Recent advances in endodontic post material

Review Article

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ABSTRACT

For many years, metal posts were used extensively for restoration of endodontically treated teeth. Their popularity is, however, declining now and there is a widespread interest in the use of non-metallic post material and techniques. Growing interest in esthetic dental restorations and adhesion dentistry has driven both manufacturers and dentists to create some innovative new post material like fiber reinforced composite and ceramics. This article provides a brief overview of recent advances in endodontic post material that have had a significant impact on the art and science of endodontic post placement.

KEY WORDS: Ceramic posts, fiber posts, metallic posts, post materials

INTRODUCTION

For nearly a century, the standard technique for restoration of badly broken down endodontically treated teeth consisted, almost exclusively, of either a cast metal post/core or a prefabricated metal post with an amalgam core build up. During the last few years, with the advent of new material and technologies, there has been a major shift away from metal custom-cast posts and cores towards prefabricated metal posts and resin-based composite cores, and recently there is a clearly observable movement towards use of fiber reinforced resin-based composite posts and ceramic posts.[1]

Fiber Reinforced Composites

Charles J. Burstone made the early scientific contributions to the development of fiber reinforced composite (FRC).[2]

FRCs have at least two distinct constituents

- Reinforcing Component (fibers) - Provides strength and stiffness.
- Surrounding Matrix (polymer matrix) - Supports the fibers and provides-workability.

Fiber Post can be Classified According to [2,3]

Fiber component –

Type of fiber used e.g. carbon, glass, quartz, ceramic, and polyethylene [Table 1]

Preimpregnated or non-impregnated[3]

In preimpregnated FRC post, the fibers and resinous matrix are coupled during the manufacturing process which results in fibers that are uniformly impregnated with matrix. In other types, the fibers are hand impregnated with a composite or unfilled resin by the dentist or laboratory technician.

Method of fabrication[2]

Chair side fabricated posts

These are custom designed and use polyethylene non-preimpregnated woven fibers (Ribbon, connect) or glass fibers (Glasspan) to reinforce the root and hold a composite core.

Prefabricated posts

These are available in different shapes, sizes and of different fiber component.

COMPOSIPOST / C-POST[4-6][FIGURE 1]

In 1990, Duret and colleagues introduced the carbon fiber post composed of 64% pretensed carbon fibers (avg.8microns) and 36% bisgma epoxy matrix.

It has a modulus of elasticity (stiffness) comparable to dentin. This post can be bonded within root canal

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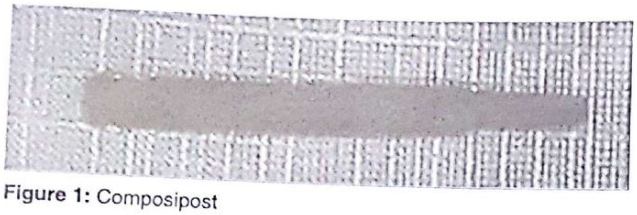

Figure 1: Composipost

space with polymer dentin bonding agents and resin cements of similar flexibility, and effectively transmits stresses between the post and the root structure, reducing stress concentration and preventing fracture. It is available in black color, two stage parallel design, three diameters: 1.4 mm, 1.8 mm, and 2.1 mm

Black color of C-fiber posts might show through all-ceramic crowns. For this reason, white fiber posts (AesthetiPlus/quartz fiber post) and quartz fiber-coated carbon fiber posts (Aestheti-Post,) with designs very similar to carbon fiber posts [Figure 2] were recently introduced in the market. The epoxy resin matrix is the same for both the new fiber and carbon fiber posts.[1]

U. M. Composipost [Figure 3]

Dr. Salam Sakkal, Professor of Endodontics at University of Montreal (U. M.), developed this post design based on familiar, standard ISO (#100, #120, and #140) guage files and reamers. The narrow, tapered, radiopaque U. M. Composipost is most often indicated for use in the narrowest canals, as found in trifurcated teeth and lower incisors. It is made of pretensed carbon fibers.

U. M. ENDOPLUS [Figure 4]

This is the "esthetic" version of U. M. COMPOSIPOST utilizing exclusive Quartz fibers, based on familiar, standard ISO (#100, #120, #140) guage files and reamers.

DT (Double Taper) WHITE POST [7] [Figure 5]

Available in white or translucent, the DT POST design features two specific tapers in each of the three sizes; one taper (2^0) for the apical portion, and specific tapers (6^0, 8^0, 10^0) for the coronal section. The developmental objectives were to create a post that: requires only minimal preparation adapts well in the apical and coronal portions offers esthetics for use with newer prosthetic ceramics

Light-post[8,9]

Introduced in 1999, Light-post made of Quartz fibers offers comparable mechanical properties, a neutral translucent shade, and the added convenience of curing light energy transmission. With the light

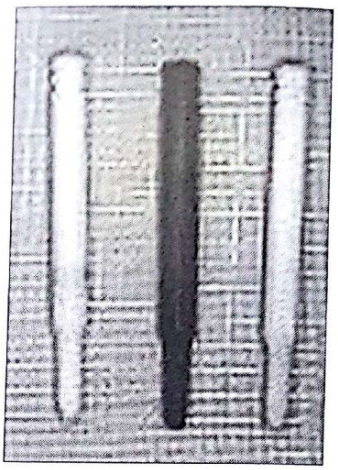

Figure 2: AesthetiPlus, C-post, Aestheti-post

post, the bonding primer and the (light-cure or dual-cure) resin cement can be expediently cured simultaneously in the canal through the post!! Light transmitting plastic posts which not only reinforce the weakened roots but at the same time, form an optimal post canal in the rehabilitated root and can accurately fit a matching retentive final post are also available.

