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Original Research

Apical Sealing Ability of Four Different Root Canal Sealers: An *In Vitro* Study

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Abstract:
Background: Aim 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 aim of the present study was to evaluate the apical sealing ability of four different root canal sealers using dye penetration method.
Materials and Methods: Total of 70 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 Tubliseal, Sealapex, AH plus, or Endorez. Dye leakage method with methylene blue was used to evaluate sealing ability.
Results: Microleakage was noticed in all the groups, Endorez showed the least apical microleakage followed by AH plus, seal apex, and Tubliseal.
Conclusion: The present study was undertaken to evaluate *in vitro*, the apical sealing ability of four different root canal sealers, and Endorez showed the least apical microleakage.

Key Words: Dye, gutta-percha, sealers

Introduction

Perfection is not attainable, but if we chase it … we can reach excellence

-Vince Lombardi

Endodontics and the science of endodontology have taken multiple traveled and untraveled roads in their quest for excellence. Concomitantly, there appears to have been a greater reliance on the clinical aspects of endodontics than on biological advances, and this in itself may have opened new roads to travel. It gained momentum since the introduction of "Hollow tube theory" which said that dead space within the body must be obturated.[1] The preliminary objective of endodontics is complete debridement with a fluid tight seal after obturation.[2] To achieve this, over the years, many different filling materials and sealers have been introduced. However none of them proved to possess all the ideal characteristics, and hence they have always fallen short of providing a fluid tight seal. Currently, the material used most often as a solid core filling is gutta-percha.[3]

Gutta-percha is non-toxic, biocompatible, thermoplastic and re-treatable. The more importantly, it is completely inert material once obturated in the root canal space.[2]

Despite having all these characteristics, gutta-percha has failed to provide an effective fluid tight apical seal. Even though many different materials that have been used as root canal fillings but none of them have been replaced gutta-percha as an obturating material which is universally accepted as the "gold standard" filling material in endodontics.[4]

Since, gutta-percha does not bond well to the canal walls, it can only adapt for which the use of a sealer during root canal obturation is essential for success.[5] Sealer enhances the possible attainment of an impervious seal and serves as filler for accessory canals, canal irregularities, and minor discrepancies.[6]

The most common used sealers are Tubliseal, Sealapex, AH plus, or Endorez. The study was done using dye penetration method to evaluate the apical sealing ability of different root canal sealers.

Methodology

Method of selection of data

About 70 single rooted maxillary incisors extracted human teeth were subjected for this study. The teeth were stored in normal saline until they were used. Then, teeth were immersed in 5.25% sodium hypochlorite for approximately 15 min to remove organic debris from the root structure.

All the samples taken for study were de-coronated, and the coronal surface of the roots were biomechanically prepared

perpendicular to the long axis of the root with a high-speed handpiece and a round bur using air water spray.

Preparation of the sample

The length of all the roots was prepared biomechanically, approximately 16 mm from the coronal surface to the apex. The working length was established with #15-flexofile (MANI) 1 mm short of apex. A 25 mm #15 flexofile was placed into the canal so that the tip would be seen at the foramen and working length calculated by reducing 1 mm.

All the teeth were instrumented up to #40 flex file 1 mm short of apical foramen followed by middle and coronal flaring using step back technique.

0.5% sodium hypochlorite was used for irrigation during instrumentation. After being cleaned and shaped, canals were dried with paper points and obturated with lateral condensed gutta-percha using with any of the sealers Tubliseal, Sealapex, AH plus, or Endorez.

Preparation of control specimen

Positive control

Root canals of five teeth were not prepared in the same manner as previously described and left unfilled, nor they were coated with nail varnish. These roots were used as positive control to prove that the dye can penetrate to full length of the root canal.

Negative control

Five teeth were conventionally filled with gutta-percha points using zinc oxide eugenol as sealer. Roots were painted completely for better seal. This group served as a negative control to prove that the dye penetration can be prevented.

The roots were divided randomly into following groups (Table 1).

The samples were dried and the root surface coated with two layers of nail varnish leaving apical 1-2 mm. Samples were placed in methylene blue dye for 7 days after which they were thoroughly washed under tap water and dried.

The roots were sectioned longitudinally with diamond discs and were checked for dye penetration using stereomicroscope at ×30 magnifications (Figure 1).

Results were analyzed statistically using analysis of variance test (ANOVA) and Tukey's *post-hoc* test.

Results

The obtained results were then tabulated and subjected to statistical analysis (Table 2 and Graph 1). Statistical comparison was performed using one-way ANOVA test for multiple groups and Tukey's *post-hoc* test for pairwise comparison.

Table 1: Experimental groups.

Groups	Methods
I	Obturated using gutta-percha with Tubliseal sealer (15 teeth)
II	Obturated using gutta-percha with seal apex sealer (15 teeth)
III	Obturated gutta-percha with AH Plus sealer (15 teeth)
IV	Obturated using gutta-percha with Endorez sealer (15 teeth)
V	Positive control (5 teeth)
VI	Negative control (5 teeth)

Table 2: Descriptive statistics of study groups.

