International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb 2024 pp: 393-400www.ijdmsrjournal.com ISSN: 2582-6018

Evaluation of different primary molar root canals obturation techniques: in-vitro study

[a]Wasan Osman Elzain, [b]Salwa Mohamed Awad, [c]Rizk Abd Alla El-Agamy.

[a]Postgraduate student, Department of Pediatric Dentistry and Dental Public Health, Mansoura University, Mansoura, Egypt.
[b]Professor, Department of Pediatric Dentistry and Dental Public Health, Mansoura University, Mansoura, Egypt.
[c]Lecturer, Department of Pediatric Dentistry and Dental Public Health, Mansoura University, Mansoura, Egypt.

Date of Submission: 03-02-2024 Date of Acceptance: 14-02-2024

Abstract

Objective: To evaluate efficacy of Lentulospiral, Endodontic Plugger, NaviTip, and Pastinject techniques in obturating primary root canals with Endoflas using Cone Beam Computerized Tomography (CBCT).

Materials/Subjects and methods: Sixty extracted primary lower first molars with certain inclusion criteria were collected from outpatient dental clinics to be used in this study. They were divided randomly into equal four groups (n=15) based on the obturation technique as follows: Group 1 (Lentulospiral), Group 2 (Endodontic plugger), Group 3 (NaviTip), and Group 4 (Pastinject). The efficacy of four techniques to obturate primary root canals to optimal length without voids was assessed using CBCT.

Results: The frequency of optimal filling was higher among Endodontic Plugger especially in distal canals, followed by Lentulospiral and Pastinject groups and lastly NaviTip group with no statistically significant difference (P=0.346). Pastinject showed a statistically significant higher frequency of voids (P=0.022) especially in mesiobuccal canals than other groups. No statistically significant correlation was observed between obturation level score and void score.

Conclusion: Endodontic pluggers were more efficient in obturating root canal optimally especially distal canals with lesser voids. NaviTip obturation technique was the least effective technique in obturating root canals to optimal length with greater amount of voids.

I. Introduction

Pulpectomy procedure entails removalof the contents of the pulp chamber and the root canal and obturation of root canal with specific materials that protect against recurrent infection.[1] The goal of pulpectomy procedure in primary dentition is to maintain a functional primary tooth until eruption of its permanent successors.[2,3]Root canal obturation creates a fluid-tight seal along the length of the root canal system from the coronal opening to the apical termination.[4] The ideal obturationshould be optimally filled without over or underfilling with no or least number of voids.[5,6]

Various techniques/devices have been used to obturate the root canal of primary teethin the available litreture.[7]Obturation techniques are classified into syringe and non-syringetechniques. Syringe techniques include Insulin syringe, Tuberculin syringe, NaviTip, Pressure syringe, Capillary tips,Disposable needle and Jiffy tube. Non-syringe techniques include Lentulospiral, Incremental technique (Endodontic pluggers), Bi-directional spiral and Past Inject.[8]

These obturation techniques don't fulfil the ideal requirements including optimum obturation to full length without voids, limited extrusion of obturating materials into periapical area, simplicity, cost effectiveness and ease of application.[7]

Endoflas consists of a powder containing zinc oxide (56.5%), iodoform (40.6%), calcium hydroxide (1.07%), barium sulfate (1.63%), and a liquid consisting of eugenol and paramonochlorphenol.[9] Endoflas resorbion rate is the same as the physiological resorption of root.[10] The resorption of Endoflas occurs only to extruded excess material. Endoflas is a hydrophilic material that is usefulin mildly humid canals. It adheres well to root canals providing good seal. It disinfects the dentinal tubules and the hard to-reach accessory canals.[11]

Routine intra-oral radiographsgivetwo dimensional images of a three dimentional object. The completeness of obturation in three dimensions can be assessed by CBCT.[12]The 3D nature of the produced images permits visualization of additional root canals, detection of initial periapical lesions,

International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb 2024 pp: 393-400www.ijdmsrjournal.com ISSN: 2582-6018

resorption defects, and help in discovering the anatomical relations of the root apices to important neighbouring structures.[13] It provides sub-millimetre resolution in high diagnostic quality images with fast scan times (10-70 seconds).[14]

The purposes of this in vitro study were to evaluate and compare the obturation quality like underfilling, optimal filling, over fillings, and the absence or presence of voids in primary molars among the Lentulospiral, Pastinject, NaviTip and Endodontic plugger techniques using CBCT.

