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Obturation techniques used in primary molars: A systematic review

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Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

Background: This systematic review aims to explore, describe and summarize the evidence available in the literature that have evaluated various methods used to obturate primary molars.

Methods: Literature search was conducted on PubMed, and EBSCO from 2012 to May 2022 wherein randomized controlled trials, cohorts, case-controlled studies cross sectional studies and in vitro studies conducted in primary molars with various techniques of obturation were included.

Result: A total of 14 studies were included in this systematic review which included children of the age group 4–10 years and 223 extracted primary teeth were used in the included in-vitro studies.

Discussion: Among the various techniques, Lentulospiral and Navi Tip showed maximum amount of optimal obturation. However, these results are based on weak evidence due to the limited number of well-designed randomized controlled trials

Keywords: pulpectomy, obturation methods, dental caries, primary tooth.

Introduction

Dental caries is one of the most prevalent chronic conditions in children and still has serious repercussions, despite measurable progress in caries prevention. This is

particularly true in the field of paediatric dentistry when early childhood caries is considered.[1]

It has been demonstrated that untreated dental caries increases the likelihood of developing new carious lesions in both the primary and permanent dentitions and results in the early loss of teeth.[2]

One of the major objectives of Pediatric dentistry is to preserve the primary dentition's integrity and function until its physiological exfoliation takes place because primary teeth serve as the best space maintainers.[3,4]The preservation of the pulpally involved primary teeth has various other benefits, which includes aid in chewing, aesthetics, and phonetics, as well as interception of aberrant oral habits.[5,6]

Based on progression of the disease there are various pulp treatment technique available. According to American Academy of Pediatric Dentistry Guidelines teeth exhibiting signs or symptoms such as a history of spontaneous unprovoked pain, a sinus tract, soft tissue inflammation not resulting from gingivitis or periodontitis, excessive mobility not associated with trauma or exfoliation, furcation/ apical radiolucency, or radiographic evidence of internal/ external resorption have a clinical diagnosis of irreversible pulpitis or necrosis and are candidates for nonvital pulp treatment. [7]

The most widely accepted technique for treating primary teeth with irreversible pulp chamber inflammation is pulpectomy.[5]

Pulpectomy is a root canal procedure used to treat pulp tissue that has become irreversibly inflamed or necrotic as a result of caries or trauma. The root canals are first debrided and shaped with hand or rotary files and then irrigated. After the canals have dried, a resorbable material, such as non-reinforced zinc/oxide eugenol, iodoform-based paste, or an iodoform-calcium hydroxide paste, is utilised to fill them. The tooth is subsequently restored with a restorative that prevents microleakage.[7]The primary goal of pulpectomy is to eliminate microorganisms from the root canals, which is accomplished by removing vital tissues, remaining necrotic debris, and diseased dentin.[8]

The success of pulpectomy is dependent on correct case selection, biomechanical preparation, and the type of obturating material utilised, as well as the method employed to obturate the root canals.[9,10]

An optimal treatment should provide complete root canal filling without under or overfilling, and with few or no voids. [11,12]

It was observed that insufficient filling length or nonhomogeneous filling are substantially associated with an increase in the development of periapical disease during follow-up. [13]

This is because of inadequate obturation which exposes the tooth it to periapical fluids, which act as a nidus for microbe localization in such dead areas, resulting in inflammation and, eventually, endodontic failure. Furthermore, material

extrusion causes irritation of periapical tissues and necrosis of bone and cementum.[14]

The success rate of obturated primary teeth is increased when both the obturation materials and primary root are resorbed as well, to avoid any harmful effect on the

permanent successor. Also, it should be resorbed if extended beyond the apex, antibacterial, radiopaque and not change the tooth colour.[15,3]

Therefore, the obturating technique as well as obturating material, both significantly influence the success rate of the endodontic therapy.[16]

Various filling procedures has been described in the literature and studies examined the success rates of the techniques used to fill the materials in the root canals of the primary teeth. [17-26,9,10]

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Nonetheless, there is a paucity of data on in vivo evaluations of various obturating procedures for primary tooth root canals.

Thus, this systematic review aims to explore, describe and summarize the evidence available in the literature that have evaluated various methods used to obturate primary molars.

