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LITERATURE REVIEW

Effectiveness ZnOE, Ca(OH)2 and Iodoform as Root Canal Filling Materials for Pulpectomy in Primary Teeth

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ABSTRACT

Background: *Dental caries is a disease that affects almost half of the world's population. A pulpectomy is an endodontic treatment by removing the entire pulp and filling the root canals of primary teeth using an appropriate root canal filling material. Root canal filling material becomes an indicator of the effectiveness of pulpectomy in primary teeth. Operators must comprehend various types of root canal filling materials available in primary dental pulpectomy treatments.* ***Objective:*** *This scoping review aims to obtain data on the effectiveness of ZnOE, Ca(OH)2, and Iodoform paste as root canal filling materials in pulpectomy treatment of primary teeth.* ***Methods:*** *This research was a scoping review. By using the PRISMA-ScR study, electronic database searches were conducted on PubMed, EBSCOhost, and Google Scholar.* ***Results:*** *A total of 89 articles were identified through a search on PubMed, 137 articles through EBSCOhost, 442 articles through GoogleScholar, and 48 articles through a search using Handsearching. The total number of articles identified through all the databases results in 716 articles. Using the PRISMA-ScR flow diagram to do the selection process, it results in seven articles that are eligible for review.* ***Conclusion****: As root canal filling materials in pulpectomy treatment for primary teeth, ZnOE, Ca(OH)2, and Iodoform paste were considered effective. The scoping review results in this study showed that Ca(OH)2 + Iodoform Paste (Metapex®) were better than ZnOE.*

Keywords*: Iodoform, Root Canal Filling Material, ZnOE, Ca(OH)2*

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Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
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INTRODUCTION

According to the 2016 Global Burden of Disease Study, dental and oral problems, particularly dental caries, affect about half of the world's population (3.58 billion people). The prevalence of cavities in early childhood is extremely high, it has reached 93%. It is implying that just seven percent of the children do not have dental caries. The Dental and Oral Health Committee formulated a program for Promotive and Preventive Strengthening via Implementation of the National Caries Free Action Plan 2030. [1] In Indonesia, dental caries is the most prevalent dental and oral condition among children. Caries in primary teeth rapidly expand and expose the pulp. The exposed pulp serves as an access site for microorganisms that can induce inflammation, if this condition persists, the pulp becomes non-vital.[2] The treatment of primary teeth is crucial for maintaining the space until the time of permanent teeth eruption.[3] The treatment of primary teeth with non-vital pulp has become a serious issue for pediatric dentists, with pulpectomy being the most common therapy.

A pulpectomy is an endodontic procedure that involves removing all pulp tissue and filling the root canals of primary teeth with a root canal filling material. A pulpectomy is performed to ease pain, maintain exposed pulp tissue, keep primary teeth in place until permanent teeth are ready to erupt, and improve aesthetics.[4,5] The selection of the proper root canal filling material is one determinant of endodontic treatment success.

The optimal root canal filler material for pulpectomy must possess multiple qualities. These qualities, which include antibacterial properties, can be absorbed at the same level as root resorption, are harmless to the permanent tooth germ, not irritate the periapical tissue, and are simple to use. The quality of the root canal filling material will result in favorable treatment outcomes. [6] According to Bahrololoomi et al, there has never been a filler material with optimal qualities.[7] Srinitya et al[4] also claim that no material can be regarded as an optimal root canal filling material. So far, no scoping reviews have been done to look at how well these three-root canal filling materials work. [4]

As root canal filling material is one of the indicators for the effectiveness of pulpectomy in primary teeth, dentists and dental students must be aware of the various root canal filling materials currently used in pulpectomy treatment of primary teeth. Clinicians can select a root canal filling material based on the patient's needs and clinical condition. In this study, Zinc Oxide Eugenol (ZnOE), Calcium Hydroxide (Ca(OH)2), and Iodoform Paste will be examined as root canal filling materials.