II. Materials and methods

The study was reviewed and approved by the Dental Research Ethics Committee (DREC), Faculty of Dentistry, Mansoura University, Egypt, with Code No. M07080921.

The calculated sample size of the study was performed with G*Power 3 sample size calculator at 5% level of significance and 80 % power of the study.[15]Based on previously published study of *Pandranki et al.*[16]. The sample size was 60 teeth that was randomly divided into four groups (15 each) to increase the study power.

Sixty extracted primary first molars having no external or internal root resorption, no or minimal (less than one third) root resorption and absence of perforation in the furcation area. Primary teeth with less than three-fourths of the original root length and calcified canals were excluded from this study.

Specimenpreparation: Manipulation of teeth were according to the Occupational safety and health administration guidelines. All teeth were stored after collection in distilled water for 1 week, disinfected in 0.1% Thymol solution. Cleansed to removeany attached tissue. The teeth were finally washed with distilled water and stored in 0.9% normal saline till used.[17]

All teeth apices were covered with a piece of paper tissue to protect the apical foramen and covered with a ball of red wax 4–5 mm in diameter to simulate the anatomical apical space around each root apex. Then the apical third of roots was covered by self-cured acrylic till it hardens.[17]Finally, the tooth was placed in boiling water to melt the red wax and leave a hollow simulating apical space.

Pulpectomy procedure: A standard access cavity preparation was donewith BR 31 diamond round bur(Dentsply Maillefer, Ballaigues, Switzerland) and Endo Z carbide(Dentsply Maillefer, Ballaigues, Switzerland). Any remaining pulp tissue in the root canals was removed using barbed broaches, followed by irrigation with 1% Sodium Hypochloride and finally with Saline.[18] Patency of the canals was checked using a size ten K-file.[19]Also, digital periapical radiographs were takenfor initial working length determination.[18,19]

All teeth canals were prepared at first using manual H-Files size 15, 20, and 25 then irrigated with 5% Sodium Hypochloride followed by saline in between different H-Files sizes. Then all teeth canals were prepared using Elephant Kidzo Kit Rotary Files (18 mm) size 25 and 30 taper 4, followed by irrigation with 5% Sodium Hypochloride and finally with saline.

Prepared teeth were assigned into four groups (n=15) according to the obturation techniquesshown in figure (1) as follows,Group 1:obturated byLentulospiral technique. In this group, the Lentulospiral was coated with Endoflas carried into the root canals and inserted into the canal while rotating, and withdrawn gently while still rotating. Additional amounts of paste were gradually introduced until the canals were filled to the orifice till the canal was assumed to be filled.Group 2: obturated by Endodontic Pluggers technique. In this group, a thick mix of Endoflas was incrementally plugged into the canals until the canal was visibly filled at the orifice.[20]

