IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 12 Ver. XI (Dec. 2017), PP 65-70
www.iosrjournals.org

Effect of Resin Cement Thickness on the Push out Bond Strength of Fibre Reinforced Composite Post to Root Canal Dentine- An In-Vitro Evaluation.

*[1]Pramod Kumar A V, [2]Vinni T K, [3]Gilsa K Vasunni, [4]Muhammed Saheer K

Professor[1], Govt Dental college, Thrissur,
Associate Professor[2], Professor[3], Assistant Professor, Govt Dental College, Kozhikode, Kerala, India
**Corresponding author: *Pramod Kumar A V*

Abstract: *Thickness of the resin cement may vary in teeth restored with fibre reinforced composite post especially in situations with large root canal space. The objective of this study was to evaluate the influence of cement thickness on the bond strength of a fibre reinforced composite post system to the root canal dentine.*

Methods: *Eighteen maxillary central incisors were decoronated. The canals were prepared and the specimens were randomly allocated to 2 groups. (n=9). Group A (low cement thickness) in which canals were enlarged to size 1 drill (1.2mm) and size I posts were cemented (1.2) and Group B were enlarged to Size 3 drill (1.5mm) and size 1 post was cemented (1.2). From each sample, 3 sections were taken (1.5 mm thickness). Cement thickness evaluation was done with Universal Measuring Microscope. Each specimen was tested for push out bond strength and data were statistically analyzed.*

Result: *Bond strength of Group A and B did not show significant differences (P=0.5249). But the film thicknesses of these Groups were significantly different (P=0.00000).*

Conclusion: *The increase in cement thickness did not significantly affect the bond strength.*

Date of Submission: 18-12-2017 Date of acceptance: 28-12-2017

I. Introduction

Endodontic posts are commonly used for restoration of badly broken-down teeth. In situations in which all-ceramic restorations are used metal posts may result in unfavourable esthetics such as grey discolouration of translucent all-ceramic crowns and the surrounding gingiva. Various tooth coloured posts such as translucent fibre-reinforced composite posts and Yttrium stabilized zirconium oxide posts are available and they provide some advantages in these situations. Fibre reinforced composite (FRC) posts offers advantages of tooth colour and modulus of elasticity similar to that of dentine which reduces the risk of root fracture.[1]Fibre reinforced composite post should be cemented using adhesive systems. Their tensile strengths depend on their adhesion to root dentine through the resin cement. Reduced shrinkage of the cement film results in less stress at the interfaces with the dentine and the post. Therefore, the thickness of the resin cement may be a determining factor in the clinical performance of fibre reinforced composite post. This may be even more important in situations with large root canal space, especially in young permanent teeth. The aim of this study was to evaluate the influence of cement thickness on the push-out bond strength of a fibre reinforced composite post system to the root dentine.

II. Review of Literature

Vallittuin1996 described that fibre reinforced composites are materials that are composed of reinforcing fibres embedded in a polymer matrix. The fibre reinforcement is characterized by its length being much greater than its cross-sectional dimensions. The fibres give strength and stiffness, while the polymer matrix combines the fibres together, forming a continuous phase around the reinforcement. This phase transfers the loads to the fibres, and also protects the fibres from the moisture of the oral environment[2]. The mechanical advantages provided by fibre reinforced composites are their flexural strength, fatigue strength, elastic modulus and bond strength (of fibres to veneering composites and resin luting cements). In addition, fibre reinforced composites are metal-free, biocompatible and esthetic[3]. The high quantity of fibres (up to 70%) resulting in high strength (maximum flexural strength of up to 1250 MPa) and a semi-interpenetrating polymer network (semi-IPN) structure of the polymer matrix, which improves the adhesive behaviour of the material. [4]

