

ORIGINAL ARTICLE

**EVALUATION OF THE APICAL SEALING ABILITY OF BIOCERAMIC AND AH PLUS ROOT CANAL SEALERS – AN IN VITRO STUDY**

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**ABSTRACT**

**OBJECTIVE:** Evaluation of apical sealing ability of Bioceramic and AH plus root canal sealers, An in-vitro study.

**METHODOLOGY:** This in vitro non-probability convenient sampling study was conducted at the Department of Operative Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro from June to December 2018. Fresh extracted 32 teeth were included and their crowns were sectioned at Cemento-Enamel Junction/service to obtain 12mm standard root length. The access cavity was gained using endodontic instruments. The teeth were divided in two groups, in Group A (n=16) MTA Bioceramic and in Group B (n=16) AH Plus were used as root canal sealers by single cone obturation technique. The obturated specimens were stored in humid conditions for one week. All root surfaces were painted with double layer of nail varnish sparing apical 2 mm, and then dipped in an aqueous solution of 1% methylene blue dye for 72 hours. Later on roots were longitudinally splited/sectioned. Linear dye penetration was measured with Stereomicroscope at 30<sup>X</sup> magnification. Analysis was done using SPSS version 20.

**RESULTS:** Mean and standard deviation of dye leakage for Bioceramic was 2.25±0.9 whereas for AH Plus was significantly lower, 1.19±0.75. Teeth included in Group A were central incisors 37.5%, lateral incisors 18.8%, canine 12.5%, lower first premolars 12.5% and second premolars 6.3%, whereas Group B consisted of central incisors 18.8 %, lateral incisors 12.5 %, canine 12.5%, lower first premolars 18.8 % and second premolars 6.3%. Dye leakage was higher in Group A compared to Group B with significant P-value < 0.001.

**CONCLUSION:** In this in-vitro study AH Plus showed the least microleakage.

**KEYWORDS:** Methylene Blue, Dye, Microleakage, Bioceramic, Apical Seal, Root Canal Sealers, Obturation, MTA, AH plus.

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**INTRODUCTION**

Primary objective of a root canal therapy (RCT) is the elimination of any diseased tissue from canal of roots, and creation of sterile environment to obturate root canals for achieving fluid tight seal which prevent reinfection<sup>1</sup>. Any leakage in this treatment results in treatment failure. A number of factors such as patient compliance, isolation, debridement or inadequate canal seal may result in a RCT failure<sup>2</sup>.

The roots have complex anatomic variations, which includes curvatures, lateral and accessory canals, apical constrictions, ramifications and off center apical foramen. That creates a great challenge in complete debridement of root canals. Micro-leakage may occur due to carious exposure of pulp tissue, traumatic injuries resulting in enamel or dentine cracks, infection in dentinal tubules. Whereas accessory or lateral canals may also provide the possible route for invasion of microflora into canal space<sup>3</sup>.

The use of NiTi rotary instruments and single cone obturation technique of gutta percha (GP) have gained popularity in recent times. GP points alone don't provide tight seal in the root canal of teeth. Therefore to obtain impervious seal, it is used along with a sealer to obtain a three dimensional seal at sealer-dentin interface. Thus, choice of good endodontic sealer has an important role in creating and maintaining root canal seal<sup>4</sup>.

The good root canal sealing material makes an excellent seal with dimensional stability, and slow setting time to provide sufficient working time. As well as insoluble in tissue fluids. It should have adequate adhesion with canal walls and should be inert, biocompatible and easily removed on retreatment<sup>5</sup>.

A range of sealers is available based on Zinc oxide-eugenol, epoxy resin, silicone, methacrylate resin, MTA, calcium silicate, calcium phosphate and Bioceramic Sealers. Most widely used are calcium hydroxide, zinc oxide eugenol or resin based sealers. AH plus is an epoxy resin based sealer and is most commonly used in recent times. Likewise Bioceramics are based on zirconium oxide, di and tri calcium silicates, calcium phosphate, calcium hydroxide, and fillers. Which are relatively easy to use in a premixed injectable syringe or as powder and liquid. In Pakistan a recently published nationwide survey has reported that Calcium Hydroxide and epoxy based, endomethasone are commonly used<sup>6</sup>.

