Current Research in Dentistry 1 (2): 11-14, 2010
ISSN 1949-0119

Shear Bond Strength of Four Cariostatic Tooth Colored Materials to Dentin of Permanent Premolar Teeth

E. Farrokhgisu and A. Eskandarizade
Department of Peadiatric Dentistry, Faculty of Dental,
Kerman University of Medical Science, Iran

Abstract: Problem statement: The purpose of this study was to compare the shear bond strength of four cariostatic restorative materials to dentin of permanent teeth. **Approach:** Restorative materials which have used in the study were composite P60 (3M), conventional glass ionomer (Fuji II, GC), light cured glass ionomer (Vitremer, 3M), compomer (F2000, 3M) and flow compoglass (Vivadent). This study was in vito study 4 groups of 10 teeth were used. Buccal surface of teeth was cut by high speed diamond cylinder burs, no 0.9 and dentin was exposed. Dentin surface was polished using "rubber cup and pumice", at low speed and repaired with one of the restorative materials according to the manufacturer's instructions. Restorative materials were placed on dentin using cylinder which had diameter of 3mm and length of 4mm. Determination of shear bond strength was performed using a universal testing machine at a speed of 0.5 mm/min. For statistical analysis, kruskal-wallis and ANOVA was used. **Results:** Ompomer had the lowest mean shear bond strength, 18.94 ± 1.85 and flow compoglass had the highest mean shear bond strength, 30.79 ± 3.02. Shear bond strength of light cured glass ionomer (30.79 ± 3.02) and conventional glass ionomer (22.64 ± 5) were respectively lower than flow compoglass. ANOVA test showed that the difference between shear bond strength of these materials was significantly difference ($p<0.05$), but these was no significant difference between shear bond strength of flow compoglass and light cured glass ionomer ($p>0.05$). Also there was significant difference between shear bond strength of these two materials and self cure glass ionomer, compoer ($p<0.05$). **Conclusion:** Flow compoglass had the highest shear bond strength and light cured glass ionomer, self cured glass ionomer and compomer, respectively had lower shear bond strength than flow compoglass.

Key words: Shear bond strength, flow compoglass, light cured glass ionomer, restorative materials, conventional glass ionomer, cariostatic restorative materials, mechanical properties, tooth structure, conventional GI, dentin surface, chemical bond

INTRODUCTION

Today, increasing the knowledge has lead to higher tendency to tooth colored restorative materials. Use of these materials lead to minimal loss of tooth structure and those which have stronger bond to enamel and dentin make restorative procedures easier (Robert *et al*., 2001).

In addition, one of the best characteristic of a restorative material is its cariostatic activity. Compomers and glass ionomer have this feature. Conventional glass ionomers are low in mechanical properties, but have chemical bond to tooth and release fluoride (Raberson *et al*., 2006).

Hybrid ionomer (resin modified glass ionomer) possess superior mechanical properties than conventional GI. This may be, in part, because of incorporating Hema and unsaturated carbon. These RMGIs display longer working time, shorter setting time and higher flexural and cohesive strength (Ruse, 1999).

Another cariostatic material is compomer which shows physical properties quite similar to those of composite resin and release fluoride slowly in oral environment (Raberson *et al*., 2006).

One of the parameter should be considered in choosing restorative material is its shear bond strength which is resistance to forces that sliding restorative material past tooth structure (Robert *et al*., 2001).

Shear bond strength is depend on bond type (micromechanical, ion exchanging) and type of restorative materials (Robert *et al*., 2001). Knowing the physical and chemical properties of different marketing materials has an important role in appropriate use of them. There is some concern about the loss of tooth structure in establishing retention form in amalgam cavity preparation especially in young permanent teeth in pediatric dentistry.

Because of the negative expansion contraction characteristics of composite resins, restorations may

Corresponding Author: E. Farrokhgisu, Department of Peadiatric Dentistry, Faculty of Dental, Kerman University of Medical Science, Iran

even have stimulated dental caries activity, but compomers and GI can reduce the risk of caries because of fluoride releasing (Christensen, 1997).

Baghdadi (2003) studied the bond strength of dyract AP and resulted that there would be higher shear bond strength if phosphoric acid was used for dentin conditioning.

Almuammar and schulman done a study to determine and compare the shear bond strength of conventional GI cement, a resin modified GI, a composite resin and three compomer restorative materials. In their study conventional GI showed the lowest mean shear bond strength and the composite resin showed the highest mean shear bond strength (Almuammar *et al*., 2001).

Glass Poole (2001) studied the effect of dentin pretreatment on bond strength of compomer and showed that there would be higher shear bond strength when dentin was etched with phosphoric acid (Glass Poole, 2001).

Recently, interest in using caryiostatic material, especially in paediatric dentistry, is increasing. So the purpose of this study was to evaluate and compare the shear bond strength of cariostatic restorative materials which used more common in paediatric clinics.

MATERIALS AND METHODS

In this observational experimental study, 50 caries free extracted human premolar teeth were used. Teeth stored in saline and thymol for 10 days to be disinfected. Them they polished by pumis and rubber cap and stored in distilled water in room temperature.

