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Comparative evaluation of efficacy of different irrigation systems and effect of different final irrigation regimens in the penetration of root canal irrigant using radiopaque dye - An in vivo study

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Abstract

Introduction: Irrigation of root canals is an integral part of chemomechanical preparation, aiming at the removal of bacteria, debris and necrotic tissue, especially from areas of the root canal that have been left unprepared by mechanical instruments. The two factors that are directly correlated with the efficient irrigation are the irrigant and the delivery system.

Objectives: This in-vivo study evaluates the efficacy of different irrigation systems and effect of different final irrigation regimens in the penetration of root canal irrigant using radiopaque dye.

Methods: Adequate number of patients requiring endodontic treatment on single rooted teeth was included in this study. Patients were randomly assigned to four groups. In group I teeth were irrigated by using

conventional needle, in group II by Max-i-probe, in group III by Canal Brush and in group IV by passive ultrasonic irrigation. The groups were subdivided into two subgroups. In subgroup 1, 3% NaOCl was used as final irrigant and in subgroup 2, 17% EDTA used as final irrigant. All canals were then irrigated with Iohexol (Omnipaque) contrast medium. With contrast media inside the canal a digital radiograph was obtained. The distance between the WL and maximum irrigant penetration was calculated by using image editing software.

Results: The maximum distance between working length and maximum irrigant penetration was observed in 26G open ended bevelled needle group, followed by Max-i-probe, which was followed by Canal Brush group and minimum distance was observed in PUI group. All the groups has showed the statistically significant results and the results in both the subgroups were not statistically significant.

Conclusion: PUI is the most effective irrigating system in the penetration of irrigant upto working length while the final irrigating solution did not make much of a difference.

Keywords: PUI; Max-i-probe; Conventional irrigation system; Canal Brush; EDTA; NaOCl

Introduction

Irrigation of root canals is an integral part of chemo mechanical preparation, aiming at the removal of bacteria, debris and necrotic tissue, especially from areas of the root canal that have been left unprepared by mechanical instruments. [2]

The two factors that are directly correlated with the efficient irrigation are the irrigant and the delivery system. [5] Sodium hypochlorite solution has long been recognized as the gold standard for irrigation, mainly because of its solvent action and broad-spectrum antiseptic activity. [1] However, NaOCl has no effect on the inorganic portion of the smear layer. [5] Therefore, a decalcifying substance such as EDTA is needed to remove the inorganic matter. The combination of these two irrigants complements the cleaning of the root canal, especially in areas of difficult access, such as dentinal tubules and lateral canals. However, there is a variation in irrigation regimens that employ these two substances, giving predominance to the use of sodium hypochlorite during all of the shaping phases of the root canal with a final irrigation using a demineralizing agent, and others authors state the order of use has not yet been defined.[11]

Currently different irrigation techniques and devices are being used to increase the mechanical flushing action of irrigants and to improve the penetration of irrigants in the apical third of the root canal. Irrigation with a syringe and a needle remains the most commonly used procedure. However, there is an uncertainty about the penetration of irrigant in this procedure in the apical part of the root canal. Max-i-probe (Dentsply- Rinn, Elgin, IL), a modified design of regular manual irrigation needles with a well-rounded, close tip and side-port dispersal has been introduced that is said to deliver the irrigant in the apical third without the risk of perfusion beyond the apex. Canal Brush (Coltene Whale dent, Langenau, Germany) is an endodontic microbrush which is highly flexible and molded entirely from polypropylene. Garip et al showed that irrigating with canal brush tended to produce cleaner canal walls. Passive ultrasonic irrigation (PUI) was introduced to increase the effectiveness of canal disinfection by agitating the irrigant solution previously placed inside the canal. Munoz R et al found that the passive ultrasonic irrigation and endovac were more effective than conventional endodontic needle in delivering irrigant to working length of root canal Throughout the

history of endodontics, endeavors have continuously been made to develop more effective irrigant delivery systems and final irrigation regimens. Therefore, in this in vivo study the research will be carried out by using radiopaque dye regarding the penetrability of irrigant using conventional needle, max-i-probe, canal brush and passive ultrasonic irrigation system and by using NaOCl and EDTA as final irrigation regimens.

