COMPARATIVE EVALUATION OF THE EFFECT OF DIFFERENT DENTIN DISINFECTION PROTOCOLS ON THE SHEAR BOND STRENGTH OF TWO RESTORATIVE MATERIALS- AN IN VITRO STUDY.

ABSTRACT

Introduction After cavity preparation and caries removal, microorganisms remain on dentinal surfaces. Disinfection of dentin surface prior to any restorative therapy is important for the longevity of the treatment. However, these dentin disinfection methods should itself not interfere with the adhesion of the restorative material.

Objectives To compare the effect of different dentin disinfections on the bond strength of two restorative materials.

Methods 72 extracted premolars were sectioned horizontally from one third of the coronal crown to expose flat dentin surface and embedded into cold cure acrylic. They were randomly divided into 3 groups with each group having 24 specimens. Group I- CTRL with no disinfection protocol (12 for RMGIC and 12 for glass hybrid) Group II- Disinfection with 2% chlorhexidine Group III- Disinfection with GLUMA® desensitize. Then a predetermined dimension 3×3mm of RMGIC and glass hybrid material was bonded to the pre-treated dentin surfaces. The samples were stored in distilled water for 24 hours at room temperature. Each sample was tested for SBS using UTM.

Results Gluma with Equia Forte showed the highest shear bond strength (SBS) among all groups (37.91 MPa). Gluma disinfection significantly improved SBS compared to chlorhexidine (CHX), especially with glass hybrid materials. EF outperformed RMGIC in both CHX and Gluma groups. CHX groups showed the lowest SBS, with no significant difference between RMGIC and EF. In contrast, Gluma groups showed a significant SBS difference between the two materials.

Conclusion The use of GLUMA and CHX based cavity disinfectants do not significantly interfere with adhesion of RMGIC and glass hybrid material.

Keywords Shear Bond Strength; Dentin disinfection; Gluma; Chlorhexidine; Resin modified glass ionomer cement; Glass hybrid restorative material

INTRODUCTION

Tooth preparation aims to create optimal space for restorations while removing infected tissue. However, conventional techniques often fail to eliminate all cariogenic bacteria, which may remain within dentinal tubules or the smear layer, leading to post-operative sensitivity, pulpal inflammation, recurrent decay, and restoration failure.[1,2,3]

Various restorative materials have been used to fill prepared cavities. An ideal material should provide strong adhesion, resist microleakage, and offer sufficient strength. Glass Ionomer Cement (GIC) is widely used for its chemical bond to tooth structure, fluoride release, and biocompatibility. However, its moisture sensitivity, slow setting, short working time, and low strength limit its application under heavy occlusal load.[4]

Resin-Modified Glass Ionomer Cement (RMGIC) enhances GIC by incorporating resin, improving strength and handling while retaining desirable properties such as fluoride release and chemical bonding.[5] RMGIC bonds via two mechanisms: (1) chemical bonding between polyalkenoic acid and calcium in hydroxyapatite, and (2) micromechanical interlocking via self-etching.

A newer glass hybrid restorative, *Equia Forte*, incorporates ultra-fine glass particles and a high-molecular-weight polyacrylic acid matrix, offering improved strength and wear resistance.[6] Unlike composites that rely on micromechanical retention, Equia Forte also forms chemical bonds via ion exchange.[7]

To reduce bacterial contamination and improve restoration longevity, cavity disinfection before restoration is recommended. However, it must not compromise adhesion.[8]

Chlorhexidine (CHX), a widely used antimicrobial agent, is effective against *Streptococcus mutans* and helps reduce bacterial load in dental tissues.[9] Gluma, containing 5% glutaraldehyde and 35% HEMA, acts as both an antimicrobial and desensitizer. It seals dentinal tubules and cross-links collagen, enhancing both bond durability and resistance to fluid movement.[9,10]

Effective cavity disinfection is essential to prevent microleakage, secondary caries, and restoration failure. Achieving strong adhesion is critical, with shear bond strength (SBS) being a key factor in resisting dislodgement forces. A higher SBS reflects better bonding performance and long-term clinical success.

MATERIALS AND METHOD

A total of 72 extracted human premolars were taken from the department of Oral and maxillofacial surgery meant for orthodontic extraction with no wear defects, fracture line, or cracks. Soft tissues, if any attached to the selected teeth were removed using a hand scaler and stored in distilled water until use.

