

Review Article



Comparative Evaluation of Mineral Trioxide Aggregate and Biodentine as Dental Perforation Repair Materials in Patients Undergoing Endodontic Treatment: A Systematic Review of Case Reports

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ABSTRACT

Aim: To evaluate and compare case reports which used MTA and Biodentine as treatment modalities for dental perforation repair in teeth indicated for endodontic treatment.

Methods: The systematic review was conducted with comprehensive search conducted on electronic databases, MEDLINE/PubMed, Google scholar and Cochrane Library were used to find case reports. Characteristics of included trials and numerical data were extracted in duplicate by two reviewers using predetermined and piloted extraction forms. A title identified from the search was screened by one reviewer with a subsequent duplicate independent checking of their abstracts/full-texts retrieved by the electronic search against the eligibility criteria by another reviewer. The risk of bias of the included studies was assessed using The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews Checklist for Case Reports.

Results: Eight articles were selected from screening after inclusion and exclusion criteria. The publication year of studies varied from 2004 to 2020. The success rate was seen as encouraging in all the included studies, most commonly Biodentine gave better results than MTA. Biodentine was the commonly used repair material than MTA as was assessed by the outcome parameters. Included studies in these systematic reviews had an overall good quality as assessed from risk of bias which the future studies can follow.

Conclusion: Biodentine is more commonly used treatment modality giving better results than MTA in treatment of root perforations.

Keywords: Pulpotomy agents, dental perforation, pulp capping, root canal.

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INTRODUCTION

Root perforation is an unintentional or pathological communication between the pulp cavity and the periodontal tissue arising from iatrogenic errors, resorption or caries.¹ It is taken as a big challenge to the most renowned endodontic specialists and clinicians, symbolizing one of the most unpleasant accidents during the endodontic treatment.²

Overall, the ideal material for the perforation repair success must exhibit proper sealing, having biocompatibility, stimulating the cementogenesis and osteogenesis, being radiopaque, with easy manipulation, not being absorbable, having dimensional stability and not being soluble to tissue fluids.³ Different materials have been designed for the treatment of perforation, among these, we can cite the amalgam, zinc oxide, and eugenol cement, calcium hydroxide, resin cement, the hydroxyapatite, and glass ionomer.⁴ There are still some

lacunae over the ideal material for perforation repair success. There is a need to conduct a summative evidence which gives clear idea about the material which has proper sealing, biocompatibility stimulating the cementogenesis and osteogenesis, radiopaque, with easy manipulation, not being absorbable and which has dimensional stability.

We conducted this systematic review to evaluate and compare case reports which used MTA and Biodentine as treatment modalities for dental perforation repair in teeth indicated for endodontic treatment.

METHODOLOGY

The systematic review was conducted in accordance with the Preferred Reporting Items of Systematic Reviews (PRISMA) guidelines and Meta-analysis statement 2009.⁵ To evaluate and compare case reports which used MTA and Biodentine modalities for dental perforation repair in teeth indicated for endodontic treatment.

P: Teeth undergoing endodontic treatment

I: Biodentine

C: MTA

O: Success rate

S: Case reports



The inclusion and exclusion criteria included the following:

