

Evaluation of the Success of Biodentine Compared to Mineral Trioxide Aggregate as PULP Rehabilitation Agents in Primary Dentition- A Systematic Review

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ABSTRACT

Aim: To systematically evaluate the success of Biodentine and MTA as pulpotomy agents in primary dentition.

Introduction: The American Academy of Paediatric Dentistry (AAPD) recommends performing a pulpotomy on primary teeth when there is significant decay and pulp exposure but no signs of radicular pathology or complaints.

Materials and methods: Electronic resources like PubMed Central, the Cochrane Database of Systematic Reviews, Google Scholar, Lilacs, and Science Direct were used to conduct a thorough search. Relevant publications were found by screening the title and abstract, and those articles were then further assessed for inclusion by reading the complete text. In order to locate more research published outside the electronic database, the bibliographies of all recognised papers were searched. All randomised control trials utilising Biodentine and MTA for pulpotomy of primary molars were chosen.

Results:Digital databases like PubMed Central, the Cochrane Database of Systematic Reviews, Google Scholar, Lilacs, and Science Direct were used to conduct a thorough search. Relevant articles' titles and abstracts were reviewed, and after reading the complete paper, those studies were further assessed for inclusion. The bibliographies of all acknowledged papers were explored in an effort to find further research that was published outside of the electronic database. For pulpotomy of primary molars, all randomised control studies involving Biodentine and MTA were selected.

Conclusion: Between Biodentine and MTA, there was no discernible change. The superiority of one substance over another is not currently supported by the evidence. A larger sample size is to be conducted, along with a consistent follow-up timeframe.

Keywords: Primary molars, Pulpotomy, Biodentine, MTA

Introduction :

Cavities is one of the most common disease impacting kids and teenagers worldwide (Kassebaum et al. 2017). The main reason for the rapid spread of caries in primary teeth (Smail-Faugeron et al. 2018) is the protrusion of enamel, dentin thickness and pulp angle. Preserving the structural integrity of the teeth and preserving the importance of the teeth is the main purpose of the care of milk teeth. This helps to preserve the structure of the teeth, thus preserving the sound, beauty and chewing function before they fall out. Improper treatment of the infection can lead to inflammation and abscesses that reduce quality of life. (King, Anthonappa, and Itthagaran 2007; Gudipaneni et al. 2022).

Pulpotomy according to the American Academy of Pediatric dentistry (AAPD) is to be performed in primary teeth with extensive decay and pulp exposure without the evidence of any radicular pathology and symptoms (Academy of Pediatric Dentistry 2016) Pulpotomy according to Ranly et al (Ranly 1994) can be classified based on the treatment objectives as devitalization of the pulp (mummification, cauterization), preservation of pulpal tissue (non inductive and minimal devitalization) or regeneration of pulpal tissue which includes inductive and reparative (Subramanyam and Somasundaram 2020).

Formocresol was the industry-standard pulpotomy material for primary teeth (MTA) before Torabinejad invented Mineral Trioxide Aggregate, a calcium silicate substance (Academy of Paediatric Dentistry 2016).

MTA is the most popular pulpotomy agent (Bossù et al. 2020) as it shows a lower failure rate and superior performance when compared to other materials (Teja et al. 2021). Though MTA is the most preferred material currently being used, it has various drawbacks which include the discoloration of the crown structure (Ramos et al. 2016; Teja and Ramesh 2021), a prolonged setting time of more than 2 hours, handling properties and high cost (Lin et al. 2014).

In order to remedy this, Septodont produced a new calcium silicate substance in 2009. It can be used as a retrograde filling material and has a quicker setting time (S. Mohanty and Ramesh 2020). The effectiveness of MTA to biodentine as pulpotomy agents has only recently been evaluated in a small number of clinical investigations because the substance was just recently released on the market (Ravindran et al. 2022; Bramhecha and Sandhya 2021). Due to the significance of these materials and their application in clinical practice (Swati Mohanty and Ramesh 2020; Akshayaa, Ravindran, and Madhulaxmi 2021; Alfawaz et al. 2018), this study was conducted. This study evaluated various clinical trials which had studied the rates of success in pulpotomies using two calcium silicate cements (MTA and Biodentine) in primary teeth.

