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Comparative evaluation of sealing ability of gutta-percha with Bioroot RCS, MTA Fillapex and AH Plus root canal sealer using Warm Vertical Compaction Technique – An Invitro SEM Study

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Abstract

Introduction

Success of endodontic treatment can only be achieved using three dimensional seal. Insufficient seal can open the doorway for bacteria and their byproducts and the tissue fluid might inflow through the root canal system. This in turn results in secondary infection and unsuccessfull root canal treatment . Hence , this invitro study was performed to assess and compare the sealing ability of gutta percha to dentinal walls by three different sealersusing 3D obturation or warm vertical compaction technique under Scanning Electron Microscope.

Methods

Thirty single rooted mandibular first premolar were selected and biomechanically prepared . All the 30 samples were divided into three groups (n = 10 each), based on the sealer used for obturation (Bioroot RCS , MTA Fillapex , AH Plus). After obturation , the samples were subjected to horizontal sectioning at the middle third (7mm) and apical third(4mm) respectively . The sealing abilty was evaluated by gap formation at sealer-dentine interphase under scanning electron microscope and the data was statistically analysed using One Way ANOVA and Post hoc Tukey test .

Result

At both middle and apical third , Bioroot RCS presented least amount of gap formation at gutta percha-dentine interphase whereas AH Plus showed maximum gap formation when checked after 2 days of obturation. None of the groups showed complete marginal adaptation at the sealer- dentin interface .

Conclusion

Bioroot RCS is the sealer of choice for maximum sealing ability when used with warm vertical compaction technique.

Keywords :*AH Plus sealer , Bioroot RCS sealer , MTA Fillapex sealer , Sealing ability , Warm Vertical Compaction .*

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I. Introduction

The purpose of root canal treatment is to clean and shape the pulp space, and completely obturate it with an appropriate filling material to develop a fluid tight seal at the apical foramen.[1] A completely sealed root canal system prevents oral pathogens from colonizing and re-infecting the root and promotes healing of periapical lesion.[2]Insufficient seal can open the doorway for bacteria and their byproducts and the tissue fluid might inflow through the root canal system which in turn results in secondary infection and unsuccessfull root canal treatment.

The gutta percha along with endodontic sealers plays a crucial role and ensures a proper seal between root dentinal walls and endodontic obturation materials. The sealer should fill tridimensionally the root canal anatomy, penetrating also in lateral and anastomotic canals [3]

Although many type of root canal sealers are present, out of which one of the epoxy resin based sealer that is AH Plus (Dentsply De Trey Gmbh, Konstanz, Germany), is a good endodontic sealers because of its extremely goodphysicochemical properties but at the same time deficit in its bioactive potential makes it difficult to extract its best clinical performance.

Another sealer which is calcium hydroxide based, is MTA Fillapex(Angelus, Londrina, Brazil) that perceives both bioactive and biocompatible properties because the calcium phosphate present in its composition

interacts with the surrounding dentinal tubules and forms hydroxyapetite, which can be considered as a real liaison between gutta percha and dentinal wall.[4]

Bioceramic sealers such as Bioroot RCS (Septodent) have been reported to induce, in vitro, the production of osteogenic and angiogenic growth factors by human periodontal ligament cells and possess lower level of cytotoxicity because of which it can induce deposition of hard tissue. Bioceramic sealers also have antimicrobial activity . The bioceramic sealers are mainly formed by combination of tricalcium silicate, zirconium oxide, and povidone in powdered form while the liquid is an aqueous solution of polycarboxylate and calcium chloride. Bioceramic sealers are inductive materials, this means that during hardening, when they come in contact with tissue fluids, calcium hydroxide reacts with phosphatase enzymes resulting in the formation of hydroxyapatite .[5]

Therefore selection of an appropriate sealer in combination with the filling obturation technique play a important role in creating a hermetic seal.[6] Although many obturation techniques are available , warm vertical compaction technique is a boon for endodontics. It presses the sealer along with gutta percha deep into isthmuses, accessory canal and dentinal tubules. Other root canal obturation techniques could not allow this pressure to reach the complex anatomy of root canal system. [7]

Since, the sealing ability of all three root canal sealers was not evaluated using warm vertical compaction , this study is undertaken to determine the sealing ability of gutta percha with Bioroot RCS (a tricalcium silicate based sealer), MTA Fillapex (a salicylate resin based sealer) and AH Plus sealer (an epoxy-resin based sealer) using warm vertical compaction under Scanning Electron Microscope

II. Methods

Thirty human extracted mandibular premolar teeth with straight, mature, fully developed, root canals and anatomically similar dimensions with rounded canal cross section were collected after radiographic examination. Only those teeth were selected which has fully formed apex . Teeth were extracted mainly due to periodontal problems and tooth extracted from the orthodontic case, whereas roots with resorption, fractures or open apices were not used.Soft and Hard tissues around the teeth was mechanically removed using a periodontal Scaler and then washed with tap water. The teeth with single canals were extracted and kept in 1% Chloramine T [Ph = 7.8] at 4 degree celcius untill use to avoid any effect that fixative might have on the dissolution of organic tissue.

