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 – 2, Issue – 6, November - December - 2019, Page No. : 601 - 608

Comparative Evaluation and Sealing Ability of four different Root Canal Sealers: An in vitro study

[1]Dr. Chinmay Vyas, Department of conservative and endodontics, Yogita dental college, Khed

[2]Dr. Nitin Mirdha, Department of conservative and endodontics, Vyas dental college, Jodhpur

[3]Dr. Roopa Babannavar, Department of conservative and endodontics, Bapuji dental college, Davengeree

[4]Dr. Siddhesh Bandekar, Department of conservative and endodontics, Yogita dental college, Khed

[5]Dr. Shirin Kshirsagar, Department of conservative and endodontics, Yogita dental college, Khed

[6]Dr. Surabhi Ghosh, Department of conservative and endodontics, Yogita dental college, Khed

Corresponding Author: Dr. Nitin Mirdha, Department of conservative and endodontics, Vyas dental college, Jodhpur

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aims: The aim of this study was to compare and evaluate the sealing ability of the four different root canal sealers.

Methods and Material: Cleaning and shaping for 80 single rooted was done using M-two file system till 30 no.6% file using crown down technique. Before and between each instrument, irrigation was done with 1ml of 5% NaOCl and final irrigation was done using 5ml of 17% EDTA solution. The specimens were divided into four, Group A (Endosequence Bioceramic), Group B (MTA fillapex), Group C (AH plus), and Group D (EWT) and obturated. The samples were splitted using diamond disc and chisel. Linear dye penetration was measured under stereomicroscope.

Statistical analysis used: Oneway ANOVA and post hoc tukey test.

Results: The result showed that AH Plus had the least leakage value of 1.253 mm, followed by bioceramic sealer 1.525 mm, MTA Fillapex 1.743 mm and finally with the maximum value of dye leakage Tubli – Seal EWT with the leakage value of 2.425 mm.

Conclusions: All of the sealers compared shows some amount of leakage, out of them AH plus shows least and Tubli seal shows maximum leakage and rest shows intermediate leakage.

Keywords: Bioceramic, Extended working time, Incubator, Leakage, Sealing ability

Introduction

The current concept of endodontic treatment is to realize a complete chemo-mechanical debridement and is the key factor of successful endodontic therapy. The long-term seal of root canal system plays an important role in supporting the healing of periapical tissues and prevents intracanal recontamination after root canal treatment.[1]

The main objective of root canal obturation is to attain and maintain a hermetic seal in the entire root canal space.[1] Sealer accomplishes the objective of providing fluid tight seal. The core occupies space serving as a vehicle for sealer.[2]

There is always progress in the recent advancement and technology, Bioceramic sealer is new to the race in dentistry. In an attempt to complement the existing

literature, the present day in vitro study was done to compare and evaluate the sealing ability of varios sealers.

Subjects and Methods

80 single rooted teeth, scheduled for extractions due to periodontal disease or orthodontic reasons were selected. Teeth were then decoronated using the diamond disc and micromotor.

Working length was determined by visual method. In this method a #15 K file was inserted until the file was visible at the apical foramen and later withdrawing the instrument 0.5 to 1mm short of the apex and cleaning and shaping was done at this obtained length. Cleaning and shaping was done using M-two (VDW) rotary file system having 6% taper. The final apical preparation was done with file number size 30. Crown down technique was used for biomechanical preparations.

Before instrumentation and between each change of instrument, irrigation with 1ml of 5% NaOCl was done using a 25-gauge needle placing up to two thirds the length of the root canal. Final irrigation was done using 5ml of 17% EDTA solution followed by saline irrigation.

The canal of each specimen was dried with absorbent paper points before obturation except the 20 samples of the Bio Ceramic group sealer. After completion of the instrumentation, the specimens were divided into four groups with twenty specimens in each group.

The groups were identified by labeling them as Group A (AH Plus), Group B (MTA fillapex), Group C (Endosequence Bioceramic), and Group D (Tubli – Seal EWT).

Each sealer was manipulated according to manufacturer instruction and was carried into root canal using lentulo spiral (size1 - Red). Obturation was done using 6% taper guttapercha points and additional 2% guttapercha points were placed if there was any requirement of accessory cones, the process was continued till the spreader had no further place to enter the canal space. Coronally 2 mm of gutta percha was removed by gutta cut to create space for the post endodontic restoration.

