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Review Article

SEALING ABILITY OF ROOT END FILLING MATERIALS- A SYSTEMATIC REVIEW

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ABSTRACT

One of the pre-requisites for the success of surgical endodontics relies on selection of root end filing material having beneficial properties such as optimum sealing ability, biocompatibility, good strength, promote healing and radiopacity. Since MTA and Biodentine are the most popularly used root end filling material, MTA has shown superior sealing properties and marginal adaptation and Biodentine showed biocompatibility and the ability to induce odontoblast differentiation. The main aim of this review is to compare sealing ability of root end filling materials.

Method: Electronic search of PubMed, Google Scholar, Institutional Library, CTRI, Ind Med, Google and manual search using DPU college library resources. and E-mail to authors revealing information about sealing ability of root end filling material using Scanning Electron Microscope (SEM) and Confocal Laser Scanning Microscope (CLSM).. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study.

Result: Total 94 articles were searched out of which 27 articles were selected after reading title and abstract. As a second step, full text papers were obtained. However studies in which different root end filling materials were used and evaluation of sealing ability was done using scanning electron microscope(SEM) and Confocal Laser Scanning Microscope (CLSM).Finally total 11 articles were included out of which 3 articles were excluded on basis of insufficient data and 8 articles were selected for final synthesis.

Conclusion: Biodentine is a better material to prevent apical microleakage and has better marginal adaptation.

INTRODUCTION

The major goal of root canal treatment is to clean and shape the root canal system and fill it with a three-dimensional obturation[1].Surgical approach is commonly indicated in situations such as persistence of periapical pathology, overfilled canals, ledges, canal obstructions, separated instruments, apical transportations and perforations[2].When nonsurgical endodontic treatment is not successful, surgical endodontic therapy is indicated which involves exposure of the apex, resection of the apical end of the root, root-end preparation, and insertion of a root-end filling material[3]. One of the pre-requisites for the success of surgical endodontics relies on selection of root end filing material having beneficial properties such as biocompatibility, good strength, optimum sealing ability, promote healing, radiopacity, easy manipulation and should not get affected by the presence of moisture[4].

Mineral trioxide aggregate (MTA), a calcium silicate-based cement (CSC), was developed (Torabinejad, Watson, & Pitt Ford, 1993) and recommended for root-end filling because of its good physical and chemical properties[5]. It has good biological compatibility as well as good sealing properties[6,7,8]. However, there are also some disadvantages associated with the use of MTA including long setting time, difficult handling, possibility of staining of tooth structure, and high cost[9,10,11]. Biodentine is a new bioactive material with similar physical and biological properties to MTA[12]. The powder contains tricalcium silicate, calcium carbonate and zirconium oxide, while the liquid contains hydrosoluble polymer and calcium chloride as a setting accelerator[13]. The material is indicated for replacement of damaged dentine and has been proposed as an alternative to MTA because of its easyhandling properties and shorter setting time[14]

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Root end filling is the procedure by which an inert non-toxic material is packed into the root canal through an apical cavity[15,16]. An ideal root end filling material should adhere to the preparation walls forming a tight seal in root canal system. It should be non-toxic, well tolerated by the periradicular tissues and promote healing, should be radiopaque, easy to manipulate, dimensionally stable, non-absorbable and not be affected by presence of moisture[17] .Confocal laser scanning microscope (CLSM) which has the ability to serially produce thin (0.5 to 1.5 micrometer) optical sections through fluorescent specimens was used to determine areas of gap and adaptation of the root-end filling materials with the dentin. Scanning Electron Microscope (SEM) is used to analyze the interface between dentin and root-end filling material and to evaluate marginal adaptation[18]. However to the best of our knowledge there was no systematic review comparing the sealing ability of Biodentine and MTA has been conducted so aim of this systematic review is to compare sealing ability of root end filling materials

Focused Question

Which material has effective sealing ability when used as root end filling material?

Objective

To assess the literature regarding the sealing ability of root end filling materials in in vitro experimental study.

METHODS

Inclusion Criteria

1. Articles in English or those having detailed summary in English
2. Studies published between 2010-2017
3. Articles providing information about Sealing ability of MTA and Biodentine
4. Studies evaluating sealing ability of MTA and Biodentine as root end filling materials using Confocal Laser Scanning Microscopy and Scanning Electron Microscope

Exclusion Criteria

1. Review, case reports, abstracts, letters to editors, editorials and animal studies.
2. Studies assessing the sealing ability of root end filling materials using techniques other than Scanning Electron Microscope and Confocal Laser Scanning Microscope

The PICOS guidelines that were selected are

P - (PRODUCT) - Human permanent extracted teeth
I -(INTERVENTION)- - Root end cavity
C - (COMPARISON)- In between MTA and Biodentine
O - OUTCOME) - Sealing ability

Information Sources

Two Internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed), Google Scholar, EBSCO HOST and SCOPUS and manual search using DPU college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study. The databases were searched up to and including September 2017 using the search strategy.