Sahafi A, et al compared the effects of surface treatments on bond strength of resin cements to posts of titanium alloy, glass fibre, and Zirconia and to dentin. Most surface treatments like roughening or sand blasting along with the application of primers resulted in improved bond strength of resin cements to the post. Etching of Zirconia post with hydrofluoric acid with and without silane treatment significantly decreased the bond strength[5]. Bitter K et al compared the effect of thermocycling on bond strength to root canal dentine. The apical region of the root canal had significantly higher bond strength compared with middle and coronal region. After thermocycling a significant increase in bond strengths was detected for middle and apical region. [6]Kalkan M et al compared the bond strength of 3 different types of glass fibre post systems - opaque, translucent and electrical glass in three different locations of prepared post space. The result shows the opaque and electrical glass fibre post exhibited similar bond strengths and the translucent post exhibited the lowest bond strength. The highest bond strength was observed in the cervical third of the post space for translucent and electrical glass fibre group[7].Magni E et al evaluated the interfacial strength between fibre reinforced composite post and luting agents following different surface treatments and to observe the effect of sandblasting on the surface morphology of methacrylate based fibre posts. The result shows silanization is a reliable method of improving bond strength. Bond strengths of resin luting agents to fibre posts were not influenced by the type of luting agents. Sandblasting does not increase the bond strength.[8]Bitter K states that bond strengths were significantly affected by resin cement, the pre-treatment and the type of post but not by thermocycling. The interpenetrating polymer network post demonstrated significantly higher bond strengths.[9] The fracture resistance of endodontically treated teeth is not influenced by the rigidity of the post material. The combination of ferrule preparation and endodontic post result in higher load resistance after thermomechanical loading than any other build up design [10].

Goracci C et al compared the trimming and no trimming variant of the microtensile technique with the micro pushout test and concluded that when measuring the bond strength of lutedfibre posts, the push out test appears to be more dependable than the micro tensile technique[11].Bianca Perez et al conducted a study to evaluate the influence of cement thickness on the bond strength of a fibre reinforced composite post system to the root dentin. fibre reinforced composite posts of two different sizes were cemented in the prepared root canal. The cement thickness was measured and bond strength was tested using pushout tests. He concluded that the increase in the cement thickness did not significantly affect the bond strength[12].

III. Methods

3.1 Preparation of the post space:

30 extracted maxillary central incisors were collected and disinfected in 0.5% Sodium hypochlorite. The coronal and root portions of the teeth were sectioned with airturbine at cervical level. Teeth with root canals larger than 1.5mm post drill were discarded. 18 teeth were selected from the total number. Root canals were enlarged with low-speed peeso drills (size 1 & 2). Teeth were divided into Group A and Group B with a sample size of 9 each (Fig 1). In group A, the root canal was enlarged with 1.2 mm post drill (Glassix, Nordin Dental, Sweden). In group B, the root canal was enlarged with 1.5mm post drill.

3.2 Mounting the specimens

After preparation of the root canals, 3mm of the root portion was embedded in copper band (size - 1.2cm x 7mm) using autopolymerizing acrylic resin to stabilize the root during post cementation maintaining the parallelism.The root canal was conditioned with 10% phosphoric acid for 15 seconds, rinsed and dried with paper points (No:80). Excite DSC bonding agent was applied to the root canal with applicator tip as recommended by the manufacturer, air dried and light cured for 20 seconds.In Group A (low cement thickness) – parallel fibre posts of size 1 (1.2mm diameter) were cemented with Variolink II composite luting cement. Mix Variolink II base and catalyst in a 1:1 ratio on a mixing pad for 10 seconds. The canal is coated with the cement using an endodontic file. The post was also coated and placed gently into the canal. After removing the excess cement flowing through the orifice with paper points light curing was done for 40 seconds through the orifice and the post. In Group B (high cement thickness) – parallel fibre posts of same size were cemented with the same cement as in Group A (fig 1&2).

3.3 Sectioning of the specimens:

Specimens were fixed to the acrylic base which was attached to the milling table. This was aligned perpendicular to the milling rod and sectioned perpendicular to the long axis with a diamond disc (size - 0.2mm thick, 1-inch diameter) under cooling (fig3). Initially a 0.5 mm cut was made and discarded. Thereafter 4 samples with 1.5mm thickness were obtained for each tooth of which 3 were selected. Apical end of each specimen was marked with a permanent marker. Specimens were stored in small containers filled with normal saline.

3.4 Cement thickness evaluation*:*

Cement thickness were measured with Universal Measuring Microscope. Measurements were performed along lines passing through the centre in X and Y axis. The mean cement thickness of each sample was obtained from 4 measurements performed on 4 opposite sides of the samples (fig 5). Thickness of each specimen were measured with digital Vernier calipers (Mitutoyo, Japan). Each sample was named. (Eg: A_1-1 to A_1- 3) and values were recorded.

