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Types of Post and Core Systems

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Abstract:
Since the advent of post and core systems, dentists have regularly accepted the traditional cast and post and core as choice of treatment modality to restore a badly broken root canal treated tooth. The important question being, if at all the cast, post is indicated in every case. Other concept being that a cast post compared to a prefabricated post improves the strength of a root canal treated tooth which has been weakened by decay or over preparation. Literature indicates the ultimate strength of the remaining tooth structure is defined by the bulk of the remaining dentin as it improves the fracture resistance of the teeth. However, a prefabricated post causes lesser tooth fracture when subjected to stress as compared to cast post system. This review aims to present the different post systems as an alternate to conventional cast post and their advantage and disadvantage.

Key Words: Esthetics, ferrule, post and core, post space

Introduction

Historically, the most commonly used post and core system was cast metal posts and cores. They remain as the treatment of choice in post endodontic situations till date for many dentists; however, they fail twice as often as prefabricated metal posts, and may also result in nonsalvageable root fractures.[1-3] The modulus of elasticity of glass fiber reinforced (GFR) composite posts is in the range of that of dentin. Therefore, the masticatory forces are gently transmitted from the restoration to the core build up and the post of the tooth. In contrast, metals have a considerably high modulus of elasticity, which promotes the transmission of stress to the root canal wall.[4] In addition, adhesive composites are used to build up the core and form a mechanical unit with the tooth. Several types of post-core systems used are highlighted here.

Carbon Fiber-Reinforced (CFR) Epoxy Resin Posts

CFR post system was developed by Duret and Renaud in France and introduced in Europe in the early 1990s. Epoxy resin is reinforced with unidirectional carbon fibers which are parallel to the long axis of the post and forms the matrix for the post. The 8 mm fibers are uniformly embedded in the epoxy resin matrix which comprises 64% of the post by weight and are stretched before injection to enhance the physical properties of the post. On application of stress, the post is reported to absorb and distribute it along the entire post channel. The carbon fibers are made by heating polyacrylonitrile by in air at 200-250°C, and then, in an inert atmosphere at 1200°C which helps in removal of hydrogen, nitrogen, and oxygen, leaving behind just a chain of carbon atoms which forms the carbon fibers.

The CFR post has been reported to exhibit high fatigue strength, high tensile strength, and a modulus of elasticity similar to dentin. The post which was originally radiolucent is made radiopaque by adding traces of barium sulfate and/or silicate to it.[4]

Carbon fiber posts being black which can reflect through the all-ceramic restorations, gingiva or tooth and along with its minimal radiopacity makes it less favorable under esthetic considerations. However, their ease of use, flexibility, and retrievability makes them favorable and appropriate for gold or porcelain fused to metal crowns.[5]

On radiographic examination of five different types of fiber post-Mannocci *et al*. found that only Composipost and Snowpost posts had uniform radiopacity.[6] On comparison of fiber-reinforced resin posts with a titanium post, Finger *et al*. found that CFR posts had an acceptable radiopacity.[7]

The surface roughness of 5-10 μm, enhances the mechanical adhesion of post to an autopolymerizing luting material and the cytotoxicity tests reveal the post to be biocompatible.[8]

Several studies have indicated that CFR posts exhibit acceptable physical properties when compared to metal posts. In a retrospective study over 4 years, Ferrari *et al*. observed that the Cosmopost system was superior to the conventional cast post and core system.[9] King *et al*. evaluated the physical properties (fracture resistance and modulus of elasticity) of CFR posts and concluded that CFR posts are superior than prefabricated metal posts.[10]

Carbon fiber post have shown a low failure rate and are clinically satisfactory in 2-3 years follow-up cases.[11] However, Sidoli *et al*. in an *in vitro* study, found that CFR posts exhibited comparatively poor strength.[12]

Martínez-Insua *et al.* reported that the fracture resistance of teeth restored with CFR was lower compared to cast post and cores. A clinical evaluation of CFR posts indicated a low performance of CFR posts when compared to a conventional cast post and cores. However, the study had a relatively small sample size (27 teeth) used in this study.[13]

Multiple studies indicate that there is a decrease in the strength of CFR posts after thermocycling and cyclic loading. In addition, contact of the post with oral fluids reduced their flexural strength values.

