Post Materials - An overview of materials used in endodontically treated tooth

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ABSTRACT

Conventional wisdom over the years has supported that endodontically treated teeth fracture more readily than vital teeth. This has been attributed to the cumulative loss of tooth structure from caries, trauma, restorative and endodontic procedures. The initial school of thought propagated that a post served to strengthen the endodontically treated tooth. However, contrary to this popular belief it was later established that the post served only to retain the core or final restoration that would eventually be fabricated.

Over the years, a variety of materials have been used for posts, ranging from wooden posts used in the 18th century to metal posts and more recently, carbon fiber, glass fiber and ceramic posts. This article attempts to review all the materials previously used as well as the newer materials that have infiltrated the market for the fabrication of endodontic posts. It also aims to aid the practitioner in formulating sound clinical judgement regarding the various endodontic post materials so as to ensure the successful restoration of endodontically treated teeth, thus increasing their longevity.

Introduction

The recent past has seen an increased interest in the restoration of endodontically treated teeth. This is attributable to the changing ideologies that have morphed the face of Prosthodontics. In today's setup, the Dentist as well as the patient is keen to increase the longevity of a tooth, vital or non vital. However, merely preserving the tooth in the dental arch is no longer sufficient. As times has changed, so has attitude, therefore in a society obsessed with youth and beauty, the motto is preservation with a primer on esthetics.[1]

In the last few years, a plethora of new materials and advanced technologies have brought about a major shift away from metal custom-cast posts and cores towards prefabricated metal posts and resin-based composite cores.[2] Recently there has been a clearly observable movement towards the use of fiber reinforced resin-based composite posts and ceramic posts.[3] The design of a post is considered a primary factor which affects the resistance to fracture of endodontically treated teeth restored with post and core systems; however the choice of the restorative material is an equally important parameter. This article attempts to highlight both the design and the restorative materials available for the restoration of endodontically treated teeth using dowel cores, so as to aid the clinician to make an informed choice regarding the most appropriate system for a particular clinical situation.

Classification

The classification of endodontic posts has been as varied and controversial as their historical development. They have been classified based on the numerous criteria which have categorized them as preformed and custom cast, metallic and nonmetallic, stiff and flexible, esthetic and unaesthetic. Posts have also been popularly classified based on the material of construction as precious alloys, semiprecious alloys, base metal alloys, carbon fiber, glass fiber and all-ceramic posts.[1]

Metal Posts

Metal posts were first introduced in 1728, by Fauchard who described the placement of metallic posts within root canals for the retention of bridges. They are broadly categorized as custom fabricated and prefabricated posts.

The ideal requirements for metallic restorations are resistance to tarnish and corrosion within the oral environment, sufficient strength for the intended purpose, biocompatibility, ease of fabrication, adequate flow to duplicate fine details during casting, minimal shrinkage on cooling after casting and easy to solder. Not all alloys meet every requirement and every material presents individual advantages and disadvantages.[4] At the end, the final choice of a particular material over another is based on the demands of the given clinical situation.

Custom Cast Metal Posts

Custom fabricated cast posts have been used for decades as a foundation to support the final restoration in endodontically treated teeth. The cast post and core system utilizes a customized post to fit the canal, and the post and core are cast together as a single unit. The major advantages associated with cast restorations are the better control of dimensions and shape of post and core. However, these

advantages are often negated by the numerous disadvantages which include a limited choice of available materials.[5]

High noble, noble and base metal alloys, all have been used for the construction of posts. Traditionally, the advantage of noble metals lie in their resistance to tarnish and corrosion, and their biggest disadvantage is the high cost associated with these alloys. Base metal alloys are gaining in popularity because of their low cost and their significant influence on weight, strength, stiffness, and oxide formation. However, the hardness of non precious and semi precious alloys pose a major disadvantage with regard to adjustment and may also predispose the tooth to root fracture.

Among the various advantages of cast posts, the predominant ones are customized fit to the prepared root canal, minimal instrumentation, better fit and adaptation within flaring and irregularly shaped root canals, sound junction between post and core as the casting is a single unit, radio opacity of material thus facilitating ease of detection in the eventuality of complications and most significantly, considerable documentation to support their popularity and effectiveness over the years.[6]

Custom cast posts have numerous disadvantages attributed to them as well. These include additional clinical and laboratory time, questionable cost effectiveness for the dentist as well as the patient, difficult temporization, higher incidence of root fractures during insertion and function, possibility of casting defects and failures, fitting the prosthesis within the root canal is difficult, limited use in case of multirooted teeth and irregularly shaped root canals, difficulty associated with casting of threaded and serrated posts and questionable esthetics.[1, 7]

Prefabricated Metal Posts

The use of prefabricated posts and plastic filling materials to fabricate post and core system was introduced in 1960s.[8] The main advantage of prefabricated posts is increased retention with minimal stress production. A variety of prefabricated posts, in terms of shape, design, and material, are available.[9, 10] The use of traditional, time tested and proven metal prefabricated posts have slowly given way to the recently introduced nonmetallic posts. Prominent among these are the carbon fiber or epoxy post.

