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An Invitro Comparative Stereomicroscopic Evaluation of Marginal Seal Between Mineral Trioxide Aggregate, Glass Ionomer Cement &Light Cured Calcium Hydroxide Paste As Root End Filling Materials Using 1% Methylene Blue As Tracer.

[1]Dr. Ambili C, Final Year Postgraduate Student, Department of Conservative Dentistry and Endodontics, RV Dental College, Bangalore

[2]Dr. B. S Keshava Prasad, Professor and Head of The Department, Department of Conservative Dentistry and Endodontics, RV Dental College, Bangalore

Corresponding Author: Dr. Ambili C, Final Year Postgraduate Student, Department of Conservative Dentistry and Endodontics, RV Dental College, Bangalore

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Abstract

The primary aim of root canal treatment is the elimination and exclusion of all the micro organisms from the root canal system. Success of endodontic treatment depends on the removal of infected canal contents followed by root canal filling using a material of adequate compatibility. The aim of this study is to comparatively evaluate stereo microscopically the micro leakage of three root end filling materials Mineral Trioxide Aggregate (MTA), Glass Ionomer Cement (GIC) and; Cal LC(light cured calcium hydroxide paste) using dye penetration.

Materials and methods: 30 extracted human maxillary central incisors are used for the study. Canals are then prepared using the complete sequence of hand files using 3% sodium hypochlorite and 17% EDTA as irrigants and obturated with gutta-percha using lateral compaction technique. Following this, the teeth are apically resected & standardized root end cavities are prepared. The teeth are then randomly divided into 3 groups of 10 specimens each & were filled with Group – I: MTA, Group – II: GIC & Group – III: Cal LC. The samples are coated with varnish & after drying, they are immersed in 1% methylene blue dye for 72hrs. The teeth are then sectioned longitudinally and examined under stereomicroscope. The depth of dye penetration is measured in millimeters.

Summary and conclusion: Within the limitations of this Invitro study, MTA showed less microleakage.

Introduction

Microorganisms play an major role in infecting root canal system[1,]. Endodontic infections occur and progress when the root canal system gets exposed to the oral environment by one reason or the other and simultaneously when there is fall in the body's immune response[2,3].

Success of endodontic treatment depends on the removal of infected canal contents followed by filling the root canal using a material of adequate compatibility[4,5].Since microorganisms may remain in the root canal system after instrumentation, a three dimensional obturation and a tight apical seal is required to prevent bacteria and their by-products from invading the apex. A perfect apical seal will prevent apical percolation[6].

Most endodontic treatment failures develop as a result of leakage of irritants from pathologically involved root canals. When non-surgical attempts prove unsuccessful or are contraindicated, surgical endodontic therapy is needed to save the tooth. The root-end filling material should yield an apical seal to an otherwise unobturated root canal or enhance the seal of existing root canal filling material and be biocompatible with the periradicular tissues[7].

This procedure includes exposure of involved apex, resection of the apical end of the root, preparation of root end cavity & insertion of root end filling material[1].

An ideal root end filling material should adhere and adapt to the walls of the root preparation, Prevent leakage of microorganisms and their products into the peri-radicular tissues. It shoukd be biocompatible, non-resorbable, unaffected by moisture, radio-opaque, easy to prepare and place, be non-toxic, non-carcinogenic, dimensionally stable[8]

Throughout the dental history, many materials have been used for retrograde fillings. Numerous root end filling materials are there but no material has been found to satisfy all the properties for an ideal retrograde filling. Following are the commonly used root end filling materials. Amalgam was the first material of choice for a root end filling for many years. Other metals such as gold-foil, titanium screws and gallium alloy are also used.

Cements such as glass ionomer, Super EBA, IRM (zinc oxide-eugenol cements), carboxylate cements, zinc phosphate cements, calcium phosphate cement, Diaket, and mineral trioxide aggregate (MTA) are also used for retrograde filling. Rarely used Root-end filling materials includes laser, citric acid demineralization, teflon, ceramic inlay[8]

Mineral Trioxide Aggregate (MTA)

Mineral trioxide aggregate (MTA) is one of the recent innovations in dentistry that has multiple applications, including as a retrograde filling material[9]. It was developed at Loma Linda University, CA, U.S.A in 1993. This cement contains tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide and other mineral oxides forming a hydrophilic powder which sets in presence of moisture[10]. The resultant colloidal gel hardens to a solid structure within 4 hours. Torabinejad et al. studied the sealing ability of a MTA when used as a root end filling material, and they concluded that leakage with MTA was significantly less compared with other root end filling materials[9].

