The Differences Fracture Resistance between Smooth and Serrated Type of Fiber Reinforced Composite Post

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Abstract
Purpose: to determine fracture resistance differences between smooth type fiber reinforced composite post and serrated types.
Methodology: the design of research is post test only control group design. The sample were 32 extracted mandibullary premolars treated endodontically crown down method with gutta percha and resin sealer. The tooth after root canal treatment is continued with the preparation of the post using precission drill. The samples divided into two group based: A. smooth type FRC post, B. serrated type FRC post. FracturSamples were loaded to failure with a Universal Testing Machine.
Results: there was a fracture resistance difference between smooth type of FRC post and serrated. Fiber reinforced composite type serrated is more resistance to fracture than FRC type smooth.

Introduction

Tooth fractures are often experienced in untreated necrotic teeth. In necrotic teeth, fractures often occur due to the loss of dentin integrity, moisture, and hardness. Tooth necrosis can be maintained in the mouth if proper root canal treatment (RCT) and restoration is performed. Trauma to young permanent teeth can cause root growth stopped so that the apical parts do not close and the root canals become wide. Preparation of root canal treatment can also cause the root canal walls become thin (Widyastuti et al., 2011). The use of a post is thought to strengthen the tooth root canal treatment and increase the resistance to tooth fracture (Karbhari and Strassler, 2007).

Fiber reinforced composite (FRC) posts have been recommended because it have modulus elasticity similar to dentin (Stewardson et al., 2010). Fiber reinforced composite post increased the distribution pressure by making the teeth more flexible when applied (Naumman et al., 2007). Fiber reinforced composite post by manufacture are divided into fabricated and prefabricated. Based on its taper, prefabricated post consist of parallel and tapered post (tappered), whereas based on its configuration prefabricated post consist of smooth and serrated post (Setyawati, 2012), see figure 1.

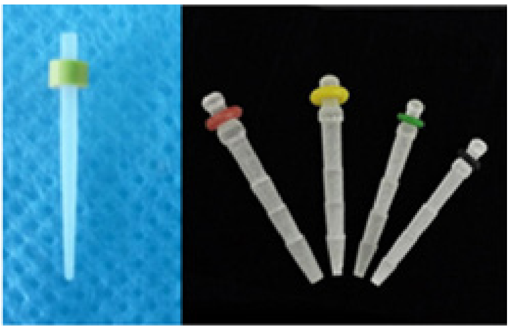

Figure 1. (a). smooth post, (b) serrated post

The serrated post has the advantage that the serrated post significantly improves post retention compared to the smooth post (Junlin, 2013). The serrated post acts as intermediate retainers and distributes pressure evenly through the root structure is also the most clinically successful post intracoronal strengthening, whereas the smooth post adapts to the anatomical shape of the root canal and is able to maintain the apical tooth structure (Triharsa and Ema, 2013) and (Sorensen,1984). The smooth post has a higher bending strength than the serrated post, although the elastic modulus is similar for the two posts (Braga et al., 2012).

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Failure after tooth restoration occurs in the event of root fracture (Testori et al., 1993) and (Wu et al., 2004). Tooth fracture susceptibility is restored with a post and is influenced by factors such as the amount of tooth structure remaining, which provides resistance to tooth fracture (Ng et al., 2006), as well as post characteristics such as material variety, modulus of elasticity, diameter, and length (Fokkinga et al., 2006).

Method

This type of research uses a laboratory experimental method with a research design posstest-only control group design. The study began with the selection of subjects using thirty two post extraction lower first premolars and stored in a saline solution. These teeth were selected to obtain teeth that were almost the same size and length, see figure 2. The coronal sections were cut so that the length of the teeth from apical to coronal was 16 mm. The tooth that has been cut is performed root canal treatment. All samples were prepared used the crown down technique with a rotary instrument file (ProTaper file) with a speed of 250 rpm. Each change of file numbers was irrigated with 2.5% NaOCL and 17% EDTA solution, then dried with papper points.

Figure 2. (a) premolar teeth will be crown cut, (b) root canal preparation

The object of the study that had been prepared then obturation using the single cone technique selected the ProTaper gutta percha according to the last measure of ProTaper used at the time of preparation. Rub the root canal walls using a lentulo that is rotated using a low speed handpiece in a clockwise direction until the entire root canal wall is coated with sealer paste. Then the root canal was obturated and temporarily restored with cavit. Each study subject was stored in an incubator 37º for 1 week and kept moist.

All study subjects (32 teeth) were made of post canal preparations by means of gutta percha taken using a heated plugger followed by a peeso reamer fitted with a stopper with a length of 10 mm. The remaining gutta percha is 5 mm. The length of the post was obtained from two thirds of the root length of the tooth (15 mm) which is 10 mm. In each group, the canal post preparation was carried out with a canal width of 1.4 mm used a peeso reamer that had been given a stopper started from the smallest size to the size of No. 4, followed by precission drills. The root canals were cleaned used sterile distilled water followed by EDTA 17% and then dried with a papper point.

The teeth were divided into two groups of group A (smooth type FRC post) the study subjects (16 teeth) were applied resin cement to the canal post used lentulo. The smooth type FRC post is inserted until it fully fills the canal post. Performed light cured for 20 seconds in a direction parallel to teeth. Group B (serrated type FRC post) the study subjects (16 teeth) applied resin cement to the canal post used lentulo. The serrated type FRC post is inserted until it fully fills the canal post. Performed light cured for 20 seconds in a direction parallel to teeth.

