To Tvaluate the Bleaching Efficacy of 10% Carbamide Peroxide, 30% Hydrogen Peroxide and Sodium Perborate for Intracoronal Bleaching of Root Filled Discoloured Teeth-a Comparative Clinical Study

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Abstract

The present clinical study of 1 year duration was designed to evaluate the bleaching efficacy of 10% carbamide peroxide relative to 30% hydrogen peroxide and sodium perborate mixed with distilled water for intracoronal bleaching of endodontically treated mild to moderate discoloured teeth.

Methodology

Among the patients visiting the Department of Conservative Dentistry and Endodontic, Government Dental College and Research Institute, Bangalore with the chief complaint of discoloured anterior teeth, 43 patients were selected based on the inclusion and exclusion criteria of the study. After obtaining the informed consent from the patients who accepted the proposed treatment, a total of 45 anterior teeth (central incisors and lateral incisors) were selected and randomly divided into 3 groups.

Group 1: 15 teeth using 10% carbamide peroxide gel.

Group 2: 15 teeth using 30% hydrogen peroxide solution.

Group 3: 15 teeth using sodium perborate powder mixed with distilled water.

Patient's thorough history was taken and careful clinical examination, pre-operative radiographic examination and baseline colour of the tooth was established. With rubber dam isolation, access restoration was removed, and approximately 3 mm of root canal filling material was removed in an apical direction beyond the clinical height of the crown (incisogingival height). A base of the glass-ionomer cement approximately 2 mm thick was applied below cemento-enamel junction in the pulp chamber in all 3 groups. After base application,

In Group I: 10% Carbamide Peroxide paste was placed in the pulp chamber.

In Group II: 30% hydrogen peroxide solution dampened in cotton was placed in the pulp chamber.

In Group III: sodium perborate powder mixed with distilled water was placed in the pulp chamber.

Then the lingual access was sealed with glass ionomer cement. The bleaching agents were replaced at day 0, 7, 14, 21 and 28 in all the 3 groups and the change in tooth colour was evaluated using Vita Lumen shade guide under standardized lighting conditions at each visit.

Results

Results of present clinical study showed that, at the end of 7 days, with group 30% hydrogen peroxide (HP), there was a mean improvement of 6 Vita Lumin shade tabs, group sodium perborate (SP); showed a mean improvement of 3 Vita Lumin shade tabs whereas group 10% carbamide peroxide (CP) had a mean improvement of 1 Vita Lumin shade tab.

After the second bleaching session, there was a mean improvement of 6 Vita Lumin shade tabs with group 30% hydrogen peroxide (HP) and with group sodium perborate (SP), there was a mean improvement of 4 Vita Lumin shade tabs whereas group 10% carbamide

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peroxide (CP) had a mean improvement of 2 Vita Lumin shade tab. Group 30% hydrogen peroxide (HP) achieved the desired shade after two bleaching session.

After the third bleaching session, there was a mean improvement of 4 Vita Lumin shade tabs with group sodium perborate (SP), whereas group 10% carbamide peroxide (CP) had a mean improvement of 3 Vita Lumin shade tab. Group sodium perborate (SP) achieved the desired shade after three bleaching session.

After the fourth bleaching session, there was a mean improvement of 3 Vita Lumin shade tabs with group 10% carbamide peroxide (CP). Group 10% carbamide peroxide (CP) achieved the desired shade after four bleaching session.

Conclusion

In conclusion, within the limits of present clinical study of 1 year duration, Intracoronal bleaching with 10% carbamide peroxide was good and equally effective as compared with 30% hydrogen peroxide and sodium perborate mixed with distilled water. However, more bleaching sessions were required with 10% carbamide peroxide to achieve results similar to 30% hydrogen peroxide and sodium perborate mixed with distilled water in endodontically treated mild to moderate discoloured teeth.