Root canal preparation

Coronal access cavities were prepared with BR 41 round bur in high speed air turbine handpiece underwater spray allowing direct access to the canal .The canal was located with the help of a DG 16 probe .The patency was determined by 10 size and 15 size K file. The root canals were ultrasonically activated with 5.25% sodium hypochlorite and saline alternatively, as deep as possible without binding. Whenever there is resistance with 10 size K file , Proglider were used . The Proglider [16/0.02] rotary files with progressive taper from 2% to 8% were used in one or more passes till it reaches the working length .Progliders with a speed of 300 rpm and torque of 2-5.2 Ncm was used. The root canal were then activated ultrasonically with 5.25% sodium hypochlorite and saline as irrigant. The working length were established with cusp tip as reference point to 0.5 mm short of anatomic apex . The coronal enlargement were done by one flare rotary file with taper of 25/0.09 , which has rotation speed 250-400 rpm and torque 3 Ncm .The root canals were then ultrasonically activated with 5.25% sodium hypochlorite and saline alternatively.Then the canals were instrumented with Protaper Next files of size S1 , S2 and final finishing of apical portion will be done with F1 . The files were used with a low torque controlled endomotor. Preparation requirements for the technique include preparing a root canal system with a continuously tapering funnel and keeping the apical foramen as small as possible. Between each file , canals were ultrasonically activated with 5.25% sodium hypochlorite inserted to 2 mm short of entire working length . After the completion of preparation , the root canals will be irrigated and ultrasonically activated with 5.25% sodium hypochlorite , saline and 40% citric acid as final irrigation .

Root canal obturation

Paper points were used to dry the canal and the teeth were kept moist at all time by wrapping them in saline soaked gauze .

Teeth were divided into 3 groups :

- GROUP A – Gutta-percha with Bioroot RCS sealer
- GROUP B – Gutta-percha with MTA Fillapex sealer
- GROUP C – Gutta-percha with AH Plus sealer

The armamentarium includes a variety of pluggers and a heat source. Schilder pluggers come in a variety of sizes (#8 = 0.4 mm, # 812 = 0.5 mm, etc., for sizes #9, #912, #10, #1012, #11, #1112, #12) with

increasing diameter.The instruments are marked vertically at 5-mm intervals. The technique involves fitting a master cone short of the prepared working length (0.5 to 2 mm) with resistance to displacement .After the adaptation of the master cone, it is removed , sealer is mixed and applied to the walls of the prepared canal using lentulo spiral. The coronal gutta percha was removed using heated plugger in successive increments and the remaining material was softened. The Touch 'n Heat (Sybron Endo) and System B (Sybron Endo) are alternatives to apply heat with a flame-heated instrument because they permit improved temperature control. The gutta percha was compacted apically using a plugger. The same method was continued untill the apical portion has been reached. System B was used for back filling the the remaining coronal canal space. Final compaction of gutta percha was done using plugger. The access cavity were sealed with glass ionomer cement (Fuji 2).The quality and apical extent of the root canal filling were assessed with radiograph and all samples were stored at 37 degree celcius and 100% humidity for 48 hours to allow the sealer cement to set completely .

Sectioning of tooth

Teeth were sectioned using a 300 micro meter thick sintered diamond wafering blade [STRUERS] perpendicular to the root canal at low speed with constant water cooling .A 1mm thick section of mid root dentine was prepared , at a level calculated to yield a main cone diameter slightly greater than 0.5 mm . Both apical and coronal aspects of each sample were photographed and examined before testing to confirm a circular canal shape and that the sealer filled the entire canal space completely without voids .

Scanning Electron Microscope

For assessment of gaps, the slices were dehydrated in an ascending ethanol series. All specimens were sputter coated with gold–palladium and viewed with a scanning electron microscope .Scanning electron microscopy (SEM) images of apical and middle sections for gap formation in all the three groups were assessed .The adaptability at the sealer- dentinal wall interface was measured in µm , as seen in the SEM images of the gap formation between the dentin surface and the sealer surface.

