Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijss/2016/331

Original Article

Comparative Evaluation of Push-out Bond Strength of Novel Smart Seal System with Resilon/Epiphany and Gutta-percha/Ah-plus Obturating System: An *in vitro* Study

K Nanda Kumar[1], M Pratap Kumar[2], P Samba Sihva Rao[2], V Pallavi[3], Sohel Ahmed[3]

[1]Professor and Head, Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad, Telangana, India, [2]Professor, Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad, Telangana, India, [3]Post-graduate Student, Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad, Telangana, India

Abstract

Background: The objective of three-dimensional obturation is to completely seal the canal system from any bacterial ingress from the oral cavity and periradicular tissues. The aim of the study to compare the push-out bond strength of the smart seal C-point obturating system with epiphany resilon obturation system and the gold standard gutta-percha/AH plus system.

Materials and Methods: Thirty extracted mandibular first premolars, instrumented until propater F3. All the teeth are divided into three groups of 10 each according to obturating material. Group I - AH plus sealer and F3 master gutta-percha cone (Dentsply Maillefer); Group II - The resilon core material of size 30/.06 and epiphany sealer; Group III - EndoSequence BC sealer and F3 C-point. Each sample was sectioned horizontally into 2 mm thick slices at each of the three-thirds (coronal, middle and apical). Specimens subjected to the universal testing machine at the vertical load at a rate of 1.0 mm/min. The bond strength was recorded in Mpa, by dividing the load in Newton by the area of bonded interface using. The data were analyzed statistically using Statistical Package for Social Sciences version 1.4 and one-way analysis of variance (ANOVA) with Tukey's *post-hoc* test.

Results: The mean push-out test values for each group were as follows in coronal third Group I (1.5±0.27 Mpa), Group II (0.99±0.21 Mpa), and Group III (3.77±0.47 Mpa); in middle third Group I (1.45±0.14 Mpa), Group II (0.96±0.15 Mpa), and Group III (3.43± 0.122); in the apical third Group I (1.39±0.01 Mpa), Group II (0.90±0.15 Mpa), and Group III (3.3± 0.78 Mpa). ANOVA revealed a statistically significant difference among the groups ($P < 0.05$).

Conclusion: Within the limitations of the study, it can be concluded that C-point/bioceramic sealer showed the highest push-out bond strength followed by gutta-percha/AH plus and epiphany/Resilon.

Key words: Push-out bond strength, Resilon epiphany, Root canal filling, Smart seal system

INTRODUCTION

Successful root canal treatment depends on the thorough debridement of the root canal system, the elimination of pathogenic organisms and finally the complete sealing of the canal space to prevent ingress of bacteria from the oral environment and spread to the periapical tissue.[1]

Access this article online

www.ijss-sn.com

Month of Submission : 04-2016
Month of Peer Review : 05-2016
Month of Acceptance : 05-2016
Month of Publishing : 06-2016

The presence of great anatomic complexity of the root canal system has advocated the evolution of different materials and techniques to achieve the desired fluid tight hermetic seal.[2]

The physical properties necessary for this function include adaptation and adhesion of the filling material to the root canal wall.[1] Gutta-percha, in combination with sealer, is the most widely used material for endodontic root canal obturation.[2] A root canal sealer is essential to not only assist in filling irregular spaces but also to enhance the seal during compaction and to penetrate into small, normally inaccessible, areas, i.e., the dentinal tubules. Gutta-percha along with sealer displayed less leakage than those without sealer.[3]

Corresponding Author: Dr. Sohel Ahmed, Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad, Telangana, India. Phone: +91-8985614597. E-mail: sohelahmed121@gmail.com

Higher bond strength decreases leakage and improves the stability of root canal obturation material.[3]

Gutta-percha with an epoxy resin-based sealer AH plus has set a gold standard as an obturation system. Despite several advantages exhibited by the system, its hydrophobic nature and its inability to sufficiently reinforce the root canal remain its drawbacks.[4]