Glass Ionomer Cement

Glass ionomer cement is a material with universal properties. It is also called dentin substitute. Its ability to bond chemically to tooth structure provides an excellent marginal seal. Studies have shown that glass ionomer cement possesses antibacterial activity due to slow releases of fluoride[11].

Light Cured Calcium Hydroxide

A visible light-cured (VLC) calcium hydroxide consists of calcium hydroxide and barium sulfate dispersed in a urethane dimethacrylate resin containing initiators and accelerators activated by visible light. The antibacterial effect of the VLC calcium hydroxide is less; the vehicle component of these light-cured products may prevent or significantly reduce any antimicrobial effects associated with the chemical cure products[12].

The root ends of the teeth can have variations in the root anatomy becoming the major cause of treatment failure. All these considerations make it essential to eliminate last apical three millimeters because of the presence of apical delta for maximum security[13] . The plane of sectioning is also a main consideration in technique of root end resection. According to research 90 degree resection can improve stress distribution in situations where root resection is needed[14]. For making a root end cavity we can use various instruments like conventional slow speed handpieces, high speed air rotar handpiece, sonics & ultra sonics. Accoding to study the depth of penetration should be ideally 3mm as number of cracks are minimal between 2-3mm[15].

There are different way to evaluate the sealing ability of filling maerials such as fluid infiltration , radioisotope, dye penetration and bacterial leakage[16]. Various types of dyes used are eosin, methylene blue, black India ink, blue ink, black ink, drawing ink, Procion brilliant blue, Rhodamine B, 0.5% fuchsin are used[17]. According to studies conducted, methylene blue has been proved to be a useful aid in endodontics[18].

The aim of the in vitro pilot study was to compare the microleakage of three different root end filling materials Glass Ionomer Cement (GIC), Mineral Trioxide Aggregate (MTA) and light cured calcium hydroxide using dye penetration method under a stereomicroscope.

Materials and Methods

Study Samples

This was a comparative pilot study involving 30 extracted teeth consisting of three groups, with 10 samples each.

Sample processing

30 extracted maxillary central incisor teeth with intact apex and no previous dental treatment were collected and stored in normal saline(fig 1). The teeth were radiographed to determine the existence of a single relatively straight canal and teeth were excluded if radiographs demonstrated multiple canals or pulpal obliteration. The samples were cleaned using ultrasonics. Preoperative radiographs were taken and access cavities were made using endo access bur.(Fig. 2) . The pulp tissue was extirpated using barbed broach. K-file was used to confirm the canal patency and the working length (Fig. 3) was determined with help of a radiograph.

Fig. 1: Sample

Fig. 2: Access opening

Fig. 3: working length

A glide path was prepared till the working length using #25 K-File. Canals were then prepared using the complete sequence of hand files using 3% sodium hypochlorite and 17% EDTA as irrigants. Between each sequential K file RC Help was used as a lubricant. Canals were dried using absorbent paper points and master cone selection was confirmed with radiographs. Canals were obturated with gutta percha by lateral compaction technique. Radiographs were taken to confirm the quality of obturation (Fig 4) and the access cavities were sealed with composite resin restorative material after 24 hours.

Fig. 4: Obturation

The apex were resected apically at 90° angle axis to the long axis of the root using cross cut fissure bur (556, Mani, Japan) removing 3 mm of the apex.(Fig. 5).

Fig. 5: apical resection

The 3 mm deep retrograde cavity was prepared using straight fissure diamond bur (SF 41, Mani, Japan) the cavities were irrigated with saline and dried. The teeth were randomly divided into 3 groups of 10 specimens each (fig 6):

1. Group I : Glass Ionomer Cement(GIC)
2. Group II : Mineral Trioxide Aggregate (MTA)
3. Group III : CAL LC

Fig. 6: (a) GIC

(b) MTA

(c) CAL LC

Fig.7: Nail varnish coat except for the apical 1mm

Fig. 8: Clear acrylic blocks made to stabilise teeth during sectioning.

These materials were manipulated according to the manufacturer's instructions and the cavities were filled using a Messing's carrier. The specimens were then coated with 3 coats of nail varnish except at the apical 1mm & then were allowed to dry.(Fig. 7) The specimens were then suspended in 1% methylene blue for 72hours. Following this the teeth were rinsed for 15minutes under running water. Clear acrylic blocks were made to stabilize them.(Fig. 8) The teeth were then sectioned longitudinally (Fig.9) and the dye penetration was examined under stereomicroscope & microleakage was evaluated in millimeters.

