Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/12390
DOI URL: http://dx.doi.org/10.21474/IJAR01/12390

RESEARCH ARTICLE

COMPARATIVE EVALUATION OF PUSH-OUT BOND STRENGTH OF FIBER POST LUTED INSIDE THE ROOT CANAL USING LIGHT CURE FLOWABLE COMPOSITE AND DUAL CURE RESIN - AN INVITRO STUDY

Dr. Aamir Bashir[1], Dr. Adil Fayaz[1], Dr. Sandeep Kaur Bali[2] and Dr. Shazana Nazir Qazi[3]

1. Post-Graduate Student, Department of Prosthodontics, Govt. Dental College & Hospital, Srinagar, Jammu & Kashmir, India.
2. Professor and Head, Department of Prosthodontics, Govt. Dental College & Hospital, Srinagar, Jammu & Kashmir, India.
3. Associate Professor, Department of Prosthodontics, Govt. Dental College & Hospital, Srinagar, Jammu and Kashmir, India.

Manuscript Info

Manuscript History
Received: 27 November 2020
Final Accepted: 30 December 2020
Published: January 2021

Abstract

Aim: The aim of this study was to compare by means of Push-Out test the difference in bond strength of two different luting agents with fibre post, and the effect of anatomical root levels on the bond strength of each cement.

Materials and Methods: A total of 40 freshly extracted maxillary central incisor and canine teeth were included in the study. The teeth were divided into two groups of twenty each, and were assigned to Groups A and B according to the luting agent (light cure, dual cure) used to cement the post inside the root canal. After decoronation, 10 mm standardized post spaces were prepared inside each root. Luting of fiber posts was carried out, as per manufacturers' recommendations, with the respective luting agents. Each root was embedded in a cuboidal plaster block and sectioning was carried out to obtain three slices of 2.5 mm thickness from the coronal, middle and apical aspect of the root. This was followed by Push-Out testing on a Universal Testing Machine after a storage period of 2 months. The recorded data were subjected to statistical analysis.

Results: Significant differences were found in the bond strength of light cure flowable composite and dual cure resin cement ($p<.05$) at different anatomical root levels. In the inter-group comparison it was found that dual cure presents superior mean bond strength in comparison with light cure composite.

Conclusion: It was concluded from this study that dual cure resin cement is the best material for luting fiber post to root canal. The push-out bond strength was lower in the apical third than the coronal third for light activated cements. Also, light cure flowable composite performs better when shorter posts are used.

Corresponding Author:- Dr. Aamir Bashir
Address:- Post-graduate student, Department of Prosthodontics, Govt. Dental College & Hospital, Srinagar, Jammu & Kashmir, India.

Introduction:-

A variety of clinical situations exist that require augmentation of the remaining tooth structure with the help of a post and core restoration[1] to obtain adequate retention of an extracoronal restoration. A variety of materials have been used to fabricate posts such as metal alloys, ceramics or fiber-reinforced composite materials. The search for a better post material led to the introduction of carbon fiber posts in restorative dentistry. They were black in colour which resulted in their replacement with white and translucent fiber posts that guaranteed better aesthetic results[2].Glass fiber posts superseded carbon fiber posts in 1992 to overcome the esthetically unpleasant appearance of carbon fiber posts[3]. These can be made of either Electrical Glass (E-Glass), Silica Glass (S-Glass) or Quartz Fibers[4].They are ideal in situations with higher cosmetic demand, especially as foundations for restorative materials that allow more light to pass through, such as all ceramic crowns. In contemporary restorative practice, as the patients and practitioners have become more conscious of esthetics, the use of fiber posts to restore endodontically treated teeth has become increasingly popular[5].

Dual cure resin cement is the most preferred restorative material for luting fiber posts to the root canals. The loss of retention of fiber posts is one of the most frequent types of failure[6]. Different methods have been used in an attempt to improve the retention of fiber posts to root canal walls. Light curing of the adhesive is an important step. It is well accepted that light-curing from the top of post spaces is insufficient to optimally polymerize light-cured adhesives and resin cements[7] and depending on the adhesive used, the extension of the light curing time may improve the bond strength[8]. It has also been reported that the curing mode of the adhesive has a significant effect on the bond strength[9].

