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IN VITRO STUDY ON IMPACT OF ORAL TISSUE FLUIDS ON COMPRESSIVE STRENGTH OF MTA AND BIODENTINE

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ABSTRACT

Aim: To evaluate the effect of oral tissue fluids like saliva and blood on compressive strength of MTA and biodentine. **Material and method**: The present study was done in the Department of Dentistry. A total of 30 freshly extracted mandibular premolars were collected and used in the study. A total of 30 cylindrical samples were prepared with internal diameter of 4 mm width and 6 mm length using acrylic blocks. Both MTA and biodentine were manipulated based on manufacturer's instructions. The moulds were coated with saliva or blood according to the group before placement of the material and a glass slab was placed at the base of the material to generate a smooth surfaced base. Finally compressive strength was evaluated. Data were tabulated and examined using the Statistical Package for Social Sciences Version 22.0 (IBM SPSS Statistics for Mac, Armonk, NY: IBM Corp, USA). **Results**: On contamination with oral tissue fluids like saliva and blood, there was no statistical significant difference in the compressive strength between the three groups i.e., MTA, MTA-S, MTA-B ($p>0.05$). Also, there was no statistical significant difference between BD, BD-S, BD-B ($p>0.05$). **Conclusion**: The results of the present study concluded that the compressive strength of MTA and biodentine was similar in comparison, both under normal as well as in contaminated conditions.

KEYWORDS: Compressive strength, Saliva, Blood, MTA, Biodentine.

INTRODUCTION

The success of root-end filling material lies in providing a complete fluid tight apical seal.[1] The failure of surgical endodontic treatment is due to inadequate apical seal.[2] The ideal root end filling material should adhere to the root canal dentine to achieve a good apical seal.[3] During surgical endodontic therapy the presence of moisture or contact with tissue fluids like blood and saliva may affect its sealing ability.[4] MTA has shown good results regarding apical seal in comparison to amalgam, resin-modified GIC, and zinc oxide-eugenol. However, the time required for MTA to set is four hours, which is considered to be too long, since it may allow the entry of liquid or microorganisms into the treatment space.[5] The study by Vanderweele RA et al[6], reported that the retention of MTA decreased on contamination with blood and study by Nekoofar MH et al[7], demonstrated that blood contamination decreased the compressive strength of MTA. Tricalcium silicate base (3CaO.SiO2) has been developed and is marketed under the trade name Biodentine™. It is similar to MTA in nature and basic materials; however, compared with MTA, Biodentine™ has a faster setting time of 12 minutes.[8]

Various studies have evaluated the compressive strength of MTA contaminated with blood, but there is a lack of evidence in the literature regarding the effect of oral tissue fluids like saliva on compressive strength of calcium silicate based cements. Therefore, it is necessary to determine the strength of these cements on exposure to the oral fluids which may come in contact during setting reaction and interfere with the setting mechanism. This study aimed to evaluate the effect of oral tissue fluids like saliva and blood on compressive strength of MTA and biodentine.

MATERIALS AND METHOD

The present study was done in the Department of Dentistry. A total of 30 freshly extracted mandibular premolars were collected and used in the study. A total of 30 cylindrical samples were prepared with internal diameter of 4 mm width and 6 mm length using acrylic blocks. They were divided into six groups i.e. Group 1-MTA (n=5), Group 2-MTA-S (n=5) Contaminated with saliva, Group 3-MTA-B (n=5) Contaminated with blood, Group 4-(BD) Biodentine (n=5), Group 5-(BD-S) Biodentine contaminated with saliva (n=5),

Group 6-(BD-B) Biodentine contaminated with blood (n=5).

Both MTA and biodentine were manipulated based on manufacturer's instructions. The moulds were coated with saliva or blood according to the group before placement of the material and a glass slab was placed at the base of the material to generate a smooth surfaced base. Samples were incubated at 37°C at 100% humidity for three days. The force needed to break the samples (in N/mm^2) was tested by universal testing machine (Instron model 1011, UK) at a crosshead speed of 1 mm/s and compressive strength (MPa) was calculated using the following formula[9]:

$$RC = F \times 9.807/A$$

RC = compressive strength (MPa), F = force/unit area (kg), 9.807 (gravity) = constant and A = base area (7.06 mm^2).

