

Evaluation of Dislocation Resistance of Three Different Root Canal Sealers From Radicular Dentin-an in Vitro Study.

Abstract:

Aim: The aim of this study is to evaluate the dislocation resistance of three different resin-based root canal sealers from radicular dentin -An 'in vitro' study.

Methodology: Sixty extracted human maxillary canines were sectioned transversally below the cement-enamel junction to obtain 2-mm-thick dentin disks that were randomly divided into three groups (n = 20) for treatment with one of three different root-canal sealers (AH Plus [Dentsply DeTroy, Germany], Bioseal (Equinox Holland), EndoREZ [Ultra dent]). Standardized cavities were prepared to simulate root canals, cavities were filled with sealer material, and push-out bond-strength testing was performed using a universal testing machine.

Result: In the present study amongst all the three sealers tested viz AHPlus, EndoREZ & Bioseal. EndoREZ (Group III) goes most superior (14.97 3.17 MPa), followed by AHPlus (Group II) (13.29 2.27 MPa) & the least bond strength was seen with Bioseal (Group I) (4.83 1.62 MPa).

There was a gradual decrease in bond strength from a coronal third of radicular dentin to the middle third followed by an apical third in all three groups.

Conclusion: Amongst all the three-sealer tested EndoREZ® gave the maximum bond strength, followed by AHPlus® & then Bioseal. Bioseal gave the least bond strength irrespective of the area in radicular dentin. There was a gradual decrease in bond strength from the coronal third of radicular dentin to the middle third followed by an apical third in all three groups.

Key-words: Resin Based sealer, Push out test, Dislocation resistance, Radicular dentin

Introduction:

Successful root canal therapy requires a complete obturation of the root canal system with non-irritant biomaterials. Sealers are used between dentin surfaces and core materials to fill spaces that are created due to the physical inability of the core materials to fill all areas of the canal. Traditionally desirable characteristics were to adhere to dentin and the core material as well as to have adequate cohesive strength. Newer generation sealers are being engineered to improve their ability to penetrate into dentinal tubules and bond to, instead of just adhering to, both the dentin and core material surfaces.¹ The bond formed between the root canal filling material and the canal walls is of particular importance for long-term success of root canal therapy [2,8]. Strength of the bond of root canal sealers to guttapercha and dentin maintains the integrity


of apical seal, and helps in obtaining a fluid impervious seal, along with cleaning and shaping the root canal. For a root canal sealer, the ability to resist disruption of the established seal through micromechanical retention or friction is highly desirable during intraoral tooth flexure. Ideally, one of the key roles of a sealer is to aggregate the root filling material &

¹SUCHITA VISHNOI, ²DEEPAK RAISINGANI,
³ASHWINI B. PRASAD, ⁴HARSHIT SRIVASTAVA,
⁵RIMJHIM JAIN, ⁶ANUBHA SINGH

¹⁻⁶Department of Conservative Dentistry & Endodontics,
Mahatma Gandhi Dental College and Hospital, Jaipur

Address for Correspondence: Dr. Suchita Vishnoi
40, Shree Rampura Colony,
Civil Lines, Jaipur
E-mail : bafnasuchi@gmail.com

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maintain it as a compact mass with no gaps, which adheres to the canal walls & provides a monoblock configuration that seals hermetically the canal spaces. Early sealers were modified zinc oxide eugenol cements based on Grossman or Rickert's formulas. They are widely available and are used throughout the world. Epoxy resin-based sealers have also been used for many years with clinical success. Resin based sealer has been marketed since 1970's, on the basis that Resin based sealer spontaneously bond to dentin and may be suitable to bond to dentin walls at the apex. An ideal endodontic sealer should, in part, adhere firmly both to dentin and to gutta-percha[3]

Although predictable clinical results have been reported with the use of gutta-percha and epoxy resin-based root canal sealers, there is an increasing interest in the use of methacrylate resin- based sealers in endodontics as the latter may be used with dentin adhesives for bonding to intra radicular dentin. These methacrylate resin-based sealers are found to provide a good apical seal and adhesive to root dentin. The development of resin-based sealers and improvements in adhesive technology has fostered attempts to incorporate adhesive dentistry in endodontics by introducing obturation systems with a specific focus on obtaining a “monoblock” in which the core material, sealing agent, and root canal dentin form a single cohesive unit[4,5,6.]

