

RATE OF APICAL EXTRUSION OF SODIUM HYPOCHLORITE: OPEN ENDED VERSUS CLOSED ENDED NEEDLES

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ABSTRACT

The objective was to compare the role of needles design (open ended versus closed ended) on the apical extrusion of sodium hypochlorite irrigant during root canal treatment.

This was an in vitro study performed at the Department of Operative Dentistry, Liaquat University of Medical & Health Sciences, Jamshoro from March 2011 to October 2011. Access cavities were prepared in one hundred extracted human maxillary first molars. The mesiobuccal canal was left open whereas the remaining canals were sealed. The acrylic receptacles were used to hold the teeth in a position as they are present in maxillary arch naturally. The starch / KI solution (A reagent that changes into blue color when comes in contact with sodium hypochlorite) was used to fill the receptacles. The teeth were divided into two groups (G1 and G2) each contained 50 specimens respectively. G1: Irrigation of the mesiobuccal canals with 5.25% sodium hypochlorite with open ended beveled needle. G2: Irrigation of the mesiobuccal canals with 5.25% sodium hypochlorite with closed ended side vented needle. Patency file was #10 K in both the groups. The change in any color of starch / KI solution was captured with digital photographs.

Results showed overall frequency of apical extrusion of sodium hypochlorite is 43% (43/100). There was higher extrusion incidence with open ended beveled needle which was 62% (31/50) than with closed ended side vented needle which showed 24% (12/50).

It was concluded that rate of extrusion was significantly high with open ended beveled needle than with closed ended side vented needle. A closed ended side vented needles appeared significantly safer than open ended beveled needles.

Key Words: *Apical extrusion, Sodium hypochlorite, Periapical tissues, Irrigant needles.*

INTRODUCTION

The microorganisms in the root canal system are main etiological factors for pulpal and periapical lesions. The elimination of pathogens from the root canal system is most important for successful endodontic treatment which needs canal preparation, canal disinfection and canal obturation.¹ For the chemomechanical preparation the most commonly used

irrigant is sodium hypochlorite (NaOCl) due to its better antimicrobial action and capacity of dissolving organic materials.^{2,3} However, due to cytotoxic nature of NaOCl, it causes lysis of red blood cells, ulceration, inhibition of migration of neutrophil and damages endothelium and fibroblast cells when it contacts vital tissues.⁴ During chemomechanical preparation NaOCl may be extruded from the apical foramen and may cause post-instrumentation pain or flare-up and possibly cause severe inflammatory response.⁵ Ulcerative and tissue necrotic processes are developed in periradicular tissues when NaOCl contacts with the periradicular tissues.⁶ In conditions, like immature teeth, root communicating with the maxillary sinus, maxillary sinus covered by thin membranes, external

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resorption, internal root resorption, there are more chances of extrusion of irrigant into the periapical space and/or maxillary sinus.^{7,8} As the essential part of chemomechanical preparation is the irrigation with antibacterial solution so the procedure which is being most commonly used for irrigation is syringe and needle.^{9,10} However, in the apical portion of root canal system there is an uncertainty about the efficiency of this procedure.¹¹ Therefore different types of needles have been proposed to increase the efficiency of syringe irrigation.^{12,13} The findings of several studies^{7,14} showed the adverse effects of NaOCl used as an endodontic irrigant during chemomechanical preparation of root canal system are most common in teeth of maxillary arch because of close relationship with the maxillary sinuses. Nevertheless, among these studies they did not have determined the type of irrigant needle which may have a role in the extrusion of irrigant. Therefore, this study was designed to assess the degree of extrusion of 5.25% NaOCl irrigant from the apical foramina of mesiobuccal (MB) root canals of maxillary first molars by using two different types of needles: irrigation with open ended beveled needle and irrigation with closed ended side vented needle.

