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Effect of ultrasonic and sonic activation of root canal sealers and thermoplatized GP injection technique on the push-out bond strength of two different sealers

Ravikumar Janga[1*] Anilkumar Pulidindi[2] Santhi Vajja[3] Krishna Chaitanya Popuri[4] Swetha Bolineni[5], Sampath Arikatla[6]

[1]Reader, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

[2]Senior Lecturer, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

[3]Professor, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

[4]Reader, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

[5]Reader, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

[6]Senior Lecturer, Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

ABSTRACT

Background: Today, it is well-recognized that apical foramen and most of the lateral or accessory canals located in the apical region of the root serve as a portal of exit for the bacteria toxins and provide a favourable route for leakage. Thus, the integrity of the root canal filling in the few apical millimetres is considered to be a crucial factor in the success of endodontic therapy.

Material and methods: The present study was carried out on 60 orthodontically extracted mandibular premolars with the aim to evaluate the effect of ultrasonic and sonic activation of two root canal sealers on interfacial adaptation and push-out bond strength (BS) to root canal dentine. The specimens were randomly divided into two groups (n = 30) according to the root canal sealer –AH Plus (Dentsply DeTrey GmbH) or NanoSeal S (Prevest) and based on type of sealer activation sub groups were (no activation, ultrasonic activation or sonic activation) were prepared with NiTi rotary instruments under irrigation with 5.25% NaOCl and 17% EDTA. Canals were filled by thermoplastized gutta-percha injection technique and AH Plus (n = 30) or Nanoseal S (n = 30). Three subgroups (n = 10) were formed according to sealer activation: no activation (NA), sonic activation (SA, 20 s) and ultrasonic activation (US, 20 s). Three 1-mm-thick slices were obtained from each root third. They were used for push-out BS test. Data were analysed by two-way ANOVA and Tukey's test (a = 0.05).

Results: The result of the study showed that AH Plus (2.58-1.21) had higher push out BS than Nanoseal S (1.45-0.71) (P =0.000). UA (2.64-1.44) had higher BS (P = 0.000) than NA (1.58-0.73) and SA (1.83-0.85), which did not differ significantly from each other (P =0.3303). The coronal third had higher BS (2.48-1.49) than the middle (2.08-0.94) (P = 0.0003) and apical (1.48-0.58) (P = 0.00) thirds. For both sealers, UA was associated with a more homogeneous filling material with better interfacial adaptation and greater quantity, density and length of tags in dentinal tubules. When UA was used, the tags had similar quantity, density and length to those formed without activation, but interfacial gaps and voids were observed.

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*__Correspondence Dr. Ravikumar Janga.__

Department of Conservative Dentistry, Drs.Sudha and Nageswararao Siddhartha Institute of Dental Sciences, Vijayawada, Andhra Pradesh, India.

Email: Not Disclosed

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Conclusion: Ultrasonic activation was associated with higher BS values, deeper intratubular penetration and greater interfacial adaptation to root dentine than sonic activation and no activation techniques, AH Plus had higher BS values than Nanoseal S irrespective of the type of activation.

Keywords: ultrasonic activation, root canal sealers, thermoplatized GP injection.

INTRODUCTION

Root canal system fillings should provide adequate sealing in order to prevent percolation of fluids and reinfection, allowing for the repair of the apical and periapical regions.[1,2] One of the important properties of root canal sealer is its firm adherence to root dentin.[3] Bonding of endodontic sealer to intraradicular dentin maintains the integrity of the sealer dentin interface during mechanical stresses caused by tooth flexure and also during preparation of postspace or operative procedures.[4]A number of sealing techniques have been proposed over the years, including thermomechanical and thermoplastic techniques. The thermomechanical technique promotes apical and lateral condensation of the filling material against the root canal walls, favoring the homogeneous filling of irregularities and accessory canals.[5] On the other hand, the thermoplastic technique plasticizes gutta-percha, forming a homogeneous mass compacted towards the apical region, allowing the sealing and filling of the root canal system with more homogeneous distribution of the filling material.[6-9] The present study was conducted to assess the effect of ultrasonic and sonic activation of root canal sealers and thermoplatized GP injection technique on the push-out bond strength of two different sealers.

