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"Comparative Evaluation of Push out Bond Strength of Different Endodontic Sealers: An *In Vitro* Study."

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Abstract
Aim: To compare the bond strength of four different endodontic sealers to root dentin through push‐out test design.Materials and Methods: Forty single‐rooted teeth with completely formed apices were selected. Teeth were decoronated, and working length was determined. Instrumentation and irrigation were performed. The teeth were divided into four groups based upon the sealer used. Group 1: Bioceramic sealer (BioRoot™RCS), Group 2: Mineral trioxide aggregate (MTA) based sealer (MTA Fill apex), Group 3: Epoxy resin based sealer (AH Plus Sealer), and Group 4: Calcium Hydroxide based sealer(Sealapex) Manipulation and application of the sealer was done as per the manufacturer instructions. All the teeth were obturated using 6% gutta‐percha. After obturation, each tooth was prepared for push‐out test with root slices of 2 mm thickness using universal testing machine. Results: The highest bond strength was found in Group 1 (BioRoot™RCS) (P < 0.05) compared to other groups. The lowest bond strength was found in Group 2 (MTA Fill apex). Statistical analysis is done by two‐way ANOVA and Newman‐Keuls multiple post hoc. Conclusion: The push‐out bond strength of Bioceramic sealer was highest followed by resin‐based sealer and lowest bond strength was observed in MTA‐based sealer.

Keywords: *Bond strength; BioRoot™RCS Sealer; MTA Fill apex; AH Plus Sealer, Sealapex ,push‐out test*

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I. Introduction

The purpose of endodontic therapy is to ensure that the root canal system to be fluid free and a single block configuration is to be created that seals hermetically the canal space.Sealers are used to create a seal between the core material and dentinal walls .It should fill imperfections and increase adaptation of the root filling material to the canal walls[1,2]

Traditionally used root canal sealers are zinc oxide eugenol, calcium hydroxide, and resin‐based sealers. Newer root canal sealers are constantly being developed to provide improved properties[3].

Bioceramic sealerBio Root RCS newly introduced sealer based on calcium silicate composition available in powder liquid form containsZirconium oxide, Calcium silicates, Calcium phosphate monobasic,Calcium hydroxide, Various filling and thickening agents.[4]

MTA Fillapex(Angelus, Londrina, Brazil) which is MTA‐based sealer. It is a two paste system consisting of MTA, salicylate resins, bismuth oxide, silica nanoparticles, and pigments sealer has good sealing ability, bactericidal effect, high biocompatibility, and low solubility.[5]

AH Plus sealer Diepoxide, Calcium tungstate,N,N-dibenzyl-5-Oxanonane-diamine-1,9 TCD-diamine1-adamantane amine, Zirconium oxide[6]

Sealapex sealer Calcium hydroxide, Barium sulfate, Zinc oxide, Titanium dioxideZinc striate[6]

The push-out test is commonly used to evaluate bond strength between sealer and root dentin. This test provides a better evaluation of bond strength because here fracture occurs parallel to the resin interface.[7]Thus the purpose of this study was to compare the bond strength of different endodontic sealers.

II. Material and methods

Forty extracted single‐rooted human teeth devoid of any defects like root defects, fractures, and with matured apices were taken for this study. Each tooth was sectioned at the cemento‐enamel junction with a low speed diamond blade, and the roots were then stored in normal saline. The root canal was negotiated with a size

10 stainless steel endodontic file until visualized at the apical foramen. Working length was determined by taking radiographs up to 1 mm short of apical foramen with K- type file. All canals were instrumented to the working length using protaper instruments till size F3. Canals were irrigated with 3% NaOCl solution and saline throughout instrumentation. Final irrigation consisted of 3 ml of 17% ethylenediaminetetraacetic for 1 min followed by 5 ml of saline. The roots were stored in normal saline and divided into four groups based on the sealer used.

- Group 1: Bioceramic Sealer (BioRootRCS)
- Group 2: MTA- based sealer (MTA Fill apex Angelus, Londrina, Brazil)
- Group 3: Epoxy rasin based (AH Plus sealer)
- Group 4: Calcium based sealer (Sealapex)

In Group 1 (BioRootRCS), is placed into the canal with the provided syringe tip up to two- third of the canal. It is tried in a matching propoint and the tip is dipped into the sealer slowly and inserted into the canal until it reaches the working length and it can be trimmed to the level of the canal orifice using a high- speed hand piece and a diamond bur. It has a setting time of 4 h as per the manufacturer's instructions.
In Group 2 (MTA Fill apex), the sealer is mixed by using a self- mixing tip attached to a syringe. A size 30/0.06 GP cone is coated with MTA Fill apex and placed to working length. The cone is then seared off at the orifice level. As per the manufacturer's instructions, the setting time of MTA Fill apex is 2 h.
In Group 3 (AH Plus), according to the manufacturer's instructions, an appropriate amount of base and catalyst is squeezed onto a mixing plate. They were mixed with the spatula for 15–20 s or until creamy and homogeneous. After thorough drying of canals AH Plus sealer was applied, tips of dry disinfected gutta- percha points dipped into the AH Plus sealer and placed up to the working length. Setting time is 8h
In Group 4 (Sealapex), according to manufacturer's instruction appropriate amount of base and catalyst placed onto a mixing pad and stirred thoroughly with a spatula to make a homogeneous texture. Sealapex was applied to the entire length of the canal and placed the gutta- percha point up to the working length. Setting time is 45 mints
The samples were coronally restored with cavit G and stored at 95% relative humidity and 37°C for 24 h. Each root was horizontally sectioned into 2 mm thick slices using a hard tissue microtome.
The filling material was loaded with a 1- mm diameter cylindrical stainless steel plunger. Loading was perfomed on a universaltesting machine at a speed of 0.5 mm/ min until deboning occurred. The load was applied in an apical- coronal direction to avoid any interference because of the root canal taper. The bond strength value in megapascals (MPa) was computed by dividing the maximum load needed to dislodge the filling material in Newton's by the interfacial area (mm2).

