

COMPARISON OF INTRARADICULAR RESTORATIVE TECHNIQUES FOR REHABILITATION OF SINGLE ROOTED DEBILITATED TEETH

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ABSTRACT

Aim: To compare between different intraradicular restorative techniques to rehabilitate single rooted badly destructed teeth.

Materials and method: Fifty sound maxillary central incisors were endodontically treated, decoronated at M-D cemento-enamel-junction and randomly distributed into five equal groups according to the intraradicular rehabilitation technique: *group A*: Coronal and intraradicular cores using G-aenial flow composite (GC Corporation, Japan), *group B*: Coronal and intraradicular cores using G-aenial flow composite (GC Corporation, Japan) with GC fiber post (GC Corporation, Japan), *group C*: Coronal and intraradicular cores using composite (Wave, SDI, Australia) compacted by ultrasonic tip with fiber post (GC Corporation, Japan), *group D*: Multiple posts (GC Corporation, Japan) together with composite core (Wave, SDI, Australia) and finally *group E*: Cast post and core which was cemented using resin cement (Rely X U 200, 3M ESPE, USA). Cr-Co copings were fabricated and cemented on all cores. All the specimens were thermocycled for 300 cycles and subjected to a compressive force at a 130° to the long axis of the tooth (Instron 8874; Instron Corp. Canton, Mass), until fracture.

Results: The highest mean value was scored in group B (509.48N) followed by group E (422.92N) then group C (418.05N) to reach group D (321.85N). The lowest score was figured in group A (291.89N). In accordance with the fracture resistance mean results, group B also showed the maximum fracture resistance (946.81N) whereas group A showed the minimum fracture resistance mean (109.69N). P values in between different groups scored insignificant results. Moreover p values between every group (A, B, C or D) in comparison with the control Group E showed insignificant results ($p > 0.05$).

Conclusions: Within the limitations of this study, it could be concluded that any of the new techniques can be used as a substitute for cast post and core.

KEYWORDS: Fiber Post, Intraradicular Rehabilitation, Compromised roots, Cast Post and core.

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INTRODUCTION

Many endodontically treated teeth are considered less resistant and more liable to fractures¹. The large, flared root canals have thin dentinal walls leaving them too fragile to withstand normal masticatory forces and as a result, liable to fracture which compromise the prediction for a long term prosperous restoration of the tooth. They are debilitated and usually lack abundant coronal tooth structure which make them difficult to restore for a variety of reasons and end up with a problem to the restorative dentist.^{2,3} Caries that extend into the radicular dentin, secondary caries around posts, trauma to young permanent teeth, fractures, iatrogenic damage resulting in large access preparations, large previous restorations, or even internal resorption require rehabilitation of the affected compromised tooth^{4,5}.

The link between tooth strength and the amount of dentin tissue remaining after endodontic treatment is directly proportional.

The traditional way of restoring such teeth by the use of a cast post and core may result in fracture due to the wedging effect of the conventional cast post and cores and the mechanical properties of the post system^{6,7}. The excess space that will remain after using a ready-made post will be filled by cement which is also prone to failure⁴. Consequently, extraction was the end result of such weakened teeth.

Recently, application of fiber-reinforced composite (FRC) posts in endodontically treated teeth has increased in popularity because of their suggested favorable biomechanical properties, esthetic appeal, easy removal for endodontic retreatment, and single visit placement⁸⁻¹⁰. Based on theoretical considerations and finite element analyses, FRC posts are more flexible than cast metal posts and allow better distribution of forces, resulting in fewer root fractures.^{8,11} Clinical studies have reported a success rate of 95% to 99% for

teeth restored with FRC posts, with no occurrence of root fracture during the study periods.^{12,13} But the problem remains with the intraradicular spaces that needed to be filled.

The benefits of use of new adhesive materials would help in the intraradicular rehabilitation of these compromised teeth^{4,14-16}. Bonded restorations that have physical properties similar to those of dentin transmit and distribute occlusal forces to the remaining tooth structures homogeneously and potentially strengthening the restored tooth¹⁷. Luminex post system and Luscent Anchor post system (Dentatus AB, Spånga, Sweden) have been introduced for intra-radicular resin reinforcement, wherein a smooth light transmitting plastic post (used in Luminex post system) and a glass fiber post (used in Luscent Anchor System) is used for polymerization of light cure composite which is placed intra-radicularly to resurface the fragile radicular walls with composite and thereby reinforce them¹⁸. Many techniques for structurally weakened teeth have been suggested¹⁹, but the important question remains in whether these techniques can replace a cast post and core and spare the tooth during function?

