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RESEARCH ARTICLE

PUSH OUT BOND STRENGTH OF TWO DIFFERENT TYPES OF FIBRE POST USING SAME SELF ADHESIVE RESIN CEMENT.

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Abstract

Materials and Methods: Twenty human mandibular single-rooted second pre-molar teeth were decoronated, endodontically treated, post space prepared and divided into two groups (n = 10);) Group I: Everstick post (GC) and G-cem resin cement(GC) Group II: Tenax fibre post(Coltene) and G-cem Resin cement(GC). Each root was sectioned to get slices of 3 ± 0.1-mm thickness. Push-out tests were performed using a universal testing machine. To express bond strength in megapascals (Mpa), load value recorded in Newton (N) was divided by the area of the bonded interface.

Results: The mean values of the push-out bond strength show that Group I had significantly higher values than Group II in middle third of the root .

Conclusions: Within limitation of present study it can be concluded that customizable post shows good bond strength than prefabricated post. But means bond strength for both type of post is higher in cervcal region than middle and apical third.

Introduction:-

Endodontically treated teeth, with a large amount of coronal tooth structure missing, frequently require the placement of a post inside the root canal, to retain a core for definitive restoration. The choice of appropriate restoration for these teeth is influenced by strength and esthetics. Depending on the clinical parameters, the choice may be a metal or an esthetic post and core restoration.

Fibre-reinforced composite (FRC) posts, as an alternative to cast post and cores and metal dowels, were introduced in the early 1990s to restore endodontically treated teeth with an excessive loss of tooth structure [1,2.]. The preference for and popularity of FRC posts can be chiefly described to an elastic modulus that is closer to that of dentin and provision of good esthetic particularly after all ceramic crowns.[3] Other advantages of FRC posts include enabling smooth cementation procedures to be carried out without friction with root canal walls[1-3] and a reduced risk of root fractures [2,4,5]. Later on several advantages are shown. An in-vitro studies have shown that FRC posts distribute occlusal stresses more evenly in the root dentin, thereby resulting in fewer and more favourable root fractures, which were often repairable. [6-8]

When post and core restorations done in esthetic region of mouth, quartz or glass fibre posts can be used [(9)]. With regard to the fibre posts that are currently available in the market, they are composed of unidirectional fibres embedded in a resin matrix in which reinforcing quartz or glass fibres are blended. Fibres are pre-stressed, and subsequently resin (as a filler) is injected under pressure to fill the spaces between the fibres, giving them solid cohesion. [10, 11.]

When posts are used, bond strength at the post-cement-root interface is affected by various factors like root canal shape, cavity configuration factor, degree of hydration of root canal dentin, surface conditioning agent, luting cement used, adaptation of post to canal walls, use of eugenol-containing sealers, the anatomic differences in density and orientation of the dentinal tubules at different levels of the root canal [12-14].

Other factors that may pose significant challenges to the bonding procedures, and hence may compromise bond strength, arise from the difficulty of gaining direct vision to the root canal[16], the difficulty of moisture control in root canal and adhesive application in the apical region of root canals,[16] the difficulty of the curing light to reach apical part of root canal[15.] Owing to the small and narrow root canal space especially in the apical region, it has been shown that the bond strength of resin cements to root dentin varied along the root dentin surface, being higher at the cervical region and lower in the apical region.[13,17,18]

For the bonding of fibre posts to root canal dentin, various luting cements and adhesive systems have been proposed. Recently used adhesive system can be divided into self-etching adhesive and total-etching adhesive systems [16]. With the newly developed self-adhesive resin cements, no pretreatment of dentin with the phosphoric acids is required, so the step of rinsing off the phosphoric acid is also eliminated, and hence the need for clinical assessment of optimal dentin wetness after rinsing dentin [12]. In other words, the simpler self-etching adhesive approach requires a reduced number of clinical procedural steps, hence offering the advantages of a shorter application time and more importantly, reduced technique sensitivity.

For bond strength measurement, a variety of test methods are currently available like pull-out bond strength, push-out bond strength, micro tensile strength. Amongst which the push-out bond strength tests are most common for material placed in root canal, which was first used in 1996 to evaluate bonding to root canal dentin. [22] It is believed that the push-out test method provides a better estimation of the actual bonding effectiveness than a conventional shear bond strength test. This is because by using a push-out protocol, failure occurs parallel to the post-cement-dentin interface, which resembles the clinical condition[22-24]. In addition, the push-out test has been considered to be more dependable than the micro tensile bond test for bonded posts because of the high number of premature failures occurring during specimen preparation and the large data distribution associated with micro tensile testing [25]

Pre fabricated posts are available for many years but these posts have some disadvantages also like rigidity and poor adaptability in oval and flared canals so new researches have introduce customizable fibre post which can be used in oval canal as it can be adapted according to the shape of the canal as custom cast post. So the present study is done to evaluate push out bond strength of customizable fibre post.