Assessment of gaps

Gap formation = Distance from sealer to root dentin interface values were calculated in micrometers.
The results for each group was recorded, tabulated and statistically analysed .

III. Result

In the given study , when the three sealers were used in conjugation with warm vertical compaction technique , the following data could be retrieved from the scanning electron microscope images.

At the middle third, AH Plus shows the highest mean value [2.720(±0.396)] for gap formation ,followed by MTA Fillapex [2.312(±0.270)] &BioRoot RCS [1.309(±0.208)].The multiple comparisons show that, there is a highly significant difference between the 3 groups in the middle third. [with BioRoot RCS (p=0.0005), MTA Fillapex (p=0.001) , AH Plus (p=0.004)].(FIGURE 1,3,5)

At the apical third, AH Plus [5.249(±0.669)] showed the highest mean value for gap formation, followed by , MTA Fillapex [4.088(±0.464)] &BioRoot RCS [2.417(±0.351)]. The multiple comparisons show that, there is a highly significant difference between the 3 groups in the apical third. [with BioRoot RCS (p=0.0005), MTA Fillapex (p=0.0005) ,AH Plus (p=0.0005)].(FIGURE 2,4,6)

GAP FORMATION OF AH PLUS ROOT CANAL SEALER

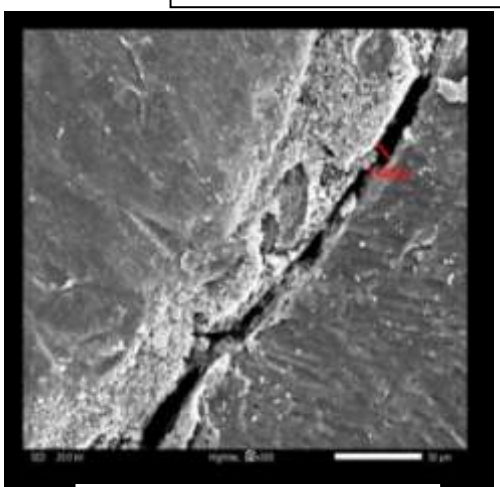


FIGURE 1 – MIDDLE THIRD

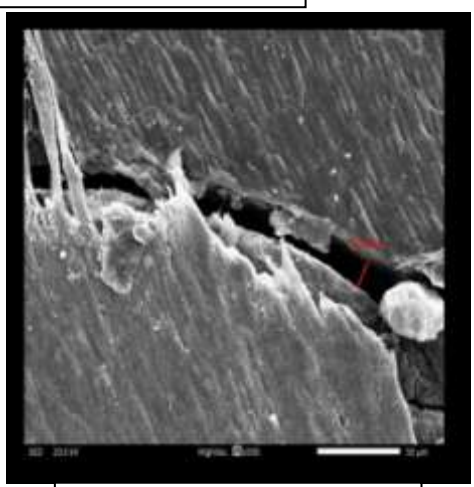


FIGURE 2 – APICAL THIRD

GAP FORMATION OF MTA FILLAPEX ROOT CANAL SEALER

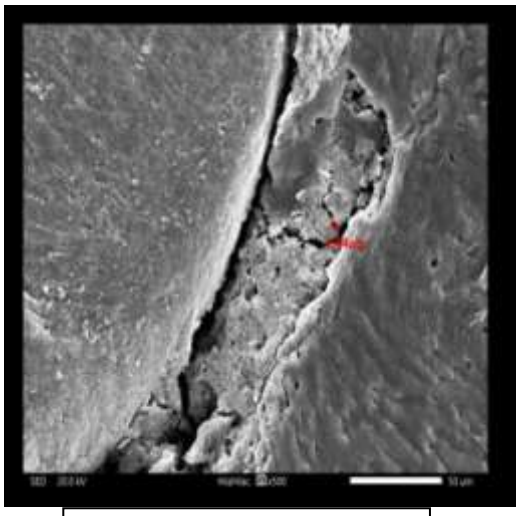


FIGURE 3 – MIDDLE THIRD

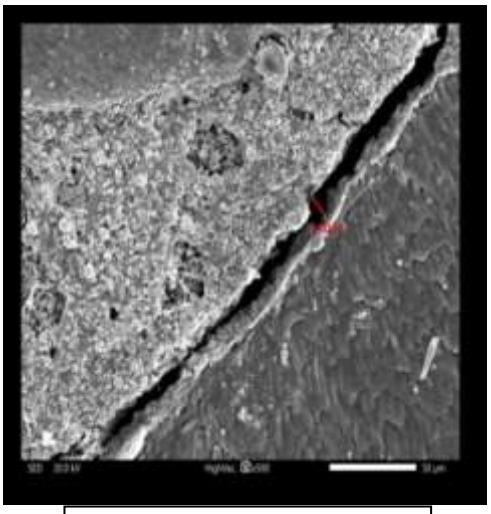


FIGURE 4– APICAL THIRD

GAP FORMATION OF BIOROOT RCS ROOT CANAL

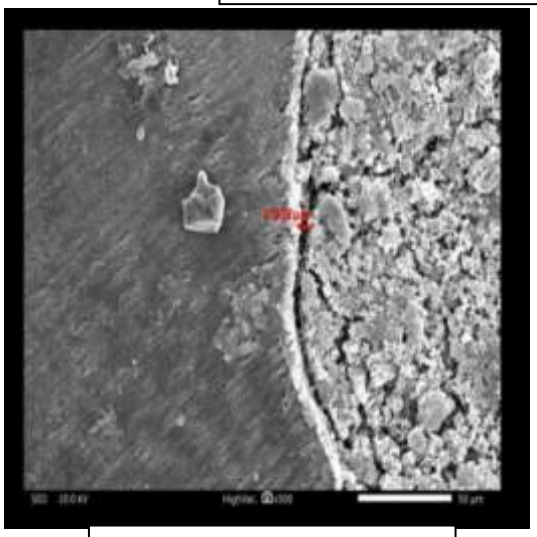


FIGURE 5 – MIDDLE THIRD

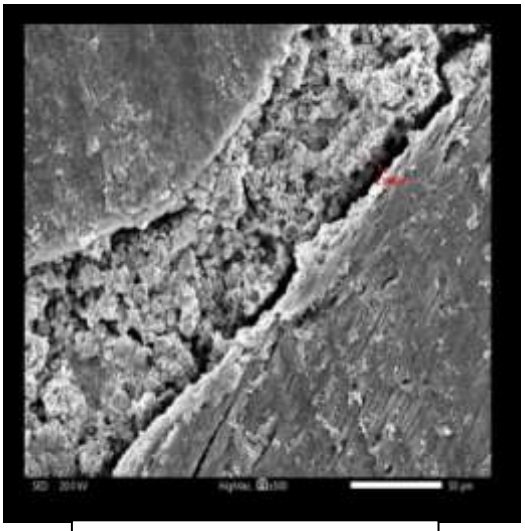
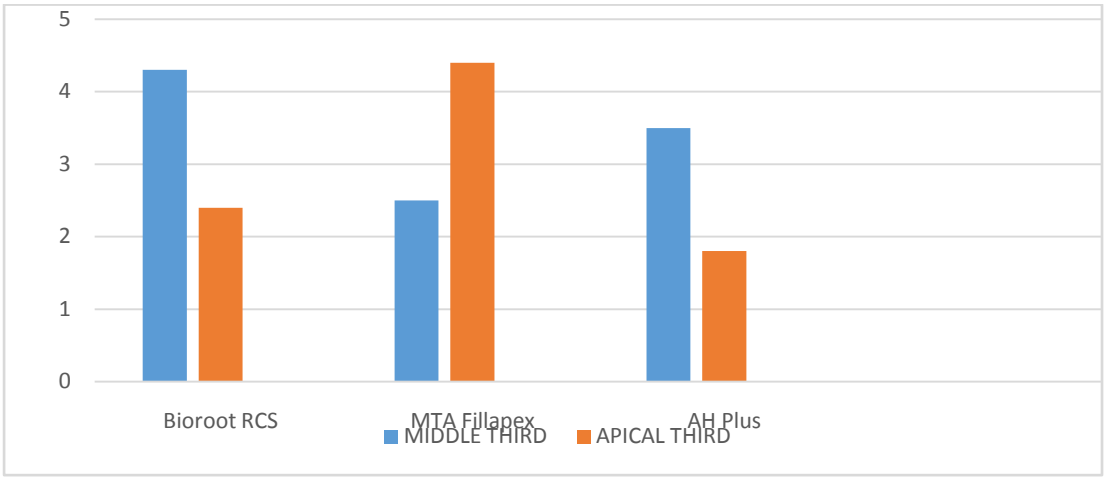


FIGURE 6– APICAL THIRD



GRAPH 1 : Comparison of gap formation at middle third and apical third of three different sealers

IV. Discussion

A fluid-tight seal is the main requisite to achieve a successful obturation. For a 3-dimensional seal, due to non-adhesive nature of gutta-percha, it alone is not sufficient, therefore, use of sealer is mandatory to fill the gap between gutta percha and dentinal tubules and provide a better seal.[8]

