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Efficacy of Push Out Bond Strength of Proroot Mta, Biodentine & Calcium Phosphate Cement Ondentin: An Ex-Vivo Evaluation

Research Article

Vanita Dattatraya Revankar[1*], Kaarunya Ravikumar[2], Mallikarjun D.Y[3], Gautam Ranjit[4], T.Sathish kumar[5], S.Anabarasu[6]

[1] Reader, Department of Conservative Dentistry and Endodontics, Vinayaka Mission Sankarachariyar Dental College, Vinayaka Mission's Research Foundation [Deemed To Be University], Salem, Tamil Nadu, India.
[2] Sr.Lecturer,Department of Conservative Dentistry and Endodontics,Vinayaka Mission Sankarachariyar Dental College, Vinayaka Mission's Research Foundation [Deemed To Be University], Salem, Tamil Nadu, India.
[3] Sr.Lecturer,Department of Conservative Dentistry and Endodontics,Vinayaka Mission Sankarachariyar Dental College, Vinayaka Mission's Research Foundation [Deemed To Be University], Salem, Tamil Nadu, India.
[4] Sr.Lecturer,Department of Conservative Dentistry and Endodontics,Vinayaka Mission Sankarachariyar Dental College, Vinayaka Mission's Research Foundation [Deemed To Be University], Salem, Tamil Nadu, India.
[5] Professor and Head (Dept.of Oral Maxillofacial Surgery), Govt. Mohan kumaramangalam Medical College & Hospital, Salem, Tamil Nadu, India.
[6] Assistant Professor, (Dept.of Conservative Dentistry & Endodontics) Govt. Mohan Kumaramangalam Medical College & Hospital, Salem, India.

Abstract

Introduction: It is well known that the biomineralization process leading to the synthesis of an interfacial layer with tag-like structures is due to the synergeticeffect of mineral trioxide aggregate (MTA) & Portland Cement with dentin in phosphate-buffered saline (PBS) at the cement-dentin interface. However, there are no investigations which have examined the effect of the influence of biomineralization process on the push-out bond strength of ProRoot MTA (Dentsply Tulsa Dental, Tulsa,OK), Biodentine & Calcium phosphate cement (BioGraft CPC).

Aim: To examine the effect of biomineralization process on the push-out strength of ProRoot MTA, Biodentine & CPC after mixing with0.2% Chlorhexidine gluconate solution and 2% local anaesthetic solution on the bond strength of MTA-dentin.

Materials and Methods: Dentin discs with uniform cavities were filled with ProRoot MTA, Biodentine & Calcium Phosphate Cement. The samples were equally divided into two groups: experimental group being immersed in PBS and control group being immersed in Saline for 2 months. Instron Testing machine (Model 4444; Instron Corp, Canton, MA) was utilised for determining the bond strength. Statistical analysis used: A two-way analysis of variance & post hoc analysis by Bonferroni test.

Results: Specimens inserted into PBS showed a significant resistance to dislodgement than that detected for the samples of Saline ($p < 0.05$). MTA & Biodentine exhibited higher resistance to dislodgement than Calcium Phosphate Cements.

Conclusion: It was concluded that the push-out bond strength of the cement mainly the MTA & Biodentine groups, were positively benefitted by the biomineralization process.

Keywords: Biomineralization; Carbonated Apatite; Biodentine; Calcium Phosphate; Cement Mineral Trioxide Aggregate.

Introduction

In the present time of regenerative endodontics, endless studies in the area of bio-materials, has brought back original form and function of even the most difficult cases a reality [1]. Iatrogenic complications of endodontic treatment like perforations can occur advancing to endodontic failure.[2]

Many materials like amalgam, Super EBA, IRM, Cavit, Composite Resin and Glass Ionomer Cements have been used in the past to seal perforation sites. These materials have their own disadvantages like microleakage, toxicity and sensitivity in the presence of moisture.

MTA exhibits very good biocompatibility, greater sealing efficien-

***Corresponding Author**:
Vanita Dattatraya Revankar,
Reader, Department of Conservative Dentistry and Endodontics, Vinayaka Mission Sankarachariyar Dental College, Vinayaka Mission's Research Foundation [Deemed To Be University], Salem, Tamil Nadu, India.
E-mail: vanitarevankar@gmail.com

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cy and capacity to set in the presence of blood.[3] A colloidal gel is formed on the hydration of the powder which solidifies in less than 4 hours to a hard structure.[4] Lately, many, new Calcium Silicate based Materials have been popularized including BioAggregate, MTA-Angelus, Calcium Phosphate Cement and Biodentine, Biodentine is a calcium-silicate based material that has been introduced in recent years and has been suggested to use in many clinical applications, such as root perforations, apexification, resorptions, retrograde fillings, pulp capping procedures, and dentine replacement.

Calcium phosphate cement (CPC)[5] consist of uniform amounts of tetracalcium phosphate (TTCP) and dicalcium phosphate anhydrous (DCPA) was exhibited to be biocompatible [6] and osteoconductive.

