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Evaluation Of Apical Sealing Ability Of A Root Canal Sealers - An Invitro Study

Research Article

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Abstract

Introduction: The success of endodontic treatment is complete obturation of the root canal system up to the cemento-dentinal junction. Obturation of the root canal is usually done with gutta-percha along with a root canal sealer. Sealers are used as binding agents, and they lubricant and aid in sealing of gutta-percha. The hermetic sealing of the root canal by means of a three dimensional obturation of the pulp space constitutes the key factor for successful endodontic therapy.
Aim and objective: The aim of the present study was to evaluate and compare the apical sealing ability of three root canal sealers using dye penetration method.
Materials and Methods: A sample of 30 single rooted extracted maxillary incisors teeth were collected and kept in saline and preserved. The coronal portion of teeth was prepared at cemento-enamel junction using step back technique. The canals were then obturated by lateral condensation method with any one of the sealers AH plus, iroot SP sealer & Zinc oxide eugenol sealers.Dye leakage method with methylene blue was used to evaluate sealing ability.
Results: Microleakage was noticed in all the groups, iRoot SP sealer showed the least apical microleakage followed by AH plus & Zinc oxide eugenol.
Conclusion: The present study was undertaken to evaluate in vitro, the apical sealing ability of three different root canal sealers, and i Root Sp sealer showed the least apical microleakage.

Introduction

The hermetic sealing of the root canal by means of a three dimensional obturation of the pulp space constitutes the key factor for successful endodontic therapy. Ingress of tissue fluids, bacteria and their by-products from the oral cavity into the canal space may lead to re-infection and failure of endodontic treatment [1]. Moreover, micro-organisms may remain active in the dentinal tubules even after meticulous preparation of the root canal [2]. Thus, perfect seal of the root canal space is mandatory to prevent the bacteria and their endotoxins from reaching the root apex. Incomplete obturation and subsequent apical leakage has been reported to be the common cause of endodontic failure. A variety of materials are available for root canal obturation, Gutta-percha is non-toxic, biocompatible, thermoplastic and re-treatable [3]. The more importantly, it is completely inert material once obturated in the root canal space. Since, gutta-percha does not bond well to the canal walls, sealer can enhances the possible attainment of an impervious seal and serves as filler for accessory canals, canal irregularities, and minor discrepancies [4].

The major function of a root canal sealer is to fill up irregularities and minor discrepancies between the Guttapercha and the root canal wall. It also fills patent accessory canals, if present. The application of sealer fills imperfections and increases adaptation of the root filling to the canal walls, failing which the chances of leakage and failure increase [5]. It has been documented that teeth obturated with Gutta-percha along with sealer display a better seal than those obturated without sealer. Different types of sealers have been used in conjunction with Gutta-percha for root canal obturation with varied success [6]. Ideally, root canal sealer should be biocompatible, antibacterial, nontoxic, radiopaque, and dimen-

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sionally stable, should have good adhesion and should eliminate the interface between the Gutta-percha and the dentinal walls completely [6, 7].

Recently, a new root canal sealer, "iRoot SP" (Innovative BioCeramix Inc., Vancouver, Canada), also known as EndoSequence BC sealer (Brasseler, Savannah, GA, USA), has been introduced to the market that claims to form hydroxyapatite during the setting process and ultimately create a chemical bond between dentinal wall and the sealer [8]. It is a convenient, premixed, ready-to-use injectable white hydraulic cement paste developed for permanent root canal filling and sealing applications. It is an insoluble, radiopaque and aluminum free material based on a calcium silicate composition, which requires the presence of water to set and harden . Dentin is composed of approximately 20% (by volume) of water and "iRoot SP" uses this water to initiate and complete its setting reaction. It exhibits potent antimicrobial action, excellent biocompatibility, significant stimulation of periodontal regeneration and is osteoconductive. The most common used sealers are Zinc oxide eugenol, AH plus [9]. The present study was done using dye penetration method to evaluate and compare the apical sealing ability of different root canal sealers (Zinc oxide eugenol, AH plus., iRoot Sp sealers).