Search

The following databases were searched on PubMed (the limits used were all full text articles in English dated from 1st Janurary 2010 to September 31st 2017), EBSCO HOST, SCOPUS and Google Scholar. For the electronic search strategy, the following terms were used as keywords in several combinations**.**

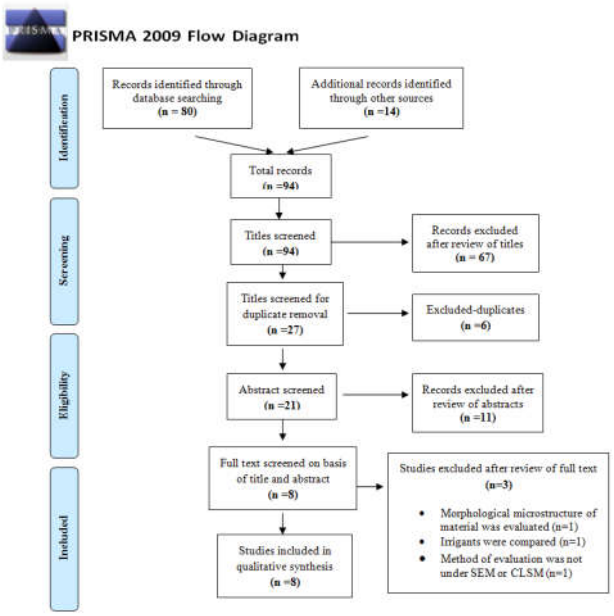
Study Selection Process

Preliminary screening consisted of total 94 articles out of which 27 articles were selected. The papers were screened independently by two reviewers. At first the papers were screened by title and abstract. As a second step, full text papers were obtained when they fulfilled the criteria of the study aim. Any disagreement between the two reviewers was resolved after additional discussion. For full-text screening, the following criteria were taken into consideration: In-vitro studies done on human extracted teeth in which different root end filling materials were used in which evaluation of sealing ability was done using scanning electron microscopy(SEM) and Confocal Laser Scanning Microscope (CLSM). Finally a total of 11 articles were included out of which 8 articles were finally synthesized in this systematic review.

Data Collection Process

A standard pilot form in excel sheet was initially used and then all those headings not applicable for review were removed. Data extraction was done for one article and this form was reviewed by an expert and finalized. This was followed by data extraction for all the articles

Sr. No.	Search strategy	Number of articles	Number of selected articles	After Duplicate Removal
1	Sealing ability AND Biodentine AND MTA AND Root end filling material AND SEM	1	1	0
2	Sealing ability AND Biodentine OR Root end filling material AND MTA OR Root end filling material AND SEM	21	0	0
3	Sealing ability AND Biodentine OR Root end filling material AND MTA OR Root end filling material AND CLSM	3	2	2
4	Dental marginal adaptation AND MTA AND Biodentine	6	4	1
5	Marginal adaptation AND Biodentine OR root end filling materials AND MTA OR Root end filling material AND SEM	27	0	0
6	Marginal adaptation AND Biodentine OR root end filling materials AND MTA OR Root end filling material AND CLSM	3	2	2
7	Microleakage AND Biodentine OR retrograde filling materials AND MTA OR Retrograde filling material AND SEM	15	0	0
8	Microleakage OR mrginal adaptation AND Biodentine OR retrograde filling materials AND MTA OR Retrograde root end filling material AND CLSM	4	2	2
9	Other sources	14	4	0
Total		94	15	6



RESULT

Total 94 articles were searched out of which 27 articles were selected after reading title and abstract. As a second step, full text papers were obtained. However studies in which different root end filling materials were used and evaluation of sealing ability was done using scanning electron microscope(SEM) and Confocal Laser Scanning Microscope (CLSM).Finally total 11 articles were included out of which 3 articles were excluded on basis of insufficient data and 8 articles were selected for final synthesis.

DISCUSSION

The main aim of root end filling is to prevent the movement of the bacteria and diffusion of bacterial products from the root canal into periapical tissues and vice versa. Gartner and Dorn proposed that an ideal root-end filling material should be easy to manipulate, radiopaque, dimensionally stable, non absorbable, insensitive to moisture, adhesive to dentin, nontoxic, and biocompatible. Many materials have been used for root-end fillings in endodontic surgery.

The 8 studies included in this review have compared sealing ability of root end filling materials under two different microscopes. Out of 8 articles included in this study 4 articles were evaluated under confocal microscope in which *Ravichandra P.V. et al (2014)*[1 8] conducted the study to evaluate the marginal adaptation of three root-end filling materials Glass ionomer cement, Mineral trioxide aggregate and Biodentine™. Confocal laser scanning microscope (CLSM) which has the ability to serially produce thin (0.5 to 1.5 micrometer) optical sections through fluorescent specimens was used to determine areas of gap and adaptation of the root-end filling materials with the dentin. Statistical analysis showed lowest marginal gaps and good marginal adaptation with Biodentine™ because it provides better adaptation and seal, better handling properties with superior biological, mechanical and physical properties followed by MTA and highest marginal gaps with GIC which were statistically significant ($p<0.0001$). They concluded that Biodentine™ showed better marginal adaptation than commonly used root end filling materials.