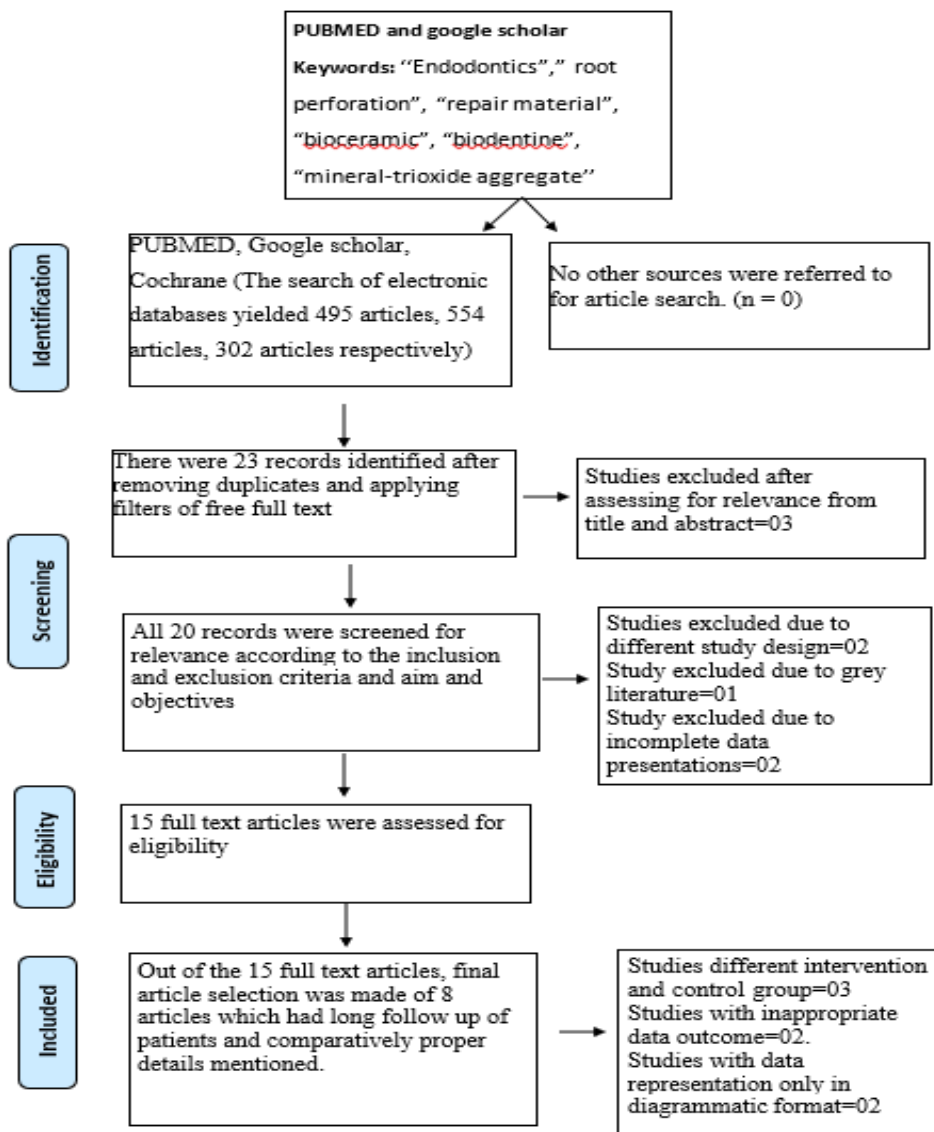
Inclusion criteria	Exclusion criteria
1. Mean follow-up time was more than 1 year.	1. Follow-up period was less than 1 year.
2. Involved tooth was in the permanent dentition.	2. Study did not involve patient treatment (e.g., studies on cell cultures or animal study).
3. Radiographic and clinical examination findings were available at follow-up, with the outcome determined with clearly defined criteria.	3. Publications were in the form of letters, commentaries, or narratives.
4. Publications were in English or foreign language, with full text available in either soft or hard copy.	4. No specified criteria were provided for evaluating the outcome of treatment, or there was no mention of how to determine the healing outcome.
	5. Patients without any chronic or systemic diseases

Literature search

A comprehensive search was conducted on electronic databases, additionally as by manual search, to spot all relevant studies associated with root perforation. MEDLINE/PubMed, Google scholar and Cochrane Library were used to find case reports, using “endodontics OR root perforation OR repair material OR bioceramic OR Biodentine AND mineral-trioxide aggregate”, as search keywords and the following Boolean operators were used. The search lined all articles printed from 1921 to 2021

Duplicate records were removed. Another search of the one electronic databases for reports of outcome was conjointly performed with the hope to not miss any potential reports that will be relevant to the present topic. Each prospective and retrospective case reports printed in English language were enclosed.

Search strategy:



Study selection

A title identified from the search was screened by one reviewer with a subsequent duplicate independent checking of their abstracts/full-texts retrieved by the electronic search against the eligibility criteria by another reviewer.

Substantial agreement between reviewers in the study selection process was obtained. After the same reviewers independently reviewed the full-text articles of the previous included studies, and studies which did not present any of the exclusion criteria were selected. Additionally, all references of the selected studies were manually screened for potentially relevant additional studies. Any possible discrepancies encountered during this process that is, inclusion or exclusion criteria, were resolved by discussion between the reviewers who selected the included studies. If a disagreement persisted, the judgment of a third reviewer was considered decisive.

Data collection process

Characteristics of included trials and numerical data were extracted in duplicate by two reviewers using predetermined and piloted extraction forms. Piloting of the forms was performed during the protocol stage until over 90% agreement was reached. Missing or unclear information was requested by the researchers.

