World Journal of Biology Pharmacy and Health Sciences

eISSN: 2582-5542

Cross Ref DOI: 10.30574/wjbphs

Journal homepage: https://wjbphs.com/

(Research Article)

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The effect of Fluoride varnish on the retention of full coverage crowns cemented by Self-adhesive cement RelyX U200

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World Journal of Biology Pharmacy and Health Sciences, 2025, 22(01), 417-423

Publication history: Received on 23 February 2025; revised on 07 April 2025; accepted on 10 April 2025

Article DOI: https://doi.org/10.30574/wjbphs.2025.22.1.0367

Abstract

Introduction: Due to the importance of the retention on long term success in fix prosthodontics and its known complications effect of insufficient retention, and due to lack of sufficient information about the effect of Fluoride varnish on the retention of full coverage crowns cemented by Self-adhesive cement (RelyX U200), in this study we evaluated the effect of Fluoride varnish on the retention of full coverage crowns cemented by Self-adhesive cement (RelyX U200).

Methods: In this experimental study, 20 intact human premolars after preparation and create 0.5 mm chamfer finish line above the cementenamel junction, allocated to the two groups of cases (10 teeth treated with Fluoride varnish) and control group (10 teeth without surface treatment). Full metal crowns were made of base metal with a ring (for retention test). Then all the crowns were cemented with RelyX U200 cement and the retention test was performed using a universal testing machine. Data were analyzed with t-test (SPSS Ver:22).

Result: The tensile strength of Fluoride varnish group (153.92±67.50) is significantly lower than control group (458.32±165.52) (P=0.0001).

Conclusion: Fluoride varnish has negative effect on the tensile strength of Self-adhesive cement (RelyX U200).

Keywords: Dentin desensitizing agent; Retention; Resin cement; Crown

1. Introduction

One of the concerns and determining factors in keeping dental crowns on prepared teeth is retention (1). The main factor involved in retention is two opposing vertical surfaces in a preparation. These surfaces may be the external surfaces such as the buccal and lingual walls of a full veneer crown (1). Optimal retention for extracoronal restorations, based on geometric morphology analyses of prepared teeth, depends on factors such as convergence, the extent of the preparation surface, the roughness of the internal crown surface, auxiliary grooves, the surface characteristics of the prepared tooth, and the type of cement used (2). Failure to adhere to these factors can lead to complications such as microleakage in the cement, the development of caries beneath the crown, complete washing out of the cement, and the complete dislodgement of the crown (2).

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During an ideal crown preparation, about one to two million dentinal tubules are exposed (3). Therefore, most patients undergoing fixed restorative procedures report some discomfort in the prepared teeth during treatment and sometimes even after the restoration is placed, manifesting as pain or other uncomfortable symptoms, which may be due to increased dentin sensitivity (4). To address this issue, desensitizing agents have been introduced (4).

Profluorid varnish consists of a colophony base, 5% sodium fluoride (22600 ppm fluoride), and xylitol (a cariostatic agent). The fluoride ions accumulate with calcium ions in the dentinal tubules, resulting in the precipitation of calcium fluoride, which seals the dentinal tubules. Profluorid varnish protects the tooth against acid and promotes remineralization through the precipitation of calcium fluoride (5, 6). The required amount of this material is 0.25-0.4 ml; a thick layer can be easily removed and has no therapeutic effect. One advantage of this material is its easy application on moist surfaces. In fact, when using Profluoride varnish, it is not necessary for the tooth surface to be completely dry; thus, it provides quick desensitizing effects and releases fluoride. According to studies, 85% of patients experienced complete relief from dentin sensitivity after a single session with Profluoride varnish. It is contraindicated in patients with ulcerative gingivitis and stomatitis.

Self-adhesive cements, which are partially hydrophilic, are used without any dentin adhesives and still demonstrate good bond strength (7). Since these cements are specifically designed for bonding to dentin without any pre-treatment, desensitizing or sealing dentin with resin may affect the bonding of these cements (7). Studies have shown that self-adhesive cements are not capable of demineralizing the smear layer, and a complete hybrid layer does not form (8). There is limited information about the effect of these types of dentin preparations on the bond strength of self-adhesive cements (7).