The hypothesis of this study was that the proposed techniques could replace the traditional way of restoring structurally compromised teeth; cast post and core.

MATERIALS AND METHOD

A sum of fifty sound, caries and restoration-free human maxillary central incisors having single canal, nearly straight roots and identical sizes were collected. The teeth were cleaned and sterilized in an autoclave at 121°C, 15 Psi for 40 minutes, they were then mounted 2 mm below the cement-enamel junction (CEJ) in an auto-polymerized acrylic resin (Vertex-Dental B.V., The Netherlands) blocks with a size of 10 x 10 x 20 mm. The clinical crowns were sectioned horizontally close to the mesio-distal CEJ, leaving a root length of 13mm. Root canals were

manually instrumented using K-files (Dentsply Maillefer, Switzerland) with #40 master apical file using step-back technique. The irrigation solution used was 2.5% sodium hypochlorite followed by 2ml of distilled water as final irrigation, the canals were then aspirated and finally dried using absorbent paper points (Dentsply, Maillefer, Switzerland). They were obturated with gutta-percha points (Dentsply, Maillefer, Switzerland) and endodontic sealer (AH Plus, Dentsply, DeTrey, Germany) using lateral condensation technique. Specimens were placed in distilled water at room temperature for 72 hours. Post space preparation was initiated by the removal of 9 mm of gutta-percha with Gates Glidden #1 drills (Dentsply, Maillefer, Switzerland) then completed using Peeso reamers #1 to #6 (Largo, Dentsply, Maillefer, Switzerland). Over preparation of each canal was done to simulate extensive clinical structural damage by cutting out the internal dentin full post space length with residual dentinal wall thickness of 0.5mm to 0.75mm at the CEJ, using Lab burs # H231FSQ followed by # H79FSQ (Komet, Brasseler, Germany). (**Fig.1**)

The weakened specimens were then randomly divided into 5 groups -according to intraradicular rehabilitation technique used- with 10 specimens each. (Table I)



FIG. (1) Over-prepared tooth.

TABLE (I) Sample grouping

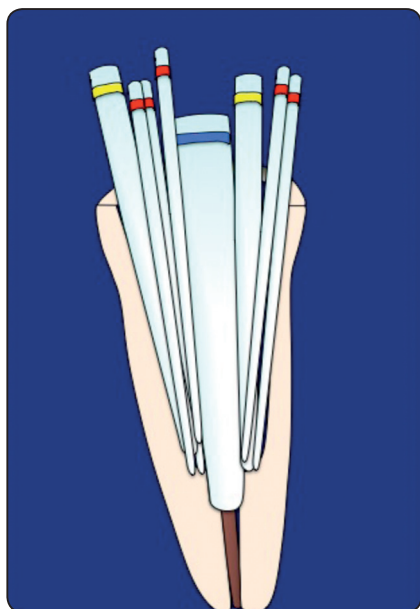
Group	Rehabilitation technique	No of samples
A	Coronal and intraradicular cores using G-aenial flow composite	10
B	Coronal and intraradicular cores using G-aenial flow composite with GC fiber post	10
C	Coronal and intraradicular cores using composite by ultrasonic tip with fiber post	10
D	Multiple posts together with composite core	10
E	Cast post and core	10
	Total	50

For group A: canal walls were painted with self-etching adhesive (Xeno V+, Dentsply, UK) using Microbrush-X (Microbrush, Grafton, USA) for 20 Sec. The material was then thinned out using air blasts for 5 sec and cured for 10 sec using LED-curing light (Elipar S10, 3M ESPE, USA). G-aenial flow composite (GC Corporation, Japan) was injected slowly into canal depth and then cured for 20 sec, using custom-made radicular light curing tip until the canal was overfilled then cured. A special core former (Coltène/Whaledent, Switzerland) was filled with G-aenial flow composite and inverted on the root-face and cured.

For group B: same technical steps as Group A except that a length-adjusted GC fiber post (GC Corporation, Japan) was inserted into canal. Curing light was applied on the post head for 20 sec.

For group C: the canal was etched, bonded and then a flowable composite (Wave, SDI, Australia) was introduced into the post hole by ultrasonic tip and adjusted GC fiber post was inserted into canal. Curing light was applied on the post head for 20 sec. The core former was filled with flowable composite and inverted on the root-face and cured.

For group D: self- adhesive resin cement (Rely X U 200, 3M ESPE, USA) was injected inside the canal. Length adjusted GC fiber posts (GC Corporation, Japan) was inserted into canal, followed by smaller sizes posts. The curing tip was used to apply static pressure over the post ends during 20 sec curing. Core former was filled with SDI composite resin and inverted on the root-face and cured. (**Diagram. 1**)



DIG (1) Group D.