Data extraction and data items

Information on authors' names, year of publications, study design, sample, inclusion criteria, groups of intervention, type of treatment, follow-up period, nature of treatment, method of outcome assessment, repair material used, success rate and results were assessed by two reviewers. Data regarding the included studies was also independently extracted by the reviewers based on a previously defined protocol in a specific form in the Microsoft Office Excel 2007 software (Microsoft Corporation, Redmond, WA, USA).

Risk of bias in individual trials:

To evaluate the risk of bias in individual studies, different tools were used for case reports. The risk of bias of the included trials was assessed using The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews Checklist for Case Reports.⁶ It was used for case reports. A main risk of bias assessment was included in the systematic review pertaining to each trial's primary outcome. Risk of bias within the studies was evaluated independently by two review researchers. The studies were classified as low risk of bias, unclear and high risk bias. The following domains were assessed: demographic characteristics, current clinical condition, test and results, interventions, post interventions, adverse events and takeaway lessons.

RESULTS

We followed the PRISMA guidelines for the methodology. The study selection process is summarized in Fig. 1 (PRISMA flow chart). All the titles and abstracts were screened based

on the stringent selection criteria. Subsequently the full texts were assessed independently by the two reviewers. A total of 08 studies over the past five decades met the inclusion criteria for full text reading and all 08 were included for further analysis.

Study characteristics

Eight articles were selected from screening of the above-mentioned number of articles by two independent reviewers. Following careful examination and discussion was conducted depending on the selection criteria by the reviewers. Any discrepancies in opinion were resolved by the third reviewer. Ultimately eight articles were finalized for qualitative synthesis. Studies meeting the inclusion criteria underwent validity assessment and data extraction. The studies that did not meet the inclusion criteria were excluded. The data provided in the selected studies should contain and were recorded in excel sheets under the headings: - author, year of study, study design, location, age, gender, sample size, tooth type and location, localization of perforation, treatment, follow-up period, outcome assessment, success rate and repair material used.

Eight studies were included for the qualitative synthesis. Out of the 08 studies, all the included studies were case reports. An overview of the included studies is presented in **Table 1**.

The publication year of studies varied from 2004 to 2020. The gender distribution was equal as in all overall individual studies. The sample size most common was 1 up to a maximum of 18. The age group of the subjects was in a range of 14 years to 35 years. One study did not mention the details regarding the age Group (Aziz A et al.)⁹ The tooth type when assessed was common as posterior teeth^{7,9,13,14} than the anterior and also the lower jaw^{7-8,13,14} (mandible) was common as tooth location when assessed for perforation repair. One study¹⁰ did not mention any details about the tooth type or location. The area of perforation was classified as apical, midroot and furcation. Specific study reported the perforation in furcation^{7,14} areas, midroot⁸ and apical⁹ while three studies reported perforation in labial region¹¹⁻¹³. The time occurrence and repair of location was common as 6 months^{13,14} in the included studies, even 3 and 4 months was also seen in two studies^{11,13} as time of event. Four studies⁷⁻¹⁰ did not mention any information regarding this outcome. All the cases were treated endodontically in a non-surgical protocol considered as primary treatment. The treatment period was varying in all the individual studies. Follow-up period averaged to 3 months in all the included studies. The outcome of the repairs was assessed as radiographs in all the included studies. The success rate was seen as encouraging in all the included studies, most commonly Biodentine gave better results than MTA. Biodentine was the commonly used repair material than MTA as was assessed by the outcome parameters. (**Table 2**)



Table 1: Demographic details of included individual studies

Sr. No	1 st Author and Year of Publication	Sample size	Age Group	Sex
1.	L. R. Surender et al. 2018 ³⁹	1	35-year	Female
2.	Rahul Grover et al. 2013 ⁴⁰	1	30year	Male
3.	Salman Aziz et al.2008 ⁴¹	2	NA	NA
4.	Douglas M. Ferris et al.2004 ⁴²	two groups of 18 participants	adults	Both male and female
5.	Dr. Ramaprabha Balasubramaniam et al.2017 ⁴³	2	15 yr old	Case 1: Female, Case 2: Male
6.	Richa Gupta et al. 2019 ⁴⁴	1	25yr old	Female
7.	Anaclea L. Heredia et al. 2016 ⁴⁵	1	28 yr old	Male
8.	Romana Nisar et al. 2020 ⁴⁶	1	14 yr old	Male