Materials and methods:-

Twenty human mandibular second pre-molars extracted for periodontal and orthodontic reasons were selected. The specimens were free of cracks, carious lesions, fractures, and resorption, with fully developed apices and without previous endodontic treatment. Teeth were cleansed using ultrasonic and disinfected by immersion in 2.5% sodium hypochlorite solution for 2 hr and stored in normal saline.(Fig-1)

Fig-1-Extracted tooth

All the teeth were decoronated 1.5-2.0 mm coronal to the cemento–enamel junction with a diamond disc to get 15 mm root length. The pulp tissue was extirpated and canal patency was assessed with a size 10 K-file. Working length was established 1 mm short of the apical foramen and canals were enlarged up to rotary protaper F3 file following the crown down technique with an intermittent irrigation using 1 ml of 2.5% sodium hypochlorite. After final irrigation with normal saline, the canals were completely dried and obturated using AH plus sealer and corresponding F3 Gutta-percha.

Post luting procedures according to adhesive approaches:-

For post space preparation, excess gutta-percha was removed with a warm plugger (Sybron Dental Specialties, Romulus, MI, USA), leaving a minimum apical seal of 4−5 mm of gutta-percha in the canal. Post space is prepared with No.3 peeso reamer, so that, post holes were prepared to a depth of 10mm from the CEJ. The roots were instrumented using the appropriate drill sizes provided in the kit from the respective post manufacturers. A final flushing of the canal space was accomplished using sterile water, and the canals were dried with paper points (Dentsply-Maillefer). The presence of any residual gutta-percha in the root canal walls along the post space was checked by radiographic evaluation.

The prepared roots were randomly divided into two groups. Group-1 and Group-2. In group-1 the fibre post used were customizable glass fibre post (Ever-stick post,GC)and in group -2 pre-fabricated glass fibre post(Tenax fibre post,Coltene) were used .Customizable fibre posts are first shaped according to the canal. Then it is light cured and bonded with Resin luting cement(Figure-2) Method used for post cementation with post composition in this study are given in Table 1.

Fig 2-Post cementation

Table-1

Material & Manufacturer	Composition	Application Method
Luting cement G-Cem Link-Ace	Silica, Glass, Methacrylated Phosphoric acid ester, acetate.	Clean, rinse and thoroughly dry the post space using paper points. Prepare the post according to the manufacturer's instruction. Attach GC automix Tip for Endo and apply extension tip. Extrude material into root canal and insert post immediately within 1 min. Remove excess cement and light cure for 20 sec.
Fibre reinforced PostTenax fibre Post	Fibre/Glass Reinforcement-75% Resin-25%	
Ever-stick Post	Interpenetrating polymer Network with Sialinated E glass fibre	

Push-out bond strength evaluation:-

To evaluate the bond strength between the fiber posts and the luting cements, a thin-slice push-out test was used in this study. Each specimen was sectioned horizontally with a low-speed diamond disk (Isomet 1000, Buehler Ltd.) under water cooling to produce three 3±0.1mmthick post-dentin sections from CEJ to apical third(cervical, medium, and apical). (Fig-3)

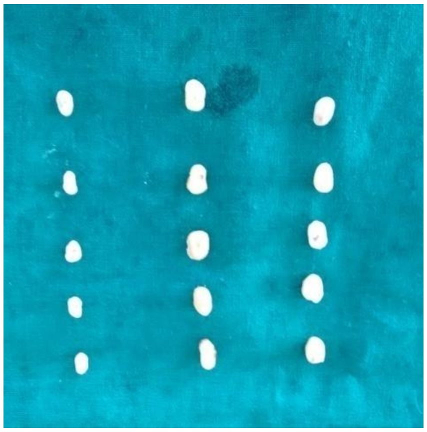

Fig 3-Sections of tooth

The first slice represented the cervical region, the next slice represented middle region and the last slice represented the apical region of the prepared post space. None of the slices failed during sectioning, and all slices were used for push-out bond strength evaluation. Each specimen was marked on its coronal surface with an indelible marker, and the exact thickness of each slice was measured using a digital caliper (0.01 mm accuracy; Mitutoyo, Tokyo, Japan).

Each section was attached to a push-out jig with a cyanoacrylate adhesive (Zapit®, Dental Ventures of America Inc., Corona, CA, USA), whereby the coronal surface of root faced the jig and the post was centred over the hole of the jig. The post segment was loaded with a custom made jig (1 mm in diameter), which was centred on the post segment and which had no contact with the surrounding dentin surface. Load was applied with a universal testing machine, in an apical-to-cervical direction with respect to the individual test specimens, at a crosshead speed of 1 mm/min until the post was dislodged. (Fig-4)Push-out bond strength was calculated for each specimen by using the following formula:

Debond stress = Debonding force (N)/A

where A=area of the post-dentin surface.

Debond stress values were converted to megapascals (MPa).