RelyX Unicem is a self-adhesive and dual-cure resin cement (9). This cement is recommended for cementing all-ceramic, metal, or laboratory composite restorations, as well as endodontic posts. When using this cement, there is no need for etching or surface preparation of the tooth. Despite the much simpler clinical steps, the bond between the cement and tooth, as well as the cement and restoration, is comparable to that of other multi-step cements. The mechanical properties of this cement are superior to those of zinc phosphate and glass ionomer cements (9, 10). One of the characteristics of this material is its strong bond to both enamel and dentin. This cement exhibits the highest color stability, showing minimal discoloration even after being immersed in coffee solution for 3 days. The tooth surface does not need to be dry; excessive drying can increase post-operative sensitivity (11).

The self-adhesive cement RelyX U200 contains acidic and hydrophilic monomers that play a crucial role in controlling the chemical polymerization reaction. However, limited information about the initiator systems prevents a clear interpretation of this material's behavior after polymerization (12).

Given the limitations and shortcomings of previous research, this study was conducted to determine the effect of applying the desensitizing agent Profluoride Varnish on the retention of full-coverage crowns cemented with RelyX U200self-adhesive cement.

2. Methods

An experimental in vitro study was conducted. Given the novelty of the research topic and the absence of similar studies, the final sample size was determined based on data from a preliminary study, with 10 = n_2 = n_1 in each of the two groups (control and experimental) (13, 14).

For this study, 20 premolar teeth, free of caries and restorations and of similar size, which had been extracted for orthodontic treatment, were placed in 0.1% thymol solution for 48 hours for disinfection. The remaining tissue around the root of each tooth was cleaned. A milling machine (Milling machine, Degussa; Germany) was used for tooth preparation (13). For this purpose, all teeth were mounted in self-curing acrylic (GC, USA), with the cemento-enamel junction (CEJ) positioned 2 millimeters above the upper surface of the resin block. To enhance retention, buccolingual grooves were created on the root of the teeth using diamond burs (Dia-Burs, Mani Inc., Tochigi, Japan) (15). Diamond burs with round-ended tips (Dia-Burs, Mani Inc., Tochigi, Japan) were used for axial and occlusal reduction of the teeth (15). Uniform cones with a 6-degree taper were achieved. The teeth were reduced to ensure that after preparation, 4 millimeters of tooth height remained (16), so that the samples had similar cementation surface areas. A 0.5-millimeter chamfer finish line (13) was created at the top of the cement-enamel junction. During the preparation, moisture was maintained to prevent the teeth from drying out. Tooth preparation was performed using fine-grit tapered diamond burs with round-ended tips (Dia-Burs, Mani Inc., Tochigi, Japan). The burs were replaced after every three preparations. All the finish lines were smoothed using abrasive strips (13). Then, direct wax patterns were made for the teeth using casting wax type II (S-U-Underlay & S-U-Modelling Wax, Schuler, Ulm, Germany). The margins were adapted to the teeth, and excess wax was removed with PKT and under magnification. The thickness of the wax patterns was 0.5 millimeters, measured with a wax gauge (S-U-Iwanson-Feeler Tweezer II for metal; Schuler-Dental, Ulm, Germany). A ring with a diameter of 5 millimeters was then attached to the occlusal surface of the wax patterns, and a sprue with a thickness of 0.8 millimeters was attached to this ring (13). This ring, which is reflected on the metal crown after casting, was used to connect a jig for retention testing in a universal testing machine (17). The wax patterns were then invested using high-strength phosphate investment plaster (Deguvest CF; Degussa AG, Hanau, Germany). The castings and looped full-metal crowns were made from a base metal alloy (nickel-chromium, Wirolly, Bego, Bremell, Germany) through the casting process (13). The castings were then gently placed on the teeth, and the marginal fit was assessed using an explorer and complete seating was checked with Fit Checker (GC, Japan, Tokyo). If the fit was inadequate, the crowns were adjusted accordingly. The castings were then finished using metal finishing stones, burs, and finally sandblasted with 50-micron aluminum oxide (AX-B5; Twin-pen sandblaster, Tianjin Aixin Medical Equipment Co. Ltd, Tianjin, China) (13).

