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Durability of bond strength of glass-ionomers to enamel

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Abstract

Purpose: To evaluate the shear bond strength of a new generation of glass ionomer (Glass Carbomer) to enamel versus a nano-filled resin-modified glass ionomer (ketac Nano) and a conventional type after different storage periods.
Materials & methods: Crowns of 36 sound and freshly extracted human permanent molars were sectioned mesiodistally into two halves. The convex buccal or lingual surface was gently ground with water cooled 200-, 400-, and 600-grit silicon carbide abrasive papers successively to obtain flat enamel surfaces. The prepared specimens ($n = 72$) were divided into three main groups (24 each): I (Ionofil Molar), II (Ketac Nano) III (Glass Carbomer). The specimens in each group were subdivided into three subgroups A, B & C according to the storage period in artificial saliva. Shear bond strength between enamel surface and the bonded material was measured using a universal testing machine at a cross head speed of 0.5 mm/min. All the debonded interfaces were examined under both binocular stereo microscope at 40× and SEM at 200× to determine the mode of failure.
Results: Ketac Nano recorded the highest shear bond strength values (9.30 ± 0.67, 12.07 ± 0.76, 6.7 ± 0.73) followed by Ionofil Molar, recording (5.25 ± 0.62, 7.82 ± 1.42, 5.91 ± 0.87) while the lowest values were found in Glass Carbomer specimens, recording (2.17 ± 0.63, 6.66 ± 0.68, 5.72 ± 0.79). There was a highly significant difference in shear bond strength values among the three different storage periods in all the tested materials ($P < 0.0001$). A positive correlation was recorded ($R = 9.3$) between the adhesive mode of failure and shear bond strength while a negative correlation was recorded ($R = 4.5$) between the cohesive mode of failure and shear bond strength using Spearman's correlation test.
Conclusions: Storage time was a factor which significantly influenced both shear bond strength and mode of failure especially in Glass Carbomer specimens.

Keywords: Shear bond strength; Enamel; Storage; Artificial saliva; Ketac N100; Glass carbomer

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1. Introduction

Restorative dentistry has seen a paradigm shift from the invasive surgical approach laid by G.V. Black "extension for prevention" to a minimally invasive approach with advancement in diagnostic system and revolution in adhesion technology [1].

An ideal material used for restoration should be adhesive, tooth colored, resistant to wear [2], non-toxic, biocompatible to the tissue [3].

A new era had begun in the world of dentistry since the introduction of glass ionomer cement (GIC) in 1972 by Wilson and Kent, which have been considered to be a leading restorative material so far as they adhere to tooth structure [4], have an antibacterial activity [5], negligible dimensional changes [6], release fluoride [7], and can be used in different clinical situations such as luting of indirect restorations, lining, basing and filling [8].

Unfortunately, the use of GI as a restorative material was limited to areas of low masticatory forces [9] due to their low mechanical properties which were also affected by the powder/liquid mixing ratio of this material [10]. Another drawback is the slow rate of setting reaction which dictates postponing the finishing and polishing procedure to an additional visit.[4]

Thus, several modifications and improvements were introduced [11].

In the late 1980's, an attempt to enhance conventional GIs was carried out through developing a hybrid material that combines composite resin and GI [12]. Resin-modified glass-ionomers (RMGICs) are light curable materials that allow for command set, less sensitive to dehydration than conventional GICs, immediate finishing and polishing following light curing [13], extended working time [4] and demonstrate higher flexural and diametral tensile strengths [14].

The shift towards the use of nano-fillers in esthetic restorative materials supported the fact that the small size allows finer polishing and smoother surface. At the same time, the grain size is too small for dislocation and higher strength can be obtained by incorporation of such nano-fillers [15]. This trend was utilized to solve the problems of esthetics and low wear resistance of RMGICs, so another type of glass ionomers based on nano-fillers was introduced, Glass Carbomer which sets chemically [16].

The use of nanotechnology greatly increases the reactive surface of the filling material, which in turn leads to a better reaction. An organic carbon chain additive, which is completely biocompatible, is also added to Glass Carbomer to provide the material with greater strength and increased transparency [17].

Although clinical trials would provide the ultimate evidence of clinical performance of dental restorations, preliminary and safety studies on dental materials should be conducted in vitro [18].

Different methods can be utilized in vitro to evaluate the durability of the bond strength to tooth structure. The shear bond strength test is one of these methods which has been widely used as it was reported to be easily performed [19].

2. Materials & methods

Thirty-six sounds & periodontally involved extracted human permanent molars were selected from patients, after signing a written consent, aging between (35–45) years for this study. Teeth were cleaned from tissue remnants and debris using periodontal curettes then polished with slurry of pumice and water.

Teeth were examined to ensure they were free of any visible hypoplastic defects, cracks or white spots (demineralized enamel) using the blue light of a light curing unit[1] [20].

They were stored in refrigerated saline solution for maximum 3 months as recommended by the ISO norms (ISO. Guidance on testing of adhesion to tooth structure.International Organization for Standardization, 1994) [21].

Crowns of the collected teeth were separated from the roots at cemento-enamel junction then, sectioned mesiodistally into two halves by cutting parallel to the long axis and facial surface using a low speed diamond disk under continuous water cooling [22].

Custom made cylindrical metallic molds of 20 mm length and 14 mm diameter were filled with chemically polymerizing acrylic resin.[2] Each metallic mold composed of an external cylindrical part surrounded another split metallic halves of 18 mm height∖12 mm diameter (Fig. 1).

These two metallic compartments were adjusted together by means of two external screws to facilitate the insertion and removal the acrylic block from the mold (Fig. 1).

Each crown half was embedded horizontally in the acrylic resin making the buccal or lingual enamel surface facing upwards (Fig. 2). Care was taken to keep the experimental surfaces free of contamination by acrylic resin.

[1] Polofil® Lux, halogen light, Voco, Germany.
[2] Imicryl, Konya, Turkey.