Properties of FRC Posts[10,12]

- Elastic modulus similar to dentin
- Flexible than metal post
- Absorbs / dissipates stress rather than transfer to the tooth
- Uniform stress distribution
- Conservation of canal structure
- Aesthetic, except c-post
- Can be removed expediently and without trauma
- Chemically compatible with current adhesives and composites
- Biocompatible and corrosion resistant
- Latest generation of FRC post are radiopaque
- FRC are anisotropic
- Hydrolytically unstable [Table 2]

All Ceramic Posts

In 1989, Kwiatkowski and Geller described the clinical application of glass-ceramic posts and cores (Dicor, Dentsply).[13]

Table 1: Types of F.R.C Post[1]

Type	Fiber Used	% Of Fiber
C-Post	Carbon	64
Aestheti Plus	Quartz	62
D.T.Light Post	Quartz	60
Fiberkor Post	Glass	42
Para Post White	Glass	42
Snow Post	Zirconium Oxide	65

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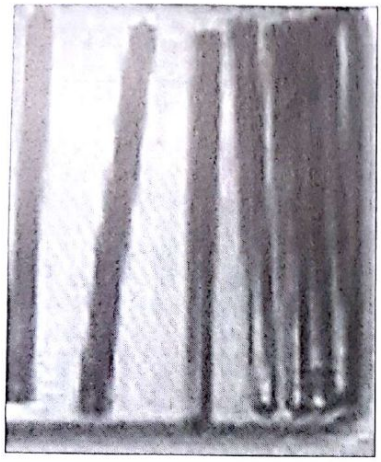

Figure 3: U.M.Composipost

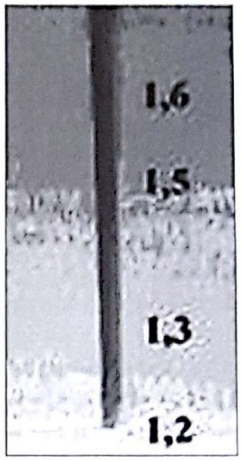

Figure 4: U.M.Endoplus

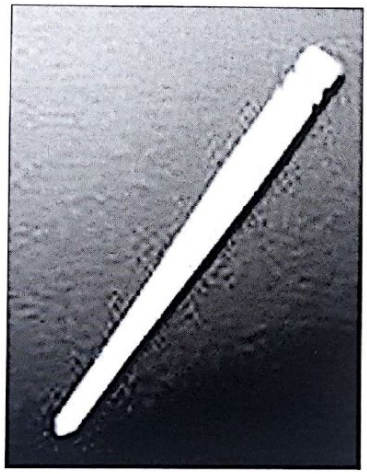

Figure 5: DT White post

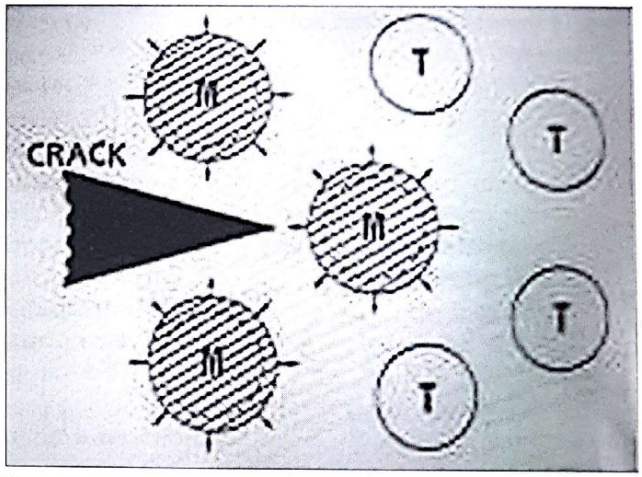

Figure 6: Schematic Representation of Transformation Toughening in PSZ.The crack propagation induces the transformation of metastable tetragonal grain (T) into monoclinic phase (M).The monoclinic grain being larger than tetragonal ones, the crack cannot propagate further on.

