Original Research

Effect of Length and Diameter of Fiber Reinforced Composite Post on Fracture Resistance of Remaining Tooth Structure

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Abstract

Introduction: Post and core has been considered for endodontically treated tooth, especially in cases with severe damage crowns. Recently fiber reinforced composite posts (FRC post) have been used in the treatment of endodontically treated teeth. Because the length and diameter of posts are effective in stress distribution, the purpose of this study is to evaluate the effect of length and diameter of FRC post on fracture resistance. **Methods:** In this experimental study, 36 glass fiber posts with combination of 7mm, 9mm, and 12mm length and 1.1mm, 1.3mm and 1.5mm diameter were divided into 9 groups of 4. These posts were cemented in root canals by Panavia. Samples were tested with 45° compressive forces for the evaluation of fracture resistance. Datas were analyzed using SPSS soft ware and One- way and Two-way ANOVA analyses. **Results:** Fracture resistance did not increase significantly with the effect of length and diameter simultaneously (P=0.85). Samples with 12mm length and 1.5mm diameter had the greatest fracture resistance (1023/33N±239/22). The minimum fracture resistance had occurred in post with 7mm length and 1.5mm diameter (503/13N ±69/18). Fracture resistance increased significantly by increasing the length and the same diameter. **Conclusion:** It can be concluded that fracture resistance is affected by the length and not the diameter of FRC post.

Key Words: Diameter, fiber reinforced composite post, fracture resistance, length.

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Introduction

Post and core is used to repair the teeth with sever damage. At first, it was thought that using post can result in the reinforcement of teeth; root canal area preparation is always accompanied by the removal of some dentin, so there is a possibility of tooth root weakening and consequently tooth fracture (1).

FRC post has been used to treat endodontically treated teeth with severe damage in recent years. These posts are to create a single-unit complex of bound root-post in the root of teeth with damage, according to desirable physical and mechanical features (proper strength, elasticity co efficiency near the dentin) (2).

In a research carried out by Newman and co-workers in 2003, it was specified that fracture in FRC post was to support tooth tissue and there was not a significant difference between thick and narrow post in fracture resistance (3).

Asmussem and Shahafi (4) showed that as the length and diameter of a composite post increase, the stress produced in dentin has been decreased. However, Grieznis et al. (5) concluded in his study that with the increase of casting post diameter, fracture resistance reduced.

The purpose of this study is to examine the effect of length and diameter of fiber reinforced composite post (FRC) on fracture resistance of the teeth.

Materials and Methods

Thirty six human natural teeth which had been extracted recently were prepared and their crowns were cut at a distance of 2mm from CEJ. Then those teeth in which Glass fiber post was used were divided into 9 groups of 4:

In groups 1, 2, and 3 FRC post had 12 mm length, with 1.1, 1.3 and 1.5mm diameter, respectively.

In groups 3, 4, and 5 FRC post had 9 mm length, with 1.1, 1.3 and 1.5mm diameter, respectively.

In groups 10, 11, and 12 FRC post had 7 mm length, with 1.1, 1.3 and 1.5mm diameter, respectively.

The posts were cemented in root canals by Panavia F cement. Then for all cases, composite core was formed in the form of a prepared tooth using celluloid matrix and each surface of the core was radiated for 40 seconds using a light apparatus and then polymerization took place.

After this stage, the cases were placed in the acrylic up to the limit of CEJ. In order to similize the instances with clinical conditions, all were placed under 1000 thermo cycling between 5^{oc} to 55^{oc}. To do the fracture resistance test, the instances were placed in a special jig at an angle of 45º, in universal testing machine under the compressive force with the speed of 0.5 mm/min and fracture took place. Then the data were analyzed using Spss soft ware, One way, Two-way variance analysis and Tuky test.

Results

According to two way variance analysis and Table 1, fracture resistance doesn't have a significant relation with the simultaneous effect of length and diameter (P=0.085).

