International Journal of Medical Toxicology & Legal Medicine Volume 27, No. 1s, 2024
e-ISSN: 0974-4614
p-ISSN: 0972-0448

Article Submitted: 12-05-2024; Revised: 25-06-2024; Accepted: 22-07-2024

Comparative Study on Fracture Resistance after Use of Bleaching Agents

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ABSTRACT

Background: As a relatively new innovation, ACTIVA BIOActive Restorative boasts an improvement thanks to "rubberized" resin, according to its makers. The mechanical properties, aesthetic appeal, and long-term durability of resin-based composites are all possessed by these ionic composite resins.

Aim: To comaprae & evaluate FR of I-OB after use of bleaching agents.

Material & method: In our study 135 single rooted pre-molar tooth in extracted form were prepared by removing debribs which was followed by $NaBO_3 \cdot 4H_2O$, CP & H_2O_2 solution.

Result: All the 3 blecahing agents show no significant differnce between them. **Conclusion:** Bleaching chemicals showed significnat influence in FR.

Keywords: FR, bleaching chemicals, pre-molar, extracted tooth**,** $NaBO_3 \cdot 4H_2O$, CP & H_2O_2, ACTIVA BIOActive Restorative, I-OB.

INTRODUCTION

Compared to teeth that have been bleached and are vital, teeth that have had endodontic treatment have been shown to have a higher risk of shattering. This is due to a number of variables, including the widening of canals that occurs throughout the biomechanical preparation process. This widening produces an increase in the occlusal pressure that is delivered to the tooth. As a consequence of this, water is lost from the dentinal tubules, which in turn reduces certain qualities of the teeth in question, which ultimately results in resorption.[1] Teeth that have been treated by endodontics but have not been restored are more likely to have coronal leakage and fractures. Both of these issues may result in bacterial contamination and make it more likely that the root canal treatment will not be successful. [2] Between 11 and

13 % of teeth that have been removed and are having endodontic treatment have been shown to be impacted by vertical root fractures in clinical studies.[3] Various materials, including Glass Ionomer Cement, RMGIC, MTA, Biodentine, and Composite, have been utilized as intraorifice barriers. According to a study by Nagas et al., compacting a dental restorative substance inside the pulp chamber has been found to improve the teeth's ability to withstand fractures.[4] An evaluation has been conducted on the modulus of elasticity, which shares similarities with dentin, to determine its potential in enhancing apexification procedures and serving as a reliable intraorifice barrier, yielding favorable outcomes.[5]

AIM

To compare & evaluate the fracture resistance (FR) of intra-orifice barrier (I-OB) after use of bleaching agents(BA).

INCLUSION CRITERIA

1. Both sex teeth were included.
2. All age group were included.
3. Teeth included were orthodontically tretaed.
4. Periodontal diseased tooth.

EXCLUSION CRITERIA

Grossly decayed or carious teeth

Fractured teeth

Root canal treated teeth

Teeth with curved roots

Resorbed roots

MATERIAL & METHOD

Material

1. Zirconomer (Shofu)
2. BIOactiva Active restorative material (Pulpadent)
3. Biodentine (Septodent)
4. Sodium Perborate (Isochem Laboratories)
5. Hydrogen Peroxide (SDI)
6. Carbamide Peroxide (Ammdent)
7. Cold cure Acrylic resin (DPI)
8. Normal Saline
9. 3% Sodium hypochlorite solution (Prime dental Pvt Ltd)
10. 17% Ethylene Diamine Tetracetic Acid (Prime dental Pvt Ltd)
11. Phosphate buffered solution (Labogens)
12. Gutta percha (Surendo)
13. Acid Etchant (37% phosphoric acid)
14. Bonding agent (3M ESPE)
15. Composite (3M Filtex)

16. AH Plus sealer (Dentsply)
17. Airotor
18. Diamond bur
19. 10 K file
20. Endomotor
21. Protaper universal rotary file
22. Needle & Syringe
23. Mixing pad & spatula
24. Applicator tip
25. Plugger

Method

In our study we have included 135 permanent single rooted extracted pre-molar teeth were the access cavity preparation was done using diamond round bur. Thw working length was determined by placemnet of 10 K file 1mm short of the apex as shown in figure 1 & 2.

