

# Comparative Evaluation of Fractured Resistance of Different Post System in Endodontically treated Teeth: An *in vitro* Study

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## ABSTRACT

**Aim:** The aim of the study is to evaluate the fracture resistance of an endodontically treated teeth restored with different post and core systems.

**Materials and methods:** Thirty extracted premolar teeth with similar size were chosen and randomly divided into three groups. After cutting the crowns and endodontic therapy, the teeth were restored with custom-made post (group I), carbon fiber post (group II), and EverStick post (group III). Fiber posts were cemented with dual-cured resin cement and cast posts were luted using luting glass ionomer cement. Samples were embedded in the acrylic resin blocks. And a compressive load was applied to the tooth at a crosshead speed of 1 mm/minute and fracture loads were recorded. The results were then analyzed by one-way analysis of variance F test and *post hoc* Tukey's test.

**Results:** There was statistically significant difference between groups I and II (mean difference 53.10,  $p = 0.001$ ) and between groups I and III (mean difference 171.60,  $p = 0.001$ ). On comparing the mean values and standard deviation, it was observed that EverStick posts (332 N) showed maximum fracture resistance followed by carbon fiber posts (213.5 N) and then custom cast (160.4 N) showed least resistance to fracture.

**Conclusion:** It can be concluded that among the three posts system used in the present study, the EverStick posts showed the maximum fracture resistance as compared with the carbon fiber posts and custom-made post. However, long-term clinical studies are required to determine the success rate of the EverStick posts.

**Keywords:** Everstick, Post, Resistance, Strength.

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## INTRODUCTION

Reconstruction of endodontically treated teeth is a great challenge in restorative dentistry since the tooth crown is usually totally or partially lost by caries, erosion, abrasion, previous restorations, trauma, or endodontic access. If more than half of the coronal structure has been lost, a root canal post is required to provide retention for the restoration.<sup>1</sup>

When assessing an endodontically treated tooth for restorative treatment, it has to be assumed that good judgments have been made previously concerning the periodontal status of the tooth, the remaining tooth structure, and the prognosis of the endodontic treatment. The tooth to be restored should exhibit a good apical seal when evaluating the radiograph, and also exhibit no sensitivity to percussion or palpation, no exudates, no fistula, no apical sensitivity, and no active inflammation.<sup>2</sup>

Although posts are recommended to strengthen the teeth, several investigators have cautioned that posts with inadequate resistance to rotational forces on the posts can weaken the teeth. Consequently, root fractures constitute the most serious type of failure in post restored teeth. To prevent root fractures, a post should have an elastic modulus similar to that of dentin – a property that enables a more uniform distribution of stress by distributing the occlusal load. On the contrary, while it is important to ensure that a post is firmly cemented to provide adequate retention for the restoration and adequate protection of the remaining tooth structure, it should yet be easily removed if retreatment were required.<sup>3</sup>

## MATERIALS AND METHODS

Forty freshly extracted single rooted premolars were selected for the study. The teeth were decoronated 2 mm coronal to the proximal cemento-enamel junction using a diamond disc.

Access opening is done. The canal was prepared by crown-down technique using rotary protaper (Dentsply,

