EFFECTS OF INTRACANAL MEDICATIONS ON THE PUSH-OUT BOND STRENGTH OF MTA AND ENDOCEM MTA IN THE ERA OF PREVENTIVE TREATMENTS

Dr. Abdulaziz Abdulrahman Aleid[1*]

Abstract

Objective. The aim of this study was to investigate the effect that a number of intracanal medications, in particular calcium hydroxide and antibiotic-steroid paste, would have on the push-out bond strength of MTA and Endocem MTA.

Materials and Methods. An in-vitro experimental study was conducted on 90 extracted anterior teeth for 6 months from Jan 2022 to June 2022. The specimens were divided into 3 groups at random with 40 samples per group. Each of these groups was subdivided into two distinct subgroups. The first subgroup was utilised as a control group. The second subgroup consisted of 20 samples per subgroup. The third subgroup comprised 20 samples in each subgroup and each of these specimens was further divided into MTA (MTA) and ENDOCEM MTA with a sample size of 20. The experimental data were analysed using a quantitative research methodology that had previously been established. The data that was collected was analysed in accordance with the primary research question as well as the research methodologies that were designed to provide answers to the same.

Results. It was found that the prior application of calcium hydrochloride as an intra-canal medicament improved the bonding strength of the MTA compared to the control group, which was the comparison that was made between the two. However, significantly high push-in bond strength was recorded for Endoca MTA (3.01±0.15) with the calcium hydrocloride intracanale medicament compare to (2.80±0.27) MTA, which is the comparison of the two, respectively. Conclusions. This study showed that the use of calcium silicate-based cement in regenerative endodontic procedures is beneficial in terms of enhancing the bond strength. Further in-vivo and long-term follow-up studies are required to provide evidence in support of the findings of our study.

Keywords: Bond strength, ENDOCEM, Intracanal medicament, MTA

[1*]Associate professor, Department of Conservative Dental Sciences, College of Dentistry, AlQassim University, Mulayda, Saudi Arabia.Email: aa.aleid@qu.edu.sa

***Corresponding Author:-** Dr. Abdulaziz Abdulrahman Aleid

[*]Associate professor, Department of Conservative Dental Sciences, College of Dentistry, AlQassim University, Mulayda, Saudi Arabia.Email: aa.aleid@qu.edu.sa

DOI: - 10.31838/ecb/2023.12.8.811

Introduction

Leakage of irritants from bacteria and their byproducts from pathologically involved root canals is the leading cause of endodontic failure. Long-term clinical success can be achieved and recontamination avoided by establishing an apical, lateral, and coronal fluid-tight seal. [2] A material capable of hermetically sealing the apex has been described by Gartner and Dorn. Materials used in root end fillings should be safe for the patient, contain no carcinogens, do not dissolve in body fluids, and closely conform to the dentinal walls of the prepared root end to seal it off from the periradicular tissues. [3]

According to Hench, a bioactive substance is one that "elicits a particular biological reaction at the material's interface, which results in the creation of a link between the tissues and the material." [4] When in contact with bodily fluids, a bioactive material has the ability to form a coating on its surface that is similar to apatite. This is one of the characteristics of a bioactive material. [5] One of these novel materials is an aggregate made of mineral trioxide. Mineral trioxide aggregate, also known as MTA, is a type of hydraulic cement that dries out when it comes into contact with water. [6] Studies have shown that MTA has a good ability to seal wounds, an excellent long-term prognosis, relative ease of manipulation, good biocompatibility, and favours the regeneration of tissue. [7] Pozzolan cement derived from MTA has been developed recently. On the endodontic market, the product known as Endocem MTA (Maruchi, Wonju, Korea) was released. Endocem has the potential to quickly set even in the absence of a chemical accelerator.

