Do Desensitizers Affect the Retention of Questionable Preparations?

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Abstract: Objectives: This study aimed to investigate the effect of different desensitizers on the retention of short and over-converged preparations. Methods: Eighty molars were prepared with 3mm occluso-cervical height and 24 degrees convergence angle. Nickel-chromium copings were cast with a loop at the occlusal surface for tensile loading after cementation. The copings were assigned to two groups (N=40 each) according to the cement used. Group 1: resin cement (Duolink). Group 2: glass-ionomer (Ketac-Cem). Each group was assigned to four subgroups (N=10 each) according to desensitizers used prior each cement. Subgroup I: control (untreated), subgroup II: Gluma Comfort + Desensitizer, subgroup III: Oxalate (Bisblock) and subgroup IV: Fluoride varnish (Flor-Opal). The retention was determined by uniaxial tensile mode of force. Two-way Analysis of Variance (ANOVA) SPSS 16.0 was used to assess cements, desensitizers and their interactions on copings retention. Results: Resin group: Oxalate (212.10±7.41N) showed the significant highest mean of retention, followed by Gluma (201.52±6.93N), then control (177.52±6.14N). Fluoride (153.80±6.03N) recorded the lowest mean. Glass-ionomer group: control (135.54±4.58N) and Oxalate (132.62±4.84N) recorded the significant highest mean, followed by Gluma (126.84±4.75N). Fluoride (101.96±6.34N) recorded the lowest mean values. Conclusions: With questionable preparations, fluoride desensitizer drastically affected the retention of both cements. Oxalate and Gluma enhanced the retention with resin cement. Oxalate desensitizer can be efficiently used with glass-ionomer. [Journal of American Science. 2010;6(11):274-283]. (ISSN: 1545-1003).

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1. Introduction

Several factors play role in the maintenance of fixed prosthesis in service, such as the retentive and resistive capacity of the prepared tooth, the characteristic properties of the luting cements and sealing of dentin prior to cementation of cast restorations to decrease post-cementation sensitivity.[1,2]

The retentive capacity of the prepared tooth is influenced by many features including; the angle of occlusal convergence and the occluso-gingival (OG) height of the preparation. According to Tylman, the angle of convergence for ideal fixed partial denture preparation should be between 2-5 degrees.[3] Clinically, this ideal taper is seldom achieved. In a previous study, the mean angle of convergence of crown preparations made by final-year dental students was reported to be of 21 degrees.[4] In another study, the mean angle of convergence of crown preparations made by general dental practitioners and by specialists was reported to be 20 degrees.[5] However, in some situations such as mal-aligned teeth, near parallelism of the preparation walls is difficult to achieve without over cutting of the mal-aligned tooth to align its proximal walls with those of other abutments. As for teeth with short clinical crowns, short preparation will result in relative reduction of crown retention. Clinically, a short crown may require lengthening before preparation. This lengthening procedure involves periodontal surgery and adds to the total cost and complexity of the treatment.[6]

Dental luting cements form the link between fixed restorations and the supporting tooth structure. Mechanical interlocking and chemical bonding are desirable factors in the fixation mechanisms of luting cements, and are critical for achieving suitable retention for metallic cast crowns.[1] Luting cements play a pivotal role in sealing the margins and overcoming preparation design errors.[7] The introduction of new strong forms of dental cements represents one of the most important changes in materials that relates to retention of fixed prosthesis.[8] When abutment tooth preparations have questionable retentive potential the use of an appropriate resin cementing medium in conjunction with a reliable bonding procedure can help to overcome retention problems.[3]

Dentin reduction and exposure of prepared tooth surface can lead to increased dentin permeability and subsequent pulpal irritation. Richardson et al, reported that approximately 1 to 2 million dentinal tubules are exposed during an average tooth preparation for a posterior crown.[9] Brännström's hydrodynamic theory speculated that any dentin stimulus can be transmitted back to nerve receptors resulting in fluid movement in the dentinal tubules with stimulation of the odontoblasts, which elicited a response by nerve fibers and resulted in pain.[10] During crown cementation, the luting agent is forced into the patent tubules before it sets and displaces an equal amount of dentinal fluid, leading to excessive hydrostatic pressure and irritation of pulpal tissues.[11] The smear layer evident after tooth preparation was also demonstrated to be in effective against luting agent irritation.[12]