The present study evaluated the dislocation resistance of three different resin-based root canal sealers (Bioseal, AH Plus, EndoREZ) from radicular dentin & compared whether the sealer applied at the apical, middle, coronal third of the root canal will affect the bond strength of sealer.

Materials and Methodology:

A. Preparation of Samples

60 extracted single -Rooted maxillary canine was collected and teeth were decoronated (Sectioned at Cemento-enamel junction perpendicular to their long axis) and roots were then sectioned to obtain a 2 mm thick dentin discs by making buccolingual sections using diamond discs.

Then with the help of diamond coated round bur truncated hole was prepared on radicular dentin adjacent to pulp.

Two holes each were prepared in apical, middle, & coronal third of the root slab respectively. These prepared cavities were equal in diameter of 1mm. Further these cavities were drilled 3mm equidistant from each other(Figure-1)

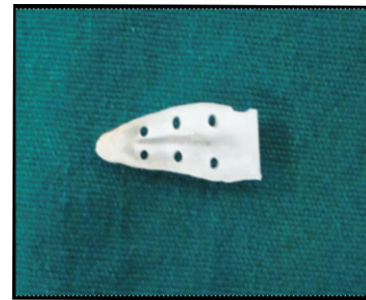


Figure-1

The roots were randomly divided into 3 groups namely: Group I, Group II, Group III consisting of 20 root slabs. Each sample provided 6 measurements, 2 in coronal, 2 in middle, 2 in apical third of the root.

Group I – Bioseal

Group II – AH Plus

Group III – EndoREZ

B. Filling of root canal sealers

- The tooth slabs were immersed in 17% EDTA & were ultrasonicated for 5 minutes to dissolve the smear layer created during the hole- shaping procedure. Further, these slabs were immersed in 5.25% Sodium Hypochlorite & again ultrasonicated for 5 minutes to remove organic debris & the demineralized collagen matrix created during EDTA application.
- All sealers were mixed according to the manufacturer's instructions on the mixing paper pads. All cavities from one tooth slab were filled with one type of sealer with the help of skini syringes. Each tooth root was placed over a Mylar strip which in turn was placed over a microscopic glass slide. The sealer was dispensed into the cavities & each hole was filled with an excess sealer. The surface of the tooth root slab was again covered with a Mylar strip & a glass slide. This assembly was secured with a binder clip (figure-2)



Figure-2

- These assemblies were transferred to humidors & were stored under 100% relative humidity for 1 week until all the sealers have been completely set.
- The binder clips were then released & the Mylar strips were removed from the tooth root slab. The top & bottom surfaces of each slab were polished with the help of polishing discs.

C. Push-out bond strength evaluation

The dislocation resistance of the set root canal sealers was evaluated using a push-out test design. Prior to testing, the thickness of each tooth slab was measured to 2mm using a pair of digital calipers. Each sealer-filled hole was subjected to compressive loading at a cross-head speed of 5mm/min in order to displace the set sealer toward the coronal aspect of the hole. After performing push-out testing of the first hole, the tooth slab was carefully removed and realigned with the second hole. The procedures were repeated until the set sealers were dislodged from all the six cavities within a tooth slab.

Statistical Analysis:

Data shall be analyzed statistically with the help of ANOVA test & Student-t test.

Results:

The present study evaluated the dislocation resistance of three different resin-based root canal sealers i.e., Bioseal (Group I), AH Plus (Group II), EndoREZ (Group III) from radicular dentin & compared whether the sealer applied at the apical, middle, coronal third of the root canal will affect the bond strength of sealer.

The samples were tested in a universal testing machine and the load necessary to fracture the sample was recorded in newton(Mpa).

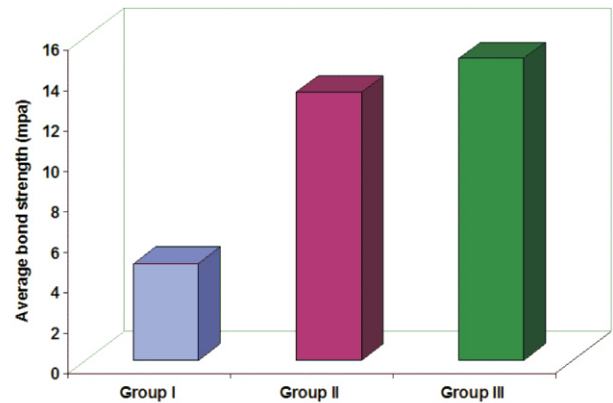
Data were analyzed statistically to ascertain any significant differences in the groups using one way ANOVA test comparing the mean resistance values. The Student t-test was used for multiple comparisons using SPSS 23.0. 'P' value <0.05 indicates a significant difference.

