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Comparative evaluation of push-out bond strength of endosequence bioceramic sealer hiflow and endoseal MTA with single cone obturation technique

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Abstract
Aim: The study aimed to evaluate the PBS of End sequence bio ceramic sealer hiflow and endoseaL MTA with single cone obturation techniques.
Materials and Methods: Twenty extracted single-root human teeth of similar sizes and circular canals were randomly selected and stored in distilled water at 4 °C.
Results: All specimens showed measurable adhesive properties to root dentin. In addition, no premature failure occurred. Overall, the push-out bond strength was the highest in the coronal third and lowest in the apical third. Endosequence bioceramic sealer hiflow specimens displayed statistically higher bond strengths (p=0.0012, 0.51- 5.9 MPa). Endoseal MTA showed the lowest bond strengths.
Conclusion: Endosequence bioceramic sealer hiflow Group had a significantly higher PBS value than other Group from the apex. At 5 and 10 mm from the apex, no significant difference in PBS was found among the endosequence bioceramic sealer hiflow and endoseal MTA (P>0.05). The most common failure mode found in all Groups was a mixed failure.

Keywords: push-out bond strength, endodontics, root canal obturation, bioceramic sealer, MTA

1. Introduction
The aim of endodontic therapy is not only to eliminate microorganisms by cleaning and shaping the root canal, but also to ensure that the root canal system will be fluid free and that a single unit can be created by the filling material (cones and sealer) and root dentin walls.
Bond strength of endodontic sealers to dentin is an important property of filling materials because it minimizes the risk of filling detachment from dentin during restorative procedures or the masticatory function [1], ensuring that sealing is maintained and, consequently, clinical success of endodontic treatment. The push-out bond strength test is a well-known evaluation method used in several other similar studies [1-4] with great reliability. Thus, its results can be useful for inferring the interfacial strength and dislocation resistance between different root filling materials and the root dentin.
Using a root canal sealer with gutta-percha (GP) is the most widely accepted obturation technique. The root canal sealer establishes a good connection between the root canal wall and the GP, preventing micro leakage causing re-infection [5, 6]. In recent years, calcium silicate-based sealers (CSBSs) have been widely used in endodontics. CSBSs are biocompatible and bioactive, thanks to their calcium silicate formulation. CSBSs form an appetite layer in contact with tissue and chemically bond to dentin. Micromechanical interlocking between CSBS and root dentin helps maintain the integrity of the sealer-dentin interface during a function [7, 8].
The push-out of bond strength (PBS) tests are used as a measure of the bond strength of root canal filling materials to the root dentin. PBS results in shear stress at the dentin-cement interface, comparable with the stress in clinical conditions.[9] The ability of the PBS test to evaluate adhesion is superior to other tests, as it creates parallel fractures in the interfacial area of the dentin bond [10] There are a few studies about the PBS of Endosequence BC Hiflow, Endoseal MTA [7, 11].

Therefore, this study aimed to evaluate the PBS of endosequence Bioceramic sealer hiflow and endoseal MTA with single cone obuturation technique.

Materials and Methods

Twenty extracted single-root human teeth of similar sizes and circular canals were randomly selected and stored in distilled water at 4 °C. To standardize the working length, a size 15 K-file (Dentsply-Maillefer, Balague, Switzerland) was inserted into the root canal until it could be visualized at the apical foramen. The working length was determined by subtracting 1 mm from this length.

After measurement, the length of all roots was standardized to 13 mm to prevent the introduction of confounders that could contribute to variations in the preparation procedures.

All canals were instrumented to the working length to a size #25/0.06 to working length. Irrigation with 0.5 mL 2% chlorhexidine gel was used before each instrument and 1 mL 0.9% saline solution after each instrument. The smear layer was removed with 3 mL 17% EDTA for 3 min. A total of 3 mL saline was used for 3 min as a final rinse. Each canal was dried with paper points.

Obturation procedures were performed using the single gutta-percha cone technique. Using a computer algorithm (http://www.random.org), the 20 roots were randomly assigned to 2 groups for obturation with one of the two sealers: Endosequence bioceramic sealer hiflow and endoseal MTA. On completion of these procedures, the specimens were radiographed at different angles to verify the quality of the filling procedure and presence of bubbles. The specimens were placed in 100% humidity for 7 days to ensure complete setting of the sealer.

