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Comparative study of Microtensile Bond Strength of Zirconomer, Conventional and Resin Modified Glass Ionomer

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Comparative study of Microtensile Bond Strength of Zirconomer, Conventional and Resin Modified Glass Ionomer

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Restorative Dentistry
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ABSTRACT

Purpose: The aim of this study was comparing the microtensile bond strength of zirconomer to conventional and resin modified glass ionomers bonded to enamel and dentin substrates. **Materials and Methods:** 30 molars were enrolled in this study, they were split into three groups according to the type of glass ionomer used (each 10 teeth) A1: conventional, A2: resin modified, and A3: zirconia infused glass ionomer. There were two subgroups in each group (each 5 teeth) in accordance with substrate that materials were bonded. B1: enamel substrate, B2: dentin substrate. After preparation of flat enamel and dentin specimens, glass ionomers were manipulated and bonded to the substrates according to its subgrouping. Specimens were cut into sections vertically to acquire beams of 1 mm^2 thickness, then two central beams were selected randomly from each group to have a total of 60 beams, then each beam was subjected to microtensile bond strength test. **Results** ANOVA test found that the difference was statistically significant between groups. The highest mean value was recorded in resin modified glass ionomer bonded to dentin, followed by Resin modified glass ionomer bonded to enamel, zirconomer bonded to enamel, conventional glass ionomer bonded to enamel, then zirconomer bonded to dentin, with the least value was recorded in conventional glass ionomer bonded to dentin **Conclusions:** The microtensile bond strength of resin modified glass ionomer bonded to both substrates was the strongest. Zirconomer and conventional types were about similar in strength with zirconomer having the strongest bond when it bonded to enamel.

KEYWORDS

Zirconomer;
Resin modified glass ionomer cement;
Micro-tensile bond strength.

- Paper extracted from Master Thesis Titled "Comparative study of Microtensile Bond Strength of Zirconomer, Conventional and Resin Modified Glass Ionomer"

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INTRODUCTION

Restoration of tooth structure lost due to dental caries using a biomimetic material is the mainstay of current dental practice. The search for a restorative material resembling the tooth structure in terms of physico-mechanical, biological, and aesthetic aspects continues. The general dissatisfaction with the clinical performance of silicate cement and the need for durable cement adhering to tooth structure directed the research towards the development of glass ionomer cement. In 1972, Wilson and Kent were the first to introduce glass ionomer cement to the field of dentistry and the material has found multiple applications in clinical dentistry ever since[1].

Fluoride release and uptake, chemical bonding with tooth structure, high biocompatibility, and a coefficient of thermal expansion similar to dentin are all clinically desirable qualities of glass ionomer cement.

However, their use in clinical dentistry as a direct restorative material in high stress- bearing areas is restricted because when compared to other direct restorative materials like composites and amalgam, it has inferior mechanical properties as toughness, low fracture strength, and moisture sensitivity, as well as wear resistance[2].

Due to these limitations along with wide chemical diversity of its structural components glass ionomer cement possess a great potential for further development. Through the years 1972 to the late 1980 multiple modifications were suggested such as water hardening glass ionomer cement, cermet, metal- reinforced glass ionomer cement and dispersed phase glass containing glass ionomers[3].

Despite all these modifications, two of the problems remained unaddressed- moisture sensitivity and lack of command cure. Attempting to upgrade the mechanical properties of conventional GICs, resin-modified glass ionomer cement was developed. Resin modified glass ionomer cement possessed the most demanded qualities of conventional versions, specially fluoride release, ion exchange, and adhesion to dentin, and had a few additional advantages namely improved mechanical properties and low interfacial shrinkage stress, reduced moisture sensitivity[1].

However, theses improvement in mechanical properties still could not promise its use in stress-bearing areas as a direct restorative material. Since mechanical properties of a restorative material directly influence their clinical performance, several strategies have been suggested to improve the mechanical properties, such as adding zirconia, fluorapatite and hydroxyapatite, etc. Among these, zirconia modified glass ionomer cement or zirconomer is a famed method for enhancing the mechanical properties of GIC. A restorative material of high strength, which has been reinforced with zirconia filler particles famed as zirconomer, was gone into dentistry as recent substitute of GIC[4].