For group E: resin patterns (Duralay, Reliance, USA) were fabricated for the canals and cast into a Co-Cr (Remanium Star, Dentaaurum, Germany) custom made posts and cores. Each cast post was cemented into its corresponding canal using self-adhesive resin cement (Rely X U 200, 3M ESPE, USA).

For all groups a 1.5 length ferrule and 0.5 mm chamfer finish line was prepared using round-end taper diamond bur with guiding pin # 8881 P (Komet, Brasseler, Germany) on a parallelometer (AmannGirrbach, Germany). Using a silicon-index technique for standardization, Co-Cr copings were fabricated for all groups and cemented using self-adhesive resin cement (Rely X U 200, 3M ESPE, USA). (**Fig. 2**)



FIG. (2) Samples before thermocycling.

All the specimens were thermocycled for 300 cycles with the sequence of 20 sec at 5°C and 20 sec at 55°C and 10 sec transport.

Samples were submitted to a compression test using a universal testing machine (Instron 8874; Instron Corp. Canton, Mass) under a constant crosshead speed of 1.00 mm/min. The specimens

were fixed in the frame cell at a 130° to the long axis of the tooth to simulate the average angle of contact between maxillary and mandibular incisors in Class I occlusion. The fracture was confirmed by sudden drop in force measurements in the testing machine.

The data recorded was coded, entered using the statistical package SPSS version 15 and summarized using descriptive statistics such as: mean, standard deviation, minimal and maximum values for quantitative variables. Statistical differences between groups were tested using Nonparametric Mann Whitney test quantitative. P- values less than or equal to 0.05 were considered statistically significant.

RESULTS

Fracture resistance mean, minimum, maximum and standard deviation are displayed in table II and chart I & II. The highest mean value was scored in group B (509.48N) followed by group E (422.92N) then group C (418.05N) to reach group D (321.85N). The lowest score was figured in group A (291.89N). In accordance with the fracture resistance mean results, group B also showed the maximum fracture resistance value (946.81N) whereas group A showed the minimum fracture resistance value (109.69N).

In table III, p values in between different groups scored insignificant results. Moreover p values between every group (A,B,C or D) in comparison with the control Group E showed insignificant results ($p>0.05$).

TABLE (II) Fracture resistance mean and standard deviation

	Minimum	Maximum	Mean	Std. Deviation
Group A	109.69	473.29	291.89	144.04
Group B	234.77	946.81	509.48	278.43
Group C	239.87	563.21	418.05	144.48
Group D	235.74	501.05	321.85	105.27
Group E	257.81	593.39	422.92	155.19

TABLE (III) P-values among groups

	Group A	Group B	Group C	Group D	Group E
Group A		0.175	0.117	0.465	0.074
Group B	0.175		0.754	0.251	0.753
Group C	0.117	0.754		0.251	0.916
Group D	0.465	0.251	0.251		0.344
Group E	0.074	0.753	0.916	0.344	

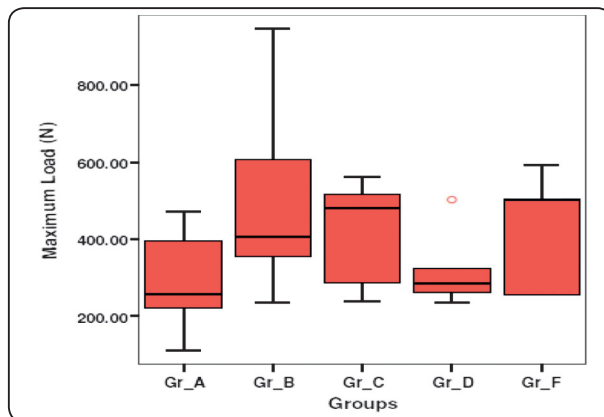


CHART (I) Fracture resistance results.

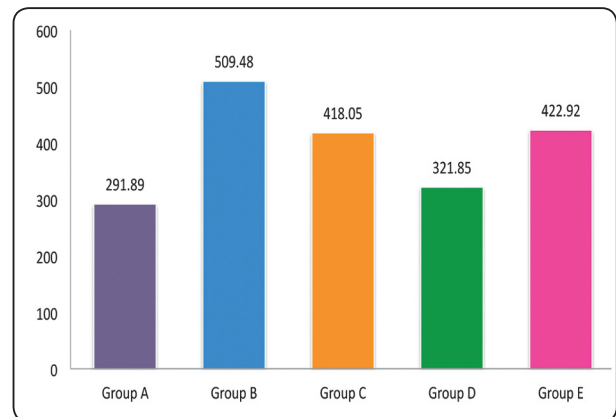


CHART (II) Fracture resistance means.

