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Comparision of Microleakage Between Conventional Glass-Ionomer, Light Cured Glass-Ionomer, Cermet And Mineral Trioxide Aggregate (White) Used As A Coronal Barrier in Nonvital Bleaching – An in Vitro Study

*Dr. Nidha Amrin .M [1],Dr. M. Kala [2],Dr. Savitha B. Naik[3]
[1](Post graduate , Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Rajiv Gandhi University of Health Sciences, India)
[2](Professor and Head of Department, Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Rajiv Gandhi University of Health Sciences, India)
[3](Reader , Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Rajiv Gandhi University of Health Sciences, India)
*Corresponding Author: *Dr. Nidha Amrin .M*

Abstract: *Freshly extracted 80 intact, non-carious single rooted human maxillary central incisors that were extracted for periodontal reasons within six months period of start of the study were collected from the Department of Oral and Maxillofacial Surgery. The root canals were instrumented using a step-back technique. Obturation was done with cold lateral compaction method using Gutta-Percha. Peeso reamer no 4 was used to remove the Gutta-Percha upto 3mm below the CEJ. The teeth were randomly allocated into four groups with twenty teeth in each group as follows:*
GroupA *:- Conventional glass ionomer cement.*
GroupB *:- Light cured glass ionomer cement.*
GroupC *:- Glass cermet.*
GroupD *:- White mineral trioxide aggregate.*
The teeth were stored for 3 days. Then Cavit G and cotton pellets were removed and replaced with new cotton pellets wetted with fresh bleaching agents. This process was repeated three times. Then pulp chamber was rinsed with distilled water and dried. Two layers of nail varnish was applied over the tooth surfaces except for access cavity margins and then immersed in 1%methylene blue dye for 72 hrs. The teeth were then washed and split longitudinally with a diamond disc using a water coolant. The depth of dye penetration was examined under a stereomicroscope (20X) to evaluate the roots for the extent of coronal microleakage. The results were then analysed statistically using one way ANOVA and Post HOC Tukey's test. Comparison of coronal dye microleakage showed mean coronal dye microleakage values of 2.61mm with a standard deviation of 0.06 for conventional glass ionomer cement, 1.79 mm with a standard deviation of 0.09 for light cure glass ionomer cement, 3.44mm with a standard deviation of 0.24 for glass cermet and 1.28 mm with a standard deviation of 0.41 for mineral trioxide aggregate (white). The marginal adaptation in terms of coronal dye microleakage can be summarized as: White mineral trioxide aggregate > light cure glass ionomer cement > conventional glass ionomer cement > glass cermet.

Keywords: *coronal barrier filling material, coronal dye microleakage, stereomicroscope, white mineral trioxide aggregate.*

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I. Introduction

Bleaching of teeth is of great importance in dental esthetics. Intracoronal bleaching is widely used in discolored non vital teeth because of its simplicity, efficiency, low cost and preservation of dental hard tissue in comparison to prosthetic treatment. The intracoronal bleaching agents most commonly used are hydrogen peroxide, carbamide peroxide and sodium perborate. [1] Walking bleach intracoronal technique was introduced by Nutting and Poe in 1976 that used 30-35% sodium perborate placed in the pulp chamber [2]. In 1989, Haywood and Heymann introduced carbamide peroxide for bleaching of vital teeth and recently it has also been recommended as an intracoronal bleaching agent. Sodium peroxide on contact with water decomposes into hydrogen peroxide releasing nascent oxygen and carbamide peroxide releases hydrogen peroxide and urea. [1]These bleaching agents though effective are associated with some complications, one of them being external resorption of cervical root. The mechanism responsible for cervical resorption in bleached teeth has not been adequately explained but it is probably caused by the highly concentrated oxidizing agents which diffuse through dentinal tubules and cementum defects and cause necrosis of the cementum, inflammation of the periodontium and subsequently root resorption [3,4]. According to some studies, enhanced osteoclastic activity leading to cervical root resorption is caused by the fall in pH at the root surface but there are different opinions on the nature of resorptive process [5]. Some opine that microorganisms from the pulp space or gingival sulcus stimulate the resorption. Others have suggested that it is an inflammatory process which may become secondarily involved by microorganisms [6]. Therefore to prevent leakage of bleaching agents into the periodontium, it is advisable to use a protective barrier over the coronal extent of root canal filling [7]. Numerous dental materials such as intermediate restorative material (IRM), hydraulic filling materials (Cavit, Coltosol), resin composites, photo-activated temporary resin materials, zinc oxide-eugenol cement, zinc phosphate cement and conventional glass-ionomer cement have been advocated as interim sealing agents during bleaching techniques . Since it is a requisite to remove the temporary sealing material after the bleaching process and before the final restoration of access cavity, glass ionomer cement of 2mm thickness has been suggested as a base material during bleaching, which can be left in place after bleaching and can serve as a base for the final restoration [7].