Previously our team has a rich experience in working on various research projects across multiple disciplines [10-24] Now the growing trend in this area motivated us to pursue this project.

Materials And Methods

Thirty permanent maxillary incisors with straight root canals were selected for the study. Teeth with caries, cracks and immature roots were excluded from the study. The obtained teeth were cleaned off of the soft tissues and calculus deposits, followed by stored in 10% formalin at room temperature. All the teeth were sectioned from the cemento-enamel junction. The working length was determined by passing a #15 K file into the root canal until the tip was visible at the apical foramen and then subtracting 1.0 mm from the total length. The root canal system was cleansed and shaped to the apical foramen to the size of a No. 40 K-type file. The rest of each canal was flared by the step-back filling technique. The canals were irrigated with a 2.5% solution of sodium hypochlorite before cleansing and after use of each file.

The prepared teeth were randomly divided into three groups, viz., Group A, Group B & Group C comprising ten teeth each.

In Group A, Gutta-percha cones were used with "iRoot SP" as sealer. The premixed sealer available in syringe form was placed into the root canal using a dispensing tip. The master Gutta-percha cone was coated with the sealer and introduced apically into the canal. The obturation was carried out using lateral compaction technique. The excess cones were removed with the help of a warm burnisher. The access cavity was sealed with intermediate restorative material. In Group AH plus and zinc oxide eugenol were used as a sealer and obturated using lateral compaction technique.

The treated roots were covered with two coats of nail polish, except the 2.0 mm apically. The specimens were immersed in 0.5% methylene blue dye. After 1 week, all the teeth were washed with tap water to remove excess dye and were dried. Nail polish was scraped off from all the surfaces. After dye penetration procedure, each sample was kept in a closed vial containing 10 ml of 65% nitric acid for complete dissolution that took 4 days. The roots were sectioned longitudinally with diamond discs & checked for dye penetration using stereomicroscope at X 30 magnifications. The penetration depth of sealer into dentinal tubules was examined & the maximum penetration dye was assessed.

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Results And Discussion

The obtained results were then tabulated and subjected to statistical analysis (Table 2 and Graph 1). For statistical analysis of data, multiple comparisons were performed using one-way analysis of variance (ANOVA) followed by the LSD test for post hoc analysis. Statistical significance was accepted at a level of $P<0.05$. Data were analyzed using SPSS (version 21.0). Values of apical microleakage were seen in mm by three sealer groups. Each group was statistically significant difference with each other groups. Bioceramic iROOT SP sealer shows least dye penetration value of 1.33mm followed by AH plus sealer of 2.05mm and zinc oxide eugenol shows maximum value of dye penetration of 3.9mm.

Main objective of endodontics is complete debridement of the pulpal space in the root canal, obtaining a fluid-tight seal at the apical foramen and total obturation of the root canal. The main purpose of using obturating materials is to create fluid-tight seal, so that it will prevent penetration of irritants from the oral cavity into the radicular tissue via unfilled root canal space, entering of microorganism and reinfecting the root canal system, tissue fluids from percolating back into the root canal system and providing a culture medium for any residual bacteria. To obtain fluid tight seal, over the years there are many different filling materials and sealers have been introduced. However none of the materials posed the ideal characteristics and hence they always fallen short of providing fluid tight seal. Presently, the material used most often as a solid core filling is gutta-percha. To achieve three-dimensional sealing of the root canal system is the prime goal of endodontic treatment and prevent re-infection and maintain healthy periodontium. To obtain such a seal, numerous endodontic sealers have been developed and evaluated. Use of zinc oxide eugenol based sealer are considered standard but several in vitro investigations studies report that zinc oxide eugenol based sealers have poor adhesion and are permeable.