Among the three groups, EndoREZ(Group III) showed the highest bond strength followed by AH Plus (Group II), Bioseal (Group I)(Table 1, Graph I)

TABLE 1: Intergroup Comparison of Bond strength

Parameter	Group I (n=60) (Bioseal)	Group II (n=60) (AHplus)	Group III (n=60) (EndoREZ)	F Value	P Value
	Meanr SD	Meanr SD	Meanr SD		
Bond strength (Mpa)	4.83r 1.62	13.29r 2.27	14.97r 3.17	297.95	<0.0001

Bar diagram showing comparison of bond strength in study groups

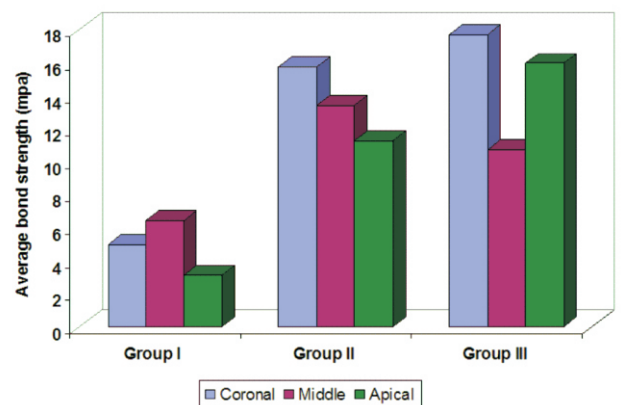


Bioseal gave the least bond strength irrespective of the area in radicular dentin. There was a gradual decrease in bond strength from the coronal third of radicular dentin, to the middle third followed by an apical third in all three groups (Table 2, Graph II)

Table 2: Comparison of Coronal, Middle and Apical bond strength in study groups (ANOVA)

Bond strength	Group I (n=20) (Bioseal)	Group II (n=20) (AHplus)	Group III (n=20) (EndoRez)	F Value	P Value
	Meanr SD	Meanr SD	Meanr SD		
Coronal	4.95r 0.79	15.73r 0.63	17.71r 1.86	633.83	<0.0001
Middle	6.41r 0.73	13.42r 1.13	15.96r 1.54	351.38	<0.0001
Apical	3.12r 1.17	10.71r 1.03	11.25r 1.40	282.19	<0.0001

bond strength in study groups



Discussion:

An ideal endodontic sealer should adhere firmly both to dentin and gutta-percha. Differences in adhesive properties of different sealers may be expected because their interaction with either dentin or gutta-percha may vary with chemical composition.^[7]

There are conflicting reports in the scientific literature regarding sealer penetration and bond strength. Some authors have concluded that the depth and consistency of a sealer's tubular penetration is influenced by the chemical and physical properties of the sealer and has no impact on bond strength.^{8,14}

No relationship was found to exist between bond strength and sealer penetration in a number of studies.^[9,11,12,14] These studies concluded that the bond strength was not higher for all sealers that were able to penetrate inside the tubules. High bond strength to dentin is an important property of sealer because it would minimize the risk of movement of set root canal filling during restorative procedures and strong adhesion would reduce leakage.^[10]

AHPlus is an epoxy-based endodontic sealer that has adequate long-term dimensional stability, its sealing ability remains controversial partly because AHPlus does not bond to gutta-percha.¹³ Despite this, AHPlus has been shown to provide adhesion to dentin and better long-term sealing ability due its reported expansion over time.

These properties lead to greater intertwining of the sealer with dentin structure, which, together with the cohesion among the cement, provides greater adhesiveness and resistance to dislodgment from dentin.^[13]

EndoREZ is a urethane dimethacrylate based resin that has hydrophilic characteristic providing excellent penetration into the dentinal tubules. This allows for improved sealing properties which may be attributed to the "mono-block" which is created by deep penetration of the sealer into dentinal tubules.

Bioseal is a biocompatible root canal sealer, marketed as an insoluble material with optimized flow characteristics and low shrinkage value, which can ensure better penetration into all root canal aberrations with an effective long term dimensionally stable seal.

Bond-strength testing has become a popular method for determining the effectiveness of adhesion between endodontic materials and tooth structure.

