



EVALUATION OF THE APICAL SEAL AFTER POST SPACE PREPARATION: IN VITRO STUDY

Elka Radeva¹, Desislava Tsanova-Tosheva¹, Alexander Bonchev¹, Rumen Radev², Mario Gruncharov³, Martin Vloka², Slavka Dimitrova³, Valena Ivancheva²

1) Department of Conservative Dentistry, Faculty of Dental medicine, Medical University – Sofia, Bulgaria

2) Students 3rd course, Faculty of Dental medicine, Medical University – Sofia, Bulgaria

3) Students 5th course, Faculty of Dental medicine, Medical University – Sofia, Bulgaria.

ABSTRACT

Introduction: Large crown destruction often leads to restoring endodontically treated teeth using post and core. As a result of post space preparation the integrity of the apical seal can be affected, thus increasing the chances of microleakage occurring.

Aim: The goal of the study is to observe and evaluate the quality of the apical seal after post space preparation.

Materials and Methods: 27 extracted single-rooted teeth were used. The coronal part was removed, and the root length was standardized to 15mm. The canals were prepared with Revo-S rotary system, irrigated with 5ml 5.25% sodium hypochlorite, saline, and 2ml 40% citric acid. The canals were filled with Adseal and gutta-percha using cold lateral condensation technique. The teeth were divided into two groups depending on post space preparation speed and one control group: first group ($n=9$) - 2800 rpm; second group ($n=10$) - 4700 rpm; control group ($n=8$) – with no preparation. Nail varnish was applied on the external root surface of the teeth except the apical 2mm, afterwards the teeth were inserted in 2% methylene blue for 24 hours and then washed under running water for the same time. The teeth were cut longitudinally in a buccal-lingual direction so that the level of dye penetration between the root canal wall and the filling material could be visualized. The measurement was done in mm.

Results: The highest average value of apical penetration was observed in the second group (4700 rpm) - 1.10 mm. The difference of the apical penetration between group 2 (1.10 mm) and control group (0.25mm) is significant, while the average value of Group 1 (2800 rpm) does not differ statistically from the other two groups.

Conclusion: Post space preparation combined with the higher speed of the drill can increase the risk of damaging the apical seal.

Keywords: apical sealing, apical microleakage, post space preparation

INTRODUCTION

Endodontically treated teeth with high destruction of the crown need to be restored with post and core. The purpose of the post is retention of the core and prevention of bacterial contamination caused by coronal leakage [1-3]. A common negative side effect during post space preparation is affecting the apical seal which can lead to microleakage. Post space preparation requires the removal of gutta-percha and sealer, or other filling material, from the coronal and middle part of the root canal and can damage the apical seal [6, 7]. The length of the remaining apical filling material is directly linked to the resistance of microleakage of the apical seal. It is widely accepted that a length of 3 to 5 mm of the remaining filling material is adequate for the apical seal [8, 9]. It is shown that the optimal apical seal is achieved when at least 6 mm of filling material is retained [9]. If the fillings are reduced to 3mm or lower then the quality of the seal depends on the type and qualities of the filling material [8].

The sealing properties of root canal sealers can be directly linked to their physical characteristics. Even in contemporary dentistry, no material fulfills all required properties for a hermetic seal of the root canals [10]. However, that does not decrease their role in eliminating the interface between the gutta-percha and the dentin walls of the filled root canal [Barros 10]. One of the main functions of the sealers is to create an environment in which bacteria cannot survive, thus preventing re-infection [2, 3].

There are many different methods of removing gutta-percha. The thermal method is one of the main methods for gutta-percha removal [11]. The chemical solvent method (using solvents as chloroform or xylene) is followed by many problems regarding its toxicity and difficulty in manipulation [6]. Another widespread method for post space preparation is mechanical - the usage of Gates Glidden drills, Peeso reamers, ProTaper Retreatment files (D1, D2, D3) however it is harder to control the amount of gutta-percha being removed and cause overheating in the root canal. The root canal filling material may be dislo-

cated creating holes in the obturation or twisted or vibrated affecting the apical seal [12].

The goal of the current study is to assess the state of the apical seal after post space preparation using peeso reamers with different speed.

