An In Vitro Study Of The Effects Of Final Irrigation Protocols On A New Bioceramic Sealer

Dr Prateek Singh¹, Dr. Rachita Mustilwar², Dr. Sidhant Pathak³, Dr Harpreet singh Chhabra⁴*, Dr. P. Charulata Sree⁵, Dr. Arindam Banik⁶

1 Reader, Department of Conservative dentistry and endodontics, Rama Dental College, Kanpur
E-mail: kushwahprateek@gmail.com
2 Lecturer, Department of Periodontology, Rural Dental College, PIMS (DU), Loni, Maharashtra, India,
E-mail: dr.rachu@gmail.com
3 Assistant Professor, Department of dentistry, Adesh Medical College & Hospital, Mohri, Shahabad, Dist. Kurukshetra.
E-mail: sidpat1@gmail.com
4 Professor, Department of Conservative dentistry and endodontics Sardar Patel post graduate institute of dental and medical sciences, E-mail: charulata014@gmail.com
5 Intern, Rungta college of Dental sciences and Research, Bilalai, Chhattisgarh, E-mail: charulata014@gmail.com
6 Postgraduate Student, Department of Conservative Dentistry and Endodontics, Awadh Dental College and Hospital, Jamshedpur, Jharkhand.

*Correspondent Author: Dr Harpreet singh Chhabra
Professor, Department of Conservative dentistry and endodontics Sardar Patel post graduate institute of dental and medical sciences, E-mail: harryagar@gmail.com
DOI: 10.47750/pnr.2022.13.S0.92

Abstract

Aim & Objective: The objective of this in vitro research was to assess how final irrigation techniques affected the apical micro leakage of a bioceramic sealer.

Materials and Methods: To standardise the canal length, sixty single-rooted mandibular premolar teeth that had been removed were obtained and decoronated. The working length of the root canals was established after accessing them. NiTi rotary files were used to prepare the root canals. Based on the final watering strategy, samples were randomly split into three groups, totaling 20 N.

Group1. 5 ml of 17% EDTA for 1min followed by 5ml of 5%NaOCl, 5ml Distilled water. Group2. 5ml of Q MIX 2 in 1, 5ml Distilled water. Using a single-cone approach and a novel bioceramic sealant, the canals were obturated. To enable the sealer to fully set, all roots were put in 100% humidity and incubated at 37 oC for 24 hours. After the root surfaces had dried, two coats of nail polish had been applied, with the exception of the 2mm at the tip, which had been submerged in 1% methylene blue for 72 hours. After that, the samples were longitudinally sectioned, and dye penetration was examined using a stereomicroscope (10x magnification). Using the Image Pro Express 6 software, the maximum apical dye penetration leakage was determined. One-way ANOVA and Tukey’s HSD post hoc analysis were used to statistically analyse the data.

Results: Of all the experimental groups, Group 1 had the least percentage of apical leakage. Between each group, there were significant variations in the degree of apical micro leakage (P 0.001).

Conclusion: Within the constraints of this investigation, it was shown that when Bioroot RCS was used as the sealer, final irrigation with 17% EDTA followed by 5% sodium hypochlorite demonstrated the least degree of apical leakage.

Keywords: 17% EDTA, 5%Naocl, 2% Chlorhexidine, Bioroot RCS, Apical micro leakage.

INTRODUCTION:
A comprehensive chemo-mechanical preparation and three-dimensional obturation are necessary for an effective endodontic procedure, which offers the root canal system a full seal [1]. The primary goals of root canal therapy are to eliminate germs from the root canal and prevent recontamination after therapy (Bystro & Sundqvist 1981). Although tools are essential for removing contaminated dentine from the main root canal, irrigants are also essential for places that are difficult for tools to reach, such as the lateral and auxiliary canals, along with the fins and webs that are present throughout the canal. For effective debridement of root canals during cleaning and shaping treatments, chemical irrigants are crucial.

The smear layer, which is an amorphous, granular, and uneven coating covering the root dentin and comprises both inorganic and organic material, is left behind by the instruments used to clean and shape root canals. In addition to preventing irrigants and sealants from reaching the dentinal tubules, the smear layer may negatively impact the cleaning of dentin walls. Additionally, it may worsen post-obturation microleakage and act as a food supply for certain intracanal...
bacteria species [1]. The root canal walls' ability to completely remove the smear layer improves sealer penetration into the dentinal tubules.

