The Effect of Fluoride Application on the Diametral Tensile Strength of Different Ionomer Based Restoratives

Thesis

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بسم الله الرحمن الرحيم
قَالُوا سُبْحَانَكَ لاَ عِلْمَ لَنَا
إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ
الْعَلِيمُ الْحَكِيمُ
صدق الله العظيم
سورة البقرة الآية

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To My

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Since Wilson and Kent had first announced the development of the glass ionomer cements in ١٩٧٢, it has shown to be a very useful adjunct to restorative dentistry. The term glass ionomer cement should be applied only to a material that involves a significant acid/base reaction as a part of its setting reaction and shows a continuous fluoride release. Glass ionomer cement composed of a calcium-alumino-silicate glass powder and an aqueous solution of an acrylic acid (homo or copolymer). The aim was to produce a cement with characteristics of both silicate cement with those of the polycarboxylate cement. Adhesion to tooth structure, anticariogenic properties, and biocompatibility are the important properties of these cements. On the other hand, glass ionomer cements suffer from disadvantages such as; short working time, brittleness, poor resistance to wear, susceptibility to moisture contamination or dehydration as well as the inferior mechanical properties, namely compressive strength, flexural strength and diametral tensile strength[٣٠,٣٦,٥٢].

Originally, the cement was designed for the aesthetic restorations of the anterior teeth and it was recommended for use in restoring teeth with class III and V cavity preparations[٣٠,٥٢].

In the late ١٩٨٠s and early ١٩٩٠s light cured glass ionomers were released on the market. So, resin-modified glass

ionomer cement was designed to produce favorable physical properties similar to those of resin composites while maintaining the basic features of the conventional glass ionomer cements[٣٦]. In mid-١٩٩٠s a subset of glass ionomer cements, the high viscous glass ionomer cements, were introduced. These high viscous glass ionomers are particularly useful for atraumatic restorative treatment technique (ART)[٣٠].

Fluoride release is a very important characteristic of the glass ionomer cements as the fluoride released will react with the tooth structure giving hydroxyfluoroapatite crystals that are more resistant to caries and acid attacks. A large fluoride release occurs over the first ٢٤-٤٨ hours followed by a rapid decline[٢-٣,١٣,١٥]. The initial burst release is from the surface fluoride while the long-term release comes from the bulk. Also the glass ionomer cements have the ability to be recharged with fluoride via topical fluoride application agents, "recharging" of glass ionomer cements with fluoride has been suggested to maintain a continuously increased level of fluoride release[١٩,٢١,٢٤]. The ability of the glass ionomer cements to act as a fluoride reservoir is mainly dependent on the type and permeability of the filling material, frequency of fluoride exposure and on the kind and concentration of the fluoridating agent[٢٦,٢٨,٣٠,٥١].

The purpose of this study was to investigate the effect of two topical fluoride gels on the diametral tensile strength of three different ionomer based restoratives.

Glass ionomer is the generic name of a group of materials that use silicate glass powder and an aqueous solution of polyacrylic acid. This material acquires its name from its formulation of a glass powder and an ionomeric acid that contains carboxyl groups; it is also referred to as polyalkenoate cement. The glass ionomer cement was developed in response to the need for an adhesive filling material. lt is the product of the hardening reaction between an ion-leachable glass and an aqueous solution of polyacrylic acid (acid/base reaction), during which the polyanion chains in the liquid become cross-linked with metal ions to form a hard gel[٣٠,٥١]. During the setting reaction which is highly sensitive to early water exposure as well as dehydration a variety of ionic constituents is released from the glass, including fluoride. The cariostatic effects of fluoride on oral bacteria and plaque are well documented and achieved from an increase of fluoride content in saliva, plaque and dental hard tissues, as the fluoride released increases tooth caries-resistance through the resistance of the acid attacks, thus; the tooth becomes less susceptible to caries. A large fluoride release occurs over the first ٢٤-٤٨ hours followed by a rapid decline[١٩,٥١].

