

# **Comparative Evaluation Of Endodontically Treatedteeth Reinforced With Bendable Titanium Post And Straight Titanium Post- An In-vitro Study**

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## **Introduction:**

Trauma and decay are often associated with an extensive loss of tooth structure, requiring a restoration for aesthetic and functional rehabilitation of the tooth. Often caries leads to loss of tooth structure and vitality of the pulp. Endodontic treatment is necessary in such cases. Adequate anchorage for restoration cannot be achieved if a significant amount of coronal section of the tooth is lost i.e. when only one wall or no wall is remaining. To increase the retention of the restoration post and core treatment is required.

Endodontic treatment influences the strain values and fracture resistance of the remaining tooth (Valdivia et al 2012). Most of the endodontic treatment failures are influenced by masticatory

load. Teeth which are nearer to transverse horizontal axis are subjected to increased amount of load as compared to anterior teeth. The fracture resistance of the tooth is also directly proportional to remaining bulk of dentin. Post space preparation can increase the amount of dentin removed thus affecting the load bearing capacity of the tooth. To prevent the major tragedy of vertical root fracture (VRF) cases, researchers have been focusing on materials used for post fabrication, designs of the post, luting agents, and the ferrule effect.

Various types of post and core systems have been introduced in dentistry. Endodontic post and core may be cast using material such as gold and nickel-chromium (Ni-Cr), or they may be prefabricated, such as titanium, stainless steel posts and fiber posts. For many years, the custom made posts have been the choice of restoration for endodontically treated teeth. However custom-made posts are technique-sensitive, might cause metal allergy and have high higher modulus of elasticity than dentin, which increases the risk of catastrophic failure (Santos-Filho et al 2014; Schwartz et al 2004). As compared to other metallic materials titanium is highly biocompatible, least corrosive and has a modulus of elasticity closer to dentin which helps in even stress distribution. Use of a straight titanium posts requires excessive post space preparation in the curved canal (Baba and Goodacre 2019). This disadvantage of straight titanium post can be overcome by bendable titanium posts due to its flexible nature. Therefore, with introduction of titanium bendable posts it is important to address the question whether these posts provide the mechanical advantage or not. The purpose of this study was to compare fracture resistance between endodontically treated teeth (ETT), endodontically treated teeth reinforced with bendable titanium posts and straight titanium posts by applying vertical force.

### **Aim:**

To evaluate and compare the fracture resistance of endodontically treated teeth reinforced with bendable titanium posts and endodontically treated teeth reinforced with straight titanium posts.

### **Materials and methodology**

Freshly extracted human permanent mandibular molars with complete root formation were collected for the study from Department of Oral and Maxillofacial Surgery, Rural Dental College, Loni over a period of six months. Institutional ethical clearance was obtained from the Ethical Committee before the start of the study. Teeth which were fractured below cement-enamel junction, root canal treated teeth, had immature apices or any signs of root resorption were excluded from the study. A total of sixty freshly extracted teeth with intact root apices were included for the study. They were cleaned for stains, tissue debris and/or calculus, and were stored in 0.2% thymol until further use. The selected sixty samples were divided into three groups using simple random lottery sampling method. Group 1 were endodontically treated teeth (control group) (n=20), group 2 were endodontically treated teeth reinforced with bendable titanium post (n=20) and group 3 were endodontically treated teeth reinforced with straight titanium post (n=20).

All the sixty samples were subjected to root canal treatment. The samples of the group 2 and 3 were sectioned using abrasive diamond discs under continuous irrigation with 0.9% normal saline, 2 mm horizontally, coronal to the cemento-enamel junction, measured buccally and lingually at the highest circumference. The access was performed using endo access kit, with high speed airtor handpiece (NSK, Japan). For working length determination, the actual root length was measured visually. A #10 k-file was placed into the most cervical edge of the apical foramen, and then were retracted back 0.5 mm. This length was kept as working length. After establishing glide path, the instrumentation of the canals was carried out using rotary files 4% till size 25 under copious irrigation with 2.5% sodium hypochlorite, 0.9% normal saline and 17% EDTA as chelating agent. Final irrigation was performed with 0.9% normal saline. The canals were then dried with paper points and obturation was done with 25 #4% gutta percha points and AH plus sealer with cold lateral compaction.