MATERIAL AND METHODS

The present study was carried out on 60 orthodontically extracted mandibular premolars with the aim to evaluate the effect of ultrasonic and sonic activation of two root canal sealers on interfacial adaptation and push-out bond strength (BS) to root canal dentine. The specimens were randomly divided into two groups (n = 30) according to the root canal sealer –AH Plus (Dentsply DeTrey GmbH) or
technique and AH Plus (n = 30) or Nanoseal S (n = 30). Three subgroups (n = 10) were formed according to sealer activation: no activation (NA), sonic activation (SA, 20 s) and ultrasonic activation (US, 20 s). Three 1-mm-thick slices were obtained from each root third. They were used for push-out BS test. Data were analysed by two-way ANOVA and Tukey's test (a = 0.05).

RESULTS

The result of the study showed that AH Plus (2.58-1.21) had higher push out BS than Nanoseal S (1.45-0.71) (P =0.000). UA (2.64-1.44) had higher BS (P = 0.000) than NA (1.58-0.73) and SA (1.83-0.85), which did not differ significantly from each other (P =0.3303). The coronal third had higher BS (2.48-1.49) than the middle (2.08-0.94) (P = 0.0003) and apical (1.48-0.58) (P = 0.00) thirds. For both sealers, UA was associated with a more homogeneous filling material with better interfacial adaptation and greater quantity, density and length of tags in dentinal tubules. When UA was used, the tags had similar quantity; density and length to those formed without activation, but interfacial gaps and voids were observed.

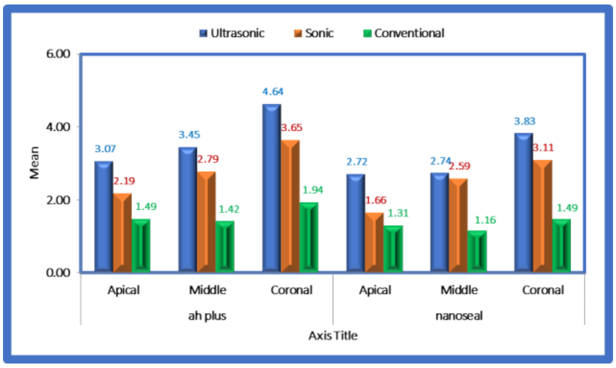
Table 1: Grouping of sample.

AH plus group (n=30)	Nanoseal S group(n=30)
Subgroup I: no activation (n=10)	Subgroup I: no activation (n=10)
Subgroup II: sonic activation (n=10)	Subgroup II: sonic activation (n=10)
Subgroup III: ultrasonic activation (n=10)	Subgroup III: ultrasonic activation (n=10)

Table 2: Comparison among Ultrasonic, Sonic, Conventional.

Group	AH plus			Nanoseal		
	Apical	**Middle**	**Coronal**	**Apical**	**Middle**	**Coronal**
I. Ultrasonic	3.07 ± 1.26	3.45 ± 0.75	4.64 ± 0.79	2.72 ± 1.13	2.74 ± 0.83	3.83 ± 0.83
II. Sonic	2.19 ± 0.75	2.79 ± 0.73	3.65 ± 0.91	1.66 ± 0.65	2.59 ± 0.69	3.11 ± 0.91
III. Conventional	1.49 ± 0.59	1.42 ± 0.58	1.94 ± 0.43	1.31 ± 0.46	1.16 ± 0.48	1.49 ± 0.43
F-value	7.5	22.6	34.28	8.29	16.02	25.52
P-value	0.003	<0.001	<0.001	0.001	<0.001	<0.001
Sig. Groups	I vs III	I vs III II vs III	I vs II I vs III II vs III	I vs II I vs III	I vs III II vs III	I vs III II vs III

Sub group	Variable	P-value		
		I vs II	I vs III	II vs III
AH plus	Apical	.099	.002	.214
	Middle	.099	<0.001	<0.001
	Coronal	.016	<0.001	<0.001
Nanoseal	Apical	.017	.001	.591
	Middle	.874	<0.001	<0.001
	Coronal	.097	<0.001	<0.001



Graph 1: Comparison among Ultrasonic, Sonic, Conventional.

