IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 3 Ver. VI (Mar. 2016), PP 87-91
www.iosrjournals.org

"Comparison of Intracoronal Sealing Ability Of Mineral Trioxide Aggregate And Glass Ionomer Cement" An *In Vitro* Study

Dr. Sharmila Tapashetti[1], Dr. Mahantesh Yeli[2], Dr. Nageswar Rao[3]
1(Endodontics, S.D.M.Dental College,India)
2(Endodontics, S.D.M.Dental College,India)

Abstract: *The present study was conducted to compare the sealing ability of MTA and GIC.*
Method: *Endodontic treatment was performed on seventy extracted teeth. 4mm of gutta percha was removed from all the teeth. Teeth were divided into two groups of thirty teeth and two groups of five teeth. Group 1 were sealed with MTA, group 2 with GIC, group 3 (positive control)were not sealed and group 4 (negative control) were sealed with amalgam. All teeth were covered with sticky wax and placed in methylene blue for 48 hours and subjected to diaphanisation. The dye penetration was checked through the cleared samples with a stereomicroscope.*
Results: *The teeth from group 2 leaked more with a mean value of 11.21mm, group 1 had a mean value of 1.86mm. Statistical analysis with Mann Whitney U test and Students t test showed that there was a significant difference between group 1 and group 2 (p value < 0.01). Group 4 showed no leakage and Group 3 showed maximum leakage with the mean value of 19.36mm.*
Conclusion: *The above results clearly indicate that MTA is a better material to be used coronally to seal the canals than the GIC.*
Keywords: *Coronal leakage, MTA,GIC.*

I. Introduction

The success of root canal treatment is largely dependant upon proper sealing of the root canals. Thus, a three dimensional fluid tight seal needs to be created to prevent bacterial ingress into the canal. Initially more stress was given to creation and maintenance of an intact apical seal. However, it has been found that failures occurred even in cases with good apical seal. This has led to studies being conducted on coronal leakage as source of the failure.[2] Improper coronal seal allows the penetration of micro organisms and their byproducts from the oral cavity into the canals leading to the failure of the endodontic treatment.[3, 4, 5, 6] So for the ultimate success of a root canal treatment, along with an intact obturation, presence of a good coronal restoration is very essential. Various materials are being tried to achieve this coronal seal. In the present study, we have tried to compare the intracoronal sealing ability of Mineral trioxide aggregate and Glass ionomer cement.

II. Methodology

Seventy extracted anterior teeth were collected and stored in normal saline. Access cavity preparation and thorough biomechanical preparation was done on all teeth. The canals were then dried and obturated. The obturation was confirmed radiographically. The gutta percha level was reduced to a depth of 4 mm which was once again verified radiographically. Then the teeth were randomly divided into four groups –

Group 1 - consisting of thirty teeth. In this group, mineral trioxide aggregate was mixed with saline as per the manufacturer's instructions and placed into the pulp chamber, and then condensed with endodontic pluggers. The access cavity was then covered with a moist cotton pellet.

Group 2 - consisting of thirty teeth. In this group, glass ionomer cement was used as the coronal sealing material. The glass ionomer cement was mixed according to manufacturer's instructions and placed into the canal and then condensed with endodontic pluggers. The access cavity was then covered with a dry cotton pellet.

Group 3 - This was the positive control group consisting of five teeth. Here no material was placed over the gutta-percha. The obturation was left open.

Group 4 - This consisted of the negative control group consisting of five teeth. Here the entire access opening was restored with silver amalgam. The homogenity of the fillings were confirmed with the help of radiographs.

Then the teeth from groups 1, 2, and 3 were covered on all surfaces with sticky wax except the access openings which were left uncovered. However, in the group 4, the entire tooth including the access cavity was covered with sticky wax. All the teeth were then immersed in the dye for 48 hours. The sticky wax was then removed after the exposure of the teeth to the dye. The teeth were then decalcified in 5 % nitric acid with fresh solution used daily. After the decalcification, the teeth were washed in running water and then subjected to dehydration which was done gradually by first immersing the teeth in 80 % ethyl alcohol overnight, then in 90 % ethyl alcohol in 2 one hour washes and then finally in 100 % ethyl alcohol in 3 one hour washes. All the teeth were then cleared in methyl salicylate. The amount of coronal dye penetration was then measured under a stereomicroscope at a magnification of 10 X.

