

Evolution of Posts - *From Rigidity to Flexibility*

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Abstract: *The completion of root canal treatment does not signal end of patient management. The restoration of the endodontically treated tooth is an important aspect of dental practice involving a range of treatment options of varying complexity. Modern dentistry aims at preserving pulpal vitality and avoiding the use of posts considering post application as the last therapeutic option. In the present era of Aesthetic, Conservative and Adhesive dentistry, Esthetic and functional restoration of a pulpless tooth is a demanding challenge. The post endodontic treatment of teeth, present the dental practitioner with the dilemma of selecting from a large array of materials, technique and designs. The purpose of current review article is to throw light on different posts available and their clinical implications*

Keywords: prefabricated posts, custom cast posts, biological post, peek post, I post

1. Introduction

Dentistry has undergone significant evolution since its beginning. Earlier extraction of teeth was the most opted treatment modality for most of the conditions instead of preservation. Now the clinicians look forward to conservative treatment options; this can be attributed to the advances in endodontics, and restorative dentistry, with its modern restorative techniques. Post endodontic restoration has evolved from empirical level to biomechanical concept process¹.

The reconstruction of endodontically treated teeth is frequently required before the accomplishment of a definitive restoration, especially when the remaining coronal tooth structure is inadequate to provide retention and resistance form for the restoration. Using a dowel to restore a tooth whose natural crown is missing is not a recent dental treatment. In the Tokugawa era (1603 to 1867), the Japanese used wooden dental restorations designed to function like the modern dowel crown². Pierre Fauchard in his book "The Surgeon-Dentist" or "Treatise on the Teeth" published in 1728, described a technique by which a silver post was used to retain a natural tooth crown or an ivory crown to a root³.

Many different types of posts have been described in the literature (Fernandes, Shetty & Coutinho, 2003). At first, cast metal alloy posts and prefabricated posts made of stainless steel, titanium or precious alloys were used. The cast post - core system requires multiple appointments accompanied by an intermediate laboratory phase to elaborate the retaining system, making the procedure more expensive. Prefabricated posts do not require this intermediate phase and therefore, allow the whole restoration to be performed in one visit, resulting in an easier, less expensive technique. However, adaptation of the post to the root canal may be less accurate (Chan, Harcourt Brockhurst, 1993).

With the advent of newer dental materials, variety of custom made and prefabricated posts have been introduced in the field of dentistry.

The objective of this article is to expound the most recent and reliable evidence pertinent to posts.

2. Effect of Endodontic Treatment on Tooth

In the past, several studies have shown that endodontically treated teeth become brittle because of reduction in water content^{4,5} and loss of cross linking of collagen⁵. On the other hand, Huang et al, compared the physical and mechanical properties of endodontically treated teeth and normal teeth for which he concluded that neither dehydration nor endodontic treatment were the attributing factors for degradation of mechanical and physical properties of dentin⁶. Major changes are seen in tooth biomechanics on account of carious lesions, fracture, cavity preparation including access cavity preparation before endodontic therapy. Loss of tooth structure during cavity preparation (conservative access) affects stiffness of dentin by only 5%⁶. Loss of marginal ridges attributes 14-44% and 20-63% reduction in tooth stiffness following occlusal or mesio-occluso-distal cavity preparation resulting in maximum tooth fragility.⁷

3. Ideal Requirement of Posts

The dowel is a metal post or rigid restorative material placed in the radicular portion of a non-vital tooth. Posts were regarded as methods of reinforcing pulpless teeth. But active posts weaken the tooth structure rather than reinforcing it^{8,9}. The foremost function of the dowel is to provide retention for the core and coronal restoration and to do so without increasing the risk of root fracture. Post should provide as many of the following clinical features as possible¹⁰:

- 1) Maximum protection of the root from fracture
- 2) Maximum retention within the root and retrievability
- 3) Maximum retention of the core and crown

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- 4) Maximum protection of the crown margins seal from coronal leakage
- 5) Pleasing esthetics, when indicated:-in the esthetic zone, the post should not detract from esthetics of the coronal tooth structure, ceramic crown or gingival.
- 6) High radiographic visibility
- 7) Biocompatibility

3.1 Types of posts

There are many ways on the basis of which posts can be classified,

- a) Metallic and non metallic post (Robbins),
- b) Active and passive, parallel versus tapered, prefabricated and custom made (Schwartz).