Materials and methods

Protocol and registration

The present review is reported according to the guideline described in The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Moher et al. 2009).[27]

Eligibility criteria

Inclusion criteria includes

1. Randomized controlled trials, cohort studies, case control studies, cross-sectional studies and studies including humans published between 2012 to 2022 year and in English language,
2. Appraising clinical trials and/or observational studies,
3. Articles addressing methods of obturation
4. Evaluating the quality of obturation

Exclusion criteria comprised studies that:

1. Included obturation methods in permanent dentition
2. Obturation in any primary teeth except primary molars
3. Studies that we were unable to access the full text.
4. Studies involving samples with specific health conditions (hospitalized or disabled children).
5. Laboratory-based animal studies were excluded from this review

Search strategy and information sources

The PICO outline was followed:

P (participants): Primary molars indicated for pulpectomy or extracted primary molar;

I (Intervention): Obturation techniques for primary teeth

C (comparison): All techniques quoted in literature

O (outcome): quality of obturation

Study Design: RCTS, NRCTS

A systematic search was performed through the electronic databases Medline via PubMed, EBSCO using broad MeSH terms and keywords to include publications in English from 2012 to May 2022 on, by two investigators. To ensure literature saturation, the electronic search was complemented by a search through the reference lists of included studies. Grey literatures were also searched.

The search strategy included the following terms;

Search#1

"Deciduous Tooth" OR "Deciduous" OR "dentition primary" OR "dentitions primary" OR "Primary Dentition" OR "Primary Dentitions" OR "Primary Teeth" OR "teeth deciduous" OR "Deciduous Teeth" OR "teeth primary" OR "tooth primary" OR "Milk Teeth" OR "teeth milk" OR "Baby Teeth" OR "teeth baby" OR "Baby Tooth" OR "Primary Tooth"

OR "child" OR "child" OR "children" OR "child" OR "infant" OR "infant" OR "toddlers" OR "child preschool" OR "preschool"

Search#2

"Root canal filling" OR "root canal obturation" OR "root canal obturating" OR "root canal treatment" OR "root canal therapy" OR "obturation method" OR "obturation methods" OR "obturation technique" OR "obturation techniques" OR "obturation" OR "obturating" OR "pulp therapy" OR "pulpectomy" OR "root canal shaping technique" OR "Root Canal Filling Quality"

#1 AND #2

("Deciduous Tooth" OR "Deciduous" OR "dentition primary" OR "dentitions primary" OR "Primary Dentition" OR "Primary Dentitions" OR "Primary

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Teeth" OR "teeth deciduous" OR "Deciduous Teeth" OR "teeth primary" OR "tooth primary" OR "Milk Teeth" OR "teeth milk" OR "Baby Teeth" OR "teeth baby" OR "Baby Tooth" OR "Primary Tooth" OR "child" OR "child" OR "children" OR "child" OR "infant" OR "infant" OR "toddlers" OR "child preschool" OR "preschool") AND ("root canal filling" OR "root canal obturation" OR "root canal obturating" OR "root canal treatment" OR

"Root canal therapy" OR "obturation method" OR "obturation methods" OR "obturation technique" OR "obturation techniques" OR "obturation" OR "obturating" OR "pulp therapy" OR "pulpectomy" OR "root canal shaping technique" OR "Root Canal Filling Quality")

Study selection

The results obtained through the search of the data-bases, journals and grey literature were managed systematically using spreadsheets (Excel 2007, Microsoft©, CA, USA). Identified duplicate studies were removed. Title and abstract screening of identified studies were screened by two reviewers independently. Cohen's kappa coefficient (j) was calculated to establish the level of inter-rater agreement. In case of any disagreement eligibility criteria were discussed further until a consensus was achieved. Any additional disagreement was discussed with one additional external reviewer.

Abstracts that did not give much information about the eligibility criteria were kept for full text evaluation. Two reviewers assessed the full texts against the inclusion/exclusion criteria independently, with any disagreement resolved by third reviewer

Data extraction process

Data extraction was performed using spreadsheets (Excel 2007, Microsoft©, CA, USA) by two reviewers with any disagreement resolved following discussion with one additional external reviewer.

