ORIGINAL RESEARCH

Comparative Evaluation of Four Different Obturating Techniques in Primary Teeth Using Cone-beam Computed Tomography: An *In Vivo* Study

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Abstract

Background: The quality of the obturation plays a significant role in the success of endodontic treatment. To date, various technologies have been used to evaluate the quality of obturation, but all of them have their own limitations. In order to overcome those limitations, recent technological advancements like cone-beam computed tomography (CBCT) can be helpful.

Aim: To compare and evaluate the efficiency of different root canal obturation techniques in primary teeth using CBCT.

Materials and methods: A total of 80 root canals in 30 children aged between 4 and 9 years were selected and divided into four groups, with 20 root canals in each. Obturation in group I was performed using the endodontic pressure syringe; group II—hand spreaders; group III—Lentulo spirals mounted on slow-speed handpiece; and group IV—insulin syringe. The quality of obturation was evaluated using a CBCT scan.

Results: Group I samples showed the most optimally filled canals followed by II and III; least in group IV. A maximum number of overfilled canals was exhibited in group III samples. Voids were minimal in all four groups and the values obtained were not statistically significant.

Conclusion: Obturation with an endodontic pressure syringe reported the highest number of optimally filled root canals and the insulin syringe showed the least number of optimally filled canals.

Keywords: Cone-beam computed tomography, Obturation, Pulpectomy, Zinc oxide eugenol.

International Journal of Clinical Pediatric Dentistry (2023): 10.5005/jp-journals-10005-2566

Introduction

Despite major improvements in dentistry, dental caries remains the most prevalent condition, with primary dentition being more vulnerable to early pulp involvement because of the variable morphological traits and picky oral hygiene behaviors of the children.[1] One of the treatments for badly decaying primary teeth is a pulpectomy. At either a single appointment or over the course of several, it refers to the entire removal of the necrotic pulp tissue, followed by filling with a resorbable material.[2] The diagnosis, case selection, biomechanical preparation, obturating material, and method used all play a role in how successfully a pulpectomy goes.[3]

The ultimate purpose of root canal obturation is to use an obturating material to seal off the entire prepared root canal space, preventing reinfection or complications after the procedure. Having voids in the apical and coronal regions, running the entire length of the root canal, or having incomplete obturation may allow for microleakage, bacterial regrowth, secondary infection, and ultimately endodontic failure. To ensure the greatest possible success in pediatric endodontic operations, a detailed assessment of the filling is necessary.[4]

Primary teeth have been obturated using a variety of methods, including the traditional manual incremental technique, lateral condensation using pluggers or spreaders, various injection or syringe techniques, the handheld and rotational Lentulo spiral method, etc.[5] Several authors have examined the effectiveness of various obturation techniques, including radiographs, dyes, radioisotopes, fluid filtration, and digital radiography, both in *vivo* and *in vitro*. Yet no approach satisfies every need of the ideal method, and it also does not evaluate obturation in three dimensions.

In vitro studies have more recently used CBCT to analyze the primary dentition's canal shape and to quickly and accurately identify voids in obturated canals. Compared to standard CT, CBCT provides clear benefits for pediatric patients, including a shorter scan time that lessens children's anxiety.

Cone-beam computed tomography (CBCT) produces images that are greatly enlarged and less distorted.[6] There are few *in vivo* studies using CBCT to evaluate the obturation in primary teeth. To ascertain the better obturation technique using new technology, that is, CBCT, this *in vivo* study was undertaken to appraise four different obturating techniques endodontic pressure syringe, hand

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How to cite this article: Ali SM, Mukthineni S, Sai Sankar AJ, *et al.* Comparative Evaluation of Four Different Obturating Techniques in Primary Teeth Using Cone-beam Computed Tomography: An *In Vivo* Study. Int J Clin Pediatr Dent 2023;16(2):218–222.

Source of support: Nil

Conflict of interest: None

spreaders, Lentulo spirals delivered through slow-speed handpiece, and insulin syringe technique using zinc oxide eugenol (ZOE) paste as an obturating material in primary teeth.

Materials and Methods

The present *in vivo* study was done in the Department of Pediatric Dentistry, Sibar Institute of Dental Sciences (SIDS), Guntur, Andhra Pradesh, India. Sample size determination was done using G* power 3.1.9.2 with the reference test one-way analysis of variance (ANOVA) considering 80% power and effect size is 0.40, $\alpha = 0.05$, the sample size is derived as 76 and rounded to 80. After obtaining ethical committee clearance 80, primary root canals from 30 healthy and cooperative children of both sexes aged between 4 and 9 years were selected by block randomization.

