ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 3(G), pp. 25092-25096, March, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

A COMPARATIVE CLINICAL EVALUATION OF SEALING ABILITY, MARGINAL ADAPTATION AND COST EFFECTIVENESS OF THREE DIFFERENT WHITE MTA MATERIALS USED IN FURCATION PERFORATION REPAIR- AN INVITRO STUDY

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DOI: http://dx.doi.org/10.24327/ijrsr.2018.0903.1790

ARTICLE INFO

Article History:
Received 15th December, 2017
Received in revised form 25th January, 2018
Accepted 23rd February, 2018
Published online 28th March, 2018

Key Words:
MTA, Perforation, Microleakage

ABSTRACT

Introduction: This study evaluated the sealing ability, marginal adaptation and cost effectiveness of MTA of three different manufacturer's (MTA Angelus, Medicept MTA, Xenon Bullet MTA) to repair iatrogenic furcation perforations.

Material and method: sixty four molars were treated endodontically, perforated in the middle of the pulpal floor and divided randomly into3groups of 20 each, while 4 teeth were used as positive and negative controls. The teeth were embedded in moistened flower sponge, the perforations were filled with respective MTA materials. The teeth remained in the soaked sponge for 28 days and submerged in basic fuchsin solution 1% for 48 hours. Dye penetration was evaluated after longitudinal sectioning of teeth.

Result: MTA angelus performed better than other groups. ANOVA Test showed highly significant difference in mean leakage score (F score=10.9,$p<0.0001$). Tukey post hoc test showed significant difference between group I and III and highly significant difference between group I and II and group I and III.

Conclusion: Angelus proved to be the best but the other products like Xenon Bullet MTA has also found to produce equivalent results

INTRODUCTION

The endodontic treatment procedure sometimes may lead to inevitable complications such as perforations, which may happen as a result of misguided bur direction during the access preparation or while post space preparation during post and core restorations (Lee SJ *et al*., 1993). The chances for increasing the perforation areas increases considerably as an effort is made to search for an root canal orifice (Nikoloudaki GE *et al*., 2014). According to the American Association of Endodontists (AAE) glossary of endodontic terms, perforation is defined as the mechanical or pathologic communication between the root canal system and the external tooth surface (AAE's glossary of endodontic terms 2003). Sanai in his study concluded that the perforations which are positioned in the middle and apical third of the root are not as complicated and critical compared to those which are occurring in the coronal third of the canal including the furcalperforations(Sanai IH, 1977).

Inadequately treated perforation have a negative impact on the prognosis and survival of the tooth and the long term prognosis of the tooth depends upon several factors such as location in relation to the gingival sulcus, the time for which the perforation is open for the contaminants, size of the perforation, periodontal health and how effective the sealing ability of the material is in repairing the perforation (Sluyk SR *et al*.,1998, Sanai IH, 1977, Jew RC *et al*.,1982). Furcal perforations can be treated either surgically or conservatively. The favourable outcome seems to be related with the non surgical intermediate repair with a restorative material to prevent the pulp chamber communication with the gingival sulcus which aids in limiting the contamination and inflammation in this area (Lemon R, 1992).

Perforation repair can be done with different materials such as GIC, Calcium hydroxide, super EBA cement, composite bonded restorations, amalgam, tricalcium phosphate, decalcified freeze dried bone and MTA (Alhadainy HA, 1994,

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Balla R *et al*.,1991, Hartwell GR *et al*.,1993, Weldon JK *et al*., 2002, Alhadainy HA *et al*., 1993, Sinai IH *et al*., 1989, Ford TR *et al*.,1995, Daoudi MF *et al*.,2002) Amongst all these materials MTA has been recommended by most clinicians for perforation repair as it has good sealing ability (Tsatsas DV *et al*., 2005), marginal adaptation(Torabinejad M *et al*.,1995 a), and biocompatibility (Ford TR *et al*.,1995,Yildirim T *et al*., 2005, Sluyk SR *et al*.,1998, Torabinejad M *et al*., 2010 c), but this material has certain drawbacks such as extended initial setting time (Torabinejad M *et al*., 1995 b), difficulty in handling and high cost (Nikoloudaki GE *et al*.,2014).

