

Clinical and Radiographic Outcomes of Calcium Hydroxide vs Other Agents in Indirect Pulp Capping of Primary Teeth: A Systematic Review

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ABSTRACT

Aim: To extract and systematically identify the existing literature on the "Clinical and radiographic outcome of calcium hydroxide vs other agents in indirect pulp capping of primary teeth".

Objective: To compare the clinical and radiographic outcome of calcium hydroxide and other agents in indirect pulp capping of primary teeth.

Search strategy: The following databases were searched: PubMed Central, Cochrane Database of Systematic Reviews, Lilacs, Science Direct, Sigle. Bibliographies of clinical studies identified in the electronic search were analyzed for studies published outside the electronically searched journals.

Selection criteria: Studies comparing the clinical and radiographic success rate of one or more indirect pulp capping agents with calcium hydroxide in primary molars were included.

Results: The initial search revealed 243 of which only 9 met the inclusion criteria and 234 were excluded based on the exclusion criteria. All the 9 included studies analysed the clinical and radiographic outcome of calcium hydroxide in comparison with other agents in indirect pulp capping of primary teeth.

Conclusion: There is a very limited good quality studies estimating the clinical and radiographic outcome of calcium hydroxide in comparison with other agents in indirect pulp capping of primary teeth. The review identified the need for more studies on the clinical and radiographic outcome of calcium hydroxide in comparison with other agents in indirect pulp capping of primary teeth.

Keywords: Biodentine, Calcium hydroxide, Indirect pulp capping, Mineral trioxide aggregate, Primary teeth.

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INTRODUCTION

Premature loss of deciduous tooth can lead to malocclusion, disintegration of dental arches, loss of function, and loss of esthetics. Hence, maintaining its vitality until its natural period of exfoliation is imperative for maintaining the arch form and integrity. To retain the tooth in the dental arch, either of the two treatments can be done, i.e., vital pulp therapy (VPT) or root canal treatment (RCT).

Endodontic treatment of a child is a challenging clinical practice, as it involves administration of local anesthesia with the syringe. Managing a child in a dental set up which involves needle is a major thought-provoking task. Hence, VPT can be done in primary teeth which do not involve the administration of local anesthesia.

Vital pulp therapy involves three approaches (a) direct pulp capping, (b) indirect pulp capping and (c) pulpotomy. This systematic review intends to provide data on radiographic outcome of calcium hydroxide and various other agents in indirect pulp capping of deciduous teeth.

Indirect pulp capping is commended for teeth with deep caries approximating the pulp with no signs and symptoms of pulp deterioration. In this treatment, the deepest layer of the remaining carious dentine (affected dentin) is covered with biocompatible material,¹ followed by an airtight restoration to achieve a good seal against microleakage, without the need to reencounter for the removal of remaining caries.²⁻⁴

Indirect pulp capping is defined as a procedure in which a protective liner or cement or dressing is placed over the remaining dentin after the removal of soft caries or infected dentin.⁵ Indirect pulp therapy intends to preserve the vitality of the deciduous

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tooth to avoid pulpectomy. Calcium hydroxide was acquainted to dentistry in 1921 by Hermann and has been considered the gold standard material used for indirect pulp capping.⁶ There are various renowned advantages to calcium hydroxide that have caused it to obtain this recognition. There are no independent clinical parameters to govern how much carious dentin should be removed during indirect pulp therapy. However, several microbiological studies have advocated excavation of only the superficial dentin layer during indirect pulp therapy.⁷⁻⁹ This soft, yellow, humid, and necrotic layer is called the infected dentin, and it cannot be remineralized.

The ideology is that the dental pulp holds the ability to form the dentin-like matrix called the reparative dentin or

tertiary dentin. Formation of reparative dentin occurs through cellular differentiation, extracellular matrix deposition, and mineralization.^{10,11} Several shortcomings of calcium hydroxide like disintegration and formation of tunnel defects¹² have led to use of other agents in indirect pulp capping for deciduous teeth.

