Evaluation of resin reinforced glass ionomer and packable composite resin used for reinforcement of weaken endodontic canals

Bahaa Abdulrazzaq Jerri (BDS, HDD, MSc) [1], **Haider Hasan Jasim**(BDS, MSc) [2], and **Nada Ali Mahdi** (BDS, MSc) [3]

Abstract

Background: When the weakened root is internally rebuilt with suitable adhesive dental materials, the root is dimensionally and structurally reinforced to support and retain a post and core for continued function of the tooth.

Objective: To evaluate the effect of reinforcement of weakened endodontically treated teeth with packable composite resin (Filtek P60™, 3M, USA) and resin reinforced glass ionomer restorative material (riva light cure, SDI, Australia) on retention of light-transmitting glass fiber post (FRC postec plus, Ivoclar Vivadent, USA) in comparison with weaken endodontic treated teeth that restored with custom cast post without reinforcement.

Materials and Methods: Specimens divided to three groups in which group A represent control group and the other groups represent the experimental groups. Ten samples made from each group giving thirty samples. All samples were stored in deionized distilled water in constant temperature at 37 Cº for 24 hr. Retention of post was measured with tensile strength in instron testing machine (ISO TR 11405,2003) with cross head speed of 0.5mm/min. The samples were pulled-out until dislodgement of post from post hole. Tensile strength was recorded in newton unit (n) for each sample. ANOVA One-way test and student–t test were used to analyze the results and to show the comparison of significance.

Results: There was increase in retention values in group B (samples reinforced with packable composite) and group C (samples reinforced with resin reinforced glass ionomer) when compared with control group (group A) that used custom cast without reinforcing the canal post. Also the retentive values of (group B) were higher than (group C).

Conclusion: Reinforcement of weakened endodontically treated teeth with either packable composite resin or resin reinforced glass ionomer restorative material lead to significant increase in the bond strength of fiber optic post. With greater retentive value for packable composite

Key words: Packable composite, weaken endodontic canal, glass ionomer restorative material.

Corresponding Author: denhaider5@gmail. com

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[1] Department of Conservative - College of Dentistry- University of Basra - Basra- Iraq.

[2, 3] Department of Conservative - College of Dentistry - Al-Mustansiria University- Baghdad - Iraq.

Introduction

Endodontically treated roots with wide and flared canals are at a high risk of fracture as the strength of roots is directly related to the thickness of remaining root dentin [1]. Two methods for restoration of weakened root canals were suggested which were conventional and intraradicular reinforcement methods. The development of "Reinforcement Technique" could be implemented for the treatment of such weakened roots. Thus, for flared and wide canals, it is important that the lost dentin is rebuilt with a strong substitute before placing the post [2]. The retentive value of the composite reinforcement bounded to the root canal wall was significantly higher than that of a custom cast post luted to the root canal wall with zinc phosphate cement [3]. Thin-walled endodontically treated teeth can be restored and reinforced using dental adhesives with composite resin in the root canal [4].

The main function of a post is the retention of a core to support the coronal restoration [5]. The prefabricated posts which have standard dimensions are made of a variety of metallic and non-metallic materials. The prefabricated composite posts provides better mechanical and aesthetic properties and reproduce better natural load transmission mechanisms because their stiffness is very close to dentine [6]. The ideal post system should have the same material for post and core and also the post's modulus should match with the dentin's modulus [7]. Post diameter should not exceed one-third the root diameter. Each millimetre of increase (beyond one-third the root diameter) causes increase in the potential for root fracture [8].

Reinforce weaken canal post with composite lead to increase retention and resistance to fracture [9]. Duret introduced Fiber posts at the beginning of the 90s [10]. The diameter and density of the fibers as well as the adhesion between them and the matrix strictly influence the quality of the post and its mechanical properties. The resinous matrix (epoxy or methacrylate) is injected into the pre-tensioned fiber bundle to completely fill the spaces between fibers. As alternative, fibers are simply immersed in a resin bath. Differences in manufacturing are strictly related to the quality, mechanical and clinical behavior of posts [11]. Fiber posts main advantage is the variability of their modulus of elasticity depending on loading direction. In particular, when considering a transversal loading, the modulus of elasticity has a value close to sound dentin [12]. This property reduces stress transmission to root canal walls and thus the risk of vertical fractures [13]. On the contrary, the highly rigid metal post would transfer lateral forces without distortion to the less rigid dentin and lead to a higher chance of root fracture [14].

