Comparison of Fracture Load and Flexural Properties of Fiber Reinforced Post and Respective Anatomical Fiber Post

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Abstract

The anatomic fiber post is a technique that can provide a close adaptation of the post to the canal wall and has properties similar to dentin. This can reduce the incidence of root fracture, which is appropriate for large, non-circular, and fragile root canals. This study compares the fracture load between anatomic and non-anatomic fiber posts in DT Light Post® (RTD Dental, Saint-Egrève, France) and FRC Postec Plus® (Ivoclar, Zurich, Switzerland). DT Light Post® (RTD Dental, Saint-Egrève, France) and FRC Postec Plus® (Ivoclar, Zurich, Switzerland) were used in this study. Each group of fiber posts (n=20) were divided into 2 groups (n=10): one for control, the other to imitate the conical shape of anatomic fiber posts. The test was carried out until the specimen broke using a three-point bending test machine (SHIMADZU, Kyoto, Japan). The data were analyzed using Shapiro-Wilk and independent T-test statistics. The results showed that the highest fracture load values (140.99 N) were in the anatomic DT Light Posts® group and the lowest force values (84.62 N) were in the non-anatomic FRC Postec Plus® group. The statistical increase of load to fracture of both anatomical fiber posts and statistical difference between commercial fiber reinforced post compared with anatomic fiber posts. However, the fracture load of both anatomic fiber post groups in this study was not significantly different. Anatomic fiber post could be used as alternative option to retain crown for extensive loss of tooth structure.

Keywords: *Anatomic fiber post, DT Light Post®, FRC Postec Plus®, Fracture load, Three-point bending test*

1. Introduction

The post and core are mostly used as a foundation to support the coronal restoration built on an endodontically-treated tooth. There are two main types of posts: metal cast post and fiber reinforced composite post (Alonso de la Peña et al., 2016; Fernandes et al., 2003; Asmussen et al., 1999). The ideal post shape should embrace the following concepts: a conservative canal preparation, a shape that is retentive and resistant to dislodgement, a minimal stress distribution to the remaining tooth structure and a good post design to approximate the canal walls. For optimal results, the post material should have properties closest to dentin (Assif et al., 1993). Unlike metal posts, the fiber reinforced composite posts have properties similar to dentin. Moreover, biting force distribution should be along the post itself to reduce the probability of root fracture in endodontically treated teeth (Biały et al., 2020; Plotino et al., 2007; Stewardson et al., 2010). The variations in root canal morphology, such as flared canals, elliptical or oval shaped canals, increase difficulties in endodontic and prosthodontic treatment. Those anatomies not only have uninstrumented areas but also unable to access the dentin surface for post cementation. Thus, post and core failure could occur. The importance of post adaptation is a key factor for successful restoration, which a metal cast post can achieve. An anatomic fiber post is another technique providing this adaptation of the post to the canal wall. It can also improve the mechanical and retentive properties of the post and core (Bonfante et al., 2007; Trope et al.,1985; Mitsui et al.,2004). Anatomic fiber posts can reduce thickness of cement layer (Rintanalert and Vimonkittipong, 2020; Teixeira et al., 2009). They combine the advantage of metal cast posts: good adaptation to canal wall, and the advantage of prefabricated fiber post: flexural properties similar to dentin.

2. Objectives

1) To compare the fracture load between anatomic and non-anatomic fiber posts of DT Light Post®
2) To compare the fracture load between anatomic and non-anatomic fiber posts of FRC Postec Plus®
3) To compare the fracture load between anatomic fiber posts of DT Light Post® and anatomic fiber post of FRC Postec Plus®

