10.5005/jp-journals-10051-0116

ORIGINAL RESEARCH

Assessment of Fracture Resistance Capacity of Various Post Systems in Endodontically Treated Teeth: *In vitro* Study

[1]Dennis Mohan, [2]Joseph Joy, [3]Civy V Pulayath, [4]Mathews Baby, [5]Anoop Samuel, [6]Vimal Remy

ABSTRACT

Introduction: Endodontic therapy of a tooth results in changes in the physical and chemical properties of the tooth. The elasticity and fatigue resistance of dentin are altered. There is also an alteration in the biomechanical behavior and morphology of the tooth, including loss of proprioception. It is advisable to place an intraradicular post that strengthens the teeth while treating them.

Aim: The present study aimed to assess the fracture resistance capacity of various post systems in endodontically treated teeth.

Materials and methods: Freshly extracted 60 single-rooted first premolars which were free of caries and with approximately the same root length were selected. The random samples were collected and allocated to three research groups, such as group I: Teeth with prefabricated metal post, group II: Teeth with prefabricated glass post, and group III: Teeth with prefabricated zirconia post. Biomechanical preparation was manually performed by using step-back technique and stainless steel K-type files. Peeso reamers were used to create post space and post were placed. In order to calculate the compressive strength, Universal testing machine was used in this study.

Results: The mean compressive strength of zirconia posts was 720.42 ± 27.276, followed by glass posts, i.e., 688.60 ± 32.118, and metal posts, i.e., 592.33 ± 28.416, and there was highly statistically significant difference between the groups.

Conclusion: The present study concluded that fracture resistance was more in zirconia posts than metal as well as glass posts in the teeth that have undergone endodontic therapy.

Keywords: Prefabricated post, Root canal-treated teeth, Stress, Universal testing machine.

How to cite this article: Mohan D, Joy J, Pulayath CV, Baby M, Samuel A, Remy V. Assessment of Fracture Resistance Capacity of Various Post Systems in Endodontically Treated Teeth: *In vitro* Study. Int J Oral Care Res 2017;5(4):282-285.

Source of support: Nil

Conflict of interest: None

[1,3,5]Reader, [2,4,6]Senior Lecturer

[1]Department of Conservative Dentistry and Endodontics Pariyaram Dental College, Kannur, Kerala, India

[2]Department of Conservative Dentistry and Endodontics, Mar Baselios Dental College, Ernakulam, Kerala, India

[3]Department of Public Health Dentistry, Malabar Dental College & Research Centre, Malappuram, Kerala, India

[4]Department of Public Health Dentistry, Mar Baselios Dental College, Ernakulam, Kerala, India

[5]Department of Conservative Dentistry and Endodontics, Noorul Islam College of Dental Science, Thiruvananthapuram, Kerala India

[6]Department of Conservative Dentistry and Endodontics Kannur Dental College, Kannur, Kerala, India

Corresponding Author: Dennis Mohan, Reader, Department of Conservative Dentistry and Endodontics, Pariyaram Dental College, Kannur, Kerala, India, e-mail: drdennismohan@gmail.com

INTRODUCTION

Endodontically treated teeth present a high risk of biomechanical failure due to the loss of tooth structure resulting from preexisting decay and endodontic therapy itself. Better results are obtained with placement of intraradicular posts for the retention of artificial crowns which support the teeth by distributing the intraoral forces along the roots. Different post systems have been proposed over the years, from the early cast metallic posts to the prefabricated metallic posts or the more recently introduced translucent fiber posts.[1]

Endodontically treated teeth with extensive loss of coronal structure can be problematic because of more reduction in their capacity to resist functional forces. The fractures that are common among the teeth that have undergone root canal therapy are vertical crown and root fractures.[2]

For many decades, custom or prefabricated metal posts were widely used and considered the gold standard due to their superior mechanical properties. But, metal posts had many disadvantages, such as the high incidence of catastrophic root fracture,[3] corrosion, inflammatory reaction, discoloration, and shadowing on the periodontium in the anterior esthetic region.[4]