Materials And Methods

Fifty-six patients referred to the Outpatient Department of Conservative Dentistry and Endodontics, National Dental College & Hospital, Dera Bassi requiring root canal treatment were selected for the study. Single rooted maxillary or mandibular anteriors and mandibular premolars were included in this prospective study. The outline of the study was approved by the ethical committee of National Dental College & Hospital, Dera Bassi. Patients were selected from regular pool of patients referred to the department of Conservative Dentistry & Endodontics, National Dental College & Hospital, Dera Bassi. A detailed medical history, dental history & drug history (including drug intake and drug allergies) of all the patients were recorded. Before starting the procedure, an informed consent was obtained from all the patients. The age, gender & tooth number of the patient was recorded. All teeth were anesthetised with 1.8ml, 2% lignocaine with 1:100,000 epinephrine. After rubber dam isolation, access cavity was prepared on each tooth and working length (WL) was determined with #15 k-file using an electronic apex locator. WL was confirmed with a digital X-ray (RVG 5100).

All canals were prepared to size #45, 2%. The root canals were irrigated alternatively with 3% NaOCl and 17% EDTA. The 56 selected patients were randomly divided into four study groups depending upon the irrigation system used as follows:

Group 1: Irrigation done with 26G open ended beveled needle

Group 2: Irrigation done with Max-i-probe.

Group 3: Irrigation done with Canal Brush.

Group 4: Irrigation done with passive ultrasonic irrigation system

All the groups were subdivided into two subgroups depending upon the final irrigant:

Subgroup 1: 3% NaOCl used as a final irrigation regimen.

Subgroup 2: 17% EDTA used as a final irrigation regimen.

After that all the canals were irrigated with Iohexol (Omnipaque) contrast medium at the rate of 1ml/30 sec with the needle tip placed 2 mm short of WL. With contrast media inside the canal a digital radiograph was obtained. With the aid of Digora, (Sopro imaging, France) a blinded observer measured the distance between the WL and maximum irrigant penetration.

Results

Values obtained are presented as distances in millimetres. One way test was performed to establish statistically significant differences between groups ($P < .05$). T test and post hoc comparisons were also performed. Maximum distances between WL and maximum irrigant penetration were observed in the 4 groups- Group I: 26 G open beveled needle, Group II: Max-i-probe, Group III: Canal Brush and Group IV: PUI and 2 respective subgroups- 3% NaOCl and 17% EDTA

Table 1: One Way ANOVA.

Descriptive Distances between WL and Maximum Irrigant Penetration

Sub Group		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
3% NaOCl	26 G open ended beveled needle	7	1.84	.3352	.1267	1.742	1.964	1.7	2.0
	Max I Probe	7	1.42	.3512	.1327	1.243	1.754	1.2	1.7
	Canal Brush	7	.884	.2340	.0884	.869	1.302	.5	1.3
	PUI	7	.310	.3302	.1248	.066	.677	.0	.7
	Total	28	1.11	1.1394	.2153	1.305	2.188	.0	3.9
17%EDTA	26 G open ended beveled needle	7	1.87	.2138	.0808	1.854	1.984	1.6	2.0
	Max I Probe	7	1.54	.3559	.1345	1.365	1.876	1.3	2.0
	Canal Brush	7	0.93	.3251	.1229	.828	1.429	.2	1.4
	PUI	7	.414	.3237	.1223	.115	.714	.0	.9
	Total	28	1.31	1.1778	.2226	1.372	2.285	.0	3.6