The most common failure that can occur with a fiber post is a "debonding" of the post, especially at the time of removing the temporary restoration, but this failure can easily be dealt with by repeating the adhesive procedures. In the presence of a fiber post, if a root fracture occurs, is usually located more coronally and is more easily retreatable [15-17]. However, the possibility of using fiber posts in post conjunction with direct composite restorations (without additional crown coverage) is becoming a reliable alternative, ensuring long-term service [11]. The post width should not exceed one-third of the root width at its narrowest dimension and most roots are not perfectly rounded [18]. Minimum of 1 mm of sound dentin should be maintained circumferentially, especially in the apical area where the root surface usually becomes narrower and functional stresses are concentrating [19].

So this study aim to evaluate the effect of reinforcement of weakened endodontically treated teeth with packable composite resin and resin reinforced glass

ionomer restorative material on retention of light-transmitting glass fiber post in comparison with weaken endodontic treated teeth that restored with custom cast post without reinforcement.

Materials and Methods

Samples selection

Thirty freshly extracted sound maxillary central incisors teeth were selected. Kept in container filled with crystal of thymol solution to avoid dryness till the time of testing. Teeth were selected with dimension ranges as; Length of crown about 10-12 mm;

Length of root about 11-13 mm; Diameter of root at the coronal part 6 mm ± 1; Diameter of root at the middle part 4 mm ± 1. Samples was randomly divided into three groups (n=10), depending on the type of post, identification are demonstrated in table 1.

Table (1): Classification of the groups in this study.

Group A	Control group
Group B	FRC postec plus post + reinforcement with packable composite resin
Group C	FRC postec plus post + reinforcement with glass ionomer restorative material

Samples preparation

Low speed hand piece and laboratory diamond disk used to sectioned teeth 1mm above the cemento-enamel junction of the tooth. Sectioning process is done were laboratory diamond disc bur was perpendicular to the long axis of the tooth with water cooling system.

Root canal filling of samples

The roots of teeth were instrumented with step-back technique according to the international standardization organization (ISO) by using files up to size #60 (master apical file). Irrigation is done with sodium hypochlorite solution 5.25%, and then the canal dried with paper point size 60. The roots canals were filled using lateral condensation technique with gutta percha size 60. Preparation of post space and weakening the canal: Mechanical method was used to prepare post space and then weakened root canal. Gates-Glidden drill no.6 used to remove coronal gutta percha. Pesso reamer no. 6 used to complete removal of gutta percha. The post space prepared by using post drill (coincide with the post size), the post space was 8 mm in depth and 2 mm in diameter leaving at least 5 mm of material at the apical end of the root.

Vernia, Post drill and stopper were used to take measurements. The final post hole was tapered in shape in which the apical part was 1 mm in diameter corresponding to the pesso dimeter and the coronal part was 2 mm in diameter (according to the dimensions of post drill). Weakening of post space is done by using laboratory diamond tapered bur with dimensions of; Length of bur is 6 mm, Diameter of bur at the narrowest end is 3mm, Diameter of bur at the widest end is 4 mm

•The Laboratory diamond tapered bur was attached to straight low speed hand piece and fixed to dental surveyor .The weakening was done with water cooling with dimensions of; 6 mm in depth and 4 mm in diameter at the coronal end of the root.

•The apical 2 mm of post space left without weakening (to retain the post inside the canal)

Control group (group A):

Canals were restored with custom cast post (nickel chrome) without reinforcement in the following sequence.

•Blue inlay wax and plastic post used to take impression in direct waxing technique.

•Nickel chrome cast post fabricated in dental laboratory in which the post fill the hole space of post.

•Zinc phosphate cement used in cementation of custom cast metal post according to manufacture instruction of cement type.

•Lentulo spiral instrument used to apply cement inside the post space. Custom cast

post fixed to dental surveyor and inserted in post space under standardized pressure

Experimental groups

Canals were restored with glass fiber post (FRC postec plus, Ivoclar Vivadent, USA) and reinforced with packable composite resin (Filtek P60™, 3M, USA) or resin reinforced glass ionomer restorative material ((riva light cure, SDI, Australia) in the following sequence;

1. We cut the post leaving 2 mm above root border to become as a Light transmitting tip for complete setting of packable composite inside the canal post.
2. Post coated with Vaseline layer to prevent adhesion of the composite to post surface.
3. The post space was rinsed with distilled water and dried with air and paper point.
4. Total etching (35% phosphoric acid solution) was applied into post space for 20 seconds.
5. Etching material was rinsed with water and cotton pellet used to blot excess water.
6. The post space dried with gentle air blast.

Group B

Adhesive applied inside the post space according to manufacture instruction. The access material is removed by paper point. Packable composite packed inside the canal by using plastic condenser, the composite packed around the post in bulk technique and then excess material is removed prior to curing procedure. Tip of light cure unit is place on the end of the post 2 mm above the coronal margin of root and curing with visible light cure for 40 seconds is done. The intensity of light cur is 800mw/cm². The light transmitting post is removed from the post space. The post space clean with alcohol (ethanol 96%) and dried with paper point before cementation.