According to William Cheung, classified dowel into:

- a) Custom made
- b) Prefabricated posts.

Custom cast post and core has a long history of success in restorative dentistry. . Nonetheless, studies have been reported high success rate pertaining to certain clinical conditions and situations^{11,12}. Clinical scenario where multiple teeth require posts, or tooth is malaligned and angulation of core must be changed in accordance with the dowel to achieve proper alignment. Cast posts are also indicated in smaller teeth like mandibular central incisor where remaining radicular dentin thickness is already compromised.

However, laboratory studies have consistently shown that the fracture resistance of teeth restored with custom cast posts is lower than that of teeth restored with many different prefabricated posts. On account of tapered design wedging forces are predominant on root. This, coupled with the added expense, extra appointment and need for temporization, have made them fall out of favor^{13,14}. Despite having varied types of commercially available custom made posts, none of them meet all the ideal biological and mechanical properties. Hence, the following are newer advancements in this field so as to overcome most of these shortcomings.

4. Biological Posts

“Biological Post” serves as a homologous recipe for intraradicular rehabilitation of a fractured endodontically treated tooth by virtue of its biomimetic property¹⁵. They are manufactured from natural, extracted teeth readily available from tooth banks. These posts aid in strengthening of intraradicular dentin.

Advantages

- 1) Monoblock effect
- 2) Does not promote dentin stress,
- 3) Preserves the internal dentin walls of the root canal.
- 4) Presents total biocompatibility and adapts to conduct configuration, favoring greater tooth strength and greater retention of these posts as compared to pre manufactured posts.
- 5) Presents resilience comparable to the original tooth.

- 6) Offers excellent adhesion to the tooth structure and composite resin and at low cost.^{16,17,18,19}

Disadvantages

- 1) Difficulty of finding teeth with a similar color and shape as that of the destroyed element
- 2) Patient may refuse to accept a tooth fragment obtained from another patient, which prevents the execution of the restoration¹⁵

Peek Posts

A high-performance polymer, polyetheretherketone (PEEK) has recently been introduced in dentistry. It has been used for the fabrication of implant fixtures, fixed and removable dental prosthesis frameworks and for implant frameworks and restorative implant parts.²⁰ Modified PEEK material containing 20% ceramic fillers (BioHPP; Bredent GmbH) has good mechanical properties and excellent biocompatibility^{21,22,23}. It can be used for the fabrication of prostheses either by injection molding or CAD-CAM procedures.

Advantages of peek posts

- 1) Major advantage of this modified PEEK material is a 4-GPa modulus of elasticity, making it as elastic as bone and allowing it to act as a stress breaker and reduce the forces transferred to the restoration and the tooth root accordingly.^{24,25,26}
- 2) Elimination of allergic reactions,
- 3) Good wear resistance,
- 4) Good polishing properties
- 5) Low plaque affinity.
- 6) Radiolucent, which may facilitate recurrent caries detection

Disadvantages of peek posts

- 1) Microleakage
- 2) Behaviour under fatigue loading is not clear
- 3) Occlusal adjustments must be done
- 4) This material cannot be polished easily, intraorally after definitive cementation which results in adulocclusal surface²⁷.