Instead, it consists of very small pieces of pozzolan cement, which hasten the setting process by increasing the amount of surface area that is in contact with the liquid that is being mixed. [8]
In the interim between endodontic treatment visits, intracanal medications are frequently administered. These antibacterial intracanal dressings are a temporary medication that helps to eliminate microorganisms that could otherwise prevent periapical healing. They do this by preventing the growth of bacteria in the canal. [9] During the time in between appointments, they might also act as a physical barrier to stop periapical bacteria from recontaminating the root canal. This would be beneficial. [10] The results of a clinical follow-up evaluation revealed that the use of temporary intracanal dressings is beneficial to the periapical healing process. [11] During endodontic treatment and apexification procedures, calcium hydroxide is frequently used as a form of intracanal medication that is administered between appointments. [12] However, due to the high alkalinity of calcium hydroxide, some of the acidic components in the dentin are neutralised or denatured, which results in the dentin becoming less strong. Calcium hydroxide is one of many potential replacement medicines, some of which have already been put into practise. As a routine intracanal medication for the treatment of postoperative pain, Ledermix, which is a combination antibiotic and corticoid, has also been recommended. 13] In order to preserve the ability of the permanent root canal filling or biomaterials to seal and bond effectively, it is imperative that these interim medicaments be removed completely from the root canal. [14] Since regenerative endodontic procedures do not utilise debridement protocols in order to preserve the thin dentinal walls, the removal of medicaments is becoming an increasingly difficult task as the number of people interested in getting these procedures has increased. As a result, there is a paucity of information regarding their potential effects on the bonding effectiveness of calcium silicate-based cement utilised in regenerative procedures. As a result, it was decided to conduct an investigation into the effect that a number of intracanal medications, in particular calcium hydroxide and antibiotic-steroid paste, would have on the push-out bond strength of MTA and Endocem MTA.

Methodology:
The in-vitro experimental investigation was completed at the Qassim University College of Dentistry. For the in-vitro analysis of the study sample, permission from the College of Dentistry's institutional ethical committee at Qassim University was taken. Based on the power of previously published research, the sample size was determined. Based on the effect size, a total of 120 samples, 40 in each arm, were required to reject the null hypothesis. The Department of Oral and Maxillofacial Surgery in the College of Dentistry at Qassim University provided one hundred and twenty human anterior teeth that had been extracted due to periodontal issues. Roots that had any visible signs of damage, such as cracks, caries, or restorations, were not included in the study. The study did include intact Maxillary anterior teeth that had been removed for periodontal reasons; however, these teeth had been extracted. After the mechanical removal of calculus, the sample was preserved in formalin in accordance with the recommendations provided by the Occupational Safety and Health Administration (OSHA) and the Centre for Disease Control and Prevention (CDC) regarding the collection, storage, and handling of samples derived from extracted teeth.

Procedure: Ninety human maxillary anterior teeth that had recently been extracted and had single, straight roots were chosen. Below the cement-enamel junction, the crowns were decoroned, and their length was modified to about 12mm. A parallel canal gap with a standard 1.25 mm diameter and 10 mm length was made using a parallel post drill. ProTaper files were used to clean and shape the root canals up to size F5, with 2 mL of 5.25 percent sodium hypochlorite placed between each file size. To remove the smear layer, the canals were irrigated for 5 minutes with sodium hypochlorite and then for 5 minutes with 17 percent ethylenediaminetetraacetic acid (EDTA). After that, 10 millilitres of water that had been distilled was used to irrigate the specimens in order to prevent the long-lasting effects of the EDTA and sodium hypochlorite. After that, paper points were used to dry the root canals. In terms of the usage of intracanal medications, the 90 specimens were then divided into 3 groups at random with 40 samples per group. Group 1 (Calcium hydroxide with distilled water), Group 2 (Antibiotic + Steroid paste) and Group 3 (Saline (control), further each of this group was subdivide into MTA and Endocem MTA with sample size of 20 per subgroup.

Utilizing Lentulo spirals (35 size), the intracanal medications were inserted into the root canal. After that, a cotton plug and an intermediate restorative material were used to close off the orifices (IRM).The samples were kept at 37^0 degrees Fahrenheit with 100 percent humidity for two weeks before the intracanal medications were flushed out with 5 mL of EDTA and a final 5 mL irrigating of sodium hypochlorite. After that, paper tips were utilised in order to dry out the root canals. On the basis of the type of root-end filling

that was utilised, the specimens were divided into two distinct subgroups. After the components had been combined in accordance with the guidelines provided by the manufacturer, they were inserted into the root canal using an MTA carrier and compacted using a hand plugger. This produced an apical plug with a thickness of 5 millimetres at the root apex, which could be seen on the radiograph. The orifices of the root canal were plugged with cotton and then coated with IRM to ensure a seal. The specimens were kept for one week at 370 degrees Celsius with a humidity level of one hundred percent. In order to obtain slices with a thickness of 3 millimetres, each root was sectioned in the apical third in a manner that was perpendicular to the long axis of the tooth. In order to evaluate the push-out bond strength, the specimens were put through a series of tests on a universal testing machine.

