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Fracture Resistance of Endodontically Treated Teeth with Different Post Systems

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Abstract: ***Endodontically treated teeth are known to present higher risk of biomechanical fracture than vital teeth. Endodontic posts or dowels are usually cemented into a prepared canal. They retain the core and equally distribute the forces of mastication to the supporting tooth structures. The study compares fracture resistance of root canal treated teeth with different types of post systems. Objectives: Comparison of Endodontically Treated Teeth with Different Post Systems. Methodology: A total of 40 recently extracted mandibular premolars will be endodontically treated divided into 4 groups of 10 specimens, then restored with glass fiber, fiber, metal screw and cast metal posts. All posts were cemented . and specimens were secured in a universal load testing machine. Results: Highest fracture resistance was observed in cast post system . The mean value of group 1 was 286.3 N, followed by 303.5 N of group 2, 338.7 N of group 3, 450.3 N of group 4. Significant differences of fracture resistance were detected between group 1 and control (p < 0.001). Conclusion: The results of our study show that Custom cast posts though demonstrated highest fracture resistance, demonstrated higher catastrophic fractures whereas carbon fibre posts and glass fibre posts showed more number of repairable fractures.***

Keywords: Fibre posts; Cast posts; Catastrophic fractures; Mandibular premolars

1. Introduction

Endodontically treated teeth are at higher risk of fracture than vital teeth due to the decreased moisture content in dentin and compromised structural integrity. Therefore, posts are essentially indicated for the root canal treated teeth to prevent fracture of the remaining tooth structure and to prevent tooth loss.[1] The main function of the post is to anchor the post and core complex within the radicular portion of the remaining tooth. The main functions of the core are to provide a visible and accessible platform for, to improve the retention of, and to strategically manage the transfer of forces from the final restoration.[2] Compared with the cast post and core technique, the use of prefabricated post systems with direct core buildups is less invasive, less time consuming.[1] It has been suggested that the post material should have the similar modulus of elasticity as dentin (18.6 GPa) to distribute the applied forces evenly along the length of the post and root.[3] Fibre posts and composite cores which have comparable elastic properties as of dentin, do not generate forces at the interface area. Whereas the metallic posts with higher modulus of elasticity as compared to tooth structure are more prone to catastrophic root fracture.[1] The high rigidity of zirconia ceramic posts produces higher stresses at the coronal portion where the tooth structure is minimal that can lead to more catastrophic root fractures *in vitro* compared to metal and carbon fiber posts.[4] Adhesive composite resin cement systems with their effective bonding, flexibility and cushioning effect of the cement layer, contribute to uniform stress distribution between the post and the dentinal walls. With a number of manufacturers claiming their product's superiority over custom cast and prefabricated post core system, this in vitro study was designed to evaluate the fracture resistance of various post systems using dual cure resin cement as luting agent.

2. Aim & Objective

To evaluate the fracture resistance of endodontically treated teeth restored with different post systems and to evaluate the fracture resistance of Glass fiber posts, Carbon fiber post, Prefabricated Gold plated metal screw, Cast post and core system luted with dual cure resin cement and to compare the fracture resistance of these posts systems.

3. Materials & Methodology

Forty freshly extracted mandibular premolars were selected for the study and their length was within mean value of 20mm. They were disinfected for 48 hrs in 2% glutaraldehyde solution. Coronal portion of all the teeth were removed leaving 2mm above the cementoenamel junction using diamond disk. The overall mean root dimension from the cementoenamel junction was 12±1.0 mm. Endodontic treatment was carried out in all the specimens using rotary ProTaper with the crown down technique. Teeth were obturated with ISO No. 25 (F-1) gutta percha cones using vertical condensation. After letting the root canal sealer to set for 48 hours, gutta percha was removed from the root canals using peeso reamer uptil No.4 to a length of 9 mm, leaving at least 4-5 mm of root canal filling in the apical ⅓ rd of the root. The post length of 12 mm was maintained for all the groups. The specimens were then randomly assigned to four groups with 10 teeth each. **In group 1,** teeth were restored with Prefabricated gold plated metal screw posts. **In group 2** Glass fiber posts of 1.5 mm in diameter were used .**In group 3,** Carbon fiber posts of 1.5 mm in diameter were used as the anchorage of composite cores. **In group 4,** teeth were restored with cast posts which were fabricated using acrylic post pattern with superior head design. The posts were cast with a nickel-chromium alloy. Root surfaces of all the teeth were wrapped in aluminium foil to a depth 2 mm below the facial cementoenamel junction to produce a 0.2- to 0.3-mm layer approximately

equal to the average thickness of the periodontal ligament. The thin layer of silicone material simulated the periodontal ligament which was introduced after removal of aluminium foil. The mounted specimens with custom-made stainless steel holder were secured in a universal testing machine. Loads were applied at the middle point of occlusal surface at a crosshead speed of 1 mm per min. Fractures in the incisal third of root, core fracture and dislodging of posts were deemed repairable, fractures below were deemed catastrophic.