Prefabricated Posts

The majority of the prefabricated posts are metallic. Recently, in response to a need for tooth colored posts, several non metallic posts are available. These include:

1) Fiber-reinforced resin post systems

Classification as :

- A. Based on composition
 - i. Carbon Fibres – Composit post, Endo post, Carbonite system, Mirafit Carbon, Lucent anchor, Fibrekor
 - ii. Silica Fibres – Glass fibre (Snow post, Fiber White, Glassix, Mirafit White) and Quartz fibre (Aesthetic post, Aesthetic plus, Style post, Light post)
 - iii. Polyethylene – Ribbond and Construct

2) Ceramic post and core system

5. Fiber-Reinforced Composite Post System²⁸

The addition of fibers to a polymer matrix results in a significant improvement in the mechanical properties of:

- Strength
- Fracture toughness
- Stiffness
- Fatigue resistance

Fibers may be composed of,

Woven polyethylene,
Glass or Carbon

Advantages

- One appointment technique
- No laboratory fees
- No corrosion
- Reduced root fracture
- No allocated orifice size
- More retention
- Conserved tooth structure
- No negative effect on esthetics

Disadvantages

- Technique sensitivity
- Proper adhesive protocol should be follow

6. Carbon Fiber Post System

1) Composit post/ C Post^{29,30,31,32}

Introduced in 1990 by Duret, Reynaud & Duret.



Figure 1: Composit Post

The Composit post system (RTD, Meylan, France), comprising a carbon fiber post, a composite core material, and a low viscosity bis-GMA bonding resin, has been recently introduced to the market. The matrix for this dowel is an epoxy resin reinforced with unidirectional carbon fibers parallel to the long axis of the dowel. The fibers are 8µm in diameter, and uniformly embedded in the epoxy resin matrix. By weight, the fibers comprises 64% of the dowel and are stretched before injection of the resin matrix to maximize the physical properties of the dowel.³³

Advantages of carbon fibre posts

- 1) Complete post/core and cement system in one kit.
- 2) Homogenous mechanical and chemical bonding of all components, which serves to reinforce the tooth.
- 3) Carbon fiber post which has a Young's modulus approximating that of natural teeth; which results in decreased stress concentration and therefore an increased longevity of the restoration.

- 4) The relative ease of removal from the post by conventional rotary instruments.
- 5) A further advantage is the elimination of corrosion when a carbon post is used in combination with a composite core, compared with some metallic post and core systems that exhibit corrosion.

Disadvantages of carbon fibre posts

- 1) Carbon fibers were dark in colour resulting in compromised post restorative esthetics
- 2) Radiopaque in nature.

i. Endopost (RTD, France)

These are narrow parallel sided cylindrical posts used for retention of core materials in narrow-diameter roots such as molars or mandibular incisors. They are available in 1-1.2 mm diameters.

ii. Carbonite system (Harald Nordin Sa, Switzerland, Kent)

Fibres are 6µm in diameter and braided together within the epoxy resin matrix. Fiber content is 65%. This arrangement provides increased resistance to bending and torsion compared with a parallel fiber arrangement. The posts are parallel sided with a 3 mm conical tip. Available in three diameters- 1.2mm, 1.35 mm and 1.5mm, with a single bur for each size. These burs are having triangular cross section with non cutting flutes.

iii. Mirafit carbon (Hager Werken, Germany)

This system appears identical to the carbonite system in its construction, dimension and presentation. It is triangular in cross section with burs for post space preparation.

7. Silica Fibre Posts

Types----glass fiber and quartz fiber.

A) Glass fiber posts

Glass fibers have a lower elastic modulus than carbon / graphite fibers. These posts can be made of different types of glasses.

i. Electrical glass (E-glass) – is an amorphous phase, made up of mixture of Silicon Dioxide, Calcium Oxide, Barium Oxide, Aluminium Oxide and some other oxides of alkali metals.

ii. High strength glass (S-glass) - is also amorphous but differs in composition.

Types of glass fibre posts

I. Snow post – (Carbotech, France)

Developed from research originally on carbon fibre by Professor Bois and colleagues at Lyon. It is composed of 60% longitudinally arranged Silica Zirconium glass fibres in an epoxy resin matrix. The surface is treated with silane to enhance bonding with resin cements. It is cylindrical in shape with a 3° taper. The taper is 4-6 mm long. Available in four diameters – 1, 1.2, 1.4, and 1.6 mm along with matching burs.