Children with a history of unprompted pain, bleeding after removal of the coronal pulpal, or the presence of inter radicular radiolucency were included in the study. Teeth that cannot be restored, teeth that show signs of internal or exterior root resorption, follicular cysts, or dentigerous lesions, as well as children with deteriorated health, were excluded. Parents were requested to read and sign a consent form outlining the study's protocol after receiving a sufficient description of the experimental design, treatment procedures, and potential outcomes.

Standardized baseline intraoral periapical radiographs were acquired prior to the start of the treatment. After administering a local anesthetic, a pulpectomy surgery was performed while isolating the teeth with a rubber dam. A high-speed airotor was used to insert a sterile round bur into the pulp chamber. With a spoon excavator, the coronal section of the pulp was severed. After radicular pulp extirpation, Radiovisiography (RVG) was used to confirm and establish the working length at 1 mm below the apex. By inserting a #10 K-file, all of the root canals were examined for apical patency (Mani Co., Tokyo, Japan). The #15 K-file (Mani Co., Tokyo, Japan) was first used to clean and shape the canal, and afterward the Kedo SG Pediatric rotary file system. After using each file, irrigation was done once with 5.25% sodium hypochlorite (1 mL) and once with regular saline.

After that, canals were dried by inserting absorbent paper points 1 mm below the radiography apex. All of the chosen teeth underwent the same treatment. By using the block randomization technique, the 80 root canals were randomly distributed into four groups of 20 each. Four distinct obturating methods, including the endodontic pressure syringe, hand spreader, Lentulo spiral mounted on a slow-speed handpiece, and insulin syringe, were used to seal these canals.

In the present study, ZOE was chosen as the obturating substance. A standardized mixture of zinc oxide (ZnO) and eugenol was prepared for obturation using the method described by Aylard and Johnson[7]. Around 0.275 mL of eugenol and 1 gm of ZnO were prepared for use with an endodontic pressure syringe, 0.4 mL of eugenol and 1 gm of ZnO were prepared for use with a spreader, Lentulo spirals mounted on the handpiece and insulin syringe.

Group I

Endodontic Pressure Syringe

Per the manufacturer's recommendations, the prepared root canals in this group were obturated with ZOE paste blended to a creamy consistency using an endodontic pressure syringe (pulpdent, root canal pressure syringe).[8]

Group II

Hand Spreader

The ZOE paste was inserted into the root canals using a 21 mm hand spreader of size 15–20. Based on the preoperative radiograph, a rubber stopper was adjusted to keep the hand spreader 1 mm away from the apex. A fresh mixture of ZOE Paste was applied to the spreader, and it was then put into the canal and turned clockwise.[9]

Group III

Lentulo Spiral

The ZOE paste was delivered into the root canals using a 21 mm Lentulo spiral of size 30 mounted on a slow-speed contra-angle handpiece (1000 rpm). ZOE paste was applied to the Lentulo spiral, which was then placed into the canal, rotated clockwise, and then withdrawn while it was still turning. The process was repeated until the canal was filled with cement.[8]

Group IV

Insulin Syringe

Using an insulin syringe, prepared root canals in group IV were obturated with ZOE paste that had been blended to a creamy consistency (BD Glide TM needle). The insulin syringe was filled with the homogenous ZOE paste mixture, the needle was placed 2 mm short of the apex, and the cement was then pressed into the canal.[8]

Postendodontic restoration is done with glass ionomer cement. CBCT (Carestream Cs 9300), manufactured by Carestream Health Inc, France, was used for the postobturation evaluation. Postobturation scans were taken using the pedo mode after the patient was fitted with a thyroid collar and lead apron. Software known as CS 3D imaging was used to analyze the images. The obturation's quality was evaluated using the standards proposed by Coll and Sadrian.[10]

- Underfilling (score 1)—canal filled >2 mm short of the apex.
- Optimal filling (score 2)—canal filling ending at the radiographic apex or <2 mm short of the apex.
- Overfilling (score 3)—filling outside the root apex.

