ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 5, Issue – 4, August - 2022, Page No. : 38 - 47

Comparison of clinical performance of Mineral Trioxide Aggregate and Calcium Hydroxide as Indirect Pulp-capping Agents in Primary Teeth - A Systematic Review

[1]Dr. Aditi Mhatre, Post Graduate Student, Dept of Paediatric & Preventive Dentistry, MARDC, Pune, Maharashtra, India.
[2]Dr. Yusuf Chunawala, HOD & Professor, Dept of Paediatric & Preventive Dentistry, MARDC, Pune, Maharashtra, India.
[3]Dr. Abhinav Talekar, Professor, Dept of Paediatric & Preventive Dentistry, MARDC, Pune, Maharashtra, India.
[4]Dr. Amol Patil, Reader, Dept of Paediatric & Preventive Dentistry, MARDC, Pune, Maharashtra, India.

Corresponding Author: Dr. Aditi Mhatre, Post Graduate Student, Dept of Paediatric & Preventive Dentistry, MARDC, Pune, Maharashtra, India.

Citation of this Article: Dr. Aditi Mhatre, Dr. Yusuf Chunawala, Dr. Abhinav Talekar, Dr. Amol Patil, "Comparison of clinical performance of Mineral Trioxide Aggregate and Calcium Hydroxide as Indirect Pulp-capping Agents in Primary Teeth - A Systematic Review", IJDSIR- August - 2022, Vol. – 5, Issue - 4, P. No. 38 – 47.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

performance of MTA & calcium hydroxide as indirect pulp-capping agents in primary teeth.

Materials and Methods: Search strategy comprehends of randomized control trials and clinical trials from the databases of PubMed, DOAJ, and Google scholar from January 2010 to November 2021. A total of four clinical trials which matched all inclusion criteria were included in this systematic review. The restorations were considered failure when there are clinical symptoms such as pain and tenderness and radiographic evidence of radiolucency in furcation region or widening of PDL.

Results: Among the four trials that are included, two studies are determined as high risk and two as moderate risk of bias. The result suggests that MTA is better medicament for IPC when compared to calcium hydroxide.

Conclusion: It can be concluded that MTA has got higher success rate and can be considered as better IPC agent when compared with calcium hydroxide.

Keywords: Calcium hydroxide, IPC, MTA, primary teeth.

Introduction

Early exfoliation of primary teeth can lead to conditions such as malocclusion, disintegration of dental arch, functional and aesthetic loss.1 It is therefore important to maintain the vitality of teeth until its natural exfoliation period. Treatment modalities available for retaining the natural form of teeth included vital pulp therapy which includes direct and indirect pulp capping and root canal treatment.1 Moreover, the avoidance of pulpal exposure in the treatment of teeth with symptom-free deep carious lesions contributes to prolonged maintenance of pulp vitality and restorative success without requiring high

cost, painful, and invasive endodontic treatments. Also, tooth vitality conserving approaches such as indirect pulp capping techniques have also become popular over the last years in the management of deep carious lesions in addition to conventional approaches that require complete removal of the caries.2-4 The aim of vital pulp therapy is to maintain and protect pulp vitality and to protect tooth and its supporting tissues.5

Vital pulp therapy does not require administration of local anaesthesia. It involves three approaches viz. direct pulp capping, indirect pulp capping and pulpotomy.1 Indirect pulp treatment (IPT) is a minimally invasive technique based on the principle of maintenance of the inner portion of carious dentin which is a vital tissue containing intact collagen and is able to remineralize.6 It is recommended for teeth with deep carious lesions approximating the pulp with no signs or symptoms of pulp degeneration.5

There are several materials available as Indirect Pulp Caping (IPC) agents amongst which calcium hydroxide is a gold standard and is being used since 1939.6 Calcium hydroxide had shown certain unfavourable effects such as internal resorption, degradation, poor sealing properties which had reduced its acceptance over a course of time.8

