Effect Of Loading Angles On The Fracture Resistance Of Two Non-Metallic Post and Core Systems

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Dedication

I would to also express my sincere appreciation to

all my family,

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And my sister

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Introduction

The endodontic therapy has reduced the rate of teeth loss, however the prognosis of the success is highly dependant on the proper restoration of these treated teeth. Various methods for making adequate restorations are available. Posts were designed to retain coronal restorations when inadequate tooth structure remained for reinforcing endodontically treated teeth. Those posts distribute forces within the radicular dentin to supporting tissue along roots [1,2].

The ability of posts and cores to sustain masticatory forces and remain firmly seated in a tooth is critical to the survival of the post. If post and/or core material fails, the artificial crown will also fail. The selection of the most adequate post system for each case is influenced by the treatment plan to restore esthetics, function, remaining tooth structure, post design and mechanical properties [3-5].

Many different kinds of posts have been described in literatures [6-12]. During the selection of the post system, post material, design, diameter and length as well as load experienced by the restored teeth, crown design and retention of the post must be considered [11,13]. The selection of post materials depends mainly on the biomechanical criteria of prefabricated posts [14-16]. Several types of post materials are available to the practioner, such as stainless steel, titanium and its alloys, platinum-gold-palladium, chromium containing alloys, ceramic and fiber reinforced posts [17,18].

Although many of metal post systems, have been used routinely for years, they are considered questionable regarding esthetics, biocompatibility and retention mechanisms [14,17]. The use of metal post systems may lead to grayish discoloration of the translucent all-ceramic crowns. Moreover, the opaque and dark color of metallic materials would have a negative influence on the color of the surrounding hard and soft tissues [17].

With the increasing aesthetic demands, tooth colored post and core restorations have became an option for restoring non-vital anterior teeth. Studying the effect of post material on the biomechanical performance of the restored teeth under different conditions is of great importance to the clinician for proper post selection.

Review of Literature

Various methods of restoring pulpless teeth had been reported for more than 200 years. In 1700s, ***Fauchard*** [19] inserted wooden dowel in canals of teeth to aid in crown retention, but by time wood expand in the moist environment to enhance retention of the post until, unfortunately, the root would often fracture vertically. Since it was discovered that the post exerted pressure on the root canal walls, the root stamp was stabilized with a gold ring to prevent the root from fracture. **In 1746**, ***Claude Mouton*** [19] designed a gold crown with a gold post that was inserted into the root canal. The use of pivot crown, a wooden post fitted to an artificial crown and to the root canal, was a common practice during the mid 1800's. During this period, a post-retained crown with a porcelain facing (Richmond crown) was also developed to function as a bridge retainer. Afterwards, a one-piece post crown was eventually replaced by the cast post and core, which was made as separate entity from the crown. This two-step technique provided an improvement in marginal adaptation and did not limit the path of insertion for the crown solely to the long axis of the tooth. In addition, an unserviceable restoration could be replaced without having to remove the post [19].

A variety of prefabricated metal posts became commercially available. These metal-based posts and built up materials were and sometimes still preferred. The materials used range from cobalt-chromium and nickel-chromium, and two precious metal alloys such as gold-platinum or silver palliadium. However, today, titanium and platinum are the most commonly used materials [20]. Questions regarding

esthetics, biocompatibility and retention mechanisms have led to critical assessment of metal-based post systems [17].

Restoring a pulpless tooth with a metal post and core in combination with all ceramic crown is a challenge, since the underlying metal from the post and core can alter the optical effects of a translucent all ceramic crown and would compromise esthetics [21].

The growing interest in esthetic dental restorations has led to development of innovative post materials for esthetic restoration of endodontically treated teeth. These newer systems have focused on physical properties to decrease stress concentration and incidence of fracture in the remaining roots [22].

By the end of the 90's several non-metallic post systems became available. A post fabricated from carbon fiber reinforced epoxy-resin was developed in France by ***Duret et al*** [23] and became commercially available in Sweden in 1992.

The fiber-reinforced posts are made of continuous fibers, which may be unidirectional, braided, or woven embedded in a resin matrix and are fabricated through a semi-automated industrial process. The diameter and density of the fibers (that represent the main constituent of the post) as well as the adhesion between them and the matrix strictly influence the quality of the post and its mechanical properties. Both glass fibers and carbon fibers have been used to reinforce endodontic posts. The dark color of the carbon fiber had led to the introduction of the translucent fibers (glass or quartz) to improve esthetics, especially when restoring anterior teeth to provide support to all ceramic crowns. Glass fibers have

a tensile strength ranging from 2.5 to 4.5 GPa while the tensile strength of carbon fibers ranges from 2.0 to 6.0 Gpa [18]. In addition, these types of posts have physical properties similar to natural dentin together with sufficient resistance to high loads [21,24-30].

The use of posts strengthened by fibers had limited the failures associated with the fracture of the supporting teeth [31,32]. The success of the fiber-reinforced materials is not only dependent on the choice of the matrix and fiber material, but is also dependent on the interfacial bond strength and geometry of reinforcement. The addition of fibers to polymer matrix showed a significant improvement in strength, fracture toughness, stiffness and fatigue resistance [18,33].

The fiber-reinforced posts possess a number of advantages including: biocompatibility, greater flexure and fatigue strength, increased resistance to corrosion, a modulus of elasticity similar to that of the dentin of the tooth, retrievability and the ability to form a single bonded “mono-block” complex within the root canal for a unified root complex. The tooth like color of the post blends-in well with the esthetics of all ceramic restoration. The term “mono-block” means a single unit and thus all materials, which compose this kind of “mono-block” should ideally have comparable modulus of elasticity to each other and to dentin. In “mono-block”, similar materials will behave predictably under stress. This may allow post flexion to mimic tooth flexion. Consequently masticatory stress absorbed by those homogenous materials is also distributed homogenously protecting the tooth from fracture [34].

The introduction of all ceramic restorations are however an important addition to the field of the esthetic dentistry. With all the

advances in ceramic technology, all ceramic posts have been developed. The major advantage of all ceramic post and core is its dentin-like shade, thus the color of the final all ceramic restoration will be derived from an internal shade similar to optical behavior of the natural tooth. Moreover, a ceramic post does not reflect intensively through thin gingival tissues, and it provides an essential depth of translucency in the cervical root areas. It also provides an excellent biocompatibility and does not exhibit galvanic corrosion [35-37].

Several types of ceramic post are available; these are either prefabricated or custom made. The In-Ceram was first introduced in 1989 by ***Sadoun*** in the International Dental Show in Stuttgart [38]. In 1991, custom-made post was fabricated as one piece from In-Ceram alumina using slip-casting technique by ***Kern and Knode*** [35]. In 1999, copy-milled post and core made-up of pre-sintered alumina ceramic blanks was fabricated using Celay system by ***Koutayas and Kern*** [35].

Zircon had been known as a gem from ancient times. The name of metal zirconium comes from Arabic word "Zargon", which means the metal of golden color. It also comes from the two Persian words Zar (gold) and Gon (color). Zirconia (ZrO_2) was identified in 1789 by the German chemist ***Martin Heinrich Klaproth*** as a reaction product after heating some gems. It was used for a long time blended with rare earth oxides as a pigment material for ceramics [39].

With all advances in ceramic technology, a ceramic **prefabricated** cylindrical tapered post made of zirconium dioxide was introduced in the 1980's as a biocompatible and radiopaque post material in order to