II. Parapost fiber white:³⁴(Colttene / Whaledent)

The ParaPost Fiber White Post (Colttene/Whaledent, Mahwah, NJ) is a filled resin, mono-directional fiber matrix with a flexural modulus that very similar to that of the natural dentin. The color of the post is white translucent, designed to minimize shadowing under all-ceramic restorations. The parallel-sided posts passively fits inside the canal, and the antirotational post head stabilizes the core materials. ParaPostfiber white are mainly available in four diameters, color-coded to matching drills. These posts can easily be removed in case of endodontic retreatment.



Figure 2: Parapost Fiber White Post

III. Glassix: (HaraldNordinSa, Switzerland)

Like its carbon fiber stable mate, the glassix posts have a braided fiber arrangement and are presented in the same dimensions.

IV. Mirafitwhite:(Hager Werken, Germany)

This is a glass fiber version of Mirafit carbon.

V. Luscent anchor post system³⁴

The Luscent anchor post (Dentatus) is a fiber-glass, clear resin post that is designed to refract and transmit natural tooth colors for esthetic post-and-core foundations. The Luscent anchor is radiolucent and identified on radiographs by the surrounding resin cement. These are placed passively in prepared canals available in three diameters, and there sizes are incorporated with the Light Transmitting Posts. The Luscent anchor is easily removed, if required, for endodontic re-treatment.



Figure 3:Luscent anchor post

VI. Twin luscent anchors

Twice the Invention, Twice the Retention !

This innovative design is visible assurance against accidental debonding of adhesive and resin-core materials. The slim mid-section creates a “physical choke”. The vent groove eliminates air resin entrapment and prevents rotational dislocation. It all adds upto a winning combination of light transmission, attractive esthetics and twice the retention.

- a) Light transmitting: Effectively polymerizes composite within the deep confines of canals.
- b) Esthetics: Eradicates shadows at the cervical portion of the tooth as well as through thin-laminate composite restorations. Reflects the surrounding colors and hues, compatible with natural esthetics.
- c) Monobloc strength: Light or dual cure composites bonds to the fiberglass reinforced anchors creating a cohesive, very strong foundation for restorations.
- d) Double-end alternatives: The anchor cone shaped-end can be placed in deeper and narrower canals without excess removal of dentin or canal wall. The parallel end can be alternatively placed into long, wider canals of teeth. The parallel canals can be refined with drills, used in parallel canal post techniques.
- e) Longitudinal vent-groove: Eliminates trapped air bubbles causing porosity, for completely filling the canal and provides an antirotational resistance in the surrounding polymerized resin material.
- f) Low modulus of elasticity (20.1 GPa): The Anchor’s elasticity in the range of healt



Figure 4:Twin luscent anchors

Types of quartz fibre posts

I. Aesthetic plus post³⁴

(RTD, France)The Aestheti-Post System (Bisco, Schaumburg, IL) is a series of posts that can be used in a variety of situations. The traditional posts are two-stage fiber posts, available in white or clear quartz fibers. There is also a tapered white fiber post. The posts have characteristics that are similar to their carbon fiber ancestors, including high flexural strength and a low modulus of elasticity. If endodontic re-treatment is required all the posts are retrievable.



Figure 5: Aestheti Post system

II. Double taper post system (D.T light transmitting post)

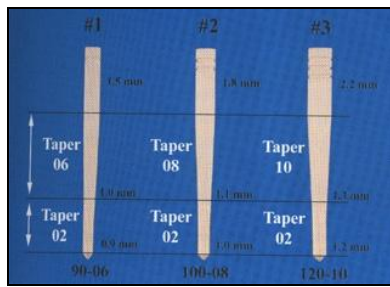


Figure 6: D.T (light transmitting post)

Post-to-canal adaptation plays a pivotal role in the biomechanical performance of the prosthetic restoration. The new DT- Post system was designed with the purpose of providing close canal adaptation with minimal tooth structure removal. It seems to offer a logical solution in restoring endodontically-treated teeth.

- A) D.T. Post provides bigger taper at the coronal level.
- B) Provide better adaptation at the coronal level, therefore, consequently decreases the thickness of the resin cement, a lower performance material, and reduces its polymerization total shrinkage.
- C) D.T post combines the conservative aspect of Endo-Composipost UM apically, and the greater size of the Composipost coronally.