ZnOE is one of the most broadly adopted root canal filling materials for primary teeth. Bonastre (1837) discovered ZnOE, which Chisholm applied in dentistry (1876).[12] ZnOE is the first root canal filling material recommended for primary teeth. [4] Calcium hydroxide (Ca(OH)2) has been utilized in dentistry for a very long time, particularly for endodontic treatment. Used in various formulations as a liner beneath restorations and as a pulp capping agent in different pathological conditions. [8]

Iodoform is a halogen compound containing bactericidal, fungicidal, viral, and sporicidal characteristics, as well as rapid tissue penetration and minimal tissue toxicity.[9] iodoform is an iodine-type halogen compound. As a mixing agent for iodoform, iodine enhances the antibacterial impact and radiopacity because it shares the same qualities as barium sulfate. These compounds can diffuse across dentin and cementum and aid in tissue repair by activating an immune response.[10] Combining Ca(OH)2 with Iodoform Paste and adding another oily additive (Vitapex®) demonstrates that the substance is bactericidal and more readily absorbed in the periradicular area. Research has revealed that combining Ca (OH)2 + Iodoform was the best filling material to be used for pulpectomy in primary teeth nearing exfoliation.[11] The addition of Iodoform paste to Ca(OH)2 serves to increase the radiopacity.[12,9] The purpose of this scoping review is to provide

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
DOI: 10.30649/denta.v17i2.3

information regarding the effectiveness of ZnOE, Ca(OH)2, and Iodoform paste as root canal filling materials in pulpectomy treatment for primary teeth.

METHODS

A scoping review approach was used to review articles from PubMed, EBSCOhost, and Google Scholar that met the following criteria:

1. Articles that discuss root canal filler materials used in pulpectomy therapy for primary teeth.
2. Articles that elaborate on the usefulness of root canal filling materials in the treatment of pulpectomy of primary teeth.
3. Articles published in the last ten years.
4. Accessible full-text articles.
5. Articles in English and Indonesian.

This scoping review began with a literature search strategy, followed by the determination of inclusion and exclusion criteria, proceeded by screening, and choosing studies using PRISMA-ScR, and lastly, data extraction. The electronic databases PubMed, EBSCOhost, and Google Scholar were searched. The search strategy was conducted based on each database used to identify relevant articles using the AND and OR Boolean operators as well as the limit function of each database if it was available. [13] Multiple keywords were combined in an online search engine to conduct article searches (Table 1).

The flow of the study selection was shown in Figure 1. The study search was carried out by following the PRISMA-ScR flowchart (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Review).[15] The first phase entails screening articles based on their titles. The abstract screening will be the next step. Articles that are relevant to the abstract will be included.

The full-text version of the article would choose. For a full-text feasibility aspect screening, full-text articles that can be accessible would be sought and read in- depth. Data extraction and analysis will be performed on articles that meet all the selection criteria. [16]

A search on PubMed revealed 89 articles, a search on EBSCOhost yielded 137 articles, and a search on Google Scholar got 442 articles. There were duplication checks performed, resulting in the collection of 618 items. The first screening was done by reading the title and abstract. 604 papers were selected because they were irrelevant and did not match the inclusion requirements; 14 articles were then retrieved for additional screening. The second screening involved reading the full text for its content. Seven articles were chosen for screening, and seven articles were subsequently obtained for review.

