

Push-Out Bond Strength of MTA as Root Canal Sealer: A Systematic Review

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ABSTRACT

Introduction: Endodontic treatment includes different phases like controlling the growth of microorganism, thorough cleaning and shaping and fluid-tight seal. Sealer plays an important role in Root Canal Treatment (RCT). Sealer fills the space between filling material and dentin. Sealer also acts as a lubricant. Sealer has ability to fill the spaces and prevent microleakage from the root canal. Mineral Trioxide Aggregate (MTA) is a calcium silicate based sealer which has high radiopacity, low solubility and good antibacterial activity.

Aim: To evaluate push-out bond strength of MTA as a root canal sealer.

Materials and Methods: Studies which were published in English, studies with different years of publication were included. Studies which includes bond strength of MTA as Endodontic Sealer to dentinal wall were also included. Studies used in this review were in-vitro studies and clinical trials. Studies showing tissue toxicity, biocompatibility of MTA were excluded. Also, case reports and in-vivo studies were excluded. All abstracts as

well as full texts were studied. PubMed/Medline, Web of Science and Scopus were used for this study. Keywords used were “root canal sealer”, “push-out bond strength”, “MTA”. Total 18 articles were collected. But only five articles fulfilled the inclusion and exclusion criteria. So only five articles were included in this study and discussed in detail.

Results: According to the results, of articles which were chosen for this study stated that MTA can be used as an endodontic sealer though it shows lesser push-out bond strength when compared with different newer sealers.

Conclusion: In this systematic review, only one in-vitro study showed that Proroot MTA used as root canal sealer exhibits high push-out bond strength than other sealers like MTA Fillapex sealer and AH plus sealer. While MTA Fillapex show lesser push-out bond strength in comparison with other sealers like Proroot MTA sealer, AH plus, Endo CPM sealer. So this systematic review partially fulfills the hypothesis as it gives a utility of Proroot MTA as a root canal sealer.

Keywords: In-vitro studies, Proroot MTA, Sealer

INTRODUCTION

Successful endodontic treatment involves various steps like thorough cleaning and shaping as well as achieving complete three dimensional fluid-tight seal. Filling material mainly consists of solid gutta percha [1]. This will occupy the canal space thoroughly. Sealer fills space between filling material and dentin [2]. Sealer also acts as a lubricant. Sealer have the ability to fill the spaces and prevent the microleakage from root canal. It should provide complete fluid-tight seal [2]. It should not be harmful to the periapical tissues. It should help in healing of periapical lesions. Three-dimensional obturation requires for success of endodontic treatment. Also, success depends upon complete disinfection of pulpal canals [3]. Root canal sealers are categorised into zinc oxide eugenol containing sealer, calcium hydroxide containing sealer, calcium silicate containing sealer that is MTA sealer and resin containing sealer [4]. Newly introduced sealer is MTA sealer, MTA Fillapex “Angelus Solucxoes Odontologicas, Londrina, Brazil” that includes salicylates and resin. It also contains nano-particulated resin, bismuth trioxide and MTA [4]. It is stated that it has more radiopacity and lesser solubility. It also shows lesser expansion while it sets [4]. It help to deposit the hard tissue [4]. Push-out test is the method which is used to measure the bond strength of endodontic filling material [5]. It provides knowledge about the adhesion properties of endodontic filling materials [5]. This test helps to evaluate the extent of bonding between sealer and dentin [5].

The prime purpose of this review was to evaluate the results of different studies which included the push-out bond strength of MTA-based sealers. Hypothesis of this study is that MTA sealer has not sufficient amount of bond strength to root dentin when it is used as a sealer when compared with other sealers.

MATERIALS AND METHODS

The study was conducted in Sharad Pawar Dental College from the year 2019-2020 and it was completed within one year of duration.

Research Question

Is the push-out bond strength of MTA (MTA Fillapex) is higher than others sealers when it is used as a root canal sealer?

Procedure

This systematic review was prepared with the help of PRISMA Chart. The studies were chosen based on inclusion and exclusion criteria. All abstracts as well as full texts were studied or screened by the author.

Inclusion criteria: Studies which includes bond strength of MTA as endodontic sealer to dentinal wall were included. Studies used for this review are in-vitro studies and clinical trials. Different studies were chosen from year 2010-2019.

Exclusion criteria: Study which showed tissue toxicity, biocompatibility of MTA were excluded. Also case reports and in-vivo studies were excluded to reduce the study bias.