Zirconomer also known as 'white amalgam' assigns a new glass ionomer class that supposedly warrant more durability and strength than conventional GIC by the manufacturers but has not been studied in detail yet. Since tooth substrates may affect the bond strength, also the glass ionomer cement bond strength with dentin is an extremely important indicator for the estimation of the strength of adhesion between restorative material and dentin. Thus, this study was designed for comparing the microtensile bond strength of three types of glass ionomers: conventional, resin modified, and zirconomer infused glass ionomer, also to compare their effect when they bonded to different substrates like enamel and dentin.

MATERIAL AND METHODS

This research was performed after the approval of local ethic committee of Faculty of Dental Medicine, Al -Azhar University for Girls, in accordance with international guiding principles, Code: REC-OP-21-10

Sample size calculation:

Power analysis determined that the current study was having a high acceptability when the sample size equal (n=10) according to the following equation: E= No of teeth – No of groups (E must Range from 10-20).

Tooth selection and preparation:

In the current study, thirty extracted human molar teeth were employed. Teeth were extracted from diabetic and orthodontic patients, from patients of age group (20-40 yrs.). All selected teeth were free of cracks, caries, and showed no visible hypoplastic defects absolutely. The selected teeth were completely cleaned from deposits and calculus using ultrasonic scaler (Cavitron) (Dentsply, U.S.A). Teeth were then polished with fluoride-free pumice using rotating brush fixed to a hand piece at conventional speed, then teeth were stored in normal saline solution with thymol as a preservative at room temperature (22-35°C); the saline was changed daily, to inhibit microbial growth. They were used within one month[5].

Preparation of the Acrylic Mould:

To make acrylic resin blocks, a specifically constructed two-half split Teflon mould (15-mm in diameter and 40-mm in height) was utilised, as well as a metal ring with two opposing screws at its top. The tooth was kept in place in a centred position, parallel to the mould's long axis by using screws, during the acrylic resin setting. Each tooth was vertically immersed up to the level of the cervical line in a self-curing acrylic resin (Acrostone Dental Factor, England), with the occlusal plane parallel to the acrylic resin base. The Teflon cylinder was removed when the acrylic substance had fully polymerized, and The blocks were kept at room temperature in distilled water[6].

Specimens Preparation:

Enamel specimen's preparation:

The buccal tables were ground and flat surfaces were created in enamel using a 180-grit wet sand paper (Buehler, Lake Bluff, IL, USA) carefully to avoid exposing the underlying dentin. Using a 600-grit polishing paper the surface created was polished, then sprayed with water and dried lightly. The teeth were glued on self-cure acrylic resin block[7].

Dentin specimen's preparation:

Under continuous water cooling, the occlusal tables were ground on a rotary grinding milling machine with #180-grit silicon carbide sheets (Gamberini s.r.1, Via Della Bastia, Caslecchio Di Reno, Italy).

To expose smooth dentin surface at a consistent depth, the occlusal enamel was removed parallel to the acrylic resin base and perpendicular to the long axis of the teeth[1].

The superficial depth was achieved by removing occlusal enamel from the teeth up to the central fossa, resulting in a flat surface. Then, with a round bur (ISO 500 204 001003 010, Komet, Germany) mounted in a low-speed driller (8000 rpm) (EV 8060, Everase, china), an indentation of 1mm in depth was made in dentin.

A rubber stopper placed to the round bur's shaft was used to guide the depth of indentation. The final depth was achieved by regrinding the occlusal surface with a grinding milling machine using #180-grit silicon carbide sheets under continuous water cooling until the indentation was no longer visible before and after grinding the dentin, a digital Calibre (Mitutoyo, Tokyo, Japan) was used to ensure that only 1mm of the entire height of the dentin was removed[6].

Sample Grouping

According to the materials employed, the thirty molars were split into three main groups, (each 10 teeth) A1: conventional glass ionomer, A2: resin modified glass ionomer and A3: zirconia infused glass ionomer. According to the substrate to which the substance was attached, each group was separated into two sections, (each 5 teeth); subgroup B1: enamel substrate and subgroup B2: dentin substrate.

