ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 7, Issue – 4, July– 2024, Page No. : 220 - 227

An in vitro analysis of sealing ability of Zirconomer, Resin-Modified Glass Ionomer Cement and Mineral Trioxide Aggregate in furcal perforation repair using Ultraviolet spectrophotometer.

[1]Dr.Kunhappan Sanjeev, MDS, Professor, Department of Conservative Dentistry and Endodontics, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

[2]Dr.Sial Shruti, MDS, Reader, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

[3]Dr.Shandilya Ashutosh, MDS, Lecturer, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

[4]Dr.Agarwal Arushi, Post Graduate student, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

[5]Dr.Roy Ankita, Post Graduate student, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

[6]Dr. Goyal Manisha, Post Graduate student, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

Corresponding Author: Dr.Kunhappan Sanjeev, MDS, Professor, Department of Conservative Dentistry and Endodontics, Govt. Dental College, Raipur, Chhattisgarh, Pin: 492001

Citation of this Article: Dr. Kunhappan Sanjeev, Dr. Sial Shruti, Dr. Shandilya Ashutosh, Dr. Agarwal Arushi, Dr.Roy Ankita, Dr. Goyal Manisha,"An in vitro analysis of sealing ability of Zirconomer, Resin-Modified Glass Ionomer Cement and Mineral Trioxide Aggregate in furcal perforation repair using Ultraviolet spectrophotometer", IJDSIR- July– 2024, Volume –7, Issue - 4, P. No. 220 – 227.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Prognosis of tooth after perforation at the furcal area largely depends on repair material to close communication created between pulp chamber and surrounding tissues. The present study evaluated and compared sealing ability of Mineral Trioxide Aggregate (MTA), Resin-Modified Glass Ionomer Cement (RMGIC) and Zirconomer in furcal perforation using dye extraction method.

Methodolgy: 33 mandibular molars were selected. Furcal perforations were made. They were then divided into three groups (n=11) based on repair material - Group 1: MTA, Group II: RMGIC and Group III: Zirconomer. The test materials were manipulated and carried to furcal perforation site. Specimens were placed in petri dishes containing basic fuchsin dye for 24 hours for dye absorbance. Each tooth was dissolved using 2 ml of concentrated 65% nitric acid. Solutions obtained were transferred into Eppendorf tubes and centrifuged at 3500 rpm for 5 minutes. Supernatant layer was collected; transferred into cuvettes and analysed under UV spectrophotometer. Readings were recorded as Absorbance unit (AU). One-way ANOVA and Tukey's-Post hoc tests were applied.

Results: MTA has shown least absorbance of dye while Zirconomer showed highest absorbance. The difference was statistically significant amongst all groups.

Conclusion: MTA can be used successfully for perforation repair at the furcation area.

Keywords: Mineral Trioxide Aggregate, Resin-Modified Glass Ionomer Cement, Zirconomer, furcal perforation, perforation repair, sealing ability, absorbance units.

Introduction

In an effort to prepare a proper access cavity, furcation area needs to be visible. The complexity of furcation, varied depth, anatomy and position makes it an ideal candidate for accidental mishaps like perforation. Furcation area is sensitive in the way that any insult will lead to leaking of toxins affecting surrounding periodontal tissues and at the same time jeopardizing the endodontic procedure. To avoid this, cutting off of this communication becomes indispensable so as to prevent the dreaded outcome of extraction of affected tooth. There are various sealers which can serve the purpose of furcation repair, however, to have one which will be ideal is still debatable.[1] Amongst various materials used, the property of biocompatibility to avoid any subsequent irritation along with ability to provide a seal which have no leakage are most sought after.[2,3]

Zirconomer is developed to eliminate the harmful effects of mercury and to retain the advantages of silver amalgam. Primarily consisting of zirconium oxide, glass powder tartaric acid and polyacrylic acid, this “white amalgam” is known to have antibacterial properties with ample strength and binding.[4] The microleakage can be a problem as the literature is inconsistent [5] but it can serve as a control to evaluate the microleakage of other materials in question.