MTA is marketed in two forms gray and white MTA. It is instructed not to use the gray MTA material in the confines of the canal and the pulp chamber area above the level of crestal bone as this material may lead to discolouration, whereas white MTA has eliminated this disadvantage and can be used in esthetically important areas (Ferris DM *et al*.,2004).

Different manufacturers claim that their MTA is the ideal material for repair of perforation, but the studies testing this are not ample. Hence the aim of this study is to evaluate the saealing ability, marginal adaptation and cost effectiveness of three different white MTA materials.

MATERIALS AND METHOD

Collection of samples

Sixty four recently extracted multirooted, permanent human molars with no caries, and fully developed non fused roots were selected for the study, selection was based on the degree of root separation so that the furcation area should be visible enough. Immediately after extraction the teeth were cleaned of any debris and were disinfected with 3% sodium hypochlorite, and then were stored in normal saline till use.

Preparation of samples

The access cavities were prepared in the teeth with a no 4 round carbide bur (Sybron endo) using airotarhand piece (NSK, Japan), the root canal system were then cleaned and shaped with step back technique using K files (Mani, Japan), sodium hypochlorite 3% was used as irrigant, after cleaning and shaping the canals were dried with paper points, AH Plus sealer (Densply-De Trey, Konstanz, Germany) was applied in the canals and the obturation was done with lateral compaction method. The outer surface of the roots were then covered with two layers of nail varnish to prevent dye penetration, from the open dentinal tubules, minor dentinal defects and lateral canals with great care to the furcation area. The pulp chamber floor was then perforated with the same round bur used for access opening in the middle, the width of the perforation was corresponded to the width of the bur and the depth of penetration was dependent on the dentine cementum thickness from the pulp chamber floor to the furcation area the samples were then dried. Sixty teeth were then randomly divided into 3 groups of 20 each (G1- G2-G3) the remaining 4 teeth were served as the control groups, 2 teeth that were perforated but not repaired served as positive control and two non- perforated teeth serves as negative control, to reconstruct the clinical conditions all teeth were embedded in distilled water soaked flower sponge till CEJ.

Repair of samples

Following materials were used for perforation repair
Gropup 1-MTA-Angelus (Angelus, Curitiba, Parana, Brazil)
Group 2- MTA (Medicept)
Group 3- Bullet MTA (Xenon, smyan Biomed India)

For all the groups the MTA was mixed according to manufacturer's instruction, the material then placed in the perforation with MAP System (Master Apical Placement, ProduitsDentaires, Switzerland) and compacted with Schilderpluggers (Hu Friedy, Chicago, IL, USA). A moist cotton pellet was then placed on the MTA for 72 hours and the cavities were restored with zinc oxide eugenol cement, after 72 hours the cotton pellet was removed and cavities were restored with IRM.

After this the crowns of the teeth were covered with two layers of nail varnish and the teeth left in the sponge for 28 days, the samples were then recovered, cleaned with the remnants of the moistened sponge and then immersed in 1 % basic fuchsin solution for 48 hours, rinsed with water and the teeth were then longitudinally sectioned with a diamond coated disk and inspected under stereoscope (Wuzhou New Found Instrument Co. Ltd, China Model: XTL 3400E, Magnification: 10 X) for the dye penetration and adaptability. The measurement of dye penetration was done (Chroma Systems Pvt. Ltd., India Model: MVIG 2005) from the furcation to the floor of the pulp chamber. The scoring was done according the following criteria

Score 0: No leakage could be detected.
Score 1: Leakage extending to1/4 of the repair material.
Score 2: Leakage extending to1/2 of the repair material.
Score 3: Leakage extending to3/4 of the repair material.
Score 4: Total leakage extending beyond 3/4 of the repair material

The data was subjected to statistical analysis.