Methodology

The Cochrane Handbook of Systematic Review and Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) criteria were followed for conducting this review.

Information sources and search strategy

A mixture of key terms including pulpotomy, clinical and radiographic success rate, calcium silicate cements, MTA, Biodentine, primary teeth, and mandibular molars were used in electronic searches. After being created for the Medline search, the MeSH search terms and methodology were applied to additional electronic databases. MEDLINE from 2000 to the present, the Cochrane Central Register of Controlled Trials, LILACS, Google Scholar, and Science Direct were the databases that were searched until April 2022. The references of the included studies and reviews were searched for appropriate research to assure literature separation. Open SIGLE database was used to search additional non indexed studies and grey literature.. Only English-language studies were included.

Criteria for study selection process

Participants in this study are required to have pulpotomized carious deciduous mandibular molars. Children between the ages of three and nine were the focus of this review. The key finding is the clinical and radiological performance of Biodentine and MTA in primary molars. Clinical success is characterised as the absence of sudden pain and/or sensitivity to pressure, as well as the absence of sinus, fistula, edoema. It is regarded as effective radiographically if there is no infection at the interradicular and/or the root regions and no internal or exterior resorption of roots. The pulp capping agents based on calcium silicate, Biodentine and MTA, are two of the intervention techniques

Types of studies included:

- Randomized controlled / Split mouth trials involving pediatric dental patients requiring pulpotomy using Biodentine and MTA.

- Studies published in English language only, as the authors skills pertain to that language alone.

Exclusion criteria:

The following exclusion criteria were used to eliminate studies.

- Studies involving children above 9 years of age.
 - Studies with other calcium silicate based pulp coating agents
- Invitro and Animal studies
- Ongoing studies with unpublished results
- Research published in languages other than English

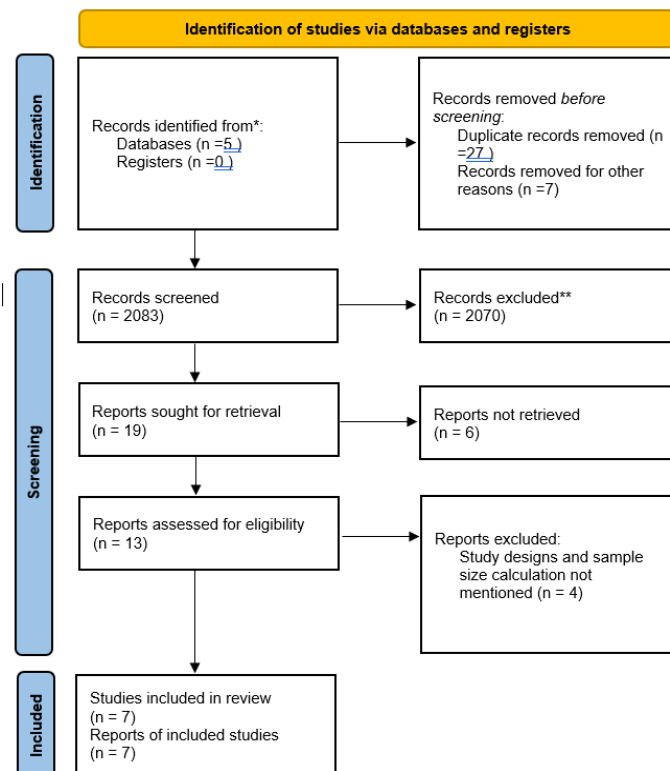


Fig 1: PRISMA flow chart depicting the study selection process

PUBMED search strategy:

Using the following keywords, an advanced search of the Pubmed search engine was conducted:

((((((Primary teeth) OR (Primary dentition)) OR (Deciduous teeth)) OR (Deciduous dentition)) OR (Milk teeth)) OR (temporary)) AND ((((((mta) OR (mineral trioxide aggregate))) AND (biodentine)) OR (calcium silicate cements)) OR (dentine substitute)) OR (bioaggregate) ("mta"[All Fields] OR)) AND ((((((pulpotomy) OR (endodontics)) OR (pulp capping)) OR (vital pulp therapy)) OR (pulp treatment)) OR (pulp exposure)) OR (partial pulpectomy))

The search resulted in 12 studies.

