Original Article

Volumetric Analysis of Root Canal Filling in Deciduous Teeth after Using Different Canal-Drying Methods: An *In-vitro* Study

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Abstract

Background: Drying the root canals in pulp therapy is often ignored, but is essential for a successful clinical outcome. The conventional method used for drying root canals is by the use of paper points, but recently, various other methods have also been employed for this purpose. **Aim:** The purpose of this study was to volumetrically analyze root canal fillings in deciduous teeth, after using different canal-drying methods namely 95% ethanol, CANAL CLEAN (Cerkamed Medical Company), and Endo-Aspirator (Cerkamed Medical Company), and compare with the conventional paper point drying method. **Methodology:** Access cavities were prepared on eighty extracted primary canines, and irrigation was done with 1% sodium hypochlorite and normal saline while enlarging the canals. The specimens were then scanned using a cone-beam computed tomography (CBCT), and preobturation volume (X) of each tooth was measured. The teeth were then randomly divided into two groups – Group 1 – Zinc oxide eugenol (ZOE) group and Group 2 – Metapex group. Each group was further divided randomly into four subgroups based on the drying agent used – Subgroup A – Control group, Subgroup B – 95% ethanol group, Subgroup C – CANAL CLEAN group, and Subgroup D – Endo-Aspirator group. After obturation, a second CBCT was taken to measure the postobturation volume (Y). The percentage of obturated volume was calculated by the following formula: (postobturation volume/preobturation volume) ×100 ([*Y*/*X*] ×100). **Statistical Analysis:** The obtained data were tabulated and subjected to statistical analysis using one-way ANOVA test and unpaired *t*-test. **Results:** A significantly high postobturation volume was seen after using 95% ethanol followed by CANAL CLEAN, Endo-Aspirator, and paper points. On comparing the obturation volumes within Metapex and ZOE groups, Metapex group had significantly high obturation volumes irrespective of the drying method used. **Conclusion:** 95% ethanol is the best intracanal drying agent as it provides optimum pupal obturation.

Keywords: *Cone-beam computed tomography, drying methods, Metapex, obturation volume, pulpectomy, zinc oxide eugenol*

Introduction

Maintaining the integrity of primary dentition till its natural exfoliation, is the primary goal of pulp therapy in pediatric dentistry. This is of utmost importance as primary teeth are essential for the growth and maintenance of facioskeletal complex. Early loss of primary teeth may lead to both functional and esthetic problems in a growing child. The most common reason for the early loss of primary teeth is dental caries and an alternative to avoid the loss of such teeth would be by endodontic therapy.[1]

A biomechanically well-prepared root canal system, along with a three-dimensional (3D) seal, is key for endodontic success. Successful obturation demands the use of materials and techniques that help in dense filling of the entire root canal system.[2] Various obturating materials are available for pulpectomy, of which the two most commonly used are zinc oxide eugenol (ZOE) and Metapex (Meta-Biomed Co,Ltd , Korea) (calcium–iodoform based).

Drying the root canal after irrigation and prior to obturation is one step which is often ignored, but is an important step to be considered. The lack of a primary bond may be due to the presence of residual moisture in the root canal that may prevent the sealer from completely coating the canal walls.[3] Presence of moisture makes it impossible to obtain a successful obturation. Various methods such as paper points, alcohols, and vacuum adapters have been used to achieve proper drying of the root canal system.

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The purpose of this study was to volumetrically analyze root canal fillings in deciduous teeth, after using different canal-drying methods namely 95% ethanol, CANAL CLEAN (Cerkamed Medical Company (Poland)), and Endo-Aspirator (Cerkamed Medical Company), and compare with the conventional paper point drying method.

Methodology

Eighty extracted primary canines were collected, and an access cavity was prepared. A size 10 K-file was introduced to confirm the patency of the canal, and the working length was measured using radiovisiography. Biomechanical preparation was done along with irrigation with 1% sodium hypochlorite and normal saline. All canals were dried using one size 40 paper point to remove the irrigant in gross. The specimens were then scanned using a cone-beam computed tomography (CBCT), and the preobturation volume of each tooth was measured (X). A total of eighty teeth were then randomly divided into two groups namely ZOE group (Group 1) and Metapex group (Group 2) by the primary investigator (PI), blinding the secondary investigator (SI). Each group was further divided randomly into four subgroups namely control Group (A), 95% ethanol group (B), CANAL CLEAN Group (C), and Endo-Aspirator Group (D). This subdivision was made by the SI. The PI was blinded for this subgroup allocation. The drying process was carried out by the SI, one subgroup at one time, and obturation was done by the PI subsequently.