Data items

A standardised data extraction form was used to record the following details:

1. Title of the study
2. Author's Name:
3. Year of publication
4. Institute and country of study
5. Study design
6. Ethical approval obtained
7. Informed consent obtained
8. Method of randomization used (if any)
9. Sample size
10. Distribution of sample to each obturation technique
11. Age of the included patients
12. Details of inclusion and exclusion criteria
13. Primary teeth treated with pulpectomy
14. Detailed description of pulpectomy procedure
15. Technique used for Biomechanical preparation
16. Material used for obturation
17. Obturation technique used
18. Outcomes assessed
19. Technique used for assessing outcomes
20. Assessment criteria for quality of obturation
21. Follow up

Result

Study selection: The initial searching of electronic databases yielded 737 articles; no relevant studies were identified in the grey literature. After exclusion of duplicates, 423 records were screened based on title/abstract and 24 of those had their full text retrieved for analysis. Lastly, according to the inclusion criteria, 13 studies were included in the present systematic review. A flowchart depicts the selection process of the articles (Figure 1)

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Study characteristics

Participants: A total of 513 primary teeth amongst the included in-vivo studies were treated either with syringe or non-syringe technique in children of the age group 4–10 years and 223 extracted primary teeth were used in the included in vitro studies.

Method: The characteristics of the 14 included studies in this systematic review are given in the results of the individual studies. Among the 14 included trials[19,28,44,49,54-63] all were randomized controlled trials. Out of all the included studies, 10 trials carried out biomechanical preparation using standarised hand files (H file and K file) and 3 trials used rotary instrument. The materials used for obturation were purely zinc oxide eugenol in 9 trials, purely endoflas in 3 trials, and 1 trial used ZOE with iodoform.

Intervention and control: The obturation techniques used were broadly divided into syringe and non-syringe techniques. The syringe techniques used were namely NaviTip, NaviTip double side port, disposable syringe, endodontic pressure syringe and capillary tips. The non-syringe techniques used in the included trials were rotary Lentulospiral, handheld Lentulospiral, bi-directional spiral, past inject, endodontic plugger and incremental filling technique.

Outcome assessed: The parameters assessed were both level of obturation and presence of voids in 10 trials using conventional radiographic technique, only voids were evaluated in 1 trial and Percentage of Obturated Volume were assessed in 1 trial. Both the studies used 3D radiographic technique.1 trial assessed the time taken for obturation and 1 trial for apical seal.

Discussion

This systematic review provides a synthesis of the body of evidence available in the literature, on obturation techniques used in primary molars (in vivo and in vitro). The results showed varied success rates and levels o f evidence. 14 articles relevant to this research were identified that showed varying level of evidence.

Several techniques have been used to fill the canals of primary teeth. These techniques can be broadly divided into non-syringe and syringe techniques of obturation in this systematic review. Non-syringe techniques of obturation comprised of Lentulospiral (handheld and rotary), Endodontic plugger, Past inject, and syringe techniques comprised of Disposable syringe, Pressure syringe, Capillary tips, NaviTip and NaviTip Double side port. **Among the non-syringe techniques**, the gold standard i.e., lentulospiral showed optimal obturation uniformly in most of the studies. It was followed by **endodontic plugger** which showed mixed outcomes making it difficult to decipher the superiority of one over the other. **NaviTip and endodontic pressure syrin**ge were the most frequently used ones, **among syringe-based techniques of obturation.**

Twelve articles compared Lentulospiral to other methods of obturation. **Gandhi et al** in their study compared the efficacy of Disposable syringe, lentulo spiral and past inject technique used for obturation and evaluated quality of canal obturation and presence of voids using postoperative radiographs. The highest number of voids were seen in canals filled with the lentulo spiral (20%), and disposable syringe group (8.3%). However, **Nagarathna *et al*** in their study found that there is no significant difference in presence of voids in obturation using disposable syringe system and lentulo spiral. It was observed that the highest number of overfilled and underfilled canals were observed with the disposable syringe and lentulospiral respectively. It was observed that the highest number of overfilled and underfilled canals were observed with the disposable syringe and lentulospiral respectively. Contrary to this result, study

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by **Rajasekhar *et al* (2017)** showed that the highest percentage of underfilled canals and voids was observed with Past inject (51.5%) when compared with capillary tip and disposable syringe technique.

Study carried out by **Nezam S *et al*** among children ranging between the ages of 4 years and 8 years compared and evaluated the quality of fill of lentulospirals and skini syringes with NaviTip obturation techniques. They observed that that skini syringe with NaviTip showed less number and smaller sized voids in comparison to the lentulospiral. Technique. The above finding is in accordance to the study reported by **Nagaveni *et al*** who compared 5 different obturation techniques namely Local anesthetic syringe, Tuberculin syringe, Endodontic plugger, hand held Lentulo-spiral, and Lentulo-spiral mounted on slow speed hand piece. . They observed thar canals obturated with a local anesthetic syringe showed inferior quality to that of lentulo-spiral and endodontic plugger. This result was consistent with the findings of **Jafarzadeh *et a.*** but is inconsistent with the study conducted by **Pandranki J** *et al* who compared and evaluated the level of obturation and the presence of voids using endodontic pluggers, (ii) lentulospirals, and (iii) NaviTips, respectively. The results revealed, motor-driven lentulospirals yielded best results with maximum optimal fills.