PubMed search strategy [Figure 2]

#	Search	Results	Time
#17	vital pulp therapy	1,331	10:50:08
#16	pulp capping	2,787	10:49:58
#15	endodontics	49,578	10:49:34
#14	pulpotomy	1,958	10:49:20
#13	bioaggregate	117	10:49:09
#12	dentine substitute	491	10:48:48
#11	calcium silicate cements	782	10:48:40
#10	biodentine	861	10:48:30
#9	mineral trioxide aggregate	2,841	10:47:37
#8	mta	10,659	10:47:23
#7	temporary	69,460	10:46:35
#6	natal	32,064	10:45:47
#5	Milk teeth	14,418	10:45:39
#4	Deciduous dentition	14,293	10:41:19
#3	Deciduous teeth	14,835	10:41:03
#2	Primary dentition	15,801	10:39:31
#1	Primary teeth	20,598	10:39:06

History and Search Details

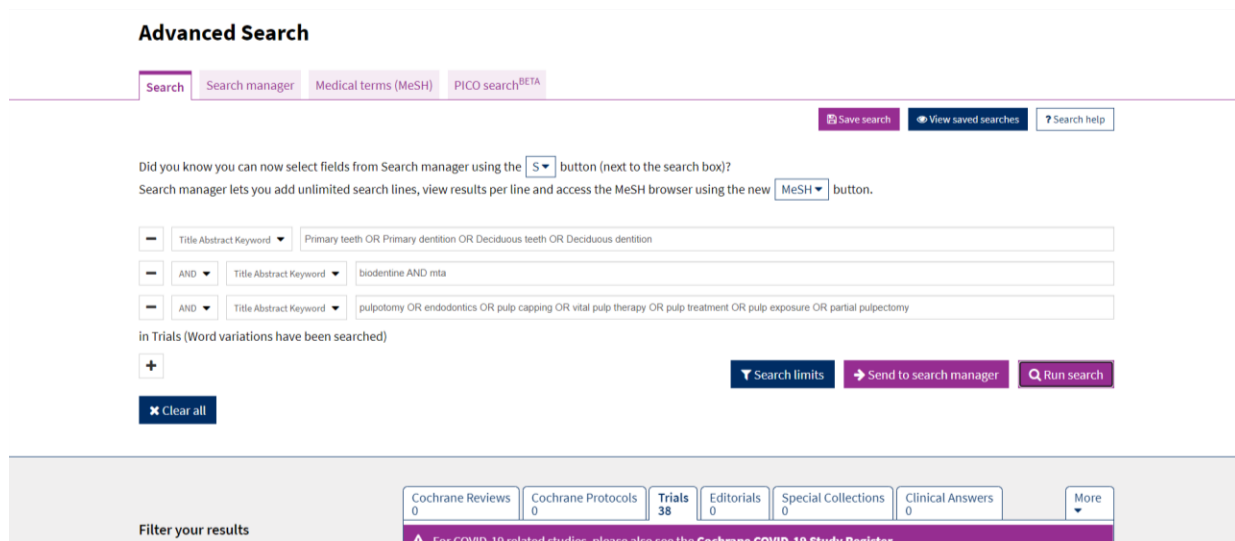
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Search	Actions	Details	Query	Results	Time
#25	...	!	Search: (((((((Primary teeth) OR (Primary dentition)) OR (Deciduous teeth)) OR (Deciduous dentition)) OR (Milk teeth)) OR (temporary)) AND ((((((mta) OR (mineral trioxide aggregate))) AND (biodentine)) OR (calcium silicate cements) OR (dentine substitute)) OR (bioaggregate) ("mta"[All Fields] OR)) AND (((((((pulpotomy) OR (endodontics)) OR (pulp capping)) OR (vital pulp therapy)) OR (pulp treatment)) OR (pulp exposure)) OR (partial pulpectomy))	92	11:06:39
#24	...	>	Search: (((((((pulpotomy) OR (endodontics)) OR (pulp capping)) OR (vital pulp therapy)) OR (pulp treatment)) OR (pulp exposure)) OR (partial pulpectomy)	61,653	11:06:13
#23	...	!	Search: ((((((mta) OR (mineral trioxide aggregate))) AND (biodentine)) OR (calcium silicate cements) OR (dentine substitute)) OR (bioaggregate) ("mta"[All Fields] OR	629	11:05:57
#22	...	>	Search: (((((((Primary teeth) OR (Primary dentition)) OR (Deciduous teeth)) OR (Deciduous dentition)) OR (Milk teeth)) OR (temporary)	91,992	11:05:39
#21	...	>	Search: partial pulpectomy	107	10:51:22
#20	...	>	Search: pulp exposure	3,306	10:51:13
#19	...	>	Search: pulp treatment	21,964	10:50:45

