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Comparative Evaluation of Fracture Resistance of Endodontically Treated Premolar Restored With Different Fibre Post System

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Abstract

Aims: The aim of this study is to determine and compare the fracture resistance of endodontically treated teeth restored with different fibre reinforced post system.

Materials and Method: A total number of 45 non-carious, single rooted human mandibular premolar teeth were selected, which were extracted for orthodontic and periodontal purpose only. After decoronation, single cone obturation and post space preparation Teeth were randomly allocated into 3 groups. Group A: Zirconia modified cylindrical fibre post (n=15); Group B: Tapered Glass fibre post (n=15); Group C: Double tapered fibre post (n=15). The different fibre post systems were cemented with paracore dual cured resin cement. Each specimen was mounted in acrylic block. Compressive loading was applied using Universal testing machine at a speed of 1mm/min in Apical direction till fracture. The fracture load was measured in newtons and converted to megapascals.

Results: Statical analysis was done. Fracture resistance of human mandibular premolar teeth restored with zirconia modified cylindrical post system (Dentsply Easypost) has highest fracture resistance among the groups tested and statistically significant than the other

groups. teeth restored with double tapered glass fibre post (Angelus Exacto) has lowest fracture resistance among the groups tested.

Conclusion: Within the parameters and limitations of this study it may be concluded that Fracture resistance of human mandibular premolar teeth restored with zirconia modified cylindrical post system (Dentsply Easypost) has highest fracture resistance among the groups tested.

Keywords: Fibre post, Fracture Resistance, Zirconia Modified post, Universal Testing Machine

Introduction

Restoration of the mutilated endodontically treated tooth is a subject that has been evaluated and discussed widely in dental literature. The endodontically treated tooth is a unique subset of teeth requiring restoration due to the loss of the tooth structure, the changed physical characteristics by the altered collagen cross Linking. [1] A post and core are a type of dental restoration required where there is an inadequate amount of sound tooth tissue remaining to retain a conventional crown.

The role of the post is firstly to retain a core restoration and crown, and secondly to redistribute stresses down onto the root, thereby reducing the risk of coronal fracture.[4] Retention form is associated to prepare geometry including post's taper, length and diameter, surface texture, luting agent and passivity A post is cemented into a prepared root canal, which retains a core restoration, which retains the final crown.[5] Fibre reinforced composite posts has a high percentage of continuous reinforcing fibres in polymer matrix of epoxy resin.

Resin cements are usually used for bonding of FRC posts to root canal walls. FRC materials are characterised by better functional and structural design, their mechanical properties can be tailored until it meets those of dentine and allowing the use of minimally invasive and adhesive techniques to preserve tooth structure during the restoration of ETT. [12] These posts are made of carbon, quartz or glass fibre embedded in a matrix of epoxy or methacrylate resin. The adhesion between quartz or glass fibres and resin matrix is enhanced by fibre salinization prior to embedding.[10] The fibres provide strength and stiffness, while the polymeric matrix keeps the fibres together in the composite structure, protects them from the environmental harm due to elevated temperature and humidity and acts as a load transfer medium between them. Fibres represent the largest volume (from 40 to 65 vol%), contribute stiffness and strength to the matrix and determine the load-bearing capacity of FRCs structure.[14]

Presence of zirconia reinforced fibres aids in the strength of the fibre post system. The use of innovative fiberglass, associated with an appropriate polymer matrix, results in post translucency and high aesthetic qualities to the final restoration.[13] Zirconia is a white metal; it's flexural strength may reach 1000 Mpa while the fracture toughness of 4-5 MPa is also superior to the regular dental ceramics. One characteristic of zirconia is especially this high resistance to fractures because the tetragonal beads are transformed from the monoclinic phase, which leads to thermo-compression of the forces around the defects, preventing their propagation.

Aims and Objective

The aim of this study is to evaluate the fracture resistance of endodontically treated teeth restored with different post core system. The objective of this study is to find which type of post and adhesives is better for endodontically treated teeth having comparatively higher resistance to fracture.

