COMPARATIVE STUDY OF THE EFFECTIVENESS OF FINAL IRRIGATION PROTOCOLS IN *SMEAR LAYER* REMOVAL: A STUDY BY MEV

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ABSTRACT

The study aims to compare the effectiveness of different final irrigation protocols in removing the smear layer (SL) in root canals, using Scanning Electron Microscopy (SEM) for detailed analysis. The residual layer, formed during endodontic treatment and composed of organic and inorganic fragments, can compromise treatment success if not properly removed. To achieve the objective, fifty bovine incisors were selected, which were decrowned and standardized. These teeth were divided into five groups: a control group, which did not receive final irrigation, and four experimental groups that used different combinations of chelating solutions (17% EDTA and 0.2% chitosan) and activation methods (conventional irrigation and passive ultrasonic irrigation). The effectiveness of the protocols was evaluated by MEV, which analyzed the presence of SL in different portions of the root canals. The results showed that the combination of EDTA with passive ultrasonic irrigation (PUI) was the most effective in removing SL, surpassing the other combinations tested. The cervical third of the root canals exhibited more open tubules compared to the middle and apical thirds, although there were no statistically significant differences between the middle and apical thirds. The study concludes that the EDTA + PUI protocol provides the best removal of SL, significantly improving cleaning and disinfection.

Keywords: Chelating Agents; Passive Ultrasonic Irrigation; Smear Layer.

INTRODUCTION

Successful root canal treatment depends on adopting a therapeutic protocol that emphasizes rigorous sanitation processes.

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A common problem is the layer of residue (SL) generated by the mechanical action of endodontic instruments on tooth walls. This layer contains organic and inorganic fragments, including pulp tissue remnants and microorganisms. Removing SL is crucial to neutralize the microbiota, improve root canal sealant adhesion, and strengthen the connection of fiberglass posts to the root dentin. Several solutions have been proposed for SL removal, including chelating agents such as EDTA, which is widely used but also known to be an environmental pollutant. Natural alternatives, such as lactic acid and chitosan, have been studied; chitosan has shown promising results. Studies indicate that a 0.2% chitosan solution may be more effective in removing LS compared to 17% EDTA, especially in the apical part of the canal.

In addition, ultrasonic agitation can improve SL removal through the formation and implosion of vapor bubbles. The research sought to evaluate the effectiveness of chitosan and EDTA with or without ultrasonic agitation, testing the null hypothesis that there would be no significant differences between the final irrigation protocols in SL removal.

METHODOLOGY

Sample Selection:

Fifty bovine incisors were selected for an experimental study based on similar anatomical characteristics of the roots and root canals with a cervical diameter of less than 1 mm, measured with a digital caliper. These teeth had mature apices and were stored in 0.05% chloramine solution until use. The crown of the teeth was removed below the cementoenamel junction using a diamond disc, resulting in standardized roots with a length of 17 mm. Initially, the permeability of the root canals was confirmed with a size 15 K-File. The anatomical diameter of the roots was then standardized using a size 20 K-File. The working length of the root canal was established at 16 mm. Pre-enlargement of the canals was performed with a size 2 LA Axxess bur (35/.06), powered by Intramatic 2068 and Intramatic 181 DBN motors, operating at 5000 rpm, until resistance was encountered. Preparation

of the root canals was completed with the ProTaper Universal nickel-titanium system up to an F5 (50/.05) instrument. Each instrument was used to prepare only five root canals. During preparation, the canals were irrigated with 2 mL of 2.5% sodium hypochlorite solution. After preparation, the root apices were sealed with fluid composite, and the roots were dried with absorbent paper points. The roots were then randomly allocated to a control group (n=10), which did not receive final irrigation, and four experimental groups (n=10). The experimental groups were defined based on the combination of chelating solution (17% EDTA and 0.2% chitosan) and method of activation/delivery of the final irrigate solution: conventional irrigation (CI) and passive ultrasonic irrigation (PUI).

Preparation of Chelating Agents:

The chelating agents were prepared from analytical grade materials using purified water. The pH of the solutions was measured. The 0.2% chitosan solution was prepared by dissolving 0.2 g of chitosan in 100 mL of 1% acetic acid and shaking for 2 hours.