Strategy for search using COCHRANE [Figure 2]

The following keyphrases were utilised in an advanced Cochrane search:

[Primary teeth OR Primary dentition OR Deciduous teeth OR Deciduous dentition] AND [biodentine AND mta] AND [pulpotomy OR endodontics OR pulp capping OR vital pulp therapy OR pulp treatment OR pulp exposure OR partial pulpectomy]

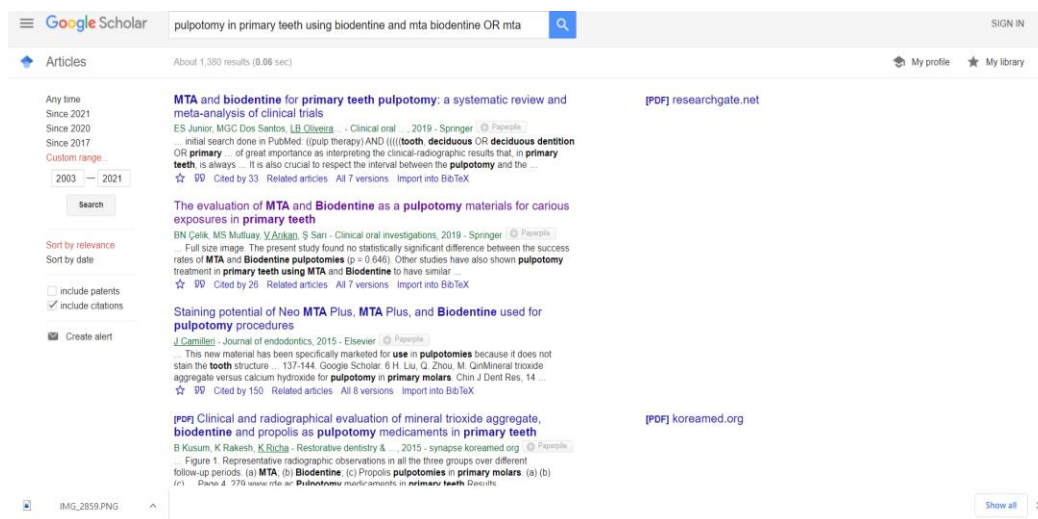


The search yielded in 38 studies.

Search strategy using Google Scholar [Figure 3]

Google Scholar search engine was searched using the following keywords with advanced search engine:

[Primary teeth OR Primary dentition OR Deciduous teeth OR Deciduous dentition] AND [biodentine AND mta] AND [pulpotomy OR endodontics OR pulp capping OR vital pulp therapy OR pulp treatment OR pulp exposure OR partial pulpectomy]



The search yielded in 1380 results.

