The Repair Bond Strength of Resin Modified Glass Ionomer After Different Surface Treatments and Time Lapsed

Thesis submitted to Faculty of Dentistry

Ain Shams University in Partial Fulfillment of the

Requirements for Master Degree in Operative Dentistry

By

Maha Salah Abd EL-Latief Moustafa

B.D.S

Faculty of Dentistry

Ain Shams University 2009

2015

Supervision

Dr. Mokhtar Nagy Ibrahim

Professor of operative dentistry

Faculty of Dentistry

Ain Shams University

Dr. Mohammad Salah Abd EL-Aziz Nassif

Assistant Professor of Dental Biomaterials

Faculty of Dentistry

Ain Shams University

*To **Mom and Dad**, A million words would be too short for your love and care through my entire life.*

*To my **Sister**, a perfect sister I am not but thankful for the one I got.*

Acknowledgment

I would like to express my deep and sincere appreciation to my supervisors:

Dr. Mokhtar Nagy Ibrahim, Professor of Operative Dentistry , Faculty of Dentistry, Ain Shams University, for his advice, support, patience, and encouragement.

Dr. Mohammad Salah Abd El-Aziz Nassif, Assistant Professor, Dental Biomaterials Department, Faculty of Dentistry, Ain Shams University, for his guidance, help and support.

I can not express enough thanks to my colleagues **Mohammed Nasser**, Assistant lecturer, Operative Dentistry Faculty of Dentistry, Ain Shams University, **Nahla Hamed** Assistant lecturer, Operative Dentistry Faculty of Dentistry, Ain Shams University, for their sincere help.

I would also like to thank, my colleague **Ahmed El Banna** Assistant lecturer, Biomaterials Department Faculty of Dentistry, Ain Shams University, for his help with the practical work at Dental Materials Testing Unit.

Last but not least, I would like to thank all my friends and colleagues for their help and encouragement.

List of Contents

List of tables

List of figures

Recently, glass ionomer cements (GIC) have become popular in clinical dentistry and so widely used as final restorative materials. It is a clinically attractive dental material that has certain unique properties that make it useful as restorative and luting materials. This includes chemical adhesion to moist tooth structures and anticariogenic properties[1].Many modifications have recently been introduced to improve the chemical, physical and mechanical behavior of the material .Through all these modifications, resin modified glass ionomer (RMGICs) was introduced, and so used as a direct filling material in high stress bearing areas as a posterior restoration.[2,3]

Among these modifications, glass ionomer was supplied in the form of capsules to obtain better mixing qualities. Clinically, there are too many situations faced that demand the addition of new mix on the already placed restoration as a form of an immediate repair. Some of these situations may be due to a technique error such as exposure of the restoration surface to excessive desiccation or even surface contamination with blood or gingival fluids. Others may be due to the presence of voids or marginal deficiencies[4].

Too much information was given about the mechanism of the adhesion of the glass ionomer to tooth structure, but unfortunately little information was given about when and how we can interfere to add increments on the already placed glass ionomer cement[5], and so the bond strength of the final restoration became a point of debate.

Therefore, it was found beneficial to study the repair bond strength of the glass ionomer after being exposed to different surface conditions with different time lapsed from the mixing time.

I-Resin modified glass ionomer (RMGICs)

Glass-ionomer cement (GIC) materials were invented four decades ago by Wilson and Kent in 1969. These materials form part of the contemporary armamentarium for restorative dentistry largely due to their adhesive, tooth-colored and fluoride-leaching properties[2]. Continued development, notably the addition of resin polymerization component improve some of the drawbacks of the conventional glass ionomer improving mechanical properties, decrease setting time, and attenuate moisture sensitivity .[1, 3]

Yap, 1996,[6] compared water sorption of six commercially available RMGICs, which were mixed in three different powder/liquid (P/L) ratios to produce a restorative, a base and a liner material. Also a resin composite restorative was used to serve as a control. He concluded that water sorption of RMGICs was both product- and time-dependent.

Attin et al. 1996, [7] compared the mechanical properties of four RMGICs, two polyacid-modified resin composites, a hybrid resin composite and a conventional GIC. The hardness test showed that the hybrid resin composite had the highest statistically significant microhardness, whereas RMGIC had the lowest statistically significant values. The hybrid resin composite yielded the highest compressive and flexural strength. Except for Fuji II LC and Photac Fil, the rest of the RMGICs exhibited higher compressive strengths than conventional GIC. They concluded that the tested RMGICs and the polyacid-modified resin composites showed inferior strength properties than did a hybrid resin composite.

Abdalla and AlhadainyH., 1997, [8] evaluated the performance of three RMGICs and a polyacid-modified resin composite in non-carious cervical lesions. Forty patients participated in this study with a total of 80 restorations placed. Each restoration was clinically evaluated after curing of the glaze layer, one year and two years. All restoration groups showed some marginal discrepancies that were not statistically significant. Restorations of Dyract showed no changes in marginal discoloration, and the other groups showed minor discoloration that was not statistically significant.

