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Original Article

Fracture resistance of post and core in immediate and delayed post space in trauma simulated teeth

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Abstract: Introduction: This research aims to assess and analyze the fracture resistance of GC Everstick post with separate composite core buildup and Edelweiss prefabricated resin composite post and core single unit into immediate and delayed post space prepared teeth. Methods: A total of 120 extracted human mandibular premolars have been subjected to a standardized protocol of mechanical trauma to simulate tooth fracture. Teeth samples were randomly divided into four groups (n = 30) on the basis of time taken for the preparation of post space (approximately following root canal obturation and 24 h after root canal obturation) for the single unit Edelweiss post and core system and GC post with separate core buildup. Compressive load has been utilized to do the analysis necessary to establish the fracture resistance using a universal testing machine. The fracture force calculated was in Newtons (N), and a stereomicroscope was utilized for investigating the common causes of failure. Results: In an immediate post space prepared tooth, the GC post exhibited a mean failure load of 970.584 N. In contrast, the Edelweiss post, and core system showed a significantly higher mean failure load of 1250.349 N. In delayed post space prepared tooth, the GC Everstick post exhibited a mean failure load of 950.287 N. In contrast, the Edelweiss post, and core system showed a significantly higher mean failure load of 1229.348 N. Conclusion: This study aims to assess and analyze the fracture resistance of the GC Everstick post with separate composite core buildup and the Edelweiss prefabricated resin composite post and core single unit in immediate and delayed post space prepared teeth. The study results showed that the failure modes in both groups were non-catastrophic in nature. These findings suggest that the Edelweiss post and core system may be a more suitable option for restoring teeth that have been subjected to traumatic conditions. The study provides valuable information for dental professionals in their decision-making process for post and core restoration techniques in teeth that have been subjected to trauma.

Keywords: Everstick, mandibular premolar, resin composite

Introduction

Posts are frequently needed in teeth with extensive hard tissue loss as an outcome of cavities or trauma in order to ensure appropriate retention of the core material [1]. Frequently, teeth that have had endodontic treatment have impaired crown structures [2]. These teeth also present altered esthetics and changed physical characteristics. Previously, several investigations have indicated that the decrease in the water content and loss of cross-linking of collagen result in the brittleness of endodontically treated tooth [1]. Hence, a suitable rehabilitation procedure is required in pulp-treated permanent teeth to achieve a desirable result [2]. A common restoration method when a large portion of coronal structure is lost is using a post and core to reconstruct the tooth, then sealing it with a crown [3]. The restorations of choice during the 20th century were metal post-and-core systems, among which custom-made post-and-cores are most commonly used. Multiple visits and laboratory fabrication are the major drawbacks of the cast post and core placement process, along with other complications such as poor retention and the risk of corrosion of the post and the potential for root fractures due to the wedging effect [4]. As a result, these factors opened a gateway for a wide selection of post systems, which are viable in the day-to-day market. Post retention could be enhanced with adhesive luting cement [5]. The incorporation of fibers into a polymatrix could lead to the substantial development of mechanical characteristics such as fracture toughness, strength, stiffness, and fatigue resistance. A mechanical unit is formed between the tooth and core using adhesive composites [6]. The advent of glass fiber posts and composite resin introduced the novel perception of "Endo Esthetics" [7].

Furthermore, the glass fiber post is translucent and forms a monoblock, bonding each constituent to the tooth either indirectly or directly and strengthening the intra-radicular teeth framework, which has exceptional transverse strength [8]. It is noted that the core structure acts as a stress conduit for the residual root dentin, the post structure, and the crown. Anytime the magnitude of the stress transmitted equals or surpasses the limit of withstanding resistance, a root fracture is observed. The GC Everstick (GC, Sydney, Australia) post is a relatively new, elastic, resin-permeated, uncured glass fiber post that contains an interpenetrating polymer network (IPN) resin matrix that is curable to form an anatomic morphology of the root canal [9]. The disadvantages of a resin composite core bonded with a fiber-reinforced post are that additional clinical time is spent at the chair side in the fabrication of the core and that there is a possible bond cohesive failure in the composite core material and post surface [10].

