DOI: 10.7860/JCDR/2023/64658.18582

Original Article

Dentistry Section

Evaluation of Intracanal Smear Layer Removal after Passive Microvolume Irrigation with Sodium Hypochlorite and Rotary Nickel-Titanium Instruments: An In-vitro Study

MS PRIYADARSHINI[1], K MADHU VARMA[2], R KALYAN SATISH[3], INDUKURI SAI LAKSHMI DURGA[4], DALAVAI PRAVEEN[5], M SOWMYA[6]

ABSTRACT

Introduction: Passive Microvolume Irrigation (PMI) with Sodium Hypochlorite (NaOCl) has been proposed as a new method for root canal disinfection. It is based on the concept that irregular surface characteristics of endodontic instruments can carry NaOCl into the canal space with controlled fluid volume, without applying any pressure.

Aim: To compare and evaluate the efficacy of 3% and 5% NaOCl PMI, Saline PMI, and 3% NaOCl Standard Irrigation (SI) in removing the Smear Layer (SL) from the root canal walls at the cervical, middle, and apical thirds of single-rooted teeth.

Materials and Methods: This study was conducted in the Department of Conservative Dentistry and Endodontics at Vishnu Dental College, Andhra Pradesh, India. The study was conducted in February 2018. Forty maxillary central incisors with a single canal, extracted within three months of the study, were collected. The teeth were divided into four groups (n=10) based on the irrigation method: Group-1 (3.0% NaOCl SI), Group-2 (3.0% NaOCl PMI), Group-3 (5.0% NaOCl PMI), and Group-4 (Saline PMI). All samples were instrumented upto F4 size with Protaper rotary files, and a final rinse of 17% Ethylenediaminetetraacetic Acid (EDTA) was used. SL removal was evaluated using Scanning Electron Microscope (SEM). The data were analysed using Statistical Package for Social Sciences (SPSS) 21.0. Statistical tests used were Kruskal Wallis and Mann-Whitney-U tests. A p-value of <0.05 was considered statistically significant for all comparisons.

Results: There was no significant difference (p>0.05) in SL removal between 3.0% NaOCl SI, 3.0% NaOCl PMI, and 5.0% NaOCl PMI in the middle and apical thirds of the root canals. However, 5.0% NaOCl PMI showed significantly higher efficiency in SL removal at the cervical third compared to the other groups (p<0.05).

Conclusion: Passive microvolume irrigation with 3% and 5% NaOCl showed comparable efficacy to 3% hypochlorite SI in the middle and apical thirds of the root canal.

Keywords: Instrumentation, Needle, Root canal, Saline, Standard

INTRODUCTION

Debridement of the root canal through instrumentation and irrigation is considered the most critical factor in the prevention and treatment of endodontic diseases [1]. Root canal debridement, achieved through irrigation and instrumentation, is crucial in treating endodontic diseases [1]. The main objective of instrumentation is to facilitate adequate irrigation, disinfection, and filling [2]. Mineralised tissues are disrupted when dentine is cut using hand or rotary instruments, resulting in a significant amount of debris [3]. The SL is formed by tiny particles of the mineralised collagen matrix that disperse throughout the surface [4]. Irrigation of root canals with NaOCl solutions (concentrations ranging from 1% to 5.25%) is a widely accepted technique. At higher concentrations, NaOCl effectively disinfects the dentinal tubules, regardless of the canal preparation technique used [5].

The traditional method of irrigating the root canal involves using a syringe and needle. However, positive pressure irrigation may sometimes lead to the extrusion of NaOCl, which can cause severe complications, ranging from chemical burns and oedemas to tissue necrosis, haemorrhagic lesions, and life-threatening airway compromise [6].

The concept of PMI aims to utilise the irregular surface characteristics of endodontic instruments to carry NaOCl into the canal space with controlled fluid volume, without applying pressure. The lower surface tension of the irrigants facilitates the percolation of NaOCl within the canal network [7]. This technique has been proposed as a potential delivery modality with minimal volume and maximum effectiveness of NaOCl [8]. To the best of the authors' knowledge, there is limited literature available on PMI. Therefore, this study was conducted to fill the knowledge gap regarding the passive microvolume irrigation technique and its effectiveness in removing the smear layer.