Sample preparation: The teeth were embedded onto cold cure acrylic with only crown portion visible and one-third of occlusal surfaces were trimmed (perpendicular to long axis of tooth) to obtain a flat dentinal surface using a diamond cutting disc attached to a slow speed micro motor hand-piece. The tooth surfaces were polished using a 600-grit silicon carbide abrasive paper.

Grouping of sample: Samples had been separated into 3 groups; 1 CTRL group and 2 experimental groups.

Group 1: CTRL- 24 premolars used as control group, no disinfection protocol (12 for RMGIC and 12 for glass hybrid). The samples' dentinal surfaces were washed utilizing distilled water as well as gently air dried for 5 sec.

Group 2: 24 premolars treated with 2% chlorhexidine (HexaChlor, SafeEndo) for 30sec utilizing a microbrush. After rinsing with distilled water, the surface was allowed to air dry for 5 sec.

Group 3: 24 premolars treated with GLUMA. Disinfection of dentin surfaces had been done utilizing GLUMA® desensitizer (GD, Heraeus Kulzer) solution for 30sec using a microbrush. After rinsing with distilled water, surface was kept air dry for 5sec.

After rinsing and drying, restorative materials were applied:

Restorative material RMGIC's placement- RMGIC (GC Gold label 2 Lc Universal Restorative, GC India) was processed as per manufacturer's instructions. It had been placed into a cylindrical plastic mold with an internal diameter along with 3×3mm height, positioned at center of treated dentin surface. Then for 20sec time period, samples were cured utilizing a light-curing device.

Placement of GH restorative material- A plastic cylindrical mold measuring 3×3mm (internal diameter×height) was filled with a glass hybrid material (EQUIA FORTE, GC India) and positioned at the center of the prepared dentinal surface. After the material had begun to set, the mold was trimmed and taken away. Then samples had been kept in distilled water at room temperature for 24hrs prior to measurement of SBS.

Shear bond strength measurement- SBS of resin-modified GI cement and GH restorative materials had been estimated utilizing a universal testing machine. Acrylic blocks were secured within a metallic ring and were exposed to forces applied at the dentin-material interface, parallel to bonded surface, utilizing a stainless steel rod with a sharp blade measuring 2.5mm in diameter, at a crosshead speed of 0.5mm/min, until restoration was dislodged. Force at which restoration was dislodged was measured in Newtons. The SBS in megapascals (MPa) was then calculated through dividing this value by the bonding interface's cross-sectional area.

FIGURE 1: PLACEMENT OF RMGIC AND EQUIA FORTE INTO 3X3 MM CYLINDRICAL MOLD

FIGURE 2: FORCE APPLICATION

STATISTICAL ANALYSIS

Version 22.0 of the SPSS (Statistical Package for Social Sciences) was employed to analyze the data. A statistical significance level of 95% (P=0.05) had been established. A P-value below 0.05 was viewed as significant, whilst a P-value above 0.05 was deemed non-significant. The data from this study underwent statistical analysis to determine the variations and significance among groups. One-way ANOVA (Analysis of Variance) had been employed for contrasting the average resistance across different groups, the Post hoc Tukey test was applied for pairwise comparisons of mean resistance observed among the groups.

RESULTS

Among CHX and GLUMA disinfectants, GLUMA shows a higher shear bond strength with EQUIA (37.9175 vs. 23.2992) compared to the **CONTROL-EQUIA** (22.06 ± 0.78) and **CHX-EQUIA** (23.30 ± 2.22) groups suggesting that GLUMA might be a more effective dentin disinfectant, with statistically significant differences ($p<0.05$). The **GLUMA-RMGIC** group exhibited higher SBS than both **CONTROL-RMGIC** (16.56 ± 1.48) and **CHX-RMGIC** (18.45 ± 0.86), with statistically significant differences ($p<0.05$). Among control groups, **CONTROL-EQUIA** showed significantly higher SBS than **CONTROL-RMGIC** ($p<0.05$), and **CHX-EQUIA** also had significantly higher SBS than **CHX-RMGIC** ($p<0.05$). However, the SBS difference between **CONTROL-RMGIC** and **CHX-RMGIC**, as well as between **CONTROL-EQUIA** and **CHX-EQUIA**, was not statistically significant ($p=0.146$). Notably, the **GLUMA-RMGIC** group exhibited the highest variability in SBS values, with a standard deviation of 3.05. Based on shear bond strength, GLUMA disinfectant appears to perform better than CHX, best with the EQUIA FORTE restorative material. In the CONTROL group, where no disinfectant was applied, Shear bond strength of EQUIA FORTE material was better than RMGIC.

