THE EFFECT OF RESIN SURFACE COATING ON SURFACE ROUGHNESS AND FLEXURAL STRENGTH OF TWO GLASS IONOMER RESTORATIONS

Thesis

Submitted to Faculty of Dentistry

Ain Shams University

For partial fulfillment of the requirements of master degree in

Operative Dentistry Faculty of Dentistry

Ain Shams University

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B.D.Sc
2004

Faculty of Dentistry - Ain Shams University

Ain Shams University
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2013

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First of all, thanks to **ALLAH** to whom I relate any success in achieving any work in my life.

My deepest thanks and appreciation are to ***Professor Dr. Farid Mohamed Sabry El Askary,*** professor of operative dentistry, head of the operative department Faculty of dentistry, Ain Shams University for his remarkable help and valuable advice, throughout the course of this research.

I would like to express my most sincere gratitude to ***Professor Dr. Makeen Amein Moussa Khalaf*** professor of operative dentistry, vice dean of post-graduate studies and research Misr International University. For his meticulous supervision and his valuable guidance that helped in the completion of this work.

Many thanks would go to ***Mr. Mohammed El-Shahat,*** metal worker.

Last but not least, I would like to thank all ***Staff Members*** of Operative Dentistry Department, Misr International University, my Professors and my colleagues, and for their constant support and cooperation.

Dedicated To………..

Those who gave me so much care and support

My dear mother and father

My beloved Family

And all my friends

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Over the years, dental researchers have elaborated a variety of restorative materials including amalgam, composite, cast alloys etc., but all had fallen short of perfection. There is no single material that would gather all the advantages of being aesthetic, adhesive, biocompatible, anticariogenic and relatively economical. In the mean time a cement came into the picture and had quite majority of some desirable properties and had a variety of modifications. This was the Glass Ionomer Cement [(1)].

Glass Ionomer Cement (GIC) is a dental restorative material used in dentistry as teeth filling material and a luting cement. These materials are based on the reaction of silicate glass powder and polyalkenoic acid. They bond chemically to dental hard tissues and release fluoride for a relatively long period, modern day applications of GICs have expanded because of the desirable properties of glass ionomer cements that make them useful in the restoration of carious lesions in low stress bearing areas [(2)].

There are many types of glass ionomer cements/restorations such as: conventional glass ionomer cements, hybrid ionomer cements or resin-modified glass ionomers, dual-cured GIC, light-cure GICs and metal reinforced GICs or cermets [(3)].

These cements possess certain unique properties that make them useful as restorative and adhesive materials, including adhesion to tooth structure, anticariogenic properties due to release of fluoride, thermal compatibility with tooth enamel, their relative economic prices, ease of manipulation in most of clinical conditions and biocompatibility with the surrounding oral and dental tissues [(4)].

The use of GICs has been limited due to their low mechanical performance and poor mechanical properties which have narrowed down their extensive use in dentistry as a filling material in stress-bearing applications such as in the posterior dental region and class II cavity restorations; they are mostly used as a long term temporary filling material. The need to strengthen these cements has led to an ever increasing research effort into reinforcement or strengthening concepts [(5)]. One of the main limitations of conventional glass ionomer cements is their low flexural strength, in addition to that; their brittleness, poor fracture toughness and initial sensitivity to moisture. Also their low abrasion and wear resistance which make their use in Class V cavities questionable [(6)].

Many trials have been made to improve their surface and mechanical properties among these trials glass ionomer surface protection with various materials such as: light cure bonding resin, chemical cure bonding resin, nail varnish, varnish and Vaseline, also surface coatings indicated by the manufacturers of the glass ionomer materials such as: Finishing Gloss for Vitremer, varnish for Fuji II LC, and glaze for Photac-Fil [(7)].

In the year 2007 G-coat plus material was innovated. It is a nano-filled, light-cured, protective coating with a self-adhesive monomer. They claimed that the material adheres to enamel, dentin, composite, glass ionomer and resin-modified glass ionomer, and suggested that it seals and protects the adhesive interface between restorations and tooth structure.

