Section: Research paper

Comparative evaluation of quality of obturation using Endoflas, Metapex and ZOE in primary molars

Dr. Dinesh kumar
Saveetha Dental College and hospitals,
Saveetha Institute of Medical and Technical sciences,
Saveetha University,
Chennai 600077.
Email – dineshdk7797@gmail.com

Dr. Lavanya Govindaraju
Senior Lecturer
Saveetha Dental College and hospitals,
Saveetha Institute of Medical and Technical sciences,
Saveetha University,
Chennai 600077.

ABSTRACT

AIM: The objective was to assess the Quality of Obturation in Decayed primary molars using 3 different obturating materials namely Endoflas, Zinc oxide eugenol and Metapex

MATERIALS AND METHODS: 45 infectious Deciduous mandibular posterior teeth which requires pulpectomy were separated into 3 subgroups (15 molars in each group) depending on the chosen obturation material : Group A (ZOE), Group B (Metapex), and Group C (Endoflas). Postoperative period, all the molars were examined clinically and radiographically by a different researcher who was unaware of the restorative material used on each molar. Mann-Whitney test, Wilcoxon Signed-Rank test, Kruskal-Wallis test were subjected into statistical analysis

RESULTS : During Evaluation of Obturation Standards, 78% of primary deciduous molars had the ideal filling, while the other cases had underfilling (9%) and overfilling (13%). In cases where some root resorption had occurred, the prevalence of overfilling was greater.

CONCLUSION: ZOE had the lowest success rate among the obturating materials, Metapex had the highest probability of success. Endoflas has a lesser amount of degradation of the material both inside and outside the pulpal space when assessed using Coll and Sadrian Method.

Keywords: Endoflass, Metapex, Zinc oxide eugenol and Quality of Obturation

INTRODUCTION

Estimated prevalence that can reach 46.2%, caries in the deciduous molars were common in pediatric dental patients, mostly developing countries. Countries like China, children between the ages 5 years had a frequency of carious lesions of 71.9%, and the standard (dmft) index was 4.24; both of these numbers were substantially greater than some of those from 10 years ago (66.0%, dmft = 3.5). In Deciduous molars, dental caries advance quickly and frequently impact the pulp within the same relatively short period of time (1). In the primary dentition, dental caries advance quickly and frequently impact the pulp within the same relatively short period of time. Pulp therapy's primary objective is to keep teeth and the ligaments that support them strong and healthy (2). A pulpectomy is an efficient treatment choice for primary dentition with irreversible pulpitis that can be repaired and aims to remove all of the affected, necrotic and inflamed dental pulp (3). Therefore, the purpose in the treating the root canal is to biomechanically clean the root canal, whether infected or not, and to fill the canal with a material that is suited for the root canal and resorbs at a comparable rate as the primary root, eliminating it quickly upon inadvertent extrusion through the apex. Primary molars have complicated root canal morphology, making perfect scavenging the infectious root canal system challenging. As a result, for pulpectomy to be as successful as possible, some researchers proposed using root canal filler materials having antimicrobial qualities (4). Only materials that are radiopaque, disappear very quickly with the root, don't irritate the periapical tissues, and gradually resorb if they protrude past the apex should be used for endodontic treatment of primary teeth. It should not discolor teeth and, if required, be injected rapidly into the root canal (5). According to Sweet's 1930 report, the first root canal filling material for mandibular molars was zinc oxide and eugenol (ZOE) paste.. The extruded ZOE will slowly deteriorate over time, its replacement permanent molar will follow a different path, the periapical tissue will become irritated, and bone necrosis will occur. A Silicone oil-based solution [Ca(OH)2] was developed by Hermann, which has been widely utilized in recent times.

In recognition of its antibacterial effects, therapeutic benefits, and capacity to be resorbed following apical extrusion, Ca(OH)2 were incorporated with iodoform. The mixed Ca(OH)2 mixed along with iodoform paste has a success percentage between 84% and 100%. Ca(OH)2 and iodoform paste has the major drawback. Root canal disintegration, which causes a hollow-tube effect, is a danger that is always present (6). Endoflas is a well-known bioabsorbable substance with ZOE and properties similar to those of Vitapex. Endoflas has the ability to phagocytose extruded material without causing intracanal material resorption. It has antimicrobial properties and promotes healing and periapical bone development because of its high pH. Despite having excellent rates of radiographic and clinical effectiveness, none of the obturating materials currently on the market satisfy the specifications for the optimal root canal internally generated. This is due to their shortcomings and dissimilarity to the mandibular teeth's natural root resorption. Due to its beneficial features, the current systematic review's goal was to assess Endoflas's clinical and radiographic success. Even though ZOE and Metapex are frequently used, they fall short of meeting all the criteria for the perfect obturation materials (7).