Criteria for Selection of the Studies

Initially, title of the selected articles was read out. After that abstracts and full texts of that titles were read out. There was lack of retrospective and clinical trials. So this review incorporated only in-vitro studies. For this reason, Population, Intervention, Comparison and Outcome (PICO) system were applied (Population: studies that demonstrate animal and human mesenchymal cells. Intervention includes study of the push-out bond strength of MTA

sealer, Comparison (MTA), and Outcomes include bond strength of MTA to dentin).

Data Sources and Search Strategy

Pubmed/Medline, Web of Science and Scopus were used for this study. During this procedure, there was no restriction of years of publication.

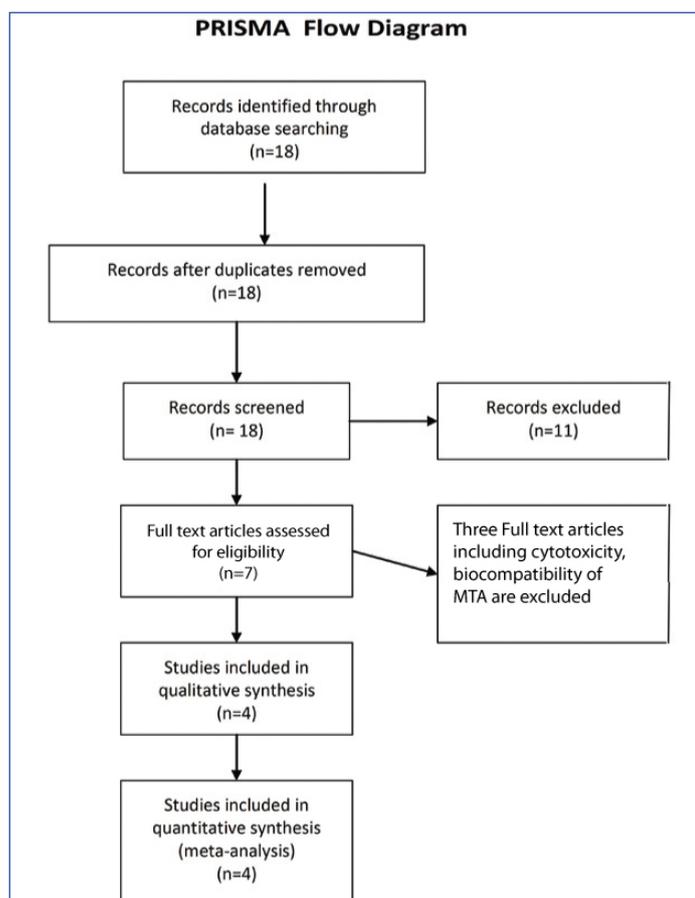
To obtain more efficient results, authors searched the data sources using Medical Subject Headings (MeSH) terms. Keywords used were “MTA,” “root canal sealer,” “push-out bond strength” and “root dentin.” The search details were mineral trioxide aggregate (all fields) and root canal sealer (all fields) and push-out bond strength (All Fields).

Quality Assessment for Risk of Bias and Data Extraction

In second step, full text of the chosen articles were read out for data extraction and quality assessment was done as per Office of Health Assessment and Translation (OHAT) tool by two independent reviewers (CR, MC). In cases of difference between reviewers, the third senior reviewer (MC) clarified the discrepancy.

Flow chart for this systematic review is shown in [Table/Fig-1]. In the beginning 18 articles were selected which includes push-out bond strength of MTA sealer only. Eleven studies which were based on cytotoxicity, biocompatibility of MTA were excluded. Also, three full text articles based on cytotoxicity and biocompatibility of MTA were excluded. Hence only four articles were selected (as shown in [Table/Fig-1]). Title, abstract, a scientific context based on push-out bond strength of MTA-based sealer was included. Also rationale, objectives hypothesis, methodology showing study type were incorporated. Intrusion, statistical analysis, evaluation period were also used and main results were extracted from each experimental study.

In this study, after quality assessment for risk of bias was done by



[Table/Fig-1]: Prisma flow diagram.

three independent reviews and by OHAT tool, it was found that all studies included low-risk of bias.

Quality assessment for risk of bias for in-vitro studies were done by OHAT tool as shown in [Table/Fig-2].