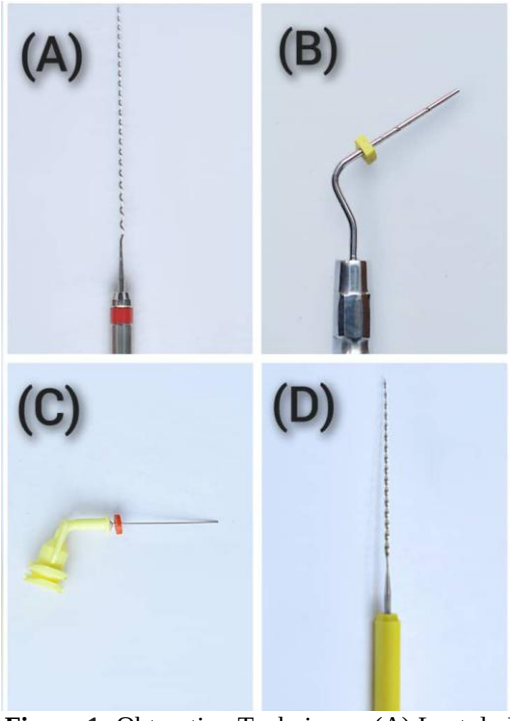

Figure 1: Obturation Techniques. (A) Lentulo Paste Carrier size 25, (B) Endodontic Plugger size 30, (C) NaviTip Tips size 20, 29 guage, 21 mm, (D) Pastinject size 20.

Group 3: obturated by NaviTip technique. NaviTip with 29-gauge, 21 mm canula was selected and a mix of Endoflas was then loaded into the 3 ml

International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb 2024 pp: 393-400www.ijdmsrjournal.com ISSN: 2582-6018

disposable syringe. The material was pressed out of the tip to flow into the canal with slow retrieval of the cannula from the canal. Once the backfill of the material occurred, the canal was assumed to be filled.[21]Group 4:obturated by Pastinject mounted in Slow Speed Handpiece technique. Pastinject was coated with Endoflas and inserted into the canal, and withdrawn gently while still rotating. Additional amounts of paste were gradually introduced until the canals were filled to the orifice.

Evaluation: Postoperative CBCT scans were taken immediately after each obturation to evaluate the obturation level and voids absence or presence. Teeth were arranged in arch like pattern on the scanning tray. The length of fill was measured on the longitudinal plane along the long axis of tooth using the ruler tool from in the measure tab on the CBCT scans and measured in millimeters between the apical end of filling material and the radiographic apex.[22,23]Also, distinct radiolucent areas present within the radiopaque materials in the canalsvoids were identified as voids.[24]

The quality of obturation was assessed based on the criteria of Coll and Sadrian as follows: Score 1 (Underfilling): Canal filled more than 2 mm short of the apex. Score 2(Optimal filling): Canal filling ending at the radiographic apex or up to 2 mm short of apex. Score 3 (Overfilling): Any canal showing filling outside the root apex. Evaluation of voids was based on their absence (score 0) or presence (score 1).[25] The statistical analysis was performed by Chi square test, Monte carlo test and ANOVA test.

III. Results

The results of this study revealed no significant difference between the four experimental groups regarding obturation level scores (p=0.346) to fill Endoflas. However; the frequency of optimal filling was highest among Endodontic Plugger 33(68.8%), followed by 24/23(51.1 %) in both Lentulospiral, Pastinject groups. While NaviTip group showed the least optimum filling scores 22(47.8%).

The results of this study showed a significant difference between the four experimental groups regarding void scores (p=0.022). Although, Pastinject 17(37.8%) showed the highest frequency of voids that was statistically significant (p=0.022). There was no significant difference between the other three experimental groups: Lentulospiral 10(21.3%), NaviTip 8(17.4%), and Endodontic Plugger 6(12.5%) groups.

Evaluation of length of fill regarding the canal type showed a statistically significant difference, p value ≤0.05as observed in Table (1).Evaluation of voids regarding the canal type showed a statistically significant difference, p value ≤0.05 as observed in Table (2).

Table (1): Obturation Level score of each studied group regarding types of canal.