DISCUSSION

After endodontic treatment is successfully completed, the dentist faces the task of restoring the remaining radicular structure to full form and function. Moreover structure must be sufficiently strong to support the post/core/crown complex²⁰. But usually the presence of wide flared canal spaces and thin dentinal walls cause many anterior teeth to be severely weakened and require restorations. These teeth are at a high risk of being fractured. New post system were recently introduced involving intraradicular composite resin polymerization with light transmitting posts, rendering the defective endodontically treated root capable of supporting a post and core, and thereby ensuring continued function of the badly damaged tooth²¹.

In this study, it was found that there were no significant differences between the fracture resistance of a cast post and core and those of different intraradicular rehabilitation techniques to strengthen weakened roots ($p > 0.05$).

In group A, Also, in a previous studies have postulated that the use of a flowable composite probably overcame the problem of propagation of micro cracks resulting from inherent porosities and flexure in the composite material, leading to subsequent failure of the restoration²². In our results opposite values were scored by having the least

value of maximum fracture resistance strength with group A (473.29N).

In group B, choosing the same material as in group A that closely resembles the properties of dentin, so as to produce a homogeneous unit and result in reduction of stresses in the root structure was used. There is a strong co-relation between the elastic modulus of the posts and the resulting stress and root fractures. Materials such as: glass fiber post has modulus of elasticity, which is nearly identical to that of dentine and reported to cause less stress in the tooth and fewer root fractures²³⁻²⁷. Results showed that in this group maximum fracture resistance strength (946.81N) was scored.

In group C, the use of ultrasonic tip was supposed to improve the wettability and penetration of thixotropic composite to the intraradicular walls. Unfortunately it didn't add an advantage to the injection of composite intraradicularly which maybe was contributed to bubbles or gaps that weren't filled.

In group D, the use of multiple posts increased the interfaces between the dentin walls and the composite resin from one side and that of composite resin and fiber posts in addition to the interfaces between the fiber posts.

In group E, the choice of cast post and core for control group was based on researches that

recommended it for restorative purposes in conjunction with endodontic therapy^{28,29}.

In accordance with our findings, Purton and Payne in 1996 implied that rigid metal posts will probably cause stress concentration followed by root fracture³⁰. Also Bernard et al (2007) found that bonding a thick intermediate layer of dentine substitute, to the remaining dentine and to the sandblasted cemented posts, resulted in a very significant increase in the fracture resistance of the roots²¹.

Whereas opposing to our results, in 1993 Mentink et al found that anterior teeth restored with cast post and core build ups surveyed over a 10 year period showed an 82% survival rate³¹.

In another 10 year study with only a limited number of cases (50 restorations surveyed), only 1 failure was reported within the 3 gold post and core systems, while 2 failures was reported in the group of prefabricated metal posts and composite resin cores, accounting for an overall 6% failure rate³².

One of the limitations in this study was using the fracture resistance test. True it is used in many studies, whilst it is the simplest to perform, it is a destructive test that may not always simulate in vivo conditions, as the forces required to fracture specimens in vitro may not occur in the oral cavity.³³⁻³⁶

In a study by Fennis et al³⁷, mastication was reported as the most frequent cause of complete cusp fracture. While the application of static force does not necessarily simulate actual intraoral loading³⁸, the general assumption was that it would at least detect differences between treatment modalities with regard to strength³⁹.

However the clinical loading of teeth is a dynamic process, in which loading force, frequency and direction vary greatly⁴⁰.

Chewing simulator could be used to give more close results to intraoral forces. The lack of appropriate chewing simulator with reasonable

number of cells was a hinder to this study. Also, in the mouth, repeated loading can lead to fatigue failure, so the interpretation of results should be done with caution.

Another limitation was that originally the cast post and cores were fabricated from gold. Gold benefits in castability, high adaptability to post space, and lower modulus of elasticity than base metal posts. The increased gold price is an obstacle along with its limited use nowadays in our region.

A strong point in the research is the variety of techniques and trying to address new materials and techniques easy to be used and adopted by practitioners as a substitute for base metal cast post and cores.

Further researches are needed utilizing different intraradicular rehabilitation techniques and using different testing methods to present possible solutions for this dilemma.

CONCLUSIONS

Within the limitations of this study, it could be concluded that any of the proposed techniques can be used as a substitute for cast post and core for rehabilitation of debilitated teeth.

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