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Original Research Article

Evaluation of Effect of Different Intraorifice Barriers on Fracture Resistance of Endodontically Treated Teeth during Non-Vital Tooth Bleaching: An Invitro Study

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Abstract

Background: Intracoronal bleaching is a simple solution to treat non-vital teeth with discoloration.

Aim: To compare fracture resistance of teeth that were treated endodontically, after placement of different intraorifice barriers in non-vital bleaching.

Materials and Methods: Sixty extracted human maxillary incisors were root canal treated, followed by removal of coronal 3mm of gutta-percha. All the samples were split into 4 groups (n=15) with Biodentine as intraorifice barrier (Group 1), MTA as intraorifice barrier (Group 2), Light cure GIC as intraorifice barrier, followed by light curing (Group 3), Control- The removal of gutta percha from the coronal part will not take place (Group 4). 35% carbamide peroxide was applied in the pulp chamber of all the samples, and was be changed every 7 days. Samples were subjected to fracture resistance testing using universal testing machine. The data was analysed using one way ANOVA and unpaired student t test.

Result: The fracture resistances of all the groups were compared. The mean and standard deviation of fracture resistance in Group 1 (Biodentine) was 1139.58±187.28 N, Group 2 (MTA) was 885.81±167.14 N, Group 3 (Light cure GIC) was 1019.58±202.32 N and Group 4 (Control) was 719.50±179.78 N. The Fracture resistance of the groups were - Group 1 (Biodentine) ≈ Group 3 (RMGIC) > Group 2 (MTA) > Group 4 (Control).

Conclusion: Fracture resistance of endodontically treated teeth undergoing intracoronal bleaching is improved by using intraorifice barrier. Maximum improvement occurs in teeth with Biodentine as the intraorifice barrier.

Keywords: Intraorifice Barriers, Bleaching, Invitro Study, Fracture Resistance.

Introduction

Discolouration of anterior teeth is a major aesthetic concern. There is increased inclination towards improving the shades of teeth. The various causes of tooth discoloration can be categorized as extrinsic or intrinsic or both, depending on the site and the cause behind it. Extrinsic discolouration occurs due to chemical absorption at the surface of tooth. Direct staining could be because of tobacco, tea, coffee, betel nut staining, plaque accumulation. Indirect staining is caused by reaction of an external substance with tooth structure, like long term use of chlorhexidine mouthwash. Treatment usually involves conservative approaches like prophylaxis, microabrasion and macroabrasion. [1]

Intrinsic discolouration occurs because of alteration in chemical structure of tooth or change in the width of dentin. It may involve vital, non-vital or root canal treated teeth. The teeth having vital pulp are usually affected at the time of tooth formation. It could be due to dentinogenesis imperfecta, tetracycline treatment, fluorosis, ageing, traumatic injury, endodontic treatment, pulp canal obliteration, etc. Discolouration present in non-vital teeth could be attributed to haemorrhage, restorative material abuse, silver-containing sealer retention in pulp chamber, eugenol compounds, antibiotic pastes, etc. It could also occur because of pulp canal obliteration induced by trauma. This yellowish discolouration is very tough to remove. Intrinsic stains are very difficult to remove and mostly require aggressive management in the form of laminates, veneers, crown, replacement of old restoration. Sometimes, such stains may respond to less invasive treatment modalities like microabrasion or macroabrasion and bleaching. Internalized discolouration occurs due to percolation of extrinsic stains into the tooth substance through enamel defects or cracks. The defects include abrasion, caries, type of filling material, etc. [2]

Discoloration due to root canal therapy is quite common. Presently, bleaching is used to treat teeth with intrinsic discolouration due to root canal therapy. The method of bleaching depends on the vitality of the concerned tooth or teeth. Intracoronal bleaching is an easy and inexpensive solution for endodontically treated teeth. [3]

Root canal filling lacks the ability to adequately prevent the penetration of bleaching agent from the pulp chamber to periodontal tissue. When the agent percolates through these structures, it causes cervical resorption. In order to prevent this complication, an intraorifice barrier is used. [4] A great deal of investigations using light cured glass ionomer cement for this purpose have taken place. The modulus of elasticity of this material is nearer to dentin and it binds by chemical adhesion. [5,6]

There are fewer studies with newer materials like MTA and Biodentine.