Post space of 7mm was prepared with the help of Gates Glidden drills size #0 to #4 (1.30 mm), under copious irrigation with 0.9% normal saline. After confirming removal of gutta percha from the walls of the canal, both the canal and the pulp cavity were irrigated with the help of sodium hypochlorite 2.5% and flushed with the help of normal saline 0.9% to remove the dentin sludge; the Filpost was tried and ensured that it was inserted to its length and was in continuity with the gutta percha. The excess was then cut off with wire cutter and removed using the Fillock reamer which comes in the case, the walls of the root canal were grooved, giving it one or two turns as recommended by the manufacturer (Fig. 1). Pre-treatment of the tooth surface was done initially by 37% phosphoric acid for 15 seconds. It was then rinsed and blot dried to keep it moist. Tetric N-Bond Universal was the bonding agent used in this study. Dual cure resin (DMG Luxacore Z, Germany) was syringed into the canal and the treated post was inserted. The core build up was performed with the help of plastic core formers. It was then cured using an LED Curing gun. The core height was standardized at 4mm from the remaining coronal tooth surface.

For the bendable group, post was inserted and bent with the help of plier to obtain added mechanical retention, enclosing it in the cavity; the pre-treatment of the canal and core build up was same as described above. Radiographs were made post cementation (Fig. 2). Tooth preparation was done with the help of SO-20 and EX- 21 diamond points (Mani Inc. Japan). Full veneer metal crown was fabricated and cemented with glass-ionomer cement (GIC) Type 1.

The specimens were mounted in individual acrylic blocks of dimension 30mm X 20mm X 20mm till the cemento-enamel junction. After the samples were mounted on to the acrylic block, compressive load was applied using a 1 mm diameter ball tip at a speed of 1mm/min, in the region of the central fossa. The specimens were subjected to compressive load in a Universal Testing Machine, until the fracture occurred. The force was measured in Newton. Statistical analysis software namely SYSTAT version 12 (made by Crane's software, Bangalore) a licensed copy was used to analyse the data.

**Results:**

The endodontically treated teeth showed the highest mean value of fracture resistance at 11063.30N. The endodontically treated teeth reinforced with bendable titanium posts showed the least mean value of fracture resistance at 6611.50N. The endodontically treated teeth reinforced with straight titanium posts showed mean value superior to bendable posts but inferior to endodontically treated teeth without posts at 7211.00N (Graph no. 1). On applying one way ANOVA test a significant difference was seen between mean values of load (N) at which fracture occurred in group 1, group 2 and group 3 when compared ( $p=0.0013$ ). Post hoc Tukey Kramer Multiple Comparison test gave a significant difference between group 1 and group 2 and in between group 1 and group 3. There was no significant difference seen between group 2 and group 3. By applying Student's Unpaired 't' test there was a significant difference between mean values of load at which fracture occurred (N) when group 1 was compared with group 2 ( $p=0.0001$ ) (Graph no. 2) and when group 1 was compared with group 3 ( $p=0.0130$ ) (Graph no. 3); while Student's Unpaired 't' test showed no significant difference between mean values of load at which fracture occurred in (N) when group 2 was compared with group 3 ( $p=0.6144$ ) (Graph no. 4).

**Discussion:**

One of the most frequent procedures of restorative dentistry is the restoration of mutilated and endodontically treated teeth. It is also difficult to repair these teeth since significant quantities of the coronal tooth structure is lost as a result of decay, prior restorative treatment, endodontic access and fractures. When a significant coronal section has been lost, resulting in the presence of one wall or no wall remaining, then adequate anchorage for the restoration cannot be achieved (Peroz et al 2005).