With robust bone regeneration, a 95.1% success rate, and no intraradicular washout, Ramar and Mungara describe Endoflas. According to Fuks et al., Endoflas had a 70% clinical chance of success and a 100% decrease in clinical and radiographic radiolucency. According to studies by Chawla et al., 54.8% of the bone regenerated completely, with 100% radiographic success. There is not a lot of research on the usage of Endoflas as a ZOE and Metapex-free efficient obturation material substitute. Even though ZOE and Metapex are frequently used, they fall short of meeting all the criteria for the perfect obturation materials. With robust bone regeneration, a 95.1% success rate, and no intraradicular washout, Ramar and Mungara describe Endoflas. According to Fuks et al., Endoflas had a 70% clinical chance of success and a 100% decrease in clinical and radiographic radiolucency. Our team has extensive knowledge and research experience that has translated into high quality publications (8–17)
. According to studies by Chawla et al., 54.8% of the bone regenerated completely, with 100% radiographic success (18). There is not a lot of research on the usage of Endoflas as a ZOE and Metapex-free efficient obturation material substitute. This clinical study's objective was to assess the quality of obturation in pulpectomized primary dentition and its relationship to obturation utilizing ZOE, Metapex, and Endoflas.

MATERIALS AND METHODS

The Ethical Committee of the Institute gave its approval for the current investigation, which was then designed and carried out. 35 healthy children, aged 3 to 7, clinical and radiographic diagnosis for 45 infected Deciduous molar teeth. All parents or guardians of participants provided written informed consent. Based on the preferred obturation material, 45 diseased deciduous mandibular molars were randomized and equally grouped into three groups (15 primary molars in each group). Our team has extensive knowledge and research experience that has translated into high quality publications (19–28).

- In 1st Group (15 molars): Obturated Using ZOE
- In 2nd Group (15 molars): Obturated Using Metapex
- In 3rd Group (15 molars): Obturated Using Endoflas

The following were the inclusion prerequisites:

1) Clinical characteristics include the development of a deep wound infection with pulp exposure, excessive bleeding following coronal dental pulp removal, spontaneous distress or persistent apical infections, aberrant mobility irrelevant to normal exfoliation, pain on percussion, fistula, or abscess.
2) The coronal radiological features are defined by the radiological signs of a serious chronic wound with radiological irreversible pulpitis in the crown.
3) The root and supporting structure's radiographic appearances can be divided into the following categories:

a) No clinical or radiographic pathology
b) Loss or break in the lamina dura
c) Caries that extend till Furcation were excluded.

Exclusion Criteria:

1) Grossly decayed tooth
2) Internal resorption
3) Physiologic root resorption

Evaluation of success of pulpectomy in primary molars:
After explaining risks and rewards, consent was gained to expose the required radiographs. The effectiveness of the pulpectomy depended on the molar evaluation meeting each of the following requirements:
Clinical criteria:
1) No Sinus tract, Fistula or gingival inflammation.
2) There is no purulent discharge visible at the marginal gingiva.
3) No abnormal movement besides that driven on by exfoliation, which is usual.
4) A postoperative checkup revealed no soreness.

RADIOGRAPHIC CRITERIA:
1)There should be no pathological indicators of external root resorption or continuing resorption, before the dental procedure.

2)Hardly a periapical radiolucency developed after surgery.

3)Lack of change or increased irregularity in the dura mater

4)Radiolucent area's size has not changed.

The pulpectomized teeth' prior apical root resorption and the effectiveness of their endodontic fillings were evaluated. The following are the different kinds of preoperative root resorption: No root resorption is characterized as the apparent lack of preoperative apical root resorption indications; negligible level disintegration is characterized by the presence of newly emerging root resorption of 1 mm or less at the apex; and large amounts resorption is characterized as the appearance of observable apical root resorption of >1 mm in any root or fraction of a root. Modifications to Coll and Sadrian's criteria were used to characterize the root canal filling's quality.