They made their experimental tests on some surface properties and flexure strength that was carried out on the surface of the specimens that were prepared of glass ionomer restorations, they found that the flexural strength and tensile bond strength results of G-coat plus was significantly higher than other products. They referred that to the adhesive monomer contained in G-coat plus which enables to create the chemical bond to non resinous materials [8]. Other researchers disagreed with these results concerning the effect of coating materials on glass ionomer cements among them Saleh and Khalil [9] and Shintome et al [10].

Therefore the effect of application of G-coat plus on the surface roughness and flexural strength of different types of G.I. restorations might be of value.

Development of glass ionomer cements:

AI-Badry and Kamel [11], 1994, made a review on the clinical use of glass ionomer cement. Glass ionomer cement (GIC) was first introduced to clinical dentistry by Wilson and Kent in 1972.The material possesses some unique properties among them tissue compatibility, fluoride release and chemical union with the underlying tooth tissue which made their use very convenient in many applications like with incipient fissure caries making use of fluoride release and the remineralization that might take place, Class III Facial or Lingual, restoration of primary teeth, cervical root caries, tunnel preparation, core build-up, can be used as a base/lining cements which provide a biological seal and a useful cariostatic action in all cavities, retrograde root fillings and can be used also in repairing perforated root canals. Since their introduction many modifications to improve their strength, physical and mechanical qualities have been introduced. It should be noted that great attention to details of application and manufacturer directions should be followed to have durable restorations.

Nagaraja and Kishore [4]**,** 2005, made a study on the GICs and its different generations; in addition to the known advantages of the material recently there have been considerable modifications for different clinical applications to overcome some of the material deficiencies. Chemistry is essentially the same for all the material categories, but there are variations in powder/ liquid ratio and powder particle size to accommodate the desired function, some modifications have been made to the chemical composition of the original glass powder: 1.Disperse phase glasses, with dispersed phases of strengthening crystallites in order to improve the strength, 2. Fiber reinforced glasses, incorporation of alumina fibers and other fibers to the existing glass powder at suitable filler / glass ratio mainly to improve the flexural strength, 3. Metal reinforced glass ionomer cement, addition of metal powders or fibres to glass ionomer cements can improve strength but simple mixtures of metal powders failed at the metal / polyacrylate matrix interface, 4. Cermet ionomer cements, sintering the metal and glass powders together, strong bonding of the metal to the glass was achieved, and 5. Resin modified glass ionomers cement, in their simplest form; these are GICs with the addition of a small quantity of a resin. Clinical experience has defined the practical advantages and disadvantages of glass ionomer cement system and this has resulted in everlasting research work for further improvements.

Singh et al [(1)], 2011, made a review on glass ionomer cements in dentistry. It's composed of powder: which is basically an acid soluble calcium aluminosilicate glass containing fluoride. It is formed by fusing silica, alumina, calcium fluorite, metal oxides and metal phosphates at 1100^0-1500^0 C, the glass formed is crushed, milled and ground to a form powder of 20 – 50 µm, they get decomposed by acids due to the presence Al^{+3} ions which can easily enter the silica network, and formed of liquid: Originally, the liquid for GIC was an aqueous solution of (poly Acrylic Acid) PAA in a concentration of about 50%. This was quite viscous and tended to gel over time. Thus, PAA was copolymerized with other acids such as itaconic, maleic and tricarboxylic acids these acids would also improve the reactivity of the liquid. This poly-electrolytic liquid of GIC is thus, also called polyalkenoic acids. Recently polyvinyl phosphoric acid has also been introduced to this system. A typical liquid of GIC contains 40-55% of 2:1 polyacrylic: itaconic acid co- polymer and water. They illustrated that GICs shows a variety of properties including: adhesion, biocompatibility, anticariogenecity, and aesthetics due to the presence of the glass fillers it possesses a degree of translucency which increases with hydration over time and its prone to dissolution and loss of soluble matrix which can lead to disintegration of the cement so it is mandatory to protect the GIC in its first half an hour of life. In spite of substantial improvements, GICs have short comings; conventional GICs are restricted to special indications especially low stress bearing areas and its longevity is restricted especially in erosion-abrasion lesions, the weakness appears to be in the matrix, which is prone to crack propagation. Further improvements are still needed to overcome its drawbacks.

