

Comparative Evaluation of Efficacy of Obturation Techniques in Deciduous Teeth Using Cone-beam Computed Tomography: An *In Vivo* Study

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ABSTRACT

Introduction: Pediatric dentistry has evolved from extraction acclimatized practice to prevention and preservation. Successful endodontic treatment is mandated for retention of pulpally involved primary teeth.

Aim and objective: To comparatively evaluate the obturation techniques namely lentulospiral and skini syringe with NaviTip in primary teeth using cone-beam computed tomography (CBCT).

Materials and methods: The study was carried out among children ranging between the ages of 4 years and 8 years of either sex with pulpal involvement of primary molars which were indicated for pulpectomy. The study population was divided into two groups according to the type of obturating technique used. Group I included samples obturated with lentulospirals while group II samples were obturated using skini syringes with NaviTip. Postoperatively, CBCT imaging was used to evaluate the quality of fill of both the obturation techniques by determining the presence of voids in the root canals.

Results: The total number of voids present in group I were 48, in which, 8 were in the coronal third, 16 in the middle third, and 24 in the apical third. On the other hand, the total number of voids present in group II was 21, out of which 7 were in the coronal third, 10 in the middle third, and 4 in the apical third. A statistically significant difference was noted between the two groups in terms of the overall voids present.

Conclusion: Within the limits imposed by the conditions used in the present study, both techniques can be used for obturation in the root canals of primary molars. Voids were observed with both the techniques, but minimum in group II, i.e., skini syringe with NaviTip.

Keywords: Cone-beam computed tomography, ECC, Obturation techniques, Pulpectomy.

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INTRODUCTION

Pediatric dentistry has evolved from an extraction-oriented practice to prevention and maintenance of primary teeth with irreversibly inflamed or necrotic pulps.¹ Preservation of these pulpally involved primary teeth has several advantages including abatement in chewing, esthetics, and phonetics, interception of aberrant oral habits. Moreover, these teeth also serve as natural space maintainers.^{2,3}

Successful endodontic management includes pulpectomy which consists of debridement of necrotic pulp followed by canal preparation and obturation using resorbable root canal filling materials.⁴ The difficulties in endodontic therapy in primary molars are due to their unique anatomy of long, slender, narrow, and flattened canals. Physiological root resorption in these teeth also causes difficulty for the clinicians.⁵

A fluid-tight seal is mandatory along the entire cleaned and prepared root canal space for a successful endodontic treatment. Voids in the obturated canals would fail endodontic treatment, as these may provide pathways for leakage which could result in bacterial growth and eventual infection. Voids in the apical or coronal portion or extending through the entire root canal length increase the risk of endodontic therapy failure. Therefore, a careful and advanced assessment of the filling of the root canals is essential for evaluating the maximum success in pediatric endodontic procedures.⁶

To outmaneuver the above-listed issues, varied root canal obturating techniques have been introduced for primary teeth.

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These include the use of handheld lentulospiral paste filler, engine-driven lentulospiral paste filler, endodontic plugger, endodontic pressure syringe, reamers, tuberculin syringes, paper points, and NaviTip.^{6–10} The quality of different filling techniques has been studied and compared both *in vivo* and *in vitro*. Techniques like the use of radiographs including digital radiography, dye penetration

procedures, radioisotopes, fluid filtration, and bacterial leakage have been used in these evaluative and comparative studies.^{11,12}

Conventional radiography has disadvantages like the superimposition of structures, determination of the spatial relationship of multiple canals in the same root, and determination of the ideal depth of instrumentation due to its two-dimensional nature.¹³ Moreover, multiple radiographs with different horizontal and/or vertical angulations have to be taken to obtain an appropriate working image, which results in increased exposures.¹⁴ The advent of cone-beam computed tomography (CBCT) imaging has overcome all the above-mentioned impediments. It is a relatively new technology, which utilizes a cone-shaped beam of radiation to obtain a detailed three-dimensional digital image. Moreover, CBCT has added advantages like being faster and lower radiation dosage.^{15,16}

With respect to the all above-mentioned facts, the present study was undertaken to compare the efficacy of two obturation techniques namely lentulospiral and skini syringe with NaviTip in primary teeth using CBCT. This was the first *in vivo* study of its kind and the possible beneficial result of this study would help us to the identification of the most efficient obturating techniques for primary teeth, thereby improving clinical treatment outcomes and thus contributing to the literature.

