Original article

Fracture Resistance Assessment of Wide Canalled, Radicularly Obturated Teeth Using Modified Fiber Post Systems With & Without Accessories

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ABSTRACT

Background: Wide canalled endodontically treated teeth present a common clinical challenging problem.
Objectives: Aiming to perform fracture resistance assessment of modified fiber post systems with different forms of customization as an effective treatment modality in the wide canalled teeth.
Methods: Freshly extracted twenty-eight maxillary central incisors were collected. Teeth were resected coronally above the cervix, radiculary prepared and obturated. Resected teeth were randomly grouped according to fiber post modification as (Group I) Custom-made post by fiber impregnated strands (CMF). (Group II) Customized fiber posts by composite (CF). (Group III) Prefabricated fiber post with accessory posts (PA). (Group IV) Prefabricated fiber posts without accessory posts (PNA). All samples were mounted on universal testing machine for fracture resistance measurements. All measurements were recorded and statistically analyzed One-way ANOVA testing along with pair-wise Tukey's post-hoc testing.
Results: The modified fiber post system studied has been significantly varied in the results, declaring that Prefabricated fiber with Accessory (PA) group recorded the highest mean ± SD value of fracture resistance (373.02±27.967 N) followed by Custom made resin impregnated fiber (CMF) group which recorded mean ± SD value of (357.48±28.748 N) then Prefabricated fiber post without Accessory group with mean ± SD value of (264.41±25.175 N) meanwhile the lowest mean ± SD value was recorded with Customized fiber post with composite (CF) group (246.4±20.948 N).
Conclusion: Accordingly with the results elaborated it can be speculated that utilization of accessory posts will provide a safe and rigid alternative in those cases by decreasing the interpenetrating thickness of cementing resin on mesial and distal sides of the master post cemented and creating a better root canal-post adaptation.
Key words: Fracture Resistance, Radicularly Obturated Teeth, Fiber Post Systems.

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INTRODUCTION

Reconstruction of radicularly obturated teeth is a great challenge in restorative dentistry since the coronal structure is usually totally or partially lost due to common caries attack , erosion incidence , abrasion effect , existence of previous restorations, massive trauma or endodontic access.[1] When more than half of the coronal structure has been lost, a root canal post is required to provide retention for the restoration and subsequently enhancing the restorability when indirect restoration is planned.[2-4]

Endodontically treated tooth could be restored by commercially available prefabricated post systems or conventional custom post and core.[5] Prefabricated post is selected in narrow circular canals while custom post and core is indicated in wide noncircular canals.[6,7] Traditionally customization of post along with coronal substitute was fabricated from cast alloy.[8] Differences in the elastic modulus between the post system and tooth resulted in unfavourable fractures of teeth. Therefore, prefabricated fiber posts were introduced to improve stress distribution between bonded structure.[9,10] Due to variability in canal space between different teeth, the use of prefabricated post yielded a large and

non-uniform cement space in the system which increases the failure rates especially in the teeth with wide or oval root canals.[11]

Lately resin, non-metallic customization was suggested to match with dentin physical properties in addition to giving a chance for direct bonding with tooth structure and more radicular adaptation of post system with decreased cement thickness.[12] The resin-based customization is dependent on reinforcement by highly resistant elements (carbon fibers, glass, quartz or polyethylene) surrounded by resin matrices. Different forms have been reported for such customization as application of additional accessory prefabricated fiber posts or condensation of fiber strips surrounded by composite resin.[13-17]

In vitro studies utilize fracture resistance of post tooth assembly for validation of strength and durability.[18] However, the impact of the treatment outcome of non-metallic customization has not yet reached a consensus. The purpose of this research is to assess the fracture resistance of post systems with different forms of customization as an effective treatment modality in the wide root canals. The hypothesis estimated that within customized fiber post systems there will be absence of significance regarding measured fracture resistance.

MATERIALS AND METHODS

Freshly extracted twenty-eight maxillary central incisors were collected with straight root canals, fully developed apices and free from decay or fractures, the average root length 16 mm ±1, mesiodistal diameter 6-7 mm at cementoenamel junction. Teeth were cleaned by soaking in Naocl solution for 30 minutes for soft tissue remnants then curettes for removal of hard deposits. Teeth sectioning was performed immediately below the cemento-enamel junction with the aid of water-coolant high speed handpiece with diamond wheel stone to ensure that all specimens were of the same length, calliper measurements of overall root length in arrange of 16 ±1 mm.

