Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2020;10:3:156-161.

# Fracture Resistance of Flared Root Canals Reinforced with Bulkfill Composite: An In-Vitro Study

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## ABSTRACT

**Background**: The aim of this study is to evaluate the fracture resistance of teeth when flared root canals are reinforced using bulkfill composite and fiber post.

**Materials and method:** A total of 30 freshly extracted human maxillary central incisors were collected. The teeth were divided into 3 groups of 10 specimens each. All specimens were simulated to flared root canals by instrumenting using peeso reamers Group 1 (control group), Group 2 (experimental group; Direct anatomic post), Group 3 (experimental group; Flowable bulk fill resin). All teeth were subjected to fracture testing using a universal testing machine and data recorded in newtons.

**Statistical analysis:** Statistical data is analyzed using one way ANOVA test and Tukey post hoc test for intergroup comparisons exhibiting the p-value of $P< 0.05$, which was significant.

**Result:** Group 2 & 3 had a statistically significant effect on the fracture strength of flared roots ($p<0.05$) When compared with group 1. Intergroup comparison shows no statistically difference between group 2 & 3 ($p>0.05$). Highest fracture resistance was observed in group 2

**Conclusion:** Both direct anatomic and flowable bulk fill technique increased the fracture resistance of teeth with no statistical significance; however, direct anatomic post group showed the highest value of fracture resistance.

**Keywords:** Post and core, endodontic, fiber post, flared root canal, fracture resistance, bulkfill composite, relining, direct anatomic post, root canal.

## INTRODUCTION

Teeth that have undergone endodontic therapy may require the use of an intra-radicular post and core to retain the final restoration.[1] Flared root canal may result from immature root apices and over instrumentation which often poses as a challenge to the clinician. Traditionally such teeth were restored

**Received:** May. 6, 2020**: Accepted**: June. 27, 2020
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pISSN 2278-0076
eISSN 2321-9270

with cast post and core, they intimately adapt to the canal morphology. They offer a better fit and high retention. However, studies have shown that cast post and core produce a wedging action under masticatory forces and thereby resulting in catastrophic root fractures.[3]

Another factor to be considered is the rigidity and high modulus of elasticity of cast post that eventually leads to root fracture.[4] It was found that to avoid root fractures, a post having a modulus of elasticity similar to that of dentin helps in distributing the stress of occlusal load in a uniform pattern[5]. For these reasons fiber post is now widely used in restoring the structurally compromised teeth and teeth with flared canals.[6,7]

Many techniques, like the direct anatomic post and the use of auxiliary post have been advocated to aid in better adaptation to the canals[6,8]. Despite any technique used, it was found that the type of luting resin cement for endodontic posts seems to have a remarkable impact on the fracture resistance of endodontically treated teeth.[9]

Bulk- fill composites have an advantage that it can be used in increments up to 4mm of thickness. This class of material exhibits low polymerization shrinkage stresses.[10] Bulk-fill composites contain a polymerization modulator that results in a slower modulus development,[12] thereby reducing polymerization stress without decreasing the degree of conversion and while keeping optimal proportions of filler to matrix ratio. This makes their mechanical properties similar to those of conventional hybrid composite resin.[11] considering the high configuration factor of root canal cavity; the properties of bulk fill composite resin makes it applicable to reinforce the flared root canals.[12]

Therefore, the aim of the present study is to evaluate the fracture resistance of simulated flared root canals when reinforced using bulk-fill composite and fiber posts.

## MATERIALS AND METHOD

A total of 30 freshly extracted human maxillary central incisors were collected. To ensure an even size distribution within groups, mesio-distal (MD) and facial-lingual (FL) dimensions were measured at the level of the cement enamel junction (CEJ). Calculus and periodontal tissues were removed, and

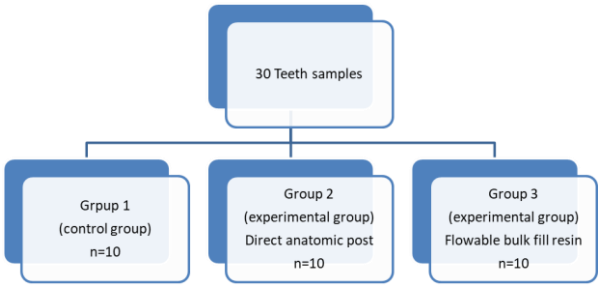


Chart 1: Flow chart of procedures

Table 1: Comparison between groups.

| GROUPS | Min-Max | Mean ± SD | 95 % CI | SIGNIFICANCE |
|---|---|---|---|---|
| GROUP I – (Control) | 172.50 - 260.00 | 202.16 ± 66.75 | 185.65 – 223.66 | P<0.05 |
| GROUP II (Direct anatomic) | 451.00 - 778.30 | 616.73 ± 121.77 | 541.25 – 692.20 | |
| GROUP III (Bulkfill) | 360.40 - 763.50 | 564.77 ± 142.48 | 476.46 – 653.07 | P>0.05 |