METHODOLOGY

A total of 100 extracted human maxillary first molar teeth were collected from the Department of Oral Surgery, Civil Hospital Hyderabad (extracted for prosthetic and periodontal reasons) satisfying the inclusion criteria. The root surfaces of teeth were cleaned of calculus and organic tissue remnants, and teeth were stored in the saline solution (NaCl 0.90%) until use. The maxillary first molars with similar dimensional morphology, fully formed root apices and without canal obliterations were chosen for this study. For confirmation of the fully root apices, the teeth were examined under $\times 12$ magnification. Presence or absence of canal obliterations were confirmed by taking periapical radiographs. The conventional coronal accesses were prepared with No. 2 round bur and an Endo Z bur at high-speed air turbine (Foshan, China). Hundred transparent self-cure acrylic receptacles were made and perforated using heated spatula to make a hole equal to size of that of molar crown. The epoxy resin was used to close the apical foramina of the distobuccal and palatal root canals. Then each tooth was attached to the acrylic receptacle with epoxy resin and epoxy adhesive in such a way that root was positioned

inside the acrylic receptacles and the crowns remains outside to simulate the tooth's position in the maxillary dental arch. The receptacles were designed in such a way that it allowed filling of a specific reagent for NaOCl (starch/KI solution supplied by the Department of Biochemistry Liaquat University of Medical and Health Sciences, Jamshoro) without leakage.

Working length (WL) of the mesiobuccal canals of all the teeth were determined as the point in which a #10 file was just visible at the root end with $\times 12$ magnification. Early coronal flaring were done by gates glidden burs # 1, 2, 3 with establishment of apical patency using #10 K file then rest of the canals were prepared by step back technique and apical preparation were finished at #30 K file (MAF) meanwhile, the canal were irrigated with 5.25% NaOCl continuously on each instrumentation by using two different types of irrigating needles assigned for their specific group (G1-canals were irrigated with open ended beveled needle and G2-canals were irrigated with closed ended side vented needle). A total of 5ml solution was used in each tooth and pressure less technique was used to inject the irrigant into the canal. Extrusion of NaOCl through the apical foramina was noticed by change of color of starch/KI solution to blue.

Data were entered and analyzed in statistical software SPSS-13. Frequency and percentage were computed for categorical variables like extrusion of sodium hypochlorite with respect to groups. Chi-square test was applied to compare rate of extrusion of sodium hypochlorite between groups. $P < 0.05$ was considered significant.

RESULTS

One hundred extracted human maxillary first molar teeth were included in this study. Teeth were equally divided into two groups; Group 1: 50 teeth were irrigated by 27 G open ended beveled needle and in group 2, 50 teeth were irrigated by 27 G closed ended side vented needle. Out of 100, 43 specimens showed the apical extrusion, Frequency of extrusion of sodium hypochlorite was 43% (43/100) as presented in Fig 1. In group 1, 31 specimens showed apical extrusion out of 50 (62 %) Fig 2. While group 2 showed the extrusion in 12 specimens out of 50 (24%) Fig 3. Frequency of extrusion was significantly high in group 1 than in group 2 (chi-square= 14.73 df=1; $p=0.0005$) as presented in Table 1.

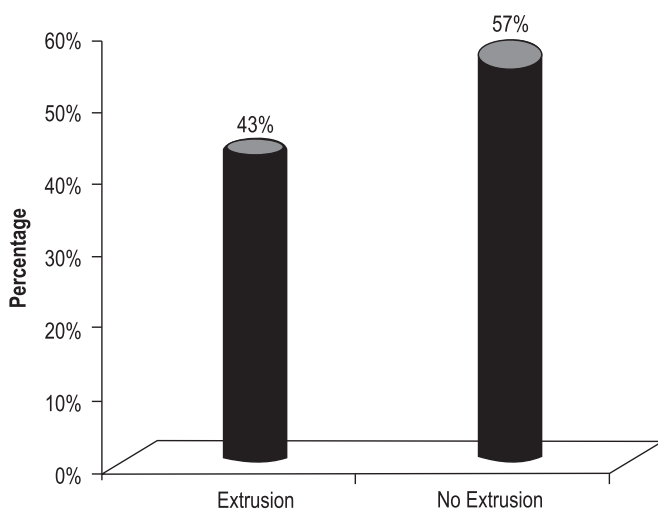


Fig 1: Overall extrusion ratio of sodium hypochlorite (n=100)

