International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb- 2024 pp 177-179 www.ijdmsrjournal.com ISSN: 2582-6018

Fracture Resistance of different Post and Core System: Impact of Material Type

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Date of Submission: 10-01-2024 Date of Acceptance: 20-01-2024

ABSTRACT
Objective: To evaluate the farcture resistance of mandibular premolars restored bypolymer-infiltrated ceramicand fiber reinforced composite resin posts.
Materials and methods: Fourty mandibular first premolars werebe collected. Teeth were beselscted with nearly homomgenous dimensions and morphology without any root abnormalities. The speicmens were divided into two groups (n=20) according to the post material:group RF; Ready-made fiber posts with composite core, group CV; Custom made Vita Enamic posts and cores. All teeth were be endontically treated and prepared to receive posts, The gutta-percha was removed from the root canals of teeth to a depth of 10 mm. Teeth were sectioned 2 mm above the cemento-enamel junction. For CV group, impression was be taken and scanned by a laboratory scanner and the image converted to CAD/CAM for milling the posts and cores, all posts were be cemented by self-adhesive resin cement. Each tooth was prepared to receive zirconia crown, then all samples were subjected to fracture test using universal testing machine.
Results: There was a significant difference (p=0.004) between the two groups as regard to fracture resistance.
Conclusions: Restoration of endodnticaly treated mandibular premolars with ready-made fiber reinforced composite resin posts enhanced their fracture resistance rather than CAD/CAM Vita Enamic.

I. INTRODUCTION

Endodontically treated teeth are generally more susceptible to fracture as a consequence of moisture loss and considerable destruction of tooth structure.[1] Endodontically treated teeth with extensive destruction require a post to provide retention for the core and restoration.

A variety of materials have been used for the manufacturing of dental posts, the ideal post would provide core retention without creating unwanted stresses within the residual tooth structure.[2] Fiber posts have become more popular in the dental industry due to their advantages in terms of ease of manipulation, mechanical properties, aesthetics, and removability, which provide predictable clinical performance.

Ceramics have excellent mechanical and biocompatibility properties, however they are rigid and hard to repair. On the other hand composite are easy to manipulate and more flexible. So, Hybrid ceramics (polymer infiltrated glass ceramics) seek to combine the optical and mechanical properties of ceramics and composite resins, two of the most used materials in restorative dentistry.[3]

Fracture resistance is defined as the ultimate stress nescessary to cause fracture or plastic deformation and is strongly affected by type of material.[4]

To date, few studies have evaluated the fracture resistance of the teeth restored by polymer infiltrated glass ceramicspost and core. Therefore, there is a need for further studies to determine the most beneficial post and core system.

The objective of the current study is to evaluate the farcture resistance of mandibular premolars restored bypolymer-infiltrated ceramic,and fiber reinforced composite resin posts.

II. MATERIALS AND METHODS

Fourty extracted mandibular premolars free of cracks and caries were collected.The length of teeth was measured from the occlusal tip of buccal cusp to the root apex by using digital caliperand the selected teeth were with average length 21 ±1 mm. Teeth were randomly divided into two groups according to post material: Group 1: (RF); Ready-made fiber Posts, Group 2: (CV); Custom made Vita Enamic posts and cores.

Teeth were endodontically treated. All teeth wereobturated with lateral condensation technique.Teeth were examined by X-ray to

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For RF group, the posts were cemented using self-adhesive dual-polymerized cement. The cores were built upwith a dual-polymerizing conventional adhesive composite resin.

After cemntation of all posts and cores, the coronal preparation was performed, then the samples were scanned using a laboratory scanner to obtain a digital 3D model. The ceramic crowns were fabricated for all specimens in zirconia. Zirconia crowns werecemented with self-adhesive dual-polymerized cement Multilink Speed.

For the fracture resistance mechanical test, the speicmens were placed in a universal testing machine. The force was loaded was applied at acrosshead speed of 1 mm/min with a custom chisel head (size 6 mm). The force was applied at an angle of 45° to the long axis of the crown on the the protuberance of the buccal cusp.