Bonding of glass ionomers to the substrates:

Following the application of the conditioner (3M ESPE Ketac™, Neuss, Germany) for 10 sec according to manufacturer recommendations, a specifically manufactured flat two halves split Teflon ring mould was utilised to fabricate glass ionomer blocks onto the enamel and dentin substrates. An external metal ring was used surrounding the two halves of the Teflon to keep the mould assembled. Cubical glass ionomer blocks (6x6mm and 4mm height)[8] were prepared in the space occupying the centre of Teflon mould.

After applying the Teflon ring to the surface of enamel and dentin that had been treated with conditioner, the glass ionomer was mixed and incrementally packed in accordance with the recommendations of the manufacturer as following:

a. Conventional Glass Ionomer (Medifil) (Promedica, Neumunster, Germany) (group A1)

Prior to mixing, the powder and liquid ratios were proportioned (1 scoop of powder: 1 drop of liquid). A strong spatula made of plastic was used to mix the ingredients on a glass slab. First, half of the powder was dissolved as soon as possible in liquid (5-10 sec.) The other ingredients were then combined and spatulated into a thick putty-like consistency (total mixing time 30- 40 sec.) A non-stick device was used to transport the mixture to the ring mould.

b. Resin Modified Glass Ionomer (Riva Self-Cure) (SDI, Ltd. Australia) (group A2)

This material is delivered in the form of a capsule. To activate the capsule, the capsule was shacked to loosen the powder, then the plunger was pushed until it was flushed with the main body. The amalgamator was used to combine the ingredients for 10 seconds after activation. The amalgamator capsule was removed and put into a metallic capsule applier. Through a capsule nozzle, the mixture was pumped into the ring mould. Condenser or ball burnisher was used to adapt the mixture to the Teflon ring mould.

c. Zirconia Infused Glass Ionomer (Zirconomer) (Shofu Inc., Tokyo, Japan) (group A3)

Prior to mixing, the powder and liquid ratios (1 scoop of powder: 1drop of liquid) were proportioned. A plastic spatula was used to mix the ingredients on a mixing pad. The powder that was provided was divided into two equal halves; the first half was stirred for 5-10 seconds with the provided plastic spatula in the dispensed liquid. The other half was then added and stirred until a thick putty-like consistency was achieved (total mixing time 30 seconds). The mixture was then transferred to the mould using a non-stick aluminium instrument.

Storage of Specimens:

Artificial saliva (SAL) was prepared in the faculty of science Al-Azhar University. It had the following composition, 20mMol-L Sodium hydrocarbonate ($NaHCO_3$), 3mMol-L sodium dihydrophosphate (NaH_2Po_4) and 1mMol-L Calcium chloride ($CaCl_2$). The bound specimens were kept in artificial saliva at pH 7 at room temperature for 24 hours[9].

Beam Preparation:

After storage, the specimens were longitudinally sectioned using Isomet 4000, (Buehler Ltd., Lake Bluff, IL, USA). A gripping attachment designed specially was used to keep acrylic blocks with mounted teeth firmly in place, in a parallel position of the sectioning direction, keeping the perpendicular relationship between the cutting disc and the flat occlusal surface of restored teeth and to keep acrylic blocks in place during sectioning with little movement.

The restored teeth were serially sectioned using a 0.3-mm thick disc coated with diamond (Buehler, IL, USA) at 2050 rpm; 8.8 mm/min feeding rate; and ample coolant after mounting in the gripping attachment. Serial sectioning was carried out in the bucco-lingual direction, then 90° clockwise and in the mesio-distal direction. A final horizontal incision

was made at the level of the cemento-enamel junction to obtain beams. Resultant beams were 1±0.1 mm in thickness. To inspect the thickness and length of all beams, a digital calliper (Mitutoyo, Tokyo, Japan) was employed[10].

Two central beams were selected randomly from each block, in order to have a total of 60 beams to have 20 beams /main group. In order to facilitate identification of beam location; whether peripheral or central, the surfaces of glass ionomer restorations were painted with permanent ink so that the end of central beams would have a different colour from peripheral ones[8].

Each beam was kept at room temperature in artificial saliva in a tight-seal plastic cone labelled with the separated groups' names[9].