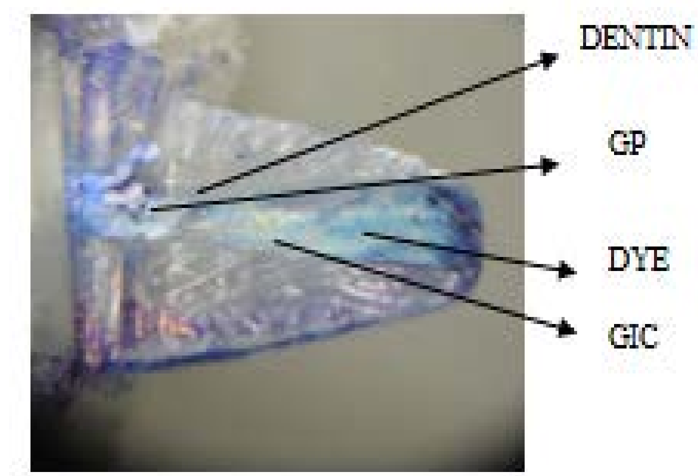


Fig 9: Dye penetration seen in Glass Inomer Cement

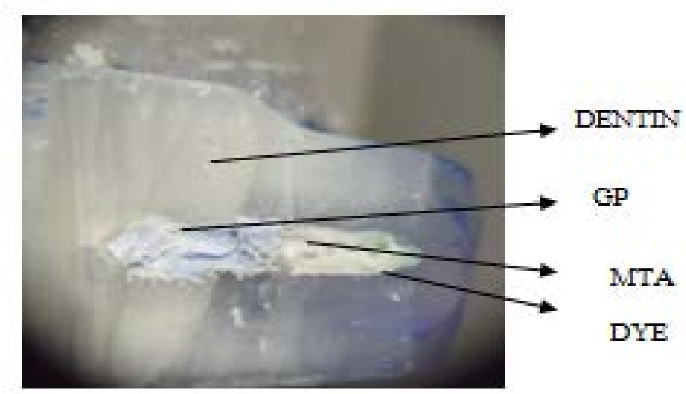


Fig. 10: Dye penetration seen in Mineral Trioxide Aggregate

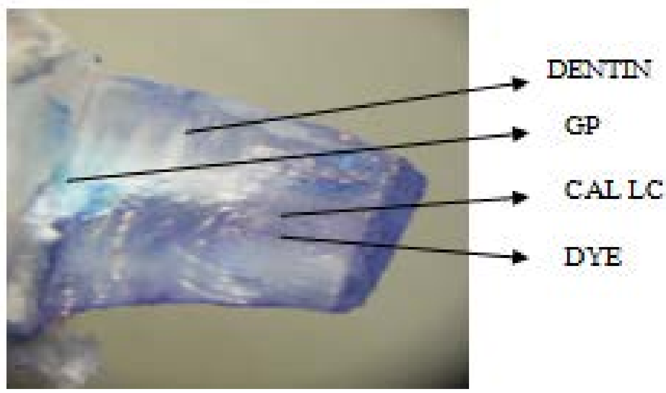


Fig .11: Dye penetration seen in CAL LC

Result

Table 1 shows microleakage values for different groups. Comparison of microleakage showed an average leakage value of 0.714 mm with a standard deviation of 0.147 for MTA, 1.424 mm with a standard deviation of 0.193 for GIC and 1.857 mm with a standard deviation of 0.263 for CAL LC.

SL NO	MTA	GIC	CAL LC
1	0.68	1.60	1.50
2	0.40	1.41	1.73
3	0.56	1.33	1.90
4	0.71	1.78	2.10
5	0.75	1.65	2.30
6	0.77	1.38	1.88
7	0.93	1.23	1.40
8	0.79	1.40	1.91
9	0.72	1.21	1.89
10	0.83	1.25	1.96
AVERAGE	0.714	1.424	1.857