The castings were then cleaned in an ultrasonic bath (Transonic 470/H, Elma, Singen, Germany) for 60 seconds (13). All the teeth were cleaned using pumice powder and water, and the interiors of the crowns were disinfected with alcohol. The teeth were then randomly assigned to two groups: the experimental group (which received the desensitizing agent fluoride varnish according to the manufacturer's instructions) and the control group (which did not receive the desensitizing agent). The fluoride varnish was applied to the tooth surfaces using a microbrush, followed by a gentle air blast, and left for 20 seconds. The remaining 10 samples were left untreated as controls. To achieve a consistent thickness of the cement (RelyX U200, 3M ESPE, St. Paul, Minn., USA), the cement was mixed according to the manufacturer's instructions, by pressing the device's lever until a "click" sound was heard. With this specific design, the required amount of base and catalyst for one unit of crown cement is dispensed from the tubes. The two pastes were then mixed for 20 seconds (18). The crowns were filled with cement and initially seated onto the teeth with firm finger pressure (15). They were then light-cured for 2 seconds using a light-curing device with an intensity of 700 mW/cm^2. Excess cement was removed with an explorer after setting (15). Afterward, the mounted teeth and crowns were transferred to a universal testing machine (Zwick z050; Roell Group, Ulm, Germany). The upper part of the machine was connected to the upper ring of the crown, and a constant axial load of 5 kilograms was applied to each crown for 10 minutes (17). After the cementation process, all samples were stored at 37°C and 100% humidity for 24 hours before the retention test (17). The retention test was then conducted on all samples using the universal testing machine (Zwick z050; Roell Group, Ulm, Germany), with a custom-made metal jig with a diameter of 3.14 millimeters attached to the upper part of the device. The samples with the cemented crowns were placed in the lower part of the device, and the vertical axis was lowered until the pin passed through the crown ring. Thus, when a load was applied to this setup, a purely vertical tensile force was created, pulling the crown and tooth apart. The force was applied until the crown was completely detached from the tooth (Fig. 1 and 2)(13). The crosshead speed of 0.5 millimeters per minute was set according to ADA standards for cement testing (13, 18). Once the crowns were removed from the prepared teeth, the debonded surfaces were carefully examined with the naked eye and under magnification to assess the failure of the cement. The modes of failure were classified as follows (15, 19):

- **Cohesive Failure:** Occurs within one of the substrates (failure within the cement).
- **Adhesive Failure:** Occurs at the interface between the two materials (which can be further categorized into: failure at the interface between cement and tooth, and failure at the interface between cement and crown).
- **Mixed Failure:** A combination of the above two types.

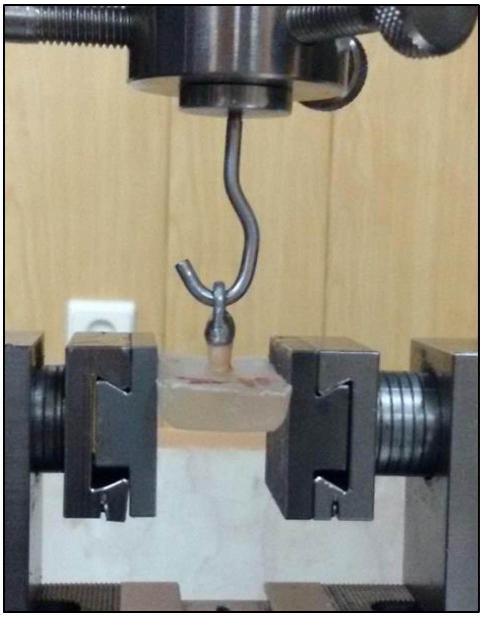

Figure 1 Load application parallel to the longitudinal axis of the tooth at a crosshead speed of 0.5 mm/min.

Figure 2 Load was applied until the crown was completely separated from the tooth.

3. Results

This study was conducted on human premolar teeth that were prepared and restored with RelyX U200 crowns, both with and without fluoride varnish. The results of the Smirnov-Kolmogorov test regarding the tensile bond strength of the two groups, measured in Newtons, are presented in Table 1. The test indicated that the tensile bond strength in both groups followed a normal distribution in the population (P>0.05).

