Original Article

Evaluation of the Effect of Glass-Fiber Post Length on Fracture Resistance of Endodontically Treated Central Incisors

Z. Mahdavi Izadi[1], E. Jalalian[2], MH. Salari[1], G. Khalili Shorini[3],T. Safaei[4], SH. Azimzad[4], MJ Kharazi Fard[5]

[1]Assistant Professor, Department of Fixed Prosthodontics, School of Dentistry, Dental Branch, Islamic Azad University, Tehran, Iran
[2]Associate Professor, Department of Fixed Prosthodontics, School of Dentistry, Dental Branch, Islamic Azad University, Tehran, Iran
[3]Dentist
[4]Dentistry Student, School of Dentistry, Dental Branch, Islamic Azad University, Tehran, Iran
[5]Research Member of Dental Research Center Tehran University of Medical Science. Tehran, Iran

Abstract

Background and Aim: Use of glass fiber posts is of widespread acceptance in restoring root canal treated teeth, but studies concerning the most proper length of the post to provide the utmost fracture resistance are inadequate. The aim of this study was to evaluate the effect of glass fiber post length on fracture resistance of root canal treated central incisors.

Materials and Methods: This experimental study was carried out on 40 maxillary central incisors in 4 groups of 10 each. RDT posts and cement was used in this experimental study with the lengths of 6, 8, 10, and 12 mm in the study groups. The samples were debrided and decoronated at the CEJ levels and endodontically treated using step-back technique. RDT drills were used for post space preparation. Then, the root canal walls were etched and the posts cemented in place. The composite cores were then prepared at the height of 5 mm and samples mounted 2mm down to their CEJ levels within acrylic blocks. An impression material (Impregum, 3M, ESPE) with a thickness of 0.2mm was used to simulate PDL around the samples. The samples were subjected to compressive forces at a 135-degree angle to their long axes using a Universal Testing Machine. Data pertaining to the fracture of the samples were analyzed using ANOVA and Tukey statistical tests.

Results: The maximum resistance to fracture was recorded in 8-and 10-mm-long posts and the minimum was observed in the lengths of 6 and 12 mm. Statistical tests showed a significant difference between 8- and 10-mm-long posts with those having lengths of 6 and 12 mm in terms of fracture resistance. There was no significant difference between 8- and 10-mm-long posts as well as 6- and 12-mm-long ones.

Conclusion: It can be concluded that the length of post is influential in the fracture resistance of the root so that the maximal resistance can be obtained in 8 to 10 mm of length and such lengths can be recommended for non-metal posts.

Key Words: Glass fiber post , lumiglass composite , impregum

Corresponding author:
E. Jalalian, Associate Professor, Department of Fixed Prosthodontics, School of Dentistry, Dental Branch, Islamic Azad University, Tehran, Iran
dr_e_jalalian@yahoo.com

Received: 1 Feb 2012
Accepted: 21 Nov 2012

Journal of Islamic Dental Association of IRAN (JIDAI) Spring 2013 ;25, (1)

Introduction

The majority of endodontically treated teeth need intra-canal posts and fixed prosthesis due to the loss of tooth structure and root canal therapy. These teeth usually have old restorations, history of trauma or endodontic manipulation. The prognosis of RCT depends on the quality of RCT, the remaining tooth structure and level of bone support [1-6].

In order to increase the survival and fracture resistance of an endodontically treated tooth in oral cavity, different post and core systems can be used. These systems are different in length, diameter, design and material of the post. These systems change the mechanical properties of the endodontically treated tooth by changing the force strain and consequent changed fracture resistance of the tooth [1].

Teeth reconstructed by post and core have lower fracture resistance than sound teeth. Post and cores are used for retention in full crowns [4].