Consequently, in order to get around the drawback of using a separate core. Edelweiss Dentistry, Austria has introduced a prefabricated tooth colored post and composite core with a high-density laser-sintered composite material with an elastic modulus similar to dentin. This post system with a core is customizable and radiopaque with a shortened chair side time and improved clinical characteristics. The need for this study would be to investigate the efficacy of numerous post and core restoration in teeth that have been subjected to simulated traumatic conditions. The results of this study could help dental professionals make informed decisions about which restoration methods are best suited for teeth that have been damaged due to trauma, and also help identify potential weaknesses in current restoration techniques. Additionally, this study would also help to improve the overall understanding of the factors that contribute to the fracture resistance of post and core in teeth that have been subjected to trauma, which could lead to the development of new and improved restoration techniques in the future.

Materials and methods

The study's approval was granted by the institution's research and ethical review board.

Specimen selection criteria

A total of 120 single rooted human mandibular first premolar teeth removed for orthodontic purposes over a period of 110 days were randomly selected at Sri Aurobindo College of Dentistry, Indore, India. In order to preserve the tooth's enamel and dentin mechanical properties for *in vitro* testing, a 0.5% chloramine-T solution was utilized at room temperature for storage. All the extracted teeth have been analyzed under dental operating microscopy to rule out the presence of pre-existing cracks.

Inclusion and exclusion criteria

To ensure the suitability of the extracted human mandibular premolars used in the research, the teeth included in the study were single-rooted with straight roots and fully developed apices and had not undergone previous root canal treatment or restoration. Additionally, the teeth had no visible cracks or defects on the surface and had similar dimensions in terms of length and diameter. Furthermore, the teeth had no signs of periodontal disease or resorption. On the other hand, the exclusion criteria consisted of multi-rooted teeth or teeth with curved roots, with incomplete root formation, or open apices, with previous root canal treatment or restoration, with visible cracks, or defects on the surface, with significantly different dimensions compared with other teeth in the sample, and those with signs of periodontal disease or resorption. These criteria were meticulously applied to ensure that the samples used in the study were appropriate for the research question and to minimize potential confounding factors.

Preparation of specimen

A single root canal was confirmed by mesiodistal and buccolingual radiographs. The effect of tooth repair under traumatic conditions was simulated by subjecting the extracted human mandibular premolars to a standardized protocol of mechanical trauma. This protocol involved creating a standardized cavity in the center of the occlusal surface of every tooth using a high-speed handpiece and then removing the cusps using a slow-speed handpiece with a diamond bur to simulate a fracture. After the simulated fracture was created, root canal treatment was performed on each tooth using a standardized protocol, the patency of the canal and the working length determination were verified using a 10k file and a 15k file, respectively. Canals were cleaned and shaped utilizing a crown-down approach and rotary ProTaper Gold files (size: F3; Dentsply Maillefer, Ballaigues, Switzerland). Simultaneous irrigation using 3% sodium hypochlorite (Neelkanth Pvt. Ltd., Jodhpur, India) and 17% EDTA (PrevestDenpro, India) took place and finally rinsed with saline (Ives Drugs, Indore, India). The canal was then dried and then obturated by a single cone obturation method using ProTaper Gutta-Percha points (size: F3) and AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland). The quality of obturation was verified with a radiograph. Post space was made instantly and after 24 h of the obturation for GC Everstick and Edelweiss post and core. Samples were randomly divided into four groups.

Distribution of study groups

Group A (n = 30): GC Everstick post was placed in the immediately prepared post space teeth, and distinct composite core buildup was done.

Group B (n = 30): A resin composite post and core single-unit Edelweiss post system was placed in the immediately prepared post space.

Group C (n = 30): GC Everstick post was put into delayed post space prepared teeth, and another composite core buildup had been done.

Group D (n = 30): Edelweiss post (Edelweiss, Wolfurt, Austria) system was placed in the delayed prepared post space.