The current study evaluates the efficacy of intracanal smear layer removal using 3.0% NaOCl SI, 3.0% and 5.0% NaOCl PMI, and saline PMI, with 17% EDTA used as a final rinse in single-rooted teeth with straight canals.

MATERIALS AND METHODS

This in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics at Vishnu Dental College, Andhra Pradesh, India in February 2018. The study protocol was approved by the Institutional Ethical Committee (IEC/VDC/MDS15 ENDO 02). A total of 40 extracted permanent human maxillary central incisors with a single canal and complete root formation were selected for the study. These teeth were extracted for periodontal reasons. A sample size of 10 teeth per group was calculated using G* Power 3.1.9.2 with 80% power and 5% significance.

Procedure

Total of 40 teeth divided into 10 teeth per group were selected for the study.

The selected teeth were cleaned from attached soft and hard tissues using ultrasonic scalers (Woodpecker, China) and were stored in sterile saline solution (0.9% Sodium Chloride) at room temperature throughout the study. The crowns of all specimens were transversely cut at the Cementoenamel Junction (CEJ) using a double-faced diamond disc (Adler, New York, US) at low speed with water coolant. The apices of the teeth were embedded in wax. The teeth were randomly divided into four groups of 10 each (n=10). A size 10 K-file (Dentsply, Maillefer, Switzerland) was inserted into each canal until its tip was just visible at the apical foramen. The length of the file was measured, and 1 mm was subtracted from this length to determine the optimal root canal preparation length. Patency was established in all canals, and rotary files were progressively used down to the working length.

The standard root canal procedure using Protaper rotary files was followed to prepare the root canals upto the finishing file F4 (Protaper, Dentsply Maillefer) with intermittent irrigation in all groups. The shaping files (S1, SX, and S2) were used with a brushing motion. In this brushing action, the files were taken passively to the point of light resistance and then 'brushed' out of the canal. The finishing files (F1 to F4) were used in an 'in and out' action passively with short penetrating strokes until the desired length was achieved. Irrigation was performed according to the established regimen for each group as follows:

Group-1: 3.0% Sodium Hypochlorite (NaOCl) SI: Irrigation was performed using a #30-gauge side-vented needle (25 mm, Disposable irrigation needle, CN, China), which was placed 1 mm short of the working length. The irrigation cycles consisted of irrigating with 2 mL of 3.0% NaOCl between each instrumentation and recapitulation with a 10 k file. This procedure was repeated for each file until the use of the F4 file. Final irrigation was done with 1 mL of 17% EDTA for one minute, followed by 2 mL of saline solution to remove any residual effects of the irrigants.

Group-2: 3.0% Sodium Hypochlorite (NaOCl) Passive Microvolume Irrigation (PMI): Irrigation in this group was performed by placing the rotary file into a dappen dish with 3.0% NaOCl for five seconds. NaOCl was carried within the surface texture of the Protaper rotary file and introduced into the canal space as the file was inserted. Upon instrument movement in the root canal, the 3.0% NaOCl was released into the canal space. NaOCl was delivered in a microvolume amount without applying any pressure. A fresh 3% NaOCl solution was used for each sample, and the solution was changed with each new sample. After instrumentation with the rotary files, the corresponding hand k-file of the same size was also dipped in the 3.0% NaOCl solution for five seconds. It was then passively inserted and moved in the root canal until it showed a snug fit. The 3.0% NaOCl carried within the irregularities of the hand k-files acted as a booster for replenishment in the root canal. This procedure was repeated for each rotary file until the use of the F4 file and hand #40 k-file. The final irrigation was done with 1 mL of 17% EDTA for one minute, followed by 2 mL of saline solution.

Group-3: 5.0% Sodium Hypochlorite (NaOCl) PMI: The instrumentation and irrigation in this group followed a similar protocol as Group-2, but with 5.0% NaOCl.