MATERIALS AND METHODS

The study was conducted in the Department of Pediatric and Preventive Dentistry, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India, after the study design was reviewed and approved by the Institute's Institutional Review Board. Informed consent was obtained from the parents of the children forming the study population.

The study was carried out in 40 selected primary second mandibular molar teeth indicated for pulpectomy or endodontic treatment among the children of either sex ranging between 4 years and 8 years of age. The study population was divided into two groups based on the obturating technique used, group I comprising of samples obturated using lentulospirals, while group II samples were obturated using skini syringes with NaviTip. Both the groups had an equal number of teeth with an equal number of canals. To ensure this, only the primary second mandibular molars with four canals (mesiobuccal, mesiolingual, distobuccal, and distolingual) were evaluated.

Intraoral periapical radiographs were taken for each tooth under scrutiny and assessed for the number and curvature of root canals. Molar teeth with at least one root and a minimum of 8 mm root length were included in the study. Teeth with caries extending to the root, root canals with evidence of internal or external resorption, developmental root anomalies like extensive curvature, presence of accessory canals were not included in the study. Care was taken to allow an equal number of similar root canals to the study groups to avoid any bias.

Access cavity was prepared in each tooth and the infected necrotic pulp tissue removed using a barbed broach. Working length was determined and established 1 mm short of the radiographic apex. Biomechanical preparation of the canals was done using a number 30 K-file (21 mm, Dentsply, Maillefer, Switzerland). The canals were repeatedly irrigated alternatively with 1% sodium hypochlorite solution and saline. After instrumentation was complete, the root canals were dried using absorbent paper

points. Post this, all canals were obturated with zinc oxide eugenol (ZOE) using the obturating technique assigned to that individual root canal. A standardized mixture of pure ZOE (DPI Ltd., Mumbai, Maharashtra, India) without additives or fillers was prepared for each technique, as per the manufacturer's recommendation and the technique limitation. The difference in the consistencies of the ZOE paste was attributable to the physical limitations of the different techniques.¹⁷

Group I (Lentulospiral)

A 21-mm lentulospiral (size 25; Dentsply, Maillefer, Switzerland) mounted in a slow-speed contra-angle handpiece (1,000 rpm) was used to deliver the ZOE into the root canals. A rubber stopper was used to keep the lentulospiral 1 mm short of the working length. The lentulospiral was dipped into the ZOE paste, inserted into the canal to its predetermined length, rotated in a clockwise direction, and withdrawn from the canal while still rotating. Additional amounts of paste were introduced until the canal orifice appeared to be filled with paste. The lentulospiral was changed after every four obturations.

Group II (NaviTip System)

Zinc oxide eugenol paste mixed to a creamy consistency was inserted into the prepared root canal using the NaviTip system (29-gauge cannula and 21-mm length; Ultradent Products, Inc., South Jordan, Utah, USA). A rubber stopper was used to mark the length of the needle to be inserted into the canal by keeping it 2 mm short of the apex. The plunger was pressed gently, and the needle was removed slowly from the canal as the material was expressed into it. Once the backfill of the paste from the canal orifice was observed, it was assumed that the canal was filled.

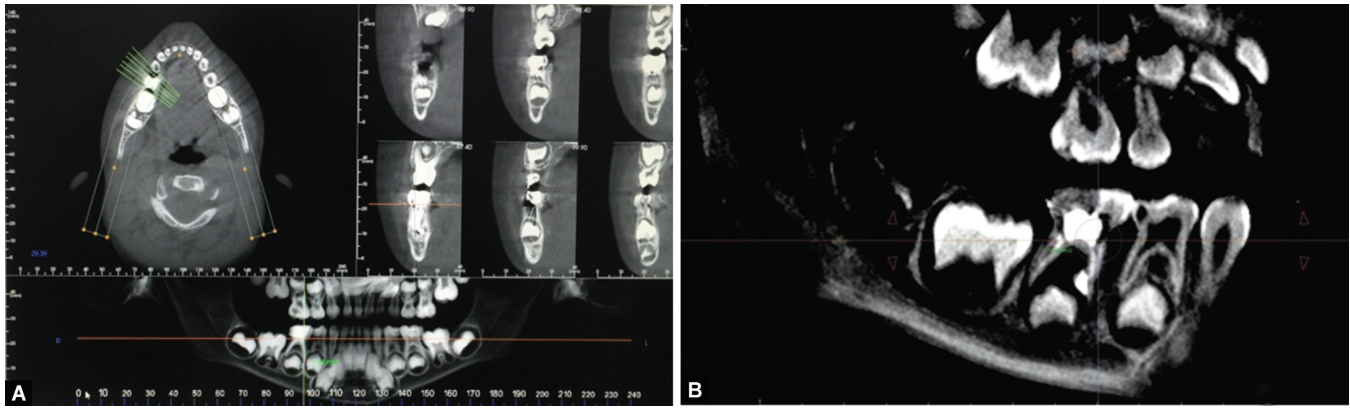
In both the groups, when the canal orifice appeared to be filled with the paste, wet cotton pellets were used to lightly press the material inside the canals. Later, the pulp chambers were restored using glass ionomer cement (type II). All pulpectomies were completed in a single visit.

