Fiber Posts and its clinical implications in endodontically treated tooth- A review

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Abstract

Objective: Concept of preserving the tooth over extractions have encouraged the development of posts. Last decade has shown significant development in posts used for reinforcement of endodontically treated teeth. Evolution from metallic posts to composite fiber reinforced posts have significantly improved the fatigue resistance. Low modulus of elasticity and excellent light conductivity improved the longevity of post endodontic restorations using fiber post. There are different types of fiber posts namely carbon fiber posts, prefabricated quarz-fiber posts, glass fiber posts, polyethylene fiber posts and hollow posts. The surface treatment, adhesive systems and luting agents used for fiber post cementation are described in this article.**Clinical significance:** Dowel systems help to retain badly broken within the arch. As the fiber posts have modulus of elasticity similar to that of dentin, they are able to absorb the forces acting on it and dissipate them uniformly. This helps to reduce the risk of fracture. Fiber posts have improved the longevity of endodontic restorations.

Keywords: Fiber post, resin cements, surface treatment

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Introduction

Clinical cases exhibiting a horizontal loss of the tooth structures due extensive carious lesions, trauma cannot be withholding a restoration due to lack of retention [1]. Endodontically treated teeth with excessive loss of the coronal structure has to be restored with additional support for the restoration. Hence a post is introduced into the root canal to achieve additional retention of the core build up material. This improves the longevity of the restoration. Posts are indicated when there is a moderate loss of tooth structure.

Posts can be broadly categorized as metallic and non-metallic posts. Initially metal posts were introduced in the market. Over a period of time the conventional metallic posts were replaced by non-metallic posts. The modulus of elasticity of a fiber posts is close to that of dentin [2]. This helps in uniform stress distribution along the vertical axis of the tooth reducing risk of root fractures [3]. Higher bond strength is achieved when fiber posts are used in comparison to metal or zirconia posts. Fiber post also reinforces the root [4].

Main Text

Composition of fiber post

Fiber post is composed of pre-stretched fibers in polymer resin matrix. The fibers reinforce the matrix providing tensile strength. They absorb the stress and dissipate it along the long axis of the tooth. The stresses usually occur at the interface between the fibers are the matrix. Based on the type of fibers used for reinforcing the matrix of the post, it can be classified as carbon post, quarts fiber post, polyethylene fiber post and hollow posts.

Carbon posts: It was introduced as in alternative to cast metal post. It comprises of a matrix of epoxy resin interspersed with unidirectional carbon or graphite fibers. However, the carbon fibers posts have poor esthetics as it has a darker hue. It exhibits similar modulus of elasticity to dentin and higher tensile strength [5]. Due to lack of radiopacity and adhesion to the core build up materials, carbon posts are not used. CF Fiber post, Carbopost are some of the commercially available carbon posts.

Quartz-fiber posts: It comprises of methacrylate or epoxy-polymer matrix with pre-stretched quartz fibers. This composite material has a highly cross-linked structure which holds the quarts fibers together. Unlike carbon posts, they have good esthetic property with flexural and fatigue strength. Some of the commercially available posts include Dt Light Post, Aesthetic Plus Post, Macrolock Illusion Post.

Glass fiber posts: It comprises of PMMA and Bis-GMA fibers reinforced with high-volume of continuous stretched unidirectional reinforcing glass fibers contained in a matrix that holds the fibers. These fibers stretch uniformly under pressure up to their breaking point. The fibers return back to their original length when the load is released [6]. Based on the chemical structure of the glass fibers, it can ne categories as A fibers (alkali), C fibers (chemically resistant), D fiber (dielectric), E fibers (electrical), R fibers (resistant) and S fibers (high strength) glass types [7]. E glass fiber is the most commonly used type. Some of the commercially available glass fibers are Snow post, Mirafit white, Radix fiber post, Reforpost, Luscent anchor, Parapost Rebilda post GT, Flexi-post Fiber, Flexi flange Fiber, EZ fit fiber.

Polyethylene fiber posts: It is a woven polyester bondable ribbon-based fiber composite laminate endodontic post and core system [8]. Plasma-treated ultra-high molecular weight polyethylene fibers woven

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into a three-dimensional structure, leno wave or triaxial braid, make up this reinforcement material. Because of the cold gas plasma pretreatment, the fiber's surface tension is lowered, ensuring a good chemical connection to the resin components. Ribbond and Ribbond THM are commercially available polyethylene fibers.

Hollow fiber posts: Inaba et al. devised a new method using a hollow fiber post to carry out core build up [9]. It a new way to administer restorative material upto bottom of the root canal by injecting it through the hollow post.

