Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

# Recent Advance in Post Systems

**Widad Ahmed**

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**Supervised by**

**Dr. Ahmed Ghazi Almaroof**

**B.D.S., M.Sc., PhD**

**College of Dentistry**

**University of Baghdad**

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## Introduction

Root canal treatment is usually performed on teeth significantly affected by caries, repeated restorations or fracture. Already structurally weakened, such teeth often further weakened by endodontic treatment including access opening and canal preparation (McComb, 2008). It is therefore accepted that root filled teeth are weaker and require special considerations for the final restoration, which is one of the most challenging procedures in clinical dentistry. The special needs involve ensuring both adequate retention for final restoration and maximum resistance to tooth fracture, this sometimes collectively termed anchorage. The controversial choice of treatment options and materials that are available and the complexity of the procedure contribute to this challenge, especially when excessive amount of tooth structure is lost (Li *et al.*, 2011).

The success and the survival of root filled teeth depend on satisfactory endodontic and restorative treatments (Gillen *et al.*, 2011). These teeth must be restored in such a way that it will withstand masticatory forces acting in vertical and lateral direction without being prone to fracture. Following the root canal treatment, placement of an immediate core at the time of endodontic obturation is recommended to further the coronal seal, which is an integral part of endodontic therapy. However, when the amount of remaining tooth structure is not sufficient to promote the retention of the final restoration, an intracanal post is generally required (Mannocci and Cowie, 2014). Basically, the post, which may be either individually casted together with the core, or prefabricated, is designed to be fitted and cemented into the root canals after post space preparation, leaving several millimeters protruding to retain an amalgam or resin composite core. The core replaces the coronal portion of the tooth and gives support for the final restoration (Goyal and Mittal, 2014).

A variety of materials have been used for posts prefabrication range from wooden posts to metal posts and more recently carbon fiber, glass fiber and ceramic posts (Jhavar *et al.*, 2015). The traditional metallic posts have some limitation in terms of rigidity and aesthetic. Newer post systems are continuously being introduced into the market. The general trend is to achieve good appearance and translucency of the restoration mimicking that of a natural tooth. This report focuses on recent advances in post systems, reviewing their application, advantages and disadvantages in restorative treatment of endodontically treated teeth (ETT).

## 1. Root canal treatment and its effect on teeth properties

It has been agreed that the retention and restoration of individual tooth is better than a bridge replacement and that a bridge is better than a removable partial denture, which, in turn, is superior to a full denture. Although recent achievement with dental implants is impressive، the function of a natural tooth is more superior. Modern dentistry introduces endodontics as an integral part of restorative and prosthetic treatment. Most teeth with pulpal involvement can be a candidate for root canal treatment (RCT) as tooth-saving procedures for severely broken-down teeth، and potential and actual abutment teeth (Ingle and Baumgartner, 2008).

The root canal treatment is indicated to remove the irreversibly inflamed or infected pulp from the root canal space by chemo-mechanical debridement (Fig.1); followed by obturation of the shaped root canal system with an appropriate material (usually gutta-percha) to prevent its reinfection with the aim of retaining the tooth function within the dental arch (Torabinejad *et al.*, 2003). When endodontic therapy performed under controlled clinical conditions, the overall success rates of non-surgical RCT can be in the range of 85% to 90% (Imura *et al.*, 2007) and a survival rate of 87.1 % after 10 years (Pirani *et al.*, 2015).

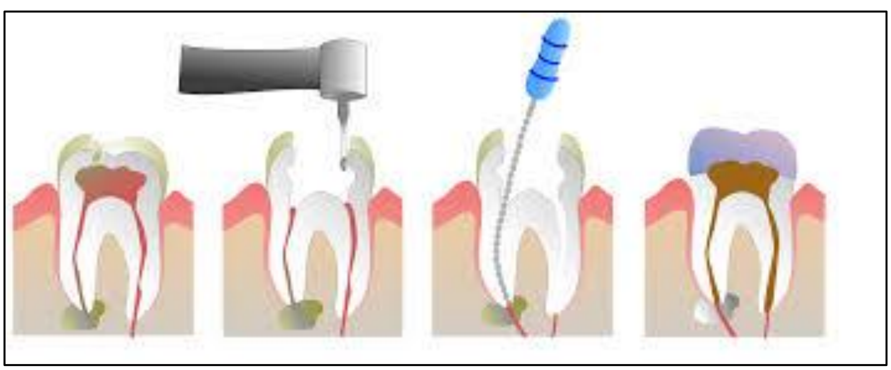


**Figure 1 The root canal treatment steps**

In most endodontically treated teeth, there is missing tooth structure caused by caries or existing restorations, loss of structural integrity associated with the access preparation and during mechanical instrumentation of the root canal system, mechanical pressure during obturation, lack of cuspal protection can weaken the tooth that lead to a higher occurrence of fractures in endodontically treated teeth compared with “vital” teeth (Williams *et al.*, 2006). Access preparations result in increased cuspal deflection during function (Pantvisai and Messer, 1995) and increase the possibility of cusp fracture and micro leakage at the margins of restorations.

On the other hand, several classic studies have proposed that the dentine in endodontically treated teeth is substantially different than dentin in teeth with “vital” pulps (Helfer *et al.*, 1972, Rivera and Yamauchi, 1993). It was thought that the dentin in endodontically treated teeth was more brittle because of water loss and loss of collagen cross-linking (Rivera and Yamauchi, 1993). However, other studies (Huang *et al.*, 1992, Sedgley and Messer, 1992) compared the physical and mechanical properties of dentine specimens from teeth with and without endodontic treatment and their results indicates that teeth do not become more brittle following endodontic treatment. The chemical use of high concentration of canal irrigants such as EDTA and NAOCL, especially in combined interact with minerals and organic contents, which reduce dentine elasticity and may also led to root fractures (Tang *et al.*, 2010). Additionally, the lack of proprioception (protective feedback mechanism) due to the removal of the pulp may contribute to increasing the risk of fracture after RCT.

The cumulative results of these effects weakened an endodontically treated tooth and special considerations for the final restoration are required.

## 2. Restoration of endodontically treated teeth

Restoration of the endodontically treated teeth describes the types of restorations that are suitable under different clinical circumstances, as well the posts and cores that can be used and the scientific evidence supporting their use.

The long-term success of endodontic treatment has always been highly dependent on the restorative treatment and is considered one of the most challenging procedures in clinical dentistry. Root canal treatment should not be considered as complete treatment until the coronal restoration has been placed. The pulpless teeth will subjected to vertical and oblique forces and more prone to fracture than vital teeth, sometimes the coronal leakage may lead to bacterial contamination of the root canal space and to the subsequent development of apical periodontitis (Sagsen and Aslan, 2006) and cause failure of root canal treatment.

The residual amount of tooth structure will determine its stability for restoration and is dependent upon the remaining walls of coronal dentine. The preservation of useful tooth structure should be considered as a primary goal, both during root canal treatment and subsequent coronal restorations. Final sealing the canal by placing an appropriate post and core will minimize leakage of oral fluids and bacteria into the peri-radicular area and is recommended as soon as possible after completion of root canal filling (Fig 2).

**Figure 2 Post core restoration of ETT with minimum remaining coronal tooth structure**

However, the survival of endodontically-treated teeth restored with posts is directly related to the remaining amount of coronal tooth structure, which is supported by both clinical data and in vitro studies (Sorrentino *et al.*, 2007, Sterzenbach *et al.*, 2012, Zicari *et al.*, 2012). These studies indicate that teeth are not strengthened by posts, their purpose is for retention of a core that will provide appropriate support for the definitive crown or prosthesis. Posts also play a role in stress distribution, the use of restorative materials with biomechanical characteristics similar to dentine allows for relatively uniform stress distribution to the tooth and surrounding tissue, thus yielding a protective effect against root fracture (Cagidiaco *et al.*, 2008).