The obturation material was taken out to 9 mm using a peeso reamer (Dentsply Maillefer, Ballaigues, Switzerland) in sizes 1, 2, 3, and 4 for the GC Everstick post. For the Edelweiss group, the manufacturer's recommended drill was used. The Edelweiss drill has a width of 1.4 mm on the apical tip and a length of 9 mm. The obturated apical gutta percha length was maintained at 5-6 mm for the apical seal. The trial fit of both the GC Everstick and Edelweiss posts and the core single unit was checked radiographically. The post space was Etched with a 37% phosphoric acid, i.e., Eco-Etch (Ivoclar Vivadent, Mumbai, India) for 20 s. The etchant was removed and properly cleaned with water after 20 s. Afterwards, post space was prepared by blotting and drying with enough paper points and cotton pellets. Using a periodontal probe (API, Delhi, India), the prepared canal's depth was calculated. The GC Everstick post of a suitable length was cut using sharpened scissors, and the post length was determined by inserting it inside the prepared root canal. Depth and taper were adjusted using sharp scissors. After shaping the post, it was light-cured for around 20 s in the canal. In the oval canal, an additional post is shaped and bonded with the main post coronally with a thin layer of Te-Econom Bond (IvoclarVivadent, Mumbai, India) and light cured for 10 s. After curing for 40 s with light from all directions, the GC Everstick post was taken out of the canal and surface-treated with a silane coupling agent using the Ultradent. The Edelweiss post and core single unit was surface-treated using the Edelweiss Veener Bond. Te-Econom Bond was coated to the post and post space with a disposable brush or applicator tip and light cured for 10 s. Dual-cured restorative cement LuxaCore Z flow (DMG America, Ridgefield Park, USA) was filled in the prepared root canal, and the post was inserted slowly and light cured for 40 s. A core buildup of an inciso-cervical length of 5.5 mm and a mesiodistal width of 5 mm was completed using Te-Econom Plus.

For the Edelweiss post and core single unit, Edelweiss veneer bond had been applied and light-cured for 20 s. LuxaCore Z flow was dispensed on the post surface using a syringe. To prepare the post space and residual coronal tooth structure, the post was immediately inserted in the prepared post space and was stabilized for 60 s. The tooth samples were mounted on an acrylic block (DPI, Mumbai, India) with a polyvinylsiloxane impression material (GC Flexceed, Gurugram, India) to replicate the periodontal ligament.

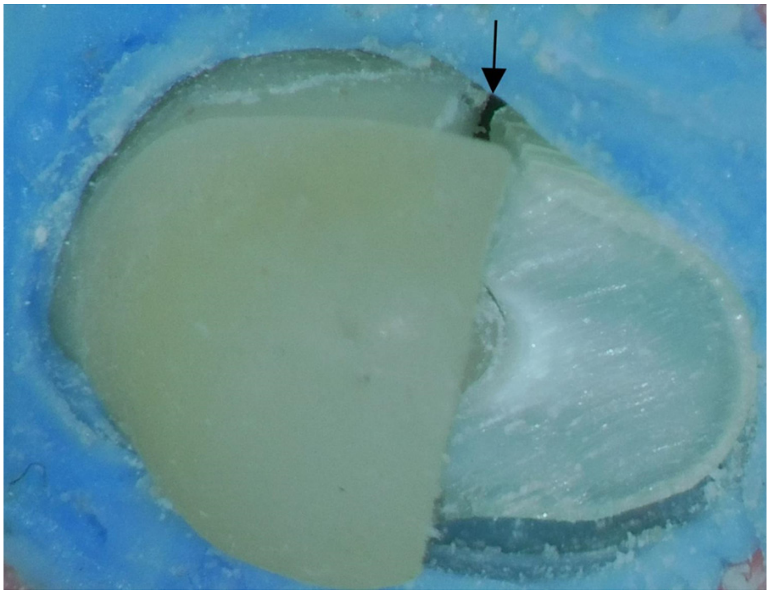

Figure 1. Root fracture - considered as catastrophic fracture (arrow).