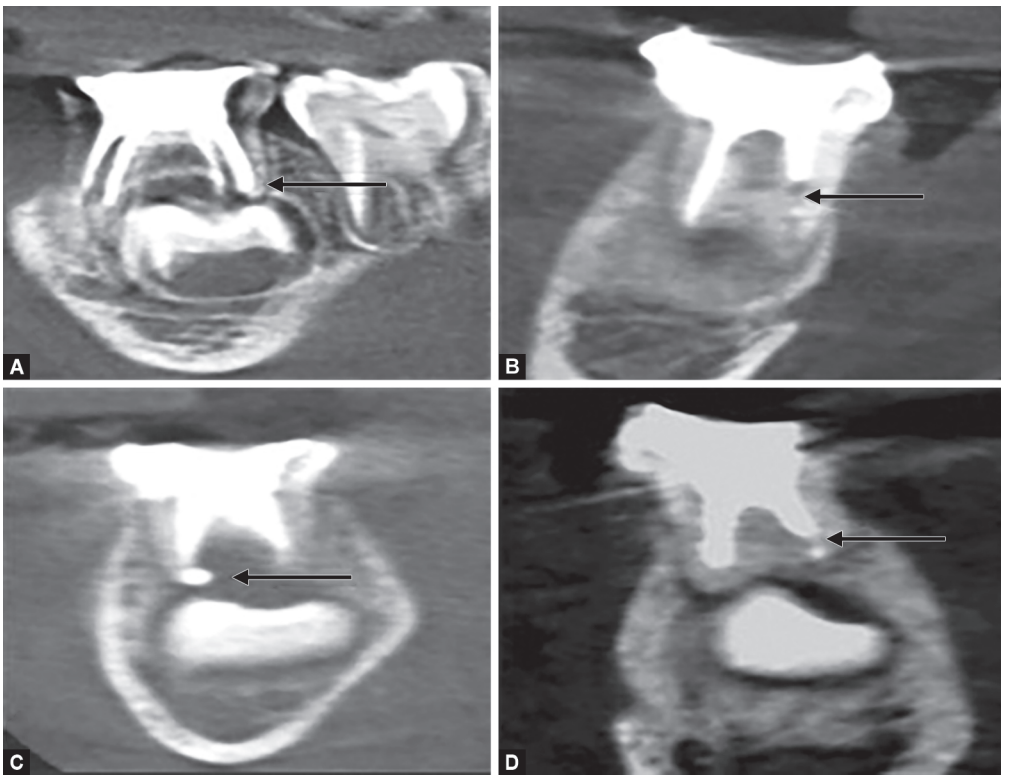
Evaluation of voids was based on their presence/absence and their number in coronal, middle, and apical third). Two researchers who were unaware of the group allocation and obturation technique evaluated the obturation's quality. The lowest score was chosen when there was a disagreement.

Results

The formula for sample selection—using G* Power 3.1.9.2 and the reference test one-way ANOVA with 80% power and effect sizes of 0.40 and 0.05, a sample size of 76 was calculated and rounded to 80. Microsoft Excel was used to enter the data, while Statistical Package for the Social Sciences version 21 was used for analysis. To assess the degree of root canal filling amongst various obturation procedures, Fisher's exact test was employed. A p-value of ≤ 0.05 was considered statistically significant.

Group I showed the highest number of optimally filled canals (Fig. 1A), 15 out of 20 canals (75%), followed by group II (65%), group III (70%), and group IV (55%). Group IV showed the maximum number of underfilled canals (Fig. 1B) in seven out of 20 samples. Whereas group III showed the highest number of overfilled canals (Fig. 1C) in four out of 20 samples (Table 1).

An insignificant number of voids were reported in all experimental groups, with one void in samples of group IV at the



Figs 1A to D: (A) Optimal filling; (B) Underfilling; (C) Overfilling; (D) Voids

Table 1: Differences in root canal fill based on the type of obturation technique

Group	*Underfilled n (%)*	*Optimum filled n (%)*	*Overfilled n (%)*	*p-value*
I	4 (20%)	15 (75%)	1 (5%)	0.386
II	6 (30%)	13 (65%)	1 (5%)	
III	2 (10%)	14 (70%)	4 (20%)	
IV	7 (35%)	11 (55%)	2 (10%)	

coronal third and one void each in samples of groups I, II, and III at the middle third and apical third (Fig. 1D and Table 2).