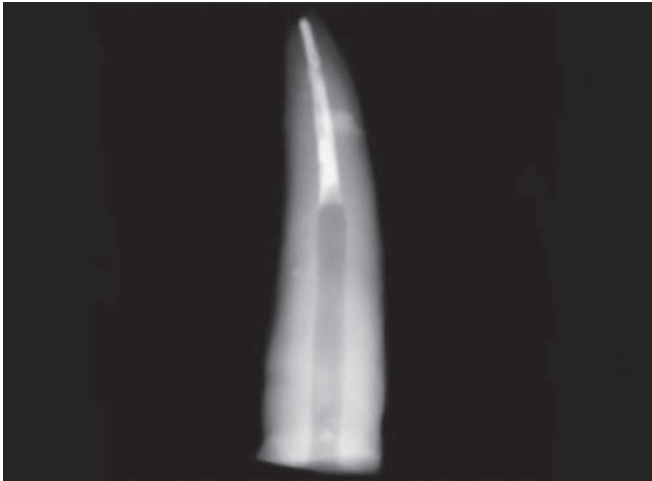
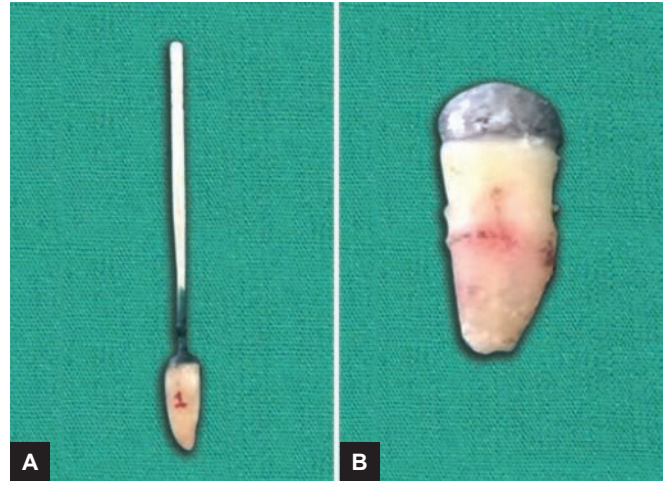


Fig. 1: Radiograph after post space preparation



Figs 2A and B: Custom cast post

Maillefer) till F2 protaper. A radiograph of each specimen was taken to confirm satisfactory obturation of the canal.

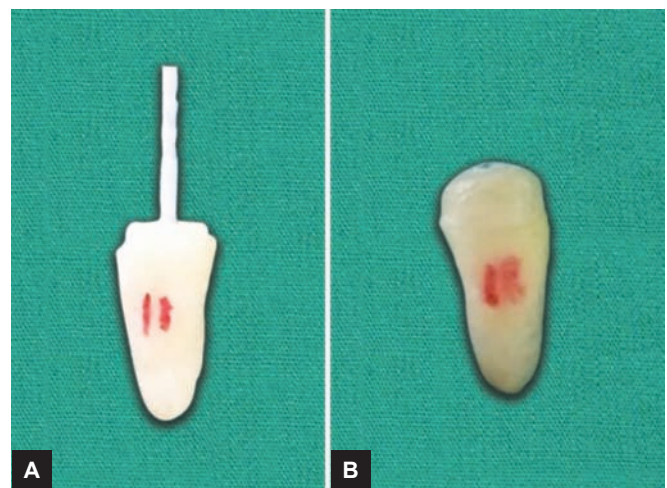
Following the post space preparations, the canal was irrigated with saline solution and dried with paper points (Dentsply, Maillefer) (Fig. 1).

All the specimens (30 samples) were then divided into 43 groups of 10 samples each.

- Group I: Custom cast post
- Group II: Carbon fiber post
- Group III: EverStick post

Group I: Wax pattern is prepared for all the samples. Wax pattern was invested and castings were obtained. Luting glass ionomer cement mixed according to manufacturer's instructions was applied to the prepared canal with lentulospiral, and applied to the custom-made post. The posts were then seated in the canals under finger pressure. Once set, excess cement was removed with a sharp hand instrument (Figs 2A and B).

Group II: SelfCem self-adhesive dual-cure resin cement is used according to manufacturer's instructions, applied to the prepared canal with lentulospiral, and applied to the post. The carbon posts were then seated in the canals under finger pressure and light cured for 40 seconds. Once set, excess cement was removed with a sharp hand instrument and composite core buildup is done (Figs 3A and B).

