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Review Article

Aesthetic post materials for restoration of endodontically treated teeth-A review

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ABSTRACT

Posts are fabricated for the purpose of retaining the restoration in cases where the coronal structure is inadequate. They strengthen the endodontically treated teeth. Metallic posts being rigid compared to the tooth structure limits its use. Post and core systems available nowadays permits the restoration of endodontically treated teeth aethetically. Features like light transmission, biocompatibility are improved with the metal free posts unlike metal posts To improve aesthetics, physical properties, biocompatibility, various aesthetic posts have been introduced and is also available in the market.

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1. Introduction

A grossly destructed tooth by any means which include decay, fracture, cavity preperation which are not conservative makes it mandatory to use post and core. They offer better retention and stability. Due to certain drawbacks like colour, corrosive nature, non adhesive bonding, high modulus of elasticity results in root fracture, conventionally used metal posts do not satisfy the standards of modern dentistry. Numerous aesthetic posts are now available in the market in an effort to improve aethetic element, physical characteristics and biocompatibility. Moreover they also have the ability to induce good adherence to the tooth tissue and core build up, which facilitates the formation of a gap free single unit in which all the stresses are equally distributed during loading.

Carbon fibre posts, zirconia posts, glass fibre posts (translucent quartz fibre), and woven fibre posts (polyethylene fibres) are some of the non metallic tooth coloured posts used to improve aesthetic outcomes. In terms of restoring severely damaged anterior tooth, these non metallic tooth coloured posts each offer advantages and disadvantages. Clinicians now have a choice based on the clinical circumstances, which will improve the prognosis and aesthetic results. Depending on type and direction of fiber, materials have specific properties; applications are related to these properties.

2. Dallari, A. and Rovatti Classification of the Posts (1996):[1]

2.1. Group I: Metal posts which are self retentive

This group include metal posts which are self retentive, provide close proximity to the walls of the root canal treated tooth eg: self-threaded metal posts, screw posts, and cast posts with serrations.

2.2. Group II: Passive retention metal posts

This group include metal posts having passive retention and cast posts bonded using different adhesive techniques, as put forward by Nathanson. These bonding techniques block the direct contact between the post and the root canal wall, by creating a room for the bonding material.

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2.3. Group III: Metal free Posts with Passive retention

This group comprise of metal free root canal posts such as ceramic posts and fiber reinforced posts also with the property of passive retention.

3. Fibre Posts

3.1. Carbon fiber posts

It was in 1990 metal free materials were introduced by Duret et al for manufactuing of posts by carbon fiber reinforcement principle. These were the first metal free post to be introduced in dentistry, which consisted bunch of extended carbon fibers which are embedded in an epoxy matrix. This post and core system is called composipost. It has been in use in Europe and Canada for 7 years and in U.S.A for 2 years as C-post dowel.[2] These posts being easy with excellent mechanical properties are also easy to handle. Low toxicity and low modulus of elasticity, same as that of dentin are also some important properties of carbon fiber posts. These posts lack radiopacity and exhibit poor adhesion to composite resin core. Coated posts like Aestheti-Posts, Bisco, Schaumberg, IL are available to overcome the complication of color being another concern.[3]

3.2. Advantages

1. Less time consuming
2. It is strong
3. Retrieval if needed is easy

3.3. Disadvantages

1. Its black colour.
2. Expensive procedure unlike cast metal posts.
3. Low stiffness and strength when compared to other post materials like ceramic & metal posts.
4. Being radioluent it is impossible to detect radiographically.

3.4. Prefabricated glass- and quartz-fiber posts

The translucent and tooth coloured silica based posts were introduced in the year 1992, which primarily is made up of prestretched silanizated glass or quartz- fibers within a highly cross-linked matrix of methacrylate or epoxy polymer.[4] An alternative option would be to utilize posts made of filled resin matrix which consist of glass and quartz fibers held together with a filled resin matrix. Glass-fiber posts consists of 42% glass fiber, 29% filler, and 18% resin by weight. Moreover, in comparison to carbon-fiber posts, they are esthetically superior and they are available in conical or parallel. In order to reduce the amount of cement used for luting at the junction of post and dentin, different systems come along with a set of their own burs, which is adopted for intraradicular preparation. Recent advances in the post systems include tapered light-post double tapered quartz fiber posts with optimum adaptation to the prepared canal.