Discussion

In 1932, pediatric endodontic therapy was developed as a way to save those primary teeth that would otherwise fall out.[11] The utilization of materials and procedures that can densely fill the canal and create a tight seal to ward against reinfection is necessary for ideal obturation.[12]

The canal should be completely filled, without being overfilled, and with the fewest possible voids. According to reports, pulpectomies with acceptable or under obturation have a much greater success rate than those with excessive obturation. When there is significant preoperative root resorption and a lengthy fill that closely resembles the developing tooth's crypt, there is a risk of over-obturation that could result in foreign body reaction, the rebound of succedaneous tooth eruption path, and enamel defects in succedaneous teeth. The finest obturation technique, according to Coll et al.,[13] is the one that gives an ideal filling of the root canal. Choosing an obturation technique that gives the proper consistency of filling material and is simple to apply is therefore essential.

Zinc oxide eugenol (ZOE) paste, calcium hydroxide [$Ca(OH)_2$] pastes alone, and $Ca(OH)_2$ pastes combined with iodoform are the most often utilized materials for primary teeth (Trairatvorakul and Chunlasikaiwan 2008). Because of its anti-inflammatory and analgesic effects, higher zone of bacterial inhibition, ease of availability, the convenience of mixing, good working time, and high success rate, ZOE was chosen as an obturating material in this investigation.[14] The delivery system chosen can affect how well these materials can entirely conform to canal walls or seal off the root apex without overfilling or leaving holes in the material (Memarpour et al.).

To date, a variety of methods and materials have been created and put to the test to determine the best way to obturate primary teeth. Regrettably, none of the obturating methods met all of the requirements. Many techniques, including fluid filtration, dye penetration, radioisotopes, microscopic analysis, the clearing procedure, classic radiographs, and digital radiography, including RVG, can be used to examine obturation. Each method has advantages and disadvantages of its own.[15]

The obturation can only be interpreted two-dimensionally (2D) using the radiography method (traditional and digital).[16] On the contrary, sectioning the root canal leads to tooth material loss, which may appear as voids, and the fluid filtration and clearing technique takes a lot of time. Clinical correlation between dye penetration investigations is lacking. Experiments to measure the number of penetrating bacteria do not accurately imitate clinical settings and require a longer observation period. However, loss of material or 2D view is the drawback of the abovementioned procedures, which failed to give foolproof results.[1,17–19]

According to radiographic assessments, the quality of obturation produced by various obturation techniques has been the subject of several research with differing success rates. According

Table 2: Association between obturation technique and the presence of voids in different regions of the root canal

Region	*Group*	*Voids present n (%)*	*Voids absent n (%)*	*Chi-square value*	*p-value*
Coronal third	I	0 (0.00)	20 (100)	3.038a	1.00
	II	0 (0.00)	20 (100)		
	III	0 (0.00)	20 (100)		
	IV	1 (5)	19 (95)		
Middle third	I	1 (5)	19 (95)	1.039a	1.00
	II	1 (5)	19 (95)		
	III	1 (5)	19 (95)		
	IV	0 (0.00)	20 (100)		
Apical third	I	1 (5)	19 (95)	1.039a	1.00
	II	1 (5)	19 (95)		
	III	1 (5)	19 (95)		
	IV	0 (0.00)	20 (100)		

to Reddy et al.[20] and Memarpour et al.,[16] Lentulo spiral was the best obturation technique for depth of fill. According to Vashista et al.,[21] there is no discernible difference between the pressure syringe and the Lentulo spiral in terms of the quality of obturation. The fact that traditional radiography does not evaluate the extent of obturation in three dimensions is one of its drawbacks.[20]

There is a continuous search for better approaches to evaluate the quality of obturation in the field of pulpectomy because none of the techniques now available meet all the requirements. There is a need for enhanced technology that could offer more accurate three-dimensional information for the evaluation of root canal systems. Therefore, there is a need for an advanced tool that may provide more precise three-dimensional information like CBCT.[4]

Cone-beam computed tomography (CBCT) is a comparatively recent dental technology that can image dentofacial structures in three dimensions, analyze root canal filling volume, and diagnose a variety of defects without cutting the study material into sections.[1] CBCT produces images with slices that are substantially thinner than those produced by traditional CT techniques, allowing for a more precise evaluation of the obturation quality of primary teeth.[4] Shorter scanning times (60 seconds) and submillimetre resolution (2 line pair/mm) pictures with improved diagnostic quality are both possible with CBCT. High dimensional precision is present, with only 2% magnification.[21–23] The key benefit of CBCT is the clinician's ability to quickly and simply apply simple software to analyze the areas of interest in any plane in pediatric patients due to shorter scan times and less complex equipment, which lowers kid anxiety.[6]

Singh et al.[4] concluded NaviTip (93.5%) and endodontic pressure syringe (91.5%) had a maximum number of the optimally filled canal, as opposed to Lentulo spiral (75.5 %) and insulin syringe (64%) as assessed using CBCT. In their work, Sijeria et al.[24] used CBCT to assess the percentage of volume and voids in obturation and depth-of-fill root canals of primary teeth (CBCT). From the findings, they concluded that the method combining the NaviTip system with the Lentulo spiral produced the largest percentage of volume and the greatest number of canals that were optimally filled.

