Comparative evaluation of apical extrusion of 2.5% NaOCl and 17% EDTA when used as root canal irrigants with manual irrigation and EndoActivator system irrigation- An invitro study

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Abstract
Aim: The aim of this study was to check the difference in the apical extrusion of 2.5% NaOCl and 17% EDTA irrigants using conventional technique (manual irrigation) and Endo Activator system irrigation.
Materials and Methods: 40 human mandibular premolars which were freshly extracted having straight single canals and mature apices verified with radiograph were selected for this study. They were divided into two main groups (A and B) depending upon the irrigant used which was further divided into subgroup (I and II) depending upon irrigation technique manual or EndoActivator respectively. The canals of each tooth were prepared using Endomotor (X-SMART DUAL) and rotary Protaper (Dentsply Mallifer) upto size F3. Eppendorf tubes were used to mount each tooth specimen and this acted as a container for collecting irrigant. The specimens were weighed before and after irrigation and the difference was calculated.
Results: Results were calculated using Mann Whitney U-test keeping level of significance set at $P<0.05$. Intergroup and Intragroup comparison revealed more apical extrusion of 2.5% NaOCl as compared to 17% EDTA. Extrusion was more using EndoActivator because of agitation effect.
Conclusion: On manual irrigation more apical extrusion of 2.5% NaOCl as compared to 17% EDTA was seen. Agitation with EndoActivator caused more apical extrusion of both 2.5% NaOCl and EDTA compared to needle and syringe irrigation

Keywords: Irrigants, Apical extrusion, NaOCl, EDTA, EndoActivator, Eppendorf, Agitation.

Aim
The study was conducted with the aim to check the difference in the apical extrusion of 2.5% NaOCl and 17% EDTA irrigants using conventional technique (manual irrigation) and EndoActivator system irrigation.

Introduction
Endodontic therapy aims at removal of all vital and microbial by-products from the root canal system through thorough cleaning and mechanical debridement of root canals. Irrigation plays an essential part in chemical debridement as it allows for cleaning beyond what might be achieved by root canal instrumentation alone. Irrigation leads to extrusion of the irrigant used as well as debris apically. Several factors like the irrigant that is being used, the apical anatomy of the tooth, irrigation needle, the depth where the needle is placed, apical preparation size and taper, and the instrumentation technique affects this extrusion.[1] The design of the needle tip affects flow pattern, flow velocity and apical wall pressure and such parameters are important accounting for irrigation effectiveness and safety.[2]

Sodium Hypochlorite (NaOCl) and Ethylenediaminetetraacetic (EDTA) are most highly used irrigants in routine endodontic therapy. Sodium hypochlorite in 2.5% is are sporicidal and virucidal and results in greater tissue dissolving effects on necrotic tissues. NaOCl if used in higher concentrations will have much better tissue dissolving effects but at the same time are more toxic than when used in lower concentrations. However hypochlorite is not effective in completely removing smear layer and hence, other irrigants are used along. EDTA was introduced by Nygaard-Ostby in 1957 as it is a chelating agent and its main mechanism of action is forming soluble calcium chelates using calcium ions in dentine. It is commonly available as 17% neutralized solution (disodium EDTA, pH 7). These chelators are also capable of removing biofilms that are adhered to root canal walls. To improve the effect of these irrigants, the efficacy of these irrigants can be increased by increasing time, volume and agitation.

There are various methods to activate/agitate the irrigant ranging from Manual Dynamic Activation to sonic devices (EndoActivator).Agitation however effects the extrusion of irrigants periapically.[3] Hence, the study was conducted to check the effect of agitation on the apical extrusion of two commonly used irrigants.

Materials and Methods
A total sample size of 40 human mandibular premolars that were freshly extracted having straight single canals with mature apices that were verified using radiograph were selected. After administration of local anesthesia access opening was done. Working length was determined for each tooth after coronal 1/3rd enlargement and confirmed visually by checking the extrusion of tip of the file at the apex. 0.5mm was deducted from this which was the final working length. Biomechanical preparation of canals for each tooth specimen was carried out using. Endomotor (X-SMART DUAL) and rotary Protaper (Dentsply Mallifer) upto size F3

(Fig. 1). In between each file irrigation was done with sodium hypochlorite (NaOCl) + normal saline.

