https://doi.org/10.5272/jimab.2017234.1839

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Journal of IMAB - *Annual Proceeding (Scientific Papers)*. 2017 Oct-Dec;23(4)

Original article

TEMPERATURE CHANGES ON THE EXTERNAL ROOT SURFACE DURING POST SPACE PREPARATION (in vitro study)

Elka Radeva[1], Desislava Tsanova-Tosheva[1], Alexander Bonchev[1], Natali Tsvetanova[2], Tsvetelina Damyanova[2], Aysel Farieva[2], Sonya Georgieva[2], Iliyan Stoyanov[2]

1) Department of Conservative dentistry, Faculty of Dental Medicine, Medical University - Sofia, Bulgaria

2) Student - 4th year Faculty of Dental Medicine, Medical University – Sofia, Bulgaria.

ABSTRACT:

Purpose: The aim of this study is to investigate the temperature changes of the external root surface which occur during post space preparation with Peeso reamers at two different speeds.

Materials and methods: Twenty nine extracted single rooted human teeth were used. The tooth crown was removed and the length of the roots was standardized at 15 mm. Then each root canal was prepared with Revo-S Ni-Ti rotary system and filled with sealer and gutta-percha by cold lateral condensation technique. The teeth were divided into three groups: Group 1 (n=12) - post space preparation was performed at 2800 rpm. Group 2 (n=12) - post space preparation was performed at 4700rpm. Control group (n=5) – without post space preparation. Two thermocouples were connected to the outer surface of the root at 4 mm and 8 mm from the coronal part. During post space preparation, the temperature rises were measured using two digital thermometers which registered the temperature changes at 10s, 20s and 30s. Statistical analysis was performed.

Results: In the first 10 seconds of the preparation a slight increase of the temperature (1-2°C) was observed in the two points of the root surface where the thermocouples were attached to the roots of both groups. In the period from start to 20s the temperature of the teeth prepared with higher speed increased by 4.9°C compared to the teeth prepared at lower speed- the temperature increased by 3.6°C. Between the beginning point and the 30s the increasing of the temperature was higher - 9.1°C in group 2.

Conclusion: In both groups, the temperature on the external root surface increased during post space preparation. The higher speed of the Peeso reamers might reach a critical level of 10 degrees on the external root surface which might lessen the possibility of a successful outcome of the endodontically treated teeth.

Keywords: post space preparation, temperature changes

INTRODUCTION

Many endodontically treated teeth are severely damaged due to previous restorations, extensive caries and endodontic access preparation. The restorations of these teeth should be done in a way that replaces the missing coronal structures properly, restores the function correctly and protects the endodontic space from reinfections. In such cases, typically different post and core systems are used. The most important role of the post is retention of the core and support of the final restoration [1].

The so-called mechanical removal of the gutta-percha and the post space preparation is usually performed by Gates Glidden and Peeso reamers. They are preferable because they are non-end cutting burs [2]. As a result of this preparation a temperature alteration on the root surface may occur [3, 4]. The removal of the root canal filling with proper drills increases the temperature of the root surface. If this temperature becomes too high the tooth and periapical tissue might be at risk.

It is nowadays assumed that the critical level of the temperature changes that may cause damage to the supportive dental tissues is 10°C. Such damages are inactivation of bone alkaline phosphatase, blood flow interruption in the bone, protein denaturation etc. [5, 6].

The working drills inside the root canal produce heat which transmits to the outer root surface and increases its temperature proportionally to the working speed and the temperature changes are of great importance during post space preparation [7]. That is why in our study we measure these changes and we try to find out the most appropriate speed of the bur during preparation that is safe for hard dental tissue and periodontal tissues.

Some authors investigate the temperature values in vitro and in vivo during vertical compaction of gutta-percha. Their results reveal that there is no statistically significant difference between the temperature changes in vitro and in vivo. This confirms the validation of the in vitro method [8,9].

Various methods are used for measuring the temperature in the mouth – subgingival thermometers, non-con-

tact infrared thermometers, and thermocouples, intraoral thermistors that can be attached to the teeth by PVC splints [10].

For the aim of this investigation, the root surface of the teeth should be measured. That is why it is impossible for the measurements to be done intraorally. For an in vitro study like this, the most proper devices that can be applied are the thermocouples which can be fixed to the root surface.

Therefore, the aim of the present study was to investigate the temperature changes of the external root surface which occur during post space preparation with Peeso reamers at two different speeds. A delayed but not an immediate post space preparation was applied. Still, the general practice is the delayed removal of the coronal filling for the post preparation [11].

