



Original Article

Evaluation of Mean Apical Sealing Ability of Bio Ceramic and AH Plus (Dentsply Sirona) Sealer in Single Rooted Teeth: An *In Vitro* Study

Jazib Memon¹, Kanza Iqbal², Mariam Raza Mallick³, Mohsin Ali Dehraj⁴, Ahsan Ali⁵ and Kelash Kumar⁶

¹Department of Operative Dentistry and Endodontics, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan

²Department of Operative Dentistry and Endodontics, Institute of Dentistry, Combined Military Hospital Lahore Medical College, Lahore, Pakistan

³Department of Operative Dentistry and Endodontics, Pakistan Institute of Medical Sciences, Islamabad, Pakistan

⁴Department of Operative Dentistry and Endodontics, Muhammad Dental College, Mirpurkhas, Pakistan

⁵Department of Operative Dentistry, Rehman College of Dentistry, Peshawar, Pakistan

⁶Department of Operative Dentistry and Endodontics, Baqai Dental College, Karachi, Pakistan

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***Corresponding Author:**

Jazib Memon

Department of Operative Dentistry and Endodontics,
 Liaquat University of Medical and Health Sciences,
 Jamshoro, Pakistan
jazib_leo@hotmail.com

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ABSTRACT

A good seal is essential to prevent bacteria from re-entering the canal. Sealers can significantly impact the success of the treatment. Understanding which sealant works better can help dentists improve the outcome of root canal treatments. **Objective:** To compare mean apical sealing ability of bioceramic sealer and AH plus sealer in single rooted tooth. **Methods:** Extracted single-rooted teeth were divided into two groups and sealed with either bioceramic or AH plus sealer. After soaking in dye solution, the depth of dye penetration was measured to assess leakage. **Results:** Bioceramic sealer showed significantly better apical sealing ability (mean 5.43 mm) compared to AH plus (mean 8.55 mm), suggesting it may be a more effective choice for preventing future problems after root canal treatment. **Conclusions:** The study concluded that bioceramic sealer is superior to AH plus in sealing the tips of single-rooted teeth. This finding can help dentists choose the most effective sealant for their patients, potentially reducing the chance of treatment failure.

INTRODUCTION

Root canal therapy aims to disinfect the inner chamber of the tooth (the root canal) and eliminate infected tissue. This creates a sterile environment essential for obturation, a process that seals the canal in three dimensions. A proper seal is crucial to prevent reinfection by isolating the tip of the root (apex), the surrounding gum tissue (periodontal space), and the entire canal. Unfortunately, inadequate sealing is a major cause of root canal failure. This can happen due to various factors like patient movement

during treatment, improper isolation of the tooth, insufficient cleaning, or failing to create a watertight seal at the end [1]. Recent advancements offer improved techniques for achieving a tight seal. One approach involves using rotary instruments made of Nickel-Titanium (NiTi) alongside specially designed gutta-percha cones. This combination, when used with a special sealing material, can create a complete and impermeable three-dimensional seal. However, sealants themselves can

sometimes be a problem. They might allow tiny leaks (microleakage) at the junction between the sealant, the dentin (tooth layer), or the core material placed on top. These leaks can provide entry points for bacteria, potentially leading to failure [2, 3]. Therefore, the success of a root canal heavily relies on the chosen sealant. An ideal root canal sealant should be biologically compatible, inert (not reactive), and strongly adhere to the canal walls after hardening. Additionally, it should provide excellent sealing properties once set. Despite ongoing research, no current sealant perfectly meets all these requirements. Several types are available, each with its own unique chemistry. Popular choices include calcium hydroxide, zinc oxide eugenol, and resin-based sealants [4, 5]. In recent years, AH plus (Dentsply Sirona) has become a favorite sealant due to its epoxy resin base. However, it has limitations. AH plus repels water (hydrophobic), which can be a disadvantage in the naturally moist environment of the mouth. Moreover, it shrinks as it hardens, potentially compromising the seal and causing microleakage [6, 7]. Bioceramics are a recent innovation in dentistry. These materials are composed of elements like zirconium oxide, calcium silicates and calcium phosphate, along with fillers and thickening agents. Despite their newness, bioceramics have gained popularity due to their high quality and user-friendliness. They come pre-mixed in syringes for injection, making them easier to use compared to traditional sealants. [8]. Previously, there was limited research comparing the effectiveness of bioceramic sealers with AH plus in sealing the tips of teeth (apical third). To address this gap, we investigated the efficacy of these sealers using a special microscope.

Our study aimed to compare how well bioceramic sealers and AH plus sealed the apices of single-rooted teeth. By understanding the differences between these sealers, dentists can choose the most suitable option for their patient's specific needs. This can significantly reduce the risk of apical microleakage and ultimately, root canal failure. This approach not only benefits patients by minimizing discomfort but also saves them time and money in the long run.