An ideal pulp capping agent should have properties like ability to form reparative dentin, to maintain the pulp vitality, to eliminate the bacteria, to be sterile and radiopaque, and to provide good bacterial seal.¹³

Other agents like calcium phosphate cement, polycarboxylate cement, RM-GIC, bonding agents, and lasers, have been familiarized for indirect pulp capping.

Recent advances in indirect pulp capping of deciduous teeth include mineral trioxide aggregate (MTA) and biodentine. MTA was brought into limelight by Torabinejad in the early 1900s. Various studies reported that MTA induced less pulpal irritation and more anticipated hard tissue barrier formation in comparison with hard setting calcium hydroxide.¹⁴

Biodentine is new-fangled bioactive cement with dentin-like mechanical properties. It can be used as a substitute for dentin. It has a progressive effect on vital pulp cells and stimulates tertiary dentin formation.¹⁵

This systematic review intends to provide information on the clinical and radiographic outcome of calcium hydroxide as an indirect pulp capping agent in deciduous teeth in comparison with other agents.

MATERIALS AND METHODS

Aim

To extract and systematically identify the existing literature on the "Clinical and Radiographic outcome of Calcium Hydroxide vs Other Agents in Indirect Pulp Capping of Primary Teeth".

Structured Question

What is the ideal indirect pulp capping agent for primary teeth?

PICO

Population: Deciduous teeth, children.

Intervention: Indirect pulp treatment, MTA, biodentine, dentin bonding agent, calcium phosphate cement, hydroxyapatite, laser, Mtya1-Ca, bone morphogenic protein, bone sialoprotein, novel endodontic cement, emdogain gel, odontogenic ameloblast-associated protein, endo sequence root repair material, theracal, zinc oxide eugenol, corticosteroids, antibiotics, polycarboxylate cement, glass ionomer, and resin-modified glass ionomer.

Comparison: Calcium hydroxide.

Outcome: Clinical outcome, radiographic outcome, dentin bridge formation.

Search Methods for Identification of Studies

To include all the studies for this review, detailed search strategies were developed for each database. The following computer databases were used to retrieve articles for the review

- PubMed (up to November 2017)
- Cochrane Library (up to November 2017)
- Science Direct (up to November 2017)
- LILACS (up to November 2017)
- SIGLE (up to November 2017) (Flowchart 1).

Search Strategy

Search 1—PubMed (MeSH terms) and (keywords):

Search pediatric dentistry OR kids OR children OR deciduous teeth OR deciduous molars OR primary teeth OR primary molars OR milk teeth OR baby teeth OR deep caries OR decayed teeth OR dental caries OR carious teeth AND indirect pulp capping OR indirect pulp therapy OR vital pulp therapy OR indirect pulp treatment OR mineral trioxide aggregate OR MTA OR portland cement OR MTA Plus OR MTA Flow OR ProRoot MTA OR gray MTA OR white MTA OR angelus MTA OR medicept MTA OR endocem MTA OR biodentin OR biodentine OR septodont biodentine OR tricalcium silicate OR dentin bonding agent OR 4-META-MMA-TBB adhesive OR Bond It OR hybridizing dentin bonding agent OR adhesive resin OR scotchbond OR calcium phosphate cement OR tetracalcium phosphate OR hydroxyapatite OR CPNE7 protein OR novel endodontic cement OR NEC OR CEM cement OR theracal OR theracal LC OR zinc oxide eugenol OR corticosteroids OR antibiotics OR polycarboxylate cement OR durelon OR glass ionomer cement OR GIC OR resin—modified glass ionomer cement OR RMGIC OR vitremer OR fuji AND calcium hydroxide OR dycal OR vitrabond AND clinical success OR radiographic success OR dentin bridge formation OR dentin thickness OR radiographic dentin thickness OR reactionary dentin.

Inclusion and Exclusion Criteria

Studies were selected based on the following inclusion criteria:

- All the studies including indirect pulp treatment in primary molars using calcium hydroxide in comparison with other agents
- Studies comparing clinical success and radiographic reparative dentin thickness and/or radiographic outcome between calcium hydroxide and other agents in indirect pulp treatment for primary teeth.

