EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 68, 1707:1712, April, 2022

Print ISSN 0070-9484 • Online ISSN 2090-2360

Fixed Prosthodontics and Dental Materials

Submit Date : 2022-02-04 • Accept Date : 2022-03-10 • Available online: 2022-03-30 • DOI : 10.21608/edj.2022.120055.1972

EFFECT OF ULTRA-SONIC ACTIVATION ON PULL OUT BOND STRENGTH OF FIBER POSTS CEMENTED WITH SELF ADHESIVE CEMENT

Ahmed W. Hashim,* Mohamed Y. Hassan** *and* Mai H. Abdelrahman***

ABSTRACT

Background; The smear layer is considered an obstacle limiting the penetration of adhesive types of cement into the dentinal tubules, thus adversely affecting the bond strength of the fiber posts.

Objective; The purpose of this study was to assess the effect of ultra-sonic activation on the bond strength of fiber posts, cemented with self-adhesive cement to the root dentin.

Methods; A total of 18 recently extracted single rooted premolars were selected. The root canals were prepared using ProTaper rotary, samples were obturated with Protaper universal gutta percha points. Post space was prepared using gates glidden drills, specimens were randomly divided into two groups of n=9 according to the irrigation application techniques; Group 1: conventional syringe, Group 2: ultra-sonic activation. Posts were cemented using Rely X Unicem2, bond strength was determined by pull out test.

Results; A statistically significant higher mean value was recorded in Group 2 compared to Group 1.

Conclusions; Ultrasonic activation can aid the irrigation with 2.6% NaOCl followed by 17% EDTA in smear layer removal, contributing in a triad way of cleaning of the root canal system and thus promoting the bond strength of fiber posts.

*Lecturer in Department of Fixed Prosthodontics, Faculty of Dentistry, October University for modern Sciences and Arts, Egypt.
**Lecturer in Department of Endodontics, Faculty of Dentistry, October University for Modern Sciences and Arts, Egypt.
*** Lecturer in Department of Dental Biomaterials, Faculty of Dentistry, October University of Modern Sciences and Arts, Egypt.

INTRODUCTION

In some cases of endodontically treated teeth, intra-canal posts are considered essential in order to enhance the final restoration retention. Compared to cast metal and core systems, fiber posts became more usable due to their better esthetics, closer elastic modulus to that of dentin, and more uniform stress distribution [1-3].

Debonding of the fiber posts at the adhesive resin–dentin junction is considered to be their most common failure reason, which is thought out to be a sequel of the thick smear layer and debris covering the root surface formed during post space preparation [1-3].

The smear layer is considered an obstacle limiting the penetration of chemical substances, intracanal dressings, and sealers into the dentinal tubules [4]. Removal of this smear layer after post-space preparation helps to prevent the presence of an obstacle in the bonding interface and introduces the possibility of increasing fiber post retention. Thus, effective elimination of the smear layer from root canal walls is considered mandatory before fiber post cementation [5].

Ideally, root canal irrigants should completely remove the smear layer and flush out debris [6-8]. The most commonly used endodontic irrigant is 0.5% to 6.25% sodium hypochlorite solution (NaOCl), due to its wide range of antibacterial action besides its ability to dissolve organic and necrotic tissues [3,9-11].

Despite its advantages, NaOCl exhibits high surface tension thus its penetration into the dentinal tubules is limited [7,8]. Combined with its inability to completely eliminate the smear layer, it has no influence on the inorganic materials [12].

Ethylene diamine tetra acetic acid (EDTA) is another irrigant solution that effectively dissolves the inorganic materials; however, it does not possess antibacterial activity[2,12].

Consequently, removal of the organic and inorganic components of the smear layer can be achieved by using an irrigant combining both sodium hypochlorite (NaOCl) and EDTA solutions; NaOCl acts as an organic tissue solvent and has a bactericidal action while the chelating effect of EDTA promotes decalcification of the inorganic components exposing the dentin collagen network [13].

The introduction of different irrigation activation techniques has been implemented to improve the efficacy of irrigation solutions within the root canal system [6,14]. Ultra-sonic activation is one of those techniques, it involves an oscillating tip activated by an ultrasonic device placed in the root canal resulting in mechanical agitation of the irrigant, without instrument contact with the root canal wall [4-6, 10,11,15]. Aiming to improve the dissociation of the irrigant in the canal system, providing a softening effect of the dentin debris and removal of bacteria and smear layer [8].

Based on a previous study; there is a synergistic effect between irrigant solutions and ultra-sonic activation [15]. Accordingly, this study aimed to assess the effect of ultra-sonic activation on the bond strength of fiber posts cemented with self-adhesive cement to the root dentin.