In this study dislocation resistance of three different resin-based root canal sealers (AH Plus, Bioseal, EndoREZ) from radicular dentin was evaluated & compared whether the sealer applied at apical, middle, coronal third of the root canal will affect the bond strength of sealer. Resin based sealers were chosen because of their better adhesive properties as previously discussed.

In the present study amongst all the three sealers tested viz AH Plus, EndoREZ & Bioseal. EndoREZ goes most superior (14.97 3.17 MPa), followed by AHPlus (13.29 2.27 MPa) & least bond strength was seen with Bioseal (4.83 1.62 MPa). The Highest bond strength was observed with EndoREZ sealer in the present study.

In a study by *Vytaute Peciuliene et al, 2009*,¹⁴ the leakage of EndoREZ sealer/ EndoREZ Points fillings is about 30% less than AHPlus sealer/gutta-percha. This was in agreement with the findings of J.A. Von Fraunhofer et al. Zmerner et al. showed that the leakage of the conventional gutta-percha/EndoREZ fillings is less in comparison with gutta-percha and Grossman sealer.

Higher bond strength was observed with AHPlus also, however there was statistical difference in bond strength of EndoREZ (14.97 3.17 MPa), than that of AHPlus (13.29 2.27 MPa). Probable reason can be because of formation of a covalent bond by an open epoxide ring to any exposed amino groups in collagen, very low shrinkage while setting & Long-term dimensional stability.^{3,7,11}

In a study by Sousa-N et al, 2002,^[16] AH Plus was found to have greater adhesion to root dentin than Epiphany. This is likely due to the fact that, as an epoxy resin-based sealer, AHPlus has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin. This fact, allied to the cohesion among sealer molecules, increases the resistance to removal and/or displacement from dentin.^[15,16]

Least bond strength was observed with Bioseal sealer. Despite having optimized flow characteristics and low shrinkage

value, which can ensure better penetration into root canal aberrations, in the present study, low bond strength was seen with this sealer.

Another finding observed in this study was that, location of sealer placement in radicular dentin, did affect the push out bond strength. There was a gradual decrease in bond strength from coronal third of radicular dentin, to middle third followed by apical third in all the three groups.

Higher values were seen in coronal area of radicular dentin with all the tested sealers. Bond strength of Bioseal was observed to be 4.95 0.79 MPa, with AHPlus bond strength in coronal third was 15.73 0.63 Mpa & with EndoREZ, it was 17.71 1.86 Mpa.

In middle one third of radicular dentin, bond strength values were seen to be lower than that of coronal third, but still they exhibited acceptable bond strength. Values being, Bioseal was 6.41 0.73 MPa, AHPlus bond strength in middle third of radicular dentin was 13.42 1.13 MPa, & with EndoREZ, bond strength was 15.96 1.54 MPa.

However, in the apical one third of radicular dentin least bond strength of all the three sealers tested was observed. Bond strength of Bioseal was 3.12 1.17 MPa, AHPlus was 10.71 1.03 MPa, & bond strength in apical third of radicular dentin with EndoREZ sealer was 11.25 1.40 Mpa.

This may be attributed due to dentin structure. Various factors, dentinal tubules, dentin permeability, dentinal sclerosis, & dentin moisture are responsible for varied results in the present study. However, a decrease in bond strength was seen from coronal third to the apical third. This can be mainly because of tubule orientation which decreases near the apex.

Conclusion:

The Selection of sealer cement is an integral part of endodontic treatment. This study compared the dislocation resistance of three resin-based sealers, AHPlus®, Bioseal, and EndoREZ® in radicular dentin. This study also evaluated variations in the bond strength with different areas of radicular dentin, i.e., coronal one-third, middle one- third & apical one-third of radicular dentin.

Within the limitations of the study conducted, the following conclusions were drawn: -

- a. Amongst all the three-sealer tested EndoREZ® gave the maximum bond strength, followed by AHPlus® & then Bioseal.
- b. Bioseal gave the least bond strength irrespective of the area in radicular dentin.
- c. There was a gradual decrease in bond strength from coronal third of radicular dentin, to middle third followed by apical third in all the three groups.
- d. Both AHPlus® & EndoREZ® have high bond strength, however difference between both sealers were statistically significant.

From the present study it can be concluded that, meth-acrylate based sealer, viz EndoREZ® can be effectively used in clinical scenario. To achieve Monoblock within root canals further investigations comparing bond strength of sealer along with gutta-percha & radicular dentin should be evaluated.

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