MATERIALS AND METHODS:

Twenty-nine extracted one rooted human teeth were used for this study. The calculus was removed completely from the surfaces of the teeth. The anatomic crown of each selected tooth was sectioned at its cervical part and roots were inspected for a canal patency with a K file No.15.The roots' length was standardized at 15 mm.

All root canals were instrumented using Revo-S Ni-Ti rotary system (speed 250-400 rpm, torque 0,8N.cm). Instrumentation was carried out with concomitant irrigation with: 3ml 3% H_2O_2, 3ml 0.5% NaOCl, 3ml 0.9% NaCl, 2ml 40% Citric Acid. After that, the root canals were dried with paper points and all of the teeth were obturated using cold lateral condensation technique of gutta-percha and sealer (Adseal, Meta Biomed Korea). X-rays were taken to check the quality of the root canal filling.

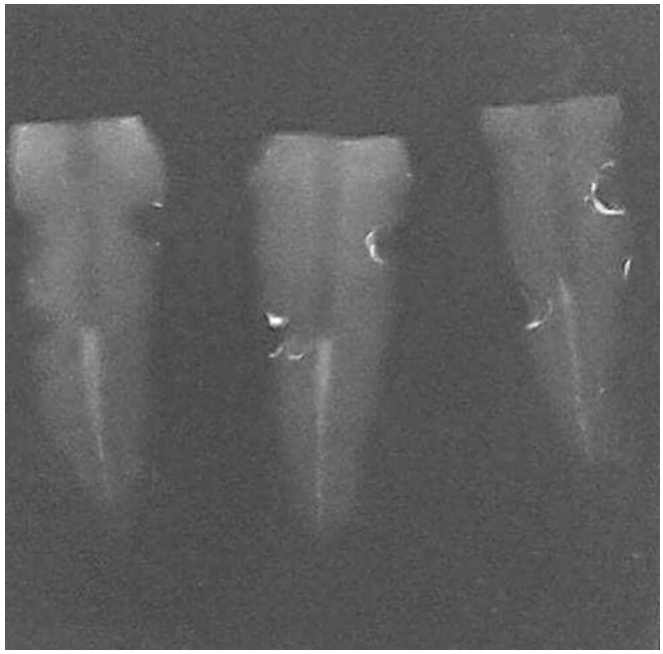
The teeth were stored for 3 weeks at 37°C in 100% humidity to allow setting of the sealer. Post space preparation was performed using Peeso reamers #3. A 9 mm post space was prepared in all root canals. Each drill was used for 30 s in the root canal.

The teeth were divided into three groups depending on the revolutions per minute used for the preparation: Group 1 (n=12) - post space preparation was performed at 2800 rpm. Group 2 (n=12) - post space preparation was performed at 4700rpm. The control group (n=5) – without post space preparation.

On the external root surface two points were prepared for thermocouples – at 4 mm and 8 mm from the coronal part.

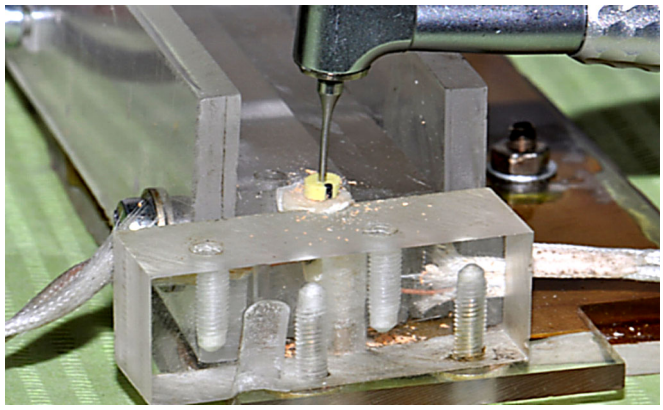
Finally, radiographic images were obtained from the specimens which confirm complete post space preparation and remained apical seal (Fig. 1).