The basic ideology behind IPC is that the dental pulp has the ability to form the dentin-like matrix called the reparative dentin or formation of reparative dentin occurs through mechanism of cellular differentiation, extracellular matrix deposition, and mineralization. A basic pulp caping agent should have properties which will help to form tertiary dentin, eliminate bacteria, to be sterile and radio opaque and also provide bacterial seal. 1 Mineral Trioxide Aggregate is a pulp sealing agent which contains mixture of tricalcium silicate, dicalcium silicate, tetra calcium aluminoferrite, and calcium sulphate dehydrate with an addition of bismuth oxide in a 4:1 ratio.8,9

Indirect pulp treatment (IPT) of primary teeth has obtained high worldwide recognition in recent years and also have a lower cost, higher long-term success, better exfoliation pattern, and better success treating reversible pulpitis than pulpotomy.8

Various studies reported that MTA had proved to be anticipated hard tissue barrier formation as compared with calcium hydroxide. Use of MTA in pulpotomy and direct pulp caping procedures is well documented in the literature.10 Thus, this systematic review was conducted to evaluate the clinical performance of MTA in indirect pulp capping and compare it with calcium hydroxide in primary teeth.

Methods

A systematic review of literature and meta-analysis was performed. This study followed the (PRISMA) Preferred Reporting Items for Systematic Review and Meta-Analyses statement guidelines[11], the Cochrane Handbook for systematic reviews of interventions, version 5.1.0. AND 4th Edition of the JBI Reviewer's Manual.

Eligibility criteria

Inclusion criteria

1. Inclusion criteria based on study characteristics:

a. Type of participants:

- Studies reporting information about participant characteristics as children with primary dentition belonging to both the genders.

b. Intervention

- Studies reporting indirect pulp capping treatment done using Calcium Hydroxide material of any brand as pulp capping agent.
- Studies reporting final restoration done using Glass Ionomer Cement.

c. Comparison

- Studies reporting indirect pulp capping treatment done using Mineral Trioxide Aggregate (MTA) material of any brand as pulp capping agent.
- Studies reporting final restoration done using Glass Ionomer Cement.

d. Outcomes

- Studies reporting outcomes in terms of Clinical performance of the restoration which includes radio graphic assessment like mean tertiary dentin deposition value and clinical outcomes like survival of the restoration.

e. Type of Studies

- Studies reporting information about the experimental, clinical, randomized controlled trials and comparative observational studies were included.
- Studies reporting ethical approval were included

Inclusion criteria based on publication characteristics

- Studies published between the period of 1st January 2010 to 30th November 2021. written in English.
- Studies in English language or other language where English translation is possible.
- Studies published in commercial scientific databases like PubMed, DOAJ (Directory of open access journal) and Google Scholar and available as full text.

Exclusion Criteria

1. Studies in any other language where English translation was not possible.
2. Studies that had Only abstracts were excluded
3. Studies with case reports, reviews and expert opinion were excluded
4. Studies reporting about a single intervention were excluded.
5. Studies done in adults were excluded.
6. Studies in unpublished format were excluded.

Search strategy

- The preferred reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[11] for conducting a meta-analysis were followed.
- The electronic data resources consulted for elaborate search were PubMed, DOAJ, and Google scholar with controlled vocabulary and free text terms.
- Articles published from 01/01/2010 until 30/11/2021 were searched, without any restriction concerning the publication's language.
- Following keywords and Mesh terms were used in combination with Boolean operators in the advanced search option

Population	Intervention	Comparison	Outcome	Study Design
Child Adolescent Children Primary teeth Deciduous teeth Primary dentition Deciduous dentition	Calcium hydroxide Indirect Pulp Capping Dycal	Mineral Trioxide Aggregate MTA	Clinical performance Tertiary dentin	RCTs Clinical trial Randomized controlled trial Comparative study Prospective study

Focused Research Question

Is there any difference in the clinical performance of Mineral Trioxide Aggregate (MTA) and Calcium hydroxide when used as indirect pulp capping agent in Primary dentition?

