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COMPARATIVE EVALUATION OF BOND STRENGTH OF FIBER POST WITH ROOT CANAL DENTINE AT DIFFERENT ANATOMICAL ROOT LEVELS USING GLASS IONOMER CEMENT AND DUAL CURE RESIN AS THE LUTING AGENTS – AN INVITRO STUDY

Dental Science

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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 divided into two groups of twenty each (Groups A and B) according to the luting agent (GIC, 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. 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. **Results:** Significant differences were found in the bond strength of dual cure resin cement ($p<.05$) at different anatomical root levels, but not with glass ionomer cement. In the inter-group comparison it was found that dual cure resin presents superior mean bond strength in comparison with glass ionomer cement. **Conclusion:** It was concluded from this study that dual cure resin 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 dual cure resin.

KEYWORDS

INTRODUCTION

Post and core restorations have been a successful treatment modality for restoration of teeth that suffer a severe loss of vertical tooth structure. A variety of materials such as metal alloys and ceramics have been used to fabricate posts for such teeth. Metallic posts have the advantages of excellent physical properties but their disadvantages like high incidence of root fracture due to stress concentration from elastic modulus mismatch, susceptibility to corrosion and nickel sensitivity, drive the desire to look for alternative materials. As such metal-free post and core systems, such as carbon and fiber reinforced posts, that reduce the risk of catastrophic failures of teeth, have been introduced[1,2].

Dual cure resin cement is the most preferred restorative material for luting fiber posts to the root canals. The resin cement bonds to glass fiber posts either by interdiffusion of the resin monomer into the polymer structure of the posts or by free radical polymerization[3]. In dentine, retention is achieved via formation of resin tags by the flow of resin into the hollow dentinal tubules that have been exposed during the procedures of cutting and smear layer removal[4].

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. The use of a light-transmitting glass fiber post has been claimed to improve polymerization through the depth of post spaces[5].

Although resin cements are mostly used in the bonding of fiber posts, glass ionomer cement has been the predominant luting agent for the majority of prosthetic work. GIC is highly preferred for its ability to resist secondary caries. The ease of manipulation, coupled with the ability to adhere to tooth structure without the need for preconditioning[6] drastically cuts down the chair-side time in comparison to composite luting agents. Overall, GIC is the preferred luting agent for a variety of indications such as luting of crowns and metallic posts, etc.

Thus this study aims to compare the bonding strength of GIC and dual cure resin with fiber post using a push out test set-up on a Universal Testing Machine.

MATERIALS AND METHODS

Forty 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. After decoronation, post space was prepared in each root with the help of post-space preparation drills fixed in a low speed contra-angle hand-piece 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 Groups A and B according to the luting cement 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	GIC (TYPE I)	DUAL CURE RESIN

Group A (Glass Ionomer Cement, Type I)

GIC was manually mixed according to the manufacturer's instructions and then inserted in the root canal space using a lentulospiral mounted on a contra-angled handpiece. A thin layer of cement was also applied on each post and the post was inserted directly into the post space with the application of slight and sustained finger pressure, and held in position so that the cement can set by self-curing.

Group B (Dual Cure Resin Cement)

The prepared root canal walls were etched with 37% phosphoric acid for 20 seconds7, 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 seconds8. 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 static 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. The bond strength (MPa) was calculated by dividing the load at failure (Newton) with bonding surface area (mm²).

$MPa = N/2\pi rh$
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(standard deviation) for coronal, middle and apical section in Group A was 69.65(12.79), 68.09(7.85) and 64.72(7.89) respectively (Fig. 1). The differences were not statistically significant with $p>0.05$. 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.