Group-4: Saline PMI: The instrumentation and irrigation in this group were similar to the procedures used in Group-2 and 3, but saline was used instead of NaOCl for root canal irrigation. In all groups, canals were dried using absorbent paper points.

Scanning Electron Microscope (SEM) observation: Deep grooves were cut on the buccal and palatal surfaces of the roots using a diamond disc. The roots were then split with a chisel and mallet. The specimens were dried, mounted on a single stub, gold-sputtered in a high-vacuum evaporator, and analysed under a SEM at 1000x magnification at the cervical, middle, and apical levels of each root half.

The cleaning of root canal walls was evaluated individually by two examiners who were blinded to the irrigation regimens. The scores were attributed according to the rating system developed by Torabinejad M et al., as follows [9]:

Score-interpretation:

1. **No SL:** No SL on the surface of the root canal, and all the tubules are clean and open.
2. **Moderate SL:** No SL on the surface of the root canal, but tubules containing debris.
3. **Heavy SL:** SL covering the root canal surface and the tubules.

STATISTICAL ANALYSIS

The attributed scores were tabulated, and statistical analysis was performed using IBM SPSS Statistics for Windows, Version 21.0 (Armonk, NY: IBM Corp). The data obtained were analysed using the kappa test to determine concordance among the examiners. The kappa test was used to assess inter-rater reliability. The score data for SL removal were statistically analysed using Kruskal-Wallis analysis for intragroup comparison and Mann-Whitney U test for pairwise comparisons. All statistical analyses were set with a significance level of $p<0.05$.

RESULTS

The results of the kappa test demonstrated good inter-examiner agreement, with values ≥0.6 for the different categories.

In Group-1, 30% of the samples showed moderate SL in the apical third of the root, and 70% showed heavy SL. In the middle third, 10% had no SL, 70% had moderate SL, and 20% had heavy SL. In the coronal third, 90% had moderate SL, and 10% had heavy SL.

In Group-2, 50% of the samples showed moderate SL, and 50% showed heavy SL in the apical third of the root. In the middle third, 10% had no SL, 60% had moderate SL, and 30% had heavy SL. In the coronal third, 10% had no SL, 80% had moderate SL, and 10% had heavy SL.

In Group-3, 10% had no SL, 60% had moderate SL, and 30% had heavy SL in the apical third of the root. In the middle third, 20% had no SL, 60% had moderate SL, and 20% had heavy SL. In the coronal third, 70% had no SL, 30% had moderate SL, and none had heavy SL.

In Group-4, 100% of the samples showed heavy SL in the apical, middle, and coronal thirds.

Intragroup comparison revealed a decrease in the efficacy of SL removal from the cervical to the apical third of the root canal in all groups, except for the saline PMI group. Intergroup comparison showed that 3.0% NaOCl SI, 3.0% NaOCl PMI, and 5.0% NaOCl PMI did not show a significant difference in SL removal in the middle and apical thirds of the root canals ($p>0.05$). There was no significant difference between 3% NaOCl SI and 3% NaOCl PMI in SL removal in the cervical third of root canals ($p>0.05$), while 5% NaOCl PMI showed significantly higher efficiency in SL removal at the cervical third compared to other groups ($p<0.05$). [Table/Fig-1,2] show the intragroup and intergroup comparison of SL removal among the four groups at the apical, middle, and cervical thirds, respectively.

SEM images showing the efficacy of SL removal at the apical, middle, and cervical regions are shown in [Table/Fig-3-6], respectively.