Statistical analysis

Data were tabulated and examined using the Statistical Package for Social Sciences Version 22.0 (IBM SPSS Statistics for Mac, Armonk, NY: IBM Corp, USA). Results on continuous measurements are presented as Mean±SD. Categorical data has been presented as frequency distribution. The statistical power calculation was based on the assumption that the data were normally distributed. P-value of <0.05 was considered as significant. Difference between the groups was determined using anova test.

RESULTS

Table 1 shows compressive strength (MPa) of MTA and biodentine contaminated with blood and saliva with for MTA and biodentine groups. On contamination with oral tissue fluids like saliva and blood, there was no statistical significant difference in the compressive strength between the three groups i.e., MTA, MTA-S, MTA-B (p>0.05). However, there was higher compressive strength in the MTA-B group when compared to MTA and MTA-S. Also, there was no statistical significant difference between BD, BD-S, BD-B (p>0.05). Among these three groups BD showed a higher compressive strength than BD-S, BD-B.

Table 1: Compressive strength (MPa) of MTA and biodentine contaminated with blood and saliva with for MTA and biodentine groups.

Groups	Mean	SD	Anova	p value
MTA	157.22	71.28	1.79	0.17
MTA-S	115.18	45.98		
MTA-B	177.83	68.42		
BD	205.67	37.41	1.93	0.10
BD-S	157.19	51.90		
BD-B	178.08	34.53		

DISCUSSION

Compressive strength is one of the main physical properties of hydraulic cements. When used in vital pulp therapies, the cement should have the capacity to withstand masticatory stress.[10] In this study, freshly drawn blood was used because the presence of an anticoagulant may decrease the bond strength.[11] In the current study, MTA and biodentine were used because of their excellent sealing ability and less microleakage when compared to amalgam, intermediate restorative material, glass ionomer cement and zinc oxide eugenol.[12]

MTA contains fine hydrophilic particles like calcium hydroxide and silicon which has the ability to set in the presence of wet environment.[13] There are various studies on the influence of blood on properties of MTA. An in vitro study by Salem MA et al., reported that exposure to blood during setting has an adverse effect on marginal adaptation and the surface microstructure of MTA.[14] Therefore, by addition of the accelerators reduces the infusion of the blood into the material thereby protecting it from deleterious effect by improving its initial strength. Recently, Biodentine has been used as a dentine replacement material in large carious lesions. On hydration reaction, tricalcium silicate produces calcium silicate gel and calcium hydroxide and they may precipitate at the surface. So, the unreacted tricalcium silicate grains are surrounded by hydrated calcium silicate gel, which are impermeable to water and decreases the setting reactions.[15]

Biodentine, due to its high porosity has higher capacity for ion exchange.[33] Biodentine improves in compressive strength with time over several hours. A study by Grech L et al., reported that biodentine had low fluid uptake and sorption values, low setting time and superior mechanical properties. The fluid uptake and setting time was the highest for MTA compared to biodentine.[16] This was supported by Camilleri J et al[17], 2013 who stated that biodentine is more dense and less porous when compared to MTA which explains its less fluid uptake. The lower the porosity, higher will be the mechanical strength.

To the best to our knowledge on the available literature, this is the one of the few studies to evaluate the compressive strength of MTA and biodentine on contamination with blood and saliva. Charland T et al[18], reported that the exposure to blood did not have a significant difference on the setting time of MTA. Kim Y et al[19], stated that the on exposure of MTA to foetal bovine serum affected the setting reaction of MTA. Though both MTA and biodentine are tricalcium based cements, the shorter setting time of biodentine makes it a demanding material for apical surgeries.

The limitation of this study includes limited sample size for evaluating the material properties. Even though the oral scenario is recreated, it was not done under controlled oral conditions. Furthermore clinical studies are warranted for evaluating the effect of oral tissue fluids on compressive strength under well controlled oral conditions.

CONCLUSION

In this study, the compressive strength of MTA and biodentine was similar in comparison, both under normal as well as in contaminated conditions. This study concludes that compressive strength of MTA and biodentine was not significantly affected by contamination with oral tissue fluids like blood and saliva.

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