Studies were debarred based on the following exclusion criteria (Table 1):

- Studies involving permanent teeth
- Studies involving direct pulp capping cases
- Studies evaluating parameters other than radiographic outcome.

RESULTS (TABLE 2, FIGS 1 AND 2)

Study Selection

The systematic search from PubMed, Cochrane library, ScienceDirect, LILACS, and SIGLE, and through hand-search revealed a total of 281 citations. On title screening, 257 articles were eliminated. After abstract screening and reviewing of full articles, 10 were included for the systematic review. A total of 10 articles met the inclusion criteria and were selected for the area of intended research.

Study Characteristics (Table 3)

Falster et al. stated that the 2-year outcome of primary molars subjected to indirect pulp treatment and restored with a composite resin was similar when the protection of the dentin-pulp complex was performed with a layer of calcium hydroxide or only with an adhesive resin system. The most frequent cause for failure of the indirect pulp treatment in this study was the development of interradicular and/or periapical lesions that indicated the presence of irreversible pulp inflammation or necrosis. In this prospective and randomized clinical trial, the

Flowchart 1: PRISMA flowchart

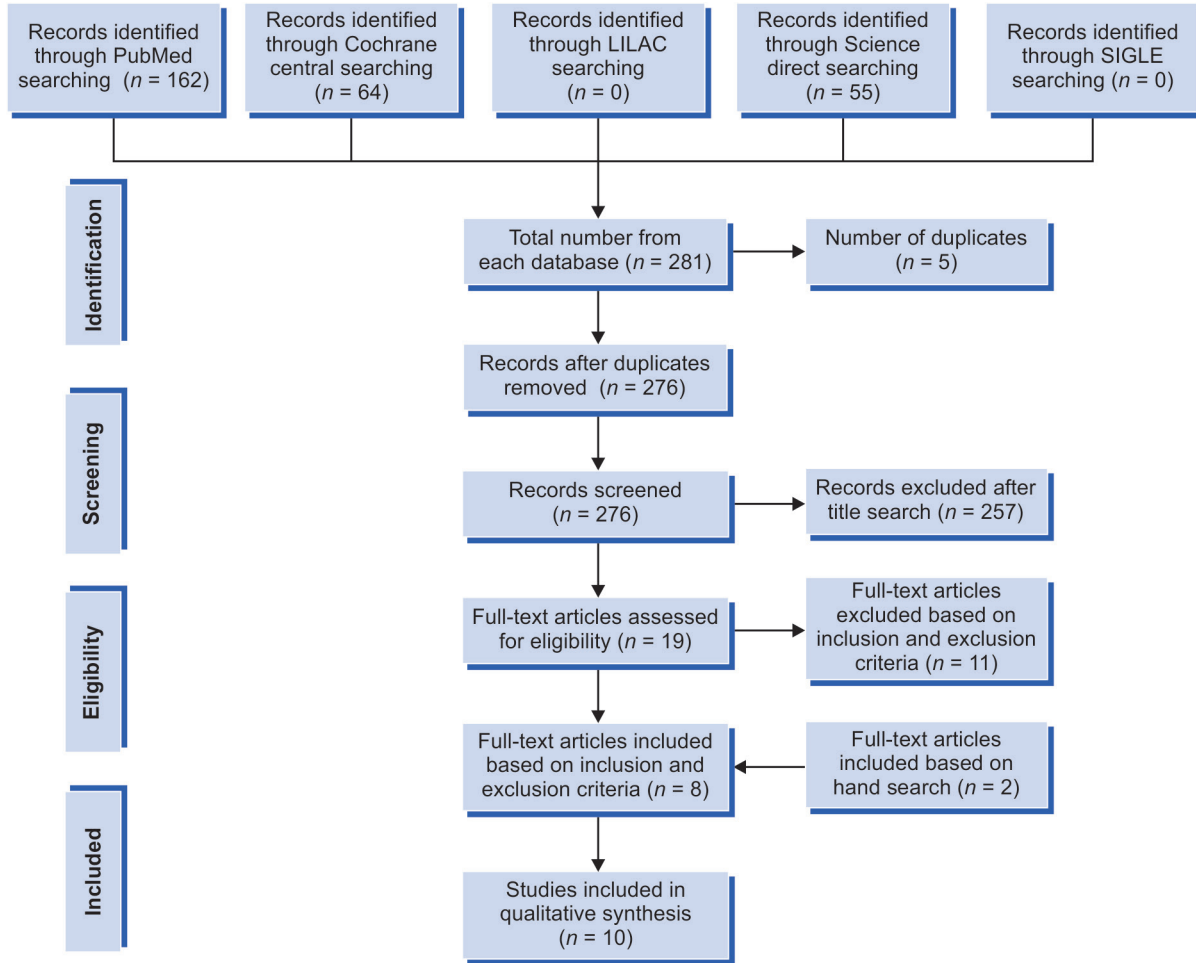


Table 1: Characteristics of excluded articles

Author and year	Reason for exclusion
Dhar et al. 2017	Review article
Pereira et al. 2017	Outcome measures were color, consistency, and moisture of dentin and bacterial count of the carious lesion
Elshamy et al. 2016	<i>In vitro</i> study
Soares et al. 2016	Permanent teeth were involved
Dalpian et al. 2014	No comparison group
Petrou et al. 2014	Permanent teeth were involved
Fernandes et al. 2013	Review article
Maltz et al. 2013	Permanent teeth were involved
Sinha et al. 2011	Permanent teeth were involved
Maltz et al. 2011	Permanent teeth were involved
Wegehaupt et al. 2009	Outcome measures were remaining dentin thickness and depth of the cavity
Costa et al. 2003	Permanent teeth were involved
Al-Zayer et al. 2003	Retrospective study
Do Nascimento et al. 2000	Permanent teeth were involved
De Souza Costa et al. 2001	Permanent teeth were involved
Hebling et al. 1999	Permanent teeth were involved

overall success rate of indirect pulp treatment was approximately 90% after 2 years.