Study group/ Samples allocation	Madhuri GV et al., [1]	Oliveira DS et al., [6]	Assmann E et al., [7]	Sönmez IŞ et al., [8]
	40 samples randomly allotted (n=10) in four groups	60 samples randomly allotted (n=15) in four groups	45 samples randomly allotted (n=15) in three groups	30 samples randomly allotted (n=15) in three groups
Experimental conditions across study groups	No	No	No	No
Was research personnel blinded to the study groups	No	No	No	No
Were outcome data complete without attrition or exclusion from analysis	No	No	No	No
Can we confident in the outcome assessment (including blinding)	No	No	No	No

[Table/Fig-2]: Quality assessment for risk of bias for in-vitro studies was done by OHAT.

RESULTS

Initially, 18 articles were identified through database searching. Titles and abstracts were studied for initial screening. Full text was read out due to unclear results. The authors evaluated the studies, later discussed the results until a decision came out. Among the 18 studies, four were screened for inclusion. In these four articles only in-vitro studies were included. And remaining articles were excluded as they included cytotoxicity, biocompatibility. As a response to possible result established in PICO, MTA-based sealer shows lower push-out bond strength compared to other sealers. Out of four in-vitro studies which were selected for this systematic review, all four studies showed that push-out bond strength of MTA Fillapex sealer was lesser compared to other sealers. While, one study shows Proroot MTA sealer shows better bond strength as compared to other sealers. This systematic review partially fulfills the hypothesis as it gives a utility of Proroot MTA as a root canal sealer According to [Table/Fig-3] first study which was given by Madhuri GV et al., resulted that Endosequence BC sealer showed higher push-out bond strength value, while MTA Fillapex showed lower push-out bond strength value [1].

In second study which was given by Oliveira DS et al., resulted that MTA showed higher bond strength value while MTA Fillapex shows lesser bond strength value [6].

In third study, which was given by Assmann E et al., resulted in the MTA Fillapex showing lesser bond strength value as compared to other sealers [7].

In the fourth study, which was given by Sönmez IŞ et al., resulted in Proroot MTA had the highest bond strength, whilst MTA Fillapex displayed the lowest values among the groups [8]. So, [Table/Fig-3] represents the comparison of push-out bond strength of MTA-based sealer with other different sealers.

Risk of Bias in Included Studies

In this systematic review, four studies were included. Quality assessment for risk of bias was done by OHAT tool as shown in [Table/Fig-2]. In all the four studies by Madhuri GV et al., Oliveira DS et al., Assmann E et al., and Sönmez IŞ et al., samples were allocated randomly [1,6,7,8]. In all the four studies, push-out bond strength was checked by universal testing machine. But in all the studies, different sealers were used. So after quality assessment for risk of bias, it was concluded that there was a chance of presence of low-risk of bias in all the four studies.

First author	Year	Type of study	Sample size	Comparative material	Push-out Bond Strength (MPa)	Results	Conclusion
Madhuri GV et al., [1]	2016	In-vitro study	40 single rooted human teeth	MTA Fillapex sealer with hybrid root seal, endosequence Bioceramic sealer, epoxy resin based-sealer.	MTA Fillapex=30.39 Hybrid root seal=51.89 Bioceramic endosequence sealer=98.72 Epoxy resin based-sealer (MM seal)=71.69	The more bond strength were shown in Group 1 "Endosequence- $p<0.05$ " when compared with others. Lesser bond strength were shown in Group 2.	Endosequence BC sealer showed higher push-out bond strength value compared to other sealers. Lowest bond strength was seen with MTA Fillapex sealer.
Oliveira DS et al., [6]	2015	In-vitro study	60 single rooted human teeth	MTA Fillapex I Root sp MTA AH Plus	MTA Fillapex=2.00 I root sp=2.9 MTA=9.3 AH plus=8.02	MTA-filled Samples had the better bond strength " $p=0.000$ ". AH Plus had significantly better bond strength compared to group I, group II ($p=0.000$). Both group I, group II were shown lesser bond strength compared to others.	The adhesion to root dentine associated with newer calcium silicate based sealers was compromised even when well-monitored laboratory conditions were used.
Assmann E et al., [7]	2012	In-vitro study	45 single rooted human teeth	AH plus sealer MTA Fillapex Endo-CPM sealer.	Endo-CPM =8.26 AH plus=3.03 MTA Fillapex=2.04	The Endo-CPM Sealer showed more bond strength compared with the others. No difference were found between the AH Plus as well as the MTA Fillapex	On the basis of the findings presented herein and within the limitations of this study, Endo-CPM sealer presented advantages when a post preparation was required. MTA Fillapex presented acceptable resistance to dislodgement, which was similar to that observed in samples filled with AH Plus sealer.
Sönmez IŞ et al., [8]	2013	In-vitro study	30 single rooted human teeth	AH plus sealer Proroot MTA MTA Fillapex	AH plus=1.27 Proroot MTA=4.07 MTA Fillapex=0.46	Push-out bond strength of group II was better than AH Plus. Group II showed better bond strength compared to group III.	Proroot MTA had the highest bond strength, whilst MTA Fillapex displayed the lowest values among the groups.