## 3. Principles for post placement

Since a post may not “strengthen” or “reinforced” an ETT and the preparation of a post space can significantly weaken the root increasing the risk of root fracture and treatment failure, the decision whether to use a post in any clinical situation must be made carefully.

Not all endodontically treated teeth need a post, core or crown, when coronal tooth structure loss is minimal and the marginal ridges are intact, endodontic posts should be avoided and a bonded composite resin is appropriate to seal the access cavity (Cheung, 2005). Usually placement of a post is recommended when two or more walls are missing (Atlas and Raman, 2013) or if the amount of residual tooth structure is not sufficient to support an amalgam or composite core (Mannocci and Cowie, 2014). In general, the amount of remaining tooth structure, anatomic position of the tooth, expected occlusal forces on the tooth and aesthetic requirement are the main factors that determine the need for post (Jotkowitz and Samet, 2010).

After excavation of all carious dentin and enamel, the first critical treatment planning question then becomes an evaluation of the amount of healthy tooth structure that remains and whether there is enough to support the foundational core for the eventual coronal restoration. The treatment planning flow chart by Atlas and Raman for restoring ETT is shown in Fig. 3.

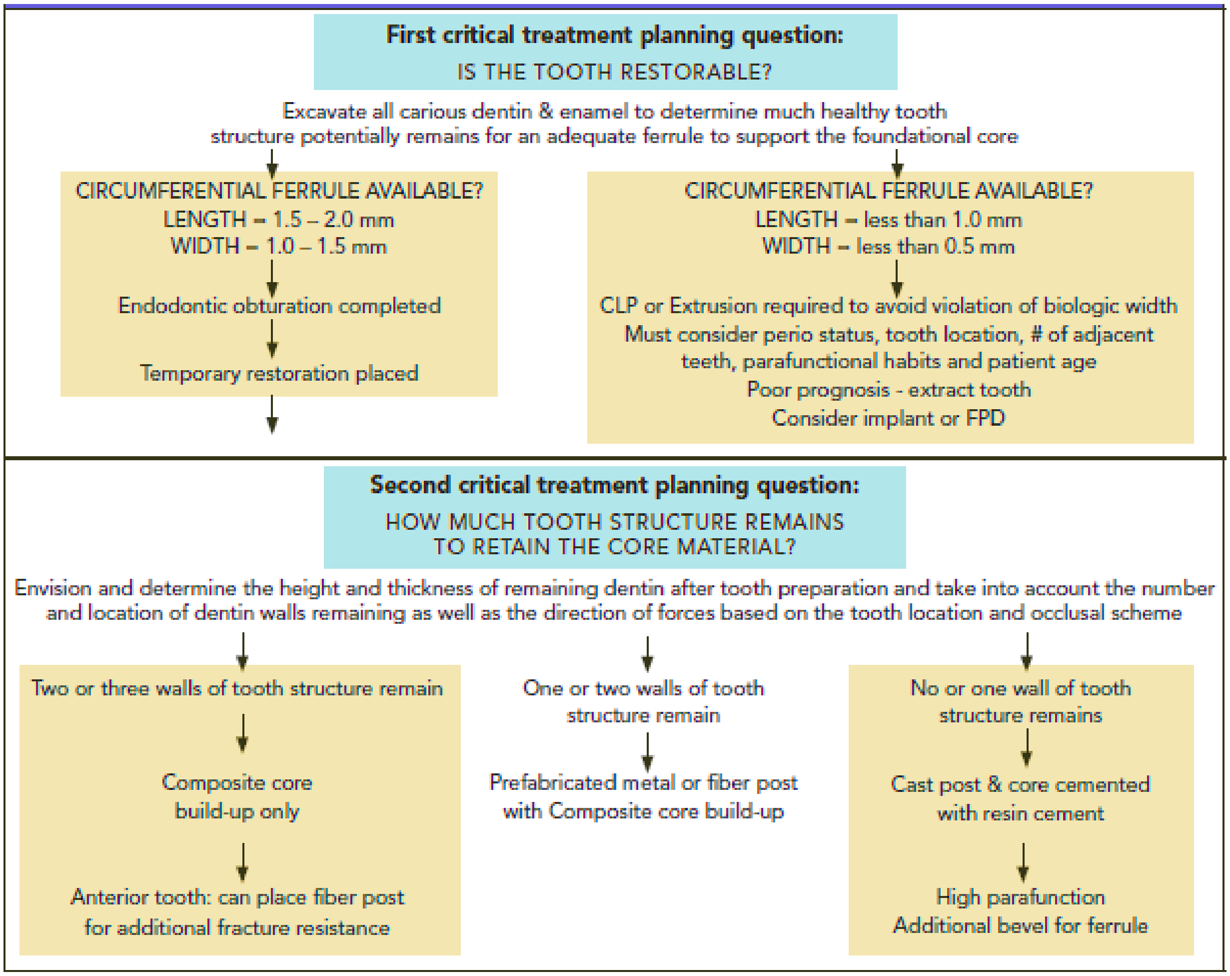



**Figure 3 Restoring the endodontically-treated tooth: Treatment planning flow chart**

Depending on the number of axial cavity wall remaining, Preoz et al (Peroz *et al.*, 2005) established five classes for post indication:

1- Class I, have four remaining cavity walls with thickness greater than 1mm, in this case, it has felt that this post is not necessary and final restoration can be utilized.

2- Class II and Class III. have two or three remaining cavity walls. These teeth can possibly be restored without post.

3- Class lV, teeth have one remaining wall, and the core material will provide minimal or no effect on the fracture resistance of endodontically treated tooth.

4- Class V, teeth no remaining walls, and a post will be required to provide for core material.

Regarding the anatomic position of the tooth, for anterior teeth with minimal loss of tooth structure, endodontic posts should be avoided and a bonded composite resin is appropriate to seal the access cavity (Cheung, 2005). However, if an endodontically treated anterior tooth is to receive a crown, a post often is indicated to provide adequate retention and resistance against lateral and shearing forces.
Molars in most cases do not require posts placement, the pulp chamber may provide an adequate retention for a core build-up and they usually receive a cuspal coverage after endodontic treatment to resist the primarily vertical forces received.

On the other hand, premolars, which are more likely to be subjected to lateral forces during mastication, have less tooth structure left after RCT with a smaller pulp chambers to provide adequate resistance and retention for a crown, therefore post placement is more often needed than molars (Schwartz and Robbins, 2004).

## 4. Dental Posts

The old concept of using wooden root canal dowel to provide the retention of a crown was modified through the years to become like the modern post and core restorations (Ring, 1992). The post (dowel) and core is often used after endodontic treatment when restoring a damaged tooth with extensive loss of coronal tooth structure, preferably with a core coping and crown or only as superstructure to gain coronal-radicular stabilization.

Figure 4 shows the structure of post restoration in ETT. Cement with or without dental bonding agent is usually used to bond the post to the root canal dentine. In prefabricated post restoration, an amalgam or resin composite core is placed around the post to replace the coronal portion of the tooth and provide a foundation for the definite crown restorations.