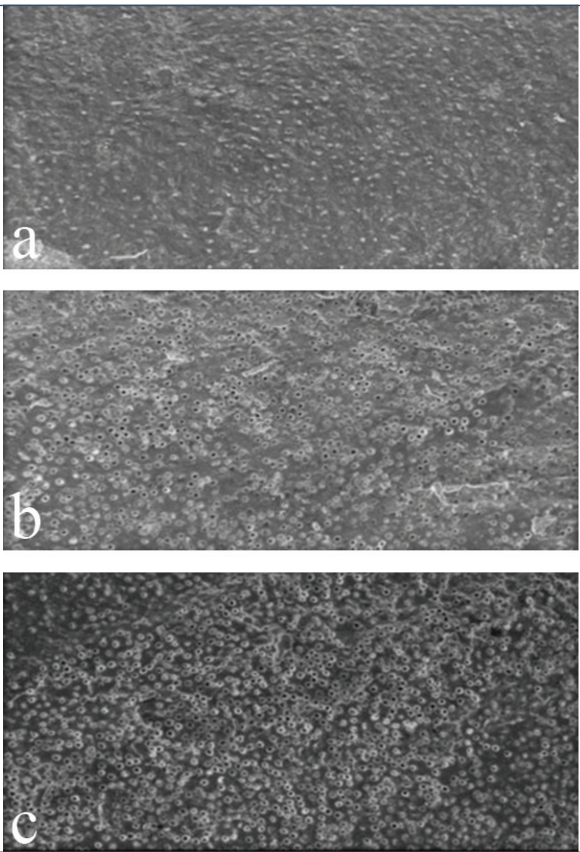
Groups	Apical vs middle	Apical vs coronal	Coronal vs middle
Group-1	**0.02***	**0.008***	0.95
Group-2	0.28	**0.04***	0.39
Group-3	0.49	**0.005***	**0.02***
Group-4	1	1	1

[Table/Fig-1]: Intragroup comparison of all groups at apical, middle, and coronal third.
Statistical Analysis: Kruskal-Wallis test; *Statistically significant

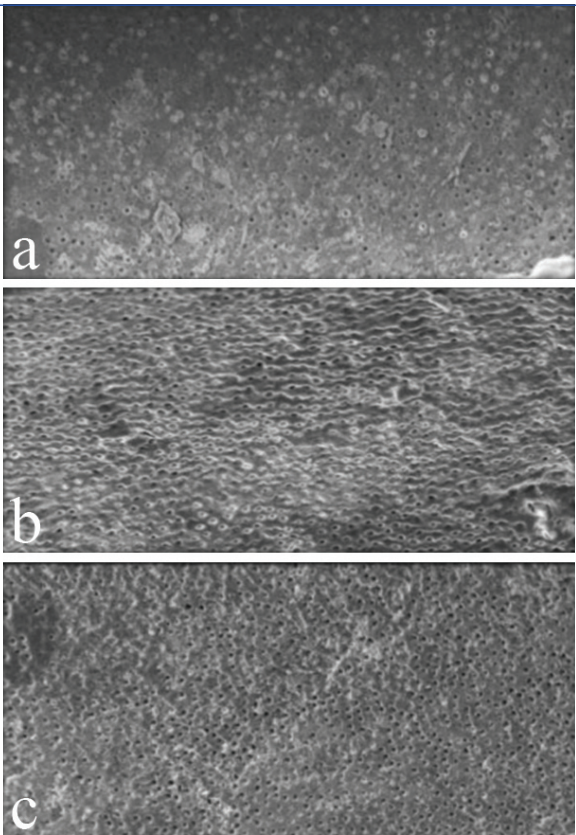
Inter-Group comparison	Apical	Middle	Coronal
Group-1 vs Group-2	0.37	0.69	0.58
Group-1 vs Group-3	0.07	0.72	**0.001***
Group-1 vs Group-4	0.07	**<0.001***	**<0.001***

Group-2 vs Group-3	0.28	0.49	**0.007***
Group-2 vs Group-4	**0.01***	**0.002***	**<0.001***
Group-3 vs Group-4	**0.002***	**0.001***	**<0.001***