The procedure is least affected by the dimension of the post used in this scenario, when compared to stainless steel posts, since factors like length and diameter of the posts do not influence the stress distribution and ability of a silica-based post to resist fracture.

Silica-based fibres can be fabricated using quartz or glass. In contrast to glass, which is monocrystalline, quartz is a crystalline variety of silica. Quartz fibre posts have been found to be more radiopaque, to have greater flexural strength than glass fibre posts, and to have greater fracture strength when used to restore teeth than glass fibre posts.

E- and S-glass fibres, on the other hand, are currently the most often utilised reinforcing fibres in dentistry. Glass fibres consistently deform under stress until they break, and when the tension is released before the fibre breaks, the fibre recovers to its initial length. Compared to S (stiff, strong)-glass, which has a different chemical constituents and offers greater tensile strength and moisture control but is costlier, E (electrical application)-glass has better tensile and compressive strengths, good electrical insulation, and is relatively inexpensive. However, fatigue resistance is poor in this case.[5]

Post debonding, which can occur at the post/cement or cement/dentine junction, is the most frequent reason for fibre post restoration failure. Because the organic constituent of the fibre post is a polymer matrix that is highly cross-linked with a greater degree of conversion and a sparse amount of carbon-carbon double bonds on the surface, it is challenging to bind glass fibre post and composite substrates using free radical polymerization.

Recent evidence indicates that the post should be treated with 24% of hydrogen peroxide for about 1 minute to controllably solubilize the polymer matrix and reveal the glass fibres, allowing the adhesive or cement to micromechanically bind with the post. This is because the polymer matrix is inert and nonreactive. Light-irradiated dual-cure materials offer the most efficient solution for post-cemention of glass fibres

Although clinical research findings have not revealed any discernible differences in the incidence of root fractures between metal and glass fibre posts, the latter are frequently the clinicians' first choice, not only because of their adequate aesthetics, biocompatibility, flexural and fatigue strength, satisfactory elastic modulus, and bond strength of fibres to composite substrates, but also because they are affordable, simple to handle, and require only one visit for treatment.[6]

However, it is important to keep in mind that the indication only pertains to teeth with adequate radicular structure when restoring teeth using prefabricated glass fibre posts. It's because they necessitate sufficient root canal

preparation to fit the shape of the post, which causes dentin loss and increases the risk of root fracture.

Additionally, when using posts like the prefabricated FRC (fibre reinforced composite) posts, the free space of a larger coronal root canal opening is only packed with cement. This could lead to the luting resin becoming detached from the dentin due to variations during polymerization shrinkage, which could ultimately result in post failure.[7]

3.5. Individually formed glass fiber posts

In the beginning of 2000s, individually formed glass fiber reinforced posts were launched to put an end to the limitations and to enhance the merits of prefabricated glass reinforced posts.[8]

They compose mainly of 2 non polymerised polymers, polymethyl methacrylate as a linear phase and poly bis-gma as a cross-linked phase along with silanated E-glass fibers which are unidirectional, altogether they configure a partially diffused polymer network (semi-IPN).[9]

The cross-linked Bis-GMA matrix are plasticized by the polymethyl methacrylate chains and therefore, the stress on the fiber-matrix interface are reduced when being deflected. The semi-interpenetrating network which is not polymerized, causes the monomer of adhesive resin and cement to disseminate into the linear polymer phase, which on polymerization form interdiffusion resulting in the formation of secondary semi-interpenetrating network structure that gives out superior core to root load transmission.

Linear polymers which contains monomers such as Bis-GMA, TEGDMA or HEMA are suitable for dissolving the interpenetrating matrix, predominantly used in restorative dentistry.

The interpenetrating posts are well adapted to the shape of the root canal with ease because of the fact they are not polymerised, which results in a considerable decrease in the possibly number of voids and also the probability of decementation of posts.