Table 1 Results of t-test for Comparing Tensile Bond Strength Between Experimental and Control Groups**.**

Groups/Tensile bond strength	Mean ± SD	C.V	P. Value
Without Fluoride varnish Desensitizer	458.32±165.52 N	2.76	0.0001
With Fluoride varnish Desensitizer	153.92±67.50 N	2.29	

The statistical characteristics of tensile bond strength in the two groups are provided in Table 2. It shows that the tensile bond strength was 458.32 ± 165.52 with a CV of 2.76 in the control group (without fluoride varnish), while it was 153.92 ± 67.50 with a CV of 2.29 in the experimental group (with fluoride varnish). This indicates that the variability of tensile bond strength is lower in the experimental group compared to the control group. According to this table, the mean tensile bond strength in the experimental group differs significantly from that in the control group (P = 0.00001).

In this study, in the experimental group (with fluoride varnish), 6 samples exhibited adhesive failure, while the remaining samples showed mixed failure, primarily observed on the crown. In fact, there was a tendency towards adhesive failure in this group. In the control group (without fluoride varnish), 3 samples showed adhesive failure, and the rest exhibited mixed failure.

4. Discussion

In this study, the tensile bond strength obtained from the group with fluoride varnish (153.92 ± 67.50) was lower compared to the control group (458.32 ± 165.52), with a statistically significant difference (P = 0.00001). The research indicated that the use of fluoride varnish reduces the retention of full metal crowns. As mentioned in the introduction, few studies have examined the effect of desensitizing agents on the retention of full metal crowns. The most recent systematic review, which investigated the effect of various desensitizing agents on the retention of fixed prosthetic crowns, found that both the type of desensitizing agent and the type of cement used affect the retention of fixed prosthetic crowns (20).

The varnish contains a colophony base, 5% sodium fluoride (22,600 ppm fluoride), and xylitol (caries-inhibiting). Fluoride ions, along with calcium ions, accumulate in the dentinal tubules, leading to the precipitation of calcium fluoride, which seals the dentinal tubules. Profluoride varnish protects the tooth against acid and enhances remineralization through the precipitation of calcium fluoride (5, 6). The choice of fluoride varnish as a desensitizing agent and self-adhesive resin cement was based on a study by Elguindy in 2010, which demonstrated that the bond strength of resin is influenced by the mechanism of fluoride varnish and its reaction with calcium and hydroxyapatite, forming CaF_2 crystals. The presence of CaF_2 at the adhesive dentin interface acts as a stress-reducing agent, which causes the cement to debond under low forces (7). (7). Yim and colleagues also noted that fluoride varnish does not polymerize with cement. Non-polymerizable desensitizers cover the irregularities of the dentin surface and prevent the penetration of the cement, thereby reducing tensile bond strength (21).

In 2014, Acar and colleagues investigated the effects of desensitizers Gluma, Aqua-Prep F, Bisbloc, Cervitec Plus, Smart Protect, and Nd:YAG laser on the microtensile bond strength (MTBS) of the RelyX U200 self-adhesive resin cement to dentin. They reported that the use of Aqua-Prep F on dentin reduced the MTBS of self-adhesive resin cement to dentin, which is consistent with our findings (5). The differences between the two studies are as follows: In this study, molar teeth were used for evaluation, whereas we used premolar teeth. The samples were thermocycled, and the number of samples in each group was half of what we had in each of our groups due to the large amount of the material tested. Additionally, this study used composite blocks as restorations instead of crowns, which does not have clinical similarity to our study. In this study, a force of 2 kg was applied for 60 seconds to achieve a uniform and appropriate cement thickness for all samples, which differs from our study and lacks a reference. We used a force of 5 kg for 10 minutes (17). This study also used fluoride as a desensitizer and RelyX U200 as self-adhesive resin cement, which is consistent with our study.

In 2010, Dundar and colleagues investigated the effect of a fluoride and triclosan-based desensitizer on the bond strength of resin cement to dentin. They reported that Aqua-Prep F increased the bond strength of both resin cements used (22), which is different from our findings. In their study, the cements used were Variolink II and Duolink, both of which differ from the RelyX U200 cement used in our study. Other differences between the two studies are as follows: The number of samples in each group differed from our study. The samples were thermocycled. Unlike our study, this study used ceramic discs as restorations, which does not have clinical similarity. We used full-metal crowns.

Additionally, the bond test used in this study was a shear bond test, which is different from the retention test used in our study. The use of premolar teeth and fluoride-based desensitizers was similar in both studies.