III. Results

It was found that the teeth from group 2 leaked more with a mean value of 11.21mm when compared to those from group 1 which had a mean value of 1.86mm. Statistical analysis was conducted using Mann Whitney U test and Students t test. Both the tests showed that there was a significant difference between group 1 and group 2 (p value < 0.01). The teeth from group 4 (negative control group) showed no leakage at all and the teeth from group 3 (positive control group) showed maximum leakage with the mean value of 19.36mm.

The Mean, Median, S.D., S.E., Minimum and Maximum values of different test groups are as depicted in Table - 1. The comparison between Group 1 and Group 2 by Students t Test is depicted in Table - 2. The comparison of Group 1 and Group 2 by Mann Whitney U Test is depicted in Table - 3.

TABLE - 1

Summary	Group 1	Group 2
Mean	1.86	11.21
Median	1.95	11.25
Standard Deviation	0.74	0.78
SE	0.13	0.14
Minimum	0.6	9.6
Maximum	3.4	12.4

TABLE – 2

Pair wise comparison of two groups by Students t-test

Group	n	Mean	SD	t-value	p-value	Significance
1	30	1.8667	0.7406	47.3627	0.0000	S
2	30	11.2133	0.7873			

TABLE - 3

Comparison of two groups by Mann Whitney U Test

Groups	Median	Rank Sum	U-value	Z - value	P-value	Significance
1	1.9500	465.0000	0.0000	-6.65299	0.0000	S
2	11.2500	1365.0000				

IV. Discussion

The failures seen in root canal treatments are usually caused when microorganisms and / or their products gain access into the canals. This can occur in cases with an improper seal leading to microleakage into the canals. Thus we need to take utmost care in creating best of the seals in all the three directions – apically, coronally and laterally. Apical seal has been in the limelight in the past and was thought to be the deciding factor of the success of a root canal treatment. In the olden days, apical leakage received the maximum attention for being the cause of an endodontic failure.[2] It has been gaining this attention due to the presence of complex anatomical variations in the apical third of the root canal. But in spite of good apical seal, sometimes we face the problems of failed endodontic treatment. This has led to more and more studies regarding the role of coronal seal in the success of a root canal treatment. It has been seen that presence of an improperly placed coronal seal or failure of the coronal restorations decide the prognosis and thus the end result of the case.[2, 5]

The various causes for coronal leakage are delay in placing the coronal restoration, dissolution of the restoration, inadequate thickness of the restoration, fracture of the tooth, and fracture of the restoration.[7] The coronal restoration may also be affected by various chemicals like the intracanal medicaments or bleaching agents used.[3]To prevent loss of this very crucial coronal seal, we need to place a good restoration after the endodontic treatment. This post endodontic restoration should have the ability to prevent recontamination of the root canal system from food debris, oral fluids and microorganisms in the oral cavity.[3]

The various materials which can be used to achieve a coronal seal are Cavit, Intermediate restorative material (IRM), Glass ionomer cements, Zinc oxide eugenol cement, Resin modified glass ionomer cements, Compomer, Composites and recently Mineral trioxide aggregate (MTA). Each of these materials have their own benefits and limitations.[3, 9]

In the present study, we have used two restorative materials Glass ionomer cement (GIC), and Mineral trioxide aggregate (MTA) to evaluate and compare their sealing ability against microleakage when used as a coronal sealing material. Microleakage is clinically undetectable passage of bacteria, bacterial products, fluid, molecules or ions from the oral environment along the various gaps present in the cavity restoration interface. These may be drawn into the gap between the restoration and tooth by capillary action. This effect is called microleakage. [29] Micro leakage can be studied by various methods like dye penetration, fluid filtration, microbial leakage, using radioactive isotopes, dye extraction method, microbial toxin infilteration, chemical tracers, neutron activation analysis, scanning electron microscopy, electrochemical studies, use of compressed air etc.[3, 30]