Introduction

Cosmetic dentistry has become an important part of restorative dental practice in recent years. The appearance of teeth is very important to patients of all ages and is often associated with a perception of health and fitness. Since white teeth are believed to be associated with health and beauty, lighter-coloured teeth have become desirable.[1] Discolouration of endodontically treated teeth is of concern to the patient and dentist. The causes most commonly cited for acquired intrinsic tooth discolouration are intrapulpal haemorrhage, pulp necrosis, intracanal medicaments, obturation materials, sealers and metallic restoration placed in the coronal access.[2]

Intracoronal bleaching is an established, simple, cost-effective and conservative method of improving the colour of discoloured teeth that have received root canal treatment in the appropriate circumstances. The most commonly used bleaching agents used to produce the desired aesthetic colour change are hydrogen peroxide and sodium perborate, either used alone or in combination. From both economic and safety reasons, it would be desirable to achieve the aesthetic change in the minimum number of sessions as well as to minimize exposure of the periradicular tissue to hydrogen peroxide. This clinical study was undertaken:

1. To evaluate the bleaching efficacy of 10% carbamide peroxide with established intracoronal bleaching agents in root filled discoloured teeth.
2. To compare the bleaching efficacy of 10% carbamide peroxide, 30% hydrogen peroxide and sodium perborate for intracoronal bleaching of root filled discoloured teeth.

Materials and Method

Source of Data

Patients visiting the Department of Conservative Dentistry and Endodontics, Government Dental College, Bangalore, requiring whitening of teeth were selected and the patients who accepted the proposed treatment with the criteria for colour evaluation were included in the study. Oral and written informed consents were obtained from all the study participants.

Methodology

This study was conducted in accordance with all the local regulations after obtaining ethical clearance. 43 patients were selected based on the inclusion and exclusion criteria of the study and a total of 45 anterior teeth (central incisors and lateral incisors) were selected and randomly divided into 3 groups.

Group 1: 15 teeth using 10% carbamide peroxide gel.

Group 2: 15 teeth using 30% hydrogen peroxide solution.

Group 3: 15 teeth using sodium perborate powder mixed with distilled water.

Patient's thorough history was taken and careful clinical examination, pre-operative radiographic examination and baseline colour of the teeth were established using vita-lumin shade guide. With rubber dam isolation, access restoration was removed, initially with a

spherical diamond point used in a high speed hand piece under air water irrigation, and then with a no.4 stainless steel round bur used at low speed to preserve a maximum amount of tooth. Approximately 3 mm of root canal filling material was removed in an apical direction beyond the clinical height of the crown (incisogingival height).

This procedure has a two fold purpose: to create space for the application of the cervical seal and to expose dentinal tubules directed toward the cervical region of the tooth. A base of the glass-ionomer cement approximately 2 mm thick was applied below cemento-enamel junction in the pulp chamber in all 3 groups. After base application,

In Group I: 10% Carbamide Peroxide paste was placed in the pulp chamber.

In Group II: 30% hydrogen peroxide solution dampened in cotton was placed in the pulp chamber.

In Group III: sodium perborate powder mixed with distilled water was placed in the pulp chamber.

Then the lingual access was sealed with glass ionomer cement. The occlusal contacts were checked and the patients were advised to chew carefully in the region of the tooth being bleached. The bleaching agents were replaced after every one week in all 3 groups with a fresh material and the tooth colour was evaluated using Vita Lumen shade guide under standardized lighting conditions. At 28th day of treatment, the access restoration was removed; the pulp chamber was flushed generously with water to remove bleaching agents and the pulp chamber was filled with a paste of calcium hydroxide mixed with water to be left in the chamber for 7 days. This procedure is intended to render the pH alkaline in the cervical region of the tooth. After the possible neutralisation of acidity in the cervical region of the teeth, the coronal access cavities were sealed with resin composite. The shade of the teeth were evaluated at day 0, 7, 14, 21 and 28 using Vita Lumen shade guide under standardized lighting conditions. The Vita shade guide was ordered by value order from lightest to darkest as determined by the manufacturer and a corresponding position number assigned and noted to allow statistical analysis of data.

Vita tab[6]	B1	A1	B2	D2	A2	C1	C2	D4	A3	D3	B3	A3.5	B4	C3	A4	C5
Position[6]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Results

Comparison of the distribution of shade grades in the three groups at baseline (day 0): The table given below shows the distribution of shade grades in the three different groups at day 0. We use chi-sq test to find out if there is any significant association between the groups with respect to shade grade.