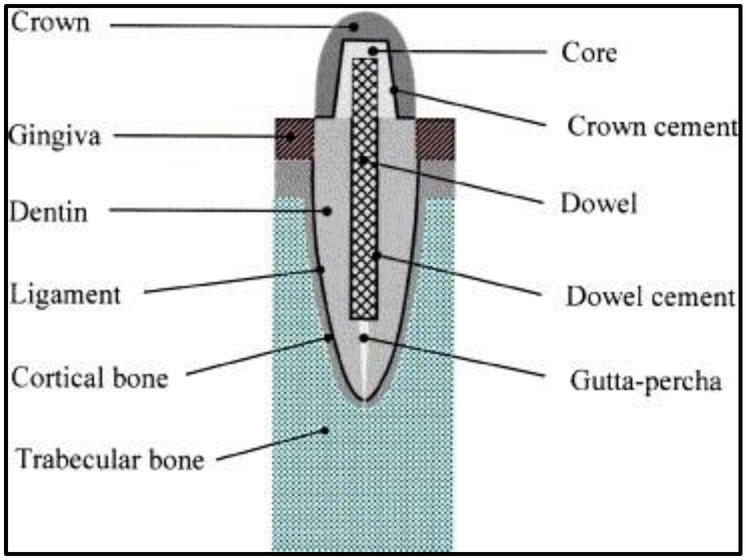



**Figure 4 Tooth model restored with dental post (Dowel) (Asmussen *et al.*, 2005).**

To achieve optimum results, post materials should have physical and mechanical properties similar to that of dentine, however, to date, there is still no agreement regarding which material or technique can be considered ideal for the restoration of ETT.

## 4.1. Ideal requirement of dental posts

The post and core system should ideally have (Fernandes *et al.*, 2003, Mannocci and Giovarruscio, 2016, Cheung and Chan, 2003):

1 - Maximum protection of root from fracture: the post should be made of resilient materials, not stiff (low modulus of elasticity), absorb more impact force to the root than stiff post.

2- Maximum retention of core and crown: Preservation of tooth structure is important when restoring the coronal portion of the tooth. Coronal tooth structure should be preserved to provide resistance and retention form for the crown

3 -Maximum protection of crown margin from coronal leakage: a more flexible post may bend under high loads and allow micromotion of the core, causing breakdown of luting cement and coronal leakage which may cause failure or loss of restoration.

4- Favourable aesthetic and radiopacity

5- Biocompatibility

6- Adequate flexural and compressive strength to resist intraoral forces.

7- Ease of manipulation.

8- The ability to bond to the remaining tooth structure.

9- The ability to inhibit dental caries.

10- Thermal coefficient of expansion and contraction similar to tooth tissue.

11- Minimal potential for water absorption.

12- Ease of retrieval when endodontic retreatment is required.

## 4.2. Important principles of dental posts

**Post retention:** It is the ability of a post to resist vertical dislodging forces. Retention is influenced by the post's length, diameter and taper, the luting cement used, and whether a post is active or passive (Felton *et al.*, 1991, Standlee *et al.*, 1972).

**Post configuration:** active post threaded (such as para post-XT, coltene whaledent) is more retentive than passive post (such as para post taper lux, coltene whaledent) (Robbins, 2002). However, when evaluating the relationship between post form and root fracture, laboratory tests generally indicate that all types of threaded posts produce the greatest potential for root fracture.

**Post resistance:** refers to the ability of the post and tooth to withstand lateral and rotational forces. It is influenced by the remaining tooth structure, the post's length and rigidity, the presence of anti-rotation features, and the presence of a ferrule. A restoration lacking resistance form is not likely to be a long-term success, regardless of the retentiveness of the post

**Ferrule effect:** defined as vertical band of tooth structure or a circumferential dentine collar of 1.5 to 2 mm at the gingival aspect of a crown preparation. Ferrule effect has been shown to be significantly associated with a higher fracture resistance of ETT (Juloski *et al.*, 2012, Ferrari *et al.*, 2012, Skupien *et al.*, 2016), it adds some retention, but primarily provides resistance form and enhances longevity. The ferrule may resist stresses such as functional lever forces, the wedging effect of taper posts, and the lateral forces exerted during posts insertion. It provides bracing or casting action to protect integrity of the root Fig 5.

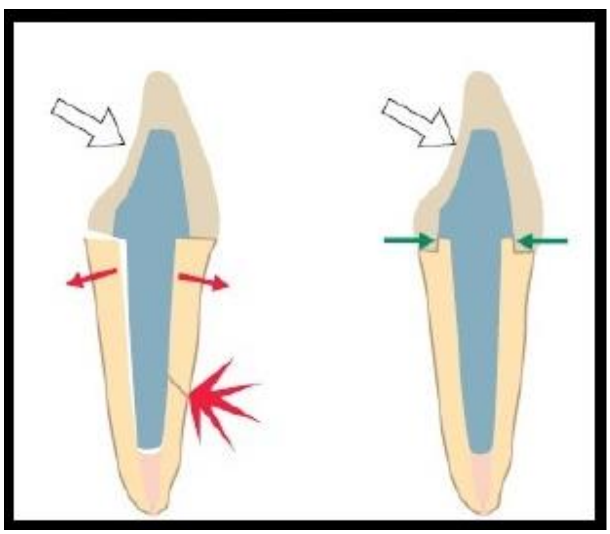


**Figure 5 Importance of ferrule**

**Post length:** The ideal post length is when it reaches two-thirds the length of the root (Ingle and Bakland 2002), which allows for better stress distribution to the alveolar bone. whenever possible, posts should extend at least 4 mm apical to the bone crest to decrease dentin stress; and (4) molar posts should not be extended more than 7 mm into the root canal apical to the base of the pulp chamber. To ensure a favourable seal, the posts should be extended to the length that retained 4-5 mm of apical gutta-percha.

**Post diameter:** post diameter also plays important role in fracture resistance; small diameter post is suggested to preserve dentin around post. However, posts diameter was found to affect flexural properties of different post systems (Seefeld *et al.*, 2007), a large diameter post possesses a significantly higher maximum fracture load (Lassila *et al.*, 2004). Post diameter of no more than one third the root width, at least 1.75 mm of retained dentin around post, and a post to root diameter 1:4 have been recommended (Mou *et al.*, 2009).

**Post shape and design:** There a wide variety of prefabricated post shapes designs have been developed. The variation of designs represents varying attempts to satisfy the objectives of retention of the restoration and protection of the remaining tooth structure.

The post design can generally be included in the following classification (Fig 6):

i) **Tapered-smooth sided post**: the oldest and most widely used design and it should be used in teeth not subjected to high functional or para-functional loads.

ii) **Tapered self- threading post**: one of the earliest of self-threading tapered post is the Dentatus, although it is more retentive than passive cemented posts, it is also more dangerous.

iii) **Parallel-sided serrated posts**: this type of post when cemented into prepared parallel channels, provide much greater retention than tapered posts. They resist tensile shear and torque forces better than tapered posts.

iv) **Parallel-sided posts with tapered apical ends**: Tapered post in taper end produce risk perforation and weakening of dentin walls so, parallel post with tapered end have been developed. Parallel post with tapered end have a lower retention than regular parallel post of comparable length and diameter.

v) **Parallel-sided threaded posts**: the most type available is the parallel-sided threaded post. Its favoured in high loads area and certain studies compare it with other posts system (tapered, whaledent "parapost", radix) and found that the parallel side threaded was the more retentive and offers superior distribution of stress under insertion and under function (Schwartz and Robbins, 2004).

Regarding post shape, parallel sided post provide better retention, less stress formation and increase fracture resistance than tapered posts (Baba *et al.*, 2009). Double-tapered posts better adapt to the shape of the endodontically treated canal, thus limiting the amount of dentine tissue to be removed in post space preparation (Goracci and Ferrari, 2011). Oval-shaped glass fibre posts were recently introduced for better adaptation into ovoid-shaped canals (Coniglio *et al.*, 2011).