Obturation quality was Assessed by Coll and Sadrian Method:

Underfilling: More than 2 mm of space was left in each canal after it was filled.

Optimal filling: At least one of the canals should always contain obturating material that ends somewhere at radiographic apex or up to 2 millimeters short of the apex.

Over Filling: any root canal with obturating material extruded outside the root apex

A molar's roots and those of adjacent and or contralateral molars were also taken into consideration when making these evaluations. The two writers evaluated five pulpectomies that weren't part of the study in order to standardize their analysis procedure before grading any of the pulpectomies (29). Each author investigated the patient's medical records, along with all the prior to and after the operation radiographs and pictures, as part of the assessment. Each group's molars were examined, and the findings were contrasted. More than 90% of respondents concurred. Issues were evaluated until an agreement was reached or the lower of the two scores was assigned, when evaluations did not concur. Block random sampling was used to assign the substances zinc oxide, eugenol, Metapex and Endoflas to their individual communities. The pulpectomy and stainless steel crown were finished by a single pediatric dentist in a single visit. When the clinical and radiographic requirements were met, the treatment was deemed successful. For statistical analysis Mann-Whitney test, Kruskal-Wallis test and Wilcoxon-Signed were used. The determination of statistical significance ratings used a P value of 0.05 or less.

RESULTS :

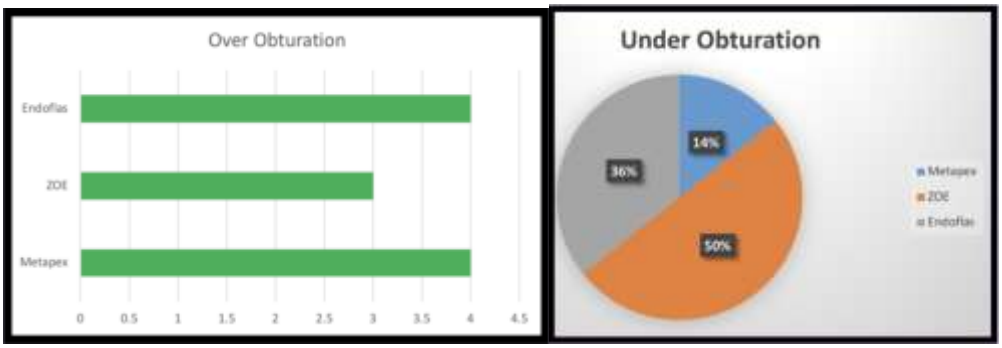
To Evaluate the quality of obturation, all of the samples were evaluated using the Coll and Sadrian method. The majority of the cases included in the study had grade 1 scores prior to surgery (Nil root resorption), with only a small proportion (Grade 2 [20%] and Grade 3 [2%]) displaying resorption indications. 78% cases had optimal filling when the integrity of the procedure was assessed, while the remaining cases had underfilling (9%), overfilling (13%) and other filling issues.. In cases where some root resorption was present, the prevalence of overfilling was greater. Canals obturated with metapex seemed to have optimal obturation when compared to the other materials when assessed using coll and sadrian criteria. Following metapex, Endo Flas Showed optimal obturation. ZOE material showed under Obturation in 50% of the canals, Followed by Endo Flas with 36% and Metapex 14% shown in Figure 1. Mann-Whitney test results revealed a statistically highly significant distinction between the groups when they were analyzed.

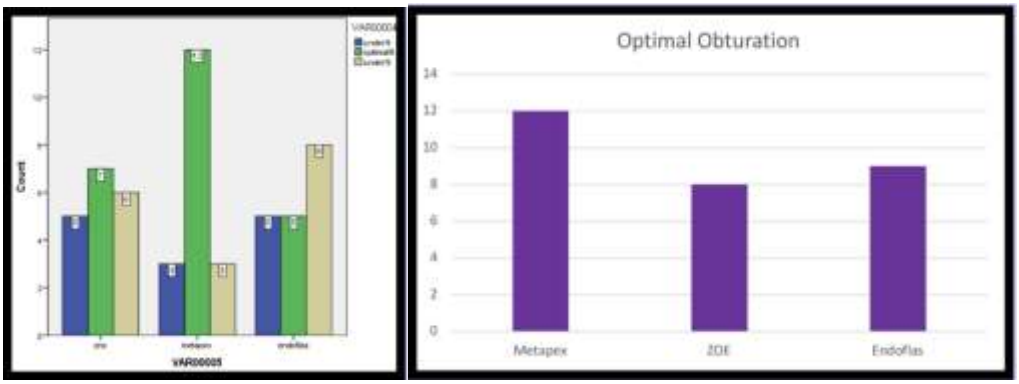
Obturation using Metapex

Obturation using EndoFlas

Obturation using ZOE

Figure 1: Quality of Obturation using different hospital material





DISCUSSION:

Due to the tortuousness of a primary molar's canals, pulpectomy has long presented a conundrum to clinicians. The best materials for root canal filling must've been biodegradable and possess durable antibacterial qualities. A primary molars root canal preparation relies more on chemical modifications than manual debridement (29,30). Since its creation by Bonastre and development in dentistry by Chisholm, zinc oxide is still one of the most commonly utilized obturating products for primary molar pulpectomies among many of these already currently available. 39 diseased primary teeth filled with ZOE were the subject of the initial single-visit pulpectomy trial. 83% of those were considered effective after 16 months (31). After 40 months, Barr et al. reported an 82% success rate for ZOE pulpectomy using a single visit formocresol method. A clinical overall performance of more than 80% after 5 years was also reported by Coll et al. Compared to primary molars with extensive (>1 mm) resorption, those with little to no preoperative root resorption had considerably greater pulpectomy success rates. According to Coll and Sadrian, the amount of root resorption was used in the present investigation to assess the infection's intensity (32). All of the unsuccessful teeth in the existing research went into the category with the most extensive root resorption, but they found that this group had the lowest success rates. This might suggest that a pulpectomy treatment has a lower chance of effectively treating a serious underlying condition. Despite possessing excellent treatment outcomes, ZOE does not entirely satisfy all requirements for the perfect root canal filling substance (33). The biggest disadvantage of ZOE is the overabundance material that is left over after filling operations and may stay in the apical region for the duration of endogenous root resorption before even being resorbed, which may take months or years (34) . Because ZOE is prone to abscess granulomatous resorption, cement pieces persisted in the clinical and radiographic region even after pulpectomized teeth were exfoliated. Following a ZOE pulpectomy, Coll and Sadrian noted anterior crossbite, palatal eruption, and aberrant eruption of the succedaneous tooth. Additionally, its antimicrobial effectiveness is restricted.

ZOE does not have the same resorbability or disinfection qualities as fast-resorbing materials (Iodoform pastes) (35). Nurko et al. also discovered that Metapex can be quickly diffused or eventually replaced by macrophages in conditions that are attached to or apical areas within as little as 1 or 2 weeks without inducing an external body reaction (36). The radiographic and clinical efficiency of pulpectomy in primary molars may be linked to Metapex's microbiological properties and its unique trait of rapid disintegration from periapical tissues (37). ZOE was overfilled by 18%. ZOE nanoparticles were partly resorbed at one tooth, but total retention was seen at eight teeth. An excellent primary dental root canal filling should really be able to dissolve at the identical amount as the root, among several other qualities (38).
The "hollow tube" appearance of well-obturated root canal system is caused by the metapex, which has been demonstrated in the current study to resorb at a significantly quicker rate than that of the root after the follow-up of 6-12 months (39). Despite having antibacterial and osteogenic differentiation properties, the success of the entire calcium hydroxide tends to disappear from the channels before the roots begin to deteriorate physiologically (40). Out of all the materials, Metapex revealed the most root canals that were optimally filled, followed by EndoFlas (41). These findings are consistent with Ramar and Mungara's observations regarding the root canals' potential to mend, the features of bone tissue regeneration, and the resorption of excessive Endoflas (42). Endoflas paste's creators assert that it is highly effective against a variety of bacteria (43). It can be utilized in canals with a little humidity because the material is hydrophilic (44). This technique is preferable to mechanical techniques for cleaning and disinfecting dentinal tubules and hard-to-reach accessory canals (45). Furthermore, the substance is resorbable since the ingredients can be taken out by phagocytosis. Fuks et al. (2002) noted that one benefit of using Endoflas paste is that resorption is only occurring in the extruded excess material (46). Inside the canal, the substance does not resorb. Because of this, although neither hollow tube impact nor the material's susceptibility to dissolution are evident.