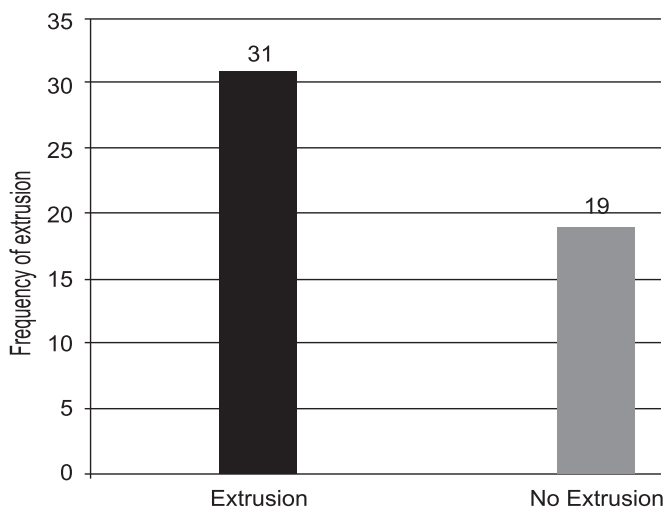


Fig 2: Frequency of extrusion of sodium hypochlorite by 27 G open ended beveled needle (n=50)

TABLE 1: COMPARISON OF RATE OF EXTRUSION BETWEEN GROUPS

Extrusion of Sodium Hypochlorite	Group 1(G1) n=50	Group 2(G2) n=50	P-Value
Extrusion	62%	24%	0.0005
No Extrusion	38%	76%	

DISCUSSION

Sodium Hypochlorite has been used at different concentrations from 0.5 to 5.25% as an irrigant since early 70s. NaOCl dissolves organic tissue remnants and has antibacterial activity as well as provides lubrication during chemomechanical preparation.^{3,14}

Severe adverse effects can occur after apical extrusion of NaOCl due to high cytotoxicity of NaOCl.

The response of the peri-apical tissues depends upon the concentration and extruded amount of the NaOCl.^{7,14,15,16}

Ferraz,¹⁷ Brown,¹⁸ and Lambrianidis¹⁹ conducted in vitro studies, the results of these studies showed that NaOCl solution may leach out of the apical foramen into the periradicular space and these results are similar to studies conducted by Hulsmann,⁷ Ehrlich,¹⁴ Serper²⁰ and others.

It is established that there is correlation between a series of variables and apical extrusion of NaOCl, including the depth of introducing the irrigation needle into the canal,^{7,8} establishment of apical patency,²¹ and instrumentation technique.¹⁵ In another studies conducted by Brown²¹ and Walton²² authors believe that the irrigating solution is flushed only coronally to the extent of penetration into the root canal by using very thin irrigation needles. However the present study focused on investigating the type of irrigating needles with apical extrusion of NaOCl solution delivered at 2 mm short of the working length of MB canals of maxillary first molars would be enough to cause irrigant extrusion to periapical tissues. The MB canals of maxillary first molars were selected due to their position in the maxillary dental arch, injection of the irrigant into these canals does not have the aid of the gravity forces.

The findings of another studies conducted by Lopes H²³ and Berbert²⁴ showed that when the root canal preparation is smaller than size # 30 file, the irrigating solution cannot reach 3 mm beyond the needle tip. The findings of these studies are contrary to results of the present study which showed even with the size 30 file and 2 mm short of WL can cause extrusion beyond apex. NaOCl extrusion occurred in 43/100 specimen with apical patency size #10 file. Isabel et al and others²⁵ conducted in vitro study showed that irrigant can reach to the periapical tissues without apical debridement (apical patency) even with irrigant injected pressureless and with the needle placed loosely at the canal entrance. The results of these studies differ from previous studies conducted by Lopes²³ and Berbert²⁴ which showed that when chemomechanical preparation of root canals is performed with instruments greater than size 30 then the irrigation solution can only reach until or beyond the apex.

