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RESEARCH ARTICLE

MINERAL TRIOXIDE AGGREGATE VERSUS CALCIUM HYDROXIDE IN INDIRECT PULP TREATMENT OF PERMANENT TEETH: A SYSTEMATIC REVIEW.

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Abstract

Background: Different materials were used in the treatment of deeply decayed vital teeth. For many years, the gold standard for indirect pulp capping procedures was Calcium hydroxide. Nevertheless, the disadvantages reported with its use has led to its replacement with other materials such as mineral trioxide aggregate.

Objective: The purpose of this systematic review is to compare the effectiveness of mineral trioxide aggregate (MTA) and calcium hydroxide (CH) in indirect pulp treatment of permanent teeth.

Methods: Detailed search on PubMed, Web of science, Cochrane Library, Google and Ebsco databases was performed. Studies meeting the criteria for inclusion were accepted, and necessary information was independently extracted by 2 authors by means of a standardized form. Evaluation was done for the success rate and dentin bridge formation.

Results: The inclusion criteria were met in three studies that were processed for data extraction and qualitative assessment.

Conclusions: Due to presence of high risk of bias in the included studies, there is no conclusive evidence on the superiority of one material over the other.

Background:-

The conventional procedure for indirect pulp treatment comprises the application of a bacteriostatic/bactericidal agent, such as calcium hydroxide, over the remaining dentin caries to encourage remineralization and pulp protection **(Falster et al., 2002)**. However, several weaknesses were documented with the use of calcium hydroxide material as: the presence of tunnels in dentin barrier, excessive dentin formation obliterating the pulp chamber, absence of adhesion and solubility in oral fluids **(Accorinte et al., 2008).** New materials have evolved recently as alternatives to CH because of its fore mentioned disadvantages. MTA became a widespread alternative for CH **(Camilleri 2008).**

This systematic review aimed to compare the effectiveness of mineral trioxide aggregate (MTA) and calcium hydroxide (CH) in indirect pulp treatment of permanent teeth.

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Materials and Methods:-

Identifying the review Question:-

Firstly, a PICO structure (Patient, Intervention, Comparators, Outcome) was used for the development of the research question as follows:

Patient / Population: Permanent teeth with deep caries.
Intervention: Indirect pulp treatment using Mineral trioxide aggregate
Control/ Comparator: Indirect pulp treatment using Calcium hydroxide.
Outcome measures: success rate and dentin bridge formation.

Research Question:-

In deeply decayed permanent teeth, will indirect pulp treatment using CH in comparison to indirect pulp treatment using MTA differ in terms of success rate and dentin bridge formation?

Search Strategy:-

In the present study, PubMed, Web of science, the Cochrane Library, Google and Ebsco were used as the electronic databases. The following key words were used: indirect pulp capping, indirect pulp cap, indirect pulp therapy, indirect pulp treatment, MTA, mineral trioxide aggregate, calcium hydroxide and Ca(OH)2. Additional search methods included a manual review of the reference lists of relevant studies.

Figure 1. Flow diagram for the search results.

Inclusion Criteria:-

1. Randomized controlled trials (RCTs),
2. Indirect pulp treatment on permanent teeth,
3. Studies comparing mineral trioxide aggregate and calcium hydroxide,
4. The success rate and or dentin bridge formation were recorded.

Data Extraction:-

Studies that fulfilled the inclusion criteria were processed for data extraction. Two authors independently extracted the necessary information. The following information were extracted from each study: year of publication, country of origin, study design, informed consent obtained, ethical approval, funding, setting, aim of the study, participants age, numbers and gender, inclusion and exclusion criteria, details of material, methods, restoration, duration of follow up, principal and secondary outcome measures, methods of assessing outcome measures and studies results.

Methodological Quality Appraisal:-

Assessment of the quality of included studies was performed using the Cochrane Collaboration's tool for assessing risk of bias.

