to the results of other study [4]. This was not surprising since the majority of traumatized teeth had grey discoloration, which was the quickest to change. Teeth with discoloration as a result of pulp canal calcification were the slowest to respond to treatment and required two weeks for treatment, consistent with the results of previous study [4]. It should be noted that in these cases standard access cavities were prepared without anesthesia due to calcified canals.

Some patients did not participate in follow-up recall visits due to long distance but announced their satisfaction with the long-term results of treatment by making phone calls. Two teeth discolored after a month, three teeth after 3 months and one after 6 months. At the review appointments, the total percentage of re-discolored teeth was 15%. Therefore, the outside procedure must be repeated periodically [29-31]. In overall short term control and patients drop of could be considered as study limitations and further studies with a larger number of patients and longer period of recall are recommended.

In this study, before the bleaching treatment, 2-mm below the CEJ were prepared to restore with light-cured glass-ionomer. After color modification and patient satisfaction, the teeth were dressed with a small cotton pellet and resin-modified glass-ionomer. After one week, the previous materials and the light-cured glass-ionomerwere removed and composite resin was used to restore the access cavity. That's why the authors found fewer cases with further discoloration compared to other restorative techniques used [4]. These findings reinforce the above-mentioned concept that further discoloration is likely to occur as a result of the restoration breakdown and uptake of food stains into the tooth structure rather than being due to chemical reduction of oxidation products produced by the bleaching itself [4]. It is recommended to follow a larger group of patients up to several years to validly examine the long-term stability of inside-outside bleaching procedures. The recall interval depends on the need for other dental treatments and patient availability. Attendance at recall examinations is a limiting factor for all the clinical reviews or follow-up studies. Although no cases of ERR were found in this study, further long-term studies are required to assess the true incidence of ERR [4]. However, at least in the short term, ERR was not found to be associated with the inside-outside bleaching technique used in this study. It is reported that ERR is more associated with dental trauma and orthodontic treatments than bleaching [32].

CONCLUSION

1- Inside-outside bleaching technique is a predictable procedure and color modification is usually "good".

2- Teeth stained due to trauma and with grey and yellow discolorations were easier and quicker to bleaching than darker teeth, which required longer treatment durations.

3- Some teeth discolored again in 6 months and this appeared to be related to the breakdown of the access cavity restoration.

There were no cases of external resorption at six-month follow-up.

REFERENCES

1. Chethana S, Sudhanva ME, Raghavendra R. (2011). Combined approach for tooth whitening: A case report. Journal of Clinical Dental Science. 2: 69-71.
2. Joiner A. (2004). Tooth colour: A review of the literature. Journal of Dentistry. 32: 13-12.
3. Zimmerli B, JegerF, Lussi A. (2010). Bleaching of nonvital teeth: A clinically relevant literature review. Schweiz Monatsschr Zahnme. 120: 306-320.
4. Abbott P, Heah SY. (2009). Internal bleaching of teeth: an analysis of 255 teeth. Australian Dental Journal. 54: 326-333.
5. Attin T, Paque F, Ajam F, Lennon AM. (2003). Review of the current status of tooth whitening with the walking bleach technique. International Endodontic Journal. 36: 313-329.