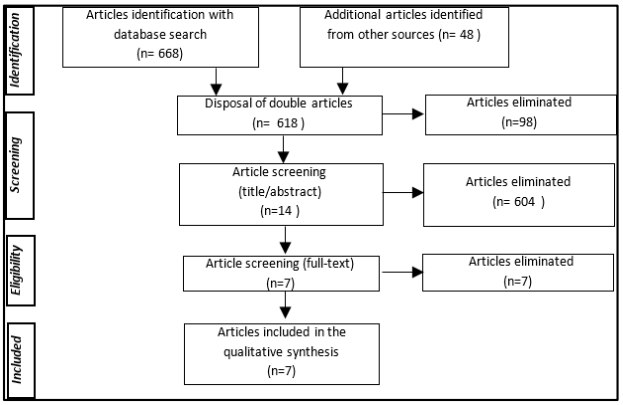

Figure 1. Flowchart of PRISMA-ScR Study Selection

RESULTS

The researcher filtered articles retrieved by collecting articles from database searches, such as PubMed, EBSCOhost, and Google Scholar, to obtain seven articles for further review. Three articles[22,25,26] revealed that ZnOE was effective. Then, four articles revealed [319,20,23,24] that Ca(OH)2 and Iodoform paste were effective. Two research articles[19,20] were based on a six-month observation period. Observations were conducted for 18 months in the study by Babashi et al[24], and for 12 months by Daniele et al[25]. Numerous obturation procedures were utilized in In Vitro-based research articles.Pasdar, et al[21] employed spiral lentulo. Orhan et a[23] combined spiral lentulo and ultrasonic stimulation in their work.

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
DOI: 10.30649/denta.v17i2.3

The results of the study search and selection resulted in a total of seven studies that matched the inclusion criteria, with the features of the articles from the selected studies shown in Table 2 and a summary of the studies covered in Table 3.

Table 1. Study Search Strategy

Electronic search engine	Search Strategy	Number of search results articles
PubMed	*((Zinc Oxide Eugenol OR Calcium Hydroxide OR Iodoform Pastes)) AND (Pulpectomy OR Pulp Treatment OR Obturation OR Caries OR Root Canal)) AND ((Primary Teeth)) Filters: Free Full text, From 2011-2021*	89
EBSCOhost	*((Zinc Oxide Eugenol OR Calcium Hydroxide OR Iodoform Pastes)) AND (Pulpectomy OR Pulp Treatment OR Obturation OR Caries OR Root Canal)) AND ((Primary Teeth)) Filters : Free Full text, From 2011-2021*	137
Google Scholar	*Zinc Oxide Eugenol, Calcium Hydroxide, Iodoform Pastes as Root Canal Filling Material in Pulpectomy Treatment of Primary Teeth. Filters: Free Full text, from 2011-2021.*	442

Table 2. Characteristics of Articles

Author's Name, Publication Year	Journal Name	Article Title	Research Site	Research Design
Rahaswanti[18] (2016)	Directory of Open Access Journals	Evaluasi Keberhasilan Pengisian Saluran Akar dengan Sediaan ZnOE dan campuran $Ca(OH)_2$ dengan Pasta Iodoform	Indonesia	Before-after two group design
Kalaskar, et al[19] (2021)	Annals of R.S.C.B	*Comparative Evaluation of Effectiveness of Pre- Mixed Syringe and Incremental Technique as a Root Canal Obturating Technique in Primary Mandibular Second Molar– A Randomized Clinical Trial*	India	Comparative study
Pasdar, et al [21] (2017)	Dental Research Journal	*Push-out bond strength of different intracanal posts in the anterior primary teeth according to root canal filling materials.*	Iran	In Vitro
Orhan dan Tatli [23] (2021)	BioMed Reseacrh International	*Evaluation of Root Canal Obturation Quality in Deciduous Molars with Different Obturation Materials: An In Vitro Micro- Computed Tomography Study*	Turki	In Vitro
Babashahi et al[24] (2019)	Frontiers in Dentistry	*Volumetric Assessment of Root Canal Obturation Using 3% Nano-Chitosan versus Zinc Oxide Eugenol (ZOE) and Iodoform- Calcium Hydroxide (Metapex), in Primary Root Canals Shaped with Rotary versus Manual Methods: A Preliminary In- Vitro Spiral CT Study*	Iran	In Vitro

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
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Daniele Vieira et al [25] (2019)	Brazilian Oral Research	*Iodoform Vs Calcium Hydroxide/ Zinc Oxide based pastes: 12 month Findings of a Randomized Controlled Trial*	Brazil	Clinical study
Ou-Yang, et al[26] (2021)	The Journal of Clinical Pediatric Dentistry	*Treatment Outcomes of Pulpectomy in Primary Maxillary Incisors Filled with ZOE and Metapex: A Two-year Retrospective Study*	Taiwan	Retrospect ive study

Table 3. A Summary of Studies Examining the Efficacy of ZnOE, Ca(OH)2, and Iodoform Paste as Root Canal Filling Materials for Pulpectomy of Primary Teeth.