Science Direct search strategy [Figure 4]

Science Direct search engine was searched using the following keywords with advanced search engine:

[Primary teeth OR Primary dentition OR Deciduous teeth OR Deciduous dentition] AND [biodentine AND mta] AND [pulpotomy OR endodontics OR pulp capping OR vital pulp therapy OR pulp treatment OR pulp exposure OR partial pulpectomy]

The search yielded in 653 articles.

LILACS search strategy [Figure 5]

LILACS search engine was searched using the following keywords with advanced search engine:

[Primary teeth OR Primary dentition OR Deciduous teeth OR Deciduous dentition] AND [biodentine AND mta] AND [pulpotomy OR endodontics OR pulp capping OR vital pulp therapy OR pulp treatment OR pulp exposure OR partial pulpectomy]

	Search	in field	
1	((((Primary teeth) OR (Primary dentition)) OR (Deciduous teeth)) OR (Deciduous dentition)) OR (Milk teeth)) OR (temporary [Words] and (((((mta) OR (mineral trioxide aggregate))) AND (biodentine) OR (calcium silicate cements) OR (dentine substitute)) OR (bioaggregate) [Words] and (((((pulpotomy) OR (endodontics) OR (pulp capping)) OR (vital pulp therapy)) OR (pulp treatment)) OR (pulp exposure)) OR (partial pulpectomy) [Words]	Words	index
2	and	Words	index
3	and	Words	index

The search yielded in 0 articles.

Data extraction and Data item

First author (NV) performed the detailed data search and the first and second author (NV and GJ) performed data extraction independently and then scrutinized them together using a form for extraction of data. Based on the characteristics of the studies, data was collected. The main features that were included were the author and year the study was carried out; design of the trial; age group and number of samples selected; pulpotomy agents; primary and secondary evaluated.

Assessment of the quality included studies:

The assessors independently assessed the risk of bias of included studies. The instrument used to evaluate the included studies risk and quality was review Manager 5.2. utilizing a variety of criteria, including selection bias, attrition, performance bias, and observational bias.

- **Random sequence generation (selection bias)**
- **Allocation concealment (selection bias)**
- Blinding of participants and personnel (Performance bias)
- Blinding of outcome assessment (Detection bias)
- Adequate reliability

Table 3: Characteristic of Included studies

Sno	Author/Year	Country	Study Design	Sample Size	Age	Pulpotomy agents used	Clinical and radiographic scoring criteria	Follow up Period
1.	Habashy 2020	Egypt	Double-blinded, split-mouth, randomized, controlled	30 primary molars, 10 children	2-6 years	MTA Biodentine	Not mentioned	3,6,12 months
2.	Ahuja et al 2020	India	Single-blinded, two-arm randomized controlled clinical trial	60 primary molars	4-7 years	MTA Biodentine Formocresol	Not mentioned	3,6,9 months
3.	Rajasekharan et al 2016	Belgium	Parallel-design,	82 primary	3-8 years	Protooth MTA Biodentine	Zurn & Seale	1,6,12,18 months

			randomized controlled clinical trial	molars		Tempophore	(2008)	
4.	Ramanandvignesh et al 2020	India	Randomized Control Trial	54 primary teeth	4-9 years	MTA Biodentine Er,Cr:YSGG Laser	AAPD criteria	3,6,9 months
5.	Walid et al 2021	Egypt	Split-mouth controlled clinical trial	84 primary teeth	3-7 years	MTA Biodentine	AAPD criteria	1,3,6,12 months
6.	Carti et al 2021	Turkey	Randomized Control Trial	50 primary teeth	5-9 years	MTA Biodentine	Not mentioned	1, 3,6,12 months
7.	Fernandez et al 2015	Spain	Randomized open label clinical trial	90 primary teeth	4-9 years	MTA Biodentine	Not mentioned	6 and 12 months

RESULTS:

Search results

2061 papers were found by searching electronic databases, and their eligibility was determined.