The amount of remaining root dentin, tooth crown and proper post space preparation play an important role in tooth restoration survival. Canal preparation in different lengths and different post systems with modulus of elasticity near to dentine can enforce the fracture resistance and improve the apical seal. [1,7,8]. Non-metallic in comparison to metallic posts can increase the fracture resistance of root by bonding to tooth structure [4,5,6].

To date, many studies have been conducted to find the most appropriate post length that provides the highest fracture resistance [2,3,9,19]. Some studies have stated that an ideal post length is equal to clinical crown length [2,9]. Others calculate it according to the root length and believe that its length should be equal to two-third or three-fourth of the root length [10].

Controversy still exists about this issue. Thus, this study was carried out to evaluate the effect of the length of glass fiber posts on fracture resistance of endodontically treated teeth.

Materials and Methods

This experimental study was conducted on 40 human central incisors with similar dimensions with no root caries, cracks, fracture, and internal or external resorption. At first, 100 central incisors with no cracks, fracture or caries were selected, measured with a caliper and teeth with similar length and diameter were chosen for the study. The teeth were then evaluated radiographically to ensure no internal root resorption. The teeth were stored in distilled water. The remaining tissue appendages were removed from the tooth surfaces with hand scaler. The teeth were then cleaned with rubber cap and pumice.

Teeth were cut at the CEJ perpendicular to the vertical axis of the tooth with 0.2mm metal disc (A-GCA Diatech Dental, Switzerland) with high-speed hand piece and water coolant. Then the edges were rounded by abrasive paper. Working length of each root canal was determined on a radiograph. Root canals were filed and flared manually up to file #60 (25mm, Mani) with step-back technique. The canals were irrigated with 25% sodium hypochlorite solution. Gutta percha cone #35 was selected as the master apical cone and the canals were obturated with lateral condensation technique by using #25 spreader, # 15 lateral cone and AH-Plus sealer. Then, the subjects were randomly divided into 4 groups of 10 each. The post space was prepared with # 1 and 2 RTD kit drills at 6 mm length in group one, 8 mm in group two, 10 mm in group 3 and 12 mm in group 4. Canal walls were etched and bonded with adhesive bonding agent) SEALBOND ULTIMA™ (according to the manufacturer's instructions. Base and catalyst of the cement (RTD cement, dual-cure) were mixed. The RTD fiber posts Match point (RTD-match post) were wetted with silane (RTD) and then with cement and inserted into the canal. The posts were pressured for 5-10 seconds and light-cured for 40 seconds. Cement excess was removed and the cores were built-up using light-cured composite resin (Lumiglass) in 5 mm height (the length of post in composite resin was 4 mm).

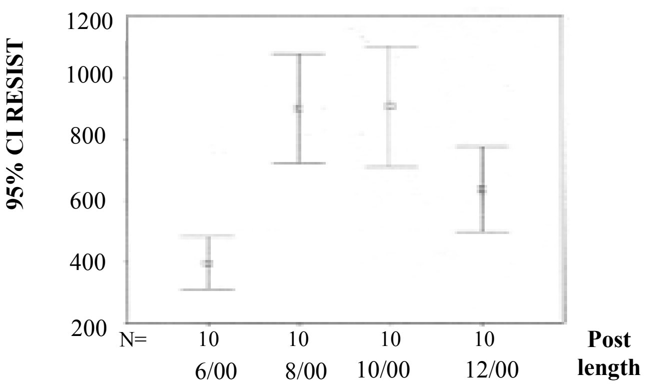
Three retentive grooves were prepared on root surface of each tooth to mount the specimens. The roots were embedded in melted wax up to 2mm below the CEJ in order to be covered by 0.2- 0.3 mm thickness of wax as spacer [2]. Then, the specimens were mounted vertically parallel to the long axis of the tooth in especial acrylic blocks. Two mm of the root was in the acrylic resin and 7mm of the specimen including the core was out of the acrylic block [11]. After observing the first sign of polymerization, the teeth were removed from the

blocks and the spacer layer was eliminated from the root surfaces and inside the blocks. The space formed in the blocks was filled with the Impregum Impression material through injection (3M) [2]. The excess of impression material was removed by scalpel to provide a smooth surface 2mm under the CEJ. By doing so, the PDL space was simulated (2). Finally, all specimens were subjected to 2000N force in Universal Testing Machine with a crosshead speed of 1 mm per minute, at 135° angle with 3 mm distance from the incisal edge. The force at which fracture occurred was evaluated in each specimen and reported in Newton. [11] One-way ANOVA and Tukey's HSD test were used for comparison of fracture loads among specimens.

