International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 4 Issue 5, May-2015, pp: (1-7), Impact Factor: 1.252, Available online at: www.erpublications.com

Evaluation the Effect of Thermocycling on Push Out Bond Strength of Fiber Post to Human Radicular Dentin (An In Vitro Study)

Rajaa T. Suliman
Department of Conservative Dentistry, College of Dentistry, University of Mosul, Iraq

ABSTRACT: To evaluate the effect of thermocycling on push out bond strength of glass fiber post to radicular dentin when cemented with a self-adhesive resin cements.

Materials and Methods: Forty single-rooted human teeth were treated, post space prepared to received glass fiber post (luxa post) cemented with self adhesive dual cure resin cements (PermaCem 2.0) and divided randomly in to 4 groups(n=10). Group1: 10 roots (without thermocycle test),Group2: 10 roots thermocycle for 500 cycles. Group 3: 10 roots thermocycled for 1000, Group 4: 10 root thermo cycled for 2000cycles between (5 -55)˚Cusing thermocyclar machine (USA), root were coded and placed in 100% humidity at 37˚C for 7 days. A horizontal sections of 2-mm thickness were cut from each root, than specimens subjected to push out using universal testing machine.

Result: Statistical analysis revealed that there was no significant difference in the push out bond strength at $p \geq 0.05$ between thermocycled and non –cycled samples, the failure mode were adhesive, cohesive and mixed.

Conclusions: Glass-fiber post (luxa post)and self adhesive resin cement (PermaCem 2.0) offer acceptable level of retention and not susceptible to produce significant reduction in push out bond strength.

Keywords: Glass fiber post, Thermo cycling, Push out bond strength.

INRODUCTION

Endodontic ally treated teeth often require to have substantional bulid up with varying post- core foundation materials to retain a complete crown and standard crown preparation. In recent years various types of fiber reinforced composite resin posts have been introduced in order to provide the dental profession an alternative to conventional post [1,2].
Glass fibers have documented reinforcing efficiency, modules of elasticity valued similar to that of dentin also good esthetic qualities compared to carbon or armed fibers, the effectiveness of fiber reinforcement is dependent on many variables including the resins used, the quality of fibers in the resin matrix, orientation of fibers, length of fiber, forms and adhesion of fiber to the polymer matrix[3,4]

Also fiber post can transmit light to deeper part of the canal so they can improve degree of polymerization for the resin cement, fiber post with resin cement produce appropriate root strengthening, the reinforcing effect of the fiber fillers is based not only on the stress transfer from the polymer matrix to the fibers, but also on the behavior of individual fiber as stress breaker[3,4,5]. Prefabricated glass fiber reinforced conical composite post used following endodontic treatment in order to establish reliable retention of core bulid up where insufficient coronal tooth structure exists[5]. The self-adhesive resin cements, characterized by high strength associated with low viscosity and eliminate the need for pre treatment of dentin and application of primer –adhesive, the organic matrix typically consists of mutifuunctional methacrylate phosphoric acid which contributes to adhesion to dental tissue ,therefore the adhesive properties are based on the new acid monomer, where the acid act as etchant and the hydroxyapatite demenerilzes allowimg monomers to infilitrate the dentin substrates, resulting in micromechanical retention, presumably chemical bonding, the establishment the effective of micromechanical retention between the resin cement and dentin tubule take place when the adhesive resin penetrates into the intra tubular and inter tubular dentin forming resin tag and the hybrid layer micromechanical interlocking is the most important adhesion mechanisms of resin to dentin. Self adhesive resin cement provide better sealing compared to self etching primer resin cement [6,7,8] Bitter et al concluded from their study that these cements(self adhesive) exhibit moisture tolerance because of water forming during the neutralization reaction of phosphoric acid methacrylate fillers and hydroxyl apatite[9].