Of the numerous options available for furcation repair some stands out in the long run more than others. Resin modified Glass Ionomer Cement (RMGIC) is developed to combine advantages of GIC with that of resin molecules. It shows better properties and is considered better for perforation repairs.[6] It exhibits antibacterial activity and is compatible to surrounding dental tissues. The bonding to dentinal tissues is satisfactory and shows good sealing. It is postulated to have less microleakage and thus can be used for accidental furcation perforation sealing.[7] The curing shrinkage can pose a problem if furcation sealing is done with this material due to close proximity of vascular periodontal tissues; however, there is lack of sufficient data on this aspect.

Mineral trioxide aggregate (MTA), after its development have shown success as root end filling material.[8] The material has become favourable as it is not only inert and biocompatible but also enhanced effectiveness in presence of moisture. It is unaffected by blood and does not irritate surrounding tissues.[9] The studies have postulated that it is similar to cementum and can grow on it.[10] It has been used as a perforation repair material because of its sealing ability however it comes with its own set of disadvantages which include expanded setting time, handling properties and being expensive.[11]

In order to have a successful endodontic prognosis after accidental furcation perforation, the clinician have to make certain that the periodontal tissue and the sterile pulp chamber as well as canals are in complete isolation with each other. [12] The material used should not allow any exchange between pulp and periodontium. In search for this, the present study was undertaken to evaluate the effectiveness of sealing produced by Zirconomer, RMGIC and MTA and at the furcal perforation using a dye extraction method.

Materials and Method

The sample size was calculated using G power software version 3.1.9.7 (Heinrich-Heine-Universitat Dusseldorf, Germany). A prior analysis was done for two tails with effect size of 1.64 keeping confidence interval and power at 95%. The sample size obtained for 3 groups was 33, which were divided equally as 11 samples in each group (Figure 1a).

Figure 1 a: Collected Samples

The samples chosen were permanent first and second molar of maxillary and mandibular arch. The teeth used were procured from department of Oral and Maxillofacial Surgery and analysis was done at department of Conservative Dentistry and Endodontics. The teeth chosen were those 1) extracted due to periodontal diseases 2) Class I and II carious lesion not extending to the furcal area within tooth and 3) with intact furcation region. The teeth which showed 1) extensive carious lesions 2) any congenital abnormality such as fusion, gemination, dilaceration 3) teeth with open apex and 4) teeth with any cemental abnormality were excluded.

The teeth were scaled using ultrasonic scalers and cleaned of any debris present using hand instruments. They were disinfected using 3% sodium hypochlorite solution for 30 minutes and thoroughly rinsed using distilled water. The samples were stored in 0.5% thymol at room temperature. Decoronation of teeth was done using diamond disc. Access cavity was prepared using round bur no. 2. Complete cleaning of pulp chamber and canals were done using spoon excavator and barbed broaches. The root cones were removed from 3 mm apical to furcation area preserving root trunk using diamond disc. A perforation at center of furcal area was then prepared using round bur no. 2 by gradually thinning the dentin (Figure 1b).

Figure 1 b: Perforation done

A periodontal probe was then passed through furcation area to achieve standardized perforation in all specimens.

They were divided into three groups.

Group I – furcation repair was done using Zirconomer (SHOFU) (Figure 1c)

Figure 1 c: Zirconomer

Group II – furcation repair was done using Resin Modified GIC (HY-BOND RESIGLASS, SHOFU) (Figure 1d)

Figure 1 d: RMGIC

Group III – furcation repair was done using MTA (Bio Structure MTA, Safe Endo) (Figure 1e)

Figure 1 e:MTA

The manipulation of the material was done as per manufacturer's instructions. The teeth were fully dried in order to avoid any contamination, respective sealing material was placed using a plastic instrument and condensed with hand pluggers (Figure 1f).

