EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 69, 3323:3329, OCTOBER, 2023
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
CONSERVATIVE DENTISTRY AND ENDODONTICS
Submit Date : 29-08-2023 • Accept Date : 17-09-2023 • Available online: 20-10-2023 • DOI : 10.21608/EDJ.2023.232253.2694

COMPARATIVE EVALUATION OF PUSH OUT BOND STRENGTH OF NEOSEALER FLO, TOTALFILL BC AND AH PLUS ROOT CANAL SEALERS: AN IN VITRO STUDY

Ehab Abdel Hamid*

ABSTRACT

Objective: the objective of the current study was to asses push out bond strength of Neosealer Flo in comparison to TotalFill BC and AH Plus sealers.

Materials and methods: 30 recently extracted human mandibular single-rooted premolar teeth with only straight canals were included in the study. Samples were decoronated and root canals were enlarged using Protaper next up to X 4 then samples were allocated randomly into three experimental groups (n=10 per group) according to sealer type that was used in obturation; Group I: Neosealer Flo sealer, Group II: TotalFill BC sealer, Group III: AH Plus sealer. Samples were obturated using single cone technique with matched gutta percha cones. After obturation three dentin slices with thickness of 2-mm were horizontally cut at 2, 7 and 12 mm length from the coronal surface of each sample then push out test was performed on each slice by a universal testing machine.

Results: AH Plus showed the statistically significantly highest push-out bond strength at coronal and middle third followed by Neosealer Flo while Total Fill BC showed the statistically significantly lowest push-out bond strength. Neosealer Flo showed the statistically significantly highest push-out bond strength at apical third followed by Total Fill BC and AH Plus where there was no difference between them.

Conclusion: the highest push out bond strength at coronal and middle third was shown by AH Plus while at apical third the highest push out bond strength was shown by Neosealer Flo

KEYWORDS: Neosealer Flo; Total Fill BC; AH Plus; Push out bond strength

* Department of Endodontics, Faculty of Dentistry, Minia University

INTRODUCTION

Efficient endodontic therapy is based on effective debridement and disinfection of all root canals followed by obturation of these canals by biocompatible material to obtain bacterial tight seal[1]. Proper obturation is essential to kill any remaining microorganisms and prevent reinfection of disinfected root canals. Root canal obturation is based on using gutta-percha as a core material and a sealer to fill gaps between core material and root canal wall [2]. Root canal sealer should ideally bind to the gutta percha and root canal wall to achieve bacterial tight seal [3]

Several root canal sealers were manufactured to fulfill ideal sealer requirements for better root canal treatment outcome. Bioceramic sealers were recently introduced due to their biocompatibility, chemical stability, high antimicrobial activity and bioactivity [4-6].

TotalFill BC (FKG, La Chaux-de-Fonds, Switzerland) is a bioceramic premixed sealer which was widely tested and evaluated for its biocompatibility, antibacterial activity, bioactivity and superior physicochemical characteristics [7-9]

Neosealer Flo (Avalon Biomed™ ,Houston, Texas, USA) is a new premixed bioceramic sealer that according to manufacturer has more bioactive properties than original bioceramic sealers [10]

AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) is a sealer that is made of epoxy resin and has been used popularly for its physical properties, low solubility and bonding ability to dentin [11], although having no bioactivity [12], it is still considered the benchmark sealer to which new sealers are compared [13].

The best currently acceptable assessment of adhesion is bond strength testing [14]. Push out test is considered an acceptable approach by which bond strength is evaluated [15].

According to literature, there was no data evaluated push out bond strength of Neosealer Flo, so the current study's objective was to assess and evaluate the push out bond strength of Neosealer Flo compared to TotalFill BC and AH Plus sealers.

MATERIALS AND METHODS

The ethical Committee of faculty of dentistry, Minia university gave the study its approval; (Committee No 96, Decision No 744)

Sample size calculation:

Sample size estimation was performed based upon the results of Sagsen B et al (2011) [16]. The mean and standard deviation (SD) for push-out bond strength at the apical level were 2.9 (1), 2.6 (2.347) and 0.6 (0.38) MPa for the three groups, respectively. With 80% power based on 5% alpha (α) level and 0.8 (β) level; the one-way ANOVA test (f) effect size was 1.02 and the minimum estimated sample size was 10 samples per group.

Samples selection:

30 recently extracted human mandibular single-rooted premolar teeth with only straight canals as confirmed by radiograph were selected. Teeth were evaluated under stereomicroscope (Nikon MA100 Japan) and only teeth with mature intact roots that were without caries, resorption or cracks were included for the study.