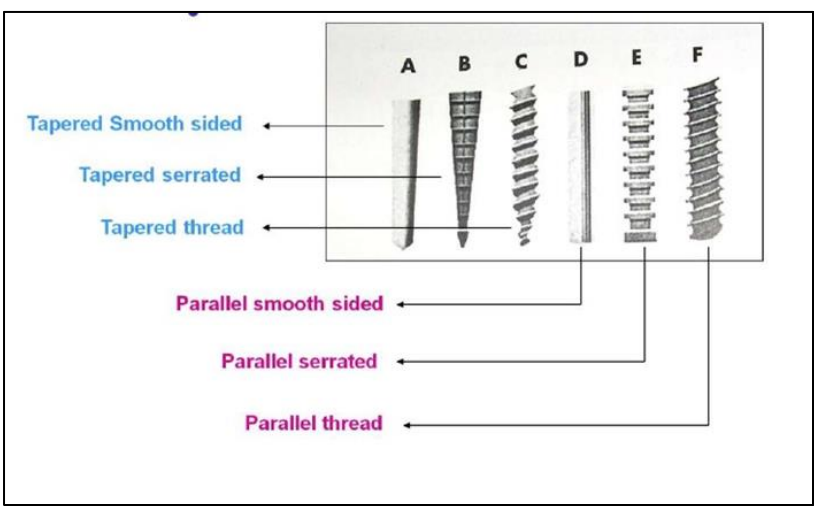



**Figure 6 Different shapes and designs of dental prefabricated posts**

## 4.3. Classification of posts

Posts can be classified in a number of different ways:

**Depending on how retention is achieved:** posts can be divided into two main subgroups: Active posts or Passive posts

1) Active post: The active post derives their primary retention directly from the root dentin by use of threads and intended to be screwed in the wall of root canal, and the primary indication for an active post in which there is a need for increased retention in short canal space that cannot be attained with a passive post(Robbins, 2002).

2) The passive post is passively placed in close contact to the dentin walls, and its retention primarily depend on luting cement used for cementation. Serrated or roughened passive post significantly increase the retention compared to smooth surface posts.

**-Depending on the shape of the post:**

Parallel or Taper

**-Posts can also be divided according to the method of fabrication into:**

Laboratory-fabricated cast post-cores or Prefabricated intracanal posts

**-Posts can be classified according to fabricating material into two general types:**

### 1. Metallic posts

Include laboratory-fabricated cast post-cores and prefabricated stainless steel and titanium posts

## Custom cast post and core

The custom cast post has been used for many years and can provide excellent strength and the advantages of this type is the lack of necessity to remove additional dentine in order to remove undercuts, which further weakens the tooth. Even clinical situations with considerable loss of internal dentine, traditionally restored with a custom cast post and core, have been shown more successful *in vitro* when restored with bonded resin composite reinforced by a central metal post (Ingle and Bakland 2002).


**Figure 7 Cast post and core**

## Prefabricated stainless -steel post

Stainless steel has been used for a long time in posts fabrication. However, the high modulus of elasticity, sensitivity to its nickel contents and corrosion are negative disadvantages of stainless steel prefabricated posts (Goracci and Ferrari, 2011).

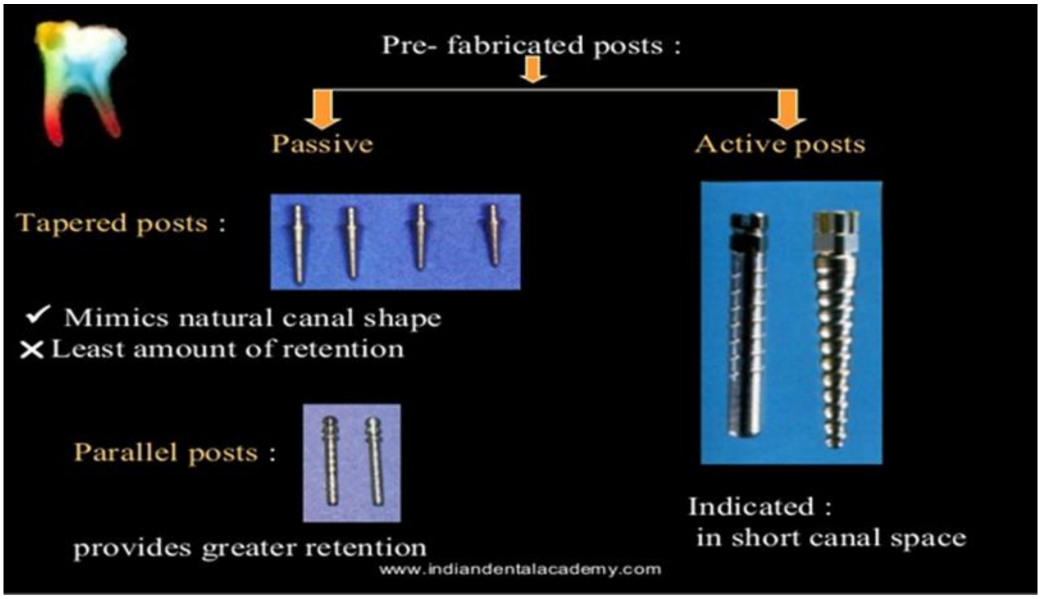



**Figure 8 prefabricated metal posts**

## Prefabricated titanium and titanium alloy posts

Pure titanium has slightly lower compressive and flexural strength than alloys and tends to break more easily compared with stainless steel posts during removal in retreatment cases. Titanium used for post fabrication present modules of elasticity at 110 GPa which is markedly above that of dentine. Furthermore, most titanium alloys used in posts have a similar radiopacities to that of gutta-percha and sealers makes them more difficult to distinguish on radiographs. However, the absence of corrosion and biocompatibility are the main advantages of this material (Cheung, 2005). However, a commonly used parallel titanium post was found to be significantly less rigid than an equivalent stainless steel post and was not recommended for clinical application where heavy loads are anticipated.

## 2. Non-Metallic Posts

Non-metallic posts composed of various different fibre-reinforced polymer or composite materials from many different manufacturers, with differing designs, sizes and composition has introduced. Newer concepts, including possible advantages from use of less rigid posts and the potential for adhesive luting cements, such as ceramic, zirconia and fibre-reinforced composite (FRC) posts.

### Ceramic posts

Ceramic posts are characterised by high flexural strength and fracture toughness, in addition to favourable aesthetic, biocompatibility and radiopacity (Purton *et al.*, 2000). However, ceramic posts have a high modulus also and showed poor bonding to dentine walls under fatigue testing (Dietschi *et al.*, 1997, Hedlund *et al.*, 2003).

Cosmopost is a ceramic post system and is indicated aesthetically important anterior region of maxilla and mandible. Cylindrically shaped with a conical tip, the cosmopost is available in two relatively wide diameters (1.4mm, 1.7mm). Generally, the 1.4mm post is used for maxillary and mandibular premolars, while the 1.7mm post is used for molars (distal canal in the mandible, palatal canal in maxilla). The posts, as manufactured, have relatively smooth surface and are subsequently treated to roughen the surface, which increases the bond strength between the post and core, whether heat pressed or luted (Stewardson *et al.*, 2010).


**Figure 9 cosmoPost**

### Zirconia posts

Zirconia posts have high flexural strength, high fracture toughness, chemical stability, biocompatibility and favourable optical properties similar to that of natural teeth (Vichi *et al.*, 2000). However, zirconia post is nearly impossible to be removed from the root canal when a failure occurs. Another disadvantage of zirconia posts is the rigidity, their high elastic modulus at 200 GPa causes stress to be transferred to the less rigid dentine, thereby resulting in root fractures (Guazzato *et al.*, 2004).

### Fibre reinforced composite (FRC) posts

FRC materials are characterised by better functional and structural design, their mechanical properties can be tailored until it meets those of dentine and allowing the use of minimally invasive and adhesive techniques to preserve tooth structure during the restoration of ETT (Fernandes et al., 2003). These posts are made of carbon, quartz or glass fibre embedded in a matrix of epoxy or methacrylate resin. The adhesion between quartz or glass fibres and resin matrix is enhanced by fibre silanization prior to embedding (Ricketts *et al.*, 2005).

