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Original Research

Comparative Evaluation of the Bleaching Efficacy of 16% Carbamide Peroxide and 30% Hydrogen Peroxide – An *In-vitro* Study

M.S. Rama Rao[1], Tejasree Rathod[2]*, V.S.S.K. Sekhar[3], Kiran Kumar Ch.[4]

ABSTRACT

Aim: To evaluate the bleaching efficacy of 16% carbamide peroxide, 30%hydrogen peroxide for intracoronal bleaching of root filled discoloured tooth. **Methodology:** Extracted teeth were artificially stained using human blood then centrifuged under 3,200 rpm speed for 30 min thrice daily for a period of 2 days to enhance penetration of the haemolysed red blood cells into the dentinal tubules. The precipitate was removed, and the teeth were immersed in the remaining haemoglobin-rich haemolysate for further 2 days, centrifuging it thrice daily for 30 min. The resultant discoloured teeth were then washed in distilled water. Root canal treatment was performed. After obturation, a 2-mm intermediate base of Intermediate restorative material IRM was placed to 1-mm apical to the cementoenamel junction. Teeth were divided into three groups with 10 teeth per group. Intracoronal bleaching was performed using either 35% carbamide peroxide gel (group CP) in one group, 35% hydrogen peroxide gel (group HP) in another group and distilled water in the control group as the third group. The bleaching agents were replaced after 5 days. The shade of the teeth was evaluated at day 0, 5 and 10 using VITA Zahnfabrik, Bad Sa¨ckingen, Germany) shade guide. The results were analysed using Kruskal–Wallis one-way analysis of variance and Mann–Whitney *U*-test. **Results:** When superoxol and control group are compared, there shows a clear difference of significance between these two materials. But when superoxol and carbamide peroxide are compared, there is no difference of significance. Both superoxol and carbamide peroxide showed same results. Both are effective bleaching agents. **Conclusion:** In our study we noticed that 16% carbamide peroxide and 30% hydrogen peroxide are equally effective in the treatment of intracoronal bleaching which we observed in a 5,10,15 days of regular intervals

KEYWORDS: Carbamide peroxide, Drug effects, Hydrogen peroxide, Tooth bleaching, Tooth discolouration, Haemoglobin-rich Haemolysate, Root canal filled tooth

INTRODUCTION

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 [1]. More recently 10% carbamideperoxide has also been recommended. One of the undesirable consequences of intracoronal bleaching is external cervical root resorption. This has been attributed to excessive hydrogen peroxide diffusing into the periradicular tissues, possibly through cemental defects [2], although the exact mechanism has not been determined [4]. Though the incidence of cervical external cervical root resorptionassociated with intracoronal bleaching is low [3] (MacIsaac and Hoen

[1]Professor and HOD, [2,3,4]Post graduate students, Department Conservative Dentistry and Endodontics, Sree Sai Dental College and Research Institute, Srikakulam, Andhra Pradesh, India
*Corresponding author email id: rathodtejasree18@gmail.com

1994; Baratieri *et al.*, 1995), some authors recommend that it is safer to avoid hydrogenperoxide for intracoronal bleaching and carbamide peroxide is used instead [2].

Studies on the efficacy of intracoronal bleachingagents in artificially discoloured teeth however, indicate that the most widely used alternative, carbamide peroxide is inferior to 30% hydrogen peroxide. consequently, further bleaching sessions will be required to achieve the desired aesthetic result [5]. The increased number of treatment sessions will increasethe cost of the treatment. The other intracoronal bleaching alternative, 10% carbamide peroxide has been found to be less effective than 30% hydrogenperoxide. From both economic and safety reasons, it would be desirable to achieve the aesthetic change in the minimum number of treatment sessions as well as to minimize exposure of the periradicular tissue to hydrogenperoxide. 16% carbamide peroxide, has emerged as a popular and effective agent for both in-office and intracoronal bleaching techniques However, the efficacy of 16% carbamide peroxide for intracoronal bleaching has not been determined. This study evaluates the intracoronal bleaching ability of 16% carbamide peroxide relative to 30% hydrogen peroxide using artificially stained extracted human teeth.