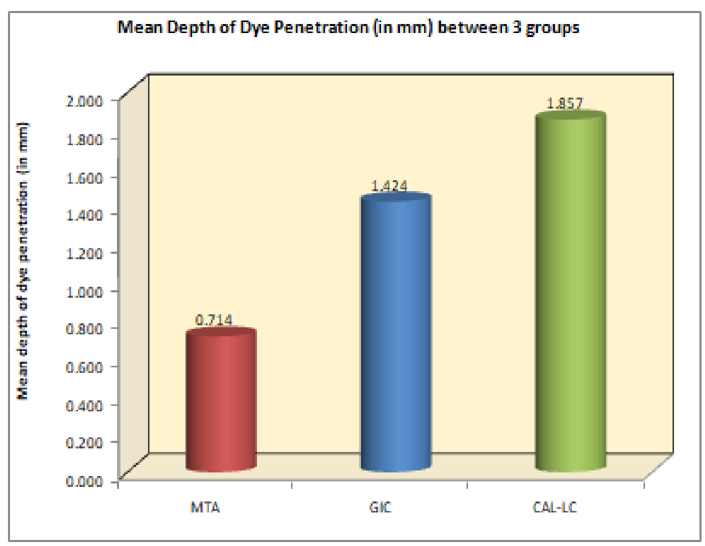
Table 1: Results

Multiple comparison of mean difference in depth of dye penetration between groups using Tukey's Post hoc Test					
(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI of the Diff.		P-Value
			Lower	Upper	
MTA	GIC	-0.710	-0.939	-0.481	<0.001*
	CAL-LC	-1.143	-1.372	-0.914	<0.001*
GIC	CAL-LC	-0.433	-0.662	-0.204	<0.001*

GP

* - Statistically Significant

Multiple comparison between groups indicates that MTA shows significantly lesser mean dye penetration depth as compared to GIC & CAL-LC, both at P<0.001. Similarly, GIC shows significantly lesser mean dye penetration depth as compared to CAL-LC at P<0.001. Hence we can infer that MTA exhibits best marginal seal among all 3 groups, followed by GIC and least with CAL-LC group.



Graph 1: showing Meanwise comparison of MTA, GIC, CAL LC

Graph 1 shows a mean wise graphic representation of the average microleakage of MTA, GIC and CAL LC in which MTA shows the least microleakage.

Discussion

Sealing ability refers to the materials ability to resist microleakage through the entire thickness of the material[10]. The aim of endodontic therapy is to hermetically seal all pathways of communication between the pulpal and periradicular tissues. Failure of non-surgical endodontic therapy or non-surgical endodontic retreatment implies that the need for endodontic surgery to save the tooth. As most endodontic failures occur as a result of leakage of irritants including microbes from infected root canals, the root-end filling material must provide an adequate apical seal and be biocompatible. . Its anti-bacterial effects and ability to stimulate regeneration of the periodontium will accelerate the healing process and reduce the incidence of failures[19]

Most in vitro studies assess leakage of the apical seals, but the correlation between dye leakage around root-end filling materials and their clinical performance is unclear. However it seems logical that the lesser leakage would prevent migration of bacteria and toxins into the periradicular tissue[18]

Mineral trioxide aggregate (MTA) was developed by Torabinejad at Loma Linda University, CA, USA in 1993. MTA cement is commercialized in two different versions, grey and white (Grey and White MTA). The main difference between the two varieties are the highest concentration of iron oxide in the Grey MTA, It consists of calcium and phosphorous ions, derived primarily from tricalcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide. Its pH is 12.5 and its setting time is 2 hours and 45 minutes. The compressive strength of MTA is reported to be 40 MPa immediately after setting and increases to 70MPa after 21 days. Several dye leakage studies have demonstrated the fact that MTA leaks significantly less than other root-end filling materials. The marginal adaptation of MTA was better with or without finishing when compared to IRM and Super EBA. MTA, when used as a root-end- filling material, showed evidence of healing of the surrounding tissues. Most characteristic tissue reaction of MTA was the presence of connective tissue after the first postoperative week[8].

Glass ionomer cement is a material with universal properties. It is also called dentin substitute, its ability to exhibit chemical bond to tooth structure provides an excellent marginal seal[18] . These cements are easy to handle and does not cause any adverse reactions in the periapical tissue[8]. Sealing ability of GIC was adversely affected when the root end cavities were contaminated with moisture at the time of placement of cement. Marginal adaptation of glass ionomer cements to dentin have been shown to improve with the use of acid conditioners and varnishes It is reported that newer glass ionomer cements containing glass-metal powder have less leakage and showed no pathologic signs. One of the disadvantages of glass ionomers is the root preparation must be completely dry and seal is adversely affected by moisture and low pH [8].

Calcium hydroxide has been used in dentistry since several decades and has become a main-stay therapeutic agent. It has a number of applications such as vital pulp therapy, pulp revascularization, apexogenesis, apexification, root resorption, intracanal medicament, and root canal sealers. The hard tissue barrier formed with regard to long-term calcium hydroxide therapy comprises of irregularly arranged cementum-like tissue, soft tissue and calcified tissue. 'Swiss cheese' consistency .