The headlines were examined and eliminated 13 articles.

There were 11 full-text publications evaluated.

Four articles were disqualified because they didn't meet the criteria for inclusion.

Chart 1 depicts the PRISMA flow diagram for the studies included.

Studies not pertaining to the inclusion criteria were excluded and the reason for exclusion are mentioned in Table 1, which gives the characteristics of the studies.

Characteristics of the study

Characteristics of the included studies were mentioned and the Outcome of these studies were assessed clinically and radiographically [Table 3]. Habashy et al, 2020 conducted pulpotomy procedures in 10 children (2-6 years) under GA using a 'double blinded approach'. The materials used were Biodentine and MTA with a follow up period of 6, 12 months. Internal root resorption was seen more in the Biodentine group but was not statistically significant.

Ahuja et al, 2020 compared Biodentine, MTA and formocresol as pulpotomy agents in 60 primary molars in

children from 4-7 years of age. Biodentine showed a hundred percent success rate, when compared to MTA and formocresol.

Rajasekharan et al, 2016 conducted a parallel design study in 58 children of 3-8 years. Double blinding was done and the clinical and radiographic success rates were evaluated 1, 6, 12, 18. It was found that there was no difference in the success rates of Biodentine and MTA.

Ramanand vignesh et al in 2020 conducted a similar such study but added lasers as the third group. The follow up was at 3, 6 and 9 month intervals. The highest success rate was seen in Biodentine but was not statistically significant.

The only split mouth study included in this systematic review was done by Walid et al which involved 21 children from the age 3-7 years. A follow up period of 1,3,6,12 months was done clinically and radiographically. The results showed that there was no statistical difference in the success rates in using Biodentine and MTA.

Carti et al in 2021 conducted a randomized control trial using Biodentine and MTA in 50 mandibular primary molars. Children ranged from 5-9 years. A follow up period of 1,3,6,12 months was done both clinically and radiographically. MTA showed better results when compared to Biodentine but it was not statistically significant.

Fernandez in 2015 conducted a randomized control trial in children of 4-9 years. The teeth were evaluated at 6 and 12 month intervals. The radiographic failure rate was 97% in MTA and 95% in Biodentine, but the results were not significant.

Risk of Bias assessment

Based on these, assessment of risk of bias was done for the included studies [Table 5], [Figure 2 and 3]

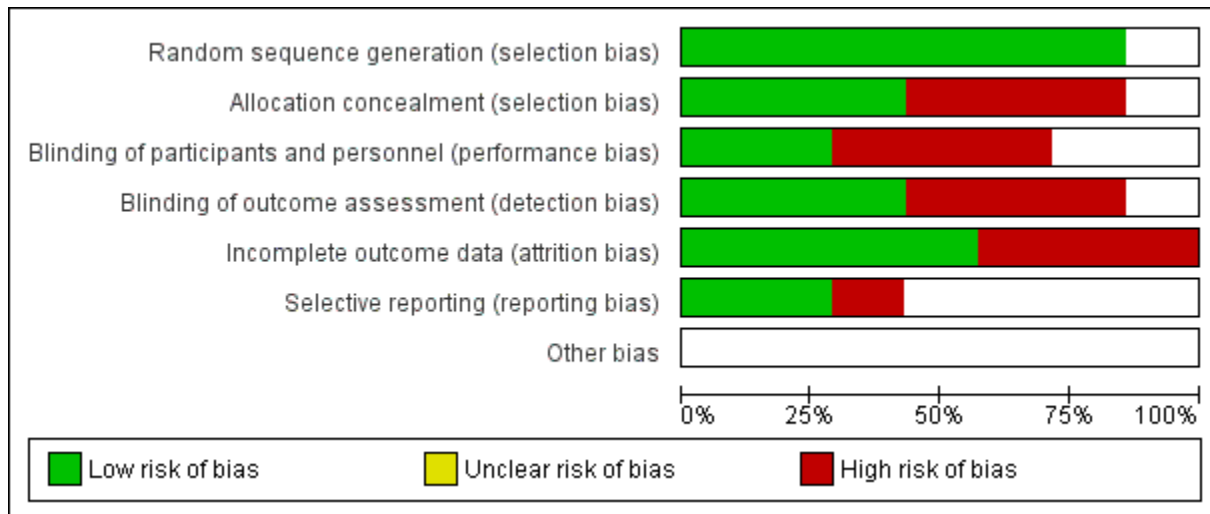
The studies relevant and pertaining to the criteria for inclusion were evaluated for the quality of the study, using the guidelines mentioned in the Cochrane Handbook of systematic reviews. All the relevant studies were included and the reasons for inclusion are mentioned in Table 3, which mention the characteristics of the included studies.