Microtensile bond strength measurement:

All beams in each group were subjected to micotensile bond strength test. To attach beams onto the universal testing machine, Geraldeli's jig was utilised (Instron, MA, USA). Each beam was positioned in the jig's centre groove then bonded in place with cyanoacrylate-based glue from its ends (Zapit, DVA Inc, USA).

The jig was then attached to a universal testing machine equipped with a 500 N load cell figure (1). At a cross-head speed of 0.5 mm/min, a tensile load was applied to the specimen until bonding failure occurred. Mega Pascal (MPa) was used to calculate bond strength (Bluehill Lite software, Instron, MA, USA). With a scalpel, specimen fragments were removed with care from the jig and preserved in their respective plastic cones which were labelled until failure mode analysis[10].

STATISTICAL ANALYSIS

Data were obtained from all the groups, collected, and statistically evaluated; The data was presented in the form of a mean, standard deviation (SD), and confidence intervals. The Kolmogorov-Smirnov test of normality was utilised to examine the data for normalcy. Because this test revealed that the data was normally distributed (parametric data), an independent t test was employed to make comparison between substrates. One-way analysis of variance (ANOVA) test was utilised for comparison between all groups as well as different materials within the same substrate. Following that, a pairwise comparison was employed using Tukey's post hoc test. Using Two Ways ANOVA test, the interaction of both factors (substrate and substance) was assessed.

The significance level was set at $p \leq 0.05$. Statistical analysis was performed with SPSS 18.0 (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) for Windows.

Figure (1) Jig mounted and parallel aligned on the Universal testing machine.

RESULTS

1. Effect of material on microtensile bond strength

Table (1) and figure (2) showed the mean, standard deviation and results of two way ANOVA test for comparing microtensile bond strength of different materials using same substrate.

Regarding enamel substrate results showed that, no statistically significant difference between the

tested materials (p=0.249). The highest mean value of microtensile bond strength was recorded with resin modified glass ionomer (2.917± 0.6), followed by zirconomer (2.790 ±0.52), with the least value was recorded with conventional glass ionomer (2.494 ±0.58).

Regarding dentin substrate results showed a statistically significant difference between the tested materials (p=0.016). The highest mean value of microtensile bond strength was recorded with resin modified glass ionomer (3.004±0.56), followed by zirconomer (2.412 ±0.94), with the least value was recorded with conventional glass ionomer (1.958±0.72).

Tukey's post hoc test revealed that zirconomer was not significantly different from the other two materials. However, conventional glass ionomer and resin modified glass ionomer were significantly different

2. Effect of substrate on microtensile bond strength:

Table (2) and figure (2) show the mean, standard deviation and results of t-test for comparing microtensile bond strength between different substrates using the same material.

a. Conventional glass ionomer

Results showed that there was no statistically significant difference between enamel and dentin (p=0.84).The highest mean microtensile bond strength value was recorded with enamel (2.494 ±0.58), followed by dentin (1.958±0.72).

b. Resin modified glass ionomer

Results showed that there was no statistically significant difference between enamel and dentin (p=0.741). The highest mean microtensile bond strength value was recorded with dentin (3.004±0.56), followed by enamel (2.917± 0.6).

c. Zirconomer

Results showed that there was no statistically significant difference between enamel and dentin (p=0.284).The highest mean microtensile bond strength value was recorded with enamel (2.790 ±0.52), followed by dentin (2.412 ±0.94).

Table (1) *Comparison between different materials using the same substrate (ANOVA test)*

Substrate		Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max	F Value	P Value
					Lower Bound	Upper Bound				
	GIC	2.494	.582	.184	2.08	2.91	1.80	3.11		.
Enamel	**R-GIC**	2.917	.599	.189	2.49	3.35	2.17	3.90	1.47	.249^{ns}
	Zr-	2.790	.517	.164	2.42	3.16	2.36	3.76		
	GIC	1.958^{b}	.720	.228	1.44	2.47	.77	3.11	4.81	. 016*
Dentin	**R-GIC**	3.004^{a}	.558	. 176	2.60	3.40	2.08	3.90		
	Zr-	2.412^{a,b}	. 942	.298	1.74	3.09	1.00	3.90		

*Significance level p≤0.05, *significant, ns=non-significant*

Different superscript in the same column indicates significant difference between them.

