Uses of Glass ionomer cements in dentistry

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Abstract

Background: To study and evaluate the glass ionomer cement used in dentistry.
Materials & methods: A total of 60 teeth were divided into different groups. Extracted teeth were included in the present study. Each experimental group consisted of 10 embedded teeth. They were classified as according to material transbond XT, GC fuji ortho LC, GC fuji ortho, gic as luting agent, EQUIA forte and EQUIA fil. Teeth were given conditions accordingly as dry, wet also the surface treated was conditioned or unconditioned. The cement with luting properties was taken as sample of 10 teeth showing luting of capping a crown was also considered. The data was collected and evaluated. Results obtained were carefully studied an compared. Complete analysis was done using SPSS software. Results: Wet or dry conditioned surfaces, however, produced higher shear bond strengths than unconditioned wet or dry surfaces. The mean shear bond strength for fuji ortho LC dry conditioned and GC fuji ortho dry unconditioned at 24 hour was 13.45 and 3.06, at 7 days was 15.40 and 4.02. The shear bond strength for glass ionomer cement in capping material was 6.00. The mean stress at maximum load for EQUIA forte was 197.36 and for EQUIA coating was 170.33.Conclusion: Glass ionomer cements provide sufficiently high shear bond strengths as capping agent, restoration and in orthodontic brackets under clinical conditions.
Keywords: glass ionomer cement, shear bond strength, orthodontic brackets.
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Introduction

The human tooth is a marvel of nature. However, it has a limited capacity for regeneration. This necessitates the replacement of tooth structure lost as a result of caries, trauma, or other reasons, with a suitable restorative material.[1] Various restorative materials have been used since years to preserve the lost tooth structure and maintain form, function, and esthetics. Dental amalgam has served as an excellent and versatile restorative material for many years.

However, it has many drawbacks like lack of esthetics and the unavoidable use of mercury, which may be regarded as harmful component to the patient's health.[2] This leads to search more improved materials.

The glass ionomer cement (GIC) was developed with the objective to produce a restorative material that would possess the desirable properties of silicate cements and polycarboxylate cement. Conventional GICs have certain properties that make them useful as a restorative material of choice. However, some deficiencies like attack by moisture during the initial setting period, short working time, long setting and maturation time, have low fracture toughness, and exhibit lower wear resistance have limited their use to areas which are not subjected to masticatory stresses. [3]

Glass-ionomer cements belong to the class of materials known as acid-base cements. They are based on the product of reaction of weak polymeric acids with powdered glasses of basic character. [4] Setting occurs in concentrated solutions in water and the final structure contains a substantial amount of unreacted glass which acts as filler to reinforce the set cement. The term "glass-ionomer" was applied to them in the earliest publication, but is not strictly correct. The proper name for them, according to the International Organization for Standardization, ISO, is "glass polyalkenoate cement", but the term "glass-ionomer" (including the hyphen) is recognised as an acceptable trivial name, and is widely used within the dental profession. [5,6] Glass-ionomers have various uses within dentistry. They are used as full restorative materials, especially in the primary dentition, and also as liners and bases, as fissure sealants and as bonding agents for orthodontic brackets.

The adhesion of glass-ionomers to the surface of the tooth is an important clinical advantage. Glass-ionomers are prepared from poly(acrylic acid) or related polymers, and this substance has been known to promote adhesion, because of the adhesion of the zinc polycarboxylate cement. [7] The advantage conferred by their adhesion was exploited many years ago, when glass-ionomers were proposed for the repair of cervical erosion lesions and as pit and fissure sealants. [8]

Tensile bond strengths of glass-ionomers to untreated enamel and dentine are good. [9] Values on enamel vary between 2.6 to 9.6 MPa and values on dentine vary from 1.1 to 4.1 MPa. Bond strengths are typically higher to enamel than to dentine, which suggests that the bonding takes place to the mineral phase. Bond strengths develop quickly, with about 80% of the final bond strength being achieved in 15 minutes, after which it increases for several days. [10] Hence, this study was conducted to study and evaluate the glass ionomer cement used in dentistry.

Materials & methods

A total of 60 teeth were divided into different groups. Extracted teeth were included in the present study. Each experimental group consisted of 10 embedded teeth. All resin and glass ionomer cements were mixed and applied to the brackets and enamel in accordance with the manufacturers' instructions. They were classified as according to material transbond XT, GC fuji ortho LC, GC fuji ortho, gic as luting agent, EQUIA forte and EQUIA fil. Teeth were given conditions accordingly as dry, wet also the surface treated was conditioned or unconditioned. The cement with luting properties was taken as sample of 10 teeth showing luting of capping a crown was also considered. The data was collected and evaluated. Results obtained were carefully studied an compared. Complete analysis was done using SPSS software.

Results

Different groups with each of 10 teeth were considered to study. Mean shear bond strength and all glass ionomer cement test conditions were noted. The shear bond strengths of the autopolymerizing GC Fuji Ortho were consistently higher than those recorded for Fuji Ortho LC under all enamel surface preparation conditions. The results also showed that wet unconditioned surfaces consistently produced higher shear bond strengths than dry unconditioned surfaces. Wet or dry conditioned surfaces, however, produced higher shear bond strengths than unconditioned wet or dry surfaces. The mean shear bond strength for fuji ortho LC dry conditioned and GC fuji ortho dry unconditioned at 24 hour was 13.45 and 3.06, at 7 days was 15.40 and 4.02. The shear bond strength for glass ionomer cement in capping material was 6.00.