Materials and Method

After approval from the institutional ethical committee the study was conducted. A total number of 45 non-carious, single rooted human mandibular premolar teeth

were selected, which were extracted for orthodontic and periodontal purpose only. Teeth with fully formed apices, absence of calcification and having straight root canal were selected. The extracted teeth were cleaned of calculus and soft-tissue remnants employing an ultrasonic scaler (Fig 4.12) and were disinfected using 5.25 % sodium hypochlorite (Fig 4.13) for at least 30 min and rinsed with distilled water.

All selected teeth were decoronated perpendicular to the long axis of the tooth by using diamond disc and air water spray coolant. The decoronation was done near the cemento-enamel junction to establish a uniform length of 16 mm of all the teeth. Length of all teeth were measured by digital callipers.

A 10k (Mani, Japan) file was placed in the canal so that the tip is visible at the apical foramen. The working Length was set 1 mm short of apex. Apical enlargement was done till 15k followed by 20k hand file. During instrumentation 2ml of 5.25% sodium hypochlorite was used for irrigation. Biomechanical preparation was done using Protaper Gold file system till F3 file. Final irrigation was done with 17% EDTA solution.

Once the canals were prepared, they were dried by paper points. AH Plus sealer was used for obturation of the root canal system. Obturation was done using single cone technique. Post space preparation was done till no 4 size peeso reamer (1.3 mm diameter) up to 10 mm working length from the canal orifice, leaving 5mm of gutta percha inside. The post space was irrigated with 17% EDTA and rinsed with normal saline. The samples were air dried.

All the 45 human mandibular premolar samples were randomly divided into 3 groups according to the different type of fibre post systems used.

Group A: Zirconia modified cylindrical fibre post (n=15); Easy Post (Dentsply Maillefer)

Group B: Tapered Glass fibre post (n=15); Rely X fibre post (3M ESPE)

Group C: Double tapered fibre post (n=15); Angelus Exacto fibre post system

Figure 1: Testing of samples under Universal Testing Machine

After post space preparation paracore dual cure resin cement was used for cementation of the post. 4 mm uniform length of post coronal to cervical margin of the tooth was kept for uniform core build up. Each specimen was mounted in a 19x 19mm x 20 mm acrylic block. Compressive loading was applied at a speed of 1mm/min plunger tip size 1mm in Apical direction. Fracture load was recorded in Newtons and Converted to Megapascal.

Results and Statistical Analysis

Statistical analysis was done using one way analysis of varience (ANOVA) and post hoc Tukey's HSD test. The descriptive statistics for Fracture strength (in MPa) are presented in Table 1. Group A had the highest mean shear bond strength of 587 ± 17.3 MPa, with a range of 566 to 620 MPa, while Group B showed a lower mean of 459 ± 16.6 MPa and a range of 427 to 485 MPa. Group C demonstrated a mean of 392 ± 14.5 MPa, with values ranging from 372 to 412 MPa.

Table 1: Descriptive statistics of the Fracture resistance (in MPa)

Groups/Descriptive summary	Number of values	Mean	Std. Deviation	Minimum
Group A	15	587	17.3	566
Group B	15	459	16.6	427
Group C	15	392	14.5	372

Table 2: Inter-Group Comparisons of the Fracture resistance (in MPa) as seen in the ANOVA table

ANOVA table	SS	DF	MS	F (DFn, DFd)	*P* value [a]
Treatment (between columns)	1025349	3	341783	F (3, 56) = 1347	<0.0001*
Residual (within columns)	14212	56	253.8		
Total	1039561	59			

Fracture resistance of human mandibular premolar teeth restored with zirconia modified cylindrical post system (Dentsply Easypost) has highest fracture resistance among the groups tested and statistically significant then the other groups.

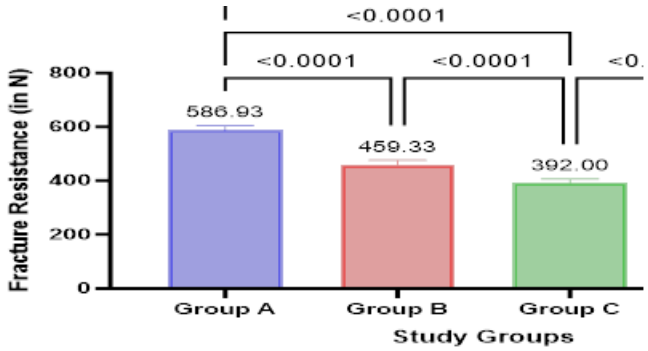

Figure 2: Inter-group Comparisons of the Fracture Strength (in MPa)

Discussion

In this present in vitro study, human mandibular premolar teeth were chosen as they are more susceptible to trauma and receive more angular forces.[36] Hence, they were selected to represent the best possible option to simulate the clinical situations.