Dual cure cements were developed to conciliate the favorable characteristics of self cure and light cured cements by extended the working time, and capable of reaching ahigh degree of conversion in either the presence or absence of light.Light penetration in to root canal is limited even with translucent posts result in lower degree of conversion of polymerized methacrylate monomer, therefore to be certain of an adequate curing within the root dual cured types of resin composite or cementwere used[10].

Fiber posts cemented adhesively resin cement is chemically bonding with the resin matrix of the posts, debonding is the most commen kind of failure in fiber posts restoration thus selecting an appropriate adhesive system for bonding posts is important for the success of fiber post restoration, The purpose of this in vitro study was to evaluate the push out bond strength for Glass fiber composite post (Luxa post, radiopaque DMG, Hamburg, Germany) cemented with self - adhesive dual cure composite luting cement (PermaCem 2.0, DMG, Hamburg, Germany) after thermocycling using thermocycler machine.

MATERIALS AND METHODS

Forty caries and crack free human lower premolars of single root canal with no root caries, cervical cavities, pre-existing restoration, root canal treatment, calcified canals, crack line, open apices and restorative defects. All teeth scaled and polished and stored in distilled water at 37℃ until used, the crown of each tooth was removed at the cement enamel junction(CEJ) using low speed water cooled dimond section disc to make all canal 14mm in length, then the root-canal were accessed, and the canal lengths were measured by inserting a size# 15 K -type file (MANI,INC, JAPAN) into each root canal until the tip of the file was visible at the apical foramen, the working length was established 1mm short of the apex. Crown down technique prepared root canal at the predetermined working length using ProTaper files (Ni-Ti) rotary instruments to size F3 with contra angle rotary hand piece (NSK, Made in Japan).3ml of 2.5% NaOCL solution (FAS a commercial house hold bleach, Iraq) used at the beginning of instrumentation and between each file size, then final irrigation with 5ml of the solution, then the root canal irrigated with 2ml of 17% EDTA (Technical and General LTD. London. UK) used for final irrigation which left in the canal for 5 minute. The use of NaOCL and EDTA in combination as a final post space irrigation can potentially modify the root canal dentine and increase the bond strength of resin cement to radicular dentine[10-14].

Afinal rinse (5 ml Distilled water) to remove any remants of the irrigating solution, then root canal were dried by F3 absorbantprotaper paper point (Dentsply, Maillefer, Switzerland), AH 26 root canal sealer (Dentsply, Detrey, Germany) was used with guttapercha cone using size F3 ProTaper Guttrapercha points (Dentsply, Maillefer, Switezerland) excess guttapercha then removed with heated instrument and cold vertical compaction performed with endodontic plugger, the canal orifice clean and sealed with glassionomer cement (vocogermany). The roots were coded and stored in100% humidity at 37℃ for 72 hrs until used and to allow setting of sealer[11-14].

Post space preparation:

Root filling was removed using (Gates-Glidden Gates Drills, assorted 1-3, length 32 mm, Dentsply, Maillefers Switzerland) and a 10- mm length post space were prepared, leaving at least 3mm of root filling apically, then post space prepared using preparation drill (size1.25 mm) to produce adequate cement gaps and to a void over post space size, radiographs were taken to check the presence of any residual gutta perch and sealer in the root canal walls along the prepared post. than the post space was irrigated with 5 ml normal saline and then 5ml of distilled water, canals were dried with ProTaper paper point, the rubber stopper placed on the spreader to verify the appropriated depth clean the prepared root canal and ensure that the dentine retains a little residual moisture and don't become overly dry.