MTA is a biomaterial introduced for endodontic applications during the early 1990s. MTA is derived from Type I Portland cement and is composed of dicalcium silicate, tricalcium silicate, tricalcium aluminate, tetracalciumaluminoferrite, and bismuth oxide. The various clinical uses of MTA are pulp capping, pulpotomy, treatment of internal root resorption, undeveloped apices (apexogenesis and apexification), root-end filling, repair of root and furcation perforations, and a coronal barrier. MTA has displayed better microleakage protection than conventional endodontic materials using various methods in majority of studies. Prolonged setting time, poor handling characteristic, and comparitively high price are the drawbacks of MTA [8].

The purpose of this study was to compare the micro leakage of conventional glass-ionomer, light cured glass-ionomer cement, glass cermet and White mineral trioxide aggregate used as a coronal barrier in nonvital bleaching technique.

II. Materials And Methods

This in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Bengaluru. Freshly extracted 80 intact, non-carious single rooted human maxillary central incisors that were extracted for periodontal reasons were used within a period of six months from start of the study , the teeth were collected from the Department of Oral and Maxillofacial Surgery. All stains, calculus and soft tissue on the teeth were removed using an ultrasonic scaler and were stored in normal saline. The teeth with fractures, cracks, or any other defects were excluded from the study. Standard endodontic access cavities were prepared and the patency of the apical foramina were determined with a size 15 K file. Working lengths were established 1 mm short of the apical foramina. The root canals were instrumented using a step-back technique. Pulp space instrumentation was completed using K-files with a master apical file of size # 50. The canals were irrigated with 10ml of 2.5% sodium hypochlorite during instrumentation. 5ml of saline was used as final irrigant. Obturation was done with cold lateral compaction method using Gutta-Percha. Peeso reamer no.4 was used to remove the Gutta-Percha upto 3mm below the CEJ. The pulp chambers were irrigated with saline and dried with cotton pellets. The teeth were randomly allocated into four groups with twenty teeth in each group as follows:

Group A: - Consisted of twenty human maxillary central incisors. Conventional glass-ionomer cement was packed into the 3mm unfilled portion of the canals to the level of CEJ below which the cotton pellet wetted with 30% hydrogen peroxide mixed with sodium perborate was placed as bleaching agent and the teeth were restored with Cavit G.

Group B: - Consists of twenty human maxillary central incisors. Light cured glass-ionomer cement was packed into the 3mm unfilled portion of the canals to level of CEJ below which the cotton pellet wetted with 30% hydrogen peroxide mixed with sodium perborate was placed as bleaching agent and teeth were restored with Cavit G.

Group C: - Consists of twenty human maxillary central incisors. Cermet was packed into the unfilled portion of the canals to the level of CEJ below which the cotton pellet wetted with 30% hydrogen peroxide mixed with sodium perborate was placed as bleaching agent and teeth were restored with Cavit G.

Group D: - Consists of twenty human maxillary central incisors. Mineral trioxide aggregate (white) was packed into the unfilled portion of the canals to the level of CEJ below which the cotton pellet wetted with 30% hydrogen peroxide mixed with sodium perborate was placed as bleaching agent and teeth were restored with Cavit G.