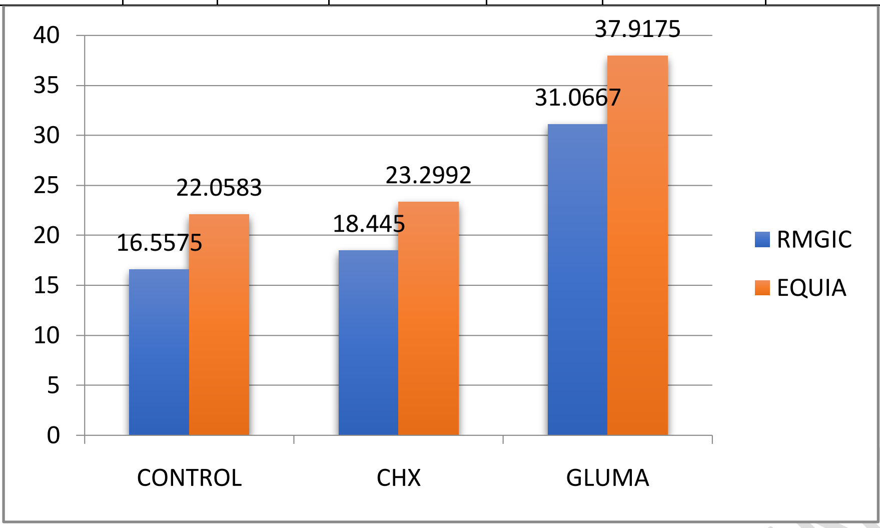
TABLE 1. DESCRIPTIVE

Descriptives

SHEAR BOND STRENGTH

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
CONTROL-RMGIC	12	16.5575	1.47901	.42695	15.6178	17.4972	14.64	19.32
CHX-RMGIC	12	18.4450	.85904	.24798	17.8992	18.9908	17.00	19.64
GLUMA-RMGIC	12	31.0667	3.05119	.88080	29.1280	33.0053	26.32	35.00
CONTROL-EQUIA	12	22.0583	.78336	.22614	21.5606	22.5561	21.00	23.00
CHX-EQUIA	12	23.2992	2.22447	.64215	21.8858	24.7125	19.82	26.64
GLUMA-EQUIA	12	37.9175	1.76459	.50939	36.7963	39.0387	35.02	40.64

Total	72	24.8907	7.67531	.90454	23.0871	26.6943	14.64	40.64



GRAPH 1- SHEAR BOND STRENGTH COMPARISION OF CONTROL,CHX,GLUMA IN RMGIC AND EQUIA

DISCUSSION

The success of adhesive restorations depends not only on the properties of restorative materials but also on optimal cavity disinfection. Disinfection must eliminate microbial contamination without compromising the adhesive interface. This study investigated the effect of two commonly used cavity disinfectants—**Chlorhexidine (CHX)** and **Gluma**—on the shear bond strength (SBS) of **resin-modified glass ionomer cement (RMGIC)** and **EQUIA FORTE** to dentin.[12,13,14]

Dentin presents a bonding challenge due to its hydrated, collagen-rich nature, which is significantly different from enamel. Hence, the interaction of disinfectants with dentin and restorative materials must be carefully assessed.[15,16]

The results of this study indicate that **both CHX and Gluma improved SBS values** when compared to the control (no disinfectant) group. Among them, **Gluma demonstrated a statistically significant increase in bond strength**, particularly with EQUIA FORTE (37.92 MPa) and RMGIC (31.07 MPa). The enhancement is likely due to Gluma's active ingredients—**10-MDP** and **4-META**—which promote chemical bonding by interacting with calcium in hydroxyapatite. Additionally, **glutaraldehyde (GA)** cross-links collagen fibrils, improving the mechanical properties of the hybrid layer and reducing enzymatic degradation, as supported by Bedran-Russo et al.[68] and Arrais et al.[17,18,19]