LC calcium hydroxide actually release less calcium ions necessary for dentine bridge formation. . The antibacterial effect of the VLC calcium hydroxide is less; the vehicle component of these light-cured products may significantly reduce any antimicrobial effects associated with the chemical cure products. The high value of dye leakage with CAL LC could be explained by the fact that cement might have well adapted to one cavity wall but the gaps might have been developed on the other cavity wall, resulting in microleakage.

Conclusion

All the three materials used in the study showed some microleakage throughout the experimental period. In this study multiple comparison between groups indicates that MTA shows significantly lesser mean dye penetration depth as compared to GIC & CAL-LC, both at $P<0.001$. Similarly, GIC shows significantly lesser mean dye penetration depth as compared to CAL-LC at $P<0.001$. So MTA displayed minimum microleakage while microleakage with CAL LC is maximum.

Thus, the sealing ability in terms of microleakage can be summarized as:

MTA > GIC > CAL LC

References

1. Siqueira JF, Rocas IN. Distinctive features of the microbiota associated with different forms of apical periodontitis. J Oral Microbiol. 2009:1. Figdor D, Sundquist G. A big role for the very small-understanding the endodontic microbial flora. Aust Dent J. 2007;52(1):38-51.
2. Siqueira JF, Rocas IN. Diversity of Endodontic Microbiota Revisited. J Dent Res. 2009;88(11):969-981.
3. Chong BS, Pitt Ford TR Watson TF, and Wilson RF (1995). Sealing ability of potential retrograde root filling materials. Endod Dent Traumatol, 11(6): 264-269
4. Ozata F, Erdilek N and Tezel H (1993). A comparative sealability study of different retrofilling materials. Int Endod J, 26(4): 241-245.
5. Muliyar S, Shameem KA, Thankachan RP, Francis PG, Jayapalan CS, Hafiz KA. Microleakage in endodontics. Journal of international oral health: JIOH. 2014 Nov;6(6):99.
6. Vasudev SK, Goel BR, Tyagi S. Root end filling materials-A review. Endodontology. 2003;15(2):12-8.
7. Bhagat K, Goel M, Bhagat N. Root End Filling Materials and Recent Advances: A Review. EC Dental Science. 2017;12:46-57.
8. Fogel HM, Peikoff MD. Microleakage of root-end filling materials. Journal of endodontics. 2001 Jul 1;27(7):456-8.
9. Shetty S, Hiremath G, Yeli M. A comparative evaluation of sealing ability of four root end filling materials using fluid filtration method: An in vitro study. Journal of conservative dentistry: JCD. 2017 Sep;20(5):307.
10. Galhotra V, Sofat A, Pandit IK, Gambhir RS, Srivastava N, Gugnani N. Comparative evaluation of microleakage of various retrograde filling materials: An in vitro study. Journal of natural science, biology, and medicine. 2013 Jul;4(2):403.
11. Arandi NZ. Calcium hydroxide liners: a literature review. Clinical, cosmetic and investigational dentistry. 2017;9:67
12. Gagliani M, Taschieri S, Molinari R. Ultrasoni root-end preparation: influence of cutting angle on the apical seal. J Endod 1998;24:726-730.
13. Sauveur G, Boccara E, Colon P, Sobel M, Boucher Y: A photoelastimetric analysis of stress induced by root-end resection. J Endod. 1998; 24(11): 740-. 743.
14. Min MM, Brown CE Jr., Kafraway AH. Invitro evaluation of effects of ultrasonic root end preparation

on resected root surfaces. J. Endodo. 1997; 23(10): 624 – 628.

15. Xavier CB, Weismann R, de Oliveira MG, Demarco FF, Pozza DH. Root-end filling materials: apical microleakage and marginal adaptation. Journal of Endodontics. 2005 Jul 1;31(7):539-42.
16. Jafari F, Jafari S. Importance and methodologies of endodontic microleakage studies: A systematic review. Journal of clinical and experimental dentistry. 2017 Jun;9(6):e812.
17. Kokate SR, Pawar AM. An in vitro comparative stereomicroscopic evaluation of marginal seal between MTA, glass inomer cement and biodentine as root end filling materials using 1% methylene blue as tracer. Endodontology. 2012 Dec;24(2):36-42.
18. Priyanka SR, Veronica A. A literature review of root-end filling materials. IOSR Journal of Dental and Medical Sciences. 2013;9(4):20-5.