All the specimens were placed in separate containers with 100% humidity and maintained at 37°C in an incubator for seven days during the complete setting of the sealers.

After seven days, each specimen was blotted dry and coated with 3 coats of nail polish except for the apical 2 mm so that the dye penetrates only from the apical 2 mm of the tooth. Each group was painted with a different color of nail polish for the easy identification of the four different groups.

The specimens were then affixed from the coronal portion into the wax and then suspended in the four different labeled petri dishes containing 2% solution of Methylene blue dye. The samples were then placed in an Incubator for the next seven days at 37°C and 100% humidity to allow complete dye penetration.

The specimens were removed from the dye after 7 days, and washed under running tap water for three minutes. The specimens were then grooved labially and lingually with a diamond disc with intermittent cutting, then were split gently with a chisel.

The filling within the specimens was removed with a sharp explorer. Both the root sections of each specimen were viewed under a Stereomicroscope with 30X magnification using electronic digital caliper. Linear measurements of the most coronal extent of dye penetration on the canal walls was recorded in millimeter up to two decimals.

Stastical Analysis

The results were statistically compared using ANOVA Test, Tukey Test and Post Hock Test

Dye penetrated almost all the samples except 2 samples of Bioceramic sealer, and one sample each of MTA fillapex, AH+ and Tubli – Seal.

One-way ANOVA test was used (Table 1)(Graph 1) to compare the microleakage of the four sealers, results revealed that there was no significant difference (P > 0.05) between the four study groups. None of the materials fully prevented the dye penetration flow. Mean apical dye leakage for Bioceramic sealer was 1.253mm which showed the least apical leakage thus ensuring the highest apical sealing ability, AH+ was 1.525mm, MTA Fillapex had 1.743mm and with the leakage of 2.425mm Tubli – Seal had the highest apical leakage.

There was no significant difference between the sealers according to the Post Hock test (Table 2), in multiple comparison, all the sealers showed the same amount of apical dye leakage.

Results

Maximum linear penetration was measured in Tubli – Seal EWT, which was 9mm. The average penetration of dye in Tubli – Seal EWT was 2.425mm. MTA fillapex showed better sealability than Tubli – Seal EWT but not more than AH+ and Bioceramic sealer, MTA Fillapex samples had dye penetration of about 1.743mm. Minimum dye penetration was observed in Bioceramic sealer with the mean value of 1.253mm followed by AH+ with an average penetration of about 1.743mm.

Discussion

Conflicting results have been presented when different materials and methodologies are used to determine the quality of obturation. In this study, the dye penetration method was used to compare the quality of apical seal between different sealers. Various types of dyes and techniques such as India ink, methylene blue, bacterial penetration and filtration of fluids have been used to evaluate the sealing ability of filling materials, however, as the dyes have smaller molecules than the pathogens that they intend to simulate, dyes application might have questionable validity. In contrast to this finding, a review of a large number of studies done on fluid filtration showed that the penetration of particles or solutions between the filling material and root canal walls are adequate measures to assess whether the root canal filling has adequate seal or not.[3] Henceforth the current day study is based on dye penetration method.

Leakage into the root canal system could occur via. four possible routes, through the apical foramen, between the root filling material or root canal wall, through the apical foramen by infusion into the material, from the outside of the tooth through the exposed cementum, accessory canals, secondary canals or defects in the coating surface and through the coronal access cavity. [4] In our study the last two routes were closed with nail varnish so the leakage observed in the study is only through apical foramen.

In 82% of leakage studies in endodontics, dye or radioisotope penetration methods have been used. Matloff *et al*. showed that methylene blue dye penetrates far further into the canal than isotope tracers, thus giving a better representation of apical leakage.[5]

Schafer and Olthoff stated that although greater linear dye penetration does not furnish data about area, it provides sufficient data about apical leakage.[6]

This dye presents a few disadvantages such as dissolution during the demineralization and in clearing process, in addition to being difficult to observe its maximum penetration point in some eases.