The aim of this study was to compare fracture resistance of teeth that were treated endodontically, after placement of three different intraorifice barriers, GIC, MTA and Biodentine in non-vital bleaching using 35% carbamide peroxide. The null hypothesis assessed was that the type of intraorifice barrier doesn't affect the fracture resistance of endodontically treated tooth in non-vital bleaching.

Materials and Methodology

Sample Preparation

60 extracted human maxillary incisors with single straight canal were included in this study (Figure 1)

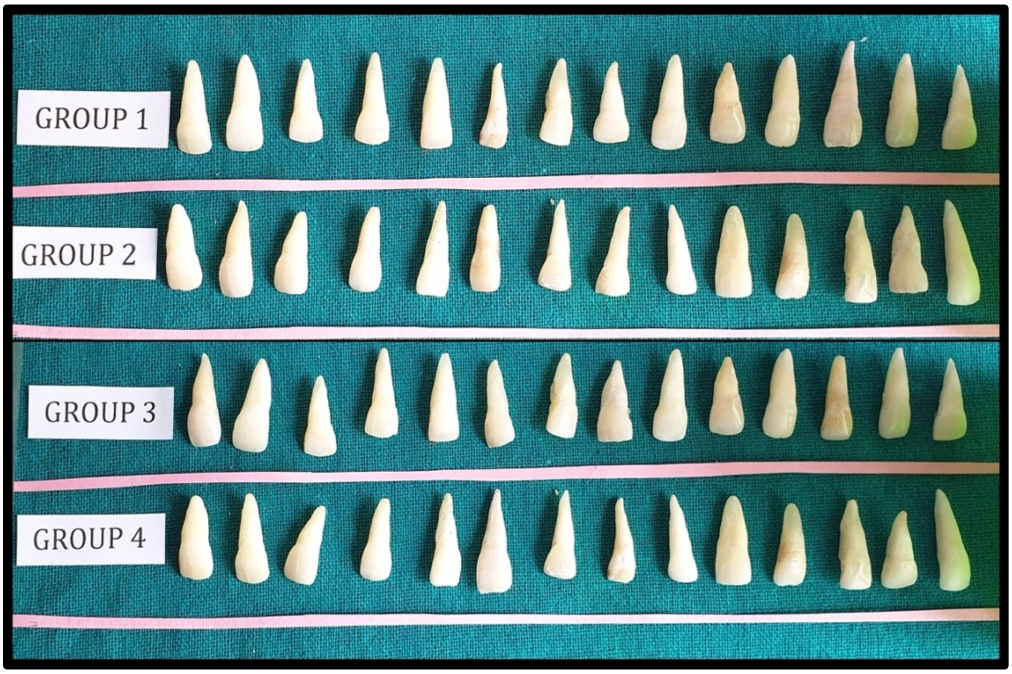

Figure 1: 60 extracted human maxillary incisors

The study protocol was approved by the ethics committee. Teeth that were extracted for orthodontic or periodontal reasons were included in this study, for which informed consent was obtained from patients and/or their parents in case of children under 16 years of age. Teeth with root caries, cervical abrasion, cracks, past restoration or endodontic intervention, external or internal resorption, calcifications and abnormal anatomy were not included in this study. Teeth were debrided and cleansed using an ultrasonic scaler to remove soft tissues and calculus flecks. These were examined under stereomicroscope to check for cracks, if any. All the samples were kept in saline solution at room temperature until use.

Specimen Preparation

Access cavity was prepared using #4 round bur and Endoaccess bur (Dentsply Maillefer, Ballaigues) followed by working length determination using #15 k-file (Mani, Inc. Japan) and then subtracting 1mm from this measurement, according to Ingle's method. The canals were shaped till #80 k-file. Irrigation was done after every subsequent file using 5% sodium hypochlorite (Prime Dental Products Pvt Ltd, India). It was followed by RC Prep (Medical Products Laboratories INC) to remove smear layer and final rinse using 0.2% w/v (ICPA Health Products Ltd, India). The canals were dried with paper point and were obturated with #80 master cone coated with AH Plus sealer (Dentsply Detrey of MbH Germany). Remaining space was filled with accessory gutta percha cones. Coronal 3 mm of gutta percha was removed using # 5 Gates Glidden drill (Mani Inc, Japan) in 45 teeth (Figure 2). The depth was checked with a Williams probe. The coronal cavity was cleaned with alcohol, followed by water and air stream drying.