MATERIALS AND METHODS

Tooth selection and preparation:

A total of 18 recently extracted single-rooted premolars were selected for this study. Teeth were cleaned using an ultrasonic scaler, placed in 5.25%NaOCl for 30 min for surface disinfection, then stored in distilled water until use. Anatomical crowns were decapitated to obtain a uniform root length of approximately 16 mm, using a low-speed diamond saw (IsoMet 4000 micro saw, Buehler, USA). The root canals were prepared at a working length (WL) of 1 mm from the apical foramen using ProTaper rotary file “DENTSPLY Maillefer, Ballaigues, Switzerland”[1,5]. Irrigation was done using sodium hypochlorite and normal saline to remove the remaining debris then dried with paper points.

Obturation and post-space preparation:

All samples were obturated with Protaper universal gutta-percha points” DENTSPLY Maillefer, Ballaigues, Switzerland” and Adseal “META BIOMED CO.LTD Korea”. The roots were stored in an incubator at 37 °C in 100 % humidity for 1 week, and then the teeth were placed in acrylic resin blocks with the tooth/post extruding from the block. The proper size of Fibre Kleer tapered glass fiber posts (Pentron Clinical, CA, USA) was selected with a 1.4 mm diameter. For each tooth, post space preparation began with the removal of gutta-percha to a depth of 12 mm using gates glidden drills (Dentsply-Maillefer) leaving a minimum apical seal of 4-5 mm. Fibre Kleer post tapered drill corresponding to the glass fiber post size was used to remove any residual root filling and complete canal preparation with water spray coolant and at a low speed [1,2,5,16]. Following post space preparations, specimens were randomly divided into two groups of n=9 according to the irrigation application techniques as follows:

Group 1:

Irrigation with 10 ml of 2.6% NaOCl over 60 seconds followed by 5 ml EDTA for another 60 seconds[17].

Group 2:

Irrigation with 10 ml of 2.6% NaOCl over 60 seconds followed by 5 ml EDTA for another 60 seconds. Then, the solutions in this group were agitated with an ultra-sonic tip mounted on an ultrasonic hand piece “Eightieth Medical Ultra X-Ultrasonic Activator” at 45 kHz ultrasonic frequencies, which utilize the principle of acoustic micro-streaming, agitation, and cavitation to reach all areas of the complex root canal system [13,17].

Post cementation:

Cementation was done using Rely X Unicem2 self-adhesive resin cement (3M ESPE Dental products).

Pull out test:

Resin composite was added to the coronal end of the posts to reinforce the grip while performing the test. The pull-out test was performed parallel to the long axis of the post at a cross-head speed of 0.5 mm/min with a universal testing machine (model 3345; Instron®, High Wycombe, UK). The force required to dislodge the FRC was recorded in newtons [16,18,19].

Statistical analysis:

Values were presented as mean, standard deviation (SD) values, and confidence intervals. Results of Kolmogorov-Smirnov test indicated that data were normally distributed (parametric data), therefore, independent t-test was used for intergroup comparisons. The significance level was set at $p \leq 0.05$. Statistical analysis was performed using a commercially available software program (SPSS 18.0-Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) for Windows.

RESULTS

Pull out test

A significantly higher mean value was recorded in Group 2 (70.07±7.98), compared to Group 1 (58.63±8.68). The mean difference between ~~the~~ both Groups was (11.45). This difference was statistically significant (p=0.039).

TABLE (1): Descriptive statistics and comparison etween groups (independent- t-test)

Groups	Mean	Std. Dev.	Differences				T	P
			Mean	Std. Error	C.I Lower	C.I Upper		
Group 1	58.63	8.68	11.45	4.82	0.71	22.19	2.78	0.039*
Group 2	70.07	7.98						

Significance level p≤0.05, * significant C.I.=95% Confidence Interval of the Difference

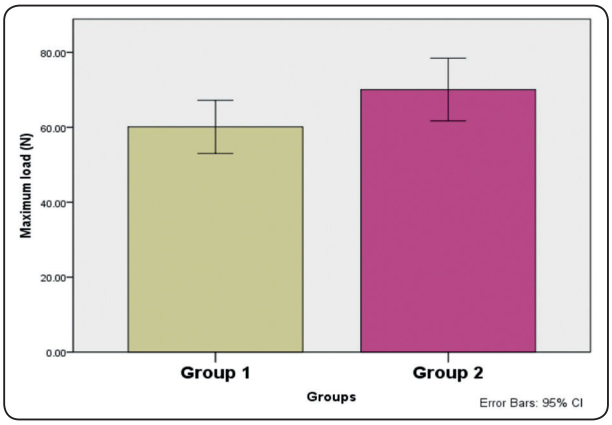

Fig. (1) : bar chart illustrating mean maximum load (N) of the pull-out-test

DISCUSSION

Fiber posts have become popular in restoring endodontically destructed teeth, owing to their mechanical properties which are close to that of dentin [5].