Any soft or hard deposits were removed by curette (Roydent Scurette, USA) and teeth were disinfected by sodium hypochlorite 5.25% for 30 minutes, then kept in distilled water till use.

Samples preparation and obturation:

Teeth were decoronated using high speed diamond stone with coolant to obtain 16 mm root length. Working length was set by inserting K file #10 (Mani, Inc, Tochigi, Japan) to the root end until the tip became visible then subtracting 1mm. Root canals was instrumented using Protaper next up to X 4 (Dentsply Maillefer, Ballaigues, Switzerland).

Irrigation was performed during instrumentation with 3 ml of 2.5% sodium hypochlorite using 30-gauge side vented irrigating needle between each file, after instrumentation 5 ml EDTA solution was used for smear layer removal and distilled water was used in between irrigating solutions and as a final flush.

Samples were then allocated at random into three groups (n=10 per group) based on sealer type that was used;

Group I: Neosealer Flo sealer

Group II: TotalFill BC sealer

Group III: AH Plus sealer

Sterile Protaper next X4 paper points (Dentsply Maillefer, Ballaigues, Switzerland) were employed for canal dryness as follows; in group I & II over dryness was avoided but in group III; root canals were completely dried.

All root canals were obturated using single cone technique with Protaper next X4 gutta percha points (Dentsply Maillefer, Ballaigues, Switzerland).

In group I& II; Neosealer Flo and TotalFill BC sealers were delivered using tip delivery method in which the syringe's tip was inserted not deeper than coronal one third of the root canal then a small amount of sealer was injected, then the master cone tip was covered with a layer of the sealer and was inserted to the full working length.

In group III; AH Plus sealer was mixed according to manufacture instruction [17], then the sealer was applied on master cone and inserted to the working length.

Then by using heated plugger (Shanghai Fanta Dental Materials Inc., Shanghai, China) all excess gutta percha was removed without vertical compaction and the root canal orifices were restored with temporary filling (Meta Biomed, Korea)

All samples were then incubated for one week to give sealers time to completely set.

Push out bond strength test

Teeth were vertically aligned in self cure acrylic resin in a custom-made mold.

Three 2mm dentin slices were horizontally cut at 2, 7 and 12 mm length from the coronal surface of each sample [18] using a diamond saw with water coolant, resulting in 30 slices per group and total of 90 slices in the three experimental groups.

Slices were coded then both coronal and apical aspects of slices were examined under stereomicroscope (Nikon MA100 Japan) and any slice that had voids or non-circular canal shape was replaced by new one.

Each slice was measured for its coronal and apical diameter under stereomicroscope, then put under compressive load with a speed of 1 mm/min using a 0.9 mm diameter cylindrical steel punch tip in a 500N load cell by a universal testing machine (Instron universal testing machine model 3345 England) in which the punch tip was contacting only the filling material **(Figure1)**. In apical coronal direction the load was applied to avoid any obstruction until the root filling material dislodged.

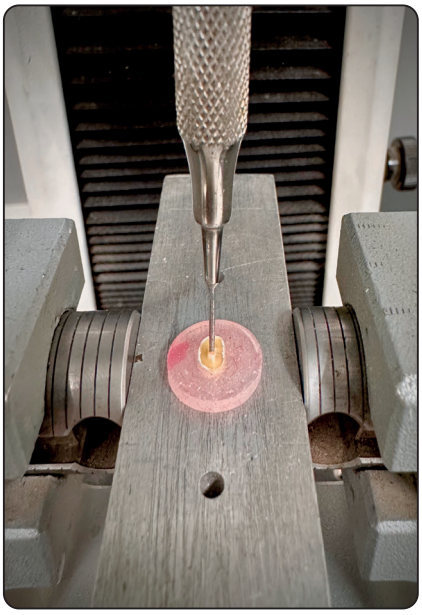

Fig. (1) Push out bond strength test

The force of failure (N) was divided by the material-canal wall interface's surface area (mm2) to get each sample's push-out bond strength (MPa).

Statistical Analysis

The distribution of the push-out bond strength data was non-normal (non-parametric) as revealed by Kolmogorov-Smirnov test. The median, range, mean, and standard deviation (SD) values were used to present the data. Kruskal-Wallis test was employed for comparison between the three groups. For comparison between root levels within each group Friedman's test was used. When there was significance, Dunn's test was applied for pair-wise comparisons. The level for significance was chosen at $P \leq 0.05$. IBM SPSS Statistics for Windows (Version 23.0. Armonk, NY: IBM Corp) was employed to perform the statistical analysis.

