

A comparative evaluation of the fracture resistance and mode of failure of GC ever Stick post and Easy post – an in vitro study

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Abstract

Introduction and Objectives: Root canal treated teeth are more prone to fracture and reconstruction of such teeth to achieve required strength, function and esthetics still remain a challenge. Therefore, this in vitro study was carried out in order to determine the mode of failure and compare the fracture resistance of endodontically treated teeth restored with GC everStick post and Easy post.

Materials and Method: 30 single rooted first mandibular premolars were endodontically treated. All the samples were randomly divided into 3 groups (n=10) according to the post system. (GC everStick post – Group I, Easy post - Group II –, Negative control - Group III). In all the samples, mesio-occluso-distal (mod) cavities were prepared and restored with composite restorative material (filtek z250xt). Fracture resistance was measured in a universal testing machine (Mecmesin, England) until fracture and the data was analyzed statistically.

Results: Group I showed highest mean fracture resistance (819.91N), followed by Group II (425.31N) and control group (204.82N). All the samples restored with GC everStick post showed repairable fracture whereas 60% samples restored with easy post showed repairable fracture.

Conclusion: This in vitro study concluded that everStick post could be a simple and efficient way to rehabilitate endodontically treated teeth.

Keywords: Fracture resistance, Glass fiber post, Fiber-reinforced composite.

Introduction

Restoration of root-filled teeth is a critical and final step for successful root canal treatment and has changed considerably in recent years.⁽¹⁾ Historically various methods of restoring pulpless teeth have been employed. However, the post and core system have played a crucial role in improving biomechanical performance to achieve optimum strength, esthetics and function.⁽²⁾

In order to achieve optimal and most favorable results, the materials used for the fabrication of post and core systems should have physical properties similar to that of dentin and should be biocompatible in the oral habitat. Post and core systems have been fabricated using various materials that vary from custom cast post to prefabricated posts, each of these systems have their own merits and demerits.⁽³⁾ Metal posts and cores have a well-established record of successful clinical service. Although still used, they have certain disadvantages like unrepairable mode of failure, difficulty in finishing and polishing, biocompatibility issues due to presence of nickel and absence of physical characteristics similar to dentin.⁽⁴⁾

Recent motivation to reinforce and protect the remaining sound tooth structure has encouraged clinicians to re-evaluate the principles of traditional restorative dentistry. Adhesive technology is advancing by leaps and bounds every day, making it possible to create conservative and highly aesthetic restorations with direct bonding to the teeth.⁽⁵⁾ Due to recent

advances in adhesive technologies, Fiber reinforced composites (FRCs), particularly glass-fiber-reinforced posts, have been advocated.^(6,7) The prevailing popularity of glass fiber posts in restorative dentistry is mainly associated with the similarity in modulus of elasticity to that of dentin, in addition to their superior esthetic properties, lesser dentin removal and ability to be bonded to dentin. EverStick post launched by GC claims to be a novel tooth rehabilitation material which is an adjustable, soft, flexible and unpolymerized glass fibre post that has the potentiality to adapt to the shape of the root canal before light-curing, thereby maintaining high strength following light curing.

The purpose of the present in vitro study was to compare the fracture resistance and determine the mode of failure between GC everStick and Easy post since only constricted information exists between aesthetic post and core systems with different moduli of elasticity.⁽⁸⁾

The null hypothesis stated that the fracture resistance and the mode of failure will not be significantly influenced by the GC everStick and Easy post.

Materials and Method

Thirty intact single rooted mandibular premolars extracted for orthodontic treatment were collected from the Department of Oral and Maxillofacial Surgery, and stored in 0.1% thymol solution, for no more than 3 months after debridement.

Root canal treatment and post space preparation:

Access cavity was prepared for endodontic therapy in conventional manner using a No 2 round bur and water spray. Canal preparations were performed with a conventional step back technique to ISO file 35 at the apex. Throughout the preparation, the canals were irrigated with 3% sodium hypochlorite solution and dried with paper points. Each canal was obturated using gutta percha cones and AH plus as root canal sealer by lateral condensation technique.

Post space preparation of all teeth was initiated by Gates Glidden drill, followed by use of Peeso reamer No 3 keeping 5mm at the apex to maintain the apical seal. The teeth were assessed radiographically and randomly divided into 3 groups of 10 each.

Grouping the specimens (n = 10)

- GC everStick - Group I
- Easy post - Group II
- Negative control (without post) – Group III

Cementation of post, Mesio-occluso-distal (MOD) cavity preparation and core-build up: For group, I GC everStick post (Batch no – 1502271) was used to restore the teeth according to manufacturer's instructions using RelyX resin luting cement.

For teeth in Group II, Easy post (Batch No - 1294451) was used to restore the endodontically treated teeth. The canal were etched with 37% phosphoric acid (Scotchbond Multipurpose Etchant) followed by treating it with Te-Econom Bond and cured for 10 sec followed by RelyX U200 self adhesive resin cement.

Group III served as a control group where the root canal treated teeth were not restored by posts.

MOD preparations was carried out in all the samples till the orifice level so that the buccal wall width of the teeth measured 2mm at the buccal occlusal surface, 2.5mm at the cemento-enamel junction, 1.5mm lingual occlusal surface, 1.5mm at the cemento-enamel junction. The restoration of the MOD cavities was done by composite restorative material Z 250 XT using LED curing light.

Periodontal ligament simulation and fracture resistance test:

Periodontal ligament (PDL) simulation of the teeth was performed by the method described by Soares et al. The roots were kept wet in order to prevent dehydration until they were subjected to fracture testing.⁽⁹⁾ The fracture resistance was measured by Universal Testing Machine (Mecmesin, England) wherein the load was applied halfway between the central fissure and cusp tip, and lingual slope of buccal cusp tip at a speed of 0.5mm/min until fracture.⁽¹⁰⁾ The load was measured in Newton (N).