A.Akashi, et al. 1999, [9] investigated the water absorption characteristics of resin-modied glass-ionomer cements and the relationship between the characteristics and mechanical strength after long-term water storage. Water absorption was measured .Water solubility was determined based on the weight of the residue in the immersed water. The compressive and diametral tensile strength were measured at 1, 2, 6, and 12 months. A correlation was observed between the diffusion coeffecient and equilibrium water uptake, which suggests the water in the cements diffuse through micro-voids in accordance with the free volumetric theory. A correlation was seen between the solubility and diffusion coefficient of the cements. The deterioration ratio, defined as the ratio of the strength at 12 months versus that at 1 month, was also calculated. Finally, a negative correlation was observed between the deterioration ratio of the compressive strength and the diffusion coeffcients of the cements.

Xie et al. 2000, [10] studied the mechanical properties and microstructure of ten commercial GICs. The flexural strength, compressive strength, diametral tensile strength (DTS), Knoop hardness number and wear resistance were evaluated. The results showed a higher flexural strength and DTS for the RMGICs but lower Knoop hardness number and wear resistance in comparison to the conventional GICs. They also found that conventional GICs exhibited a brittle behavior, while RMGICs exhibited substantial plastic deformation under compression. They concluded that more integrated microstructure, i.e. better glass particle-polymer matrix bonding, resulted in higher values of flexural strength, DTS, and wear resistance.

Mitsuhashi et al. 2003, [11] investigated the effect of different P/L ratios on the fracture toughness of a RMGIC and a conventional GIC. They also evaluated the effect of powder particle size reduction on the fracture toughness of an experimental RMGIC. They found that the fracture toughness of the RMGIC was significantly higher than that of the conventional GIC and was not greatly influenced by the P/L ratio. For the experimental RMGIC, it was observed that fracture toughness gradually decreased as the powder particle size became finer. They concluded that the resin components in the liquid play an important role in the improvement of the mechanical properties of the RMGIC. A reduction in the powder particle size up to 10µm, which resulted in a smoother surface, can maintain high fracture toughness.

Prentice et al. 2005, [12] conducted a study to investigate the variation in properties of an experimental GIC when a combination of large (Powder A) and small (Powder B) particles was used. Large particle size (mean size 9.60µm) and small particle (3.34µm) glass powders were blended in various proportions and mixed with powdered polyacrylic acid

(PAA) to make a range of glass-ionomer powders. These powders were mixed with a glass-ionomer liquid at P/L ratios of 2:1, 2.5:1 and 3:1. The resultant cements were evaluated for working time, setting time, clinical handling and compressive strength. It was found that an increased proportion of smaller particles corresponded to higher strength, whereas an increased proportion of larger particles led to a decrease in viscosity of the unset cement. When 20–30% by weight of small particles was used, the paste demonstrated a peak in cohesion and working time, with a viscosity similar to commercial restorative GICs. The 24 hours compressive strength of the material mixed at 3:1 ratio showed a linear increase with powder B content. Although, no workable paste could be formed at 100% powder B.

Van Dijken and Pallesen 2008,[13] compared the retention of resin composite restorations using three different bonding systems, 3-step etch-and-rinse systems, a 4-step etch-and-rinse, a 1-step self-etching adhesive and a RMGIC in 270 non-carious class V lesions for 13 years. The restorations were evaluated at baseline, 6, 12, 18 and 24 months and then every year during a 13 years follow-up period. The percentage of restoration failure was used to determine the dentine bonding efficiency for each adhesive system. They observed that 50.3% of all restorations were lost by the end of the follow-up period, with the best retention percentage for the RMGIC and the etch-and-rinse systems. On the contrary, the lowest retention percentage was observed for the 1-step self-etching adhesive. They concluded that the degradation of the adhesive was continuous all over the observation periods and the success of the restorations was independent of the adhesive category.

Mauro et al. 2009, [14] used 40 human third molars to test the shear bond strength (SBS) of a RMGIC (Fuji II LC) to dentine using different conditioning protocols. Occlusal enamel was removed to expose a flat dentine surface. Teeth were divided into four groups according to the dentine treatment prior to application of Fuji II LC; 1) no treatment, 2) 10% PAA, 3) 37% phosphoric acid with the dentine left moist after rinsing and 4) 37% phosphoric acid with the dentine dried after rinsing. The results showed that 10% PAA had the highest significant SBS, followed by 37% phosphoric acid/dry dentine.

Shantanu Choudhari, et al. 2010, [15] compared the clinical efficacy regarding marginal integrity, anatomical form and recurrent caries in primary anterior teeth after restoration with Fuji II, Fuji VIII and compomer- DYRACT. They restored a total 130 class III and class V lesions on the maxillary and mandibular anterior teeth. After one, three and six months, these restorations were evaluated. They concluded that Fuji VIII has got slight higher marginal integrity over compomer-DYRACT but difference was not statistically significant. At the end of three months, fuji VIII has got maximum retention of anatomical form followed by compomr DYRACT and fuji II, which was statistically significant. Fuji II showed highest rate of recurrent carries followed by fuji VIII and compomer-DYRACT.

Perdigão, et al. 2012,[16] compared the clinical performance of Fuji II LC, Ketac Nano and a nano-filled resin composite bonded with a simplified etch-and-rinse adhesive in non-carious cervical lesions. A total of 92 restorations were placed in this study. All the restorations were evaluated after one week (base line) and a photograph was taken at