

A Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth Restored with Different Composite Resin Core Build-Up Materials: An In Vitro Study

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ABSTRACT

AIM AND OBJECTIVE: To compare and evaluate the fracture resistance of endodontically treated teeth with different composite resin core build-up materials: An *in vitro* study .

METHOD: In this in-vitro study, sixty human permanent mandibular premolars were taken and divided into six groups containing 10 samples each.

Group A (n=10): Negative Control (Not subjected to cavity preparation or root canal treatment.); Group B (n=10): Positive Control (Subjected to cavity preparation and root canal treatment but left unrestored.); Group C (n=10): Ever X Posterior composite; Group D (n=10): Beautifil bulk Restorative Composite; Group E (n=10): Vittra APS Composite; Group F (n=10): Palfique Omnichroma Composite.

Standardised mesio-occlusal-distal (MOD) cavities were prepared in the remaining 50 teeth. The root canals for all the teeth were prepared, and the canal orifices were sealed with GIC. All the specimens were restored with different composite materials and cured. Fracture strength testing was performed using a universal testing machine.

RESULTS: The fracture strength demonstrated substantial variation among the six groups. Group 1 (control – intact teeth) showed the highest mean fracture strength (920.71 ± 13.37 N), indicating maximum resistance to fracture. In contrast, Group 2 (control – unrestored endodontically treated teeth) exhibited the lowest mean fracture strength (230.01 ± 9.00 N). Among the experimental groups, Group 3 (EverX Posterior) recorded the highest mean fracture strength (735.50 ± 16.89 N), followed by Group 4 (Beautifil Bulk Restorative) with a mean value of 639.79 ± 26.63 N. Group 5 (Vittra APS Composite) and Group 6 (Omnichroma Composite) demonstrated mean fracture strengths of 609.26 ± 20.09 N and 587.49 ± 25.99 N, respectively.

CONCLUSION: Although the restored groups did not attain fracture resistance comparable to intact teeth, all experimental groups showed markedly higher fracture strength compared to the unrestored endodontically treated control group. Ever X Posterior showed highest fracture resistance among the tested materials and can be used as core build up materials.

Keywords: Fracture resistance, Endodontically treated teeth, Composite resin core build-up, EverX Posterior, Bulk-fill composite.

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INTRODUCTION

Caries, trauma, preparation of access cavity, and radicular preparation lead to loss of tooth structure.¹ The effectiveness of root canal therapy, the quantity of remaining dentine thickness, and post-endodontic healing affect the survival of endodontically treated teeth.² The chemicals that are used for biomechanical preparation and intracanal medications also affect the fracture resistance of such teeth. Teeth that have had undergone root canal therapy are less resistant to fracture and have less fracture toughness due to loss of water content and

anatomic structure, which causes loss of its structural integrity. Therefore, a better core build-up material is required to preserve the remaining tooth structure and increase its resistance and retention.³ Modern composite materials have been introduced with various properties to suit any clinical situation as they have improved fillers and polymer processes.⁴ Fiber-reinforced composite has been shown to reduce the risk of tooth fracture in endodontically treated teeth. They have been recommended for the biomimetic replacement of dentine in larger cavities and endodontically treated

teeth due to their superior mechanical and physical properties.⁵

In this study, the teeth that have been endodontically treated and are restored using different composite materials have been examined to evaluate the fracture resistance of each material.

Bulk-fill composite reinforced with short fibres (SFC), EverX Posterior (GC Corporation, Tokyo, Japan), is a high-strength restorative material, and its compressive strength is 329 MPa. It features an optimal blend of barium glass fillers and E-glass fibres within a solid polymer matrix. The integration of short fibres enhances fracture toughness, making it superior to collagen-reinforced dentin and nearly twice as strong as conventional composites.⁶ A beautiful bulk restorative (Shofu, Japan) is made by combining several fillers with different monomers to minimise shrinkage and stress during the polymerisation

process. The glass fillers in Beautiful bulk-fill restorative are more wettable and better incorporated into the matrix. It has a 340 MPa compressive strength.⁷

Vittra APS (Advanced polymerisation system) Composite is the Universal chroma light-curing premium composite and is based on zirconium silicate, for all dental shades. Its compressive strength is 358 MPa. It has the following benefits: Contains zirconia silicate for high resistance and shine, and is BPA-free. It maintains polished surfaces even after acid exposure. APS Technology allows longer working time, improved photopolymerization, and better aesthetics with enhanced shade transmission.