The findings from this study fully agreed with those of previous research, suggesting that, in some circumstances, more definitive evaluations could be made at longer follow-up periods, despite this same American Academy of Pediatric Dentistry's possible contender following four components that the combined with the overarching infectious procedure of pulpectomized tooth surfaces must assist in resolving in 6 months . It's important to highlight that the sample for the study was selected using more stringent criteria. To prevent permanent tooth buds from contacting the primary molars' roots and furcations, as well as to make it easier for the scientist to examine the radiography pathology and recovery, only lower molars were used. In other studies, both the mandibular and maxillary first teeth have been utilized. This may be the cause of why our overall performance was lower than that of other trials.

However, there hasn't been any extensive research on how early Metapex resorption affected the success or the correct emergence of succedaneous teeth. For the long-term impacts to be

determined, more research is necessary. The investigation's methodology suffered from the usual limitations of a longitudinal study. Different readings may result from the evaluation of root resorption, the length of follow-up, the sequence of tooth exfoliation, and the evaluation of trauma.

CONCLUSION:

The Obturation Quality was significantly correlated with the success rate of pulpectomies. The success rate was much higher for those who filled to or just below the apex than for those who overfilled. In cases where some root resorption had occurred, the prevalence of overfilling was greater. Metapex had the greatest success rate of all the materials, followed by Endoflas. The degree of pretreatment root resorption was correlated with pulpectomy success. The rate of success of molars with extensive pretreatment root resorption was considerably lower than that of teeth with no or minimal preoperative root resorption.

REFERENCES:

1. Pandranki J, Chitturi RR, Vanga NRV, Chandrabhatla SK. A comparative assessment of different techniques for obturation with endoflas in primary molars: An Study. Indian J Dent Res. 2017 Jan-Feb;28(1):44–8.
2. Elicherla SR, Bandi S, Venkata Saikiran K, Nunna M, Sai Sahiti P, Nuvvula S. The clinical and radiographic success of Endoflas compared with other root canal obturating materials in primary teeth: A systematic review. Dent Res J . 2022 Sep 26;19:72.
3. Nagarathna C, Vishwanathan S, Krishnamurthy NH, Bhat PK. Primary Molar Pulpectomy Using Two Different Obturation Techniques: A Clinical Study. Contemp Clin Dent. 2018 Apr-Jun;9(2):231–6.
4. Pragadeesh AP, Sanguida A, Prathima GS. Obturation techniques in Primary teeth. Clever Fox Publishing; 148 p.
5. Coll JA, Dhar V, Vargas K, Chen CY, Crystal YO, AlShamali S, et al. Use of Non-Vital Pulp Therapies in Primary Teeth. Pediatr Dent. 2020 Sep 15;42(5):337–49.
6. Jeevanandan G, Ravindran V, Subramanian EM, Kumar AS. Postoperative Pain with Hand, Reciprocating, and Rotary Instrumentation Techniques after Root Canal Preparation in Primary Molars: A Randomized Clinical Trial. Int J Clin Pediatr Dent. 2020 Jan-Feb;13(1):21–6.
7. Chandrasekhar S, Prasad MG, Radhakrishna AN, Saujanya K, Raviteja NVK, Deepthi B, et al. A comparative efficacy of three spiral techniques versus incremental technique in obturating primary teeth. J Indian Soc Pedod Prev Dent. 2018 Jan-Mar;36(1):71–5.
8. Malli Sureshbabu N, Selvarasu K, V JK, Nandakumar M, Selvam D. Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases. Case Rep Dent. 2019 Jan 22;2019:7046203.
9. Ahad M, Gheena S. Awareness, attitude and knowledge about evidence based dentistry among the dental practitioner in Chennai city. J Adv Pharm Technol Res. 2016;9(11):1863.
10. PradeepKumar AR, Shemesh H, Jothilatha S, Vijayabharathi R, Jayalakshmi S, Kishen A.

Diagnosis of Vertical Root Fractures in Restored Endodontically Treated Teeth: A Time-dependent Retrospective Cohort Study. J Endod. 2016 Aug;42(8):1175–80.