RESULTS

Comparison between groups

Median and mean values of push out bond strength of different sealers at three root levels are presented in table (1). A statistically significant difference had been between sealer types at the three root levels. At the coronal and middle root thirds; the push out bond strength value for AH Plus was the highest statistically significant followed by Neosealer Flo then Total Fill BC which showed the lowest statistically significant push-out bond strength value.

At the apical third; Neosealer Flo showed the statistically significantly highest push-out bond strength value while Total Fill BC and AH Plus showed lower statistically significantly push-out bond strength values with no statistical significant difference between them.

Comparison between root thirds within each group

With respect to push out bond strength values at various root thirds, the three groups revealed statistically significant differences. Neosealer Flo and Total Fill BC showed the statistically significantly highest push-out bond strength values at apical third but lower values at coronal and middle thirds with no statistically significant difference.

AH Plus showed statistically significant higher push out bond strength values at coronal and middle thirds than apical third

TABLE (1) Descriptive statistics and results of Kruskal-Wallis test for comparison between push-out bond strengths (MPa) in the three groups and Friedman's test for comparison between root thirds within each group

Root third	Neosealer Flo (n = 5)		Total Fill BC (n = 5)		AH Plus (n = 5)		*P*-value	*Effect size (Eta squared)*
	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)		
Coronal	1.74 (1.48-1.79) ^{BE}	1.66 (0.14)	0.38 (0.15-2.92) ^{CE}	0.91 (1.17)	3.14 (1.2-3.6) ^{AD}	2.82 (0.94)	0.027*	0.505
Middle	2.37 (1.99-2.82) ^{BE}	2.34 (0.31)	0.67 (0.24-2.26) ^{CE}	0.98 (0.88)	3.64 (3.61-4.04) ^{AD}	3.72 (0.18)	0.003*	0.838
Apical	4.41 (3.96-4.65) ^{AD}	4.38 (0.27)	2.69 (2.42-7.39) ^{BD}	3.67 (2.1)	2.23 (2.06-3.2) ^{BE}	2.55 (0.54)	0.022*	0.309
Overall	2.81 (2.68-2.87)	2.8 (0.07)	1.45 (1.16-3.27)	1.86 (0.88)	3.15 (2.64-3.26)	3.03 (0.25)	0.105	0.535
P-value	0.007*		0.022*		0.022*			
Effect size (w)	1		0.76		0.76			

: Significant at P ≤ 0.05,
Superscripts A, B, and C in the same row denote a statistically significant difference between groups.,
In the same column, the superscripts D, E, and F denote a statistically significant difference in root levels.

DISCUSSION

A high-quality root canal filling should bind to root canal wall and overcome dislodgement forces[19], as resistance of dislodgement of root filling materials prevents microleakage and support root structure [20]. Resistance of dislodgement of root filling materials is evaluated by push out test [15].

In the present study, the push out bond strength of Neosealer Flo was compared to TotalFill BC and AH Plus sealers.

Single cone obturation technique was employed in the current study as it is more reproducible than other obturation techniques which may affect push out bond strength test results [21,22]

The present study's findings revealed that AH Plus had the statistically significantly highest push-out bond strength at coronal and middle thirds than other bioceramic sealers; Neosealer Flo and Total Fill BC, which consistent with previous studies that compared push out bond strength of AH Plus sealer with calcium silicate-based sealers [23-27]. This was attributed to stronger chemical bond that formed between AH Plus epoxide rings and amino group of dentinal collagen than calcium silicate dentin interaction [28,29].

However, at apical third Neosealer Flo showed highest statistically significant push out bond strength which could be explained by lower viscosity of Neosealer Flo that increased flowability and allowed for deeper penetration into canal irregularities and accessory anatomy at apical third which provided larger surface area resulted for stronger micromechanical interaction due to formation of mineral infiltration zone [30].

AH Plus and Total Fill BC that did not demonstrate statistically significant different push out bond strength values at apical third which was consistent with a previous study [31].

At coronal, middle and apical thirds; Neosealer Flo showed higher statistically significant push out bond strength than Total Fill BC which could be explained by higher production of hydroxyapatite forming stronger mineral infiltration zone also

lower viscosity and smaller particle sizes that enhanced its flowability inside dentinal tubules resulted in more in depth penetration into canal irregularities.

In the present study push out bond strength of AH Plus sealer was lower in apical third than coronal and middle thirds which was in accordance with previous study [32].

The current study assessed push out bond strength of Neosealer Flo using single cone technique, further studies are recommended to assess the push out bond performance of Neosealer Flo using other obturation techniques.

