



Comparative evaluation of compressive strength of esthetic restorative materials

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Abstract

The present study was aimed to evaluate and compare the compressive strength of conventional glass ionomer cement with resin modified glass ionomer, compomer and microhybrid composite. A total of 40 specimens of esthetic restorative materials were fabricated using customized cylindrical teflon mould measuring 6mm height and 4mm diameter and were grouped with ten specimens in each group, Group I: Conventional glass ionomer cement (Fuji II). Group II: Resin modified glass ionomer (Fuji II LC). Group III: Compomer (Dyract AP) and Group IV: Microhybrid composite resin (Tetric Ceram). They were covered with Mylar strip and were cured using LED light curing unit. Compressive strength was evaluated using Universal testing machine. The result showed that there were a significant difference among the groups in which Tetric Ceram showed highest compressive strength and Fuji II showed the least compressive strength.

Introduction

The eventual objective of dental restorative material is to substitute the biological, functional and aesthetic properties of healthy tooth structure. For more than a century, dental amalgam and gold alloys have been used as dental restorative materials, especially in posterior teeth, because their mechanical properties replicate those of natural teeth; however, these metallic materials are not aesthetic. With the introduction of composites in dentistry over four decades ago, the issue of aesthetics has been overcome to a certain extent. Composites have an edge over other restorative materials as they offer advantages of easy handling and better aesthetics (1,2).

For many years, glass ionomer cements were solely used for the restoration of anterior teeth, due to

their poor mechanical strength. New technologies have been continuously investigated in esthetic dentistry with the aim of improving the physical, mechanical and esthetic properties of esthetic restorative materials. Resin-modified glass ionomers, compomer and resin composites are commercially available, with superior values of mechanical strength when compared to conventional cements, (3,4)

Resin-modified GIC (RMGIC) is used for both anterior and posterior cavities and it reported to have improved strength seems to be responsible for increased success rates being characterized by less marginal and bulk fractures. Compomers (polyacid-modified resin composites, COM) were introduced in 1994 for posterior and anterior restorations.

Compared with GIC, improved mechanical properties were verified *in vivo*. According to the authors, an average compliance is sufficient for clinical success. A split-mouth study with a COM (Compoglass) and a resin composite (TPH) did not reveal differences between materials (5).

Studies have been performed in an attempt to better understand the properties of esthetic restorative materials, and compressive strength testing is the most commonly employed method to evaluate the strength of these materials (4).

Compressive strength is significantly essential because in clinical setting, the restorations are subjected to endless combinations of forces and moments which result in the development of compressive, tensile and shear stresses. All these factors tend to influence the durability of the restoration (2). Thus with this background in mind, the present study was undertaken to evaluate and compare the compressive strength of conventional glass ionomer cement with resin modified glass ionomer, compomer and microhybrid composite. Universal Instron testing machine was used for measuring compressive strength.

Materials and methods

The study sample consisted of forty specimens. Four groups were made of four different esthetic restorative materials having ten specimens in each group. All the specimens were fabricated according to ISO (9917, 2000) (6) using teflon mould with height 6 ± 0.1 mm and diameter 4 ± 0.1 mm.

Materials used in this study were grouped as follows: Group I: Conventional glass ionomer cement (Fuji II). Group II: Resin modified glass ionomer (Fuji II LC). Group III:

Compomer (Dyract AP) and Group IV: Microhybrid composite resin (Tetric Ceram). Composition and manufacture of the materials are listed in table 1.

All the materials were prepared according to the manufacture instruction. Group I (Fuji II Capsules) and Group II (Fuji II LC capsule): Before activating, the capsule was tapped on a hard surface to loosen the powder and the plunger was pushed until flushed with the body of the capsule for activation. It was then placed in a triturator and mixed for 2 seconds (4,300 RPM). The specimens were prepared by inserting the nozzle of the capsule into the mold. Group III (Dyract AP): The capsule put in the gun, then compules tip inserted into the notched opening of the applicator gun barrel. Dispense Dyract AP directly into the mold.