Marchi et al. concluded that the clinical and radiographic success of a 48-month follow-up of the indirect pulp capping was similar when the protection of the dentin–pulp complex was performed with glass ionomer cement (93%) or with a layer of calcium hydroxide (89%) with no statistical significant difference between the materials. The most frequent cause of failures in both groups was the clinical observation of a fistula in the period of a 6–12-month follow-up, suggesting a misdiagnosis of the pulpal condition.

Casagrande et al. concluded that indirect pulp treatment has a high clinical and radiographic long-term success rate in primary teeth and provides a conservative, alternative treatment of teeth with deep carious lesions.

Casagrande et al. stated that IPT has a high clinical and radiographic success rate in primary teeth, independent of capping materials used over the remaining carious dentin. IPT provides a conservative alternative treatment of primary teeth with deep caries.

Buyukgural et al. evaluated 240 primary teeth and concluded that after 2 years, the clinical and radiographic success rates were 100%. With regard to protection of dentin–pulp complex, all the four groups showed similar outcomes.

Table 2: Quality of assessment of the included studies

S. no.	Study	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data assessment	Selective reporting of outcome	Other source of bias	Risk of bias
1	Falster et al. 2002	High risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	Low risk	High risk
2	Marchi et al. 2006	High risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	Unclear risk	High risk
3	Casagrande et al. 2008	High risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	Unclear risk	High risk
4	Casagrande et al. 2008	High risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk	Unclear risk	High risk
5	Buyukgural et al. 2008	Low risk	Low risk	Low risk	Unclear risk	Low risk	Unclear risk	Unclear risk	High risk
6	Casagrande et al. 2010	High risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Unclear risk	Unclear risk	High risk
7	Chutima et al. 2013	High risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk	Unclear risk	High risk
8	Mathur et al. 2016	Low risk	High risk	High risk	High risk	Low risk	Unclear risk	Unclear risk	High risk
9	Rangel et al. 2017	Low risk	Low risk	Low risk	Low risk	Low risk	Unclear risk	Low risk	Moderate risk
10	George et al. 2017	Unclear risk	High risk	High risk	High risk	Low risk	Unclear risk	High risk	High risk

Casagrande et al. evaluated 32 teeth from a total baseline of 40. 25 cases met the criteria for clinical and radiographic success, reaching an overall success rate of 78% with no statistical difference between the groups. Failures occurred after the first-year follow-up and were detected by radiographic evaluation.