Resilon/epiphany (Pentron Clinical Technologies, Wallingford, CT) is the first obturation system to claim the ability to compose a "monoblock" between the canal walls and obturation material.[5] This product is used in combination with a self-etching primer to create a solid monoblock. Resilon is a thermoplastic synthetic resin material that is based on polymers of polyester and contains a bifunctional methacrylate resin, bioactive glass, and radiopaque fillers. The resin sealer, epiphany root canal sealant, contains bisphenol-A diglycidyl dimethacrylate (Bis-GMA), ethoxylated Bis-GMA, urethane dimethacrylate, hydrophilic difunctional methacrylates, silane-treated barium borosilicate glasses, barium sulfate, silica, calcium hydroxide, bismuth oxychloride with amines, peroxide, photoinitiator, stabilizers, and pigment. The primer is an aqueous solution of an acidic monomer. The system also includes pellets that can be used for backfilling in thermoplasticized techniques.

The most recent advancement in endodontic obturating materials uses a hydrophilic polymer in the root canal, the smart seal C-point system (EndoTechnologies, LLC, Shrewsbury, MA, USA). The C-point system is a point-and-paste root canal filling technique that consists of pre-made, hydrophilic endodontic points and an accompanying bioceramic sealer. These points are designed to expand laterally without expanding axially, by absorbing residual water from the instrumented canal space and that from naturally-occurring intra-radicular moisture. The inner core of C-point is a mix of two proprietary nylon polymers: Trogamid T and Trogamid CX. The polymer coating is a cross-linked copolymer of acrylonitrile and vinylpyrrolidone, which has been polymerized and cross-linked using allyl methacrylate and a thermal initiator. The lateral expansion of C-point is claimed to occur non-uniformly, with the expandability depending on the extent to which the hydrophilic polymer is pre-stressed (i.e., contact with a canal wall will reduce the rate or extent of polymer expansion). This nonisotropic lateral expansion is said to enhance the sealing ability of the root canal filling, thereby reducing the possibility of re-infection, and potentiating the long-term success of root canal treatment.[6]

In the literature, negligible data is available regarding the accentuation on the hydrophilic obturating systems on the push-out bond strength of root canal nature. Therefore, the purpose of this study was to compare the hydrophilic smart seal C-point obturating systems, with resilon epiphany and the gold standard gutta-percha/AH plus system.

MATERIALS AND METHODS

Thirty extracted sound-matured human mandibular first premolars extracted for orthodontic reasons were selected and stored in 10% formalin until the beginning of the experiment. Teeth were sectioned horizontally below the cementoenamel junction under water coolant, to obtain a standardized root length of 13 mm. The working length was determined by introducing a 15 K file until it could be seen at the apical foramen, subtracting 1 mm from this length. Thirty teeth were instrumented up to a master apical file size of F3 with protaper rotary files (Dentsply Maillefer) using a 16:1 reduction handpiece with torque and speed-controlled electric motor (X smart; Dentsply Maillefer). The canals were irrigated with 2 ml of 3% sodium hypochlorite (Prime Dental Products, Thane, India) during instrumentation. After preparation, canals were filled with 5 ml of 17% ethylenediaminetetraacetic acid (Anabond Stedman Pharma Research, India) for 1 min to remove the smear layer, and the final flush was performed using 5 ml of distilled water. The samples were then dried with absorbent protaper paper points (Dentsply). Thirty teeth were divided into 3 Groups of 10 samples each.

Obturation and Distribution of Specimens

Group I ($n = 10$) - (AH plus + gutta-percha) AH plus sealer was mixed according to the manufacturer's instructions and placed into the root canals with a lentulo spiral filler and obturation was done with corresponding protaper gutta-percha cones.

Group II ($n = 10$) - (resion + epiphany SE) epiphany self-etching sealer was then expressed using the automix syringe tip and obturation was done with corresponding 6% resilon points. Once the obturation was completed, the coronal surface was light-cured for 40 s.

Group III ($n = 10$) - (C-point + bioceramic sealer) bioceramic sealer was placed into the root canals using the syringe and capillary tip and obturated by corresponding C-point.