The needles evaluated in the present study were positioned at 2 mm short of the WL. The distance was chosen based on preliminary simulation, as to create

a challenging case for both needles types and allow evaluation of the flow towards the apex. According to Computational Fluid Dynamics (CFD) model side vented needle appeared to achieve adequate irrigant replacement within 1 to 1.5 mm apically to its tip regardless of position. Only the 1 mm position presented adequate replacement to the WL.²⁶ The open ended needle led to a more extensive irrigant exchange apically to its tip, which reached the WL in 1 and 2 mm positions and high shear stress was identified apically to its tip because the open ended needle led to higher mean pressure at the apical foramen than the side vented needle.

The unidirectional performance of the side vented and double side vented needle has been reported in different studies.^{13,27,28} The second outlet of double side vented needle only slightly affected the overall performance. It was confirmed that shear stress developed by closed ended side vented needles is significantly higher on the walls facing the outlet.²⁹ Various kinds of closed ended multivented needles have been proposed for use during syringe irrigation.^{30,31} In order to recreate the needle geometry, a commercially available needle was used that is similar to multivented needles previously used for syringe irrigation although this needle is only recommended for use with a negative pressure system (Endovac).³² The closed ended side vented needles appeared to be the safest in term of apical extrusion but on the other hand, limited penetration and replacement of the irrigant apically necessitates placement very close to the WL, if possible less than 1 mm. An additional disadvantage is the concentration of high shear stress on a very limited area.²⁹ Boutsoukis et al found that needles that achieved improved irrigant replacement in the apical part of the root canal like open ended needles also led to increased mean pressure at the apical foramen, indicating an increased risk of irrigant extrusion toward the periapical tissue.^{26,29}

Several authors^{17,18,19} have reproduced in vitro the physiologic conditions as close to those found in the oral environment, because in vivo studies cannot be conducted due to ethical reasons. That's why the study was conducted on extracted teeth to check this extrusion of irrigant and that may in turn contribute clinically to improve the endodontic procedure. The custom-made apparatus was made to hold the tooth in same position as it is present in the dental arch. However, the some clinical situations are different from this in vitro setup, as clinically there is a pressure present at the periapical area by the intercellular fluid and

periapical tissue which resists the outward movement of the irrigant solution from the root apex and thus limit the direct contact of the solution with periapical tissue and structures.²⁶ In vivo condition tooth acts as a closed system in which apical vapor lock restrict fluid flow through the apical foramen but adversely affects debridement efficacy.²⁸

In present study, NaOCl-specific reagent (starch/KI solution) was used to determine NaOCl extrusion through the apical foramina. NaOCl-specific reagent changes its color to blue when contact with NaOCl due to iodine release. The reaction between the starch/KI solution and NaOCl revealed irrigant extrusion even with the side vented needles.

It was concluded according to the frequency of extrusion based on the results that how easily endodontic irrigants might cross the apical foramen and get in contact with the periradicular tissues. Both the needles showed extrusion of irrigant, but as far as the comparison between the needles design is concerned the frequency of apical extrusion of NaOCl was dependent on the type of irrigant needles used for irrigation, the conventional open ended needles resulted in the greater frequency of apical extrusion as compare to closed ended side vented needles. A side vented needles appears significantly safer than open ended needles.

CONCLUSION

Overall frequency of apical extrusion of sodium hypochlorite was 43%. There was higher extrusion incidence with open ended beveled needle which was 62% than with closed ended side vented needle which showed 24%. Rate of extrusion was significantly high with open ended beveled needle than with closed ended side vented needle. Frequency of apical extrusion of NaOCl was dependent on the type of irrigant needles used for irrigation. A closed ended side vented needles appeared significantly safer than open ended beveled needles.

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