In 2010, Elguindy and colleagues investigated the effect of different desensitizing agents on the retention of crowns on teeth with short and overly convergent preparations. They reported that the fluoride desensitizer decreased the retention of both cements studied (23), which supports the findings of the present study. The cements used in their study were resin cement (Duolink) and glass ionomer cement (Ketac-Cem), both of which differ from the cement used in our study, RelyX U200. However, the desensitizing agent studied was similar to ours. Their study also used full-coverage crowns and evaluated tensile strength, which is comparable to our study. Molar teeth were used for evaluation in this study, whereas we used premolars. The sample size in each group was similar to ours. The samples underwent thermocycling, while we immersed our samples in a water bath for 24 hours. To achieve a uniform and appropriate cement thickness for all samples, a 5 kg force was applied for 15 minutes in this study, similar to our study, except that we applied the force for 10 minutes. Both studies used a crosshead speed of 0.5 mm per minute for the tensile test.

Adhesive cements have higher technical sensitivity compared to conventional cements, and clinical success may be jeopardized by these technical challenges. These issues were addressed with the introduction of self-adhesive resin cements. RelyX U200, used in the present study, is a newly introduced self-adhesive resin cement that includes an additional monomer and a new rheology modifier added to the mix, optimized with filler particles. Utilizing a cement with these characteristics is one of the positive aspects of the present study. Additionally, using this cement eliminated the problems and confounding variables associated with the multiple steps involved in conventional resin cements (etching, rinsing, bonding). Despite the in vitro nature of the current study and consequently its lower clinical similarity, the results suggest the need for clinical studies with greater simulation of the oral environment (chewing force simulation, thermal environment simulation, etc.). The use of full-coverage crowns for evaluations is less common due to the difficulty of tooth preparation and crown fabrication. By conducting this study, we laid the groundwork for further research using this methodology, which has greater clinical similarity and can be applied with other desensitizing agents and cements. We recommend this approach for conducting other evaluations. However, this difference in the methodology of the present study made it difficult to compare its findings with other studies. In this study, pulp pressure and dentinal fluid were not simulated. However, the teeth were immersed in an aqueous environment, ensuring the presence of water in the dentinal tubules.

5. Conclusion

Given the limitations of this study and its methodology, the negative impact of fluoride varnish on the bond strength of self-adhesive cement (RelyX U200) was confirmed. Therefore, we do not recommend the use of fluoride varnish on sensitive teeth before cementing crowns with self-adhesive cement.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Ramesh G, Nayar S, Chandrakala S. Principles of Tooth Preparation-Review Article. Indian Journal of Forensic Medicine & Toxicology. 2020 Oct 1;14(4).

[2] Bangar B , Deepika D, Patel B. D, Bose S, Malde N & Bisht H. Analysis of impact of desensitizing agents on the retention of crowns cemented with luting agents. International Journal of Health Sciences.2022; 6(S3), 4993–4997.

[3] Sharma R. Evaluation of effect of desensitizing agents on the retention of crowns cemented with luting agents: A clinical study. IJLBPR.2023 Jan;12(1):519-521.

[4] Abdollahi A, Jalalian E. Effectiveness of two desensitizer materials, potassium nitrate and fluoride varnish in relieving hypersensitivity after crown preparation. J Contemp Dent Pract. 2019 Apr 1;20(4):489-93.

[5] Ozlem Acar, Duygu Tuncer, Bulem Yuzugullu, Cigdem Celik. The effect of dentin desensitizers and Nd:YAG laser pre-treatment on microtensile bond strength of self-adhesive resin cement to dentin. J Adv Prosthodont. Apr 2014; 6(2): 88–95.

[6] GVR Himashilpa, Y. Ravishankar, Kalluri Srinivas. INFLUENCE OF DESENSITIZING AGENTS ON THE RETENTION QUALITY OF COMPLETE CAST CROWNS CEMENTED WITH VARIOUS LUTING AGENTS – AN IN-VITRO STUDY.J Scientific Research. 2019 July ;7(8): 2277 - 8179

[7] Elizalde-Hernández A, Hardan L, Bourgi R, Isolan CP, Moreira AG, Zamarripa-Calderón JE,etc. Effect of Different Desensitizers on Shear Bond Strength of Self-Adhesive Resin Cements to Dentin. Bioengineering. 2022 Aug;9(8):372.