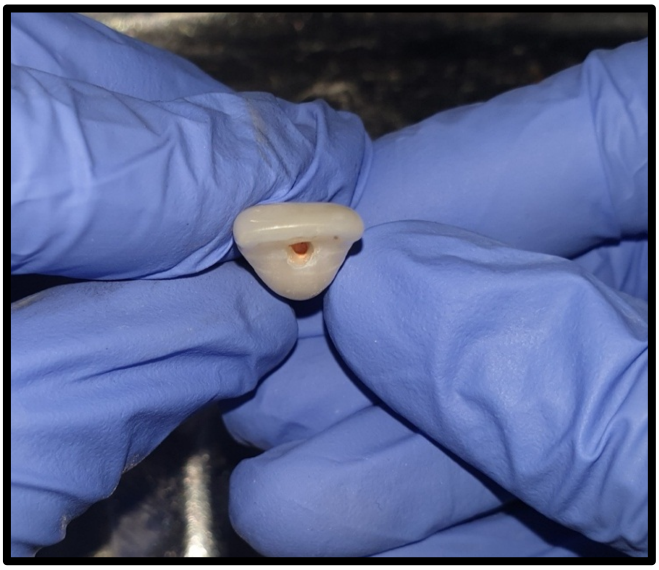

Figure 2: Gutta percha removed 3mm apical to orifice

Placement of Intraorifice Barrier and Bleaching

All the samples were split into 4 groups (N=15)

Group 1: Biodentine® (Septodont®, France) was placed as the intraorifice barrier (Figure 3).

Group 2: MTA Angelus® (Angelus® ,Brazil) was placed as the intraorifice barrier (Figure 4).

Group 3: Light cure GIC (3M™ RelyX™, USA) was placed as the intraorifice barrier, followed by light curing (Figure 5).

Group 4: Control- The removal of gutta percha from the coronal part did not take place.

35% carbamide peroxide (24 Carat Pure White Smile, Prevest DenPro®, India) was applied in the pulp chamber of all the samples, and was changed every 7 days (Figure 6). Teeth were sealed using temporary restorative material.