The type of the resin cement and its curing mode have been a subject of major focus in the literature because light attenuates through the fiber post to a level which can't polymerize dual cure resin cements. This represents another problem in bonding fiber posts to root canal dentin[10]. The use of a light-transmitting glass fiber post has been claimed to improve polymerization through the depth of post spaces[11].

Thus this study endeavours to compare the bonding strength of two types of luting cements viz dual cure resin and light cure flowable composite with fiber post using a push out test set-up on a Universal Testing Machine.

Materials And Methods:-

Specimen Preparation:

Thirty nine intact, extracted, human single rooted maxillary central incisor and canine teeth were selected. The teeth were cleaned with an ultrasonic scaler and stored in alcohol. Periapical radiographs of each tooth were taken in a bucco-lingual and mesio-distal direction to confirm the presence of a straight, single, unobliterated root canal. Then the crown of each tooth was cut approximately at the level of cemento-enamel junction (CEJ) with a water-cooled diamond blade mounted on a straight micromotor handpiece. Post space was prepared in each root with the help of post-space preparation drills fixed in a low speed contra-angle hand-piece and a straight parallel sided post space was developed in each root with continuous supply of water acting as a coolant. The depth of the post space prepared was 10 mm with 4 mm of apical tooth structure left unprepared. The root canal in each tooth was rinsed with distilled water and dried gently. A total of forty roots were prepared and assigned randomly to two equal groups (A, B) according to the luting agent used to fill the post space as shown in the table below. The same type of translucent fibre post was used in all the three groups.

GROUP	A	B
NO. OF SAMPLES	20	20
LUTING CEMENT	LIGHT CURE FLOWABLE COMPOSITE	DUAL CURE RESIN

Group A (Light Cure Flowable Composite):

For the light cure group the tooth and post surface were etched with 37% Phosphoric acid for 20 seconds[12], rinsed with water; and dried with paper points and a gentle spray of air, respectively. The post space was coated with adhesive with a microbrush. After a period of 20 seconds, the excess adhesive was removed with paper points. Light curing was performed for 20 seconds. The surface of the post was also coated with adhesive, and the excess was removed with a gentle spray of air after 20 seconds, followed by light curing for 20 seconds. Light cure flowable composite was dispensed on a lentulospiral and introduced into the root canal. The post surface was also coated with a layer of flowable composite. The post was placed inside the root canal with finger pressure and held in place for 30 seconds. Light curing was performed from the top of the post for a period of 60 seconds[13].

Group B (Dual Cure Resin Cement):
The prepared root canal walls were etched with 37% phosphoric acid for 20 seconds[12], rinsed with water using a syringe and then gently dried with paper points. Adhesive was applied to the root canals by means of a micro-brush tip provided by the manufacturer. After 20 seconds, excess adhesive was removed using paper points. The adhesive was light cured for 20 seconds[14]. Phosphoric acid (37%) etching of the post surface for 20 seconds was also carried out, rinsing with water and gentle air drying followed. Adhesive was applied with the microbrush and excess was removed with a gentle spray of air after a period of 20 seconds. Light curing was done for 20 seconds. Equal amounts of the base and catalyst paste were mixed on a mixing pad following manufacturer's instructions and loaded into the root canal with a lentulospiral mounted on a contra-angled handpiece rotating at slow speed in the clockwise direction. A thin layer of cement was also applied on the surface of the post, and the post was inserted into the root canal with finger pressure, and held in place for 30 seconds. Light curing was done for a period of 20 seconds, as was recommended by the manufacturer.

The post cemented roots were then embedded in cuboidal plaster blocks with the help of a surveyor, taking care to orient the post parallel to the vertical walls of the block. Each plaster block was placed on the platform of a precision slicing machine. Each post cemented root was thus sectioned perpendicular to the long axis of the post with the help of water cooled diamond blade on the precision slicing machine to obtain three slices each of 2.5 (±0.2) mm thickness from the coronal, middle and apical sections of the root. The sections were numbered 1, 2 and 3 corresponding to the coronal, middle and apical sections of the root.