MATERIALS

- Extracted teeth
- Sodium hypochlorite 16% Carbamide peroxide
- 30% Hydrogen peroxide
- Saline
- Human blood
- Centrifugal machine
- Test tubes
- Incubator
- Interim restorative material

METHODOLOGY

For this study, 15 teeth were selected incisors all caries free (Figure 1), without structural enamel defects or previous restorative treatments and their initial colour was greater than or equal to C4 (Vita Classical guide – VITA Zahnfabrik, Bad Säckingen, Germany). They were randomly distributed into two groups (1, 2 and 3) of five teeth each. From extraction until use and during the treatment process, the teeth were kept in physiological saline solution. After that, a gauze (Figure 2) soaked with a solution of 2.25% sodium hypochlorite was used to remove any soft tissue covering the root surface. Any debris and calculus was removed using ultrasonic scaler. The teeth were stored in distilled water. Standard access cavities were prepared using no. 2 round carbidebur in a high speed hand piece, and the cervical thirds of the canals were widened with Gates-Glidden drill no 2. Roots were resected between the coronal and middle thirds (1-mm apical to the cementoenamel junction) using carborundum disk mounted on a straight handpiece

Figure 1: Showing single-rooted teeth before centrifugation

Figure 2: Showing wrapping the discoloured teeth in the gauze cloth

Figure 3 and 4: Placing the test tubes in centrifuge machine

The teeth were stored in saline solution. The teeth were immersed in whole human blood [6] without the serum (Figure 3), and centrifuged (Figure 4) at 3,200 rpm for 20 min twice daily over 3 days to enhance penetration of the haemolysed red blood cells into the dentinal tubules.

The precipitate was removed and, the teeth were immersed in the remaining haemoglobin-rich haemolysate for a further 3 days, centrifuging it twice daily as previously described. The resultant discoloured teeth were then washed in distilled water (Figure 5).

Figure 5: Showing discoloured teeth

After standard access cavity preparation, the root canals were cleaned and shaped using 2.25% sodium hypochlorite for irrigation, and size 4 Gates-Glidden drills were used to maintain the taper [1].

All the discoloured teeth were mounted and access cavity preparation was also done. The root canals were obturated with gutta-percha and zinc oxide eugenol as root canal sealer. Sufficient gutta-percha was removed to allow placement of a 2-mm thick intermediate base interim restorative material to a level of 1-mm apical to labial cemento-enamel junction [6].

The prepared teeth were randomly divided into three groups of five specimens each, and the baseline colour evaluation was performed before they were intracoronally bleached twice 5 days apart using either:

Placing the Superoxol Bleaching Material into the Teeth

1 Group CP: 16% carbamide peroxide gel.
2 Group HP: 30% hydrogen peroxide gel superoxol.
3 Group 3: distilled water.

A 0.04-ml bleaching agent was syringed into the access cavity in group 1

Thermocatalytic technique was performed in group 2.

Group 3: distilled water only (control group).

After 0.04 ml of the bleaching agent was syringed into the access cavity of the tooth, it was sealed with Interim restorative material After 5 days, the colour of the bleached teeth was evaluated.

The original bleaching agent was then washed out with water and a fresh portion of bleaching agent was syringed into the access cavity as described previously.

The teeth were left for another 5 days before the next colour evaluation was performed at days 10 and 15. The teeth were wrapped in gauze soaked with distilled water and kept in an incubator at 37 °C throughout the experiment.

The colour of each tooth was evaluated using the Vita Lumin shade guide under standardised lighting conditions. Evaluation was performed at day 0,5& 10.

The shade tabs were arranged in a permuted sequence suggested by the manufacturer, and each was assigned a numeric value ranging from 1 to 16 (B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4 and C4)

In control group after placing, we observed no colour change on day 5, day 10 and day 15. It means that distilled water plays no role in colour change.

In carbamide peroxide group on the day 0 after the placement of bleaching agent there is no colour change. All the samples showed a shade of C4 according to the vita shade guide tab. On the day 5, samples have changed the colour and shaded off (Figure 6).