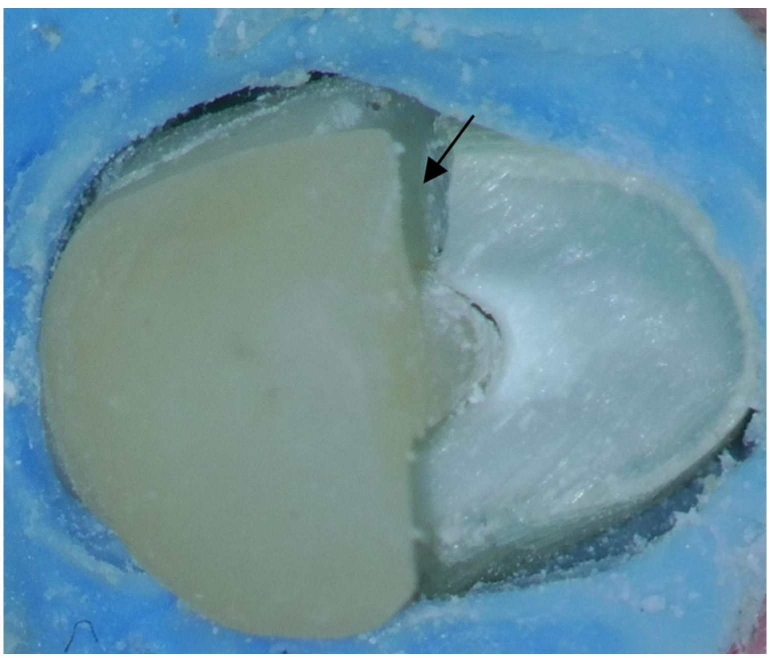

Figure 2. Core fracture - considered as non-catastrophic fracture (arrow).

Evaluation of samples

All 120 samples were put through manual thermocycling (serological water bath) at 5°C and 55°C with a residue time of 30 s. Fracture resistant testing was performed using the universal testing machine (Mecmesin, MultiTest-i Systems, United Kingdom), with the specimen mounted on the retaining arms of the machine. The load tip was placed at 135° on a horizontal plane on a standard marking made in the middle of the lingual occlusal line core angle, and continuous compressive force was applied with a cross-head speed of 0.5 mm/min until fracture was created.

Mode of failure

To identify the reason for the failure, every specimen is assessed under a stereomicroscope (Lawrence and Mayo, Lynx, Mumbai, India) at 20× magnification. Root fractures were thought of as catastrophic fractures (**Figure 1**), while core fracture, debonding of the post, post fracture, and tooth fracture were believed to be non-catastrophic fractures (**Figure 2**).

The observation indicators of this study could include

Fracture resistance of the post and core: This is the main outcome measure of the study, and it can be evaluated by measuring the maximum load that the tooth can withstand before it fractures. This was measured using a universal testing machine.

Mode of failure: This refers to the mode (catastrophic or non-catastrophic fracture) of tooth fracture and can be evaluated by examining fracture surfaces using the stereomicroscope. Different modes of failure include cohesive failure within the tooth structure, adhesive failure among the post and core and tooth structure, and mixed failure (a combination of cohesive and adhesive failures).

Time points of post space preparation: This is also a categorical variable and can be evaluated by recording the time point at which the post

Table 1. Overall inter group comparison of mean failure load among four study groups using One-way Anova F test respectively

	Mean	SD	One-way Anova F test	*P* value, Significance
Group A	970.58	220.2	F = 15.752	P<0.001**
Group B	1250.34	330.4		
Group C	950.28	225.3		
Group D	1229.34	340.7		

**P<0.001 - highly statistically significant difference.

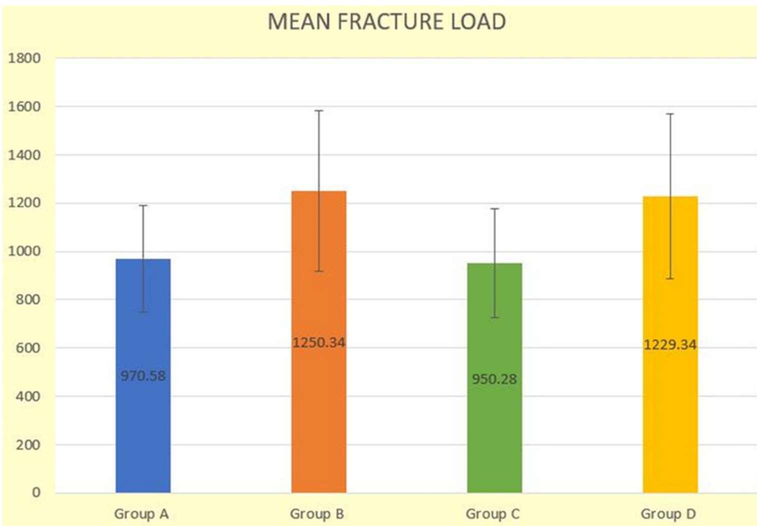

Figure 3. Mean fracture load in immediate and delayed post space prepared tooth.

space was prepared (immediately following root canal obturation or 24 h after root canal obturation).