Steps in fibre post placement

1. Post selection: There are various factors to take be taken into consideration while selecting a post.

a) Post length: Based on the mechanical retention required and need to maintain the apical seal, the post length has to be decided. Retention increases with increase in the length of the post. However, long post can pose a risk for root perforation

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Silverstein WH et al. (1964) proposed that the length of the post should be longer than the crown.
Burnell SC et al. (1964) proposed that the post length should be four fifth the length of the root.
Dooley BS et al. (1967) proposed that post length should be one and one third the length of the crown.
Baraban DJ et al. (1967) proposed that length of the post should be half the length of the crown.
Dewhirst RB et al. (1969) proposed that post length should be two third the length of the root.
Perel and Muroff et al. (1972) proposed that post length should be half the root length.
Johnson and Sakumura (1978) proposed that post length should be three fourth the root length as it makes it 20 to 30 % more retentive.
Abou-Rass M et al. (1982) proposed that post length in molars should not be more than 7 mm apical to the orifice of the canal.
Sorenson and Martinoff (1984) proposed that post length should be equal to the length of the crown.

Leary et al. (1987) proposed that post length should be one fourth or half the length of the root.
Goodacre and Spolnik (1995) proposed that post length should be three fourth the length of the canal.
Abramovitz et al. (2001) proposed that atleast 5mm of the gutta-percha should be preserved.
Al-Omiri et al. (2011) proposed that the post above the crest of the alveolar bone leads to increase in dentinal stresses near the apex of the post.

Table 1: Recommendations on the requirements of post length as postulated by various authors.

b) Post diameter: Post diameter corelates to the amount of preparation that needs to be carried. The post diameter should be less than one third the diameter of the root at the cementoenamel junction and 1 mm or more of dentin should remain around the post. When there is reduced thickness of canal walls, it reduces the effect of ferrule. Diameter of the post must be kept minimal to preserve more of peri-cervical dentin reducing the risk of perforations and fracture [11]. Preservationist philosophy states that at least 1 mm of sound dentin has to be preserved around the entire circumference of the root canal. Propertionist philosophy states that Stern and Johnson et al. that diameter of the post space prepared should be one third the diameter of the root. As per Conservationist philosophy, the canal space preparation should be kept as minimal as possible. It is a very conservative approach with minimal instrumentation restricted to removal of undercuts. This permits the removal of dowel patterns providing adequate retention without compromising the fracture resistance of the root.

c) Post design:

Post can be cylindrical, conical or combined. Parallel-sided posts are more retentive than tapered posts. It can distribute stresses more uniformly along their length when forces act on it [12]. However, a combined shape is preferred because the cylindrical half is placed at the coronal part of the root and the tapered part in the apical region.

2. Post space preparation

Gutta Percha removal: Lemon (1981) found no difference in the immediate and one-week canal preparation when 4 mm of gutta percha was retained. Dickey et al (1982) reported contrasting results they found significantly greater leakage with immediate gutta-percha removal. However, immediate gutta percha removal has certain advantages. When a slow setting sealer is used, the remaining gutta percha filling can

be condensed to improve the seal. There is no need for additional appointment for placement of post [13]. When there is an increased length of time of contact for eugenol-containing materials, there is a decrease in adhesion. Therefore, effective removal of eugenol-based sealers should be performed immediately after obturation.

Canal preparation: Before preparing a post space, the GP must be removed to the required post length. Rotary instruments with a non-end cutting bur such as GG Drill or peeso reamer, heat and solvents such as Chloroform, Eucalyptol, Xylene can be used for removal of gutta percha. After removal, progressive enlargement of the canal should be carried out using a series of post preparation drills to an appropriate post size. The orientation of the reamer should be in the same axis and prepare concentrically in the apical part of the post channel.

3. Try in of fiber post: The post should pass along the whole length of the prepared canal. It is further confirmed using a radiograph.

4. Surface treatment: To improve the bond strength of fiber post, surface treatment is carried out. This helps improve the chemical and micro-mechanical retention between different constituents [14].

a)Silane coupling agent
a)Pre-Treatment with Air-Borne Particle Abrasion - 50 µm alumina particles were used to treat post surface
a)Pre-Treatment with Hydrofluoric Acid
Pre-Treatment of post surface with Laser - Nd:YAG laser and Erbium Lasers
Pre-Treatment post Surface with Etching Agents - Dichloromethane , 37% phosphoric acid
Pre-Treatment of post Surface with 20% Hydrogen Peroxide for 20 minutes
Sandblasting - Aggressive for fiber hence it should be used with caution

Table 2: Steps involved in surface treatment of fiber post

5. Bonding procedure: Bonding to root dentin is considered challenging as there is limited access and visibility to the area [15]. Currently there are two approaches for adhesion namely etch-and-rinse approach and self-etch approach. In etch and rinse approach, an etchant is used to remove the smear layer from the canal walls. The acidic monomers in the self-etch adhesives that conditioned the dentin was less effective when compared to the phosphoric acid in the etchant [16]. Research showed that cementation of the post using etch and rinse approach lead to higher bonding when compared to the self-etch approach. However, self-etch approach is preferred by favored by the clinicians as it is because less technique sensitive.