[8] Calheiros-Lobo MJ, Vieira T, Carbas R, da Silva LF, Pinho T. Effectiveness of Self-Adhesive Resin Luting Cement in CAD-CAM Blocks—A Systematic Review and Meta-Analysis. Materials. 2023 Apr 10;16(8):2996.

[9] Skapska A, Komorek Z, Cierech M, Mierzwinska-Nastalska E. Comparison of Mechanical Properties of a Self-Adhesive Composite Cement and a Heated Composite Material. Polymers. 2022 Jun 30;14(13):2686.

[10] Ling L, Ma Y, Chen Y, Malyala R. Physical, Mechanical, and Adhesive Properties of Novel Self-Adhesive Resin Cement. International Journal of Dentistry. 2022 Apr 8;2022.

[11] Yu H, Cheng SL, Jiang NW, Cheng H. Effects of cyclic staining on the color, translucency, surface roughness, and substance loss of contemporary adhesive resin cements. The Journal of prosthetic dentistry. 2018 Sep 1;120(3):462-9.

[12] Sinche-Ccahuana I, Ladera-Castañeda M, Paucar-Rodríguez E, Aliaga-Mariñas A, Dapello-Zevallos G, Cervantes-Ganoza L,etc. Microleakage in indirect onlay restorations cemented with three different types of adhesives: An in vitro study. J Clin Exp Dent. 2023 Aug 1;15(8):e641-e648.

[13] Lawaf, S.; Jalalian, E.; Roshan, R.; Azizi, A. Effect of GLUMA desensitizer on the retention of full metal crowns cemented with Rely X U200 self-adhesive cement. J. Adv. Prosthodont. 2016, 8, 404–410.

[14] Kumar S1, Rupesh PL2, Daokar SG3, Yadao AK4, Ghunawat DB5, Sayed SS4.Effect of Desensitising Laser Treatment on the Bond Strength of Full Metal Crowns: An In Vitro Comparative Study.J Int Oral Health. 2015 Jul;7(7):36-41.

[15] Dewan H, Sayed ME, Alqahtani NM, Alnajai T, Qasir A, Chohan H. The effect of commercially available desensitizers on bond strength following cementation of zirconia crowns using self-adhesive resin cement—An in vitro study. Materials. 2022 Jan 10;15(2):514.

[16] Supraja K, Vinnakota DN, Krishna DV, Pottem SR. Evaluation of freshly prepared "arginine-calcium carbonate-fluoride" and "casein phosphopeptide-amorphous calcium phosphate-fluoride" desensitizing agents on crown retention: An in vitro study. World Journal of Dentistry. 2020 Sep 28;11(5):355-60.

[17] Himashilpa, G.V.R.; Ravishankar, Y.; Srinivas, K.; Harikrishna, M.; Shameen Kumar, P.; Satyendra, T. Influence of desensitizing agents on the retention quality of Complete cast crowns cemented with various luting agents—An in-vitro study. J. Sci. Res. 2019, 8, 1–4.

[18] Johnson GH, Hazelton LR, Bales DJ,Lepe X. The effect of a resin based sealer on crown retention for three types of cement. J Prosthet Dent 2004;91:428-35.

[19] Summitt, J.B., Robbins, J.W., Hilton, T.J. and Schwartz, R.S. Fundamentals Of operative dentistry: a contemporary approach.3rd ed. China: Quintessence publishing Co,Inc.2006:184-185.

[20] Sayed ME. The Effect of Dentine Desensitizing Agents on the Retention of Cemented Fixed Dental Prostheses: A Systematic Review. Medicina. 2023 Mar 6;59(3):515.

[21] Yim N.H., Rueggerberg F.A.,Caughman F., Gardner M. and Pashley D.H.. Effect of dentin desensitizers and cementing agents on retention of full crowns using standardized crown preparations. J Prosthet Dent 2000; 83: 459-465

[22] Dündar M, Cal E, Gökçe B, Türkün M, Ozcan M. Influence of fluoride- or ticlosan-based desensitizing agents on adhesion of resin cements to dentin. Clin oral Investig.2010 Oct;14(5):579-86.

[23] ElGuindy, Jylan F, Dina H. Mostafa, and rana M.Sherif. Do desensitizers affect the retention of questionable preparations. J Am Sci 2010;6:274-83.