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Research Article

Comparative Evaluation of Microtensile Bond Strength of Four Glass-Containing Materials with Primary Teeth Dentin

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Abstract

Background: Bonding to the tooth structure and fluoride release of the restoration are substantial factors to prevent the caries progression in children.

Objectives: The aim of this study was to compare micro tensile bond strength of four glass-containing materials with primary teeth dentin.

Methods: In this in-vitro study, 16 extracted primary molar were prepared and disinfected with 0.2% thymol solution. The occlusal box was prepared until a thin enamel wall remained and the dentin exposed at the pulpal floor. This enamel wall played the matrix role for placing the restorative materials. The teeth were randomly divided into 4 groups and restored with resin modified glass ionomer (RMGI), giomer, zirconomer and cention N. The teeth were mounted in acrylic mold and entered into a CNC cutting machine to provide specimens with a thickness of 1 × 1 mm. The tensile bond strength of the specimens was calculated by micro tensile measuring device. The failure of the samples (adhesive, cohesive, admix) was observed under a stereomicroscope. The data were analyzed using one-way analysis of variance and Fisher's exact test.

Results: There was a significant difference between zirconomer and other groups (P < 0.001), also between giomer and other groups (P < 0.001). There was no significant difference in the pattern of the failure among groups, except RMGI and cention N.

Conclusions: The micro-tensile bond of the giomer was the strongest, cention N and RMGI were approximately of equal strength, and zirconomer showed the lowest tensile bond strength.

Keywords: Dentin, Tensile Strength, Primary Teeth

1. Background

Early childhood caries is a specific form of dental caries in young children which spread rapidly. The etiology of this caries in children is multifactorial and complex. Combination of factors including diet, fluoride exposure, host susceptibility, micro flora and interaction of these factors with social, cultural, and behavioral factors can lead to caries in children. Restoration of anterior teeth provides esthetics and self-confidence in children (1).

Different restorative materials have been used to preserve the tooth structure and maintain its form, function and esthetics. Dental amalgam has been used for many years. However, lack of adhesion to the mineralized tissues, lack of esthetics and the unavoidable use of mercury, are some undesirable characteristics of this substance (2). Today tooth colored restorative materials, which adhere to tooth structure by minimal preparation are in demand.

Substitution of the biological, functional, and esthetic properties of healthy tooth structure is the main purpose of the restorative materials. Proper adherence of restorative material to the cavity walls is one of the most important aspects for the success of restoration (3). Adhesion of restorative materials to dentin unlike enamel is difficult and unpredictable due to its complex histological structure and variable composition (4).

In children using glass containing materials for restoration can restrain the caries progression by fluoride release properties. Materials which bond to the tooth structure better, providing fluoride release are the best choice to prevent the caries progression and to ensure proper longevity of the restoration especially in anterior teeth (1).

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2. Objectives

The purpose of this study was to evaluate the strength of micro tensile bond of four glass containing materials. namely resin modified glass ionomer (RMGI), zirconomer, giomer and cention N, to primary teeth dentin.

3. Methods

Sixteen sound, caries-free freshly extracted primary molars for orthodontic reasons were collected and used. The teeth which were cracked or had any signs of hypoplasia were excluded from the study. The samples were cleaned and disinfected with 0.2% thymol and kept in distilled water for 24 hours before use.

An occlusal box was prepared with a disc shaped bur (Jota, Swiss) and hand piece with air water spray by one experienced operator in a way that the enamel was completely removed in the pulp floor and a thin enamel shell remained around the box as a mold to place restorative material.

The pulp sheath was polished with 600 grit silicon carbide sandpaper. The teeth were randomly divided into 4 groups to restore with RMGI, giomer, zirconomer and cention N (Table 1).

3.1. First Group: RMGI (Fuji II LC, GC Corporation Tokyo, Japan)

The dentinal surface was conditioned with 20% polyacrylic acid for 20 seconds. Then it was washed for 10 seconds and dried with gentle air flow. The powder and liquid of the RMGI were mixed according to the manufacture's instruction and placed in two increments on the dentin surface and each increment light cured for 40 seconds (Demetron LC Kerr, USA).