Postoperatively, CBCT was done to evaluate both the obturation techniques [motor driven lentulospiral (Fig. 1) and NaviTip with skini syringes (Fig. 2)] for the presence of voids in the root canals. Analysis and measurement of the data acquired from CBCT were done by a single operator (radiologist). *In vivo* software version 5.4 was used to analyze all the images. Axial and coronal sections were taken to evaluate the number of canals. Coronal sections for buccolingual canals and sagittal sections for mesiodistal canals were used to evaluate the number and area of voids. The reference lines were oriented along the long axis of the canals. Each case was evaluated three times or more and only the common findings were included. If the same canal had a void in middle and coronal thirds the number was summed to 2.

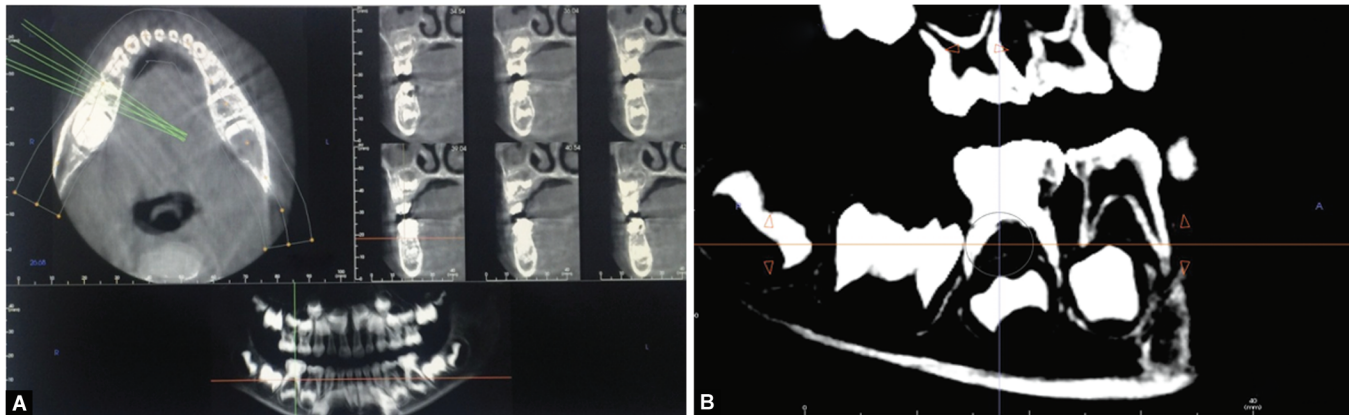
The thickness of each slice was fixed at 0.125 mm. The volume of each slice was calculated by multiplying the area of the void with the section thickness in which the image had been captured, i.e., 0.125 mm. The image was captured at 37.07 mAs, 120 kVp, and the acquisition time was 26.9 seconds.

Statistical Analysis

Data were entered into the excel sheet. Mann-Whitney test, Fisher's test, and Chi-square test were applied to the data obtained using SPSS (version 16) and Graph pad (version 5) statistical software. A p value ≤ 0.05 was considered statistically significant.



Figs 1A and B: (A) Postoperative CBCT (motor driven lentulospiral technique) axial and coronal views; (B) Sagittal view



Figs 2A and B: (A) Postoperative CBCT (NaviTip and skini syringe technique) axial and coronal views; (B) Sagittal view

Table 1: Evaluation of different groups for the presence of voids at different locations

Location	Group I (n = 80)		Group II (n = 80)		Significance of difference (p value)
	Number of voids	%	Number of voids	%	
Coronal third	8	10.00	7	8.75	1.0 (ns)
Middle third	16	20.00	10	12.50	0.2839 (ns)
Apical third	24	30.00	4	5.00	<0.0001 (s)
Total	48	60.00	21	26.25	<0.0001 (s)

Fisher’s test, significant (s), non-significant (ns)

RESULTS

The total number of voids present in group I was 48, 8 in the coronal third, 16 in the middle third, and 24 in the apical third. In group II, out of 21 voids present, 7 in the coronal third, 10 in the middle, and 4 in the apical third. A statistically significant difference was seen between groups I and II in respect to the overall voids present ($p < 0.0001$) (Table 1).