The teeth were dry stored for 3 days. Later the Cavit G and cotton pellets were removed and replaced with new cotton pellets wetted with fresh bleaching agents. In groups from A-D, the process was repeated three times. The pulp chamber was rinsed with distilled water using a syringe and dried. Two layers of nail varnish was applied over all the teeth surfaces except for access cavity margins. To evaluate the coronal microleakage, the teeth were suspended so that only coronal part of the teeth were immersed in methylene blue dye. The teeth were washed and split longitudinally with a diamond disc using a water coolant. The depth of dye penetration was examined under a stereomicroscope with a magnification of 20X to evaluate the roots for the extent of coronal microleakage. The results were then analysed statistically using one way ANOVA and Post HOC Tukey's test.

III. Observations and results

Method of statistical analysis**:** Data collected by experiments were computerized and analysed using Statistical Package for Social Sciences (SPSS) version 13.0 software. Parametric tests namely one way ANOVA and Post Hoc Tukey's test were used.

Null Hypothesis: There is no significant difference in the coronal dye microleakage values recorded between the groups i.e. $\eta1=\eta2=\eta3=\eta4$

Alternate Hypothesis: There is a significant difference in the coronal dye microleakage values recorded between the groups i.e. $\eta1\neq\eta2\neq\eta3\neq \eta4$

Level of Significance**:** $\alpha=0.05$

Statistical test used: one way ANOVA and Post HOC Tukey's test

Decision Criterion: p value less than 0.05 is considered statistically significant. If $p\geq0.05$,the null hypothesis is accepted. If $p<0.05$, the null hypothesis is rejected and the alternate hypothesis is accepted. If there is a significant difference between the groups, then intergroup comparison is done using Post Hoc Tukey's test. The stereomicroscopic images of 20x magnification were analysed using MOTIC images plus 2 software. The coronal dye microleakage between the coronal barrier and the root dentin was measured and the values were recorded in millimetres.

Table 1 : Coronal Dye Microleakage Values In Each Group Measured In Millimeters

Samples	Group A	Groupb	Groupc	Groupd
1.	2.55	1.83	3.50	1.14
2.	2.65	1.85	3.61	1.18
3.	2.68	1.72	3.55	1.21
4.	2.63	1.80	3.50	1.13
5.	2.69	1.74	3.81	1.16
6.	2.65	1.61	2.97	0.94
7.	2.55	1.84	3.55	0.98
8.	2.59	2.01	3.19	2.10
9.	2.60	1.83	3.42	1.15
10.	2.68	1.85	4.02	1.20
11.	2.53	1.78	3.35	1.41
12.	2.55	1.82	3.49	1.28
13.	2.69	1.88	3.47	1.12
14.	2.56	1.69	3.56	1.01
15.	2.58	1.81	3.38	2.70
16.	2.53	1.74	2.99	1.09
17.	2.52	1.80	3.54	1.18
18.	2.60	1.73	3.46	1.22
19.	2.69	1.84	3.21	1.19
20.	2.71	1.68	3.28	1.14

Computations: Table 2 shows the mean and standard deviation values for each group. Comparison of coronal dye microleakage showed mean coronal dye microleakage values of 2.61mm with a standard deviation of 0.06 for conventional glass ionomer cement, 1.79 mm with a standard deviation of 0.09 for light cure glass ionomer cement, 3.44mm with a standard deviation of 0.24 for glass cermet and 1.28 mm with a standard deviation of 0.41 for mineral trioxide aggregate (white). In accordance with the findings in Table 2, the mean coronal dye microleakage value was found to be highest in group C (glass-cermet) and lowest in group D (mineral trioxide aggregate).

Average coronal dye microleakage values:

Group C>Group A>Group B>Group D

Table 2: Mean, Standard deviation, Standard error and coefficient of variation of coronal dye microleakage

Groups	N	Mean	SD	SE	CV
Group A	20	2.61	0.06	0.01	2.46
Group B	20	1.79	0.09	0.02	4.81
Group C	20	3.44	0.24	0.05	7.11
Group D	20	1.28	0.41	0.09	32.06

Table 3 gives us various computations and the p value. The statistical analysis using one-way ANOVA revealed overall statistically significant difference between all the groups at $p<0.05$ ($p=0.00001$). The null hypothesis is rejected and the alternate hypothesis is accepted. Group D (Mineral trioxide aggregate) presented least coronal dye microleakage when compared to Group A (Conventional glass ionomer cement), Group B (Light cure glass ionomer cement) and Group C (Glass cermet) and the difference is statistically significant.