Cementation of the post:
According to manufacture instruction, the self adhesive resin cement, Dual cure (PermaCem 2.0, DMG, Hamburg, Germany), the cement was applied to canal according to manufacture instruction, applying cement directly in to the prepared canal with the aid of appropriate mixing tip (auto-mixed past) as shown in Figure (1),when doing so insert the tip as deeply as possible in to the canal, insert the glass fiber reinforce composite post (Luxa post diameter size 1.25mm, DMG, Germany) in to the root canal according to manufacture instruction, insert the post immediately in to the canal within first 30 sec, using dental tweezer and attach using slight pressure, remove excess cement within 30 sec of inserting the root post with simple brush, allow the material to chemically cured fully for 7:00 minute from the start of mixing the post maintained under pressure until initial hardening of the cement had occurred, then polymerization with light cure(output500 nm, for 60 second through the post, 20scervically, buccally and lingually, place light cure tip as close as possible to the surface, then all fiber posts were cut at a distance of 5mm from coronal surface of the roots. Core build ups for all specimens were created incrementally from alight polymerized microhybrid composite resin (Saremco extra, Dental product, Switzerland) to sealing the coronal part of the roots and sealing the apical foramen with composite filling before thermocycling to avoid extra heat leakage from coronal and apical parts of the root, specimens were coded and placed in 100% humidity at 37˚C for 7 days and until used[11-14].

Thermocycling :

Thermocycling for the samples after 1 week of storage between (5-55)C° 500,1000,2000collective cycles, 30-sec.soaking, 5 sec intervals using thermocyclare machine (USA) as shown in Figure (2A).

Sectioning:

Each root was then embedded in acrylic resin in a plastic tube, after setting of the acrylic resin, a horizontal section of 2 mm thickness(figure 4) were cut from the coronal third of each root by using a microtome (Struers- Denmark) under water cooling and the exact length of each segment was measured using adigital verina (made in germany).

Bond strength Test:

A push out test performed in a computer controlled(Universal testing machine, Alfa, UK), the root section wasthen subjected to a comprasive load via a universal testing machine at acrosshead spead of 1mm /min using a 0.8mm diameter stailess steel cylindrical plunger, the plunger tip was positioned so that it only contacted the post material, the push out force was applied in an apico-coronal direction until bond failure occurred, which was manifested by extrusion of the post materials [(11-14).]The maximum failure load was recorded in Newton(N) required to extrude the post from the root segments and was used to calculate the push out bond strength in Megapascals (Mpa) according to the following formula([11-14).]: **(σ= Fmax/A),**where push out bond strength (MPa) = (Fmax) was the maximum load when dislodgement of the luxa post was occurred in (N),(A) the effective adhesive surface area of the root canal in (mm^2) which can calculated according to the following formula: **$A= \pi(r1+r2)\sqrt{\{(r1 - r2)^2 + h^2\}}$.**

Where π=constant 3.14, r1= larger radius of root canal (coronal) , r2= smaller radius of root canal (apical), were measured using steromicroscope (at X 20,Motic,Taiwan) , h=the thickness of the section in mm. using digital vernia (Made in Germany), Statistical analyses were performed using a one-way analysis of variance (ANOVA) and Duncan's multiple range test to determine if there were statistically significant differences among groups at ($p \leq 0.05$). The failure mode were evaluated under steromicroscope at X20 magnification and divided in to three catigaries: adhesive failure between cement-dentin and post-cement , cohesive failure (within cement or post or dentin) or mixed [(15)].

RESULT

Statistical analysis include One Way Analysis of variance (ANOVA) and Duncan Multiple Range test at $P \leq 0.05$ was performed to evaluate the statistical differences in the push out bond strength in megapascale (MPa) among tested groups, One way analysis of variance demonstrated reduce in push out bond strength with increase thermocycling test with no significant difference in strength among control and thermocycling group as shown in Table (2,3). There was no significant difference in the mean of push out bond strength among non-cycled and thermocycling samples, G1=19.33±0.625MPa/SD, G2=19.120±0.616MPa/SD,G3=18.73±1.35MPa/SD, G4=18.28±0.828MPa/SD.

The mode of failure in this study were adhesive, cohesive and mostly mixed as shown in table (5), figure(4).