In 1991, Kern and Knode introduced posts and cores made of glass-infiltrated aluminum oxide ceramic (In-ceram, vita zahnfabrik).[13]

In 1995, Pissis proposed a "monobloc" technique for the fabrication of a post and core and a crown as a single component made out of glass ceramic materials (IPS-Empress, Ivoclar).[13]

In 1994 and 1995, Sandhaus and Pasche and others introduced prefabricated zirconia ceramic endodontic posts to restorative dentistry. Sandhaus and Pasche also suggested the use of zirconia ceramic for the fabrication of a core buildup and post in 1 piece. [13]

High- toughness ceramics, such as the glass-infiltrated alumina ceramic In-ceram and the dense-sintered alumina ceramic procera (Nobel Biocare), show three to six times more flexural strength and fracture toughness than conventional feldspathic and glass ceramics.

Contemporary zirconia powder technology contributes to the fabrication of new biocompatible ceramic materials with improved mechanical properties, i.e., further increased flexural strength and fracture toughness (Christel and others, 1989; Shimizu and other, 1993). Therefore, zirconium oxide ceramic seems to be a very promising material for the fabrication of all ceramic posts and cores.

ADVANTAGES[11,13]

- The major advantage of an all-ceramic post and core is its dentin like shade. It does not reflect intensively through thin gingival tissues, and provides an essential depth of translucency in the

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Table 2: Mechanical Properties

Type	Fiber Used	% of Fiber	Flexural strength (Gpa)	Tensile strength (Mpa)	Flexural Modulus (Mpa)	Elastic Modulus (Gpa)
C-post	Carbon	64	1100	2900	120-140	17.8
AesthetiPlus	Quartz	62	1400	2200	44	15
D.T.Light post	Quartz	60	1600	2050	46	15
Fibrekor post	Glass	42	960	1200	13.5	n/a
Snow post	Zirconium	65	n/a	1229	n/a	45.1

cervical root areas.

- All ceramic posts and cores provide an excellent biocompatibility.
- They do not exhibit galvanic corrosion.
- They are dimensionally stable with oral tissues.
- It has good strength. The strength of porcelain is usually measured in terms of Flexure strength. It has flexure strength of 141.1 Mpa.
- It is insoluble and impermeable to oral fluids. Also it is resistant to most solvents.
- They are radiopaque.

DISADVANTAGES [11,13]

- The main obstacles for an extended use of conventional dental ceramics as post and core materials are their relatively low fracture strength and fracture toughness.
- They have high modulus of elasticity (69 Gpa).
- They are much harder (460 KHN) than natural teeth.
- It is difficult to bond ceramic post
- Removal of ceramic post without trauma is difficult.

ZIRCONIA

- Zirconium is found in ignesious rocks like schist, gneiss, syenite and granite. This occurs as oxide baddeleyite with small amount of hafnium oxide and as compound with silica.
- Zirconium oxide also called as zirconia. Zirconia belongs to new class of ceramics and exhibits high strength and toughness.[14]
- Zirconia, (ZrO_2) exhibits three well-defined polymorphs, the monoclinic, tetragonal and the cubic phases. The monoclinic phase is stable up to about 1170°C where it transforms to tetragonal phase, which is stable up to 2370°C when the cubic phase exists up to, the melting point of 2680°C. Of greatest significance is the tetragonal to monoclinic transformation. The addition of stabilizing oxides such as MgO, CaO andY_2O_3 allows the stability of the tetragonal form of zirconia. Mechanical properties rely primarily on the tetragonal monoclinic transformation, which is Martensitic in nature. This transformation can be induced by externally applied stress and is associated with a relatively large volume expansion (three to five per cent) that results in the development of internal stresses opposing the opening of a crack and therefore, acts to increase the resistance of the material to crack propagation [Figure 6]. This property results in high fracture toughness of Zirconia [14,15]
- Zirconia post and core systems were introduced by Meyeberg *et al.*[14]
- The Cosmopost (Ivoclar Vivadent) and the Cerapost (Gebr Brasseler, Lemgo, Germany) are prefabricated zirconia dowel system made of 94.9% Zirconium dioxide (ZrO_2), stabilized with 5.1% yttrium oxide (Y_2O_3). They are available in two diameters-1.4mm,1.7mm
- Ypsz Compared To Alumina Exhibit

High Fracture Toughness - K_{ic}= 9 -10mn/$M^{3/2}$
High Bending Strength-- 900 -1200 Mpa vs. 400 Mpa
Lower Modulus of Elasticity - 200 Gpa vs. 350 Gpa

- To achieve a stable resin bond to smooth ZrO_2 surface is difficult. Adhesion of luting agents to zirconia can be improved with air abrasion / silanes / plasma spray.

CONCLUSION

Physical properties of dowel systems became more important as residual intact tooth structure decreased. Intermittent loading response of teeth restored with quartz-fiber, carbon-quartz fiber, and zirconium dowels showed that the fiber dowels were able to reduce the risk of root fractures.[16] In the last decade, *in vitro* and *in vivo* testing has demonstrated that some fiber- reinforced endodontic posts can dramatically reduce the incidence of root fracture, tissue discoloration and allergic reaction. If endodontic retreatment is necessary, most fiber posts can be removed from the root canal with ease and predictability when necessary, without compromising their only true function- core retention.[1]

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