Mesiodistal and buccolingual radiographs were taken to confirm complete filling. After root filling, the coronal 1 mm of the filling materials was removed, and the spaces were filled with a temporary filling material (orafil G). The teeth were stored at 37°C at 100% humidity for 48 h to allow the sealers to set.

Push-out Bond Test

Each sample was sectioned horizontally into 2 mm thick slices at each of the three-thirds (coronal, middle and apical) of the root using a diamond disc with continuous water flow.

The cylindrical stainless steel plunger tip that closely match the size of the filling material was selected and positioned to cover as much as possible of the root filling, yet avoiding any contact with the canal walls. The vertical load at a rate of 1.0 mm/min was applied in an apical-coronal direction to avoid any constriction interference that may have been caused by the root canal taper during push-out testing. The bond strength was recorded in Mpa, by dividing the load in Newton by the area of bonded interface using.

$$\text{Bond strength (Mpa)} = \frac{\text{Load in newton}}{\text{Area of bonded surface}}$$

The data were analyzed statistically using Statistical Package for Social Sciences version 1.4 and one-way analysis of variance (ANOVA) with Tukey's *post-hoc* test for multiple comparisons were performed. The level of significance was set at $P < 0.05$.

RESULTS

The mean push-out test values for each group were as follows (Table 1) in coronal third (Graph 1) Group I (1.5± 0.27 Mpa), Group II (0.99± 0.21 Mpa), and Group III (3.77±0.47 Mpa); in middle third (Graph 2) Group I (1.45±0.14 Mpa), Group II (0.96± 0.15Mpa), and Group III (3.43± 0.122); in the apical third (Graph 3) Group I (1.39±0.01 Mpa), Group II (0.90±0.15 Mpa), and Group III (3.3± 0.78 Mpa). ANOVA revealed a significant difference among the groups ($P < 0.05$).

DISCUSSION

Adhesion of root canal filling material to dentinal walls is important in both static and dynamic situations.[7]

Bond strength testing has become a popular method for determining the effectiveness of adhesion between endodontic materials and tooth structure. There are different techniques to measure the bond strength of materials and push-out test is one of the most reliable methods based on the results of previous studies. In this test, the conditions are comparable to clinical conditions, in which the tested items are directly placed within prepared canals with normal tubular configuration and organization.[3]

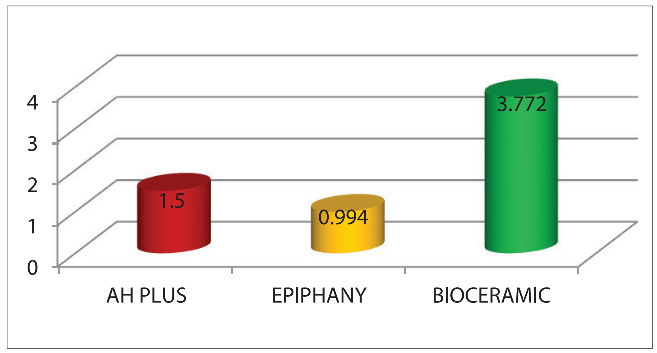
About 10% formalin was utilized for preserving teeth before study. Previous studies have reported no consequential time effect of formalin on dentin bond strength.[7] Jameson *et al.*[8] found that covalently cross-linked Type I collagen in dentin is not significantly affected by formalin storage. It has additionally been documented that teeth stored in formalin do not experience dihydrogen monoxide loss or dehydration for up to 12 weeks of storage.