3.2. Second Group: Giomer (Shofu INC.Kyoto Japan)

First, according to the manufacturer's instructions, self-etching primer (Clearfil, Kuraray, Japan) was rubbed on the dentin surface for 20 seconds and dried with gentle air flow. Then the self-etch bonding (Clearfil SE bond Kuraray, Japan) was used and light cured for 10 seconds. Finally giomer was placed on dentin surface in two increments and each increment light cured for 40 seconds with the same curing unit.

3.3. Third Group: Zirconomer (Shofu INC.Kyoto, Japan)

Dentin conditioner was applied for 20 seconds, washed and dried with gentle air flow. Zirconomer was mixed according to manufacturer's instruction and placed in the box and adapted with condenser. After three minutes the zirconomer was self-cured. 3.4. Fourth Group: Cention N (Ivoclar Vivadent AG, Liechtenstein)

Self-etch bond (Clearfil, Kuraray, Japan) was applied on the dentin surface according to group one. The powder and liquid were mixed based on the manufacturer's instruction and placed in the box. After four minutes the material was self-cured.

The teeth were completely embedded in cylindrical mold (Acropars. Iran) with a diameter of 12 mm and a length of 25 mm. then entered into a CNC cutting machine (Nano-pars. Mashhad, Iran) to provide specimens with a thickness of 1×1 mm.

At least 17 samples with a minimum length of 5 mm were prepared from each dental material. The tensile bond strength of the specimens was calculated by micro-tensile measuring device (MTD-500 plus. SD Mechatronic, Germany) at a speed of 1 mm/min. The failure type of the samples (adhesive, cohesive, admix) was observed under a stereomicroscope (Trinocular Zoom stereo Microscope. MP, 200USA) with a magnification of (\times 40).

The cohesive failure happens when the material separates from itself. In the adhesive failure the fracture happens at the bond line between the two dissimilar materials. In the admixed failure both of these fractures happens (5).

The results of micro-tensile bond strength of specimens were analyzed in statistical package for social sciences (SPSS) version 22 with one-way analysis of variance and the results of failure type were analyzed with Fisher's exact test at a significance level of 0.05.

This in vitro study was approved by the Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran (ethics code No. IR.MUI.REC.1396.3.549).

4. Results

The highest mean of micro-tensile bond strength was related to giomer specimens followed by cention N and the least one was in zirconomer group (Table 2). According to study results, there was a significant difference between mean micro-tensile bond strengths of the four materials (P < 0.001).

There was significant difference in bond strength of zirconomer and giomer with other materials separately (P < 0.001), but no difference between cention N and RMGI (P = 0.33).

The most prevalent pattern of failure in all material groups was adhesive failure. To compare the frequency of the pattern of failure in the four groups (Table 3), Fisher's exact test exhibited a significant difference between the

lable 1. Materials Used in the Study							
Material	Туре	Manufacturer	Composition				
Fuji II LC	Resin-modified glass ionomer	GC Corporation, Tokyo, Japan	Liquid (24 wt%): PAA, HEMA, proprietary ingredient, 2, 2, 4 -trimethylhexamethylenedicarbonate, TEGDMA fillers (76 wt%): fluoroaluminosilicate glass.				
Beautifil	Giomer	Shofu INC.Kyoto Japan	Filler: multi-functional glass filler and S-PRG filler based on fluoroboroaluminosilicate glass. Filler loading: 83.3 wt% (68.6% vol). Particle size range: 0.01 to 4.0 μ m. Mean particle size: 0.8 μ m. Base resin: Bis-GMA/TEGDMA resin.				
Zirconomer	Zirconia reinforced-glass ionomer	Shofu INC. Kyoto Japan	Powder: fluoroaluminosilicate glass, Zirconium oxide, pigments and others. Liquide: polyacrylic acid solution and tartaric acid.				
Cention N	Alkasite restorative material	Ivoclar Vivadent AG, Schaan, Liechtenstein	Liquid: dimethacrylates, initiators, stabilizers, additives and mint flavour. Powder: calcium fluoro-silicate glass, barium glass, calcium-barium-aluminium fluoro-silicate glass, iso-fillers, ytterbium trifluoride, initiators and pigments. The inorganic fillers size: 0.1 to 7 μ m. Filler loading: 78.4 wt%, or 57.6 vol%.				