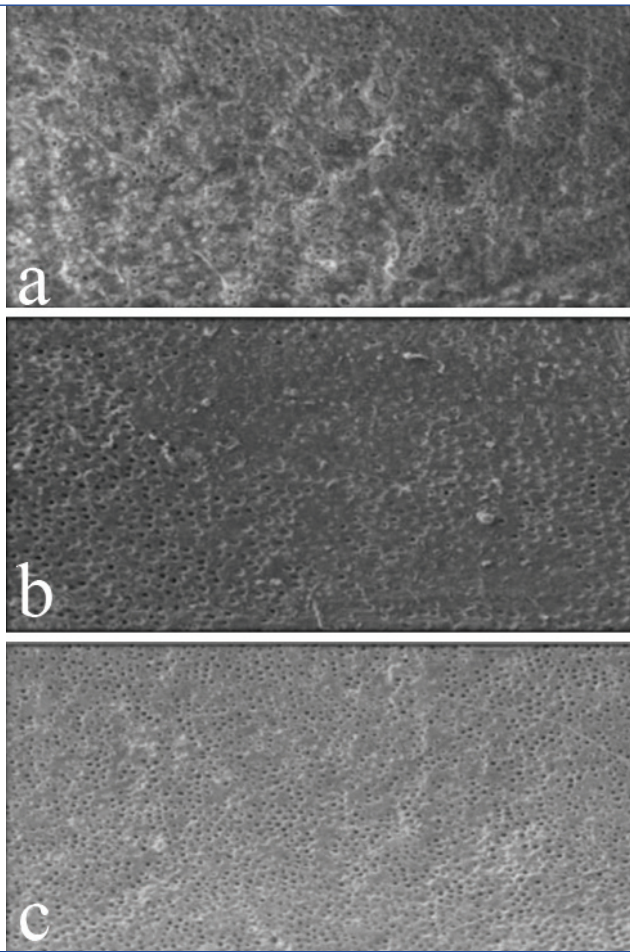
[Table/Fig-2]: Intergroup comparison of all groups at apical, middle and coronal third.
Statistical Analysis: Mann-Whitney U-test; *Statistically significant



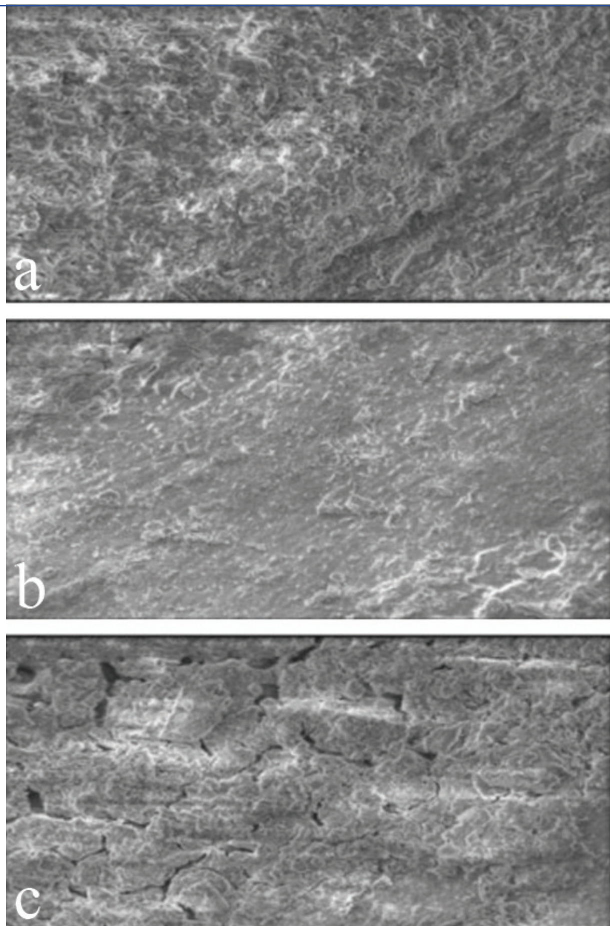
[Table/Fig-3]: A 3% NaOCl SI Scanning Electron Microscope (SEM) (1000× magnification) photographs of Smear Layer (SL) removal at: a) apical; b) middle and; c) coronal thirds of root canal.