In literature there are various dyes used to assess microleakage such as radioisotopes and glucose. A number of dyes are available but Methylene blue was chosen due to its low molecular size<sup>7</sup>.

The aim of this study was to evaluate the sealing ability of two endodontic sealers including epoxy resin based AH plus and a MTA Bioceramic Sealer through an *In-vitro* dye leakage test.

**METHODOLOGY**

In this in vitro study sample was collected by non-probability convenient sampling technique. Study was conducted at the Department of Operative Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro from June to December 2018. The freshly extracted 32 teeth were included. The inclusion criteria were single rooted permanent maxillary and mandibular teeth, extracted for orthodontic reasons, with straight roots and patent canal. Whereas previously root canal treated, teeth with root caries, external and internal resorption, and fractured root were excluded. All teeth were cleansed externally by ultrasonic scalar, rinsed and placed in 10% Formalin (antiseptic solution) for 24 hours. Teeth were conveniently divided into two groups i.e.: Group A: (n=16) and Group B: (n=16). Their crowns were cut sectioned at cervical line (cemento-enamel junction), and root access openings were prepared. The root lengths were standardized at 12 mm of all teeth. Working length (WL) was measured about 1 mm short to standard length/apical foramen. And 11mm canal length was prepared of samples using Universal Rotary File System (Protaper Dentsply, Tulsa Dental Specialties). Freshly prepared solution of 5.25% Sodium hypochlorite and saline were used to flush out the canal debris using a disposable syringe, whereas paper points were used to dry the canals. All teeth roots were obturated using single cone GP points technique. Teeth in Group A; were obturated/sealed using Bioceramic MTA (Fillapex Angelus, Londrina, Brazil), whereas teeth in Group B: were sealed with AH Plus sealer (Dentsply, Sirona, USA). After that coronal portions of all roots were filled with type 2 Glass ionomer cement (ketac™ Molar 3M ESPE). Later on samples were left for 1 week in humid conditions.

***DYE LEAKAGE TEST***

W.P.Saunders criteria for dye leakage scoring was used, which is numerical and 0=no leakage detected, 1= less than 0.5mm, 2= 0.5 to 1mm and 3= leakage more than 1mm respectively. Whereas scores of 0-1 were termed as having good seal, and scores of 2-3 were having poor seal.

After a week all the surfaces of roots were painted with a double layer of nail varnish except apical 2 mm of root. Samples were dipped in 1% methylene blue dye for 72 hours. Afterwards roots were thoroughly washed and dried in air, and were sectioned longitudinally with diamond disc. The sectioned roots were observed with stereomicroscope at 30<sup>x</sup> magnifications to measure the penetration of dye in millimeters.

Data was analyzed using SPSS version 20. Confidence interval was set at 95%, whereas t test was used to compare between groups. And frequency, means and standard deviations were determined.

**RESULTS**

Teeth included in Group A were central incisors 37.5%, lateral incisors 18.8%, canine 12.5%, lower first premolars 12.5% and second premolars 6.3%. Whereas Group B consisted of central incisors 18.8 %, lateral incisors 12.5 %, canine 12.5%, lower first premolars 18.8 % and second premolars 6.3%. Dye leakage was higher in Group A compared to Group B with significant P-value < 0.001. The frequency of sample with depth of vertical dye penetration in two groups A and B have been shown in Table I. Means and standard deviations of dye penetration in groups A and B for depth of dye penetration and comparison of both groups by applying independent sample t-test are given in Table II with significant statistical differences P= 0.001.

**TABLE I: DYE PENETRATION SCORES OF TWO GROUPS**

LEAKAGE SCORE	GROUP A (n=16) MTA SEALER		GROUP B(n=16)AH PLUS SEALER	
	Sample Frequency	Percentage	Sample Frequency	Percentage
0	1	6.3%	2	12.5%
1	2	12.5%	10	62.5%
2	5	31.3%	3	18.8%
3	8	50%	1	6.3%
Total	16	100%	16	100%

**TABLE II: STATISTICS OF BOTH GROUPS WITH INDEPENDENT SAMPLE T-TEST**

GROUPS	N=32	Mean	Std Deviation	P. VALUE
A=BIOCERAMIC	16	2.25	.93	0.001
B= AH PLUS	16	1.19	.75	

**DISCUSSION**

The main purpose of root canal obturation should be complete filling of a root canal and its associated lateral canals three dimensionally<sup>8</sup>. Microleakage whether coronal or apical has deleterious effects over root canal treated teeth causing failure of treatment<sup>9</sup>. Apical portion of root canals have complex anatomy, so it is at higher risk of microleakage unless adequate measures are taken to ensure a hermetic seal, even after which it is impossible to seal the apex entirely<sup>10</sup>.