Buccal surface of middle third of the teeth were cut by a water cooled diamond burs no 0.9 and dentin was exposed. Dentin surface was cleaned with pumis and rubber cap then washed for 15s with water spray and dried for 10s with compressed air. The samples were randomly divided into 5 groups of 10 teeth. Materials used in the study were composite P60 (3M), conventional glass ionomer (Fuji II, GC), Light cured glass ionomer (Vitremer, 3m), compomer (F2000, 3M) and flow compoglass (Vivadent).

For placement and maintenance of material during polymerization, translucent plastic cylinders were used.

These cylinders had length of 4mm and inner diameter of 3 mm.

Preparation in each group was as below:

Group 1: GI (Vitremer, 3M): Dentine surface was conditioned with 15 % polyacrylic acid.

Group 2: GI (Fuji II, GC): no pretreatment was done. (There was no polyacrylic acid in the box)

Group 3: Compomer (F200, 3M): Two layers of single bond were used on dentin with 20s intervals (According to manufacturer's instruction).

Group 4: Flow compoGlass (Vivadent): primer and adhesive was used on dentin surface according to the manufacturer's instruction.

Each 2 mm increment was light-activated for 20 seconds (500mv $cm^{-2)}$ by exposing it to the visible light curing unit (Astratis 3, Vivadent). For self cured GI, the whole length of the GI was applied in one period. Finally surface of restorative materials in the cylinder was convex and contact between cylinder and buccal surface of tooth was from center to circumference, it prevented from producing void in bonding region.

Extra materials were cut with blade, carefully. The teeth were mounted in acryl and placed in bags with wet cotton and closed to prevent moisture exchange.

At 24 hours after, a shear test was performed using a universal testing machine (Ametek model, Accuforce, E500, US). The specimen were loaded to failure at a cross head speed of 0.5 mm/minute using a blade parallel to dentin surface at interface between tooth and restorative material. After shear bond strength testing, the specimens were examined by stereomicroscope (wild photomakroskop M400 Here brugg. Switzerland) and the failure were recorded as adhesive (b) or cohesive (a) bulk fracture. For statistical analysis kruskal wallis and Anova was used and P-values less than 0.05 were considered statistically significant.

RESULTS

Statistical analysis: The purpose of our study was to investigate and compare the shear bond strengths of 5 restorative materials: A resin modified glass ionomer, a conventional glass ionomer, a composite flow, a compomer and a composite p60. Data analysis of this study was carried out using SPSS Version 18.Significancy level of 0.05 % used for statistical analysis. To test the differences in shear bond strengths of materials we used One- Way ANOVA and multiple group comparisons among materials were made with Tukey-Kramer HSD test (Table 1-3).

Table 1: Mean shear bond strength of evaluated materials

Restorative materials	Mean (MPa)*	S. D¥
Composite p60	31.96	±3.89
Composite flow	30.79	±3.03
Resin modifide glass ionomer	26.77	±4.50
Conventional glass ionomer	22.66	±5.00
Compomer	18.85	±1.57

*: Megapascals, ¥: Standard deviation

Table 2: The Results of One-Way ANOVA and Tukey HSD Test comparing shear bond strengths in (MPa*) of groups evaluated

		df	Pvalue	F
Group	Mean square	4	<0.001	21.03
Total group	303.07	Mean difference	P value	CI¥
Composite (p60)-composite flow		1.17	0.96	-3.66-5.99
Composite p60-resin modifide glass ionomer		5.19	0.03	0.37-10.01
Composite p60-conventional glass ionomer		9.3	<0.001	4.48-14.13
Composite p60-compomer		13.11	<0.001	8.29-17.94
Composite flow-resin modifide glass ionomer		4.02	0.14	-0.80-8.85
Composite flow-conventional glass ionomer		8.14	<0.001	-3.31-2.96
Composite flow-compomer		7.92	<0.001	7.12-16.77
Resin modifide glass ionomer conventional glass ionomer		4.11	0.13	-0.71-8.94
Resin modifide glass ionomer compomer		7.92	<0.001	3.09-12.74
Conventional glass ionomer compomer		3.81	0.18	-1.01-8.63

*: Megapascals, ¥: Confidence interval

Table 3: Fracture pattern of restorative materials

Restorative materials	Fracture pattern
Flow compoglass	bbbabbaabb
Light cured glass ionomer	aabaabaaaa
Self cured glass ionomer	aaaaababaa
compomer	bbbbbabbbb

a: Cohesive bulk fracture, b: Adhesive fracture

DISCUSSION

Aim of this study was to evaluate the shear bond strength of cariostatic tooth colored restorative materials. The results show that flow compoglass had the highest bond strength and vitremer glass ionomer, conventional glass ionomer and compomer respectively had lower bond strength than flow compoglass.

Statistical analysis showed no significant difference between flow compglass and light cured glass, also between compomer and conventional glass ionomer. But there was a significant difference between compoer and flow compglass, light cured glass ionomer and conventional glass ionomer.

