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Comparative Study of MTA, Biodentine, and GIC for Root Perforation Repair: Clinical Outcomes and Properties

Xu Dong[1,2], Xin Xu[1,2*]

[1] State Key Laboratory of Oral Diseases and National Clinical Research Center for Oral Diseases, West China Hospital of Stomatology, Sichuan University, Chengdu, China
[2] Department of Cariology and Endodontics, West China Hospital of Stomatology, Sichuan University, Chengdu, China

***E-mail** ✉ xin.xu@scu.edu.cn

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ABSTRACT

A root perforation is any situation, whether pathologic or the consequence of an accident, that causes a direct connection between the pulp and periodontal tissue due to iatrogenic dental caries or reabsorption. This study aimed to determine the clinical characteristics and efficacy of MTA, biodentine, and GIC in mending root perforations. Articles were selected from the previously published scientific articles, and inclusion and exclusion criteria were met to ensure that only articles with pertinent information were taken into consideration for evaluation. The approach used was a systematic review. In this comprehensive analysis, the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were used. The main query is: Which material is better for the repair of root perforations, among MTA, biodentin, and GIC? The results indicate that since the majority of the research focused on biodentine, it is preferred over MTA and GIC. The clinical outcomes for the repair of root perforation with biodentine are better than those with GIC and MTA. According to this systematic review, most previous studies have shown that biodentine has better clinical outcomes. As a result, this study may be used by clinical practices to ensure improved clinical results when it comes to root perforation healing.

Keywords: MTA, Biodentine, GIC, Root perforations

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Introduction

Any situation that results in the direct connection between the pulp cavity and periodontal tissues due to reabsorption, iatrogenic, or dental caries is referred to as a root perforation, whether it is pathologic or the consequence of an accident [1, 2]. Many eminent physicians and endodontic subspecialties view root perforation as a difficult problem since it is thought to be one of the most unusual mishaps that occur during endocrine therapy. According to Mangala and Pawar [3], maintaining a functioning and distinctive dentition is necessary to have a highly attractive and tasteful state. However, several unheard-of circumstances, such as striking the root water divider, can occur during endodontic therapy. Wavdhane *et al.* [4] recognize the difficulty of a dentist's perforation repair.

The major objective of endodontic therapy is to guarantee that all germs within the root cavity or canal are eradicated and that the root trench structure is properly sealed, as Mangala and Pawar [3] note. Endodontic punctures, on the other hand, result in bacterial invasion, bone issues, periodontal access damage, and epithelial

proliferation, all of which can eventually cause tooth loss. It is thought that the main iatrogenic problem that might cause endodontic disorders is furcation punctures [3]. Root canal therapy, or RCT, is a multi-step process that is both more reliable and one of the most troublesome. An evaluation of root canal systems, the existence of confluence apices, the distance to the root end, and the symmetry of the two teeth must all be done. To accomplish effective therapy, it is crucial to repair these punctures using the best materials.

Notwithstanding the efforts, none of the solutions that have been developed to address root aperture issues have been demonstrated to properly repair pierced furcations. Zinc phosphate concrete, light-cure glass ionomer, amalgam, indium foil, calcium hydroxide, cavit, and glass ionomer concrete were among the materials utilized [3]. The problem with these materials is that they are unable to seal the gap between the root hole and the submerged tissues. To close the current puncturing gap, advanced materials, including glass ionomer cement (GIC), mineral trioxide aggregate (MTA), and biodentine, were needed. Based on the results of Alghamdi and Aljahdali [1] and Alazrag *et al.* [5], the ideal perforation fix material must be biocompatible, radiopaque, sealed tightly, non-absorbable, and simple to manipulate. The purpose of this comprehensive assessment is to assess the efficacy and therapeutic properties of MTA, biodentine, and GIC in treating root perforations.

Materials and Methods

This systematic review utilized the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. The focused question is: which material is the most effective in repairing root perforations between MTA, Biodentine, and GIC?

Search Strategy

Finding high-quality papers that might be utilized to offer high-quality information regarding the repair of root perforations was the goal of the search. The data was looked up using a variety of resources, including PubMed, ProQuest, and Google Scholar. During the search, several keywords were utilized. These consist of “biodentine,” “root perforation,” “repair material,” “glass ionomer cement,” and “mineral trioxide aggregate.”

Inclusion Criteria

Several requirements were part of the inclusion criteria that the chosen articles had to fulfill. First, all of the included papers were published in English and covered the years 2019–2021. The second group of papers that were reviewed included both human and animal studies. The third requirement was that the paper must discuss either mineral trioxide aggregate, glass ionomer cement, biodentine, or all three. Lastly, only papers in full text might be considered for evaluation.