In the present study, the extent of microleakage was studied using dye penetration where in the samples were decalcified, dehydrated and then cleared to see the amount of dye penetration which was checked using a stereomicroscope. This process is called diaphanisation. Dye leakage is a time tested method to study the amount of microleakage. The various dyes that can be used for this purpose are eosin, methylene blue, India ink, procion brilliant blue etc. The dye penetrates through microspaces between the restoration and the cavity wall mainly by action of capillarity. The amount of dye penetration is affected by the particle size, pH, and chemical reactivity of the dye. [30] Methylene blue is the most common dye used in dye penetration studies because it is inexpensive, easy to manipulate, has a high degree of staining and has molecular weight lesser than most bacterial toxins. It has also been found that methylene blue has similar amount of leakage as butyric acid which is a microbial by product used for microleakage studies.[30] Diaphanisation is a process to study the amount of dye penetration which was given by Okumura in 1927. Here, the teeth are decalcified in an acid, dehydrated using an alcohol and then cleared with methyl salicylate thus making them completely transparent. These provide a three dimensional view of the internal anatomy making it easier to view the dye penetration. It has also been found that clearing technique was more precise than taking sections to check the amount of leakage.[30]

In the present study, the two materials being compared for the amount of dye leakage when used as coronal sealing materials were Glass ionomer cement (GIC) and Mineral trioxide aggregate (MTA). Glass ionomer cement also known as Alumino silicate poly acrylic acid was developed by Wilson and Kent in 1972 and is also sometimes referred as 'Man made dentin' and 'Dentin substitute'. In endodontics GIC has been used as a root canal sealer, as a retrograde filling material, for repair of perforations, and as a coronal sealing material. The unique features of glass ionomer cement are it's excellent biocompatibility, fluoride release, aesthetic appearance and the ability to adhere chemically to the tooth.[31]
However, it has been observed that the bond strength to enamel is more than that present with dentin. Marginal adaptation and sealing ability of GIC has been shown to improve with the use of conditioners. [31]

However it has certain disadvantages like sensitivity to contamination by water before the initial set of the cement which can lead to early dissolution of the cement.[31] It also tends to undergo some amount of shrinkage during the setting which can cause loss of the marginal integrity thus leading to microleakage.[9]

The other material used in the study was Mineral trioxide aggregate (MTA). MTA was developed by Dr. Mahmoud Torabinejad and his associates at Loma Linda University in California in 1993.[32] MTA has been proposed to be used in vital pulp therapy, repair of perforations, as a retrograde filling material, as a coronal sealing material after completion of endodontic treatment and for repair of fractured roots. The MTA powder consists of fine hydrophilic particles. The principal compounds present in this material are tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide. Bismuth oxide powder has also been added to provide radio opacity. MTA is available in two forms – white and gray. Both of these are almost same with very minor changes. The white MTA differs from the grey MTA by the exclusion of iron compounds. It also does not contain large particles as seen in gray MTA, which accounts for its improved clinical handling properties.

The hydrophilic particles tend to set in presence of moisture. Hydration of the powder results in a colloidal gel which solidifies to a hard structure in about 3 hours. MTA has a pH of 10.2 after mixing and rises to a pH of 12.5 after setting which is responsible for it's antimicrobial nature.[32, 33, 34] MTA undergoes dissolution on contact with tissue fluids releasing all of it's major cationic constituents. Of all the ions released, Ca^{++} is the most dominant. As it is sparingly soluble in biologic fluids, it leads to precipitation of hydroxyapatite. The reaction responsible for the precipitation is

$$10\ Ca^{2+} + Ca(PO_4)^{3-} + 2(OH)^{-} \longrightarrow Ca_{10}(PO_4)_6(OH)_2$$