Table 3: Comparison of four groups (A,B,C,D) with respect to coronal dye microleakage (in mm) by one way ANOVA

Sources of variation	Sum of squares	Degrees of freedom	Mean sum of squares	F-value	p-value
Between groups	54.12	3	18.04	302.0232	0.00001*
Within groups	4.54	76	0.06		
Total	58.66	79			

*p<0.05

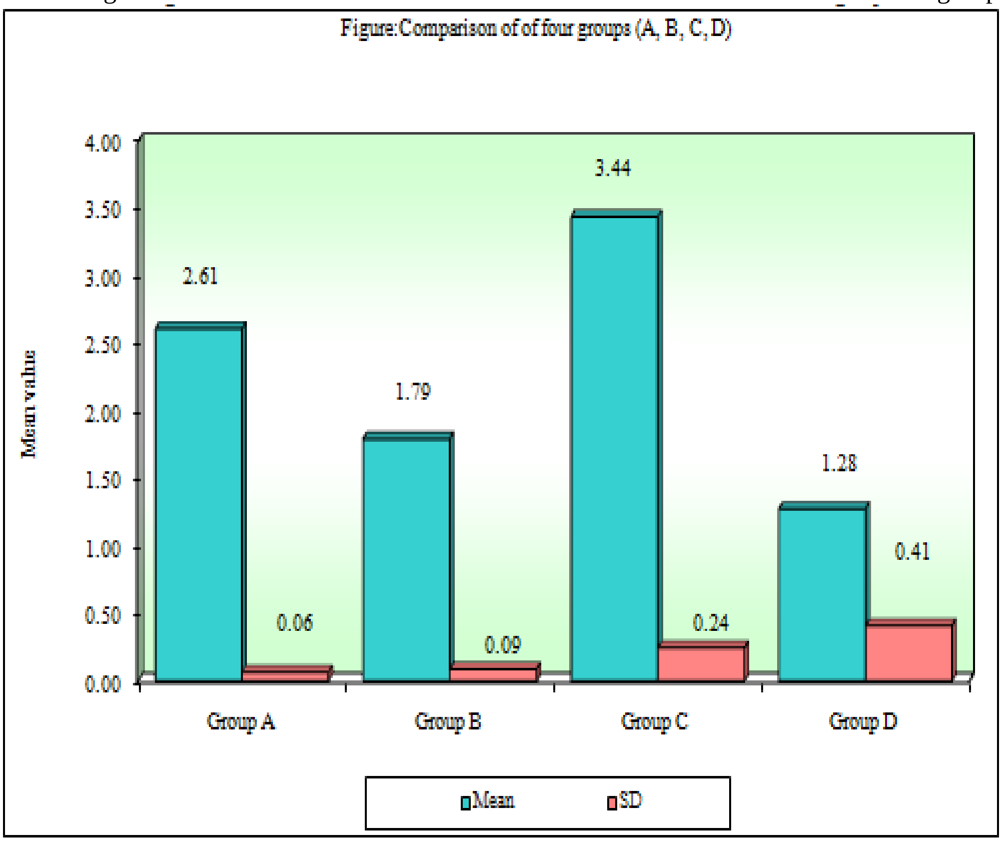
Minimum coronal dye microleakage was found in group D (Mineral trioxide aggregate) followed by group B (Light cure glass ionomer cement), groupA (conventional glass ionomer cement) and group C (glass cermet). Intergroup comparison with Post Hoc Tukey's test revealed that all the groups show statistically significant difference ($p=0.0002$).