Control group (paper points)

After irrigating with 1% sodium hypochlorite, final rinsing was done with distilled water to remove all chemicals. The canals were blot dried with paper points until complete dryness of the last point is confirmed visually [Figure 1].

Ethanol group

After irrigation, 2 ml of 95% ethanol was administered into the canals using a tuberculin syringe having a 30G blunt-tip needle. The needle was carried to the working length and ethanol was carefully injected into the canal while at the same time slowly moving the needle out [Figure 2].

CANAL CLEAN group

After biomechanical preparation and irrigation, CANAL CLEAN was used as the last agent, applied by means of a syringe with an endodontic needle as per manufacturer's instructions [Figure 3].

Endo-Aspirator group

After root canal preparation and final irrigation, Endo-Aspirator was connected to the suction device. The suction device was turned on, and the applicator was directly inserted into the root canal [Figure 4].

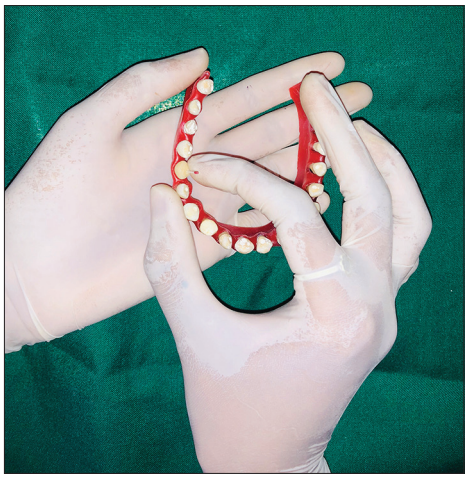

Figure 1: Drying with paper points

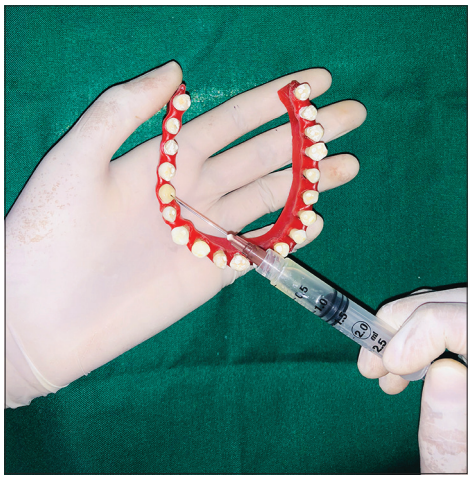

Figure 2: Drying with 95% ethanol

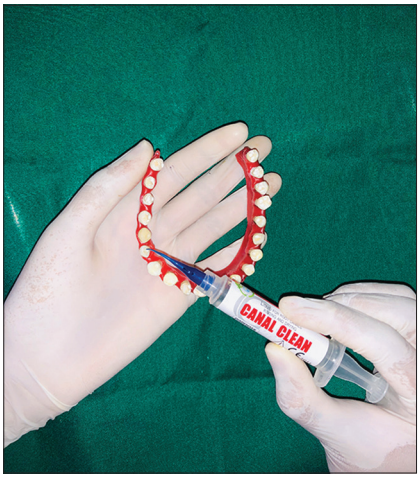

Figure 3: Drying with canal clean

After obturation, a second CBCT was taken to measure the postobturation volume (Y).

The percentage of obturated volume (POV) was calculated by the following formula: (postobturation volume/ preobturation volume) ×100, i.e., ([*Y*/*X*] ×100) [Figure 5].

Results

The mean POV of ZOE and Metapex group after using the various drying agents is shown in Tables 1 and 2, respectively. There was a statistically significant difference in POV ($P < 0.001$), between paper point, 95% ethanol, CANAL CLEAN, and Endo-Aspirator subgroups in both Metapex and ZOE obturation. On comparison of mean obturation rate with ZOE and Metapex in different drying agent groups, Metapex showed a statistically significantly higher POV ($P < 0.001$) irrespective of the drying agent used [Table 3].

Discussion

Endodontic treatment comprises of a sequence of strict protocols, to get a complete 3D seal of the root canals. The steps include a proper access cavity preparation, complete removal of infected pulp, biomechanical preparation, irrigation, drying, and obturation with suitable materials. Although drying of the canals appears to be a trivial step among these, it is of clinical importance for a successful root canal treatment.