Doing one way variance analysis, it was specified that there is a significant relation between fracture resistance and increase of length in FRC post (P= 0.000). Samples with 12mm length have more fracture resistance compared to those with 7 and 9mm diameter. However, fracture resistance does not have a significant relation with diameter increase. The average proportion of fracture resistance with different length and diameters has been mentioned in Tables 2 and 3.

The average of fracture resistance in the studied groups has been shown in table 4. The maximum fracture resistance was observed in groups 3 with 12mm length and 1.5mm diameter (1023/33± 239/21). The minimum fracture resistance was in group 9 with 7mm length and 1.5mm diameter (503/73±69/18).

After fracture resistance test, the created fracture all took place above CEJ and in the middle of post and core.

Table 1. Two way variance analysis shows the lack of a significant relationship between fracture resistance and the simultaneous effect of length & diameter

Source	F	Sig.
Corrected Model	7.979	0.000
Intercept	1010.789	0.000
Length	2.1777	0.000
Diameter	25/156	0.133
Diameter Length	2.292	0.085

Table 2. Fracture strength average in groups with different FRC length

Length (mm)	Samples	Standard Deviation± Mean
7	12	570.61±145.24
9	12	602.34±94.24
12	12	914.68±182.95
Amount of P		P= 0.000

Table 3. Fracture strength average in groups with different FRC diameters

Length (mm)	Samples	Standard Deviation ± Mean
1.1	12	645.13±119.26
1.3	12	755.87±200.14
1.5	12	686.63±285.14
Amount of P		P= 0.446

Table 4. The average fracture resistance (FR) in the studied groups

Length (mm)			
1.5	1.3	1.1	Length (mm)
Standard Deviation Mean	Standard Deviation Mean	Standard Deviation Mean	
772.88±68.95 (First group)	947.8±129.41(Second group)	1023.33±239.21 (Third group)	12
633.68±68.98(Forth group)	640.50±97.93(Fifth group)	532.83±93.92(Sixth group)	9
528.85±51.73(seventh group)	679.29±214.14(Eighth group)	503.73±69.18(Ninth group)	7

Discussion

The created fractures in samples above CEJ were at the attachment place of post and core. No fracture was seen in teeth or post and similar to other studies all the fractures were recurable and reversible while the created fractures in casting posts mostly result in vertical root fractures. The reason is the higher elasticity coefficient of metal materials compared to dentin. In FRC post, due to elasticity coefficient similar to dentin, stress distribution may be more desirable and fracture took place in the weakest part of post and core that is to say at the attachment place of post and core.

Using thicker post is accompanied by more dentin removal and consequently tooth fracture resistance reduces and fracture possibility increases (1).

On the other hand, in the studies done by Asmussen and Shahafi (4) and Holmes et al. (9) it was stated that with the increase of composite post diameter and using binding factors in cementing, the distribution of stress in dentin becomes more desirable, it can be claimed that FRC post have similar elasticity coefficient with dentin and a consistent structure of post-dentin is created with the help of adhesive cements. So in cases in which using thicker post is inevitable, FRC post with more diameters does not result in root fracture and the created probable fracture is curable.

With the increase of FRC post, the resistance arm increases and so the fracture resistance increases too. In the present study, the fracture resistance has a significant relation with the relation between resistance and diameter increase.

The maximum fracture resistance was in a group which used FRC post with 12mm length and 1.5 mm diameter (1023±239.22). The minimum fracture resistance was also observed in FRC post with 7mm length and 1.5mm diameter (503.73N±69.18). Although among the studied groups, there was not a significant relation between fracture resistance and the simultaneous increase of length and diameter, it is quite clear that the reason why fracture resistance is more in the first group is that post length is more so according to Asmussen's study, stress distribution is more proper in this state. In the present study, the fracture resistance is within an acceptable range according to the fact that resultant occlusal forces even at the present of parafunction forces are between 254N and 632N.

Conclusion

Within the limitation of this study, it is concluded that:

1. Fracture resistance does not have significant relation with simultaneous increase of length and diameter of post.
2. As the length increases and FRC post diameter remains fixed, fracture resistance increases.
3. In fixed lengths, the increase of FRC post diameter does not have a significant effect on fracture resistance.

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