Original Article

Ophthalmology

In Vitro Comparison of the Apical Microleakage of Mineral Trioxide Aggregate (MTA) with Amalgam as a Retrograde Filling Material

1. Faisal Bhangar 2. Naresh Kumar 3. Kashif Ali Channar 4. Syed Abrar Ali 5. Nadia Inayat

1. Asstt. Prof. of Operative Dentistry, LUMHS, Jamshoro 2. Asstt. Prof. & Incharge Science of Dental materials, LUMHS, Jamshoro 3. Asstt. Prof. of Oral and Maxillofacial Dept. LUMHS, Jamshoro
4. Asstt. Prof. of Endodontics, Hamdard University Dental Hospital, Karachi
5. Asstt. Prof. of Paedodontics, Hamdard University Dental Hospital, Karachi

ABSTRACT

Objective: The objective of this study was to compare apical microleakage of MTA with Amalgam following retrograde root filling.

Study Design: Experimental study

Place and Duration of Study: This study was conducted at the Department of Operative Dentistry, Fatima Jinnah Dental College & Hospital, Karachi March 2006-March 2007.

Materials and Methods: One hundred twenty extracted human single rooted teeth were randomly assigned into four groups of 30 teeth each. The root canal filling carried out and retropreparations were cut in each root using round bur to a depth of 2-3mm.cavity varnish applied prior to retrofillings. Group I retrofilled with amalgam. In group II MTA was used, Group III served as negative control and group IV as a positive control. Roots were suspended in 2% methylene blue and placed into incubator at 37°C for 7 days. Teeth were split and chosen halve evaluated using a dissecting microscope at 10^xmagnification. . The roots were evaluated and scored as either acceptable or unacceptable.

Results: The results showed that MTA displayed significantly less dye leakage than Amalgam. 24 samples (83%) out of 29 samples of MTA scored as acceptable, where as 4 specimens (16%) out of 28 samples of Amalgam showed acceptable score. MTA was found to be superior to Amalgam in providing apical seal when used as a root-end filling material.

Conclusions: Favorable results were obtained with MTA in leakage study and it was concluded that MTA provided a better apical seal than Amalgam.

Key Words: Apicectomy, Amalgam, Retrograde filling, MTA.

INTRODUCTION

The preliminary objective of conventional root canal therapy is to effectively debride and obliterate the root canal completely in order to develop a hermetic apical seal failure to adequately seal the apex generally requires an apicectomy with a retrograde filling.[1] The purpose of a root-end filling material is to establish a fluid–tight seal between the root canal space and the periradicular tissues. This seal may prevent the movement of tissue fluid into the root canal system and the egress of microorganism and their by-products from the root canal to the surrounding tissues.[2] The ideal root-end filling material should be easy to manipulate, be radiopaque, dimensionally stable, nonabsorbable, and not affected by the presence of moisture. It should also adhere to the prepared walls and seal the root canal system, be non-toxic, be well tolerated by periapical tissues and promote healing. There are a plethora of studies published concerning the sealing ability and biocompatibility of retrograde filling materials. These materials are reinforced zinc oxide-eugenol (IRM), gutta percha, zinc oxide-eugenol, composite resin, amalgam, glass ionomer and gold foil.[2] Dental amalgam is the most widely used restorative material for retrofilling of the root canal. Amalgam is the "gold standard" to which other dental materials are usually compared.[3] A newer material, mineral trioxide aggregate (MTA) has been shown as a potential alternative material to the presently used materials in endodontics.[4] In recent years MTA has been investigated in several studies as a material for sealing the communication between root canal and external area of teeth. It is commercially available under the name Pro-Root MTA (Dentsply/Tulsa Dental).[5] Well designed studies have shown that MTA researched as a potential root-end filling material and has shown promising results. It may also be used to seal perforations, open apices, or cap vital pulp. MTA powder consists of fine hydrophilic particles. The principle compound present in this material are tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. In addition, small amounts of other mineral oxides are present that are responsible for the chemical and physical properties and bismuth oxide is present to make the aggregate radiopaque.[6]Studies