The fibres provide strength and stiffness, while the polymeric matrix keeps the fibres together in the composite structure, protects them from the environmental harm due to elevated temperature and humidity and acts as a load transfer medium between them. Fibres represent the largest volume (from 40 to 65 vol%), contribute stiffness and strength to the matrix and determine the load-bearing capacity of FRCs structure (Zicari *et al.*, 2013). Fiber-reinforced posts can be separated into three groups: **carbon, glass** and **quartz fiber posts.**

The main advantages of these posts:

1-flexing slightly under load,

2- they distribute stresses to the root dentine in a more favorable manner than metal posts.

3-the addition of fibers to a polymer matrix; have enhanced mechanical properties like strength, fracture toughness stiffness and fatigue (Ricketts et al., 2005).

## Carbon fiber post:

Is a Unidirectional, longitudinal fibre reinforced composite post, made of fibres (60%by volume) embedded in epoxy resin matrix (40% by volume) and contain radiopacity –barium filler in the resin matrix.

Carbon fiber posts have been successfully used by dentist because:

1-the material is strength and relative flexibility

2- ease of placement or ease of removal, if necessary for endodontic treatment.

**The disadvantages of these post:**

The black color of carbon post alters the aesthetic effect and hence they cannot be used clinical situation in which subsequent non-metal and translucent crowns are planned (Gordon Christensen 1998).


**Figure 10 carbon fiber post**

**Quartz type of fibre post:** quartz is pure silica in crystallized form, it is an inert material with low coefficient of thermal expansion, uses for reattachment of complex crown root fracture and according to the modulus of elasticity, that are closely matched to dentin to decrease stress concentration within the root canal and reduce incidence of fracture. Several commercial types have been introduced to the markets including:

**Aesthetic post**: It retains a core of carbon fiber bundle surrounded by quartz fiber similarly arranged longitudinally, the ratio of the quartz fibers/epoxy matrix is 60/40, has a higher flexural strength and a low modulus of elasticity (close to that of dentin) to allow the post to flex along with the restored tooth.

**Aesthetic plus:** It is also composed entirely of quartz fiber. The traditional posts include white or clear quartz fibers and the ratio of quartz fiber is 60% and by volume epoxy resin matrix is 40%.


**Figure 11 Quartz fiber post**

## Glass type of fiber post

Glass type of fiber post have a lower modulus of elasticity than carbon/graphite. These posts can be made of different types of glasses:

### Para post fiber white system:

This type is designed to complement and extended the existing para post system, fiber white has longitudinally arranged glass fiber.

1- Post is essentially parallel and has small steps for mechanical retention of the luting cement.

2-the post has white translucent color that minimize shadowing.

3-its metal free and the fiber matrix strengthens the structures without compromising flexibility

4- the head of the fiber white post is anti-rotational and has two rounded sections to help in retention of the core material. Its available in diameter of 1.14mm.

5- para post has a vertical groove cut along the length of its serration to allow the cement to escape and provide the distribution of masticatory force of all available post design.

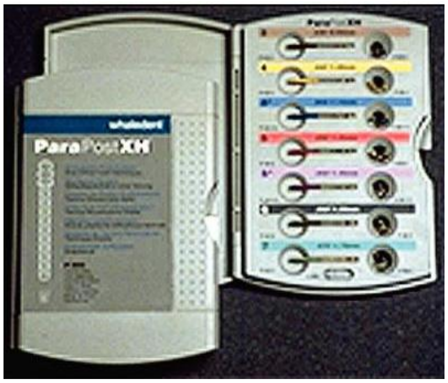



**Figure 12 para post fiber white system**

**Snow post and snow light**

Snow post and snow light are fiber –reinforced composite posts. These are white, radiopaque embedded in resin matrix (patented). Both types of posts may be used with bonding resins cements and composite core materials for all composite corono-radicular stabilization

The features of these posts are:

a- composed of 60% longitudinally arranged silica zirconium glass fibers in an epoxy resin matrix.

b-Its shape is cylindrical and has a 3 degree tapered apex.

c-Four diameters of sizes 1mm, 1.2mm, 1.4mm and 1.6mm- are contained in the complete kit, together with matching burs.

d-light transmitting qualities allowing cementation with dual cure resin cement and light cure cement

e-The tapered end is 4 to 6mm long**.**


**Figure 13 snow post**

**Luscent anchor post system**

The luscent anchor post (Dentatus) is fiber –glass, clear resin post that is designed to refract and transmit natural tooth colors for esthetic post- and-core foundation. It is formed from glass fibers embedded in resin matrix.

The advantages of luscent post system:

1-They bond to the composite core crown complex and offer benefits in transilluminating light, radiolucency, retention and aesthetic.

2-They offered in 6 sizes and diameter combinations, ranging from 15mm long and 1mm diameter up to 19mm long and 1.80mm diameter.

3-whenever required for endodontic retreatment, the luscent anchor can be easily removed.

4- The type of post and core is retentive and anti-rotational because sound radicular and coronal structure is maintained

5-They reinforce thin walled roots through resin bonding internal root splitting.

**Figure 14 luscent anchor post system**

## Polyethylene fibre post (Ribbon)

It is also called bondable reinforcement fiber post (Ribbon fiber post). This method uses bondable reinforcement fiber fourth-generation bonding agent and dual cure composite as the core build up. The reinforcement materials used for the post consists of polyethylene woven fibers that are treated with a cold-gas plasma.

The use of cold gas plasma treated polyethylene woven fibers embedded in conventional resin composite been advocated for corono-radicular stabilization of pulpless teeth. For this technique to work well, they should be sufficient light to reach the depth the space. It is believed that Ribbon PE posts can maintain the natural strength of the tooth and create a root canal mono-block allowing for a more favourable stress distribution along the root dintine, reducing the incidence of vertical root fracture (Belli *et al.*, 2011)..

**Figure 15 Ribbon fiber post**

## 4.4. Failure Mode

All post systems have some percentage of clinical failure. However, some posts cause a higher percentage of failures that result in teeth that are non-restorable. The post and core restorations of ETT have been extensively investigated by both *in vitro* and *in vivo* studies. Many laboratory studies have focused on the effect of post placement, comparing the fracture strength and failure mode of post / tooth complex using continuous or, more properly cyclic loading to represent *in vivo* conditions. The outcome of these studies concluded that a more favourable failure mode could be more valuable clinically than a high fracture resistance. Metal posts of high stiffness promoted higher values of fracture load and higher levels of irreparable tooth fractures (Barcellos *et al.*, 2013, Wandscher *et al.*, 2014). In contrast, teeth restored with less rigid posts, such as fibre posts with a low modulus, tend to have failures that are more likely to be restorable.

# 5. Recent advance in post systems

The complex procedure of endodontic and restorative treatment necessitates the need of new techniques to protect the structure of ETT. Recently, several efforts have been introduced to develop new post-core systems, by the assessment of novel fabricating materials, post shape and design, and new generation of bonding systems.

Ambica *et al* decided to restore the root canal treatment by using dentine post and evaluate the fracture resistance in comparison to glass and carbon fibre post. The experimental dentine posts demonstrated the highest fracture resistance under static and fatigue loadings (Ambica *et al.*, 2013).