DISCUSION

Fiber-reinforced composite (FRC)post have been suggest as group which offers stiffness equal to that of dentin, as well as high durability ,have advantages over conventional post, also the rigidity of the post should be equal or close to that of the root in order to distribute the occlusal force along the length of the root[(16,17),] glass fiber post, the use of such materials offer a number of advantages including biocompatibility, esthetic properties, dental like rigidity, resistance to corrosion and fatigue ,mechanical properties that closely match to tooth and easy removal of post from the root canals, among of these properties[(16,17)] Good adhesion between post and cement and cement and dentin is one of the important factors in load transfers, the resin cement provides a micromechanical and chemical bond to post and dentin not observed in the other cements. Glass fiber post ,resin cement and composite resin cores has advantage include more conservative post hole preparation also establish reliable retention for core bulid up where insufficient coronal tooth structure exists [(17,18)]

Mechanical instrumentation usually results in an amorphous irregular smear layer covering the canal dentinal surfaces and plugging the dentinal tubules, smear layer composed of debris and sealer/gutta perch remnants that has adverse effect on the adhesion to the radicular dentin[(19)]. Sodium hypochlorite(NaOCL) and ethylenediaminetetracetic acids(EDTA) are substances usually used during the endodontic treatments, NaOCL used for their antibacterial and tissue dissolving properties for the organic portion of the smear layer, EDTA is a chelating agent that removes calcium ions to produce dentin demineralization, therefore sodium hypochlorite and EDTA has long been efficient in removing endodontic smear layer. NaOCL and EDTA remove both organic and inorganic components in which it is total remove improves the adaptation of filling materials to root canal also the effective removal of the smear layer by EDTA allowed for the extention of the resin into the open dentinal tubules creating efficient microretention[20,21]

Statistical analysis include One Way Analysis of variance (ANOVA) and Duncan Multiple Range test at $P \leq 0.05$ was performed to evaluate the statistical differences in the absorbance means among tested groups, One way analysis of variance demonstrated reduce in push out bond strength with increase thermocycling test with no significant difference in strength among control and thermocycling group as shown in Table (3,4). There was no significant difference at $p \geq 0.05$ in the mean of push out bond strength among non-cycled and thermocycling samples, G1=19.33MPa/SD, G2=19.12MPa/SD, G3=18.73MPa/SD, G4=18.28MPa/SD.

Push out bond strength for glass fiber post and resin cement reduce with increase in thermal changes, thermocycling has been viewed as an essential aspect of dentin adhesion testing, it is a part of an international standard for adhesion tests thermal changes, thermo cycling create stress at the cementing agent-hard tissue interface, this caused either by differences in thermal expansion coefficients within the multi component material or by an accelerated hydrolytic degeneration of the cementing agent ,also there is a potential deteriorative effect of water on the interfacial adhesion between polymer matrix to glass fiber [1,22,23] water sorption contribute to the observed reduction in bound strength, solubility and sorption may cause stress induced degradation for cement, the presence of water in the polymer network may have impaired further resin cement polymerization[24].Water act as a plasticizer increasing free volume and decreasing the glass transition temperature of the polymer matrix, there is a potential deteriorative effect of water on the interfacial adhesion between polymer matrix to the glass fiber through rehydrolysis at silane coupling agents, Water permeates through resin- based materials by various mechanisms, such as direct diffusion into the resin matrix, penetration in to voids incorporated into the resin and damage already present in the material generated by hydrolysis and cause cohesive failure or movement of water along the filler matrix interface and cause adhesive type of failure[25] Several study have shown that the retention is a relevant problem of intraradicular posts, therefore it is necessary to understand the retention mechanisms of the posts to root canal, the type of bond strength test used directly influences the obtained results, in the push out tests produce stress at the post-cement interface as well as at the dentin cement interface, the tensions in the adhesive interface are greater at the post /cement than at the dentin /cement interface which may promote cohesive failure [6].The mode of failure and position give an idea about quality of the bond between the tooth and adhesive, in this study mode of failure were adhesive, cohesive and mainly mixed.