ANOVA

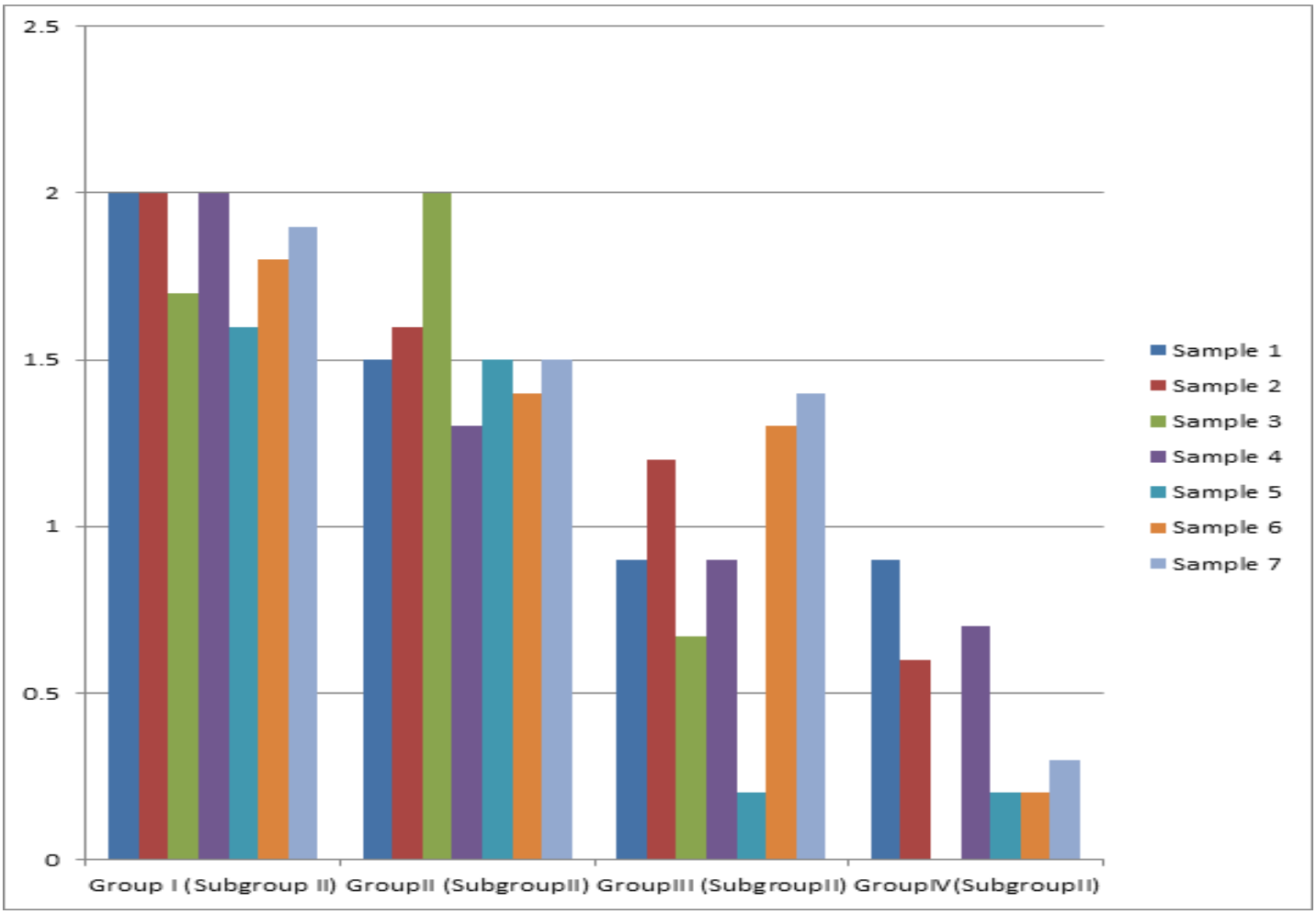
Distances between WL and Maximum Irrigant Penetration

Sub Group		Sum of Squares	df	Mean Square	F	P-value
3% NaOCl	Between Groups	32.653	3	10.884	108.971	<.001**
	Within Groups	2.397	24	.100		
	Total	35.050	27			
17%EDTA	Between Groups	35.160	3	11.720	122.448	<.001**
	Within Groups	2.297	24	.096		
	Total	37.457	27			

Inference: The data showed the mean values of groups and subgroups with minimum and maximum values of mean percentage. ANOVA test showed intergroup values that were statistically significant and subgroups which were not statistically significant. The mean

distances between working length and maximum irrigant penetration in decreasing order are:

26 G needle, 17% EDTA > 26 G needle, 3% NaOCl > Max i probe, 17% EDTA> Max i probe, 3% NaOCl> Canal Brush, 17% EDTA> Canal Brush, 3% NaOCl> PUI, 17 % EDTA> PUI, 3% NaOCl. Thus, the results of NaOCl subgroups were better than their corresponding EDTA subgroups although the difference was not statistically significant.



Discussion

Endodontic therapy over a period of time has developed into an art and science to retain grossly carious, infected and mutilated teeth whenever possible, hence valuing each and every tooth and increasing its longevity in the mouth to the greatest extent. To achieve the goal of endodontic therapy, an effective irrigation technique should be implemented to facilitate the penetration of the irrigant solution to the apical third of the canals without forcing it to the periapical tissues (Desai and Hamel 2009). Many in vitro studies have debated over the irrigant penetration in the apical third of root canal but no comprehensive investigation has occurred in vivo regarding the penetrability of irrigant using different irrigation systems and effect of NaOCl and EDTA as final irrigation regimens. Therefore, in this in vivo study the research was carried out by using radiopaque dye regarding the penetrability of irrigant using Conventional needle, Max-i-Probe, Canal Brush and Passive Ultrasonic Irrigation system and by using 3 % NaOCl and 17 % EDTA as a final irrigation regimen.