The specimens were loaded by employing a bespoke stainless-steel cylindrical plunger with a diameter of 1 mm, which was then positioned on a piece of universal testing equipment. At a crosshead speed of one millimetre per minute, a push-out force was applied in a cervico-apical direction, and it was maintained until the root filling material debonded. The bond strength failure, measured in megapascals, is determined by dividing the load by the area of the bonded interface (MPa). The following formula was used to determine the area in each section: Area is equal to 2r + h, where r is the intraradicular space's radius and h is the height in mm (where is a constant of 3.14).[15]

Results:
An in-vitro experimental study was conducted on 90 extracted teeth for 6 months from Jan 2022 to June 2022. Before the start of the study, institutional ethical clearance was obtained from the College of Dentistry, Qassim University. The data that was collected was analysed in accordance with a quantitative research methodology that had previously been established. Additionally, the primary research question as well as the research methodologies that were designed to provide answers to the same were analysed and interpreted. In the current investigation, the bond strength of MTA and Endocem MTA was analysed using 30 samples from each group. The samples had previously been treated with either calcium hydroxide, Ledermix paste, or saline. Oveall push-out bond strength was significantly high in Endocem MTA compared to MTA regardless of intracanal medicament. However, significantly high push-out bond strength was recorded for Endocem MTA (3.01±0.15) with the calcium hydroxide intracanal medicament compare to (2.80±0.27) MTA with calcium hydroxide intracanal medicament. Whereas the least push-out bond strength was recorded with Ledermix paste intracanal medicament.

Discussion:
The materials used to fill the root end should be radio opaque, biocompatible with the tissue fluids, closely adapt to the walls of the root end preparation, and be dimensionally stable. In order to achieve these desirable functional characteristics, the filling materials must hermetically seal the dentinal walls while also adhering to the dentinal walls. The aim of this experimental *in vitro* study is to evaluate the influence of the intracanal medicament (Calcium hydroxide, Ledermix paste), applied as dressing over a period of 1 week, on the apical sealing of the apical barrier (MTA, Endocem MTA) placed in permanent teeth with simulated immature apices and to compare the push-out bond strength of MTA and Endocem MTA on the apical sealing of the plug under the influence of this dressing. In the current study, the use of calcium hydroxide as an intracanal medicament demonstrated an improved bond strength of MTA and Endocem MTA in comparison to the group that served as the control. The reason for this is either due to the conversion of calcium hydroxide to calcium carbonate or the reaction of MTA with any calcium hydroxide that is still present. [14] Because of this, the researchers found that the presence of calcium hydroxide that had been left behind in the dentinal tubules contributed, through the supply of calcium ions that had been left behind, to an increase in the bond strength of calcium silicate cements. Both the study by Nagas et al. [15] and the study by Felippe et al. [16] were supported by the findings of this experiment. Before the placement of a permanent root filling, calcium hydroxide has traditionally been the material of choice for inducing the formation of an apical hard tissue barrier in preparation for the placement of the filling. [17] When calcium hydroxide was used by itself or in conjunction with other substances, the results of many studies showed that it produced favourable outcomes. [18,19]
In comparison to the group that served as the control, the MTA and Endocem MTA samples that had previously been treated with Ledermix paste exhibited the weakest levels of bond strength. It's possible that this is because Ledermix, which includes demeclocycline and triamcinolone, has a lower molecular weight, which allows for greater diffusion into the dentinal tubules. This result was comparable to the one that was

found in the research carried out by Nagas et al. [15], in which the authors found that Triple Antibiotic Paste, Augmentin, and Ledermix were linked to an increase in the debonding force of MTA and Biodentine.
Also, in this study it was found that the bond strength of Endocem MTA was greater than MTA with the prior application of Calcium hydroxide. The Endocem MTA possess a very similar chemical composition to that of MTA, and small pozzolanic particles are added to their composition. These small particles are attributed to the pozzolanic reaction in which calcium hydroxide is consumed to produce calcium silicate hydrate and calcium aluminate hydrate products.[20] These products form the stable crystals within the dentinal tubules that enhance the strength of the cements.[21]

Conclusion:
In this study, the prior application of calcium hydroxide as an intracanal medicament improved the bond strength of MTA and Endocem MTA in comparison to the control group. However, the limitations of the study methodology and the procedures performed prevent any definitive conclusions from being drawn. It was discovered that the Endocem MTA has a higher bond strength than the MTA, which was the comparison that was made between the two. However, additional in-vivo and long-term follow-up studies are required to provide evidence in support of the findings of our study.