Results

Table 1 shows the fracture resistance in different groups. According to the results of one-way ANOVA, the fracture resistance was different in different groups. These differences were statistically significant. The fracture resistance in 6 and 12 mm posts was less than the rate in 8 and 10 mm posts ($P<0.05$); but, the differences between 8 mm and 10 mm posts were not statistically significant ($P=0.999$).

The difference between 6 and 12 mm posts was not significant either ($P=0.085$). (Graph 1)



Graph 1: Error bar graph of mean fracture resistance of endodontically treated Central incisors based on post length with 95% confidence interval

Discussion

This study was carried out to find the proper length of glass fiber posts with the highest fracture resistance. Data obtained after load application were subjected to statistical analyses.

The results showed the greatest fracture resistance for 10mm, 8mm, 12 mm and 6 mm posts in a decreasing order. The mean fracture resistance was almost the same for 8 and 10 mm posts. The 12 mm posts showed less fracture resistance than 8 and 10 mm posts. Although it was expected that longer posts cause greater tension to the root resulting in increased fracture resistance, the tension caused by posts longer than 10 mm was not spread which is one of the differences between glass fiber and metal posts. Glass fiber posts are expected to show different characteristics from metal posts because of the MOE close to dentine, different bonding system and different form and composition. The fiber posts longer than 10 mm probably decrease the fracture resistance by weakening the internal apical dentine [7].

Statistical analyses showed no significant differences between 8 and 10 mm posts. The stress distribution in root was almost the same in both groups; therefore, in a central incisor 8 mm posts can be used to provide maximum fracture resistance instead of 10mm posts in order to decrease excess removal of dentin.

Inter-group comparison revealed no significant difference between 6 and 12 mm posts. Although the mean fracture resistance was higher in 12 mm posts, these two groups had the lowest fracture resistance. The low fracture resistance of 6 mm posts could be due to the short length of the post and higher stress accumulation by leverage forces. In 12 mm posts, low fracture resistance could be attributed to the weakening of intra-canal root dentin.

Finally, the fracture resistance of 8 and 10mm posts was significantly different from that of 6 and 12mm posts. Eight and 12 mm posts are the most appropriate for a standard 16mm central incisor. Santos et al. and McLaren et al. showed higher fracture resistance in 10mm posts in comparison to 5mm ones [11,12].

Buttel et al. found that in 6 mm posts the fracture resistance was higher than in 3mm posts [13]. Therefore, the graph of fracture resistance versus

Table 1: Fracture resistance in endodontically treated central incisors based on the post length

Post length	6 mm		8 mm		10 mm		12 mm	
Fracture resistance	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	396/8	162/9	900/5	268/8	906/9	295/7	636/3	196/1

length is a path that first ascends with a peak at 8 to 10 mm and then descends.

In this study, we used central incisors with standard shapes and forms. The teeth were subjected to loads exerted at 135° angle relative to the axis of the tooth which is equal to the actual amount of loads on an upper central incisor in class I occlusion [2,10]. We also used Impregum to simulate the PDL. Not using it may change the results because the hard acrylic resin around the root may reinforce the outer structure of the roots. The methodology of our study was somehow the same as that of Adanir and Beli. In their study, they compared 6, 9and 12 mm fiber-posts, and the 6 mm ones showed the least fracture resistance similar to our finding. They could not find significant differences between 9 and 12mm posts [12], while our study showed that the fracture resistance was ideal in 8 to 10 mm posts and decreased significantly in 12 mm posts. Such dissimilarities could be attributed to the differences in type of post and cementation.