Shade	Day 0			Total	Chi-sq	P-value
	Group 1	Group 2	Group 3			
A3	0	4	0	4	20.886	0.022
B3	0	0	3	3		
A3.5	0	2	0	2		
B4	3	1	1	5		
C3	2	2	3	7		
A4	10	6	8	24		
Total	**15**	**15**	**15**	**45**		

From the above table we notice that there is a significant association between the groups with respect to shade grades at day 0 (P<0.05).

Comparison of the distribution of shade grades in the three groups at day 7: We observe that there is a significant association between the shade grades and the groups at day 7 (P<0.001). We observe a shift in the grades of all the samples in all the groups. A higher change is noticed in group 2 compared to group 3 and group 1. 4 samples (26.57%) in group 2 had reached the desired shade grade of A1 by day 7 and were thus excluded from further analysis. No sample in group 1 and group 3 had reached the shade grade of A1 by day 7. The distribution of shade grades in the groups was found to be statistically significant at day 7. Therefore, we conclude that group 2 is superior to group 1 and group 3.

Shade	Day 7			Total	Chi-sq	P-value
	Group 1	Group 2	Group 3			
A1	0	4	0	4		
A2	0	4	0	4		
C2	0	1	0	1		
A3	3	6	4	13		
D3	0	0	4	4	43.913	<0.001
B3	3	0	0	3		
A3.5	5	0	6	11		
B4	4	0	1	5		
Total	**15**	**15**	**15**	**45**		

Comparison of the distribution of shade grades in the three groups at day 14: We notice a significant association between shade grades and groups at day 14 (P<0.001). We also observe that all the samples in group 2 have reached the desired shade grade of A1 by day 14. Group 2 is thus excluded from further analysis. No sample in group 1 and group 3 had reached the shade grade of A1 by day 14. The distribution of shade grades in the groups was found to be statistically significant at day 14. It is further established that group 2 is superior to group 1 and group 3.

Shade	Day 14			Total	Chi-sq	P-value
	Group 1	Group 2	Group 3			
A1	0	10	0	10		
B2	1	0	0	1		
A2	2	0	5	7		
C2	0	0	3	3	56.825	<0.001
A3	5	0	7	12		
B3	7	0	0	7		
Total	**15**	**10**	**15**	**40**		

Comparison of the distribution of shade grades in the three groups at day 21: At day 21, we notice that there is a significant association between shade grades and groups (P<0.05). Group 3 had more no. of samples in the desired shade grade of A1. 2 samples (13.33%) in group 1 and 5 samples (33.33%) in group 3 were in shade grade A1 at day 21 and therefore these samples have not been considered for further analysis. The distribution of shade grades in the groups was found to be statistically significant at day 21. We conclude that group 3 is superior to group 1.

Shade	Day 21		Total	Chi-sq	P-value
	Group 1	Group 3			
A1	2	5	7	14.104	0.015
B2	1	0	1		
D2	0	3	3		
A2	4	7	11		
C2	1	0	1		
A3	7	0	7		
Total	**15**	**15**	**30**		

Comparison of the distribution of shade grades in the three groups at day 28: We notice that there is a significant association between groups and the shade grades at day 28 (P<0.01). We observe that more no. of samples in group 3 have reached the desired shade grade of A1 whereas the same is less in group 1. 2 samples (15.38%) in group 1and 7 samples (70%) in group 3 were in shade grade A1 at day 28. The distribution of shade grades in the groups were found to be statistically significant at day 28 & therefore we conclude that group 3 is superior to group 1.

We also observe that 1 sample in group 1 (7.69%) and 3 samples (30%) in group 3 have reached the shade grade of B1. This further establishes that group 3 is superior to group 1.

Shade	Day 28		Total	Chi-sq	P-value
	Group 1	Group 3			
B1	1	3	4	13.618	0.003
A1	2	7	9		
B2	2	0	2		
A2	8	0	8		
Total	13	10	23		

Among the three groups it was found that group 2 was better than the others. The change in shade grades was noticed at a faster pace in group 2. 26.57% of the samples had reached the

desired shade grade of A1 at day 7 where as none of the samples in the other groups had reached A1 at this time interval. The differences in change in the shade grades among the groups at day 7 was found to be statistically significant ($P<0.001$).

The remaining samples in group 2 reached the desired shade grade of A1 by day 14, whereas, none of the samples in group 1 & group 3 had reached the desired shade grade of A1. This establishes the superiority of group 2 over the other two groups. It was found that the distribution of shade grades among the groups at day 14 was statistically significant ($P<0.001$).