Radicular part of the teeth was mechanically prepared till master cone #45 then roots then obturated with eugenol-free sealer (ADSEAL) with gutta-percha using the lateral condensation technique. The resected roots storage in moist environment was done for 24 hours by immersion in distilled water and kept at room temperature. The coronal gutta-percha was removed using contra angle low speed hand piece with #4 drill and 3-5 mm thick layer of gutta-percha was left for apical seal. The prepared roots were assigned into four groups (n=7) according to technique of post restoration as follows: (Group I) Custom-made post by fiber impregnated strands (CMF). (Group II) Customized fiber posts by composite (CF). (Group III) Prefabricated fiber post with accessory posts (PA). (Group IV) Prefabricated fiber posts without accessory posts (PNA).

Custom-made post (Group I) by fiber impregnated strands (CMF);[1] After post space preparation canals acid etched for 30 seconds, rinsed for 30 seconds, dried by using air then universal bond was applied and light cured for 10 seconds. The resin impregnated fibers were cut into the length of the canal + 3 mm for core construction, inserted in the canal and lateral condensed, light cured for 20 seconds then another increment inserted, and light cured until filling of the whole the canal. (Group II) Customized fiber posts by composite (CF); The canal lubricated by vaseline then an increment of packable composite (Z350 XT 3M ESPE)were packed around fiber post[2] and inserted into the canal to take shape of the canal, cured then removed from the canal and checked for any voids or defects. The canal was washed with alcohol to remove the Vaseline followed by etching, rising, dryness and bond application as done in the first group. The customized fiber post was cemented along with the excess cement removal followed by light curing for 20 seconds. (Group III) Prefabricated fiber post with accessory posts (PA); Etching, rinsing and bond application was done as described previously.

Cement was injected into the canal by intracanal tip then the main fiber post inserted into the center of the canal followed by two accessory posts; one mesial and one distal to the main post. The excess cement removal and light curing was done as in the previous groups. (Group IV) Prefabricated fiber posts without accessory posts (PNA); only single one main fiber post was utilized. The same steps as in group (III), but without accessory posts. The forms of modified fiber post systems are shown in: Figure (1).

Core fabrication was done in the same manner for all samples; celluloid crown former was used for fabrication of standardized core for each. The core material[3] were injected inside the

[1] Grand TEC® fiber reinforced composite: A pre-impregnated glass strands with methacrylate resin (light cured).

[2] DENTOCLIC: light transmitting fiber post. It is made from glass fibers load by 80% embedded in epoxy resin by 20%.