Despite all the advantageous properties, *in vivo* applications of the CFR post can be questionable. When the ferrule is small or absent in an endodontically treated tooth restored with a CFR post, loads may cause the post to flex causing a micromovement of the entire core resulting in a compromised cement seal at margin of the crown accompanied by microleakage of oral bacteria and fluids. As a result, secondary caries may develop in the space and may not be easily detected.

GFR Epoxy Resin Posts

The need for esthetic restorations and all ceramic crowns led to the innovation of a variety of tooth-colored post systems as a substitute to metal and carbon reinforced posts.

The GFR epoxy resin post is made of glass or silica fibers (quartz) making them translucent or white, hence enhancing the esthetics of all-ceramic restorations. Glasses such as electrical glass (E-glass), high-strength glass (S-glass), or quartz fibers are used in making of GFR, However, the commonly used fibers are silica-based (50-70% SiO_2), along with other oxides.

The GFR post is available in different shapes: Cylindrical, cylindroconical, or conical shape. The composition of the glass fibers in the matrix determines its strength. Studies found that the posts with higher content of glass fibers displayed greater strength. GFR post has been reported to exhibit high fatigue strength, high tensile strength, and a modulus of elasticity closer to dentin than that of CFR posts. The GFR post is as strong as the CFR post and approximately twice as rigid.[14]

The flexural strength of GFR posts is not related to the type of glass fiber used. Galhano *et al.* on evaluation of the flexural strength of carbon fiber, quartz fiber, and glass fiber post, reported that all the posts behaved similarly due to the presence of the same concentration and type of the epoxy resin used in the fibers.[14]

Glass fiber posts provide all the advantages of nonmetal posts as well as the advantage of bonding the fractured tooth pieces to one another.[15] It lowers the stress concentration in the tooth hence reducing the incidence of catastrophic root fractures. In addition, this is a conservative and economic method that yields esthetically satisfying result.

Some, but not all, glass fiber posts transmit curing light to the internal area of the root, which allows the use of dual-cure adhesives cements. The amount of light transmitted varies significantly among fiber posts, from <0.1 mW to more than 2 mW. Light transmitting posts and bonded composite have been shown to reinforce weak roots with flared canals, providing increased fracture resistance. Because they do not require post space preparation, they preserve the integrity and strength of the dentin. Once cured, these posts reflect the internal shape of the canal but do not increase the risk of root fracture. Fiber posts have little to moderate radiopacity and may be difficult to visualize in radiographs when cemented within the dentin.[16]

Fiber posts are adhesively bonded in the root. The direct composite fiber post/composite resin core combination is bonded together at the interfaces of the root and the individual components. Their retention may not be as long as traditional posts. Qualtrough *et al.* showed that the parallel type of fiber posts are more retentive.[17] Retrievability is an important feature of endodontic posts, and fiber posts are easily removed for endodontic retreatment.[18]

Occlusal forces cannot be eliminated. They are transferred through the core and the post and ultimately disbursed along the length of the root. Ideally, the more the components behave such as dentin, the less the force is concentrated between the components and the root during the function. Fiber posts have a lower modulus of elasticity than rigid posts of metal or zirconia. These resilient posts prevent root from the fracture. Several studies have shown that teeth restored with nonrigid posts have less catastrophic and irreparable root fracture.[19]

When at least 25% of tooth structure or 3-4 mm of the axial crown is present, then the use of nonrigid posts are suitable, as the cervical tooth structure itself resists lateral flexion.

In the absence of cervical tooth structure, excessive flexibility can result in micromovement of the core and the coronal leakage. The physical properties of nonrigid posts are especially important for teeth with only a moderate amount of remaining tooth structure because in these teeth post must provide both protection to root and retention to core. In a three point bending test, fiber posts with no voids, bubbles or microscopic defects showed greater resistance to fracture than posts with these defects. These defects cause stresses which can lead to fracture at lower levels of force.[19]

The surface morphology of fiber posts can be modified with hydrogen peroxide and hydrofluoric acid, significantly enhancing the interfacial strength between them and core materials.[20] Air abrasion has also shown to increase the retention of fiber posts.[21]

Polyethylene Fiber-Reinforced Posts (PFR)

They are polyethylene-woven fiber ribbon of ultrahigh molecular weight (Ribbond, Ribbond Inc., Seattle, WA).