On the other hand Barthel *et al*. suggested that the molecular size of the dye may not be a relevant parameter in leakage tests.[7]

Indian ink particles with diameter smaller than or equal to 3 pm are also widely used, as it is unlikely that bacterial invasion would occur in spaces inside the canal where this dye is unable to penetrate.[8]

Among various types of sealer used today AH plus has gained better results due to its contents of adamantine and bonds to root canal. It is a two-component paste root canal sealer. AH plus has greater adhesion to root dentin than, it can be likely due to the fact that, as an epoxy resin-based sealer, AH Plus has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin.[5] The resin sealer resisted the dye penetration better than the other three sealers because of formation of the hybrid layer.

A similar study conducted in 2016 by Gusiyska *et al.* showed the same results, lowest leakage values were shown by AH plus. As it is a two-component epoxy resin based material, based on polymerization reaction of epoxy resin-amines and showed good sealing ability[1], similar study conducted by Ozgur *et al.* (2014) gave same results as that of the current study, minimum microleakage values were obtained from the teeth obturated with AH Plus as compared to EndoREZ and Hybrid Root Seal[7], similarly Chandra Vijay Singh *et al.* (2014) conducted an SEM study on comparison of penetration depth of three root canal sealers. Accordingly, statistically significant difference was found between AH Plus sealer and Resino Seal sealer and Zinc Oxide Eugenol sealer and concluded that AH Plus showed maximum penetration depth into dentinal tubules and hence the maximum sealing capability and the least was shown by the Zinc Oxide Eugenol sealer. Results of this study completely coincide with that of the current day study.[9] Johannes Ebert *et al.* (2014) conducted a study, both forms of GuttaFlow showed very good and predictable sealing ability when compared with the former versions of GuttaFlow as well as with the established sealer AH Plus, and hence this study showed up deviation from the current day study results.[10]

Hitesh Gupta (2013) conducted a study to check the sealing ability of sealers and favoured the current study results, as the AH Plus showed the highest bond strength to the dentinal tubules and hence showing the highest sealing abilities.[11] A study conducted by Anil Kumar S. *et al.* in 2011 to compare and evaluate the apical sealing ability and adaptation to dentine of three resin based sealers(Epiphany, AH Plus and Endorez) concluded that Epiphany had better apical sealing ability and better adaptability to dentine than epoxy based AH Plus sealer and methacrylate based Endorez sealer.[12]

Endosequence BC Sealer is a recently introduced Calcium Silicate based BC sealer, described by its manufacturer as an insoluble, radiopaque, aluminum-free material that requires the presence of water to set and harden. BC sealer being biocompatible and hydrophilic in nature it expands on setting forming a ‘self seal’, this expansion can reach upto 0.2% on completion of setting reaction. This expansion, chemical and micromechanical bonding all in total increase the bonding of the sealer to root canal walls. Adding to this, high pH (12.8) during the initial 24 hours of the setting process makes this sealer strongly antibacterial.[5]

The composition of the powder in this cement is similar to gray MTA Angelus, consisting of Portland cement clinker and bismuth oxide. The development of MTA based sealer aimed at the achievement of an endodontic sealer combining the biological and sealing properties of MTA. It presents volumetric expansion during setting due to water sorption caused by the presence of calcium oxide; this characteristic may increase its solubility, thus raising the risk of leakage over time.[13]

Our results coincide with the study conducted by Bruno Carvalho *et al*, according to which AH Plus showed better results at longer observation periods. MTA Sealapex, and

MTA-Obtura showed progressively increased leakage over extended experimental periods.[13]

More leakage with the zinc oxide eugenol sealer as compared to the other three sealers may be due to its non-adherence to the root canal dentinal walls. In this study, there was less leakage and better seal of the root canals obturated using resin based, Bioceramic based and MTA based sealers when compared with zinc oxide eugenol sealer.[14]

This study has the limitation that it used the classical dye penetration method. It is recommended that future studies using dye-extraction, i.e., dissolution method and fluid filtration method on a larger sample and in vivo analysis should be performed to confirm sealing ability of newer endodontic sealers.[2]

Another reason for leakage could be due to incomplete removal of smear layer and other factors such as presence of accessory canals, fins or oval-shaped canals that are difficult to prepare and fill adequately.[15]

Conclusion

Results showed that there was no significant difference between the four sealers, which means all the groups had almost same sealing abilities and any one of them can be used clinically.