Bond Strength Assessment:
Prior to the assessment of bond strength the samples were stored in vials containing normal saline solution for a period of 2 months. The vials were covered with black colored tape to obscure light from entering and creating any changes in the chemical or physical properties of the materials.

To assess the bond strength between the luting cement and the fibre posts, push-out test was carried out on each section of the root.

The setup comprised a horizontal platform made of cast iron, with a central circular perforation of 3 mm; and a plunger with its tip in the shape of a metal rod 0.8 mm thick, that was used to apply a vertical load to only the post without stressing the surrounding root canal walls. To avoid any limitation to post movement due to root canal taper during load application, the load was applied in the apical aspect of the root slice in an apico-coronal direction so that the post could be pushed towards the wider part of the root slice. Force was applied by a Universal Testing Machine at a crosshead speed of 1 mm/min till the post was extruded out of the root section by a distance of 0.5 mm, manifesting bond failure. The bond strength (MPa) was calculated by dividing the load at failure (Newton) with bonding surface area (mm^2). $MPa = N/2\pi rh$

where $\pi = 3.14$,
r is the radius of the post (mm), and
h is the thickness of the post segment (mm).

Results:-

The maximum force at failure was recorded in Newtons, and converted to Megapascals (MPa). The mean and standard deviation for Group A (Fig. 1) at the coronal, middle and apical section were 119.16/10.41, 83.68/12.44 and 25.90/5.07. The results were statistically significant at each level of the root canal ($p < 0.05$). For Group B (Fig. 2), the mean and standard deviation were 96.46/7.94, 78.45/4.97 and 79.90/3.64 for the respective sections. The results were statistically significant ($p< 0.05$) except when middle and apical sections were compared, where a p value of 0.799 was obtained.