CONCLUSION

Within the confines of the current study, it could be concluded that AH Plus sealer showed greatest push out bond strength values at coronal and middle thirds while Neosealer Flo sealer showed greatest push out bond strength value at apical third.

Conflict of interest

There were no any conflicts of interest related to this study

REFERENCES

1. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature - part 1. Effects of study characteristics on probability of success. Int Endod J. 2007 Dec;40(12):921-39. doi: 10.1111/j.1365-2591.2007.01322.x.

2. Schäfer E, Olthoff G. Effect of three different sealers on the sealing ability of both thermafil obturators and cold laterally compacted Gutta-Percha. J Endod. 2002 Sep;28(9):638-42. doi: 10.1097/00004770-200209000-00003.

3. Grossman LI. Physical properties of root canal cements. J Endod. 1976 Jun;2(6):166-75. doi: 10.1016/S0099-2399(76)80059-3.

4. Zhang W, Li Z, Peng B. Ex vivo cytotoxicity of a new calcium silicate-based canal filling material. Int Endod J. 2010 Sep;43(9):769-74. doi: 10.1111/j.1365-2591.2010.01733.x.

5. Zhou HM, Shen Y, Zheng W, Li L, Zheng YF, Haapasalo M. Physical properties of 5 root canal sealers. J Endod. 2013 Oct;39(10):1281-6. doi: 10.1016/j.joen.2013.06.012.

6. Al-Haddad A, Che Ab Aziz ZA. Bioceramic-Based Root Canal Sealers: A Review. Int J Biomater. 2016;2016:9753210. doi: 10.1155/2016/9753210.

7. Khalil I, Naaman A, Camilleri J. Properties of Tricalcium Silicate Sealers. J Endod. 2016 Oct;42(10):1529-35. doi: 10.1016/j.joen.2016.06.002.

8. López-García S, Pecci-Lloret MR, Guerrero-Gironés J, Pecci-Lloret MP, Lozano A, Llena C, Rodríguez-Lozano FJ, Forner L. Comparative Cytocompatibility and Mineralization Potential of Bio-C Sealer and TotalFill BC Sealer. Materials (Basel). 2019 Sep 22;12(19):3087. doi: 10.3390/ma12193087.

9. Yang DK, Kim S, Park JW, Kim E, Shin SJ. Different Setting Conditions Affect Surface Characteristics and Microhardness of Calcium Silicate-Based Sealers. Scanning. 2018 Jan 16;2018:7136345. doi: 10.1155/2018/7136345.

10. https://cdn.shopify.com/s/files/1/0605/6729/0045/files/Avalon-Biomed-NeoSealer-Flo-NeoPutty-Product-Sheets.pdf?v=1667245865

11. Versiani MA, Carvalho-Junior JR, Padilha MI, Lacey S, Pascon EA, Sousa-Neto MD. A comparative study of physicochemical properties of AH Plus and Epiphany root canal sealants. Int Endod J. 2006 Jun;39(6):464-71. doi: 10.1111/j.1365-2591.2006.01105.x.

12. Borges RP, Sousa-Neto MD, Versiani MA, Rached-Júnior FA, De-Deus G, Miranda CE, Pécora JD. Changes in the surface of four calcium silicate-containing endodontic materials and an epoxy resin-based sealer after a solubility test. Int Endod J. 2012 May;45(5):419-28. doi: 10.1111/j.1365-2591.2011.01992.x.

13. Silva Almeida LH, Moraes RR, Morgental RD, Pappen FG. Are Premixed Calcium Silicate-based Endodontic Sealers Comparable to Conventional Materials? A Systematic Review of In Vitro Studies. J Endod. 2017 Apr;43(4):527-535. doi: 10.1016/j.joen.2016.11.019.

14. Orstavik D, Eriksen HM, Beyer-Olsen EM. Adhesive properties and leakage of four root canal sealers in vitro. Int Endod J 1983;16:59–63./ Lee KW, Williams MC, Camps JJ, et al. Adhesion of endodontic sealers to dentin and gutta-percha. J Endod 2002;28:684–8.

15. Pane ES, Palamara JE, Messer HH. Critical evaluation of the push-out test for root canal filling materials. J Endod. 2013 May;39(5):669-73. doi: 10.1016/j.joen.2012.12.032.

16. Sagsen B, Ustün Y, Demirbuga S, Pala K. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. Int Endod J. 2011 Dec;44(12):1088-91. doi: 10.1111/j.1365-2591.2011.01925.x.