Groups	Range	Mean	SD	*P** value, significant
Tubliseal	2.5-6.75	4.48	1.32	*P*<0.001 (HS)
Sealapex	2.0-8.0	4.22	1.54	
AH Plus	2.0-5.4	3.97	0.85	
Endorez	0.0-3.8	1.67	1.48	
Positive control	7-8	6.12	2.24	
Negative control	0	0	0	

*One-way analysis of variance test, SD: Standard deviation, NS: Not significant

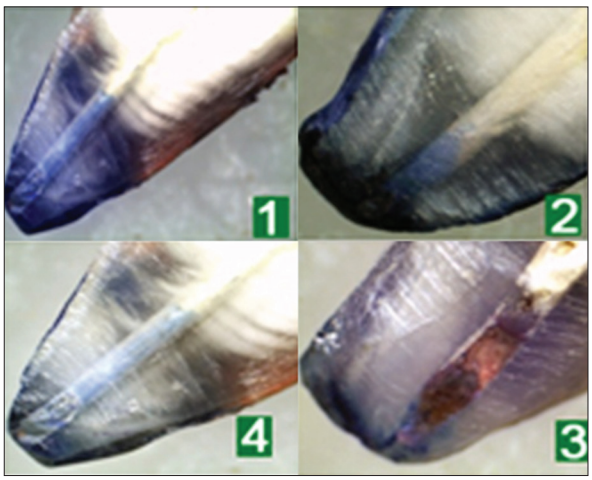
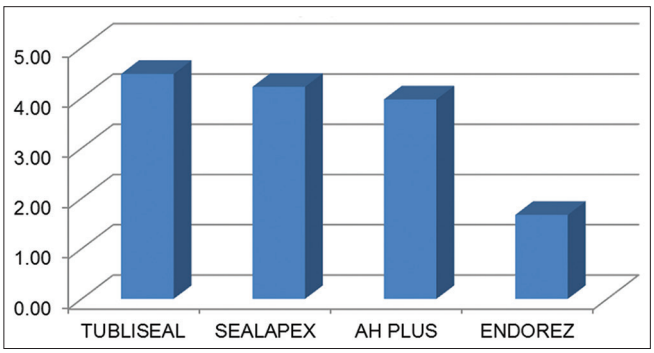


Figure 1: Stereomicroscopic photographs of samples showing leakage.



Graph 1: Mean of dye penetration in mm.

Values of apical microleakage were seen in microns by four sealer groups. Each group as statistically significant difference with each other groups. Endorez shows least value of 1.67 μ, AH plus shows 3.97, seal apex shows 4.22 μ, and Tubliseal shows maximum value of 4.48 μ.

Discussion

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.[2] 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.[1]

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.[3] 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.[7] Use of zinc oxide eugenol based sealer are considered standard clinically as well as controls in several *in vitro* investigations for comparison.[8-10] Primordial studies report zinc oxide eugenol based sealers have poor adhesion and are permeable.[11,12]

In this study Sealapex group shown high levels dye penetration.[1] Some other studies have shown that Sealapex presented good sealing ability initially, then very poor sealing after being stored in water for a long time. Satisfactory results produced initially may be related to the volumetric expansion after setting, whereas sealing ability loss may be related to sealer dissolution over time. Sonat has described similar results. Siqueira *et al*. observed that liberation of hydroxyl ions is rapid but limited and may be related to sealer solubility and disintegration in an aqueous environment. So, it seems that the high solubility of Sealapex is a determining factor in microleakage control.[13]

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. Miletic *et al*. showed significant sealing ability of AH plus while compared to AH 26 and Diaket. It is difficult to compare present results with previous studies as dyes were used as marker. However our results are in agreement with results of Miletic *et al*. study, because same testing model and conditions were used.[14]

Endorez is a new resin-based root canal sealer, the active ingredient of which is urethane dimethacrylate resin. It has two-component (base and catalyst), dual-curing self-priming sealer. The formulation contains base and catalyst as bismuth compound with radio-opaque filler, and small amounts of diurethane dimethacrylate triethylene glycol dimethacrylate, a peroxide, and photo initiator.[2]

Manufacturer recommends that Endorez can be used on slightly moist canals because of its hydrophilic property and provides hermetic seal. The results of the present study shows the leakage of Endorez sealer is about 30% less than AH Plus sealer. This finding is in accordance with J.A. Von Fraunhofer *et al*.[14]

Maximum sealing ability of Endorez may be attributed to the "mono-block" concept of deep penetration into dentinal tubules and achieving chemical bond between Endorez sealer and resin coated gutta-percha points.[15] Monoblock, a multilayered structure with no inherent weak inter-layer interfaces. The unique advantage of this system is that it reinforces the tooth structure. Therefore, the integrity of the final endodontic-restorative continuum monoblock approaches that of the original healthy tooth itself. Monoblock created in the root canal spaces may be classified as primary, secondary or tertiary depending on the number of interfaces present between the bonding substrate and the bulk material core. A primary monoblock has one interface that circumferentiate between material and root canal wall. Secondary monoblocks have two circumferential interfaces one between dentin and cement while other between core material and cement.

The dye penetration method used for measuring sealing ability is the most popular method and can be is performed easily.[16] According to many studies conducted on methylene blue has been proved to be a simple, useful aid in endodontic therapy. Methylene blue dye was chosen for this study because it exhibits a high sensitivity,[17] and its particles are of similar size to microorganisms and their metabolites.[18] Recently, Endorez introduced very few reports about its properties in the market. As in the present study, Zmener also related good performance when comparing Endorez with other resin-based sealers. Sevimay and Kalayci compared AH Plus and Endorez, the later showing better sealing ability and adaptation to dentine walls.[14]

However that the sealing failure observed in both the materials resulted solely from problems inherent in the sealers. Other factors such as entrapped air at the interface, accessory canals, fins, or oval-shaped canals are difficult to prepare and fill adequately due to standardized preparation. Hence, the results of the present study should be interpreted with caution, and these aspects need to be investigated.

Conclusion

The present study was undertaken to evaluate apical sealing ability of four different root canal sealers *in vitro*. Under the conditions of this study, neither material produced an effective apical seal; Leakage was noticed in all the groups. Endorez showed the least apical microleakage followed by AH Plus,

Sealapex, and Tubliseal. Fluid tight seal remains an enigma hence the search for an ideal root canal sealer has to go on.

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