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# *Ex vivo* fracture resistance of teeth restored with glass and fiber reinforced composite resin

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ABSTRACT

*Objectives:* This study aims to compare the *ex vivo* fracture resistance of root canal treated (RCT) teeth restored with four different types of fibers under composite resin.
*Subjects and methods:* One hundred and forty extracted mandibular first molar teeth were assigned to seven groups (n = 20/group). Group 1 was the control group. In groups 2 − 7, endodontic access and standard Mesio-occluso-distal (MOD) cavities were prepared. Following RCT, group 2 was left unrestored. In group 3, flowable composite resin (FCR) was used to line the cavities and restored with composite resin. In groups 4,5,6 and 7, Ribbond, Everstick, Dentapreg and Bioctris fibers were inserted in flowable resin and restored respectively.
*Results:* All the groups restored with fiber reinforced composite displayed higher fracture resistance than the group restored with only composite resin ($p < 0.001$). In addition, Groups restored with Everstick and Bioctris (Groups 5 and 7) showed higher fracture resistance when compared to Ribbond and Dentapreg (Groups 4 and 6).
*Conclusion:* E glass fibers demonstrated highest fracture resistance and hence can be preferred over other fiber types to reinforce RCT teeth with weakened crown structures.

## 1. Introduction

The primary objective of a post-endodontic restoration is to provide adequate fracture resistance to the weakened pulpless teeth. Composite resins are one of the preferred and more conservative approach to restore such teeth. The introduction of fibers in composite resin has brought about a distinctive class of materials in the armamentarium of restorative dentistry. These fibers were incorporated into the composite resin material for their reinforcing effect (AlJehani et al., 2016). The various attributes of the fiber reinforced composite (FRC) include increase in flexural modulus and fracture resistance (Vallittu, 1998), stress relievers (Belli et al., 2006) and resistance to crack propagation (Meiers and Freilich, 2001). The inclusion of a fiber sub-structure under composite resin have demonstrated superior characteristics when placed under composite resin in root canal treated teeth as a core build up material (Khan et al., 2013; Freilich and Meiers, 2004).

Currently, numerous types of fiber with different architecture and composition are commercially available. The mechanical properties of FRC are dependent upon fiber type, ratio of fiber to matrix resin, fiber architecture and quality of impregnation of fiber and resin (Soares et al., 2008). A literature review revealed numerous studies which were conducted to test microfiber embedded in resin matrix in composite restoration and as fiber post systems. However, there are very few studies which evaluated the effectiveness of glass fibers substructure under composite resin.

Bioctris, a novel glass fiber framework system has been developed which provides a fortifying effect on the restorative material. However, the fracture resistance of this fiber system under composite resin restoration has not been tested. Hence, this study was designed to compare the effect of four different types of fibers on the fracture resistance of root canal treated teeth under composite resin.

## 2. Materials & methods

One hundred and forty intact mandibular first molar teeth were selected for the study. The samples were subjected to thermocycling (6000 cycles at 5–55 °C, dwell 30 s, transfer time 5 s) and stored in 37 °C sterile water for 10 days. The teeth were assigned to seven groups of

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twenty teeth each.

Group 1 was used as a control group and no cavity preparation were performed. For Groups 2–7, standard access cavities were prepared in the teeth using a #245 carbide bur (SS White, Lakewood, NJ, USA) with a high- speed handpiece and air-water coolant spray. The canals were instrumented using Endoprep- RC® (Anabond Stedman, Pharma Research (P) Ltd, India) and 5.25% sodium hypochlorite irrigant. Apical preparation was performed to size 35 for distal canals and size 30 for mesial canals and step back preparation was done till size 70. Teeth were obturated with 2% gutta percha (Dentsply De Trey, Johnson City, TN) using cold lateral condensation technique. After obturation, radiographs were taken. The chamber was then cleaned and excess sealer wiped off with cotton. Standard mesioocclusо-distal (MOD) cavities were prepared. The thickness of the cavity walls was measured as 2 mm at the buccal-occlusal surface, 2.5 mm at the cemento-enamel junction, and 1.5 mm at the lingual occusal surface and cemento-enamel junction. These measurements were made using a vernier calipers. The cavities for Group 2 were left unrestored.

For Group 3, the surface of the cavity wall was etched with 37% phosphoric acid gel (Eco-Etch; Ivoclar Vivadent, Schaan, Liechtenstein, Swiss) for 15 s and rinsed with water for 15 sThe cavity surface was gently blot dried. Bonding agent (Te-Econom Bond® Ivoclar Vivadent®/ Schaan, Liechtenstein) was applied to the cavity surface using micro-brush and light cured for 20 s using a quartz-tungsten-halogen curing unit (QTH) (Astralis 7, Ivoclar Vivadent). The cavity surfaces were then coated with a layer of low viscosity flowable composite resin (FCR) (Te-econom Flow, Ivoclar, Vivadent, Schaan, Liechtenstein) in the buccal and lingual walls and the pulpal floor. The cavities were then restored with a hybrid resin composite (Te-Econom Plus, Ivoclar Vivadent, Schaan, Liechtenstein) using an incremental technique and each layer was cured for 40 s.

For Group 4, the cavity surfaces were etched and bonded using the same technique as used for Group 3. The cavity surfaces were then coated with a layer of flowable resin composite. Leno-woven ultra-high molecular weight polyethylene ribbon fiber (Ribbond; Seattle, WA, USA) was removed from the package using cotton pliers. A piece of the fiber 10 mm long and 3 mm wide was cut. The fiber was subsequently coated with adhesive resin. Excess material was blotted off with lint-free gauze. Then the fiber was embedded inside the flowable composite on the buccal wall, pulpal floor and lingual wall of the cavities. After light curing for 20 s, the cavities were restored with hybrid composite as described above using an incremental technique, where each layer was light cured for 40 s.

