EFFECT OF THE PREFABRICATED METALLIC POST LENGTH ON RESTORED TEETH: FRACTURE STRENGTH AND STRESS DISTRIBUTION

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INTRODUCTION

In order to restore devitalized teeth, modern restoring techniques in Dentistry use an external element, the intraradicular post, as a retention system for the material used in the tooth restoration to be carried out later.

Although non-metallic posts are being increasingly used, metallic posts continue to be the standard for most situations because they have stood the test of time [1]. Different aspects of the post design have been studied [2,3,4], but the influence of the post length on the mechanical strength of the restored tooth is lacking. The aim of this work was to study how the prefabricated metallic post length affects the biomechanical performance of restored teeth.

METHODS

A combined theoretical and experimental method was used to analyze the influence of post length (from 3 to 14 mm) for the ParaPost Stainless Steel (Coltène/Whaledent Inc, Ohio, USA).

First, an experimental fracture strength test was performed over thirty extracted human teeth. The purpose of this test was to analyze the differences in strength between the post systems with different post lengths. The teeth were decoronated, treated endodontically and restored with stainless steel posts. The specimens were placed in a retention device and mounted on the universal testing machine. This device allowed the teeth to be loaded on the palatal side at an angle of 30º to the radicular axis, in the vestibular direction. A controlled loading force was applied to the teeth at a rate of 5 N/s, until failure. Three group lengths were considered based on the post length to root length ratio: 'short' (<0.5), 'normal' (0.5 to 0.8) and 'long' (>0.8). The loading force (N) required to cause failure was recorded and the results for the groups were compared by using an ANOVA test.

Secondly, the finite element technique was used to develop a 3D model of the restored tooth. The model allowed us to study the stress distribution pattern on the restored tooth under external loads, for the different post lengths considered. The stress distribution pattern provided information about the fracture mechanism of the restored tooth. To generate the geometry, measurements were taken on 40 extracted human maxillary central incisors: cervico-apical height and mesio-distal and vestibulo-palatal diameters at both cervical and medial root heights were recorded. Mean values from these measurements defined the geometry of the tooth used for the study. Finally, the results from the fracture strength test were used to check the validity of the finite element model and the results from the simulations.

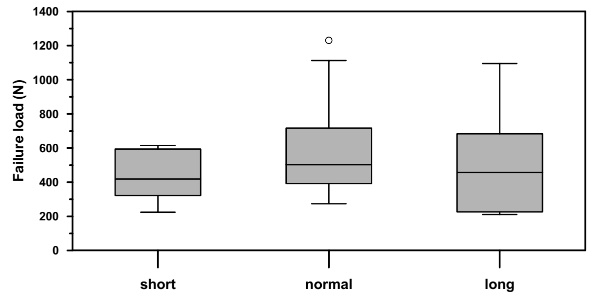

Figure 1: Box-whisker graphs showing spreads of failure load values for the groups of studied specimens.

RESULTS AND DISCUSSION

From the experimental fracture strength test, no significant differences ($p=0.3>0.05$) were observed between the failure loads of the different groups (short, normal and long) of teeth restored using stainless steel posts. Box-whisker graphs showing spreads of values in the data sets can be observed in Fig. 1. Restored teeth showed a fracture of the core along the juncture with the post, on the vestibular side.

The model of the restored tooth predicted similar stress distribution and peak stresses for the different post lengths considered, which agrees with the ANOVA test results. And a stress concentration was predicted along the interface of the post with the composite core, according to the failure mode experimentally observed.

CONCLUSIONS

It has been experimentally proved that the biomechanical performance of teeth restored with stainless steel posts present a low dependency on post length. This is an important finding because the length of the post has a significant effect on its retention. The more apically the post is placed in the root canal, the more retentive it becomes [2,3]. However, it may not always be possible to use a long post, especially when the remaining root is short or curve.

The experimental results corroborated the estimations from the developed model, thus validating the model. The proposed model could be a useful tool for studying the influence that different post design variables have on the biomechanical performance of restored teeth, by means of simulations.

REFERENCES

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