Fig. 1: Cleaning and shaping using endomotor and protaper

The teeth were dried with absorbent paper points and mounted in an eppendorf tube using putty impression material (DPI Photosil soft putty dental impression material).The eppendorf tube containing the tooth acted as a collecting container for the irrigant that extruded through the foramen of the root. These samples were divided then into 2 main groups consisiting of group A(Sodium hypochlorite) and group B(EDTA) of irrigants which were further subdivided into 2 subgroups.(group I for manual irrigation technique and group II for EndoActivator technique with 10 samples each). Each specimen was weighed before and after carrying out the experiment using a digital balance with a precision of 0.000g.

Group A (I): Syringe Irrigation Group for NaOCl

All the specimens in this group were irrigated with NaOCl delivered using side-vented needle of 30 gauge whose tip was positioned 2-3 mm short from the working length. The irrigation protocol began with 5ml of 2.5% NaOCl delivered at a flow rate of 1.5ml/min. This was done for each tooth in this group.

The experimental setup containing extruded irrigant was then weighed after irrigation protocol. The irrigant extruded apically was weighed and calculated as the difference between the post irrigation and pre irrigation weights of the specimens.

Group A (II): EndoActivator Irrigation Group for NaOCl

All the specimens in this group were irrigated with NaOCl delivered using a side-vented needle of 30 gauge whose tip was positioned 2-3 mm short of the working length. The process was same as that done for Group A(I), but the irrigant was activated by placing the EndoActivator tip(taper 35/.04) within 2-3mm short of the working length. It was activated by moving it up and down simultaneously with the irrigation. The irrigation protocol began with 5ml of 2.5% NaOCl delivered at a flow rate of 1.5ml/min. This was done for each tooth in this group.

The experimental setup containing extruded irrigant was then weighed after irrigation protocol. The irrigant extruded apically was weighed and calculated as the difference between the post irrigation and pre irrigation weights of the specimens.

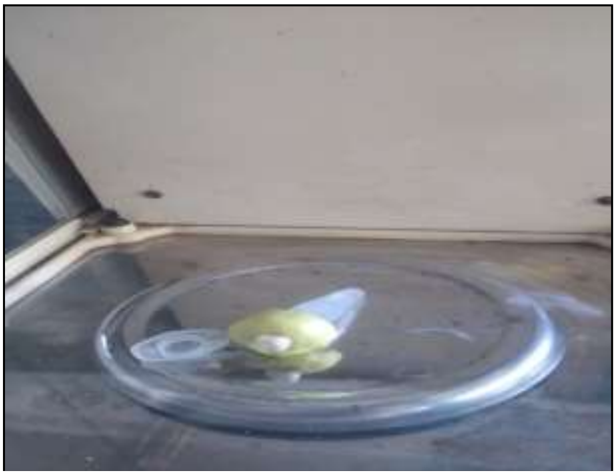

Fig. 2: Weighing of specimen on a Digital balance

Group B(I): Syringe Irrigation Group for EDTA

All the specimens in this group were irrigated with EDTA.The process was same as that done for Group A(I), but the irrigant delivered was EDTA using side-vented needle of 30 gauge whose tip was positioned 2-3mm short of the working length.

The irrigation protocol began with 5ml of 17% EDTA delivered at a flow rate of 1.5ml/min. This was done for each tooth in this group._The experimental setup was weighed and the difference between pre-irrigation and post-irrigation weights was calculated.

Group B (II): EndoActivator Irrigation for EDTA

The process was same as that done for GROUP A(II) using EndoActivator for activation simultaneously while irrigating, but the irrigant delivered was EDTA using side vented needle of 30 gauge whose tip was positioned 2-3mm short of the working length. Irrigant was activated by moving the tip up and down slowly while irrigation. The irrigation protocol began with 5ml of 17% EDTA delivered at a flow rate of 1.5ml/min. This was done for each tooth in this group.

The irrigant extruded apically was weighed and the difference was calculated.

Results

Table 1: Intragroup comparison of study variables

		Mean	SD	Minimum	Maximum	P value
EDTA	Manually	0.15	0.019	0.132	0.184	<0.001(S)
	EndoActivator	0.247	0.028	0.197	0.281	
	Total	0.199	0.055	0.132	0.281	
NaOCl	Manually	0.228	0.027	0.192	0.282	<0.001(S)
	EndoActivator	0.31	0.033	0.232	0.351	
	Total	0.269	0.051	0.192	0.351	