Chutima et al. stated that there was no statistically significant difference in overall success rates between calcium hydroxide indirect pulp treatment (CH-IPT) and 3Mix-MP sterilization (3MixMP) for the management of deep caries approximating the pulp in mandibular primary molars at either the 6–11-month or the 12–29-months follow-ups.

In Mathur et al., all the three dental materials tested, i.e., calcium hydroxide (setting), GIC type VII, and MTA, were found to be equally suitable for IPT, following clinical and radiographic criteria. The success rate with calcium hydroxide (setting) was found to be 93.5%; with GIC (type VII), it was 97%, and with MTA, it was 100%, respectively.

Rangel et al. included 80 children, aged four to eight years old, with 160 primary teeth that were treated in a split-mouth design trial comparing indirect pulp capping using bioactive tricalcium silicate or calcium hydroxide. The teeth were restored with preformed crowns and assessed clinically and radiographically for one, three, six, and 12 months. The combined clinical and radiographic success rates were 98.3% for tricalcium silicate and 95% for calcium hydroxide. No significant differences were found for success rates between the two study groups ($p > 0.05$). The combined success rates for both groups were 96.7%.

In George et al., clinically both MTA and dycal are good IPT medicaments in primary teeth. Radiographically, MTA is superior to dycal as IPT medicament in primary teeth. Dentin deposition is more when MTA is used than dycal after 3 months and 6 months. Dentin deposition is more in first 3 months than second 3 months for both MTA and dycal.

DISCUSSION

Dental caries is the most common oral health concern among children. To maintain the arch spaces, integrity, occlusion, and pulp vitality, it is essential to retain primary teeth in the dental arch. Treating deep carious lesion may require the administration of local anesthesia, which proves to be a major challenge to pediatric dentist. A less-conservative and an early intervention of the carious lesion is always a treatment of choice rather than an invasive procedure. Hence, indirect pulp therapy (IPT) performed at early stage is less time consuming, less tedious, and does not involve syringe. It possesses an additional advantage of using the regenerative potential of the tooth, thus having a shift of paradigm from dentin removal to dentin preservation and regeneration.

Various dental materials have been revolutionized for indirect pulp therapy in deciduous teeth, calcium hydroxide being the “Gold Standard” material. Calcium hydroxide was introduced by Hermann in 1921 and is widely used as a pulp capping agent. Studies comparing several agents to calcium hydroxide have been published over the years.^{16,17} Calcium hydroxide has a long tenure of record for clinical success as a pulp capping agent for follow-up of up to 10 years. There are some disadvantages that restrict its use such as poor adhesive quality and improper seal.¹⁷ Another criticism illustrated of calcium hydroxide was the presence of the so-called “tunnel defects” in reparative dentin formed underneath calcium hydroxide.¹⁶ The main goal is to achieve reparative dentine formation. Calcium phosphate has good biocompatibility, efficient compressive strength, and superior capacity of producing dentinal bridge than calcium hydroxide.

Glass ionomer also delivers an exceptional bacterial seal and decent biocompatibility when used in close approximation to the pulp.

Newer agents like MTA and biodentin came into limelight lately. MTA was introduced by Torabianajed. MTA induced less pulpal

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Buykgural et al. 2008	+	+	+	?	+	?	?
Casagrande et al. 2008	-	?	?	?	+	?	?
Casagrande et al. 2008 (2)	-	?	?	+	+	?	?
Casagrande et al. 2010	-	?	?	?	+	?	?
Chutima et al. 2013	-	?	?	+	+	?	?
Falster et al. 2002	-	?	?	?	+	?	+
George et al. 2017	?	-	-	-	+	?	-
Marchi et al. 2006	-	?	?	?	+	?	?
Mathur et al. 2016	+	-	-	-	+	?	?
Rangel et al. 2017	+	+	+	+	+	?	+