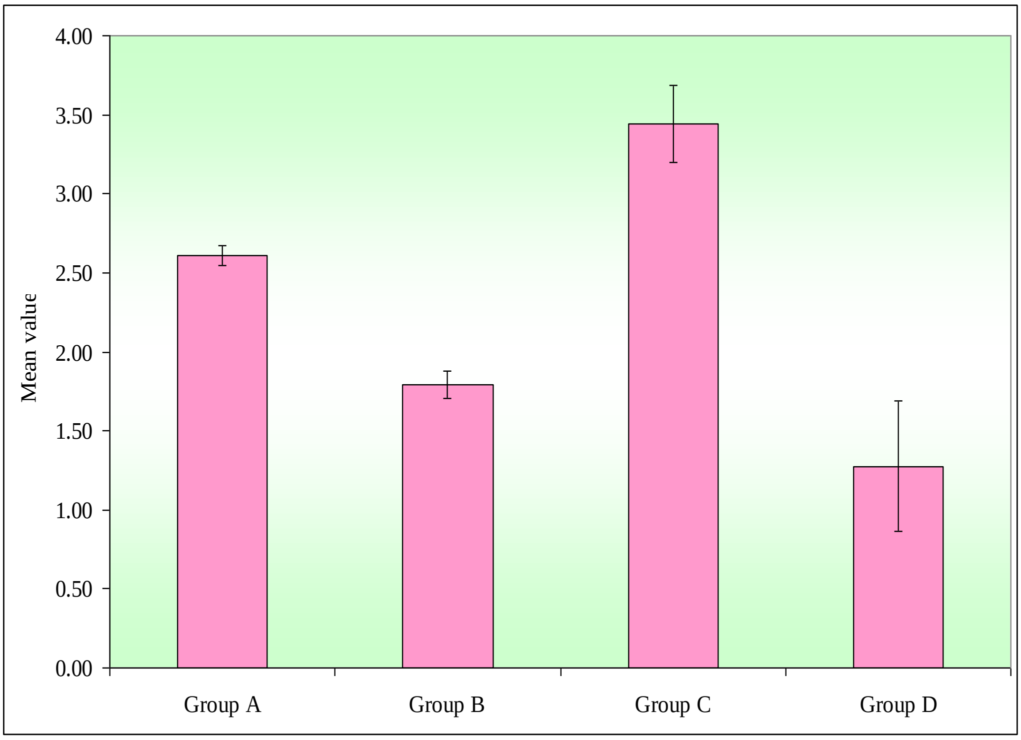
Table 4: Intergroup comparison of four groups (A,B,C,D) with respect to coronal dye microleakage (in mm) by Tukeys multiple post hoc procedures

Groups	Group A	Group B	Group C	Group D
Mean	2.6115	1.7925	3.4425	1.2765
SD	0.0642	0.0863	0.2448	0.4092
Group A	-			
Group B	P=0.0001*	-		
Group C	P=0.0001*	P=0.0001*	-	
Group D	P=0.0001*	P=0.0001*	P=0.0001*	-

*p<0.05

The bar diagram below shows the mean and standard deviation values in each of the four groups.





Bar diagram showing mean values

The results can be summarized as follows:

1. All the groups showed some extent of coronal dye microleakage in all the samples.
2. Least amount of coronal dye microleakage was seen in group D (Mineral trioxide aggregate) with as mean value of 1.28mm followed by Group B (Light cure glass ionomer cement) with a mean value of 1.79mm and Group A (Conventional glass ionomer cement) with a mean value of 2.61mm. Highest amount of coronal dye microleakage was observed in Group C (Glass cermet) with the mean value of 3.44mm and the results were statistically significant ($p<0.05$).