Between group 1 and group 3, it was found that group 3 was superior to group 1. This fact was established by the change in shade grades noticed at day 21 and at day 28 among these groups. Higher no. of samples in group 3 achieved the desired shade grade of A1 compared to group 1. The differences in change in the shade grades among group 3 and group 1 was found to be statistically significant at day 21 and day 28 ($P<0.05$).

Discussion

When a patient has a non vital intact discoloured tooth, the dentist must decide which type of treatment to perform. The most conservative approach is to bleach the tooth, and then restore it with resin composite. Three basic techniques have been used to bleach non vital discoloured teeth: the intracoronal ("walking") bleaching technique, thermocatalytic technique and combination of both techniques.[32]

The first description of the walking bleach technique using a mixture of sodium perborate and distilled water was mentioned in a congress report by Marsh and published by Salvas (1938). In this procedure, the mixture was left in the pulp cavity for a few days and the access cavity was sealed with provisional cement. This concept of application of a mixture of sodium perborate and water to the tooth for a few days was re-considered again by Spasser (1961) and modified by Nutting & Poe (1963) who used 30% hydrogen peroxide instead of water to improve the bleaching effectiveness of the mixture. The use of an intracoronal filling of sodium perborate mixed with water or H_2O_2 continued till today, and has been described many times as a successful technique (Nutting & Poe 1967, Serene & Snyder 1973, Boksman et al. 1983, Rotstein et al. 1993, Attin & Kielbassa1995).

The thermocatalytic technique uses 30% to 35% hydrogen peroxide placed in the pulp chamber and it is activated by heat. Because of the occurrence of external cervical root resorption, reported in literature, the use of 30% to 35% hydrogen peroxide and the techniques that employ heat should be avoided.[32]

Since its introduction by Haywood and Heymann, nightguard vital bleaching has been suggested as an efficient and simple procedure for removing intrinsic and extrinsic stains from teeth. Many products and systems have appeared on the market for in-office use, such as 35% hydrogen peroxide. However, a 10% carbamide peroxide bleaching agent is the most commonly used at home bleaching product, owing to its safety and effectiveness. Variations of this technique have been introduced, including the use of higher concentrations of carbamide peroxide agents (from 10 to 22 percent), with carboxypolymethylene polymer used as a thickening agent to improve tissue adherence and to result in a timed or sustained release of the whitening agent.[33]

Aldecoa & Mayordomo (1992) described good clinical success rates when using a mixture consisting of sodium perborate and 10% carbamide peroxide gel. This suspension was used as a temporary intracoronal filling after application of a regular walking bleach paste with sodium perborate and H_2O_2. The authors claimed that this procedure led to long-term stability of the tooth whitening therapy.[5] Recently use of 10% carbamide peroxide as an intracoronal bleaching agent has been proposed.[32]

The present clinical study of 1 year duration was designed to evaluate the bleaching efficacy of 10% carbamide peroxide relative to 30% hydrogen peroxide and sodium perborate mixed with distilled water for intracoronal bleaching of endodontically treated mild to moderate discoloured teeth.

Carbamide peroxide ($CH_6N_2O_3$) also known as urea hydrogen peroxide, exist in the form of white crystals or as a crystallized powder

containing approximately 35% hydrogen peroxide. It forms H_2O_2 and urea in aqueous solution. It is mostly used in home bleaching materials with concentration ranging from 10 to 30% (equivalent to approximately 3.5% to 8.5% H_2O_2); however those containing 10% carbamide peroxide appear to be the most common. 10% carbamide peroxide breaks down to 3.4% hydrogen peroxide and is classified as an "oral antiseptic" by the US Food and Drug Administration (FDA) monograph of 1988 and therefore minimizes the risks (Haywood, 1993).[19]

Sodium perborate $(N_aBO_2(OH)_2).n(H_2O)$ with n=0: monohydrate, n=4: trihydrate, n-6: tetrahydrate) in the form of mono-, tri- or tetrahydrate is used as a H_2O_2-releasing agent. Sodium perborate in the solid aggregate state exists as a cyclic peroxoborate. The whitening efficacy of sodium perborate mono-, tri- or tetrahydrate mixtures with either water or H_2O is not different (Ari & Ungor 2002). H_2O_2 is released during the decomposition of perborate. The released H_2O_2 can generate different radicals or ions depending on pH value, light influence, temperature, existence of co-catalysts and metallic reaction partners (Feinman et al.1991, Goldstein & Garber 1995).

