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To Evaluate the Push out Bond Strength of Fiber Post System Using A Self-Etch Resin Cement and A Total-Etch Resin Cement

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ABSTRACT

Aim: The push out bond strength of a fiber post system was evaluated and compared using a self-etch resin cement and a total-etch resin cement.

Materials and method: In this in-vitro study 30 maxillary central incisors were decoronated from the CEJ. Root canal preparation and obturation were done and post space was prepared using peeso reamers (Size #3). Samples were randomly divided into 2 groups (15 samples each). Group A consisted of posts luted using self-etch resin cement (RelyX U200; 3M ESPE), and Group B consisted of posts luted using total-etch resin cement (Variolink N Intro Pack; Ivoclar Vivadent). The samples were then sectioned into 3 parts – Coronal, Middle and Apical; and subjected to push out bond strength testing under a Universal Testing Machine.

Results: There was no significant difference seen in the push out bond strength of the fiber post system (RelyX U200:84.353, Variolink N Intro Pack: 28.741); whereas, significant difference was seen at different root levels.

Conclusion: The push-out bond strength of both the cement was non-significant. When the push-out bond strength was compared at various root levels; the coronal segment exhibited higher push-out bond strength, followed by the middle segment and the lowest was shown by the apical segment.

Key Words: *Self-etch resin cement, Total etch resin cement, Fiber post, Universal Testing Machine*

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INTRODUCTION

With increase in aesthetic considerations among patients, preserving the tooth structure has become a significantly important for dental practitioners worldwide. Numerous techniques for maintaining and conserving the tooth structure have been used, one of which being the Post and Core system. The post and core technique extends back to 1871 when Harris advocated a post or "pivot" for holding an artificial crown in a root that had undergone root canal therapy [1].

Fibre posts were launched in the 1990s, and they quickly gained popularity. The fiber posts outperform conventional metal posts due to their superior mechanical properties, which resemble more closely the properties of dentin, give uniform distribution of stress in the root canal, need minimal preparation of the tooth structure, provide aesthetics and more light transmission in the apical region – which aids in the polymerization of resin cement [2].

Additionally, fiber posts have favorable fracture patterns that make them more likely to be restorable due to their less rigid structure and ability to be easily removed from the root canal in the event of endodontic retreatment. In comparison to the bond produced between a metal post and resin core, the bond strength between a fiber post and resin core is also stronger [3, 4].

The cement used for cementing the restoration to the tooth is critical to the clinical success of any restorative procedure [5]. It was determined that resin cements significantly improve post retention and tooth fracture resistance [5, 6]. There are mainly three types of resin cements: conventional (total etch), adhesive (self-etch), and self-adhesive. In the self-etch and rinse method, phosphoric acid is used to dissolve the smear layer and demineralize the dentin underneath. Next, a hydrophilic monomer is applied, which penetrates the conditioned dentin surface. By skipping the rinsing step, these processes produce a less harsh demineralization that is followed by the application of the adhesive resin [7].

In varying lengths of the root canal, the binding strength of fiber posts to the dentin varies. This might be a result of the curing light's inability to penetrate more apical portions of the root canal, the difficulty of accessing the deeper regions of the root canal, and the difficulty of applying adhesive and controlling moisture in the apical section of the root canal [8].

The goal of this study is to use a Universal Testing Machine (UTM) to compare the push-out bond strength of a fiber-reinforced composite post system bonded with self-etch cement and a traditional resin cement system in the coronal, middle, and apical regions of the root canal. The null hypothesis states that for various lengths of the post space, there is no appreciable difference in the binding strength of fiber posts with both self-etch resin cement and traditional resin cement.

MATERIALS AND METHODOLOGY

A total of 30 extracted caries-free human maxillary single-rooted central incisors were free of cracks, carious lesions, fractures, and resorption, with fully developed apices without previous endodontic treatments, posts, or crowns, the sample preparation shown in Fig.1 (a) to (h). These samples were stored in 0.5% chloramine T solution, were used for this study.