Author's Name, Publication Year	Author's Location	Sample Quantity and Type	Materials	Research Method	Assessment Criteria (Calibration)	Analysis Test	Findings
Rahaswanti[18] (2016)	Indonesia	16 primary molars	ZnOE and $Ca(OH)_2$ + pasta iodoform (Metapex®)	3 months observation	Kriteria Nurko C, Gracia-Godoy F. (1999) clinical and radiographic examination	Dianalisis dengan Uji Fisher's Exact	$Ca(OH)_2$ + Iodoform paste (Metapex®) and ZnOE offered promising potential as root canal filling materials for diagnosing pulp necrosis in primary molars.
Kalaskar, et al[19] (2021)	India	60 primary molars	$Ca(OH)_2$ + pasta iodoform (Vitapex®) and ZnOE	Observation for 6 months with clinical and radiographi c examinatio n	Kriteria (Coll & Sadrian, 1996) performed by one operator on all tooth samples with a calibration score of 1 for under filling, 2 for optimal filling and 3 for overfilling	Examined by Fisher's Exact Test	$Ca(OH)_2$ + iodoform paste (Vitapex®) showed better obturation quality of primary teeth than ZnOE.
Pasdar, et al[21] (2017)	Iran	60 primary incisors	ZnOE and $Ca(OH)_2$ + pasta iodoform (Metapex®)	In Vitro	The assessments criteria were determined independently. This was accomplished by examining the push-out binding strength of root canal fillings.	Two-Way Anova Test	ZnOE significantly reduced intracanal post strength compared to $Ca(OH)_2$ + iodoform paste (Metapex®) in root canal filling of primary molars
Orhan dan Tatli[23] (2021)	Turki	30 primary molars	$Ca(OH)_2$, $Ca(OH)_2$ + pasta iodoform (Metapex®) and ZnOE	In Vitro	Feldcamp et al's criteria (1989) with calibration of Micro Computed Tomography image analysis.	Mann Whitney Test dan Kruskal Test	$Ca(OH)_2$ + Iodoform (Metapex®) improved obturation quality in primary molar fillings compared to ZnOE.

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
DOI: 10.30649/denta.v17i2.3

Babashahi et al[24] (2019)	Iran	152 root canals of primary molars	ZnOE, $Ca(OH)_2$ + pasta iodoform (Metapex®) and nano-chitosan	In Vitro	Self-made criteria with calibration of Micro Computed Tomography image analysis.	Descriptive statistics with ANOVA. test	$Ca(OH)_2$ + iodoform paste (Metapex®) was preferable to ZnOE material for filling the root canal of primary molars.
Daniele Vieira et al [25] (2019)	Turki	27 primary molars	Iodoform pasta, Calen®/ Zinc Oxide and $Ca(OH)_2$	Observation for twelve-month with clinical and radiographi c	Kriteria were judged by Barcelos et al (2012). Clinical success was deemed the absence of signs or symptoms of infection, such as pain, swelling, fistula, or sensitivity to percussion	Descriptive analyses	Iodoform pasta atau Calen®/ZO outcomes indicated successful treatment, although the frequency of ideal level of the root canal filling was higher in Calen®/ZO group.
Ou-Yang, et Al [26] (2021)	Taiwan	309 primary molars	ZnOE and $Ca(OH)_2$ + pasta iodoform (Metapex®)	Observation for 12 and 24 months	Criteria of Smail-Faugeron, et al (2013) with clinical and radiographic	Multivariate analysis using multiple logistic regression.	ZnOE is preferable to use than $Ca(OH)_2$+ iodoform paste (Metapex®).

