A comparative evaluation of effect of different bleaching agents on fracture resistance of endodontically treated maxillary incisors – An in vitro study

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ABSTRACT

Objective: The present study was carried out to evaluate the effect of different bleaching agents on fracture resistance of endodontically treated extracted maxillary central incisors and the effect of an antioxidant along with bleaching agents on the fracture strength of these teeth. **Methods:** A total of 80 freshly extracted human maxillary central incisors were collected and root canal treatment was done on them. After 24 hours, the gutta-percha was removed to a level just below the labial-gingival margin and a 2 mm layer of resin modified glass ionomer cement was applied. Roots of all the teeth were immersed in autopolymerizing acrylic resin upto the cemento-enamel junction and the bleaching agents and the antioxidant were applied using the walking bleach technique. After that the fracture resistance of the specimens was measured with a Universal Testing Machine and the forces necessary to fracture each tooth were recorded in Newtons. **Results:** The comparison revealed that the control group, where only the root canal treatment was performed without the application of the bleaching agents and antioxidant had the highest mean value of fracture resistance. Group-1, where 30% hydrogen peroxide and sodium perborate (tetrahydrate) were used as bleaching agents had the lowest mean value of fracture resistance. **Conclusion:** It was concluded that hydrogen peroxide 30% and sodium perborate cause the lowest resistance to fracture as compared to 45% carbamide peroxide and sodium ascorbate 10% solution can reverse the effects of a decrease in the fracture resistance.

Keywords: Antioxidant; Carbamide peroxide; Fracture resistance; Hydrogen peroxide; Sodium perborate

INTRODUCTION

The union of dental art and science is known as aesthetic dentistry. It describes any dental procedure that enhances the attractiveness of teeth with a particular emphasis on colour, orientation, shape, size, alignment and overall appeal of the smile. A person's social and psychological conduct, as well as their self esteem is positively impacted by their self perceived satisfaction with dental aesthetics [1]. Nearly 10% of teeth that have undergone endodontic treatment exhibit shade variations [2].

Chromogens from frequent food sources, such as wine, coffee, tea, carrots, oranges, liquorice, and chocolate, as well as from tobacco, mouthwashes, or plaque on the tooth surface are the extrinsic causes of tooth discolouration [3].

The pulpal necrosis, intra pulpal haemorrhage, pulp tissue remnants after endodontic therapy, products of tissue putrefaction, inappropriate access cavity design that traps chromophore materials inside the pulp chamber or obturation materials remaining in the pulp chamber due to inadequate cavity cleaning and dressing placement can cause intrinsic discolourations of teeth that have undergone endodontic treatment [4].

The most commonly described cause of non-vital tooth discolouration is intracoronal blood decomposition. The release of iron occurs concurrently with the hemolysis of erythrocytes in the dentinal tubules. This combined with hydrogen sulphate forms ferric sulphate, a black compound responsible for the discolouration of the tooth [5]. The pigments that cause intrinsic discolourations consist of long-chain organic molecules [6].

Bleaching of teeth is significant in cosmetic dentistry and is a more conservative and cost effective way to enhance the dentition's appearance [7]. Spasser in 1961 proposed a technique that involved sealing a solution of sodium perborate with water into the pulp chamber, leaving it in situ for a week, and then having the procedure repeated until the desired lightening effect was achieved [8]**.** This was refined by Nutting and Poe in 1963 using a solution of 30% hydrogen peroxide and sodium perborate enclosed inside the pulp chamber for a certain period, now known as the walking bleaching technique [9].

The bleaching agents that are most frequently described in the literature include hydrogen peroxide, carbamide peroxide and sodium perborate. These three agents promote reversion of the chromatic change through oxidative reactions [5]**.**

It has been asserted that bleaching agents cause surface breakdown making the tooth surface porous. Enamel demineralization has been associated with the acidity of bleaching agents causing a compromise in the tooth strength [10]**.**

Although many methods have been used to reverse the compromised bond strength, using antioxidants have shown the best results in neutralizing the oxygen [11]. Application of various antioxidants like sodium ascorbate, ascorbic acid, catalase, acetone, butylated hydroxyanisole and oligomericproanthocyanidin have been mentioned [12].