The pulp tissue was removed from the root canal, and working length was established using a 15K file followed by decoronating at the Cementoenamel Junction (CEJ) using diamond discs under continuous water cooling. The biomechanical preparation was completed using the step-back technique (master apical file = 40K). The root canals were then dried using paper points, followed by obturation using Gutta-Percha (Meta-Biomed) with lateral condensation method. The sealer used in obturation was Sealapex Root Canal Sealer (Kerr Manufacturing Co., California, USA). Next, the coronal root canal openings were filled using a provisional restorative material. All the samples were stored in 100% humidity at 37^0 C for 1 week in an incubator to mimic the oral cavity environment. After completion of 1 week, post space was created using a peeso reamer (Mani Inc.), keeping the length 4mm short from the radiographic apex. This step was repeated with size 2, followed by size three and finally size 4, until an entire post space was prepared. A standard of 4mm gutta-percha – measured from the Cemento-Enamel Junction – was left behind in the apical third of all the samples, regardless of their working length, followed by copious irrigation with saline. Repost Glass Fiber post size 2 (Angelus) were cemented in the root canal and were cut to the desired length measured from the cementoenamel junction; underwater irrigation using diamond disks and were disinfected, followed by air drying.

The teeth were randomly allocated into two equal groups. Group A and Group B contained 15 samples each, in which the posts were luted, according to manufacturer's instruction, using different luting types of cement; i.e., self-etch resin cement (RelyX 200; 3M ESPE) and Total-etch resin cement (Variolink N Intro Pack, IvoclarVivadent).

Post cementation with different cement systems were shown in Fig. 2 (a) to (j). Once the cementation procedure was complete, all the specimens were stored in normal saline at 37^0 C for one week. Each root was then sectioned under constant water cooling with a diamond disk to create 3mm thick slices. Thus, one coronal, middle and apical section was obtained from each root, and the diameters were measured using digital callipers. The teeth were divided into 2 groups (n=15) as follows: group A (15 samples) posts were luted using self-etch resin cement and group B (15 samples) posts were cemented into the root using total-etch resin cement.

To perform the push-out test, the upper part of each section was loaded with a 0.5 mm diameter cylindrical stainless-steel plunger that provided nearly complete coverage over the post without touching the canal wall. The plunger was fixed in the upper art of a Universal Testing Machine (automated software based) Company: Star Testing Systems, India. Model No. STS 248, Accuracy of the machine ± 1, crosshead speed= 1mm/minute, was used to measure the push-out bond strength by recording the peak force (N), which was required to extrude the posts from the cut sections; cut at various levels – coronal, middle, apical. The bond strength is expressed in MPa by dividing the load at failure (N) by the area of the bonded interface. The samples were mounted in such a way to ensure that the direction of the plunger push was from the apical to the coronal direction in each section. This was done to avoid any interference owing to any root canal taper. The push-out bond strength was calculated with the following formula

$A = \pi(r_1 + r_2)\sqrt{(r_1 - r_2)} 2 + h2$ 116 117

Where, $\pi = 3.14$, r_1 is coronal post radius, r_2 is apical post radius and h is section thickness in millimetres.

Statistical Analysis:

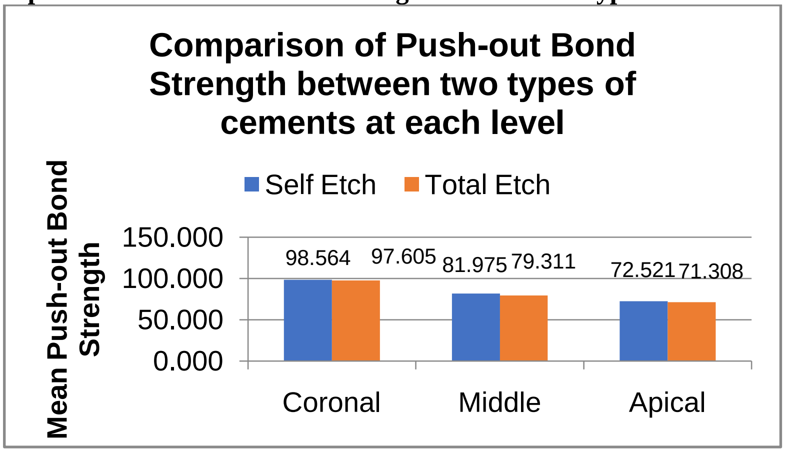
The data were analysed by SPSS (21.0 version) and statistical Analysis of the collected data was done using student 't-test – paired and unpaired at p<0.05 was set for statistical non-significance.