Following search strategy was used

1. Population: (Adolescent [MeSH] OR Teenagers [Text Word] OR Teens [Text Word] OR Kids [Text Word] OR School children [Text Word] OR children [Text Word] OR Youngsters [Text Word] OR Youth [Text Word] OR Primary dentition [Text Word] OR

deciduous teeth [Text Word] OR Primary teeth [Text Word] OR deciduous teeth [Text Word]

2. Intervention: (Calcium Hydroxide [Text Word] OR Dycal [Text Word] AND Indirect pulp capping [Text Word]

3. Comparison: (Mineral Trioxide Aggregate [Text Word] OR MTA [Text Word]

4. Outcome: (IOPA [Text Word] OR Clinical [Text Word] OR Survival [Text Word]

Search Combination

(Adolescent [MeSH] OR Teenagers [Text Word] OR Teens [Text Word] OR Kids [Text Word] OR School children [Text Word] OR children [Text Word] OR Youngsters [Text Word] OR Youth [Text Word] OR Primary dentition [Text Word] OR deciduous teeth [Text Word] OR Primary teeth [Text Word] OR deciduous teeth [Text Word])) AND ((Calcium Hydroxide [Text Word] OR Dycal [Text Word] AND Indirect pulp capping [Text Word])) AND (Mineral Trioxide Aggregate [Text Word] OR MTA [Text Word])) AND ((IOPA [Text Word] OR Clinical [Text Word] OR Survival [Text Word])

Selection of studies

The title and the abstract of each study were reviewed and critically assessed by two independent reviewers. The methods used to apply the selection criteria were the following:

a) integration of the searched outcomes to delete duplicate entries

b) examination of titles and abstracts to delete clearly irrelevant articles

c) recovery of the full text of potentially relevant articles

d) binding and gathering of multiple articles of the very same study

e) examination of the articles' full text to verify the degree of compliance that the studies had with the eligibility criteria.

f) establishing connection with researchers, if necessary, to clarify the study's eligibility.

g) deciding about the study's inclusion and proceeding with data gathering.

Data extraction

Two reviewers independently extracted data from the included studies. Disagreements were again resolved through discussion. Data gathered was carried out using a verification list of items that were considered for data extraction. The main items of this list were as follows:

- Study Definition,
- Risk of Bias Assessment,
- Total Length of the Study,
- Unit of Randomization,
- Unit of Analysis,
- Participants' Characteristics,
- Interventions,
- Outcomes,
- Results and Other Items.

Details regarding the publication and the study, the participants, settings, the interventions, the comparators, the outcome measures, study design, statistical analysis and results, and all other relevant data (funding; conflict of interest etc.) were carefully and accurately extracted from all included studies. Data extraction was done and accurately recorded in the excel sheets for all the primary outcomes separately.

Quality assessment of included studies

Quality assessment of the selected studies was executed by using the Cochrane Risk of bias (ROB-2)[12] Tool which included domains like random sequence generation, allocation concealment, blinding of participants, incomplete outcome data, selective

reporting, and other bias. Studies were qualified in terms of high risk, low risk and unclear risk.

Results

Literature Search

The initial electronic database search on Pub Med/ MEDLINE and Cochrane library resulted in 660 titles. After screening the abstracts and removal of duplicates, 275 relevant titles were selected by two independent reviewers and 385 were excluded for not being related to the topic. Following examination and discussion by the reviewers, 19 articles were selected for full-text evaluation. Hand searching of the reference lists of the selected studies did not deliver additional papers. After pre-screening, application of the inclusion and exclusion criteria and handling of the PICO questions, four studies remained which were included in the qualitative synthesis. These studies were subjected for data extraction.

Figure 1 illustrates a flowchart of the search results.

There are 04 studies included in this review. The general characteristics of these studies are presented in Table 1. Majority of the studies included, were conducted in India.

The study design of all four studies was randomised control trial. The age of the participants ranged from 5 to 16 years old throughout the interventions' conducting period. A total of 277 primary teeth were part of the studies' analyses, with 138 of those included in intervention groups and 139 in control groups.

Quality assessment of the studies

Quality assessment showed a huge variety across the included studies. Quality assessment of the four studies was executed according Cochrane Risk of Bias (ROB-2) Tool (Table 2). Two studies showed a moderate potential risk of bias and two studies a high potential risk of bias (Figure 2, 3).