MATERIALS AND METHODS

Twenty-seven extracted single-rooted teeth were stored in saline at room temperature, and used for the research. The coronal part of the teeth removed with a diamond bur and the roots were measured at 15mm each. All of the canals were prepared with Revo-S Ni-Ti rotary system as far as AS35 in the zone of apical constriction. The final irrigation was done with 5 ml 5.25% sodium hypochlorite, saline, and 2ml 40% citric acid. The root canal filling was done with epoxy resin-based sealer (Adseal) and gutta-percha using cold lateral condensation technique. The teeth were divided into 3 groups:

Group 1 ($n=9$) - the post space preparation was performed at 2800 rpm with Peeso-reamer;

Group 2 ($n=10$) - post space preparation was performed at 4700 rpm with Peeso reamer;

Group 3 ($n=8$) - Control group. The root canals were prepared and filled (without post preparation).

After processing, the teeth have been covered with two layers of water-resistant nail varnish. Only the apical 2 mm of the root surfaces were left uncovered. The coronal parts of the samples were sealed with light curing resin composite.

The teeth were placed in 2% methylene blue solution for 24 hours and then washed under running water for the same time. After that, they were left to dry-for dye fixation. The teeth were cut longitudinally in a buccal-lingual direction so that the level of dye penetration between the root canal wall and the filling material could be visualized. The measurement was done in mm.

The data was entered and processed with the statistical package IBM SPSS Statistics 23.0. The significance level for rejecting the null hypothesis was $p<0.05$. We applied the following statistical methods: *Variation analysis, Graphical analysis, One Sample nonparametric test of Shapiro-Wilk, ANOVA, Tamhane's T2 Post Hoc test.*

RESULTS

In the current study, apical microleakage was seen in all experimental groups but at different levels. The results in table 1 show that:

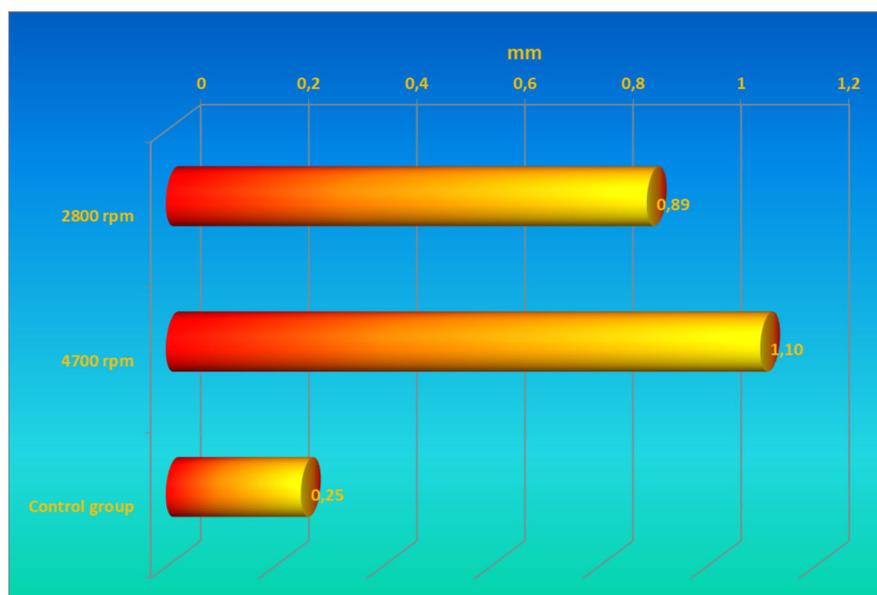
- The apical microleakage has the highest average value in Group 2 (4700 rpm);
- The difference between the value in Group 2 and the Control Group is significant, while the average value of the apical microleakage in Group 1 (2800 rpm) does not statistically differ from that in the other two groups (fig. 1-2).

Table 1. Comparative analysis of the apical microleakage (mm) in the investigated groups

Group	n	X	SD
2800 rpm	9	0,89 ^{ac}	0,74
4700 rpm	10	1,10 ^a	0,61
Control group	8	0,25 ^{bc}	0,19

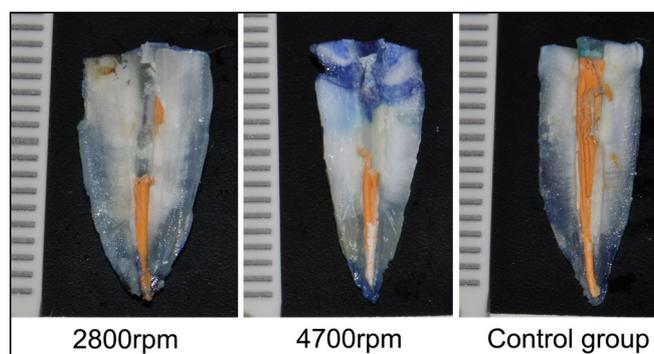
* - the same letters mean lack of significant difference between the mean values and the different – significant difference ($p<0,05$)