METHODS

An *in vitro* experimental study to assess the mean apical sealing ability of (insert material being tested) was conducted at the Department of Operative Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan. The study took place between October 2020 and April 2021 and received approval from the College of Physicians and Surgeons of Pakistan vide Ref No. CPSP/REU/DSG-2017-166-2145. To evaluate sealing effectiveness, researchers measured the depth of dye penetration in millimeters. Extracted teeth were filled with

the test material, then soaked in a 1% methylene blue dye solution for 72 hours. A deeper dye penetration indicates a less effective seal [9]. Nonprobability consecutive sampling was used, with a sample size of 32 in each group. The sample size was calculated using OpenEpi, based on the mean dye penetration of bioceramic sealer 5.37 ± 1.42 and AH plus (Dentsply Sirona) 8.04 ± 2.02 , with a 99% confidence interval [10]. Single-rooted teeth meeting the inclusion criteria of being permanent, single-rooted, single-canal teeth with a well-developed root, close apex, and straight roots were selected for the study. These teeth were extracted from the Department of Oral and Maxillofacial Surgery, Institute of Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro. Teeth with prior endodontic therapy, root caries, root resorption, fractures, or cracks, as well as those with curved roots, were excluded. After extraction, the teeth were preserved in normal saline following a 2-hour soak in a 2.5% sodium hypochlorite solution. The teeth were then decoronated 12 mm from the apex to make the canals accessible. Finishing and shaping were performed using rotary protaper files, with irrigation using a 2.5% sodium hypochlorite solution. Sterile paper tips were inserted once the canals were dry. After fulfilling the inclusion criteria, teeth were divided into two groups. In group A, the canals were obturated using an endosequence bioceramic sealer, while in group B, AH plus (Dentsply Sirona) sealer. The coronal opening was then sealed with glass ionomer cement, and varnish was applied to the teeth's surfaces 2 millimeters before the apex. The teeth were immersed in a 1% methylene blue dye solution for three days, followed by thorough rinsing with water. The teeth were then sliced in half lengthwise using diamond discs, and dye penetration was measured using a stereomicroscope (Figure 2 and 3). These results were used to record all data in a proforma. SPSS 20.0 was used to analyze the data. Mean apical sealing ability was assessed by dye penetration depth and the means and standard deviations for both sets of sealers were calculated (in mm). The data on teeth were presented as a frequency and percentage distribution. Using a T-test, the mean apical sealing ability of the two groups was compared. P-value ≤ 0.05 was considered as significant.

RESULTS

The tooth in the study consists of equal distribution of Maxillary Central Incisor (18%), Maxillary Lateral Incisor (7%), Maxillary Canine (8%), Mandibular Central Incisors (15%), Mandibular Lateral Incisor (12%), Mandibular Canine (4%), Mandibular 1st premolar (32%) and mandibular 2nd premolar (4%) as shown in figure 1.

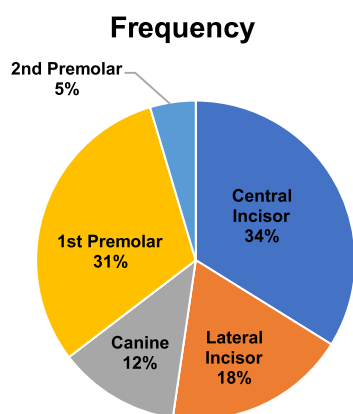


Figure 1: Distribution of Various Tooth Types According to Frequency

The mean apical sealing ability of bioceramic sealer was 5.43 ± 0.43 , and the mean apical sealing ability of AH plus (Dentsply Sirona) sealer was 8.55 ± 0.25 in single-rooted plants. P-value was 0.01 as shown in table 1.

Table 1: Mean Dye Penetration Depth in Both Groups

Groups	Bioceramic Sealer Treatment (Group A) Mean \pm S.D	AH Sealer Treatment (Group B) Mean \pm S.D	p-Value
Depth of Dye Penetration (mm)	5.43 ± 0.43	8.55 ± 0.25	0.01

Confocal laser microscopy shown the interfacial gaps and sealant depth at apical area. The comparison between bioceramic sealers and AH plus is visually represented, highlighting the differences in sealant profiles and gap formation as shown in figure 2.