Table 2: Characteristic details of included individual studies

Sr. No	Tooth type	Tooth Location	Localization of perforation	Time between Occurrence & repair of perforation	Nature of treatment	Treatment period	Follow up period	Outcome assessmentmethod	Success rate	Repair material
1	Posterior	Mandible	Furcationarea	-	Retreatment	begins after 6 months of cause	few months	asymptomaticand radiographic evaluation	encouraging results	Biodentine
2	Anterior	Mandible	Midrootlevel	-	Primary treatment	3months	post 3months	"Patient was re-called after 3 months, clinically and radiographicallytooth was evaluated.	"In this case, we have preferred Biodentine instead of MTAs it has features which are superior to MTA. Its Consistency is better suited to the clinical use and it ensures a better handling and safety thanMTA. It does not require a two-step obturation as in the case ofMTA and itssetting is biocompatibility and sealing faster, therefore lower risk of bacterial contamination than with alkaline pH, with controlled MTA.	"a new material Biodentine, With physical properties far superior to those of MTA, especially in terms of setting time and Compressive strength, it exhibits the same characteristics of MTA and itssetting is biocompatibility and sealing faster, therefore lower risk of ability, after setting in an (size and spatialorganization) formation of calcium salts

3	"Case 1- posterior. Case 2- posterior (generalized taurodontism)"	Mandible	"Case 1- Strip perforation on distal surface of mesiobuccal Root Case 2- apical perforation of the distal canal"		Primary treatment	Case1- 2 months Case 2- 3months	6months	Asymptomatic and radiographic evaluation	"both cases showed successful MTA recovery in short period of recall visits	
4	-	-	-	-	-	1-2 days	60days	"Two of 18 gray-colored MTA samples leaked and three off-white- colored MTA samples leaked	There was no significant difference between the two types of MTA in preventing leakage of F.nucleatum postfurcal perforation repairs.	Mineral trioxide aggregate
5	upper right front tooth	Maxilla	"Case 1: iatrogenic perforation in 11 case 2: localized Gingival swelling in relation to labial aspect of 11	"case 1: trauma with avulsion of 11 three months Case 2: trauma and root canal treatment in 11 and 21 before one year.	"Case 1: non-surgical management of perforation Site using Biodentine and subsequent management of cosmetic contouring of 11. case 2: re-treatment of 11 was planned	not mentioned	Case 1: 2 weeks And 1year, Case 2: 2 weeks	Case 1: the site was completely debrided and sealed with Biodentine (manipulated according to manufacturer's instructions) (Septodont, France). Immediate post-operative x-ray was taken. Clinical evaluation two weeks later showed normal gingival appearance. Access cavity was sealed with composite and the necessary esthetic management of Cosmetic contouring was done. Case 2: The site was thoroughly debrided and cleaned. Biodentine (Septodont), was mixed according to manufacturer instruction and the perforation site was sealed.	Case 1: Clinical evaluation two weeks later showed normal gingival appearance. Access cavity was sealed with composite and the necessary esthetic management of cosmetic contouring was done. One year follow up X-ray and clinical photograph showed satisfactory healing. Case 2: Two weeks review showed satisfactory healing and the access cavity was sealed with composite. The crown preparation was modified and impression was taken. Postendodontic restoration was given in 11 and 21. Nine month follow up X ray and clinical photograph showed satisfactory healing.	Biodentine
6 ⁴⁴	right maxillary central incisor 6 months	Maxilla	perforation on labial aspect at middle third level of the root	6 months	nonsurgical root canal treatment and repair of the perforation	not mentioned	3 weeks And 18 months	no leakage	At the recall appointment after 3 weeks, tooth 11 was completely asymptomatic, the swelling had disappeared. Then the case was planned for an All Ceramic crown. Tooth preparation was done, and All ceramic crown was placed rehabilitating the total form and function of tooth. Case was followed up to 18 months showing no sign or symptom either clinically or radiographically.	Mixture of Biodentine powder (Septodont)



7	lower right posterior region	Mandible	perforation of 1.5 x 2mm on the floor of the chamber	6 months	repair of the perforation followed by root canal treatment	21	4 months	Reduced tenderness, no leakage	The canals were irrigated and obturated by lateral condensation on a four month follow up, a radiograph was taken which showed that the periapical radiolucencies had reduced considerably along with absence of radiolucency in the furcal area. The tenderness on percussion had subsided and there was no recurrence of the dentoalveolar abscess.	Biodentine
8	Right lower back tooth	Mandible	furcal perforation	4 months	repair with endodontic repair material	1 visit	no mention	No mention	No mention	Biodentine