Therefore, the current study was designed to investigate the fracture resistance of endodontically treated teeth undergoing intracoronal bleaching and the effect of sodium ascorbate as an antioxidant on the fracture resistance of these bleached teeth.

MATERIALS AND METHODS

A total of 80 freshly extracted human maxillary central incisors were used and were collected and were cleaned of blood stains and organic debris by placing them in 3% solution of sodium hypochlorite (Septodont Parcan, Septodont, India) for 15 minutes. The remaining surrounding tissues were mechanically removed using curette. Soft tissue tags and attached bone were removed with the scalpel blade. Calculus and stains were removed with ultrasonic scaler. The teeth were stored in artificial saliva for 10 days.

In all the teeth, root canal preparation was done using standardized techniques. After 24 hours of obturation, removal of gutta-percha was done to a level below the labial-gingival margin and a sufficiently thick layer of atleast 2mm of resin modified glass ionomer cement (GC Light sured universal restorative glass ionomer cement, GC Fuji II 2 LC, GC, Tokoyo, Japan) was given and a 0.3 mm periodontal ligament space was simulated with a polyvinylsiloxane impression material. Using cylindrical moulds, the roots of all teeth were immersed in autopolymerizing acrylic resin upto the cemento-enamel junction, and the openings in the root canals were closed off with Cavit (3M, ESPE, Cavit-G, 3M ESPE, Germany). The bleaching agents and the antioxidant were then applied using the walking bleach technique.

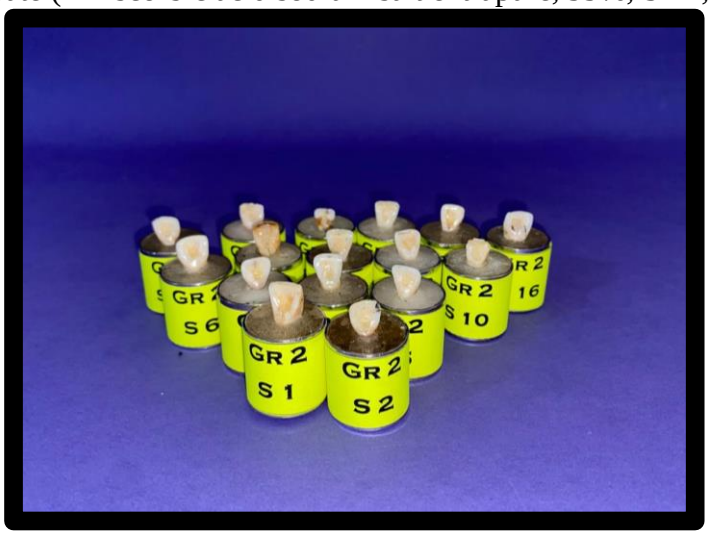
After the root canal treatment, all teeth were randomly divided into five groups with 16 specimens in each group.

BLEACHING AGENTS AND ANTIOXIDANT GROUPS:

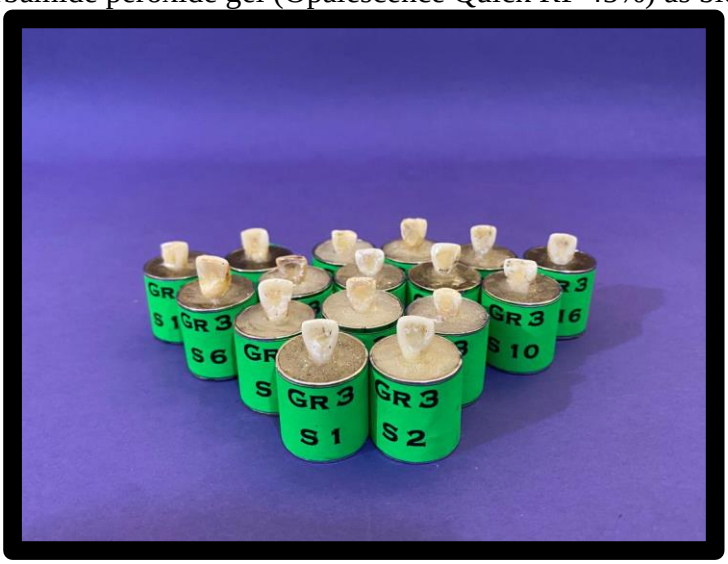
The group distribution was according to the type of bleaching agent used. The groups were:

Group-1: 30% hydrogen peroxide solution (Hydrogen peroxide 30% W/V solution, Molychem, India) and sodium perborate (tetrahydrate) (Sodium perborate tetrahydrate, H Media, India) as bleaching agents.

Group-2: 30% hydrogen peroxide and sodium perborate (tetrahydrate) as bleaching agents. Then the intracoronal bleached surface of the teeth was treated with an antioxidant solution of 10% sodium ascorbate (L-Ascorbic acid sodium salt extrapure, 99%, SRL, India).

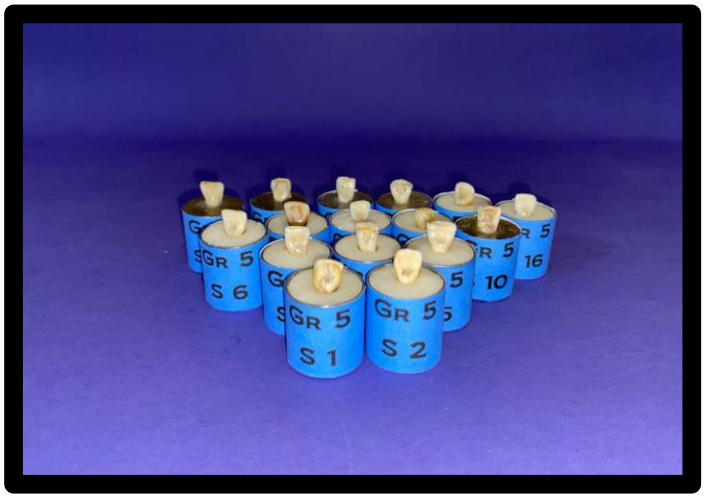


Group-3: 45% carbamide peroxide gel (Opalescence Quick RF 45%) as bleaching agent.



Group-4: 45% carbamide peroxide gel as bleaching agent. Then the intracoronal bleached surface of the teeth was treated with an antioxidant solution of 10% sodium ascorbate.

Group-5: Control Group**:** Only root canal treatment was performed without the application of bleaching agents and antioxidant.



After that the fracture resistance of the specimens was measured with a Universal Testing Machine (P.S.I. Sales Pvt. Ltd., New Delhi) above the cingulum at a crosshead speed of 5mm/min at a 130 degree angle with the long axis of the root. The forces necessary to fracture each tooth were recorded in Newtons.

STATISTICAL ANALYSIS

Descriptive and comparative analysis was performed. Difference among the groups was analysed by analysis of variance tests and *post hoc* Tuckey tests. A $p<0.05$ was considered statistically significant for all tests. Variables were expressed as means and standard deviation.

Experimental Data on Fracture Resistance Of the Specimens In respect of the Five Groups (in Newtons)