To evaluate these observational indicators, appropriate statistical methods were used. Descriptive statistics, such as the mean, SD, and percentage, were used to summarize the data. Inferential statistics and t-tests were used to test for substantial variances among groups.

Statistical analysis

Statistical software SPSS 19.0 (SPSS Inc., Chicago, IL, USA) was used to process the data. Fracture load were expressed as mean standard deviation (SD). Bond failure count was expressed in frequency and percentage. One-way Anova F test was used for overall inter-group comparison among four study groups in relation to mean failure load count followed by Tukey's post hoc test for pairwise intergroup comparison. Chi square test was used for comparison of different bond failure type among four study groups. The level of significance was determined at P<0.05.

Results

On overall inter group comparison of mean failure load among four study groups using One-way Anova F test respectively, there was found to be highly statistically significant difference (P<0.001) among four study groups. Highest failure load resistance seen in Group B followed by Group D, followed by Group A and least in Group C (**Table 1**; **Figure 3**).

On pairwise inter group comparison of mean failure load between four groups using Tukey's post hoc test, it was observed that the timing of post space preparation has been found to have a significant impact on the sealing ability of two different materials. There was a significant difference observed in the fracture resistance of the two posts (Edelweiss resin composite post and core single unit, and G.C. everstick post and core) when used in both immediately and delayed post space-prepared teeth (P<0.05). Edelwiss post & core group was found to have highly statistical significantly greater fracture resistance load (P<0.001) as compared to Everstick post both with immediate & delayed preparation. However, there was no significant difference (P>0.05) observed in the fracture resistance of either post when intra-group comparisons were made between immediate and delayed post space preparation (P>0.05). On comparison between immediate and delayed preparation, Immediate preparation tends to have greater fracture resistance as compared to delayed preparation but the difference was not found to be of statistical significance in both material post & core (**Table 2**).

In immediate post space prepared tooth

The GC Everstick post exhibited a mean failure load of 970.584 ± 220.234 N (**Table 1**) with 45% of tested samples resulting in core frac-

Table 2. Pairwise inter group comparison of mean failure load between four groups using Tukey's post hoc test

Tukey's post hoc test for pairwise comparison			
Group	Comparison Group	Mean Difference	*P* value, Significance
Group A	Group B	279.76	P<0.001**
	Group C	20.3	P = 0.762 (NS)
	Group D	258.76	P<0.001**
Group B	Group C	300.06	P<0.001**
	Group D	21.0	P = 0.713 (NS)
Group C	Group D	279.06	P<0.001**

P>0.05 - no significant difference (NS), *P<0.05 - significant, **P<0.001 - highly significant.

ture, post debonding in 40%, and post fracture in 15% (**Tables 1**, **3**). In contrast, the Edelweiss resin composite post and core single unit showed a significantly higher mean failure load of 1250.349 ± 330.489 N (**Table 1**), with 80% and 20% of samples exhibiting core and tooth fractures, respectively, and no post debonding, or post fracture observed (**Tables 1**, **3**).

In delayed post space prepared tooth

The GC Everstick post exhibited a mean failure load of 950.287 ± 225.345 N (**Figure 3**) with 50% of tested samples resulting in core fracture, post debonding in 40%, and post fracture in 10% (**Tables 1**, **3**). In contrast, the Edelweiss resin composite post and core single unit had a mean failure load of 1229.348 ± 340.786 N (**Table 1**) with 75% and 30% of samples exhibiting core and tooth fractures, respectively, and no post debonding, or post fracture observed (**Tables 1**, **3**).

The majority of failure patterns seen in immediate post space prepared teeth in the GC Everstick post and Edelweiss post and core were core fractures, followed by post debonding seen in both immediate and delayed post space prepared teeth for the GC Everstick post (**Table 3**; **Figure 4**).