have suggested that MTA provides a better seal than formerly used materials such as IRM, Amalgam and super-EBA. Further MTA has low cytotoxicity and excellent biocompatibility.MTA appears to be a suitable material to tightly seal dental hard tissues from the periodontium or to cap the exposed pulp.[7]Apical microleakage in the root canal system after endodontic therapy has been demonstrated using dyes, fluids, bacteria, and radioisotopes as tracers. There is no universally accepted method for leakage evaluation. Examples include: dye penetration, bacterial penetration, electrochemical method, and dissolution of hard tissues.[8] This study, which is simple and economical, will compare the apical microleakage of MTA aggregate with Amalgam as a root-end filling using methylene blue dye penetration technique.

MATERIALS AND METHODS

One hundred twenty extracted human maxillary and mandibular anterior teeth with straight roots and single canals were collected and stored in tap water at room temperature. All teeth were radiographed to confirm patency of the root canals, closure at the apices, and an absence of fracture and root defects. In all teeth, an access cavity was prepared through the crowns in to the pulp spaces, using a no.2 round bur in a high-speeds handpiece. Working lengths were determined using a no.15 K-type file, with the tip to be 0.5-1mm short of radiographic apices. Instrumentation, appropriate to the size of the canals using a conventional step-back technique, was accomplished by hand using K-type files. NaOCl 5.25% was used as an irrigant. After final irrigation, all canals were dried with paper points and then obturated with gutta percha and canal sealer (Sealapex, Kerr Sybron, USA) using a standard lateral condensation technique. The access cavities were closed with Kalzinol (Dentsply, USA). The teeth were held in water-moistened gauze to prevent dehydration during all instrumentation procedures. Radiographs were taken from a labio-lingual direction to verify complete obturation of the root canals. The teeth were stored in a tap water between each step, including a two-week period following obturation in order to allow the sealer to harden .Two to three mm of the apical end of the teeth were sectioned off almost perpendicular to the long axis using a 700 crosscut fissure bur in a high-speed handpiece with water coolant. Teeth were randomly divided into four groups. Teeth in the first 3 groups were dried using an air syringe and all tooth surfaces, including the sectioned surfaces, were coated with a layer of clear nail polish.

Retropreparations were cut in each root using a round bur to a depth of two-three mm and a width appropriate to the size of the apical opening. Following apical cavity preparation, each tooth was placed back into a humid environment, maintained by a tightly sealed glass jar containing moist cotton pellets. The retropreparation of the group I with 30 teeth were coated two layers of cavity varnish and filled with dental amalgam which was mixed according to the manufacturer's instructions. In group II of 30 teeth MTA was used, it was mixed with water to a putty consistency using a powder to water ratio 3:1. In group III of 30 teeth the retropreparation and the exposed gutta percha left unaltered. This group served as a negative control to verify that nail polish prevented dye penetration. In group IV of 30 teeth, served as a positive control to verify the efficacy of the methylene blue dye, not yet applied. The apical one-half of all specimens were vertically suspended in 2% methylene blue solution by utilizing strands of dental floss, tied around the cervical region of each tooth. Each group was placed in special glass containers containing the dye. The specimens were then placed into an incubator at 37°C for 7 days. Following that time period, the teeth were removed from the dye and rinsed for 15 minutes under tap water. Teeth were then sectioned in a labio-lingual direction by making labial, lingual and incisal grooves using a diamond disc. Care was taken not to penetrate the root canal spaces or the reverse filling. The teeth were then split by exerting force in the prepared grooves with a laboratory knife. Two similar halves were produced, but only one of the halves was chosen for evaluation. The depth of dye penetration was evaluated by using a dissecting microscope at a 10 × magnification. The roots were evaluated and scored as either acceptable or unacceptable. An acceptable score was defined as either no leakage or leakage that did not extend beyond the retrofilling material into the root canal space. An unacceptable score was defined as any leakage that extended beyond the retrofilling material into the root canal space.