With the aid of a post, anchorage can be gained in such conditions. The main objective of the post is to provide retention for the core and the coronal restoration (Peroz et al 2005 and Torbjorner et al 1995). Posts should not be positioned arbitrarily because post space preparation introduces a degree of risk to a restorative operation by disrupting the seal of the root canal filling, which can lead to micro-leakage. The risk of perforation or tooth fracture increases due to the removal of sound tooth structure (Cheung 2005).

An ideal post should distribute the functional stresses along the root surface in such a manner that minimum stresses are developed and provide esthetic compatibility with the surrounding tissues. It should also be able to retrieve easily, have good retention and should be compatible with core material. The remaining amount of tooth structure determines the stability for the restoration (Torbjorner et al 1995). In addition, the tooth's prognosis is influenced by different factors such as occlusal contacts, its location in dental arch and ferrules (Valea and Pena 2017). 1.5 to 2 mm height of ferrule is the minimum requirement to obtain sufficient

fracture resistance (Assif et al 1993). The ferrule with the help of core and dentin reduces the stress on the entire restoration.

On the use of cast posts researchers have found large difference between the Young's modulus of metal and that of dentin and concluded that it causes stress concentration around the end of the post instead of distributing it all over the surface of root, resulting in vertical root fracture and extraction (Martinez-Insua 1998 and Holmes, Diaz-Arnold and Leary 1996). There are several kinds of prefabricated posts (in terms of form, design, material) (Cheung 2005). Their use has become popular as the technique is simple and fast, requires only one session for reconstruction of the lost coronal part of the tooth and contamination of the root canal between making the impression and placing the cast post is avoided. Stainless steel has been used for a long time in prefabricated posts. But there are concerns of nickel sensitivity and corrosion. However, pure titanium, with respect to compressive and flexural strength, has slightly lower physical properties than alloys, but it is less corrosive and the most biocompatible material (Monaghan, Roh and Kim 1992). Within the prefabricated post classification, Filpost is a passive grooved post made of titanium. It has a conical shape and anatomical design. Unlike other current titanium posts, it is made from pure titanium (99.8%), the main advantage of which is that it is a flexible metal post and can be bent for various purposes, for instance, it can be included in preparation of the core when the axis of the crown of the tooth being restored needs to be altered in order to place two or more posts, when required. It is also possible to bend the coronal portion of the post to position it more strategically for core retention (Baba and Goodacre 2019). They can be placed in dilacerated canals since they can be contoured to follow the canal anatomy, thus bending internally, creating a mechanical lock for the resin core and increasing the retention surface; it can be bent up to 236 degrees without compromising the post's integrity. A further benefit of flexible posts is that dentine elimination is reduced by following the morphology of the channels in curved channels (Abou-Rass et al 1982).

In the present study, extracted mandibular first molars of humans were used as abutments, as the properties of the extracted teeth, such as modulus of elasticity, stiffness, tensile strength and bonding characteristics simulates the normal healthy living human teeth, with slight changes in chemical properties (Isidor, Brondum and Ravnholt 1999). There was large variation seen in the sample teeth as it was collected from population with variation in age, size, shape, quality, making it difficult to standardize. In order to solve this, an attempt was made to section the tooth horizontally at a distance of 2 mm from cement-enamel junction (CEJ) and to retain the post length of 7 mm as it cannot be extended further than 7 mm through the apical root canal to the base of the pulp chamber (Baba and Goodacre 2019). The main reason to look towards flexible or bendable posts is that these posts can adapt to the thin curved walls of mandibular molars, especially in the distal surface of the mesial root and the mesial surface of the distal root (Vertucci 2005).

Post space was standardized in all the samples, keeping it approximately to a length of 7mm, so that the distribution of the force will be evenly distributed. Studies have shown that, in order to

prevent disturbance of the apical seal and microleakage, a minimum of 5 mm of gutta percha must remain (Mattison and Von Fraunhofer 1983 and Mattison et al 1984). Post space preparation was done using a special Fillock reamer which creates the grooves needed in the wall of the canal for perfect retention of the post in the root canal, which in turn helps relieve the hydrostatic pressure during cementation and prevents rotation following cementing. As a bonding agent containing low acid monomer amounts, Tetric N-Bond Universal has been used as a mild-etching adhesive as it effectively reduces the distance between the hydrophilic tooth substrate and the hydrophobic restorative resin (Jayasheel et al 2017).