[3] Dentocore; A highly stackable nano-fill composite

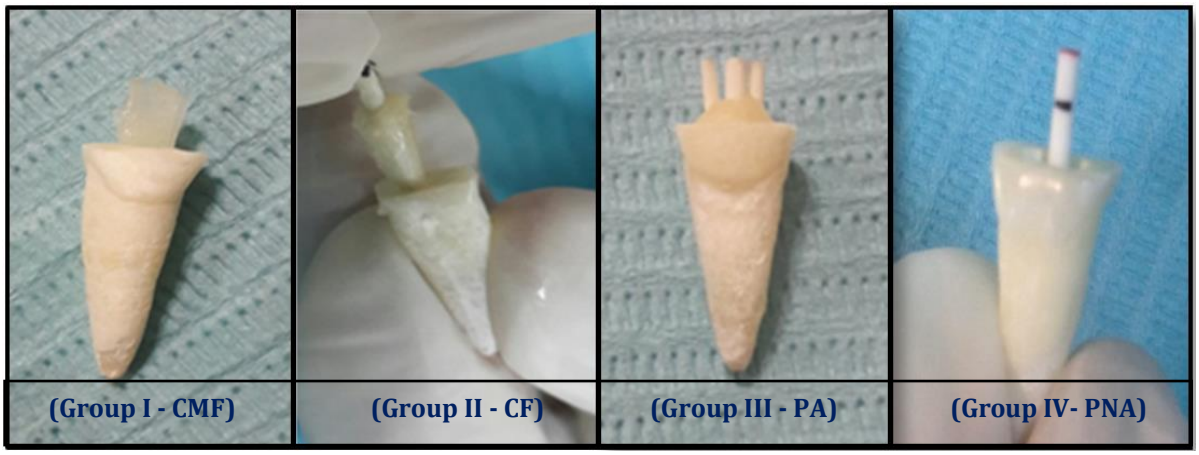

Figure (1): Different groups of post & core

crown former then inverted over the coronal extension of the root-post assembly. Removal of the excess core material was checked before light curing with duration of 20 seconds.
After that the crown former was removed. All finished samples were mounted in acrylic resin mould using dental surveyor.

Fracture resistance test: Assessment of samples fracture resistance was established with the aid of universal testing machine (3345; Instron, USA) and applied load of 5 kN with speed of 1mm/min. Data management were performed using testing machine specified software (Bluehill Lite Software; Instron, USA).

Load application was done by metallic road of 5mm diameter flat tip which is fixed to the upper compartment. Specially designed 45° angle jig was used to mount the samples in the lower compartment of the testing machine allowing the samples to be angled at 135° to the applied load, Figure (2).

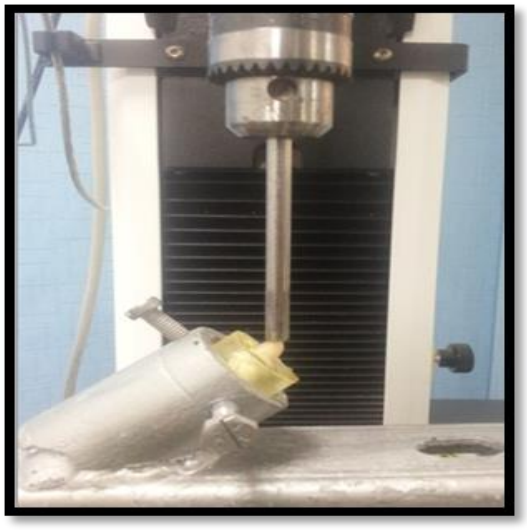

Figure (2): Fracture resistance test (Sample fixed in 45° jig)

Loading of each sample in the universal testing machine was terminated upon occurrence of crack accompanied by sudden drop in load-deflection curve (in Newton) recorded by the machine software.

RESULTS

Analysis of data started was initiated by descriptive statistics. One-way ANOVA testing accompanied by pair-wise Tukey's post-hoc testing was followed to navigate for significance between post groups. Analysis was conducted with Graph-Pad Prism version 4.00 for Windows, Graph-Pad Software, San Diego California USA. P values ≤ 0.05 were stated as statistically significant in all tests. The mean values and standard deviation of fracture resistance test results for all groups are summarized in table (1).It was found that Prefabricated fiber with Accessory (PA) group recorded the highest mean ± SD value of fracture resistance (373.02±27.967 N) followed by Custom made resin impregnated fiber (CMF) group which recorded mean ± SD value of (357.48±28.748 N) then Prefabricated fiber post without Accessory group with mean ± SD value of (264.41±25.175 N) meanwhile the lowest mean ± SD value was recorded with Customized fiber post with composite (CF) group (246.4±20.948 N).

Significant difference was evident as indicated by one-way ANOVA (F=18.9, P=<0.0001) (<0.05). Pair-wise Tukey's post-hoc testing outlined non-significant difference (P>0.05) between customized Fiber post with Accessories and Custom made resin impregnated group, also there was non-significant difference (P>0.05) between Prefabricated without Accessories and

Customized fiber post with composite group as shown in Table (1).

Table 1: Fracture resstence of all groups

Group	Variable	**Mean ±SD**	**Median**	**Minimum**	**Maximum**
(Group III - PA)	Prefabricated with Accessory	373.02^{A}±27.967	354.97	335.29	455.76
(Group I - CMF)	Custom made resin impregnated fiber	357.48^{A}±28.748	364.89	298.19	414.76
(Group II - CF)	Customized fiber post with composite	246.4^{B}±20.948	230.81	223.96	305.25
(Group IV- PNA)	Prefabricated without Accessory	264.41^{B}±25.175	262.17	229.96	335.59
ANOVA (p value)		<0.0001*			