Though, the query is as to if these medications will possibly trigger chemical reaction to debase MTA, Biodentine & CPC or impede with its bond to dentin has not been well stated in the earlier studies.

`The aim of this study was to compare & detect the effect of 0.2% CHX & 2% LA on the bond strength of PROROOT-MTA, Biodentine & CPC dentin in vitro.

Materials And Method

The study was done in the department of conservative dentistry ad endodontics after obtaining ethical approval from institutional ethics committee. One hundred & twenty human premolars extracted for orthodontic purposes were utilised in the present study.

The crowns were detached and mid-root dentin was diagonally sectioned into 2.00mm wide segment with a water cooled low-speed carborundum disc. With a spherical diamond bur,the area of the canal was broadened and two complete passes of a #5 Gates-Glidden bur was done to get 1.3mm diameter uniform cavities. The segments were inserted in 17% EDTA for 3 minutes proceeded by 1% sodium hypochlorite for 3 minutes. They were then cleaned in distilled water immediately and desiccated.

One hundred & twenty sectioned teeth samples were split into two uniform groups, one being control group A and the other being experimental group B. Each group was further divided into 6 sub-groups.

o Sub-Group 1A: Samples were filled with ProRoot MTA mixed with 0.2%Chlorhexidine gluconate solution & immersed in Saline.
o Sub-Group 2A: Samples were filled with ProRoot MTA mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in Saline.
o Sub-Group 3A: Samples were filled with CPC mixed with 0.2% Chlorhexidine gluconate solution & immersed in Saline.
o Sub-Group 4A: Samples were filled with CPC mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in Saline.
o Sub-Group 5A: Samples were filled with Biodentine mixed with 0.2% Chlorhexidine gluconate solution & immersed in Saline.
o Sub-Group 6A: Samples were filled with Biodentine mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in Saline.

Similarly,

o Sub-Group 1B: Samples were filled with ProRoot MTA mixed with 0.2% Chlorhexidine gluconate solution & immersed in PBS solution.
o Sub-Group 2B: Samples were filled with ProRoot MTA mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in PBS solution.
o Sub-Group 3B: Samples were filled with CPC mixed with 0.2% Chlorhexidine gluconate solution & immersed in PBS solution.
o Sub-Group 4B: Samples were filled with CPC mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in PBS solution.
o Sub-Group 5B: Samples were filled with Biodentine mixed with 0.2% Chlorhexidine gluconate solution & immersed in PBS solution.
o Sub-Group 6B: Samples were filled with Biodentine mixed with a Local anaesthetic solution (Lidocaine HCL- 2%) & immersed in PBS solution.

ProRoot MTA, CPC & Biodentine powder was mixed with 0.2% CHX solution & 2% LA at a powder-liquid ratio of 3:1.When the mixture showed putty consistency, it was compacted with a plugger into root canals with a help of a carrier . All samples wereassessed using a microscope at 16 X magnification. Samples with cracks, defects or gaps between the material and dentin walls were excluded.

Immediately after filling, 10 samples from the control group (A) were placed in a saline solution of 15ml (Ph =7.2) for 2 months at 37- degree centigrade & experimental group (B) were placed in phosphate buffer solution. The solution was changed once in every 5 days.

Push-out Test: After experimental periods,specimens were kept in a steel holder which was firmed to an aligning apparatus that held it centered below a steel piece with a cylindrical punch. Bond strengths were measured.using an MTS testing machine.

The barrel shaped end of a 2/4 hand plugger with 1 mm diameter was utilizedas a force probe placed on the moving head of the MTS. The force probe moving at a speed of 0.2mm/min, enforced pressure to the surfaces of MTA in all samples until the material was dislodged. The maximum force used to MTA before displacement taken place was noted as N force.

All values were fed into the computer and checked by means of SPSS 16.0 system for windows. A two-way analysis of variance comparisons with 5% significance level was done to test the differences in dislodgement force between the twelve groups. A post hoc analysis by Bonferroni test was performed within the same cement type inserted in PBS & Saline solutions.

Results

Two-way ANOVA analysis exhibitted that the mean values showed a statistically significant variance in the mean expulsion force among the CPC and all other sub-groups (table1).

Table 1. Demonstrates the comparison in between the mean bond strength of each subgroup.