Because of its remarkable antibacterial properties and capacity to destroy necrotic tissue, sodium hypochlorite (NaOCl) is one of the most helpful irrigating solutions for root canal therapy. As a result, EDTA and NaOCl have been used to remove the smear layer effectively [2]. Because of its antibacterial action, substantivity, and relative lack of cytotoxicity, chlorhexidine digluconate (CHX) is employed as a final irrigant. The range of concentrations utilised is 0.12% to 2%. It works by disrupting bacterial cell membranes by cationic binding. CHX lacks the capacity to dissolve tissue and is ineffective in removing the smear layer [3].

To create an impermeable barrier between the core filling material and the root canal wall, root canal sealers are used in combination with core filling materials. Additionally, root canal sealants may enter spaces that gutta-percha cannot, including as accessory canals, lateral canals, and dentinal tubules [2]. To improve the uniformity of root fills, root canal sealers are utilised in combination with gutta-percha or other solid cones. Due to its versatility and simplicity, lateral compaction of cold gutta-percha is a widely used process that is often used as a benchmark to test new methods. A new tricalcium silicate-based sealer called BioRoot RCS was just just released; it is a water-based sealer that comes in both liquid and powder form. Zirconium oxide and tricalcium silicate are also present (Camilleri 2015, Xuereb et al. 2015). After setting, BioRoot RCS releases calcium hydroxide, but MTA Fillapex does not (Camilleri 2015). When compared to EndoSequence BC Sealer, BioRoot RCS exhibits twice the calcium ion leaching and leaches large quantities of calcium.

This in vitro study's objective is to evaluate the impact of several final irrigation techniques on the apical microleakage of a novel Bioceramic sealer (17%EDTA followed by 5%NaOCl, Qmix 2 in 1, and Chlorhexidine 2%).

**METHODOLOGY:**

The research comprised sixty human mandibular premolar teeth that matched the inclusion and exclusion criteria. To eliminate calculus and soft tissue remains, teeth were collected and then meticulously cleaned, scaled, and curetted. Samples were kept in distilled water, which was replaced twice each week. The crowns of the removed teeth were decorated with a diamond disc at the intersection of the cement and enamel while being kept cold by water. A size #15 K-file (Dentsply Maillefer) was put into the root canal after the canals were opened, and it was pushed toward the apex until the tip of the instrument was barely visible at the apical foramen. The length of the file was measured, and the working length of the root canal was calculated by deducting 1mm from the measured length. According to the manufacturer's instructions, canal were instrumented with Hero shaper NiTi rotary files to size No. 30, 6%. For irrigation, EDTA (17%) solution was applied after each file size.

Based on the final watering strategy, the prepared specimens were randomly split into three groups, totaling 20 N.

1. Group 1. 5 ml of 17% EDTA for 1min followed by 5ml of 5%NaOCl,5ml Distilled water.
2. Group 2. 5ml of QMIX 2 in 1, 5ml Distilled water.
3. Group 3. 5ml of 2% CHLORHEXIDINE, 5ml Distilled water.

Following the last irrigation, the canals were dried with absorbent paper points before being obturated using the single-cone method with a size 30, 6% gutta-percha cone and new bio-ceramic sealer. A gutta-percha point was used to apply sealer into the root canal while manipulating it in accordance with the manufacturer's recommendations. The gutta percha cone was then positioned up to the working length and given a single, thin application of sealant. The coronal apertures will be sealed with glass ionomer cement of the restorative type after the extra gutta percha was removed using a heated tool (Type 2, GC Gold Label, Japan). The samples were then kept in an incubator for 24 hours at 37°C in a humid environment. Following drying of the sample surfaces, two coats of coloured nail polish were applied to the surface, stopping 2 mm short of the apex. Then, for 72 hours, roots were suspended in newly made 1% methylene blue. The roots were then washed under running water for 15 minutes. Preparation of samples for analysis of microleakage. The roots were separated longitudinally parallel to the long axis using a diamond disc and water cooling after the varnish layers were scraped off. Each sample's apical microleakage was assessed using a stereomicroscope (at 10-x magnification). Images were taken, stored, and Image Pro Express 6 was used to assess the greatest apical dye penetration leakage (Media Cybernetics Inc.401N Washington street, Suite350 Rockville MD 20850 USA). A single operator carried out all setup and testing operations to remove the operator variable. Statistical analysis was performed using one-way ANOVA t-test and Post Hoc Tukey procedures.