Canal	Length Score	Lentulospiral group (n=47)	Endodontic plugger (n=48)	NaviTip group (n=46)	Pastinject group (n=45)	Test of significance
MB	1 2 3	2 (13.3%) 10 (66.7%) 3 (20.0%)	3 (20.0%) 10 (66.7%) 2 (13.3%)	4 (26.7%) 10(66.7%) 1 (6.7%)	2 (13.3%) 10 (66.7%) 3 (20%)	P=0.913
ML	1 2 3	7 (50.0%) 6 (42.9%) 1 (7.1%)	6 (42.9%) 8 (57.1%) 0 (0%)	9 (60.0%) 5 (33.3%) 1 (6.7%)	6 (46.1%) 6 (46.1%) 1 (7.7%)	P=0.899
DB	1 2 3	1 (33.3%) 1 (33.3%) 1 (33.3%)	0 (0%) 4 (100%) 0 (0%)	0 (0%) 1 (100%) 0 (0%)	0 (0%) 0 (0%) 2 (100%)	P=0.165
DL	1 2 3	0 (0%) 3 (100%) 0 (0%)	3 (75.0%) 1 (25.0%) 0 (0%)	1 (100%) 0 (0%) 0 (0%)	1 (50%) 1 (50%) 0 (0%)	P=0.191
D	1 2 3	8 (66.7%) 4 (33.3%) 0 (0%)	1 (9.1%) 10 (90.9%) 0 (0%)	4 (28.6%) 6 (42.9%) 4 (28.6%)	6 (46.2%) 6 (46.2%) 1 (7.7%)	**P=0.007***

MC: Monte carlo test , *p value significant ≤0.05, MB: Mesiobuccal canals, ML: Mesiolingual canals, DB: Distobuccal canals, DL: Distolingual canals, D: Distal canals, Score 1: Underfilled canal, Score 2: Optimumfilled canal and Score 3: Overfilled canal.

Table (2): Voids scores of each studied group regarding types of canal.

Canal	Void Score	Lentulospiral group (n=47)	Endodontic Plugger (n=48)	NaviTip group (n=46)	Pastinject group (n=45)	Test of significance
MB	0 1	11 (73.3%) 4 (26.7%)	13 (86.7%) 2 (13.3%)	14(93.3%) 1 (6.7%)	7 (46.7%) 8 (53.3%)	**P=0.018***
ML	0 1	12 (85.7%) 2 (14.3%)	12 (85.7%) 2 (14.3%)	13(86.7%) 2 (13.3%)	10 (76.9%) 3 (23.1%)	P=0.894
DB	0 1	3 (100%) 0 (0%)	3 (75.0%) 1 (25.0%)	1 (100%) 0 (0%)	2 (100%) 0 (0%)	P=1.0
DL	0 1	3 (100%) 0 (0%)	4 (100%) 0 (0%)	1 (100%) 0 (0%)	1 (50%) 1 (50%)	P=0.305
D	0 1	8 (66.7%) 4 (33.3%)	10 (90.9%) 1 (9.1%)	9 (64.3%) 5 (35.7%)	8 (61.5%) 5 (38.5%)	P=0.393

MC: Monte carlo test , *p value significant ≤0.05, MB: Mesiobuccal canals, ML: Mesiolingual canals, DB: Distobuccal canals, DL: Distolingual canals, D: Distal canals, Score 0: No void present, and Score 1: Void present.

The results of this study showed no statistically significant correlation observed between obturation level score and void score in all groups, p value > 0.05.

IV. Discussion

Root canal treatment is the procedure performed to prevent subsequent re-infection by the total abolition of the microbes and bacteria from the root canals.[26] It serves such a purpose using various materials and techniques to fill the canals of primary teeth.[25]

The present study was carried out in vitro study on extracted teeth. Dental procedures are best performed directly on extracted human teeth as they best simulate the clinical situations.[27,28] Also, the quality of obturation is affected by the tooth position in the oral cavity, as well as by the management of children's behavior.[29] Only extracted lower first primary molars were selected in this study for the standardization of the study to produce a more consistent results since significant differences in the root canal anatomy among the used specimens may

be a source of bias.[30] This is consistent with *Damle et al.*[31]