17. https://www.dentsplysirona.com/en-gb/categories/endodontics/ah-plus.html

18. Gokturk H, Bayram E, Bayram HM, Aslan T, Ustun Y. Effect of double antibiotic and calcium hydroxide pastes on dislodgement resistance of an epoxy resin-based and two calcium silicate-based root canal sealers. Clin Oral Investig. 2017 May;21(4):1277-1282. doi: 10.1007/s00784-016-1877-1.

19. Lee KW, Williams MC, Camps JJ, Pashley DH. Adhesion of endodontic sealers to dentin and gutta-percha. J Endod. 2002 Oct;28(10):684-8. doi: 10.1097/00004770-200210000-00002.

20. Ulusoy OI, Genç O, Arslan S, Alaçam T, Görgül G. Fracture resistance of roots obturated with three different materials. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Nov;104(5):705-8. doi: 10.1016/j.tripleo.2007.07.013.

21. Gade VJ, Belsare LD, Patil S, Bhede R, Gade JR. Evaluation of push-out bond strength of endosequence BC sealer with lateral condensation and thermoplasticized technique: An in vitro study. J Conserv Dent. 2015 Mar-Apr;18(2):124-7. doi: 10.4103/0972-0707.153075.

22. Mokhtari H, Rahimi S, Forough Reyhani M, Galledar S, Mokhtari Zonouzi HR. Comparison of Push-out Bond Strength of Gutta-percha to Root Canal Dentin in Single-cone and Cold Lateral Compaction Techniques with AH Plus Sealer in Mandibular Premolars. J Dent Res Dent Clin Dent Prospects. 2015 Fall;9(4):221-5. doi: 10.15171/joddd.2015.040.

23. Donnermeyer D, Dornseifer P, Schäfer E, Dammaschke T. The push-out bond strength of calcium silicate-based endodontic sealers. Head Face Med. 2018 Aug 20;14(1):13. doi: 10.1186/s13005-018-0170-8.

24. Assmann E, Scarparo RK, Böttcher DE, Grecca FS. Dentin bond strength of two mineral trioxide aggregate-

based and one epoxy resin-based sealers. J Endod. 2012 Feb;38(2):219-21. doi: 10.1016/j.joen.2011.10.018.

25. Oliveira DS, Cardoso ML, Queiroz TF, Silva EJ, Souza EM, De-Deus G. Suboptimal push-out bond strengths of calcium silicate-based sealers. Int Endod J. 2016 Aug;49(8):796-801. doi: 10.1111/iej.12519.

26. Carvalho NK, Prado MC, Senna PM, Neves AA, Souza EM, Fidel SR, Sassone LM, Silva EJNL. Do smear-layer removal agents affect the push-out bond strength of calcium silicate-based endodontic sealers? Int Endod J. 2017 Jun;50(6):612-619. doi: 10.1111/iej.12662.

27. Gokturk H, Bayram E, Bayram HM, Aslan T, Ustun Y. Effect of double antibiotic and calcium hydroxide pastes on dislodgement resistance of an epoxy resin-based and two calcium silicate-based root canal sealers. Clin Oral Investig. 2017 May;21(4):1277-1282. doi: 10.1007/s00784-016-1877-1.

28. Fisher MA, Berzins DW, Bahcall JK. An in vitro comparison of bond strength of various obturation materials to root canal dentin using a push-out test design. J Endod. 2007 Jul;33(7):856-8. doi: 10.1016/j.joen.2007.02.011.

29. Neelakantan P, Sharma S, Shemesh H, Wesselink PR. Influence of Irrigation Sequence on the Adhesion of Root Canal Sealers to Dentin: A Fourier Transform Infrared Spectroscopy and Push-out Bond Strength Analysis. J Endod. 2015 Jul;41(7):1108-11. doi: 10.1016/j.joen.2015.02.001.

30. Atmeh AR, Chong EZ, Richard G, Festy F, Watson TF. Dentin-cement interfacial interaction: calcium silicates and polyalkenoates. J Dent Res. 2012 May;91(5):454-9. doi: 10.1177/0022034512443068.

31. Ersahan S, Aydin C. Dislocation resistance of iRoot SP, a calcium silicate-based sealer, from radicular dentine. J Endod. 2010 Dec;36(12):2000-2. doi: 10.1016/j.joen.2010.08.037.

32. Dibaji F, Mohammadi E, Farid F, Mohammadian F, Sarraf P, Kharrazifard MJ. The Effect of BC Sealer, AH-Plus and Dorifill on Push-out Bond Strength of Fiber Post. Iran Endod J. 2017 Fall;12(4):443-448. doi: 10.22037/iej.v12i4.15863.