Conventional GIs are leader of cariostatic materials which used less because of low mechanical properties.

To improve their mechanical properties, Resin modified GI was developed that had higher shear bond strength than conventional GI. Al Moamer (Ruse, 1999), Swift *et al*. (1995) Suzukiy showed higher shear bond strength of RMGI than Conventional GI. Higher attachment of these materials to tooth structure is not responsible for this character and that is because of higher cohesive strength of them (Ruse, 1999).

In this study, shear bond strength of RMGI was higher than Conventional glass ionomer, too. This may be because of adding HEMA and unsaturated carbons (Summit *et al*., 2006).

Polyacrilic acid is a weak acid and when used in dentin conditioning, partially removes smear layer. It removes smear layer and leaves smear plug (Swift *et al*., 1995). RMGI forms chemical bond and a little micromechanical bond to tooth.

Compomer (F 2000, 3M) and flow compoglass (Ivoclar vivadent) have HEMA in their composition which infiltrate into the demineralized dentin and participate in formation of hybrid layer and forms micromechanical bond (Summit *et al*., 2006). Pretreatment of tooth in these materials are different from GI. Primer and conditioner are used prior to GI to get stronger bond (Glasspoole *et al*., 2001) and they washed completely before GI placement. Probably, Compomers have stronger bond because of HEMA. In this study, the same results achieved and flow compoglass had higher shear bond strength than compomer, conventional GI and vitremer. It seems that higher shear bond strength of flow compoglass compare to compomer is because of higher concentration of HEMA in it (Summit *et al*., 2006) and better wet ability of flow type than paste type. Proper dentin pretreatment was done using self etching material. Because of the similarity between compomers and Compglass, acid etch and dentin bond were used to get highest bond.

In this study, for dentin pretreatment before compomer, we used only two layers of bonding according to the manufacturer's instruction, so compomer had the lowest shear bond strength. Glass Pool (Almuammar *et al*., 2001) showed that if phosphoric acid was used for dentin pretreatment before placement of compomer, shear bond strength would become twice.

Baghdadi (Glasspoole *et al*., 2001) evaluated the effect of pretreatment on bond strength of compomer in permanent and deciduous teeth and resulted that using phosphoric acid would improve bond strength.

Shear bond strength is not only in relation to proper pretreatments, but also is in direct relation to the amount of HEMA. Flow compoglass had the highest bond strength because of high concentration of HEMA.

Before vitremer, only dentin conditioning was performed and washed completely. But before compomer and compoglass, dentin bonding was used because of their similarity to composite.

Evaluation of sample using electron microscopy showed that in compomer group the most fracture pattern was Adhesive, but in vitremer and conventional glass ionomer was cohesive and in compomer was adhesive. There was no direct relation between shear bond strength and fracture pattern and cohesive fracture didn't show higher shear bond strength. These results are in agreement with Almoamar (Ruse, 1999).

CONCLUSION

In this study, flow compoglass had higher bond strength than compomer and for dentin pretreatment, self etch material was used, but before compomer, dentin pretreatment was done using only dentin bond. Conditioning using polyacrilic acid is essential for Glass ionomer and there is no relationship between shear bond strength and fracture pattern.

REFERENCES

Almuammar, M.F., A. Schulman and F.S. Salama, 2001. Shear bond strength of six restorative material. J. Clin. Pediat. Dent., 25: 221-225. http://pediatricdentistry.metapress.com/content/r8g48vn51l46421m/

Baghdadi, Z.D., 2003. Bond strength of dyract AP compomer material to dention of permanent and primary molar phosphoric acid versus non-rinse conditioner. J. Dent. Child., 70: 145-152. PMID: 14528776

Christensen, G.J., 1997. Compomers VS. Resin-reinforced glass inomers. J. Am. Dent. Assoc., 128: 479-480. http://jada.ada.org/content/128/4/479.full.pdf

Glasspoole, E.A., R.L. Erickson and C.L. Davidson, 2001. Effect of enamel pretreatment on bond strength of compomer. Dent. Mater., 17: 402-408. http://www.demajournal.com/article/S0109-5641%2800%2900098-1/abstract

Raberson, T.M., H.O. Strutevant and E.J. Swift, 2006. Art and Science of Operative Dentistry. 5th Edn., Stmosby, ISBN-10: 0323030092, pp: 1032.

Robert, C., John M. Powers and John Powers, 2001. Restorative Dental Material. 11th Edn., Mosbey, ISBN-10: 0323014429, pp: 672.

Ruse, N.D., 1999. What's a "computer". J. Can. Dent. Assoc., 65: 500-504. PMID: 10560212

Summit, J.B., J.W. Robbins, T.J. Hilton, R.S. Schwartz and J.D.O.S. Santos 2006. Fundamentals of Operative Dentistry. 3rd Edn., Quintessence Pub Co., ISBN-10: 0867154527, pp: 599.

Swift, E.J., M.A. Pawlus and M.A. Vargas, 1995. Shear bond strength of resin modified glass inomer restorative materials. Oper. Dent., 20: 138-143. PMID: 8700781