Methylene blue was used as the dye in the present experimental set-up based on dye clearance method. It was preferred over India ink or other commonly used dyes in leakage experiments because of its smaller molecular size, which resulted in superior penetration ability, and it's better performance during the measurement of volumetric microleakage. In this study, iRoot SP sealer were used as root canal sealers. In iRoot SP sealer, the incorporation of nanoparticle size facilitates its better spread. The sealing characteristics of hybrid Root seal are attributed to the formation of hybridized dentin that provides the better seal with root dentin whereas i Root SP sets in the presence of water and achieves excellent adhesion to the canal's wall by forming a chemical bond

Table 1. Representing the comparison of the mean % of maximum dye penetration among three groups.

	Sum of squares	df	Mean Square	P value
Between Groups	10.487	2	5.243	< 0.01
Within Groups	0.232	6	0.039	
Total	10.719	30		

Figure 1. Demonstrating Thirty decoronated samples.

Figure 2. Demonstrating obturation with lateral compaction technique.

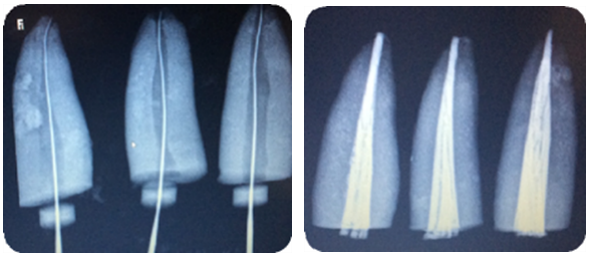


Figure 3. Showing Stereomicroscopic image photograph.

Figure 4. Bar graph representing the mean dye penetration in mm. Statistically significant difference observed between any of the groups at any of the levels (p>0.05).

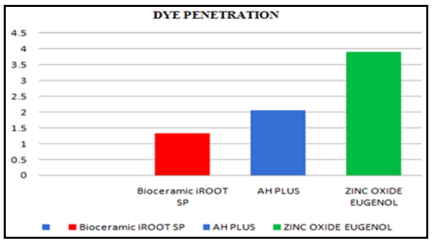
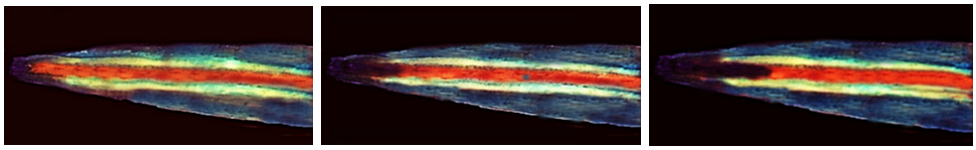


Figure 5. Demonstrating Stereomicroscopic photographs of i Root SP sealer, AH plus sealer and Zinc oxide eugenol samples showing leakage.



with dentin. AH plus sealer with gutta-percha points are used for root canal obturation since many years. Miletic et al. reported that AH plus exhibited greater leakage compared to AH 26. Similar results were also reported by Zmener et al. Faster setting time of AH plus initiates shrinkage stress and leads to debonding.

The slight better performance of iRoot SP can be explained on the basis of its low particle size, hydrophilicity and low contact angle which enable the cement to spread easily over the dentin walls of the root canal and get inside and fill the lateral microcanals. In addition, it also has a significant expansion of 0.20%. These features lead to the formation of a gap free chemical bond

between the sealer and the dentinal walls that makes it an effective sealer. However, Hybrid Root SEAL being a methacrylate based sealers inherently undergo polymerization shrinkage coupled with high C-factor inside the root canals. Immediate light-curing from the coronal side of the roots may also create a large polymerization stress during setting by preventing flow of resin-based sealers and may lead to de-bonding of the resin from the root canal walls, which results in gap formation and subsequently affecting the sealing ability of the sealer.The result is in accordance to the in vitro study conducted by Zhang et al where in iRoot SP performed better than a resin-based sealer AH Plus in its sealing ability.

Our institution is passionate about high quality evidence based research and has excelled in various fields [14, 25-34].

Conclusion

From this study, it can be inferred that both sealers, iRoot SP shows a promising potential in terms of their sealing ability as a root canal sealer. Since, iRoot SP is less toxic, easy to manipulate and possesses regenerative abilities and it may be recommended for clinical use. However, further studies should be encouraged to evaluate the long term efficacy of these sealers.

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