Fig 1: Risk of bias summary

inflammation and more anticipated hard tissue barrier formation in comparison with calcium hydroxide.¹⁸ In a study done by Farsi et al. in 2006, clinical and radiographic success rate of MTA was found to be 93% at 24-month follow-up.¹⁷ Biodentin is a new bioactive material that has a constructive effect on vital pulpal cells and induces tertiary dentin formation.¹⁵

In all the included studies in this systematic review, clinical and radiographic outcome of each material has been compared with calcium hydroxide in indirect pulp capping of primary teeth. The parameters for clinical and radiographic success evaluated were pain, sensitivity, mobility, tender on percussion, furcal radiolucency, external and internal resorption, and PDL widening. Casagrande in 2008 compared calcium hydroxide with self-etching adhesive system (Clearfill SE bond). After two years of follow-up, the overall success rate was 87% with no significance difference between the groups. He also concluded by stating that IPT provides a conservative alternative treatment of primary teeth with deep carious lesion. Failures occurred after 12-month follow-up, which were detected by radiographs.

Casagrande also published a 5-year follow up of the same study in which he stated that 93% of the teeth treated with adhesive technique and 80% of the teeth treated with calcium hydroxide had both clinical and radiographic success.¹⁸ Adhesives and dentin bonding agent used for indirect pulp capping do not form calcific bridge formation.¹⁷ Three failures were observed, two at 36–48 months in dycal group and one at 48–60 months in resin system group. The failures were due to furcal and apical lesions. Miyakoshi demonstrated that adhesives and hybridizing dentin bonding agents provide superior adhesion to outlying hard tissues and provides effective seal against micro leakage.

In this systematic review, two studies have compared calcium hydroxide and GIC as an indirect pulp capping agent. The success rate of calcium hydroxide was 93.5% and of GIC was 97% in a sample of 36 teeth and 38 teeth, respectively.¹⁹ One tooth that was treated with GIC was diagnosed with abscess after 8-month follow-up. Two more patients reported with pain in teeth treated with calcium hydroxide at 11-month follow-up.¹⁹ Another study by Marchi et al. has compared calcium hydroxide with GIC, and success