Therefore the use of various dentin desensitizing agents after crown preparation or before cementation has been shown to be an effective clinical treatment in reducing sensitivity.[13] Desensitizers obturate exposed dentinal tubules with a resinous material and block tubular fluid flow thus reducing pain sensation.[14] Although the application of desensitizing has gained popularity, but unfortunately their effect on crown retention is still somewhat unclear and contradictory.

The purpose of this study was to investigate the effect of different desensitizers on the retention of short and over-converged preparations of crowns cemented with two adhesive luting agents.

2. Materials and Methods

Teeth preparation:

Eighty caries free mandibular molars of similar sizes were collected and stored in water in a refrigerator to avoid dehydration until used. The teeth were embedded in acrylic resin blocks up to 2 mm below the cemento-enamel junction. To secure the tooth in the resin blocks, a hole in the root was drilled where an orthodontic wire was placed and protruded for mechanical interlocking within the resin. Using an industrial lathe machine the teeth were prepared for full veneer preparation with standardized dimensions of 24 degrees angle of convergence (wall angle of 12 degrees) as the convergence angle equals the sum of the taper of two opposing preparation walls.[5] The preparation had 3 mm occluso-cervical height, 3 mm occlusal diameter, 6 mm cervical diameter, 1 mm shoulder finish line and flat occlusal plane.

Cast coping construction:

Eighty impressions for the prepared teeth were made with polyether impression material (Impergum, 3M ESPE, Germany) using custom made trays, Figure 1, and poured into stone die (Moldaroc, Bayer dental Lever Kusen, W Germany). The stone dies were trimmed, and die spacer was applied (Isocera BEGO). Direct wax pattern (Kerr, Mfg Co. Rommulus, Mich) was made in the form of coping with a loop attached to the occlusal surface to allow tensile load testing after cementation. The wax patterns were cast in nickel chromium (Ni-Cr) alloys (Wiron 99, BEGO Bremer, Germany); according to the manufacturer's instructions, then were sprued and invested with Begoral phosphate bonded investment specific for the Ni-Cr alloy (BEGO Bermer, Germany). Wax burn out was carried out and casting was completed using an induction casting machine (Fornax 35 casting machine, BEGO Bremer, Germany). To simulate the construction conditions for ceramo-metallic restorations, after casting and divesting, the copings were subjected to the ceramic firing cycles recommended for the Vita VMK95 ceramics in the porcelain furnace. The fitting surface of the copings was sandblasted with 50 µm aluminum oxide particles for 15 seconds under a pressure of 60 PSI at a standard distance of 1cm away from the nozzle of the sandblasting machine (BEGO, Bremer, Germany). Before cementation, it was verified that the castings were not retentive as the copings were separated from the tooth preparations without any resistance when the samples were held upside down.

Coping cementation:

The 80 copings were assigned to 2 groups (N=40 each) according to the adhesive luting cement presented in Table 1. Group 1 (R): Resin cement (Duolink).

Group 2 (G): Glass-ionomer cement (Ketac-Cem). Each group was then divided into 4 subgroups (N=10 each) according to desensitizers used prior each cement, Table 1.

Subgroup I: Untreated control (CON). Subgroup II: Gluma comfort + Desensitizer (GLU). Subgroup III: Oxalate (OXA). Subgroup IV: Flor-Opal (FLU).

RCON

The dentin was etched with Uni-Etch etchant followed by One-step Plus bonding agent application. Duolink resin cement was mixed according to the manufacturers instructions and applied to the internal walls of the copings for cementation.

R GLU

The dentin was etched with Gluma Etch followed by Gluma Comfort Bond + Desensitizer application following the manufacturers instructions, then Duolink resin cement was used for copings cementation.