Afterwards, each root was sectioned horizontally into eight 1±0.1 mm-thick serial slices by using a low-speed saw with a diamond disk under continuous water irrigation.

The root filling of each sample was loaded with a 0.5-mm diameter stainless steel cylindrical plunger. The plunger tip was sized and positioned to touch only the root filling. The load was always applied in an apical-coronal direction to avoid any constriction interference caused by root canal taper during push-out testing. Loading was performed on a universal testing machine (Instron Corporation, Norwood, MA, USA) at a crosshead speed of 0.5 mm/min until debonding occurred. Each cross section was coded and measured for the apical and coronal diameters of the obturated area by using an optical stereomicroscope. A load/time curve was plotted during the compression test using real-time software. To express the bond strength in MPa, the load at failure recorded was divided by the area of the bonded interface.

The normality test of Shapiro-Wilkand and Levenes variance homogeneity tests were applied to the data showing normal distribution and homogeneity of variance among the groups. Two-way analysis of variance (ANOVA) and the posthoc Tukey test were used for the data analysis; the independent variables were root canal filling material and root canal third ($p<0.05$).

Results

Table 1: Push-out bond strength mean values (MPa) and standard deviation (SD) of the different root canal filling system to root dentin

Group	Mean (SD)*
Endosequence bioceramic sealer hiflow	3.80±1.90B
Endoseal MTA	0.25±0.10A

All specimens showed measurable adhesive properties to root dentin. In addition, no premature failure occurred. Overall, the push-out bond strength was the highest in the coronal third and lowest in the apical third. ENDOSEQUENCE BIOCERAMIC SEALER HIFLOW specimens displayed statistically higher bond strengths ($p=0.0012$, 0.51- 5.9 MPa). Endoseal MTA showed the lowest bond strengths.

The values of the push-out bond strength data in each experimental group are shown in Table 1.

Discussion

Gutta-percha does not bond to root dentin and is used in conjunction with a root canal sealer [1], so the adhesive properties of endodontic sealers are important. It was suggested that, if a material bonds to the root canal walls, it resists dislodgement of the filling [12]. It is also believed that chemical bonding to root dentin improves the push out bond strength of sealers to root canal walls [13].

In this study, the push-out test was used to test the dentin bond strength of different root canal sealers. It has been suggested that this test provides a better evaluation of bond strength than the conventional shear test because in the pushout test, fracture occurs parallel to the dentin-bonding interface, which makes it a true shear test for parallel-sided samples [14, 15].

During chemo-mechanical preparation, a layer of debris, the smear layer, is formed. Current theories of dentine bonding mechanisms involve either chemical modification of the smear layer and bonding directly to it, or removal of the smear layer and bonding to subjacent tooth structures [4, 16].

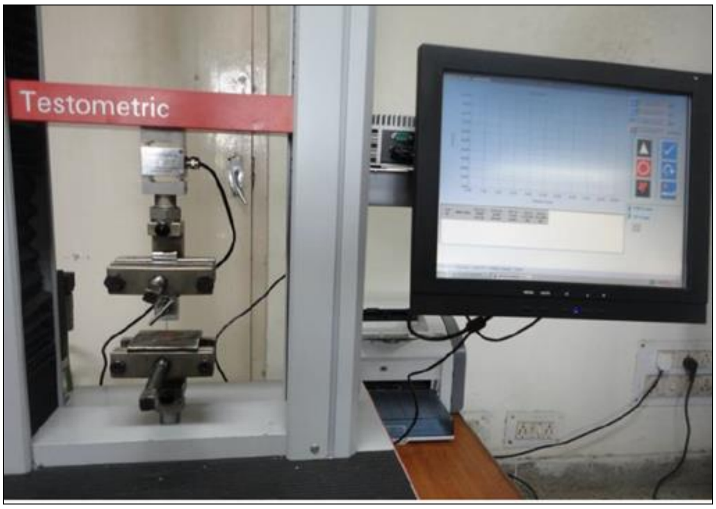
Some studies have shown that removal of the smear layer enhances the adhesion of sealers to the root canal wall [17, 18]. The smear layer can act as a reservoir or substrate for microorganisms [19], and can also block the extension of sealer tags into the dentinal tubules, thereby decreasing micromechanical adhesion18. In the current study, 17% EDTA was used after instrumentation to remove the smear layer.

In this study, we have selected two different types of endodontic sealers, i.e. Bioceramic sealer (Endosequence BC Sealer HiFlow), MTA-based sealer (Endoseal MTA).