Discussion

This study examined the fracture resistance of root canal-treated, GC Everstick-restored teeth and core (core buildup material: Te-Econom Plus) versus laser-sintered nanohybrid composite post and core single unit Edelweiss post system. A total of 120 tooth samples, all less than six months old, were extracted, and preserved in a 0.5% chloramine T solution for this research [11].

In teeth that lost the majority of their coronal structure and were endodontically treated, the post, and core system was utilized as an elementary material for their ultimate restoration, which includes the decision of whether or not posts should be used. Based upon remanent axial cavity walls, access preparation with all four axial cavity walls remaining is classified as Class I; Class II when one cavity wall is lost, either mesio-occlusal, or disto-occlusal; Class III with a loss of mesio-occluso-distal walls; Class IV when only one wall is remaining, mostly the buccal or lingual wall; and Class V when a decoronated tooth is present in the absence of any cavity walls. The ultimate factor that influences the ability to withstand complex crown-root functional stresses is the nominal thickness of the wall of the cavity, which is generally kept at around 1 mm. Full crown preparation is not possible on hard tissue that is thinner than 1 mm. Hard tissue thickness >1 mm is adequate for stabilizing the core material following crown preparation. The minimum height of the cavity wall to achieve a satisfactory level of ferrule effect is 2 mm. In certain cases where at least two axial walls are persistent, no post is needed. If there is just one cavity wall left or if there are none at all, a post should be placed, but a ferrule of 2 mm is needed to ensure a decreased likelihood of root fracture [12]. Previously, cast metal posts were the most prevalent in the post and core system. Few dentists still use them as their preferred option for post-endodontic conditions. However, they failed two times as often as prefabricated fiber posts and may also result in catastrophic root fractures [7].

An investigation of the fracture resistance of glass fiber posts, carbon posts, and quartz fiber posts, and concluded that quartz, carbon, and fracture resilience are excellent in glass fiber-reinforced posts and therefore can be utilized in endodontically treated teeth [13]. The fracture resistance of GC Everstick, glass fiber, and carbon fiber posts was also compared in another investigation, and it was concluded that although the GC Everstick posts manifest-

Table 3. Comparison of bond failure among four study groups

Failure pattern	Group A (n = 30) N (%)	Group B (n = 30) N (%)	Group C (n = 30) N (%)	Group D (n = 30) N (%)	*P* value (Chi square test)
Tooth Fracture	0/30 (0%)	6/30 (20%)	0/30 (0%)	7/30 (23.3%)	P = 0.036*
Core Fracture	13/30 (43.3%)	24/30 (80%)	15/30 (50%)	23/30 (75%)	P = 0.17 (NS)
Post Debonding	12/30 (40%)	0/30 (0%)	12/30 (40%)	0/30 (0%)	P = 0.011*
Post Fracture	5/30 (15%)	0/30 (0%)	3/30 (10%)	0/30 (0%)	P = 0.26 (NS)

P>0.05 - no significant difference (NS), *P<0.05 - significant.

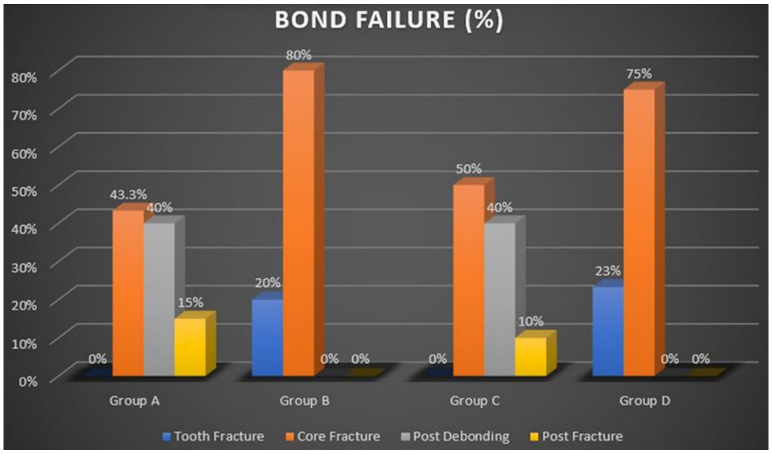

Figure 4. Bond failure analysis-percentage wise distribution.

ed maximum bonding resin penetration, which clinically affects getting a strong coronal seal, the fracture resistance values were less than those of other posts [14].