	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
Ahuja et al 2020		+	-	-	+		
Carti et al 2021	+	-	-		-		
Fernandez et al 2015	+	-		+	+	+	
Hebashy et al 2020	+	+	+	-	+		
Rajasekharan et al 2016	+	+	+	+	+	+	
ramanandvignesh et al 2020	+	-	-	-	-	-	
Walid et al 2021	+			+	-		

Figure 2: Risk of bias summary: Judgement about each risk of bias item for each included study

Figure 3: Risk of bias Graph: judgement about each risk of bias item presented as percentage among

included studies.percentage among included studies.



Discussion:

Pulpotomy is a vital pulp treatment which is routinely used in asymptomatic primary molars that are affected by caries. The chamber of the pulp is exposed and amputated but care is taken to leave the radicular pulp intact. This is protected by a pulp capping agent that promotes healing. Various materials have been used in pulpotomies, but recently silicate based materials have been gaining popularity. (Nowicka et al. 2013) showed that calcium based silicate materials formed a calcific bridge and a reduced pulpal response, which is more advantageous than the conventional formocresol method.

The main goal of this systematic review was to evaluate and examine the current scientific data about the effectiveness of Biodentine and MTA as pulpotomy agents in primary dentition. The success rate of Biodentine and MTA in pulpotomizing primary teeth was the outcome which was evaluated in all the trials included. Only 3 of the 7 studies mentioned the scoring criteria for the clinical and radiographic success. While the other two studies (Ramanandvignesh, Gyanendra, and Mridula 2020; Fouad and Al Gawad 2019) used the AAPD guidelines for scoring, the one study (Rajasekharan et al. 2017) used the Zurn & Seale (2008) scale.

This systematic review was conducted to find out which material had superior properties. Biodentine introduced by Septodont has a few advantages over MTA, such as ease of handling and shorter setting time(Cuadros-Fernández et al. 2016; Abdul Salam, Varghese, and Shenoy 2019).

The Cochrane database was used to conduct the quality evaluation, and the following criteria were looked at: production of random sequences, concealment of allocations, participant and researcher blinding, absence of complete data of the outcome results, and selective reporting. (Rajasekharan et al. 2017) found that there was a low probability of bias across the 7 RCTs. All studies mentioned randomization, but only three of them used allocation concealment. Due to the obvious visual differences between MTA and Biodentine, operator blinding could not be done. When the information from the clinical studies comparing the materials is combined, the findings reveal that Biodentine and MTA are similar

Due to some discrepancies in the selection criteria for participants, randomization, and sample group allocation, the majority of studies displayed a high or moderate risk of bias. The follow-up period of the research is the primary limitation of the studies included in the current systematic review. Different comparisons were hampered by different studies' use of different follow-up durations. The fact that only articles with English text were included in

the SR is one of the study's significant shortcomings. The research' usage of Protooth MTA or MTA may have made the SR's findings invalid. Last but not least, the majority of the studies had a moderate to high risk of bias, which lowers the quality of the evidence.

Conclusion:

Biodentine and MTA did not differ significantly from one another. The advantage of one substance over another is not differentiated by the available evidence. A bigger sample size with a consistent follow-up time should be used for future studies. used the AAPD scoring criteria.

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