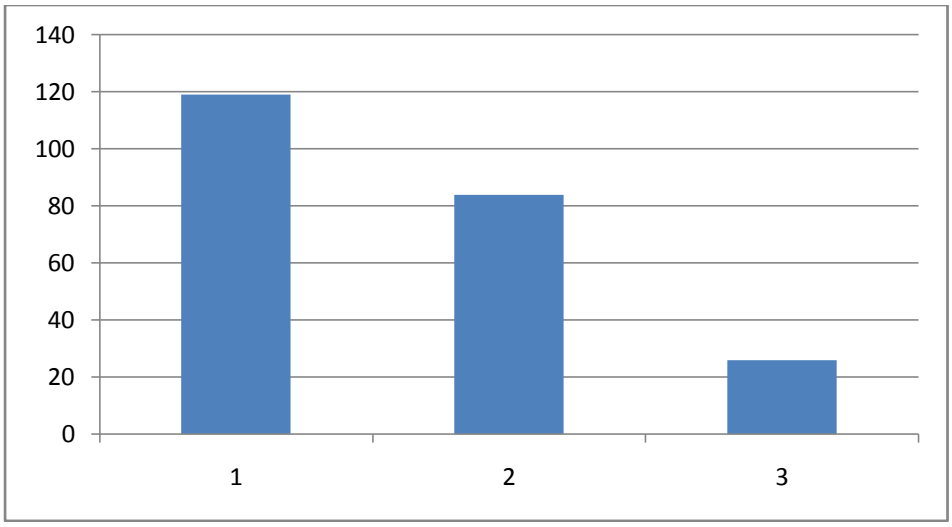

Fig. 1:-

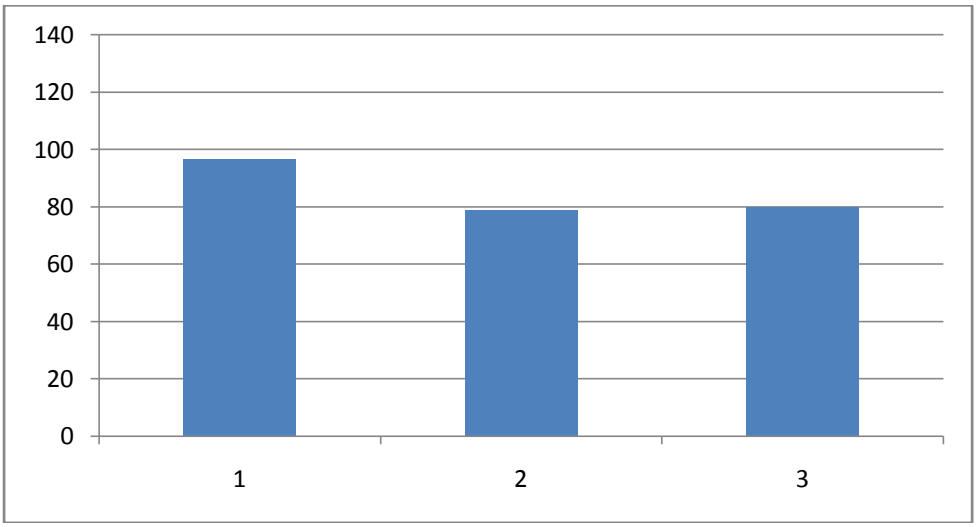

Fig. 2:-

Intergroup comparison was also performed using One-way ANOVA. It was found that light cure material performs better ($p<0.05$) than dual cure resin when only the coronal sections, or the coronal and middle sections cumulatively are subjected to statistical analysis. As deeper apical sections are included, the mean bond strength of dual cure resin becomes greater than light cure material, but the differences are not statistically significant ($p>0.05$).

Discussion:-

Achievement of reliable bonding and adhesion between any restorative material and tooth structure is a factor of great importance. If only a minimal tooth structure is present, attempts to restore the vertical height with a post and core restoration after endodontic treatment might be of great assistance in improving the prognosis of a tooth[15,16]. McDonald and her colleagues in 2005 developed the 'Tooth Restorability Index' in an attempt to simplify the decision making process for a post-core restoration[17].

Due to the trend towards esthetic consciousness, the more life-like translucent ceramic materials have gained in popularity. The esthetics of these restorations are affected by the shade of the underlying core. Thus, in order to restore teeth especially in the esthetic zone with all-ceramic restorations, non metallic esthetic colored post and core restorations have become the choice of the clinician. Amongst them, epoxy resin posts reinforced with carbon fibers, epoxy or methacrylate resin posts reinforced with quartz or glass fibers, zirconia posts, and polyethylene fiber-reinforced posts are notable. In addition, the major advantage of the Fibre Reinforced Composite posts is the elastic

modulus, which is comparable to that of dentin, as well as high durability which may lead to a better distribution of the occlusal loads along the root[14,16,18].

The luting procedure is an important step in the success of any post and core restoration. Traditionally glass fiber posts have been luted with dual cure resin cements or self cure resin. The use of light transmitting fiber posts has been recommended to enhance the ability of light to reach the depth of root canal and ensure a better degree of conversion of the dual cure resin[19]. Transmission of light through the post also makes it possible to light-cure the resin cement and the bonding system in only one clinical step (one-shot cementation), thus simplifying and shortening the clinical procedure[14].

Although traditionally dual cure materials have been recommended for the cementation of fibre posts, recent studies have shown that similar results can be obtained when light cure flowable composite is used to bond fiber posts to root canals[2,20]. If that is the case, indefinite working time is a luxury a prosthodontist can always enjoy.

Most of the clinical failures encountered with endodontically treated teeth restored with fibre posts are due to loss of retention[21]. The selection of an adequate adhesive strategy inside the root canal is, thus, paramount but unfortunately still a matter of debate, and data from studies demonstrate contradictory results.

In this study, for Group A, i.e. the light cure group, it can be seen that the mean bond strength of each section is significantly different at the different anatomical root levels. The mean bond strengths are 119.16, 83.68 and 25.90 for the coronal, middle and apical sections, respectively. The data were statistically significant at each root level. The decrease in bond strength from coronal to apical third can be attributed mainly to light attenuation through the fiber post at points further away from the point of illumination[13,22,23,24]. Yoldas et al demonstrated that the transmission of light through a fiber post decreases significantly beyond a distance of 8 mm[11]. Also due to the increase in distance from the source of illumination the amount of energy delivered decreases in proportion to the square of the distance between the two. Other factors, such as moisture control in the apical region, the presence of residual gutta-percha, and incomplete dentin hybridization, may result in deficient sealing of the resin cement-dentin interface in the apical third[25].

