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Effect of Ferrule Design, Post Type and Functional Loading on the Fracture Strength and Coronal Leakage of Endodontically Treated Maxillary Premolars

Thesis

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Introduction

The approach towards restoring endodontically treated teeth is changing. Conventional treatment of severely damaged root-filled teeth was cast post and core and a covering crown. Being time-saving and economical, prefabricated metal posts with amalgam or composite cores, were described as treatment alternatives in the 1970s and since the mid-1980s nonmetal post systems have also been used.

As post materials, fiber-reinforced composites (FRC) have many benefits compared to metals. Their modulus of elasticity is closer to that of dentin[1]; therefore less stresses are induced in the root. In terms of esthetics and biocompatibility, Glass FRC posts were proved to be superior to metallic ones. However, like all prefabricated posts, a circular post preparation is required which offers little resistance to rotational forces. Furthermore, When the morphology of the canal is critical, e.g. in the case of oval canals, minimal contact with canal walls can be achieved.

Attempts to eliminate the disadvantages of prefabricated FRC posts have been made by developing a plastic, light-curable material that can be used to construct direct custom-made FRC posts (The Ever-Stick post system). The ability of this post to be shaped as the root cavity presents an effective way to conserve root tissue, reduce cement thickness and reduce stress concentration at the restoration-tooth interface.

Other factors from those related to post type are of importance for the success of post-retained restorations. Researchers agree that the extent of remaining tooth structure is a key issue for prognosis[2,3]. However, the question arises as to what extent the degree of dentin preservation influences the success and how effective a ferrule of nonuniform height would be in preventing failure of a restored tooth?

Loading condition is another paramount factor that has been brought into focus in recent years after the well documented high success rates of endosseous implants. A clinician is now often required to choose between using an endodontically treated tooth or an implant to support a fixed or removable prosthesis. There is a widely held view that Endodontically treated teeth serve less well as bridge abutments. If this is true the reason could be within the tooth itself, the type of prosthesis or a combination of the two.

Clinical success depends on application of sound biomechanical principles for the specific tooth and clinical situation. Thus, to enhance longevity, the restorative procedure of endodontically treated teeth calls for careful consideration of treatment alternatives to select the best technique and material according to tooth condition and functional demands.

Review of Literature

Although the restoration of endodontically treated teeth has been extensively studied, yet remains controversial. The difficulty to determine a treatment plane was shown in a study by ***Tu¨rp et al in 2007***[4], who asked four specialists about the best treatment for a fractured lateral incisor and received different treatment strategies based on literature.

1. Biomechanical aspects of endodontically treated teeth:

It is generally believed that endodontic treatment renders the teeth weaker and more susceptible to fracture than vital teeth. Certain mechanical terminologies have been frequently applied by many authors to describe the physical condition of teeth that have had root canal treatment, such as increased "brittleness", "friability" and "fragility" or reduced "elasticity" and "strength". However, there are in-vitro studies that dispute this finding.

Back in ***1992, Sedgley and Messer***[5] compared the mechanical properties of dentin samples from endodontically treated teeth with an average10 years of treatment and their contralateral vital pairs. Aside from a slight difference in hardness (vital dentin was 3.5% harder than the dentin from endodontically treated teeth), the properties were comparable. ***Huang et al***[6] in the same year compared the physical and mechanical properties of dentin specimens from teeth with and without endodontic treatment at different levels of hydration. They concluded that, neither dehydration nor endodontic treatment caused deterioration of the mechanical properties of dentin, which were modified so few to affect the fracture resistance of these teeth. However, Fractures were still reported to be more common in pulpless teeth than vital ones[7].

A possibility that has been suggested but never extensively explored is the reduction of pressoreception or an elevated pain threshold that allows larger loads on the endodontically treated teeth without triggering a protective response. ***Randow & Glantz in 1986***[8] evaluated the cantilever loading pain capacities of non-vital and vital teeth. Results revealed that: non-vital teeth withstood markedly higher cantilever loading levels before pain was elicited than did the contralateral or neighboring vital teeth. Mean pain threshold levels of the non-vital teeth were more than twice as high as those of vital teeth. Upon applying the cantilever loading experiments on anesthetized teeth, no differences in reaction levels were observed.

A factor that may be more critical to the failure of endodontically treated teeth is the cumulative loss of tooth structure from caries, trauma, restorative and endodontic procedures. Loss of connecting structures, in particular, such as pulp chamber roof and one or both marginal ridges leads to greater risk of fracture. ***Reeh et al in 1989***[9]**,** evaluated the reduction of tooth stiffness as a result of endodontic and restorative procedures, and found that if the coronal segment of the tooth is intact, endodontic procedures had a relatively small impact, by reducing the relative stiffness about 5% whereas an average loss of stiffness by 63% was recorded for teeth with MOD cavities.

By assessing root deformation upon loading ***Lang et al in 2006***[10]**,** investigated the effects of different steps of endodontic treatment on the rigidity of teeth. It was found that, teeth were increasingly destabilized by every treatment (access preparation, manual instrumentation and tapered and parallelsided post preparation). While increased deformability was significant after access preparation and post preparation. They came to a