**RESULTS:**

In terms of Mean, SD, and Range, descriptive statistics represents the vertical penetration depth (measured in mm). Inferential Statistics: To evaluate the mean vertical penetration depth (measured in mm) across the research groups, a one-way ANOVA test was utilized, followed by a Tukey's HSD Post Hoc Analysis. P <0.05 was chosen as the [P-Value] threshold of significance. Table 1 displays the mean, standard deviation, lowest and maximum apical microleakage values for the experimental groups. Between the groups, there were statistically significant differences (p< 0.001).
Tables 1. Comparison of mean vertical penetration depth (in mm) between 03 study groups using One-way ANOVA test.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Std. Error</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>20</td>
<td>0.5139</td>
<td>0.1052</td>
<td>0.0232</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Group 2</td>
<td>20</td>
<td>0.7425</td>
<td>0.0245</td>
<td>0.0110</td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>20</td>
<td>1.0245</td>
<td>0.1456</td>
<td>0.0345</td>
<td></td>
</tr>
</tbody>
</table>

Note: Group 1 - 5 ml of 17% EDTA for 1 min, 5 ml of 5% NaOCl, 5 ml Distilled water Group 2 - 5 ml of QMIX 2 in 1, 5 ml Distilled water Group 3 - 5 ml of 2% CHLORHEXIDINE, 5 ml Distilled water.

As shown in Table, an ANOVA test of dye penetration in several groups revealed significant variance. Statistically significant when P < 0.001. P value is statistically significant, therefore mean values in the various groups varied substantially. Group 3’s mean values were at their highest, followed by Group 2’s, and Group 1’s at their lowest.

Tables 2. Multiple comparison of mean vertical penetration depth (in mm) between 03 study groups using Tukey’s HSD post hoc Analysis.

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean Difference (I-J)</th>
<th>95% CI for Mean Diff</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Group 2</td>
<td>-0.1455</td>
<td>0.2825</td>
<td>0.0743</td>
</tr>
<tr>
<td></td>
<td>Group 3</td>
<td>-0.5427</td>
<td>0.5381</td>
<td>0.3755</td>
</tr>
<tr>
<td>Group 2</td>
<td>Group 3</td>
<td>-0.3478</td>
<td>0.3495</td>
<td>0.1945</td>
</tr>
</tbody>
</table>

Using Tukey’s HSD post hoc Analysis, we conducted multiple comparisons to determine which groups had a significant difference. As can be seen in Table 2, a comparison of the degree of significance for each group indicated that Group 1 had the least amount of apical leakage, followed by Group 2 and Group 3.

DISCUSSION:
To prepare a clean, bacteria- and debris-free channel for obturation is the ultimate goal of root canal instrumentation and irrigation. Schneider recommended choosing straight, single-rooted, single canal mandibular premolars with a root length of around 20–22 mm and a curve less than 5 degrees in order to prevent anatomic variance and preserve consistency [4]. The removal of vital and necrotic pulp tissue, infected dentine, and dentine debris is the main goal of root canal instrumentation in order to get rid of the majority of the microorganisms in the root canal system (European Society of Endodontology 1994, American Association of Endodontists 1998) [5]. Regardless of method or file type, traditional instrumentation with stainless steel files has been proven to produce variances in canal morphology. In less time than it takes to use conventional methods, NiTi rotary devices can efficiently create a smooth funnel form with a decreased danger of ledging and convey the canal.

Chemomechanical pretreatment is the main method used nowadays to sterilise the root canal system. However, instrumentation can only prepare 60 to 80 percent or less of canal outlines circumferentially (Peters2004). Smear layer is one of the elements that might negatively impact apical and coronal microleakage and jeopardise the treatment’s long-term effectiveness, according to Torabinejad et al [5]. According to Haapasalo et al., removing the smear layer might make it easier for intracanal medications to reach the diseased root canals’ dentinal tubules and, as a result, improve the cleaning process [6].

Sodium hypochlorite is the most popular irrigant utilised during chemomechanical preparation (NaOCl). According to many studies, this solution may disintegrate organic tissue (Beltz et al., 2003; Koskinen et al., 1980; Senia et al., 1971; Zehnder et al., 2002) and is a powerful antibacterial agent (Sena et al., 2006; Vianna et al., 2004) [7].

In nonsurgical endodontic therapy, the smear layer is often removed with EDTA because of its propensity to form compounds with calcium ions (Ingle and Bakland, 2002; Hulsmann et al., 2003) [8]. Goldman LB and Yamada reported the finding that chelating agents eliminated the smear layer [9]. However, it does not have antibacterial properties and is used with NaOCl to effectively irrigate root canals. Furthermore, when EDTA and NaOCl are combined rather than utilised separately, both the cleansing and antibacterial activities are more noticeable.
During chemo-mechanical operations, root canal irrigants function as antimicrobial agents, disintegrate organic tissue leftovers, lubricate the dentinal walls, and help drain out debris while also aiding in the removal of the smear layer. The removal of the smear layer results in improved adhesion and sealing capabilities [10].

