Vol 9, Special Issue 2, 2017

INTERNATIONAL JOURNAL OF APPLIED PHARMACEUTICS

ISSN - 0975-7058

Research Article

SHEAR BOND STRENGTH OF RESTORATIVE PARTICULATE RESIN COMPOSITE WITH A SHORT FIBER-REINFORCED RESIN COMPOSITE SUBSTRUCTURE

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Received: 16 September 2017, Revised and Accepted: 3 October 2017

ABSTRACT

Objective: This study aimed to identify the shear bond strength of two different restorative particulate resin composites with a short fiber-reinforced resin composite (SFRC) substructure.

Methods: Two restorative particulate resin composites, G-aenial Posterior™ (Group A, 10 specimens) and Tetric N-Ceram™ (Group B, 10 specimens), were used as an upper layer of everX posterior™, an SFRC. A shear bond strength test was performed using a universal testing machine with a load of 100 kgf and a crosshead speed of 0.5 mm/min. The data were analyzed statistically using the independent samples t-test.

Results: The mean shear bond strength values were found to be18.64±1.5 MPa (Group A) and 22.05±1.8 MPa (Group B). A significant difference in shear bond strength between the two groups was found.

Conclusion: The shear bond strength value is higher in the Tetric N-Ceram™ restorative particulate resin composite with SFRC as a substructure than the G-aenial Posterior™ restorative particulate resin composite.

Keywords: Fiber-reinforced resin composite, Restorative particulate resin composite, Substructure, Bond strength.

 DOI: http://dx.doi.org/10.22159/ijap.2017.v9s2.42

INTRODUCTION

Recently, resin composite materials with fiber reinforcement have been developed to improve the mechanical properties of dental materials [1]. Fiber-reinforced resin composites (FRCs) are structural materials that have at least two different constituencies.

These types of composites consist of fibers that act as a reinforcement, providing strength, and stiffness; moreover, the matrix around the fibers supports and facilitates the dental work being done [2].

FRCs are used to manufacture fixed dentures, removable dentures, periodontal splints, and orthodontic retainers [3]. They can also be used in the field of restorative dentistry for posterior teeth restorations. FRCs are designed to replace dentin as substructures, and combined with a restorative particulate resin composite as an enamel replacement layer on top, employing a sandwich technique to achieve biomimetic restoration. In its application, the bond between the two resin composites (FRC combined with a restorative particulate resin composite) is very important to ensure that the material acts as a unit of a restoration [4]. Furthermore, the bond between the two resin composite materials must be considered to avoid delamination of the restoration [5].

FRCs are classified as anisotropic materials, and their strength depends on the direction of the fiber that is used [2]. An FRC product that contains short, randomly arranged fibers have previously been developed [4].

Garoushi *et al*. conducted a study that found that the use of short FRCs (SFRCs) can significantly improve fracture resistance and flexural strength in comparison to bulk-fill restorative particulate resin composites [6]. Tanner conducted a study using a short multidirectional FRC with some commercial restorative particulate resin composite products [7].

Their results indicate that the bonding properties of short multidirectional FRCs were equal to the bonding properties of the commercial restorative particulate resin composite products they tested [7]. Garoushi *et a*l. (2006) conducted a study on load-bearing capacity and the use of SFRC as a substructure for a restorative particulate resin composite [8]. They found that the load-bearing capacity significantly increased as the SFRC thickness increased [8].

However, these studies did not evaluate the bonding strength of SFRCs containing different restorative particulate resin composite products, so it necessary to study that effect.

METHODS

In the present research study, two types of everX posterior™ (GC Corp, Tokyo, Japan) SFRC products were used as a substructure. In Group A, the microfilled hybrid bisphenol glycidyl dimethacrylate free (Bis-GMA free) G-aenial Posterior™ (GC Corp, Tokyo, Japan) restorative particulate resin composite was used as the top layer. In Group B, the nanohybrid universal Bis-GMA Tetric N-Ceram™ (Ivoclar Vivadent AG, Schaan, Liechtenstein) restorative particulate resin composite was used. Both groups consisted of 10 specimens, for a total of 20 specimens.

The SFRCs were placed in an acrylic mold with a circular cavity (6 mm × 4 mm) and then cured with a light-emitting diode (LED) light curing unit (LEDMAX- Hilux) with light irradiation of 700 mW/cm^2 for 20 s, as recommended by the manufacturer. Restorative particulate resin composite was then added to the surface of the SFRC substructure using a circular cavity (4 mm × 2 mm) and then cured with a LED light curing unit with light irradiation of 700 mW/cm^2 for 20 s, as recommended by the manufacturer.

The specimens are stored in a container filled with distilled water in an incubator at 37°C for 24 h. Then, the bonding area measurements were taken using a digital caliper. The specimen was placed in a universal testing machine (Shimadzu Japan), with a blade positioned at the interface, and with a crosshead speed of 0.5 mm/min and a load of 100 kgf.

The results were recorded and entered into the shear bond strength formula. After the test was completed, the fracture surfaces were observed under a stereomicroscope with 10× and 20× magnification.

The independent samples t-test was used to analyze the significance of the differences in the shear bond strength value between the two groups. All data were subjected to a normality test and Levene's test of homogeneity of variance (α=0.05) following the assumption of equal variances.

RESULTS

The shear bond strength test results are presented in Table 1 and shown graphically in Fig. 1. The shear bond strength test results of the microfilled hybrid Bis-GMA free (GC G-aenial Posterior™, Group A) showed a mean value of 18.64±1.5 MPa; the results for the nanohybrid universal Bis-GMA (Ivoclar Tetric N-Ceram™, Group B) showed a mean value of 22.05±1.8 MPa. The independent samples t-test result demonstrated a statistically significant difference in shear bond strength between the two groups. Schematics and stereomicroscope pictures of the fracture surface conditions are shown in Fig. 2–7 [9]. Of 20 specimens, eight had mixed cohesive fractures, six had cohesive fractures in the restorative particulate resin composite, three had cohesive fractures in the SFRC, and three had a fracture at the interface between the SFRC and the restorative particulate resin composite; cohesive fractures in the restorative particulate resin composite.