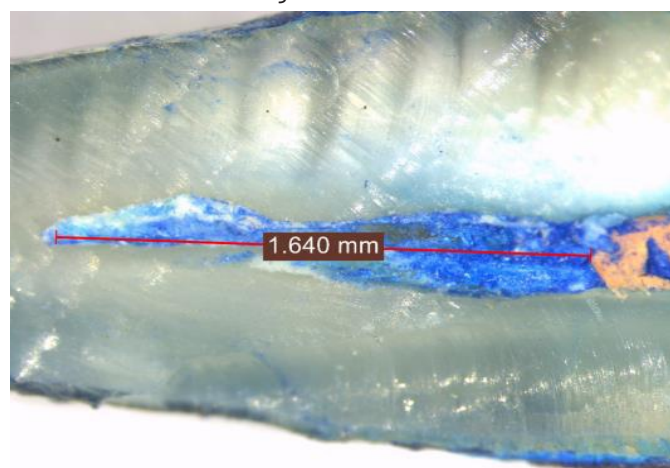


Figure 2: Dye Penetration in AH Plus Sealer Showing Leakage Depth

Utilizing confocal laser microscopy, the study illustrates interfacial gaps and sealant depth at the apical area, visually contrasting bioceramic sealers with AH plus, emphasizing differences in sealant profiles and gap formation as shown in figure 3.

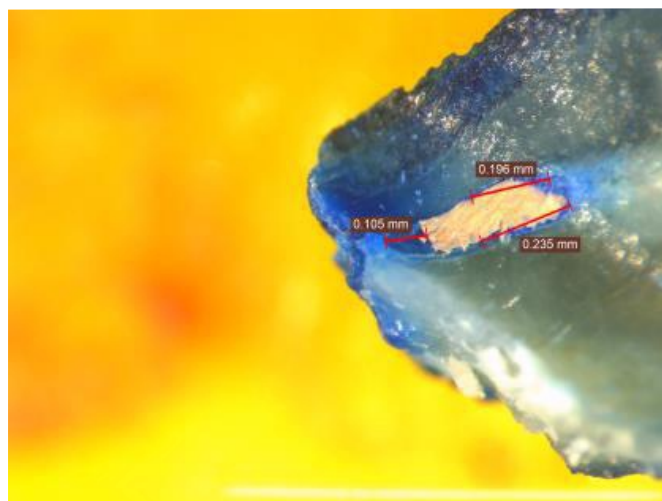


Figure 3: Dye Penetration Depth Showing Bioceramic Sealer

DISCUSSION

Root canal therapy is successful if the root canal system is properly debrided, pathogenic organisms are eradicated, and the canal area is sealed to prevent the flow of fluid. Utilizing an endodontic sealer in conjunction with a core material, a fluid-tight seal is created. If the sealer and core materials combine to produce a single mass that chemically adheres to the dentine, leakage can be reduced. Since it is biocompatible, readily accessible, radiopaque and easy to apply, the use of AH plus (Dentsply Sirona) sealant to fill root canals has gained in popularity [11, 12]. AH plus (Dentsply Sirona) is an adamantine-containing epoxy-bis-phenol resin that attaches to the root canal wall. AH plus (Dentsply Sirona) root canal sealant is a two-component paste/paste formulation. Since the epoxy resin in AH plus (Dentsply Sirona) sealer makes it adhere more securely to the dentin in your teeth's roots, you will experience fewer leaks. Due to its creep capacity and long setting time, AH plus (Dentsply Sirona) enhances the mechanical contact between the sealer and the root dentin, helping it to penetrate further into the micro defects [13]. As demonstrated by Pawar et al., experiment's insufficient bonding between the sealant and the gutta-percha site allows for leakage at this contact [10]. AH plus (Dentsply Sirona) has a quicker setting time and contains resin, both of which lead to untimely root canal debonding. Mineral Trioxide Aggregate (MTA) is a promising biomaterial for root end fillings, pulpotomies, apexifications and perforation repairs, according to the dental community [8, 14, 15]. MTA, a bioactive material, can develop a surface coating of hydroxyapatite or carbonated apatite when exposed to a phosphate-containing solution for two months. This interfacial layer forms a chemical interaction between the MTA and the dentinal walls. Sealing ability and limited adjustability are two of MTA's greatest strengths. Its retention properties increased from 24 to 72 hours while

