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To Assess The Push-Out Bond Strength Of New Calcium Silicate-Based Endodontic Sealer (Bioroot Rcs) - An In Vitro Study

Research Article

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Abstract

Aim: To evaluate and compare the push-out bond strength of root filled with Endosequence BC, AH Plus and Endomethasone N sealers using lateral condensation and thermoplasticized technique.
Materials and Methods: Thirty specimens with complete obturation through lateral condensation were formed. Teeth were decoronated, working length was determined. Instrumentation and irrigation were performed. Teeth were then obturated with Group 1(AH plus) (n = 15) or Group 2-Bioroot RCS (n = 15). Each group had 5 samples each based on the coronal , middle and apical region in the form of a disc of 2mm each. Each sample was then subjected to a micro push-out test. Data was analyzed with ANOVA.
Results: AH Plus sealer in Group 1 showed (37 ± 1.67 MPa) push-out bond strength . The mean strength of Bioceramic sealer Group 2 was higher (46 ± 0.76 MPa) .
Conclusions: The push-out bond strength of Bioroot RCS sealer was higher than the AH Plus root canal sealer in coronal and apical specimens.

Keywords: Push Out Bond Strength; Bioroot Rcs; Ah Plus Sealer.

Introduction

Over the past century, numerous obturation materials and delivery techniques have been introduced in dentistry. The continued research on obturation materials is based on the concept that, the primary cause for failure of Root Canal Treatment is the apical migration of microorganisms and their by-products in a poorly filled and leaking root canal obturation. To overcome this, Grossman studied the physical properties of filling materials and found adhesion to be a very desirable property in root canal cements. Caicedo and von Fraunhofer have also stated that the endodontic cements must seal the root canal space and, ideally, should adhere to both the gutta-percha cone and the canal walls[1].

With this concept, Monoblock was introduced in endodontics by Tay and Pashley who further classified it into primary, secondary and tertiary depending on the number of interfaces present between the bonding substrate and the bulk core material. Epoxy resin type sealers have been used for many years. They showed higher bond strength to dentin than zinc oxide eugenol types, calcium hydroxide-based and glass-ionomer sealers[2].

Recently, BioRoot RCS (Septodont USA) has been introduced , which is described by its manufacturer as an insoluble, radiopaque, aluminum-free material composed of calcium, calcium phosphate, calcium hydroxide and zirconium oxide that requires the presence of water to set and harden. Also Bioroot RCS sealer show alkaline pH, antibacterial activity, radio-opacity and biocompatibility.The apical sealing ability and the push-out bond strength of Bioroot RCS were found to be slightly more to that of AH Plus sealer[3].

With the increasing trend of using efficient sealing technique to obtain a three-dimensional filling of the root canal system, this study aimed to evaluate the push-out bond strength of Bioroot RCS comparing it with AH Plus sealer (Dentsply DeTrey GmbH,

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Konstanz, Germany) [4].

Previously our team has a rich experience in working on various research projects across multiple disciplines [5-19]. Now the growing trend in this area motivated us to pursue this project.

Materials And Methods

Thirty extracted sound-matured single rooted teeth were used for this study. Teeth were sectioned transversely below the cemento-enamel junction, to obtain a standardized root length of 15 mm. Canal patency and working length were established by inserting a 15 K file in the canal until its tip could be seen through the apical foramen under operating microscope (Seiler) at 12X magnification. The tooth length was then checked and 1 mm was subtracted to determine the working length. Instrumentation was completed using Protaper Rotary files (Dentsply) up to F3 at working length. The canals were irrigated with 2 ml of 3% sodium hypochlorite (Neelkanth Health Care (P.) LTD., India) during instrumentation. After preparation, canals were filled with 5 ml of 17% ethylene diamine tetra-acetic acid (Ammdent) for 1 min to remove the smear layer, and the final flush was performed using 5 ml of distilled water. It was then dried with absorbent paper points (Dentsply) of 0.06 taper 30 size.

The obturation was done by a single operator for all the teeth with the help of AH plus sealer which was considered as the gold standard in the study. The other sealer used for comparison in the study was recently bioceramic based sealer Bioroot RCS [20].

After obturation the teeth samples were set to dry for a minimum period of 24hrs under ideal conditions. These samples once had dried up were sectioned into a dentinal disc of thickness 1 mm each from the coronal , middle and apical segment of the root. The samples were stored under ideal conditions and were subjected to push out bond strength tests thru the Instron Universal Testing Machine[21]. The data was recorded in the excel sheet which was tabulated and was subjected to IBM SPSS statistical software 22.0 for statistical analysis.

In group I, the master cone of size 30, 0.06 taper (Dentsply-Tulsa Dental, Tulsa, OK) was selected. Canals were then coated with sealer using lentulo-spiral (Dentsply-Tulsa Dental, Tulsa, OK) and the master cone was introduced up to the working length. After this, a 25-size finger spreader (Dentsply-Tulsa Dental, Tulsa, OK) was introduced vertically to create space for accessory GP. Accessory GP cones were then coated with sealer and introduced into the canal.After obturation, teeth were placed immediately at 37°C and 100% humidity for 48 hours, to allow the sealers to set completely.