Hiremath MC *et al* compared endodontic pressure syringe, insulin syringe, jiffy tube, and local anesthetic syringe. The endodontic pressure syringe showed the best results (98.5% optimal fillings) and jiffy tube showed the poor results (37.5% optimal fillings) for the length of obturation. Similar results were obtained by **Subramaniam P *et al* (2021)** who compared two methods of obturation namely lentulo spiral and endodontic pressure syringe. The results revealed rotary preparation of canals with obturation using an **endodontic pressure syringe** resulted in fewer voids.

A study done by **Thimmegowda U *et al* (2021) *et al*** showed that overall, more optimal filling was seen in NaviTip followed by Lentulospiral and Endodontic Plugger. In a vivo study done by **Pandranki J** *et al,* reported that lentulospiral is the best filling technique in root canals for primary teeth, which is not following the results of the above study.

An in vitro study done by **T. Walia *et al*** showed that obturation done with motor-driven lentulo spiral produced fewer voids. A contrasting result was seen in a clinical by **Joseph EJ et al (2019)** and in vivo study by **Khubchandani M et al (2017)**], where maximum voids were seen with motor-driven lentulo spiral however, comparison with handheld lentulo spiral filling technique was not performed.

Joseph **EJ et al (2019)** in their study compared Navitip® Double Sideport with Lentulospiral. The results revealed that Navitip Double Sideport showed the least number of voids and maximum optimum fill.. The results of our study were similar to another study by **Khubchandani et al** where the NaviTip syringe was efficient enough in reducing voids when compared with the lentulospiral group. It was observed that all the studies assessed the quality of obturation i.e., length/extent of obturation, presence of voids and one study evaluated apical seal. First parameter i.e. the extent of obturation was assessed using various criteria's which were given by Coll and Sadrian, **Mermapur M et al., Subba Reddy and Shakunthala.and Guelmann** . Since different criteria have been used for assessing the quality of obturation, it poses a challenge to compare the techniques of obturation.

The second parameter assessed in majority of studies is presence of voids. Presence of voids was a constant

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finding and is inevitable with all the obturation techniques. The third and one of the crucial parameters i.e. apical seal was assessed in only one studies. **Khubchandani et al**. determined the apical seal to be adequate or inadequate based on the calculation on radiograph using a grid. They did not observe significant difference in apical seal between NaviTip and Lentulospiral group. Also we know that pediatric patients have a short attention span so prolonged dental procedures tend to make the child impatient and hence disrupt their cooperation. This was assessed in one study conducted by Rajasekhar et al wherein he had compared three techniques: Past Inject, Disposable needle and Capillary tips. The observations showed significantly lesser time taken for syringe techniques of obturation (Capillary tips followed by disposable needle).

Obturation quality of in vivo or in vitro techniques has beeen evaluated using conventional radiographs, digital radiography like radio-visiography (R.V.G) ,cone beam computed tomography (C.B.C.T) method, sct or micro computed tomography.

Cone-beam computed tomography used by **Nezam S *et al* (2021)** had 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. Spiral computed tomography used by **Nagaveni NB et al (2017)** is associated with advantages like avoids the loss of material, gives reproducible results, and moreover, the specimen can be used for further research.

Conclusion

This systematic review tried to evaluate the obturation quality of various obturation techniques. Among non-syringe approaches, lentulospiral demonstrated optimal obturation in the majority of investigations, while NaviTip demonstrated promising outcomes among syringe techniques of obturation. Overall, syringe approaches provide good obturation quality with fewer voids in less time, but there is a substantial risk of obturation overextension. However, due to the small number of RCTs, these results were based on insufficient data. Other factors like as apical seal and time taken for obturation were measured in only one trial, preventing us from drawing any conclusions about these parameters.