Figure 1: PRISMA Flow Chart

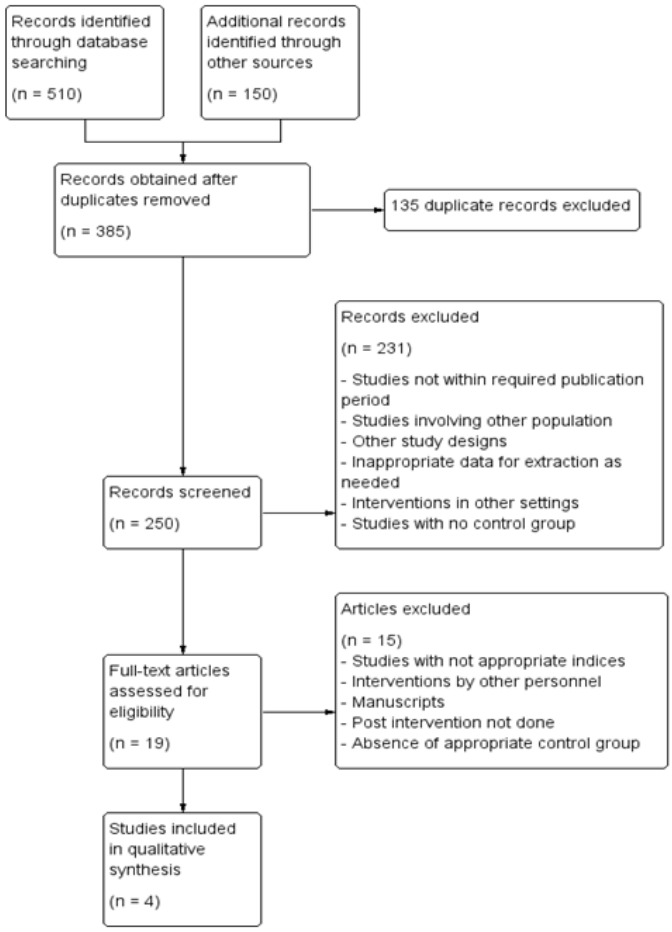


Table 1: Characteristics of included studies

Sn.	Study ID	Place of study	Study design	Sample size	Age group	Gender	Follow up	Intervention	Comparison	Author's conclusion
1.	George (2015)[8]	Kerala, India	Prospective clinical trial	40	5-9 years	-	3 months,6 months	Group I = MTA	Group II = Dycal (Dentsply De Trey	Based on the results, authors suggested that MTA happens to be superior to Dycal as a

									Konstanz, Germany)	medicament for IPT in primary teeth.
2	Mathur (2016)[7]	India	Longitudinal interventional study	57	7-12 years	-	8 weeks, 6months, 1 year	MTA, GIC Type VII	Dycal	Authors concluded that significant results were seen in radiodensity of barrier formed (in HU). All the three materials were equally suitable as IPC agents which suggested of the mineral gain.
3	Chauhan (2018)[6]	India	Clinical trial	45	5-9 years	-	3 months, 6 months	MTA, Biodentine	Dycal	Authors concluded that radiographically, the superior amount of tertiary dentin deposition was noted with Bio dentine. Among Dycal and MTA, more amount of tertiary dentin deposition was seen in Group II(MTA)
4	Gurcan (2019)[5]	Istanbul	Invivo, interventional study	135	4-15 years	F=52 M=43	1 month, 3 months, 6 months, 12 months, 24 months	MTA (Pro Root MTA, Dentsply Tulsa, Johnson City, TN, USA) Thera Cal (Bisco Inc., Schaumburg, IL, USA)	Dycal (Dentsply De Trey Konstanz, Germany)	Authors concluded that IPC is important for the longevity of vitality of primary teeth and apex ogenesis of young permanent teeth. MTA was proved more effective in forming dentin bridge than dycal.