3. Materials and methods

Two groups of prefabricated fiber posts were used in this study. The first group was 20 pieces of DT Light Post® (RTD Dental, Saint-Egrève, France) 1.25 mm in diameter and 20 mm in length, and the second group was 20 pieces of FRC Postec Plus® (Ivoclar, Zurich, Switzerland) 1.35 mm in diameter and 20 mm in length. Each group consisted of 10 pieces of anatomic fiber post and 10 pieces of non-anatomic fiber post. All specimens were tested using Three-point bending test to measure the fracture load. Anatomic fiber posts were prepared from stainless-steel mold (figure 1), which had a 15 mm length with 2.5 mm diameter at coronal part, 1.75 mm diameter at middle part and 1 mm diameter at apical part. 30% Hydrogen peroxide solution was used to treat the surface of DT Light Post® for 5 minutes. 37.5% phosphoric acid was used to treat the surface of FRC Postec Plus® for 1 minute. All specimens were applied a silane coupling agent (Monobond® N, Ivoclar Vivadent AG, Schaan, Liechtenstein) for 1 minute and air dried. The internal surface of metal mold was applied separating media, then Multicore Flow® (Ivoclar Vivadent, Schaan, Liechtenstein) was injected to the mold and a fiber post was inserted inside Multicore Flow®, light-cured with output intensity of 1,100 mW/(cm)^2 for 40 seconds and stored in dry area at room temperature.

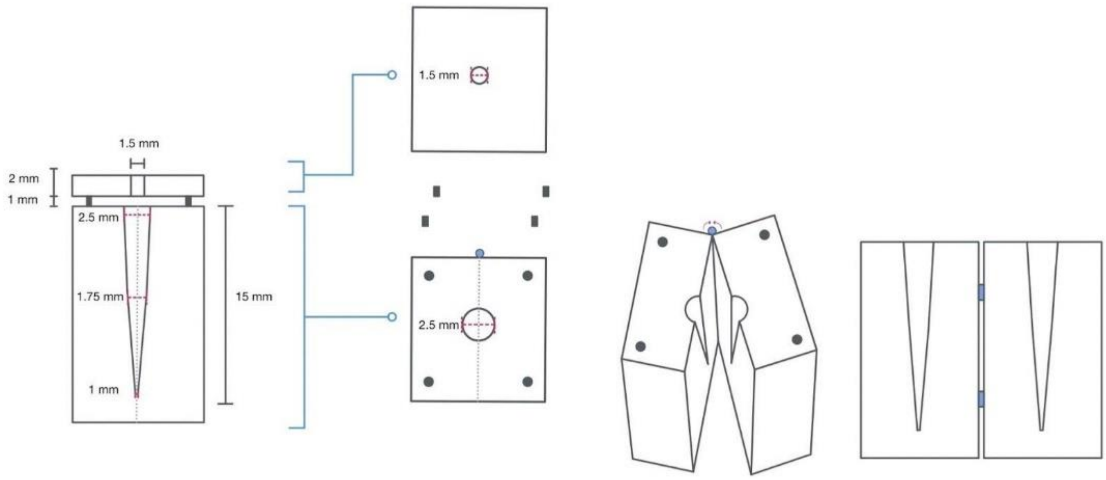

Figure 1 The stainless-steel mold size and diameter

A SHIMADZU machine was used for the Three-point bending test to measure the flexural properties of all specimens. According to the ISO 10477, A 500 N load cell with 1 mm/min speed was applied at the mid-point of the center of the specimen. The diameter of the supports was 2.0 mm. The length between two supports was 10.0 mm to assure testing only on the parallel portion of the post. In tapered posts, they were loading at midpoint of the post length.

Data analysis was performed using SPSS software (Statistical Package for the Social Science, SPSS Inc., Ill, USA). Statistically significant differences in this study were analyzed by SHAPIRO-WILK and independent t-test statistics.

4. Results and Discussion

4.1 Results

According to a three-point bending test, independent t-test revealed a significant difference ($p<0.05$). There were significant differences ($p<0.05$) in fracture loads between non-anatomic DT Light Post® and non-anatomic FRC Postec Plus®. The fracture load of the anatomic DT Light Post® group and anatomic FRC Postec Plus® group were not significantly different ($p>0.05$). The highest fracture load values (140.99 N) were the anatomic DT Light Post® group and the lowest values (84.62 N) were the non-anatomic FRC Postec Plus® group (table 1). The results from Table 1 found that there was a significant difference between two groups of non-anatomic fiber posts. Non-anatomic DT Light Post® group (1.25 mm diameter) was significantly higher than non-anatomic FRC Postec Plus® group (1.35 mm diameter) in fracture load (p<0.001). Whereas there was no significant difference in fracture load between two groups of anatomic fiber posts. When comparing between anatomic and non-anatomic fiber post groups, both groups of anatomic fiber posts had significantly higher than non-anatomic fiber posts in fracture load (p<0.001).