In the present study, Endosequence BC Sealer HiFlow showed the highest bond strength with a statistically significant difference ($P = 0.0001$). This may be due to its true self-adhesive nature, which forms a chemical bond (through production of hydroxyapatite during setting) with dentine. Moreover, it is hydrophilic, possess low contact angle allowing it to spread easily over the canal walls providing adaptation and good hermetic seal [25]. In an *in vitro* study done by Ghoneim *et al*., it was seen that the resistance to vertical fracture of roots obturated with iRoot SP (Bioceramic-based sealer) and Activ GP cones was comparable to that of intact teeth [26]. The Bioceramic cones or Activ GP cones has the capability to absorb water from the tooth environment and expand in the lateral direction only to hermetically seal the root canal [27]. Christopher Delong in his study concluded that Bioceramic sealer showed highest bond strength than MTA plus sealer when used in a single cone technique [28].

This finding might be explained by the fact that in comparison with other CSCs, pozzolan-based materials are associated with a significantly lower Ca-releasing ability and Ca/P ratio of the apatite-like crystalline precipitates [30]. This explanation is supported by the fact that the concentration of available ions affects the nucleation and growth of the apatite layer [31]. Moreover, Endo Seal MTA is premixed with non-aqueous but water-miscible carriers and, contrary to powder forms of MTA, uses only the environmental moisture to initiate and complete the setting reaction [29]. These differences might predispose Endo Seal MTA to lower dislodgement resistance.

A



B

C

D

Fig ABC and D: All specimens showed measurable adhesive properties to root dentin

Conclusion

Endosequence bioceramic sealer hiflow Group had a significantly higher PBS value than other Group at the apex. At 5 and 10 mm from the apex, no significant difference in PBS was found among the endosequence bioceramic sealer hiflow and Endoseal MTA obturated using two different techniques (P>0.05). The most common failure mode found in all Groups was a mixed failure.

References

1. Sagsen B, Ustün Y, Demirbuga S, Pala K. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. International endodontic journal. 2011 Dec;44(12):1088-91.
2. Assmann E, Scarparo RK, Böttcher DE, Grecca FS. Dentin bond strength of two mineral trioxide aggregate–based and one epoxy resin–based sealers. Journal of endodontics. 2012 Feb 1;38(2):219-21.
3. Nagas E, Cehreli ZC, Durmaz V, Vallittu PK, Lassila LV. Regional push-out bond strength and coronal microleakage of Resilon after different light-curing methods. Journal of endodontics. 2007 Dec 1;33(12):1464-8.
4. Ungor M, Onay EO, Orucoglu H. Push-out bond strengths: the Epiphany–Resilon endodontic obturation system compared with different pairings of Epiphany, Resilon, AH Plus and gutta-percha. International endodontic journal. 2006 Aug;39(8):643-7.
5. Whitworth J. Methods of filling root canals: principles and practices. Endodontic topics. 2005 Nov;12(1):2-4.
6. Stoll R, Kirsten B, Stachniss V. The influence of different factors on the survival of root canal fillings: a 10-year retrospective study. J Endod. 2005;31(11):783-90.
7. Donnermeyer D, Dornseifer P, Schäfer E, Dammaschke T. The push-out bond strength of calcium silicate-based endodontic sealers. Head & face medicine. 2018 Dec;14(1):1-7.
8. Donnermeyer D, Vahdat-Pajouh N, Schäfer E, Dammaschke T. Influence of the final irrigation solution on the push-out bond strength of calcium silicate-based, epoxy resin-based and silicone-based endodontic sealers. Odontology. 2019 Apr;107(2):231-6.
9. Pane ES, Palamara JE, Messer HH. Critical evaluation of the push-out test for root canal filling materials. Journal of endodontics. 2013 May 1;39(5):669-73.