Results:-

Results Characteristics of Included Studies:-

From 62 potentially relevant studies, only 3 studies were eligible **(Leye Benoist et al. 2012, Petrou et al .2014 and Sultana et al. 2016)**. Two studies reported the success rate **(Leye Benoist et al. 2012 and Petrou et al. 2014).** The success rate was higher for MTA compared to CH in both studies as follows: (MTA 94.5 %, CH 86.9 %, p =0.72) and (89.6% with MTA, and 73% with CH, P = 0.63). Also, two studies **(Leye Benoist et al. 2012 and Sultana et al. 2016)** reported the dentin bridge formation. **Leye Benoist et al .2012** showed that at 6 months, there was an increase of 0.235 mm with MTA and of 0.221 mm with CH. No statistically significant difference was found in the dentine thickness between the two groups. While, **Sultana et al. 2016** showed that at 12 months' observation period, 24 teeth (96%) of MTA and 19 teeth (76%) of CH with reparative dentin formation.

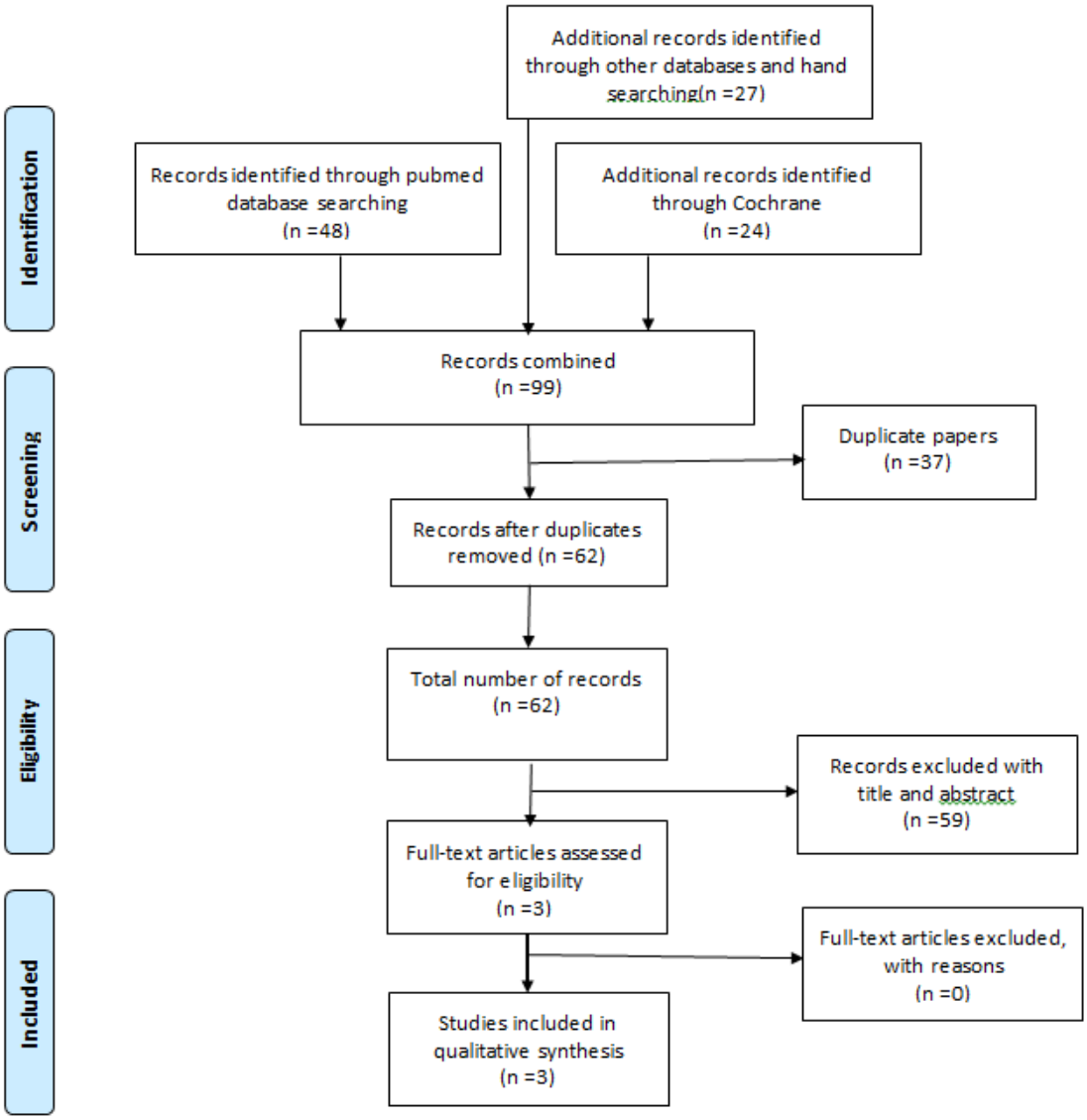

Figure 1:- Flow diagram for the search results.