However, the leakage values varied the result and showed that AH Plus had the least leakage value of 1.253 mm, followed by bioceramic sealer 1.525 mm, MTA Fillapex 1.743 mm and finally with the maximum value of dye leakage Tubli – Seal EWT with the leakage value of 2.425 mm.

Further studies need to be done with larger sample size and with comparative incorporation of more new sealers to substantiate the results obtained.

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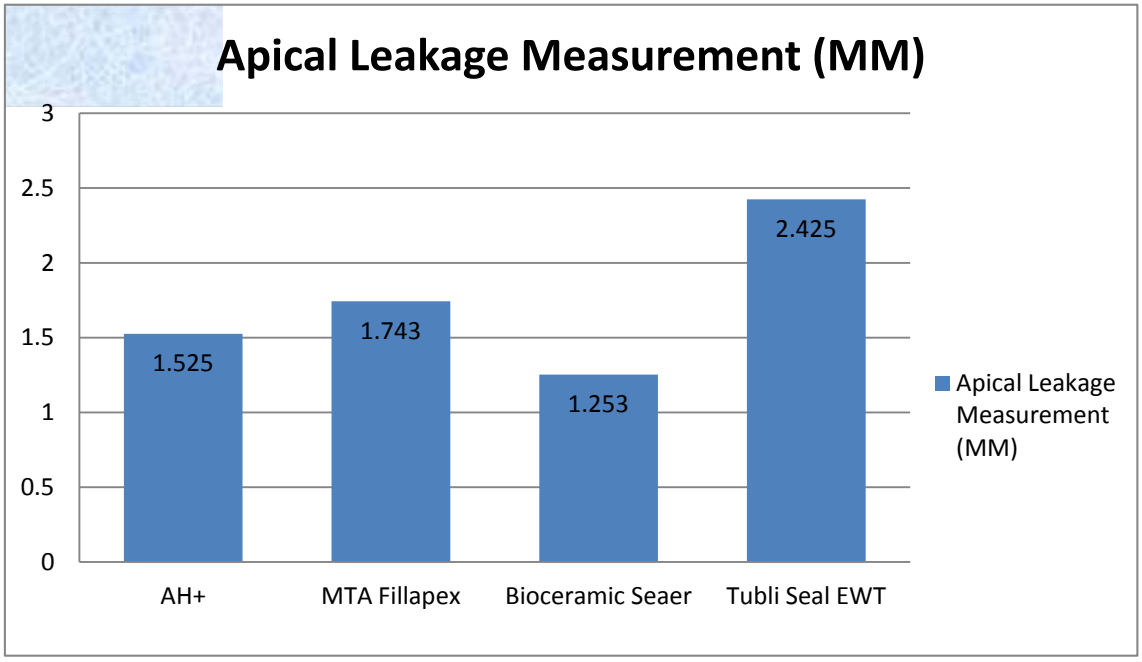
Legends Figure and Tables



Graph 1:Mean apical leakage has been demonstrated.

Group	N	Mean	Std. Deviation	Minimum	Maximum	ANOVA	P-Value
AH+	20	1.525	1.6341	.0	7.0	1.828	.149
MTA Fillapex	20	1.743	1.8310	.0	7.0		
Bioceramic Sealer	20	1.253	.9915	.0	4.0		
Tubli Seal EWT	20	2.425	1.9952	.0	9.0		
Total	80	1.736	1.6832	.0	9.0		

Table 1: Apical leakage measurement (mm)

Group	Group	Mean Difference	P-Value	Interpretation
AH+	MTA Fillapex	.2175	.982	Non-Significant Difference
	Bioceramic Sealer	.2725	.965	Non-Significant Difference
	Tubli Seal EWT	.9000	.405	Non-Significant Difference
MTA Fillapex	Bioceramic Sealer	.4900	.831	Non-Significant Difference
	Tubli Seal EWT	.6825	.640	Non-Significant Difference
Bioceramic Sealer	Tubli Seal EWT	1.1725	.181	Non-Significant Difference

Table 2: Scheffe (Post Hock Test)