Gu et al. confirmed that 10mm height is an ideal length for glass fiber posts in post and cores systems for metal fused to ceramic crowns [14]. In Cochin's study 8mm posts showed the highest fracture resistance [15].

Conclusion

According to the results of this study, post length affects the fracture resistance. The highest fracture resistance was found in 8 to 10 mm posts and thus, they are preferred over the other non-metallic posts.

References

1- Santos-Filho PC, Castro CG, Silva GR, Campos RE, Soares CJ. Effects of post system and length on the strain and fracture resistance of root filled bovine teeth. Int Endod J. 2008 Jun; 41(6):493-501.

2- Adanir N, Belli S. Evaluation of different post lengths' effect on fracture resistance of a glass fiber post system. J Europ J Dent. 2009, Jan;8 (3):57-64.

3- Black G.V. Method of grafting artificial crowns on roots of teeth. J Mo Dent. 1869;1:233.

4- Nandini VV, Vankatesh V. Current concepts in the restoration of endodontically treated teeth. J Indian prosthod Soc. 2006 Jan;6(2):63-67.

5- Assif D, Gorfil C. Biomechanical considerations in restoring endodontically treated teeth. J prosthet Dent. 1994 Jan;71(6):565-7.

6- Ya–xing Z, wei-hong Z, Zhi-yue Lu, Ke-li W. Fracture strength of custom – fabricated celay all-ceramic post and core restored endodontically treated teeth. J Chin Med. 2006 Nov; 119 (21):1815-20.

7- Jalalian E, Nikouei S, Shams S, Jamhari S. Comparison of effect of non-metal posts on the fracture resistance of restored teeth with composite. Shiraz Univ Dent J. 2010;10(4):299-308.

8- Salari MH, Jalalian E, Soleimani S. Ferrule effect onthe fracture resistance of teeth restored with bonded post and cores. J Islamic Dental Asso. 2007 Sum;10(2):86-90.

9- Scotti R, Valandro LF, Galhano GA, Baldissrra P, Bottino MA. Effect of post length on the fatigue resistance of bovine teeth restored with bonded fiber posts: A pilot study. Int J Prosthod. 2006 Sep-Oct;19(5):504-6.

10- Schiavetti R, García-Godoy F, Toledano M, Mazzitelli C, Barlattani A, Ferrari M, Osorio R. Comparison of fracture resistance of bonded glass fiber posts at different lengths. Am J Dent. 2010 Aug;23(4):227-30.

11- Ng CC, Dumbrigue HB, Al- Bayat MJ, Griggs, Wake field CW. Influence of remaining coronal structure location on the fracture resistance of restored endodontically treated anterior teeth. J Prosthet Dent. 2006 Apr:95(4):290-4.

12- Mclaren JD, Mclaren CH, Yaman P, Bin-shuwaish M, Dennison J, Mcdonald N. The effect of post type and length on the fracture resistance of endodontically treated teeth. J Prosthet Dent. 2009;101:174-182.

13- Buttle L, Krastl G, Lorch H, Naumann M, Zitzmann NU, Weiger R. Influence of post fit and post length on fracture resistance. J Inter Endod. 2009;42:47-53.

14- Gu XH, Huang JP, Wang XX. An experimental study on fracture resistance of metal-ceramic crowned incisors with different post-core systems. Zhonghua Kou Qiang Yi Xue Za Zhi. 2007 Mar; 42(3):169-72.

15- Cecchin D, Farina AP, Guerreiro CA, Carlini-Júnior B. Fracture resistance of roots prosthetically restored with intra-radicular posts of different lengths. J Oral Rehabil. 2010 Feb;37(2): 116-22.