Fig. 1. Radiographs of root canals after post space preparation



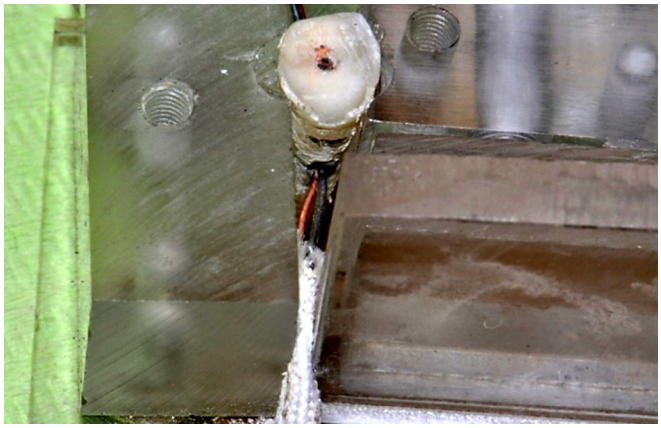
The experimental model was made in the Institute of Electronics in the Bulgarian Academy of Sciences, especially for the aim of the study (Fig. 2).

Fig. 2. Experimental model



Two thermocouples were positioned on the outer surface of the root at a distance of 4 and 8mm from the coronal part and connected to digital thermometers by wetting root site with a conductive gel containing silver (fig. 3). The temperature changes were registered at 10s, the 20s, and 30s.

Fig. 3. Position of thermocouples to the outer surface of the root



Statistical analysis was conducted using commercial software IBM SPSS Statistics 23.0. 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, Mauchly's Test of Sphericity, Repeated measures ANOVA, Independent samples T-test of Student, Test of Friedman for several related samples, Nonparametric test of Wilcoxon for two related samples, Paired samples T-test of Student, Nonparametric test of Mann-Whitney-U for two independent samples.

RESULTS:

In the first 10 seconds of the preparation a slight increase of the temperature (1-2°C) was observed in the two points of the root surface where the thermocouples were attached to the roots of both groups. In the period from the start to 20s the temperature of the teeth prepared with higher speed increased by 4.9°C compared to the teeth prepared at lower speed- the temperature increased by 3.6°C. Between the beginning point and the 30ths, the increase of the temperature was higher - 9.1°C in group 2.

The results in Table 1 show that there is a significant increase in the temperature, regardless of the rpm and the measuring distance (table 1).

Table 1: Temperature dynamics during measurement, rpm and distance

rpm	Distance (mm)	Time(sec)							
		Start		10		20		30	
		$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
2800	4	25.50[a]	0.53	27.10[b]	1.37	29.10[c]	1.66	31.30[d]	1.25
	8	25.50[a]	0.53	26.50[b]	0.71	28.20[c]	0.92	30.00[d]	0.82
4700	4	25.40[a]	0.52	28.00[b]	1.25	30.30[c]	1.25	34.50[d]	2.64
	8	25.40[a]	0.52	27.30[b]	0.82	29.20[c]	1.03	31.40[d]	1.35

* different letters on horizontals show that there is a significant difference ($p<0.05$).

On table 2 the results have shown that there is a statistically significant difference between measured temperatures on a distance of 4 and 8 mm, only on the 30th second of measurement (table 2).

Table 2: Comparison analysis of a temperature according to a distance, time and rpm.

Time (sec)	Rpm	Distance (mm)				P
		4 mm		8 mm		
		$\overline{X}$	SD	$\overline{X}$	SD	
0	2800	25.50	0.53	25.50	0.53	1.000
10		27.10	1.37	26.50	0.71	0.353
20		29.10	1.66	28.20	0.92	0.247
30		**31.30**	1.25	30.00	0.82	0.029
0	4700	25.40	0.52	25.40	0.52	1.000
10		28.00	1.25	27.30	0.82	0.165
20		30.30	1.25	29.20	1.03	0.063
30		**34.50**	2.64	31.40	1.35	0.005

Results in Table 3 show that the significant difference between measured temperatures in both tested rotations per minute is:

- At a distance of 4 mm - only at the 30th s of measurement;
- At a distance of 8 mm - at the 10th, 20th and 30th s of the measurement (table 3).

Table 3: Comparison analysis of the temperature according to revolutions, time of measurement and distance

Time (sec)	Distance (mm)	Rpm				P
		2800		4700		
		$\overline{X}$	SD	$\overline{X}$	SD	
0	4 mm	25.50	0.53	25.40	0.52	0.739
10		27.10	1.37	28.00	1.25	0.739
20		29.10	1.66	30.30	1.25	0.085
30		**31.30**	1.25	34.50	2.64	0.009
0	8 mm	25.50	0.53	25.40	0.52	0.739
10		**26.50**	0.71	27.30	0.82	0.001
20		**28.20**	0.92	29.20	1.03	0.043
30		**30.00**	0.82	31.40	1.35	0.019

The significance level for rejecting the null hypothesis was $p<0.05$.