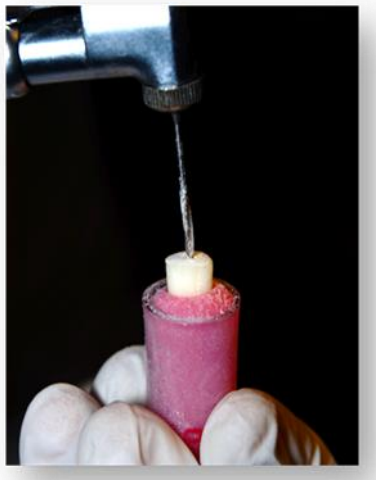

Fig a: Preparation of flared canal.

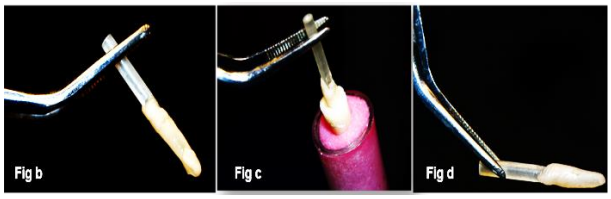


Fig b -d: Preparation of direct anatomic post and its restoration using resin cement.


Fig e, f: Checking the post fit, injecting the flowable bulk fill resin. Fig g: Insertion of fibre post in bulk fill resin.

Fig g: Flared canal. Fig h: Relining the canal using flowable bulk fill resin.

teeth were stored in 0.9% saline solution at 37$^0$C. The teeth were examined using a dental operating microscope at 6X magnification to verify the absence of caries resorption and cracks. Canal morphology was verified from standardized periapical radiographs. Teeth with large root canals or roots with apex dilacerations, resorption, or surface defects were excluded from the study.

The teeth were divided into 3 groups of 10 specimens each (chart 1). Anatomical crowns were transversely sectioned at 1.0 mm coronal to the CEJ of the buccal aspect using a diamond low-speed rotary cutting instrument (Buenoaires, Argentina). All teeth underwent root canal treatment. The root canals were instrumented manually in a step-back technique to an apical size of ISO 40 (Mani, Japan). The canals were dried with absorbent paper points and obturated using gutta-percha and sealer (AH plus, Dentsply, Germany) with cold lateral condensation.

**POST SPACE PREPARATION AND FLARING OF CANALS:**

Post space preparation for all teeth was initiated after 48 hrs from obturation by the use of a peeso reamers (Mani, japan ) from size 1 to 6 and leaving the apical 5mm of gutta-percha (fig: a). No solvent was used during the whole procedure. Samples were irrigated using the saline solution during the procedure to minimize the heat generation. All samples were stored at 37ºC and 100% relative humidity for 48 h[9].

**Post cementation for group 1:**

Ten teeth served as a control group. The post was conditioned with 37% phosphoric acid gel (Ivoclar, Vivadent) for 15 seconds, followed by silane application (Monobond). The adhesive was applied on coronal tooth structure and introduced into the canal and rubbed in for 20 seconds. The excess was removed using paper points and a gentle stream of air for about five seconds. The adhesive was then light-cured for 20 seconds. Dual-cured flowable resin cement (Multilink, Ivoclar-Vivadent) was introduced into the root canal using the dispenser tip followed by cementation of fiber post. Light curing was done for 60 seconds.

**Post cementation for group 2:**

Ten teeth served as an experimental group, for group 2 postconditioning was done in the same manner as that of group 1. For the samples of this group direct anatomic post was made as follows: The fiber post (D.C white post, FGM) was covered with a nanohybrid composite resin (Tetric N-Ceram, Ivoclar-Viva-dent) (fig: b), and the set (fiber post and composite resin) was inserted into the canal (fig: c) which was previously lubricated with a hydrosoluble gel (Glycerin).

This set was removed and replaced twice for better adaptation (fig: d), the excess cervical resin composite was removed. The composite resin was light-cured for 20 seconds with the post inside the root canal. The relined fiber post was then removed, and the composite resin was additionally light-cured for 20 seconds on each surface for additional polymerization. Adhesive was applied into the root canal space and dual cured resin cement (multilink, Ivoclar vivadent) was injected. After which the relined post was seated in the canal followed by additional curing for 60 seconds.

**Post cmentation for group 3:**

10 teeth served as experimental group. Adhesive was applied to the coronal tooth structure and the root canal by rubbing in for 20 seconds. The excess was removed with paper points and a gentle stream

of air for about five seconds. The adhesive was then light-cured for 20 seconds. The light-curing unit had an intensity of. Bulk Fill Flowable composite resin (Ivoclar, Vivadent) was inserted in the flared root canal (fig: f), then a fiber post (White Post DC), previously lubricated with glycerin gel, was inserted in the composite resin (fig: g). Light activation was done on the top of the translucent post for 20 seconds. The fiber post was removed from the resinous root canal, and additional light activation was completed for 40 seconds, keeping the tip of the light-curing unit in contact with the entrance to the root canal.