Activation/Delivery Method of the Final Irrigant:

In groups 2 and 3, 5 mL of the non-activated chelating solutions were introduced into the root canals using a 5 mL disposable syringe (Ultradent Products Inc, South Jordan, UT, USA) coupled to a 29-gauge needle (NaviTip; Ultradent Products Inc). The needle was inserted 1 mm below the RCWL without touching the canal walls and left in place for 3 minutes. In groups 4 and 5, 5 mL of the chelating solutions were passively activated for 60 seconds using a Piezo-Electric MTS ultrasonic unit (Multitask Cart, Spartan Obtura, USA) with a size 15 ultrasonic tip (Satelec, Acteon, France). The ultrasonic tip was positioned 1 mm below the RCWL without touching the canal walls, allowing it to vibrate freely. The ultrasonic unit was set to 40% power. After activation, the specimens were irrigated with 2 mL of 2.5% NaOCl, followed by a rinse with 10 mL of distilled water and dried with absorbent paper points. All clinical procedures were performed by a single operator (an endodontist with 10 years of experience).

Scanning Electron Microscopy (SEM) Analysis:

This was performed to examine the presence of luminous substance (LS) in the roots of bovine teeth. First, longitudinal grooves were made on the buccal and lingual surfaces of each root with a carborundum disc, taking care not to expose the canals. The specimens were then sectioned with a double-beveled chisel, choosing the buccal and lingual surfaces of each root with a carborundum disc, taking care not

to expose the canals. The samples were then sectioned with a double-beveled chisel, choosing the side of the root with the fewest irregularities to best represent the total length of the root canal.

The samples were dehydrated with an alcohol battery (50%, 60%, 70%, 80%, 96%, 100%), followed by drying with carbon dioxide using the Autosamdri 815. After drying, a 30 nm layer of gold was applied to the samples with a vacuum metallization device under controlled conditions: pressure of 0.01 mbar, current of 40 mA, distance of 50 mm, and coverage time of 110 seconds.

The samples were then analyzed with a Jeol JSM 6610 microscope, using a Thermo Scientific NSS spectrometer with an excitation wavelength of 448 nm. Photomicrographs with 500x magnification were captured from the apical, middle, and cervical portions of the root canal, positioned 3 mm, 9 mm, and 15 mm below the root apex. Each image was evaluated by three blind examiners, who assigned scores from 1 to 5 based on the amount of SL present. The scores were 1: SL covering the entire surface; 2: SL partially covering, with few visible tubules; 3: Half of the surface with SL and half with open tubules; 4: SL covering a small part of the surface, with visible tubules; 5: Absence of SL. Each photomicrograph received a unique score, and in cases of disagreement, consensus among the examiners was required. A total of 150 images (50 samples x 3 portions) were analyzed and reviewed twice with a 7-day interval.

Statistical analysis:

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). Data were analyzed using Kruskal-Wallis and Mann-Whitney U tests. Statistical significance was set at $p<0.05$. Agreement between examiners was assessed using the Cohen-Kappa test.

RESULTS

The kappa value for agreement between examiners was determined to be 0.89, indicating a high level of agreement between evaluators. Table 2 shows the means and standard deviations observed in the different groups and thirds of the root canals for the various protocols employed. The best results for the removal of the residual layer (SL) were observed in the EDTA + Passive Ultrasonic Irrigation (PUI) group, followed by the Chitosan and PUI group and the Chitosan + Conventional Irrigation (CI) group. In general, the cervical third of the canals exhibited more open tubules (2.91 ± 0.99), while there was no significant difference between the middle (2.51 ± 1.01) and apical (2.18 ± 1.11) thirds ($P = 0.101$). Photomicrographs obtained by scanning electron microscopy (SEM) evaluation, together with the corresponding scores.

CONCLUSION

The most effective final irrigation protocol for removing the residual layer (SL) was the use of EDTA with passive ultrasonic irrigation (PUI). Although chitosan showed promising results, especially when combined with PUI, EDTA + PUI was superior. The cervical third of the root canals had more open tubules compared to the middle and apical thirds, with no significant differences between the latter two. The analyses confirmed the effectiveness of the methods and the reliability of the results between examiners.

BIBLIOGRAPHICAL REFERENCES

1. Estrela C, Holland R, Estrela CR, Alencar AH, Sousa-Neto MD, Pecora JD. Characterization of successful root canal treatment. Braz Dent J. 2014;25(1):3-11.
2. Ashraf H, Asnaashari M, Darmiani S, Birang R. Smear layer removal in the apical third of root canals by two chelating agents and laser: A comparative in vitro study. Iran Endod J. 2014;9(3):210-214.
3. Zand V, Mokhtari H, Reyhani MF, Nahavandizadeh N, Azimi S. Smear layer removal evaluation of different protocols of Bio Race file and XP-endo Finisher file in corporation with EDTA 17% and NaOCl. J Clin Exp Dent. 2017;9(11):e1310-e1314.
4. Oliveira LV, Maia TS, Zancope K, Menezes MS, Soares CJ, Moura CCG. Can intra-radicular cleaning protocols increase the retention of fiberglass posts? A systematic review. Braz Oral Res. 2018;32:e16.