(a) Etch and rinse approach: Etching is carried out using phosphoric acid. Etchant is rinsed with water for at least 15 seconds. Canals are dried using paper points. Gentle air-drying should be carried out. 95–100 % of ethanol is applied for 1 min. Apply the adhesive inside the root canal using a rounded-tip micro brush. Apply at least two coats of adhesive to all root walls for 10–15 seconds actively. It is then light cured for 20 to 40 seconds.

(b) Self-etch approach: Etching step is eliminated in this approach. The bonding agent is directly on the root dentin. It is scrubbed on the dentinal surface for 10 seconds and air thinned. Two coats of the adhesive are applied after which light curing is carried out for 20 to 40 seconds.

7. Luting procedure: Resin cements are used for luting fiber post. Dual cured resin cement is most commonly used for cementation of fiber post. This material can undergo polymerization in the absence of light and has extended working time. Studies have shown that dual resin cements have higher bonding to root dentin [18]. A time delay between mixing the resin cement and activation improves the bonding of resin to dentin [19]. When rapid light curing takes place, there is a rapid increase in viscosity which hinders the reaction of acidic monomers with the dental tissues weakening the bond. It also reduces the polymerization shrinkage stress [19].

Resin cement is introduced into the canal and applied on to the canal walls. The post is inserted into the canal. Due to hydraulic forces, post gets pushed out of the channel. Hence it is essential to hold the post in the canal space. The excess cement recess gets collected in the access cavity which had to be removed used a microtip brush. It is then light cured for 40 seconds

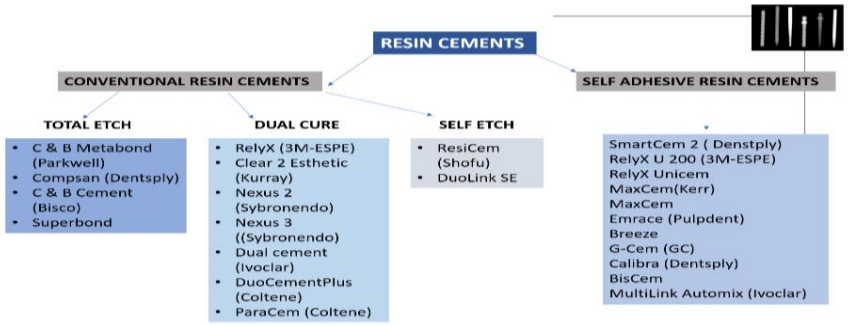

Figure 1: Various commercially available resin cements for the cementation of fiber posts

8. Removal of excess of fiber post: Wheel or diamond bur should be to cut off the excess of fiber post. A wire cutter should not be used to remove the excess fiber post to avoid damage to the fibers. Alcohol is used to clean or swab the debris after which core build up can be carried out.

Limitations: This review highlights the importance of fibre pots for strengthening of the grossly destroyed tooth structure with the concept of monoblock effect.

Abbreviations

CF Fiber post: CF Carbon Fiber post

PMMA: Poly(methyl methacrylate)

Bis-GMA: Bisphenol A-glycidyl methacrylate

THM: Thinner Greater Modulus

MMP: Matrix Metalloproteinase

CHX: Chlorhexidine

GP: Gutta Percha

GG: Gates Glidden

Nd:YAG: Neodymium-doped Yttrium Aluminum Garnet

EDTA: Ethylenediamine tetra acetic acid

C factor: Cavity configuration factor

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Authors' Contributions

SL and RM: Conceptualization, Methodology and Investigation

SL and RM: Conceptualization and Data Curation.

SL and RM: Writing - Review and Editing and Supervision.

SL and RM: Writing - Original Draft and Writing - Review and Editing.

SL and RM: Writing - Original Draft and Project Administration.

SL and RM: Resources and Writing - Review and Editing.

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Availability of data and materials

The data used to support the findings of this study can be made available upon request to the corresponding author.

Declarations

Ethics approval and consent to participate

The present review was approved by the Ethics Committee of Manipal College of Dental Sciences, Mangalore, and only individuals who provided written informed consent were included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest

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