ProTaper Gold [Dentsply Tulsa Dental Specialties, Tulsa, USA. File system was chosen for root canal preparation in this study for its unique design, greater cutting efficiency and lesser extrusion of debris apically. ProTaper Gold [Dentsply Tulsa Dental Specialties, Tulsa, USA] is a new heat-treated NiTi rotary system. ProTaper Universal was the first system to offer active cutting edges, a progressively tapered design on a single file, and both Shaping and Finishing files. ProTaper Gold [PTG] has the exact geometries as ProTaper Universal, but fortuitously has been metallurgically enhanced through heat treatment technology [21]. They were developed with proprietary advanced metallurgy and have a progressively tapered design that is claimed by the manufacturer to enhance cutting efficiency and safety.

The Easy Post group (Group A) showed high fracture resistance than other groups tested, this may be attributed to the close elastic modulus of Easy Post to dentin that flexes together under loading force. Presence of zirconia reinforced fibres aids in the strength of the fibre post system. Also, the dentin-like behaviour of the post facilitates better stress distribution and yielding high fracture strength values[29]. An in vitro evaluation of fracture strength of endodontically treated teeth with different fibre post system have acted as a stress breaker for the system under compressive loading. This effect was reported for root reinforcement with composite resin, which resulted in the transfer of low levels of stress to the cervical region of the tooth.

J K Prajapati et al (2024) concluded that ultraconservative posts (size 0) of Hi-Rem and Easy Post had greater fracture resistance than conservative posts (sizes 1 and 2). Furthermore, size 0 Hi-Rem posts performed marginally better than size 0 Easy Post. Favorable fractures are most common with both Hi-Rem and Easy Post.[24] The results of this study are similar with our study.

The results of this study are similar to T M Belgati et al (2018) where the author found easy post to have superior fracture resistance then that of ever stick fibre post. Sirimai and Sidoli demonstrating no root fractures for fibre post. [23] The results of this study are similar with our study.

Exacto Post group (Group C) showed approximately half the fracture strength of teeth restored with zirconia modified posts. This lower fracture strength compared with the values of with zirconia modified posts. may be attributed to the displacement or fracture of the resin cement layer, composite core, or resin post during mechanical testing. Material property of the post has been shown to affect the stress distribution.[28]

M Chirila et al (2016) The fracture resistance of the teeth endodontically treated and restored with FRC posts, respectively Exacto and Reforpost (Angelus), did not register statistically significant differences.[28] which is in agreement with our study.

A Jayasenthil et al (2016) conducted a study was to relate the fracture resistance of endodontically treated teeth in relation to post geometry. They concluded that The Parallel design had lesser number of catastrophic failure and had better fracture resistance. Teeth restored with Reforpost showed highest fracture resistance followed by Parapost and Exacto conical.[28] which is in agreement with our study.

Therefore, from this study it can be agreed that the fibre post has characteristics simulating natural dentinal structure than any other previously used post and it acts as a shock-absorber, dissipating much stresses on the finished restoration with small fraction forces to dentinal walls thus demonstrating restorable fractures. The composite core has excellent adaption and forms strong bond to remaining tooth structure, bondable posts, resin cements, and ultimately the final restoration creating the Monoblock. In addition, it is aesthetic, simple and predictable[25] bonding every component directly or indirectly thus reinforces the intra-radicular tooth structure with excellent transverse strength.[26] It is more favourable when two substances of equivalent or almost near modulus of elasticity approximate each other.

limitations of the study include not simulating the periodontal ligament space. Roots were embedded directly into the resin blocks. In our study the tests were carried out in single rooted teeth, with specific dimensions and testing done under a static compressive loading applied at a single point and at a fixed angulation. Thus, dynamic or fatigue behaviours cannot be inferred. Methodologically, the limitation of this study was that static loading testing was used to evaluate fracture resistance.

