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Comparative evaluation of shear bond strength of mta and a newer bioceramic material- 'meta bonemedik', with a dual cure composite resin- 'multilink speed' in regenerative endodontics: An in-vitro study.

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Abstract

Introduction: Bioceramic materials show properties that favours regenerative treatment. The success rate of treatment depends on an adequate restoration that prevents microleakage. However, research regarding the bond strength between the restorative and bioceramic materials used in regenerative procedures is limited. Thus the aim of this study was to compare and evaluate the shear bond strength of MTA and a newer bioceramic material- Meta Bonemedik, with a dual cure composite resin- Multilink Speed.

Methodology: Twenty wells in acrylic blocks were filled with bioceramic materials representing 2 groups: Group I- Angelus MTA & Group II- Meta bonemedik. After the samples were set, the exposed surfaces of the bioceramic materials were restored with a composite resin- Multilink Speed. The samples were allowed to set for 7 days at 37°C and 100% humidity to ensure absolute setting of the bioceramic material. Each block was secured in a universal testing machine and shear bond strength was calculated followed by data comparison.

Results: The shear bond strength of Angelus MTA (Group I) was significantly higher than Meta bonemedik (Group II) when used with a dual- cure composite resin.

Conclusion: Higher bond strength in Angelus MTA indicates potentially decreased surface area susceptible to microleakage and thus reduces the probability of

subsequent contamination of the pulp space in regenerative endodontic procedures.

Keywords: Bioceramic, Dual-Cure Composite Resin, Regenerative Endodontics, Shear Bond Strength.

Introduction

Calcium silicate–based cements or bioceramics, have received increased attention in dentistry especially in the field of endodontics. They can function as cements, root-end restorations, perforation repair materials, root canal sealers and obturation materials and have found a contemporary niche in regenerative endodontics. Successfulregenerative endodontic procedures depends on an effective coronal seal after treatment with a pulp space barrier followed by final restoration. The main aim of regenerative endodontics is to inhibit microbial invasion of the pulp space through creation of a double seal by placing MTA or other bioceramic material below the cementoenamel junction and covering it with a bonded restoration, this permits revascularization of the pulp-dentin complex.

Mineral trioxide aggregate (MTA) and other bioceramic materials show physical and biological properties that are favorable for various clinical procedures such as preservation of pulp vitality and regenerative techniques. They demonstrate excellent biocompatibility and also have the ability to set in the presence of biological fluids including blood[1–4]. The sealing ability, biocompatibility and dentinogenic activity of MTA have been attributed to the physiochemical reactions between dentin and MTA[5]. Newer bioceramic materials are released in the market having its own advantages and disadvantages but there are very few studies evaluating the interface between these new materials and composite resin.

Meta bonemedik is a silicon containing coralline hydroxyapatite bone graft substitute, indicated as a cancellous bone substitute or augmentation material for the repair of bone defects. It is a non-osteogenic bone graft substitute similar in structure and composition to human cancellous bone. Meta bonemedik is derived from the exoskeleton of marine coral which has a natural trabecular structure that consists of large pores which run parallel to the major growth axis and smaller interconnecting pores which run perpendicular to the major growth axis. This structure resembles the multidirectional, interconnected porosity of cancellous bone. The marine coral is machined to block or chip configurations. A chemical process converts the coralline calcium carbonate structure in the blocks to a mixture which contains a minimum of 95% crystalline hydroxyapatite and a maximum of 1% silicon. The interconnected pores of the Meta bonemedik trabecular network have a median pore diameter 400 microns. It is a new material and its use in endodontics has not been studied.

Research evaluating the interface between the bioceramic materials and the composite resin restorative materials, which is commonly placed over them is important. If the tested materials demonstrate a higher bond strength, this indicates a potentially decreased surface area subject to microleakage and thus a lower likelihood of subsequent contamination of the pulp space that is undergoing regenerative activity. Thus, thisstudycompared the shear bond strength of MTA and a newer bioceramic material- ‘Meta bonemedik’, with a dual cure composite resin- ‘Multilink speed’ in regeneration.

Aim of the study

Comparative evaluation of shear bond strength of MTA and a newer bio ceramic material- ‘Meta Bonemedik’, with a dual cure composite resin- ‘Multilink Speed’ in regenerative endodontics.

Objectives of the study

To evaluate the shear bond strength of MTA and a newer bioceramic material- 'Meta Bonemedik', with a dual cure composite resin-'Multilink Speed' in regenerative endodontics.

To compare the shear bond strength of MTA and 'Meta Bonemedik', with 'Multilink Speed' in regenerative endodontics.

Materials & Methodology

Sample size calculation: The sample size has been estimated using the GPower software v. 3.1.9.2 The total sample was calculated as 20. Each group consisted of 10 samples (10 x 2 groups = 20 samples).