[Table/Fig-4]: A 3% NaOCl PMI Scanning Electron Microscope (SEM) (1000× magnification) photographs of Smear Layer (SL) removal at: a) apical; b) middle; and c) coronal thirds of root canal.



[Table/Fig-5]: A 5% NaOCl PMI Scanning Electron Microscope (SEM) (1000× magnification) photographs of Smear Layer (SL) removal at: a) apical; b) middle; and c) coronal thirds of root canal.



[Table/Fig-6]: Saline PMI Scanning Electron Microscope (SEM) (1000× magnification) photographs of Smear Layer (SL) removal at: a) apical; b) middle; and c) coronal thirds of root canal.

DISCUSSION

The average canal volume of maxillary incisors is 9.86±3.97 μL [10]. Typically, 2-5 mL of NaOCl per canal was used for irrigation between instruments [11]. However, despite using copious amounts of irrigants, significant amounts of tissue or debris, or both, remained in the root canals [12]. In the present study, NaOCl was carried within the surface texture of the rotary file and released into the canal space upon instrument movement, using a technique called PMI (passive microvolume irrigation). The lower surface tension of the irrigants and the permeability of porous media (dentin) allowed the NaOCl to percolate into the canal. PMI is a different approach from current philosophies and fulfills the safety factor of irrigation as it introduces NaOCl into the canal in microvolumes without applying any pressure [8].

The penetration of irrigants into the apical third of canals depends on the final size of the instrument used [13]. In this study, the root canals were prepared upto the F4 finishing file. The larger the apical file size of the Protaper system used for preparation, the better the cleaning [14]. For adequate penetration of irrigants and elimination of debris and Smear Layer (SL) from the apical third of the root canals, a minimum instrumentation size of a #30 file was needed [13,15].

All specimens in the saline PMI group exhibited heavy SL covering the root canal walls. A significant difference (p=0.002) in the removal of SL was observed because only EDTA was used as the sole irrigation solution in the saline PMI group, unlike the NaOCl PMI groups where NaOCl was used followed by EDTA. In the apical third, both the 3.0% NaOCl SI and saline PMI groups showed similar results in removing the SL. The possible reason for this could be the vapour lock effect [16,17]. Due to the reduced dimensions of the root canal in the apical third, irrigation may result in entrapment of air bubbles, preventing complete irrigation [18].

SL removal with 3.0% NaOCl PMI and 5% NaOCl PMI was as efficient as 3.0% NaOCl SI in the apical and middle thirds of the root. The unique design and texture of the Protaper rotary instrument would have aided in carrying an adequate quantity of NaOCl irrigant into the root canal. Introducing the rotary file carrying NaOCl into the canal and moving it within the canal in a rotating action might have agitated and dispersed the irrigant, removing debris from the extremities of the canal [19]. Additional NaOCl carried within the irregularities of hand k-files in the PMI method acted as a replenisher in the root canal, refreshing the NaOCl. Carrying NaOCl with k-files allowed it to remain in the root canal system for a prolonged period, facilitating a complete chemical removal of organic debris.

A possible contributing factor to the efficient removal of the smear layer with the PMI technique might be temperature. Temperature is a critical parameter that can potentially affect the efficacy of hypochlorite. An increase in temperature enhances the chemical reactivity and depth of penetration of any solution inside a root canal [3]. Rotary instrumentation during endodontic treatment generates heat within the dentine of the tooth. The mean external temperature rise recorded in the middle third was 37.3°C, and 37.08°C in the apical third with the Protaper system [3]. However, the intracanal temperature might be higher than this externally recorded temperature due to the poor thermal conductivity of dentine [20].

In the present study, there was no statistically significant difference between the SI and 3.0% NaOCl PMI groups, as well as between the SI and 5.0% NaOCl PMI groups, in the critical apical third of the root canal. The relatively small space in the apical third could be responsible for less debris removal, leading to more Smear Layer (SL) remaining [21]. The bulk of the instruments or the clockwise rotation of the rotary file, which promotes coronal movement of debris, might have hindered the circulation and flushing action of the irrigant in the PMI groups, particularly in the apical third [22].