Figure 1 f:Perforation repair done

The specimens were then left for setting of material. Once the material was completely set, a double coat of nail varnish was applied on all specimens. The area of furcal repair was devoid of any varnish to allow leaching of the test dye. The samples were then stored at body temperature (98.3-degree F) for next 48 hours while maintaining humidity to simulate oral condition. Then specimens were kept immersed in basic fuchsin dye for another 48 hours to allow for dye penetration. After that, they were washed under running tap water twice with a break of 5 minutes in between to remove off excess dye. The nail varnish was removed with scalpel and teeth were immersed in 5ml test tube containing 2 ml concentrated 65% nitric acid to dissolve the tooth (Figure 1g).

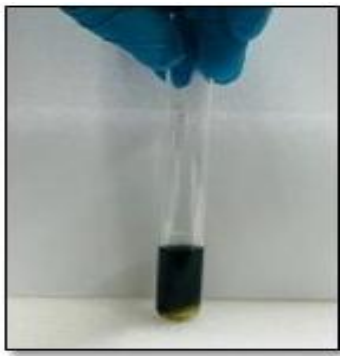

Figure 1 g:Tooth sample dissolved in nitric acid

They were kept until there was no traces of hard tissue remaining, solution obtained were then centrifuged (REMI R-8C) at 3500 rpm for 5 minutes (Figure 1h).

Figure 1 h: Centrifuge Machine

The resultant supernatant fluid obtained was then transferred into Eppendorf tubes and analyzed for absorption of dye Figure 1i).

1 i: Supernatant obtained after centrifugation

An Ultraviolet (UV) Spectrophotometer (LABINDIA) set at 550 nm wavelength using 65% concentrated nitric acid as blank recorded the Absorbance Units (AU) of each sample which suggested sealing ability of test materials (Figure 1j).

Figure 1 j: Spectrophotometer

The data obtained were compiled and subjected to statistical analysis using SPSS version 15.0 (Statistical package for social sciences, IBM, Chicago, IL, USA). One-way Anova was applied for descriptive statistics keeping the probability for significance at 0.05. Post hoc tukey was applied to assess individual inferential statistics comparing each group. The data were normally distributed as per Levene's test for homogeneity.

Result

The values of Absorbance unit were expressed in terms of mean and standard deviation. One way ANOVA had shown that Group III (MTA) had shown minimum values suggesting that there was minimum leakage from furcation repair. Group II - RMGIC has shown more AU than MTA but lesser than Group I - Zirconomer which has shown maximum dye leakage (Table 1) and (Graph 1). There was statistically significant difference amongst the three groups. Tukey HSD has shown there a difference of 0.026 between Group I and Group II, while a difference of 0.079 between Group I and Group III. Group II and Group III also showed a mean difference of 0.052 (Table 2).

Discussion

Mishaps are common human errors and a good clinician should be able to correct it. In case of furcation perforation, a prompt response is required as it will exclude the possibility of tooth loss. The communication developed as a result of perforation in the furcal area will cause direct exchange of fluids from periodontal tissues to inside of hard tissues which is harmful. It will eventually result in bone loss in the surrounding as well pain due to leaching in the root canals. This is self-explanatory so as to why a perforation repair material which completely seals the opening is necessary. Thus, the present study was done to assess the sealing ability of Zirconomer, RMGIC and MTA. The size of perforation was kept at 2 mm which allows sufficient dye to penetrate.[13]

Zirconia induced GIC has an advantage of increased compressive and flexural strength. They are composed of fluoroaluminosilicate glass and zirconium oxide which can chemically bind the tooth structure thus marginal adaptation is optimum. It releases fluoride making it considerable for furcation repair. Thus, in the present study we chose zirconomer as it is readily available and cost effective too.[10] Albesti et al in their study have shown that zirconomer was effective to prevent microleakage as they form a chelating reaction between calcium of hydroxy apatite in tooth and carboxylic group of polyacrylic acid of the liquid.[11] The present study, however have presented that zirconomer exhibited maximum dye penetration with a mean AU of

0.287. As the material is slightly viscous which prevented the material to flow and might have inadequately filled or sealed the perforation. Also, presence of moisture in the furcation might have adversely affected the sealing ability of the material.[4]