Table (2) *Comparison between different substrates using the same material (t-test)*

Groups	Mean	Std. Dev	Difference				t Value	P Value
			Mean	Std. error	C.I. lower	C.I. upper		
GIC-Enamel	2.494	.582	-.535	.293	-1.15	.081	1.83	.084^{ns}
GIC-Dentin	1.958	.720						
R-GIC-Enamel	2.917	.599	.087	.259	-.457	.631	.336	0.741^{ns}
R-GIC- Dentin	3.004	.558						
Zr- Enamel	2.790	.517	-.379	.340	-1.11	.350	1.11	
Zr- Dentin	2.412	.942						0.284^{ns}

Significance level p≤0.05, ns= non-significant

3. Interaction between groups:

Table (3) and figure (2) show the mean, standard deviation, minimum, maximum and results of microtensile bond strength of various types of glass ionomer bonded to different substrates.

ANOVA test showed a statistically significant difference between groups (p=0.010).The highest mean value was recorded in resin modified glass ionomer bonded to dentin (3.004±0.56), followed by resin modified glass ionomer bonded to enamel (2.917± 0.6), then zirconomer bonded to enamel (2.790 ±0.52), then conventional glass ionomer bonded to enamel (2.494 ±0.58), then zirconomer bonded to dentin (2.412 ±0.94), with the least value was recorded in conventional glass ionomer bonded to dentin (1.958±0.72).

Table (3) *The mean, standard deviation (SD) values, and results of ANOVA test between different groups*

	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max	F Value	P Value
				Lower Bound	Upper Bound				
GIC- Enamel	2.494^{a,b}	.58	.18	2.08	2.91	1.80	3.11	**3.393**	**.010***
R-GIC- Enamel	2.917^{a}	60	.19	2.49	3.35	2.17	3.90		
Zr- Enamel	2.790 ^{a,b}	.52	.16	2.42	3.16	2.36	3.76		
GIC-Dentin	1.958 ^{b}	.72	.23	1.44	2.47	.77	3.41		
R-GIC-Dentin	3.004^{a}	.56	.18	2.60	3.40	2.08	3.94		
Zr-Dentin	2.412 ^{a,b}	.94	.30	1.74	3.09	1.00	3.99		

Significance level p≤0.05,

**significant, Different superscript in the same column indicates significant difference between them.*

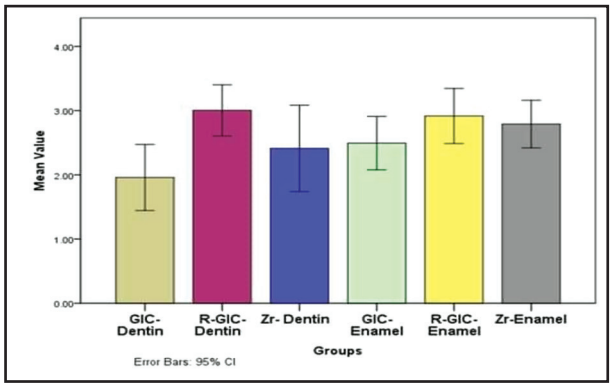

Figure (2) Column chart showing mean values in different subgroups

DISCUSSION

Wilson and Kent presented glass ionomer as one of the earliest cosmetic restorative materials in the dentistry sector in 1972. Glass ionomer cements have the benefits of adhering to non-etched tooth substrates while also releasing fluoride. Since their inception in the early 1970s, they have undergone numerous advancements and adjustments to their initial chemistry[11].

In 1988, resin components were added to the glass ionomer composition, resulting in resin modified glass ionomer. This allowed for the provision of an on-command light-activated setting reaction, which is very useful in practise. The indication area of glass ionomer is very variant, there are formulations of conventional and resin modified glass ionomer for temporary and permanent filling, luting of indirect restorations, crowns and bridges, and brackets, sealing of pits and fissures, among other applications[12].

Several creative modifications to GIC's properties and ease of use have been made in the previous decade. These newer systems, unlike earlier glass ionomers, are easier and more practical to utilise as dental restoratives and luting materials.