A thick smear layer is formed during post space preparation, which interferes with the ability of the self-adhesive cement to form the hybrid layer thus the bond strength is adversely affected [1,12].

Bond strength of the fiber posts depends on the effectiveness of smear layer removal and depth of cement penetration into the dentinal tubules [2,5]. Thus, dentin surface cleanliness after post space preparation is a crucial procedure affecting the longevity and durability of the post retention [2].

Despite the advantages of NaOCl irrigation, NaOCl alone cannot completely eliminate the smear layer, consequently preventing full penetration of the cement [13]. Moreover, it has a negative effect on the adhesion of resin cement; NaOCl decomposes into sodium chloride (NaCl) and oxygen (O_2), the released O_2 inhibits polymerization of the adhesive cement [5].

Previous researches demonstrated that the NaOCl/EDTA combination would eliminate the smear layer efficiently by removing the remaining organic and inorganic remnants [5,13].NaOCl dissolute organic tissues, while EDTA acts on the inorganic portion of the smear layer. The resultant pH of NaOCl/EDTA combination favors the selectivity of the chelating agent; EDTA, for calcium ions, promotes its action. Moreover, the ability of EDTA to selectively eliminate non-collagen and hydroxyapatite proteins; prevents major changes in the collagen fibers' structure. Thus, it aids in preserving the interfibrillar minerals, promoting dehydration resistance, and therefore resinous material infiltration is improved [13].

Application of 17% EDTA for 1-minute showed satisfactory smear layer elimination, however, the application of EDTA for more than 1-minute might cause extreme dentinal erosion [17].

Nowadays, various irrigation application techniques have been introduced and reported success in improving smear layer removal [17]. Passive ultra-sonic irrigation (PUI) works by agitating the irrigant solution injected inside the canal. An ultrasonic tip is activated in the canal, in order to prevent it from binding with the root canal walls, it is passively moved in an upwards-downwards motion [6].

It has been reported that regardless of the type of irrigant passive ultra-sonic agitation, it can efficiently eliminate the smear layer from the dentin surface [1].

Many obstacles are being faced during post adhesion, thus the adhesion process must be as simple as possible [17]. Therefore, self-adhesive systems became the choice as they can be applied in both wet and dry environments and they do not require bonding agent application [1,5,19].

In this study, the bond strength was determined by the pull-out test as it provides the highest values of bond strength compared to push-out and micro-tensile tests. It allows uniform stress distribution along all the post surfaces and consequently lowers the stress values at the bond interface and the resultant shear forces are comparable to that of the clinical findings [20].

Results of the current study showed that Group 2 demonstrated higher bond strength values compared to Group 1. The obtained result revealed that ultra-sonic activation had an additional improving effect on the bond strength of fiber posts, which might be attributed to the effect of ultra-sonic activation on smear layer removal. This may be explained by acoustic streaming induced by ultra-sonic activation giving the chance for the irrigating solutions to reach the full length of the root canal and thus improving their cleaning efficiency. This was in accordance with ***Ekim SNA and Erdemir A in 2015***[5].

On the other hand, ***Ali RJ and Kadhim AJ in 2021***[12], evaluated the effect of normal saline (control group), 5.25% NaOCl, 2% chlorhexidine, 17% EDTA irrigants each perse or with ultrasonic activation on the push-out bond strength of glass fiber post to the root dentin. They concluded that the bond strength did not increase by ultra-sonic activation of the tested irrigant solutions. Also, ***Martinho FC et al in 2018***[21], compared the influence of different irrigants 2% chlorhexidine (CHX), 2.5% sodium hypochlorite (NaOCl), and saline solution (control) with and without ultra-sound or laser irradiation on the bond strength of glass fiber posts. They concluded that dentin pretreatment with ultrasound or laser irradiation had no significant effect on the bond strength of glass fiber posts. The conflicts in their results and the results of the present study might be due to the use of different irrigants solutions, different irrigation times' applications, or different methodologies.

CONCLUSION

Within the limitations of the current study, it can be concluded that; ultrasonic activation can aid 2.6% NaOCl followed by17% EDTA irrigants in smear layer removal, contributing in a triad way of cleaning of the root canal system and thus promoting the bond strength of fiber posts. Further studies are required to evaluate the depth of demineralization caused by ultra-sonic activation.