The root canals were irrigated alternatively with the NaOCl and EDTA. According to Tatsuta et al. (1999), the use of 5.25% NaOCl and 15% EDTA alternatively, produces an effective removal of smear layer, predentin and pulp debris. The combination of EDTA and sodium hypochlorite has been shown to be even more effective in smear layer removal than the use of these two solutions alone Baumgartner and Mader (1987) and also has demonstrated increased antibacterial efficacy (Bystrom and Sundqvist 1985).

In this study, results have depicted that 26 G needle was least efficient in delivering the irrigant upto working length. de Gregorio et al. (2009) have shown that conventional needle irrigation leaves large amount of debris clogged in the irregularities of the root canal system. This is in accordance with our study because it was found that conventional endodontic syringe/needle system does not efficiently deliver irrigant solution into the apical third.

In our study, Max-i-probe has shown better penetration results than 26 G needle. Similar to our results, Kahn, Rosenberg and Gliksberg (1995) has also observed that the Max-i-Probe was more effective in irrigation than the conventional needles routinely used. Pavlovic and Zivkovic (2008) have observed in their study that laterally perforated needles for irrigation allow more efficient cleaning of root canal walls as compared to open ended conventional needles. The better results of Max-i-probe may be due to the reason that Max-i-Probe has a laterally perforated needle which develops a laterally directed hydraulic pressure within the root canal. This mechanism allows the removal of the debris from the wall surfaces.

However, both the 26 G needle and Max-i-probe groups gave less significant results in the penetration of 3% NaOCl as well as 17% EDTA than Canal Brush and PUI. This could be explained by the fact that both 26 G needle and Max-i-Probe are positive pressure irrigation devices due to which they were unable to eliminate the vapor lock effect seen in the apical part of root canal in a closed system. The presence of an apical vapor lock adversely affects debridement efficacy when using positive pressure irrigation. According to Tay et al. (2010) in the closed system, irrigant extrusion beyond 1-1.5 mm of Max-i- Probe generates a liquid film along the air bubble-canal wall interface. Fluid stagnation in this ‘‘dead water zone’’ fails to provide adequate irrigant replacement, resulting in gross debris retention in this region.

In our study, Canal Brush has conveyed more significant results than 26 G needle and Max-i-probe. Canal Brush was used with a circumferential and 2- to 3-mm up-and-down motion, in a slow-speed handpiece. According to Plotino (2009) Canal Brush is standardized and can be used without risk of fracture in curved canals. Narmatha and Thakur (2015) claim in their study that Canal Brush is more efficient in removing smear layer than the conventional needle. Findings reported by Garip et al. (2010) showed that in an in vitro study irrigating with brushing tended to produce cleaner canal walls. However, study done by Gorduysus et al. (2012) showed that Canal Brush was not as effective in removing calcium hydroxide from root canal system and resulted in packing effect of calcium hydroxide through the apex.

In our study, PUI was selected as an irrigating system and was most effective and has showed most significant results than all other groups. This was in accordance with the studies done by Monoz and Camacho-Cuadra (2012). Cameron (1987) which has demonstrated that ultrasonic irrigant activation is more efficient than conventional needle in removing remnants of pulp tissue and dentin debris from root canals.

This may be due to the energy transmitted by PUI which is by the means of ultrasonic waves and can induce acoustic streaming and cavitation of the irrigant. When the root canal is filled with an irrigant solution, the ultrasonically oscillating file activates the irrigant. The file moves freely and the irrigant can penetrate more easily into the apical part of the root canal system and because of the active streaming of the irrigant, its potential to contact a greater surface area of the canal wall is enhanced. This seems to improve the efficacy of irrigation solutions in removing organic and inorganic debris from the root canal walls. A possible explanation for the improved action is that a much higher velocity and volume of irrigant flow is created in the canal during PUI (Ahmad et al. 1988).

In our study either of the subgroups NaOCl and EDTA have not showed significantly different results, however NaOCl has showed more penetration upto working length than EDTA. This result was in accordance to a study done by Goldman, Goldman and Kronman (1981) and Yamada, Armas and Goldman (1983), where the final flush of ml of 17% EDTA followed by 10 ml of 5.25% NaOCl showed the removal of superficial debris and smear layer. This could be due to that EDTA causes decalcification upon the inorganic components of the smear layer and peri - & intertubular dentine, and leaves the collagen exposed and subsequently, the use of NaOCl dissolves the collagen, leaving the entrance to the dentinal tubules more open and exposed (Serper and Calt 2002).

Conclusion

PUI is the most effective irrigating system in the penetration of irrigant upto working length while the final irrigating solution did not make much of a difference.

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