DISCUSSION

A wide canaled tooth with radicular obturation was in the focus of the present research in order to estimate most suitable way for durable restoration. The selection of intact natural central incisors seems to represent the best possible option to simulate clinical situations for endodontically treated teeth[16] . As the maxillary anterior teeth are more prone to trauma and fracture, these teeth were selected to simulate an in vivo condition.[19] The major privilege in utilization of the fiber post systems is the reported similarity to of elasticity modulus of dentin.[20]

Circular shaped posts usually don't provide a good post fitting to the canal walls of wide and flared ones. This is due to the discrepancies or spaces left between the post's circular cross section and canal's configuration leading to irregular increase in cement space It is also obvious when a smaller post system is chosen to avoid too much cutting from dentin.[21] From the other side, in narrow and oval-shaped root canals the insertion of large circular shaped posts requires the removal of unnecessary healthy dentin tissue using preformed drills which alters the anatomy of oval canals with subsequent root weakening.[22,23] Originally customization of post and core assembly was proposed to prevent unnecessary cutting in case of narrow oval canals in addition to decreasing discrepancy of cement spaces around the post in wide flared canals.[24]

Different approaches of customization have been suggested based on resin and fiber utilization. Braz et al.[14] suggested using a main glass fiber post and three accessory fiber posts as the ideal method of restoration in roots with wide root canals. Newman et al.[16] reported a direct relationship between the proportion of fiber and tooth fracture strength. Bonfante et al.[25] tested an alternative technique where fiber strips were applied around the post to fill the empty spaces in the root canal. The same technique was also proposed by Grandini et al.[15] but with relining the fiber posts with composite resins to obtain reduced thickness of the inter penetrating cement in wide canaled teeth, improving the behaviour of the tooth post assembly to be more resistant to adhesive failures and increasing post retention. Ayad et al.[13] suggested relining thin-walled roots with composite resin prior to cementation of fiber posts. Porciani et al.[17] suggested the use of combinations of multiple smaller posts when an endodontically treated tooth with a small and oval root canals. There was a common agreement regarding fiber post customization that it caused dramatic reduction in the thickness of the cementation material compared to the same condition in case of applying fiber post alone.[26]

Comparing the customization material selected for restoring flared canals, the usage of metallic post and core customized cast assembly has revealed pronounced prominence of catastrophic cracks in relation to fiber post customization with composite relining or accessory.[27] biomechanically it is important to obtain homogenous structure, a benefit obtained from usage of fiber post with matching elastic modulus in addition to absorbing shock behavior adding more strength and resistance to the restored teeth.[28]

General speaking it is not recommended to do unnecessary cutting from surrounding dentin even with enhanced resistance observed in wide canalled teeth restored by such systems.[29] This was confirmed by extreme rising of clenching force resistance as ten times upon utilization of fiber post without over preparation intraradicularly.[30] From the other side considering adhesion

performance over time between tooth dentin intraradicuary and cementation medium with thick interface which require more intensive attention for improvement.[31]

Accordingly, data interpretation by statistical analysis has led to rejection of the null hypothesis as persistence of statistical significance between investigated systems by One Way ANOVA analysis ($F=18.9$, $P=<0.0001<0.05$). While Pair-wise Tukey's post-hoc testing revealed non-significance ($P>0.05$) between Prefabricated fiber post with Accessory and Custom made resin impregnated group, also there was non-significant difference ($P>0.05$) between prefabricated without Accessory and Customized fiber with composite group.

Considering present result would be speculated that in esthetic restorative dentistry, the use of accessory fiber posts customization will provide a safe and rigid alternative in those cases by decreasing the cement thickness on mesially and distally to the master post cemented and creating a better root canal-post adaptation. From the other side limitations also should be considered as the way the load applied as increasing of load over the tooth is not mimicking the actual condition intraorally but can provide indication partially of enhanced resistance.

Conclusion

Upon analysis of results, Customized fiber post with accessory post or resin impregnated fibers attained support as effective method to improve resistance to fracture focused for treatment of wide canaled teeth. However, additional studies using different loading protocols are of paramount importance to explore the actual responses elected in addition to evaluation of survivability over time.

Declaration

It is worthy to declare that this work done in this study was established without any conflict of interests, in addition to private work without granting or funding.

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