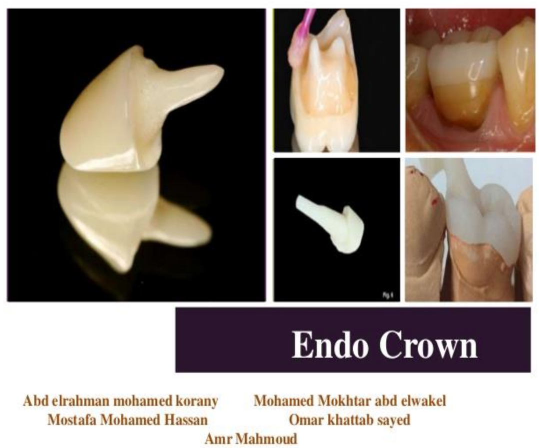
In other experiment, the fibre reinforced composite (FRC) posts based on alkaline-resistant (AR) glass fibres composed of dimethacrylate resins and particulate filler composites and has suitable elastic modulus, which should result in fewer root fracture and proposed as an alternative to epoxy resin/glass fibres commercial endodontic posts (Baldea *et al*., 2015).

In another attempt, a fibre reinforced plastic, hollow fibre post use as a new direct core build-up method for restoration of ETT. It was proposed the development procedure by injecting the restorative material into the bottom of the root canal through the hollow post decreases the number of voids in the core and increases the bonding strength to the fibre post when compared with those of samples prepared by the conventional method (Inaba *et al.*, 2013).

A custom-made post system utilising silanted glass fibres impregnated with a semi-IPN polymer matrix (everStick Post; Stick Tech Ltd, Turku, Finland) has been also developed with the same concept of individually formed post. Because of its pre-curing plastic state, this post can fill the entire space of the root canal with more reinforcing fibres in the cervical portion using minimally invasive preparation and increasing the load-bearing capacity as a potential benefit of this post system (Le Bell-Rönnlöf *et al.*, 2011).

For the restorative techniques, the use of anatomic post technique, which involves the anatomical shaping of the prefabricated fibre posts with a composite resin into the root to provide a close adaptation of the post to the root canal has been reported by several studies, this treatment option for the restoration of ETT with weakened root will reduce the resin cement thickness, and therefore, improve the retention (Silva *et al.*, 2011, Mongruel Gomes *et al.*, 2014).

Another recent technology for the restoration of ETT with extensive coronal destruction which induced by the development of dentin adhesives is endocrown as alternative to post-core system (Fig. 16). In the past, the endocrown described as adhesive endodontic crowns and characterized as total porcelain crown fixed to endodontically treated posterior teeth (Biacchi *et al.*, 2013). In recent study, endocrown, which could be fabricated from hybrid resin composite or ceramic (Gresnigt *et al.*, 2016), is a monolithic restoration bonded on ETT and using the entire extension of the pulp chamber and possibly the root canal entrances as a retentive resource instead of the intra radicular post. One of the main advantage of endocrown is conservative with proper marginal stability that enhanced by retaining maximum enamel to improve adhesion. This provides a good seal of the root canal opening, and prevent micro leakage which in turn affecting the long-term prognosis of ETT. One of the major disadvantages of endocrown restorations is the high risk of fracture failure because of the absence of a metal or high-strength ceramic substructure as in conventional full-crown.



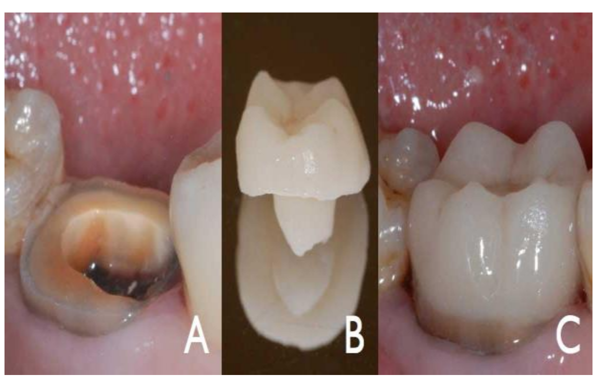




**Figure 16 Endo Crown restoration**

## 6. Technique of post system

### 6.1. post cavity preparation

1- The first step for all types of post restoration is removal of gutta percha or resilon from the canal. Various method or techniques have been used for post space preparation, including thermal method (eg, Sybron Endo system) or with rotary instrument, using gate-glidden or peso reamer to the desired length. Ideally there should be minimized enlargement of the canal post that incurred during endodontic instrumentation.

2- Verify the drill path and length radiographically, to avoid perforation and to maintain an adequate apical seal at least 4-6 mm.

3- Prepare the coronal residual tooth structure to accommodate the crown with minimal wall thickness greater than 1.5mm and determine if the post is going to be fabricated by direct or indirect means depending on the residual tooth structure.

4- The procedures should be performed under rubber dam isolation, good magnification and illumination. The final step is verification of the final post space radiographically, using a prefabricated metal post to do so. Following this, the tooth is ready for an impression

### 6.2. Impression for the cast post and core

The clinical steps for the impression are as follows:

a) dry the post space with a cotton point

b) Cut the metal post that was utilized for radiographic verification down to the appropriate size and bend its coronal aspect slightly so that it will engage the impression material.

4. Syringe light-body VPS impression material into the post space and place the metal post into the post space and move it up and down to remove any air bubbles and ensure maximum adaptation.

5. Place heavy-body VPS impression material into the custom tray.

6. Place the custom tray intra orally and make the impression

7. Fabricate the interim provisional crown

8. Cement the provisional crown using a non-eugenol temporary cement and be sure to obtain a complete seal to protect the tooth during the interim phase of post fabrication.

The laboratory will make a master cast of the impression for the wax-up of the cast post and core restoration, and the post and core is cast in Type III gold and inspected on the master

9-select prefabricated post suitable for both the tooth and he restoration being utilized.

10- determine the prerequisite preparation depth and make this length on the corresponding instruments with silicone stopper.

**Gate-Glidden for prefabricated post**

**Selected post for radiographic verification**

**Use of paper point**

**Selected fiber post and corresponding post space drill**

**Injection of dual-cured core build-up material for fiber and metal post cementation**

**Dual cured core material light cured for post cementation before core builed-up performed**

**Figure17 Technique of post system**

## 6.3. Post cementation

The purpose of the cement is to secure the retention inherent in the design and to ensure a seal against micro-leakage. Cements are best introduced into the canal and the post also coated with cement. Current resin-modified glass ionomer luting cements provide adequate properties and are widely used for routine cementation (Robbins *et al*, 2002) Zinc phosphate cement cannot be discounted as it provides high modulus, ease of use, and has withstood the test of time.

For post situations with less than optimal retention, resins cements can provide a significant increase in retentive strength. The concept of adhesive fixation of a post and core in order to stabilize tooth is an emerging concept (Peroz et al., 2005).

Several studies suggest adhesive cementation of post can both increase post retention and reinforce the tooth (Mendoza *et al.*, 1997). Effective bonding of the post can also reduce dentin stresses (Asmussen *et al.*, 2005). Bonding, however can be impaired by the presence of remnants of endodontic sealer and it has been suggested that the canal surface be cleaned.

**The procedure of post cementation:**

1-after preparing the post space rinse the canal and flush with alcohol.

2-clean the canal a canal brush (Coltene whaledent) or similar.

3-check proper fit of the post.

4-fiber post should be cleaned with phosphoric acid 37% for 60 second then irrigation and dry.

5-use dual cure luting cement to place in the canal and remove excess, then polymerize for 20 second from the occlusal aspect of the post and as near to the post as possible, or wait 5minutes to allow self-curing initially and then light cure.

6- ideally the core can be build up using the same luting material.

7- the tooth is then prepared for the final restoration located on 2 to 3mm of natural tooth structure.

A: After etching with phosphoric acid, the be rinsed and dried with high volume section.


B: A dual-cured bonding agent should be mixed and placed in the canal.

C: The bonding agent is placed in the canal with a cylindrical micro brush.