These newer glass ionomers also claim to address issues like surface crazing and low fracture resistance, which have hampered their clinical use for a long time.

Zirconomer, a high-strength restorative material supplemented with zirconia filler particles, has recently become a popular alternative to GIC in dentistry[13].

Zirconia (ZrO2) infused GIC (zirconomer) is a recent addition to the GIC family that has been produced to overcome all of the problems that have afflicted conventional glass ionomers.

Zirconomer was found to have better strength than the conventional posterior restorative materials and used as a replacement for amalgam as posterior direct tooth coloured restoration. Addition of zirconia fillers in the glass component of the zirconomer strengthens its structural integrity and provides excellent mechanical qualities in the posterior load-bearing area[14].

It also possesses a shear bond strength comparable to amalgam and a fluoride release capacity comparable to conventional GIC, according to the manufacturer, so the aim of this study was comparing microtensile bond strength of zirconia infused GIC to conventional and resin modified GIC bonded to different tooth substrates.

Glass ionomers are primarily utilised to repair and seal carious dentin lesions. As a result of the restorations' adhesion to dentin and enamel in the ART field trials, they remain in place. Furthermore, the GIC repair adheres not only to the dentin on the floor of the cavity, but also to the walls of the cavity.

This might encompass the entire spectrum of prism structure. Furthermore, if the bond strength is higher when tubules are cut in a parallel way to the bonded interface than when they are cut perpendicularly, it is possible that the bond strength is significantly higher on the cavity walls than on the cavity floor in clinical conditions[15].

In this study, enamel and dentin were used as tooth substrates because the chemical and histological nature of the substrate may affect the bond strength as concluded with previous studies[16,17]

Human molars were selected in this study due to their availability from diabetic or orthodontic patients[18].

Many mechanical testing methods, such as traditional shear and tensile, have been recommended for evaluating bond strength. However, microtensile bond strength test has more advantages than other bond strength testing methods. It enables for proper sample alignment, resulting in a more uniform distribution of stress. It also allows for more efficient use of samples, greater management of regional differences, and the testing of uneven surfaces. As a result, it might be regarded as the most sensitive tool for assessing and comparing bonding strengths[19].

Dental materials must undergo preclinical in vitro testing to demonstrate their mechanical capacity and compatibility for use in oral cavity. Static loading of test specimens in a universal testing machine till failure is the norm in traditional laboratory testing. While this type of testing can give information about material strength, predict risk of failure, and compare variants of the material, it is still insufficient for prediction of the long-term performance of the restorations in service[20].

Many problematic variables exist in the oral environment around dental restorations, such as acidic or basic pH, humidity, and cyclic loading. As a result, laboratory testing should mimic several features of the oral environment in order to create tiredness similar to that experienced in clinical practise[21].

In the present study, before bonding all types of glass-ionomers into substrates, a cavity conditioner was employed to remove debris and make relative demineralization, that increased the contact area, created microporosity, and reacted with hydroxyapatite[22].

Also, the teeth were sectioned in a buccolingual and mesiodistal directions with a diamond disk at a low speed and a cutting machine at a right angle to the tooth surface to produce cylinders with an approximate surface area of 1 mm^2 as this shape and size was the most suitable for microtensile bond strength testing specimens from previous investigations.

Trimming was done with superfine diamond-points to avoid putting additional stress on the bonded interface and to prevent formation of a visible pre-notch, which could be the source of crack propagation[21]. To imitate oral circumstances and the intraoral environment, all specimens were kept in artificial saliva[9].

In the present study, regarding the material variable, resin modified glass ionomer recorded the highest mean value of microtensile bond strength, followed by zirconomer, with the least value was recorded with conventional glass ionomer. The difference between materials was not statistically significant. Regarding the substrate variable, enamel recorded a higher value, compared to dentin, with no statistically significant difference between enamel and dentin.

For all groups, The highest mean value of micro tensile bond strength was recorded in resin modified glass ionomer bonded to dentin, followed by Resin modified glass ionomer bonded to enamel, then zirconomer bonded to enamel, then conventional glass ionomer bonded to enamel, then zirconomer bonded dentin, with the least value recorded in conventional glass ionomer bonded to dentin.