Because of the porous nature of MTA, precipitation continues internally within it and leads to a change in overall composition of MTA adjacent to dentinal wall.[35]

So it has been proposed that MTA after placement, undergoes gradual dissolution, with the formation of hydroxyapatite crystals which further nucleate and grow to fill the microscopic spaces between MTA and dentin. Initially the seal is mechanical, but with time, due to diffusion of ions, a chemical bond develops.[35]

It has also been shown that MTA expands on setting and thus helps to achieve a good seal. This expansion is said to be the cause for the superior sealing ability of MTA.[33] The advantages of MTA are it's excellent biocompatibility, hydrophilic nature, radio opacity, ability to initiate cementogenesis, and antimicrobial nature.[34] However MTA has the disadvantages of long setting time, difficulty in manipulation and is an expensive material.

V. Conclusion

Within the scope of the study performed, we can reach to the conclusion that Mineral trioxide aggregate has a better sealing ability than glass ionomer cement when used as a coronal sealing material. However, further long term clinical studies are necessary to substantiate the results and to find an ideal coronal restorative material.

References

[1]. Louis I. Grossman, Seymour Oliet, Carlos E. Del Rio, Endodontic Practice, 11th edition, 266.
[2]. Stephen Cohen, Richard C. Burns, Pathways of the pulp, 8th edition, 313.
[3]. John I. Ingle, Leif K. Bakland, Endodontics, 5th edition, 572, 649 – 656.
[4]. Akbar Khayat, Seung Jong Lee, Mahmoud Torabinejad, Human saliva penetration of coronally unsealed root canals. J Endod 1993; 19: 458 – 461.
[5]. H. A. Ray, M. Trope, Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endod J 1995; 28: 12 – 18.
[6]. Marat Tselnik, Craig Baumgartner, J. Gordon Marshall, Bacterial leakage with mineral trioxide aggregate or a resin modified glass ionomer used as a coronal barrier. J Endod 2004; 30: 782 – 784.
[7]. Saunders W. P, Saunders E. M, Coronal leakage as a cause of failure in root canal therapy : a review. Endodontics & Dental Traumatology 2002; 10: 105-108
[8]. K. M. Barrieshi Nusair, H. M. Hammad, Intracoronal sealing comparison of mineral trioxide aggregate and glass ionomer. Quintessence Int 2005; 36:539 – 545.
[9]. Christopher J. R. Stock, Kishor Gulabivala, Richard T. Walker, Jane R. Goodman, Color atlas and text book of endodontics, 2nd edition, 149 – 150.
[10]. Carel L. Davidson, Ivar A. Mjor, Advances in glass ionomer cements, 193–196.
[11]. W. P. Saunders, E. M. Saunders, Assessment of leakage in the restored pulp chamber of endodontically treated multirooted teeth, Int Endod J 2000; 23: 28–33.
[12]. Kian Chong Lim, Microleakage of intermediate restorative materials, J Endod 1990; 16: 116 – 118.
[13]. A. M. Diaz Arnold, L. R. Wilcox, Restoration of endodontically treated anterior teeh : An evaluation of coronal microleakage of glass ionome and composite resin materials, J Prosthet Dent 1990; 64: 643 – 646.
[14]. Mahmoud Torabinejad, Borasmy Ung, James D. Kettering, In vitro bacterial penetration of coronally unsealed endodontically treated teeth, J Endod 1990; 16: 566 – 569.
[15]. Bruce M. Beckham, Ronald W. Anderson, Charles F. Morris, An evaluation of three materials as barriers to coronal microleakage in endodontically treated teeth. J Endod 1993;19: 388 – 391.
[16]. M. Torabinejad, T. M. Watson, T. R. Pitt Ford, Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J Endod 1993; 19 : 591 – 595
[17]. John E. Carman, James A. Wallace, An in vitro comparison of microleakage in the pulp chambers of human molar teeth, J Endod 1994; 20: 571 – 575.
[18]. Mahmoud Torabinejad, Akbar Falah Rastegar, James D. Kettering, Thomas R. Pitt Ford, Bacterial leakage of mineral trioxide aggregate as a root end filling material, J Endod 1995; 21: 109 – 112.
[19]. Thomas R. Pitt Ford, Douglas J. McKendry, Mahmoud Torabinejad, Stalin P. Kariyawasam, Use of mineral trioxide aggregate for repair of furcal perforations, Oral Surgery Oral Medicine Oral Pathology Endod 1995; 79: 756 – 762.
[20]. P. Chailertvanitkul, W. P. Saunders, E. M. Saunders, D. Mackenzie, An evaluation of microbial coronal leakage in the restored pulp chamber of root canal treated multirooted teeth. Int Endod J 1997; 30: 318 – 322.
[21]. T. T. Nakata, K. S. Bae, J. C. Baumgartner, Perforation repair comparing mineral trioxide aggregate and amalgam using an anaerobic bacterial leakage model. J Endod 1998; 24: 184 – 186.
[22]. Mahmoud Torabinejad, D. Snider, H. M. Tang, L. K. Bakland, Effect of root canal obturation and / or coronal seal on the success of root canal therapy.J Endod 1999; 25 : 294.
[23]. Claudia R. Barthel, Axel Srobach, Helga Briedigkeit, Ulf B. Gobel, Jean Francois Roulet, Leakage in roots coronally sealed with different temporary fillings. J Endod 1999; 25: 731 - 734.