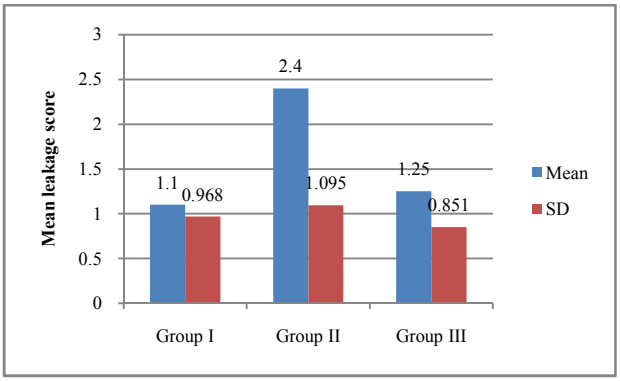
RESULTS

The results of our study showed that all three groups exhibited microleakage. Positive control group showed massive dye penetration whereas the negative control group showed no dye penetration. The mean scores of the groups (Table 1, Chart 1)

Table 1

MICRO leakage score	Group I	Group II	Group III
Mean±SD	1.1±0.968	2.4±1.095	1.25±0.851

One way ANOVA test is applied to test the significant difference in mean leakage score
ANOVA Test showed highly significant difference in mean leakage score
(F score=10.9,p<0.0001)
Now we will apply Tukey post hoc test to test the significance of difference in mean leakage score between two group comparison



showed that the Angelus exhibited least microleakage followed by Xenon bullet MTA and Medicept MTA. One way Anova has been applied to test the significant difference in the mean leakage scores which showed highly significant difference in mean leakage score (F score=10.9,p<0.0001). Now the Tukey post hoc test was applied (table 2) to test the significance of difference in mean leakage score between two group comparison, which showed highly significant difference between grp 1 and grp 2, and between grp 2 and grp 3 whereas there is only significant difference between grp 1 and 3. the adaptability of the three groups were found to be satisfactorily similar fig 1,2,&3.

Table 2

Mean leakage score	P value
Grp I vsGrp II	P<0.01 HS
Grp I vsGrp III	P<0.05 S
Grp II vsGrp III	P<0.01 HS

S= Significant difference HS= Highly significant difference

Figures Showing Adaptability and Dye Penetration

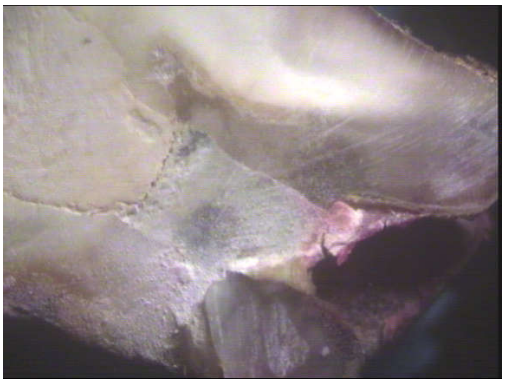


Fig 1 MTA Angelus

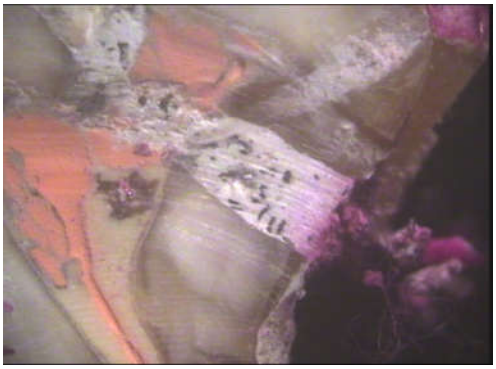


Fig 2 Medicept MTA

Fig 3 Xenon Bullet MTA

DISCUSSION

The results of our study showed that the MTA Angelus had given better sealing and marginal adaptability as compared to Xenon bullet MTA and Medicept MTA. A perforation of the furcation usually leads to failure. Seltzer very well discussed how important the sealing of perforations is, in his studies (Seltzer S *et al*.,1970).

