Original Article

# Evaluation of the Apical Sealing Ability of Bioceramic and AH Plus Root Canal Sealers – An In Vitro Study

Ramla Rizvi, Saleem Raza Khuhawar, Ashique Hussain Sahito, Muhammad Rafique Tagar, Sumaira Rafique, Wasfa Rasheed

**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-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 into two groups, in Group A (n=16) MTA Bioceramic and in Group B (n=16) AH Plus was used as root canal sealers by single cone obturation technique. The obturated specimens were stored in humid conditions for one week. Analysis was done using SPSS version 20.**

**RESULTS: Mean and standard deviation of dye leakage for Bioceramic were 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 a significant P-value < 0.001.**

**CONCLUSION: It can be concluded based on this study that AH Plus offers a better apical seal as compared to Bioceramic-based MTA Fillapex sealers.**

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

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## INTRODUCTION

The primary objective of root canal therapy (RCT) is the elimination of any diseased tissue from the canal of roots, and the creation of a sterile environment to obturate root canals for achieving a fluid-tight seal that prevents reinfection[1]. Any leakage in this treatment results in treatment failure. Several factors such as patient compliance, isolation, debridement, or inadequate canal seal may result in an RCT failure[2].

The roots have complex anatomic variations, which include 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[3].

The use of NiTi rotary instruments and the single cone obturation technique of gutta-percha (GP) have gained popularity in recent times. GP points alone don't provide a 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 the sealer-dentin interface. Thus, the choice of a good endodontic sealer has an important role in creating and maintaining root canal seal[4].

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[5].

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 tricalcium 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[6].
In literature, there are various dyes used to assess microleakage such as radioisotopes and glucose. Several dyes are available but Methylene blue was chosen due to its low molecular size[7].
This study aimed to evaluate the sealing ability of two endodontic sealers including epoxy resin-based AH plus and an 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. The 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 an ultrasonic scaler, 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 the cervical line (cementoenamel 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. An 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 the 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 a good seal and scores of 2-3 were having a poor seal.
After a week all the surfaces of roots were painted with a double layer of nail varnish except apical 2 mm of the root. Samples were dipped in 1% methylene blue dye for 72 hours. After words roots were thoroughly washed and dried in air and were sectioned longitudinally with a diamond disc. The sectioned roots were observed with a stereomicroscope at $30^x$ magnifications to measure the penetration of dye in millimeters.
Data were analyzed using SPSS version 20. The confidence interval was set at 95%, whereas a 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 a significant P-value < 0.001. The frequency of sample with a 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 | 0.93 | 0.001 |
| B= AH PLUS | 16 | 1.19 | 0.75 | |

## DISCUSSION

The main purpose of root canal obturation should be the complete filling of a root canal and its associated lateral canals three dimensionally[8]. Microleakage whether coronal or apical has deleterious effects over the root canal treated teeth causing failure of treatment[9]. The apical portion of root canals has

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[10].

The primary objective of a sealer, as suggestive of its name is to provide an impermeable fluid-tight seal[11]. Each sealer offers different Physico-chemical properties and a wide range of these materials are available. So there is always room for more studies[12]. 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 techinique[13]. Due to the complex anatomical importance of the root apical region, this study had also focused on the apical third of the root specifically. The performance of these contemporary sealers was assessed based on linear penetration of dye in root canals[14]. The dye leakage scores were recorded under a stereomicroscope. Methylene blue dye was used as a marker in this experiment due to its small molecular size, mimicking the effect of bacterial leakage[15].

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±0.93, while that for AH Plus in Group B was calculated to be 1.19±0.75. Hence according to these results, teeth obturated with resin-based AH Plus showed the least dye penetration scores, showing better apical sealing ability than MTA Fillapex[16].

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 an inferior seal in comparison to AH Plus and ProRoot MTA[17]. The results of their study showed greater microleakage values ($p < 0.05$) in the MTA group without any statistically significant differences in the other two groups[18]. 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 the observation made under stereomicroscope magnification $40^x$. Results of their study are also in agreement with current work showing AH Plus to have a better apical seal than the other two Bioceramic sealers[19].

Solubility of the sealer is another factor and is associated with the quality of the seal. Following ANSI/ADA standards and others reported MTA Fillapex to have higher solubility as compared to AH Plus[19]. Although the current study suggests the inferior apical sealing properties of MTA Fillapex based on 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[20]. Careful evaluation of all these factors is required as well.

***Limitations***

- The materials were compared in the light of the following limitations;
- There was a limited sample size which may not be sufficient.
- For comparison, more sealers have not been added to the study.
- The single cone obturation technique was considered to be inferior as compared to more advanced warm vertical 3 D compaction techniques.

## CONCLUSION

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

**Ethical Permission**: Liaquat University of Medical & Health Sciences REC permission letter No. LUMHS/ REC/-688, Dated 08-06-2018.

**Conflict of Interest:** There is no conflict of *interest among the authors.*

**Financial Disclosure / Grant Approval:** There was no funding agency / self-funded study.

**DATA SHARING STATEMENT**: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## AUTHOR CONTRIBUTIONS

Rizvi R: Conception, design, collection of data
Khahawar SR: Critical revision of article for important intellectual content, final approval
Sahito AH: Drafting of article, analysis & interpretation of data
Tagar MR: Analysis & interpretation of data, drafting of article
Rasheed S: Critical revision of article for important intellectual content & data analysis
Rasheed W: Statistical expertise and assembly of data

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*AUTHOR AFFILIATION:*

**Dr. Ramla Rizvi**
PG Trainee, Liaquat University of Medical and Health Sciences
(LUMHS), Jamshoro, Sindh-Pakistan.

**Dr. Saleem Raza Khuhawar**
*(Corresponding Author)*
Associate Professor
Department of Oral Biology
Bibi Aseefa Dental College (BADC) @ SMBB Medical University
Larkana, Sindh-Pakistan.
Email: oralbiologistsaleem@gmail.com

**Dr. Ashique Hussain Sahito**
Noor Dental Surgery and Aesthetic Clinic
Nawabshah, Sindh-Pakistan.

**Dr. Muhammad Rafique Tagar**
Associate Professor
Department of Biochemistry
BADC, Larkana, Sindh-Pakistan.

**Dr. Sumaira Rafique**
PG Trainee
LUMHS, Jamshoro, Sindh-Pakistan.

**Dr. Wasfa Rasheed**
Registrar
Liaquat College of Medicine and Dentistry
Karachi, Sindh-Pakistan.