DISCUSSION

Sonic and ultrasonic activation devices are widely used to increase the effectiveness of irrigating solutions.[11,24] Neelakantan et al. revealed that the push-out test has been widely used to evaluate the bond strength of root fillings.[10] Push-out test has been widely used to evaluate the bond strength of root fillings. [10,25,26] Arslan et al. concluded that ultrasonic activation of canal sealers have been proposed to increase their penetration into the dentinal tubules and improve the interfacial adaptation between the material and root dentine.[11] Vander Sluis et al., Gu et al., Jiang et al. concluded that ultrasonic activation has a direct action on the irrigation solution, displacing debris, and also induces turbulence of the solution, increasing and decreasing hydrostatic pressure and forming cavitation bubbles, which implode and ultimately increase temperature and pressure.[12,13,14] Vansan et al., Macedo et al. concluded that ultrasonic activation at a high frequency and with small oscillation amplitude provides sufficient energy to the sealer for a more homogeneous setting and a better packing of filler particles.[15,16] Ultrasonic activation has a direct action on the irrigation solution, displaces debris, and also induces turbulence of the solution. The frequent changes in hydrostatic pressure and the process of cavitation ultimately increase temperature and pressure.[15,27] High frequency ultrasonic energy with small oscillation amplitude provides sufficient energy for a more homogeneous setting of the sealer and a better packing of its filler particles.[17] Also, the heat generated during this process reduces sealer viscosity, better incorporation of filler particles into the organic matrix and thus improving the mechanical properties of the material.[18] This fact, combined with the increase of sealer pressure against the canal walls, allows a more effective filling of irregularities and of accessory canals.[11] in this study according to the result we found higher bond adhesion is possible with ultrasonic activated canals than the normal irrigated canal. Oral et al. revealed that the heat generated during this process reduces sealer viscosity and provides better incorporation of filler particles into the organic matrix, thus improving the mechanical properties of the material, especially its cohesive strength.[17] Studies by Bittmann et al., Lionetto & Maffezzoli concluded that the increase of sealer pressure against the canal walls, facilitates a more effective filling of irregularities.[18,19] Bittmann et al., Lionetto & Maffezzoli, Arslan et al. reported greater penetration of sealer into simulated accessory canals after sonic activation.[18,19,11] Arslan et al. revealed that greater penetration into dentinal tubules with formation of more numerous and longer tags with greater density.[11] Gharib et al., Jardine et al. concluded that depth of penetration of sealer tags and sealer adaptation at low magnifications.[20,21] MjCor et al., concluded that lower bond strength was observed in the apical and middle thirds because the coronal root third has a greater number of tubules, tubular diameter and amount of intertubular dentine.[22] Studies by Neelakantan et al., Carneiro et al. showed that the greater number of tubules, tubular diameter and amount of intertubular dentine in coronal root third favouring the adhesion of sealers to dentine walls and to the collagen structure.[10,23]

CONLUSION

Within the limitation of this study we concluded that ultrasonic activation resulted in higher bond strength and better interfacial adaptation of sealers to canal walls than sonic activation and no activation. And AH Plus sealer had higher bond strength than NANOSEAL sealer.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Guimarães BM, Amoroso-Silva PA, Alcalde MP, Marciano MA, Andrade FB, Duarte MA. Influence of ultrasonic activation of 4 root canal sealers on the filling quality. J Endod. 2014;40(7):964-8.

2. Ozkocak I, Sonat B. Evaluation of effects on the adhesion of various root canal sealers after ER:YAG laser and irrigants are used on the dentin surface. J Endod 2015,41(8):1331-6.

3. Saleh IM, Ruyter IE, Haapasalo MP, Orstavik D et. al. Adhesion of endodontic sealers: scanning electron microscopy and energy dispersive spectroscopy. Journal of Endodontics. 2003; 29(9):595-601.

4. Shokouhinejad N, Hoseini A, Gorjestani H et. al. The effect of different irrigation protocols for smear layer removal on bond strength of a new bioceramic sealer. Iran Endod J. 2013; 8(1):10-3.

5. Michelotto AL, Moura-Netto C, Araki AT, Akisue E, Moura AA, Sydney GB. *In vitro* analysis of thermocompaction time and gutta-percha type on quality of main canal and lateral canals filling. Braz Oral Res. 2010;24(3):290-5.

6. Horiuchi ZH, Silva-Sousa YT, Raucci Neto W, Rached-Júnior FJ, Souza-Gabriel AE, Silva SR, et

al. Effect of thermoplastic filling techniques on the push-out strength of root sealing materials. Braz Oral Res. 2016;30(1). pii: S1806-83242016000100207.

7. Wiesse PE, Silva-Sousa YT, Pereira RD, Estrela C, Domingues LM, Pécora JD, et al. Effect of ultrasonic and sonic activation of root canal sealers on the push-out bond strength and interfacial adaptation to root canal dentine. Int Endod J. 2017;51(1):102-11.