In group I, a total of 8 voids were present in the distobuccal (DB) canal out of which 2 were in the coronal third and 3 each in the middle and apical thirds. In the distolingual (DL) canal, 7 voids were present, 1 each in the coronal and middle third, and 5 in the apical third. In the mesiobuccal (MB) canal, a total of 19 voids were seen among which 1 was seen in the coronal third, 8 in the middle third, and 10 in the apical third. In the mesiolingual (ML), 14 voids were detected, 4 each in the coronal and middle third and 6 in the apical third. A statistically significant difference was observed among the

four canals of group I in the middle third location ($p = 0.0435$) in terms of voids present. However, this difference was statistically non-significant in the coronal and apical third (Table 2).

In group II, out of 4 voids present in the DB canal, 1 was seen in the coronal third, 3 in the middle third while the apical third showed absence of voids. In the DL canal, 1 void each was observed in the coronal and middle third, while no voids were present in the apical third. In the MB canal, a total of 10 voids were seen, 2 in the coronal third, 5 in the middle third, and 3 in the apical third. In the ML canal, 3 voids were seen in the coronal third, 1 in the middle third, and 1 in the apical third. Statistically, a non-significant difference was observed in-between the four canals for all the three thirds [i.e., coronal, middle, and apical third ($p > 0.05$)] (Table 3).

The overall mean value of the void area in group I (0.191) was higher than group II (0.121) and the difference was found to be statistically significant ($p = 0.0094$) (Table 4).

Table 2: Comparison of the presence of voids at different locations in different canals of group I

Group I	DB		DL		MB		ML		Significance of difference (p value)
	(n = 20)	%	(n = 20)	%	(n = 20)	%	(n = 20)	%	
Coronal third	2	10.00	1	5.00	1	5.00	4	20.00	0.343 (ns)
Middle third	3	15.00	1	5.00	8	40.00	4	20.00	0.0435 (s)
Apical third	3	15.00	5	25.00	10	50.00	6	30.00	0.1027 (ns)

Chi-square test, significant (s), non-significant (ns)

Table 3: Comparison of the presence of voids at different locations in different canals of group II

Group II	DB		DL		MB		ML		Significance of difference (p value)
	(n = 20)	%	(n = 20)	%	(n = 20)	%	(n = 20)	%	
Coronal third	1	5.00	1	5.00	2	10.00	3	15.00	0.632 (ns)
Middle third	3	15.00	1	5.00	5	25.00	1	5.00	0.1697 (ns)
Apical third	0	0.00	0	0.00	3	15.00	1	5.00	0.0972 (ns)

Chi-square test, significant (s), non-significant (ns)

Table 4: Between-group comparison for the overall mean value of void dimension (cu units)

Overall	No. of specimen	Mean	SD	p value
Group I	80	0.191	0.108	0.0094 (s)
Group II	80	0.121	0.077	

Mann-Whitney test, significant (s), non-significant (ns)

The mean value of the void area in the coronal third in the DB canal of group I was (0.201) higher than group II (0.141) and statistically significant. Similarly, the mean values of the middle third (0.158) and apical third (0.261) of group I were higher than group II middle third (0.035) and apical third (0.00), respectively, but the difference was not statistically significant.

The mean value of the void area in the coronal third in the DL canal of group I (0.111) was significantly lower than group II (0.138) whereas the mean void area of the middle third in group I (0.200) was statistically higher than group II (0.140). The mean void area of the apical third of group I (0.224) was higher than group II (0.00).

The mean value of the void area in the coronal third in the MB canal of group I (0.053) was significantly lower than group II (0.176) and statistically significant ($p < 0.001$). Whereas the mean value of middle third (0.180) and apical third (0.188) of group I was higher than group II middle third (0.126) and apical third (0.149), respectively, but statistically not significant.

The mean values of void areas in the coronal third (0.282) and apical third (0.238) in the ML canal of group I was higher than group II coronal third (0.135) and apical third (0.100). The values in the middle third of group II was higher than group I but statistically not significant ($p > 0.05$) (Fig. 3).