Fig. 1. Comparative analysis of apical microleakage (mm) in the investigated groups



The results in Figure 1 show that the apical penetration has the highest average value in Group 2 (4700 rpm) - 1.10 mm. The difference in the apical penetration levels between Group 2 (1.10 mm) and Group 3 (0.25mm) is significant, while the average value of Group 1 (2800 rpm) does not differ statistically from the other two groups.

Fig. 2. Apical microleakage was seen in all experimental groups



DISCUSSION

In the limitation of this study, the post space preparation was performed using Peeso reamers at a different speed, for Group 1 - 2800rpm and for Group 2 - 4700 rpm leaving 5mm of material apically. Some studies reported that the mechanical removal of gutta-percha with a Peeso drill was the most desirable method of post space preparation compared with chemical solvent or heated instrument [2, 7, 12]. Post space preparation with Peeso reamers is more efficient but has the highest potential for creating ledge, lateral root perforation, canal transportation, over enlargement of the canal, which-results in weakened remaining root structure.

The negative sides of using Peeso reamers are the increase of temperature in the root canal, which may lead to damage of the organic tissue. Increasing the temperature by 10°C might cause damage to the alveolar bone and periodontal ligament [13-15]. Another possible complication is breaking of the apical seal during post space preparation and creating voids in the seal [12].

Dye penetration technique was used in this study to evaluate the degree of apical microleakage. The samples were immersed in 2% methylene blue for 24 hours. This is a commonly used method in many studies [6, 7, 16]. Longitudinal sectioning of the samples is widely used to assess dye leakage [17]. The advantage of this method is the ability to measure the leakage from a single section. We chose to use this method in the current study due to its reliability and easy to assess results. There are other dye methods that include 0.5% eozine, 1% black India ink, 0,5% rhodamine B, 0,5% fuchsin and others [17].

There are still contradictions about whether the post space preparation should be done immediately after root canal obturation or after 3-7 days. There are many studies that compare the positive and negative sides of immediate and delayed post space preparation and its effect on the stability of the apical seal [6,18-20].

Nagas et al. [19] evaluated the effects of immediate and delayed post space preparation on apical leakage using different filling material and obturation technique. They establish that significantly better sealing was achieved at the apical end using delayed post space preparation (24 hours, 7 days) than with immediate.

Aidemir et al. [18] investigated the effect of immediate and delayed post space preparation on the integrity of the apical seal, and their results suggested that there was no significant difference between both methods. In the present study, we chose to conduct post space preparation 7 days after obturation.

The types of obturation techniques can influence over hermetical seal of the root canal The lateral conden-

sation technique is widely used and considered to be very effective [21], the vertical condensation technique using warm gutta-percha was created to offer a more dense and stable filling [22] and the single cone technique provides void-free obturation along with a minimal sealer thickness and is all used in the present [23]. There are various studies that compare the efficiency of these obturation techniques [24, 25].

In the current study, we used Adseal, which is an epoxy-based resin. The studies have shown that epoxy-based resin sealer is more reliable when it comes to preventing apical microleakage and reinfection, due to its long setting time, good flow and penetration into the dentinal tubules during the obturation, it forms a good mechanical adhesion to the dentin, though it can not bind to the gutta-percha. The epoxy-based materials show some expansion after setting – up to 1.2% during the 4-week period, and these dimensional changes could be the possible reason for minimal apical leakage [26]. Other authors use different filling materials such as Resilon-Epiphaney, due to the better adhesion to the dentine and resistance to the rotational forces [27]. Thermafil, which demonstrates a better hermetic seal and has a limited use due to manipulation difficulties [28]. Mittal [29] et al. find that for Resilon-AH plus, the apical microleakage is minimal due to the better adhesion of AH plus to the root canal walls.

The quality of the root canal filling is important for the integrity of the apical seal during post space preparation

Maintaining the apical seal is crucial for a successful endodontic treatment, and it should not be broken during the post space preparation. The optimal amount of gutta-percha that should remain apically is 5mm. Maintaining a length of 5 mm is important for prevention of reinfection and microbial leakage. Though there have been studies carried out to determine the impact on the apical seal and the possibility of reinfection depending on the amount of residual root canal filling material apically [9,30]we have decided to leave at least 5 mm of filling material, a length that is considered optimal.