In literature many materials have been proposed to seal the perforations (Alhadainy HA, 1994, Balla R *et al*.,1991, Hartwell GR *et al*.,1993, Weldon JK *et al*., 2002, Alhadainy HA *et al*., 1993, Sinai IH *et al*., 1989, Ford TR *et al*.,1995, Daoudi MF *et al*.,2002) and amongst them MTA has shown to have excellent sealing ability and marginal adaptation (Tsatsas DV *et al*., 2005).Allhadainy in his review discussed the ideal properties of the material to be used as perforation repair, as per this review the material used for perforation repair should be non toxic, biocompatible, should exhibit excellent sealing , non resorbable, radiopaque and bacteriostatic (Alhadainy HA, 1994) , and importantly it should be esthetically pleasing (Ferris DM *et al*.,2004).

The present study selected the microleakage evaluation by dye penetration method along two surfaces, namely the surface of the perforation cavity and the restorative material, because of the antibacterial effect of the MTA due to its high alkaline pH the bacterial leakage models were not used, also the reliability of the fluid transport models couldn't be trusted in perforation models. Methylene blue, basic fuchsin, rhodamine B, silvernitrate, India ink, pelican ink are some of the dyes which have been mentioned in the past literature for evaluating the sealing ability of a restorative material. It has been found that MTA discoloured methylene blue(Wu MK *et al*., 1998)but same effect has not been seen with basic fuchsin(Nikoloudaki GE *et al*.,2014) hence 1 % basic fuschsin has been used in this study.

MTA is a mixture of refined Portland cement and bismuth oxide, and contain traces of Silicon Dioxide (SiO2), Calcium Oxide (CaO), Magnesium Oxide (MgO), Potassium Sulfate (K2SO4) and Sodium Sulfate (Na2SO4) and has two important clinical features (i) setting in presence of moisture and (ii) vast antimicrobial action (Fridland M *et al*., 2003, Sarkar NK *et al*.,2005, Camilleri J*et al*., 2006, Al-Hezaimi K *et al*., 2006). The strength of the material is because of the hydration reaction of di and tri calcium silicate , moreover the compressive strength of MTA increases till 21 days in presence of moisture (Dammaschke T *et al*., 2005), hence all the samples were kept in moistened sponge for 28 days to provide continuous hydration and to simulate clinical conditions.

In our study all the three groups exhibited microleakage but the microleakage with respect to Medicept was found to be highest followed by Xenon Bullet MTA and MTA Angelus. The literature comparing gray and white MTA is ample but as per our knowledge there is no literature available till date which will throw light on the comparision of white MTA material.

As the composition of the different white MTA material is almost similar this diference in the microleakage can be justified by the variations in the particle size, water powder ratio during manipulation of the material as this may lead to porosity in the material which shows an increasing trend along

with increase in water during mixing(Fridland M *et al*., 2003). Factors such as the quantity of water used during mixing, mixing procedure, compaction pressure, humidity in the environment and the temperature (Torabinejad M *et al*., 1995 b), are some difficult factors to control in laboratory studies also the thickness of the MTA used for perforation repair was dependent on the depth of the perforation cavity which was not similar for the samples this difference in our study could also accounts for greater incidence of leakage between the groups.

CONCLUSION

Though all the three materials in our study exhibited microleakage, but under the limitations of this invitro study Angelus proved to be the best, the other products like Xenon Bullet MTA also found to have produced equivalent results and its performance can't be neglected hence it can be used as an alternative as far as the efficacy and cost effectiveness is concerned.

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How to cite this article:

Pankaj Kumar Gupta *et al*.2018, A Comparative Clinical Evaluation of Sealing Ability, Marginal Adaptation And Cost Effectiveness of Three Different White Mta Materials Used In Furcation Perforation Repair- An Invitro Study. *Int J Recent Sci Res.* 9(3), pp. 25092-25096. DOI: http://dx.doi.org/10.24327/ijrsr.2018.0903.1790

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