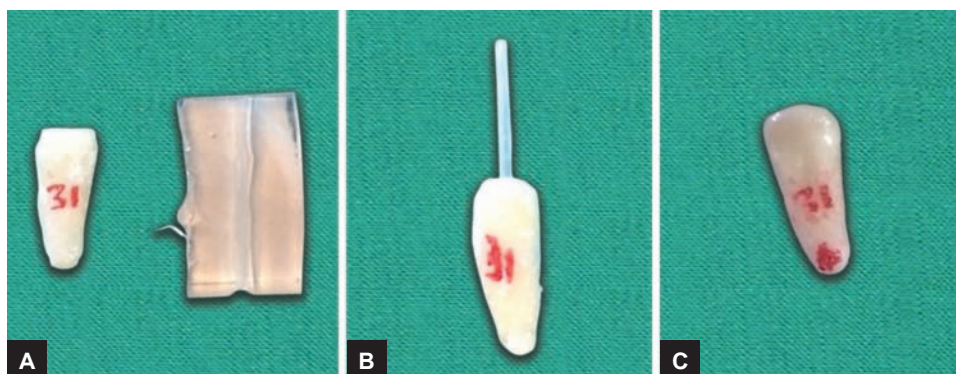


Figs 3A and B: Carbon fiber post

Group III: SelfCem self-adhesive dual-cure cement is applied on the wall of the canals and EverStick post is adapted to the canal walls and it is cured for 40 seconds. Composite core build is done (Figs 4A to C).

All the samples are embedded in the acrylic resin blocks by using a mold that provided a flat surface.

A device was designed that allowed loading of the tooth at an angle of 90° to its long axis. Then the specimens



Figs 4A to C: EverStick post

were mounted on the lower plate of the universal testing machine and a compressive loading was applied vertically to the coronal surfaces of the roots at a cross-head speed of 1 mm/minute until fracture occurred. The load at which failure has occurred was recorded and expressed in Newton. The results were then analyzed by one-way analysis of variance (ANOVA) F test and *post hoc* Tukey test.

## RESULTS

There was statistically significant difference between groups I and II (mean diff 53.10,  $p = 0.001$ ) and between groups I and III (mean diff 171.60,  $p = 0.001$ ) (Tables 1 to 3).

On comparing the mean values and standard deviation, it was observed that EverStick posts (332 N) showed maximum fracture resistance followed by carbon fiber posts (213.5 N) and then custom cast (160.4 N) showed least resistance to fracture.

## DISCUSSION

Endodontics and prosthodontics go hand-in-hand to retain pulpless, badly broken down teeth that would have otherwise seemed fit for extraction, and thereby, reinstating them as a functional member of the masticatory system.<sup>4</sup>

When the remaining tooth structure cannot provide adequate support and retention for restoration, endodontically treated teeth are usually restored with posts. Restoring these teeth using materials with a similar elastic modulus to dentin appears advantageous due to the reduced risk of root fracture. The fracture resistance

of endodontically treated teeth has been reported to be principally dependent on the amount of remaining tooth structure and adhesive surface, the quality of adhesion, and the type of post because posts increase the fracture resistance of the root, especially in the absence of a full crown.

Cast post and core have been widely used to reestablish the dental structures lost during endodontic treatment. In spite of its popularity, the cast post and core restoration has some disadvantages that may jeopardize long-term success. Disadvantages mentioned in the literature include tooth weakness related to the removal of root structure to accommodate the necessary post length, lack of cement retention, corrosion risks, poor stress distribution leading to root fracture, difficulties in removal of the post, necessity for two appointments to complete the procedure, and laboratory costs.<sup>5</sup>

In the last several years, there have been significant advances in the development of bondable, fiber-reinforced, esthetic posts to reinforce endodontically treated teeth. These fiber posts are improvements on other types of esthetic posts used in the past. The specific needs of light, translucent composite resins and ceramics to mimic the natural tooth require the use of translucent posts in the esthetic zone. The presence of a metal post can cause shadowing of the soft tissues adjacent to the root surface, which will adversely affect the esthetic results required of bonded resin and ceramic restorations in the anterior region. The earliest fiber-reinforced composite (FRC) posts were introduced in the United States in 1995 and were fabricated with carbon fibers. They had excellent physical properties but because of the carbon, fibers were black. More esthetic fiber posts were developed and clinical trials with these earliest fiber posts (which have similar properties to the current generation of tooth-colored fiber posts) have been highly successful. When compared with ceramic posts, esthetic fiber posts provide endodontically treated teeth with higher fracture resistance.<sup>2</sup>