Flexure strength and mechanical characteristics:

Miyazaki et al [(2)], 1996, studied the effect of surface coatings on flexural properties of glass ionomers. They investigated the change in flexural strength and fracture toughness of light cured glass ionomer cements after long term immersion in water, and also the effect of surface coatings on their properties. Using two resin modified glass ionomer and one conventional glass ionomer cement, a 25x2x2 mm stainless steel mold was used for flexure testing (3 point bending at 0.5 mm/min). For the fracture toughness, single edge notch specimens with dimensions of 25x2.5x5 mm and a 0.5 mm notch were prepared in a stainless steel mold. Light cured resin coatings Fuji Coat LC were employed. Specimens were coated with resin coatings using a brush then light cured. As a control, uncoated specimens were prepared, storage in 37°C water for the periods of 1 h, 24 h, 1 wk, 1 month, and 6 months were made. Regarding the effect of surface coating on strength of the resin modified cements, differences between the coated and uncoated cements were observed at 1 h test period and with no significant differences after 24 h storage in water. For the conventional cement, no significant differences were seen between coated and uncoated after 1 wk storage in water. It has been suggested that there are advantages of using barrier coating for both conventional and resin modified glass ionomer, and recommended that resin coatings should be routinely placed over the restorations, even for the later one which is more water stable, coating agent might protect the surface during the early stage of setting reaction to maintain sufficient mechanical properties.

Gladys et al [(12)], 1997, made a comparative study on the physico mechanical characterization of new hybrid restorative materials with conventional glass-ionomer and resin composite restorative materials, utilizing eight hybrid restorative materials, two conventional glass ionomers, one micro-filled and one ultrafine compact-filled resin composite, for the surface roughness study they used eight cylindrical specimens of each material, after setting completely were polished to high gloss using an automatic polishing device and for the clamped fracture strength and flexural fatigue limit were determined with a custom-made fatigue machine utilizing sixty rectangular specimens, one group was stored dry at 35°C for one month, while the other group was stored for an equal amount of time in distilled water at 35°C. They found that the hybrid restorative materials showed a pronounced diversity in their physical and mechanical characteristics. They exceed conventional glass ionomers in fracture strength and fatigue resistance. However, they remain inferior to resin composites in the characteristics needed for a universal dental restorative material.

Xie et al [13], 2000, investigated the mechanical properties and microstructures of glass-ionomer cements. Measuring flexural strength (FS), compressive strength (CS), diametral tensile strength (DTS), Knoop hardness (KHN) and wear resistance(WR) of seven CGICs: Ketac-Bond, α-Silver, α-Fil, Ketac-Silver, Ketac-Fil, Ketac-Molar and Fuji II, and three RMGICs: Vitremer (Tricure), Fuji II LC and Photac-Fil, cylindrical specimens were prepared for CS, DTS, KHN and WR tests, rectangular specimens were prepared for the FS test. Mechanical testing of specimens was performed on a screw-driven machine for the CS, DTS and FS measurements, the hardness of the specimens were determined using a microhardness tester. The Knoop hardness test was performed using a diamond indenter, and WR of the materials was measured using a pin on disc type apparatus. Fracture surface of one representative specimen for each material from the FS tests was observed with a SEM. Results suggested that important relationships exist between the compositions, microstructures and mechanical properties of commercial GICs. The RMGICs had much higher values of (FS) and (DTS), and exhibited substantial plastic deformation in compression. The CGICs generally had higher values of KHN and superior in vitro wear resistance for several materials, but displayed brittle fracture in compression.

Musanjea et al [14], 2001, studied the water sorption and mechanical behaviour of cosmetic direct restorative materials in artificial saliva, using forty bar shaped specimens of each of the following materials: compomer (Dyract AP) (D-AP), filled resin (SureFil) (SF), and glass ionomer (ChemFlex) (CF), randomly distributed into eight groups of: dry air, saturated water vapour (WV), and five in artificial saliva (AS) at pH6, all at 37° C, as well as untreated control (UC), i.e. exposed only to