10. Sudsangiam S, van Noort R. Do dentin bond strength tests serve a useful purpose. J Adhes Dent. 1999 Jan 1;1(1):57-67.
11. Abdelwahed A, Roshdy N, Elbanna A. Evaluation of Push-out Bond Strength of CeraSeal Bioceramic sealer with Different Obturation Techniques. Egypt Dent J. 2021;67(3):2655-2662.
12. Shipper G, Ørstavik D, Teixeira FB, Trope M. An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). Journal of endodontics. 2004 May 1;30(5):342-7.
13. Onay EO, Ungor M, Ari H, Belli S, Ogus E. Push-out bond strength and SEM evaluation of new polymeric root canal fillings. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Jun 1;107(6):879-85.
14. Drummond JL, Sakaguchi RL, Racean DC, Wozny J, Steinberg AD. Testing mode and surface treatment effects on dentin bonding. Journal of Biomedical Materials Research: An Official Journal of The Society for Biomaterials and The Japanese Society for Biomaterials. 1996 Dec;32(4):533-41.
15. Üreyen Kaya B, Keçeci AD, Orhan H, Belli S. Micropush-out bond strengths of gutta-percha versus thermoplastic synthetic polymer-based systems–an ex vivo study. International endodontic journal. 2008 Mar;41(3):211-8.
16. Yu XY, Joynt RB, Davis EL, Wieczkowski Jr G. Adhesion to dentin. Journal of the California Dental Association. 1993 Jun;21(6):23-9.
17. De Gee AJ, Wu MK, Wesselink PR. Sealing properties of Ketac-Endo glass ionomer cement and AH26 root canal sealers. International Endodontic Journal. 1994 Sep;27(5):239-44.
18. Pécora JD, Cussioli AL, Guerisoli DM, Marchesan MA, Sousa-Neto MD, Brugnera Junior A. Evaluation of Er: YAG laser and EDTAC on dentin adhesion of six endodontic sealers. Braz Dent J. 2001 Jan 1;12(1):27-30.
19. Pashley DH. SmearLayer: physiological consideration. Oper. dent.. 1984;3:13-29.
20. Ferraz CC, de Almeida Gomes BP, Zaia AA, Teixeira FB, de Souza-Filho FJ. *In vitro* assessment of the antimicrobial action and the mechanical ability of chlorhexidine gel as an endodontic irrigant. Journal of endodontics. 2001 Jul 1;27(7):452-5.
21. Hashem AA, Ghoneim AG, Lutfy RA, Fouda MY. The effect of different irrigating solutions on bond strength of two root canal–filling systems. Journal of Endodontics. 2009 Apr 1;35(4):537-40.
22. Gonçalves L, Silva-Sousa YT, Raucci Neto W, Teixeira CS, Sousa-Neto MD, Alfredo E. Effect of different irrigation protocols on the radicular dentin interface and bond strength with a metacrylate-based endodontic sealer. Microscopy research and technique. 2014 Jun;77(6):446-52.
23. Weston CH, Ito S, Wadgaonkar B, Pashley DH. Effects of time and concentration of sodium ascorbate on reversal of NaOCl-induced reduction in bond strengths. Journal of Endodontics. 2007 Jul 1;33(7):879-81.
24. Sarkar NK, Caicedo R, Ritwik P, Moiseyeva R, Kawashima I. Physicochemical basis of the biologic properties of mineral trioxide aggregate. Journal of endodontics. 2005 Feb 1;31(2):97-100.
25. Gade VJ, Belsare LD, Patil S, Bhede R, Gade JR. Evaluation of push-out bond strength of endosequence BC sealer with lateral condensation and thermo plasticized technique: An *in vitro* study. J Conserv Dent. 2015;18:124-7.
26. Ghoneim AG, Lutfy RA, Sabet NE, Fayyad DM. Resistance to fracture of roots obturated with novel canal-filling systems. J Endod. 2011;37:1590-2.
27. Pathivada L, Krishna MK, Dang AB. Smartseal: New age obturation. Ann Dent Spec. 2013;1:13-5.
28. DeLong C, He J, Woodmansey KF. The effect of obturation technique on the push-out bond strength of calcium silicate sealers. *J Endod.* 2015;41:385–8.
29. Yoo YJ, Baek SH, Kum KY, Shon WJ, Woo KM, Lee W. Dynamic intratubular biomineralization following root canal obturation with pozzolan-based mineral trioxide aggregate sealer cement, Scanning. 2016;38(1):56.
30. Han L, Kodama S, Okiji T. Evaluation of calcium-releasing and apatite-forming abilities of fast-setting calcium silicate-based endodontic materials, International Endodontic Journal. 2015;48(2):124–130.
31. Weng J, Liu Q, Wolke J, Zhang X, De Groot K. “Formation and characteristics of the apatite layer on plasma-sprayed hydroxyapatite coatings in simulated body fluid, Biomaterials. 1997;18(15):1027–1035.