Alcohols are known for their surfactant activity and dehydrating effect. When used as an irrigant in root canal systems, it reduces the surface tension of irrigants and root canal sealers, which, in turn, increases the flow of the obturating material into the dentinal tubules.[4] Alcohols spread into the dentinal tubules and dry the root canal as it evaporates, thus having a dehydrating effect.[5] Dentin has been shown to become more hydrophobic after dehydration and thus becomes more compatible with endodontic sealers and obturating materials.[3]

In 1982, Cunningham *et al*. first investigated the effect of ethanol, on the spreading property of NaOCl using a capillary tube measurement. They found that it significantly reduced the surface tension of the NaOCl, which improved its ability to spread *in vitro*.[4]

Wong and Spencer demonstrated that dentinal tubules normally remain filled with water unless the canal is thoroughly dried.[6] Wakabayaski *et al*. showed that canals dried with paper points demonstrated moisture at the apical

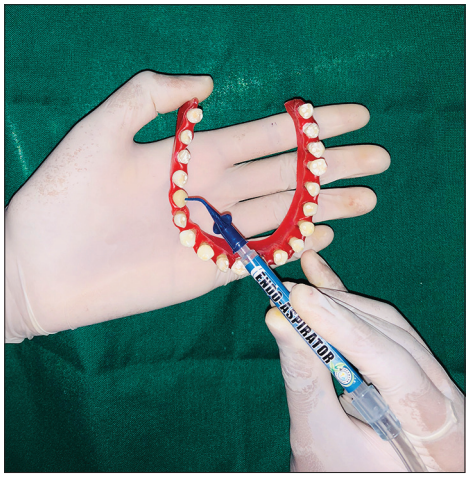

Figure 4: Drying with endoaspirator

Figure 5: Scanning specimens using cone-beam computed tomography

Table 1: Comparison of mean obturation rate with different drying agents in ZOE group

ZOE	*n*	Obturation (%)		95% CI for mean		Minimum	Maximum	One-way ANOVA
		Mean	SD	Lower	Upper			
Group A	10	75.01	0.54	74.63	75.40	74.42	75.61	F=4078.62, P<0.0001
Group B	10	93.50	0.25	93.32	93.68	93.18	93.88	
Group C	10	90.47	0.34	90.22	90.71	90.00	90.91	
Group D	10	88.08	0.43	87.78	88.39	87.50	88.64	

SD: Standard deviation; CI: Confidence interval; ZOE: Zinc oxide eugenol

Table 2: Comparison of mean obturation rate with different drying agents in Metapex group

Metapex	*n*	Obturation (%)		95% CI for mean		Minimum	Maximum	One-way ANOVA
		Mean	SD	Lower	Upper			
Group A	10	79.74	1.53	78.64	80.83	78.05	81.82	F=687.53, P<0.0001
Group B	10	95.74	0.13	95.64	95.84	95.56	95.92	
Group C	10	92.63	0.33	92.40	92.87	92.11	93.02	
Group D	10	89.92	0.57	89.51	90.33	89.19	90.70	

SD: Standard deviation; CI: Confidence interval

Table 3: Comparison of mean obturation rate with ZOE and Metapex in different drying agent groups

	n	Obturation (%)		Mean difference	Unpaired *t*-test	
		Mean	SD		*t*	*P*
Group A						
ZOE	10	75.01	0.54	−4.73	−9.21	<0.001
Metapex	10	79.74	1.53			
Group B						
ZOE	10	93.5	0.25	−2.24	−24.68	<0.001
Metapex	10	95.74	0.13			
Group C						
ZOE	10	90.47	0.34	−2.16	−14.44	<0.001
Metapex	10	92.63	0.33			
Group D						
ZOE	10	88.08	0.43	−1.84	−8.19	<0.001
Metapex	10	89.92	0.57			

SD: Standard deviation; ZOE: Zinc oxide eugenol

stop and in the apical third of the canal wall.[7] Sometimes, absorbent paper points cannot reach the apical end of the canal in long-curved roots of primary teeth. The use of ethanol helps to overcome these disadvantages.[4]

We used extracted primary canines, and the mean obturation rate of ethanol group was found to be 93.50 and 95.74 while obturating with ZOE and Metapex, respectively. This was in accordance to an *in-vitro* study which used a final rinse on 95% ethanol in primary canines and concluded that the obturation volumes after using ethanol showed a much higher value than using paper points.[8]

In clinical practice, a series of paper points are used to dry the canal. The use of ethanol could enhance the drying process and is less time consuming and economical. Despite its advantages, the use of 95% ethanol in primary teeth can be questioned because of the resorbing roots, open apices, and the potential side effects on the developing permanent tooth bud. Ethanol commonly causes tissue fixation due to its ability to desiccate and coagulate proteins. For tissue fixation to occur, it takes a long time and the volume of ethanol used should be high.[9] In the current study, we have used a very small quantity (2 ml) of ethanol for a very short period of time. If the same is replicated in a clinical scenario, under proper isolation and without applying positive pressure while irrigating, there is no possibility of extrusion of the material.

