Original Article

# An in vitro study to evaluate retentive property of resinous dental adhesives and other dental luting cements

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## ABSTRACT

**Background:** *Retention of crowns depends on various factors such as the retentive properties of the luting cements and the type of cast metal. Limited information is available regarding the retentive strengths of crowns, cemented with resin cements.*

**Objective:** *The purpose of the study was to evaluate the retentive property of resinous dental adhesives with three other luting cements.*

**Material and methods:** *Twenty freshly extracted human sound first mandibular molar was used for the study. The root of each tooth was embedded into a cylindrical shape block of self cured resin. Each of the tooth samples was prepared to receive a full metal crown. Total samples were divided into four groups, each containing five samples, for cementation of the metal crown in order to compare retentive properties of resinous adhesive and other luting agents; group A- resinous adhesive Panavia, group B - Zinc Phosphate cement, Group C- Glass ionomer cement, and group D- polycarboxylate cement. After 10min of cementation, the retention test was performed in an Instron tensile testing machine, to analyze the retentive properties of different luting cements. A one-way analysis of variance was used to analyze the data, with a significance level of alpha =.05.*

**Results:** *Result showed a maximum mean retentive strength in Panavia Ex. (281.34kg), followed by Glass Ionomer (70.21kg), Polycarboxylate (63.06kg), and least in Zinc Phosphate cement (40.31 kg), which was statistically significant.*

**Conclusion:** *Within the limitation of the present study, it was concluded that resinous adhesive Panavia Ex. cement has better retentive properties compare to other luting cements.*

**Keywords:** *Cements, metal crown, retention, resin cements, strength*

## Introduction

Retention of crown prosthesis on an abutment is vital to successful prosthetic service. In general retention is a function not only of the mechanical properties of luting agents but also of topography of the preparation and restoration. Cements such as Zinc Phosphate, Zinc Silico-Phosphate and Zinc Oxide Eugenol are principally dependent upon this mechanical interlocking for retention. On the other hand the other two dental cements namely glass ionomer and zinc polycarboxylate bond chemically to tooth structure. The retention of luting cements has been reported extensively in the literature,[1, 2] however it has been demonstrated that retention of artificial crowns varied not only with mechanical properties of luting medium [3] but also with the geometric relationship of the prepared tooth surface [4] and definitive restoration. [5] These factors can influence stress distribution within the interposed cement layer, [6] the bonding efficiency of cement to both surfaces, and durability of the cement including the long-term resistance to mechanical deterioration. The two primary adhesive mechanisms of dental cements are mechanical

interlocking and physicochemical bonding. [7] Zinc phosphate cement is a luting agent that adheres by mechanical interlocking to irregularities in the tooth and casting. [8] Glass ionomer cements attain their adhesion primarily through physicochemical bonding. An actual ionic chemical reaction occurs between calcium of the hydroxyapatite and carboxyl ions of a polyacrylic acid. [9] It has been claimed that Panavia-EX resin cement adheres chemically and mechanically to tooth structures. [10]

The present study was an attempt to compare the retentively of a resinous adhesive with other commonly used luting agents.

## Material and Methods

Twenty non carious freshly extracted human mandibular molars, which were advisable for extraction due to orthodontic purpose, selected for the study. The teeth were cleaned by tap water immediately after extraction and were stored in normal saline solution throughout this course of the experiment. The root of each tooth was embedded into a cylindrical shape block of self cured resin.

**Preparation of Samples**

- **Tooth preparation**

Teeth were placed in a lathe and reduced with a tungsten carbide tool under water spray until they were the shape of cone with axial wall inclination of 5 degrees. A shoulder was prepared circumferentially to outline a gingival finish line and to give a 7 mm base diameter to the preparation. The occlusal surface was flattened perpendicular to the long axis of the tooth producing a truncated cone with a height of 4 mm. (Fig. 1)

**Fig. 1 Prepared teeth samples embedded into cylindrical shape blocks**

- **Wax Patterns Preparation**

On the prepared tooth a lubricant was applied with help of brush to prevent the sticking of wax on preparation. Blue inlay wax was used to prepare direct pattern and the cervical region of the teeth were scribed with vertical lines, so that the casting could be properly oriented during cementation. A U shape sprue wax attached to the wax pattern. The loop was used to facilitate the removal of crown for tensile testing with instron testing machine.

**Investing procedure**

The Gate's Sprue design was used for investing the wax pattern and phosphate bonded invest material was used. (Fig. 2)


**Fig. 2 Gate's Sprue design used for investing the wax pattern**

**Casting procedure:** The castings were made in N.C.M. alpha alloys in the induction casting machine.

**Sand blasting and surface finishing:** After, Cooling the cast sample was removed from the ring and sand blasted with 50-100 mile micron particle size silica sand used at 50 lbs pressure to remove adherent investment. (Fig. 3)

**Fig. 3 Metal crowns after casting procedure**

**Surface treatment of the crown:** The sand blasting was done using 50 micron particle size alumina power under 50-60 psi air pressure for 15 second. All the sample were cleaned in distilled water in ultrasonic cleaner and air dried and stored in clean bottles to avoid contamination.

The study was divided into four groups for cementation of the crown in order to compare retentive properties of resinous adhesive and other luting agents. Groups A – In this group the cementation was done with resinous adhesive Panavia Ex. (Kuraray Europe, Germany) Group B – In this group the cementation was done with Zinc Phosphate cement Group C – In this group the cementation was done with Glass ionomer cement Group D - In this group the cementation was done with Polycarboxylate cement

**Cementation of the crown:** After drying of cast crown, different luting cements were mixed according to the manufactures direction and cementation of crown was achieved with force of five kilogram weight. (Fig.4)

**Fig. 4 Metal crown cemented on the die**

All of cemented crown were kept for 10 minutes for final setting of cement under 5 k.g. weight and stored at 37$^{o}$ c and 100% relative humidity for 24 hrs. before testing for retention.