As compared to other procedures in the study, the endodontic pressure syringe approach produced the most optimally filled canals. This might be a result of the endodontic pressure syringe's plunger system, which is significantly superior at delivering the much higher pressure necessary to release the thicker ZOE mixture. Additionally, compared to the nonflexible or rigid needle of the insulin syringe, the endodontic pressure syringe's relatively thin and flexible needle offers a homogenous filling with fewer and smaller-sized voids and allows it to bend, simulating the curvature of posterior primary teeth root canals.

Reddy et al.[20] examined the depth of the canal fill, the voids, and the amount of canal overfill. Based on the findings, the tuberculin syringes and endodontic pressure syringe function better. Also, it was discovered that the endodontic pressure syringe was better at regulating the extrusion of ZOE cement. According to Hiremath and Srivastava,[3] endodontic pressure syringes delivered superior outcomes with a greater number of optimum fillings in terms of obturation length. Yet, the obturation clearly had voids in it.

In this study, Lentulo spirals had the second-highest percentage of optimally filled canals. This was in line with a study by Memarpour et al.[16] that examined six methods of obturating primary teeth using digital radiography and the anesthetic syringe, NaviTip, pressure syringe, tuberculin syringe, Lentulo spiral, and plugger. According to the findings, the Lentulo spiral offers superior results over other approaches. However, compared to other techniques, the Lentulo spiral technique demonstrated a higher percentage of overfilled canals (20%) in the current study. This can be due to improper placement of the stopper and excessive application of pressure in the apical direction. The findings are consistent with the work by Chandrasekhar et al., which found that the Lentulo spiral technique produces more overfilled canals than other procedures.

Comparing the filling quality of various obturating procedures in primary molars was done by Khubchandani et al. in 2017.[25] The author concluded that the NaviTip syringe was sufficiently effective voids removal and a tight apical seal, while the Lentulo spiral had the best results in terms of depth of canal fill. The effectiveness of various obturation techniques [(endodontic plugger, LS (handheld), LS (slow-speed handpiece), and local anesthetic syringe tuberculin syringe)] in carrying the filling material was assessed by Nagaveni et al.[17] using a CBCT scan. They concluded that among the five groups examined in primary teeth, the Lentulo spiral mounted to the handpiece demonstrated the optimum method of obturation utilizing CBCT.

When compared to the other procedures, the insulin syringe technique in the current investigation displayed the highest frequency of underfilled canals. The hub's small, slender size and intracanal reach, which only extends to the middle third of canals rather than the apical third, maybe the cause of the increased number of voids and decreased material fill. The current study

findings are consistent with those of investigations by Nagar et al.[29] and Akhil et al.[1], which found fewer canals that were optimally filled.

Primary teeth with voids in the root canal fillings can experience microleakage, which can result in bacterial contamination. The risk of failure may be increased by voids in the apical or coronal region or throughout the full length of the root canal. The least amount of voids is seen in all procedures in the current analysis. This might be a result of proper isolation of the teeth using a rubber dam, proper cleaning and shape, drying of the root canals using paper points, standardization of powder to liquid ratio, working qualities of the material, the stage of root resorption, and technique mastery.[26–29]

The present study evaluated only the depth of the obturation and voids in the obturation; however, the volumetric analysis, a more reliable method to study the quality of obturation three-dimensionally, was not assessed. Additional studies can be recommended with different obturation techniques and materials by the volumetric analysis method.

Conclusion

The endodontic pressure syringe approach produced better results (75% optimum fillings) when used on primary root canals. The insulin syringe approach (35%) and hand spreaders (30%) showed the highest percentage of underfilled canals, whereas Lentulo spirals mounted on slow-speed handpieces (20%) showed the highest percentage of overfilled canals. In all four categories, there were the fewest voids.

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