IV. DISCUSSION

Non vital teeth could get discoloured due to trauma. Failing to control bleeding during endodontic therapy or a blow to the tooth causing death of pulp tissue may result in haemorrage in pulp chamber. The dentinal tubules get infiltrated with blood which gets haemolysed ensuing in liberation of haemoglobin and its breakdown products leading to yellowish discolouration. Iron sulfide is formed as a degradation product of iron pigment causing discolouration.[9,10].Invasive methods like full veneer crowns to least invasive procedures like bleaching are the treatment alternatives available to the dentist following endodontic therapy. Though non-vital tooth bleaching has been vastly mentioned in the literature as an option in the post endodontic management, an exhaustive review of the literature surprisingly showed us that there were very minimal case reports and follow up reports on non-vital tooth bleaching. The main reason for this is the apprehension of cervical resorption following non-vital tooth bleaching, as appropriate precautions are not taken during the bleaching procedure [11]. A variety of bleaching techniques and materials have been recommended in order to attain satisfactory bleaching and no damages to dental hard tissues and periodontal ligament. The intracoronal bleaching agents most often used are hydrogen peroxide, carbamide peroxide and sodium perborate[1]. Sodium perborate contains about 95% perborate and 9.9% available oxygen. When sodium perborate contacts moisture, it decomposes into hydrogen peroxide and sodium metaborate. Sodium metaborate (pH – 10.6 in 0.1% solution) is alkaline and raises the pH of bleaching solution. Carbamide peroxide decomposes into 6.4% urea and 3.6% hydrogen peroxide. The by-product urea decomposes into carbon dioxide and ammonia, which increases the pH values of the bleaching agent. Hydrogen peroxide (30%) has pH value of approximately 4.0 (acidic) and decomposes into water and nascent oxygen. The nascent oxygen is the cause for bleaching. Some reports suggest that peroxides can penetrate through the dentinal tubules, reach periodontal ligament and consequently bone. This can cause some problems, such as inflammatory reactions, osteoclastic activity, bone and external cervical root resorptions [12, 13]. One of the various causative factors associated with these complications is the pH of the bleaching materials; since the low pH value of hydrogen peroxide leads to an acidic environment, which is a stimuli for osteoclastic activity and consequently, bone resorption. Also bleaching agents can cause

superficial structural changes to dentin. The low pH may cause acid-etch effect on dentin, dissolving the smear layer and increasing diffusion of hydrogen peroxide through dentinal tubules [2].
Microleakage in endodontics refers to the movement of fluid and microorganisms along the interface of the dentinal walls and the root filling material or through voids within the root filling material. Earlier the chief cause for the failure of endodontic treatment was contemplated to be due to apical microleakage. Therefore, studies evaluating apical microleakgae in endodontically treated teeth are abundant in the literature. Nevertheless, a large number of recent studies have recognized that for the conclusive success or failure of root canal treatment, coronal seal is equally valuable [14].

Fundamental studies on dental silicate cements and replacement of phosphoric acid in silicate cements by organic chelating acids resulted in invention of glass ionomer cement. It was supported by work on the zinc polycarboxylate cement in which it was shown that dental cements exhibiting the property of adhesion could be prepared from polyacrylic acid. Glass ionomer cement has hence been described as a hybrid of silicate cements and zinc polycarboxylates. In early 1990's Dr. M. Torabinajad and Dean J.White developed Mineral trioxide aggregate (MTA). Advantages of MTA are that it can be used as a root end filling material and as a repair material for lateral root perforations [15]. It is biocompatible because calcium and phosphorus make up the principle ions in it which are also the main ions in dental hard tissues[16]. In the presence of moisture, MTA sets by hygroscopic expansion, therefore it has better sealing ability and decreased apical microleakage. It also has antifungal and antibacterial properties. In a bacterial endotoxin microleakage study, MTA showed lower endotoxin microleakage than IRM and Silver Amalgam.[17]

Mcclean and Gasser developed glass cermet cements to improve resistance of conventaional glass ionomer cement by sintering the metal and glass powders together, this increased the strong bond of metal to glass. Ion leachable calcium aluminium fluorosilicate glasses were used in the preparation of the glass powder and a number of metal powders were tried, including alloys of silver and tin, pure silver, gold, titanium and palladium. After a number of clinical experiments, gold and silver were found to be the most suitable materials. Glass-cermet cements have appreciably increased resistance to abrasion when compared with glass-ionomer cements and their flexural strength is also greater. Nonetheless, their strength is still inadequate to replace silver amalgam alloys and their use should be limited to low stress-bearing cavity preparations. Moisture sensitivity and low initial setting strength are two drawbacks of conventional glass ionomer cements. To solve these disadvantages, efforts were made to combine glass ionomer with the composite resins. In the late 1980s and early 1990s, light cured glass ionomers were introduced into the trade. So, resin modification of glass-ionomer cement was created, while preserving the fundamental features of the conventional glass ionomer cement [15].