Another study by *Mandava P. et.al. (2015)*[19] evaluated the apical microleakage of root end cavities filled with Mineral trioxide aggregate, Biodentine and light cure GIC. They concluded that MTA showed significantly less microleakage because of the formation of the hydroxyapatite like crystals at the interface between material and canal wall due to which the material shows superior adhesion preventing the penetration of the dye and thus showed least microleakage when compared to Biodentine and light cure GIC. *Nanjappa S.A. et al (2015)*[20] conducted another study to determine the sealing ability of MTA, Biodentine and Chitra- Calcium phosphate root end filling materials. Results were as follows, positive control group had highest dye penetration while negative control group had the least penetration. Among all the three materials, Biodentine showed less microleakage followed by MTA and Chitra-Calcium Phosphate. There was significant difference among the three groups ($P>0.05$). They concluded that Biodentine is a better material s prevent apical microleakage in comparison to MTA and Chitra-Calcium Phosphate.

Khandelwal A. et.al.(2015)[21] conducted the study to compare sealing ability of mineral trioxide aggregate (MTA) and Biodentine as root end filling material, and also to compare the effect of different retro preparation techniques i.e. conventional bur v/s ultrasonic tips on sealing ability of both the root end filling materials. Results were as follows, Biodentine and ultrasonic preparations showed significantly less microleakage due to its better handling properties, smaller particle size and fast setting time which further avoids leakage to take place than MTA and bur preparations. They concluded that Biodentine can be used as a replacement for MTA, as a root end filling material.

Studies conducted under scanning electron microscope was mentioned in 4 articles out of 8 articles selected for this review. *Soundappan S. et.al.(2014)*[22] conducted the study to evaluate the marginal adaptation of Bio-dentine in comparison with Mineral Trioxide Aggregate (MTA) and Intermediate Restorative Material (IRM), as a root end filling material. No statistically significant differences between MTA and IRM but both were superior when compared to Biodentine. At 1mm level there was no statistically significant difference among any of the tested materials. At 2mm level MTA was superior to both IRM and Biodentine. They concluded that MTA and IRM were significantly superior when compared to Biodentine in terms of marginal adaptation, when used as retrograde filling material.

Bolhari B. et.al.(2015)[23] conducted the study to evaluate marginal adaptation of mineral trioxide aggregate (MTA), calcium enriched mixture (CEM) cement, Biodentine and BioAggregate Results were as follows, there were no significant differences in marginal adaptation of the groups ($P>0.05$). They concluded that blood contamination does not affect the marginal adaptation of MTA, CEM cement, Biodentine or BioAggregate. *Islam A. Abd El-Aziz Ali.et al(2017)*[24] conducted the study to compare microleakage and marginal adaptation of White Mineral Trioxide Aggregate (WMTA), Biodentine and chemical-cured glass ionomer cement (GIC) as root-end filling materials using scanning electron microscope (SEM). The results obtained were that WMTA had the lowest mean dye absorbance value and the smallest interfacial gap width followed by Biodentine and

EQUIA-GIC, with no significant difference between them. They concluded that WMTA, Biodentine and chemical-cured GIC demonstrated comparable sealing ability as root-end filling materials.

SelenKuçukkayaEren et al (2017)[25] conducted the study to evaluate the sealing ability and marginal adaptation of calcium silicate-based cements (CSCs) in root-end cavities prepared by ultrasonic and laser tips. The sealing ability was measured by fluid transport method. No significant difference was found between materials regarding the sealing ability and marginal adaptation ($p>0.05$). Significantly greater fluid movement and poor marginal adaptation were seen for materials placed in cavities prepared by laser tips ($p<0.05$). In conclusion, root-end cavity preparation with laser application negatively affected the sealing ability and marginal adaptation of root end filling materials while no difference was found between the materials.

Limitations

The limitation of this systematic review is that there is lack of literature searched for systematic review and lack in the literature searched other than electronic data bases.

CONCLUSION

One of the pre-requisites for the success of surgical endodontics relies on the selection of root end filling material and the type of retro preparation technique used. This systematic review presents an overview of the marginal adaptation of various root end filling materials. In 3 studies, Biodentine showed better marginal adaptation than MTA due to its better handling properties which leads to better adaptation to the cavity walls and its smaller particle size which adapts well to the cavity surface. In 3 studies MTA showed better marginal adaptation because of the formation of the hydroxyapatite crystals at the interface between material and canal wall due to which the material shows superior adhesion preventing the penetration of the dye and thus showed least microleakage. One study showed that root end preparation with Er:YAG laser exhibited lesser amount of dye penetration when compared to ultrasonics due to the absence of chipping during the root end cavity preparation. 1 study concluded that cavities prepared with ultrasonic retrotips showed less leakage than conventional preparation with bur because ultrasonic retrotip showed cleaner cavities and are free of smear layer, which may be responsible for good marginal fit.

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