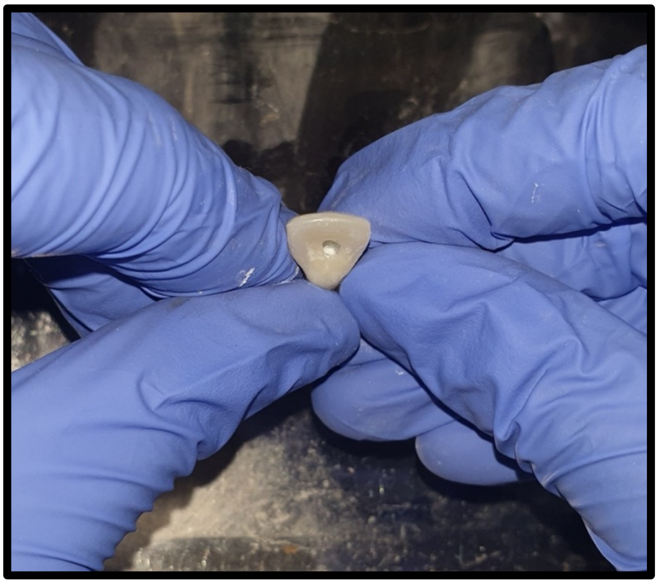

Figure 3: Intraorifice barrier of Biodentine

Figure 4: Intraorifice barrier of MTA

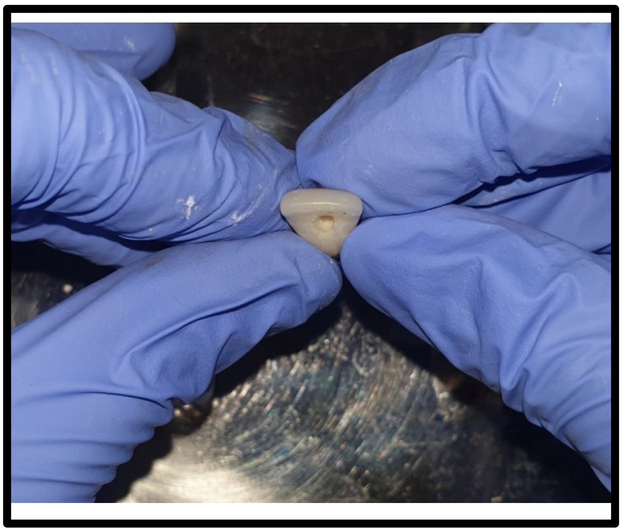

Figure 5: Intraorifice barrier of resin modified glass ionomer cement

Figure 6: Bleaching agent placement in pulp chamber

Fracture Resistance Testing

The samples were fixed in acrylic blocks at an angle of 45°. They were subjected to fracture resistance test under a Universal Testing Machine (Computerized, Software Based, ACME Engineers, India. Model : UNITEST 10). The speed of the machine was 5mm/min with an accuracy of ±1% (Figure 7).

Figure 7: Sample undergoing testing for fracture resistance on universal testing machine

Results

The fracture resistances of all the groups were compared. The mean and standard deviation of fracture resistance in Group 1 (Biodentine) was 1139.58±187.28 N, Group 2 (MTA) was 885.81±167.14 N, Group 3 (Light cure GIC) was 1019.58±202.32 N and Group 4 (Control) was 719.50±179.78 N. ANOVA test was applied to find the differences between groups, having F value 14.34 and P value 0.01. The result shows statistically significant differences between the groups. (Table 1)

Table 1: Comparison of fracture resistance of different intraorifice barriers used during non-vital bleaching in endodontically treated teeth

Group	N	Mean	Std. Deviation	Std. Error	F	P value
Biodentine	15	1139.58	187.28	48.35	14.34	0.001**
MTA	15	885.81	167.14	43.15		
Light cure GIC	15	1019.58	202.32	52.23		
Control	15	719.50	179.78	46.42		
Total	60	941.12	239.12	30.87		

** Highly Significant, ANOVA test

The groups were further analysed with student t test to find the differences between the pairs of groups.

The mean and standard deviation of fracture resistance in Group 1 (Biodentine) was 1139.58±187.28 N and Group 2 (MTA) was 885.81±167.14 N. Student t test was applied to find the differences between groups, showing t value 3.91 and P value 0.001. The result shows statistically significant differences between the groups. The Fracture resistance of Group 1 > Group 2. (Table 2)

Table 2: Comparison of fracture resistance of Biodentine and MTA as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	t	P value
Biodentine	15	1139.58	187.28	48.35	3.91	0.001**
MTA	15	885.81	167.14	43.15		

** Highly Significant, Unpaired t test

The mean and standard deviation of fracture resistance in Group 1 (Biodentine) was 1139.58±187.28 N and Group 3 (Light cure GIC) was 1019.58±202.32 N. Student t test was applied to find the differences between groups, showing t value 1.68 and P value 0.103. The result shows statistically non-significant differences between the groups. The Fracture resistance of Group 1 ≈ Group 3. (Table 3)

Table 3: Comparison of fracture resistance of Biodentine and Light Cure GIC as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	t	P value
Biodentine	15	1139.58	187.28	48.35	1.68	0.103#
Light cure GIC	15	1019.58	202.32	52.23		

Non Significant, Unpaired t test

The mean and standard deviation of fracture resistance in Group 1 (Biodentine) was 1139.58±187.28 N and Group 4 (Control) was 719.50±179.78 N. Student t test was applied to find the differences between groups, showing t value 6.27 and P value 0.031. The result shows statistically significant differences between the groups. The Fracture resistance of Group 1 > Group 4. (Table 4)

Table 4: Comparison of fracture resistance of Biodentine and Control group as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	t	P value
Biodentine	15	1139.58	187.28	48.35	6.27	0.031*
Control	15	719.50	179.78	46.42		

* Significant, Unpaired t test

The mean and standard deviation of fracture resistance in Group 2 (MTA) was 885.81±167.14 N and Group 3 (Light cure GIC) was 1019.58±202.32 N. Student t test was applied to find the differences between groups, showing t value 2.17and P value 0.049. The result shows statistically significant differences between the groups. The Fracture resistance of Group 2< Group 3 (Table 5).