REFERENCES

1. AbouShahba ME. The effect of different post space surface treatments on push-out bond strength of fiber posts adhesively bonded to root canal dentin. EDJ. 2019; 65(1): 755:761.
2. Pradhan PK, Dipallini S, Sahoo KC, Patri G and Lata S. Effect of temperature and activation techniques of irrigating solutions on push-out bond strength of fiber post. J Conserv. Dent.2020; 23(3):295-298.
3. Jouhar R. Effect of sonic activation on push-out bond strength of fiber post: an in vitro study. Mater. 2021; 14(5038): 1-12.
4. Souza MA, Motter FT, Fontana TP, Ribeiro MB, Miyagaki DC and Cecchin D. Influence of ultrasonic activation in association with different final irrigants on intracanal smear layer removal. Braz. J. Oral Sci. . 2016; 15(1).
5. Ekam SNA and Erdemir A. Effect of different irrigant activation protocols on push-out bond strength. Lasers Med Sci (2015) 30:2143–2149.
6. Prasad KP, Tiwari A, Sankhala A, Madan G, Parakh S and Singh A. Effect of different irrigant activation techniques on the bond strength of a mineral trioxide aggregate-based sealer: an in vitro study. IJOCR. April-June 2017; 5(2):91-96.

7. Mohammadi Z, Shalavi S, Giardino L, Palazzi F and Asgary S. impact of ultrasonic activation on the effectiveness of sodium hypochlorite: a review. IAE. 2015; 10(4): 216-220.

8. Vieira EMMPM, Basting RT, França FMG, Amaral FLB and Turssi CP. Bond strength of fiber posts to intraradicular dentin after the use of ultrasonically activated irrigants. OHDM. 2017;17(1):1-8.

9. Ilieva IT and Karova E. The effect of different irrigants with or without ultrasonic activation on root dentin microhardness. IMAB.2021;27(1):3534-3538.

10. Palatyńska-ulatowska A, Buła K and Klimek L Influence of sodium hypochlorite and ultrasounds on surface features and chemical composition of Biodentine tricalcium silicate-based material. . Dent Mater J. 2020;39(4): 1-6.

11. Virdee SS, Farnell DJJ, Silva MA, Camilleri J, Cooper PR and Tomson PL. The influence of irrigant activation, concentration and contact time on sodium hypochlorite penetration into root dentine: an ex vivo experiment. IEJ. 2020; 53: 986–997.

12. Ali RJ and Kadhim AJ. The effect of the type of post space irrigation on the push-out bond strength of glass fiber post (an in vitro study). JRMDS. 2021;9(5):118-123.

13. Moura AS, Pereira RD, Rached-Junior FJA, Crozeta BM, Mazzi-Chaves JF, Souza-Flamini LE and Cruz-Filho AM. Influence of root dentin treatment on the push-out bond strength of fiber-reinforced posts. Braz. Oral Res. 2017;31:e29.

14. Pardo MS, Esteve R, Pablo OV, Fedele GR and Cisneros R. Root canal penetration of a sodium hypochlorite mixture using sonic or ultrasonic activation. Braz. Dent. J. 201; 25(6): 489-493.

15. Pirela CM, Maggiolo S and Yévenes I. Determination of sodium hypochlorite concentrations in the activation of the irrigant by passive technique with ultrasonic, during the ex vivo endodontic protocol.. Int. J. Inter. Dent. 2020; 13(3); 132-134.

16. AlMadi MK, Khabeer A, AlHilal S, AlShahrani AS and Ali S. Pull-out bond strength of fiber post luted with two types of resin luting cements using different light curing units. Niger. J. Clin. Pract. 2021; 24(12):1841-1845.

17. Elkhodary S and Elbasty R. The effect of different irrigation materials and application techniques on push-out bond strength of fiber post to root dentin. EDJ. 2018; 64, 3895:3906.

18. Pereira JR, Rosa RA, Valle AL, Ghizoni JS, Só MVR and Shiratori FK. The influence of different cements on the pull-out bond strength of fiber posts. J Prosthet. Dent. 2014;112:59-63

19. Macedo VC, Souza NAY, Faria e Silva AL, Cotes C, Silva C, Martinelli M and Kimpara ET. Pullout bond strength of fiber posts luted to different depths and submitted to artificial aging. Oper. Dent. 2013; 38(4):1-6.

20. Huwari M, El-Mahallawi O and El Alaily. Efficacy of post length and post material on the pull-out bond strength of individually formable glass fiber post versus custom made metal post on endodontically treated mandibular premolar teeth (an in vitro study). EDJ. 2016; 62 (1): 123-128.

21. Martinho FC, Carvalho CAT, Oliveira LD, Lacerda AJF, Xavier ACC, Augusto MG, Zanatta RF and Pucci CR. Comparison of different dentin pretreatment protocols on the bond strength of glass fiber post using self-etching adhesive. JOE. 2015; 41(1):83-7.