Figure 1: Freshly extracted mandibular premolars

Figure 2: Biomechanical preparation and obturation

Figure 3: Types of posts used for the study

Figure 4: Fracture of tooth samples under universal testing machine at 90^0at the cross head speed of 1 mm per minute

Figure 5: Group 1- metal screw posts, Group 2- glass fibre posts, Group- carbon fibre posts, Group 4- cast metal posts (each group contains 10 samples) Figure:6. Fractured samples

4. Results

For the purpose of the study, 40 specimens were divided into 4 groups as shown in Table-I.

Table 1: Showing Distribution of Samples in Various Groups

Groups	No. of samples	Post-system
Group 1	10	Metal screw post
Group 2	10	Glass fibre post
Group 3	10	Carbon fibre post
Group 4	10	Cast post

The fracture strength of these samples was recorded using Universal testing machine.

Table 2: Comparative Evaluation of Fracture Strength (in Newton)

Groups	N	Mean	Std. Dev.	One Way ANOVA		TUKEY HSD Test*	
				'F' Ratio	'P' Value	Group Mean	'P' Value
Group 1	10	286.3	115.2	4.598	0.008 (S)	M1&M2	0.985
Group 2	10	303.5	75.86			M1&M3	0.705
Group 3	10	338.7	127.8			M1&M4	0.009 (S)
Group 4	10	450.3	109.1			M2&M3	0.887
						M2&M4	0.023 (S)
						M3&M4	0.118

Table 3: Type of Fractures in Different Groups

Group	Favorable fracture		Catastrophic fracture	
	N	%	N	%
Metal screw posts	1	10	9	90
Glass fibre posts	6	60	4	40
Carbon fibre posts	7	70	3	30
customized cast posts	3	30	7	70

Chi-square = 9.309 with 3 degrees of freedom; **P = 0.033 (S)**

The highest fracture resistance was observed in group 4, i.e of custom cast posts . The mean value of group 1 was 286.3 N with metal screw posts, followed by 303.5 N of group 2 with glass fibre post, 338.7N of group 3 with carbon fibre posts, and 450.3 N of group 4 with custom cast post, The fracture resistance of various specimens was in the descending order as: Group 4> Group 3> Group 2> Group 1

Favourable fractures were mostly observed in group 3 and group 2 whereas catastrophic fractures were observed mostly in group 4 and group 1.

5. Discussion

A post and core [5] is required to reinforce the weakened teeth and subsequently to retain the crown. Each post system has characteristics related to its design. Parallel-sided prefabricated post systems exhibit maximal retention but threads in parallel posts have been reported to be capable of creating excessive stress levels at the dentinal-thread interface [6]. It has already been proven that tapered and threaded post increase root fracture 20 times in comparison to parallel post [7]. This has lead to an increased use of parallel post because they provide better retention, cause less incidence of root fracture and are passively fitting.[8] Thus, the cast post-and-core technique has been advocated as the gold standard restoration for decades[5]. Human teeth have been commonly used for the in vitro testing of post restorations[9],[10]. Some authors have used plastic teeth[3]. **Strub *et al***[11] reported that higher fracture loads were observed with natural test teeth than with artificial roots. Taking all this into consideration extracted human teeth were used for the preparation of the test specimens in this study, even though there is disadvantage of the use of human teeth is the relatively large variation in size and mechanical properties[12], often resulting in large standard deviations. In the study, mandibular premolar was selected as it is the most vulnerable tooth to trauma because of its position, being in the front and thereby requiring maximum restoration in terms of post-core. Extracted mandibular premolars were initially stored in glutaraldehyde solution for 48 hours [13]. This was done as a precautionary measure to prevent cross- contamination. In this study all teeth received endodontic treatment, even though some investigations [14], [15] do not report root canal preparation, it seems crucial to include this step to carefully simulate all clinical and oral parameters. **Kantorowicz G.F**.[16] recommended that the post should be atleast as long as the length of the crown being restored but if that is not possible then post should extend to within 5 mm of radiographic apex. In the present study, the highest fracture resistance was observed in group 4, in which cast post system were used for restoration. The number of repairable fractures in group 3 (carbon fibre posts) and group 2 (glass fibre posts) was significantly greater as shown in Table III, than that of any other group, in agreement with the findings reported by other researchers[17]. Finally, within the limitations of this in vitro study, it can be stated that fibre posts can be recommended as a better alternative to the cast post and cores and prefabricated metallic posts in the anterior region and resin cement might give additional fracture resistance when used for post and crown cementation.

6. Conclusion

The greatest number of repairable fracture was observed with carbon fibre posts and glass fibre posts. Custom cast posts though demonstrated highest fracture resistance, demonstrated higher catastrophic fractures whereas carbon fibre posts and glass fibre posts showed more number of repairable fractures, demonstrating that fibre posts possess a modulus of elasticity much better matched to dentin. Type of failure that occurred with fibre post systems were primarily post and core fractures that could potentially allow retreatment of the tooth. . Rigid metallic posts were responsible for stress concentration at the apical end and the coronal third of the canal wall, resulting in catastrophic vertical root fractures.

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