[Table/Fig-3]: Represents the comparison of push-out bond strength of MTA-based sealer. with other different sealers [1,12,13,15].

DISCUSSION

For the success of endodontic treatment complete filling of root canal is utmost important to avoid reinfection [1]. It is also important to remove the viable bacteria which cause infection [3]. Sealer fills the space between filling material and dentin [9]. It also fills the space among the core material as well as the accessory canal [9]. It also acts as a lubricant. Ultimately, it helps in achieving three dimensional seal [10]. In any clinical scenario, adhesion is mandatory to evade dislocation of sealer [10].

Push-out test is the method which helps to evaluate the bond strength among sealers as well as dentinal walls [1]. This test is based on the stresses which are generated between root dentin and cement. The force is applied from coronal to apical direction [1]. Force will be applied till the filling material is dislodged from the canals [2]. This testing method completely replicates the performance of sealer [11]. And, it also provides information which can be a useful tool for comparison of different endodontic sealers or obturation techniques [1]. Few studies were conducted to compare the biocompatibility and sealing ability of MTA and other routine sealers, which includes calcium hydroxide-based, zinc oxide eugenol-based sealers [12]. Also, resins-based sealers and bioceramic sealer were included in the comparison [13,14]. Till date, there were no systematic reviews are present based on push-out bond strength of MTA as an endodontic sealer. The various studies conducted have stated following results of using MTA as an endodontic sealer.

Madhuri GV et al., stated that MTA Fillapex had shown lesser bond strength compared to Endosequence (bioceramic) sealer, hybrid root seal as well as MM seal. It is because of release of calcium ion. It also releases hydroxyl ions from the set sealer which forms tag-like structures. This tag-like structure interferes with bonding of endodontic sealer with root dentin. So it has lesser amount of bond strength [1].

Oliveira DS et al., stated that MTA sealer showed highest bond strength. Because it can seal the entire root canal space as it consists of MTA powder or hydrophilic powder. Water is required for its setting and formation of a hydrocolloid gel [6]. This gel hardens after some period of time and form strong impermeable barrier within

four weeks. This setting ability of MTA gives its high strength [5].

Assmann E et al., stated that MTA Fillapex show less push-out bond strength than Endo-CPM and AH plus sealer. It is because tag-like structure formed by MTA Fillapex. It will form by releasing calcium and hydroxyl ions during its setting reaction. This tag like structure interferes with bonding between sealer and core material (gutta percha) as well as sealer and dentin [7].

Sagsen B et al., studied in 2011 that MTA Fillapex has lowest push-out bond strength. This is due to release of calcium and hydroxyl ions by the set sealer [15], which will ultimately form tag like structures. This tag like structure interferes with bonding of sealer with root dentin so it shows lowest bond strength [8].

Sönmez IŞ et al., stated that Proroot MTA showed highest push-out strength in comparison with AH plus as well as MTA Fillapex sealer [8]. Sealers are binding agents used to fill up the gap between root canal wall and obturating material [16]. ProRoot MTA sealer helps to seal whole canal space. It is because of hydrophilic powder present in MTA which sets in presence of water [8].

Limitation(s)

Few clinical trials and in-vivo studies are present on use of MTA as a root canal sealer. Hence, it is possible that in this systematic review, some articles may have been missed. Therefore, it leave chance of error in the colcusion drawn. Future reviews should include use of MTA as root canal sealer.

CONCLUSION(S)

In this systematic review, one in-vitro study showed that when Proroot MTA used as a root canal sealer it exhibited high push-out bond strength than other sealers like MTA Fillapex sealer and AH plus sealer. While MTA Fillapex show lesser push-out bond strength in comparison with other sealers. So according to this review MTA is used as a root canal sealer as it exhibit better push-out bond strength compared to other sealers. But further clinical trials, in-vivo studies are required to study the application of MTA as an endodontic sealer in terms of their push-out bond strength.

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