Table 2: Risk of bias assessment of individual studies

Sn.	Study ID	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias	Risk of bias
1.	George (2015)	Unclear	Unclear	Yes	No	Yes	Yes	Yes	High risk
2.	Mathur (2016)	Yes	Unclear	No	Yes	Yes	Yes	Yes	Moderate risk
3.	Chauhan (2018)	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Moderate risk
4.	Gurcan (2019)	Unclear	Yes	Unclear	No	No	Yes	Yes	High risk

Figure 2: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

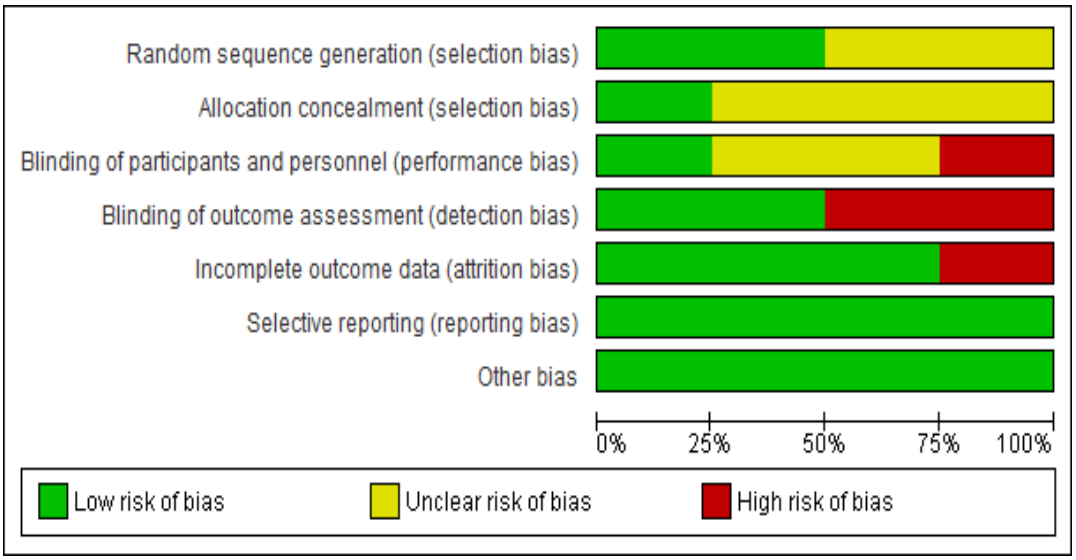
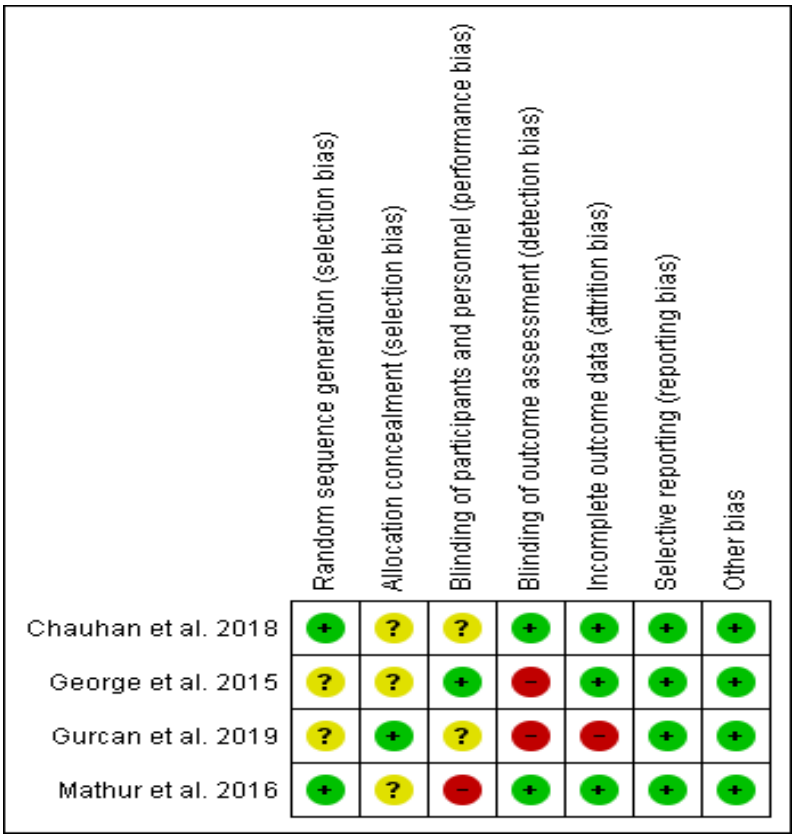