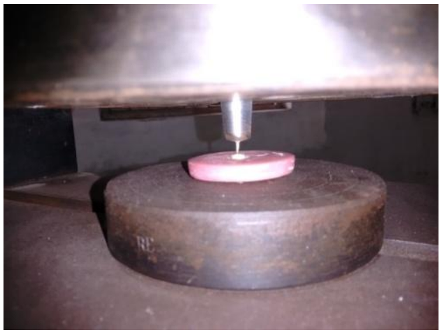

Fig 4-Push-out bond test

Results:-

Table-2 Group-I

Coronal(Mpa)	Middle(Mpa)	Apical(Mpa)
7.96	8.49	8.49
6.63	7.96	7.07
10.68	7.96	10.61
8.49	8.80	6.63
10.68	8.52	6.63
7.99	7.99	8.52
6.66	7.99	7.10
10.71	8.83	10.64
8.52	8.55	6.66
10.71	10.74	6.66

Group-II

Coronal (Mpa)	Middle (MPa)	Apical (Mpa)
8.68	6.94	8.68
8.10	7.52	8.70
8.79	8.10	8.69
7.89	6.94	8.69
9.60	7.52	8.70
8.71	6.97	8.71
8.13	7.55	8.73
8.82	8.13	8.72
7.92	6.97	8.72
9.63	7.55	8.73

Statistical Analysis:-

Statistical Analysis was performed with help of Epi Info (TM) 3.5.3 which is a trademark of the Centers for Disease Control and Prevention (CDC). t-test was used to test the significant difference between means. $p \leq 0.05$ was considered statistically significant.

Table-3

	Ever stick –G link (Group I) (n=10)	**Tenax –G-link (Group II) (n=10)**	**Group-A Vs Group-B**
Coronal (Mean±s.d.)	8.90±1.67	8.63±0.63	t_{18}= 0.47 ;p=0.6440
Middle (Mean±s.d.)	8.58±0.83	7.42±0.46	t_{18}= 3.86 ;p=0.0011
Apical (Mean±s.d.)	7.90±1.61	7.42±0.46	t_{18}=1.59 ;p=0.1292

t-test showed that no significant difference was found between mean coronal strength of Group-A and Group-B (p=0.6440) though Group-A has higher mean coronal bond strength than Group-B.
t-test showed that mean middle strength of Group-A was significantly higher than that of Group-B (p=0.0011).
t-test showed that no significant difference was found between apical strength of Group-A and Group-B (p=0.1292) though Group-A has higher mean apical bond strength than Group-B

Discussion:-

In the present study, the push-out bond strengths of two different types of post with same luting cements at three different root regions after dual polymerization were measured. In particular, the statistical significant difference in bond strength results between pre fabricated glass fiber- and custom made glass fiber-reinforced composite posts suggested the relatively superior fitting of the customizable fibre post(Everex post) might enhance the friction level between post and tooth structure when compared with pre-fabricated post. The result of this study echoed the finding by Bell et al,2005 that demonstrated higher bond strengths of an individually formed IPN post compared to an prefabricated fiber post.

Irrespective of post type, highest bond strength values were achieved in the cervical region, whereas the lowest values were obtained in the apical region[13,24,27]. This outcome was to be expected on two fronts: more difficult access to the apical region and a possible limitation of cement flow. At the middle and apical regions, reduction in curing light transmission could account for a decrease in the polymerization of the luting cements in these regions, thereby accounting for the lower bond strengths achieved by the luting cements in these regions.

Another factor that may cause reduced dentin bond strengths is the polymerization shrinkage stress created by the luting cement within the long narrow post space. These shrinkage stresses are caused by a high C-factor (ratio of bonded to non-bonded surfaces) of the post space, which may even exceed 200[13]. With resin composite restorations, the C-factor is much higher and more complex in root canals than in cavity preparations[30]. To overcome reductions in dentin bond strength caused by rapid polymerization shrinkage —especially that of thin layers of light-cure resin composite cements, dual-cure luting cements which contain a chemically activated component have since emerged on the market[13,31].

For luting cement the behaviour is influenced by several factors: the adhesive approach (pre-etched or self-adhesive), the type of initiation[32], and the compatibility between adhesive and cement. The adhesive system bonds to root canal dentin by diffusion of the hydrophilic bonding agent into the collagenous layer —a phenomenon that depends on whether the smear layer is present or eliminated. It has been reported that thick smear layers and other debris retained on root canal walls after acid-etching[33] might prevent optimal adhesive infiltration than self etching primers also might not be able to etch through thick smear layers[(34)] thorough rising canal and cleaning is very important after post space preparation when self adhesive cement is used

On the test method used to evaluate adhesion to root canal walls, the thin-slice push-out test is considered to be the most accurate and reliable technique when compared with conventional and Other advantages of the push-out test method include allowing several specimens to be fabricated out of one root, as well as testing for regional differences in bond strength between root segments is also possible [25]. In light of these superior advantages, the push-out strength test was the preferred testing method for the present study.

Conclusion:-

Within limitation of present study it can be concluded that customizable post shows good bond strength than prefabricated post. But means bond strength for both type of post is higher in cervcal region than middle and apical third. Push out bond strength show higher value when same post and luting cement is used from same manufacturer.

Further in-vitro and in-vivo study is necessary on this new type of fibre post.

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