CHX, although not statistically significant compared to Gluma, showed improved SBS values over the control, especially in the **CHX–EQUIA** group (23.30 MPa). CHX's antimicrobial and **MMP-inhibitory properties** help preserve the hybrid layer and maintain long-term bond durability, as demonstrated by Carrilho et al.[39] However, its interaction with RMGIC may be less favorable due to its cationic nature possibly interfering with the setting reactions, as suggested by Dursun et al.[20,21]

Furthermore, **EQUIA FORTE exhibited superior SBS values compared to RMGIC** across all groups, possibly due to its highly viscous GIC formulation, enhanced with nano-sized reactive glass particles and high molecular weight polyacrylic acid. The chemical bonding mechanism of EQUIA FORTE, involving ionic exchange with dentin, may also contribute to its consistent performance.[22,23]

These findings align with previous studies indicating that both CHX and Gluma can be safely used as cavity disinfectants without negatively affecting bond strength. In fact, **Gluma not only disinfects the cavity but also enhances adhesion**, making it a promising agent in adhesive restorative protocols.[24,25]

CONCLUSION

The choice of restorative material should align with the dentin disinfection protocol to ensure optimal bonding. In this in vitro study, the use of GLUMA and CHX as cavity disinfectants did not adversely affect the adhesion of RMGIC and EQUIA Forte to dentin. In fact, all disinfectant-treated groups demonstrated improved shear bond strength (SBS) compared to the control group. Among the disinfectants, GLUMA proved more effective than CHX in enhancing SBS for both materials. Although CHX increased the SBS of RMGIC and EQUIA Forte compared to the control, the differences were not statistically significant. When no disinfectant was used, EQUIA Forte showed significantly higher SBS than RMGIC, indicating its superior bonding performance under control conditions. It is recommended that both disinfectants seem to be good choices under restorative materials.

REFERENCES

1. Sekhar A, Anil A, Thomas MS, Ginjupalli K. Effect of various dentin disinfection protocols on the bond strength of resin modified glass ionomer restorative material. J Clin Exp Dent. 2017 Jul 1;9(7):e837-e841.
2. Ercan E, Erdemir A, Zorba YO, Eldeniz AU, Dalli M, Ince B, Kalaycioglu B. Effect of different cavity disinfectants on shear bond strength of composite resin to dentin. J Adhes Dent. 2009 Oct;11(5):343-6.
3. Jain B, Tiku A. A comparative evaluation of shear bond strength of three different restorative materials to biodentine and TheraCal LC: an in-vitro study. International Journal of Applied Dental Sciences. 2019;5(2):426-9.
4. Wang L, Sakai VT, Kawai ES, Buzalaf MA, Atta MT. Effect of adhesive systems associated with resin-modified glass ionomer cements. Journal of oral rehabilitation. 2006 Feb;33(2):110-6.
5. Costa SB, de Oliveira RV, Montenegro RV, Fonseca RB, de Carvalho FG, de Barros S, Carlo HL. Bond strength evaluation of composite resin bonded to glass ionomer cements after different periods of setting. International Journal of Adhesion and Adhesives. 2013 Dec 1;47:146-50.
6. Hasani YS, Paryab M, Saffarpour A, Kharazifard MJ, Shahrabi M. The effect of disinfection with chlorhexidine on the shear bond strength of equia resin-modified glass ionomer cement to dentin in permanent teeth after two thermocycling protocols. Journal of Dentistry. 2017 Dec;18(4):265.
7. Borompiyasawat P, Putraphan B, Luangworakhun S, Sukarawan W, Techatharatip O. Chlorhexidine gluconate enhances the remineralization effect of high viscosity glass ionomer cement on dentin carious lesions in vitro. BMC Oral Health. 2022 Mar 5;22(1):60.
8. Davalloo R, Tavangar SM, Ebrahimi H, Darabi F, Mahmoudi S. In vitro comparative evaluation of newly produced desensitizer, chlorhexidine and Gluma on bond strength and bond longevity of composite to dentin. Journal of Dentistry. 2020 Jun;21(2):111.