Table 1: Comparison of Push-out Bond Strength between two types of cements at each level

Level	Self-Etch		Total-Etch		't' value	P value
	Mean	± SD	Mean	± SD		
Coronal	98.564	39.360	97.605	29.421	0.076	0.940; NS
Middle	81.975	34.934	79.311	30.735	0.222	0.826; NS
Apical	72.521	37.823	71.308	26.771	0.101	0.920; NS

Student't' test Unpaired: NS: p > 0.05; Not significant

Graph 1: Comparison of Push-Out Bond Strength between two types of cements at each level.



Graph 2: Comparison between different levels in each type of cement

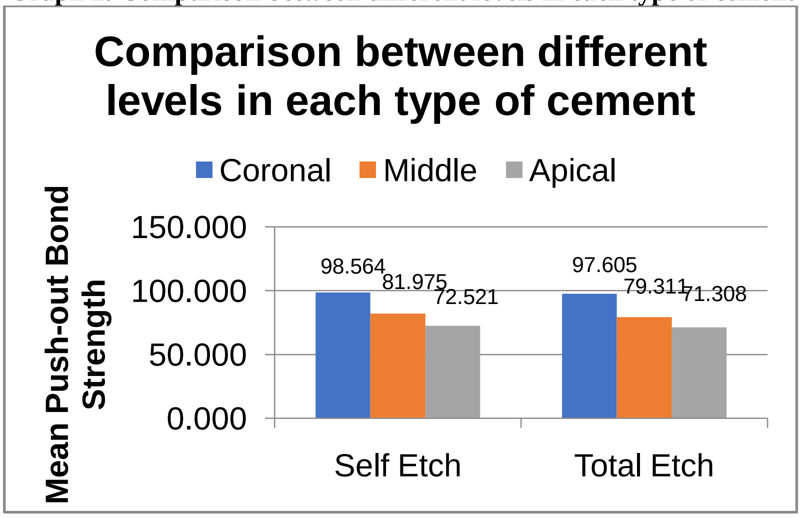


Table 2: Comparison between different levels in each type of cement

Cement	Level	Mean	± SD	't' value	P value
Self-Etch	Coronal	98.564	39.360	1.253	0.231; NS
	Middle	81.975	34.934		
	Coronal	98.564	39.360	2.246	**0.041***
	Apical	72.521	37.823		
	Middle	81.975	34.934	0.666	0.516; NS
	Apical	72.521	37.823		
Total-Etch	Coronal	97.605	29.421	3.992	**0.001***
	Middle	79.311	30.735		
	Coronal	97.605	29.421	3.967	**0.001***
	Apical	71.308	26.771		
	Middle	79.311	30.735	1.263	0.227; NS
	Apical	71.308	26.771		

Student 't' test Paired: NS: p > 0.05; Not significant; *p<0.05; Significant

RESULTS

The results revealed that the push-out bond strengths between the two cements (Self-etch resin cement and Total-Etch Resin Cement) were statistically non-significant (Table 1, Graph 1). Amongst both the groups, the coronal third, middle third and the apical third of the self-etch resin cement exhibited slightly higher values than the coronal third, middle third and apical third of the total-etch resin cement, which was statistically significant (Table 2, Graph 2). Within a cement, the push out bond strength decreased from the coronal segment towards the apical segment.