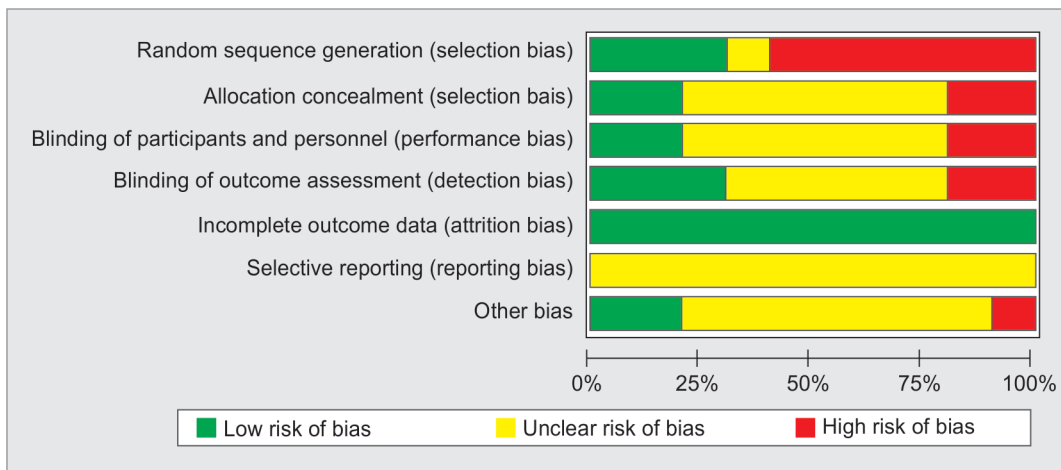


Fig 2: Risk of bias graph

Table 3: Characteristics of included studies

S. no.	Author and year	Study design	Sample size	Indirect pulp capping agent used		Outcome assessment
				Test groups	Control	
1	Falster et al., 2002	Randomized controlled trial	48 (3–5 years)	Adhesive resin system scotchbond multipurpose	Dycal	<ul style="list-style-type: none"> • Absence of spontaneous pain and/or sensitivity to pressure • Absence of fistula, edema, and/or abnormal mobility; • Absence of radiolucencies at the interradicular and/or periapical regions • Absence of internal or external root resorption
2	Marchi et al., 2006	Randomized clinical trial	17 children Experimental group—15 teeth Control group—12 teeth Age group: 4–9 years	Glass ionomer cement	Calcium hydroxide	<ul style="list-style-type: none"> • Absence of pathological root resorption • Absence of periapical lesion • Absence of pain and sensitivity • Absence of mobility • Absence of fistula • Absence of furcal radiolucency
3	Casagrande et al., 2008	Randomized controlled trial	48 primary molars 3–5 years old	Adhesive resin system scotchbond multipurpose	Dycal	<ul style="list-style-type: none"> • Absence of spontaneous pain and/or sensitivity to pressure • Absence of fistula, edema, and/or abnormal mobility • Absence of radiolucencies at the interradicular and/or periapical regions • Absence of internal or external root resorption
4	Casagrande et al., 2008	Clinical trial	40 primary teeth 4–8 years old	Self-etching adhesive system	Dycal	<ul style="list-style-type: none"> • Absence of spontaneous pain and/or sensitivity to pressure • Absence of fistula, edema, and/or abnormal mobility • Absence of radiolucencies at the interradicular and/or periapical regions • Absence of internal or external root resorption
5	Buyukgural et al., 2008	Clinical trial	240 primary teeth 5–10 years old	<ul style="list-style-type: none"> • Total-etching with 36% phosphoric acid followed by an acetone-based adhesive (prime and bond NT) • A self-etch adhesive system (Xeno III) • An acetone-based adhesive (prime and bond NT) without prior acid conditioning 	Calcium hydroxide	<ul style="list-style-type: none"> • Remaining dentin thickness • Absence of clinical symptoms like spontaneous pain and/or sensitivity pressure/percussion, fistula and/or edema, abnormal mobility • Absence of radiolucencies at the interradicular an periapical regions • Absence of internal or external resorption • Marginal quality of restorations

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S. no.	Author and year	Study design	Sample size	Indirect pulp capping agent used		
				Test groups	Control	Outcome assessment
6	Casagrande et al., 2010	Clinical trial	40 primary teeth 4–8 years old	Self etching adhesive system	Dycal	<ul style="list-style-type: none"> • Absence of spontaneous pain and/or sensitivity to pressure • Absence of fistula, edema, and/or abnormal mobility • Absence of radiolucencies at the interradicular and/or periapical regions • Absence of internal or external root resorption
7	Chutima et al., 2013	Single blinded randomized controlled trial	82 mandibular primary molars	3Mix-MP	Calcium hydroxide	<ul style="list-style-type: none"> • Absence of fistula, swelling and mobility • Absence of pain • Intact lamina dura and absence of furcal radiolucency • Absence of internal/external resorption
8	Mathur et al., 2016	Longitudinal interventional randomized control trial	90 teeth 7–12 years	GIC Type VII MTA	Dycal	<ul style="list-style-type: none"> • Mean dentin depth
9	Rangel et al., 2017	Single-blinded randomized split-mouth clinical trial	Sample size: 80 patients 160 teeth	Biodentine	Light activated calcium hydroxide	<ul style="list-style-type: none"> • Radiographic success • Furcal radiolucency • Internal/external root resorption • Periradicular infection • Absence of pain • Absence of sensitivity to percussion
10	George et al., 2016	Clinical trial	Sample size—40 Age group: 5–9 years	MTA	Dycal	<ul style="list-style-type: none"> • Radiographic dentin thickness • Absence of root resorption • Absence of PDL widening • Absence of periapical radiolucency • Absence of pulpal calcifications

rate of 93% was found in GIC group and 89% in calcium hydroxide group. The failure rates in both the groups were observation of fistula in 6–12-month follow-up in a sample of 12 teeth and 15 teeth, respectively.