Parameter

Group	Number	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Saline 1A	10	26.47	6.81	21.60	31.34	15. 58	35.54
solution 2A	10	26.11	10.84	18.36	33.86	9.86	43.84
3A	10	13.0 1	4.40	9.87	16.16	6.82	21 .68
4A	10	10.70	4.02	7.82	13.57	5.36	18 .80
5A	10	28.18	10.10	20.95	35.40	10.16	41.43
6A	10	25.72	1125	17.67	33.76	1268	38.86
Total	60	21.70	10.75	18.92	24.47	5.36	43.84
PBS 1B	10	34.79	9.	27.81	41.76	20.46	46.32
Solution 2B	10	33.71	4.41	30.55	36.87	2a 40	36.40
3B	10	21.12	5.40	17.26	24.98	16.61	32.36
4B	10	20.37	5.59	16.37	24.37	14.60	30.60
5B	10	40.57	11.12	32.61	48.52	20.19	54.56
6B	10	3420	4.81	30.76	37.64	26.78	42.68
Total	60	30.79	1028	28.14	33.45	14.60	54.56

Table 2. Demonstrates the comparison in between the mean bond strength of each subgroup.

Post hoc analysis by bonferroni test

Dependent Variable: Parameter

subgroup			Mean Difference (l.J)	Std.Error	p	
S with	p	BC	8.315	3.760	0.040	sig
		BL	7.602	3.700	0.045	sig
		cc	8.106	2.2()2	0.002	HS
		CL	9.674	2.178	0.000	HS
		PC	12.389	4.750	0.018	sig
		PL	8.4S3	3.868	0.042	sig

S=Saline solution, P=PBS solution, HS=highly significant, sig=significant

The mean dislodgement force of MTA-dentin reduced in/the control group. The greatest degree of mean dislodgment force was exhibitted by MTA & Biodentine subgroups. Table 1 demonstrates the comparison in between the mean bond strength of each subgroup. Bonferroni test was applied to perform a comparison among individual groups. The results showed that among the samples inserted in Saline (P>0.05), samples inserted in PBS showed a significantly higher resistance to displacement as shown in table 2. Bond strength was significantly higher in subgroups 1B, 2B, 5B & 6B than in the others (P>0.05).

There was no statistically significant variationin the mean dislodgment force between the 0.2% Chlorhexidine gluconate & 2% LA subgroups. Subgroups 3B &4B exhibited significantly low amount of bond strengths then compared with other subgroups.

Discussion

MTA has been used in both surgical and nonsurgical utilization, along with root-end fillings,[7-10] direct pulp cappings [11, 12], perforation repairs in roots or furcations [13, 14] and apexification.[15] In functional areas MTA should not be placed, because of its low compressive strength [16]. Biodentine and MTA are applied in pulp capping due to their active role in mineralized tissue bridge formation, the maintenance of pulpal vitality, and facilitation of odontoblast layer integrity [17] For health-care providers and dentists, Biodentine is new bioactive cement that is similar to the widely used MTA.

With concern to dentin bridge formation, it was noted that Biodentine and MTA are likely to favour the formation of reparative dentin, and they have direct results on odontoblasts when applied in Direct Pulp Capping Procedures.

Root perforations can be remodeled by using materials like Calcium phosphate cement(CPCs). They coalescence the osteocompatability and biocompatibility of hydroxyapatite implants and mouldability of acrylic bone cement and are extremely versatile in applications. The most frequently used solutions are saline, chlorhexidine, Local anaesthesia & NaOCl, etc. There are not many previous literatures which have stated that these agents would potentially stimulate chemical interaction to debase MTA & Biodentin or reduce its bond to dentine.Saline and Local anesthetic solutions are commonly mixed with Portland-derived cement be-

cause of its easier handling and availability in clinical procedures. The present research was designed to check the effect of the biomineralization mechanism which resisted dislodgement of different types of cement from the dentinal wall.This study has evaluated the effects of 0.2% chlorhexidine and 2% LA on the bond strength of ProRoot MTA, Biodentine & CPC-dentin in vitro. The mean values of push-out bond strength all the experimental groups are in accordance with the results of previous literatures 18-20, which also assessed the push-out test for other purposes. The present study displayed that all PBS-immersed samples exhibited a significantly greater resistance to dislodgement compared to the control group & also displayed statistically significant difference in the mean dislodgment force between theMTA, Biodentine and CPC groups. No statistical significant difference was noted between 2% LA and 0.12% chlorhexidine groups.

MTA promotes the precipitation of carbonated apatite, stimulating a controlled mineral nucleation on dentin as the production of an interfacial layer with tag-like structures.[18] Even though, all cement form tag-like structures when inserted in PBS, it is necessary to figure out that the samples of ProRoot MTA &Biodentine displayed statistically significant resistance to dislodgement than the CPC.

Reduced mechanical properties of CPC are the main drawback of this material. Since the material is weak under tensile forces.[19] The particle size of cement also influences variation in push-out strength. It is clearly established that the variations in the particle size of the material tested are of higher significant for the mechanical characteristics of the bound cement. Therefore, the usage of cement with an uneven size of fragments may not be ideal, in cases when higher forces could be placed with the cement, when used as a permanent restoration.

Conclusion

The main conclusion of this study was that the biomineralization process showed positive influence on the resistance to displacement from dentin of all cement tested. However, MTA & Biodentine benefited more than CPC from the process.However, more researches are needed before this cement can safely be used in clinical practice.

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