Table 5: Comparison of fracture resistance of MTA and Light cure GIC as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	t	P value
MTA	15	885.81	167.14	43.15	2.17	0.049*
Light cure GIC	15	1019.58	202.32	52.23		

*Significant, Unpaired t test

The mean and standard deviation of fracture resistance in Group 2 (MTA) was 885.81±167.14 N and Group 4 (Control) was 719.50±179.78 N. Student t test was applied to find the differences between groups, showing t value 2.62 and P value 0.014. The result shows statistically significant differences between the groups.The Fracture resistance of Group 2 > Group 4. (Table 6).

Table 6: Comparison of fracture resistance of MTA and Control group as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	T value	P value
MTA	15	885.81	167.14	43.15	2.62	0.014*
Control	15	719.50	179.78	46.42		

*Significant, Unpaired t test

The mean and standard deviation of fracture resistance in Group 3 (Light cure GIC) was 1019.58±202.32N and Group 4 (Control) was 719.50±179.78 N. student t test was applied to find the differences between groups shows t value 4.29 and P value 0.001. The result shows statistically significant differences between the groups. The Fracture resistance of Group 3 > Group 4. (Table 7)

Table 7: Comparison of fracture resistance of Light cure GIC and Control group as intraorifice barrier during non-vital bleaching

Group	N	Mean	Std. Deviation	Std. Error Mean	t	P value
Light cure GIC	15	1019.58	202.32	52.23	4.29	0.001**
Control	15	719.50	179.78	46.42		

*Significant, Unpaired t test

The Fracture resistances of the groups were analysed with the help of one Way ANOVA and unpaired student t test and on the basis of the result of these tests the study result gave the following conclusion-

The fracture resistances of Group 1 ≈ Group 3 > Group 2 > Group 4

Discussion

Intracoronal bleaching is responsible for cervical root resorption in 6-8% cases when 35 % hydrogen peroxide is used. The percentage increases to around 20% when heat activation of hydrogen peroxide is done. [7,8] One of the most accepted methods to prevent deleterious effect of bleaching agent on healthy surrounding tissue is placement of an intraorifice barrier. Bleaching materials may penetrate the root filling towards the apical foramen or reach cervical area causing resorption. The attempt is to obstruct percolation of the agent by application of a protective layer. The results of the present study indicate that intraorifice barrier affects the fracture resistance of root canal treated teeth. The results were statistically significant between groups having barrier than the control group. The use of Biodentine, MTA and resin modified glass ionomer cement increases the fracture resistance of such teeth. However, the augmentation is more prominent with Biodentine and RMGIC as compared to MTA, difference not being statistically significant between the former two ($p > .05$).

Aboobaker et al conducted a study and found that Tetric N Flow (flowable hybrid composite) and Fuji GC LC GIC (resin modified glass ionomer cement) provide adequate fracture resistance when used as an intraorifice barrier in endodontically treated teeth. [9] Mahalakshmi V et al evaluated the effect of light cure GIC and Biodentine as intraorifice barrier on the microleakage and fracture resistance of teeth. They found that Biodentine has lesser leakage and better fracture resistance. [10] There many studies done on MTA based product as intraorifice barrier. However, there are fewer studies found on Biodentine as an intraorifice barrier. It is a contemporary material with various advantages, hence it was decided to incorporate it in the study.

In the present study, Biodentine showed promising results. The maximum increase in the fracture resistance was attributed to this agent. The difference in fracture resistance was statistically significant than MTA ($p < .05$) and control group ($p < .05$). However, the difference between Biodentine and RMGIC were not statistically significant ($p > .05$). Many materials have been suggested in the literature like glass-ionomer cements, resin composites, polycarboxylate cements, and zinc phosphate cements, intermediate restorative material (IRM), Cavit and Coltosol, photo- activated temporary resin materials such as Fermit, zinc oxide–eugenol cements. [11]