OMNICHROMA is the first universal composite in the world that uses a single shade to aesthetically match every patient, from A1 to D4. OMNICHROMA is able to match all 16 VITA classic shades due to its evenly sized supra-nano spherical fillers (260 nm spherical SiO₂-ZrO₂), a technology refer to as Smart Chromatic Technology.

METHOD

This in vitro experimental study was conducted in the Department of Conservative Dentistry and Endodontics in collaboration with I.T.S Engineering College, Greater Noida.

Sample Selection

Sixty extracted human mandibular premolars with single straight canals were selected according to predefined inclusion and exclusion criteria.

Group Distribution

Samples were randomly divided into six groups (n=10):

- Group A: Intact teeth (negative control)
- Group B: Prepared and endodontically treated unrestored teeth (positive control)
- Group C: EverX Posterior Composite
- Group D: Beautiful Bulk Restorative Composite
- Group E: Vittra APS Composite
- Group F: Palfique Omnicroma Composite

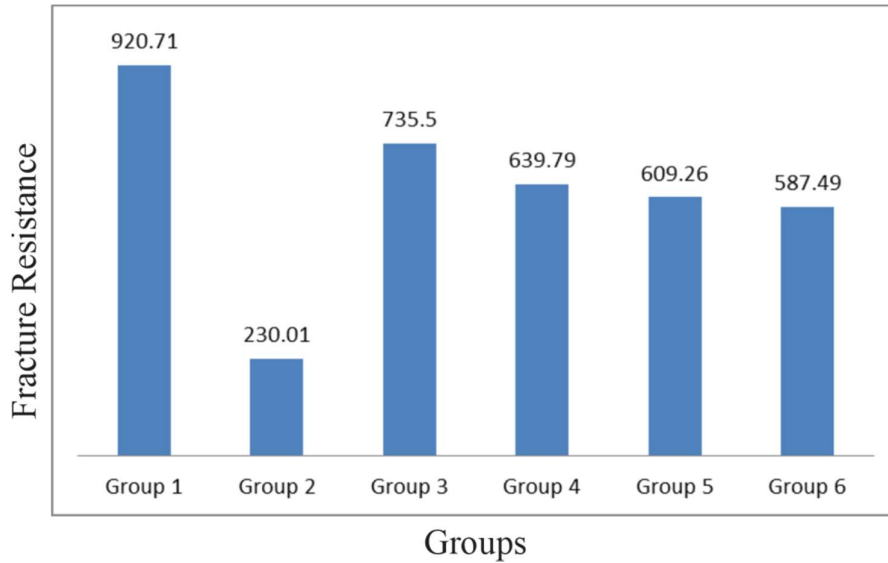
Methodology

Standardized MOD cavities were prepared in all groups except Group A using a straight fissure bur and a high-speed arotor handpiece. Root canal treatment was completed using crown-down technique with rotary instrumentation up to size 30-4% using the Safe Endo rotary file system as per manufacturer's recommendation. Irrigation was performed using 5.25% sodium hypochlorite, 17% EDTA, and saline. Obturation was done with gutta-percha and AH Plus sealer and the canal orifices was sealed with GIC. Restorations were performed according to manufacturer instructions. Group C received EverX Posterior covered with Tetric N-Ceram composite, while Groups D, E, and F were restored using Beautiful Bulk Restorative, Vittra APS Composite, and Omnicroma Composite respectively.

Fracture Resistance Testing

Samples were stored in distilled water at 37°C for 24 hours before testing. Fracture resistance was evaluated using an Instron Universal Testing Machine with a compressive load applied at 1 mm/min until fracture occurred. Maximum load at fracture was recorded in Newtons (N).

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RESULTS.

Group	Mean	Std. Deviation	Std. Error	95% CI (Lower)	95% CI (Upper)	Minimum	Maximum
Group 1	920.71	13.365	4.226	911.152	930.274	895.450	947.100
Group 2	230.01	9.001	2.846	223.572	236.450	216.540	241.430
Group 3	735.5	16.887	5.340	723.425	747.585	695.460	757.370
Group 4	639.79	26.627	8.420	620.745	658.841	592.420	667.720
Group 5	609.26	20.086	6.352	594.895	623.631	585.950	646.880
Group 6	587.49	25.986	8.217	568.902	606.080	553.630	633.780
Total	620.460	209.731	27.017	566.284	674.642	216.540	947.100