According to the requirements of the crown restoration the interpenetrating-posts can be twisted and adjusted to the needed angulation. They are not contra indicated in any forms of root canals either round or oval or even large canals, lateral condensation permits the placement of posts varying in dimensions like length and diameter being placed in the very same canal.

Apart from the fact that individually formed glass fiber posts display higher flexural strength, higher fracture resistance, higher bond strength, when being compared with prefabricated glass fiber posts, Eventhough adhesive failure migh be comparatively less, clinician find with inexperience find it difficult to use due to the sticky behaviour of the non-polymerized matrix and tendency of fibers to get seperated.

4. Polyethylene Fiber Posts

Polyethylene fiber posts can be used for post endodontic restorations. It has been accesible in the market from 1992. The composition consist mainly of plasma treated UHMW polyethylene fibers into a 3D interpenetrating structure, also called leno wave or triaxial braid. The exceptional design of the cross-linked threads provide a remarkable mechanical interconnection. The superficial tension of the fiber's has been minimised with cold gas plasma pretreatment in an intention to make sure a good chemical bond to resin materials is achieved.[10]

The breaking point of polyethylene fibers, as claimed by the manufacturer is so high that it surpass fiberglass, making it so tough that particular scissors are necessary to cut them up. Apart from having properties like excellent translucency, unlike loosely interlaced or bunch of unidirectional fibers, these fibres does not open out and come apart because of the thick lattice of locked-stitched threads that stop the movement of fibers from the beginning of manipulation till adaptating it.[11]

Because of these characteristics, these ultra-high molecular weight fibers can be knitted to facilitate a closer mechanical interconnection within the threads. In addition to this, they also posses a better coefficient of elasticity, stretch resistance, deformation and friction that permits a close adaption with respect to the shape of the root canals and to facilitate a proper condensation, thus raising the content of the respective post which inturn minimising the quantity of luting-agent, therefore its polymerization shrinkage.

Canal enlargement is not required, due to their better adaption to the root canal. Therefore, strength of the tooth is conserved and any chance of the perforating the root is also eliminated. A customized polyethylene post with dual-cure resin cement exhibit minimum microleakage in over prepared root canals when they are compared to any other fiber reinforced posts.

These fibers strengthen the polymer in every direction so that all the mechanical properties are also uniform unlike the continuous unidirectional fibers that strengthens the fiber in only one direction, i.e, in the direction of fiber orientation alone. Fracture resistance is enhanced by woven fiber architecture which is even noticeable in load induced cracking, where crack ceases at the node of the leno-lock-stitch weave, hence haulting any further transmission of the crack from restoration to intact tooth and thereby aiding to sustain the unity of the reinforced fiber.[12]

Polyethylene-reinforced resin provides amble retention neccessary for clinical longetivity of the post and core. Sufficient fracture resistance along with improved incidence of fractures which can be correctable in anatomically effected canals.

4.1. Polyethelene woven fiber

Recommended to be used along with composite while fabricating dowels and cores. Ribbond is the commonly accessible among these fibers with the adhesive restorative materials. It is more easier to make esthetic dowels and core foundation with these posts.

It has also been reported that polyethelene ribbon fibers is another option for rehabilitating severely destructed deciduous incisors. In addition to stability and esthetics, root and coronal retention are also offered by these fibers.

The ability to withstand fracture of non-pre-impregnated resin fibers (glasSpan) and pre-impregnated resin fibers (Splint-it), used as post and core in the restoration of deciduous dentition were also analyzed in this study. The results revealed that the latter provide an acceptable resistance to fracture when employed as a post in root cnal treated deciduous anterior dentition.[2]

4.2. Advantages

1. Esthetics.
2. Modulus of elasticity approximating dentin.
3. The distribution of stress over a large area, enhanced load. threshold.

4.3. Disadvantages

1. Radiopacity can vary among different brands.
2. When subjected to frequent mechanical loading and constant contact with moisture, fibre posts undergo degradation, which in turn lowers the modulus of elasticity and also elevated risk of debonding.

