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Effect of surface treatments of glass fiber posts on the shear bond strength to composite resin core.

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Dedication

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INTRODUCTION

Posts are frequently inserted into the root canals of endodontically treated teeth to provide retention for the core in the restorative treatment of these teeth. Several studies had investigated the failure of teeth restored with post and core systems which mostly occur due to loss of retention or fracture of either root, post or core [1,2].

Recently, the use of fiber posts in the restoration of endodontically treated teeth has increased in popularity [3,4]. Fiber posts are currently perceived as promising alternatives to cast metal posts, as their elastic moduli are similar to that of dentin producing a favorable stress distribution and providing more esthetic outcomes for endodontically treated anterior teeth [3,5].The use of tooth-colored fiber posts, together with the wide choice of composite resins available for core foundation restorations, allows better reproduction of the underlying natural tooth shade, resulting in a more esthetic solution[6].

The clinical success of a post-and-core restoration depends on the composite resin selected and the quality of the post and-core interface, where materials of different compositions are in intimate retentive contact [7]. In vitro and in vivo researches[3,8,9,10] indicate that failure of fiber post-and-core restorations often occurs because of debonding between the fiber post-resin and/or resin-root canal dentin interfaces as a result of inadequate bond strength. It has also been demonstrated that parameters such as post length, shape, and post surface characteristics influence post retention [9,10]. The durability of a composite resin core restoration depends on the formation of a strong bond between the composite resin and the residual dentin, as well as between the composite resin and the fiber

post, enabling the interface to effectively transfer stress under functional loading[7]. One difficulty with some of the available prefabricated fiber posts is that the polymer matrix between the post material fibers is highly cross-linked and, therefore, less reactive. This makes it difficult for these posts to bond to resin luting agents and tooth structure [6,7,11] .

It is critical to establish durable bond between core materials and the smooth surface of post-head, as in all non metallic prefabricated posts, to obtain maximum retention. This includes an effective surface treatment of post-head which may fall within three categories:

1) Treatment that results in roughening the post surface either by sandblasting or etching with chemical acids [7,15].
2) Treatment that intends to create chemical bonding between core and post materials [10,12].
3) Combination of the two above mentioned treatments [4,17,18,].

Chemical treatments are aimed at roughening the post surface, thus enhancing the mechanical retention between the post and resin luting cement. In previous studies[12,13], certain chemical solutions such as hydrogen peroxide (H2O2), potassium permanganate, hydrofluoric acid (HF), and silane coupling agents have been evaluated in an attempt to improve the bond strength between the fiber posts and the composite resin core materials[6,10,14]. It was found that application of HF and silane did not improve shear bond strength of the composite resins to fiber posts; however, H2O2 and potassium permanganate increased bond strengths [7,12,14]. The etching procedures with potassium permanganate only affected the superficial part of the epoxy resin matrix of the fiber post. The authors also

speculated that potassium permanganate, besides exposing the quartz fibers, may activate the latter by improving their hydrophilicity [7] .The application of potassium permanganate is time consuming, because it involves many steps. At the same time, the etching effect of hydrogen peroxide depends on its capacity to partially dissolve the resin matrix, breaking epoxy resin bonds and exposing the surface of fibers to silanization through a mechanism of substrate oxidation [10,13]. Etching with H2O2 was found to be effective for enhancing the retention between fiber posts that contain an epoxy resin matrix and composite resin [10,13].

Therefore testing the shear bond strength of glass fiber posts bonded to composite resin core after different surface treatments will be the aim of the present study.

Review of literature

Endodontically treated teeth may be damaged by decay, excessive wear, or previous restorations, resulting in a lack of coronal tooth structure. The endodontic therapy has reduced the rate of teeth loss; however the prognosis of success is highly dependent on the proper restoration of these treated teeth. Various methods for making adequate restorations are available [83,84].

The restoration of endodontically treated teeth with a significant loss of coronal tooth structure may require the placement of a post to ensure adequate retention of a core foundation [10,24,25].

History:

The concept of using the root of tooth for retention of a crown begun in the early 1700s when Pierre fauchard inserted wooden dowels in canals of teeth to aid in crown retention. Over time the wood would expand in the moist oral environment to enhance retention of the dowel until, unfortunately, catastrophic vertical root fracture occurred [26]. **In 1746, Claude Mouton** 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 the mid 1800's.During this period, a post-retained crown with 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 tooth. In addition, an unserviceable restoration could be replaced without having to remove the post [26].

Restoring a pulpless tooth with a metal post and core in combination with all ceramic crown is challenge, since the underlying metal post and core can alter the optical effects of a translucent all ceramic crown and would compromise esthetics[85].

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 [92]** and became commercially available in Sweden in 1992.

Recently tooth colored posts have been developed to be used mainly in anterior area for all ceramic restoration construction. That could be fiber reinforced composite posts or zirconium posts [1,28,29,30,31].

The use of tooth-colored fiber posts, together with the wide choice of composite resins available for core foundation restorations, allows better reproduction of the underlying natural tooth shade, resulting in a more esthetic solution[6]. The clinical success of a post-and-core restoration depends on the composite resin selected and the quality of the post and core interface, where materials of different compositions are in intimate retentive contact [7]. In vitro and in vivo researches indicates that failure of fiber post-and-core restorations often occurs because of debonding between the fiber post-resin and/or resin-root canal dentin interfaces as a result of inadequate bond strength [3,8,9,10]. It has also been demonstrated that parameters such as post length, shape, and post surface characteristics influence post retention [9,10]. With the increasing aesthetic demands, tooth colored post and core restoration have become an option for restoring non-vital anterior teeth.

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. In addition, these types of posts have physical properties similar to natural dentin together with sufficient resistance to high loads [31,32,85].

1- FIBER REINFORCED POST SYSTEM

Many different kinds of posts have been described in literatures [86,87]. During the selection of 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[88,89].

Properties of posts materials:

The selection of post materials depends mainly on the biomechanical criteria of prefabricated posts [90.91]. Also the restoration of endodontically treated teeth with physiochemically homogeneous materials that have physical properties similar to those of dentin has become a major objective in dentistry [32]. The ideal post and core material should have physical properties such as modulus of elasticity, compressive strength and coefficient of thermal expansion that are similar to those