RESULTS

Carbamide peroxide on the day 5

- Sample 1 A 3.5
- Sample 2 A2
- Sample 3 A 3.5

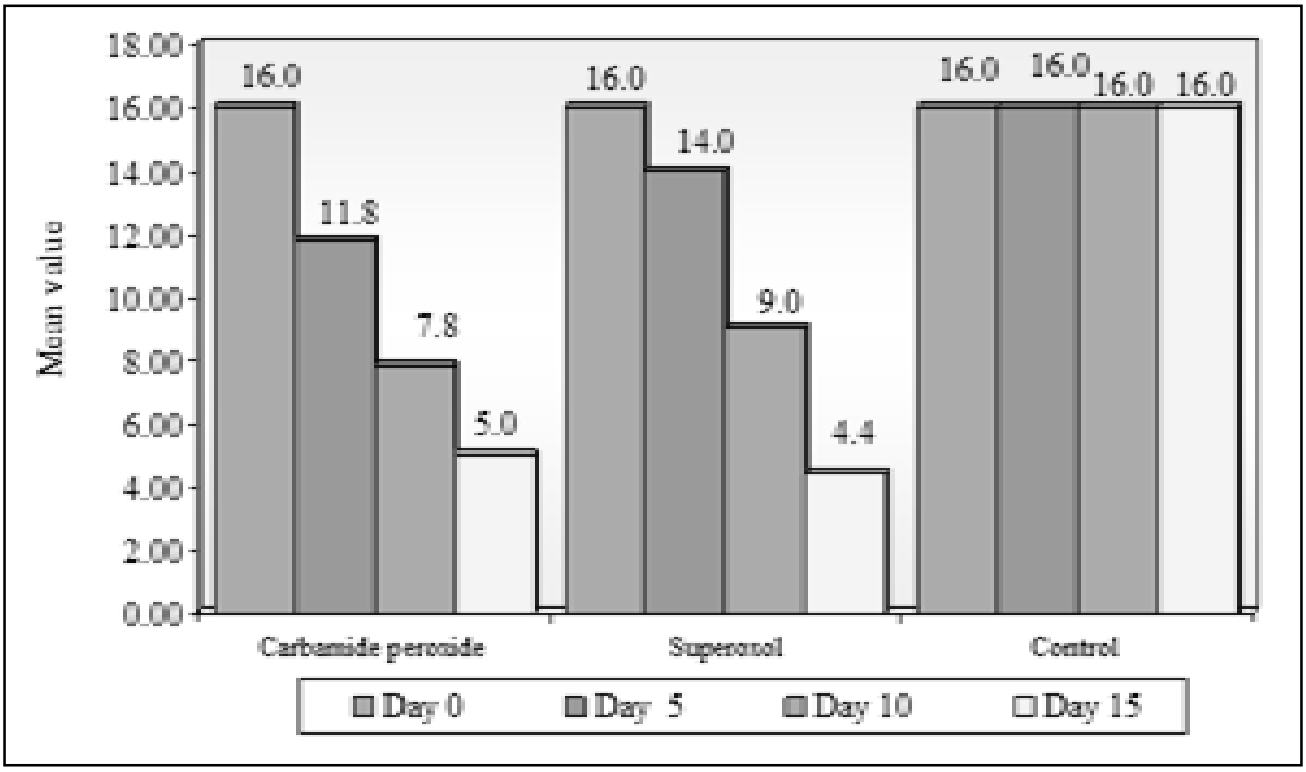

Figure 6: Comparison of different time points in three groups with respect to colour change

- Sample 4 A4
- Sample 5 A4
- A mean difference of 4.20 is observed from the day 0 to day 5.

Carbamide peroxide on the day 10

- Sample 1 B3
- Sample 2 B3
- Sample 3 D3
- Sample 4 B2
- Sample 5 B2
- A mean difference of 8.20 is observed from the day 0 to day 10.

Carbamide peroxide on the day 15

- Sample 1 B3
- Sample 2 A2
- Sample 3 A1
- Sample 4 A3.5
- Sample 5 B2
- A mean difference of 11 is observed from day 0 to day 15.

Superoxol on the day 5

- Sample 1 A4
- Sample 2 A3
- Sample 3 A4
- Sample 4 A4
- Sample 5 C4
- A mean difference of 2.00 is observed from the day 0 to day 5.

Superoxol on the day 10

- Sample 1 B3
- Sample 2 A2
- Sample 3 A1
- Sample 4 A3.5
- Sample 5 B2
- A mean difference of 7.00 is observed from the day 0 to day 10.

Superoxol on the day 15

- Sample 1 B3
- Sample 2 A2
- Sample 3 A1
- Sample 4 A3.5
- Sample 5 B2
- A mean difference of 11.60 is observed from the day 0 to day 15.