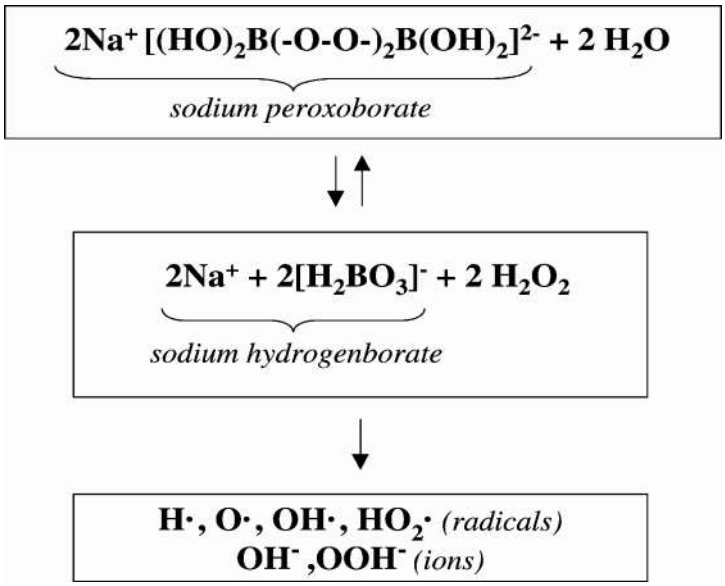

Figure: After adding water to sodium peroxoborate, H_2O_2 is formed that is further decomposed into different radicals or ions.

Thus, perhydroxy radicals preferably arise in an alkaline environment resulting in effective bleaching agents (Goldstein & Garber 1995). These products are formed after the cleavage of H_2O_2 and are responsible for the oxidation and reduction effect of coloured molecule and therefore the bleaching properties of H_2O_2. The radicals can crack unsaturated double bonds of long, coloured molecules or reduce the coloured metallic oxides like Fe_2O_3 ($Fe3^+$) to colourless FeO ($Fe2^+$).[5]

An early description of hydrogen peroxide application was reported by Harlan (1884/ 1885), Superoxol (30% hydrogen peroxide, H_2O_2) was mentioned by Abbot (1918). Some authors proposed using light (Rosenthal 1911, Prinz 1924), heat (Brininstool 1913, Leendert et al.1984) or electric current (Kirk1889, Westlake 1895) to accelerate the bleaching reaction by activating the bleaching agent.[5]

Results of the present clinical study of 1 year duration revealed that 30% hydrogen peroxide (HP) was more effective than sodium perborate (SP) and sodium perborate (SP) was more effective than carbamide peroxide (CP) after one bleaching session. With group hydrogen peroxide (HP), there was a mean improvement of 6 Vita Lumin shade tabs; with group sodium perborate (SP), there was a mean improvement of 3 Vita Lumin shade tabs whereas group carbamide peroxide (CP) had a mean improvement of 1 Vita Lumin shade tab at one bleaching session.

After the second bleaching session, there was a mean improvement of 6 Vita Lumin shade tabs with group hydrogen peroxide (HP) and with group sodium perborate (SP), there was a mean improvement of 4 Vita Lumin shade tabs whereas group carbamide peroxide (CP) had a mean improvement of 2 Vita Lumin shade tab. Group HP achieved the desired shade after two bleaching session.

After the third bleaching session, there was a mean improvement of 4 Vita Lumin shade tabs with group sodium perborate (SP), whereas group carbamide peroxide (CP) had a mean improvement of 3 Vita Lumin shade tab. Group sodium perborate (SP) achieved the desired shade after three bleaching session.

After the fourth bleaching session, there was a mean improvement of 3 Vita Lumin shade tabs with group carbamide peroxide (CP). Group carbamide peroxide (CP) achieved the desired shade after four bleaching session.