Each root was then divided into 3 segments of 2 mm each using diamond disc. Thus, each group comprised 15 samples (n = 15) for each subgroup). Thus, a total 30 samples were prepared.

Sample Preparation

The root slices were then mounted on acrylic blocks of 1.5 × 1.5 mm dimension. The shear bond strength was then tested with micro push-out technique by using a universal testing machine (Instron). This was accomplished by using a 0.7 and 0.4 mm diameter cylindrical stainless steel plunger of length 4 mm. A constant compressive load at a speed of 1 mm/min was applied until bond failure occurred. The disk specimens were positioned to allow plungers to move in apical to the coronal direction. The bond strength was determined using a computer software program. The bond strength was recorded in Mpa according to Skidmore et al., by dividing the load in Newton by the area of bonded interface using the following formula.

Bond Strength(Mpa)=(Load In Newton)/(Area of Bonded Surface)

Failure Analysis

The failure of the sample was recorded by the universal testing machine, the graph was obtained on the software programme with further values of compressive strength , tensile strength and young's modulus of elasticity [Y][22]. The statistical significance of fixed and interaction effects were evaluated at 5% level, and the analysis was carried out using SPSS 22.0 (SPSS Inc.).

Results & Discussion

Adhesion of root canal filling material is important in both the static situation to eliminate any space that allows the percolation of fluids in between fillings and walls and dynamic situation to resist the dislodgement of filling during subsequent manipulation. Extrusion testing in dentistry was first described by Roydhouse[23]. The push-out test is based on the shear stress at the interface between dentine and cement, which is comparable with stresses under clinical conditions. Model used in this study is similar to one used by Ungor et al., which is effective and reproducible and can also evaluate the root canal sealers with a low bond strength.

The result obtained from the study -

A measurable adhesive property was seen in all the groups in this study. It was seen that the mean push-out strength of Group 1(Ah plus) was higher as compared to Group 2(Bioroot RCS) in middle third of root, while the Group 2(Bioroot RCS) had higher push out bond strength in the apical and coronal third than Group 1(Ah plus) .Thus the group effect was prominent for Bioroot RCS sealer .

Numerous studies have shown AH Plus to have higher bond strength than most other sealers. In the present study, AH Plus sealer showed significant higher bond strength than Bioroot RCS in the middle third sample.. The higher bond strength obtained with AH Plus may be associated with its ability to react with any exposed amino groups in collagen to form covalent bonds between the resin and collagen upon opening of the epoxide ring. Epoxy-based resin sealer penetrates deeper into the dentinal tubules due to its flowability and long-term polymerization time, which might contribute to enhancing the mechanical interlocking between the sealer and dentin. Thus, a very low shrinkage while setting and long-term dimensional stability shown by AH Plus might also contribute to its observed bond strength[24].

Bioroot RCS, because of its true self-adhesive nature, which forms a chemical bond (through production of hydroxyapatite during setting) with dentine. Also it is hydrophilic, possesses low contact angle allowing it to spread easily over the canal walls providing adaptation and good hermetic seal. In an in vitro study done by Ghoneim et al., it was seen that the resistance to vertical fracture of roots obturated with iRoot SP (Bioceramic-based sealer) and ActiV GP cones was comparable to that of intact teeth. So it can be said that the lower value achieved in group 1(AH Plus) can be attributed to the fact that as it does not bond with the gutta-percha cones, but if Bioceramic cones were used, the bond strength might have increased[25].

Since, uptil now no other known study has been performed using Bioroot Rcs and AH plus sealer and the higher bond strength achieved by BioRoot Rcs sealer remains unexplainable and requires further investigation.

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Table 1 . Push Out Bond strength values obtained from all the specimens