David et al study the effect of thermocycling on the retention of glass fiber root canal posts (light post)cemented with Panavia F resin cement ,there were no significant differences in the forces required to cause post retention failure between the control and thermocycling samples[1] Xiao et al evaluate the effect of thermomechanical loading on the retention of glass fiber post in root canals, bond strength was evaluated using pullout test they concluded that increase the ability for pull out strength for glass fiber post after thermomechanical loading [26].

REFERENCES

[1]. Daivid, Alison JE: Effect of thermocycling on the retention of glass fiber root canal post, QuntessenceInt J, 2003;34:366-369.
[2]. Torrs S, Montoya S, Cordob P: Fracture resistantance of endodontically treated teeth restored with glass fiber reinforced posts and cast gold fiber reinforced posts and cast gold post and core cemented with three cements, J Prosth,2013:10(2):127-33.
[3]. Rodovi, CorciolaniG,Magni E:Light transmission through fiber post, Dent Mater, 2009,98(3):193-198.
[4]. Dyer SR, Lassi LV, Jokinen M: Effect of fiber position and orientation on fracture load of fiber reinforced composite, Dent Mat, 2004; 20:947-55.
[5]. SufyanG, Pekka K, Vallitu L: Continuous and short fiber reinforced composite in root post –core system of sevsraly damaged incisor, Oper Dent J;2009,3,42-47.
[6]. Sullen Z, Manoel DN, Renato R, YaraTC: Micro tensile bond strength of glass fiber posts cemented with self adhesive and self etching resin cements, J adhesive Dent,2011;13:55-59.
[7]. Patricia M, Yasushi S, Allierza S:Nanoleakage expression and micro shear bond strength in resin cement –dentin interface, Adhesive Dent J,2010,12:393-401.
[8]. Volkan T, Deniz S, Betul T: Adhesion of 10 MDP containing resin cements to dentin with and with the out the etch and rinse technique,J Adhesive Prosthodontic ,2013,5(3)266-233.
[9]. Bitter K, Meyer L, Priehn K, Kanjupara J: Effect of luting agent and thermocycling on the bond strength to root canal dentin,Endo J,2006;39:809-18.
[10]. Nagas E, Cehreli ZC, Durmaz V: Regional push out bond strength and coronal microleakage of resilon after different light-curing methods, J Endod, 2007;33:1464-8.
[11]. Ramin M, Alireza H:Push out bond strength of afiber post system with two resin cements, Dent Res J,2011,8(11):8-93.
[12]. Dominika M, Anna MB, Lippo V :Effect of cementation technique of individually formed fiber –reinforced post on bond strength and microleakage,Oper Dent J,2013;7(3):68 -75.