RMGIC include a resin component which is 2-hydroxyethyl methacrylate (HEMA), this allows for resistance to moisture contamination, increased fluoride relase and better strength compared to GIC.[14] This forms the basis to which it can be suitable in clinical condition such as perforation repair. However, the result has shown there has been some dye leakage (0.26) from the material. Mohan et al have also shown similar results when RMGIC had greater microleakage in their study as compared ProRoot MTA and biodentin.[11] This can be attributed to the contraction shrinkage which may happen during polymerization reaction. This will result in voids in between the dentin and material.[15] This shrinkage can be avoided, if proper protocol is maintained, RMGIC could be a good choice. Keshrani et al had suggested that use of internal matrix along with RMGIC can provide better seal for furcation repair.[16]

Mineral Trioxide Aggregate is calcium-based silicate material composed mainly of tricalcium aluminate and tricalcium silicate. The hydrophilic nature with a property of expansion while setting makes it ideal to work in an environment where contamination with water or blood is expected.[17] The expansion caused will help to achieve better seal after perforation repair. This is the probable explanation to why there was least amount of dye penetration (0.208 AU) in our study. In a study done by Sarkar et al, they suggested that MTA cause deposition of hydroxyapatite crystals which fills the microgaps between calcium silicate molecules and dentinal walls.[18] Also, they are osteoinductive in nature making it a first choice for sealing material.[2] The findings of the study were in concordance with Keshrani et al[16] and Zarzour et al.[19] Srikumar et al in their study had contrasting results where MTA was not as effective as biodentine and white mineral trioxide aggregate.[20]

In the present study dye extraction method was used with fuchsin dye. This technique has been recommended by many for studying microleakage as it measures the effective amount of dye used up by the specimen.[21] However, there were certain limitations to this. The study was done in a simulated environment trying to replicate the oral conditions as much as possible but it can't be exactly same. The specimens were lost in quantification and use of negative control was not done.

Conclusion

The present study was of in-vitro experimental in nature to quantify the sealing ability of three materials Zirconomer, RMGIC and MTA in furcation perforation. The sealing was achieved by all three materials but MTA showed minimum presence of dye in the dye extraction method using fuchsin dye. Best sealing ability was observed with MTA followed by RMGIC and Zirconomer was least effective. Long term and in vivo studies should be done to strengthen the findings of this study.

References

1. Jeevani E, Jayaprakash T, Bolla N, Vemuri S, Sunil CR, Kalluru RS. Evaluation of sealing ability of MM-MTA, Endosequence, and biodentine as furcation repair materials: UV spectrophotometric analysis. J Conserv Dent 2014;17:340–3.
2. Aggarwal V, Singla M, Miglani S, Kohli S. Comparative evaluation of push-out bond strength of ProRoot MTA, Biodentine, and MTA Plus in furcation perforation repair. J Conserv Dent 2013;16:462–5.