R OXA

The dentin was etched with Uni-Etch etchant, followed by Bisblock application following the manufacturers instructions. The adhesive One-step Plus was then applied followed by Duolink resin cement.

R FLU

Flor-Opal varnish was applied to the prepared dentin surface following the manufacturers instructions, then Duolink resin cement was used for copings, cementation.

G CON

Glass-ionomer cement (Ketec-Cem) was mixed according to the manufactures instructions and applied to the internal walls of the copings for cementation.

G (GLU,OXA and FLU)

Desensitizers were applied to the prepared tooth surface in a similar way as with the resin groups, and then Ketec-Cem glass- ionomer cement was used for copings cementation.

Each coping was first placed onto its corresponding tooth with finger pressure, and then a standardized static load of 5 kgN was applied with a specially fabricated loading device, Figure 2. The excess cement was removed while loading was maintained for 15 minutes to ensure complete setting of the cement. The eighty cemented samples were stored in water at 37°C in an incubator (Torre Picenardi, Italy) for 48 hours. To simulate the oral conditions thermocycling of the cemented samples was performed for 500 cycles between 5°C to 55°C + 2°C with a dwell time of 30 seconds in each water bath.[15]

Coping Retention Test Procedure:

The assembled teeth and copings were mounted on a computer controlled materials testing machine (Model LRX-Plus; Lloyd instruments Ltd., Fareham, UK) with a load cell of 5KN (Kilo Newton), and data were recorded using computer software (Nexygen-MT; Lloyd Instruments). Samples were secured to the lower fixed compartment of the testing machine by tightening screws. Coping retention was determined by uniaxial tensile mode of force using a specially fabricated attachment with a rigid metallic hook attached to the upper movable compartment of testing machine traveling at cross-head speed of 5mm/min. The hook was designed to grip the loop of the copings, Figure 3. The tensile load required to dislodge the cemented copings was recorded in Newton (N). The mean values and standard deviations for each group of both tested alloys were calculated and statistically analyzed.

Statistical Analysis

Tensile strength data were presented as mean and standard deviation (SD) values. Data were explored for normality using Kolmogorov – Smirnov test, and no significant departures from normality were observed (all P-values > 0.05). Homogeneity of variances among the groups was tested using Levene test, and the variances were found to be homogenous (P-value > 0.05).

Regression model with Two-way Analysis of Variance (ANOVA) was used in testing significance for the effect of cement, desensitizers and their interaction on mean retention. Tukey's post-hoc test was used for pair-wise comparison between the means when ANOVA test was significant. The lack of Fit test revealed P-value = 0.524 which means that the model adequately fits to describe the relationship between dependent and independent variables. Residual plots (Observed Predicted standardized residuals) for the dependent variable were produced. The points representing the residuals lie close to a line indicating a normal probability plot of the residuals. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with SPSS 16.0® (Statistical Package for Scientific Studies) for Windows.

3. Results

The results showed that the regression model is fit to describe the relationship between the studied variables. Cement, desensitizers and their interaction had a statistically significant effect on mean retention, Table 2.

The means, standard deviation (SD) values and results of ANOVA test presented in Table 3, revealed that there was a statistically significant difference between the different interactions. Tukey's test showed that group resin (R) subgroup oxalate (OXA) showed the statistically significant highest mean of retention, followed by (R) subgroup Gluma (GLU), (R) subgroup control (CON) then (R) subgroup fluoride (FLU) that showed the lowest mean retention values. There was no statistically significant difference between group glass-ionomer (G) subgroup control (CON) and (G) subgroup oxalate (OXA), which showed high retention values, followed by (G) subgroup Gluma (GLU). Group glass-ionomer (G) subgroup fluoride (FLU) showed the statistically significant lowest mean retention.

Resin cement showed statistically significant higher mean of retention than glass-ionomer cement, Table 4.

Table (1): Different cements and desensitizers used in the study.