D: An endo-tip allow the dual cure cement to be placed in the canal without bubble formation if it is kept immersed. The post is placed immediately.

E: An auto mix syringe with two different diameter tips expedites both placement of cement into the canal and the core build-up. The cement is then allowed to self-cure or it can be light-cured for 20 s.

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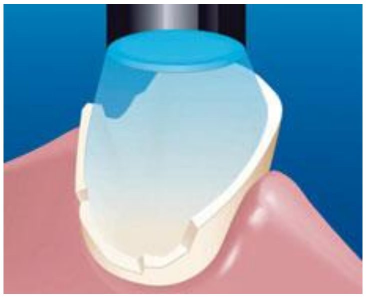

F: The final core build is cured for 40second.

**Figure 18 Steps of post cementation**

## References:


AMBICA, K., MAHENDRAN, K., TALWAR, S., VERMA, M., PADMINI, G. & PERIASAMY, R. 2013. Comparative evaluation of fracture resistance under static and fatigue loading of endodontically treated teeth restored with carbon fiber posts, glass fiber posts, and an experimental dentin post system: an in vitro study. *Journal of endodontics,* 39**,** 96-100.

ASMUSSEN, E., PEUTZFELDT, A. & SAHAFI, A. 2005. Finite element analysis of stresses in endodontically treated, dowel-restored teeth. *The Journal of Prosthetic Dentistry,* 94**,** 321-329.

ATLAS, A. M. & RAMAN, P. 2013. Restoration of the endodontically treated tooth: Treatment planning concepts for optimal results in restorative dentistry. *Dental Learning* 1**,** 20-36.

BABA, N. Z., GOLDEN, G. & GOODACRE, C. J. 2009. Nonmetallic prefabricated dowels: a review of compositions, properties, laboratory, and clinical test results. *J Prosthodont,* 18**,** 527-36.

BALDEA, B., SILAGHI-DUMITRESCU, L. & FURTOS, G. 2015. Fracture load and force load at upper yield of alkaline-resistant glass fiber-reinforced endodontic posts. *Polymer Composites*.

BARCELLOS, R. R., CORREIA, D. P., FARINA, A. P., MESQUITA, M. F., FERRAZ, C. C. & CECCHIN, D. 2013. Fracture resistance of endodontically treated teeth restored with intra-radicular post: the effects of post system and dentine thickness. *J Biomech,* 46**,** 2572-7.

BELLI, S., ERASLAN, O., ESKITASCIOGLU, G. & KARBHARI, V. 2011. Monoblocks in root canals: a finite elemental stress analysis study. *Int Endod J,* 44**,** 817-26.

BIACCHI, G. R., MELLO, B. & BASTING, R. T. 2013. The endocrown: an alternative approach for restoring extensively damaged molars. *Journal of Esthetic and Restorative Dentistry,* 25**,** 383-390.

CAGIDIACO, M. C., GORACCI, C., GARCIA-GODOY, F. & FERRARI, M. 2008. Clinical studies of fiber posts: a literature review. *International Journal of Prosthodontics,* 21.

CHEUNG, G. & CHAN, T. 2003. Long-term survival of primary root canal treatment carried out in a dental teaching hospital. *International Endodontic Journal,* 36**,** 117-128.

CHEUNG, W. 2005. A review of the management of endodontically treated teeth. Post, core and the final restoration. *J Am Dent Assoc,* 136**,** 611-9.

CONIGLIO, I., MAGNI, E., CANTORO, A., GORACCI, C. & FERRARI, M. 2011. Push-out bond strength of circular and oval-shaped fiber posts. *Clin Oral Investig,* 15**,** 667-72.

DIETSCHI, D., ROMELLI, M. & GORETTI, A. 1997. Adaptation of adhesive posts and cores to dentin after fatigue testing. *Int J Prosthodont,* 10**,** 498-507.

FELTON, D., WEBB, E., KANOY, B. & DUGONI, J. 1991. Threaded endodontic dowels: effect of post design on incidence of root fracture. *The Journal of Prosthetic Dentistry,* 65**,** 179-187.

FERNANDES, A. S., SHETTY, S. & COUTINHO, I. 2003. Factors determining post selection: a literature review. *The Journal of prosthetic dentistry,* 90**,** 556-62.

FERRARI, M., VICHI, A., FADDA, G., CAGIDIACO, M., TAY, F., BRESCHI, L., POLIMENI, A. & GORACCI, C. 2012. A randomized controlled trial of endodontically treated and restored premolars. *Journal of Dental Research,* 91**,** S72-S78.

GILLEN, B. M., LOONEY, S. W., GU, L.-S., LOUSHINE, B. A., WELLER, R. N., LOUSHINE, R. J., PASHLEY, D. H. & TAY, F. R. 2011. Impact of the Quality of Coronal Restoration versus the Quality of Root Canal Fillings on Success of Root Canal Treatment: A Systematic Review and Meta-analysis. *Journal of Endodontics,* 37**,** 895-902.

GORACCI, C. & FERRARI, M. 2011. Current perspectives on post systems: a literature review. *Aust Dent J,* 56 Suppl 1**,** 77-83.

GOYAL, S. & MITTAL, S. 2014. Prosthodontic Management of Endodontically Treated Teeth-A Review. *Journal of PEARLDENT,* 5**,** 13-19.

GRESNIGT, M. M. M., ÖZCAN, M., VAN DEN HOUTEN, M. L. A., SCHIPPER, L. & CUNE, M. S. 2016. Fracture strength, failure type and Weibull characteristics of lithium disilicate and multiphase resin composite endocrowns under axial and lateral forces. *Dental Materials,* 32**,** 607-614.

GUAZZATO, M., ALBAKRY, M., RINGER, S. P. & SWAIN, M. V. 2004. Strength, fracture toughness and microstructure of a selection of all-ceramic materials. Part II. Zirconia-based dental ceramics. *Dental Materials,* 20**,** 449-56.

HEDLUND, S. O., JOHANSSON, N. G. & SJOGREN, G. 2003. Retention of prefabricated and individually cast root canal posts in vitro. *Br Dent J,* 195**,** 155-8.

HELFER, A. R., MELNICK, S. & SCHILDER, H. 1972. Determination of the moisture content of vital and pulpless teeth. *Oral Surgery, Oral Medicine, Oral Pathology,* 34**,** 661-670.

HUANG, T.-J. G., SCHILDER, H. & NATHANSON, D. 1992. Effects of moisture content and endodontic treatment on some mechanical properties of human dentin. *Journal of Endodontics,* 18**,** 209-215.

IMURA, N., PINHEIRO, E. T., GOMES, B. P. F. A., ZAIA, A. A., FERRAZ, C. C. R. & SOUZA-FILHO, F. J. 2007. The Outcome of Endodontic Treatment: A Retrospective Study of 2000 Cases Performed by a Specialist. *Journal of Endodontics,* 33**,** 1278-1282.

INABA, Y., TERAOKA, F., NAKAGAWA, M. & IMAZATO, S. 2013. Development of a new direct core build-up method using a hollow fiber-reinforced post. *Dent Mater J,* 32**,** 718-724.

INGLE, J. I. & BAUMGARTNER, J. C. 2008. *Ingle's endodontics*, PMPH-USA.

JHAVAR, N., BHONDWE, S., MAHAJAN, V. & DHOOT, R. 2015. Recent Advances in Post Systems: A Review. *Journal Of Applied Dental and Medical Sciences,* 1**,** 3.

JOTKOWITZ, A. & SAMET, N. 2010. Rethinking ferrule--a new approach to an old dilemma. *Br Dent J,* 209**,** 25-33.

JULOSKI, J., RADOVIC, I., GORACCI, C., VULICEVIC, Z. R. & FERRARI, M. 2012. Ferrule Effect: A Literature Review. *Journal of Endodontics,* 38**,** 11-19.