Exclusion Criteria

Articles that discussed various repair materials without mentioning mineral trioxide aggregate, glass ionomer cement, or biodentine were excluded based on the first criterion. Studies that focused on the various therapeutic uses of restorative materials without a specific emphasis on root perforation constitute the second exclusion factor. The plan was to make sure the chosen publications were pertinent and provide the data required to demonstrate facts about MTA, GIC, and biodentine. Lastly, viewpoints, surveillance reports, and opinion pieces are additional articles that were not taken into consideration.

Every study that was chosen was examined to see if it satisfied the requirements for inclusion. Reading the abstract of certain articles and determining how well the summary encapsulated the topic’s keywords allowed for evaluation. Since their subjects were too general to provide all the information covered in those resources, other publications were examined in greater detail. Additionally, it was determined whether the references utilized in the research were produced by recognized experts and came from reliable databases. Above all, every paper that was chosen for evaluation underwent peer review. This action was taken to ensure that only trustworthy and legitimate data could be utilized to achieve the goals of this systematic review. Every article’s applicability was assessed, and those that met the inclusion requirements were scheduled for review. A total of 20 publications were selected from a pool of 150 studies following screening. According to relevance, the PRISMA flowchart in **Figure 1** shows the eligibility requirements for the removal and inclusion of publications.

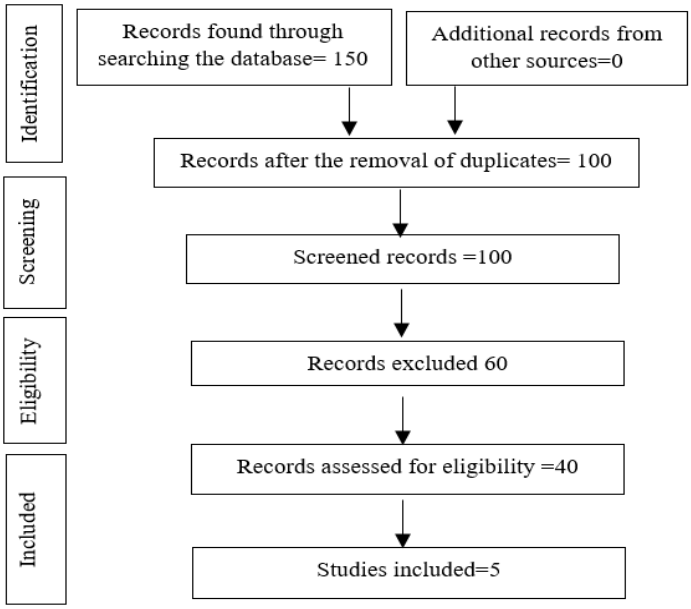

Figure 1. Eligibility criteria for inclusion and exclusion based on PRISMA guidelines

Bias Risk Assessment

All of the chosen articles underwent a bias risk evaluation using the Cochrane risk of bias evaluation method. Five domains—reporting, attrition, efficiency, selection, and additional bias—form the basis of this type of bias evaluation. As a result, bias is evaluated using a high, low, or uncertain verdict. The Cochrane danger of bias evaluation is displayed in **Table 1**. The total danger of biased judgment is displayed in **Table 2**.

Table 1. Cochrane risk of bias assessment

Domain	Description	High risk of bias	Low risk of bias	Unclear risk of bias	Reviewer assessment
Selection bias Random sequence generation	Explains the procedures used to generate an allocation sequence to determine whether or not comparable groups ought to be generated.	Selection bias is implied by inadequate random sequence generation.	For the production of random sequences, comparable groups have to be created.	Not described in enough detail	Judgment
Selection bias Allocation concealment	Techniques for hiding allocation that are mentioned	Insufficient concealment suggests bias in selecting.	The potential for not anticipating intervention allocations	Not enough details	Judgment
Reporting bias Selective reporting	It should include the analysis of selective result reporting.	Selective result reporting causes prejudice.	No discovery of reporting bias associated with the selected results.	Not enough details	Judgment
Other bias	Any other issues related to bias not covered	Concerns of bias resulting from problems not addressed elsewhere	No detection of other bias	Too little information to identify further bias	Judgment

Table 2. The overall risk of bias judgment

Study	Risk of bias judgment	Justification
[1]	Low risk of bias	No detection of any form of bias for the study.
[3]	Low risk of bias	No form of bias can be detected in the article.
[6]	Unclear risk of bias	Not enough details to reveal selection, reporting, and other biases.
[7]	Low risk of bias	There was no evidence of selection or reporting bias in the research.