Examination of specimens in Group-3 revealed efficient removal of the SL and clean and open tubular apertures (70% of the samples) in the cervical third of the root canal compared to other groups. The higher concentration of NaOCl (5%) used in this group might be the reason for its effectiveness in removing the organic part of the SL. Higher concentrations of NaOCl have been shown to be more effective in removing the SL, and they also penetrate deeper into dentinal tubules [23,24]. Additionally, the larger size of the canals in the cervical third may have allowed for better circulation and action of the irrigating solution, resulting in more efficient removal of the SL and debris [25].

PMI with 3.0% and 5.0% NaOCl showed a comparable efficacy to SI in single-rooted, straight canal teeth. Carrying the irrigant within the surface texture of the rotary file and simultaneously instrumenting with it may have agitated the NaOCl, breaking the vapour lock and potentially enhancing the temperature effect.

Limitation(s)

Limitations of the study include not evaluating the total time of irrigation method, the volume of NaOCl used, and the effects of immersing rotary files in NaOCl at different concentrations. Additionally, the study was conducted on extracted straight canal, single-rooted teeth, which may not accurately reflect the outcomes of the tested irrigation method in a clinical scenario. Factors such as blood, tissue remnants, and other variables that may be present in the root canal system were not taken into account. It should be noted that deeper penetration of the needle occurs in single-rooted maxillary central incisor teeth due to wider canals, and the results of this study may vary in posterior teeth with narrower canals.

CONCLUSION(S)

Within the limitations of the present study, it can be concluded that both PMI and SI were equally effective in removing the smear layer from the cervical and middle thirds of the root canal, despite the microvolume of NaOCl used in the PMI technique. However, both systems were ineffective in completely removing the smear layer from the apical third of the root canal.

REFERENCES

[1] Adigüzel M, Yilmaz K, Pamukçu İİ. Comparison of the efficacy of sonic irrigation and conventional syringe irrigation in the removal of curcumin and triple antibiotic paste from root canals. J Dent Res Dent Clin Dent Prospects. 2021;15(3):157-62.
[2] Yalniz H, Koohnavard M, Oncu A, Celikten B, Orhan AI, Orhan K. Comparative evaluation of dentin volume removal and centralization of the root canal after shaping with the ProTaper Universal, ProTaper Gold, and One-Curve instruments using micro-CT. J Dent Res Dent Clin Dent Prospects. 2021;15(1):47-52.
[3] Damade Y, Kabir R, Gaddalay S, Deshpande S, Gite S, Bambale S, et al. Root canal debridement efficacy of heated sodium hypochlorite in conjunction with passive ultrasonic agitation: An ex vivo study. J Dent Res Dent Clin Dent Prospects. 2020;14(4):235-38.
[4] Violich DR, Chandler NP. The smear layer in endodontics- a review. Int Endod J. 2010;43(1):02-15.
[5] Berber VB, Gomes BP, Sena NT, Vianna ME, Ferraz CC, Souza-Filho FJ. Efficacy of various concentrations of NaOCl and instrumentation techniques in reducing Enterococcus faecalis within root canals and dentinal tubules. Int Endod J. 2006;39(1):10-17.
[6] Mitchell RP, Baumgartner JC, Sedgley CM. Apical extrusion of sodium hypochlorite using different root canal irrigation systems. J Endod. 2011;37(12):1677-81.
[7] Palazzi F, Morra M, Mohammadi Z, Grandini S, Giardino L. Comparison of the surface tension of 5.25% sodium hypochlorite solution with three new sodium hypochlorite-based endodontic irrigants. Int Endod J. 2012;45(2):129-35.
[8] Les Kalman AD. Passive micro-volume management of sodium hypochlorite in endodontic treatment. Roots C.E. Endo Tribune. 2014;9(4):05-08.
[9] Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB, Bozhilov K, et al. A new solution for the removal of the smear layer. J Endod. 2003;29(3):170-75.
[10] Peters OA, Boessler C, Paqué F. Root canal preparation with a novel nickel-titanium instrument evaluated with micro-computed tomography after canal surface preparation over time. J Endod. 2010;36(6):1068-72.
[11] Edgar S. Irrigation of the root canal. ENDO. 2007;1(1):11-27.
[12] Baker NS, Eleazer PD, Overbach RD, Seltzer S. Scanning electron microscopic study on the efficacy of various irrigation solutions. J Endod. 1975;1(4):127-35.
[13] Khademi A, Yazdizadeh M, Feizianfard M. Determination of the minimum instrumentation size for penetration of irrigants to the apical third of root canal systems. J Endod. 2006;32(5):417-20.