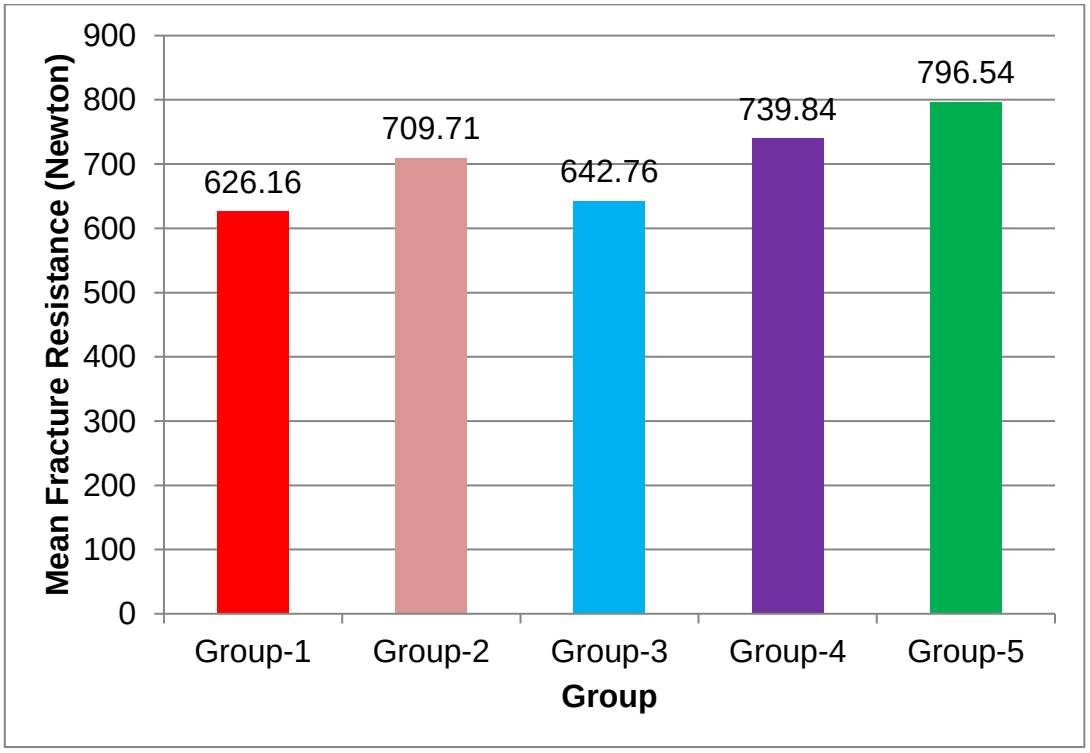
Specimen No.	Group-1	Group-2	Group-3	Group-4	Group-5
1	672.2	823.1	545.1	894.5	697.4
2	578.6	768.5	705.9	721.3	987.6
3	689.8	659.8	678.4	789.9	721.1
4	593.4	634.5	554.0	858.0	621.9

5	645.5	811.9	579.9	732.8	927.5
6	521.3	715.4	684.3	708.8	879.0
7	601.5	634.3	712.2	699.4	809.6
8	651.1	754.3	659.6	568.6	797.4
9	655.2	769.3	691.3	670.6	762.0
10	676.1	704.0	589.9	809.2	759.7
11	612.6	745.7	650.6	751.6	745.3
12	712.3	697.9	595.7	728.0	692.8
13	589.2	636.7	679.9	821.4	712.7
14	621.5	683.4	632.5	649.3	868.7
15	566.2	615.2	612.8	639.3	821.7
16	632.1	701.3	712.1	794.7	940.2

Descriptive Statistics From The Experimental Data

Group	No of Observations	Mean	SD	SE_m	CV (%)	95% Confidence Limits	
						Lower	Upper
Group-1	16	626.16	48.78	12.20	7.8	600.17	652.15
Group-2	16	709.71	62.58	15.65	8.8	676.36	743.06
Group-3	16	642.76	54.81	13.70	8.5	613.55	671.97
Group-4	16	739.84	83.12	20.78	11.2	695.55	784.13
Group-5	16	796.54	98.77	24.69	12.4	743.91	849.17

Master Graph on the Comparison of the Experimental Groups w.r.t. the Mean Values of the Fracture Resistance



RESULTS

This study evaluated the of fracture resistance of endodontically treated maxillary central incisors using various bleaching agents along with the use of an antioxidant. The bleaching

agents used were 30% hydrogen peroxide and sodium perborate and 45% carbamide peroxide. The antioxidant that was used was 10% sodium ascorbate solution.
It was concluded that endodontically treated teeth become weaker with the application of bleaching agents. Hydrogen peroxide 30% and sodium perborate caused the lowest resistance to fracture as compared to 45% carbamide peroxide gel. The results also showed that 10% sodium ascorbate solution can reverse the effects of a decrease in the fracture resistance. Therefore, carbamide peroxide 45% gel along with the application of 10% sodium ascorbate antioxidant solution had the highest fracture resistance amongst other groups.

