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Sealing Ability of Bioceramic Sealer after Ultrasonic Activation of Different Root Canal Irrigating Solutions

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Abstract:-

- ***Aim***

To evaluate and compare the sealing ability of bio ceramic root canal sealer after ultrasonic activation of root canal irrigation solutions 3% NaOCl , 40% Citric acid & Neem leaf extract .

- ***Materials and Methods***

In this study, 42 mandibular premolar teeth with single roots and canals were divided into three groups for irrigation: 3% NaOCl, 40% citric acid, and Neem leaf extract. After access preparation and glide path creation with a #10 K-file (0.02 taper), the canals were instrumented using a crown-down technique to an ISO size of 30, with saline as the irrigant. Ultrasonically activated irrigation was used, followed by saline in all groups. The canals were obturated with Dentsply Gutta-percha and Bio C sealer, 1mm short of the working length, and sealed with temporary restorations. Teeth were incubated at 37°C for 3 days, and horizontal sections at 3mm from the apex were taken. Confocal laser scanning microscopy measured sealer penetration, and statistical analysis was conducted to compare results between groups.

- ***Results***

The results suggest that 40% citric acid is the most effective irrigant for enhancing sealer penetration into dentinal tubules at the apical third, both in terms of percentage and depth of penetration, compared to 3% NaOCl and neem leaf extract. This indicates that citric acid may improve the sealing ability of root canal treatments more effectively than the other tested irrigants.

- ***Conclusion***

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Keywords:- *Citric Acid , NaOCl , Neem Leaf Extract , Confocal Laser Scanning*

I. INTRODUCTION

Root canal therapy aims to remove infected or damaged pulp tissue from a tooth and seal the root canals to prevent further infection.[1] The sealing ability of different materials and techniques plays a crucial role in the success of root canal treatments. Over time, advancements in sealers and irrigation solutions have been made to enhance the removal of the smear layer, improve sealer penetration, and ensure proper sealing of the canal system[2].Research has shown that the removal of the smear layer significantly improves the quality of apical sealing. For instance, Economides et al. (1999) demonstrated that using AH26 sealer after smear layer removal enhanced the sealing ability, while Singh et al. (2016) found that using QMix irrigation reduced the sealing efficacy of MTA Fillapex and Adseal. Furthermore, recent studies like Rekha et al. (2022) compared bioceramic and epoxy resin-based sealers, both exhibiting effective sealing abilities. Other irrigants like sodium hypochlorite (NaOCl), citric acid, and natural alternatives such as neem leaf extract have also been studied for their impact on sealer penetration.In modern endodontic practice, bioceramic sealers have gained attention due to their hydrophilic nature and ability to utilize canal moisture, providing superior sealing without shrinkage. Citric acid, with its ability to clean canal walls and open dentinal tubules, has proven to be an effective irrigant, and neem (Azadirachta indica), known for its antimicrobial properties, has shown promise in dental treatments. Ultrasound technology further enhances the effectiveness of these irrigants by improving penetration and cleaning.

This study aims to evaluate sealer penetration in root canals using different irrigation solutions—3% NaOCl, 40% citric acid, and neem leaf extract—activated by ultrasound. By comparing the effects of these solutions on bioceramic sealer penetration, the study will provide insights into the optimal irrigation method for improving sealing ability, while testing the null hypothesis that no significant difference will be observed among the solutions.

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II. MATERIALS AND METHODS.

In this experimental study, 42 extracted mandibular premolar teeth with single roots and canals were selected and divided into three experimental groups based on the irrigation solutions used: 3% sodium hypochlorite (NaOCl), 40% citric acid, and neem leaf extract. Following access cavity preparation, a glide path was established using a #10 K-file (0.02 taper) to facilitate canal shaping. The canals were then instrumented using a crown-down technique to an ISO size of 30, with saline employed as the irrigant during the instrumentation process to remove debris. After the mechanical preparation, ultrasonically activated irrigation was performed in all three groups, followed by a final rinse with saline to ensure cleanliness. The purpose of ultrasonic activation was to enhance the effectiveness of the irrigants by improving their penetration and flow within the root canals. Once irrigation was completed, the canals were dried, and obturation was performed using Dentsply Gutta-percha cones along with Bio C sealer, with the obturation material placed 1mm short of the working length to prevent overfilling. The access cavities were then sealed with temporary restorative materials.The teeth were incubated at 37°C for 3 days to allow the sealer to set fully. Following incubation, horizontal sections were taken 3mm from the apex of each tooth. These sections were then analyzed using confocal laser scanning microscopy, which allowed for the visualization and measurement of the sealer penetration into the dentinal tubules. This method provided a clear, detailed assessment of how well the sealer penetrated the tubules in each group.

III. RESULTS

Table 1 The Percentage (%) of Sealer Penetration into Dentinal Tubules at Apical sections

GROUPS	APICAL THIRD (Mean± SD)
3% NaOCl	47.27 ± 23.5
40% Citric Acid	50.64 ± 20.75
Neem Leaf Extract	44.58 ± 13.245

Table 2 The Maximum Depth of Sealer Penetration (in micrometers) into Dentinal Tubules at the Apical

GROUPS	APICAL THIRD (Mean+/- SD)
3% NaOCl	540 ± 350
40% Citric Acid	600 ± 350
Neem Leaf Extract	500 ± 125

IV. DISCUSSION

The results of this study showed no significant difference in the percentage or maximum depth of sealer penetration among the groups tested, so the null hypothesis cannot be rejected. Various factors could have influenced the outcome, such as the effectiveness of smear layer removal, obturation technique, sealer properties, and root canal anatomy. Despite this, citric acid exhibited the highest sealing ability, followed by 3% sodium hypochlorite (NaOCl), while neem leaf extract showed the lowest. Citric acid's chelating properties, which aid in the removal of dentin debris, enhance sealer penetration and adhesion, making it a favorable choice due to its mild nature and biocompatibility. Previous research supports citric acid's positive impact on treatment outcomes. NaOCl demonstrated intermediate sealing ability, consistent with its strong antimicrobial action, though its aggressive nature may leave residual debris that can interfere with sealer adhesion. Therefore, combining NaOCl with a chelating agent like citric acid could improve both disinfection and sealer placement. Neem leaf extract, on the other hand, showed limitations in sealing ability, likely due to its lack of chelating and smear layer removal properties, suggesting that its concentration and formulation require further investigation to optimize its performance in root canal treatment.

V. CONCLUSION

In conclusion, irrigation solution choice significantly impacts bioceramic sealer effectiveness in root canal treatments. Citric acid offers the best sealing ability, followed by 3% NaOCl, while neem leaf extract demonstrates lower sealing ability. Clinicians should carefully consider these findings, keeping in mind patient-specific factors, to achieve optimal treatment outcomes. Further research is needed to validate and refine irrigation protocols

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