Furthermore, it is difficult for the sealer to penetrate into the dentinal tubules because of the hindrance caused by the presence of smear layer on the dentinal walls. During root canal instrumentation, smear layer is formed on the surface of dentinal wall which in turn again hampers the adaptation and penetration of root canal sealer into the dentinal tubules.the presence of a smear layer on the dentinal walls also reduce the dentin permeability and hinders with the penetration of the root canal sealer into the dentinal tubules.[9]The performance of root canal sealer could be judged on the basis of depth of penetration of root canal sealer into the dentinal tubules because its penetration forms a physical barrier, destroying the residual bacteria and improves the retention of the root canal filling. However, studies have been performed where no correlation was found between the actual sealer penetration into dentinal tubules and the sealing ability of the endodontic filling material.[10]

Along with that, Biomechanical preparation is a significant step to obtain a successful endodontic treatment outcome. Shaping and cleaning of root canals are important phases in endodontic therapy. As Schilder in 1974 justified that the aim of cleaning and shaping should focus on both the biological and mechanical objectives. In which the Biological objective aims at total debridement of the root canal and obtain a glossy smooth wall whereas the mechanical objective is accomplished by creating a continuously tapering funnel with the smallest diameter at the apex and the widest diameter at the orifice. ProTaper Next which is a conventionally used NiTi rotary system was used in the study which has variable taper along its length and a convex triangular cross- section.[11] The use of this rotary file system reduces the time required for shaping and also improves the standardization of instrumentation.[12]

However, this does not neglact the importance of the quality of the obturation in which the sealer has a major role to play.[13]Several types of endodontic sealers have been recommended to achieve this goal. Adhesion of the root canal sealer to root dentin at the dentin- sealer interface is a basic requirement of any root canal filling material.[14]In all the groups tested for this study, the BioRoot RCS sealer revealed best sealing ability at the apical and middle third with minimal gap formation.Although many bioceramic sealers are available BioRoot™ RCS (Septodont, France) is a recently introduced tri-calcium silicate-based bioceramic sealer that utilizes the "Active Biosilicate Technology" which is resin and eugenol free, and thus provides exceptional biological and bioactive properties.[15,16] It releases high levels of calcium in solution. This is much higher than other similar sealer types. Also, *Small particle size*, *hydrophilicity*, and *low contact angle* makes it easy for the sealer to spread evenly over canal walls and micro-canals. It also shows gap free chemical bonding with dentinal walls due to a significant expansion of 0.20%.[17]

On the other hand , one of the resin based sealer is AH Plus which has good physicochemical properties and antibacterial effect . It is a commonly used sealer in clinical practice in conjugation with cold lateral compaction technique for obturation. The presence of adamantine in AH Plus makes it easier for the sealer to bond to the core material and dentine of the root canal and prevent microleakage at the interface but the presence of *silicone* content in AH Plus creates *high surface tension* forces, making the sealer more difficult to spread resulting in more marginal gaps.[18]

On the other side in 1999 , there was introduction of Tricalcium silicate-based sealers because of its calcium releasing ability and bioactivity.[19] The first commercial tricalcium silicate-based sealer introduced was

MTA Fillapex, which was the first developed MTA based paste- paste, salicylate resin root canal sealer, that is mostly composed of a salicylate resin rather than MTA. The catalyst paste comprises of a natural resin, salicylate resin, diluting resin and bismuth oxide, while the base paste consists of MTA, nanoparticulate silica and pigments.MTA Fillapex does not form calcium hydroxide on hydration and also exhibits low calcium ion release in solution.Therefore , even after showing great biological regeneration along with excellent seal, it was not propitious due to its cytotoxic and genotoxic levels when compared withBioroot RCS.[20,21,22,23]

Although these sealers have been used in conjugation with many obturation techniques , warm vertical compaction technique presses the sealer along with gutta percha deep into isthmuses, accessory canal and dentinal tubules. Other root canal obturation techniques could not allow this pressure to reach the complex anatomy of root canal system. [7]

V. Conclusion

- *BioRoot RCS showed the highest sealing ability* with gutta percha on dentinal walls using warm vertical compaction technique as seen in the scanning electron microscope.
- *MTA Fillapex* and *AH Plus* groups showed similar adaptation, of which MTA Fillapex was better.
- All tested sealers showed significantly better adaptation and sealing ability at the middle thirds than the apical third.
- Bioceramic sealers showed higher penetration at the middle third.

Limitations of the study

Sealing ability of gutta percha with root dentine could not be identified for different root anatomy (curved canals , calcified canals , etc).Sealing ability might vary among different tooth in maxillary and mandibular arch .

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