being 50% smaller than standard MTA and less than 1 micron in size. The two most important roles of a root canal filling material are sealing off the channel and preventing the entry of microorganisms. It aids in microbial control if any bacteria remain in the canal walls or tubules and creates an impermeable seal between the core filling material and canal wall [16, 17]. The results of the study show that there was an equal distribution of various types of teeth used in the study, including maxillary central incisor, maxillary lateral incisor, maxillary canine, mandibular central incisors, mandibular lateral incisor, mandibular canine, mandibular first premolar, and mandibular second premolar. The mean apical sealing ability of the bioceramic sealer was found to be 5.43 ± 0.43 , while the mean apical sealing ability of the AH plus (Dentsply Sirona) sealer was 8.55 ± 0.25 in single-rooted teeth. The P-value of the study was found to be 0.01, which suggests a statistically significant difference between the mean apical sealing ability of the two sealants. These results indicate that the AH plus (Dentsply Sirona) sealer was more effective in sealing the apices of the teeth compared to the bioceramic sealer. Based on these results, dentists can consider the use of the AH plus (Dentsply Sirona) sealer for root canal therapy as it is more effective in sealing the apices of the teeth. This can reduce the risk of apical microleakage and endodontic treatment failure, thereby providing patients with more comfortable and cost-effective treatment options. Pawar et al., did a study which is like findings in our study with bioceramics showing less leakage than AH plus (Dentsply Sirona) sealer [10]. In his study he utilized 75 extracted human permanent teeth with a single root. The root canals were instrumented, and the teeth were decorated. The specimens ($n = 25$) were obturated using a process involving continuous wave condensation and then randomly divided into three groups. Group A utilized the Endosequence BC, Group B utilized the AH plus (Dentsply Sirona) sealer, and Group C utilized the Resilon-Epiphany system. Microleakage was determined using the dye penetration method. At 2, 4, and 6 mm from the pointed end, horizontal lines were produced by slicing the teeth lengthwise through the middle. Under a stereomicroscope, authors measured the dye's penetration depth (30X magnification). Group B demonstrated greater vertical and horizontal dye penetration than groups A and C, showing that the root canal was more effectively sealed with the new BC sealer and Epiphany sealer than with the AH plus (Dentsply Sirona) sealer. However, another study comparing the effectiveness of the sealants AH plus (Dentsply Sirona), pulp canal sealer EWT, Sealapex, and MTA Fillapex for filling and dentinal penetration revealed no statistically significant differences [18]. Forty single-rooted teeth were treated with chemical-mechanical

preparation and root-canal filling in this investigation. Using confocal laser scanning microscopy and stereomicroscopy, slices of the root obtained 2, 4, and 6 millimeters from the tip were examined. Apart from the MTA Fillapex, which failed at 4 and 6 mm from the root apex, each of the four sealers were found to be equivalent in terms of the filling material's capacity to adapt to the root canal walls. Except for the pulp canal sealer EWT, all of the sealants were shown to have comparable penetration into the dentinal tubules. Compared to MTA Fillapex and AH plus (Dentsply Sirona), the EWT pulp canal sealer performed poorly at 4 and 6 mm. In contrast to our findings, another study comparing bioceramic sealers with AH plus (Dentsply Sirona) sealer based on their interfacial adaptability and sealer thickness to root dentin found that the bioceramics permitted greater leakage [19]. In this study, 0.1% fluorescent Rhodamine B dye was added to sealants, and 60 extracted single-root premolars were randomly assigned to one of four groups. Calculated was the ratio of canal area to sealer area. Using a confocal laser microscope, the ratio of the gap-containing region to the canal's circumference was measured. The thickness of the sealant was greatest at the middle and apical levels and decreased toward the coronal levels. Compared to EndoSequence BC, the profiles of MTA Fillapex and AH plus (Dentsply Sirona) were substantially slimmer. Bioceramic sealants produced more gaps than AH plus (Dentsply Sirona), but there were no noticeable differences between the other kinds. The coronal level displayed the fewest interfacial gaps as compared to the apical and intermediate levels. In another trial, both with and without the butterfly effect, the depth and quality of root canal sealer and ProRoot MTA penetration into the buccolingual and mesial regions of roots were evaluated [20]. Where dentinal tubule density is extremely great, the butterfly effect can be observed in a few roots. Then, 120 teeth were randomly assigned to one of five obturation groups: ProRoot MTA alone, gutta-percha with AH With, EndoREZ, Kerr Pulp Canal Sealer, MTA Fillapex, or MTA Fillapex plus a sealer (each containing 10 butterfly and 10 non-butterfly roots). The authors examined penetration and adaptability with confocal laser scanning and scanning electron microscopy. The bucco-lingual penetration of butterfly teeth, on average, was greater than their mesio-distal penetration. The butterfly effect augments positive therapeutic effects.

CONCLUSIONS

In conclusion, the results of this study suggest that bioceramic sealer is a more effective sealing material compared to AH plus (Dentsply Sirona) sealer in sealing the apices of single-rooted teeth. This information can be useful for dentists in choosing the best sealant for their

patients, which can reduce the risk of apical microleakage and endodontic treatment failure.

Authors Contribution

Conceptualization: JM

Methodology: JM, MAD

Formal analysis: KK

Writing, review and editing: KI, MRM, AA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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