11. Jangid K, Alexander AJ, Jayakumar ND, Varghese S, Ramani P. Ankyloglossia with cleft lip: A rare case report. J Indian Soc Periodontol. 2015 Nov;19(6):690–3.
12. Kumar A, Sherlin HJ, Ramani P, Natesan A, Premkumar P. Expression of CD 68, CD 45 and human leukocyte antigen-DR in central and peripheral giant cell granuloma, giant cell tumor of long bones, and tuberculous granuloma: An immunohistochemical study. Indian J Dent Res. 2015 May;26(3):295–303.
13. Manohar J, Abilasha R. A Study on the Knowledge of Causes and Prevalance of Pigmentation of Gingiva among Dental Students [Internet]. Vol. 10, Indian Journal of Public Health Research & Development. 2019. p. 95. Available from: http://dx.doi.org/10.5958/0976-5506.2019.01859.x
14. Sekar D, Mani P, Biruntha M, Sivagurunathan P, Karthigeyan M. Dissecting the functional role of microRNA 21 in osteosarcoma. Cancer Gene Ther. 2019 Jul;26(7-8):179–82.
15. Girija SA, Jayaseelan VP, Arumugam P. Prevalence of VIM- and GIM-producing Acinetobacter baumannii from patients with severe urinary tract infection. Acta Microbiol Immunol Hung. 2018 Dec 1;65(4):539–50.
16. Maheswari TNU, Venugopal A, Sureshbabu NM, Ramani P. Salivary micro RNA as a potential biomarker in oral potentially malignant disorders: A systematic review. Ci Ji Yi Xue Za Zhi. 2018 Apr;30(2):55–60.
17. Subashri A, Maheshwari TNU. Knowledge and attitude of oral hygiene practice among dental students. J Adv Pharm Technol Res. 2016;9(11):1840.
18. Navit S, Jaiswal N, Khan SA, Malhotra S, Sharma A, Mukesh, et al. Antimicrobial Efficacy of Contemporary Obturating Materials used in Primary Teeth- An In-vitro Study. J Clin Diagn Res. 2016 Sep;10(9):ZC09–12.
19. Priyadarshini P, Jeevanandan G, Govindaraju L, Subramanian EMG. Clinical evaluation of instrumentation time and quality of obturation using paediatric hand and rotary file systems with conventional hand K-files for pulpectomy in primary mandibular molars: a double-blinded randomized controlled trial. Eur Arch Paediatr Dent. 2020 Dec;21(6):693–701.
20. Jeevanandan G, Juliet S, Govindaraju L, Ravindran V, Subramanian E. Comparison between three rotary files on quality of obturation and instrumentation time in primary teeth − A double blinded randomized controlled trial. J Orofac Sci. 2020 Jan 1;12(1):30.
21. Divya S, Jeevanandan G, Sujatha S, Subramanian EMG, Ravindran V. Comparison of quality of obturation and post-operative pain using manual vs rotary files in primary teeth - A randomised clinical trial. Indian J Dent Res. 2019 Nov-Dec;30(6):904–8.
22. Jeevanandan G, Govindaraju L, Subramanian EMG, Priyadarshini P. Comparative Evaluation of Quality of Obturation and Its Effect on Postoperative Pain between Pediatric Hand and Rotary Files: A Double-blinded Randomized Controlled Trial. Int J Clin Pediatr Dent. 2021 Jan-Feb;14(1):88–96.
23. Preethy NA, Jeevanandan G, Mathew MG, Subramanian EM. Evaluation of Quality of

Obturation Using Two Different Rotary Files and Hand Files in Primary Teeth: A Randomized Controlled Trial. Int J Clin Pediatr Dent. 2021 Jul-Aug;14(4):471–4.