The dye penetration, which showed the success of the procedure, was recorded for the two groups. The leakage scores for two groups were calculated and compared using the chi-square test. The results of the study were statistically analyzed using SPSS for windows version 11. Dye penetration scores confirmed whether the apical seal provided by two retrofilling materials was adequate to prevent apical microleakage and simultaneously identified the more effective root-end filling material.

RESULTS

Positive control samples (Group IV) showed dye penetration throughout the length of canal, while the negative control samples (Group III) had no dye penetration. Two root samples from Group I and one root sample from Group II were eliminated from study because they exhibited a vertical fracture that allowed dye penetration into the canal system.

The results of Table 1 from Group I using Dental amalgam showed that 24 (84%) of 28 samples were scored as unacceptable, because dye penetration was

found in the root canal space beyond the retrograde filling. whereas 4 specimens (16%) showed acceptable score because penetration was observed only within the retrograde filling material.

Table No.I: Results for Leakage of Retrofilling Materials

Groups	Retrofillings	Number of samples	Acceptable	Un-acceptable
I	Amalgam	28	04	24
II	MTA	29	24	05

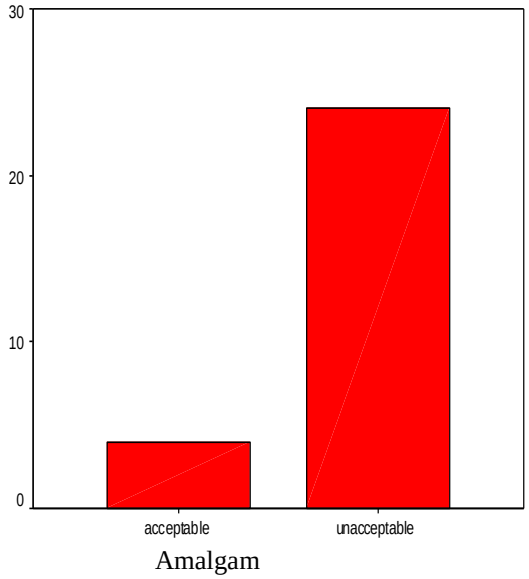

Figure No.I: Bar graph showing score of acceptable and unacceptable teeth for Amalgam

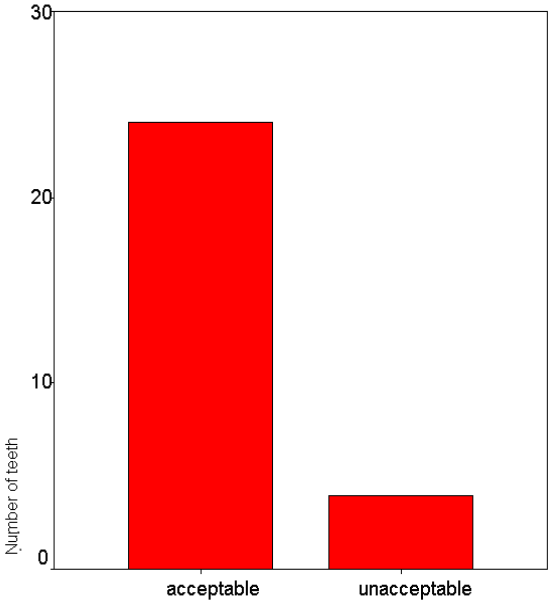

Figure No.2: Bar graph showing score of acceptable and unacceptable teeth for MTA

Group II using MTA exhibited that 5 (17%) of 29 samples were scored unacceptable owing to dye penetration observed into the root canal system beyond the retrofilling material, while 24 (83%) samples showed promising results and scored as acceptable, because dye penetration was found within the retrofilling material. The data from both groups were submitted for statistical analysis. The chi-squared test revealed a statistically significant difference between both groups ($P< 0.0005$).