3.5Measurement of push out bond strength:

Each sample was positioned on a custom made metallic device measuring 2cm x 2cm x 2cm in with a central pit of 8mm diameter to place the sections. The pit is having a central opening of 2mm diameter which is larger than the diameter of the root canal. The coronal portion was turned downward (load direction: from apical to coronal). The push-out bond test was accomplished by pressing a metallic cylinder (tip diameter: 0.85mm) onto only the post. Testing was performed in a Universal Testing Machine (Shimadzu, Japan) at a crosshead speed of 1mm/minute (fig 4). The mean bond strength of each specimen was calculated from 3 samples per tooth.The push-out bond strength (σ) (MPa) was achieved by the formula, **σ = F/A,** where F= rupture load of the specimen (N), and A = the bonded area (mm^2).

The bond area was calculated using the following formula for calculation of the lateral area (A) of the cylinder: $A = 2\pi rh$, where $\pi = 3.14$, r = radius of the FRC post and h = height of the sample as measured with a digital caliper. Since the sections did not incorporate the apical convergent part of the post, only the diameter of the cylindric mid-coronal part was used for the surface area measurements.

3.6 Failure type analysis

All samples were further analyzed with universal measuring microscope (Carl- Zeiss, Germany) and failure types were grouped as follows: -

a. Type I: failure at the adhesive between the root dentin and the cement
b. Type II: failure at the adhesive between the cement and the post
c. Type III: cohesive failure in the cement

Fig-1-Group A Specimens

Fig-2-Group B Specimens

Fig-3-Sectioningthe specimen

Fig-4-Testing bond strength

Fig-5-section through microscope

IV. Results

Table I shows the Rupture load (N), Surface area calculated using the formula 2πrh(r is the radius of fibre reinforced composite post, h is the thickness of the sections) and the Pushout bond strength of the specimens (MPa) calculated using the formula σ = F/A (F is the rupture load and A is the bonded area). Table II &III shows t he statistical analysis. no statistically significant difference between the pushout

Sample	Rupture Load (N)	Surface area	Push-out bond strength (MPA)
A1	14.2	5.275	2.69
A2	12.5	5.31	2.35
A3	32.5	5.35	6.07
A4	40.3	5.388	7.48
A5	36.6	5.539	6.6
A6	46.8	5.501	8.5
A7	42.3	5.501	7.69
A8	37.8	5.464	6.92
A9	20.3	5.35	3.79
B1	44.7	5.539	8.07
B2	51.9	5.69	9.12
B3	4.8	5.577	0.86
B4	32.0	5.464	5.86
B5	38.4	5.388	7.14
B6	1.5	5.501	0.27
B7	27.8	5.464	5.09
B8	37.1	5.426	6.84
B9	8.1	5.464	1.48

Table 1 – shows the rupture load, surface area and pushout bond-strength.

bond strength of Group A & B (P = 0.5249). Pearson correlation analysis was done to compare between Group A & B. increase in cement thickness did not decrease bond strength significantly thus rejecting the hypothesis. ($r2 = 0.0062$) Table IV shows failure mode of the specimens. Majority of the specimens of Group A (89%) and group B (89%), failed at the interface between the post and cement.

Table- II - Film thickness, highly significant difference between Groups A &B(P-Value = 0.00000**)**

Group	Mean Cement Thickness (µ)	Std. Dev	df	P
A	89.911 ± 10.64	13.8434501	16	0.00000
B	268.16 ± 6.95	22.0582184		