Kent et al. ١٩٧٩[٣١] evaluated the preparation of novel fluorine-containing aluminosilicate glasses along with the properties of cements formed by their reaction to aqueous solutions of polyacrylic acid (PAA). Glasses were prepared and

concentrated (PAA) solutions were prepared. Cement pastes were made from various glass powders and aqueous solutions of (PAA). The properties of these cements-consistency, setting time, compressive strength, a laboratory measurement of working time, solubility and disintegration were assessed. The results showed that; the use of $A١_٢O_٣$:$SiO_٢$ ratio was of considerable importance in controlling the rate of setting. An increase in $AlPO_٤$ and fluoride content had increased the working time. They concluded that; the controlling factor of the set was the $Al_٢O_٣$:$SiO_٢$ ratio. The entry of $Al^{٣+}$ into network-forming sites increased the vulnerability of a glass to acid attack. The presence of Na^+ ions in glasses had an adverse effect on the hydrolytic stability of the prepared cements.

Diaz-Arnold et al. ١٩٩٥[١٣] studied the short-term fluoride release/uptake of four glass ionomer restoratives. Samples were fabricated and stored in deionized water. Initial fluoride release was measured at ٢٤ hours intervals for seven days, and ٢٤ hours intervals at the end of each week for five weeks, samples were divided into groups and each group was treated for six minutes with one of the following: APF, neutral NaF, and $SnF_٢$ gels. Fluoride measurements were carried out at ٢٤ hours intervals for seven days, and ٢٤ hours intervals at the end of the two weeks. Fluoride exposure was repeated, and measurements were again recorded over three weeks. The results showed that; initial fluoride release by all materials was highest during the first ٢٤ hours and decreased sharply over

the first week. After exposure to APF, fluoride release increased significantly for all materials. Exposure to NaF also resulted in increased fluoride release for all materials although it was not as high as the increase recorded after exposure to APF gel. They concluded that; certain fluoride gels may replenish fluoride within some glass ionomers and thus prolong their cariostatic potential.

Grobler et al. ١٩٩٨[٣٤] compared the fluoride release from various dental materials (four resin-modified glass ionomers a polyacid-modified composite resin and a bonding agent). Samples were prepared and suspended in water up to ٣٠٠ days; ٢٤-hours fluoride release was determined. The results showed that; the variation in the amount of fluoride released for each material at each time interval was the highest for Vitremer, then Fuji II LC and the lowest for Optibond. No significant fluoride levels could be found for Zl٠٠. They concluded that; the amount of fluoride released during the first day was the greatest for Vitremer than Advance, Fuji II LC, OptiBond, Dyract Compomer and Enforce. At the second day there was a slight change and fluoride release had remained almost the same for the rest of the ٣٠٠-day period. There was also an increase in fluoride release during the ٦٠-٢٠٠ day period relative to previous period.

Vermeersch et al. ٢٠٠١[٥٠] evaluated the short and long term fluoride release of: seven conventional glass ionomers, five

light-cured glass ionomers, two polyacid modified resin composites and two resin composites. Samples were prepared and then suspended in deionized water. After different incubation times, the samples were rinsed with deionized water and transferred to fresh water. Measurement of fluoride was done. The results showed that; conventional GICs release more fluoride than resin-modified GICs, which release more than high powder:liquid ratio GICs. They concluded that; the initial fluoride release from all materials was highest during the first ٢٤ hours and decreased sharply over the first week. However, it was impossible to correlate the fluoride release of the materials by their type except if we compared the products from the same manufacturer.

Ellakuria et al, ٢٠٠٣[١٨] compared the effect of a ١٢-month storage period in water on the surface microhardness, measured in Vickers units (VH), between a glass ionomer cement (GIC) and a resin-modified glass ionomer cement (RMGIC) group and to determine if the addition of resins improved the GIC microhardness. VH microhardness was assessed for the samples stored in distilled water for ١٢ months. Measurements were taken at ١, ٧, ١٥, ٣٠, ٩٠, ١٨٠ and ٣٦٥ days. The results showed that; there were significant VH differences among the materials studied and within each material over storage time. GICs, except for KS, showed a higher VH throughout the study period. Among RMGIC, VI showed a significantly higher VH at ١٢ months than at one day. The VH