Group C

The glass ionomer material supplied in capsule. The material was held in capsule applicator (DENTSPLY, USA) and injected inside the post space around the glass fiber post, then the material packed with plastic condenser and the access material removed prior to light curing. The light curing procedure performed for 10 seconds through the glass fiber post according to the manufacturer instructions. The light transmitting post is removed from the post space. The post space clean with alcohol (ethanol 96%) and dried with paper point before cementation.

For both groups (B and C), the fiber optic post cemented in post space with Rely X adhesive resin cement (3M ESPE, USA) according to the manufacturer instructions. All samples now stored in deionized distilled water, placed in incubator in constant temperature at 37C° for 24 hours.

Tensile strength (testing procedure) After storage period the samples now embed in acrylic resin. Tensile bond strength was evaluated with Instron testing machine, with a cross head speed of 0.5mm/ min (ISO TR 11405, 2003).

Results

Means and standard deviations of three different groups are listed in table 2. The data revealed that, there were increase in retention values in group B (samples reinforced with packable composite) and group C (samples reinforced with resin reinforced glass ionomer) when compared with control group (group A) that used custom cast without reinforcing the canal post. Also the retentive values of (group B) were higher than (group C).

Table (2): Descriptive statistics of all groups in newton (N) unite

Groups	Group A	Group B	Group C
Mean	89.52 ±	267.36 ±	169.63 ±
SD	5.82	7.93	5.24

Statistical analysis of data by using one-way ANOVA test revealed that, there was a highly significant difference (P<0.0001) among the different groups (table 3).

Table (3): One-way ANOVA test among different groups.

	ss	df	ms	f	p
Between	158.65	2	79.32	1.9	0.0001
Within	1.118	27	41.42		
Total	159.77	29			

SS: Standardized square. **DF:** degree of freedom. **MS:** mean square. **P:** probability

After using ANOVA test, student t-test was performed to compare between the means of the tested groups as shown in table 4.

Table (4): Student t-test compare between tested groups

Groups	t-test	P-value	Significance
A vs. B	57.17	0.0001	VHS
A vs. C	32.34	0.0001	VHS
B vs. C	32.51	0.0001	VHS

***VHS** = very highly significant

There was a very highly significant difference in retention values when comparing the control group with the other two groups. Also the difference was very highly significant at level p<0.0001 between Group B and Group C.

Discussion

In this study, the forces required to dislodge fiber optic post from the reinforced root canals were significantly greater than control group. The mechanical interlocking of resin cement in the post irregularities and its better bonding may explain the highest bond strength values obtained when compared to zinc phosphate cement. Also during cementation with zinc phosphate cement, the method used was lentulo spiral (conventional method). This method may lead to trapping air bubbles and creating voids and lead to debonding in cement-post adhesions surface [20]. The FRC postec plus post was used in this study for the purpose of light transmitting during photopolymerization. Lui in 1994 observed high depth of cure up to 8 mm inside canal post [4]. Yoldas *et al*. found microhardness of composite inside the canal at the depth of setting up to 8 mm if used glass fiber post as light transmitting [10]. Moreover, Rely X adhesive cement was used in this study because it adhered more on glass fiber than zirconia fiber [1]. FRC postec plus post composed of glass fiber (70 % vol), dimethacrylate resin matrix (21% vol) and ytterbium fluoride YbF2 (9 % vol). Ytterbium fluoride modifies the setting characteristics, strength and surface hardness of post [21]. In our study, the canals that reinforced with packable composite resin showed retention values significantly higher than canals that reinforced with resin reinforced glass ionomer cement. The packable composite resins are characterized by a high filler load and a filler distribution giving material with higher viscosity and

stiffer than glass ionomer materials [22]. The higher molecular weight of the packable composite resin results in less shrinkage, reduced aging and a slightly softer resin matrix [2]. Additionally these resins impart a greater hydrophobicity and are less sensitive to changes in atmospheric moisture [13]. All these properties produce packable composite of good adaptation to dentin wall and less stress concentration so it leads to increase retention of post. Also strong chemical and mechanical adhesion (compared to the chemical bond of glass ionomer restorative material) are found when packable composite used because adhesion is done between dentin and composite by use 5th generation bonding system that use one bottle adhesive (prime and bond) with strong acid (37% phosphoric acid) [20].

Complete setting of packable composite inside the canal post and fine filler particle give good adhesion surface and lead to increase retention [23].

In conclusions, under the limitation of this in vitro study, reinforcement of weakened endodontically treated teeth with either packable composite resin or resin reinforced glass ionomer restorative material lead to significant increase in the bond strength of fiber optic post. Also the reinforcement with packable composite imparts greater retentive values than reinforcement with glass ionomer material.

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