DISCUSSION

A post placement is frequently required into the root canal of an endodontically treated tooth where substantial amount of coronal tooth structure has been lost. It was recommended that placing an intra articular post doubles the fracture resistance of the root [9]. In the present study no significant difference in the mean push-out bond strength of self-etching and conventional resin cement systems was found. The type of cement used had no effect on the bonding strength when universal adhesives were employed. As a result, it can be asserted that the adhesive system is critical for adhesion and the kind of cement is secondary [10].

The prefabricated metal post and custom cast are rigid, lack bonding ability, and different modulus of elasticity as from the tooth structure which induces stresses and results in root fracture. Due to their spherical form, they offer less resistance to rotational forces. Thus, preferred choice is; fiber posts to increase the success rate of endodontically treated tooth restorations [11, 12]. Additionally, fibre posts are recommended due to their simplicity of use, mechanical qualities, aesthetics, and removability [13, 14]. Their mechanical features are comparable to dentin's, they form a mechanically homogeneous unit and create a "monoblock" with virtually the same modulus of elasticity [15]. The fibres in the fibre post, disperse stresses across a larger surface area. When fiber posts were present, both on cervical and on root-furcation horizontal sections, the highest levels of stress seemed to be concentrated within the fiber posts and away from the radicular dentin [16].

In the present study, there was no statistically significant difference in the push-out bond strength of self-etch resin cement (Group A) and total etch resin cement (Group B) at all three levels. However, mean push-out bond strength of the two cements was not significantly different. Within a cement, the push out bond strength was seen to decrease as we moved from the coronal segment towards the apical segment. One of the major reasons for the decline in push out bond strength from the coronal to the apical segment is the decrease in the intensity of the curing light. This leads to decrease in the polymerization of the resin cement in the apical segment; and hence leading to a decrease in the bond strength of the fiber post in this region [17].

Bitter K et al. evaluated different luting agents push out bond strength with tooth-coloured posts among which two were total-etch resin cements and a self-etch resin cement. They determined that the push-out bond strength of all luting cement was almost the same and that the difference between the self-etch and total-etch resin cement was insignificant [18]. The probable reason could be that the hybrid layer and the resin tags formed due to etching of the dentin surface, were nearly the same in both the luting agents [19].

The strength of the push-out bond was much greater in the cervical region. The coronal segment showed higher push out bond strength values as compared to the middle and the apical segment, it was in accordance with the study of Tavares AF et al. who studied the effect resin cement application strategy had on the push out bond strength of fiber post system at different root regions; and concluded that in all the cements, the push out bond strength was variably more at the cervical third as compared to the middle and the apical thirds [20]. Also, Musharraf R and Haerian A determined that the dentinal tubule density and diameter decrease from the cervical third to the apical third [21]. Also, the greater number of tubules present per mm [2], the higher is the bonding to the tooth. This occurs because of greater adhesion that is enhanced by greater penetration of the resin into the tubules. This decrease in tubule density gives us a reduced area available for bonding. The dentin hybridization that occurs is not uniform in the apical part of the root, and the lateral branches that are formed by the resin tags are not observed in this region.

According to Özcan S et al., factors such as apical sclerosis, the high value of configuration factors, difficult visibility and accessibility and the tendency for air bubble formation during cement application; all affect the bond strength at various levels of the root canal [22].

The limitation of the present study includes that the influence of fatigue loading and thermal cycling on the push-out bond strength were not considered. Further research is however needed with more studies and greater number of samples with varied root/canal numbers; and considering various other factors.

CONCLUSION

On calculating the push out bond strength among the two cements, it was concluded that the difference in the bond strengths of the two cements is insignificant. Based on the results and under the conditions of this study, it was concluded that posts cemented using either self-etch resin cement or total-etch resin cement; expressed no difference in their push out bond strengths whatsoever. Whereas their push out bond strength did vary within themselves at different levels of the roots; with the highest being at the cervical region and the lowest being at the apical region. Hence, the outcome of the bond strength of the post with the root dentin wall does not depend on the type of cement used. Also, proper technique should be followed, to avoid the formation of any voids inside the canal and any other procedural errors.

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