Other alcohols can also be used as a canal-drying agent; one such is isopropyl alcohol commercially available as CANAL CLEAN. It contains 70% isopropyl alcohol, acetone, and water. Our study showed a mean obturation rate of 90.47 and 92.63 for ZOE and Metapex groups, respectively, when dried with CANAL CLEAN. This is in accordance with a study which concluded that the bond strength, interfacial ultrastructure, and tag penetration of sealers increased after using 70% isopropyl alcohol as the active final rinse.[10]

Short-chain alcohols primarily confine themselves to the hydrophilic headgroup region instead of the hydrocarbon core. Their location is responsible for its dehydrating action and increased membrane fluidity. The efficacy of alcohols of various chain lengths tends to exhibit a so-called cutoff effect, i.e., the potency of alcohols increases with increasing chain length, which then eventually levels off.[9]

The efficacy of alcohols ranging from methanol to butanol is almost comparable, and there is not much of a difference in their biological effects. Thus, ethanol and isopropyl alcohol should have almost same efficacy, but we observed that, ethanol showed a better drying property when compared to CANAL CLEAN (isopropyl alcohol). The reason attributed to this is probably the presence of a higher polarity molecule in ethanol (C_2H_5OH) which could have favored greater water removal from dentinal tubules when compared to isopropyl alcohol (C_3H_7OH), with a lower polarity.[11]

Endo-Aspirator system is a modification of EndoVac™, with an ultra-fine tip of 0.2 mm, and has a good penetration even in primary root canals. Using this EndoVac system, the obturation volume was 88.08 and 89.92 for ZOE and Metapex groups, respectively, which was significantly better when compared to that of paper points. It also has an added benefit of less time consumption. Although its efficacy was shown to be lesser than alcohols, it does not have any potential side effects, such as the chances of injuring the permanent tooth bud or causing periapical irritation.[12] Thus, it can definitely be used as a good alternative to paper points in clinical practice. On comparing all the four drying agents used in the current study, 95% ethanol is found to produce best obturation volumes followed by CANAL CLEAN, Endo-Aspirator, and paper points.

We also observed that the overall obturation volume was significantly higher in Metapex group when compared to ZOE group irrespective of the drying agent used. This may be attributed to the flow property of Metapex. As it contains an oil-based vehicle, it tends to flow better inside the canals in extremely dry conditions. An *in-vitro* study which compared the obturation volumes of primary molars, after drying with conventional paper points, using spiral computed tomography (CT) showed a postobturation volume percentage of 84.05 for ZOE and 88.32 for Metapex.[13] This is comparable to the postobturation volume percentage obtained in the paper point group of our study. However, we have obtained much higher obturation volume percentages by using other drying agents (ethanol – 93%–95%, CANAL CLEAN – 90%–92%, and Endo-Aspirator – 88%–90%). There are three probable reasons for this result. The first and most important being the quality of dryness in the canals during obturation, which was much superior in our study and thus has given very good quality and high volume of obturation. In addition, the imaging technique used in other studies was a spiral CT, whereas we have

used CBCT imaging technique. Although spiral CT scan has been used for the volumetric evaluation of obturation materials in primary teeth, CBCT has various advantages over it, such as easier image acquisition and multiplanar reconstruction.[14]

Nagaveni *et al*. used CBCT to volumetrically analyze various obturation techniques in primary teeth and found that the obturation percentage of canals dried with paper points and obturated with ZOE, using conventional endodontic pluggers, was 77%–82%.[14] This is again much lower than the obturation volumes obtained in our study, leading us to the conclusion that it is the drying agent which plays a very crucial role in the quality and volume of obturation.

Conclusion

1. A dry root canal system is a must for optimum and successful obturation
2. A significantly high volume of obturation was obtained while using 95% ethanol, CANAL CLEAN, and Endo-Aspirator in comparison to paper points
3. Among the drying agents, the volume of obturation was highest for 95% ethanol, followed by CANAL CLEAN and Endo-Aspirator
4. The volume of obturation was significantly higher in Metapex group when compared to that of ZOE group, suggesting that Metapex flows well under dry conditions.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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