All the materials placed with 3 increments of approximately 2mm thick. The insertion was done slowly to adapt the material into the mold and avoid bubble formation then each increment was exposed to LED light curing unit (Kerr, West Collins, CA, USA) for 10 seconds. After insertion of last increment, a transparent polyester strip and 1 mm thick glass slide were placed onto the matrix and pressure was applied to extrude excess material.

After removing the glass slide, the materials were then irradiated from the top and bottom surfaces through the mylar strip as per the manufactures instructions using the using the LED light curing unit. The specimens were taken out of the Teflon mould and light cured in the middle of the specimen at opposing sides. In total, 40 specimens were fabricated according to the grouping done. Study was performed in controlled temperature by keeping it in distilled water bath for 24h at 37°C. All specimens were transferred to the universal Instron testing machine

individually and subjected to compressive strength analysis at crosshead speed of 1.0mm/min.

Data were collected and analyzed statically using descriptive statistic, ANOVA and LSD test at a significance level was 5%.

Result

The results of compressive strength are shown in Table (2 & 3) and in Figure 1. Statistically significant differences were observed among the four groups of restorative materials at ($p < 0.05$). Highest compressive strength mean values were found for the group IV (composite resin) (230 MPa) with statistical significant difference from the other groups, followed by group III (compomer) (205.3 MPa) then group II (resin modified glass ionomer cement) (183 MPa). While group I (Conventional glass ionomer cement) showed lowest compressive strength mean value .

Discussion

There are several clinical indications for the use of glass ionomer cements, such as bonding to the dental substrate and fluoride release. However, some of these indications are limited by their mechanical strength. Several ionomer materials have been developed (such as resin modified glass ionomer and compomer) in an attempt to enhance their mechanical properties, a fact that justifies the constant research effort that has been made to assess the alleged improvements (4)

One of the important properties in restorative materials, particularly in the process of mastication, is Compressive strength, since several of the masticatory forces are of compressive nature. The maximum resistance to compression is calculated by the

original cross-sectional area of the test specimens and the maximum force applied. The compression forces applied on each side of the test specimens are dissipated into shear forces along the cuneiform area on each side. As a result of the action of the two cones on the cylinder, traction forces arise in the central portion of the mass (7,8).

The result of the present study showed that there are significant difference among the groups in the compressive strength mean values in which the composite resin showed significantly highest mean compressive strength values followed by compomer, then the resin modified glass ionomer. While the conventional glass ionomer showed the lowest than the compomer (Table 2). This result is in accordance with a study done by Abdul Qader et al., (2012) (9) who showed that composite resin have significantly higher CS as compared to compomer

The differences obtained between the various studies groups could be explained by the composition of each materials. The literature has shown the chemical composition of dental composites affect on their mechanical properties. In which mechanical behavior depends upon the concentration and particle size of the inorganic filler, filler type, resin composition, filler matrix bonding and cure conditions. Tetric Ceram is a light curing, radiopaque fine particle microhybrid composite for the restorative purposes. It has 50 wt% of inorganic phase have higher contact surface with the organic phase. In addition, Owing to a wide size distribution, an increased filler load can be achieved in this type of resin composite without increasing their viscosity result in better mechanical properties and improving the material strength. (1,8, 10, 11)

On comparing the compressive strength of Tetric Ceram with other studies, the result of the present study showed a mean value of (230 Mpa). While in the study of Hedge et al, (2011) (1) and Kiran et al., (2014) (2) which were (291 Mpa) and (167.13 Mpa) respectively. The difference in the result may be due to difference in the dimension of the specimens used

In this study, the resin-modified glass ionomer cement presented higher strength values than the conventional material, irrespective of the matrix dimensions employed for specimen fabrication. Probably, this is due to the inclusion of resinous polymers that present higher mechanical strength. These results were already expected, as observed in other studies of (Xie et al., 2000) (12) and (Mallmann et al., 2007 (4)) and mentioned in the classic dental materials literature (Anusavice 1996) (3).