The primary objective of a sealer, as suggestive of its name is to provide an impermeable fluid tight seal<sup>11</sup>. Each sealer offers different physico-chemical properties and a wide range of these materials are available. So there is always a room for more studies<sup>12</sup>. This study focused on the canal sealing ability of two endodontic sealing materials. Which includes a Bioceramic based MTA Fillapex and a Resin based AH Plus sealer. Both materials were used with a single cone GP points obturation technique<sup>13</sup>. Due to the complex anatomical importance of root apical region, this study had also focused on apical third of root specifically. Performance of these contemporary sealers was assessed on the basis of linear penetration of dye in root canals<sup>14</sup>. The dye leakage scores were recorded under stereomicroscope. Methylene blue dye was used as a marker in this experiment due to its small molecular size, mimicking the effect of bacterial leakage<sup>15</sup>.

In this dye leakage study significant statistical differences were observed between two groups with P-value < 0.05. The mean dye leakage observed for MTA Fillapex in Group A was  $2.25 \pm 0.93$ , while that for AH Plus in Group B was calculated to be  $1.19 \pm 0.75$ . Hence according to these results, teeth obturated with resin based AH Plus showed least dye penetration scores, showing better apical sealing ability than MTA Fillapex<sup>16</sup>.

The results of this study are comparable to a similar dye leakage study on 51 freshly extracted teeth using 2% methylene blue dye, reported MTA Fillapex to have inferior seal in comparison to AH Plus and ProRoot MTA<sup>17</sup>. The results of their study showed greater microleakage values ( $p < 0.05$ ) in MTA group without any statistically significant differences in other two groups<sup>18</sup>. Other similar studies were conducted matching our experiment. They also compared apical seals of resin based Ad sealer similar in composition to AH Plus with MTA Fillapex and ProRoot MTA. Their results are based on observation made under stereomicroscope magnification 40<sup>x</sup>. Results of their study are also in agreement with current work showing AH Plus to have better apical seal than the other two Bioceramic sealers<sup>19</sup>. Solubility of the sealer is another factor and is associated with quality of the seal. In accordance with ANSI/ADA standards and others reported MTA Fillapex to have higher solubility as compared to AH Plus<sup>19</sup>. Although current study suggests the inferior apical sealing properties of MTA Fillapex on the basis of dye leakage at micron level which is undesirable clinically. Multiple other factors are also involved in the success and failure of a root canal therapy<sup>20</sup>. Careful evaluation of all these factors is required as well.

**LIMITATIONS**

The materials were compared in the light of following limitations;

- There was a limited sample size which may not be sufficient.
- For comparison, more sealers have not been added in the study.
- Single cone obturation technique is considered to be inferior as compared to more advanced warm vertical 3 D compaction techniques.

**CONCLUSION**

Thus it can be concluded on the basis of this study that AH Plus offers better apical seal as compared to Bioceramic based MTA Fillapex sealers.