Seven articles evaluated utilized ZnOE, Ca(OH)2, and Iodoform paste. There were additional materials, nano-chitosan, and endoflas, in one study.[24] Rahsawanti[19] with a research article entitled "Evaluation of the Success of Root Canal Filling with ZnOE and Ca(OH)2 Mixture with Iodoform Paste" locatedin Indonesia using a before-after two- group design study and observation for 3 months and a total sample of 16 primary molars. The results showed that Ca(OH)2 + Iodoform Paste (Metapex®) and ZnOE had good potential as root canal filling materials for primary molars for diagnosis of pulp necrosis. Kalaskar presented similar results[20] in India, with the research title Comparative Evaluation of Effectiveness of Pre-Mixed Syringe and Incremental Technique as a Root Canal Obturating Technique in Primary Mandibular Second Molar – A Randomized Clinical Trial with a total sample of 60 primary molars and a comparative study design observation for 6 months of clinical and radiographic trials stated that Ca(OH)2 + iodoform paste (Vitapex®) showed better obturation quality of primary teeth compared to ZnOE.

Pasdar's[21] in Iran, Orhan and Tatli[23] in Turki, and Babashahi[24] in Iran, all of them employed in vitro research methods. Pasdar[21] with the research title "Push-out bond strength of different intracanal posts in the anterior primary teeth according to root canal filling materials" using a sample of 60 primary incisors showed that ZnOE significantly reduced intracanal post strength compared to Ca(OH)2 + iodoform paste (Metapex®) in root canal filling of primary molars.

The research by Orhan and Tatli[23] entitled Evaluation of Root Canal Obturation Quality in Deciduous Molars with Different Obturation Materials: An In Vitro Micro-Computed Tomography Study with the samples of 30 primary molars found that Ca(OH)2 + Iodoform (Metapex®) improved the obturation quality of filling primary molars compared to ZnOE. Babashahi's study[24] entitled Volumetric Assessment of Root Canal Obturation Using 3% Nano-Chitosan versus Zinc Oxide Eugenol (ZOE) and Iodoform- Calcium Hydroxide

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
DOI: 10.30649/denta.v17i2.3

(Metapex), in Primary Root Canals Shaped with Rotary versus Manual Methods: A Preliminary In- Vitro Spiral CT Study and a sample of 152 root canals of primary molars showed that Ca(OH)2 + iodoform paste (Metapex®) was preferable in filling the root canals of primary molars than ZnOE material.

Research by Daniele Vieira[25] in Turki entitled Iodoform Vs Calcium Hydroxide/ Zinc Oxide based pastes: 12 month Findings of a Randomized Controlled Trial Study with a sample of 27 primary molars using Observation for twelve-month with clinical and radiographic found that Iodoform pasta atau Calen®/ZO outcomes indicated successful treatment, although the frequency of ideal level of the root canal filling was higher in Calen®/ZO group.

Research by Ou-Yang[26] in Taiwan entitled Treatment Outcomes of Pulpectomy in Primary Maxillary Incisors Filled with ZOE and Metapex: A Two-year Retrospective Study and a sample of 309 primary molars with a retrospective study of 12 and 24 months observation resulted that ZnOE was better used than Ca(OH)2 +iodoform paste (Metapex®).

DISCUSSION

The findings of the seven articles reviewed discovered four articles[19,20,23,24] indicating Ca(OH)2 + Iodoform Paste (Metapex®) was more effective as a root canal filling agent for primary molars compared to ZnOE. The four studies employed Ca(OH)2 + Paste Iodoform (Metapex®) with the same composition: a mixture of Ca(OH)2 , iodoform, and silicone oil,as well as ZnOE with the same composition: a mixture of zinc oxide powder, rosin, zinc acetate, and liquid eugenol. The hydrophobic and lipophilic nature of ZnOE made it easy for it to enter the bacterial cell membrane by increasing the permeability of the bacterial cell membrane, causing the bacterial cell membrane to become damaged, allowing macromolecules and bacterial ions to easily leave the cell, causing the bacterial cell to be damaged and die. Impaired cell membrane permeability inhibited bacterial protein synthesis, resulting in a change in protein structure and the protein's inability to function. Protein denaturation occurred when proteins failed to function, followed by protein coagulation, which disrupted bacterial metabolism and caused bacteria to die.[28-29] Ca(OH)2 stimulated the production of hard tissue by releasing Ca+ ions, whereas the antibacterial action was produced by releasing OH- ions, resulting in an elevation in pH, which caused bacterial cell wall destruction.[31] Iodoform is an iodine-type halogen compound. Because it has the same qualities as barium sulfate, iodine as an iodoform mixing agent increases the antibacterial impact and increases radiopacity. These chemicals can penetrate across dentin and cementum and aid in tissue regeneration by activating an immune response.[10]