The criteria for selection of prefabricated posts is based on strength, corrosion resistance, retention, stress distribution, safety and conservation of tooth structure.[8]

Prefabricated metal posts can be made of platinum-gold-palladium, stainless steel, brass, pure titanium, titanium based alloys, chromium-based alloys. Pure titanium has superior biocompatibility, corrosion resistance and low thermal conductivity; however it is significantly less rigid than stainless steel. This compromised rigidity negates it as the choice of material in regions of anticipated heavy occlusal loading such as those encountered in patients with a history of parafunctional habits such as bruxism. To some extent this problem of decreased fracture strength can be overcome by the use of titanium alloys, the most popular of which is Ti-Al-V alloy. However, the mechanical properties cannot parallel those of stainless steel. Another major disadvantage of titanium posts is that they are not readily detected on radiographic examination. On the other hand, base metal alloys such as Ni-Cr, Co-Cr and stainless steel alloys have the advantage of equal corrosion resistance as gold alloys, along with the additional advantages of decreased cost and weight and superior mechanical properties. No material is perfect and thus the disadvantages associated with base metal alloys include hardness, stiffness, technique sensitivity and complex production procedure.

Based on geometry, prefabricated posts are also classified as tapered, parallel sided and parallel-tapered. Based on surface configuration prefabricated posts may be classified as threaded, serrated or smooth.[11] Based on mode of retention they are classified as active (mechanically engage dentin) or passive (retained by cement) prefabricated posts.[1, 2]

Advantages of prefabricated posts include less time consumption, simplicity, wide range of material availability, avoidance of casting imperfections, lower incidence of root fractures, ease of use in multirooted non parallel canals, ease of temporization and cost effectiveness.[6, 10]

Notable among the disadvantages are, removal of additional tooth structure, limited use in clinical situations having adequate remaining coronal tooth structure, introduction of an additional interface between the post and the core which are made of different materials and negligible resistance to rotational forces.[9, 12]

Composite Resin Posts

The use of composite resin post and cores in 1965, presented an esthetic alternative to the use of metallic posts. Though lacking in tensile and compressive strength when compared to gold, it still has adequate strength to withstand normal masticatory forces. The biggest advantage of composite resin posts lies in the fact that when subjected to failure loads, the post will fracture before the tooth root, thus protecting the tooth from potentially detrimental forces. Another advantage is the decreased possibility of root perforations. The composite post derives its retention by engaging undercuts within the root canal, thus the need for minimal root preparation and decreased risk of tooth perforation.[13] This particular property also makes them ideally suited for placement in teeth with irregular canals or multi rooted teeth.[14]

The advantages of composite resin posts includes a simplified one visit procedure, cost effectiveness, added retentiveness as compared to cast gold dowels, and superior esthetics due to translucency of the material. The major disadvantages associated with composite posts are lack of adhesiveness and thus the inherent potential for micro leakage.[13, 15]

Fibre Reinforced Composite Posts

Charles J. Burstone introduced Fibre Reinforced Composites (FRC) as a viable treatment option for the restoration of severely broken down endodontically treated teeth. FRC consists fibers which are held together by a resinous matrix. The mechanical properties of the resultant post are thus attributed individually to the fibers and the matrix. Factors that have a considerable influence on the mechanical properties are the fiber length, orientation and concentration. Higher density of fibers yields a post displaying increased fracture resistance. Fibers that are oriented parallel to the long axis of the tooth are more suited to stress distribution than fibers that diverge from the longitudinal axis. A unique property which is peculiar to the FRC posts is that the fibers have the potential to change their orientation to correspond to the direction of the applied load.[16]

Fiber posts have been classified based on the fiber component, that is, polyethylene, glass, carbon, quartz and ceramic. Another method is to classify them based on the method of fabrication, that is, chair side or prefabricated posts. They may also be classified as preimpregnated or non impregnated posts.[17]

Prominent among the advantages of FRC posts is the fact that the flexural and tensile strength is similar to that of the root structure. Additionally, the material is anisotropic, which indicates that the properties of the material vary according to the direction in which they are measured. Also FRC posts require minimal preparation of the root canal as the post utilizes the undercuts and surface irregularities to increase the surface area for bonding. This conservation of tooth structure is beneficial as it reduces the chances of eventual tooth fracture. Also, the mechanical properties of the post ensure that in case of pathological loading, the post will fracture prior to the root, thus protecting the tooth from catastrophic root fracture. The FRC posts also display an excellent biocompatibility and are easy to retrieve.[16-19]

Initially, carbon fiber posts with their black coating were perceived as unaesthetic. However this particular disadvantage was easily overcome with the introduction of FRC posts such as Aestheti-Plus, FibreKor and Para Post Fiber White which were manufactured in natural tooth shades. Another disadvantage associated with FRC posts is their propensity for micro leakage.[19, 20]

All Ceramic Posts

Ceramic was first used as a post and core material in 1989. Glass-ceramic posts & cores (Dicor, Dentsply) were the first to be utilized and thus far feldspathic ceramics, glass infiltrated aluminium oxide ceramic(In Ceram), glass ceramic materials (IPS-Impress) and Zirconia (Cerapost) have been used to restore endodontically treated teeth.

The biggest advantage of all ceramic posts is their excellent esthetics. Other advantages include excellent biocompatibility, dimensional stability, strength and radioopacity.

The main disadvantage of ceramic posts is their brittleness which makes them susceptible to fracture. The increased cost, technique sensitivity and complicated retrieval procedures also pose significant problems to their use.[21, 22]

Conclusion

The evolution of posts, from the cast metallic posts and preformed posts of yester years to the modern day esthetic fiber post designs has been driven by a number of factors, the forerunner of which has been the ever burgeoning need for aesthetics. This, along with the reinforcing capabilities, functional harmony, biocompatibility, radiopacity, post design, fracture resistance, cementation, retention and ease of retrieval has been the factors which have spearheaded the quest for the ideal post. A plethora of post materials and designs are available in the market, each developed to satisfy a characteristic demand. It is thus left to the clinical acumen of the practitioner to select the system most ideally suited to the individual situation.

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