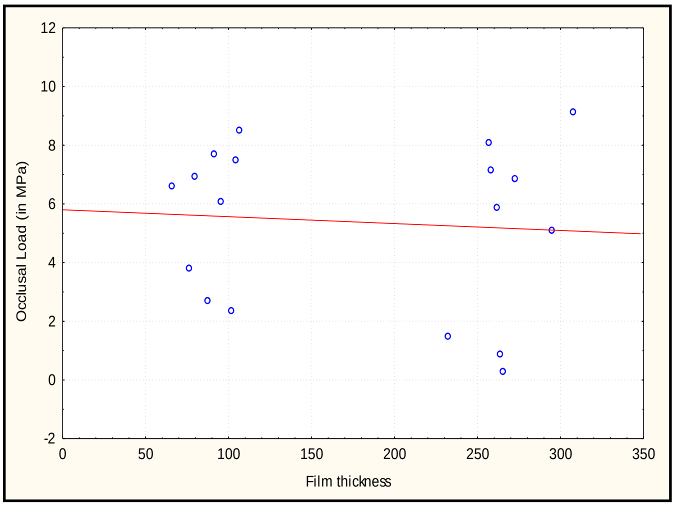
Group	Mean Bond Stength (MPa)	Std. Dev	df	P
A	5.788 ± 1.745	2.27115487	16	0.5249
B	4.97 ± 2.53	3.297859154		

Table III -Bond Strength, No significant difference between Groups A & B (P-value = 0.5249)

Group	Failure mode					
	Type I		Type II		Type III	
	No	%	No	%	No	%
A	3	11	24	89	0	0
B	2	7	24	89	1	4

Table IV Failure mode

Type I: failure at the adhesive between the root dentin and the cement
Type II: failure at the adhesive between the cement and the post
Type III: cohesive failure in the cement



Graph-1-Scatter plot for the correlation between the cement thickness and bond strength values

V. Discussion

Fibre reinforced composite posts is an esthetic alternative to conventional metal posts for the restoration of endodontically treated teeth. Fibre reinforced composite post has to be cemented using an adhesive system and a resin luting cement. Their tensile strength depends on their adhesion to root dentine through the resin cement. Reduced shrinkage of the thinner resin cement film result in less stress at the interface with the dentin and post. Therefore the thickness of the resin cement may be a determining factor in the clinical performance of fibre reinforced composite posts. This may be even more important in situations with extreme loss of root canal dentine, especially when young permanent teeth with large pulp space was restored. The objective of this study was to determine the effect of film thickness of resin cement on the pushout bond strength of fibre reinforced composite post luted to root canal dentine. The hypothesis was that an increase in cement thickness would reduce the bond strengthA dual cure resin cement (Variolink II, Ivoclar) was used to cement the fibre reinforced composite post. As there are very few samples fractured at the interface between tooth and composite, the bonding system used in this study is adequate for the cementation of fibre reinforced composite post. Only one cohesive fracture occurred in this study, the use of Variolink II, dual cure cement for cementation of fibre reinforced composite post is justified. Most of the fracture occurred at the interface between post and the cement, the bond strength of this interface may be improved. As there is no statistically significant difference between the cement thickness and pushout bond strength, the cement can be used to fill the gap between the fibre reinforced composite post and root canal dentine. In this study, a few samples showed reduction in bond strength. Some of the sections of the specimens also showed reduced bond values. The factors possibly interfering with the development of high bond strength to root dentine are the non-uniform adaptation of the bonding material or its incomplete polymerization, or both, related to the difficult access of the root canal wall during handling. These factors may account for the lower bond strength achieved by adhesive cements in the middle apical root section[13]. Hence care should be taken in the application of the bonding agent and coating of the root canal with resin cement.

The type of bond between the fibre reinforced composite post and resin cement is chemical in nature. Even though the fibre reinforced composite post consists of epoxy resin with glass fibres, there may be problem with bonding with fibre reinforced composite post. This may be due to shortage of unpolymerized residual resin monomers in the fibre reinforced composite post. Etching or surface conditioning with the fibre reinforced composite post increases the bond strength which was experimentally found out in studies conducted by Monticelli in 2006, Magni E in 2007, and Bitter K in 2007[14,8,9].Conditioning with 10% phosphoric acid followed by the application of silane primer (Monobond S, Ivoclar), should theoretically provide chemical bond to glass fibres, even though improvement should be done to enhance the bond strength[9].As there is no statistically significant difference between the cement thickness and the bond strength, the hypothesis was rejected. The result of this study is in correlation with the study conducted by Bianca Perez et al in 2006[12]However, there are some limitations for this study. The magnitude and direction of occlusal forces applied to an endodontically treated teeth restored with a fibre reinforced composite post is different from the experimental method. Clinically there is less chance of pulling out of the post from the root canal.   In literature review it has been found that pushout bond test is the most appropriate test for testing the bond strength of fibre reinforced composite post. The result of this in-vitro study has to be confirmed with well documented long term clinical trials.Another disadvantage is the frictional component involved during pushing of the post through the root canal. This value may be added to the true bond strength and will result in higher bond values.