Two more studies have compared calcium hydroxide with MTA in which 100% success rate was found in MTA group, 93.5% success rate in calcium hydroxide, and 97% success rate in GIC group in a sample of 109 teeth.¹⁹ Another study by George et al. demonstrated that there was a significant difference between MTA and dycal to deposit reparative dentin in a total sample size of 40. One patient had reported with sinus opening at 6-month follow-up, and no failure rates were seen in the MTA group.²⁰

Rangel et al. in 2017 compared biodentin and calcium hydroxide on 160 primary teeth and achieved a combined clinical and radiographic success rates of 98.3% and 95%, respectively.¹⁷ In the biodentin group, one tooth was associated with spontaneous pain, mobility, swelling, abscess, furcal radiolucency, and root resorption. In calcium hydroxide group, three teeth were considered failure due to same reasons. All these failures were observed at 6–12-months follow-up. There was no significant difference between the success rates of the two agents after one-year follow-up.

Triple antibiotic paste is used for the management of periapical lesions in RCT of permanent teeth. It can also be used as an indirect pulp capping agent. Chutima in the year 2013 compared calcium hydroxide with 3Mix-MP and found success rates of 82% and 81%, respectively, after 11 months and 94% and 78%, respectively, after 29 months.¹⁷ Four teeth in the calcium hydroxide group and one tooth in the 3Mix-MP group showed radiographic failures.⁶ Gardner et al. stated that vancomycin, in combination with calcium hydroxide, was more effective than calcium hydroxide used alone and stimulated a more regular reparative dentin bridge.²¹

The risk of bias for all the studies was assessed using Cochrane criteria. Seven parameters were evaluated to assess the risk of bias on individual studies. Eight out of nine included articles have high risk of bias due to unclear risk in allocation concealment, blinding of participants, personnel and outcome assessment, and high risk in random sequence generation. One study has moderate risk of bias as its maximum parameters for quality is at low risk. High risk of random sequence generation was seen in the studies done by Marchi et al. 2006, Casagrande et al. 2008, Casagrande et al., 2008, and Chutima et al., 2013.

Random sequence generation was found to be at low risk in the studies done by Mathur et al., 2016 and Rangel et al., 2017.

Randomization was not clear in the study done by George et al., 2017. Allocation concealment was not clear in the studies done by Marchi et al., Casagrande et al. and Chutima et al., and was at high risk in the studies done by Mathur et al. and George et al. Allocation concealment was at low risk in the study done by Rangel et al.

There was no clear-cut evidence of blinding of participants and personnel in the studies done by Marchi et al., Casagrande et al. and Chutima et al. Blinding was at high risk in the studies by Mathur et al. and George et al. It was at high risk in the study done by Rangel et al. Blinding of outcome assessment was at low risk in the studies done by Casagrande et al., Chutima et al., and Range et al. Blinding of outcome assessment was not clearly illustrated in the studies by Marchi et al. and Casagrande et al., 2010. High risk of blinding of outcome assessment was seen in the studies by Mathur et al. and George et al. An incomplete outcome of data assessment was seen in all the 9 included studies. Selective reporting of outcome was not clear in all the 9 included studies.

There are certain limitations in the included studies such as: there is a lack of proper random sequence generation and allocation concealment in few studies, and some other studies have small sample size. Few studies have not employed blinding. Therefore, more studies are required with an appropriate randomization technique, allocation concealment and blinding.

CONCLUSION

This systematic review aimed to analyze the literature on clinical and radiographic outcome of calcium hydroxide vs other agents in indirect pulp therapy of deciduous teeth. Based on the studies evaluated, there is no clear evidence on the best material for indirect pulp capping agent in primary teeth. Hence, more studies are required in regard to indirect pulp capping of primary teeth.

CLINICAL SIGNIFICANCE

This systematic review gives detailed information about indirect pulp capping in deciduous teeth using various agents. It is a review of all the articles comparing calcium hydroxide indirect pulp capping and other agents providing the clinician with a clear idea to choose the best indirect pulp capping agent for primary teeth.

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