3. Solanki NP, Venkappa KK, Shah NC. Biocompatibility and sealing ability of mineral trioxide aggregate and biodentine as root-end filling material: A systematic review. J Conserv Dent 2018;21:10-5.
4. Lagisetti AK, Hegde P, Hegde MN. Evaluation of bioceramics and zirconia-reinforced glass ionomer cement in repair of furcation perforations: an in vitro study. J Conserv Dent 2018;21:184-9.
5. Albeshti R, Shahid S. Evaluation of microleakage in zirconomer: a zirconia reinforced glass ionomer cement. ActaStomatol Croat 2018;52:97-104.
6. Sidku SK, Watson TF. Resin modified glass-ionomer materials. a status report of American Journal of Dentistry. Am J Dent 1995;8:59-67.
7. Alhadainy HA, Abdalla AI. Artificial floor technique used for the repair of furcation perforations: a microleakage study. J Endod 1998;24:33–5.
8. Tawil PZ, Trope M, Curran AE, Caplan DJ, Kirakozova A, Duggan DJ et al. Periapical microsurgery: an in vivo evaluation of endodontic root-end filling materials. J. Endod 2009;35:357–62.
9. Torabinejad M, Hong CU, Pitt Ford TR, Kaiyawasam SP. Tissue reaction to implanted Super-EBA and mineral trioxide aggregate in the mandible of guinea pigs: a preliminary report. J Endod 1995;21:569–71.
10. Holland R, Filho JA, de Souza V, Nery MJ, Bernabe PF, Junior ED. Mineral trioxide aggregate repair of lateral root perforations. J Endod 2001;27:281–4.
11. Mohan D, Singh AK, Kuriakose F, Malik R, Joy J, John D. Evaluation of Sealing Potential of Different Repair Materials in Furcation Perforations Using Dye Penetration: An In Vitro Study. J Contemp Dent Pract 2021;22:80–83.
12. Reddy S, Shenoy R, Mandadi LR, Saluja I, Thomas MS. Effect of blood contamination and various hemostatic procedures on the push-out bond strength of Biodentine when used for furcation perforation repair. J Conserv Dent 2021;24:260-4.
13. Hashem AA, Hassanien EE. ProRoot MTA, MTA-Angelus, and IRM used to repair large furcation perforations: sealability study. J Endod 2008;34:59-61.
14. Cho E, Kopel H, White SN. Moisture sensitivity of resin modified glass-ionomer materials. Quintessence Int 1995;26:351-8.
15. Watts DC, Kisumbi B, Toworfe GK. Dimensional changes of resin ionomer restoratives in aqueous and neutral media. Dent Mater 2000;16:89–96.
16. Keshrani P, Shah N, Patel N, Oak A, Bagda K, Patel P. Sealing ability of two different furcal perforation repair materials with and without internal matrix: an in vitro study. World J Dent 2019;10:359–63.
17. Singh FJ, Ahuja L, Kakkar G, Kakkar A, Garg A, Mahajan A. An in vitro Comparative evaluation of the sealing ability of five different root end filling materials under confocal laser microscopy. Contemp Clin Dent 2020;11:51-4.
18. Sarkar NK, Caicedo R, Ritwik P, Moiseyeva R, Kawashima I. Physicochemical basis of the biologic properties of mineral trioxide aggregate. J. Endod 2005;31:97–100
19. Zarzour DS, Habib AA, Doumani M, Layous K, Aldajani EH, Alhasan DS et al. Comparative evaluation of sealing ability of three materials used in furcal perforation repair (in vitro). World J Dent 2021;12:178–82.
20. Srikumar GPV, Jaipuriar N, Gurnani A, Nishad G, Rahane S, Ghosh M. Evaluation of the sealing ability of mineral trioxide aggregate repair HP,

biodentine and white mineral trioxide aggregate as furcation repair materials: An in-vitro ultraviolet spectrophotometric analysis. Int J Health Sci 2022;6:11194–1207.

21. Hamad HA, Tordik PA, McClanahan SB. Furcation perforation repair comparing gray and white MTA: A dye extraction study. J Endod 2006;32:337-40.

Legend Tables& Graph

Table 1: Table showing descriptive statistics (One-way Anova) of Absorbance value of all the three groups

Absorbance Value (Au)	Mean	Std. Deviation	95% Confidence Interval for Mean		Sig.
			Lower Bound	Upper Bound	
Group I (Zirconomer)	0.2874	0.00594	0.2834	0.2914	0.001*
Group II (RMGIC)	0.2608	0.00662	0.2564	0.2653	
Group III (MTA)	0.2084	0.00535	0.2048	0.2120	

Table 2: Table showing Post hoc tukey comparing the mean Absorbance value of all the three groups.

Multiple Comparisons (Tukey HSD)						
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group I	Group II	0.02655*	0.00255	0.001*	0.0202	0.0328
	Group III	0.07900*	0.00255	0.001*	0.0727	0.0853
Group II	Group III	0.05245*	0.00255	0.001*	0.0462	0.0588

Graph 1: Graph showing means Absorbance value obtained from three materials