Section A -Research paper

Comprehensive Assessment of Plugged Out Bond Strength of Commercially Available Mineral Trioxide Aggregate And Biodentine: An in vitro (Original Research) Study

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Abstract

Aim: The exclusive aim of this study was to assess plugged out bond strength of commercially available mineral trioxide aggregate and biodentine.

Materials & Methods: Two commercially available bioactive dental materials Septodont Biodentine and MTA were studied in two groups. Sampling was done carefully for 24 maxillary lateral incisors with strict predetermined inclusion criteria. Samples were cleaned and sectioned to remove apical and coronal one third segment of tooth. Further transverse re-sectioning of the piece leaving middle 2 mm potions were also done. Group one has total 12 maxillary lateral incisors samples in which Septodont Biodentine was used. Group two has total 12 maxillary lateral incisors samples in which MTA was used. All samples were then tested for their plugged out bond strength by universal testing machine. The maximum load required to dislodge the cement plug was recorded in Newton. P value less than 0.05 was considered significant ($p< 0.05$).

Statistical Analysis and Results: The statistical analysis was conducted by SPSS software. All preliminary data was entered into excel sheet and entered into computer. For Group I, the mean plugged out bond strengths for group I was 4.62. The calculated standard deviation was

0.948 and measured standard error was 0.647. The p value was highly significant (0.02). For Group II, the mean plugged out bond strengths for group II was 1.31. The calculated standard deviation was 0. 637 and measured standard error was 0.466. The ANOVA testing confirmed about highly significant p value (0.001).

Conclusion: Within the limitations of the study authors concluded that Biodentine has high plugged out bond strength compared to the MTA. Biodentine showed highly significant values also. However, authors anticipate some other studies to be conducted with larger samples size and thorough analysis.

Key Words: Mineral Trioxide Aggregate, Biodentine, Bond Strength, Endodontics, Root Perforation

Introduction

Endodontic practice has been revolutionized with the advent of newer materials, technologies and techniques. Despite of all these facilities, complications do occur.[1,2,3] Some of the common post operative complications of endodontic practice are pain, swelling, root perforation and others. Many researchers have shown that root perforation is the second common reason of failure of root canal therapy. As discussed in the literature this root perforation is usually initiated by mechanical instrumentation coupled with bacterial invasion.[4,5,6] Other possible etiology is root resorption. Many of the researchers have shown that root perforation is primarily due to missed path of root canal instruments.[7,8] It may be associated to limited operator skill, improper aid of radiographs and lack of experience. Biodentine and MTA are the materials those are used frequently for repairing or sealing purpose of these defects. Biodentine is Tricalcium silicate based cement which have Calcium carbonate, Calcium chloride, polymer as additive. Biodentine is available as powder and liquid.[9,10,11] The powder is supplied in a capsule while the liquid is in an ampoule. The design of Biodentine ensures optimal properties and thus improved clinical performance. Hence considering all these interesting factors, this study was aimed to assess the plugged out bond strength of commercially available mineral trioxide aggregate and Biodentine.

Materials & Methods

The study was conducted with the ideology of using biological materials in different endodontic therapies. For the same, authors finalized two commercially available bioactive dental materials Septodont Biodentine (Raigad, India) and MTA (Medicept Dental, Harrow England). Both are considered as excellent root repair material during various clinical situations. Additionally they exhibit acceptable biocompatibility and dimensional stability with minimum incidence of micro-leakage. Sampling was done carefully utilizing simple random sampling procedure. For this, maxillary lateral incisors were chosen. Total 24 maxillary lateral incisors were arranged with following features: teeth with no caries/decay, teeth with normal/acceptable anatomy, teeth with single non tortuous root canal, teeth without any sign of fracture. All specimens which did not