The Edelweiss post and core system is a laser-sintered nanohybrid composite that employs a homogenous monoblock. The manufacturer's claim, close to 0% likelihood of post and core debonding.

The Edelweiss post and core single unit is available in seven forms: upper anterior, premolar, molar and lower anterior, premolar and molar, and a universal post without the core. The study used the lower premolar form of this post and core system, with a post length of 9 mm and an apical diameter of 1.4 mm. Core dimensions include an inciso-cervical length of about 5.5 mm and a mesiodistal width of 5 mm.

The GC Everstick post is a relatively new, flexible, resin-impregnated, uncured glass fiber post made with IPN resin matrix that could be treated to the anatomic morphology of a root canal [11]. It is available in three sizes: 0.9, 1.2, and 1.5. In this investigation, the 1.5 GC Everstick post was used.

The core dimensions include an inciso-cervical length of about 5.5 mm and a mesiodistal width of 5 mm. Root length was measured consistently across samples, and a post system was selected based on that data. All samples underwent root canal therapy after work length had been formed. In 2017, Poletto D et al. compared apical leakage among immediate and delayed post space prepared teeth using the AH plus sealer. They described how gutta percha might exhibit some motions and perhaps break the connection at the sealer interface because of the rotational stresses caused by Gates Glidden drills and concluded that post spaces prepared just after obturation showed a notably reduced amount of leakage [13]. In our study, the apical gutta percha was maintained at 5-6 mm to provide apical seal. Poletto explained that 17% EDTA with 2.5% sodium hypochlorite is needed for the efficient removal of smear layer. Study also explained that after post space preparation, ultrasonic activation had little impact on the elimination of the secondary smear layer [14].

In the proposed investigation, 17% EDTA (PrevestDenpro, India) and 3% sodium hypochlorite were used. Sodium hypochlorite is used to disinfect and clean the root canal space, while EDTA is used to improve the bond strength between the core material and the dentin by removing the mineralized layer and smear layer, and improving the wettability of the dentin. The post space and the remaining dentin were etched with 37% phosphoric acid (the total etch system). Te-Econom Bond dental adhesive was used for further bonding. Te-Econom Bond is a light-cured dental adhesive used to bond composite materials that combines the adhesive and primer into a single container. A decrease in the number of components and procedural steps facilitates usage, maintains a higher grade of bond strength, and provides protection against microleakage. The weakest link in the repair is post adhesion in the root canal. The resin substance is utilized in luting and forming the core that reacts with the post surface to produce a link between the fiber post and composite material. Recently, numerous surface treatments have been suggested in an effort to intensify resin bonding to the posts: 1) salinizing and applying adhesive; 2) acid etching, sandblasting, and silica coating; and 3) different etching methods (combining micromechanical and chemical components) [15]. Salinizing and applying adhesive represent the most scrutinized surface treatments in our literature. To improve fiber post adhesion to composite resins, silane coupling agents are used as coatings [15].

In the present investigation, the GC Everstick post was surface-treated using a silane coupling agent (Ultradent) and the Edelweiss post and core single unit was surface-treated with Edelweiss Veener Bond. After salinization, the posts were cemented with LuxaCore Z flow. It is Dual Cure Core Buildup Material utilized for the Cementation of Endodontic Posts. The LuxaCore Z flow is a two-part system made up of the base and the catalyst. Which form a dual-cured, exceedingly filled composite resin core buildup and post-cementation material on mixing. When the post has been firmly cemented, core buildup is subsequently accomplished by the GC Everstick post samples to obtain a standard core buildup at a length of 5.5 mm and a width of approximately 5 mm. With the Edelweiss post and core single unit system, after fixing the post, and core unit, the deficient areas were restored with the LuxaCore Z flow dual cure composite. In the Edelweiss post and core single unit, the core dimension was standardized to a length of 5.5 mm and a mesiodistal width of approximately 5 mm.