III. RESULTS

One-way ANOVA test demonstrate that there was significant difference (p=0.004) between the two groupsregards to fracture resistance Table 1.

Table 1. Descriptive analysis of fracture resistance between RF and CV

	RF	**CV**	**test of significance**
	n=10	n=10	
Mean ± SD	494.37±75.88	403.60±33.82	t=4.11 p=0.004*

Group1: RF, Group 2:CV,
t: Student t test, *statistically significant (if p≤0.05)

esthetic material, they found that the hybrid ceramic, and experimental epoxy resin reinforced by glass fiber did not differ from each other.

The finding of this study come in agreement with the results obtained from the study of **Mosharrafet et al(2017)**[8]which compared the fracture resistance and failure modes of endodontically treated teeth restored, they found that the fiber post and composite core group has mean fracture resistance was (416.5±81.58 N).

The results of this study come in agreement with the results obtained from the study of **Teixeira et al(2020)**[9]who evaluate the fracture resistanceof custom-made post-and-cores manufactured with different esthetic material, they found that the mean fracture resistance of the fiber post and composite core group was (449.6 ± 66.5 N).

A systematic review and meta-analysis by **Jurema et al (2022)**[10] showed that use of fiber post for restoration of endodontically treated teeth confirm that canal was fully obturated.Theteeth were placed in a dental surveyor attached to the vertical axis, perpendicular to the ground, they were then inserted into a model tube containing cold cure acrylic resin.

Specimens were resected 2 mm coronal to cementoenamel junction. Post space was adjusted at a length of 10 mm, the desired post length and diameter 1.6 mm. The length was obtained by initially removing the gutta percha leaving at least 5-6 mm of apical seal of gutta-percha.

Impression of post and core spaces were taken with light viscosity silicone-based impression material. The resulting standard post and core pattern were scanned using a laboratory scanner (DOF Edge 3D Scanner, Korea) to obtain a digital 3D model, and the data were transformed into a standard template library.

After finishing the design of post and core for the CV group, the mill command was given to a CAD\CAM milling machine to begin the milling. For the milled VITA Enamic group, the post and core were cemented using self-adhesive dual-polymerized cement.

IV. DISCUSSION

The successful restoration of the endodontically treated teeth continues to be one of the most challenging procedures in dentistry. Endodontically treated teeth with extensive destruction require a post to provide retention for the core and restoration.[5]

Dietschi et al (2007)[6] found that the strength experienced by a tooth would be better distributed along the root with a material whose elasticity modulus is closer to natural structures.

In vitro testing was used because it over comes the many drawbacks associated with clinical testing such as individual variation by creating a controlled environment. Fracture resistance test was chosen in this study as it is the important factor that determine the durability and success of the restoration.

In contrast to our study **Spina et al (2017)**[7] evaluate the fracture resistance of custom-madepost and core manufactured with different

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increased their fracture resistance. They attributed this improvement to better stress distribution in tooth structure. Stress is accumulated at the cervical part of the teeth that have lost a large portion of their structure due to extensive caries and endodontic treatment. Thus, fiber post placement aids in better stress distribution and higher fracture resistance.[11]

In contrast to our study **Bittner et al (2010)**[12] state that the clinical performance of restorations machined by CAD/CAM provides a post and core with durability. As in our study ready-made fiber post provide fracture resistance higher than milled fiber and milled Vita Enamic.

For the ready-made fiber post and composite core, they achieved good performance, they captured the anatomy of the root canal Thus, good post adaptation was found to increase frictional retention, thereby resulting in a better performance.

V. CONCLUSIONS

Within the limitations of this in-vitro study, it was concluded that

1- Restoration of endodnticaly treated mandibular premolars with ready-made fiber reinforced composite resin posts enhanced their fracture resistance rather than CAD/CAM Vita Enamic.

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