[24]. Claudia R. Barthel, Stefan Zimmer, Ralf Wussogk, Jean Francois Roulet,Long term bacterial leakage along obturated roots restored with temporary and adhesive fillings, J Endod 2001; 27:559 – 562

[25]. M. Firas Daoudi, William P. Saunders, In vitro evaluation of furcal perforation repair using mineral trioxide aggregate or resin modified glassionomer cement with and without the use of the orgianry microscope, J Endod 2002; 28: 512 –515.
A. A. Zaia, R. Nakagawa, I. De Quadros, B. P. F. A. Gomes, C. C. R. Ferraz, B. Teixeira, F. J. Souza Filho, An in vitro evaluation of four materials as barriers to coronal microleakage in root filled teeth. Int Endod J 2002; 35: 729 – 734.

[26]. Stephen Jenkins, James Kulild, Karen Williams, William Lyons, Charles Lee, Sealing ability of three materials in the orifice of root canal systems of obturated with gutta percha. J Endod 2006; 32: 225 – 227.

[27]. J Esra Uzer Celik, Ayse Gozde Duransoy Yapar, Mustafa Ates and Bilge Hakan Sen, Bacterial microleakage of barrier materials in obturated root canals.Endod 2006; 32: 1074 – 1076.

[28]. John M. Powers, Ronald L. Sakaguchi, Craig's Restorative dental materials 12th edition, 115.

[29]. Denusa Moreira Verissimo, Monica Samaio do Vale, Methodologies for assessment of apical and coronal leakage of endodontic filling materials : a critical review. Journal of Oral Science 2006; 48: 93 – 98.

[30]. Kenneth J. Anusavice Philips' Science of dental materials 11th edition 471 – 479.

[31]. Mahmoud Torabinejad, Noah Chivian, Clinical applications of mineral trioxide aggregate. J Endod 1999; 25: 197 – 205

[32]. Intekah Islam, Hui Kheng Chng, Adrian U. Jin Yap, Comparison of the physical and mechanical properties of MTA and Portland cement. J Endod 2006;32: 193 – 197.

[33]. Richad S. Schwartz, Michael Mauger, David J. Clement, William A. Walker Mineral trioxide aggregate : A new material for endodontics. JADA 1999; 130: 967 – 975.

[34]. N. K. Sarkar, R. Caicedo, P. Ritwik, R. Moiseyeva, I. Kawashima Physicochemical basis of the biologic properties of mineral trioxide aggregate. J Endod 2005; 31: 97 – 100.