Materials (Manufacturer)	Ingredients	Application protocol
Bisco, Inc, IL 60193 Schaumburg, U.S.A	**Uni-Etch** Phosphoric acid (32% Benzalkonium chloride (BAC) (0.1-1%)	Apply for 15 seconds washing with water, then gentle air drying for 2-3 seconds
Biso, Inc, IL 60193 Schaumburg, U.S.A	**One step plus**: Bisphenyle dimethacrylate (15-40%) Hydroxyethyl methacrylate (15-40%). Acetone (40-70%) Dental glass (1-10%).	Apply to the prepared tooth surface; use gentle air stream to evaporate the solvent. Light cure for 10 seconds.
Duolink resin luting cement (Bisco, Inc, IL 60193 Schaumburg) U.S.A	**Base**: - Bisphenol A.diglycidyl methacrylate (5-30%). - Triethylene glycol dimethacrylate (5-20%). - Glass filler (50-80%) - Urethane dimethacrylate (5-15%). **Calalyst**: - Bis-GMA (<31%). - Triethylene glycol Dimethacrylate (<21%) - Glass filler (<65%)	A dual-syringe delivery system is used for dispension of equal amounts of base and catalyst. Light cure for 40 seconds
Ketac-Cem glass – ionomer cement (ESPE – Seefeld W. Germany).	**Powder**: - Glass powder - poly carboxylic - pigments **Liquid**: - Water - tartaric acid - conservation agents.	Mix a full one scope of powder to two drops of liquid for 30 seconds.
Gluma Comfort Bond + Desensitizer (Heraeus Kulzer, Inc 10504 Armonk, NY USA)	**Etchant:** 20%, phosphoric acid, blue dye: **Matrix**: UDMA HEMA 4-META Maleic acid polycarboxylic acid ester gluteraldhyde **Filler**: None	Etch the tooth surface for 20 seconds then wash with water. Use gentle air stream to remove excess moisture for 1-2 seconds. Leave dentin surface moist and shiny apply Gluma Comfort + Desensitizer with a brush in copious amount. Leave undisturbed for 15 seconds then use gentle air blast to evaporate the solvents. Light cure for 20 seconds.
Bisblock desensitizer (Bisco, Inc. IL 60193 Schaumburg, U.S.A).	Oxalic acid (1-4%)	Apply on etched tooth surface and leave for 30 seconds to allow calcium oxalate crystals formation Wash with water and leave the surface slightly moist for wet bonding.
Flor-Opal varnish desensitizer (Ultradent Products, Inc, 505 West 10200 South, South Jordan Utah 84095, U.S.A).	50 mg sodium fluoride in alcohol and natural resin suspension.	Supplied in the form of two syringes inter connected together for mixing their contents. Air drying the tooth surface their express a small bead of varnish from Fx Flex tip. Brush the varnish on the tooth surface then spray with water to harden.

Table (2): Results of regression analysis.

Source of variation	Sum of Squares	df	Mean Square	*P*-value
Corrected Model	104184.428	7	14883.490	<0.001*
Cement	76867.601	1	76867.601	<0.001*
Desensitizers	22465.034	3	7488.345	<0.001*
Cement x Material	4851.120	3	1617.265	<0.001*

*: Significant at P ≤ 0.05, R Squared = 0.976 (Adjusted R Squared = 0.974)

Table (3): The means, standard deviation (SD) values in Newton, results of comparison between the different interactions

	Mean	**SD**	**P-value**
Resin Control	177.52 [c]	6.14	**<0.001***
Resin Gluma	201.52 [b]	6.93	
Resin Oxalate	212.10 [a]	7.41	
Resin Fluoride	153.80 [d]	6.03	
Glass-ionomer Control	135.54 [e]	4.58	
Glass-ionomer Gluma	126.84 [f]	4.75	
Glass-ionomer Oxalate	132.62 [e]	4.84	
Glass-ionomer Fluoride	101.96 [g]	6.34	

*: Significant at P ≤ 0.05, Means with different letters are statistically significantly different according to Tukey's test result

Table (4): The means, standard deviation (SD) values in Newton and results of comparison between the retention of the two cements

Resin		**Glass-ionomer**		***P*-value**
Mean	**SD**	**Mean**	**SD**	
186.24	23.70	124.24	14.30	**<0.001***