They are not posts and cores in the traditional sense. This polyethylene-woven fiber ribbon is coated with a dentine bonding agent and packed into the canal where it is then light polymerized in a position where it becomes rigid and acts like post. The leno weave or a triaxial architectural design imparts a three dimensional structure which composes of numerous nodal intersections that prevents propagation crack and also providing good retention for the composite cement. Comparative studies of PFR posts with fiber-reinforced posts revealed a lower incidence of vertical root fracture with PFR posts. The PFR post had an increased the strength of the post and core complex with the addition of a small size prefabricated post. However, the strength of the PFR post did not match that of cast metal post and core.

Comparative studies found the PFR posts to protect the remaining tooth structure. These results may be attributed to the manufacturer's instructions of limiting the canal enlargement, maintaining the undercuts within the root canal, and providing adequate crown ferrule. Core material of large volume and a sufficient dentin bonding area coronally have shown to great affect the mean load to failure value of PFR posts.[22]

Teeth with apical resection has been found to benefit from PFR post, and in cases of narrow canals, they outperformed GFR posts. PFR post takes the shape of the canal and also witnessed lesser microleakage when compared with zirconia posts.

Glass Fiber Posts

Glass fibers have a lesser modulus of elasticity compared to carbon/graphite fibers. Different types of glasses are employed in the making,

i. E-glass is a type of glass which is commonly used, where silicon dioxide, calcium oxide, barium oxide, aluminum oxide, and some other oxides mixed form amorphous phase
ii. High S-glass has a same amorphous phase but differing in their composition.

Types of glass fiber posts

Snow post (Carbotech, France)

Developed by Bios *et al.* at Lyon, composing of 60% of silica zirconium glass fibers in an epoxy resin matrix. Silane surface treatment is performed to enhance bonding to resin cements. Has a three-degree taper and a cylindrical shape. Available in different diameters – 1, 1.2, 1.4, and 1.6 mm.

Parapost fiber white (Coltene/Whaledent)

Designed to complement and extend the existing parapost system, having glass fibers which are longitudinally arranged. The small steps on the post aid in better mechanical retention to core material. The color-coded ring around the head helps in identification. Available in four diameters – 1.14, 1.25, 1.4, and 1.5 mm.

Glassix (Harald Nordin, Switzerland)

Like its carbon fiber stable mate, the Glassix posts have a woven fiber arrangement with similar dimensions.

Mirafit white (Hager Werken, Germany)

This is a similar to Mirafit carbon except that it is made of glass fiber.

Luscent anchor (Dentatus, Sweden)

These are tapered posts made up of translucent longitudinal glass fibers with in a resin matrix. Diameter at the coronal and 1.4, 1.6, and 1.8 mm with matching burs.

Fiber kor (Jeneric/Pentron, USA)

Unlike, the other system fiber kor posts consist of a filled composite as the matrix which surrounds the fibers. The fibers are glass, arranged longitudinally and comprise 42% by weight. The composite resin and filler both make up 29% by weight, respectively.

These posts bear similarity to fiber white posts in their stepped parallel shape, but have no separate shaping of their heads and are supplied with a pair of tweezers and matching burs in three sizes (1, 1.25, and 1.5 mm). Intermediate sizes are also available (1.125 and 1.375 mm).

FRC postec (Ivoclar/Vivadent)

These posts are composed of a methacrylate composite matrix and parallel glass fibers. These fibers transmit light toward the apical part of the tooth when dual curing composites are used. The post is silanized with Monobond-S. They are available in two sizes and can be processed chairside or in the laboratory. They are translucent naturally looking and can be removed with rotary instruments.

Quartz Fiber Posts

Types of quartz fiber posts

Esthetic post (RTD, France)

These posts retain the central core of carbon fiber bundle surrounded by quartz fibers arranged longitudinally.

Esthetic plus post (RTD, France)

Belong to the next generation of esthetic posts and is composed entirely of quartz fibers. Combines Quartz-fiber esthetics with the 2-stage taper design.

Light post (RTD, France)

A translucent quartz fiber post designed to permit light curing materials to the used for luting.[22] All of these variations are produced in the same shapes and sizes as the original composite post. RTD has recently introduced a series of posts with a double taper.

Style post (Metalor Technologies, London)

Parallel-sided, tapered, end quartz fiber post system.

Conclusion

For a successful post and core systems, the clinician should keep in mind regarding proper obturation, post space, post length, post diameter, ferrule design, and should preserve the root dentin as much as possible.

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