In a recent study, the problems with the overflared canal reinforcement can be solved by a newly released novel, direct, and anatomically adjustable glass fiber-reinforced everStick post. This post is a minimally invasive, soft, flexible polymer of polymethyl methacrylate, and resin-impregnated bisphenol A glycidyl methacrylate (bisGMA) uncured glass fiber post. It can be customized and it will be closely adapted to the structure of the root canal giving the best choice for flared, oval, and curved canal. Their flexural strength and elasticity are nearly similar to the dentin, thus an equal distribution of occlusal stresses along the root surface will evenly minimize the risk of root fracture.[5]

Zirconia posts have a high percent of silica. Zirconia fibers embedded in the polyester matrix for strength with flexibility are close to natural dentin. The advantages of a zirconia post are many, to name a few, it has a higher filler ratio of 60%, is white in color, and has high light transmissive properties.[6]

Both metallic and nonmetallic materials are used to build cores. In earlier years, amalgam was popular and in later times cements like glass ionomer and modified ionomers were used; now improved high-strength composite resins are being used to build cores.[7] Hence, the present study was performed to assess the fracture resistance capacity of various post systems in endodontically treated teeth.

MATERIALS AND METHODS

This study was carried out on freshly extracted 60 single-rooted first premolars which were free of caries and with approximately the same root length and these were selected. All teeth were carefully examined by using a stereomicroscope under 10× magnification to confirm that they were free of cracks. A total of 60 sample teeth were randomly allotted to three study groups (n = 20).

Group I: Teeth with prefabricated metal post
Group II: Teeth with prefabricated glass post
Group III: Teeth with prefabricated zirconia post

Preparation of Sample Teeth

All the teeth samples were decoronated 2 mm above the cementoenamel junction. Preparation of a 1-mm-deep chamfer finishing line with a 2-mm ferrule was done. Biomechanical preparations were manually performed using stepback technique and stainless steel K-type files. A no. 30 K-file was used as the master apical file and Gates Glidden drills no. 2 through 4 were used for coronal flaring. Paper points were used to dry the root canals and canals were obturated using lateral compaction of gutta-percha using resin sealer. Sealer was introduced into the root canal using a Lentulo spiral instrument. Gutta-percha points were coated with the sealer and placed in the root canals to the working length. All the specimens were stored in distilled water at 37°C for 24 hours, following which the teeth were mounted in a block of acrylic resin measuring 2 cm in diameter at cementoenamel junction.

Post Space Preparation

Piezo reamers were used to remove the gutta-percha from the cervical aspect of the root canal. Post spaces were prepared for all the 60 teeth. From the cut tooth surface that was taken as the reference point, the post space was standardized measuring 10 mm deep. Post space was prepared using special preparation drills provided by the manufacturer.

Core Buildup

Light-cured composite resin was used for core buildup consisting of hybrid bisGMA composite resin. It has a filler content by weight of 80% and filler particle size of 2 to 5 mm. It is radiopaque.

Testing of the Samples

Each sample was mounted and positioned in an acrylic block with their longitudinal axis perpendicular to the load direction. Specimens were loaded in the universal testing machine for measuring the physical properties. A custom-made loading plunger was used to load the specimens at 90° to the long axis and 2 mm from the tooth–core interface with a crosshead speed of 0.5 mm/min until primary failure occurred.

Statistical Analysis

Statistical analysis was done using Statistical Package for the Social Sciences version 20.0. Fracture resistance capacity of various posts was analyzed using one-way analysis of variance and Tukey's *post hoc* test and it is considered statistically significant when p-value was less than 0.05.

RESULTS

Different posts and their manufacturer details are mentioned in Table 1. Each type of post was placed in 20 specimens and checked for their fracture resistance capacity.

Table 2 shows the comparison of different posts for mean compressive strength. The maximum fracture resistance capacity was found in the zirconia posts (720.42 ± 27.276) followed by glass posts (688.60 ± 32.118), metal posts (592.33 ± 28.416), and there was highly statistically significant difference between the groups.

Statistically significant difference was found between metal posts and glass posts, metal posts and zirconia posts, glass posts and zirconia posts (Table 3).