Sample under Universal Testing Machine.

Armamentarium used in the study.

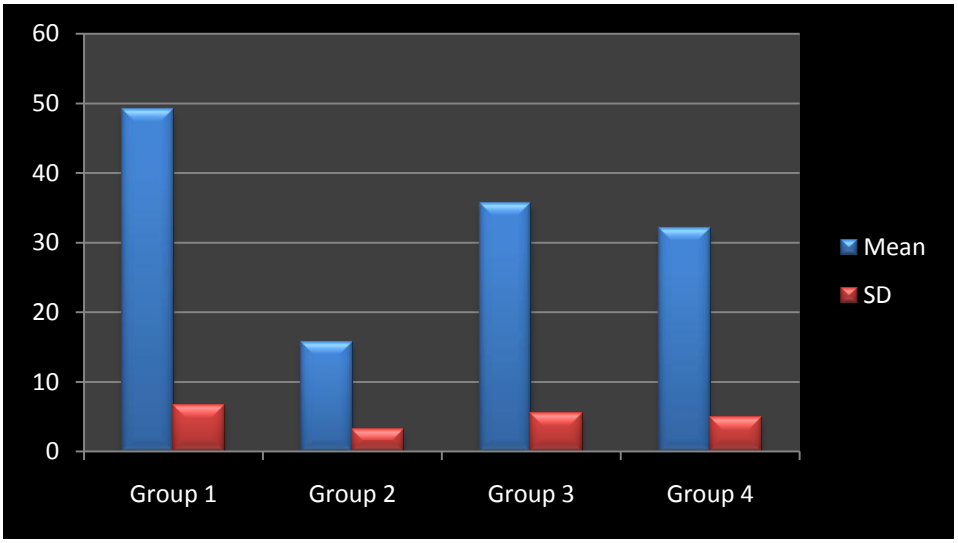
III. Results

The statistical analysis is done by two- way ANOVA and Newman- Keuls multiple *post hoc* and it revealed a statistically significant difference among the groups.

Statistical version used for the study is SPSS 21.0 (IBM Corporation, USA). The highest bond strength was found in Group 1 (BioRootRCS) ($P < 0.05$) compared to other groups . The lowest bond strength was found

in Group 2 (MTA Fill apex). There was statistically significant difference among all the experimental groups . Stereomicroscopic evaluation of the specimens showed more of cohesive or mixed failures .

GROUPS	**MEAN**	**SD**
GROUP 1	49.1	6.68
GROUP 2	15.73	3.16
GROUP 3	35.65	5.57
GROUP 4	32.05	4.84



IV. Discussion

The aim of endodontic therapy is not only to eliminate microorganisms by cleaning and shaping the root canal but also to ensure that the root canal system to be fluid free and that a single block configuration is created that seals hermetically the canal space. Because of the poor adhesiveness of gutta- percha, the use of sealers has been considered mandatory. The major function of a root canal sealer is to fill imperfections and increase adaptation of the root filling material to the canal walls, failing which the chances of leakage and failure increase.[8,9,10,11]

Bond strength minimizes the risk of filling detachment from dentin during restorative procedures or the masticatory function, ensuring that sealing is maintained and, consequently, clinical success of endodontic treatment[12].The bond (sealer and canal walls) through frictional retention or micromechanical adhesion may be beneficial in maintaining the integrity of this crucial interface between dentine and cement. The force is applied in apico- coronal direction to avoid interference due to canal taper, during dislodgement of the filling material[13]

Leakage studies have drawbacks, as does the micro-tensile method, which can result in premature bond failure when cutting the specimens so in this study , a push-out bond strength test was used.[14]

The ability of the push-out test to evaluate the bonding strength surpasses that of other tests because it generates parallel fractures in the interfacial area of dentin bonding[7]However, a limitation of the push- out test is that it creates non- uniform stress distribution [15]We prevented this limitation in this study by using 2 mm thick slices.

In the this study, compared to all other sealers, BioRootRCS showed the highest bond strength with a statistically significant difference ($P < 0.05$). This may be due to its true self-adhesive nature, which forms a chemical bond (through production of HA during setting) with dentine.

V. Conclusion

- BioRoot RCS (Bioceramic Sealer) showed the highest push-out bond strength
- MTA Fillapex showed lowest bond strength among all the four groups

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