Figure 3: Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Discussion

Treatment of carious lesions approaching pulp may require the administration of local anesthesia, which proves to be a challenging task for dentists. A less-conservative and an early intervention of the carious teeth is always an intended treatment of choice compared to an invasive procedure. Indirect pulp therapy (IPT) performed at early stage is less time consuming and less tedious task. There is 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[1] The rationale for Indirect Pulp Treatment (IPT) is based on the observation that postmitotic odontoblasts can be induced to upregulate their synthetic and secretory activities in response to reduced infectious challenge. This results in deposition of a tertiary dentin matrix that has the effect of increasing the distance between the caries and the pulp that results in decreased dentin permeability.[15] IPC is credited to show a long-term success of 3–4 years over other alternatives of VPT such as pulpotomy in primary molars.[16] The pulp response is influenced by the thickness of the remaining dentin.[17] A remaining dentin thickness (RDT) of 1.5-2 mm must be present to protect the pulp. However, when caries extends deeper into dentin, this thickness can be distinctly compromised owing to pulpal inflammation. Some investigators have found a minimum thickness of about 0.5 mm to 1 mm to be sufficient for pulpal protection.[18]

Calcium hydroxide is one of the gold standard materials for pulp-capping procedures as it possesses antibacterial properties, which can minimize or eliminate bacterial penetration into the pulp. In its pure form, the substance has a high pH that stimulates reparative dentinogenesis which is explained by the release of bioactive molecules.[10] Calcium hydroxide is known to solubilize bone morphogenic protein and transforming growth factor-beta 1 from dentin, lending credence to the release of these bioactive molecules as a significant mediator in pulp repair following pulp capping.[11,14]

MTA was introduced by Torabinejad and it induces less pulpal inflammation and more anticipated secondary dentin barrier formation when compared with calcium hydroxide. 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.[1,14,15] All the studies included in present systematic review evaluated clinical and radiographic outcome of calcium hydroxide and compared it with MTA. The parameters for clinical and radiographic success evaluated were dental pain, dentinal hypersensitivity, tooth mobility, tenderness on percussion, furcal radiolucency, external and internal resorption, and PDL widening. In all the studies GIC was used for final restoration. In all the studies MTA was observed to be superior to calcium hydroxide. [5,6,7,8] A 2 year follow up study done by Gurcan et al found the success rate of 94.4% as of MTA when compared with calcium hydroxide.[2] Another study done by Mathur et al showed 100% success rate of MTA when compared with calcium hydroxide.[4] In study done by George V et al statistically significant difference was found in dentin deposition between calcium hydroxide and MTA suggesting MTA to be superior than calcium hydroxide.[8] Assessment of risk of bias for all the studies was done by Cochrane risk of bias (ROB-2) tool. Overall moderate to high risk of bias was observed in the included studies. Studies done by Mathur et al and Chauhan et al reported about random sequence generation.[6,7] The allocation concealment was followed only in the study done by Gurcan et al.[2] Study conducted by George et al reported for low risk of bias for blinding of participants and personnel while Mathur et al showed high risk of bias for the same. High risk of bias was observed for blinding of outcome assessment and attrition bias in study conducted by Gurcan et al.[5,19,20] A variety of materials with bacteriostatic, bactericidal, or remineralizing properties of the defected dentin are applied before the restoration. Their effect on the remaining defected layer was intensively discussed in the literature and it seems that they have no significant influence on the success rates. According to the literature review of Hayashi et al,

most of the researchers prefer calcium hydroxide as the appropriate material for indirect pulp capping.[21]

The result of this systematic review suggest that MTA is better medicament for indirect pulp capping when compared with calcium hydroxide. The previous systematic review conducted by Nair et al suggested MTA as a better medicament for direct pulp capping when compared with other materials.[2] It was observed that there were certain limitations in the included studies such as lack of random sequence generation and allocation concealment, blinding was not followed. In future studies following proper randomization and blinding should be conducted. Besides studies evaluating the cost effectiveness of MTA should also be conducted.

Conclusion

This systematic review analysed the literature on clinical and radiographic outcome of calcium hydroxide vs MTA in indirect pulp therapy of deciduous teeth. Based on the included studies it can be concluded that MTA has got higher success rate and can be considered as better indirect pulp capping agent when compared with calcium hydroxide.

