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Original Research Article

A comparative evaluation of microleakage in three different luting agents used for posterior full metal crown: An in vitro study

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ABSTRACT

Aims: The purpose of the study was to evaluate and compare the microleakage at the margins of nickel – chromium full metal crowns cemented with Zinc Phosphate cement, glass ionomer cement. And resin cement.

Materials and Methods: thirty freshly extracted human molars were selected for the study. Standardized tooth preparation is done with the help of customized metal zig attached to dental surveyor. On prepared teeth castings were fabricated and devided into three groups for the three luting agents namely zinc phosphate cement – Harvard, Glass ionomer cement – Ketac Cem and Resin cement – Rely X U200, each containing 10 samples. After cementation the cemented specimens were stored in artificial saliva for 24 hours. The teeth were then thermocycled between 5°C and 50°C and then treated with 50% silver nitrate stain for 60 minutes. Samples were placed under 150 watt flood lamp for 5 minutes to allow proper fixation of unfixed stain. Then they were embedded in clear acrylic resin and sectioned twice longitudinally. The sections were observed under the stereomicroscope and stain penetration were recorded at tooth cement interfaces. The readings were tabulated and analyzed statistically using Mann-Whitney U test and Kruskal-Wallis H test.

Results: Zinc phosphate cement showed significantly maximum microleakage as compared to glass ionomer cement and resin cement.

Conclusion: Resin cement showed significantly less microleakage as compared to glass ionomer cement and zinc phosphate cement. Glass ionomer cement showed more microleakage as compared to resin cement but less as compared to zinc phosphate cement

1. Introduction

The longevity of fixed restorations depends on retention, marginal fit and microleakage, which in turn are affected by many factors, but all are related to the properties of the luting cement.[1] Considerable evolution has taken place from an ionomer based to resin based adhesive luting agent. Today's dentist has the choice of a water-based luting agent (zinc phosphate, zinc polycarboxylate, glass ionomer, or reinforced zinc oxide-eugenol) or a resin system with or without an adhesive or resin-modified glass ionomers.

Numerous studies have done to evaluate the effect of luting agents on the phenomena of microleakage have provided conflicting results. the present study was undertaken to compare the microleakage of three commonly used luting agents viz. zinc phosphate cement, glass ionomer cement and resin cement in posterior full metal crowns.

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2. Materials and Methods

A total 30 freshly extracted intact human molars were collected and stored in distilled water for 24 hours.[2] They were mounted in a plaster block of 1x1cm keeping the cementoenamel junction exposed above the plaster block.

2.1. Preparation of teeth

Tooth preparation was carried out on the mounted molars following standardized tooth preparation procedures. (Figure 1) An assembly with the airotor mounted on the dental model surveyor was used to achieve a uniform taper of six degree[3] and chamfer cervical margins were given. The prepared teeth were cleaned with pumice and water.

2.2. Fabrication of wax pattern

For each of the prepared teeth wax patterns were prepared .Three coats of die spacer was applied on the tooth to provide space for the luting cements to get space of 24-25μm for the cement layer.[4] Care was taken to keep it short of the margins by 1 mm.[5] The wax patterns for the crowns were fabricated using the dip wax technique to get a close adaptation of the wax to the tooth surface. Thirty wax patterns were prepared, one for each preparation.

2.3. Investing and casting of metal copings

The casting was carried out in the induction casting machine with nickel chromium base metal alloy. The crowns were placed back on the respected teeth to check for the fit and marginal adaptation. This was critically observed under the optical microscope. The crowns with marginal discrepancies of more than 39μm were rejected and castings were repeated for accurate marginal fit.[6]

2.4. Cementations of crowns

The metal crowns were divided into three groups of ten samples each. The metal crowns of Group A were luted with Zinc Phosphate cement (Harvard Cement, Harvard, Germany). The metal crowns of Group B were luted with glass ionomer cement (Ketac Cem ™radiopaque – 3M ESPE, Germany). The metal crowns of Group C were luted with resin cement (Rely X U200,3M ESPE, Germany). The cements are mixed according to the manufacturer's instruction. The cement was applied on the internal surface of the crowns and crowns were placed on respective teeth by applying digital pressure. After seating the crowns on respective prepared teeth they were subjected to an axial load of 6 kg for 7 minutes by placing it under a Brinell hardness machine[7](Figure 2). Thus the load exerted on each sample was standardized. The excess cement from the margins was cleaned and dental varnish was applied on the margins soon after cementation. All crowns of each group were cemented in similar manner.