In conclusion, within the limits of present clinical study of 1 year duration, intracoronal bleaching with 10% carbamide peroxide was good and equally effective as compared with 30% hydrogen peroxide and sodium perborate mixed with distilled water. However, more bleaching sessions were required with 10% carbamide peroxide to achieve results similar to 30% hydrogen peroxide and sodium perborate mixed with distilled water in endodontically treated mild to moderate discoloured teeth.

According to Weiger R and Kuhn A, external cervical root resorption may result from the use of caustic bleaching agents, such as 30-35% hydrogen peroxide, heat source, and the lack of an effective isolating intracoronal base. Therefore, to prevent external cervical root resorption, the use of 30-35% hydrogen peroxide and heat (in the thermocatalytic, walking bleach or the combination technique) should be avoided.

In an analysis of all reported cases of external cervical resorption associated with intracoronal bleaching, the common trend in all the affected cases was the absence of a seal over the root filling (MacIsaac & Hoen 1994, Baratieri et al. 1995). It would therefore, be prudent that the root filling is sealed off from the bleaching agent with an intermediate base, no matter which intracoronal bleaching agent is selected for use.[6]

Moreover, the isolating base prevent not only the diffusion of the bleaching agent through the tooth to the periodontal ligaments but also the contamination of the filled root canal (gutta percha filling) by bacterial ingress.[32]

Several restorative materials, such as gutta-percha, cavit, zinc phosphate, IRM and zinc oxide eugenol have been used as intracoronal isolating base. However, the most recent generation of glass-ionomer cements, mainly the resin-modified glass-ionomer cements, seems to combine many requirements needed by an isolating base. They show a coefficient of thermal expansion very close to that of dentine, contain no eugenol and bond to resin composite.[32]

In the present study, a base of resin-modified glass ionomer about 2 mm in thickness was placed at the cementoenamel junction in the access cavity, to prevent possible bleaching hazards.

The intracoronal (walking) bleaching technique with sodium perborate and water has not been associated with external root resorption and it is as effective as other techniques.[32]

In an evaluation of the diffusion of hydrogen peroxide through the discoloured, root filled tooth undergoing intracoronal bleaching, Lee et al. determined that there was no significant difference in hydrogen peroxide detected in the periradicular area when using either 35% carbamide peroxide gel or sodium perborate with distilled water. A statistically significant (greater) amount of hydrogen peroxide diffused out using 35% hydrogen peroxide gel. Therefore, 35% carbamide peroxide gel could be used as the intracoronal bleaching agent of choice as it appears to be equally safe as sodium perborate but with the efficacy of 35% hydrogen peroxide.[6]

In present study, 10% carbamide peroxide is as effective as sodium perborate but took longer time to achieve the desired result. The equal effectiveness could be that carbamide peroxide penetrates less readily in the dentinal tubules (Cooper et al. 1992). Thus it may remain within dentine where it can effectively break down the chromogens more efficiently as opposed to

hydrogen peroxide that penetrates dentine more readily.[6]

Another contributing factor to the greater efficacy of carbamide peroxide relates to the effect of between pH, the more free radicals are available for bleaching. Optimal ionization occurs when hydrogen peroxide is buffered in the range of pH 9.5-10.8. In this range, the bleaching effect could be 50% better than when it is more acidic (Sun 2000). Since 30% hydrogen peroxide has a pH 2-3 and 10% carbamide peroxide gel has a pH of 6.5 (Price et al. 2000), carbamide peroxide gel may have approximately the same quantity of free radicals as 30% hydrogen peroxide available for bleaching.[6]

The present clinical study of one year duration showed that the shade of teeth was stable and radiographic examination revealed no evidence of external cervical root resorption after one year proving the efficiency of the 10% carbamide peroxide as an intracoronal bleaching agent comparable to the sodium perborate mixed with distilled water and 30% hydrogen peroxide in endodontically treated mild to moderate discoloured teeth, however, the extent of the discolouration of the non vital tooth is also an important factor for the good clinical results to be achieved.

Conclusion

In conclusion, within the limits of present clinical study of 1 year duration, intracoronal bleaching with 10% carbamide peroxide was good and equally effective as compared with 30% hydrogen peroxide and sodium perborate mixed with distilled water. However, more bleaching sessions were required with 10% carbamide peroxide to achieve results similar to 30% hydrogen peroxide and sodium perborate mixed with distilled water in endodontically treated mild to moderate discoloured teeth.

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