Table 3: Risk of bias for included individual studies

Study	Demographic characteristics	Patient's history	Current clinical condition	Diagnostic tests and results	Intervention(s) or treatment procedure	Post- intervention clinical condition	Adverse events	Takeaway lessons
1	No	Yes	Yes	Yes	Yes	Yes	No	Yes
2	No	Unclear	No	Yes	Yes	Yes	No	No
3	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
4	No	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
5	No	Yes	Yes	Yes	Yes	Unclear	No	Yes
6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Assessment of risk of bias

The methodological quality of individual selected studies was done using the risk-of-bias assessment tool as elaborated in The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews Checklist for Case Reports. The results are presented in Table 3 as the risk of bias. The quality assessment of included 08 studies was done with 08 item questionnaire. All the studies showed unclear allocation concealment and not mention of blinding of participants or the outcome assessed. Included studies in this systematic reviews had an overall good quality as assessed from risk of bias which the future studies can follow. (Table 3)

DISCUSSION

An ideal material for perforation repair should be radiopaque, biocompatible, non resorable, should seal the perforation against bacterial ingress, and should induce healing in periodontal tissues.¹⁵ In recent years, various material like Biodentine, MTA plus have been introduced with the aim to overcome some of the disadvantage of the MTA.¹⁶ This systematic review we summarized and consolidated and aimed to answer the following question: To evaluate and compare case reports which used MTA and Biodentine modalities for dental perforation repair in teeth indicated for endodontic treatment

The search strategy was done using various electronic databases line PubMed and Google Scholar. Only case reports were identified in the search and were used in the present systematic review. Eight case reports were included which fulfilled the decided eligibility criteria. The systematic review tried to summarize the different treatment materials used for one of the commonest complication of endodontic treatment i.e. perforation. The commonly followed treatment material used is Biodentine and we also compared it with MTA. Although risk of bias of case reports is variable, careful quality assessment of the included studies allowed interpreting the results and summarizing the information more accurately based on the knowledge available to the date. Follow-up period averaged to 3 months in all the included studies.

The quality assessment was performed with The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews Checklist for Case Reports. Some studies did not appropriately report criteria inherent to this checklist, such as demographic characteristics, and details about adverse events. Non adherence to methodological principal of case reports increases the risk of bias, which ultimately diminishes the study's validity.

The type and location of furcation was assessed. The treatment material used was also recorded and it was found that Biodentine was more commonly used than MTA. The follow-up period varied from 3 weeks to 6 months.

A literature review by Kaur M et al. stated that Biodentine was advantageous over MTA owing to easy manipulation, low cost and faster setting. Compressive and flexural

strength are superior to that of MTA. Biodentine was the commonly used repair material than MTA, thus advocating maneuverability and economical factors fall in favour of Biodentine. Bansal et al.¹⁷ found out that Biodentine was superior to MTA Plus and ProRoot MTA after it exhibited a reduced hole at the edge of the root-end and dentin filling materials. Also, Nabeel et al.¹⁸ rooted for Biodentine in periradicular surgeries instead of ProRoot MTA despite the latter exhibiting greater sealing ability.

On the other hand, Mohan et al.¹⁹ assert that MTA provides a more efficient root perforation restoration compared to other perforation repair materials. Grover et al. (2020)²⁰, Kakani et al. (2020)²¹, Tang et al. (2019)²² hold that Biodentine has a better sealing ability compared to MTA.

In a systematic review by Abdulhassan H et al²³ uncovered that most of the previous researches found Biodentine to exhibit better clinical outcomes. Therefore, clinical practices can leverage this study to guarantee better clinical outcomes when dealing with root perforation repair. This was in consensus to our findings.

The treatment period was varying in all the individual studies. Follow-up period averaged to 3 months in all the included studies. The outcome of the repairs was assessed as radiographs in all the included studies. The success rate was seen as encouraging in all the included studies, most commonly Biodentine gave better results than MTA.

We had a limited access to small number of included studies and restricted access to databases. Also only case reports were included and we found substantial heterogeneity among these studies with respect to patient age, gender, comparator groups, and medicaments used for outcome measurement.

We recommend future studies to assess clinical trials to better contribute on a concrete conclusion and support our findings and build on our contribution through this study.

CONCLUSION

Although the results obtained from 08 studies appraised in this systematic review were conflicting, most of them verified the clinical efficacy of Biodentine compared to MTA in treatment of root perforations. Some of the researches have reported that no significant difference between both the agents, and most of the studies proposed better results (both rapid and long lasting) for MTA.

However, it can be concluded that, from this study that Biodentine is more commonly used treatment modality giving better results than MTA in treatment of root perforations.



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