The obturation techniques used in this study are Lentulospiral, Endodontic Plugger, NaviTip syringe and Pastinject. Lentulospiral is one of the most effective, economical, flexible and highly accepted obturation techniques.[32] This is in agreement with*Ali et al.*[33] The Pastinject provides good placement of the obturating material, eliminate voids and provide a high density obturation.[34] It has a very high flexibility and additionally its helical form creates a translational circulate movement delivering the filling material onto the canal walls.[35] This is in line with *Ozturk et al.*[36]

In the current study Endodontic Finger Plugger is assessed as it is a simple and effective technique for incremental packing of obturating material into the long and straight canals.[37] Also, packing of thick consistency filling materials.[38] This is also consistent with *Anika et al.*[39]

NaviTip advantage is that it is rigid at the shank region, which doesn't further bends and the end of the tip is flexible to allow navigation even through curved canals.[6] It provides a uniform densely filled canal with minimum voids.[40] This is in accordance with *Raju et al.*[41]

Therefor in the present study the obturation quality was assessed by Coll and Sadrian criteria (1996) which is classified into underfilled, optimally filled, and overfilled canals along with presence and absence of voids. Therefore, it was selected to produce comparable results. Some of the studies that are in accordance are *Akhil et al.*[42], *Sithara et al.*[22] and *Joy et al.*[43]

Regarding the results of this study, evaluation of CBCT scans revealed no significant difference between the four obturation technique groups regarding scores for optimum fill level of obturation to deliver Endoflas. In the present study, the highest percentage of root canals were optimally obturated by Endodontic Plugger. One of the possible reasons for this result might have been better preparation of root canals by the rotary system, resulting in better access to the apex. Endodontic Plugger result is in agreement with *Dandashi et al.*[44] On the other hand,the results were inconsistent with*Pandranki et al.*[16] and*Jose et al.*[12]

In this study Lentulospiral demonstrated good results similar to Pastinject and superior to NaviTip. Lentulospiral has the advantage of increased flexibility which allows it to carry the paste well in narrow and curved canals resulting in good quality of obturations. This is in agreement with *Memarpour et al.*[45], *Khubchandani et al.*[37] and*Pandranki et al.*[16]

Regarding NaviTip in this study NaviTip had the least number of optimally filled canals. This may be due to the high viscosity and density of Endoflas material which resulted in difficulty in expelling the material from the NaviTip leading to short or incomplete obturations. This was consistent with *Raju et al.*[46]

In this study, Pastinject resulted in the highest number of voids that was statistically significant than other three groups. This may be attributed to the repeated removal and reinsertion of the Pastinject which may displace the paste and thereby creating voids. Differences in the concentration of the obturation material, smearing action of Endoflas, and differences in the skill of the operator may cause more number of voids in Pastinject technique obturation. Pastinject result is in agreement with *Chandrasekhar et al.*[35]Pastinject result is in disagreement with *Grover et al.*[5]and *Gandhi et al.*[34]

Regarding the results of this study, it was revealed that the frequency of optimal filling in distal canals was highest in Endodontic Plugger group than among Lentulospiral, NaviTip & Pastinject groups, respectively with a statistically significant difference. As the cross section of distal canal is more rounded than thin ovoid canals of mesial roots canals that are wider buccolingually.[47] This allows for better obturation of root canals. Since most of instrumentation and Endodontic Pluggers have rounded cross section of its tip. Also the distal canals are wider than their mesial counterparts allowing smoother flow of the material. This was in line with *Sengupta et al.*[24]

Regarding the results of this study, the frequency of voids in mesiobuccal canals were highest among Pastinject group than Lentulospiral, Endodontic Plugger and NaviTip groups, respectively with a statistically significant difference.

No statistically significant difference was observed regarding void frequency in the other canals. This may be due to the more curved nature of the mesiobuccal canals in comparision to the mesiolingual and distal canals which may result in more voids.[48] Also, the cross section of the mesial canals shows thin ovoid canals in comparision to the distal canals.