During post space preparation the integrity of the apical seal can be disrupted which creates a pathway for bacterial invasion and reinfection of the root canal system. In our study, the apical microleakage has the highest average value in Group 2 (4700 rpm).

CONCLUSION:

The post space preparation itself, as well as the higher speed of drill, increase the risk of damaging the apical seal.

REFERENCES:

1. Gupta PK, Garg G, Kalita C, Saikia A, Srinivasa TS, Satish G. Evaluation of Sealing Ability of Biodentine as Retrograde Filling Material by Using two Different Manipulation Methods: An In Vitro Study. *J Int oral Heal JIOH*. 2015 Jul; 7(7):111-4. [[PubMed](#)]
2. Grecca FS, Rosa AR, Gomes MS, Parolo CF, Bemfica JR, Frasca LC, et al. Effect of timing and method of post space preparation on sealing ability of remaining root filling material: in vitro microbiological study. *J Can Dent Assoc*. 2009 Oct;75(8):583. [[PubMed](#)]
3. Savadkouhi ST, Bakhtiar H, Ardestani SE. In vitro and ex vivo microbial leakage assessment in endodontics: A literature review. *J Int Soc Prev Community Dent*. 2016;6(6): 509-16. [[Crossref](#)]
4. Solano F, Hartwell G, Appelstein C. Comparison of apical leakage between immediate versus delayed post space preparation using AH Plus sealer. *J Endod*. 2005 Oct;31(10): 752-4. [[PubMed](#)] [[Crossref](#)]
5. Mattison GD, Delivanis PD, Thacker RW, Hassell KJ. Effect of post preparation on the apical seal. *J Prosthet Dent*. 1984 Jun;51(6):785-9.
6. Chen G, Chang Y-C. Effect of Immediate and Delayed Post Space Preparation on Apical Leakage Using Three Root Canal Obturation Techniques After Rotary Instrumentation. *J Formos Med Assoc*. 2011 Jul; 110(7):454-9.
7. Chen G, Chang YC. The effect of immediate and delayed post-space preparation using extended working time root canal sealers on apical leakage. *J Dent Sci*. 2013 Mar 1;8(1):31-6.
8. Corrêa Pesce AL, González López S, González Rodríguez MP. Effect of post space preparation on apical seal: influence of time interval and sealer. *Med Oral Patol Oral Cir Bucal*. 2007 Oct 1;12(6):E464-8.
9. Rahimi S, Shahi S, Nezafati S, Reyhani MF, Shakouie S, Jalili L. In vitro comparison of three different lengths of remaining gutta-percha for establishment of apical seal after post-space preparation. *J Oral Sci*. 2008 Dec;50(4):435-9.
10. Dultra F, Barroso JM, Carrasco LD, Capelli A, Guerisoli DMZ, Pecora JD. Evaluation of apical microleakage of teeth sealed with four different root canal sealers. *J Appl Oral Sci*. 2006 Oct;14(5):341-5. [[PubMed](#)]
11. Bodrumlu E, Uzun Ö, Topuz Ö, Semiz M. Efficacy of 3 Techniques in Removing Root Canal Filling Material. *J Can Dent Assoc*. 2008;74(8): 721-721e.
12. Arora C, Kumari M, Taneja S, Practitioner P, Pradesh U. Comparative evaluation of apical leakage after post space preparation in root canals obturated using three resin-based root canal sealers: an in-vitro study. *IJO CR*. 2014;2(4):20-5.
13. Gokturk H, Ozkocak I, Taskan MM, Aytac F, Karaarslan ES. In vitro evaluation of temperature rise during different post space preparations. *Eur J Dent*. 2015;9(4):535-41.
14. Nazari Moghadam K, Shahab S, Shirvani S, Kazemi A. Temperature Increase during Different Post Space Preparation Systems: An In Vitro Study. *Iran Endod J*. 2011;6(3):116-8.
15. Radeva EN, Tsanova-Tosheva D, Bonchev A, Tsvetanova N, Damyanova T, Farieva A, et al. Temperature changes in the external root surface during post space preparation (in vitro study). *J of IMAB*. 2017 Dec; 23(4):1839-44. [[Crossref](#)]
16. Ayer A, Manandhar T, Agrawal N, Vikram M, Suwal P. A comparative study of apical microleakage of different root canal sealers by apical dye penetration. *Bangladesh J Med Sci*. 2017 Mar;16(2):219.
17. Jafari F, Jafari S. Importance and methodologies of endodontic microleakage studies: A systematic review. *J Clin Exp Dent*. 2017 Jun; 9(6):e812-9. [[PubMed](#)]
18. Aydemir H, Ceylan G, Tasdemir T, Kalyoncuoglu E, Isildak I. Effect of immediate and delayed post space preparation on the apical seal of root canals obturated with different sealers and techniques. *J Appl Oral Sci*. 2009 Dec;17(6):605-10.
19. Nagas E, Karaduman E, Sahin C, Uyanik O, Canay S. Effect of timing of post space preparation on the apical seal when using different sealers and obturation techniques. *J Dent Sci*. 2016 Mar;11(1):79-82. [[Crossref](#)]
20. Padmanabhan P, Das J, Kumari RV, Pradeep PR, Kumar A, Agarwal S. Comparative evaluation of apical microleakage in immediate and delayed postspace preparation using four different root canal sealers: An in vitro study. *J Conserv Dent*. 2017 Mar-Apr;20(2):86-90. [[PubMed](#)] [[Crossref](#)]
21. Emmanuel S, Shantaram K, Sushil KC, Manoj L. An In-Vitro Evaluation and Comparison of Apical Sealing Ability of Three Different Obturation Technique - Lateral Condensation, Obtura II, and Thermafil. *J Int oral Heal JIOH*. 2013 Apr;5(2):35-43.
22. Joseph JM; Bhagwat SV. An in vitro evaluation of apical leakage observed in different root canal obturation techniques. *Endodontology*. 1994;6(1):3-7.
23. Deniz Sungur D, Moinszadeh AT, Wesselink PR, Çalt Tarhan S, Özok AR. Sealing efficacy of a single-cone root filling after post space preparation. *Clin Oral Investig*. 2016 Jun 28;20(5):1071-7. [[PubMed](#)] [[Crossref](#)]
24. Faisal Al-Huwaizi AHA-S. Comparison of apical seal of four obturation techniques after delayed post space preparation. *Restorative Dent*. 2012; 24(2):1-4.
25. Al-Bakri MM. A comparative study of apical microleakage by using different preparation and obturation techniques. *Restorative Dent*. 2009;21(2):35-8.
26. Kim HR, Kim YK, Kwon TY. Post space preparation timing of root canals sealed with AH Plus sealer. *Restor Dent Endod*. 2017 Feb;42(1):27-33. [[PubMed](#)] [[Crossref](#)]
27. Dhaded N, Dhaded S, Patil C, Patil R, Roshan JM. The Effect of Time of Post Space Preparation on the Seal and Adaptation of Resilon-Epiphany Se & Gutta-percha-AH Plus Sealer- An Sem Study. *J Clin Diagn Res*. 2014 Jan;8(1):217-20. [[PubMed](#)] [[Crossref](#)]
28. Pusinanti L, Rubini R, Pellati