[8]	Unclear risk of bias	The report doesn't explain how the various types of bias have been dealt with.

Results and Discussion

Twenty investigations that satisfied the standards for inclusion and exclusion were found as a consequence of the investigation. According to the selected keywords, 150 articles in total matched the search strategy. Nevertheless, 60 studies were eliminated from the 100 publications chosen for screening following the elimination of duplicate entries. At this stage, 40 articles qualified for evaluation since they were complete pieces. 5 of the 40 studies met the requirements to be part of the qualitative synthesis. These investigations specifically examined the roles of MTA, GIC, and biodentine in root perforation. Retrospective clinical investigations, randomized controlled trials (RCTs), in vitro research, and in vivo research are among the research that were gathered. Most of the articles covered many interesting topics. Some publications, for example, compare biodentine with GIC, while others compare biodentine and MTA, yet others compare biodentine and GIC. Some papers compared GIC, MTA, or biodentine with other materials utilized for root perforation, whereas other investigations focused on one of these three materials. An overview of the investigations is presented in **Table 3**.

Table 3. A summary of the studies

Study	Inclusion criteria	Findings
[1]	Addressed MTA and biodentine	There is no unanimity in regards to the most suitable repair material for root perforation.
[3]	Addressed biodentine, MTA, and GIC	Biodentine is superior to MTA in perforation sealing, even though the difference is insignificant statistically.
[6]	Addressed biodentine and MTA.	Biodentine is better than MTA for root-end filling due to the least margin gap at the edge.
[7]	Focused on MTA and biodentine, among other root perforation filling materials	Based on the leakage mean, MTA samples showed better results with a reduction in the value of the leakage mean after a month compared to Biodentine.
[8]	Addressed biodentine, GIC, and pro-root MTA	Biodentine showed better results compared to Pro-Root MTA and resin-modified GIC concerning sealing ability.

The overall conclusion drawn from the synthesized research was that the prognosis for root perforation is influenced by the physical and chemical characteristics of the materials employed. This systematic study set out to collect information about the various materials used to repair root perforations. To determine the best material for root perforation treatment, the systematic review gathered, evaluated, and synthesized high-quality research information from 20 publications. The overall findings indicate that the examined experiments validated the use of a variety of restorative materials for root perforation.

There is no consensus about the best material to use for treating root perforation, according to research by Alghamdi and Aljahdali [1]. According to some of the research they reviewed, Alghamdi and Aljahdali [1] found that when the sealing capacity of MTA and biodentine was evaluated, it was determined that there were no appreciable differences between the two materials, with biodentine being the preferred substitute for MTA. According to Mangala and Pawar [3], light-cured GIC permits higher dye leakage than MTA and biodentine. Biodentine was shown to be better than MTA Plus and ProRoot MTA by Bansal *et al.* [6] because it showed a smaller hole at the margin of the root end and dentin filling materials. In peri-radicular procedures, Nabeel *et al.* [7] advocated using biodentine rather than ProRoot MTA, even though the latter had a better sealing ability.

However, in contrast to other perforation repair materials, Mohan *et al.* [8] claim that MTA offers a more effective root perforation restoration. According to Grover *et al.* [9], Kakani *et al.* [10], and Tang *et al.* [11], biodentine is more effective at sealing than MTA. According to Francis *et al*. [12], there is no discernible distinction between MTA-angelus and Biodentine's sealing capabilities for extensive furcal holes. Jian *et al.* [13], nevertheless, provide evidence in favor of MTA by confirming that the fixed effectiveness of MTA is positively correlated with patient ages, fix substances, and perforation sizes. In the pulpotomy of primary teeth, MTA is superior to bioentine, according to Bossù *et al.* [14]. MTA-based sealers fall under the broad group of calcium silicate-based root canal sealers, according to Saad [15].

According to Bjørndal *et al.* [16], biodentine can address a few of the discoloration issues that are associated with MTA. In favor of biodentine, Arandi and Thabet [17] assert that it has a strong clinical effectiveness in pulp capping. Alzahrani and Alghamdi [18] claim that MTA helped with painless tissue healing using percussion and palpation. According to Aldayri *et al.* [19], MTA has the potential to be used as a repair material in "furcal perforated-pulpotomized primary molars". Furthermore, during the healing of its hole, MTA might stimulate the development of cementum tissue [20].

Conclusion

It is clear from the reviewed research that, in comparison to MTA and GIC, biodentine is the most preferred substance for repairing root perforations. According to the systematic review, biodentine is preferable to the other three since it has been shown in most prior studies to have better clinical results. Consequently, healthcare procedures can use this research to ensure improved clinical results when repairing root perforations.

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