After the cementation of the two-part systems in their respective groups, the samples were then mounted on acrylic resin blocks. The height and breadth of the acrylic block were standardized at 2.1 × 2.1 × 2.7 cm^3. The use of a rigid material for embedding extracted teeth can possibly alter the load value and the specimen's mode of failure. It was for this reason that an effort had been implemented to replicate periodontal ligament and adjacent anatomical structures by coating roots with polyvinyl siloxane and subsequently embedding roots in acrylic resin [16]. The samples underwent many thermal cycling tests. Thermal cycling is considered a fundamental aspect of dentin adhesion testing. Thermal cycling creates stress at the bonding agent-solid tissue interface because of variances in the coefficient of thermal expansion within multi-component materials or an increased rate of hydrolytic degeneration of the cementing agent. Temperatures of 50°C and 55°C with a hold time of 30 s were given for every sample.

To ascertain the fracture toughness, a universal testing machine was used after the thermocycling (serological water bath) process [17]. A load tip of 1 mm in diameter was placed at 135° on a horizontal plane on a standard marking formed in the midlingual occlusal line core angle, which is in line with earlier research. A continuous compressive force was applied with a cross-head speed of 0.5 mm/min until fracture occurred [18]. The point of fracture was determined by an immediate drop of the applied force, and the audible crack, and the force were calculated in Newtons. The fracture toughness of the GC Everstick post was examined in the proposed investigation, and the Edelweiss single-unit composite post was subjected to load until failure. The fracture toughness under load on the Edelweiss composite post and core system showed higher fracture resilience in comparison to the GC Everstick post. The resin composite material is a nanohybrid composite adapted by the unique laser sintering and vitrifying processes, which results in the composite becoming a single inorganic phase, improving its mechanical and physical properties, and is therefore a possible explanation for high fracture resistance.

A stereomicroscope was used to view the failure mode of each sample at 20 × magnification. Various types of failure modes were seen in the glass fiber post, such as core fracture, post debonding, post fracture, tooth fracture, and root fracture. According to our research, debonding of posts is the main reason for failure linked to fiber-reinforced composite posts.

The debonding occurred at the post-cement interface instead of the cement-dentin or intracemental fracture.

Shortcomings of the study

Changes were observed in the distribution of forces to the root, post, and core complexes when the whole crown with a 2-mm ferrule was cemented upon a sound tooth framework. Cores that were not cemented with a complete crown were also included to study the test loads. This was to exclude the impact of any external reinforcement on the post and core foundation. If the whole crown over the core was included, the outcomes of our research might be different [19]. Another constraint of this study was that a continuous increase in static load was applied to samples that are not kinds of load into oral cavity. An experiment under cyclic loading could have probably mimicked forces acting on the teeth in the oral cavity [20]. Furthermore, this is *in vitro* research; the efficacy of the material could vary in a clinical situation. The study did not evaluate the long-term success or failure rates of these systems, which may be important for clinical decision-making.

Effectiveness of these materials in recovering the tooth's inherent strength in the long run-in clinical evaluations will aid in their juxtaposition.

Conclusions

Based on the fracture toughness and failure mode of the GC Everstick post, core buildup using Te-Econom Plus, and the Edelweiss resin composite post and core single unit, it could be inferred that the fracture resistance of the Edelweiss resin composite post and core single unit is significantly higher in simulated dental trauma scenarios compared with that of the GC Everstick post. Failure modes in both systems were non-catastrophic in nature. The modes of failure of the GC Everstick post were mainly core fracture, post debonding, post fracture, and tooth fracture, whereas those of the Edelweiss resin composite post and core single unit are core fracture and tooth fracture. However, the Edelweiss post and core single unit showed no signs of debonding or fracture.

This study can help future research by providing a foundation for investigating the fracture resistance of different post and core systems in simulated traumatic conditions. Overall, this study can contribute to the development of a body of evidence that can guide clinical decision-making for the repair of traumatically injured teeth. The outcomes of our research could have significant implications for clinical practice. The Edelweiss post and core system is found to be more resistant to fracture under traumatic conditions than other post and core systems, it could become a preferred choice for restoring traumatized teeth. This study may also prompt further research into developing post and core materials that can better withstand traumatic forces. It would be interesting to conduct long-term follow-up studies to evaluate the survival and success rates of teeth restored with different post and core systems, particularly in patients who have experienced traumatic injuries. Biomechanical analysis of the fracture behavior of different post and core systems could also provide a deeper understanding of the underlying mechanisms of post and core failure under traumatic conditions.

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Disclosure of conflict of interest

None.

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