The cemented specimens were stored in artificial saliva for 24 hours. The specimens were then thermocycled after twenty four hours by placing the samples in water at 5°C for thirty seconds. Then they were transferred to a container with water at 50°C for thirty seconds. 250 cycles were followed with travel time of 20 seconds between 5°C and 50°C.[8]

2.5. Staining of the samples

After thermocycling samples were removed and dried. Dental varnish was coated 1 mm below the margins of the crowns to prevent stain from penetrating the tooth structure for exposed surface of the roots. The samples were placed in a beaker with 50 % silver nitrate solution. The samples were left in the solution for sixty minutes to allow the stain to penetrate through the margins. They were removed and placed in the developer for half an hour and fixed under 150 Watt flood lamp for six hours.[7]

2.6. Sectioning of the samples

The samples were embedded in clear epoxy resin and were allowed to set for 24 hours. All the samples were sectioned mesio-distally and bucco-lingually by using diamond disc, so as to get four sections of each sample. All the samples were placed under 150 Watt flood lamp for 5 minutes to allow proper fixation of unfixed stain.[7]

2.7. Evaluation of microleakage

Marginal microleakage is the linear penetration of silver nitrate stain from the external margin of luting cement where the cement interfaces with the tooth. Eight interfaces of each sample were evaluated for microleakage under a stereomicroscope (LEICA-Germany) (Figure 3) at x50 magnification and the extent of penetration was recorded (Figure 4).

The readings of microleakage were categorized as follows:

0 – No evidence of stain penetration at the interface of the crown and tooth surface.

1 – Evidence of slight stain penetration less than half the height of the axial wall of the preparation.

2 – Evidence of stain penetration at half the height of the axial wall of the preparation.

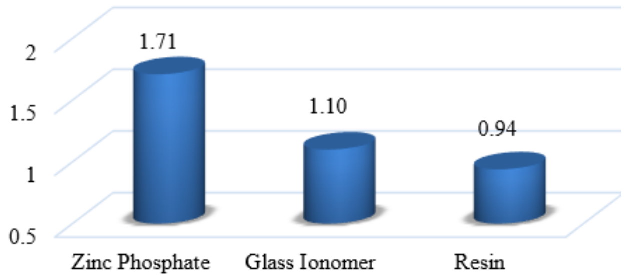
3 – Evidence of stain penetration in excess of half the height of the axial wall and extending to the occlusal aspect of the preparation.

The readings were tabulated and analyzed statistically.

3. Result

Table 1 shows the Arithmetic mean and standard deviation for each group. Table 2 shows the P-values for comparison of two groups at a time viz. Group A v/s Group B, Group

A v/s Group C and Group B v/s Group C, using Mann-Whitney U test. Table 3 shows the P-value for Overall comparison viz. Group A to Group C, using Kruskal-Wallis H test. The Graph 1 shows the distribution of microleakage across three study groups.