DISCUSSION

The study focused on the comparison and evaluation of the post-obtured root canals of primary teeth using two different obturating techniques. The present study was designed to keep two factors constant namely the use of a single technique of biomechanical preparation and a single obturating material (ZOE was used in this study according to the manufacturer's recommendations). Then, the quality of fill was assessed using CBCT. Zinc oxide eugenol is one of the most widely used preparations for

primary tooth pulpectomies and has proven to be beneficial in the preservation of chronically infected teeth.¹⁸

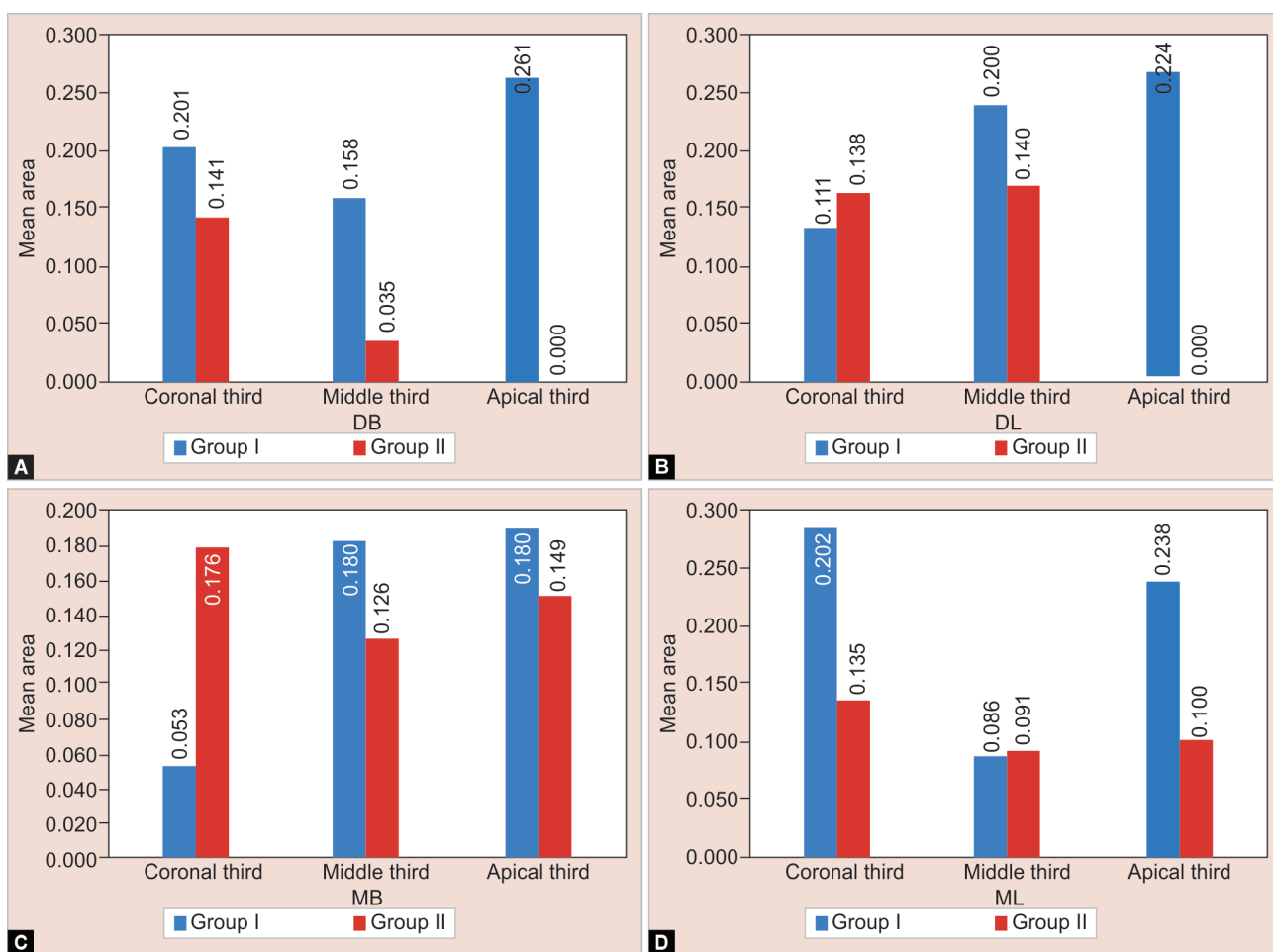
The accomplishment of a successful pulpectomy depends on several factors including proper case selection, appropriate material selection, and also the befitting technique of obturation of the root canals. The presence of voids in the root canals after obturation is impermissible for the success of pulpectomy techniques. These voids if present would result in leakage, ultimately culminating in the re-growth of the microorganisms and hence, re-infection. The presence of several large-sized voids increases the risk of post-treatment disease.