[14] Baratto-Filho F, Leonardi DP, Zielak JC, Vanni JR, Sayão-Maia SM, Sousa-Neto MD. Influence of ProTaper finishing files and sodium hypochlorite on cleaning and shaping of mandibular central incisors-a histological analysis. J Appl Oral Sci. 2009;17(3):229-33.
[15] Srikanth P, Krishna AG, Srinivas S, Reddy ES, Battu S, Aravelli S. Minimal apical enlargement for penetration of irrigants to the apical third of root canal system: A scanning electron microscope study. J Int Oral Health. 2015;7(6):92-96.
[16] Pasricha SK, Makkar S, Gupta P. Pressure alteration techniques in an endodontics-a review of the literature. J Clin Diagn Res. 2015;9(3):01-06.
[17] Kandaswamy D, Venkateshbabu N. Root canal irrigants. J Conserv Dent. 2010;13(1):256-64.
[18] Agarwal A, Deore RB, Rudagi K, Nanda Z, Baig MO, Fareez MA. Evaluation of apical vapor lock formation and comparative evaluation of its elimination using three different techniques: An in vitro study. Contemp Clin Dent. 2017;18(9):790-94.
[19] Palaniswamy U, Kaushik M, Surender LR, Prashar N, Arya S, Pasari S. A SEM evaluation of smear layer removal using two rotary instrument systems with EDTA and vinegar as a root canal irrigant. J Res Dent. 2016;4:17-21.
[20] Chauhan A, Nilker V, Mandke LP. Effect of temperature rise on periodontal tissue during endodontic treatment: An in vitro study. Indian J Oral Health Res. 2015;1(2):66-71.
[21] Sharma G, Kakkar P, Vats A. A comparative SEM investigation of smear layer remaining on dentinal walls by three rotary NiTi files with different cross-sectional designs in moderately curved canals. J Clin Diagn Res. 2015;9(3):43-47.
[22] Walters MJ, Baumgartner JC, Marshall JG. Efficacy of irrigation with rotary instrumentation. J Endod. 2002;28(12):837-39.
[23] Hand RE, Smith ML, Harrison JW. Analysis of the effect of dilution on the necrotic tissue dissolution property of sodium hypochlorite. J Endod. 1978;4(2):60-64.
[24] Zou L, Shen Y, Li W, Haapasalo M. Penetration of sodium hypochlorite into dentin. J Endod. 2010; 36(5):793-96.
[25] Setlock J, Fayad MI, BeGole E, Bruzick M. Evaluation of canal cleanliness and smear layer removal after the use of the Quantec-E irrigation system and syringe: A comparative scanning electron microscope study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;96(5):614-17.

PARTICULARS OF CONTRIBUTORS:
1. Former Resident, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
2. Professor, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
3. Professor, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
4. Assistant Professor, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
5. Reader, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
6. Former Resident, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Indukuri Sai Lakshmi Durga,
Assistant Professor, Department of Conservative Dentistry and Endodontics,
Vishnu Dental College, Bhimavaram-534202, Andhra Pradesh, India.
E-mail: lakshmiindukuri111@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 14, 2023
- Manual Googling: Jul 22, 2023
- iThenticate Software: Aug 31, 2023 (20%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. No

Date of Submission: **Apr 11, 2023**
Date of Peer Review: **Jul 19, 2023**
Date of Acceptance: **Sep 02, 2023**
Date of Publishing: **Oct 01, 2023**