Fig .1: Access cavity Preparation

Fig .2: Working length determination

The internal canal diameter was standardized by using Protaper universal F1 file. The debris was removed using 3% NaOCl followed by 17% EDTA.

PREPARATION OF SAMPLES

The obturating material was removed with plugger upto 3mm. The obturated specimen were categorized into 3 groups which is as follows:-

<u>Group 1) Zirconia reinforced GIC</u>

Cement was mixed with liquid in ball like consistency & placed inside tooth as shown in figure 3.

Fig .3: Zirconomer

Group 2) Biodentine

The biodentine was mixed with distilled water & mixed till it get wet sand consistency. It was condensed in tooth with help of plugger asshown in figure 4.

Fig .4: Biodentine

Group 3) Bioactiva active restorative material

Tooth was etched with 37% phosphoric acid for 30 seconds. This tooth was watered & air dried. They were bonded with single bond universal adhesive (3M ESPE) bonding agent for 30 sec. After bonding the composite material was filled in tooth as shown in figure 5.

Fig .5: BIOActiva Active restorative material

After placement of I-OB, tooth underwent bleaching by using the following bleaching agents:-

a. Sodium Perborate ($NaBO_3 \cdot 4H_2O$) as shown in figure 6.

Fig 6: Placement of Sodium Perborate

b. Carbamide Peroxide (CP) as shown in figure 7.

Fig .7: Placement of Carbamide Peroxide

c. Hydrogen Peroxide (H_2O_2) as shown in figure 8.

Fig .8: Placement of Hydrogen Peroxide

After placement of bleaching agents, temporary restoration was done & samples were stored in phosphate buffered solution for 1 week as shown in figure 9.

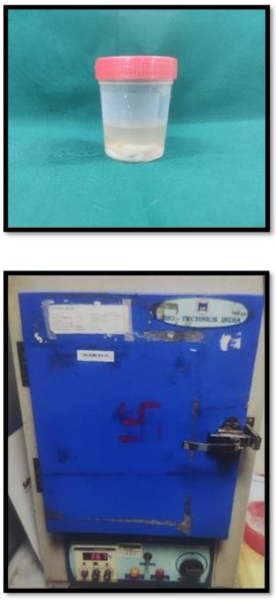

Fig .9: Storage of samples in phosphate buffered and incubator

The bleaching agents were replaced with freshly prepared bleaching agent after 1 week for 3 weeks. The teeth were kept in phosphate buffered solution (PBS) at 37˚C after which FR of samples were checked. The samples were mounted in cold cured acrylic resin 2 mm below CEJ. It was then placed inside the cylinder with a diameter of 3.5 cm and a height of 5 cm.The FR was measured with a universal testing machine at a crosshead speed of 5mm/min with the long axis of the root. The FR was recorded in kilonewtons as shown in figure 10.

Fig .10: Evaluating fracture resistance under Universal testing machine

STATISTICAL ANALYSIS

All the groups were compared for FR by Kruskal Wallis test & Mann Whitney "U" test to find pair-wise comparison. Descriptic statistics were expressed as mean & standard deviation (SD) for each group for FR. P value less than or equal to 0.05 ($p<0.05$) was taken to be statistically significant. The data was entered into microsoft excel 2010 and all the analysis were performed using SPSS software version 2.0.

RESULT

Subgroup A (Sodium Perborate)	Mean	SD	Kruskal Wallis test	P value, Significance
Group 1A (ZIRCONOMER)	902.07	355.18		
Group 2A	706.13	328.74		

(Biodentine)			H = 2.765	p = 0.251
Group 3A (Bioactiva)	943.53	474.26		

Mann Whitney 'U' test to find pairwise comparison			
Group	Comparison Group	Mean Difference	P value, Significance
Group 1A (ZIRCONOMER) Vs	Group 2A (Biodentine)	195.93	P =0.365
	Group 3A (Bioactiva)	41.462	P =0.955
Group 2A (Biodentine) Vs	Group 3A (Bioactiva)	37.4	P =0.232

TABLE 1: INTER-GROUP COMPARISON- $NaBO_3 \cdot 4H_2O$

The highest FR was seen with Bioactiva (943.53±474.26) and lowest was seen with Zirconomer (902.07±355.18).Thus showed no statistical significant differnce as the p value was >0.05.