24. Aishuwariya T, Ramesh S. Comparison Of Quality Of Obturation Using Radiographs-A Retrospective Study. Int J Dentistry Oral Sci. 2021;8(6):2833–8.
25. Sruthi S, Jeevanandan G, Govindaraju L, Subramanian E. Assessing quality of obturation and instrumentation time using Kedo-SG blue, Kedo-SH, and reciprocating hand K-files in primary mandibular molars: A double-blinded randomized controlled trial. Dent Res J . 2021 Sep 25;18:76.
26. Jeevanandan G, Govindaraju L. Clinical comparison of Kedo-S paediatric rotary files vs manual instrumentation for root canal preparation in primary molars: a double blinded randomised clinical trial [Internet]. Vol. 19, European Archives of Paediatric Dentistry. 2018. p. 273–8. Available from: http://dx.doi.org/10.1007/s40368-018-0356-6
27. Jeevanandan G, Thomas E. Volumetric analysis of hand, reciprocating and rotary instrumentation techniques in primary molars using spiral computed tomography: An in vitro comparative study. Eur J Dent. 2018 Jan;12(1):21–6.
28. Jayachandar D, Gurunathan D, Jeevanandan G. Prevalence of early loss of primary molars among children aged 5-10 years in Chennai: A cross-sectional study. J Indian Soc Pedod Prev Dent. 2019 Apr-Jun;37(2):115–9.
29. 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 Jun;14(2):104–8.
30. Neelakantan P, Subbarao CV. An analysis of the antimicrobial activity of ten root canal sealers--a duration based in vitro evaluation. J Clin Pediatr Dent. 2008 Winter;33(2):117–22.
31. Fuks A, Peretz B. Pediatric Endodontics: Current Concepts in Pulp Therapy for Primary and Young Permanent Teeth. Springer; 2016. 164 p.
32. Camilleri J. Endodontic Materials in Clinical Practice. John Wiley & Sons; 2021. 320 p.
33. Soxman JA. Handbook of Clinical Techniques in Pediatric Dentistry. John Wiley & Sons; 2021. 400 p.
34. Asgary S, Torabzadeh H. Indirect pulp therapy in a symptomatic mature molar using calcium enriched mixture cement [Internet]. Vol. 16, Journal of Conservative Dentistry. 2013. p. 83. Available from: http://dx.doi.org/10.4103/0972-0707.105306
35. Marwah N. Pocket Book of Pedodontics. Jaypee Brothers,Medical Publishers Pvt. Limited; 2008. 352 p.
36. Waterhouse PJ, Nunn JH, Whitworth JM. Prostaglandin E2 and treatment outcome in pulp therapy of primary molars with carious exposures [Internet]. Vol. 12, International Journal of Paediatric Dentistry. 2002. p. 116–23. Available from: http://dx.doi.org/10.1046/j.1365-263x.2002.00321.x
37. Ilan Rotstein DDS, John I. Ingle DDS. Ingle's Endodontics. PMPH USA; 2019. 1326 p.
38. Kotlow L. Pulp Therapy for Primary Teeth [Internet]. Lasers in Endodontics. 2016. p. 157–

69. Available from: http://dx.doi.org/10.1007/978-3-319-19327-4_8
39. Nagarathna C, Jaya AR, Jaiganesh I. Radicular cyst followed by incomplete pulp therapy in primary molar: A case report [Internet]. Vol. 31, Journal of Indian Society of Pedodontics and Preventive Dentistry. 2013. p. 191. Available from: http://dx.doi.org/10.4103/0970-4388.117974
40. Rao A. Principles and Practice Of Pedodontics. JP Medical Ltd; 2012. 529 p.
41. Waterhouse P, Nunn JH, Whitworth J. An investigation of the relative efficacy of Buckley's Formocresol and calcium hydroxide in primary molar vital pulp therapy [Internet]. Vol. 188, British Dental Journal. 2000. p. 32–6. Available from: http://dx.doi.org/10.1038/sj.bdj.4800380a
42. Zhou X, Nanayakkara S. BUCCAL INFILTRATION WITH 4% ARTICAINE MAY BE AN ALTERNATIVE OPTION TO INFERIOR ALVEOLAR NERVE BLOCK WITH 2% LIDOCAINE FOR PULP THERAPY IN PRIMARY MANDIBULAR MOLARS. J Evid Based Dent Pract. 2022 Dec;22(4):101801.
43. Garg N, Garg A. Textbook of Endodontics. Jaypee Brothers Medical Publishers; 2018. 607 p.
44. Kalaskar RR, Badhe HK, Ninawe NS, Khade AV, Balasubramanian S, Kamki H. Comparative Evaluation of Ozonoid Olive Oil and Calcium Hydroxide as an Indirect Pulp Capping Agent in Primary Mandibular Second Molar: A Randomized Controlled Trial. J Contemp Dent Pract. 2022 Feb 1;23(2):208–14.
45. Carrotte P. An investigation of primary molar vital pulp therapy [Internet]. Vol. 188, British Dental Journal. 2000. p. 25–25. Available from: http://dx.doi.org/10.1038/sj.bdj.4800377a
46. Takiguchi M, Fujiwara T, Sobue S, Ooshima T. Radicular cyst associated with a primary molar following pulp therapy: a case report [Internet]. Vol. 11, International Journal of Paediatric Dentistry. 2001. p. 452–5. Available from: http://dx.doi.org/10.1046/j.0960-7439.2001.00312.x