The retention test was performed in an Instron tensile testing machine (Fig. 5) by using a cross head speed of 1.25 mm per minute. The observations were subjected to ANOVA then a post hoc test with a significance level of alpha =0.05 using SPSS version 16 was applied to compare the different groups.

**Fig. 5 Performing retention test using Instron tensile testing machine**

## Results

The present study was carried out to compare the retentive strength of resinous dental adhesive Panavia Ex. With the three other commonly used dental

luting agents, the retentive strength with each luting agent was tested using an Instron machine at a cross head speed of 1.25mm/min. The data obtained was subjected for statistical analysis for evaluating the retentive capacity of crown which was cemented with resinous dental adhesive Panavia Ex. and some dental luting agents. One way ANOVA was performed to see any significant differences in the retentive strengths among the different groups namely A, B, C and D. The result is represented in Table 1. Further, Tukey's post hoc test was performed. It was found that the mean retentive strength of cemented samples using Panavia (group A) have greater retentive strength (281.34±3.38), compare to Zinc phosphate (40.31±3.14), Glass Ionomer (70.21±3.04) and Polycarboxylate cements (63.06±3.63) in following order; A > C > D > B. (Table 2)

Table: 1 Mean retentive strength of different luting cements used in the study

| Group | A | B | C | D |
|---|---|---|---|---|
| Mean±SD | 281.34±3.38 | 40.31±3.14 | 70.21±3.04 | 63.06±3.63 |

Group A - Panavia Ex., Group B - Zinc phosphate, Group C - Glass ionomer, Group D – Polycarboxylate

Table: 2 Comparison of different groups by Tukey HSD[a]

| | | Subset for alpha = 0.05 | | | |
|---|---|---|---|---|---|
| Different groups | N | 1 | 2 | 3 | 4 |
| Group B | 5 | 40.31 | | | |
| Group D | 5 | | 63.06 | | |
| Group C | 5 | | | 70.22 | |
| Group A | 5 | | | | 280.54 |
| Sig. | | 1.000 | 1.000 | 1.000 | 1.000 |

Means of group in homogenous subsets are displayed. A. Uses Harmonic Mean Sample Size=5.000

## Discussion

The modern concept in dentistry aims at preserving the natural teeth, and maintaining the normal anatomy, physiology and function of the masticatory system. Thus cast crowns and fixed partial denture restoration play an important role in maintaining the form and function of masticatory system.

The retention of crown prosthesis largely depends on a number of variables, such as the geometry assigned to the abutment tooth which is to receive the prosthesis and the cementing agent being used. Modifying the metal surface by various methods such as sand blasting or electrolytic etching has been shown to increase the retention of crown.

This study was carried out in vitro using freshly extracted human first mandibular molars to evaluate the bond, not only between the tooth and cement but also that between the cement and the crown. The first mandibular molars were chosen for study as these teeth are subjected to maximum masticatory load and are also most commonly found to be in use of a fixed prosthesis. Non-precious alloys such as Ni –Cr was used to fabricate crown for each prepared tooth. Cements like Zinc phosphate, Zinc Silicophosphate and Zinc oxide Eugenol are principally

depend on this mechanical interlocking for retention. Glass ionomer and Polycarboxylate bonded chemically to tooth structure in addition to mechanical bonding. [11] In this way retention capacity of these two cements are significantly greater than Zinc Phosphate cements.

The retentive strength of each cement was tested as a function of the tensile separation force in order to separate the cemented crown from the abutment using the Instron machine has been used and considered to be very reliable and suitable by various workers. Gorodovsky and Zidan [12] reported no significant difference in retention between glass ionomer and zinc phosphate cements.

The mean retentive strength of Glass ionomer cement was found to differ greatly than that of Panavia EX. possible explanation for this significant disparity could be that the glass ionomer contained polyacrylic acid which makes bonds only with calcium present in enamel and dentin but it does not form any bond with metal restoration. This adhesive bond failure attributed to this less retentive property of this cement. However, Glass ionomer showed more mean retentive value than the Zinc Phosphate and Polycarboxylate this is in accordance with the study of Omer et al. [13]

Swartz and Phillips, [14] Swanson et al [15] found that the dry tooth surface exhibit better retention with all cements, moisture affects the retention of crown in different cementing agents. The finding of this study shows that polycarboxylate has less retentive strength than Panavia Ex. This failure may be explained on the basis of bond between metal and cement. Polycarboxylate cement cannot form a bond with metal surface though it showed better retention than the Zinc Phosphate but not superior than the Glass ionomer. Thus it can be concluded from this study that the resinous adhesive Panavia Ex. was most effective adhesive while Glass ionomer, Polycarboxylate and Zinc Phosphate cement followed in sequence effectiveness.

The present study compared the retentive property of resinous adhesive Panavia Ex. with three other dental luting agents i.e Zinc phosphate, Glass ionomer and polycarboxylate. Resinous adhesive Panavia Ex. provided greatest retention followed by glass ionomer and polycarboxylate cement. Zinc phosphate cement provided the least retention. Factor influencing the retention of full cast crown may be attributed to the choice of the cementing medium used, provided other factors like configuration of the preparation are kept standardized.

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