Results of Methodological Quality Assessment:-

The three studies were assessed using the Cochrane Collaboration's tool for assessing risk of bias. Table 4, shows the findings for each risk of bias in each study. All studies revealed randomization, but they failed to define means for random sequence generation and did not sufficiently define allocation concealment. Blinding of the participants and personnel was mentioned in only one study that MTA and CH could be distinguished by the operator and so a double-blind clinical trial was not possible. Regarding the assessments of the outcomes in two studies, there was blinding of the assessor and detection bias was considered low risk. A description of withdrawals and dropouts was given in two studies. other sources of bias were not found in the three studies.

Table 1:- The Characteristics of the Included Studies.

Reference		Details of Study						
	Country of origin	Year of publication	Study design	Informed consent obtained?	Ethical approval	Funding	Setting	Aim of study
Petrou et al. 2014	Germany	2014	prospective in vivo clinical trial with three parallel treatments arms	yes	The study was approved by the ethical committee University of Greifswald/Germany	Not mentioned	The dental clinic of Greifswald University and in a private practice.	To compare the clinical and microbiological outcomes of mineral trioxide aggregate (MTA), medical Portland cement, and calcium hydroxide on the dentin–pulp complex of permanent and primary teeth treated with two-step IPT.
Leye Benoist et al. 2012	Senegal	2012	single-blind clinical trial	yes	The study had been approved by the ethics commission of the institution.	The study was not financed by any company or manufacturer and has no commercial aim.	The faculty clinic of the Department of Dentistry, University Cheikh Anta Diop, Dakar, Senegal.	To assess the effectiveness of mineral trioxide aggregate (MTA) used as an indirect pulp-capping material in human molar and premolar teeth.
Sultana et al. 2016	Bangladesh	2016	prospective comparative study.	yes	The proposed study protocol was approved by the Ethical Review Committee, BSMMU	Not mentioned	The Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, BSMMU	To assess the clinical and radiological outcomes of MTA and calcium hydroxide as indirect pulp capping agents in deep carious lesions of permanent teeth

Table 2:- Data Extraction of the Included Studies (participants and intervention).

	Participants				Interventions				
	Number	Age:	Gender	Inclusion and exclusion criteria	Grouping	Details of material	Methods	Final rest	Duration of Follow up
Petrou et al.	Eighty-six	17.2 year	-51	(a) deep caries lesion with absence of	Three groups	(a) Aqueous suspension of	Partial	Glass ionomer	6 m

2014	teeth	s ±13.8	% Male; -49 % Female	radiolucencies at the periapical regions (b) Absence of pulp exposure, fistula, swelling of periodontal tissues, abnormal tooth mobility, and history of spontaneous pain;(c) Healthy appearance of adjacent gingiva;(d) Normal tooth color;(e) Positive vitality. Whereas non-restorable teeth or without functional use were excluded from the study.	: (a) calcium hydroxide (b) medical Portland cement (c) pure White MTA	calcium hydroxide (Greifswald University Pharmacy, Germany); (b) medical Portland cement (Holcim 103, White Portland Cement CEM) (c) pure White MTA (Ledermix® MTA, Riemser)	caries removal on 2 visits, 6 months interval	resin-enforced zinc oxide eugenol followed by Compomer and amalgam	
Leye Benoist et al. 2012	60 paired permanent teeth (30 in each group)	16–34 years	-34 Male -26 Female	Active deep carious lesion on either the occlusal or proximal surface with reversible pulp inflammation. Teeth with periodontal lesions, internal or external root resorptions, and patients with systemic medical conditions, were excluded from the study.	Two groups: (a) calcium hydroxide (b) MTA	MTA (ProRoot; Dentsply ⁄ Tulsa Dental, Tulsa, OK, USA) and calcium hydroxide material (Dycal_ Ivory, Dentsply Caulk, Dentsply, L.D. Caulk, Milford, DE, USA)	One visit	Glass ionomer cement placed during the 6-month evaluation period . The final restoration was either amalgam or composite	6 m
Sultana et al. 2016	Fifty permanent teeth from 43 patients	16-30 years		Permanent teeth having a deep carious lesion closer to but not involving the pulp, having reversible pulp status based on the clinical sign, symptom, and radiograph and could be restorable.	Two groups: (a) calcium hydroxide (b) MTA	Calcium hydroxide powder (Deepti Dental Product, India) mixed with normal saline MTA (Proroot, Dentsply, Tulsa Dental, USA) powder mixed with sterile water in a 3:1 ratio.	One visit	The base of the cavity was filled with FujiIX glass ionomer cement and restored by composite restoration (Giomer)	12 m