For Group B (Dual Cure Group), the mean bond strengths obtained were 96.46 for the coronal, 78.45 for the middle and 79.90 for the apical section. The bond strength at the coronal third is significantly higher than the middle and cervical third. This can be explained by the effect of light activation on the degree of conversion at the coronal third of the root canal, where sufficiently high levels of light intensity are observed. In the middle and apical third the effects of light are less significant[22,23,26]. Consequently the self curing of the cement plays a greater role in the setting of the material at these locations. It can also be seen from the means of bond strength at the middle and apical third that the bond strength of the apical third is slightly higher. This can be explained by the predominantly self curing of the cement at the apical third that causes release of polymerization stresses, improving the adaptation of the luting cement to the post surface and canal walls[20,27].

Alkhudhairy et al[28], Perdigao et al[29] found that the bond strength of cervical specimens was higher than the apical specimens which is in agreement with our findings. Similar findings were reported by D'Arcangelo et al[21]. It has been observed from studies that the dentinal tubules are more patent in the cervical area than in the deeper sections, explaining the higher bond strength in the cervical section[28,30] , alongwith other factors like better access, higher light intensity, etc.

The differences between the light cure group and dual cure group can be attributed to differences in the mechanism of curing, as light cure flowable composite is totally dependent on light activation for curing. The attenuation of light in the deeper parts of post space is directly responsible for the decreased curing, and thus lower resistance to dislodgement of the post. Consequently the higher bond strength of coronal section in Group A is offset by the reduction in the same at the apical area.

Conclusion:-

Within the limitations of this study it can be concluded that the best material available for luting of fiber posts at present is the dual cure resin cement. While light cure flowable composite presents high bond strength in the coronal and acceptable strength in the middle segment, there is an appreciable drop of the tensile bond strength at the apical section. As such shorter roots and roots with severe curvatures that don't allow the extension of a straight stiff post

much beyond the cervical third of the root can be better secured with light cure materials, owing to their indefinite working time and ease of manipulation.