Dental instruments such as Pastinject and Endodontic Plugger have more circular than ovoid circumference which may result in some areas of the canals not being well filled. For both first and second primary molar teeth the mesiobuccal canals tends to be the longest which may result in a higher frequency of voids.[47]This was in accordance with *Sengupta et al.*[24]

V. Conclusions

1. The frequency of optimal filling was higher among Endodontic Plugger, followed by Lentulospiral and Pastinject groups and then lastly the NaviTip group.
2. Pastinject technique showed the highest number of voids when compared to other techniques.
3. No statistically significant correlation was observed between obturation level score and void score in all groups.

References

[1]. Baik SA, Mkenah A, Khan A, Alkhalifah A, Makinah A, Alqquraini H. Pulpotomy vs. pulpectomy techniques, indications and complications. Int J Community Med Public Health. 2018;5(11):1-4.
[2]. Dummett CJ, HM. K. Pediatric endodontics. In: Ingle JI, Bakl and LK, editors. Endodontics". 5th ed Hamilton: BC Decker Inc. 2002:861-902.
[3]. Ounsi HF, Debaybo D, Salameh Z, Chebaro A, Bassam H. Endodontic considerations in pediatric dentistry: a clinical perspective. Int Dent SA. 2009;11(2):40-50.
[4]. Kalaskar RR, Thosar N, Kalaskar AR. Insights of Primary Teeth Root Canal Obturation Techniques: A Mini Review. Ann Romanian Soc Cell Biol. 2021:2169-75.
[5]. Grover R, Mehra M, Pandit IK, Srivastava N, Gugnani N, Gupta M. Clinical efficacy of various root canal obturating methods in primary teeth: a comparative study. Eur J Paediatr Dent. 2013;14(2):104-8.
[6]. Guelmann M, McEachern M, Turner C. Pulpectomies in primary incisors using three delivery systems: an in vitro study. J Clin Pediatr Dent. 2004;28(4):323-6.
[7]. Kumar S, Raj S, Konde S, Rai K. Comparison of obturation techniques using three delivery systems: An in vitro study. Manipal J Dent Sci. 2016;1(2):13-7.
[8]. Kalaskar RR, Thosar N, Kalaskar AR. Insights of Primary Teeth Root Canal Obturation Techniques: A Mini Review. Ann Romanian Soc Cell Biol. 2021:2169-75.
[9]. Shindova M. Root canal filling materials in primary teeth–review. Folia Medica. 2021;63(5):657-62.
[10]. Pandranki J, Vanga NRV, Chandrabhatla SK. Zinc oxide eugenol and Endoflas pulpectomy in primary molars: 24-month clinical and radiographic evaluation. J Indian Soc Pedod Prev Dent. 2018;36(2):173.
[11]. Kp B, Poornima P, Lobo N. Comparative Evaluation of Quality of Obturation in Primary Teeth Using Zinc Oxide Eugenol and Endoflas under Spiral Computed Tomography: An In Vitro Study. CODS J Dent. 2017;9(2):46-9.
[12]. Jose EJ, Akhil, Prashant B, Shashibushan KK. Comparative evaluation of three obturation techniques in primary incisors using digital intra-oral receptor and CBCT—an in vitro study. Clin Oral Investig. 2018;23:689-96.
[13]. Svetlozarova S, Borisova-Papancheva T. Cone Beam Computed Tomography as a Diagnostic Tool in Endodontics-A Review of the Literature. Adv Res Dent Oral Health. 2019;11(2):80-5.
[14]. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PMH. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals Int Endod J. 2011;44(11):990-9.
[15]. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175-91.
[16]. Pandranki J, Chitturi RR, Vanga NRV, Chandrabhatla SK. A comparative assessment of different techniques for obturation with endoflas in primary molars: an in vivo study. Indian J Dent Res. 2017;28(1):44.
[17]. Walia T, Ghanbari AH, Mathew S, Ziadlou AH. An in vitro comparison of three delivery techniques for obturation of root canals in primary molars. Eur Arch Paediatr Dent: Offi J Eur Acad Paediatr Dent. 2017;18(1):17-23.
[18]. Azar MR, Safi L, Nikaein A. Comparison of the cleaning capacity of Mtwo and Pro Taper rotary systems and manual instruments in primary teeth. J Dent Res. 2012; 9 (2): 146.
[19]. Pinheiro SL, Araujo G, Bincelli I, Cunha R, Bueno C. Evaluation of cleaning capacity and instrumentation time of manual, hybrid and rotary instrumentation techniques in primary molars. Int Endod J. 2012;45(4):379-85.
[20]. Pandranki J, Chitturi RR, Vanga NRV, Chandrabhatla SK. A comparative assessment of different techniques for obturation with endoflas in primary molars: an in vivo study. Indian J Dent Res. 2017;28(1):44.
[21]. American Academy of Pediatric D. Guideline on pulp therapy for primary and young