Fig. 1: Materials used for the study

Sample preparation: Twenty acrylic blocks were made and wells were drilled at the centre of the blocks with a dimension of 3x3mm. The blocks were divided randomly into 2 groups of 10 blocks in each group. Group I and II are divided depending on the different test materials used, Group I- Angelus MTA (Angelus, Londrina, Brazil) and Group II- Meta bonemedik (Meta Bio Med Co. Ltd, South Korea). Both the bioceramic materials were mixed according to the manufacturer's instructions and placed in the well within the acrylic block, it was then leveled using a mixing spatula till the surface of the acrylic block. Before the bonding procedure, the samples were allowed to set at 37°C and 100% humidity for the manufacturer's full recommended setting time. Multilink Speed (Ivoclar Vivadent), a dual-cured composite resin was placed over the bioceramic material with the automix delivery tip into a cylindrical- shaped plastic matrix having a dimension of 3x3 mm, followed by light polymerization for 20 seconds. The samples were allowed to set for 7 days at 37○C and 100% humidity to ensure absolute setting of the bioceramic materials.

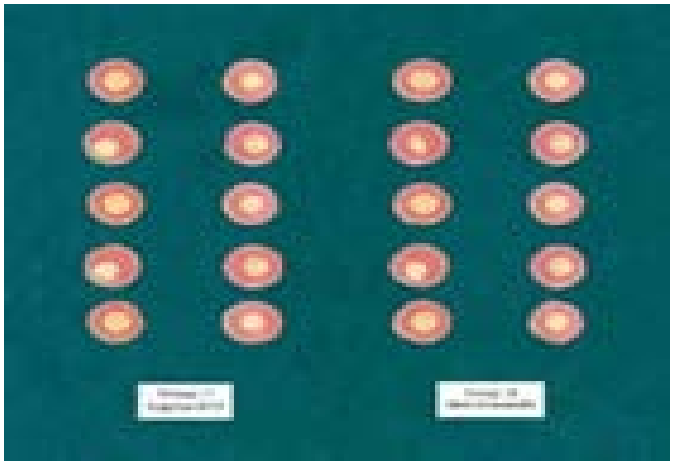


Fig. 2: Acrylic blocks

Shear bond strength test: All the samples were subjected to shear bond strength test using a universal testing machine with a crossheadspeed of 0.5 mm/min.

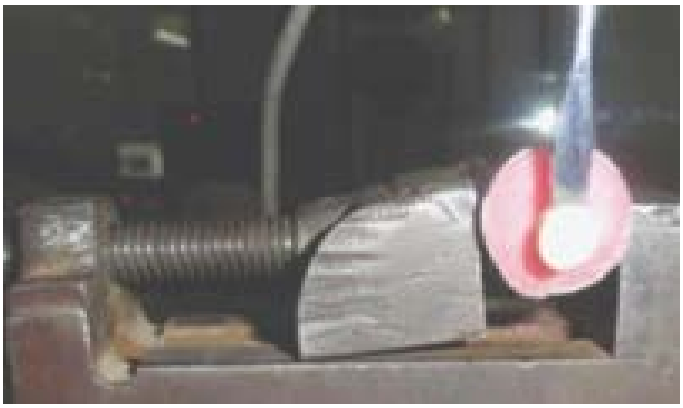


Fig 3: Universal Testing Machine

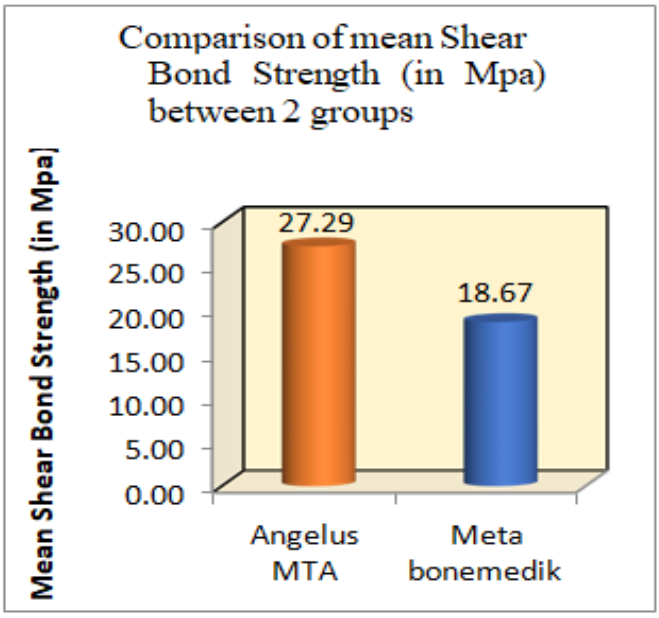
Statistical Analysis: Independent Student t Test was used to compare the mean shear bond strength between the 2 groups. The levelof significance was set at $P<0.05$

Result

The test results demonstrated that Group I showed significantly higher mean shear bond strength (27.29 ± 2.16) as compared to Group II (18.67 ± 1.71) with a mean difference of 8.62 MPa at P<0.001.