Subgroup B (CarbamidePeroxide)	Mean	SD	Kruskal Wallis test	P value, Significance
Group 1B (ZIRCONOMER)	934.2	435.29	H = 0.745	p =0.689
Group 2B (Biodentine)	1030.5	460.85		
Group 3B				

(Bioactiva)	1058.1	464.6		
Mann Whitney 'U' test to find pairwise comparison				
Group	Comparison Group		Mean Difference	P value, Significance
Group 1B (ZIRCONOMER) Vs	Group 2B (Biodentine)		96.26	p =0.831
	Group 3B (Bioactiva)		123.86	P =0.737
Group 2B (Biodentine) Vs	Group 3B (Bioactiva)		27.6	P =0.985

TABLE 2: INTER-GROUP COMPARISON- CP

The highest FR was seen with Bioactiva (1058.1±464.6) and lowest was seen with Zirconomer (934.2±453.29).Thus showed no statistical significant differnce as the p value was >0.05.

Subgroup C (HydrogenPeroxide)	Mean	SD	Kruskal Wallis test	P value, Significance
Group 1C (ZIRCONOMER)	1061.2	479.27	H = 3.007	p =0.222
Group 2C (Biodentine)	794.0	349.07		
Group 3C (Bioactiva)	881.2	404.05		
Mann Whitney 'U' test to find pairwise comparison				

Group	Comparison Group	Mean Difference	P value, Significance
Group 1C (ZIRCONOMER) Vs	**Group 2C (Biodentine)**	**267.2**	**P =0.193**
	Group 3C (Bioactiva)	**180.0**	**P =0.466**
Group 2C (Biodentine) Vs	**Group 3C (Bioactiva)**	**87.2**	**P =0.833**

TABLE 3: INTER-GROUP COMPARISON - H_2O_2

Highest FR was seeen with Zirconomer (1061.2±479.27) and lowest was seen with Bioactiva (888.1±404.05). Thus showed no statistical significant differnce as the p value was >0.05.

Zirconomer with Sodium Perborate	902.07±355.18
Zirconomer with Carbamide Peroxide	934.2±435.29
Zirconomer with Hydrogen Peroxide	1061.2±479.27
Biodentine with Sodium Perborate	706.13±328.74
Biodentine with Carbamide Peroxide	1030.5±460.85
Biodentine with Hydrogen Peroxide	794±349.07
Bioactiva Active with Sodium Perborate	943.53±474.56
Bioactiva Active with Carbamide Peroxide	1058.1±464.6
Bioactiva Active with Hydrogen Peroxide	881.2±404.05

TABLE 4: I-O B for FR

On comparison we found that, Zirconomer showed more mean± SD than bioactiva active followed by biodentine.

DISCUSSION

In today's modern era, dentists are consistently exceeding expectations by utilizing cutting-edge materials and techniques.[6] Whitening teeth is a straightforward and non-invasive method to enhance the brightness of teeth and eliminate stains in both healthy and pulpless teeth. It is also a cost-effective option.[7] In our study , anterior teeth with single canal were used. This was done to ensure that the research was conducted consistently and to make it easier to repair the orifice of the front teeth. To guarantee that the canal was prepared to a standard width, biomechanical preparation was carried out up to F1 Protaper. The ability of teeth to endure occlusal forces is proportional to the quantity of tooth structure that remains. It is essential to provide a restoration after root canal treatment to avoid tooth breakage. Factors that influence a tooth's resistance to fracture include the quantity of hard tissue lost, the magnitude and duration of the load, the tooth type, the direction of pressure application, and the angle of the cuspal inclines.[8] Bleaching agents would work by oxidation or reduction of such pigments via the "fractioning" of the molecular chains in their arrangement.1948 [9] H202,CP and $NaBO_3 \cdot 4H_2O$ are the whitening agents used to brighten non-vital root canal treated teeth. During the reduction process, H_2O_2 generates highly reactive free radicals. H_2O_2 tends to be slightly acidic when in an aqueous form. Converting H_2O_2 into an alkaline solution initiates the formation of the hydroxyl ion. The optimal pH range for this should be between 9.5 and 10 [10] In this pH range, the bleaching action of H_2O_2 is enhanced because of its buffering effect and ionization, resulting in the production of more perhydroxyl free radicals.[11]