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Legends figures and tables

Fig. 1: PRISMA flow diagram

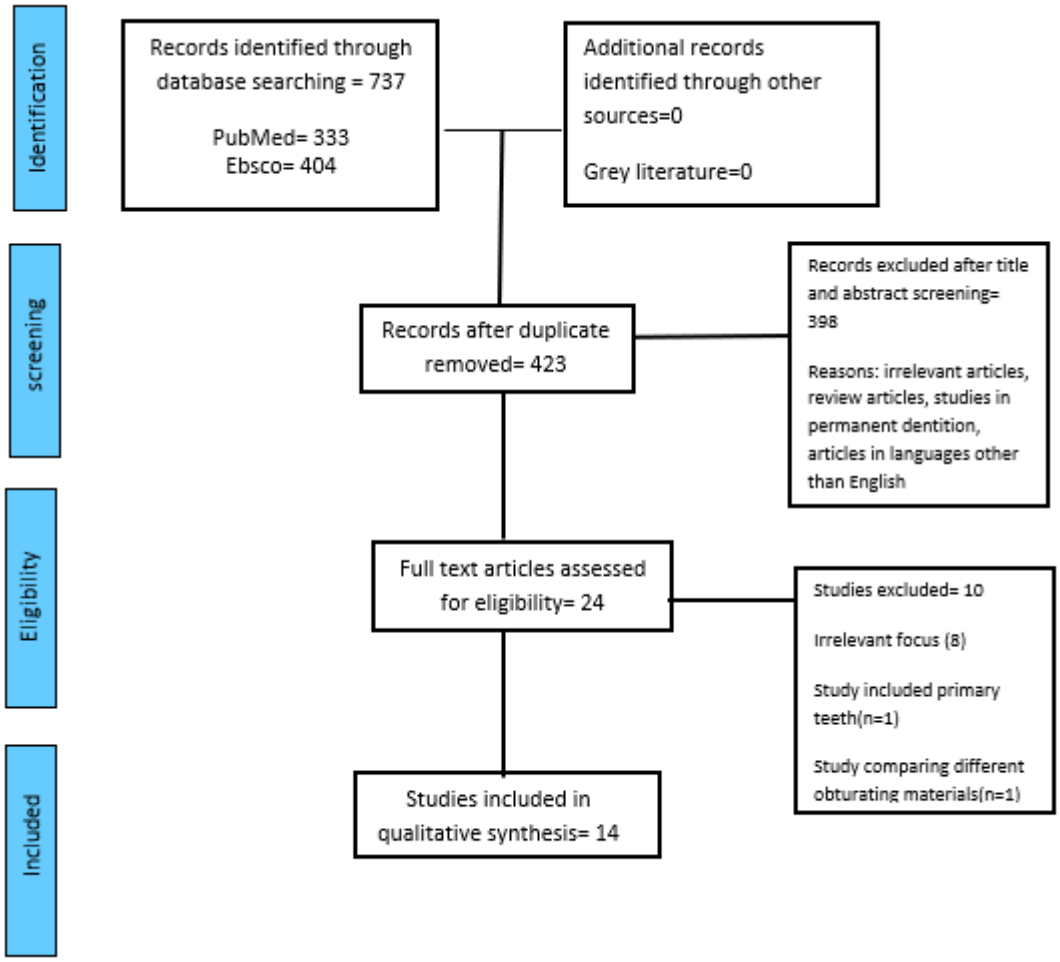

Table 1:

Sn.	Author and year of publication	Study design	Age	N	Method used	Criteria employed to measure the quality of obturation.	Success rate	Result
1	Hiremath MC *et al* (2016)	In vitro	Extracted molars	48	• Endodontic pressure syringe, • Insulin syringe, • Jiffy tube, • Local anaesthetic syringe	Coll and Sadrian	• Endodontic pressure syringe- 95.8% • Jiffy tube- 37.5% • Insulin syringe- 79.2% • Local anaesthetic syringe- 66.7%	Endodontic pressure syringe produced the best result
2	Gandhi M *et al* (2017)[54]	RCT	4-9 yrs.	60	• Disposable syringe, • Lentulo spiral and past inject	Graded based on criteria given by Memarpur M et al. criteria	• Disposable syringe- 8.3% • Lentulo spiral - 5.0% • Past inject- 18.3%	The results suggest that the most successful technique for obturation of primary teeth was past inject.
3.	Khubchandani M et al (2017)[55]	In vivo study	4–8 yrrs	30	• Lentulospir • NaviTip System	modification of the grading criteria employed by Subba Reddy and Shakunthala.	• Lentulospiral 40% • NaviTip System 26%	Lentulospiral produced the best results in terms of length of obturation, while NaviTip syringe was efficient enough in controlling voids and produced