The current study showed that irrespective of the obturating technique or the material used, voids were seen in the canals postoperatively. This finding was in concordance with several other authors including Aylard and Johnson, Bawazir and Salama, and Sigurdsson et al.^{9,17,19} The additional benefit of using CBCT was that it led to the detection of more voids along the canal walls and within the fill as it provided a three-dimensional (3D) analysis of the filled canals in very thin slices.

The added advantage of 3D imaging can be seen in the present study and we recommend the use of CBCT in pediatric endodontics. Three-dimensional high-resolution imaging of intraoral structures does not differ much from conventional intraoral radiography. Cone-beam computed tomography has the added advantage of examining limited volumes which allow each root to be viewed separately in multi-rooted teeth, which is not feasible using conventional radiographic techniques.

Several studies have reported that the techniques used in the present study namely the lentulospiral and NaviTip system can be effectively used to deliver ZOE to optimally fill the root canals of primary teeth.^{4,8,9,17,20,21} A search in PubMed and English literature showed that no published data are comparing the efficacy of obturating techniques in primary molars *in vivo* using advanced imaging method. Thus, the present study was undertaken to comparatively evaluate the quality of fill of the root canals of primary teeth by using two different obturating techniques, namely, lentulospiral and skini syringe with NaviTip using CBCT. The quality of fill was determined by evaluating the number and volume of voids in the different areas of the canals, postoperatively.

Our study showed that skini syringe with NaviTip showed less number and smaller sized voids in comparison to the lentulospiral



Figs 3A to D: (A) Between-group comparison of mean area covered by voids at different locations in DB canal; (B) Between-group comparison of mean area covered by voids at different locations in DL canal; (C) Between-group comparison of mean area covered by voids at different locations in MB canal; (D) Between-group comparison of mean area covered by voids at different locations in ML canal

technique, a finding in accordance with Singh et al., Guelmann et al., and Nagaveni et al.^{11,12,20} While using the NaviTip system, excellent control can be excised on paste extrusion from the apical foramen, which results in less number of voids.^{4,12} Moreover, the small diameter of the syringes facilitates the flow of viscous materials with minimal plunger pressure. On the other hand, factors like the incorporation of air bubbles during mixing of the powder with liquid, the need for repeated removal and reinsertion of the instrument in the canal during the filling procedure could explain the increased number of voids when using the lentulospiral technique.¹²

In our study, the number as well as the area covered by the voids in both the groups were measured using CBCT, and we found that the mean value of the coronal third in the DB canal of the lentulospiral group was (0.201) higher than the NaviTip group (0.141) and was also statistically significant ($p < 0.01$). Similarly, the mean value of the middle third (0.158) and apical third (0.261) of the lentulospiral group was also higher than the NaviTip group, but statistically, the difference between them was not significant. These findings are unique to our study as no other study exists in the literature compared these aspects.

According to our study, the least area covered by the voids was seen in the middle third in both the groups, a finding consistent with the findings of Estrela et al.²² In addition, we also found more voids in the coronal third of the lentulospiral group, which may be

attributed to the finishing procedure used, a finding in harmony with Singh et al.¹

The disadvantage of NaviTip over lentulospiral is the comparatively higher cost. Moreover, extra time is needed to disassemble the tool in case extra material is required, the process is cumbersome and complex. Moreover, the NaviTip has to be cleaned immediately after use, which is difficult and not feasible when working on uncooperative children.

The present investigation and findings of the study were limited to second primary molars. We suggest that future studies must be conducted with a larger sample size and longer periods of evaluation, as there are several frequently encountered clinical factors like patient age, their cooperation level, intraoral opening, access to the involved teeth and canals, facility of imaging techniques like CBCT to reach a firm conclusion regarding the most effective and efficient obturating technique for primary teeth.

CONCLUSION

We thereby conclude that within the limits imposed by the conditions used in the present study, both the techniques, lentulospiral and the Skini syringe with NaviTip can be used for obturating the root canals of primary molars with ZOE. Voids were observed with both the techniques; however, they were minimum when skini syringe with NaviTip was used.

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