DISCUSSION

The primary aim of root canal treatment is the elimination and future exclusion of all microorganisms from the root canal system. Conventional root canal treatment is the preferred treatment to achieve this aim. A retrograde root filling is placed to establish an "apical seal" to prevent the passage of microorganisms or their products into periapical tissues. 'Apical seal' is the single and most important factor in achieving success in surgical endodontics. In the present study, the apical 2-3 mm of the root–end were sectioned off almost perpendicular to the long axis of the teeth. This was also supported by Sauveue et al.[9] who demonstrated in their photoelastimetry study that perpendicular resections offer a better distribution of stress exerted at the apical region. Furthermore, in the current study, retropreparations were performed using a round bur although bur-prepared cavities may be misaligned relative to the long axis of the root and despite the advantages of ultrasonic tips exhibited by some investigators. O'conner et al.[10] indicated no significant differences was noted between both cavity preparation techniques. In addition, cavity varnish was applied prior to insertion of amalgam in an attempt to prevent initial marginal leakage and to produce what appears to be the best seal that can be achieved using amalgam. Other investigators have found that regardless of type of amalgam used, the apical seal was significantly improved when varnish was applied to the retropreparation prior to placement of the retrofilling.[11] In the current investigation, the effectiveness of the apical seal was evaluated by utilizing dye penetration technique. Pitt Ford et al.[12] reported that this technique is the most frequently utilized method to assess the sealing capability of numerous root-end filling materials. Although amalgam generally has been the most commonly used root-end filling material, it has a number of disadvantages such as scattering of amalgam particles into the surrounding tissues, corrosion, and setting properties which allow dimensional changes and fluid leakage. High copper amalgam (12% copper or more) which does not contain the corrosion prone γ2–phase should be considered as root end filling material.[13] Torabinejad et al,[14] further recommended the use of MTA as a root-end filling material based on its sealing properties when compared to amalgam. In

contrast to existing amalgam, cementum-like repair has been observed to occur directly on MTA, which is considered a desirable healing response.[15] It appears that MTA induces cementogenesis by offering a biologically active substrate for osteoblasts, allowing good adherence of bone cells to the material, and it also stimulates cytokine production.[16] The sealing ability of MTA is attributed to its hydrophilic nature and expansion when cured in a moist environment. It has been shown that the optimum depth of retrograde cavity must be reached to achieve an adequate apical seal.[17] MTA as a root-end filling provides a better apical seal than materials such as amalgam, IRM, super EBA and gutta percha.[18] The greater sealing capability of MTA is probably related to its superior marginal adaptation and to the possible expansion of the material while setting in a moist environment.[19] MTA material is easily mixed, its handling characteristics are not ideal and care must be taken not to wash out or disturb the material after placement. It can be difficult to place and compact in many root-end preparations. MTA is costly and has a long setting time as compared to amalgam.[20] the use of dyes is one of the oldest and commonest method of studying microleakage a variety of dyes have been used; these include Indian ink, erythrosine B solution, aqueous solution of fuchsine, fluorescent, methylene blue solutions and others.[21] Torabinejad et al,[22] investigated that using Rhodamine B fluorescent dye and a confocal microscope found that mineral trioxide aggregate leaked significantly less than amalgam. Under the experimental conditions of our in vitro study it was seen that MTA showed less dye leakage in comparison to amalgam. The leakage data in this study agreed with the findings of Chong et al and concluded that all the amalgam root-end fillings leaked with maximum dye leakage scores.[23] Furthermore the results of this present study exihibited that MTA has the potential of being used as a root-end filling material because it provides an hermetic seal. These results corroborate with previous findings that show MTA seal significantly better than amalgam. These findings suggested that mineral trioxide aggregate (MTA) could be considered as a viable alternative to amalgam for retrograd filling.

CONCLUSION

In this study, retrograde fillings were carried out using Amalgam in group I and MTA was used in group II. Both materials showed methylene blue dye leakage. Optimal results were obtained with MTA in leakage study and it was concluded that MTA provided a better apical seal than Amalgam when used as retrograde filling material. Hence it should be considered as a viable alternative retrograde filling material.