*: Significant at P ≤ 0.05

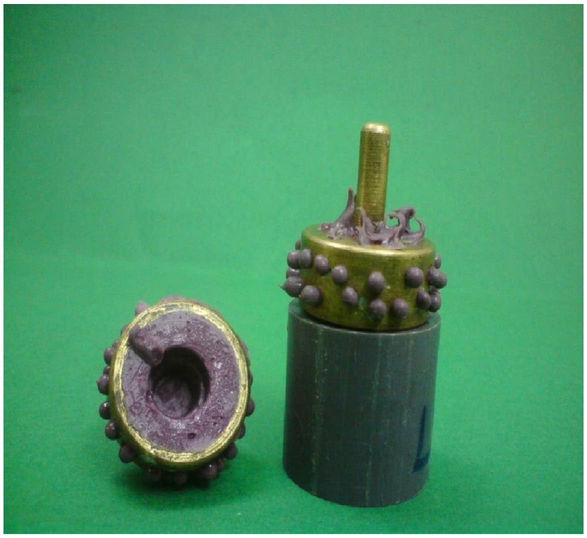

Figure 1: Polyether impression for the prepared tooth surface in perforated Copper tray

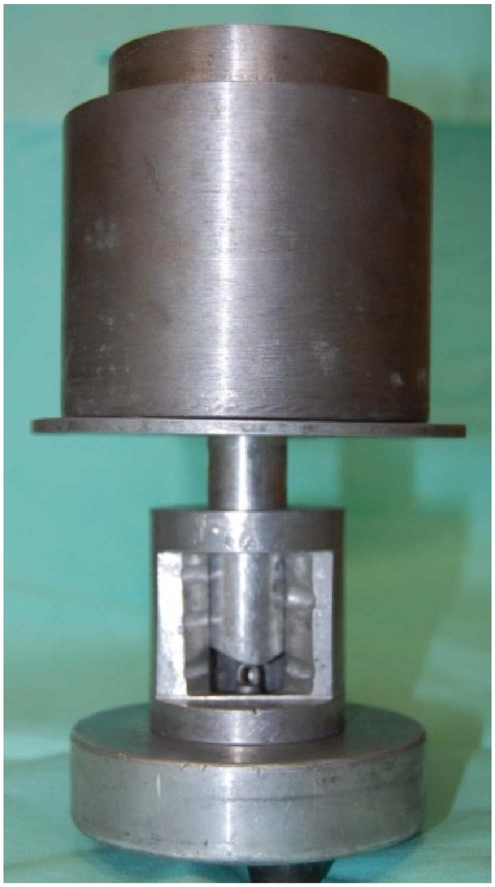

Figure 2: Metal coping sample within the cementing device

Figure 3: representative coping during tensile testing.

4. Discussion:

In the oral environment, failure of retention of crowns and fixed partial dentures occurs under a combination of masticatory forces repeated over time. These are mainly direct compressive forces and some resultant shear lateral forces. In addition, there is a small component of tensile force. Most laboratories testing for crown retention, however, uses direct tensile force.[6,8] Consequently, one may state that the findings of this study, which used direct tensile loading, can be considered to relate directly to the clinical situation.

In the present study, prepared teeth with 24 degrees occlusal convergence angle and 3mm occluso-cervical height, were selected to approximate certain clinical situations. In this manner, the contribution of the cement to retention of the crown was better assessed.

Our study shows that with questionable retentive preparations oxalate and Gluma enhanced the retention of copings luted with resin cement. Only oxalate desensitizer can be efficiently used with glass-ionomer.