Serial No.	Specimen	Max Force [N]	Compressive Stress [mpa]	Young's Modulus of Elasticity[mpa]
1	AH plus - Apical	4.45	0.63	2736.27
2	AH plus - Apical	9.75	1.38	608.07
3	AH plus - Apical	4.58	0.65	693.56
4	AH plus - Apical	22.5	3.18	1958.66
5	AH plus - Apical	12.13	1.72	942.96
6	AH plus - Middle	16.83	2.38	1534.07
7	AH plus - Middle	9.32	1.32	703.54
8	AH plus - Middle	8.04	1.14	1691.64
9	AH plus - Middle	11.33	1.6	760.02
10	AH plus - Middle	8.07	1.14	1004.92
11	AH plus - Coronal	37.91	5.36	1904.4
12	AH plus - Coronal	6.73	0.95	816.54
13	AH plus - Coronal	4.29	0.61	1041.11
14	AH plus - Coronal	17.9	2.53	19854.6
15	AH plus - Coronal	13.37	1.89	1742.58
16	Bioroot - Apical	13.78	1.95	1017.32
17	Bioroot - Apical	21.18	3	2972.8
18	Bioroot - Apical	8.74	1.24	1393.05
19	Bioroot - Apical	22.8	3.22	3277.45
20	Bioroot - Apical	5.05	0.71	108.87
21	Bioroot - Middle	4.06	0.57	322.71
22	Bioroot - Middle	4.67	0.66	3894.69
23	Bioroot - Middle	6.29	0.89	2318.22
24	Bioroot - Middle	6.4	0.91	1066.3
25	Bioroot - Middle	7.02	0.99	547.1
26	Bioroot - Coronal	4.73	0.67	7305.59
27	Bioroot - Coronal	9.62	1.36	618.83
28	Bioroot - Coronal	15.35	2.17	703.15
29	Bioroot - Coronal	11.77	1.67	4963.47
30	Bioroot - Coronal	46.1	6.52	872.35

Table 2 . Push Out Bond strength values obtained from all the specimens with mean and standard deviation

Sealer Groups	Mean	N	Std.Deviation
AH plus-Apical	10.682	5	7.3943
AH plus-Middle	10.718	5	3.66978
AH Plus- Coronal	16.04	5	13.35687
Bioroot- Apical	14.31	5	7.68652
Bioroot-Middle	5.208	5	1.06591
Bioroot -Coronal	17.974	5	16.01608
Total	12.4887	30	9.79137

Figure 1 - Graph depicting the push out bond strength of Ah plus sealer in the apical cross section of specimen

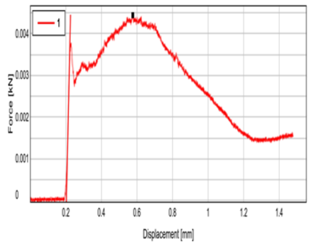


Figure 2 - Graph depicting the push out bond strength of Ah plus sealer in the mid root cross section of specimen

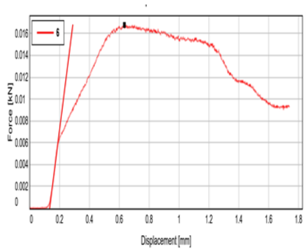


Figure 3 - Graph depicting the push out bond strength of Ah plus sealer in the coronal cross section of specimen

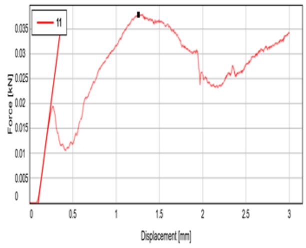


Figure 4 - Graph depicting the push out bond strength of Bioroot RCS sealer in the apical cross section of specimen

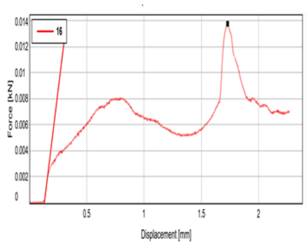


Figure 5 - Graph depicting the push out bond strength of Bioroot RCS sealer in the mid root cross section specimen

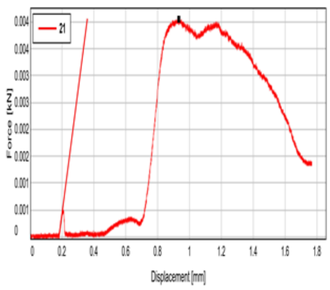


Figure 6 - Graph depicting the push out bond strength of Bioroot RCS sealer in the coronal specimen cross section specimen

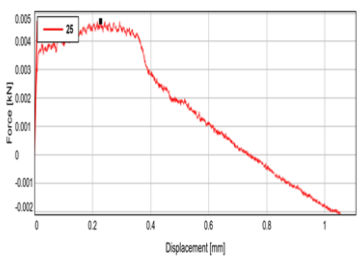
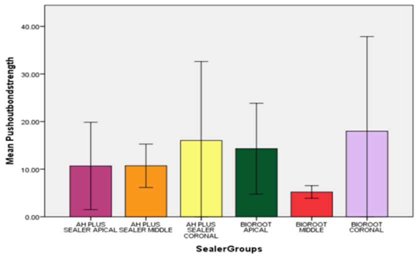


Figure 7 - Graph depicting the Mean push out bond strength of Bioroot RCS sealer in the coronal cross section specimen.The Bioroot RCS sealer (coronal) depicted by light violet colour has more push out bond strength than the Ah plus sealer(coronal). Bioroot RCS sealer (apical) denoted by dark green colour has more push out bond strength than Ah Plus sealer(apical). Ah plus sealer (middle) has more push out bond strength than Bioroot RCS(middle).



research and has excelled in various fields [9,26-35]

Conclusion

The push-out bond strengths in the coronal and apical specimens were significantly higher than those of the middle specimen in case of Bioroot Rcs. The study didn't yield a statistically significant output.

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