DISCUSSION

In the present study, a significant difference was found in the shear bond strength value between the SFRC and the specimens with both types of restorative particulate resin composites (Group A, microfilled hybrid Bis-GMA free; 18.64±1.5 MPa and Group B, nanohybrid universal Bis-GMA;22.05±1.8 MPa). The significant difference can be due to the differences in the composition of the restorative particulate resin composites.

The percentage of the filler content in the restorative particulate resin composite products used in this study was similar: 81% wt (GC G-aenial Posterior™) and 80.5% wt (Ivoclar Tetric N-Ceram™); therefore, it is possible that the filler content did not have any effect on the differences in the shear bond strength values for the two groups [10-12]. Nonetheless, both of the restorative particulate composite products used in the study contained different types of monomers. The monomer used in the GC G-aenial Posterior™ restorative particulate resin composite consists of urethane dimethacrylate (UDMA), and it does not contain Bis-GMA. The monomer used in in the Ivoclar Tetric

Table 1: The shear bond strength test results

Groups	Mean shear bond strength test value (MPa)±SD
Microfilled hybrid Bis-GMA free (GC G-aenial Posterior™, Group A)	18.64±1.5
Nanohybrid universal Bis-GMA (Ivoclar Tetric N-Ceramtm™, Group B)	22.05±1.8

SD: Standard deviation

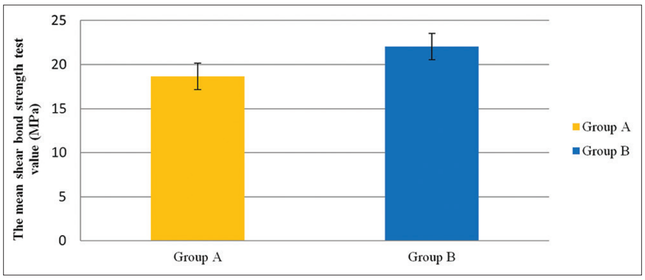

Fig. 1: The shear bond strength test results

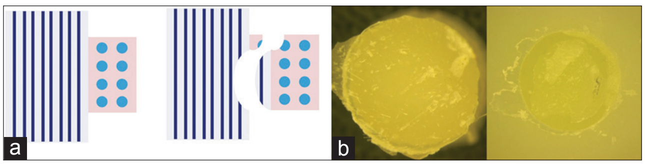

Fig. 2: (a) Schematics of the fractures, (b) stereomicroscope pictures of the fractures, Group A; cohesive fractures in the short fiber-reinforced resin composite and restorative particulate resin composite

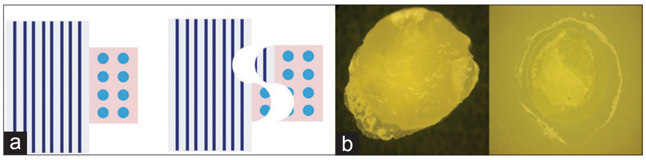

Fig. 3: (a) Schematics of the fractures, (b) stereomicroscope pictures of the fractures, Group A; cohesive fractures in the short fiber-reinforced resin composite and restorative particulate resin composite

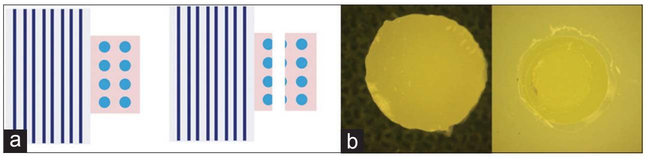

Fig. 4: (a) Schematics of the fractures, (b) stereomicroscope pictures of the fractures, Group A; cohesive fractures in the restorative particulate resin composite

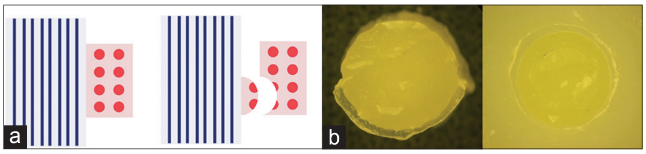

Fig. 5: (a) Schematics of the fracture, (b) stereomicroscope pictures of the fractures, Group B; fractures at the interface between the short fiber-reinforced resin composite and the restorative particulate resin composite; cohesive fractures in the restorative particulate resin composite

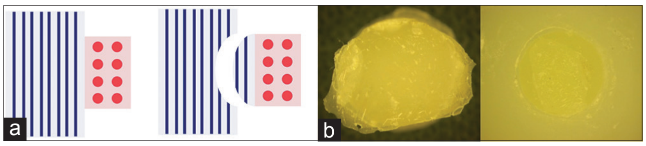

Fig. 6: (a) Schematics of the fractures, (b) stereomicroscope pictures of the fractures, Group B; cohesive fractures in the short fiber-reinforced resin composite

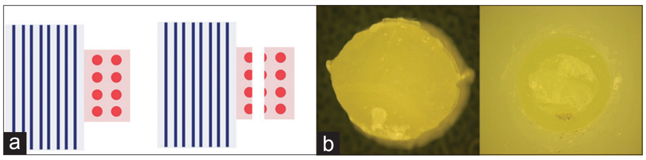

Figure 7: (a) Schematics of the fractures, (b) stereomicroscope pictures of the fractures, Group B; cohesive fractures in the restorative particulate resin composite