9. Ritter AV, Bertoli C, Swift Jr EJ. Dentin bond strengths as a function of solvent and glutaraldehyde content. American journal of dentistry. 2001 Aug 1;14(4):221-6.
10. Griffin J, Ruddy M, Mavreas D, Nace S, Vannet BV, Stanton KT. Comparison of shear bond strength and ARI of four different adhesive systems used to bond molar tubes: an in vitro study. International Orthodontics. 2021 Mar 1;19(1):117-22.
11. Patil SB, Shivakumar AT, Shah S. Effect of salivary contamination on shear bond strength of two adhesives: An: in vitro: study. Dental Hypotheses. 2014 Jul 1;5(3):115-20.
12. Coelho, A.; Vilhena, L.; Antunes, M.; Amaro, I.; Paula, A.; Marto, C.M.; Saraiva, J.; Ferreira, M.M.; Carrilho, E.; Ramalho, A. Effect of Different Cavity Disinfectants on Adhesion to Dentin of Permanent Teeth. J. Funct. Biomater. 2022, 13, 209.
13. Simões, D.M.S.; Basting, R.T.; Amaral, F.L.B.; Turssi, C.P.; França, F.M.G. Influence of chlorhexidine and/or ethanol treatment on bond strength of an etch-and-rinse adhesive to dentin: An in vitro and in situ study. Oper. Dent. 2014, 39, 64–71.
14. Bin-Shuwaish, M.; AlHussaini, A.; AlHudaithy, L.; AlDukhiel, S.; Al-Jamhan, A. An in vitro evaluation of microleakage of resin-based composites bonded to chlorhexidine-pretreated dentin by different protocols of a universal adhesive system. Saudi Dent. J. 2021, 33, 503–510.
15. Effect of ethanolic extract of propolis on antibacterial and microshear bond strength of glass-ionomer restorations to dentin
16. A.S. Pinto, F.B. de Araújo, R. Franzon, M.C. Figueiredo, S. Henz, F.G. Godoy, et al., Clinical and microbiological effect of calcium hydroxide protection in indirect pulp capping in primary teeth, Am. J. Dent. 19 (6) (2006) 382–386.
17. Yim NH, Rueggeberg FA, Caughman WF, Gardner FM, Pashley DH. Effect of dentin desensitizers and cementing agents on retention of full crowns using standardized crown preparations. The Journal of prosthetic dentistry. 2000 Apr 1;83(4):459-65.

18. Bedran-Russo AKB, Pashley DH, Agee K, Drummond JL, Miescke KJ. Changes in stiffness of demineralized dentin following application of collagen crosslinkersJ Biomed Mater Res B Appl Biomater. 2008; 86: 330- 334.
19. Francois P, Vennat E, Le Goff S, Ruscassier N, Attal JP, Dursun E. Shear bond strength and interface analysis between a resin composite and a recent high-viscous glass ionomer cement bonded with various adhesive systems. Clinical oral investigations. 2019 Jun 1;23:2599-608.
20. Wadenya R, Menon S, Mante F. Effect of chlorhexidine disinfectant on bond strength of glassionomer cement to dentin using atraumatic restorative treatment. N Y State Dent J. 2011; 77: 23-26.
21. Ersin NK, Candan U, Aykut A, Eronat C, Belli S. No adverse effect to bonding following caries disinfection with chlorhexidine. J Dent Child (Chic). 2009; 76: 20-27.
22. Cunningham MP, Meiers JC. The effect of dentin disinfectants on shear bond strength of resin-modified glass-ionomer materials. Quintessence Int. 1997; 28: 545- 551.
23. Dursun E, Le Goff S, Ruse DN, Attal JP. Effect of chlorhexidine application on the long-term shear bond strength to dentin of a resin-modified glass ionomer. Oper Dent. 2013; 38: 275-281.
24. Carrilho MR, Geraldeli S, Tay F, de Goes MF, Carvalho RM, Tjäderhane L, et al. In vivo preservation of the hybrid layer by chlorhexidine. J Dent Res. 2007;86:529-33.
25. Ersin NK, Candan U, Aykut A, Eronat C, Belli S. No adverse effect to bonding following caries disinfection with chlorhexidine. J Dent Child (Chic). 2009;76:20-7.