TABLE 1 - DESCRIPTIVE STATISTICS OF FRACTURE STRENGTH BY GROUP

The descriptive analysis of fracture strength demonstrated substantial variation among the six groups. **Group 1 (control – intact teeth)**

showed the highest mean fracture strength (920.71 ± 13.37 N), indicating maximum resistance to fracture. In contrast, **Group 2 (control – unrestored endodontically treated teeth)** exhibited the lowest mean fracture strength (230.01 ± 9.00 N), highlighting a pronounced reduction in fracture resistance following cavity preparation and root canal treatment when no restorative intervention was performed. Among the experimental groups, **Group 3 (Ever X Posterior)** recorded the highest mean fracture strength (735.50 ± 16.89 N), followed by **Group 4 (Beautiful Bulk Restorative)** with a mean value of 639.79 ± 26.63 N. **Group 5 (Vittra APS Composite)** and **Group 6 (Omnichroma Composite)** demonstrated mean fracture strengths of 609.26 ± 20.09 N and 587.49 ± 25.99 N, respectively. Although the restored groups did not attain fracture resistance comparable to intact teeth, all experimental groups showed markedly higher fracture strength compared to the unrestored endodontically treated control group.

GRAPH 1- DESCRIPTIVE STATISTICS OF FRACTURE STRENGTH BY GROUP

ISSION

Endodontically treated teeth are more prone to fractures as compared to vital teeth and to ensure the long-term functionality of these teeth, it is crucial to preserve sound root dentin of teeth, and its structure to facilitate proper canal filling and post restoration.⁸

In the present study, standardised mesio-occlusal-distal (MOD) cavities were prepared. These are consistent with the findings of Corsentino et al.'s study, which found that the fracture resistance of ETTs was considerably decreased by the loss of mesial and distal walls.⁹ Additionally, Ibrahim et al. found a positive

linear correlation between fracture resistance and the remaining coronal dentin surface area.¹⁰

The strength of a tooth depends on the remaining structure, especially the peri cervical dentin, which is critical for stress distribution. Loss of this dentin increases fracture risk, and excessive tapering of rotary instruments can weaken radicular dentin.¹¹

In addition to strengthening, repairing, and reinforcing the tooth, the restoration serves as an efficient seal between the oral cavity and the canal system. Following cavity preparation and endodontic treatment, the teeth's strength was significantly reduced. To support the remaining tooth structure, the cavity must be reinforced with a restorative material. In contrast to pin retaining or tooth cutting for crown restoration, restorative material preserves the greatest amount of healthy tooth structure.¹²

In the present study, four different composite resin core buildup materials were tested for their fracture resistance values with two control groups.

Group A (negative control), consisting of intact teeth without cavity preparation or endodontic intervention, exhibited the highest fracture strength with a mean value of 920.710 ± 13.365 N, reflecting the inherent structural integrity of sound tooth tissue.

Group B (positive control), which included teeth subjected to cavity preparation and endodontic treatment but left unrestored, showed a drastic reduction in fracture strength (230.010 ± 9.001 N). The extremely low fracture resistance in this group underscores the critical role of restorative intervention in endodontically treated teeth.

Group C, Ever X Posterior is a fibre-reinforced composite designed to be used as dentin replacement, in this study, this group showed highest fracture resistance value compared to other experimental groups and lesser than Group A negative control group. It avoids crack formation through the filling, which is considered to be the main cause of composite failures. The randomly arranged barium glass and silicinated E-glass fillers provide an isotropic reinforcement action in different directions. Having a fibre length that is equal to or greater than the critical fibre length improves the mechanical characteristics. The length of the E glass fibres in the bisphenol A glycol dimethacrylate polymer matrix is 3 mm, which is longer than the critical fibre length of 0.5–1.6 mm. This may have affected the study's findings, which demonstrated the tooth's

greater resistance to fracture.¹³

Group D, Beautifill bulkfill which is a giomer, i.e. a combination of glass ionomer and a polymer. It contains surface pre-reacted glass ionomer (S-PRG) filler particles within the resin matrix. It is considered a true hybrid of composite resin and glass ionomer, and therefore, the presence of glass ionomer is responsible for its weak compressive load values, not making it a true bulkfill composite. In this present study, the fracture resistance of this group was found to be lower than Group A and Group C.

Group E Vittra APS composite, in the present study showed less fracture resistance as compared to Group A, C, D and higher fracture resistance than Group F and B.

Group F Omnicroma Composite showed least fracture resistance value than Group A, C, D, E and higher value than Group B.

The present study has certain limitations -The study was performed in vitro, so the effect of oral environment was neglected and in vivo studies are required to investigate the possible effect of forces on the fracture resistance of restorative materials.

According to the observations and results of the present study it was concluded that among the tested composite resin material, Ever X posterior composite provided the greatest reinforcement, followed by Beautifil Bulk Restorative, Vittra APS composite, and Palfique Omnicroma composite.

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