Table 3:- Data Extraction of the Included Studies (outcomes and results)

Reference	outcome		Results
	Principal and secondary outcome measures	Methods of assessing outcome measures	
Petrou et al. 2014	The success rate -Clinical (color, humidity, and consistency of dentin) -Microbiological (Lactobacilli/Mutans Strep. counts)	-The color of the dentin either: light yellow, yellow, light brown, dark brown, or black. -The consistency of the dentin either: very soft, soft medium hard or hard - The existence of humidity(wet/dry)	The success rate (MTA 94.5 %, Portland cement 90.5 %, CH 86.9 %, χ2-test p =0.72).
Leye Benoist et al. 2012	The success rate and the thickness of the newly formed dentine	-Maintenance of pulp vitality with a normal response to thermal and electrical tests without signs of spontaneous pain. -Dentine bridge formation and no furcation radiolucency, periodontal ligament space widening, internal or external root resorptions.	At 3 months, the clinical success rates of MTA and calcium hydroxide were 93% and 73%, respectively (P = 0.02). At 6 months, the success rate was 89.6% with MTA, and remained steady at 73% with calcium hydroxide (P = 0.63). The mean initial residual dentine thickness was 0.23 mm, and increased by 0.121 mm with MTA and by0.136 mm with calcium hydroxide at 3 months. At 6 months, there was an increase of 0.235 mm with MTA and of 0.221 mm with calcium hydroxide
Sultana et al. 2016	Postoperative pain, the vitality of the pulp and formation of reparative dentin	Pain assessment was performed according to VAS (Visual Analogue Scale) system. Pulp vitality was assessed by vitality test. Reparative dentin formation was assessed by means of intraoral periapical radiograph (IOAP). Reparative dentin formation was observed (present/absent) from the radiograph.	In all observation periods, MTA showed more capable of reducing pain and maintain pulp vitality which was statistically significant than that of calcium hydroxide. At12 months observation period, 24 teeth (96%) of MTA and 19 teeth76%) of calcium hydroxide showed reparative dentin (formation.

Table 4:- Assessment of the quality of included studies

	Random sequence generation*	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment.	Incomplete outcome data	Selective reporting
Leye Benoist et al. 2012	*High risk*	*High risk*	*Participants: unclear Operator: Low risk*	*Clinical assessor: unclear Rad. Assessor: Low risk*	*Low risk*	*Unclear*
Petrou et al. 2014	*Unclear*	*Unclear*	*Unclear*	*Unclear*	*High risk*	*High risk*
Sultana et al. 2016	*Unclear*	*Unclear*	*Unclear*	*Low risk*	*Unclear*	*Unclear*

Interpretation:-

The available studies showed a higher success rate for MTA compared to CH. Also, more dentin bridge formation was shown with MTA. Regarding the quality of the investigated studies (Table 4), a high risk of bias was found.

Conclusions:-

Due to presence of high risk of bias in the included studies, there is no conclusive evidence on the superiority of one material over the other.

Further, high quality and long span clinical trials for indirect pulp treatment materials are still required to assess the most effective material owing to the high risk of bias and the short-term follow-up in the available studies.

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