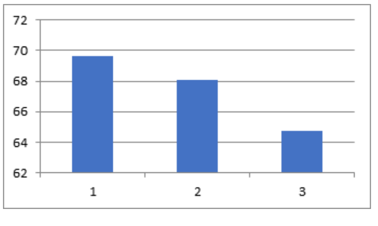

Fig. 1

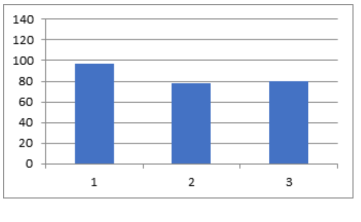

Fig. 2

Inter-group comparison was also performed using one way ANOVA. The results indicate a statistically significant difference in favour of dual cure resin as against the use of GIC for the purpose of luting fibre post inside a root canal.

DISCUSSION

Achievement of reliable bonding and adhesion between any restorative material and tooth structure is a factor of great importance. For any mechanism of retention to be effective, presence of adequate tooth surface is essential. 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[9,10]. Various guidelines have been proposed to decide whether a tooth is indicated for post and core restoration[11,12,13,14]. 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[15].

The posts can be prefabricated (metal dowels, fiber posts) or they can be custom made (cast post and core)[16]. 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. As such metallic posts and carbon fibre posts have become a lesser accepted treatment option. 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. 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[8,10,17].

Traditionally dual cure materials have been recommended for the cementation of fibre posts with high degree of success. GIC, one of the materials with a very long track record, has also been recommended for cementation of fiber posts inside root canals, and according to some studies shows promising results[18,19]. Nevertheless, glass ionomer cement presents some disadvantages, mainly related to its clinical handling and mechanical properties[20,21], requiring further evaluations that prove its effectiveness as an alternative to the resin cements frequently used.

Most of the clinical failures encountered with endodontically treated teeth restored with fibre posts are due to loss of retention[22]. 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.

Thus this study was undertaken with the aim of identifying which material among GIC and dual cure resin yields best mechanical properties when used along-with fibre post to restore endodontically treated teeth.

For the Group A (GIC Group) the average bond strength obtained for the sections at coronal, middle and apical third were respectively, 69.65, 68.09 and 64.72. The results were not statistically significant. It implies that the bond strength of fiber post to root canal on using GIC as the luting agent is not dependent on the anatomical location of the canal. Factors like access to the apical third of root canal, the cleanliness of the root canal, etc play a less significant role in determining the success of luting procedure. The histological parameters like presence of secondary dentin, density of dentinal tubules at different levels of the root, etc also seem to play a less significant role in determining the strength of the bond. It may thus be concluded that frictional retention is the primary parameter that determines the bond strength between fiber post and root canal, with a Glass Ionomer interface[19,23]. The findings are consistent with results obtained in the study be Pereira et al[18].

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[24,25,26]. 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[27,28]. Our study contrasts with the results obtained in the study by Pereira et al[18] who found that bond strength did not differ significantly at different anatomical root levels. This difference may be attributed to the difference in the properties of materials used in the study.

Perdigao et al[29] , Alkhudhairy et al[30]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[31]. 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[30,32], alongwith other factors like better access, higher light intensity, etc.

In the inter-group comparison it was found in this study that the mean bond strength of Group A (67.49) is lower in comparison with Group B. The lower value of GIC Group can be attributed to the predominantly inferior physical properties of glass ionomer cement[21], and mainly frictional retention. Timpavat et al have also cited the formation of greater number of voids in the GIC interface as a possible reason for low values of bond strength obtained with it[33]. The findings were also supported by the study done by Lall et al[34]. Thus from an analysis of the literature discussed above it can be said that while choosing a fiber post and core strategy to restore a broken down tooth, many factors need to be considered. The characteristics of the post including its chemical structure, light transmissibility, surface characteristics are important parameters to consider. The luting agent has to be carefully chosen depending on the depth of the root canal space, accessibility to the apical third of root canal, opaqueness of post chosen, and many other factors. From a review by Skupien et al we can conclude that endodontic treatment, method of cement application, and post pretreatment are factors that might significantly affect the retention of glass-fiber posts into root canals, mainly when cemented with regular resin cement. Self-adhesive resin cements were found to be less technique-sensitive to luting procedures as compared with regular resin cements[35]. There is no single protocol that can be applied in all the clinical situations, and optimization of different variables shall help in achieving the best results for the patient and the practitioner alike.