8. Woven-Fibre Composite Materials/

Polyethylene Fibre Materials

The use of cold gas plasma treated, polyethylene woven fibers embedded in conventional resin composite have been advocated for coronal radicular stabilization of pulpless teeth. They consist of woven fiber ribbons. Used as a matrix for the construction of direct etch – retained composite splints.

Ceramic Post Core System

Metal-free ceramic restorations offer a highly esthetic appearance, as well as biocompatibility. These restorations can be fabricated with a variety of ceramic crown systems, including In-ceram (VITA Zahnfabrik, Bad Sackingen, Germany), Procera (Nobel Biocare, Goteborg, Sweden), and IPS Empress 2 (Ivoclar Vivadent, Schaan Liechtenstein). With the introduction of the current all-ceramic systems, the use of the all-ceramic posts & cores was suggested as an alternative to solve the esthetic problems that metal posts & cores exhibit.

Advantages:

- 1) The major advantage of an all-ceramic post & core is its dentin like shade. The positive contribution of the dentin shade ceramic core is related to the deeper diffusion and absorption of the transmitted light in the ceramic core mass.
- 2) All ceramic posts & cores, as metal free constructions, provide an excellent biocompatibility.
- 3) They do not exhibit galvanic corrosion.
- 4) They are dimensionally stable with oral tissues.

- 5) It has good strength. The strength of porcelain is usually measured terms of flexure strength. It has flexure strength of 141.1 Mpa.
- 6) It is insoluble and impermeable to oral fluids. Also it is resistant to most solvents.
- 7) They are radiopaque.

Disadvantages

- 1) Relatively low fracture strength and fracture toughness. Ceramic has good strength. However it is brittle and tends to fracture.
- 2) Fracture toughness of a ceramic material seems to be more predictive of its failure rate.
- 3) They have high modulus of elasticity (69 Gpa).
- 4) They are much harder (460 KHN) than natural teeth.
- 5) It is difficult to bond ceramic post.
- 6) Removal of ceramic post without trauma is difficult

9. Smart Posts

As the quest for an “ideal restorative material” continues, a newer generation of materials was introduced. These materials may be altered in a controlled fashion by stimulus such as stress, temperature, moisture, pH, electric or magnetic field. Some of these are “biomimetic” in nature as their properties mimic natural tooth substance such as enamel or dentin. A key feature of smart behavior includes its ability to return to the original state even after the stimulus has been removed.³⁵

In 2001, White et al. introduced the concept of self repair using controlled release devices to stop crack propagation in a structural epoxy resin composite in response to crack initiation. The material incorporates unpolymerised resin containing micro capsules that ruptures upon crack intrusion during mechanical stress³⁶.

Pang and Bond further extended the self repair concept by inclusion of subsurface layer of hollow glass fibres. For damage sensing hollow glass fibres were imbedded with a U V fluorescent dye. For self repair purpose hollow fibres were filled with 30% acetone diluted, uncured epoxy resin monomer³⁷.

I POST

I post is a new post system with unique features developed by integrated endodontics. I post [Figure is a passive, parallel, pillar-like metal post made of stainless steel alloy. This post has a unique design, which compensates the anatomic flare of the coronal part of the root canal.



Figure 7: I post

Every canal has a natural/anatomic coronal flare, which needs to be compensated by the post. The I post has an innovative design with a pillar-like shape coronally, which fits into the coronal flare of the root canal. Its passive parallel design prevents fracture of the root under

mastication. Thus, I post enhances retention and resistance features of the post endodontic restoration.³⁸

10. Conclusion

The primary function of endodontic post is to provide retention for the core and enable full sealing of coronal portion of the root canal. Since much attention is given to esthetics, using esthetic posts with composite/ceramic cores has become very common in restorative dentistry. In fact, this is becoming a standard because these posts are esthetically pleasing, biocompatible and have good physical properties. The clinician should be aware of the differences between different intracanal posts in order to select and use the most appropriate post system in each specific situation.

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