permanent teeth. Pediatr Dent. 2009;31(7):179-86.
[22]. Sithara CA, Jeeva2 TV, Anupam Kumar3 VP, Kannan4 P, Vaishak Nath5 RS. Comparative Evaluation of Quality of Obturation between Two Obturation Techniques in Pulpectomy of Lower Primary Molars – An In Vivo Study. An In Vivo Study Int J Sci Stud 2022;10(9):22-7.
[23]. Dandashi MB, Nazif MM, Zullo T, Elliott MA, Schneider LG, Czonstkowsky M. An in vitro comparison of three endodontic techniques for primary incisors. Pediatr Dent. 1993;15:253-.
[24]. Sengupta M, dutta B, Bajoria A, Bagchi A. A Cone-Beam Computed Tomographic Assessment of Different Obturation Techniques in Primary Molars-An In Vivo Study. 2020;3:378-89.
[25]. Nagarathna C, Vishwanathan S, Krishnamurthy NH, Bhat PK. Primary molar pulpectomy using two different obturation techniques: A clinical study. Contemp Clin Dent. 2018;9(2):231.
[26]. Jena A. Pulpectomy: A Comprehensive Review. Prof(Dr) RK Sharma. 2020;20(4):41786.
[27]. Tijare M, Smitha D, Kasetty S, Kallianpur S, Gupta S, Amith HV. Vinegar as a disinfectant of extracted human teeth for dental educational use. J Oral Maxillofac Pathol: JOMFP. 2014;18(1):14.
[28]. Gogineni S, Ganipineni K, Babburi S, Venigalla A, Pinnisetti S, Kotti AB, et al. Evaluation of Vinegar as a Disinfectant for Extracted Human Teeth-An in-Vitro Study. J Clin Diagnostic Res: JCDR. 2016;10(7):ZC50.
[29]. Almeida LHS , Krüger MM , Pilownic KJ, Costa VPP, Romano AR, Pappen FG. Root canal filling techniques for primary molars: an in vitro evaluation. G Ital Endod. 2019;33(1).
[30]. Alqarawi FK, Alkahtany MF, Almadi KH, Ben Gassem AA, Alshahrani FA, AlRefeai MH, et al. Influence of different conditioning treatments on the bond integrity of root dentin to rGO infiltrated dentin adhesive. SEM, EDX, FTIR and microRaman study. Polymers. 2021;13(10):1555.
[31]. Damle S, Bansal R, Sakhare D. Success Rate of Obturation of Root Canals by Different Techniques in Primary Molars: A Comparative Clinical Study. Curr Dent. 2020;02.
[32]. Jose EJ, Akhil, Prashant B, Shashibushan KK. Comparative evaluation of three obturation techniques in primary incisors using digital intra-oral receptor and CBCT—an in vitro study. Clin Oral Investig. 2018;23:689-96.
[33]. Ali SM, Mukthineni S, Sankar AJS, Enuganti S, Kundeti SS, Yalamanchili S. 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.
[34]. Gandhi M, Tandon S, Vijay A, Kalia G, Rathore K. Clinical assessment of various obturating techniques for primary teeth: A comparative study. J Clin Diagnostic Res: JCDR. 2017;11(7):ZC48.
[35]. Chandrasekhar S, Prasad MG, Radhakrishna AN, Saujanya K, Raviteja NVK, Deepthi B, et al. A comparative In vivo efficacy of three spiral techniques versus incremental technique in obturating primary teeth. J Indian Soc Pedod Prev Dent. 2018;36(1):71-5.
[36]. Ozturk G, Aydinbelge M, Gumus H. Comparison of Various Root Canal Filling Materials and Obturation Techniques for Primary Teeth Using Microcomputed Tomography. J Adv Oral Res. 2022;13(1):53-61.
[37]. Khubchandani M, Baliga MS, Rawlani SS, Rawlani SM, Khubchandani KM, Thosar N. Comparative evaluation of different obturation techniques in primary molars: an in vivo study. European J Gen Dent. 2017;6(01):42-7.
[38]. Mortazavi M, Mesbahi M. Comparison of zinc oxide and eugenol, and Vitapex for root canal treatment of necrotic primary teeth. Int J Paediatr Dent. 2004;14(6):417-24. 43.
[39]. Anika SA, Nessa J, Shikder AHMZH, Joty NM, Galib MM, Islam S. A Comparative Evaluation of Obturation Techniques in Primary Molars between Incremental filling technique and Lentulo Spiral Technique.
[40]. Sijeria P, Bhartia R, Kv NS, Kulkarni S, Singla S. Evaluation of root canal filling in primary teeth by volumetric analysis: In vitro study. Int J Clin Pediatr Dent. 2018;11(5):386.
[41]. Raju SS, Reddy RE, Rani TS, Merum K, Mudusu SP, Tulluru AM. Assessment of Four Obturation Methods in Deciduous Teeth Using Digital Radiography: An In Vivo