5. Zirconia Posts

In response to the need for a dowel post that possess good optical and biologic properties, compatible with an all ceramic crown these posts were developed in the late 1980s by Christel et al. They were made from fine grained tetragonal zirconium polycrystals (TZP) and is reported to possess high flexural strength and fracture Toughness.[2] Posts fabricated by partially stabilized zirconium dioxide (ZrO2), a ceramic material, formed by adding yttrium oxide (Y2O3), was introduced by the end of 1980's possess high fracture and bending strength by which the posts can withstand functional loads. Along with its favorable chemical stability, good esthetic and physical properties, zirconia also yields excellent radiographic opacity.[13] They also hold superior light transmission properties and Young's modulus[14] similar to that of the stainless steel alloy.

Eventhough ceramic materials are tough and have high compressive strength their tensile strength is poor, when subjected to shear stresses, ceramic posts itself fracture rather than root as in case of metals posts. Depth of translucency is increased because dentine like shade is obtained of all-ceramic posts by glass infiltration giving a natural appearance to final all ceramic restorations.[2]

Also, zirconia posts are stiff, but at the same time are very brittle, poor ductility. Hence, it is necessary to make a deep post preparation which is also not a minimally invasive approach when it comes to removing the dentin tissue. The reported strength becomes a significant disadvantage when a failure occurs and there is a need for endodontic retreatment because it is nearly impossible to retrieve a zirconia post from the root canal.

Grossly destructed tooth, areas with heavy forces, in high lip line, thin gingival tissue are areas where zirconia posts are indicated for achieving better esthetics. It is recommended to use resin cements and do surface pretreatment to improve the bond strength of zirconia post to core and root dentin, of which the most effective is airborne particle abrasion using silicated Al2O3 particles in combination with silanization.[15]

5.1. Advantages

1. In severely destructed coronal structure of teeth, composite restorative materials are known to lack the resistance to deformation when used to support crowns. Therefore, zirconia dowels with zirconia enriched glass-ceramic cores are suitable for adequate strength.
2. A new indirect technique allows the addition of a heat pressed ceramic core to a Zirconia dowel to form an all ceramic tooth colored dowel and core, as an alternative to composite cores bonded to zirconia dowels. The drawbacks of composite core buildup like high polymerization shrinkage, higher thermal expansion coefficient which will contribute to functional deformation and micro leakage has been prevented by this technique.
3. For an all ceramic post and core construction for narrower root canals where the other techniques are contraindicated, the smaller zirconia posts (150050,090) might be used.
4. The heat pressed technique is advantageous because a familiar technique that is followed for fabrication of metal post and cores is also used for the fabrication of uniform all-ceramic post and core restoration i.e, with prefabricated high precious metal posts. When glass-ceramic and the zirconia ceramic material are used in combination, results in a corresponding shrinkage and a good fit after heat pressing procedure because of similarity of their thermal expansion coefficients.

5.2. Disadvantage

1. Compromised adhesion to tooth and composite which becomes a problem for retreatment.
2. Zirconia posts are brittle with inherently.

3. High modulus of elasticity, therefore are not indicated for patients with bruxism.

6. Conclusion

To impart better retention for the core and to establish complete sealing of the coronal portion of the root canal is the principal function of endodontic posts. Hence, it must bond strongly to the buildup core and root dentin. Since esthetics is of primary concern, it has become common to use these posts with cores of composite/ceramic, infact it has become a quality mark because these posts being esthetically pleasing are also biocompatible and have excellent physical properties.[2]

The various aesthetic post materials available now are carbon fiber posts which include pre fabricated glass and quartz fiber posts, indvidually formed glass fiber posts, polyethylene fiber posts, zirconia posts. The main disadvantage of glass fiber post is its black colour and low stiffness which makes it inferior to other aesthetic post materials. Depending on the particular restorative need and the clinicians ability any of the fiber posts which has good modulus of elasticity and zirconia posts, which are highly aesthetic and has remarkable strength can be used. Restoring a root canal treated tooth has always been challenge for a dentist. Several element like remaining quantity of tooth structure coronal, size of root canal ,configuration of root, position of tooth, functional and occlusion needs are to be evaluated before inserting a post. Therefore, a long term clinical evaluation with all available esthetic post materials should be conducted so that a material for post and core to be advocated as flawless and acceptable for use.

7. Source of Funding

None.

8. Conflict of Interest

None.

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