Graph 1: The distribution of micro leakage across three study groups

Fig. 1: Tooth preparation with surveyor attached

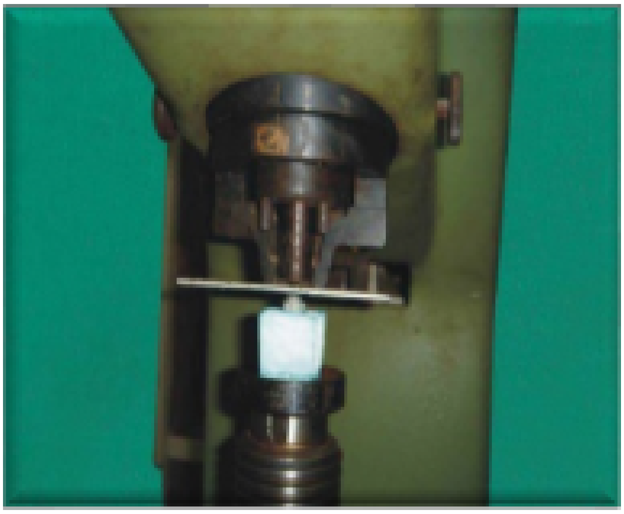


Fig. 2: Brinnel hardness machine

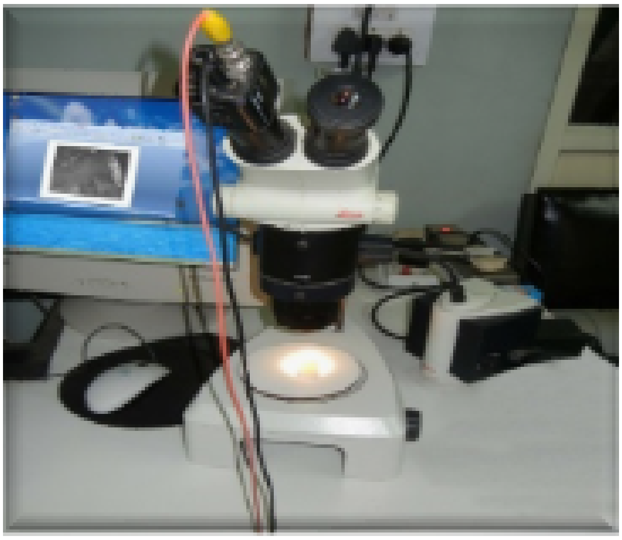


Fig. 3: Stereomicroscope

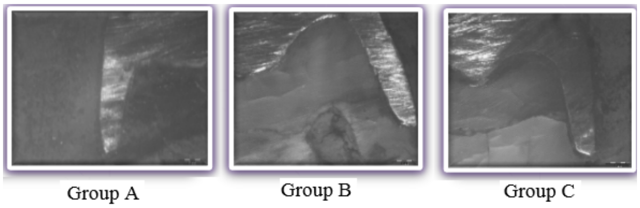


Fig. 4: Stereomicroscopic evaluation of microleakage. Group A (Zinc phosphate cement) Group B (Glass ionomer cement) Group C (Resin cement)

4. Discussion

The analysis of the influence of different cement types on crown microleakage measured at 8 surfaces evidenced a statistically significant difference in microleakage values between different cement types at all the observed points (Table 3, Graph 1). Microleakage occurred primarily at

Table 1: The mean and SD of microleakage across three study groups.

Group name	Group A Zinc Phosphate Cement	Group B Glass Ionomer Cement	Group C Resin Cement
No. of samples (n)	10	10	10
Mean	1.71	1.10	0.94
Standard deviation(SD)	0.19	0.41	0.34

Table 2: Mann-whitney U test

	Group Comparisons		
	Group A v/s Group B	Group A v/s Group C	Group B v/s Group C
P-values	0.001 (Significant)	0.001 (Significant)	0.315 (Non-Significant)

Table 3: Kruskal-wallis H test

	Overall group comparison (Group A to Group C)
P values	0.001 (Significant)

cement-tooth interface, instead of within the cement layer or cement casting interfaces. The readings were tabulated and analyzed statistically. For group A (Zinc phosphate cement); the mean value for microleakage was 1.71 + 0.19. For group B (Glass ionomer cement); the mean value for microleakage was 1.10 + 0.41. For group C (Resin cement); the mean value for microleakage was 0.94 + 0.34 (Table 1). When group A was compared with group B and group A was compared with group C, the P values was 0.001 which was stastically significant but When group B was compared with group C, the P value was 0.315 which was stastically non-significant (Table 2). So, the results of microleakage in different types of cements obtained in this study is Resin cement < glass-ionomer < zinc-phosphate cement.

The greater leakage of the zinc phosphate cement (Harvard) compared to the glass ionomer cement (Ketac Cem) and the resin cement (RelyX U200) might be attributed to solubility of zinc phosphate cement combined with the coefficients of thermal expansion of the material involved (i.e. tooth substance, cement, metal crown). While resin cement shows least microleakage as they bind to tooth structure by forming a hybrid layer with dentinal surface. They also show least solubility in water.

The result of the present study are consistent with those done by Vesna Med et al.,[9] Piwowarczyk et al.,[2] Rossetti PH et al.,[10] White S.N, Sorenson,[7] Zhaokun, Shane White,[11] Terry Lindquist, J.Connoly,[12] Piemjai et al.[13] The result of the present study is in contradiction with those studies done by Anthony Tjan et al.,[14] L.K.Mash et al.[15] Results were different as they used varied conditions, like non adhesive resins, which did not bind with tooth structure. They checked microleakage immediately after cementation which used to be more in non adhesive resins.

Hence a clinical study would be required, and final evaluation of the material performed should be determined under long-term study

5. Conclusion

Within the limits of this in vitro study it was concluded that Resin cement showed significantly less microleakage as compared to glass ionomer cement and zinc phosphate cement. Glass ionomer cement showed more microleakage as compared to resin cement but less as compared to zinc phosphate cement. Zinc phosphate cement showed significantly maximum microleakage as compared to glass ionomer cement and resin cement.

Although we used established protocols to simulate the oral environment, the real-life scenario is too complex to be fully reproduced by experimental set-ups of this type. On balance, it is reasonable to assume that the data obtained in the various study groups constituted a viable basis for comparison. In clinical practice, however, additional factors such as biocompatibility, thermal/electric conductivity, ease of use, and, most important, the specific requirements of each case must enter the equation to find out which cementing agent is most appropriate.

6. Conflict of Interest

None.

7. Source of Funding

None.

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