References

1. Nair M, Guru Nathan D. Clinical and Radiographic Outcomes of Calcium Hydroxide vs Other Agents in Indirect Pulp Capping of Primary Teeth: A Systematic Review. Int J Clin Pediatr Dent 2019;12 (5):437–444.

2. Schwendicke F (2017) Contemporary concepts in carious tissue removal: a review. J Esthet Restor Dent 29:403–408.

3. Ricketts D, Lamont T, Innes NP, Kidd E, Clarkson JE (2013) Operative caries management in adults and children. Cochrane Database Syst Rev:CD003808.

4. Pari say I, Ghoddusi J, For Ghani M (2015) A review on vital pulp therapy in primary teeth. Iran Endod J 10:6–15.

5. Gurcan AT, Seymen F. Clinical and radiographic evaluation of indirect pulp capping with three different materials: A 2-year follow-up study. Eur J Paediatr Dent. 2019;20(2):105–10.

6. Chauhan A, Dua P, Saini S, Mangla R, But ail A, Ahluwalia S. *In vivo* outcomes of indirect pulp treatment in primary posterior teeth: 6 months' follow-up. Contemp Clin Dent 2018;9: S69-73.

7. Mathur VP, Dhillon JK, Logani A, Kalra G. Evaluation of indirect pulp capping using three different materials: A randomized control trial using cone-beam computed tomography. Indian J Dent Res. 2016;27(6):623–9.

8. George V, Janardhan an SK, Varma B, Kumaran P, Xavier AM. Clinical and radiographic evaluation of indirect pulp treatment with MTA and calcium hydroxide in primary teeth (in-vivo study). J Indian Soc Pedod Prev Dent. 2015;33(2):104–10.

9. Schuur's AH, Gruythuysen RJ, Wesselinde PR. Pulp capping with Resin based composite versus calcium hydroxide: A review endodontics. Dental Trauma 2000; 16:240-50.

10. Camilleri J, Montesin FE, Brady K, Sweeney R, Curtis RV, Ford TR. The constitution of mineral trioxide aggregate.DentMater2005; 21:297-303.

11. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews.

12. Sterne JA, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Ember son JR. Rob 2: a revised tool for assessing risk of bias in randomised trials. bmj. 2019 Aug 28;366.

13. Vij R, Coll JA, Shelton P, Farooq NS. Caries control and other variables associated with success of primary molar vital pulp therapy. Pediatr Dent 2004;

26:214-20.

14. Nawras Maher Mostafa, Shady Ahmed Moussa. Mineral Trioxide Aggregate (MTA) vs Calcium Hydroxide in Direct Pulp Capping – Literature Review. On J Dent & Oral Health. 1(2): 2018.

15. Tziafas D, Smith AJ, Lesot H. Designing new treatment strategies in vital pulp therapy. JDent. 2000;28(2):77–92.

16. Farooq NS, Coll JA, Kuwabara A, Shelton P. Success rates of for Mo cresol pulpotomy and indirect pulp therapy in the treatment of deep dentinal caries in primary teeth. Pediatr Dent. 2000;22(4):278–86.

17. Tomer AK, Miglani A, Chauhan P. An In-Vitro Evaluation of Remaining Dentine Thickness through Cbct Using Different Files [Internet]. Vol. 16, IOSR Journal of Dental and Medical Sciences. 2017. p. 121–4. Available from: http ://dx. doi. org/ 10. 9790/ 0853-160 201 121 124

18. Stanley HR. Dental iatrogenesis. Int Dent J. 1994 Feb;44(1):3–18.

19. Garrocho-Rangel A, Quintana-Guevara K, et al. Bioactive tricalcium silicate- based dentin substitute as an indirect pulp capping material for primary teeth: a 12-month follow-up. Pediatr Dent 2017;39(5): 377–382.

20. Bogen G, Kim JS, et al. Direct pulp capping with mineral trioxide aggregate: an observational study. J Am Dent Assoc 2008Mar31;139(3):305–315.

21. Hayashi M, Fujitani M, Yamaki C, Momoi Y (2011) Ways of enhancing pulp preservation by stepwise excavation—a systematic review. J Dent 39 (2): 95–10.