Better performance of resin modified GIC may be contributed to their projected dual adhesion mechanism or improved mechanical qualities. A combination of a dynamic ion exchange process and a micromechanical bonding mechanism is most likely responsible for the adhesion[1]. This could also be owing to the use of a specialised applier and injection syringe. For repairing cavities with hand-mixed types, however, hand instruments are required, which may cause gaps at the restoration–substrate interface due to the lack of intimate adaptation between the restoration and the cavity walls[23].

On the other hand, conventional glass ionomers had the lowest mean value of microtensile bond strength, which could be because conventional glass ionomers only bond to tooth substrate through ion-exchange, whereas RMGIs bond to tooth substrate through ion-exchange and also micromechanical interlock[24].

In this study, micro-tensile bond strength for ziconomer was found to be lower than that for resin modified glass ionomer cement this also could be explained by the mechanism of bonding of zirconomer with the dentin is chemical in nature, thus lacks the reinforcement of bond with micromechanical interlocking and the presence of fewer amounts of free carboxylic groups that can chemically bond with dentin. The development of hydrogen bonds between glass ionomer filling material and tooth structure is dependent on the interaction of free carboxyl groups in the cement with firmly bound water on the mineral phase surface of tooth[25].

These findings are consistent with those of a previous study that was undertaken by Poggio et al (2014)[26] who evaluated the effects of dentin surface treatments on bond strength of glass ionomer cements. They reported higher bond strength of RMGIC to dentin when compared to conventional GIC.

These results are also in agreement with the results of another study which conducted by Sapkale et al (2020)[1] who compared microtensile bond strength of conventional, resin modified, and zirconomer reinforced glass ionomers bonded to dentin. They reported that, μtbs of RMGIC was statistically significantly higher than both conventional GIC and zirconomer. The microtensile bond strength values for zirconomer were higher than those for conventional GIC, however the difference was not statistically significant.

These findings are consistent with those of a previous study that was undertaken by Elsawy M. et al (2021)[25] who evaluated the shear bond strength and wear resistance of zirconomer versus resin modified glass ionomer in class II restorations of primary molars. They reported that, RMGI is better in bond strength than zirconomer, while the two materials have the same resistance to wear. This was attributed to the dual bonding mechanism of RMGI compared to zirconomer. They also contain poly acrylic acid, that can interact significantly with the tooth's mineral phase.

They also contain HEMA, a substrate that is now employed in the manufacture of dentin bonding agents. The existence of fewer free carboxylic groups that can chemically bond with dentin may explain the decreased shear bond strength of zirconomer. The creation of hydrogen bonds between glass ionomer filling material and tooth structure is dependent on the interaction of free carboxyl groups in the cement with firmly bound water on the surface of the mineral phase of the tooth. True ionic connections, created by cations in the tooth reacting with polymeric anions in the cement, appear to gradually replace hydrogen bonds.

In the present study, regarding the substrate variable, enamel recorded a higher value compared to dentin. This could be due to the fact that dentin is naturally moist. Due to the increased organic content of dentin, fluid pressure from dentinal tubules, and the existence of a smear layer, adherence to dentin can be problematic[16].

There is evidence in this study that RMGI bonds strongly to dentin than to enamel, which could be due to their HEMA content, unlike conventional glass-ionomers and zirconia-infused glass ionomer[26].

These findings are consistent with those of a prior study conducted by Korkmaz et al (2010) [17], they evaluated the bond strength between a light-curing nano-ionomer restorative and enamel or dentin after acid etching, after erbium:yttrium–aluminum–garnet (Er:YAG) laser etching, or after combined treatment. They concluded that bond strength values were higher for enamel than dentin in the light-curing nano-ionomer restorative.

The shape of dentinal tubules, occurrence of pathophysiological alterations (sclerotic regions), and high water content in its composition all played a role in their findings. The ion-exchange system may also be more active on enamel due to the increased concentration of phosphate and calcium ions in it[27].

CONCLUSIONS

The microtensile bond strength of resin modified glass ionomer bonded to both substrates was the strongest. Zirconomer and conventional types were approximately of equal strength and zirconomer showed the highest strength when it bonded to enamel. Enamel substrate showed the highest bond strength compared to dentin.

Conflict of Interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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