REFERENCES

1. Grossman I, Abu el Naag A, peled M. Root–end filling material in apicoectomy. Refuat Hepheh Vehas hinayim 2003 ; 20 47-54
2. Aqrabawaii sealing ability of amalgam, Super EBA cement and MTA when used as a retrograde filling material. Br Dent J 2000 11; 5:266-80
3. Dina Al-Saudani, Saad AY. Use of a chemically activated resin modified glass ionomer as a retrograde filling material: An In Vitro Study JADA 2001;10(1).
4. Torabinejad M, Chivian N. Clinical application of mineral trioxide aggregate. J Endod 1999;25: 197-205.
5. Myriam M, Barberia E, Plennlls P, Vera V. Treatment of a non-vital immature incisor with mineral trioxide aggregate (MTA). Dent Traumatol 2003;19:165-9.
6. Spangberg L. Instrument, Material, and devices, In: Cohen S, Burns RC, editors. Path of the pulp. 8th ed. New Dehli: Elsevier;2004.p.562.
7. Kim S. Endodontic Microsurgery. In:Cohen S, Burns RC, editors. Path of the pulp. 8 th ed. New Dehli: Elsevier 2004;721.
8. Shipper G, Grossman ES, Betha AJ, Cleaton-jones PE. Marginal adaptation of (MTA) compared with amalgam as a root end filling material. A low vaccum (LV) versus High-vacuum (HV) SEM Study. Int Endod J 2004;325-6.
9. Gohring KS, Lehnert B, Zehnder M. Indication for use of MTA. Schweiz Monatsschr Zahmed. 2004;114:143-53.
10. Wu MK, De Gee AJ, Wesselink PR, Moorer WR. Fluid transport and bacterial penetration along root canal fillings. Int Endod J 1993;26:203-8
11. Hovland EJ, Dumsha TC. Leakage evaluation in vitro of the root canal sealer cement Sealapex. Int Endod J 1985;18:179-82.
12. De Almeida WA, Leonardo MR, Tanomaru Filho M, Silva LA. Evaluation of apical sealing of three endodontic sealers. Int Endod J 2000;33:25-7.
13. von Fraunhofer JA, Branstetter J. The physical properties of four endodontic sealer cements. J Endod 1982;8:126-30.
14. Goldberg F, Gurfinkel J. Analysis of the use of Dycal with gutta-percha points as an endodontic filling technique. Oral Surg Oral Med Oral Pathol 1979;47:78-82.
15. Jacobsen EL, Shugars KA. Sealing efficacy of a zinc oxide-eugenol cement, a cyanoacrylate, and a cavity varnish used as root canal cements. J Endod 1990;16:516-9.
16. Block RM, Pascon EA, Langeland K. Paste technique re-treatment study: a clinical, histopathologic, and radiographic evaluation of 50