Table 1: Mean shear bond strengths and all glass ionomer cements test conditions

Groups and materials	Environment	Surface treatment	N	Mean SBS 24hr	Mean SBS 7d
Control Transbond XT	Dry	Etched (37% phosphoric acid)	10	22.33	25.32
Case Fuji ortho LC	Dry	Conditioned	10	15.40	13.45
Fuji ortho LC	Dry	Unconditioned	10	1.26	2.48
Fuji ortho LC	Wet	Conditioned	10	11.33	16.56
Fuji ortho LC	Wet	Unconditioned	10	5.36	12.85
Case GC fuji ortho	Dry	Conditioned	10	14.22	18.22
GC fuji ortho	Dry	Unconditioned	10	4.02	3.06
GC fuji ortho	Wet	Conditioned	10	13.66	17.23
GC fuji ortho	Wet	Unconditioned	10	6.45	13.12
GIC luting		Capping crown	10	6.00	-

The mean stress at maximum load for EQUIA forte was 197.36 and for EQUIA coating was 170.33.

Table2: glass ionomer cement as restorative material

Groups and Materials	Mean stress at maximum load (MPa)	P- value
EQUIA forte coating	197.36	0.12
EQUIA coating	170.33	

Discussion

A bonded bracket must withstand both the forces of mastication and the orthodontic forces that it is subjected to in the oral environment. It is also a clinical requirement that the bond should reach sufficient strength shortly after bracket bonding to allow archwire placement at the bonding appointment. This mechanochemical bond must be durable enough to last over the period of active treatment. It has been established that tensile bond strengths of adhesives in the range of six to eight MPa are required for successful clinical bonding. [11,12] In our study, different groups with each of 10 teeth were considered to study. Mean shear bond strength and all glass ionomer cement test conditions were noted. The shear bond strengths of the autopolymerizing GC Fuji Ortho were consistently higher than those recorded for Fuji Ortho LC under all enamel surface preparation conditions. The results also showed that wet unconditioned surfaces consistently produced higher shear bond strengths than dry unconditioned surfaces. Wet or dry conditioned surfaces, however, produced higher shear bond strengths than unconditioned wet or dry surfaces.

One of the study by Brzovic Rajic V et al, determine compressive strength of new restorative materials over a longer period of time, materials were analysed under simulated conditions where cyclic loading replicated masticatory loading and thermocycling simulated thermal oscillations in the oral cavity. Four groups of samples (n=7)—(1) Equia Fil (GC, Tokyo, Japan) uncoated; (2) Equia Fil coated with Equia Coat (GC, Tokyo, Japan); (3) Equia Forte Fil (GC, Tokyo, Japan) uncoated; and (4) Equia Forte Fil coated with Equia Forte coat (GC, Tokyo, Japan)—were subjected to cyclic loading (240,000 cycles) using a chewing simulator (MOD, Esetron Smart Robotechnologies, Ankara, Turkey). Compressive strength measurements were performed according to ISO 9917-1:2007, using the universal mechanical testing machine (Instron, Lloyd, UK). Scanning electron microscope (SEM) analysis was performed after thermocycling. There were no statistically significant differences between Equia Fil and Equia Forte Fil irrespective of the coating ($p<0.05$), but a trend of increasing compressive strength in the coated samples was observed. [13] In our study, The mean shear bond strength for fuji ortho LC dry conditioned and GC fuji ortho dry unconditioned at 24 hour was 13.45 and 3.06, at 7 days was 15.40 and 4.02. The shear bond strength for glass ionomer cement in capping material was 6.00. The mean stress at maximum load for EQUIA forte was 197.36 and for EQUIA coating was 170.33.

Another study by Somani R et al, comparing shear bond strength of various glass ionomer cements (GICs) to dentin of primary teeth. Sample size taken for the study was 72 deciduous molars with intact buccal or lingual surfaces. Samples were randomly divided into three groups, i.e., groups A, B, and C and were restored with conventional type II GIC, type II light cure (LC) GIC, and type IX GIC respectively. Thermocycling was done to simulate oral conditions. After 24 hours, shear bond strength was determined using Instron Universal testing Machine at crosshead speed of 0.5 mm/ minute until fracture. Results were tabulated and statistically analyzed. It was found that the shear bond strength was highest in group B (LC GIC) 9.851 ± 1.620 MPa, followed by group C (type IX GIC) 7.226 ± 0.877 MPa, and was lowest in group A (conventional GIC) 4.931 ± 0.9735 MPa. [14]

In the literature, there are not clear guidelines about shear force limits, but in fact a good orthodontic biomaterial should allow good adhesion in order to sustain masticatory forces (with a minimum bond strength of 5–10 MPa). [11] On the other hand, adhesion forces should not be too strong in order to avoid enamel loss after debonding (40–50 MPa). [15]

Conclusion

The results of this study suggest that glass ionomer cements provide sufficiently high shear bond strengths as capping agent, restoration and in orthodontic brackets under clinical conditions.

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