Xu et al. (2003) (13) found the mean compressive strength of compomer (262 MPa). This finding is higher than the present study finding. The difference may be due to small sample size, defect in storage of sample or due to manufacturers problem.

Conclusion

From the findings of the present in vitro study; it was observed that microhybrid composite have higher compressive strength as among the materials under study. Glass ionomer cement has the least compressive strength.

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Table (1): composition, classification and manufacture of restorative materials used in the study

Matreials	Classification	Composition	Manufacture
Fuji II	Conventional glass ionomer cement	Powder: 95% fluoroaluminosilicate glass (amorphous) 5% polyacrylic acid Liquid: 50% distilled water 40% polyacrylic acid	G.C. Corporation, Tokyo/Japan
Fuji II LC	Resin modified glass ionomer cement	Powder: Aluminofluorosilicate glass. Improved version has smaller glass particles for better polishing. Liquid: Polyacrylic acid, tartaric acid, distilled water, camphorquinone, dibutyl hydroxy toluene, and three resin complex (mainly HEMA).	G.C. corporation, Tokyo/ Japan
Dyract AP	Compomer	Urethan dimethacrylate (UDMA) Tetracarboxylic acid-hydroxyethylmethacrylate-ester (TCB Resin) Alkanoyl-poly-methacrylate Strontium-fluoro-silicate glass Strontium fluoride Photo initiators Butyl hydroxy toluene Iron oxide pigments	Dentsply/ Caulk/USA
Tetric Ceram	Microhybrid composite resin	Monomer: (19%) Bis GMA, UDMA and Decandiol dimethacrylate Fillers: (81%) Barium glass, Ba-Al- fluoro-silicate glass, ytterbium trifluoride, highly dispersed silicon dioxide and speroid mixed oxide	Ivoclar Vivadent, Schaan, Liechtenstein.

Table (2): Mean compressive strength values (MPa) and standard deviations obtained for the esthetic restorative materials

Restorative materials	N	Mean	Std. Deviation	Std. Error
CGIC	10	95 a	6.218 a	1.966
RMGIC	10	183 b	9.649 b	3.051
Compomer	10	205.3 c	11.833 c	3.742
ComposteResin	10	230d	15.398 d	4.869

Table (3): ANOVA test for difference among groups for compressive strength of the tested materials

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	103628.675	3	34542.892	271.510	.000
Within Groups	4580.100	36	127.225		
Total	108208.775	39			

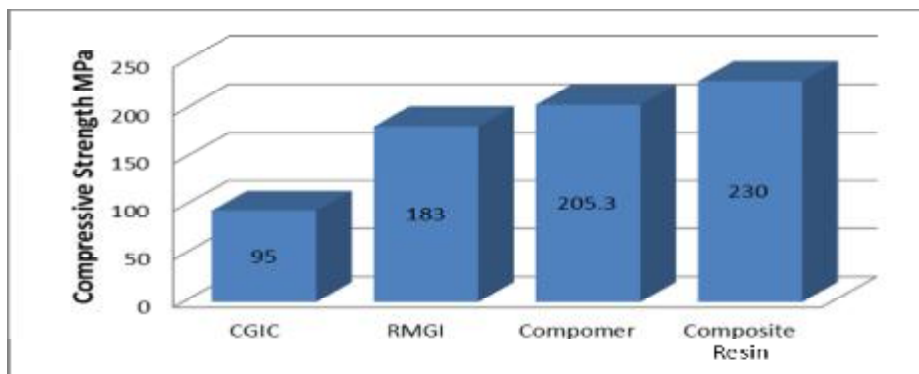


Figure (1): Bar chart for the means of mean values of the tested materials