Figure 3. Implantation in an acrylic resin mold

Each research subject was planted in acrylic resin measuring 15 x 15 x15 mm, see figure 3. Cemento enamel jucntion (CEJ) is 1.5 mm above the acrylic resin which functions as the alveolar crest. The research subjects were planted in acrylic resin with a slope of 45°. After that the research subjects were kept for 48 hours so that the acrylic resin was completely polymerized.

Resistance test using universal testing mechine. Research subjects who have been immersed in block resin are placed in a mounting jig. The type of load is a static load that is placed in the middle of the tooth. The load application speed given is the crosshead speed, which is 1.0 mm / minute. The angle of application of the load is 45 ° to the tooth axis. The intensity of the load that is given starts from 0 N until the root of the tooth is fractured, the post is broken, and the post is released due to failure of cementation. The sample was tested for compressive strength using a Universal Testing Machine at a speed of 5mm / minute until the sample fractured. The monitor will show the maximum force value in Newton (N). This value is then entered into the formula $\sigma = F / A$ where F is the load (N), A shows the cross-sectional area (mm^2), σ is the fracture resistance (MPa), see figure 4.

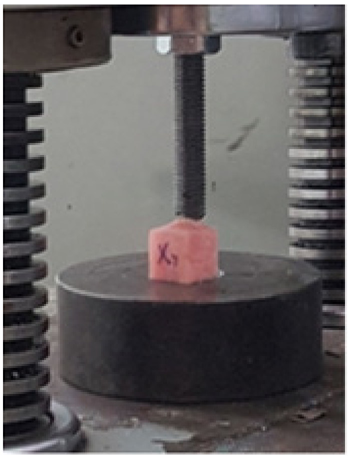

Figure 4. Testing using a universal testing machine

RESULTS AND DISCUSSION

Table 1. Mean values and standard deviation of fracture resistance (Mpa)

Group	N	$\overline{X}$ ±SD
FRC smooth	16	18,66±0,02
FRC serrated	16	19,92±0,02

n: Number of Samples   SD: Standard Deviation
$\overline{X}$: Average   FRC: Fiber Reinforced Composite

Furthermore, the normality test was carried out on the research data to determine that the sample came from a normally distributed population used Shapiro-Wilk. Analysis of the results of the Shapiro-Wilk normality test in both groups showed a p value> 0.05. Table 2. shows that the data in the two groups are normally distributed.

Table 2. Shapiro-Wilk normality test

Group	Sig
FRC tipe smooth	0,087
FRC tipe serrated	0,578

Sig: the level of significance

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Table 3. Levene's Test homogeneity

Levene's Test	
Sig.	0,219

Based on the results of the homogeneity test, there are similarities between data groups (p> 0.05), this indicates that the data obtained is homogeneous in each group. There are three requirements that must be considered in the parametric test, the measurement scale must be numeric, the data should be normally distributed, and the data variance must be homogeneous. It is known that all the requirements have been fulfilled, so an Independent t-test can be done to determine the difference in fracture resistance of fiber reinforced composite posts of smooth and serrated types with a significance level of 95% (α = 0.05) which is shown in Table 4.

Table 4. Independent t-test results

Group	Sig.
FRC tipe *smooth* FRC tipe *serrated*	0,000

The results of the independent t-test showed that the significance value of the t-test was 0.000 (p <0.05), meaning that there was a significant difference between the two treatments. These results are in accordance with the hypothesis, there are differences in the fracture resistance of fiber reinforced composite posts smooth and serrated types. The fracture resistance of fiber glass posts ranges from 18–20 Gpa (stewardson et al., 2013). The results of this study were known to have higher fracture resistance of serrated posts than smooth posts. In this study, the fracture resistance depends on the variations possessed by the tooth such as age, time after extraction, storage conditions of the tooth and things that affect the effectiveness of the FRC post, including the resin used. The factors affecting the occurrence of after post restoration root fracture after root canal treatment are influenced by the post shape or post configuration (Kishen, 2006) and (Nam et al., 2010)

The results obtained in this study were smooth post has less retention than serrated post type. This occurs because the excess serrated post with a serrated post configuration makes retention greater, whereas a smooth post with a smooth or flat post configuration reduces retention, making it easier for root fractures to occur. The serrated post configuration with discontinuous fibers can result in lower stiffness and thus prevent root fracture. A post with a smooth configuration has a higher post stiffness which makes it easier to fracture the root (Novais, 2016).

The assembly of the serrated post can prevent internal stress so that the possibility of root rupture occurs due to lower post pressure. Moreover, it also does not have a stretching effect which tends to cause root splitting and reduces the incidence of root fracture during cementation and functional loads (Yubhar, 1996). Serrated posts are well adapted to root canal shapes because serrated posts provide mechanical retention to the cement so that the bond between the post and the root canal wall is stronger than smooth post and less mechanical bonding to the cement. The mechanism of cement attachment to teeth is the exchange of calcium ions in dental dentin with carboxylate ions in cement. The cement bond with the root canal wall is not strong enough to cause root fracture easily.

Serrated posts act as intermediate retainers and distribute pressure evenly through the root structure and are successful in intracoronal reinforcement. Previous studies serrated post had less stress and showed a low frequency of root fracture, whereas the smooth post produced the greatest pressure on the apical which caused greater root fracture than the serrated post (Kapil et l., 2014). Serrated post more durable than smooth post and so serrated post can be used in the long term (Luthra et al., 2015) and (Seefeld et al., 2007). This supports the results of the study which showed that the fracture resistance of the serrated FRC post was greater than smooth FRC post.

Conclusion

Based on the theory above, it can be concluded that there is a difference in fracture resistance between smooth and serrated fiber reinforced composite posts. The fracture resistance of the serrated type fiber reinforced composite post was greater than that of the smooth type fiber reinforced composite post.

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