After visual inspection of the fracture, it was classified as either favorable or repairable (fracture above the cemento-enamel junction) or unfavorable or non-repairable fracture (fracture below the cemento-enamel junction).

Statistical analysis of data was compared and analyzed by one way analysis of variance (ANOVA), Chi- squared test, multiple comparisons (post-hoc test) using Bonferroni test to pairwise comparison of the post systems

Results

The highest mean fracture resistance was demonstrated by the GC group that showed mean fracture strength of 819.91 N. EASY post Group followed the GC group that showed a mean fracture strength of 425.31N while the Negative control group showed the least fracture strength of 204.82N. (Table 1). The difference in the mean fracture resistance among the groups was found to be statistically significant ($p < 0.001$) among all the groups.

The association between type of fracture and the groups was found to be statistically significant ($P < 0.001$). All the samples in the GC group showed repairable type of fracture, while in Easy group 60% samples showed repairable fracture whereas in control group all the samples were found to be of non-repairable type.

Table 1: Mean Fracture Resistance (N) recorded in the groups

Group	Mean	Std Dev	SE of Mean	95% CI for Mean		Min	Max
				Lower Bound	Upper Bound		
GC	819.91	54.25	17.15	781.10	858.72	727.80	898.40
EASY	425.31	10.39	3.29	417.87	432.75	410.30	436.30
Control	204.82	46.43	14.68	171.61	238.03	133.40	264.40

Table 2: Multiple comparisons (post-hoc) using Bonferroni test

Group (I)	Group (J)	Mean Difference (I-J)	P-Value	95% CI for Mean Diff	
				Lower Bound	Upper Bound
GC	RELYX	394.600	<0.001*	347.05	442.15
	Control	615.090	<0.001*	567.54	662.64
EASY	GC	-394.600	<0.001*	-442.15	-347.05
	Control	220.490	<0.001*	172.94	268.04
Control	GC	-615.090	<0.001*	-662.64	-567.54
	RELYX	-220.490	<0.001*	-268.04	-172.94

*denotes significant difference

Discussion

Root canal treated teeth undergo numerous changes, such as reductions in resiliency and fracture resistance.⁽¹¹⁾ There are various factors that contribute to the loss of tooth structure after root canal treatment, one of the most important factors being the width of the tooth in such a way that MOD cavity is considered as the worst case in terms of fracture resistance.⁽¹²⁾ Therefore, in the current study, preparation of MOD cavity was considered for simulation of the worst clinical situation.

Results of the study showed that higher mean fracture resistance ((819.91N) was recorded in Group I followed by Group II (425.31N) and Group III (204.82) respectively. Group II showed approximately half the fracture strength compared to Group I. The null hypothesis was thus rejected.

Due to the close approximation of glass fiber posts to that of dentin in terms of modulus of elasticity and flexural strength, glass fiber posts were selected for this study.^(13,14) Easy post (Dentsply, India) used in this study, mainly consists of zirconium enriched glass fibres (60%) in epoxy resin matrix (40%) An earlier study conducted with the use of glass fiber composite posts containing 70% zirconia (Ice Light, Danville, USA) claimed that due to the existence of zirconium enriched glass fibres these posts had flexural strength close to that of dentin which eventually contributed to better distribution of stresses.⁽¹⁵⁾

The highest mean fracture resistance was demonstrated by the GC group that showed mean fracture strength of 819.91 N. The value obtained in this result is higher compared to many other glass fiber posts tested in various in vitro studies.^(16,17) This could be associated with the unique nature of the Interpenetrating Polymer Network (IPN) matrix of the everStick post. Anil Kishen et al in their study indicated that the remaining dentin thickness of the radicular portion of the tooth possesses a low modulus of elasticity due to decreased mineralization and more collagen deposition. GC everStick has a considerable edge over other glass fiber posts as it requires minimal dentin removal and also helps in a balanced and even distribution of occlusal load throughout the canal. An acceptable adherence between post, cement and dentin is one of the important factors in load transfer. Studies have shown that in everStick post, the monomers of the adhesive resins and cement are dispersed into the linear polymer phase, thereby causing swelling of it and by polymerization, it forms inter-diffusion bonding which is called as secondary semi-IPN structure. Enhanced bonding allows transfer of loads from the crown-core system to the root through the root canal post.⁽¹⁸⁻²⁰⁾ The mode of failure recorded in all the samples in the GC everStick Group was of a restorable type. The possibility for this could be attributed to the even distribution of occlusal stress on the root, thereby

reducing the risk of fractures. The other unique advantages of GC everStick post include its adaption to the morphology of the canal in order to maximize the adhesive surface and the strength in the most critical part of the tooth, tooth preservation as canal preparation is not needed to the same degree as with traditional prefabricated posts and its elasticity is very similar to the natural elasticity of dentin.⁽²¹⁾

In the present study, a unidirectional load was applied which is considered to be a major limitation as the oral environment is exposed to multidirectional masticatory forces, which cannot be duplicated in the Universal Testing machine.⁽²²⁾ Ideally, more relevant test methods should be developed so that the results of the in vitro tests more closely mimic the failure mechanisms of the teeth that are observed clinically. Therefore, further research and clinical investigations are recommended to verify the in vitro results taking into consideration different prefabricated aesthetic post and core systems.

Conclusion

This in vitro study concluded that in root canal treated teeth with acceptable loss of tooth structure, the GC everStick Post could be considered as a simple and efficient option that would provide alternative modes to rehabilitate and reconstruct such teeth thereby, accomplishing patient's functional and esthetic requirement.

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