Table 1: Mean shear bond strength between 2 groups

Comparison of mean Shear Bond Strength (in Mpa) between 2 groups using Independent Student t Test								
Group	N	Mean	SD	Mean Diff	95% CI of the diff.		t	P-Value
					Lower	Upper		
Angelus MTA (Group I)	10	27.29	2.16	8.62	6.79	10.45	9.887	<0.001*
Meta bonemedik (Group II)	10	18.67	1.71					



Graph 1: Comparison of mean shear bond strength between 2 groups.

Discussion

The degree of success of regenerative endodontic procedures depends on the elimination of symptoms, evidence of bony healing, increased root wall thickness and/or increased root length and a positive response to vitality testing8. Three important principles of regenerative endodontics are: elimination of bacteria from the canal system, introduction or creation of a scaffold to support ingrowth of new tissues and prevention of reinfection by creating a bacteria-tight seal7. In root canal revascularization, most failures are associated with reinfection of the root canal, therefore bacteria-tight seal after regenerative procedures is very important. After disinfection of the canal space, a barrier is placed over the blood clot that is formed. Bioceramic materials like MTA is used for this purpose. These materials create a bacteria-tight seal and have advantages over other materials because of their properties like biocompatibility, conductivity and inductivity1–3. A layer of 3 to 4mm of MTA is recommended, this layer acts as a pulp space barrier, which is followed by the placement of a final restoration7. MTA has a long setting time (10-15 minutes) and requires the placement of a moist cotton pellet over it to speed up the setting time, thus the newer bio ceramic materials have become popular with several advantages like shorter setting time, immediate placement of permanent restoration and improved handling properties. Meta bonemedik is silicon ion containing porous hydroxyapatite bone grafting material used to fill, augment or reconstruct periodontal, maxillofacial and osseous defects created from traumatic injury to the bone, it is also used for filling of peri-implant defects in conjunction with products intended for Guided Bone Regeneration (GBR). It is a Biphasic Calcium Phosphate (BCP) material. BCP bio ceramics belong to a group of bone substitute biomaterials that consist of a mixture of hydroxyapatite (HA) and beta tricalcium phosphate (β-TCP) of varying HA/β-TCP ratios. BCP have become the

material of choice in various orthopaedic and maxillofacial bone repair procedures. One of their main advantages is their biodegradation rate that can be modified by changing the proportional ratio of the composition phases. Hence, Meta bonemedik was used to evaluate its effect in regenerative endodontics. Multilink Speed is a self-adhesive, dual curing composite resin cement. As a result of its self-adhesive properties, Multilink Speed is recommended for luting indirect restorations made of high-strength all-ceramics (zirconium oxide ceramics, lithium disilicate glass-ceramics), fibre-reinforced composites, metal and metal-ceramics. Multilink Speed combines the benefits of conventional cements with those of adhesive luting resins. The composite cement is characterized by a straightforward application protocol and good mechanical properties. The focus of this study was to evaluate shear bond strength between bioceramic material and self adhesive composite, used during regeneration- MTA and Meta Bonemedik. Studies showed that increased bond strength between components placed coronal to the regenerating canal space could minimize potential leakage, resulting in less recontamination of the regenerating pulp space13. Angelus MTA (Group I) showed significantly higher shear bond strength than Meta bonemedik (Group II) when used with a dual- cure composite resin, this is due to the bond at the interface between MTAand dentin. The result of our study is in agreement with the result of a study done by Sarkar et al5 who stated that hydroxyapatite, formed from the dissolution of minerals in MTA, formed a chemical bond with dentin, resulting in the formation of an interfacial layer between MTA and dentin. Hydroxyapatite crystals nucleate and grow, filling the microscopic space between MTA and the dentinal wall. Initially, this seal would be mechanical but with time, the apatite layer and dentin leads to their chemical bonding, due to the creation of a seal at the MTA-dentin interface3. Higher bond strength indicates potentially decreased surface area susceptible to microleakage and thus reduces the probability of subsequent contamination of the pulp space as in regenerative procedures. Meta bonemedik on the other hand showed lower shear bond strength because it does not possess sufficient mechanical strength. They provide limited biomechanical support because they are brittle and have less tensile strength. Although increase in porosity and pore size facilitates bone ingrowth but it results in reduction of mechanical properties. Thus, an increase in the void volume results in a reduction in mechanical strength, this could be the reason for showing less bond strength and there are no studies on this material as reference. The bond strength values of different adhesive systems to dentin has beenreported to range from 13–35 MPa and the recommended bond strength values to achieve a restoration with proper seal and no marginal discrepancies has been reported to be 17–20 MPa17,18. The bond strength values between composite resin and the bioceramic materials used in this study are much higher than the recommended values. Higher bond strengths between bioceramics and composite leads to superior sealing, thus preventing bacterial contamination and ultimately leading to the success of regenerative endodontic procedures.

Conclusion

Within the limitations of this study, Angelus MTA showed significantly higher shear bond strength than Meta bonemedik when used with a dual- cure composite resin. The bond strength between Meta bonemedik and composite resin are much higher than the recommended values to achieve are sortation with no marginal discrepancies and proper seal, thus Meta bonemedik can

be used as a bio ceramic material in regenerative endodontics.

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