Clinical Significance

The result of this study shows there is no statistically significant difference between the film thickness of cement and pushout bond strength. This allows the usage of the small prefabricated fibre reinforced composite post available in the market to restore teeth with larger root canals.

VI. Conclusion

Fibre reinforced composite posts is an esthetic alternative to conventional posts for the restoration of endodontically treated teeth along with all-ceramic crowns. They are also having advantage of elastic moduli similar to that of dentine, which results in reduced risk of root fracture. The adhesive system used in this study is capable of producing good bond strength with the dentine but the bonding with the post can be improved. Resin cements can be used to fill the space between root canal dentine and fibre reinforced composite posts in teeth with large root canal.

References

[1]. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. IntJProsthodont2003;16:39-44
[2]. Vallittu PK. A review of fiber-reinforced denture base resins. J Prosthod1996;5:270-276
[3]. Vallittu PK. Experiences of using glass fibres with multiphase acrylic resin systems. Theoretical background and clinical examples. In: vallittupk (ed). The first symposium on fibre reinforced plastics in dentistry. University of Turku, Institute of Dentistry, 1998
[4]. VallittuPK. Strength and interfacial adhesion of frc-tooth system. In: VallittuPK (ed). The second symposium on fibre-reinforced plastics in dentistry. University of Turku, Institute of Dentistry, 2001
[5]. Cormier CJ, Burns DR, Moon P. In vitro comparison of the fracture resistance and failure mode of fiber, ceramic, and conventional post systems at various stages of restoration. J Prosthodont2001;10:26-36
[6]. Bitter K, Meyer-Lueckel H, Priehn K, Kanjuparambil JP, Neumann K, Kielbassa AM.Effects of luting agent and thermocycling on bond strengths to root canal dentine. IntEndodJ2006;39:809-818
[7]. Kalkan m, usumez a, ozturk an, belli s, eskitascioglug.bond strength between root dentin and three glass-fiber post systems. J ProsthetDent 2006;96:41-46.
[8]. MagniE, MazzitelliC, PapacchiniF, RadoviclI, GoracciC, ConiglioI, Ferrari M. Adhesion between fiber posts and resin luting agents: a microtensile bond strength test and an sem investigation following different treatments of the post surface. J AdhesDent 2007;9:195-202
[9]. Bitter K, NoetzelJ, Neumann K, KielbassaAM. Effect of silanization on bond strengths of fiber posts to various resin cements.
[10]. Quintessence Int2007;38:121-128
[11]. Naumann M, Preuss A, FrankenbergerR. Reinforcement effect of adhesively lutedfiber reinforced composite versus titanium posts. Dent mater 2007;23:138-144
[12]. Gorracci C, Raffaelli O, Monticelli F, Balleri B, Bertelli E, Ferrari M. The adhesion between prefabricated frc posts and composite resin cores: microtensile bond strength with and without post-silanization. Dent Mater 2005;21:437-444
[13]. Bianca E M Perez, Silvia H Barbosa, Renata M Melo, Sandra C Zamboni, MutluOzcan. Luiz Felipe Valandro, Marco A Bottino
[14]. Does the thickness of the resin cement affect the bond strength of a fiber post to the root dentin? IntJProsthodont2006 3;19:606-609
[15]. GoracciC, Tavares Au, Fabianelli A, Monticelli F, Raffaelli O, Cardoso Pc, Tay F, Ferrari M. The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. EurJOral Sci 2004;112:353-361
[16]. MonticelliF, Toledano M, Tay Fr, Cury Ah, Goracci C, Ferrari M.Post-surface conditioning improves interfacial adhesion in post/core restorations. Dent Mater 2006;22:602-609

*Pramod Kumar A V. "Effect of Resin Cement Thickness on the Push out Bond Strength of Fibre Reinforced Composite Post to Root Canal Dentine- An In-Vitro Evaluation." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 16.12 (2017): 65-70