Conclusion

Within the parameters and limitations of the in-vitro study it may be concluded that Fracture resistance of human mandibular premolar teeth restored with zirconia modified cylindrical post system (Dentsply Easypost) has highest fracture resistance among the groups tested and statistically significant then the other groups. Human mandibular premolar teeth restored with double tapered glass fibre post (Angelus Exacto) has lowest fracture resistance among the groups tested.

References

1. Gutmann JL. The dentin-root complex: anatomic and biologic considerations in restoring endodontically treated teeth. The Journal of prosthetic dentistry. 1992; 67(4):458-67.
2. Helfer AR, Melnick S, Schilder H. Determination of the moisture content of vital and pulpless teeth. Oral Surgery, Oral Medicine, Oral Pathology. 1972; 34(4):661-70.
3. Rivera EM, Yamauchi M. Site comparisons of dentine collagen cross-links from extracted human teeth. Archives of oral biology. 1993; 38(7):541-6.
4. Qing H, Zhu Z, Chao Y, Zhang W. In vitro evaluation of the fracture resistance of anterior endodontically treated teeth restored with glass fiber and zircon posts. The Journal of prosthetic dentistry. 2007; 97(2):93-8.
5. King PA, Setchell DJ. An in vitro evaluation of a prototype CFRC prefabricated post developed for the restoration of pulpless teeth. Journal of Oral Rehabilitation. 1990; 17(6):599-609.
6. Teixeira EC, Teixeira FB, Piasick JR, Thompson JY. An in vitro assessment of prefabricated fiber post systems. The Journal of the American Dental Association. 2006; 137(7):1006-12.
7. Sahafi A, Peutzfeldt A, Asmussen E, Gotfredsen K. Retention and failure morphology of prefabricated posts. International Journal of Prosthodontics. 2004; 17(3).
8. Ingle JI, Barkland LF, Baumgater JC: Ingale Endodontics. 6th edition, 2008.
9. Hargreaves K M, Cohen S, Berman L H: Cohen's Pathway of pulp. Mosby Publishers1oth Edition, 2011.
10. Nergiz I, Schmage P, Özcan M, Platzer U. Effect of length and diameter of tapered posts on the retention. Journal of oral rehabilitation. 2002; 29(1):28-34.
11. RUD J, OMNELL KA. Root fractures due to corrosion diagnostic aspects. European Journal of Oral Sciences. 1970; 78(1-4):397-403.
12. Stockton LW. Factors affecting retention of post systems: a literature review. The Journal of prosthetic dentistry. 1999; 81(4):380-
13. Qualtrough AJ, Mannocci F. Tooth-colored post systems: a review. Operative Dentistry. 2003; 28(1): 86-91.
14. Fredriksson M, Astbäck J, Pamenius M, Arvidson K. A retrospective study of 236 patients with teeth restored by ~ 201 ~ International Journal of Applied Dental Sciences carbon fiber-reinforced epoxy resin posts. The Journal of prosthetic dentistry. 1998; 80(2):151-7.
15. Ferrari M, Vichi A, Mannocci F, Mason PN. Retrospective study of the clinical performance of fiber posts. American journal of dentistry. 2000; 13(Spec No):9B-13B.
16. Fernandes AS, Shetty S, Coutinho I. Factors determining post selection: a literature review. The Journal of prosthetic dentistry. 2003; 90(6):556-62.
17. Lassila LV, Tanner J, Le Bell AM, Narva K, Vallittu PK. Flexural properties of fiber reinforced root canal posts. Dental Materials. 2004; 20(1):29-36.
18. Mitsui FH, Marchi GM, Pimenta LA, Ferraresi PM. In vitro study of fracture resistance of bovine roots using different intraradicular post systems. Quintessence international. 2004; 35(8).
19. Christensen GJ. Posts and cores: state of the art. Journal of the American Dental Association (1939). 1998; 129(1):96-7.

20. Federick DR. An application of the dowel and composite resin core technique. The Journal of prosthetic dentistry. 1974; 32(4):420-4.
21. Christensen GJ. Post concepts are changing. Journal American Dental Association. 2004; 135(9):1308-10.
22. Naumann M, Blankenstein F, Dietrich T. Survival of glass fibre reinforced composite post restorations after 2 years—an observational clinical study. Journal of dentistry. 2005; 33(4):305-12.