DISCUSSION

The aim of the present study was to compare the change in the temperature at 4mm and 8mm of the root canal surface using the different speed of drills (2800 rpm and 4700 rpm) and measured at a different time (10th, 20th and 30th s). The results showed that no matter of the distance or the rpm, the temperature increases.

Gates Glidden drills, Peeso reamers, ultrasonic and specific drills are recommended for post space preparation. Peeso reamer is more efficient for removing of gutta percha [12,13]. The post length is very important for the retention [14]. The post should be as long as possible bearing in mind limitations such as root length, root morphology and maintenance of the apical seal. According to some authors post space preparation procedures should be delayed in time [15, 16] because they could cause dilution of the uncured sealer and lessen the quality of the apical seal. The post space preparation should not disturb the apical seal. Short posts have poor retention and transmit larger lateral forces to the remaining root structure. The post diameter is important for post strength and resistance to post fracture. Wide post leads to an increased risk of lateral root perforation, introduce greater cervical stress and lead to root fracture. In our study, we prepared a 9 mm post space in all root canals. The apical seal was approximately 6 mm. This contributes to the results in a study where the investigators managing this problem have concluded also that the most proper length of the apical seal should be minimum 6 mm [17].

According to some authors use of engine driven drills to prepare post space in teeth may generate temperature rises that may cause periradicular tissue damage [6,18,19].

The result of the present study showed that during root post space preparation temperature increases from 4.5 ºC to 9.1ºC. This shows that the speed that has been used for this study is safe because it does not exceed 10°C.

In another comparative study, is used higher speed for post space preparation - the lowest is 6500rpm and the highest - more than 9500 rpm. Thermocouples have also been used for temperature measurements. The increase of the temperature for all speeds and in all points is between 0.66 to 4.81°C. And unexpectedly they have found that the temperature does not increase with the higher speed over 8000rpm.The time they have made the preparations is 10s to 15s for each group. It is interesting that in our results the temperature reached through the preparations at lower speed is higher than theirs. Perhaps the reason for that is the longer time we use for the preparation. But in both studies, the temperatures in all speeds and all locations of the root surfaces do not exceed the critical 10°C (20).

Saunders and collaborators measured the rise of the temperature at a point 6 mm from the apex of the tooth using a thermocouple attached to a chart recorder [19]. They established that the temperature rise was greatest when the removal of gutta-percha was combined with post channel preparation. Temperature rises of up to 31°C were recorded [19].

There are studies, which compared techniques for removal of obturating material (sealer,gutta-percha) from the root canal for post space preparation [13].

In another in vitro study the authors evaluated the temperature rise of the external root surface during post space preparation [21].The temperature was measured by means of digital thermometer MT-405 (Comercio Co., Sao Paulo, Brazil).The results demonstrate that using BeeFill pack system during post space preparation may damage periodontal tissues because there is a significant increase of the temperature up to 11.3ºC.

Other investigators established higher values of overheating when the smaller reamers are used 1, 2- up to 8-9°C (to 45°C)during root canal preparation for radicular posts [6].

Others investigated the influence of temperature rise on a single rooted tooth during biomechanical tooth preparation, obturation and root canal preparation for the radicular post. In group 5, post space preparation was done using peeso reamers. The mean temperature rise at the middle third for group 5 was 9.46°C. This result is similar to the result in our study where the temperature in-

creased to 9.1°C at the 30th sec in 4700rpm [3].

The results may vary due to the device used for temperature measurement, the number of used thermocouple tip, and the teeth used. Some factors may affect the temperature rise during the preparation of post canal, such as the operator force, the drill type and diameter, the anatomy of the root canal, the friction between root canal dentin and drill, the use of water coolant, and the use of new drills [10].

CONCLUSIONS:

With the limitations of this study in mind, the following conclusions were drawn:

1. In both groups, the temperature on the external root surface increased during post space preparation.

2. There was a significant statistical difference in the temperature increase when post space preparation was performed at 4700 rpm.

3. The higher speed of the Peeso reamers in Group 2 might reach a critical level of 10 degrees on the external root surface. That could produce thermo-mechanical alterations to the root-filled teeth and may damage the tooth tissue and the surrounding support structure.

Acknowledgment:

The authors wish to thank Prof. P. Petrov, Institute of Electronics in the Bulgarian Academy of Sciences for his technical support for the experimental model and Prof. G. Genchev for the statistical analysis.

REFERENCES:

1. Cheung W. Properties of and important concepts in restoring the endodontically treated teeth. *Dent Asia.* 2004; 5:40-7.