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. As far as GIC is concerned, as a luting agent it has revealed far more inferior tensile properties when used along with fiber posts, thus it should be avoided as much as possible in these clinical situations. GIC should be used only as a last resort luting material, if at all the need be.

References:

1. Cheung W. A review of the management of endodontically treated teeth. Post, core and the final restoration. J Am Dent Assoc. 2005 ;136:611-619.
2. P M, L R, J K. Corrosion behaviour of selected implant alloys Journal of Dental Research. 1992;71(1 suppl):253.
3. Mannocci F, Sherriff M, Watson TF, Vallittu PK. Penetration of bonding resins into fibre-reinforced composite posts: a confocal microscopic study. International endodontic journal. 2005 ;38:46-51.
4. Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. J Biomed Mater Res. 1982; 16:265-273.
5. 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.
6. Yiu C, Tay F, King N, Pashley D, Sidhu S, Neo J, et al. Interaction of glass-ionomer cements with moist dentin. J Dent Res. 2004;83:283-289
7. 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
8. 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
9. 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.
10. Lamichhane A, Xu C, Zhang F. Dental fiber-post resin base material: a review. J Adv Prosthodont 2014;6:60-5
11. Sorenson JA, Martinoff JT. Clinically significant factors in dowel design. J Prosthet Dent 1984; 52:28-35
12. Fernandes AS, Dessai GS. Factors affecting the fracture resistance of post-core reconstructed teeth: a review. Int J Prosthodont 2001; 14:355-363
13. Sorenson JA, Engleman MJ. Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990; 63:529-536
14. Assif D, Bitenski A, Pilo R, Oren E. Effect of post design on resistance to fracture of endodontically treated teeth with complete crowns. J Prosthet Dent 1993; 69: 36-40
15. McDonald A, Setchell D. Developing a tooth restorability index. Dent Update 2005; 32: 343-348
16. Miller AW. Post and core systems: Which one is best? J Prost Dent 1982; 48(1): 27-38
17. 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.
18. Pereira, J. R., Rosa, R. A., Só, M. V., Afonso, D., Kuga, M. C., Honório, H. M., Vidotti, H. A. (2014). Push-out bond strength of fiber posts to root dentin using glass ionomer and resin modified glass ionomer cements. Journal of Applied Oral Science, 22(5), 390-396
19. 19---Lorenzetti CC, Bortolatto JF, Ramos ATPR, Shinohara AL, Saad JRC, Kuga MC. The effectiveness of glass ionomer cement as a fiber post cementation system in endodontically treated teeth. Microsc Res Tech. 2019;1–7
20. Kerby RE, Knobloch L (1992). Strength characteristics of glass ionomer cements. Oper Dent 17:172-174
21. Attar N, Tam LE, McComb D. Mechanical and physical properties of contemporary dental luting agents. J Prosthet Dent 2003;89:127-34
22. 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
23. Goracci C, Fabianelli A, Sadek FT, Papacchini F, Tay FR, Ferrari M, et al. The contribution of friction to the dislocation resistance of bonded fiber posts. J Endod 2005;31:608-12
24. 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
25. 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
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. 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: 629-634Bouillaguet 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. 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
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. 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
31. D'Arcangelo C, D'Amario M, Prosperi GD, Cinelli M, Giannoni M, Caputi S. Effect of surface treatments on tensile bond strength and on morphology of quartz-fiber posts. J Endod 2007;33:264-7
32. 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
33. Timpavat S, Harnirattisai C, Senawonge P. Adhesion of a glass ionomer sealer to the root canal walls. J Endod;2001:27:168-71
34. Lall S, Runu R. The effect of different cementation strategies on the pull-out bond strength of fiber post: an ex-vivo study. Int J Sci Rep 2016; 2(4):68-73
35. Adiel J, Sarkis R, Sérgio M, de Moraes RR, Pereira-Cenci T. A systematic review of factors associated with the retention of glass fiber posts. Braz Oral Res [online]. 2015;29(1):1-8