LASSILA, L. V. J., TANNER, J., LE BELL, A.-M., NARVA, K. & VALLITTU, P. K. 2004. Flexural properties of fiber reinforced root canal posts. *Dental Materials,* 20**,** 29-36.

LE BELL-RöNNLöF, A.-M., LASSILA, L. V., KANGASNIEMI, I. & VALLITTU, P. K. 2011. Load-bearing capacity of human incisor restored with various fiber-reinforced composite posts. *Dental Materials,* 27**,** e107-e115.

LI, Q., XU, B., WANG, Y. & CAI, Y. 2011. Effects of Auxiliary Fiber Posts on Endodontically Treated Teeth With Flared Canals. *Operative Dentistry,* 36**,** 380-389.

MANNOCCI, F. & COWIE, J. 2014. Restoration of endodontically treated teeth. *British Dental Journal,* 216**,** 341-6.

MANNOCCI, F. & GIOVARRUSCIO, M. 2016. *Reastoration of Endodontically Treated Teeth. In: Harty's endodontics in clinical practice*, Elsevier Health Sciences.

MCCOMB, D. 2008. Restoration of the endodontically treated tooth. *Ensuring Countinuing Trust–DISPATCH***,** 1-20.

MENDOZA, D. B., EAKLE, W. S., KAHL, E. A. & HO, R. 1997. Root reinforcement with a resin-bonded preformed post. *Journal of Prosthetic Dentistry,* 78**,** 10-14.

MONGRUEL GOMES, G., MONGRUEL GOMES, O. M., GOMES, J. C., LOGUERCIO, A. D., CALIXTO, A. L. & REIS, A. 2014. Evaluation of different restorative techniques for filling flared root canals: fracture resistance and bond strength after mechanical fatigue. *Journal of Adhesive Dentistry,* 16.

MOU, Y.-B., CHEN, Y.-M., SMALES, R. J. & YIP, K. 2009. Optimum post and tooth root diameters for a cast post-core system. *American Journal of Dentistry,* 22**,** 311-314.

PANTVISAI, P. & MESSER, H. H. 1995. Cuspal deflection in molars in relation to endodontic and restorative procedures. *Journal of Endodontics,* 21**,** 57-61.

PEROZ, I., BLANKENSTEIN, F., LANGE, K.-P. & NAUMANN, M. 2005. Restoring endodontically treated teeth with posts and cores--a review. *Quintessence international,* 36.

PIRANI, C., CHERSONI, S., MONTEBUGNOLI, L. & PRATI, C. 2015. Long-term outcome of non-surgical root canal treatment: a retrospective analysis. *Odontology,* 103**,** 185-193.

PURTON, D. G., LOVE, R. M. & CHANDLER, N. P. 2000. Rigidity and retention of ceramic root canal posts. *Oper Dent,* 25**,** 223-7.

RICKETTS, D., TAIT, C. & HIGGINS, A. 2005. Post and core systems, refinements to tooth preparation and cementation. *Br Dent J,* 198**,** 533.

RING, M. E. 1992. *Dentistry: an illustrated history*, New York, NY, Abradale-Mosby.

RIVERA, E. M. & YAMAUCHI, M. 1993. Site comparisons of dentine collagen cross-links from extracted human teeth. *Archives of Oral Biology,* 38**,** 541-546.

ROBBINS, J. W. 2002. Restoration of the endodontically treated tooth. *Dental Clinics of North America,* 46**,** 367-384.

SAGSEN, B. & ASLAN, B. 2006. Effect of bonded restorations on the fracture resistance of root filled teeth. *Int Endod J,* 39**,** 900-4.

SCHWARTZ, R. S. & ROBBINS, J. W. 2004. Post placement and restoration of endodontically treated teeth: a literature review. *Journal of Endodontics,* 30**,** 289-301.

SEDGLEY, C. M. & MESSER, H. H. 1992. Are endodontically treated teeth more brittle? *Journal of Endodontics,* 18**,** 332-335.

SEEFELD, F., WENZ, H. J., LUDWIG, K. & KERN, M. 2007. Resistance to fracture and structural characteristics of different fiber reinforced post systems. *Dent Mater,* 23**,** 265-71.

SILVA, G. R. D., SANTOS-FILHO, P. C. D. F., SIMAMOTO-JúNIOR, P. C., MARTINS, L. R. M., MOTA, A. S. D. & SOARES, C. J. 2011. Effect of post type and restorative techniques on the strain and fracture resistance of flared incisor roots. *Brazilian dental journal,* 22**,** 230-237.

SKUPIEN, J., LUZ, M. & PEREIRA-CENCI, T. 2016. Ferrule Effect A Meta-analysis. *JDR Clinical & Translational Research***,** 2380084416636606.

SORRENTINO, R., MONTICELLI, F., GORACCI, C., ZARONE, F., TAY, F. R., GARCIA-GODOY, F. & FERRARI, M. 2007. Effect of post-retained composite restorations and amount of coronal residual structure on the fracture resistance of endodontically-treated teeth. *American Journal of Dentistry,* 20**,** 269-74.

STANDLEE, J., CAPUTO, A., COLLARD, E. & POLLACK, M. 1972. Analysis of stress distribution by endodontic posts. *Oral Surgery, Oral Medicine, Oral Pathology,* 33**,** 952-960.

STERZENBACH, G., FRANKE, A. & NAUMANN, M. 2012. Rigid versus Flexible Dentine-like Endodontic Posts—Clinical Testing of a Biomechanical Concept: Seven-year Results of a Randomized Controlled Clinical Pilot Trial on Endodontically Treated Abutment Teeth with Severe Hard Tissue Loss. *Journal of Endodontics,* 38**,** 1557-1563.

STEWARDSON, D. A., SHORTALL, A. C., MARQUIS, P. M. & LUMLEY, P. J. 2010. The flexural properties of endodontic post materials. *Dental Materials,* 26**,** 730-736.

TANG, W., WU, Y. & SMALES, R. J. 2010. Identifying and reducing risks for potential fractures in endodontically treated teeth. *Journal of Endodontics,* 36**,** 609-617.

TORABINEJAD, M., KHADEMI, A. A., BABAGOLI, J., CHO, Y., JOHNSON, W. B., BOZHILOV, K., KIM, J. & SHABAHANG, S. 2003. A New Solution for the Removal of the Smear Layer. *Journal of Endodontics,* 29**,** 170-175.

VICHI, A., FERRARI, M. & DAVIDSON, C. L. 2000. Influence of ceramic and cement thickness on the masking of various types of opaque posts. *J Prosthet Dent,* 83**,** 412-7.

WANDSCHER, V., BERGOLI, C., LIMBERGER, I., ARDENGHI, T. & VALANDRO, L. 2014. Preliminary results of the survival and fracture load of roots restored with intracanal posts: weakened vs nonweakened roots. *Operative dentistry,* 39**,** 541-555.

WILLIAMS, C., LOUSHINE, R. J., WELLER, R. N., PASHLEY, D. H. & TAY, F. R. 2006. A comparison of cohesive strength and stiffness of Resilon and gutta-percha. *Journal of Endodontics,* 32**,** 553-5.

ZICARI, F., COUTINHO, E., SCOTTI, R., VAN MEERBEEK, B. & NAERT, I. 2013. Mechanical properties and micro-morphology of fiber posts. *Dent Mater,* 29**,** 5.

ZICARI, F., VAN MEERBEEK, B., SCOTTI, R. & NAERT, I. 2012. Effect of fibre post length and adhesive strategy on fracture resistance of endodontically treated teeth after fatigue loading. *Journal of Dentistry* 40**,** 312-21.