Table 2. Comparison of Microtensile Bond Strength of Restorative Materials

Dental Material	Number	Micro Tensile Bond Strength		Difference Between Materials	
		Mean \pm SD	Range	Group Compared	P Value ^a
Zirconomer	17	4.84 ± 2.63	0.20 - 9.40	RMGI	< 0.001
zirconomer				Cention N	< 0.001
PMCI	22	10.46 ± 3.66	4.50 - 18.50	Zirconomer	< 0.001
KHOI				Giomer	< 0.001
Ciomer	17	19.26 ± 4.96	11.90 - 28.70	RMGI	< 0.001
Giomer				Zirconomer	< 0.001
Cention N	21	12.85 ± 5.06	5.80 - 26.70	RMGI	0.330
Cention IV				Giomer	< 0.001

Abbreviation: RMGI, resin modified glass ionomer.

^aSignificance level < 0.05.

frequency of fracture pattern in RMGI and cention N (P = 0.026). It means that in cention N group the percentage of failure was significantly higher than RMGI. But the difference between the other groups was not significant.

5. Discussion

Early Childhood caries is the most common chronic disease of children in our society. The carious teeth need to be restored to prevent the infection and pain (1). Different materials are available to preserve the lost tooth structure and maintain its form, function and esthetics. Today new esthetic materials with ability to fluoride release like glass-containing materials are available. The bond strengths of adhesives when applied to permanent teeth were higher than to primary teeth dentin. Since composite resin showed high failure rate in primary dentition, it is suggested that glass-containing materials may become the materials of choice in primary teeth (6).

The results of this study revealed that the higher and lower mean micro-tensile bond strength was related to giomer and zirconomer respectively.

The slow release of fluoride in glass-containing materials, cease the process of decay. These materials have good biocompatibility, similar to linear thermal expansion to tooth, and also the physical and chemical bonding to enamel and dentin structure (7).

Today, hybrid restorative materials that incorporate glass ionomer and resin composites have been developed to improve mechanical properties and overcome the problems of conventional glass ionomers such as moisture sensitivity, low initial mechanical properties, and low translucency. One of the most commonly used materials is the resin modified glass ionomer that has better adhesion and bond strength, as well as a lower moisture sensitivity (8, 9). Giromers are other hybrid restorative materials that have good clinical features, such as high radiopacity, antiplaque properties, fluoride release and recharging (2, 10).

Dental Material	Failure Pattern			Difference Between Materials	
	Adhesive	Admixed	Cohesive	Group Compared	P Value ^b
Tirconomor	16 (94.1)	0(0)	1 (5.9)	RMGI	0.152
Zirconomer				Cention N	0.335
PMCI*	16 (69.6)	1(4.3)	6 (26.1)	Zirconomer	0.152
KWGI				Giomer	0.324
Ciomor	15 (86.7)	1(6.7)	1(6.7)	RMGI	0.324
Glomer				Zirconomer	0.726
Cention N	19 (90.5)	2 (9.5)	0 (0)	RMGI	0.026
Cention N				Giomer	0.746

 Table 3. Comparison of Failure Pattern of Restorative Materials^a

Abbreviation: RMGI, resin modified glass ionomer.

^aValues are expressed as No. (%).

^bSignificance level < 0.05.

Zirconomers are other materials that are easy to use. On the other hand, the proper working time and the release of fluoride make it an ideal cosmetic restorative material for posterior teeth, especially in patients with high caries. Also cention N is an innovation in the restorative materials to achieve ideal properties (11-13).

The adhesion of restorative materials to dental tissue leads to less microleakage and more conservative cavity preparation. The bond strength is altered by remained dentinal thickness, calcium amount of dentin, dentinal age and permeability aw as well as bonding surface (14).