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								the best results for apical seal.
4.	Nagaveni NB et al (2017)[19]	In vitro study	Extracted molars	50 canals	• Local anesthetic syringe • Tuberculin syringe • Endodontic plugger • handheld Lentulo-spiral • Lentulo-spiral mounted on slow speed hand piece.	Post obturation volumes were obtained using SCT scan	• Local anaesthetic syringe 61.60± 4.49% • Tuberculin syringe 74.60 ±5.03% • Endodontic plugger 70.54±5.40% • Lentulo spiral handheld 90.70± 2.37% • Lentulo spiral-mounted to hand piece 89.21± 3.28%	Lentulo-spiral handheld is the best obturating technique among the 5 groups
5.	Walia t et al (2017)[56]	In vitro	Extracted molar	45	• Premixed syringes • Handheld Lentulospiral • Rotary lentulospiral	-	• Handheld lentulospiral - 46.2% • Rotary lentulospiral - 46.2 • Premixed syringe - 7.7%	lentulo spiral technique, both handheld and rotary, showed a better quality of filling
6.	Pandranki J *et al* (2017)[57]	In vivo study	4-9 yrs.	45	• Plugger • Lentulo spiral mounted in slow speed handpiece • NaviTip	Graded based on Guelmann *et al*. criteria	• Plugger-62.2% • Lentulo spiral mounted in slow speed handpiece-64.4% • NaviTip-48.9%	Motor-driven Lentulospiral and pluggers were almost equally efficient to fill Endoflas
7	Nagarathna C *et al* (2018)[58]	A Clinical Study	4-8 yrs.	60	• Handheld Lentulospiral • Modified disposable syringe	Coll and Sadrian	• Handheld lentulo spiral -18% • Modified disposable syringe-20%	Both the hand-held Lentulospiral and modified disposable syringe technique are effective
8	Jafarzadeh M *et al* (2019)[59]	In vitro	Extracted molars	No of teeth-80 No. of canals-221	• Lentulo spiral • Endodontic plugger • Anaesthetic syringe • Tuberculin syringe technique	-	• Lentulo spiral-55.2% • Endodontic plugger-57.1% • Anaesthetic syringe-51.9%, • Tuberculin syringe -39.6%	No significant difference among the root canal obturation techniques
9.	Rajasekhar S *et al* (2019)[44]	RCT	4-8 yrs.	34 teeth with 103 canals	• Past inject™, • Disposable needle • Capillary tips	Coll and Sadrian.	• Past inject™-48.5% • Disposable needle-41.2% • Capillary tips-63.9%	Capillary tip technique proved to be the most effective
10.	Joseph EJ et al	RCT	Not	36	• Rotary	Coll and Sadrian	• Rotary Lentulospiral-20%	Navitip® Double Sideport

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	(2019)[28]		ment ione d		Lentulospiral • NaviTip® • NaviTip® Double Side-port	criteria	• NaviTip® -18% • NaviTip® Double Side-port-20%	showed the better results in terms of extent of obturation and absence of voids
11	Nezam S *et al* (2021)[60]	RCT	4-8 yrs.	40	• Lentulospiral • NaviTip System	Cone-beam Computed Tomography	• Lentulospiral-60% • NaviTip System-26%	Voids were minimum when skini syringe with NaviTip was used.
12	Subramaniam P *et al* (2021)[61]	In vivo study	5-9 yrs.	100	• Endodontic pressure syringe • Lentulo spiral	Graded based on criteria given by Memarpur M et al. criteria	• In mandibular molars, Endodontic pressure syringe-80–90% • Lentulo spiral-58–71%. • In maxillary molars • Endodontic pressure syringe-92–100% • Lentulo spiral-83–89%	Rotary preparation of root canals followed by endodontic pressure syringe proved more effective.
13.	Thimmegowda U *et al* (2021)[62]	RCT	4-10 yrs.	60	• Lentulospiral • Endodontic Plugger • NaviTip	Coll and Sadrian criteria	• NaviTip-90% • Lentulospiral-65% • Endodontic Plugger -40%	The NaviTip, followed by the Lentulospiral, provided the best obturation of the root canals of primary molars
14.	Hanaa Mahmoud Shalan (2022)[63]	RCT	4-7 yrs.	120	• Pressure syringe (Map System), • Endodontic plugger • rotary lentulo Spiral		• rotary lentulo 38.74% • pressure syringe29.73% • endodontic plugger31.53%	Good results were observed with Lentulospiral technique in terms of quality of obturation (optimum filling) followed by endodontic plugger technique.

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