cases. Oral Surg Oral Med Oral Pathol 1985;60: 76-93.
17. al-Khatib ZZ, Baum RH, Morse DR, Yesilsoy C, Bhambhani S, Furst ML. The antimicrobial effect of various endodontic sealers. Oral Surg Oral Med Oral Pathol 1990;70:784-90.
18. Branstetter J, von Fraunhofer JA. The physical properties and sealing action of endodontic sealer cements: a review of the literature. J Endod 1982;8:312-6.
19. Ozata F, Onal B, Erdilek N, Turkun SL. A comparative study of apical leakage of Apexit, Ketac-Endo, and Diaket root canal sealers. J Endod 1999;25:603-4.
20. Leonardo MR, Silva LA, Utrilla LS, Assed S, Ether SS. Calcium hydroxide root canal sealers--histopathologic evaluation of apical and periapical repair after endodontic treatment. J Endod 1997; 23:428-32.
21. Mannocci F, Ferrari M. Apical seal of roots obturated with laterally condensed gutta-percha, epoxy resin cement, and dentin bonding agent. J Endod 1998;24:41-4.
22. Sugawara A, Chow LC, Takagi S, Chohayeb H. In vitro evaluation of the sealing ability of a calcium phosphate cement when used as a root canal sealer-filler. J Endod 1990;16:162-5.
23. Barkhordar RA, Stark MM, Soelberg K. Evaluation of the apical sealing ability of apatite root canal sealer. Quintessence Int 1992;23:515.
24. Staninec M, Holt M. Bonding of amalgam to tooth structure: tensile adhesion and microleakage tests. J Prosthet Dent 1988;59:397–402.
25. Tarim B, Suzuki S, Suzuki S, Cox CF. Marginal integrity of bonded amalgam restorations. Am J Dent 1996;9:72–6.
26. Eakle WS, Staninec M, Lacy AM. Effect of bonded amalgam on the fracture resistance of teeth. J Prosthet Dent 1992;68:257–60.
27. Staninec M. Retention of amalgam restorations: undercuts versus bonding. Quintessence Int 1989;20:347–51.
28. Mahler DB, Engle JH, Simms LE, Terkla LG. One-year clinical evaluation of bonded amalgam restorations. JADA 1996;127:345–9.
29. Chong BS, Pit Ford TR, Kariyawasam SP. Short term tissue response to potential root-end-filling materials in infected root canals. Int Endod J.1997; 30:240-49.
30. Saunders EM, Saunders WP. Long-term coronal leakage of JS Quickfill root fillings with Sealapex and Apexit sealers. Endod Dent Traumatol 1995;11:181-5.
31. Owadlly ID, Pit Ford TR, Effects of addition of hydroxyapatite on the physical properties of IRM. Int Endod J 1994; 27: 227-32.
32. Rud J, Munksgaard EC, Andreason JO, Rud V et al. Root filling with composite and a dentine bonding agent.1-VI. Tandlaegebladet 1989;93: 156- 60
33. Belcher MA, Stewart GP. Two-year clinical evaluation of an amalgam adhesive. JADA 1997;128:309–14.
34. Mahler DB, Engle JH Clinical Evaluation of Amalgam Bonding in Class I and II Restorations. JADA 2000 ;131(1):43-49.
35. Calamia JR, Styner DL. Effect of Amalgabond on cervical sensitivity. Am J Dent 1996; 8(6):283-4.
36. Ozturk B, Usumez A. In vitro assessment of temperature change in the pulp chamber during cavity preparation. J Prosthet Dent 2004;91: 436-440.
37. Kazemi RB, Safavi KE, Spangberg LS. Dimensional changes of endodontic sealers. Oral Surg Oral Med Oral Pathol 1993;76:766-71.
38. van der Burgt TP, Eronat C, Plasschaert AJ. Staining patterns in teeth discolored by endodontic sealers. J Endod 1986;12:187-91.
39. Grossman LI. An improved root canal cement. J Am Dent Assoc 1958;56:381-5.
40. Torabinejad M, Kettering JD, Bakland LK. Evaluation of systemic immunological reactions to AH-26 root canal sealer. J Endod 1979;5:196-200.
41. Harnden DG. Tests for carcinogenicity and mutagenicity. Int Endod J 1981;14:35-4
42. Council update on "adhesion" and "adhesive" materials. Council on Dental Materials, Instruments, and Equipment. J Am Dent Assoc 1981;103:252-3.
43. De Almeida WA, Leonardo MR, Tanomaru Filho M, Silva LA. Evaluation of apical sealing of three endodontic sealers. Int Endod J 2000;33:25-7.
44. Smith DW, Wong M. Comparison of apical leakage in teeth obturated with a polyamide varnish or zinc oxide and eugenol cement using lateral condensation. J Endod 1992;18:25-7.
45. Meryon S, Johson SG, Smith AJ. Eugenol released and cytoxicity of different zinc oxide-eugenol combination. J Dent 1988; 16: 66-70.

Address for Corresponding Author:
Dr. Faisal Bhangar
15/c Old Railway Bunglow.Opp: Karachi Club Dr Ziauddi Road, Karachi, Pakistan.
E-mail: dentistbhangar @yahoo.com.
Mobile # 0333-7342286