Rekha et al. (8) compared tensile bond strength and microleakage of conventional glass ionomer cement, RMGI and compomer to primary tooth dentin and found that the highest tensile bond strength was observed with compomers and the least tensile bond strength for RMGI. Prabhakar et al. (15) compared shear bond strength between composite, compomer and resin modified glass ionomer cement in primary and permanent teeth .They showed that resin modified glass ionomer and composite exhibited significantly higher shear bond strength in primary and permanent teeth. Bahrololoomi et al. (16) compared the bond strength of RMGI and compoglass to primary tooth dentin and found that compoglass had more bond strength than RMGI.

Almuammar et al. (17) determined the shear bond strength of conventional glass-ionomer cement, RMGI, composite resin and three compomer restorative materials. They concluded that the compomer shows higher shear bond strength than conventional glass-ionomer and resin modified glass-ionomer in permanent dentition.

Eldesouky et al. (18) compared the marginal leakage in primary molars class II restored with giomer and com-

pomer and found that giomer restorative material showed lower microleakage scores than compomer.

Yadav et al. (19) compared the marginal leakage of compomer, ormocer, giomer and RMGIC in class I restoration of deciduous molars and demonstrated that the highest and lowest marginal sealing ability of restorative materials was related to ormocer and giomer respectively.

None of the various studies surveying bond strength of different esthetic materials discuss the bond strength of new materials such as giomer and cention N in primary teeth. Also literature review reveals controversial reports regarding the material of choice for increasing tensile bond strength and decreasing the micro-leakage in primary teeth.

The results of this study showed that the mean microtensile bond strength of giomer was higher than that of other materials with a statistically significant difference. This finding is in accordance with the study of Walia et al. (11) and Quader et al. (20). Manuja et al. (2) found that the higher bond strength of giomer is related to higher amount of RPG filler in its structure. In this study, the lowest micro tensile bond strength was that of zirconomer, which was significantly different from other groups. This finding was in accordance with study results reported by Walia et al. (11).

In the present study, there was no significant difference between the microtensile bond strength of the resin modified glass-ionomer and cention N groups, which can be due to their similar structures, although there was a significant difference between the pattern of failure of these two materials.

The percentage of adhesive failure of ziconomer was higher than RMGI. It may be due to the low bond strength

of this material to the dentin surface of tooth structure, because this failure type occurred in the interference of the dentinal surface and material.

In conclusion, it seems that in primary teeth, use of giomer can provide desirable bond strength to dentin. Anti-carious properties of giomer due to fluoride release of this glass-containing material as well as ideal bond strength can make it the material of choice to restore primary tooth. Yet more studies with more samples are needed to investigate the properties of this material in clinical situations. In this in vitro study, the teeth were not subjected to biological factors such as mechanical stress and occlusal wear. Therefore, further studies with considering long-term bond strength of the restorative material in clinical situations is useful in order to have a better choice for restorations in primary molars.

5.1. Conclusions

The results of this study indicate that among the four test groups, the highest and lowest micro-tensile bond strength was related to giomer and zirconomer respectively. The micro tensile bond strength of RMGI and cention N was approximately the same. In all groups, adhesives showed the most prevalent failure pattern, which did not show a statistically significant difference in comparison with different groups except RMGI and cention N.

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Footnotes

Authors' Contribution: Study concept and design: Narjes Amrollahi and Atiyeh Feiz. Acquisition of data: Fereshte Ziaei and Atiyeh Feiz. Analysis and interpretation of data: Atiyeh Feiz. Drafting of the manuscript: Narjes Amrollahi, Fereshte Ziaei, and Atiyeh Feiz. Critical revision of the manuscript for important intellectual content: Narjes Amrollahi. Statistical analysis: Narjes Amrollahi, Atiyeh Feiz, and Fereshte Ziaei. Study supervision: Narjes Amrollahi and Atiyeh Feiz.

Conflict of Interests: It is not declared by the authors. **Ethical Approval:** This in vitro study was approved by the Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran (ethics code No. IR.MUI.REC.1396.3.549).

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