The post was rinsed with water to remove the lubricant, dried with a stream of air, etched for 15 seconds, rinsed with water, and dried again. After which silane was applied and left for 60 seconds followed by thoroughly drying the post with an air stream. A disposable applicator was used to apply the adhesive on the entire post surface to be luted, and was light-cured for 20 seconds. The canal was copiously rinsed with water to remove the lubricant gel. The dual-cured resin cement (multilink, Ivoclar, Vivadent) was applied on the post and in the canal, and the post was placed in the root reinforced with bulk-fill flowable composite. After removing the excess, the cement was polymerized through the translucent post for 60 seconds. For all the samples of 3 groups core bulid up was done using packable composite.

All the specimens were subjected to a universal testing machine (Instron 8500 Plus), set to deliver an increasing load until fracture. The specimens were placed at an angle of 45 degrees to the long axis of the tooth, with the application point midway between the lingual slope of the buccal cusp, and between the central fissure and the cusp tip. The crosshead speed of 0.01 cm/min was used, and the load was applied at an angle of 45 degrees to the long axis of the tooth. The force applied was recorded in newtons.

### STATISTICAL ANALYSIS

Statistical data is analyzed using one way ANOVA test and Tukey post hoc test for intergroup comparisons exhibiting the p-value of $P< 0.05$, which was significant.

## RESULTS

Group 2 & 3 had a statistically significant effect on the fracture strength of flared roots ($p<0.05$) When compared with group 1. Intergroup comparison shows no statistically difference between group 2 & 3 ($p>0.05$). Highest fracture resistance was observed in group 2(TABLE- 1).

## DISCUSSION

A flared root may show compromised longevity due to the thin remaining tooth structure. The treatment options vary considerably depending on the amount of remaining dentin for retaining the crown and the internal nature of the root structure.

In an attempt to improve the fracture resistance of endodontically treated teeth restored with a post-and-core system, extensive research has been conducted on post materials, post designs, luting agents, and ferrule effect.[13,14,15] One of the other methods of restoring the flared roots is the use of accessory posts in which entrapment of air bubbles could be the main disadvantage and may compromise the fracture resistance of teeth.[15] It was found that the weakest link in post and core restorations is the cement and dentin interface. Use of conventional technique i.e. use of resin luting cement and fiber post in an attempt to adapt the flared canals, increases the polymerization shrinkage and its stresses.[9] This could be the reason of low fracture resistance in the present study for the teeth in group 1.

According to the study by Silva et al., dowel relining technique is a way of reducing the cement thickness in flared roots and thereby decreasing the polymerization shrinkage stresses.[16,17] The importance of glass fibre–reinforced dowels relined with composite resin in flared roots are confirmed by other studies.[18,19] Amin and others[19] concluded that the group restored with glass fiber reinforced dowels relined with composite resin in flared roots showed significantly higher fracture resistance values.

In the present study, flowable bulk fill resin was used as it has better flowability and can be cured up to 4-5mm. Bulk fill composites have improved photoinitiator efficacy by the incorporation of additional photoinitiators, including trimethylbenzoyl-diphenylphosphine oxide (TPO)

derivatives or benzoyl germanium compounds (Ivocerin, Ivoclar Vivadent), providing a synergistic effect to camphorquinone.[20]

Fiber posts have a low modulus of elasticity, and the stress generated by the load is distributed evenly along the length of the post.[21,22,23,24] Duret, et al.[27] (1990) reported that this type of post transmits stress along with the post-dentin interface and reduces the stress concentration. Another factor that increases the stress distribution is the possibility of bonding between the fiber post and radicular dentin.[25,26]

The white post-DC has been selected for the present study as it has increased light transmission. Morgan et al. [28] assessed the luminous energy transmitted through different translucent fiber posts with a digital photometer and showed an increased light transmission up to 12mm of depth.

In the present study, no statistical difference was observed between experimental groups; however, the group restored with direct anatomic post showed an increased fracture resistance than other groups. The reason could be attributed to reduced resin cement layer between the relined post and dentin in group 2 thereby reducing the polymerization stresses when compared with group 3 which had thick resin that might have increased the polymerization shrinkage stresses.

## CONCLUSION

Intraradicular posts in Flared root canals restored using relining technique showed an increase in fracture resistance. Both direct anatomic and flowable bulk fill technique increased the fracture resistance of teeth with no statistical significance; however, direct anatomic post group showed the highest value of fracture resistance. Flowable Bulk fill relining technique required fewer steps, and it is less time-consuming procedure when compared to direct anatomic post technique.

## CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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