During chemo-mechanical preparation, a layer of debris, the smear layer, is formed.[9] Some studies have shown that removal of the smear layer enhances the adhesion

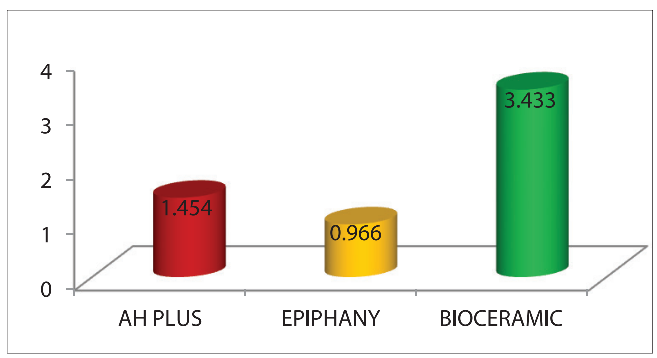
Table 1: Mean push-out bond strengths in MPa at coronal, middle and apical third

Location	Group I		Group II		Group III	
	Mean (MPa)	SD	Mean (MPa)	SD	Mean (MPa)	SD
Coronal third	1.500	0.02751	0.9940	0.21609	3.7720	0.47338
Middle third	1.4540	0.14362	0.9660	0.03035	3.4330	0.12257
Apical third	1.3970	0.01826	0.9010	0.15160	3.0310	0.07838

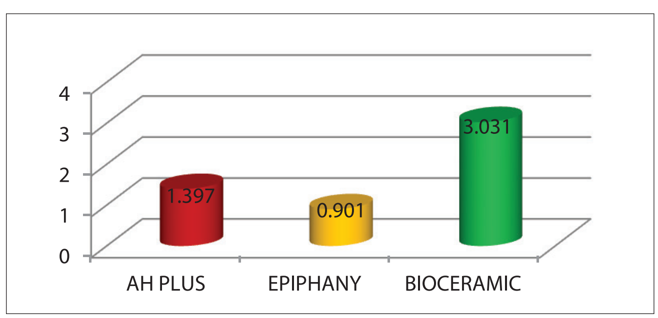
SD: Standard deviation



Graph 1: Comparison of mean push out bond strengths at coronal third



Graph 2: Comparison of mean push out bond strengths at middle third



Graph 3: Comparison of mean push out bond strengths at apical third

of sealers to the root canal wall;[10,11] therefore, the canals were irrigated with 3% NaOCl and a final rinse of 17% ethylenediaminetetraacetic acid for removal of smear layer. Sodium hypochlorite was not used as the final irrigating solution since it is an oxidizing agent that leads to oxidation of some component of the dentin matrix. Furthermore, oxygen has been shown to inhibit polymerization of resins, thus leading to reduced resin bond strengths.[12,13]

The present results demonstrated that the push-out bond strengths for the coronal and middle root dentin were higher than that of the apical root dentin. This is probably due to inadequate volume or penetration of the irrigation and final rinse solutions into the apical portion of the canal[14] This can be also explained by the structure of dentin in the apical region of human teeth where the number of dentinal tubules was significantly lower than that in the cervical and mid-root dentin[15,16] The low number of dentinal tubules, the irregular structure of secondary dentin, and the presence of cementum-like tissue apically on the root canal wall result in reduced penetration of adhesives into the apical root dentin compared to coronal dentin.[17,18]

Among the three obturating systems, Group III showed higher push-out bond strength it could be assumed that the slow-setting of the BC sealer combined with the slow expansion of the C-point when exposed to moisture may have potentially pushed the sealer into places[2] and The hydrophilic nature of the sealer[19] may have potentially resulted in more intimate contact with the canal walls.

In this study resilon/epiphany showed the least mean pust out bond strength may be because of the higher polymerization shrinkage rate of resilon/epiphany that may be involved along with the high C-factor associated with root canal.[4]

The push-out bond strength of AH Plus/Gutta-percha was higher than resilon/epiphany might be because of the ability of the epoxy resin based sealers to penetrate into the micro irregularities due to their creep capacity. Another reason might be the formation of covalent bond by an epoxide ring to amine group in collagen network.[20]

CONCLUSION

Within the limitations of the study, it can be concluded that C-point/bioceramic sealer showed the highest push-out bond strength followed by gutta-percha/AH plus and epiphany/Resilon.