Mann–Whitney *U*-test reveals that when carbamide peroxide and control group are compared (Table 2), there is a clear difference of significance *p*-value less than 0.05.

When superoxol and control group are compared (Table 3), there shows a clear difference of significance between these two materials. But when superoxol and carbamide peroxide (Table 1) are compared, there is no difference of significance. Both superoxol and carbamide peroxide showed same results and are effective bleaching agents.

The superoxol is having few disadvantages due to thermocatalytic technique such as cervical burn and resorption.

It is safer to use carbamide peroxide as it is having more advantages than superoxol like longer shelf life, and it does not show disadvantages like superoxol.

DISCUSSION

It is well established that visual colour determination is subjective, compared with the objectivity of spectrophotometric evaluation[7] utilised a spectrophotometer to monitor colour change associated with intracoronal bleaching. Based on the spectrophotometer readings at the completion of intracoronal bleaching, all the teeth were still statistically significantly darker than they were before being artificially discoloured, implying the bleaching agents evaluated

Table 1: Pair wise comparisons of carbamide peroxide and superoxol groups with respect to colour change at different time points by Mann- Whitney U test

Time points	Carbamide peroxide group			Control group			U-value	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Day 0	16.00	0.00	5.50	16.00	0.00	5.50	12.50	0.0000	1.0000
Day 5	11.80	4.09	3.00	16.00	0.00	8.00	0.00	-2.6112	0.0090*
Day 10	7.80	3.56	3.00	16.00	0.00	8.00	0.00	-2.6112	0.0090*
Day 15	5.00	2.45	3.00	16.00	0.00	8.00	0.00	-2.6112	0.0090*
Day 0 to Day 5	4.20	4.09	8.00	0.00	0.00	3000	0.00	-2.6112	0.0090*
Day 0 to Day 10	8.20	3.56	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 0 to Day 15	11.00	2.45	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 5 to Day 10	4.00	4.85	7.50	0.00	0.00	3.50	2.50	-2.0889	0.0367*
Day 5 to Day 15	6.80	4.44	7.50	0.00	0.00	3.50	2.50	-2.0889	0.0367*
Day 10 to Day 15	2.80	3.56	7.00	0.00	0.00	4.00	5.00	-1.5667	0.1172

*p<0.05

Table 2: Pair wise comparisons of carbamide peroxide and superoxol groups with respect to colour change at different time points by Mann- Whitney U test

Time points	Carbamide peroxide group			Superoxol group			U-value	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Day 0	16.00	0.00	5.50	16.00	0.00	5.50	12.50	0.0000	1.0000
Day 5	11.80	4.09	4.40	14.00	2.83	6.60	7.00	-1.1489	0.2506
Day 10	7.80	3.56	4.40	9.00	5.34	6.20	9.00	-0.7311	0.4647
Day 15	5.00	2.45	6.80	4.40	4.83	4.20	6.00	-1.3578	0.1745
Day 0 to Day 5	4.20	4.09	6.60	2.40	2.83	4.40	7.00	-1.1489	0.2506
Day 0 to Day 10	8.20	3.56	6.20	2.00	2.83	4.40	7.00	-1.1489	0.2506
Day 0 to Day 15	11.00	2.45	4.20	7.00	5.34	4.80	9.00	-0.7311	0.4647
Day 5 to Day 10	4.00	4.85	4.90	11.60	4.83	6.8	6.00	-1.3578	0.1745
Day 5 to Day 15	6.80	4.44	4.40	5.00	4.64	6.10	9.50	-0.6267	0.5309
Day 10 to Day 15	2.80	3.56	4.70	9.60	4.45	6.60	7.00	-1.1489	0.2506

were unsuccessful. However, clinicalexperience and visual evaluation in other studies have shown intracoronal bleaching is capable of restoring teeth to their original colour or even lighter. Therefore, suggested that although their spectrophotometer readings may indicate a statistical difference, these differences could be clinically indistinguishable to the human eye [7]. Some studies to evaluate the effectiveness of external tooth bleaching agents have also used both spectrophotometer and visual evaluation of colour change using the Vita Lumin shade guide [8]. Results from these studies using both methods of evaluation were consistent. Therefore, in this study, only human visual evaluation of colour change was

Table 3: Pair wise comparisons of carbamide peroxide and control groups with respect to colour change at different time points by Mann- Whitney U test