In the present study White mineral trioxide aggregate(WMTA) was chosen to compare its coronal sealing ability with 3 commonly used materials like conventional glass ionomer cement , light cured glass ionomer cement and glass cermet. WMTA was chosen because of its better sealing ability and decreased apical microleakage which it exhibits due to its hygroscopic expansion..

The rationale for removing 3mm of gutta percha below CEJ and sealing it with a coronal barrier is that the bleaching agents cause external resorption of cervical portion of the tooth. A variety of dental materials such as intermediate restorative material (IRM), hydraulic filling materials (Cavit, Coltosol), resin composites, photo-activated temporary resin materials, zinc oxide-eugenol cement, zinc phosphate cement and glass-ionomers , light cured glass ionomer , glass cermet are utilized as coronal barrier material. From the above said materials, three of the most commonly used materials, conventional glass ionomer cement, light cured glass ionomer cement, glass cermet were chosen in this study to compare coronal sealing ability with newer material , White MTA.

.The comparison of coronal dye microleakage showed mean values of 2.61mm with a standard deviation of 0.06 for conventional glass ionomer cement, 1.79 mm with a standard deviation of 0.09 for light cure glass ionomer cement, 3.44mm with a standard deviation of 0.24 for glass cermet and 1.28 mm with a standard deviation of 0.41 for mineral trioxide aggregate (white). The statistical analysis using one-way ANOVA revealed overall statistically significant difference between all the groups at $p<0.05$ ($p=0.00001$). Minimum apical dye microleakage was found in group D (WMTA) followed by group B (Light cured glass ionomer cement), group A (conventional glass ionomer cement) and group C (glass cermet). Intergroup comparison with Post Hoc Tukey's test revealed that all the groups show statistically significant difference ($p=0.0002$). Least amount of coronal dye microleakage was seen in group D (WMTA) with a mean value of 1.28mm followed by Group B (Light cure glass ionomer cement) with a mean value of 1.79 mm and Group A (Conventional glass ionomer cement) with a mean value of 2.61mm. Highest amount of coronal dye microleakage was observed in Group C (Glass cermet) with the mean value of 3.44mm and the results were statistically significant ($p<0.05$).

The marginal adaptation of the coronal barrier filling material to dentin in terms of coronal dye microleakage can be summarized as:

Glass cermet > conventional glass ionomer cement> Light cure glass ionomer >white mineral trioxide aggregate.

From this in vitro study, it can be concluded that in terms of marginal adaptation properties of materials used for the purpose of intra coronal bleaching, White Mineral trioxide aggregate is a better coronal barrier filling material than the commonly used coronal barrier filling materials like conventional glass ionomer cement, light cure glass ionomer cement and glass cermet. However, further in vivo studies are to be conducted to evaluate White Mineral trioxide aggregate as an ideal intracoronal barrier filling material.

V. **Conclusion**

Within the limitation of this present study, it can be concluded that none of the materials tested were able to avoid coronal dye microleakage. Of the four coronal barrier filling materials tested in this in vitro study, White Mineral trioxide aggregate displayed minimum coronal dye microleakage, while microleakage with glass cermet was found to be the highest. White Mineral trioxide aggregate presents an efficient marginal adaptation when used as a coronal barrier filling material showing significantly better results than conventional glass ionomer cement, light cured glass ionomer cement and glass cermet. The marginal adaptation in terms of coronal dye microleakage can be summarized as: White Mineral Trioxide Aggregate>light cured glass ionomer cement > conventional glass ionomer> glass cermet. This study concludes that in terms of marginal adaptation, Mineral trioxide aggregate is a better coronal barrier filling material. However, further in vivo studies are to be conducted to evaluate White Mineral Trioxide Aggregate as an ideal coronal barrier filling material.