**Conflict of Interest:** There is no conflict of interest

**Funding:** Funding was not requested/self-funded

**REFERENCES**

1. Kulkarni G. Apical seal between adhesive root canal obturation system and gutta-percha/ah-plus sealer: An in vitro comparison study. *J Evid Based Med. Health.* 2016; 3(32): 1497-1501.
2. Ballullaya SV, Vinay V, Thumu J, Devalla S, Bollu IP, Balla S. Stereomicroscopic dye leakage measurement of six different root canal sealers. *J Clin Diag Res.* 2017; 11(6): 65.
3. Huang Y, Orhan K, Celikten B, Orhan AI, Tufenkci P, Sevimay S. Evaluation of the sealing ability of different root canal sealers: a combined SEM and micro-CT study. *J Applied Oral Sci.* 2018; 26.
4. Al-Maswary AA, Alhadainy HA-H, Al-Maweri SA. Coronal microleakage of the resilon and gutta-percha obturation materials with epiphany SE Sealer: An in-vitro Study. *J Clin Diagn Res:* 2016; 10(5): ZC39.
5. Salem AS, Saleh AR, Elmasmari HA. Assessment of Apical Leakage of Bioceramic Endodontic Sealer with Two Obturation Techniques. *Open Dent J.* 2018; 12(1).
6. Asawaworarit W, Pinyosopon T, Kijssamanmith K. Comparison of apical sealing ability of bioceramic sealer and epoxy resin-based sealer using the fluid filtration technique and scanning electron microscopy. *J Dent Sci.* 2020; 15(2): 186-92.
7. Rahawi OS, Ahmed MB, Ismail SA. Evaluation of Apical Microleakage of Endodontically Treated Teeth Sealed With Three Different Root Canal Sealers. *Al-Rafid Dent J.* 2019; 19(1): 11-9.
8. Daoudi MF, Saunders WP. In vitro evaluation of furcal perforation repair using mineral trioxide aggregate or resin modified glass ionomer cement with and without the use of the operating microscope. *J End.* 2002; 28(7): 512-5.
9. Ahirwar A, Kumari D, Chohan A, Shilpa M. In vitro Evaluation of Sealing Ability and Marginal Adaptation of Different Root canal Sealers. *J Adv Med Dent Sci Res.* 2019; 7(3): 112-5.
10. Poggio C, Dagna A, Ceci M, Meravini MV, Colombo M, Pietrocola G. Solubility and pH of bioceramic root canal sealers: a comparative study. *J Clin Exp Dent.* 2017; 9(10): 1189.
11. Patri G, Agrawal P, Anushree N, Arora S, Kunjappu JJ, Shamsuddin SV. A Scanning Electron Microscope Analysis of Sealing Potential and Marginal Adaptation of Different Root Canal Sealers to Dentin: An In Vitro study. *J Contemp Dent Pract.* 2020; 21(1): 73-7.
12. Vula V, Ajeti N, Kuçi A, Stavileci M, Vula V. An In Vitro Comparative Evaluation of Apical Leakage Using Different Root Canal Sealers. *Med Sc Mon Basic Res.* 2020; 26: 928175-1.
13. Rathod RK, Taide PD, Dudhale RD. Assessment of antimicrobial efficacy of bioceramic sealer, epiphany self-etch sealer, and AH-plus sealer against *Staphylococcus aureus* and *Candida albicans*: An In vitro study. *Niger J Surg.* 2020; 26(2): 104.
14. Raghavendra SS, Jadhav GR, Gathani KM, Kotadia P. Bioceramics in endodontics - a review. *J Istanbul Univ Fac Dent.* 2017; 51(1): 128-37.

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15. Oltra E, Cox TC, LaCourse MR, Johnson JD, Paranjpe A. Retreatability of two endodontic sealers, EndoSequence BC Sealer and AH Plus: a micro-computed tomographic comparison. *J Restor Dent Endod.* 2017; 42(1): 19-26.
16. Ahuja L, Jasuja P, Verma KG, Juneja S, Mathur A, Walia R, et al. A Comparative Evaluation of Sealing Ability of New MTA Based Sealers with Conventional Resin Based Sealer: An In-vitro Study. *J Clin Diagn Res.* 2016; 10(7): 76-79.
17. Bhatti UA, Qureshi B, Azam S. Trends in Contemporary Endodontic Practice of Pakistan: A National Survey. *J Pak Dent Assoc.* 2018; 27(2): 50-56.
18. El Sayed MA, Al Hussein H. Apical dye leakage of two single-cone root canal core materials (hydrophilic core material and gutta-percha) sealed by different types of endodontic sealers: An in vitro study. *J Conser Dent.* 2018; 21(2): 147.
19. de Melo TV, Prado MC, Junior RH, Fidel SR, da Silva EJ, Sassone LM. Improved sealing ability promoted by calcium silicate-based root canal sealers. *Braz J Oral Sci.* 2018; 17: 18148.
20. Hasnain M, Bansal P, Nikhil V. An in vitro comparative analysis of sealing ability of bioceramic-based, methacrylate-based, and epoxy resin-based sealers. *Endodontology.* 2017; 29(2): 146.