For Group 5, the cavity surfaces were etched and bonded as described for Group 3. The cavity surface was then coated with FCR and Everstick (Everstick C&B, GC Corp., Tokyo, Japan). Two fibers of 10 mm long and 1.5 mm wide dimension was cut and embedded in the FCR adjacent to each other and cured and restored as performed for Group 4.

For Group 6, the cavity surfaces were etched and bonded as described for Group 3. The cavity surface was the coated with FCR and Dentapreg fiber (UFM, ADM AS, Brno, Czech Republic) of 10 mm long and 3 mm wide dimension was cut and embedded in the FCR and cured and restored similar to Group 4.

For Group 7, the cavity surfaces were etched and bonded as described for Group 3. The cavity surface was then coated with FCR and Bioctris fiber (Bio Composants Medicaux, France) of 10 mm long and 3 mm wide dimension was cut and embedded in the FCR and cured and restored similar to Group 4.

Finally, all the teeth were mounted in self-curing acrylic resin using 5.1 cm * 5.1 cm custom made molds. The teeth were embedded in the resin up to the level of cemento-enamel junction. The specimens were stored in an incubator at 37 °c in 100% humidity for 24 h.

Fracture resistance testing done in the Instron Universal Testing Machine (Instron, Buckinghamshire, England). Compressive force was applied with a 6 mm diameter stainless steel bar centered on the tooth.

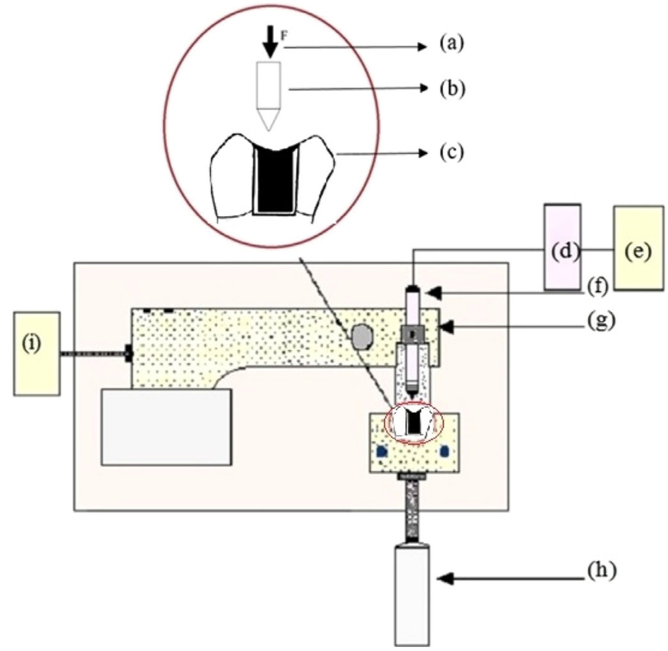


**Fig. 1.** Diagram of stress apparatus: (a) Compressive force; (b) Stainless steel bar; (c) Sample; (d) Signal conditioning unit (RDP Unit); (e) Computer; (f) LVDT Transducer; (g) Load-cell; (h) Base; (i) Instron Universal Testing Machine.

Each sample was loaded at a crosshead speed of 0.5 mm/min (Fig. 1). The test machine's software recorded the peak-loaded fracture in newtons (N) for each sample and tabulated.

One-way ANOVA was used to compare the failure load data at a significance level of 5%. Post hoc testing was performed with *t*-tests and a Bonferroni correction for multiple testing. The analyses were performed with SPSS version 11.0 (SPSS Inc., Chicago, IL, USA).

## 3. Results

Mean fracture resistance (N) and standard deviation for all the groups are presented in Table 1. Fracture resistance of Group 1 was significantly higher than all the other groups ($p < 0.001$). Group 2 showed the least fracture resistance. All the groups restored with fibers (Groups 4,5,6 and 7) displayed higher fracture resistance than the group restored with only composite resin (Group 3). In addition, Groups restored with Everstick and Bioctris (Groups 5 and 7) showed increased fracture resistance when compared to Ribbond and Dentapreg (Groups 4 and 6). No statistical difference was found between Groups 5 and 7 or between Groups 4 and 6. Everstick fibers showed a fracture resistance of 1433.14 N and Bioctris displayed a fracture resistance of 1480.20 N (Table 1).

**Table 1**
Fracture strength in newton.

| Groups | Fracture Load (N) | | | |
|---|---|---|---|---|
| | Minimum | Maximum | Mean | SD |
| Group 1 | 1450.90 | 1926.70 | 1677.08$^{e}$ | 155.19 |
| Group 2 | 280.60 | 402.60 | 352.54$^{a}$ | 32.74 |
| Group 3 | 602.30 | 910.00 | 775.14$^{b}$ | 101.93 |
| Group 4 | 800.50 | 1243.80 | 959.28$^{c}$ | 128.67 |
| Group 5 | 1280.40 | 1595.50 | 1433.14$^{d}$ | 98.57 |
| Group 6 | 856.30 | 1324.00 | 979.17$^{c}$ | 124.22 |
| Group 7 | 1301.40 | 1616.70 | 1480.20$^{d}$ | 102.90 |

Different superscript letters between subgroups denote significance at 5% level (post-hoc test).