A, Zerman N. A simplified post preparation technique after Thermafil obturation: evaluation of apical microleakage and presence of voids using methylene blue dye penetration. *Ann Stomatol (Roma)*. 2013 Jun;4(2):184-

90. [[PubMed](#)]

29. Mittal R, Singla MG, Garg A, Gupta S, Bansal A. Comparative analysis of apical microleakage for two obturating materials-resilon and gutta-percha with two resin-based

sealers. *Saudi Endod J*. 2012; 2(1):14-18. [[Crossref](#)]

30. Siqueira JF, Lopes HP. Mechanisms of antimicrobial activity of calcium hydroxide: A critical review. *Int Endod J*. 1999;32(5):361-9.

Please cite this article as: Radeva E, Tsanova-Tosheva D, Bonchev A, Radev R, Gruncharov M, Vloka M, Dimitrova S, Ivancheva V. Evaluation of the apical seal after post space preparation: in vitro study. *J of IMAB*. 2019 Jan-Mar;25(1):2327-2331. DOI: <https://doi.org/10.5272/jimab.2019251.2327>

Received: 24/08/2018; Published online: 21/01/2019



Address for correspondence:

Assoc. Prof. Elka Radeva
Department of Conservative Dentistry Faculty of Dental Medicine/Medical University, Sofia, Bulgaria;
1, St. Georgi Sofiiski blvd., 1431 Sofia, Bulgaria
E-mail: eliradeva@abv.bg