THE SHEAR BOND STRENGTH OF GLASS IONOMER ROOT CANAL SEALER TO ELEPHANT TUSK DENTINE CONDITIONED WITH COMMON ENDODONTIC IRRIGANTS

1AMJID NASEER, BDS, MSc
2TAHIR ALI KHAN, BDS, MDSc
3BABAR AHAD, BDS, MPH

ABSTRACT

The purpose of this in vitro study was to evaluate the shear bond strength of glass ionomer sealer to dentine exposed to common endodontic irrigants in both well and poorly prepared dentine surface.

In the methodology four groups of elephant dentine sample were used. Each group was well cleaned and prepared with different irrigants for the effective removal of smear layer. One group was treated with distilled water with smear layer retained. All the dentine used for the experiment was cut in form of disks of about 2.4mm thickness with a hole in the centre and subjected to root canal preparation. All the prepared dentine samples were filled with Ketac-Cem sealer and metal pin was inserted. The shear bond strength of metal pin and sealer was tested using Instron universal testing machine. The observations of bond strength in the four sample groups were analysed statistically through ANOVA test. It was found statistically that shear bond strength with phosphoric acid treated samples was quite higher than the other samples.

Key words: Elephant tusk dentine, Ketac-Cem radiopaque sealer, Push out test, Shear bond strength, Smear layer

INTRODUCTION

Glass ionomer cement (GIC) is known to have favourable biological, chemical, and physical characteristics, including tissue compatibility and the ability to adhere to dentine and enamel. The periradicular pathosis develops subsequent to infection of the root canal system as a result of the interaction between microorganisms and host tissues. One of the objectives of an endodontic treatment is to protect periradicular tissues from the effects of microorganisms and their by-products. This is accomplished by debridement and disinfection of the root canal space to eliminate existing microorganisms and by filling it to prevent recolonization. The conventional root filling materials consists of a gutta percha core and a sealer, usually based on zinc-oxide eugenol or epoxy resin.

A glass ionomer cement based root canal sealer might exhibit long-term adhesion to dentine which would be an obvious advantage over zinc oxide eugenol type or epoxy resin-type sealer cements.

More recently, glass ionomer cement has been modified for use as a root canal sealer. The characteristic properties of glass ionomer based sealer include bonding to dentine, antimicrobial activity and biocompatibility. These properties give this sealer an advantage over the other commonly used sealers. When compared to Grossman sealer glass ionomer based sealer also showed excellent and superior adaptation to the root canal wall.

The sealing ability of a root canal sealer can be determined by its ability to adhere to the root canal walls by bonding to dentine. For restorative applica-
tions the strength and nature of the adhesive bond has been described for glass ionomer cement. But the root canal sealers have not been characterized particularly in regard to the bond with root canal and its influence on the smear layer and the various medicaments used in root canal therapy, such as sodium hypochlorite (NaOCl) and ethylene diamine tetra acetic acid (EDTA).

It has been assumed that a strong adhesion would reduce leakage but no correlation has been found so far between leakage of the root-canal filling and the strength of the bond of the sealer to dentine in vitro. Even a strong bond does not guarantee that the entire surface of the root canal has been covered with a sealer. It has been suggested that limited localized areas of deficiency of sealer in its adhesion to the root walls may persist or be created after manipulation, thus permitting percolation to occur.

However, glass ionomer cement has been successfully used in the management of root fracture as a root canal sealer which is then condensed into the root canal to bind the segments together. After instrumentation the root canal space may not provide an ideal environment to make a maximum bond with a glass ionomer sealer to the dentine due to the formation of a tenacious layer of debris, the smear layer. Studies have shown that removal of smear layer can increase the adhesion of glass ionomer sealer to the root canal wall.

The objective of this study was to evaluate the shear bond strength of the commercially available and experimental glass ionomer cement based root canal sealer (Ketac-Cem, Espe, Seefeld, Germany) to dentine being exposed to common endodontic irrigants like citric acid and phosphoric acid.

**METHODOLOGY**

A fragment of elephant tusk from an elephant was used in this study. The bulk of this material is referred as ivory and is composed of dentine. As compare to human dentine, the characteristic feature of elephant dentine is the tubule that sits in a matrix forming the mineralized collagen fibres. The elephant dentine is micro structurally similar to human dentine but there are some differences between them like in elephant dentine the tubules are more elliptical in shape and the peritubular cuff is small or non-existent as compared to human dentine, although the tubule density and mineral content appear to be similar to human dentine.

The elephant tusk dentine was prepared in the form of disks of diameter 2.4mm thickness with a hole of 1.6 mm in the centre (Fig 1). The hole was made with the help of 1.6mm drill bit being held in a lathe. Forty samples were prepared for the study. The metal wire being used as pin/post had a diameter of 1.3 mm and was cut of approximately 10mm in length with the help of wire cutter and one end of wire was made smooth and flat at the edges with a Struers water proof silicon carbide paper (P #320 FEPA, Germany) mounted on a grinding and polishing machine (Struers Kruth-Rotor 3, Germany) (Figure-2a and 2b).

Ketac-Cem radiopaque glass ionomer sealer is used in the present study. Its liquid is clear and had a
low viscosity. The powder is white and its coarse particles were distinguished during spatulation.

