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Original Research

Assessment of the fracture resistance in an endodontically treated maxillary central incisor restored prefabricated glass fiber post and custom made cast post using finite element analysis

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ABSTRACT:
Background: The present study was conducted to assess the fracture resistance in an endodontically treated maxillary central incisor restored prefabricated glass fiber post and custom made cast post using finite element analysis. **Materials & Methods:** The present study was conducted on 50 recently extracted maxillary central incisor. Teeth were divided into 2 groups of 25 each. In group I, endodontically treated central incisor restored with custom-made cast post with a metal ceramic superstructure which was simulated. In group II, endodontically treated central incisor restored with prefabricated glass fiber post with a metal ceramic superstructure which was simulated. **Results:** In group I, stress value (MPa) of vertical load in dentin was 4.68, in post was 9.72 and in crown was 9.71, horizontal load in dentin was 5.92, in post was 22.5 and in crown was 29.4. In group II, stress value (MPa) of vertical load in dentin was 4.69, in post was 8.61 and in crown was 7.93, horizontal load in dentin was 18.5, in post was 5.2 and in crown was 30.8. **Conclusion:** Authors found that both groups exhibited similar stress during vertical load. Cast metal post dissipates less stress to the dentin and gives better fracture resistance to the tooth when compared to glass fiber post.
Key words: Cast metal post, Fracture resistance, Glass fiber post

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INTRODUCTION

Restoration of endodontically treated teeth is challenging. Since the time Pierre Fauchard used gold, silver, or wooden dowels to retain crowns, various types of post-and-core systems have been introduced to dentistry.[1] Endodontic posts may be cast with the core, such as gold and nickel-chromium (Ni-Cr) posts, or they may be prefabricated, such as titanium and stainless steel posts.[2] Recently, non-metallic posts such as fiber-reinforced composite (FRC) and ceramic posts have been introduced as theoretically acceptable alternative materials. One of the functions of post-and-core systems is to improve the tooth's resistance by dispersing the functional forces along the root length.[3] The post system includes components of different rigidity because the rigid component is able to withstand forces without distortion and the stress is transferred to less rigid substrate.[4] The difference between the elastic modulus of dentin and the post material may be a source of stress for root structures.[5] The use of post systems that have an elastic modulus similar to that of dentin results in the creation of a mechanically homogenous unit with better biomechanical performance. Thus, the post and core

material affects stress distribution in endodontically treated teeth.[6]

Finite element analysis (FEA) has recently become a powerful technique in dental biomechanics.[7] The present study was conducted to assess the fracture resistance in an endodontically treated maxillary central incisor restored prefabricated glass fiber post and custom made cast post using finite element analysis.

MATERIALS & METHODS

The present study was conducted in the department of Endodontics. It comprised of 50 recently extracted maxillary central incisor.

Teeth were divided into 2 groups of 25 each. In group I, endodontically treated central incisor restored with custom-made cast post with a metal ceramic superstructure which was simulated. In group II, endodontically treated central incisor restored with prefabricated glass fiber post with a metal ceramic superstructure which was simulated. The qualitative stress distribution analyses were recorded by von Mises criteria. Results thus obtained were subjected to statistical analysis. P value less than 0.05 was considered significant.

RESULTS

Table I Distribution of teeth

Groups	Group I	Group II
Post	Cast post	Glass fiber post
Number	25	25

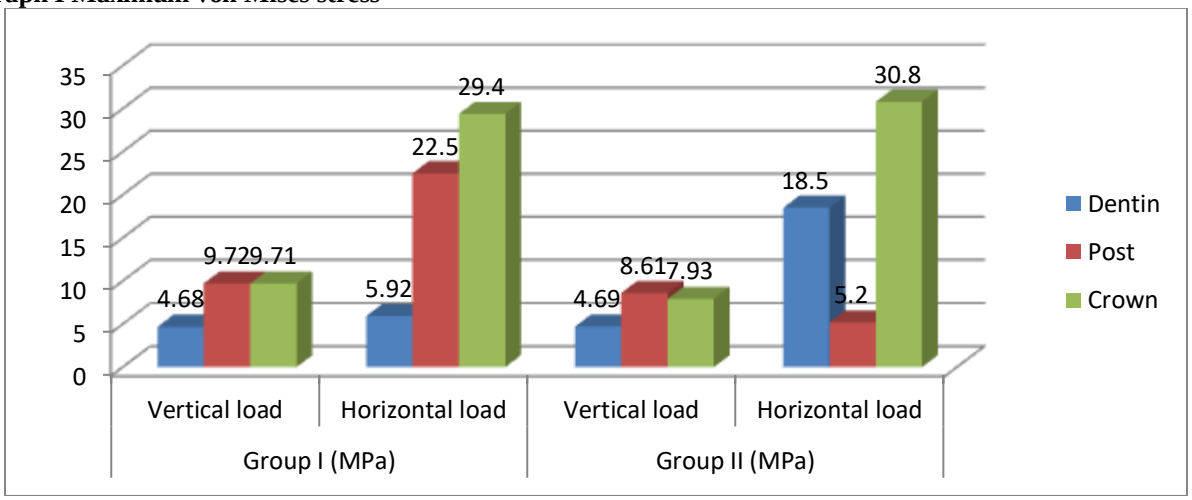
Table I shows that In group I, central incisor restored with custom-made cast post and in group II, central incisor restored with prefabricated glass fiber post. Teeth were divided into 2 groups of 25 each.