Ca(OH)2 + Iodoform Paste (Metapex®) and ZnOE were excellent root canal filling agents because promoted faster healing.[17] $Ca(OH)_2$ + Paste Iodoform (Metapex®) was superior in the healing process, binding strength to root canals, absorbed faster, and filled root canals better than ZnOE. [20,23,24] It can be concluded that Ca(OH)2 + Iodoform Paste (Metapex®) is considered to have more ideal material criteria compared to ZnOE despite disadvantages such as a relatively high material cost. Ca(OH)2 + Iodoform Paste (Vitapex®) to ZnOE in an experiment. Post-pulpectomy teeth were used with Ca(OH)2 + Iodoform Paste (Vitapex®) filled with a syringe, while ZnOE used incremental, which showed that the overall results of the comparison of the two substances with this technique showed a significant difference in obturation quality. When compared to ZnOE, the application of Ca(OH)2 + Iodoform Paste (Vitapex®) with a syringe resulted in improved root canal filling, cavity closure, clinical and radiographic results.[20] ZnOE has the disadvantage of using the incremental technique, which is difficult to apply to narrow root canals. There has been no research done using Ca(OH)2 + Iodoform Paste (Vitapex®) as an obturation strategy that analyzes obturation time using the syringe approach.[22] However, the

Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/21
DOI: 10.30649/denta.v17i2.3

advantage of the syringe technique is that the disposable needle tip can avoid contamination of the substance, and the thin and flexible needle tip allows the obturating material to flow freely into the root canal and push the obturating material into the canal.[22]

Different from the four studies[19,20,23,25], which all concluded that Ca(OH)2 + Paste Iodoform (Metapex®) was more effective than ZnOE. According to research conducted by Ou-Yang et al[26], ZnOE was a more effective root canal filling material for primary molars than Ca(OH)2 + Iodoform paste (Metapex®). ZnOE substance had a greater success rate than $Ca(OH)_2$ + Iodoform Paste (Metapex®) in controlled clinical trials at 12 and 24 months, while Ca(OH)2 + Iodoform Paste (Metapex®) exhibited clinical signs such as pain and soft tissue pathosis at 24 months.[26]

Based on the findings of the seven articles discussed above, it is possible to infer that Ca(OH)2 + Iodoform Paste (Metapex®) and ZnOE were suitable root canal filling material for primary molars. The scoping review results in this study showed that Ca(OH)2 + Iodoform Paste (Metapex®) were better than ZnOE. This was because Ca(OH)2 + Iodoform has advantages including faster healing,[19] more effective antibacterial, faster absorption ability, [23] and was effective in filling the volume of the dental canal as well as high sealing potential which contributes to clinical success.[24] These findings was consistent with the findings that Iodoform + Ca(OH)2 filling materials showed better clinical and radiographic performance when compared to non-iodoform-based filling materials in the short term, and similar performance in the long term.[27]

This scoping review has a limitation in that the variability of results may be attributable to the assessment and method of pulpectomy in primary root canals using different criteria. Variations were seen in the number of samples, type of molars, and treatment control duration. The inclusion and exclusion criteria of each study can also contribute to the variation in outcomes. In fact, this study did not assess the quality of the articles, allowing for a substantial amount of bias in the selection of the publications that were examined.

CONCLUSION

As root canal filling materials in pulpectomy treatment for primary teeth, ZnOE, Ca(OH)2, and Iodoform paste were considered effective. The scoping review results in this study showed that Ca(OH)2 + Iodoform Paste (Metapex®) were better than ZnOE.

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Denta Jurnal Kedokteran Gigi, Agustus 2023; Vol.17 No.2; Hal 57-66
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