Study. Int J Clin Pediatr Dent. 2022;15(Suppl 1):S52.

[42]. Akhil JEJ, Prashant B, Shashibushan KK. Comparative evaluation of three obturation techniques in primary incisors using digital intra-oral receptor and CBCT—an in vitro study. Clin Oral Investig. 2019;23:689-96.

[43]. Joy AS, Singh Jawa Deepti, Somani Rani, Jaidka S, Singh S, Deepa P. et al. A Comparative Evaluation of Efficacy of Different Obturation Techniques Using Cbct: An In Vitro Study. Int J Adv Res (Ijar). 2022;5(10):76-84.

[44]. Dandashi MB, Nazif MM, Zullo T, Elliott MA, Schneider LG, Czonstkowsky M. An in vitro comparison of three endodontic techniques for primary incisors. Pediatr Dent. 1993;15:253-.

[45]. Memarpour M, Shahidi S, Meshki R. Comparison of different obturation techniques for primary molars by digital radiography. Pediatr Dent. 2013;35(3):236-40.

[46]. Raju SS, Reddy RE, Rani TS, Merum K, Mudusu SP, Tulluru AM. Assessment of Four Obturation Methods in Deciduous Teeth Using Digital Radiography: An In Vivo Study. Int J Clin Pediatr Dent. 2022;15(Suppl 1):S52.

[47]. Salama FS, Anderson RW, McKnight-Hanes C, Barenie JT, Myers DR. Anatomy of primary incisor and molar root canals. Pediatr Dent. 1992;14(2):117-8.

[48]. Katge F, Wakpanjar MM. Root canal morphology of primary molars by clearing technique: An: in vitro: study. J Indian Soc Pedod Prev Dent. 2018;36(2):151-7.