**Table 1:** Mean and standard deviation values

Groups	Mean	Standard deviation
Custom-made fiber post	160.4	6.71
Carbon fiber post	213.5	9.18
EverStick post	332	36.42

**Table 2:** One-way ANOVA F-test

Source of variation	Sum of squares	Degree of freedom	Mean square	F-ratio calculated	Sig.
Between groups	194,219.475	3	64,739.825	170.427	0.001
Within groups	13,675.300	36	379.869		

**Table 3:** *Post hoc* Tukey analysis of comparison of fracture resistance between different types of post system

	Custom	Carbon	EverStick	Glass
Custom	-	Mean diff = -53.10 ( $p = 0.001$ )	Mean diff = -171.60 ( $p = 0.001$ )	Mean diff = -2.00 ( $p = 0.996$ )
Carbon	Mean diff = -53.10 ( $p = 0.001$ )	-	Mean diff = -118.50 ( $p = 0.001$ )	Mean diff = 51.10 ( $p = 0.001$ )
EverStick	Mean diff = 171.60 ( $p = 0.001$ )	Mean diff = 118.50 ( $p = 0.001$ )	-	Mean diff = 169.60 ( $p = 0.001$ )

$p \leq 0.05$  = significant using one-way ANOVA



In order to minimize root weakness, numerous tooth FRC posts have been introduced as an alternative to cast post core and ceramic posts. These FRC posts are composed of fibers (e.g., carbon, quartz, silica, zirconia, or glass) in a resin-based matrix. Metal posts have a homogeneous (isotropic) structure, whereas posts made of FRC are anisotropic. The presence of parallel fibers in FRC posts enables them to absorb and dissipate stresses.<sup>6</sup>

The first fiber posts were made of carbon fibers due to their good mechanical properties. However, they were black in color and thus lack cosmetic qualities. Although the flexural strength of fiber posts has been shown to be relatively high, large variations in the reported flexural modulus of carbon/graphite fiber posts can be found.<sup>7</sup>

One study reported that a carbon fiber-reinforced post had flexural modulus values comparable to a stainless steel post.<sup>8</sup> Other study<sup>7</sup> suggested that teeth restored with carbon fiber posts have higher fracture strengths than those with prefabricated titanium posts or cast metal post restoration.

A study done by Chakmakchi et al<sup>9</sup> stated that the teeth receiving EverStick post were associated with the highest fracture resistance ( $1780.30 \pm 155.2$ ) in Newton. This could be due to the multiphase polymer matrix of these types of posts consisting of both linear and cross-linked polymer phases. The monomers of the adhesive resins and cements can diffuse into the linear polymer phase, swell it, and by polymerization form interdiffusion bonding and so-called secondary semi-interpenetrating polymer network (IPN) structure, which will reduce stress formation at post/dentin and post/cement interfaces.

In our study, which is in accordance with the results, on comparing the fracture resistance, it was observed that EverStick posts (332 N) showed maximum fracture resistance followed by carbon fiber posts (213.5 N) and then custom-made posts (160.4 N) showed least resistance to fracture.

EverStick post is an ideal solution for curved, oval, and large root canals, offering the advantage of a cast post but with superior bonding ability. Patented IPN technology is at the heart of EverStick fibers. EverStick fiber bundles have up to 4,000 individual silanated E glass fibers that are fully impregnated with resin. It is soft and flexible and has high flexural strength after curing. Its elasticity is very similar to that of dentin. Adhesive and micromechanical bonding to both composite cement and

core composite ensures a strong bond to the root canal and the composite core.<sup>10</sup>

In the present study, EverStick posts was proven to have better fracture resistance than the other post systems used. Because laboratory testing cannot exactly simulate *in vivo* conditions, the result of any *in vitro* investigation must be viewed with caution. The method evaluated in this study is technique sensitive. So, results may vary according to knowledge and experience of the operator of the technique.

## CONCLUSION

Under the limitation of the present study, it can be concluded that among the three post systems used in the present study, the EverStick posts showed the maximum fracture resistance as compared with the carbon fiber posts and custom-made post. However, long-term clinical studies are required to determine the success rate of the EverStick posts.

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