2. Ricketts DN, Tait CME, Higgins AJ. Post and core systems, refinements to tooth preparation and cementation. *Br Dent J.* 2005 May 14;198(9):533-41. [PubMed] [CrossRef]

3. Chauhan A, Nilker V, Mandke L. Effect of Temperature Rise on Periodontal Tissue During Endodontic Treatment: An In Vitro Study. *Indian J Oral Heal Res.* 2015; 1(2):66-71. [CrossRef]

4. Reyhani MF, Yavari H, Ghasemi N, Rahimi S, Barhaghi MHS, Mokhtari H, et al. Comparing the Coronal Seal of Different Thicknesses of MTA with Gutta-Percha after Post Space Preparation. *Sci World J.* 2015 (2015): 708639:p.5. [CrossRef]

5. Amade ES, Novais VR, Roscoe MG, Azevedo FM, Bicalho AA, Soares CJ. Root Dentin Strain and Temperature Rise During Endodontic Treatment and Post Rehabilitation. *Braz Dent J.* 2013 Dec;24(6):591-8. [PubMed] [CrossRef]

6. Dimitrov S, Gueorgieva T, Dogandzhiyska V, Angelov I. In vitro investigation of influence of temperature rising on periodontal tissue during endodontic treatment. *J of IMAB.* 2009; 15(2):32-5. [CrossRef]

7. Hardie EM. Further studies on heat generation during obturation techniques involving thermally softened gutta-percha. *Int Endod J.* 1987 May;20(3):122-7. [PubMed]

8. Saunders EM. *In vivo* findings associated with heat generation during thermomechanical compaction of gutta-percha. Part II. Histological response to temperature elevation on the external surface of the root. *Int Endod J.* 1990 Sep;23(5):268-74. [PubMed] [CrossRef]

9. Saunders EM. In vivo findings associated with heat generation during thermomechanical compaction of gutta-percha. Part I. Temperature levels at the external surface of the root. *Int Endod J.* 1990 Sep;23(5):263-7. [PubMed] [CrossRef]

10. 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 Oct-Dec;9(4):535-41. [PubMed] [CrossRef]

11. Abramovitz I, Tagger M, Tamse A, Metzger Z. The effect of immediate vs. delayed post space preparation on the apical seal of a root canal filling: a study in an increased-sensitivity pressure-driven system. *J Endod.* 2000 Aug;26(8):435-9. [PubMed] [CrossRef]

12. 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. [PubMed] [CrossRef]

13. Ashofteh Yazdi K, Razmi H, Ghabraei S, Shokouhinejad N, Aligholi M, Rahmani S. The effect of two post-space preparation techniques on the seal of resilon and gutta-percha obturation materials. *Iran Endod J.* 2010 Spring;5(2):64-8. [PubMed]

14. Stockton LW. Factors affecting retention of post systems: A literature review. *J Prosthet Dent.* 1999 Apr; 81(4):380-5. [PubMed] [CrossRef]

15. 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]

16. 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]

17. Qu Z-Z, Li X-G, Wang Q. [Study of dental apex sealing effects after post space.] [in Chinese] *Shanghai Kou Qiang Yi Xue.* 2016 Oct;25(5): 560-5. [PubMed]

18. Zmener O. Effect of dowel preparation on the apical seal of endodontically treated teeth. *J Endod.* 1980 Aug;6(8):687-90. [PubMed] [CrossRef]

19. Saunders EM, Saunders WP. The heat generated on the external root surface during post space preparation. *Int Endod J.* 1989 Jul; 22(4):169-73. [PubMed] [CrossRef]

20. Weller RN, Kimbrough WF, Anderson RW. Root surface temperatures produced during post space preparation. *J Endod.* 1996 Jun; 22(6): 304-7. [PubMed] [CrossRef]

21. 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. [PubMed]

Please cite this article as: Radeva E, Tsanova-Tosheva D, Bonchev A, Tsvetanova N, Damyanova T, Farieva A, Georgieva S, Stoyanov I. Temperature changes on the external root surface during post space preparation (in vitro study). *J of IMAB.* 2017 Oct-Dec;23(4):1839-1844. DOI: https://doi.org/10.5272/jimab.2017234.1839

Received: 29/08/2017; Published online: 19/12/2017

Address for correspondence:
Assoc. Prof. Elka Nikolaeva Radeva, DMD, PhD,
Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University-Sofia,
Bul. "G. Sofiiski" #1,f..10. Rm. 1018, 1431 Sofia, Bulgaria.
E-mail: eliradeva@abv.bg