In this study the high values of retention recorded for group (R) subgroup (OXA) were attributed to the unique application technique and mechanism of action of BisBlock which is designed to prevent intra-tubular fluid movement causing dentinal sensitivity**.** BisBlock was applied on the dentin after surface decalcification by acid etching and rinsing, where the top 5-10µm of the matrix became depleted from calcium. Thus the oxalic acid was privileged to diffuse deeper into the dentinal tubules till reaching the calcium ions of dentin (mineralized matrix) and dentinal fluid forming insoluble calcium oxalate crystals.[16] This caused blockage of dentinal fluid movement thus eliminating sensitivity and reducing outward fluid movement during the subsequent bonding procedure. This "subsurface tubular occlusion" left the dentin surface unobstructed for the infiltration of the adhesive into the demineralized collagen matrix (the top 5-10µm). The adhesive penetrated inbetween the calcium oxalate crystals and entrapped them during its polymerization. Thus, preventing dislodgment of these crystals and prepared the surface for bonding. This unique mechanism of action might have provided tubular occlusion, plus formation of resin tags inside the dentinal tubules and subsequently enhanced the retention.

These results were consistent with Pashley et al 2001, and Jalalian et al 2009, who found that different formulations of potassium oxalate produced significant reduction in hydraulic conductance resulting in less permeable and acid resistant dentin surface.[16,17]

In this study, oxalate was incorporated into a compatible system (Uni Etch etchant and one step plus adhesive) to obtain the best performance. Uni Etch is a 32% phosphoric acid (H_3PO_4) supplied as semi-gel etchant. It has the advantage of leaving no silica debris on the etched surface that impede the flow of primer and/or resin over the surface or into the dentinal tubules.[18] The percentage of phosphoric acid also represented a major contributing factor for the success of Bisblock because if the content has exceeded 32% this might have reduced the oxalate affectivity by additional etching, leading to hydrolytic degradation of the resin dentin bond and oxalate crystals.[19]

One step plus is a total etch two step bonding agent (Etch and Rinse) containing Bisphenol dimethacrylate (BPDM) with some hydrophilicty that enhances the wettabitity of the adhesive. Hydroxyethyl methacrylate (HEMA) being a wetting agent and promoter for the infiltration of the adhesive into the tooth structure, allowed intimate contact between the adhesive and the collagen fibers.[20] It also contains acetone as organic solvent that displaced water from the dentin surface and from the moist collagen network, thus promoting the infiltration of the polymerizable monomers into the open dentinal tubules and the nanospaces in the collagen network.[21,22] The organic solvent being volatile was easily eliminated by air jet so that only the polymerazible monomer remained.[23] However, this study is inconsistent with the findings of Abou El Dahab, 2007, who declared that oxalate treatment decreased the bond strength of resin cement. The auther attributed the results to the incompatibility between the oxalate desensitizers and adhesives used in the study, which had a low pH and high fluoride content.[24] The Low pH values might have increased the solubility of calcium oxalate crystals in the dentinal tubules and transformed them into calcium and oxalate ions. This was according to le Châtelier´s principle that once calcium oxalate crystals are exposed to high H_3O^+, more calcium oxalate dissolves into calcium and oxalate ions to compensate for the depletion of oxalate ions and maintain the equilibrium constant.[25] The free fluoride ions from the adhesives might have also interacted with calcium and phosphate ions on dentin surfaces to form spherical globules of calcium fluoride (CaF_2). The presence of these spherical globules at the bonded interface and in the adhesive layer acted as stress raisers that would create debonding at lower stresses than would occur in their absence and will hinder the adhesive infiltration and hybridization of demineralized dentin.[26] In the present study the adhesive used (One Step Plus) was with almost pH 4.6 and low fluoride content (70 ppm). The results of our study is also contradictory to the findings of Nadu, who reported that oxalate has a low occlusive effect due to its solubility in oral fluids.[27] However One Step Plus adhesive used penetrated in between the oxalate crystals and entrapped them during polymerization and thus prevented their dislodgment.