Immediately before experimentation, the smear layer was produced on the dentinal surface with #600 silicon carbide paper and barbed broaches under water irrigation. The specimens were then randomly assigned into four groups of ten specimens each:

Specimens of group 1 were cleaned and irrigated with distilled water; Specimens of group 2 were cleaned and irrigated with 6% citric acid; Specimens of group 3 were cleaned and irrigated with 35% phosphoric acid; Specimens of group 4 were left untreated and were not washed with any of the liquid with no smear layer being removed from it.

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The group of the specimen treated with water was used as a control group and the group that was left untreated was used as a negative control. Each conditioning medium was directly syringed onto the dentine for over a period of 20 seconds. Paper point was then used to dry the dentine. After the glass ionomer sealer was mixed following the manufacturer instruction, the dentine disk with the hole was filled with freshly mixed sealer. The prepared pin was inserted within the hole onto which the sealer had been applied and was carefully placed on a metal support (Fig 3). The sealer was allowed to set and appropriate method and time was given to ensure complete setting of the sealer before being tested for the shear strength. Approximately 60 minutes were given to the cement to set.

The specimens were placed in distilled water to avoid dehydration. Immediately before testing it for the shear strength the specimens were then carefully removed from the distilled water and shear tested to failure in an Instron Model 5584 Universal testing machine. The shear bond strength value was determined in megapascals (MPa). The mean and standard values were calculated for each group of 10 specimens. One factor ANOVA test was used to compare the shear bond strength of the glass ionomer sealer to the three conditioning protocols.

RESULTS

In this study shear bond strength of Ketac-Cem sealer was measured for various elephant dentine samples being treated with common endodontic irrigants. The mean shear bond strength values are given in Table 1.

In group 1 the shear bond strength value ranged from 0.15-0.97 MPa with a mean value of 0.431±0.271. In group 2 the shear bond strength value ranged from 0.60-1.40 MPa with a mean value of 1.072±0.267. In group 3 the shear bond strength value ranged from 0.50-1.50 MPa with a mean value of 1.130±0.318. In group 4 the shear bond strength value ranged from 0.10-0.65 MPa with a mean value of 0.319±0.181.

The results showed that shear bond strength of group 3 was significantly (P < 0.0001) higher than that of group 1 and group 4. The difference between group 2 and group 3 was not significant. In the groups with the lower shear bond strength, the lower value was obtained in group 1 (distilled water) compared to group 2 (6% citric acid) and group 3 (35% phosphoric acid). Group 4 (untreated) showed the lowest shear bond strength value, which was significantly lower than the other groups. This indicates that the use of common endodontic irrigants can significantly affect the shear bond strength of glass ionomer sealer to elephant tusk dentine.
The shear bond strength of glass ionomer root canal sealer to elephant tusk smear layer removed bond strength ranged from 0.267-1.130 MPa. The mean bond strengths for samples treated with phosphoric acid (1.13 MPa) and citric acid (1.07 MPa) were similar and showed a significant difference from those treated with water (0.43 MPa) or those that were left untreated (0.319 MPa). The results of ANOVA test has been summarized in Table 2.

**DISCUSSION**

The shear bond strength methodology is commonly used to determine the bonding of dental materials to the tooth structure. In this study elephant tusk dentine was used for evaluation of shear strength rather than human dentine. The shear bond strength was tested as a measure of adherence of the Ketac-Cem sealer to the dentine.

The adhesion of glass ionomer sealer to dental tissue relies primarily on chemical interaction and to a lesser extent on micromechanical interlocking. Some factors like root canal preparation, cleaning, filling technique and type of sealer can interfere with the sealer adhesion to the root canal walls. In the mouth Ketac endo sealer shows setting time of 26 minutes at 3, than 60 minutes. In accordance with these parameters, the sealer was allowed to set for 60 minutes and was tested for failure at 24-48 hours, to determine the short term adhesion characteristics.

The high bond strength to dentine appears to be an important property of the endodontic sealer for two main reasons: firstly it would minimize the risk of movement of the set root-canal filling during restorative procedures. The second reason for the requirement of a good adhesion is the assumption that it would reduce leakage.

A previous study determined that Ketac-Cem sealer has shown increase shear bond strength to dentine surfaces treated with citric acid or phosphoric acid than being treated with 15% EDTA and polyacrylic acid. This may be due to increased contact surface in the dentine due to the smear layer being removed. In another study Ketac Endo sealer demonstrated lower adhesion to dentine as compare to Ketac-Cem sealer. One reason is that Ketac-Endo is luting cement, being formulated for endodontic use. The second possible reason is that the previous experiment measured tensile strengths on the curved inner wall of root canals rather than on the flatter surface.

The bond strength of Glass ionomer sealer in this study was significantly decreased when the dentine...
was conditioned with water or when it was left untreated with any of the irrigants. The distilled water alone leaves the smear layer intact while the conditioning with citric acid and phosphoric acid is known to remove the smear layer and showed increased bond strength to dentine. The results highlighted the affect and influence of smear layer on the bonding of sealer to dentine. In this study the mean bond strength obtained by the use of citric acid and phosphoric acid used for the surface treatment was almost similar and was quite higher than for surfaces treated with distilled water and those that were left untreated.

**CONCLUSION**

Within the limitation of this study it has been concluded that in order to get higher bond strength of the sealer to the root canal walls the canal should be well prepared and the smear layer should be removed with an endodontic irrigant like citric acid or phosphoric acid before applying the glass ionomer sealer.

**REFERENCES**