[13]. NabbaLA, Rujai M: Aging and thermocycling effects on adhesion of fiber posts to human radicular dentin, Braz J Oral Sci,2012,11(2):106-111.
[14]. Bandeca MC, Kassem AS, EL- Mowafy, Nadlin MR, Queiroz RS , ClavijoVR,Saad JR: influence of storage time on bond strength of resin cement s to root canal,Mater Res. 2010;13 :25-28.
[15]. Bitter K, Paris S, PfuertnerC,Neumann K, Kielbassa AM: Morphologyical and bond strength evaluation of different resin cements to root dentin,Eur J Oral Sci, 2009,117:326-333.
[16]. Jasmina B, Sufyuan G, Pekka V:Fracture load of restored with fiber post and experimented short fiber composite,Oper Dent,2011,5:58-65.
[17]. Horieh M, Fathem M, Soodabeh K: Fracture resistance of endodontically treated teeth restored using three root reinforcement methods, J of Contemporary dental practice;2008,9(1):2-9.
[18]. Ozcan M, Valandra LF: Fracture strengthof endodontically treated teeth restored with post and core and composite core only ,Oper Dent,2009,34(4):429-436.
[19]. Serafino C, Gallina G, Cumbo E: Surface debris of canal walls after post space preparation in endodontic aly treated teeth: a scanning electron microscop study ,Oral Surg Oral MedOral Pathol Oral Radiol and Endod;2004;97:381-7
[20]. TaggerM,TaggerE,Tjian AH, Bakland LK: Measurment of adhesion of endodontic sealers to dentin, J Endodo, 2002,28:351-4.
[21]. Kim D, Prak S, Choi G, Choi K: Effect of EDTA treatment on the hybrid layer durability in total etch dentin adhesive, Dent Mater J ,2011;30:717-722.
[22]. Ander P,RalfB,Peter O: Long term between dual polymerizing cementing agent and human hard dental tissue,2006,Dent Mater,9(12):2-7.
[23]. Hayashi M, Takahashi Y: Fracture resistance of pulpless teeth restored with post –core and crowns, Dent Mater, 2006, 2(2):477-85.
[24]. BandecaMC,Kassem AS,EL-MowafyO,Nadalin MR: Influence of storage times on bond strength of resin cement to root canal,Mater Res,2010,13:25-28.
[25]. Mese A, Burrow MF,Tyas MJ:Sorption and solubility of luting cements in different solutions, Dent Mater J,2008;27(5):702-9.
[26]. XiaoJ,SanjunZ,Lina NM: effect of luting cement and thermomechanical loading on the retention ofglass fiber post in root canal,J of Dent, 2014,42(1):75-83

Table (1): Composition of the Materials used in the Present Study

Materials	Composition
Luxa Post (prefabricated translucent glass fiber post	**Pre-silanized glass fiber in a Bis GMA based resin matrix**
Perma Cem 2.0 (Universal auto mix dual- cure self adhesive rein cement.	**Barium glass in a Bis-GMA based matrix of dental resins, pigments additives and catalysts, filler content 69 wt.%.**

Table (2): One Way Analysis of Variance (ANOVA) for the push out bond Strength for the four Different Groups

	Sum of seq.	DF	Mean	F .Values	P. Value Sig
Between group Within group Total	5.562 29.15 34.716	3 36 39	1.854 0.810	2.289	**0.095**

DF: degree of fredum, P≥0.05 no significant difference

Table (3): Duncan Multiple Range test for the push out bond strength for the four different groups

Group	Mean± SD	Minmum values	Maxium values	Duncan groups
Group 1	19.33±0.625	18.2	20.7	**A**
Group 2	19.120±0.616	18.00	20.4	**A**
Group3	18.73±1.35	17.2	20.0	**A**
Group4	18.28±0.828	16.2	19.4	**A**

Table(4): Failure mode distribution among four experimented groups

Groups	Adhesive	Cohesive	Mixed
G1	2	4	**4**
G2	2	4	**4**
G3	2	3	**5**
G4	2	4	**4**

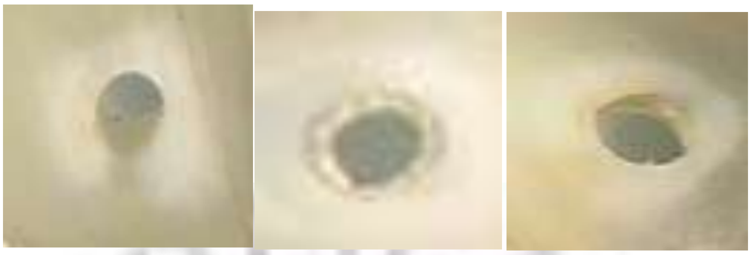
Figure (1): Materials used in the study

A **B**

International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 4 Issue 5, May-2015, pp: (1-7), Impact Factor: 1.252, Available online at: www.erpublications.com

C

D



E

Figure (2)A:Thermocyclare machine, B: Thermocycled samples C: Section samples(coronal,apical side), D: Sample under loading using computer controlled universal testing machine. E: failure mode(adhesive,cohesive and mixed respectively).