CP biodegrades into urea, which in turn breaks down into other chemical molecules. Additionally, it breaks down into hydrogen peroxide, which in turn breaks down into water and oxygen. Arends et al. found that urea may penetrate enamel and influence the interprismatic zones in bleached specimens. Roughness and structural changes to enamel may be caused in part by urea. [12] The alkaline nature of the urea increases the pH of the bleaching solution, which in turn reduces the negative effects; nevertheless, it may promote the good side effects.[13] The negative side effects of bleaching include sensitivity to heat and cold, enamel loss at the gingival third due to filling material byproducts, and changes in the tooth's inorganic hard tissue. When bleaching chemicals diffuse into periodontal tissues via dentin tubules, one of the side effects is invasive cervical resorption. The chemical alters its pH when it reaches the dentinal tubules from the pulpal to the periodontal area. Finally, the properties limiting the inorganic structure of the tooth are reduced when hydrogen peroxide promotes highly reactive oxygen.[14]As a result, the most appropriate and effective measure to prevent BA from entering the periodontal ligaments is the introduction of interdental bite plate (IOB). [15] The Therefore, an intraorifice barrier should be placed to seal the root canal orifice.

In a study conducted by Llena et al, the bleaching efficiency of H_2 and CP was compared. Based on the findings, it was observed that HP caused morphological changes and a decrease in Ca and P ions. On the other hand, CP did not show any alterations, and the reduction in mineral component was relatively smaller. The alkaline medium created by the presence of urea in CP leads to a decrease in demineralization.[16]

The findings of our research are comparable to those of Lim et al., who determined that a 35% concentration of CP may be recommended as an effective alternative to $NaBO_3 \cdot 4H_2O$ and H_20_2 for intracoronal bleaching. The high concentration of the Active ingredient in 35% Hydrogen Peroxide results in an excessive amount, which may easily pass through the root tissue without undergoing any chemical reactions. This phenomenon explains why both this solution and 35% CP gel have the same level of effectiveness. Another hypothesis is that because of its slower penetration into dentine compared to H_20_2, CP may have a longer duration of action, allowing it to more effectively degrade chromogens. [17]

ZIRCONOMER>BIOACTIVA ACTIVE>BIODENTINE

Zirconomer, a more recent iteration of glass ionomer cement, has equivalent strength and durability to amalgam. It has the same chemical bonding characteristics as glass ionomer cement. It forms a chemical bond with the tooth structure and has a thermal expansion coefficient that matches that of the tooth, leading to decreased levels of stress. [18] In order to get the necessary particle size and properties, the glass component of Zirconomer is subjected to micronization. When thoroughly mixed with the glass component, it significantly enhances the strength of the material, guaranteeing long-lasting durability and the capacity to withstand severe occlusal loads.[19] Active The BIOACTIVE RESTORATIVE is a very intelligent restorative substance that incorporates the Embrace resin. The material is a bioactive rubberized ionic-resin matrix that chemically attaches to tooth structure, providing shock-absorbing properties. This bonding ability sets it apart from glass ionomers. It emits calcium, phosphate, and fluoride ions. The resin matrix consists of diurethane and methacrylates, which are combined with modified polyacrylic acid. The rubberized molecules in the ACTIVA matrix provide both high toughness and impact strength. The resilience of the resin enables it to effectively absorb the stresses of mastication and other external pressures, enhancing the durability and strength of dental restorations. [20]

CONCLUSION

The use of bleaching chemicals was shown to have a substantial influence on the FR of intraorifice barriers. The material that was discovered to have the greatest FR was determined to be Zirconomer, which was followed by Bioactiva Active and Biodentine in the order that they were discovered.

In comparison to the other components that were put through the bleaching process, CP, H_2O_2, and $NaBO_3 \cdot 4H_2O$ were shown to have the greatest efficacy. Thus, more researchers should done in future to validate our results.

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