DISCUSSION

Dentine is primarily responsible for determining the colour of teeth, but enamel's colour, translucency, degree of calcification, and thickness—particularly at the occlusal or incisal edge—can also have an impact. The enamel's blue, green, and pink hues, which are complemented by the dentine's yellow to brown hues, determine the usual colour of teeth [13].
But dental discolorations are common and can either be intrinsic or extrinsic, depending on the location of the stain [14].
The intrinsic discolourations result from chromogenic material that is present in the enamel or dentin. The two categories of this type of stain are – pre-eruptive and post-eruptive.
Due to high fluoride consumption during the tooth development, endemic fluorosis is the most prevalent kind of pre-eruptive staining. Tetracycline staining, diseases like amelogenesis imperfecta and dentinogenesis imperfecta, thalassemia and sickle-cell anemia also cause pre-eruptive dental stains.
There are several different reasons why intrinsic post-eruptive stains might develop on teeth. For instance, in the event of dental trauma, pulpal haemorrhaging may take place, causing blood to enter the dentinal tubules. Due to the build-up of secondary dentin, tertiary dentin, and pulp stones, the natural ageing process can also result in post-eruptive dental stains. Insufficient obturation of the pulp chamber during endodontic therapy and dental procedures can also cause tooth discoloration [15].
Pulpal haemorrhagic products after trauma are one of the most frequent causes of intrinsic tooth discolourations. Pulpal haemorrhage was presumed to be the source of the discoloration of teeth after severe trauma. Following haemolysis of the red blood cells, the putrefying pulpal tissue and the released haem group would combine to generate black iron sulphide [14].
For intrinsic discolorations, non-vital bleaching is recommended. It is a minimally invasive method for restoring the aesthetics of stained non-vital teeth.
The most commonly used bleaching agents are sodium perborate, hydrogen peroxide and carbamide peroxide.
Currently available tooth bleaching products contain hydrogen peroxide as their active component. It can be created chemically from sodium perborate or carbamide peroxide, or it can be applied directly [3].
A major side effect of nonvital bleaching is a reduction in fracture resistance.
Due to the inevitable loss of dentin during endodontic therapy, there is an increase in tooth susceptibility to fracture [4].
Bleaching agents were found to negatively affect the integrity of organic enamel structures including proteins and collagen. Additionally, it was found that in bleached dental hard tissues, there was loss of minerals, loss of fluoride, increased susceptibility to erosion, increased surface roughness, lower enamel micro tensile strength, reduced fracture stability and a decrease in abrasion resistance [15].

Although some methods have been used to reverse the decreased bond strength, other studies have placed a lot on emphasis on utilizing an antioxidant to neutralize oxygen released during the bleaching procedures. Ascorbic acid and its sodium salt have been employed as antioxidants in recent years because of their potential to reduce oxidative compounds, particularly free radicals [4].

The results of this study show that Group-5, which was the control group had the best fracture resistance as compared to other groups. Group-5 included teeth that were unbleached and after root canal treatment, only post endodontic restoration was performed. The group that performed the best amongst the experimental groups was Group-4 in which the teeth were bleached with carbamide peroxide bleaching agent along with sodium ascorbate antioxidant.

CONCLUSION

Within the limitations of this study, it was concluded that endodontically treated teeth become weaker with the application of bleaching agents. Hydrogen peroxide 30% and sodium perborate cause the lowest resistance to fracture as compared to 45% carbamide peroxide gel. Sodium ascorbate 10% solution can reverse the effects of a decrease in the fracture resistance. Carbamide peroxide 45% gel along with the application of 10% sodium ascorbate antioxidant had the highest fracture resistance amongst other groups.

Sodium perborate and 30% hydrogen peroxide along with the application of 10% sodium ascorbate antioxidant was resistant to fracture but the mean fracture resistance values of it were less than the group in which carbamide peroxide 45% gel along with the application of 10% sodium ascorbate was used.

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