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بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات:
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Fracture Resistance of Customized Fiber Posts versus Custom Made PEEK Posts with Two Fabrication Techniques

(Finite element analysis and an in vitro study)

Thesis

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INTRODUCTION

The treatment of endodontically treated teeth has always been considered a practical challenge due to their brittleness and the significant loss of tooth structure. Post and core system have been widely used for the restoration of endodontically treated teeth that have suffered loss of considerable amount of tooth structure. Traditionally, Post-core systems were classified into two basic types: one-unit custom made post-core and separate elements system consisting of a ready-made post with a separate composite core. [1]

Formerly, cast metal alloy post-core systems were the treatment of choice to restore severely damaged teeth. However, due to the wide difference in elastic modulus between metals and dentin, functional stresses can concentrate around the post, that might result in catastrophic fracture of the root. [1] In addition, they might adversely affect the esthetic outcome when combined with all-ceramic crowns especially with high-translucency ceramics. [2]

The emergence of new post material with a lower elastic modulus, fiber glass for example, resulted in more favourable stress distribution. However, as fiber glass posts are supplied as ready-made products, they have limited conformity to the figures of the root canal. In addition, although fiber glass posts have reduced moduli of elasticity (from45.7 to 53.8GPa) than those of different metal alloy posts (110.0GPa for titanium and 95.0GPa for gold), these are still nearly three times the elastic modulus of dentin (18.6GPa). [1]

Recently, new biocompatible high performance polymers, PolyEtherEtherKetones (PEEKs), were introduced as new dental materials. Because of their acceptable fracture resistance, better shock-absorbing ability and stress distribution, high performance polymers are considered as alternative materials for metal and glass ceramics [3] allowing this material to be used as post material.

The widespread of Cad-Cam (Computer aided design-Computer aided manufacturing) technology and its applications in the dentistry field has brought to innovation in treatment solutions. Like the fabrication of custom made posts made from zirconia or glass-fiber and PEEK as a new alternative. [4]

Unfortunately, studying biomechanical behavior and performing multi-parameter analysis on different types of post-core systems is difficult, time consuming and uneconomic.

For the aforementioned reasons, another method for analysis was developed. The finite element stress analysis method (FEM) is an important tool for determining stress distribution in biomechanical studies; FEM allows the adjustment of different mechanical parameters in the computer model. [5]

So the necessity to test the stress distribution and fracture resistance of the new material and its fabrication methods as a custom made post became a must.

REVIEW OF LITERATURE

The tooth is a complex structure mainly formed of centralized pulp enclosed by dentin, cementum, and enamel, the tooth is surrounded by periodontal tissues which comprises the periodontal ligament and alveolar bone. [6]

It is involved with the most important activity of chewing and grinding of food, that later on results in generation of force and its transferral from the crown to the supporting alveolar process of the bone. [7]

The natural biomechanical equilibrium of the tooth is well suited for this objective, with the physical properties of its previously mentioned components performing together to achieve this end. Therefore, the tooth should withstand the stress generated during the chewing procedure; if it does not, it would fracture, particularly in the root, inducing loss of function permanently. [8]

It is mostly accepted that extensively damaged tooth, whether by fracture or decay, must undergo the root canal treatment. [7]

Biomechanics of endodontically treated teeth:

Endodontically treated teeth are weaker and more fragile than vital ones [9] [10] [11] [12]. Among many causes for this increased weakness, it is recently highly accepted that the affection of tooth substance due to the former pathology and the endodontic treatment procedure is the main important biomechanical change [13] [14], affecting the long-term follow up and prognosis of the tooth. [15]

The type of restoration chosen for a root filled tooth will depend on the remaining hard tooth structure available. The amount of tooth remaining will dictate the fracture resistance of a tooth [16] and how the restoration will need to be retained. It follows that the preservation of as much tooth tissue as possible will improve likely outcome.

The resistance to fracture of devitalized tooth is related to several factors including the root canal treatment procedure (vertical root fracture susceptibility), the system of the post and core installed (the post material and its size, material of the core, effect of the ferrule) and factors related to the coronal part (quality and quantity of remaining structure, type of the restoration and loading context). [15]

There are different challenges in restoring the anterior and posterior dentition. The posterior dentition undergoes much higher forces when eating and chewing and is more susceptible to fracture. Anterior teeth are less prone to fracture but from a patient perspective the esthetic demand is greater.

Peroz et al. [17]classified endodontically treated teeth according to the number of remaining axial cavity walls into five classes:

Class 1: teeth have four remaining cavity walls, with a thickness greater than 1 mm. In this case, it isn't necessary to insert post and any final restoration can be utilized. [18]

Class II and Class III: have two or three remaining cavity walls. These teeth can possibly be restored without a post as the remaining hard tooth structure provides enough surface area for bonding, the use of direct or indirect adhesive restoration can provide adequate fracture resistance without the need for a post. [19]

Class IV: teeth have one remaining wall, with lack of adequate surface area for core material bonding and retention that can further affect the fracture resistance of the endodontically treated tooth [20]. The use of tooth as an abutment for a fixed or removable partial denture will result in reduced fracture resistance as a consequence of crown preparation [21]**,** therefore, a post is indicated for such cases, for esthetic concerns a non-metal post is indicated for treatment of anterior teeth, metal or non-metal posts can be used for posterior teeth.

Class V: teeth have no remaining walls, and a post will be required to provide retention for core material. A ferrule, which is characterized by a 360-degree metal crown collar surrounding parallel walls of dentin and extending coronal to the shoulder of the preparation, would greatly increase the fracture resistance of the tooth. [22] If a ferrule cannot be obtained, surgical crown lengthening or forced eruption may be required.

However, the actual challenge is restoring endodontically treated teeth having insufficient remaining tooth structure. Procedures to overcome the deficiency of remaining structure include surgical crown lengthening and orthodontic extrusion.

Although, they may adversely affect the crown/root ratio, with unfavourable esthetic outcomes or reduced static load failure of the teeth taking place. [23] [24]

Classification of post and core systems:

A post-and-core might be essential to promote retention and resistance form for the tooth-restoration unit, when a full crown is the line of treatment needed to restore an endodontically treated tooth. [25]

Two types of post-and-core systems are usually adopted in order to rehabilitate a root canal [26] and provide retention for crown: custom-made posts and prefabricated posts. [27] [28]

- A custom-made post is obtained on the basis of a mould taken directly from the root cavity, [29] the custom made post-and-core provides intimate adaptability in a canal wall and resists torsion force, it is specially indicated in case of an insufficient ferrule and an irregularly shaped canal. [30]
- A prefabricated posts is commercially available in different geometries, dimensions and materials. [27] Prefabricated posts allow the whole restoration to be performed in one visit, resulting in an easy, less expensive treatment. [31]

Materials used for fabrication:

When taking into account the restoration of devitalized teeth, dental materials have to be able to restore this structure loss, in order to guarantee mechanical and functional properties, esthetics and preservation of coronal seal. [32]