6. FasanaroTS. (1992). Bleaching teeth: history, chemicals and methods used for common tooth discolorations. Journal of Esthetic Dentistry. 4: 71-78.
7. Pearson HH. (1951). Successful bleaching without secondary discolouration. Journal of Canadian Dental Association. 17: 200-201.
8. Joiner A. (2006). The bleaching of teeth: A review of the literature Journal of Dentistry. 34: 412-419.
9. Giachetti L, Bertini F, Bambi C, Nieri M, Russo DS. (2010). A randomized clinical trial comparing at-home and in-office tooth whitening techniques: A nine-month follow up. Journal of American Dental Association. 14: 1357-1364.
10. Bizhang M, Chun YH, Damerau K, Singh P, Raab WH, et al. (2009). Comparative clinical study of the effectiveness of three different bleaching methods. Operative Dentistry. 34: 635-641.
11. Polydorou O, Hellwig E, Hahn P. (2008). The efficacy of three different in-office bleaching systems and their effect on enamel microhardness. Operative Dentistry. 33: 579-586.
12. Al Shethri S, Matis BA, Cochran MA, Zekonis R, Stropes M. (2003). A clinical evaluation of two in-office bleaching products. Operative Dentistry. 28: 488-495.
13. Buchalla W, Attin T. (2007). External bleaching therapy with activation by heat, light, or laser—A systematic review. Dental Materials. 23: 586-596.
14. Amato M, Scaravilli MS, Farella M, Riccitiello F. (2006). Bleaching teeth treated endodontically: long-term evaluation of a case series. Journal of Endodontics. 32: 376-378.
15. He LB, Shao MY, Tan K, Xu X, Li JY. (2012). The effects of light on bleaching and tooth sensitivity during in-office vital bleaching: a systematic review and meta-analysis. Journal of Dentistry. 40: 644-653.
16. Brunton PA, Burke FJ, Sharif MO, Creanor S, Hosey MT, et al. (2012). Contemporary dental practice in the UK in 2008: aspects of direct restorations, endodontics and bleaching. British Dental Journal. 212: 63-67.
17. Burrows S. (2009). A review of the efficacy of tooth bleaching. Dental Updates. 36: 537-538, 541-544, 547-548.
18. RollyShA, Suparna GS. (2011). Inside-Outside bleaching of discolored non-vital teeth. International Journal of Dental Clinics. 3: 95-96.
19. Settembrini L, Gultz J, Kaim J, Scherer W. (1997). A technique for bleaching non-vital teeth: inside/outside bleaching. Journal of American Dental Association. 128: 1283-1284.
20. Lim MY, Lum SO, Poh RS, Lee GP, Lim KC. (2004). An *in vitro* comparison of the bleaching efficacyof 35% carbamide peroxide with established intracoronal bleaching agents. International Endodontic Journal. 37: 483-488.
21. Plotino G, Buono L, Grande NM, Pameijer CH, Somma F. (2008). Nonvital tooth bleaching: a review of the literature and clinical procedures Journal of Endodontics. 34: 394-407.
22. Leith R, Moore A, O'Connell AC. (2009). An effective bleaching technique for non-vital, discoloured teeth in children and adolescents. Journal of Ireland Dental Association. 55: 184-189.
23. Lee SS, Zhang W, Lee DH, Li Y. (2005). Tooth whitening in children and adolescents: a literature review. Pediatric Dentistry. 27: 362-368.
24. Rotstein I, Friedman S, Mor C, Katznelson J, Sommer M, et al. (1991). Histological characterization of bleaching-induced external root resorption in dogs. J Endod. 17: 436-441.
25. Brighton DM, Harrington GW, Nicholls JI. (1994). Intracanal isolating barriers as they relate to bleaching. J Endod. 20: 228-232.
26. Kelleher M. (2008). Management of discolored dead anterior teeth Quintessence Pub Co, Dental Bleaching 1st Ed. Ch. 3: 35-52.
27. Polydorou O, Wirsching M, Wokewitz M, Hahn P. (2013). Three-month evaluation of vital tooth bleaching using light units-a randomized clinical study. Operative Dentistry. 38: 21-32.
28. Poyser NJ, Kelleher MG, Briggs P. (2004). Managing discoloured non-vital teeth: the inside/outside bleaching technique. Dent Update. 3: 204-10, 213-4.
29. Howell RA. (1981). The prognosis of bleached root-filled teeth International Endodontic Journal. 14: 22-26.
30. Friedman S, Rotstein I, Libfeld H, Stabholz A, Heling I. (1988). Incidence of external root resorption and esthetic results in 58 bleached pulpless teeth. Endod Dent Traumato. 14: 23-26.
31. Brown G. (1965). Factors in fluencingsnccessful bleaching of the discolored root-filled tooth. Oral Surg Oral Med Oral Pathol. 20: 238-44.
32. Heithersay GS. (2004). Invasive cervical resorption. Endodontic Topics. 7: 73-92.