Test applied Mann Whitney U-test
Level of significance was set at P<0.05

Table 2: Intergroup comparison of study variables

		Mean	SD	Minimum	Maximum	P value
Manually	EDTA	0.15	0.019	0.132	0.184	<0.001(S)
	NaOCl	0.228	0.027	0.192	0.282	
	Total	0.189	0.046	0.132	0.282	
Endoactivator	EDTA	0.247	0.028	0.197	0.281	<0.001(S)
	NaOCl	0.31	0.033	0.236	0.351	
	Total	0.279	0.044	0.197	0.351	

Discussion

Irrigation plays an important role in endodontic treatment. Irrigants facilitate removal of all micro-organisms, tissue remnants, and debris from the root canal through a flushing mechanism. It also prevents extrusion of infected material, hard and soft tissue apically through the canal. In addition, several irrigants exhibit antimicrobial activity and can actively kill bacteria once introduced in direct contact with the micro-organisms.[4] However, these irrigating solutions when used in excess can be cytotoxic and may cause pain if they gain access into periapical tissues.[5]

Sodium hypochlorite (NaOCl) is mostly recommended in endodontic therapy because of its tissue dissolution ability, which basically is a function of its concentration, available surface area of the involved tissue, exposure time, variations in temperature, surface tension, and its volume. Dentists recommends NaOCl to be used in concentrations ranging from 0.5 to 6%. Its main mechanism of action is it ionizes in water to form Na+ and the hypochlorite ion, OCl- which establishes an equilibrium with hypochlorous acid (HOCl). This by-product hypochlorous acid (HOCl) is mainly responsible for exhibiting antibacterial activity disrupting microbial cell resulting in its death. The most commonly employed concentrations of NaOCl are 5.25%, 2.5%, and 1.25%.[6,7]

EDTA as an irrigant is employed mainly as a final rinse due to its ability to remove the inorganic component of smear layer and is recommended in a concentration of 17% for a period of one minute. EDTA reacts with calcium ions in dentin resulting in the formation of calcium chelates.[8]

Amongst Indian endodontic practitioners, an overwhelming majority are found to be employing conventional needle-syringe irrigation protocol.

However, it has been observed that conventional needle syringe technique results in inadequate debridement of the apical third. Thus, focus of endodontic research has always been on improving irrigation dynamics.

In this study, EndoActivator was used to evaluate the dynamics of irrigants that was used. It is a sonically-driven canal irrigation system which is used to improve the irrigation. It comprises of portable handpiece with 3 types of disposable polymer tips of different sizes that do not cut root dentin. It is design in a way such that it allows for safe intracanal irrigation and produces vigorous fluid agitation. It comparatively shows better irrigation than with traditional needle-syringe irrigation alone.[9]

Extrusion of irrigating solution was seen in all the groups. Activation of the irrigants used in this study caused increased extrusion of the irrigant from the apex.

Table 1 shows the intragroup comparison when irrigation was done with EDTA or NaOCl. A significant difference was seen in extrusion of both EDTA and NaOCl when irrigant was activated with sonic irrigation.

The above result are in accordance with the studies done by PK Kanumuru et al on comparing penetration of irrigant activated by traditional and sonic and ultrasonic methods.[10]

Table 2 shows the intergroup comparison when irrigation was carried out either manually or with sonic agitation. In both the groups there is more extrusion of NaOCl compared to EDTA.

In this study a side venting needle was used and it was kept 2-3 mm short of the working length, as recommended. It has been observed that one of the most essential parameters related to flow characteristics of any fluid is its viscosity, which is basically the resistance exhibited by a fluid while it is being deformed by tensile or shear stresses. The lesser the viscosity, the better is the fluid flow.[11]

In a study done by Velayutham Gopikrishna et al, it was observed that temperature and concentration affect the viscosity of irrigants. It was shown in the study that 5.25% NaOCl and 17% EDTA had similar viscosities whereas with decreased concentration viscosity of NaOCl also decreased.[12] In this study, the concentration of NaOCl used is 2.5% which caused decreased viscosity and increased flow. Hence, this can explain more apical extrusion of 2.5% NaOCl compared to 17% EDTA as in Table 2.

Thus, irrigation techniques strive to maintain a critical balance between cleaning efficacy and patient safety.[13]

Conclusion

It can be concluded that there was more apical extrusion of 2.5% NaOCl as compared to 17% EDTA. Also, agitation with EndoActivator caused more apical extrusion of both 2.5% NaOCl and EDTA compared to needle and syringe irrigation.

Since, this was an invitro study, results have to be co-related with in vivo results.

Conflict of Interest: None.

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