However, not all fulfil the requirement of an intraorifice barrier. The sealing ability, bonding to tooth structure, no interference with permanent restoration, strength, elastic modulus are some properties that determine the choice of material.[4] A great deal of research has been carried out in testing resin glass ionomer as intraorifice barrier. Resin modified glass ionomer cement (RMGIC) is a modification of the traditional glass ionomer cement, by adding resin to it. However, the properties are more towards that of conventional glass ionomers. It adheres primarily by chemical bond with hydroxyapatite, hence strengthening the interface. The elastic modulus is closer to that of dentin, which helps in transmission of stresses uniformly. Also, the flexural strength is high (60-93 GPa), allowing it to withstand forces prior to transmitting to the root. The reason for higher fracture resistance with this barrier application could be attributed to these properties. It is one of the most commonly used and studied material for intraorifice barrier. [12] MTA is a revolutionary material, that was introduced in the mid- 1990s by Torabinejad. [13] It has a superior sealing ability, alkaline pH and optimum radiopacity. Earlier, ProRoot MTA was the product that was tested experimentally and used clinically. MTA Angelus consists of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalciumaluminoferrite, bismuth oxide (radio-opacifier). The manufacturers could decrease the setting time to 10 minutes as compared to older products by elimination of calcium sulphate. It has superior marginal adaptation because of adherent interfacial layer at dentin surface. [14] According to Asgari, sealing ability of calcium enriched mixture cement is more than MTA. [15] Milani et al showed similar ability of CEM and MTA to increase fracture resistance. [16]. It has excellent biocompatibility and is bioactive in nature. It also has superior leakage resistance. [6]

Biodentine (Septodont, Saint Maur des Fosses, France) is another calcium silicate based cement, which consists of tricalcium silicate, calcium carbonate, water reducing agent, zirconium oxide (radio-opacifier) and a water-based liquid containing calcium chloride (accelerator). Apart from biocompatibility of calcium silicate, the other advantages of Biodentine are enhanced strength (due to low water/powder ratio by presence of water soluble polymer) and fast setting (due to calcium chloride). [17]

The barrier location is assessed by probing the epithelial attachment level. Periodontal probing is done labially, mesially and distally to determine the level of epithelial attachment from the incisal edge of the tooth. The coronal extent of the barrier is achieved by adding 1 mm to the external probing depth. The coronal outline of barrier should correspond to the internal contour. The apical extent of the barrier should be at least 2 mm. [11] The properties that hold importance are seal, bond strength, workability, inertness with the final restoration. This barrier is placed between the root canal filling and the bleaching agent. [4]

Overtime, a variety of dental materials have been taken into consideration to be used as intraorifice barriers. [18] The literature suggests glass ionomer cement, temporary restorative material, and different types of cements. In the past, various chemicals have been put to use for non-vital bleaching, like carbamide peroxide, H2O2, or sodium perborate. [3] Hydrogen peroxide molecule has a small size, hence it diffuses through the dentinal tubules and produces free radicals. Sodium perborate also results in release of hydrogen peroxide, which is responsible for the conversion of big coloured organic molecules into small colourless molecules. Nowadays, usually carbamide peroxide is preferred because of its slow rate of oxygen release (40 - 90 minutes, due to addition of carbopol, a water based polyacrylic acid polymer), high pH (causing less resorption), less damage to hard tissues and less chances of caries progression. Although many studies show decrease in bond strength to teeth after bleaching, however, there is still controversy over the effect of fracture resistance of root canal treated teeth after walking bleaching. [19] According to Grazioli G et al, 15% of hydrogen peroxide should be the highest permissible concentration, as more than this increases the chances of changes in surface morphology, enamel hardness, acidity of the medium, however no improvement in the whitening effect. [20] Alteration in surface quality decreases hardness and increases roughness; low pH reduces the mineral content of dental hard tissues. [21] According to Francischone et al , when teeth were bleached with perborate and hydrogen peroxide, the fracture resistance declines. It was 20% less than non-bleached teeth and 45% less than non-treated teeth with an access cavity for endodontic treatment. [22] Furthermore, according to Bonfante et al, intracoronal bleaching with 37% carbamide peroxide did not have any significant effect on the fracture resistance of endodontically treated teeth. [23] Other studies showed a reduction of 17%–53% of the fracture resistance after bleaching with perborate and 30% hydrogen peroxide, whereas they indicated that 37% carbamide peroxide is a more conservative procedure. [22] Hence in this study it was decided to use 35% carbamide peroxide as the bleaching agent.

This study was an invitro experiment based on teeth mounted in acrylic, which cannot entirely simulate exact clinical condition. The cushioning effect of PDL might distribute masticatory forces, hence increasing the fracture resistance of teeth. Hence, more invitro and invivo studies are required to illustrate the effectiveness of intraorifice barrier in non-vital bleaching to surpass such limitations. [24]

Conclusion

Fracture resistance of endodontically treated teeth undergoing intracoronal bleaching is improved by using intraorifice barrier. Maximum improvement occurs in teeth with Biodentine as the intraorifce barrier.

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