meet these inclusions criteria were immediately discarded. All these sample selections and finalization was performed by a single operator. All samples were cleaned comprehensively by immersing them into standard solution of sodium hydrochloride for 11 minutes. Cleaned samples were then stored in to pre-numbered containers having distilled water. Sectioning procedure was performed to remove apical and coronal one third segment of tooth. All sectioning were conducted in to horizontal direction with low speed motored diamond disc. Actual study samples were obtained from these sectioned segments by transverse re-sectioning of the piece leaving middle 2 mm potions. All experiments and studies were performed in these 2 mm thick tooth samples. Root canal spaces were enlarged to standard dimension by Peeso reamers. Removal of smear layers and intermittent irrigation was also ensured to maintain the integrity and accurateness. In these dried up root canals, two experimental materials were utilized. Group one has total 12 maxillary lateral incisors samples in which Septodont Biodentine was used. Group two has total 12 maxillary lateral incisors samples in which MTA (Medicept Dental) was used. All mixing of material was as per manufacturer instructions and guidelines. All samples were then tested for their plugged out bond strength. This test was being assisted by universal testing machine. Individual samples were positioned one by one on UTM testing platform. The mechanical tip of machine then applies the load and the maximum load required to dislodge the cement plug was recorded in Newton. All plugged out bond strengths were then tabulated group wise for further analysis. Results and data was compiled in table and sent for basic statistical analysis. P value less than 0.05 was considered significant ($p< 0.05$).

Statistical Analysis and Results

All relevant findings and details were sent for statistical analysis using statistical software Statistical Package for the Social Sciences version 22 (IBM Inc., Armonk, New York, USA). Appropriate statistical tests were also utilized to obtain p values, mean, standard deviation, chi-square test, standard error and 95% CI. Table 1 showed that out of 24 samples, 12 were in group I [Septodont Biodentine (Raigad, India)] and next 12 were in group II [MTA (Medicept Dental, Harrow England)]. Table 2 illustrates about the basic statistical explanation with level of significance evaluation using pearson chi-square test [FOR Group I]. Here, the mean plugged out bond strengths for group I was 4.62. The calculated standard deviation was 0.948 and measured standard error was 0.647. The p value was highly significant (0.02). Table 3 illustrates about the basic statistical explanation with level of significance evaluation using pearson chi-square test [for Group II]. Here, the mean plugged out bond strengths for group II was 1.31. The calculated standard deviation was 0. 637 and measured standard error was 0.466. The p value was not significant (0. 08). Table 4 shows about the comparison among the 2 study groups using one-way ANOVA [for group I, II]. The ANOVA confirmed about highly significant p value (0.001). Graph 1 illustrates about individual plugged out bond strengths for group I. Graph 2 illustrates about individual plugged out bond strengths for group II.

Table 1: SAMPLE DISTRIBUTION AND GROUPINGS

Sr. No	Group	Material	n
1	I	Septodont Biodentine (Raigad, India)	12
2	II	MTA (Medicept Dental, Harrow England	12

Table 2: BASIC STATISTICAL EXPLANATION WITH LEVEL OF SIGNIFICANCE EVALUATION USING PEARSON CHI-SQUARE TEST [FOR Group I]

Group	Mean	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Group I	4.62	0.948	0.647	1.96	1.324	1.0	0.02*
							***p<0.05 significant**

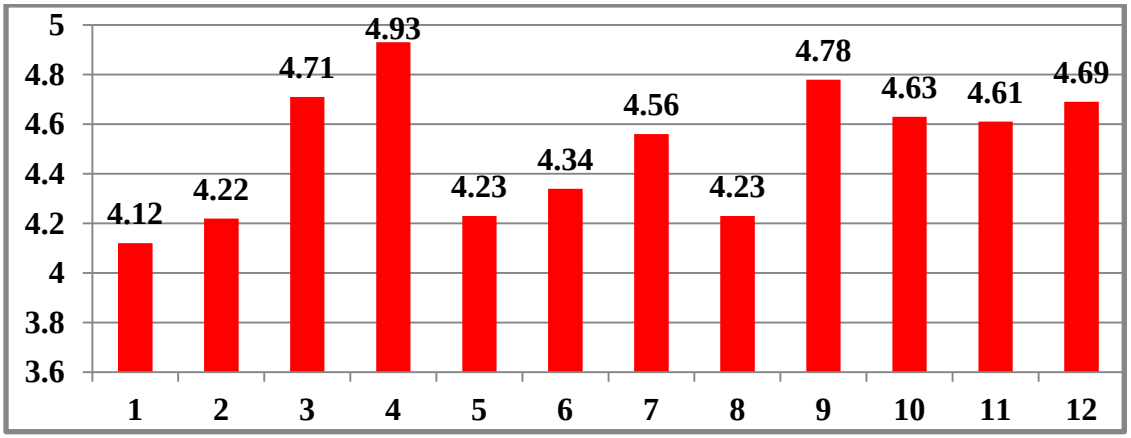
Table 3: BASIC STATISTICAL EXPLANATION WITH LEVEL OF SIGNIFICANCE EVALUATION USING PEARSON CHI-SQUARE TEST [FOR Group II]