Time points	Carbamide peroxide group			Superoxol group			U-value	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Day 0	16.00	0.00	5.50	16.00	0.00	5.50	12.50	0.0000	1.000
Day 5	14.00	2.83	3.50	16.00	0.00	7.50	2.50	-2.0889	0.0367*
Day 10	9.00	5.34	3.00	16.00	0.00	8.00	0.00	-2.6112	0.0090*
Day 15	4.40	4.83	3.00	16.00	0.00	8.00	0.00	-2.6112	0.0090*
Day 0 to Day 5	2.00	2.83	7.50	0.00	0.00	3.50	2.50	-2.0889	0.0367*
Day 0 to Day 10	7.00	5.34	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 0 to Day 15	11.60	4.83	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 5 to Day 10	5.00	4.64	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 5 to Day 15	9.60	4.45	8.00	0.00	0.00	3.00	0.00	-2.6112	0.0090*
Day 10 to Day 15	4.60	4.22	7.50	0.00	0.00	3.50	2.50	-2.0889	0.0367*

*p<0.05

used, as only relative colour changes were of interest. Furthermore, the results will be more meaningful to both the clinician and the patient, and the clinician will be able to relate to the results of this study. The results could also serve as a guide to the relative colour changes that may be expected in intracoronal bleaching using the different bleaching agents. Colour perception is very complex. Furthermore, the evaluator's experience appears to have no bearing on their colour matching ability [7]. To minimise the subjective influences in this study, both evaluators performed colour determination independently under the same lighting conditions, and only conferred when re-examining samples and when there was no initial agreement. The 53% inter-evaluator agreement in this study was within the range of 50–65% majority agreement determined by [7,9]. The inter-evaluator disagreements arose in situations where, as clinicians will be familiar, a tooth's colour is not always identical to a Vita colour tab, and a decision has to be made as to which of two adjacent colour tabs is closer. Our results indicate that groups CP and HP were equally effective for intracoronal bleaching, and both groups were better than group SP after one bleaching session ($p< 0.05$). With groups CP and HP, there was a mean improvement of Vita Lumin shade tabs. In fact, approximately half of all teeth from all groups did not undergo further colour change after one treatment session. Those that did undergo further lightening after the second bleaching session did so by a mean of three tabs for both groups CP and HP. Therefore, intracoronal bleaching for both CP and HP showed equal results. The present study has demonstrated that the efficacy of 16% carbamide peroxide gel is similar to 30% hydrogen peroxide gel, that both are equal intracoronal bleaching of artificially stained teeth. As a consequence, today the thermocatalytic technique is used less because of the high risk of external root resorption that is associated with heat application [10]. In an evaluation of the diffusion of hydrogen peroxide through the discoloured, root filled tooth undergoing intracoronal bleaching some authors determined that there was no significant difference in hydrogen peroxide detected in the periradicular area when using either 35% carbamide peroxide gel. A statistically significantly greater amount of hydrogen peroxide diffused out using 30% hydrogen peroxide gel. Therefore, 16% carbamide peroxide gel could be used as the intracoronal bleaching efficacy of 30% hydrogen peroxide. As 16% carbamide peroxide breaks down

to the approximate equivalence of 3% hydrogen peroxide, the results obtained were perhaps surprising, as it was expected that 30% hydrogen peroxide gel would produce a greater bleaching effect than 16% carbamide peroxide. After all, in comparisons using different concentrations of carbamide peroxide for external vital tooth bleaching, higher concentrations tend to be more effective, although after more bleaching sessions the weaker bleach will eventually produce the same lightening effect [9]. The equal effectiveness of 30% hydrogen peroxide and 16% carbamide peroxide gel could be because with 30% hydrogen peroxide there is an excess of active ingredient, which simply just diffuses unreacted through the root tissue. Another possibility is that carbamide peroxide penetrates dentine less readily than hydrogen peroxide [11]; 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. Another contributing factor to the greater efficacy of carbamide peroxide relates to the relationship between pH and rate of reaction of the bleaching reaction; as the higher the pH, the more free radicals are available for bleaching. Optimal ionisation occurs when hydrogen peroxide is buffered in the range of pH 9.5–10.8.

CONCLUSION

In our study we noticed that 16% carbamide peroxide and 30% hydrogen peroxide are equally effective in the treatment of intracoronal bleaching which we observed in a 5,10,15 days of regular intervals

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