Dual cure adhesive system was used as light curing proves to be ineffective in the deepest portion of apical region of endodontically treated teeth. While zinc phosphate cement has demonstrated push-out forces like other resin cements for titanium cementation (its elastic modulus was very close to the dentin and its dentin stress levels were weak), zinc phosphate cemented posts have not been able to cope with their relatively large elastic modulus, fragility and decreased ability of bonding to the dentin of root and post surfaces (Aksornmuang et al 2006; Aksornmuang et al 2007; Tay Fand 2007).

Two interfaces are seen when a post is luted to the core and surrounding dentin. The first interface is formed between the luting agent and dentin and the second interface is formed between the luting agent and core material. This type of restoration is termed as secondary monoblock restoration in endodontic literature review. According to manufacturers, LuxaCore dual (DMG) possesses strength, durability, and insulation properties similar to that of dentin. Aluminoborosilicate glass, smoked silica, and titanium oxide are the forms of fillers in LuxaCore, which may be the explanation for their high strength. Seung-Geun Ahn and John A. Sorensen found similar findings in a research review (Seung-Geun Ahn and Sorenson 2003).

In our study, we used the TUFC 1000 Universal Testing Machine to perform load testing. During specimen loading, it was determined that primary failure occurred due to a drop in the values in the curve (Amarnath et al 2015). This drop corresponded with a visible separation of the core or failure of the individual components of the restoration complex (Rosentritt et al 2000).

From the recorded values it is clear that, endodontically treated teeth reinforced by bendable titanium post had the least resistance to fracture, while endodontically treated teeth had the maximum values of fracture resistance. However, one advantage was been observed during the study that bendable posts favored the adaptation of core material around the post.

Fiber reinforced posts are usually the posts of choice when it comes to restoring endodontically treated teeth, as their elasticity is considered equivalent to that of dentin. But increased elasticity of the post leads to decreased fracture resistance of the entire restoration complex (Toksavul et al 2005). This was seen in our study as well, as shown by the recorded values of fracture resistance of titanium posts. The maximum value was seen in root canal treated teeth, as their dentin removal is less, and therefore, remaining tooth structure is more.

In the same study (Toksavul et al 2005), it was also clear that on examination of restoration complexes that involved placement of the prosthesis, debonding of the crown was most likely followed by composite core fracture. The load bearing capacity of the restoration complex decreases due to weakening; this in turn contributes to post fracture. Therefore gradual and continual load on the specimen of the crown results in debonding at core tooth structure junction leading to post fracture. Same results were observed in the study we conducted. The studies conducted in 1999 and 2003 (Mannocci, Ferrari and Watson 1999; Maccari, Conceicao and Nunes 2003). It was seen that zirconia post and core systems and titanium systems showed more catastrophic types of fractures than their fiber post counterparts. This is in contrast to our study since all of the fractures that occurred were above the cement-enamel junction (CEJ). Some of the reasons for that could be the preparation of the ferrule and placement of the crown. These are important factors that improve fracture resistance of a post and core complex.

The study we conducted is an in vitro type of study. The test standards and conditions are not ideal but it allows for standardization of all parameters. One of the main limitations is that oral environment is not simulated entirely and therefore more in vivo and clinical studies as well observational retrospective studies need to be conducted to reach conclusive results. Another important limitation of the study conducted is also that we need to standardize the curvature of the canal and pre-curving of the post. The relation between the two can also be explained by conducting an independent study.

### **Conclusion:**

Within the limitations of the study, it could be concluded that the value of fracture resistance was seen maximum in the endodontically treated teeth without posts while minimum value was seen in the group which was reinforced by bendable titanium post. No statistically significant difference was seen between group 2 and group 3. Bendable titanium post failed to provide any mechanical advantage over straight titanium post.

Further studies can be conducted to check the applicability of pre-curving the bendable post and placing it in curved canal and subjecting it to stress.

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