References

[1]. VALERA, Marcia Carneiro et al. Effectiveness of carbamide peroxide and sodium perborate in non-vital discoloured teeth. J. Appl. Oral Sci.2009; 17(3):254-261.

[2]. Barcellos DC, Borges AB, Silva RCDSP, Riberio LM, Pucci CR, Torres CRG. PH- changes during intra coronal bleaching: An in vivo study. jContemp Dent Pract.2011;12(2):109-113.

[3]. Rotstein I, Torek Y, Misgav R. Effect of cementum defects on radicular penetration of 30% H2O2 during intracoronal bleaching. JEndod. 1991; 17: 230-3

[4]. Koulaouzidou E, Lambrianidis T, Beltes P, Lyroudia K, Papadopoulos C. Role of cementoenamel junction on the radicular penetration of 30% hydrogen peroxide during intracoronal bleaching in vitro. Endod Dent Traumatol. 1996;12:146-50.

[5]. Zimmerli B, Jeger F, Lussi A. Bleaching of nonvital teeth. A clinically relevant literature review. SchweizMonatsschrZahnmed. 2010;120:306-20.

[6]. Patel S, Kanagasingam S, Pitt Ford T. External cervical resorption: a review. JEndod. 2009;35:616-25

[7]. Vosoughhosseini S, Lofti M, Shahmordi K, Saghiri MA, Zand V, Mehdipour M, Ranjkesh B, Mokhtari H, Salemmilani A, Doosti S. Microleakage comparison of glass- ionomer and white mineral trioxide aggregate used as a coronal barrier in nonvital bleaching. Med Oral Patol oral Cir Buccal. 2011 Nov 1; 16 (7):e1017-21.

[8]. Hamid Reza Yavari1 DDS, MS, Mohammad Samiei1 DDS, MS, Shahriar Shahi1 DDS, MS, Mohammad Aghazadeh2 DMD, MS, Farnaz Jafari3 DDS, MS, Majid Abdolrahimi3 DDS, Saeed Asgary4 DDS, MS.Microleakage comparison of four dental materials as intra-orifice barriers in endodontically treated teeth Iranian Endodontic Journal 2012;7(1):25-30

[9]. Ingle J, Bakland: Endodontics, ed 5. Philadelphia, Lea and Febiger, 1976.

[10]. Cohen SC, Bums RC. Pathways of the Pulp. St. Louis, C.V. Mosby Co,1980

[11]. PrasannaneelaKantan, nithyaJagannathan.Non Vital Bleaching – A Non Invasive Post Endodontic Treatment Option: A Case Report. Journal of Clinical and Diagnostic Research. 2012 May (Suppl-1), Vol-6(3):527-529.

[12]. Pashley DH, Livingston MJ. Effect of molecular size on permeability coefficients in human dentine. Arch Oral Biol1978;23:391-95.

[13]. Wang JD, Hume WR. Diffusion of hydrogen ion and hydroxyl ion from various sources through dentine. IntEndod 1988;23:391-95.

[14]. Ashwija S, Raghu S, Farhat N. Comparison of the sealing ability of mineral trioxide aggregate and three conventional restorative materials when placed coronally over gutta-percha as sealing material - An invitro study. Original research

[15]. Nagaraja U, Kishore G. Glass ionomer cement- the different generations. Trends Biomater. Artif. Organs, Vol18(2), January 2005.

[16]. D. Saini a, G. Nadig b, R. Saini. A comparative analysis of microleakage of three root end filling materials – an in vitro study. Archives of Orofacial Sciences.2008;3(2):43-47.

[17]. Perinpanayagam H. Cellular response to mineral trioxide aggregate root-end filling materials. J Can Dent Assoc. 2009 Jun;75(5):369-72. Review.

*Dr. Nidha Amrin .M . "Comparision of Microleakage Between Conventional Glass-Ionomer, Light Cured Glass-Ionomer, Cermet And Mineral Trioxide Aggregate (White) Used As A Coronal Barrier in Nonvital Bleaching – An in Vitro Study." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 16.10 (2017): 56-62