The high values of retention recorded of group (R) subgroup (GLU) could be attributed to the unique mechanism of action of Gluma Comfort Bond + Desensitizer as explained by Dijkman et al and Schupbach et al. They postulated that the Gluteraldehyde compound of Gluma was responsible for the intrinsic blockage of dentinal tubules. It reacted with serum albumin present in the dentinal fluid by coagulation, causing setting up of multiple septa [walls] that blocked the flow of fluids in the tubules which is referred to as interdental sealing and thus counteracting the hydrodynamic mechanism of dentin hypersensitivity.[28,29,30]

Another possible explanation of these results can be related to gluteraldehyde as a naturally occurring cross-linker that bonds covalently to collagen fibers and straightens the collapsed ones. This efficiently stabilized the dentin collagen, helped in its rewetting, reduced its marginal contraction gap and subsequently improved the adhesive strength.[31]

The Combination of a resin adhesive with a desensitizing agent seems to be contradictory' at first sight, since effective adhesives are expected to seal the etched dentin surface by inter-peritubular hybridization and by resin tag formation in the opened dentinal tubules. However Jacobsen and Finger when examined the resin tags formed with Gluma bonding system postulated that the occluding protein precipitates were apparently not tight, but permeable for monomers.[32] It might be speculated that a similar combined sealing effect of protein precipitation and resin penetration might occur to the adhesive Gluma Comfort Bond + Desensitizer on the etched dentin surface producing a regular dentin surface sealing. The high retention values can be also attributed to 4-methacryloyloxyethyl-trimelitate anhydride (4-META) which is a wetting agent contained in adhesive Gluma Comfort Bond + Desensitizer and has the ability to chemically adhere to metal and calcium ions producing good bond with tooth structure.[33] The combined water and ethanol solvents might have served to the deep penetrating action of the Gluma. The ethanol being a water chaser and solvents for monomers ensures a good infiltration of the adhesive, better sealing and good bond strength. Also it doesn't evaporate too quickly, which might affect the bond strength, while the water act as a re-wetting agent that prevents the collapse of collagen fibers.[34]

However, contradictory findings were demonstrated by, Assis et al, 2006 who declared that Gluma desensitizer caused reduction of bond strength of resin cement. [35] But in their studies they used Gluma desensitizer which is a non polymerizable desensitizer that is not capable of forming a bond with the resin cement. While, in our study we used Gluma Comfort bond + Desensitizer which is an adhesive bonding agent with desensitizing effect that reacted with resin and even enhanced retention.

Surprisily, the low retention values of fluoride group, maybe attributed to the superficial mechanism of action of fluoride varnish where it reacted with calcium of hydroxyapatite and formed CaF_2 crystals, which are loosely bound spherical crystals. The presence of these CaF_2 crystals at the bonded interface and within the adhesive layer, might have acted as stress raisers that would create debonding at lower stresses than would occur in their absence.[24,26]

The low retention values can be also related to the fact that fluoride varnish doesn't polymerize with the cement to increase bond strength. Yim et al, explained that a non polymerizable desensitizer would fill in the surface irregularities of dentin and prevent mechanical interlocking of the cement, thus decreasing the bond strength.[36]

Sodium fluoride varnish being a non polymerizable desensitizer it might have negatively affected the glass-ionomer bond strength. This postulation is in agreement with Yim et al, who explained that a non polymerizable desensitizer might have filled in and smoothened the surface irregularities, thus precluding any ability of glass-ionomer to lock into surface irregularities and form chelation bonding.[36] The interaction of sodium fluoride with dentin surface and formation of CaF_2, might have also deprived glass-ionomer from calcium ions needed for chelation.[37]

The significant higher tensile loads obtained for Ni-Cr crowns cemented with resin cements (186.24 ± 23.70 N) compared to that with glass-ionomer luting agent (124.24 ± 14.30 N) were attributed to the ability of dentin desensitizers to polymerize with resin cement and subsequently enhancing the crowns retention. This finding is in agreement with Yim et al, who declared that, crown retention was not enhanced when using glass-ionomer cement and polymerizable dentin desensitizer, and was lowered when a non polymerizable one was used. While the use of resin cement with desensitizing agent capable of polymerizing to the cement provides the greatest retentive strength.[36]

5. Conclusion

Within the limitations of this study, it was concluded that teeth with questionable retentive preparations, fluoride desensitizer drastically affected the retention of copings luted with both resin and glass-ionomer cements. The use of oxalate and Gluma enhanced the retention of copings luted with resin cement. Oxalate desensitizer can be efficiently used with glass-ionomer cement.

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