References:-

1. Pirvani M, Khan S, Malik S. Evaluation of Push out Bond Strength of A Dual-cure Self-adhesive Resin-cement with Fiber Post Systems and Dentine. J Pak Dent Assoc 2015; 24(1):28-34
2. Giachetti L, Grandini S, Calamai P, Fantini G, Russo DS. Translucent Fiber post cementation using light- and dual- curing adhesive techniques and a self-adhesive material: Push-out test. Journal of Dentistry. 2009; 37:638-642
3. Kalkan M, Usumez A, Ozturk AN, Belli S, Eskitascioglu G. Bond strength between root dentin and three glass-fiber post systems. J Prosthet Dent. 2006; 96:41-46
4. Lassila LVJ, Tanner J, Le Bell A-M, Narva K, Vallittu PK. Flexural properties of fiber reinforced root canal posts. Dental Materials. 2004 1//;20:29-36
5. Aziz TMA, Anwar MN, El-Askary FS. Push-out bond strength of Fiber Posts to root canal dentin using a one-step self-etching adhesive: The effect of solvent removal and light-curing methods. J Adhes Dent. 2014; 16:79-86
6. Goodacre J, Spolnikn K.The prosthodontic management of endodontically treated teeth: a literature review Part I. Success and failure data, treatment concepts. J Prosthodont 1994;3:243-250
7. Pirani C, Chersoni S, Foschi F, Piana G, Loushine RJ, Tay FR, et al. Does hybridization of intraradicular dentin really improve fiber post retention in endodontically treated teeth? Journal of Endodontics 2005;31:891–4
8. Aksornmuang J, Nakajima M, Foxton R, Tagami J. Effect of prolonged photo-irradiation time of three self-etch systems on the bonding to root canal dentine. J Dent 2006; 34:389-397
9. Zhang M, Magni E, Radovic I, Wang Y, Chen J, Ferrari M. Effect of curing modes of dual-curing luting systems and root regions on retention of translucent fiber posts in root canals. J Adhes Dent 2008;10:219-226
10. Ho Y, Lai Y, Chou I, Yang S, Lee S. Effects of light attenuation by fibre posts on polymerization of a dual-cured resin cement and microleakage of post-restored teeth. J Dent 2001;39:309-315
11. Yoldas O, Alacam T. Microhardness of composites in simulated root canals cured with light-transmitting post and glass-fiber reinforced composite posts. Journal of Endodontics 2005;31:104–6
12. Kadam A, Pujar M, Patil C. Evaluation of push-out bond strength of two fi ber-reinforced composite posts systems using two luting cements in vitro. J Conserv Dent 2013;16:444-8
13. Ho YC, Lai YL, Chou IC, Yang SF, Lee SY. Effects of light attenuation by fibre posts on polymerization of a dual-cured resin cement and microleakage of post-restored teeth. Journal of Dentistry 39 (2011) 309-315
14. Grandini S, Sapio S, Goracci C, Monticelli F, Ferrari M. A one step procedure for luting glass fibre posts: an SEM evaluation. International Endodontic Journal, 37, 679–686, 2004.
15. Ferrari M, Vichi A, García-Godoy F. Clinical evaluation of fiber- reinforced epoxy resin posts and cast post and cores. Am J Dent 2000;13:15B-18B
16. Lamichhane A, Xu C, Zhang F. Dental fiber-post resin base material: a review. J Adv Prosthodont 2014;6:60-5
17. McDonald A, Setchell D. Developing a tooth restorability index. Dent Update 2005; 32: 343-348
18. Cekic-Nagas I, Ergun G, Egilmez F. Light transmittance of fiber posts following various surface treatments: A preliminary study. Eur J Dent 2016;10:230-3
19. Vichi A, Grandini S, Davidson CL, Ferrari M (2002a) An SEM evaluation of several adhesive systems used for bonding fibre posts under clinical conditions. Dental Materials 18:495-502
20. Giachetti L, Russo DS, Bertini F, Giuliani V. Translucent fiber post cementation using a light-curing adhesive/ composite system: SEM analysis and pull-out test. Journal of Dentistry 2004;32: 629-634
21. D'Arcangelo C, D'Amario M, De Angelis F, Zazzeroni S, Vadini M, Caputi S. Effect of application technique of luting agent on the retention of three types of fober-reinforced post systems. J Endod 2007; 33:1378 –1382
22. Roberts HW, Leonard DL, Vandewalle KS, Cohen ME, & Charlton DG (2004) The effect of a translucent post on resin composite depth of cure Dental Materials 20(7):617-622
23. Galhano GÁ, de Melo RM, Barbosa SH, Zamboni SC, Bottino MA, Scotti R. Evaluation of Light Transmission Through Translucent and Opaque Posts. Operative Dentistry, 2008:33(3); 321-324
24. Goracci C, Corciolani G, Vichi A, Ferrari M. Light-transmissing ability of marketed fiber posts. J Dent Res 2008; 87(12):1122-1126
25. Calixto LR, Bandeca MC, Clavijo V, Andrade MF, Vaz LG, Campos EA. Effect of resin cement system and root region on the push-out bond strength of a translucent fiber post. Operative Dentistry, 2012: 37(1); 80-86

26. Alves Morgan LF, Pinotti MB, Ferreira FM, Gomes GM, Silva GC, Albuquerque RD, et al. Influence of light transmission through fiber posts: Quantitative analysis, microhardness, and on bond strength of a resin cement. Indian J Dent Res 2018;29:74-80
27. Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strength between adhesive cements and root canal dentin. Dental Materials 2003; 19:199-205
28. Alkhudhairy FI, Yaman P, Dennison J, McDonald N, Herrero A, Bin-Shuwaish M. The effects of different irrigation solutions on the bond strength of cemented fiber posts. Clinical, Cosmetic and Investigational Dentistry 2018:10; 221-230
29. Perdigão J, Lopes M, Geraldeli S, Lopes GC, García-Godoy F. Effect of a sodium hypochlorite gel on dentin bonding. Dent Mater. 2000;16(5): 311–323
30. de Munck J, Vargas M, van Landuyt K, Hikita K, Lambrechts P, van Meerbeek B. Bonding of an auto-adhesive luting material to enamel and dentin. Dent Mater. 2004;20(10):963–971.