REFERENCES

1. Jainaen A, Palamara JE, Messer HH. Push-out bond strengths of the dentine-sealer interface with and without a main cone. Int Endod J 2007;40:882-90.
2. Arora S, Hegde V. Comparative evaluation of a novel smart-seal obturating system and its homogeneity of using cone beam computed tomography: *In vitro* simulated lateral canal study. J Conserv Dent 2014;17:364-8.
3. Forough Reyhani M, Ghasemi N, Rahimi S, Salem Milani A, Mokhtari H, Shakouie S, *et al*. Push-Out Bond Strength of Dorifill, Epiphany and MTA-Fillapex Sealers to Root Canal Dentin with and without Smear Layer. Iran Endod J 2014;9:246-50.
4. Hegde V, Arora S. Fracture resistance of roots obturated with novel hydrophilic obturation systems. J Conserv Dent 2015;18:261-4.
5. Hegde V, Arora S. Sealing ability of a novel hydrophilic vs. conventional hydrophobic obturation systems: A bacterial leakage study. J Conserv Dent 2015;18:62-5.
6. Didato A, Eid AA, Levin MD, Khan S, Tay FR, Rueggeberg FA. Time-based lateral hygroscopic expansion of a water-expandable endodontic obturation point. J Dent 2013;41:796-801.
7. Cobankara FK, Ungör M, Belli S. The effect of two different root canal sealers and smear layer on resistance to root fracture. J Endod 2002;28:606-9.
8. Jameson MW, Tidmarsh BG, Hood JA. Effect of storage media on subsequent water loss and regain by human and bovine dentine and on mechanical properties of human dentine *in vitro*. Arch Oral Biol 1994;39:759-67.
9. 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. Int Endod J 2006;39:643-7.
10. De Gee AJ, Wu MK, Wesselink PR. Sealing properties of Ketac-Endo glass ionomer cement and AH26 root canal sealers. Int Endod J 1994;27:239-44.
11. Pécora JD, Cussioli AL, Guerisoli DM, Marchesan MA, Sousa-Neto MD, Brugnera Júnior A. Evaluation of Er: YAG laser and EDTAC on dentin adhesion of six endodontic sealers. Braz Dent J 2001;12:27-30.
12. Ari H, Yasar E, Belli S. Effects of NaOCl on bond strengths of resin cements to root canal dentin. J Endod 2003;29:248-51.
13. Patil SA, Dodwad PK, Patil AA. An *in vitro* comparison of bond strengths of Gutta-percha/AH Plus, Resilon/Epiphany self-etch and EndoREZ obturation system to intraradicular dentin using a push-out test design. J Conserv Dent 2013;16:238-42.
14. Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB, Bozhilov K, *et al.* A new solution for the removal of the smear layer. J Endod 2003;29:170-5.
15. Whittaker DK, Kneale MJ. The dentine-predentine interface in human teeth. A scanning electron microscope study. Br Dent J 1979;146:43-6.
16. Carrigan PJ, Morse DR, Furst ML, Sinai IH. A scanning electron microscopic evaluation of human dentinal tubules according to age and location. J Endod 1984;10:359-63.
17. Cecchin D, Souza M, Carlini-Júnior B, Barbizam JV. Bond strength of Resilon/Epiphany compared with Gutta-percha and sealers Sealer 26 and Endo Fill. Aust Endod J 2012;38:21-5.
18. Mannocci F, Ferrari M. Apical seal of roots obturated with laterally condensed gutta-percha, epoxy resin cement, and dentin bonding agent. J Endod 1998;24:41-4.
19. Nagas E, Uyanik MO, Eymirli A, Cehreli ZC, Vallittu PK, Lassila LV, *et al.* Dentin moisture conditions affect the adhesion of root canal sealers. J Endod 2012;38:240-4.
20. 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;33:856-8.

How to cite this article: Kumar KN, Kumar MP, Rao PSS, Pallavi V, Ahmed S. Comparative Evaluation of Push-out Bond Strength of Novel Smart Seal System with Resilon/Epiphany and Gutta-percha/Ah-plus Obturating System: An *in vitro* Study. Int J Sci Stud 2016;4(3):114-117.

Source of Support: Nil, **Conflict of Interest:** None declared.