In the current investigation, alternating watering with 17% EDTA and 5% NaOCl was utilised to effectively and completely remove the smear layer, taking works by Baumgartner et al. and Yamada et al. into consideration [6]. In endodontics, chlorhexidine gluconate (CHX) is utilised as an irrigant and an intracanal medication. Both gram-positive and gram-negative microorganisms are targeted by broad-spectrum antibiotic activity (Delany et al. 1982) and biocompatibility (Yesilsoy et al. 1995) [11]. By two versions of QMix 2 in 1 (QMix I [pH = 8], QMix II [pH = 7.5]), Dai et al. examined the Smear and debris scores of QMix in the coronal third, middle third, and apical third of root canals using SEM. It was determined that following the first usage of NaOCl as the initial rinse, the two variants of the experimental antimicrobial (QMix) are just as efficient as 17% EDTA in eliminating canal wall smear layers from the whole root canal area in straight root canals.

EDTA is used in the root canal system of single-rooted teeth to remove the smear layer and reveal the dentinal tubules. QMix was used as the final irrigant in the current investigation [1]. Because it raises the levels of adhesion to dentin, CHX, which was utilised as a final irrigant in the current investigation, has been proven to be advantageous (Lindblad et al., 2010; Ricci et al., 2010) [7]. In particular, with canals instrumented with greater taper Ni-Ti rotary files, the use of single cone obturation technique may be encouraged by the development of new types of endodontic sealers and/or obturation core materials, which may eliminate the microleakage associated with currently used materials [12]. Due to the extensive usage of matched-taper gutta-percha cones and rotary nickel-titanium (NiTi) instruments, single-cone obturation techniques are becoming more and more common. Additionally, this method is said to be straightforward, enhances practise, and reduces stress for both the patient and the physician.

The dentistry industry was supported for many years by root canal sealers based on zinc oxide and eugenol, although their irritancy potential, cytotoxicity, and solubility in oral fluids are also well recognised. The majority of non-eugenol sealants are based on calcium hydroxide. According to the theory, using calcium hydroxide as a sealer may encourage a sterile biological closure of the apical area, improving the seal and treatment effectiveness [13].

"Hand instruments and chloroform solvent followed by one minute of instrumentation with an ultrasonic No. 25 file may effectively remove Ketac Endo sealer," according to the manufacturer.

More recently, a more biological method is being used in which the sealers try to interact with the root dentin, producing bioactivity [14], rather than attempting to hermetically seal the root canal. Additionally, the MTA includes bismuth oxide, an insoluble additive that adds radiopacity. A new tricalcium silicate sealer has just been released by Septodont (Saint-Maur Des Fosses, France) and is titled (BIOR-OOTTM RCS). The maker claims that this cement comprises a pure mineral composition that won't discoulour teeth, is created from pure calcium silicate, and is monomer-free to ensure 0% shrinkage.

It has significant capacity to close auxiliary canals because to its high flowability and hydrophilic behaviour, which permits continuous sealing in the presence of moisture [15]. It gives good adherence to dentin and gutta-percha points. Given that this sealer is water-based and changes when heated, warm vertical compaction should be avoided while using it. Instead, a single-cone obturation method should be employed. Comparing single-cone obturation with a tricalciumsilicate-based sealer to teeth filled with lateral compaction, a substantial reduction in porosity was observed [14].

According to Koch et al., bioceramic sealer absorbs water from the dentinal tubules when it is inserted into a root canal. The setting process is then started, creating a combination of hydroxyapatite and calcium silicate hydrogel. The hydroxygroup in the hydroxyapatite causes the calcium silicate hydrogel to chemically connect with it. On the dentinal walls, hydroxyapatite is continuously growing into crystals, resulting in the hydroxyapatite production in the sealer [16].

The present study's findings indicate that final irrigation with EDTA reduced apical microleakage values for BioRoot RCS. This finding may be explained by the absence of a smear layer and smear plugs formed during biomechanical preparation, which allowed sealer penetration inside the dentinal tubules to increase the mechanical retention of the sealer and the bond strengths of sealer to root canal dentin. In the current investigation, groups watered with QMix and chlorhexidine had greater dye leakage values than those irrigated with EDTA and NaOCl. The inability of QMix solutions to breakdown organic tissues in the root canal system may be to blame for this result.

CONCLUSION:

Conclusion: The primary goal of removing the smear layer is to establish a dentinal surface structure that best matches the properties of the applied sealer, as well as to clear the dentinal tubules of organic and inorganic material. The assessment of sealers' sealing capacity as well as the impact of root canal irrigants on the apical seal need more long-term in vivo research.
REFERENCES:


12. Tomer AK, Gupta R, Ramachandran M, John AG, Rana AA, Behera A, Mittal N. Comparison of the apical sealing ability of calcium hydroxide, MTA, and silicone based sealers.2018