Table 1 Mean fracture load and standard deviation between anatomic fiber post and non-anatomic fiber post

Post		Fracture load (N)	
Anatomic fiber post			
DT Light Post®		140.99±9.61	
FRC Postec Plus®		137.94±11.79	P<0.001
Non-anatomic fiber post	P<0.001		
DT Light Post® Ø1.25		111.57±3.54	P<0.001
FRC Postec Plus® Ø1.35		84.62±2.80	

4.2 Discussion

Fracture load is the load placed upon a structure or test piece which is exactly sufficient to break it. The fracture load from the result, non-anatomic DT Light post was significantly higher than non-anatomic FRC Postec Plus, which corresponds with the difference of diameter of two types of fiber posts. In this study, the DT Light post and FRC Postec Plus, which are different in diameter was used. The DT Light post has a smaller diameter than FRC Postec Plus. We may state that the fiber post with a smaller diameter had a higher fracture load than the fiber post with larger diameter. The result was conformed to previous studies (Monticelli et al., 2006; Warangkulkasemkit and Pumpaluk, 2019; Boksman et al., 2011). The fracture load of prefabricated fiber posts appears directly proportional to density of fibers and their interface to the matrix (Boksman et al., 2011). Many studies showed that quartz fiber posts are higher fiber loading with no void in matrix. Whereas glass fiber posts had lower fiber and high resin matrix content (Monticelli et al., 2006; Warangkulkasemkit and Pumpaluk, 2019; Boksman et al., 2011). Some studies proved that quartz fiber posts were superior to glass fiber posts in higher resistance to loading stress (Boksman et al., 2011). However, Zicari et al. (2013) revealed that the fracture load of the fiber post depends on types and diameters of the fiber post. Fiber posts with a larger diameter had higher loading resistance than fiber posts with a smaller diameter. In some cases, the structure of the fiber post does not affect the value of fracture load. This may result from voids at the interfacial adhesion between fiber and resin matrix. As a consequence, sizes and defects from the manufacturer can decrease the value of fracture load of fiber post. The result from our study, both groups of anatomic fiber posts were not significantly different in fracture load. These results may be according to the properties of Multicore flow integrated in anatomic fiber posts, played an important effect on the properties of both groups. According to Warangkulkasemkit and Pumpaluk (2019) mechanical properties of composite core build-up materials depended on types and filler. Multicore flow consists of barium glass and silicon dioxide fillers. There are lower filler loads than the other core built-up materials. When the composition of Multicore flow was combined to non-anatomic fiber posts, they showed the higher fracture load in both groups of anatomic fiber posts. Therefore, the higher fracture load in anatomic fiber posts could be a consequence from Multicore flow although they had different types of non-anatomic fiber posts inside this material.

Therefore, the higher value of fracture load in anatomic fiber posts could be a consequence from Multicore flow.

This study found that the anatomic fiber posts, with higher fracture loads, can resist deformation better than the non-anatomic fiber posts. Therefore, anatomic fiber posts withstand more biting force before breaking. In case of extensive loss of tooth structure, this finding will be beneficial for patients. However, the fracture load of anatomic fiber posts was not as high as that of metal cast posts. The probability of root fracture is also associated with the fracture load. Thus, root fracture from anatomic fiber posts should be less frequent than those from metal cast posts.

5. Conclusion

From this study, an anatomic fiber post in each group had a higher fracture load than a non-anatomic fiber post. An anatomic fiber post can be used as an alternative option to retain a crown in extensive loss of tooth structure. An anatomic fiber post has good adaptation to root canal wall and might decrease the incidence of vertical root fracture, which can lead to restorative failure. In this study, fracture loads were tested. Further study investigating other properties of anatomic fiber post should be conducted.

6. Acknowledgements

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