Table II Maximum von Mises stress

Location	Group I (MPa)		Group II (MPa)	
	Vertical load	Horizontal load	Vertical load	Horizontal load
Dentin	4.68	5.92	4.69	18.5
Post	9.72	22.5	8.61	5.2
Crown	9.71	29.4	7.93	30.8
P value	0.05	0.01	0.05	0.001

Table II shows that in group I, stress value (MPa) of vertical load in dentin was 4.68, in post was 9.72 and in crown was 9.71, horizontal load in dentin was 5.92, in post was 22.5 and in crown was 29.4. In group II, stress value (MPa) of vertical load in dentin was 4.69, in post was 8.61 and in crown was 7.93, horizontal load in dentin was 18.5, in post was 5.2 and in crown was 30.8.

Graph I Maximum von Mises stress



DISCUSSION

Among the methods used for the restoration of endodontically treated teeth, the methods that can be highlighted uses cast metal and prefabricated posts, particularly glass fiber and carbon fiber posts and the choice of the retainer is usually based on the amount of remaining crown to be restored, and aesthetic in the rehabilitation of the anterior teeth.[8] In situations where there is only a small amount of remaining crown, the use of a cast metal post is preferred.[9] The high elastic modulus of the metal alloys used for casting could contribute to increased root fracture rates. However, studies have reported that the use of a cast metal post has a similar success rate to the use of prefabricated fiber posts.[10] The present study was conducted to assess the fracture resistance in an endodontically treated maxillary central incisor restored prefabricated glass fiber post and custom made cast post using finite element analysis.

In present study, in group I, stress value (MPa) of vertical load in dentin was 4.68, in post was 9.72 and in crown was 9.71, horizontal load in dentin was 5.92, in post was 22.5 and in crown was 29.4. In group II, stress value (MPa) of vertical load in dentin was 4.69, in post was 8.61 and in crown was 7.93, horizontal load in dentin was 18.5, in post was 5.2 and in crown was 30.8. Vignesh et al[11] compared two different post systems – 1) prefabricated glass fiber post and 2) custom made cast post. The qualitative stress distribution analyses were recorded by von Mises criteria. Von Mises stress in an intact tooth was concentrated in the crown near the cingulum under oblique load and on the incisal edge with vertical load. With horizontal load- In the crown region, maximum von Mises stress was observed in both the cast post and fiber post. Within the post region, maximum von Mises stress was observed in cast post when compared to fiber post. In the root dentin, more von Mises stress was observed in fiber post when compared to cast post.

Nokar et al[12] in their study 12 3D models of a maxillary central incisor were simulated in the ANSYS 5.4 software program. The models were divided into three groups; the first group included: 1-Gold post and core and 2-Nickel-chromium (Ni-Cr) post and core restored with metal-ceramic restorations (MCRs). The second group included: 1-Stainless steel post, 2-Titanium post, 3-Carbon fiber post, 4-Glass fiber post, and 5-Quartz fiber post with composite cores and MCRs. The third group included: 1-Zirconia post and core, 2-Zirconia post, 3-Carbon fiber post, 4-Glass fiber post, and 5-Quartz fiber post; the last four models had composite cores restored with all-ceramic restorations (ACRs). Each specimen was subjected to a compressive load at a 45-degree angle relative to its longitudinal axis at a constant intensity of 100 N. The models were analyzed with regard to the stress distribution in dentin. Two stress concentration sites were detected in the models. The first group showed the lowest stress levels in the cervical region, while the stress levels detected in the second group were higher than those in the first group and lower than those found in the third group. Fiber-reinforced posts induced a higher stress concentration between the middle and cervical thirds of the root compared to other posts.

The shortcoming of the study is small sample size and only 2 post systems were compared.

CONCLUSION

Authors found that both groups exhibited similar stress during vertical load. Cast metal post dissipates less stress to the dentin and gives better fracture resistance to the tooth when compared to glass fiber post.

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