8. Goldberg F, Artaza LP, De Silvio A. Effectiveness of different obturation techniques in the filling of simulated lateral canals. J Endod. 2001,27(5):362-4.

9. Karabucak B, Kim A, Chen V, Iqbal MK. The comparison of guttapercha and Resilon penetration into lateral canals with different thermoplastic delivery systems. J Endod. 2008;34(7):847-9.

10. Neelakantan P, Subbarao C, Subbarao CV, De-Deus G, Zehnder M (2011) The impact of root dentine conditioning on sealing ability and push-out bond strength of an epoxy resin root canal sealer. International Endodontic Journal 44, 491–8.

11. Arslan H, Abbas A, Karatas E (2016) Influence of ultrasonic and sonic activation of epoxy-amine resin-based sealer on penetration of sealer into lateral canals. Clinical Oral Investigations 20(21) 61–64.

12. Vander Sluis LW, Versluis M, Wu MK, Wesselink PR (2007) Passive ultrasonic irrigation of the root canal: a review of the literature. International Endodontic Journal 40, 415–26.

13. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR (2009) Review of contemporary irrigant agitation techniques and devices. Journal of Endodontics 35, 791–804.

14. Jiang LM, Lak B, Eijsvogels LM, Wesselink P, van der Sluis LW (2012) Comparison of the cleaning efficacy of different final irrigation techniques. Journal of Endodontics 38, 838–41.

15. Vansan LP, Pecora JD, Costa WF, Maia-Campos G (1990) Effects of various irrigating solutions on the cleaning of the root canal with ultrasonic instrumentation. BrazilianDental Journal 1, 37–44.

16. Macedo RG, Verhaagen B, Fernandez Rivas D et al. (2014) Sonochemical and high-speed optical characterization of cavitation generated by an ultrasonically oscillating dental file in root canal models. Ultrasonics Sonochemistry 21,324–35.

17. Oral I, Guzel H, Ahmetli G (2012) Determining the mechanical properties of epoxy resin (DGEBA) composites by ultrasonic velocity measurement. Journal of Applied PolymerScience 127, 1667–75.

18. Lionetto F, Maffezzoli A (2013) Monitoring the cure state of thermosetting resins by ultrasound. Materials 6, 3783–804.

19. Bittmann B, Haupert F, Schlarb AK (2009) Ultrasonic dispersion of inorganic nanoparticles in epoxy resin. Ultrasonics Sonochemistry 16, 622–8.

20. Gharib SR, Tordik PA, Imamura GM, Baginski TA, Goodell GG (2007) A confocal laser scanning microscope investigation of the epiphany obturation system. Journal of Endodontics 33, 957–61.

21. Jardine AP, Rosa RA, Santini MF et al. (2016) The effect of final irrigation on the penetrability of an epoxy resin-based sealer into dentinal tubules: a confocal microscopy study. Clinical Oral Investigations 20, 117–23.

22. Mj€or IA, Smith MR, Ferrari M, Mannocci F (2001) The structure of dentine in the apical region of human teeth. International Endodontic Journal 34, 346-53.

23. Carneiro SM, Sousa-Neto MD, Rached-J_unior FA, Miranda CE, Silva SR, Silva-Sousa YT (2012) Push-out strength of root fillings with or without thermomechanical compaction. International Endodontic Journal 45, 821–828.

24. Karatas E, Ozsu D, Arslan H, Erdogan AS. Comparison of the effect of nonactivated self-adjusting file system, Vibringe, EndoVac, ultrasonic and needle irrigation on apical

extrusion of debris. Int Endod J. 2014;48(4):317-22.

25. Sousa-Neto MD, Passarinho-Neto JG, Carvalho-Júnior JR et. al. Evaluation of the effect of EDTA, EGTA and CDTA on dentin adhesiveness and microleakage with different root canal sealers. Brazilian Dental Journal 2002; 13:123-8. 12.

26. Martins CV, Leoni GB, Oliveira HF et al. Influence of therapeutic cancer radiation on the bond strength of an epoxy- or an MTAbased sealer to root dentine. International Endodontic Journal 2015; 49:1065-1072

27. Machado R, Silva Neto UX, Carneiro E et al. Lack of correlation between tubular dentine cement penetration, adhesiveness and leakage in roots filled with gutta percha and an endodontic cement based on epoxy amine resin. Journal of Applied Oral Science 2014;22;22-8.