Table 1: Different posts used in the study

Post system	*Company*	*N*
Metal posts	Coltene Whaledent	20
Glass posts	Coltene Whaledent	20
Zirconia posts	Snow posts—Danville	20

Table 2: Comparison of different posts for mean compressive strength

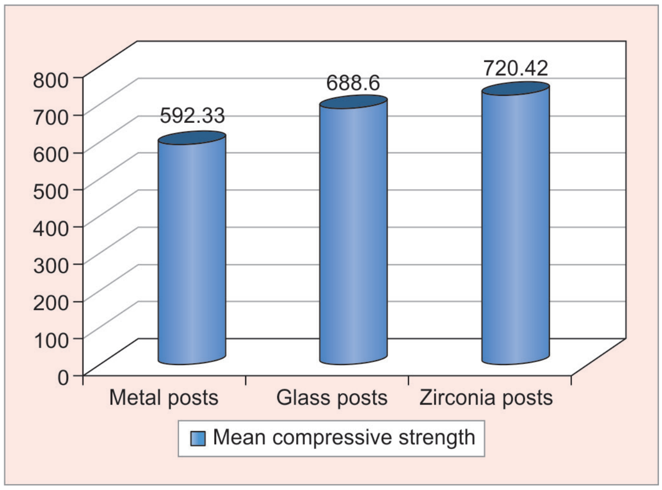
Posts	*Mean*	*Standard Deviation*	*F value*	*p-value*
Group I—Metal posts	592.33	28.416		
Group II—Glass posts	688.60	32.118	54.242	0.0001***
Group III—Zirconia posts	720.42	27.276		

***Highly significant

Table 3: Multiple comparisons using Tukey's *post hoc* test

Posts	*Compared with*	*Mean difference*	*p-value*
Metal posts	Glass posts	88.46	0.0001***
	Zirconia posts	104.60	0.0001***
Glass posts	Zirconia posts	36.42	0.004**

**Significant; ***Highly significant



Graph 1: Mean compressive strength among different posts

Graph 1 shows the mean compressive strength among different posts. It can be observed that zirconia posts showed the maximum mean compressive strength and the metal posts showed the least compressive strength among the three posts.

DISCUSSION

Several studies in the past have proven that the cervical region of the endodontically treated teeth, mainly the single rooted teeth, is the region of greatest stress generation due to the angular forces acting at that particular area and also[8,9] due to less surface area for dissipation of forces. It is controversial whether the post reinforces the tooth or weakens the tooth. However, in this study, we have used different posts to check the fracture resistance capacity.

There has been a tremendous interest in fiber-reinforced posts in the dental literature, with numerous studies focusing on post materials, luting agents, post designs, and ferrule effects to investigate the fracture resistance of these materials.[10] In the present study a less mean fracture resistance capacity of the metal post is shown. Some studies,[10,11] contrary to the present study, indicated that endodontically treated teeth restored with fiber-reinforced posts exhibited lower fracture resistance compared with teeth restored with other posts, such as those composed of metal. Similarly, some investigators found that the fracture resistance of endodontically treated teeth which are restored with fiber-reinforced posts is equal to or greater than those teeth restored with metal posts.[12,13] A few authors concluded that posts are not necessary in endodontically treated teeth with minimal loss of tooth structure. It is also uncertain whether fiber-reinforced posts strengthen endodontically treated tooth during clinical service.[14]

The present study shows 688.60 N as the mean compressive strength of glass post; this finding agrees with those of Kivanç et al[15] and Bolay et al[10] who recorded 938.4 and 705.5 N, respectively, and is in contrast to the study by Maccari et al[16] who reported 136.3 N with the use of glass fiber-reinforced resin post. These conflicting results may be due to variations in methodology, sample sizes, the biochemical composition of human extracted teeth, canal morphology, and physical and chemical properties used in this study.

In the present study, zirconia post shows maximum fracture resistance. Meyenberg et al[17] stated that zirconium posts are quite rigid, with a modulus of elasticity higher than stainless steel and it possess high flexural strength and fracture toughness. But Dietschi et al[18] report zirconia post has lower fracture resistance than metal posts and poor resin-bonding capabilities of the post to radicular dentin.

CONCLUSION

In conclusion, zirconia posts show more fracture resistance than metal and glass posts in endodontically treated teeth.

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