Group	Mean	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Group II	1.31	0.637	0.466	1.96	2.152	2.0	0.08
							***p<0.05 significant**

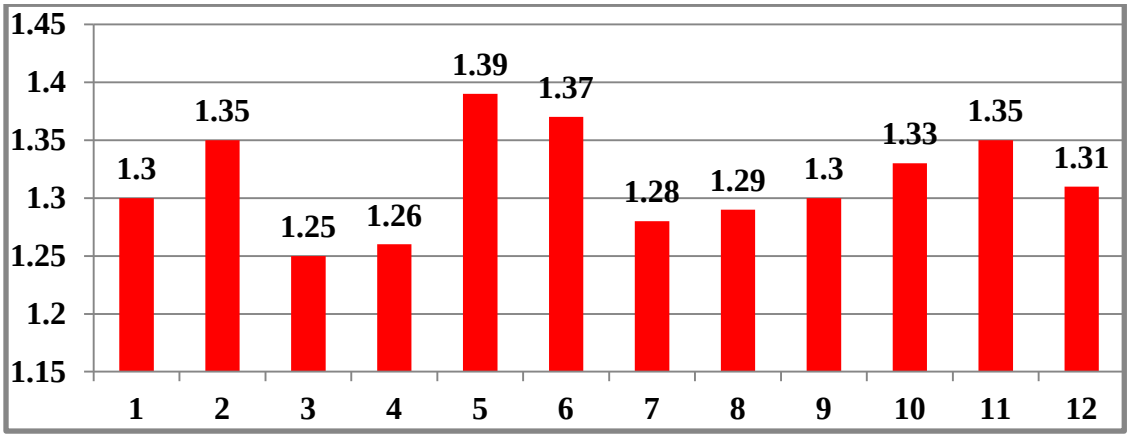
Table 4: COMPARISON AMONG THE 2 STUDY GROUPS USING ONE-WAY ANOVA [FOR GROUP I, II]

Variables	Degree of Freedom	Sum of Squares ∑	Mean Sum of Squares m∑	F	Level of Significance (p)
Between Groups	3	2.751	1.238	2.1	0.001*
Within Groups	22	5.303	0.118	-	
Cumulative	121.43	11.001	***p<0.05 significant**		

Graph 1: INDIVIDUAL PLUGGED OUT BOND STRENGTHS FOR GROUP I



Graph 2: INDIVIDUAL PLUGGED OUT BOND STRENGTHS FOR GROUP II



Discussion

The precise selection of material is important for successful clinical results. Several hydraulic calcium silicate cements are available in the market like MTA, Theracal, ProRoot MTA.[12-14] Biodentine is popularly also known as dentine in capsule. Its liquid contains water with some additions of calcium chloride and a water soluble polymer. Biodentine usually releases calcium ion so considered as ideal pulp capping agent. Many case reports and case series have shown that Biodentine show predictable results in irreversible pulpitis by reducing the size of apical regions. However literature has also evidenced that reaction of Biodentine with pulp is somewhat similar to the regular MTA.[15-18] Some studies also confirmed that Biodentine shows less micro-leakage than resin based dentine substitution materials. Also, Biodentine exhibited improved cyto-compatibility and bioactivity than MTA Angelus. Several research studies also confirmed high success rate in pulpotomy procedures with usage of Biodentine.[19-21] Since Biodentine is second generation hydraulic calcium silicate material, it must be utilized very carefully. Mostly it is used as a dentine repair material but it can also be successfully employed in other clinical applications.[22,23] Akbulut and associates have studied about push-out bond strength of BIOfactor mineral trioxide aggregate, a novel root repair material. Their results were highly comparable

with our results. The results were significant also.[24] Elsayed and colleagues have studied about effect of different chelating agents on the shear bond strength of calcium silicate-based cements to coronal dentin. Their outcomes were highly predictable and imperetive.[25]

Conclusion

Within the limitations of the study authors concluded highly remarkable inferences. It was shown that Biodentine has high plugged out bond strength compared to the MTA. Moreover the results for Biodentine were highly significant also. ANOVA testing also revealed high significance of comparison of these materials. Also, the clinical behavior of these materials is highly subjective and depends on various factors. Therefore, clinical application of this information must be evidence based and judicious. Authors expect some other studies to be performed with larger samples size and comprehensive analysis.

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