References:
1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposure of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol 1965;8(3):340-8.
2. Siqueira JR JF. Strategies to treat infected root canals. J Calif Dent Assoc 2001; 29(12):825-37.
3. Gartner AH, Dorn S. Retrograde filling materials: Retrospective success-failure study of amalgam, EBA, IRM. JOE 1990;16(8):391-393.
4. Geeta Asthana et al Bioactive Materials: A Comprehensive Review. Sch. J. App. Med. Sci. 2014; 2(6E): 3231-3237.
5. R Vinoddhine, S Pradeep. A review on bioactive materials used in endodontics. IJPT 2015; 7:2:3273-3281.
6. Camilleri J, Pitt Ford TR. Mineral trioxide aggregate: a review of the constituents and biological properties of the material. International Endodontic Journal. 2006; 39(10):747-54.
7. Rao A, Shenoy R. Mineral trioxide aggregate—a review. Journal of Clinical Pediatric Dentistry. 2009; 34(1):1-8.
8. CHOI Y, PARK SJ, LEE SH, HWANG YC, YU MK, MIN KS, Biological effects and washout resistance of a newly developed fast-setting pozzolan cement. J endod 2013; 39:467-472.
9. Sundqvist G. Bacteriological studies of necrotic dental pulps [dissertation]. Umeå, Sweden: Umeå University; 1976.
10. Sjögren U. Success and failure in endodontics [dissertation]. Umeå, Sweden: Umeå University; 1996.
11. Trope M, Delano EO, Ørstavik D. Endodontic treatment of teeth with apical periodontitis: single vs. multivisit treatment. J Endod 1999; 25:345-50.
12. Heithersay GS. Stimulation of root formation in incompletely developed pulpless teeth. Oral Surg Oral Med Oral Pathol 1970; 29:620 –30
13. Baumgartner JC, Xia T (2003) Antibiotic susceptibility of bacteria associated with endodontic abscesses. Journal of Endodontics 29, 44–7.
14. Kawashima N, Wadachi R, Suda H, Yeng T, Parashos P (2009) Root canal medicaments. International Dental Journal 59, 5-11.
15. A.A. Elgendy, M.M. Nagy. The effect of different intracanal medications on fracture resistance of root canal dentin. Tanta Dental Journal 12 (2015) 163-167.
16. Felippe WT, Felippe MC, Rocha MJ (2006) The effect of mineral trioxide aggregate on the apexification and periapical healing of teeth with incomplete root formation. International Endodontic Journal **39**, 2-9.
17. Granath LE. Some notes on the treatment of traumatized incisors in children. Odont Rev 1959;10:272.
18. Chawla HS. Apexification: follow-up after 6 –12 years. J Indian Soc Pedod Prev Dent 1991;8:38–40.
19. Alrebdi, A. Bibliometric assessment of laser therapy in dentinal hypersensitivity. International Journal of Health Sciences, 2022, 6(S3), 10747–10754.
20. Theodore C, Scrivener K. Alkali fixation of C-S-H in blended cement pastes and its relation to alkali silica reaction. Cem Concr Res 2012;42:1049-54.

21. Askarinejad, A., Pourkhorshidi, A. R., & Parhizkar, T. (2012). Evaluation the pozzolanic reactivity of sonochemically fabricated nano natural pozzolan. Ultrasonics Sonochemistry, 19(1), 119–124.

Table 1: Mean difference between MTA and Endocem MTA's push-out bond strengths when using various intracanal medications

Intracanal medicament	**N**	**MTA**	**Endocem MTA**
Calcium Hydroxide	30	2.80±0.27	3.01±0.15
Ledermix paste	30	2.31±0.14	2.55±0.27
Saline	30	2.59±0.22	2.73±0.14

Table 2: Comparative evaluation of MTA and Endocem MTA's push-out bond strengths

Root End Filling	Intracanal medicament	Mean±S.D	t-value	p-value
MTA	Calcium Hydroxide	2.80±0.27	-2.27	0.01
Endocem MTA		3.01±0.15		
MTA	Ledermix paste	2.31±0.14	-2.45	0.01
Endocem MTA		2.55±0.27		
MTA	Saline	2.59±0.22	-2.03	0.02
Endocem MTA		2.73±0.14		

$P<0.05$ significant