Original Article

Comparison of the Percentage of Voids following Root Canal Obturation with Gutta Percha and AH26 Sealer Using Four Different Sealer Placement Techniques

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Abstract

Background and Aim: Different techniques are employed for sealer placementinto the root canal system. The purpose of this study was to compare the percentage of voids following root canal obturation with gutta percha and AH26 sealer using four different sealer placement techniques.

Materials and Methods: In this laboratory experimental study, root canals of 50 mandibular second premolars were prepared using the step-back technique. The teeth were assigned to 4 experimental groups of 10 and one control group based on sealer placement technique. After sealer application and canal obturation with lateral condensation technique, specimens were horizontally cut into 3 mm slices. Sections were evaluated under a digital microscope at 150X magnification for void detection in apical, middle and coronal thirds. Kruskal Wallis and Bonferroni tests were applied to compare the percentage of voids between different groups.

Results: No significant difference was found in void percentage in one-thirds or total sections between the four methods (p=0.276).

Conclusion: Overall, no significant difference was noted in void percentage between the four techniques of sealer placement.

Key Words: Void detection, Digital microscope, Sealer placement techniques

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Introduction

Root canal obturation is a critical phase in success of root canal treatments [1-3]. Gutta percha is the most commonly used root canal filling material [4] but it cannot seal the entire root canal space alone because it does not have the ability to adhere to dentinal canal walls. Thus, sealers are used to fill up the gap between the gutta percha and canal walls [5, 6]. Sealers should be applied to the root canal system using a predictable technique and must completely cover the dentinal walls. For this purpose, several techniques have been proposed for placement of sealer into the root canal including the use of files, reamers, Lentulo spiral, gutta percha cones, paper points and recently ultrasonic files [7-9]. To date, studies comparing the efficacy, dentinal wall coverage and void formation in these techniques have been scarce [1,2,7-12]. Some studies have investigated the percentage of voids radiographically [9]. However, radiography has a limitation in detection of voids smaller than 300 microns [13] and may negatively affect the accuracy of results. Cone beam computed tomography (CBCT) does not have a superior accuracy thanthe conventional and digital radiography in evaluation of the quality of root canal filling [10, 11] and its

results should be interpreted with caution [12]. Several other studies have evaluated and compared the role of different sealer placement techniques in root canal obturation without the core root canal filling material like gutta percha cones [1]. However, the standard root canal obturation technique is comprised of the use of a core root canal filling materialalong with sealer and the mentioned studies have not answered the question that which method of sealer placement in the standard root canal obturation technique has the lowest percentage of voids. Ng et al, in a systematic review evaluated 63 studies and showed that in primary root canal treatments presence or absence of voids had a significant effect on the success of root canal therapy [13].

The present study aimed to compare the percentage of voids in root canal obturation with gutta percha and AH26 sealer using 4 different techniques of sealer placement including the use of K file, Lentulo spiral, gutta percha cone and ultrasonic file. For this purpose, horizontal sections were cut and evaluated under a microscope at 150X magnification.

Materials and Methods

In this laboratory experimental study, 50 mandibular second premolars with straight roots and round cross-sections extracted due to periodontal disease or as part of prosthodontic or orthodontic treatment plans with a slight curvature (<10°)according to Schneider's classification of curvatures were selected and stored in sterile water. The teeth were examined clinically and radiographically and those with immature apex, previous RCTs, root caries or root resorption were excluded from the study.

Coronal sections of the teeth were cut with a diamond disc to reach an 11 mm length. For working length determination, a #10 K file was introduced into the canal until the tip was visible at the apex. The file was then withdrawn for one mmand the length was measured as the working length. After introduction of a hand file as a glide path, cleaning and shaping of the canal were performed using ProTaper (Dentsply, Tulsa Dental, Tulsa, OK) files to F_3. During canal preparation, one cc of 0.5% sodium hypochlorite (Taj, Iran) was used as an irrigation solution in between files. After completion of cleaning and shaping, 5 cc of 17% ethylene di-amine tetra acetic acid was used according to the manufacturer's instructions for smear layer removal followed by 5ml of sodium hypochlorite according to Goldman [15]. Canals were then rinsed with 5 ml of isopropyl alcohol and dried with a paper point.

AH26 sealer (Dentsply, EU & USA) was mixed according to the manufacturer's instructions until reaching a suitable consistency. For each canal, 0.4 ml of AH26 sealer was allocated. A one ml tuberculin syringe was used for equal distribution of this amont of sealer between samples and for each canal. The teeth were then randomly divided into 5 groups of 10. In group 1, sealer was applied to the apical 4 mm of a #35 K file. The file was introduced into the canal using anti-clock wise rotation of the file and a mild pumping motion and remained for 5 seconds in the canal. This was repeated several times to transfer all 0.4 ml of sealer into the canal. After that, #35 gutta percha conereached the working length, lateral cones were added and canals were filled using lateral condensation technique. In group 2, sealer was applied to the apical 4 mm of a #3 Lentulo (Sendo Line, Sweden). The Lentulo was attached to a hand piece operating at 300 rpm and inserted into the canal for 5s with clockwise rotation. This was continued until all 0.4 ml of sealer was transferred into the canal. Afterwards, #35 gutta percha reached the working length minus 0.5 mm, lateral cones were added and the canals were filled using lateral condensation technique.

In group 3, sealer was applied to the apical 4 mm of #35 gutta percha cone (Gapadent, Republic of Korea).The cone was introduced into the canal with a mild pumping motion and remained for 5 s. This was repeated several times until all the 0.4 ml sealer was transferred to the canal. Next, #35 gutta percha cone reached the working length, lateral cones were inserted and canals were filled using lateral condensation technique. In group 4, sealer was applied to the apical part of a #20 ultrasonic file with 55 kHz frequency (Satelec, France). The file was introduced into the canal and remained there for 10s. This was repeated several times until all the 0.4 ml sealer was transferred to the canal. In the next step, #35 gutta percha reached the working length, lateral cones were inserted and canals were filled using lateral condensation technique.

Group 5 was considered as the control group. In 4

teeth in the control group, sealer and gutta percha were not used in order to show canal morphology and ensure the complete removal of canal debris. In another 3 teeth, sealer was applied to the apical 4 mm of a #3 Lentulo and pumped into the canal with up and down motion at 300 rpm for 30 s. This was repeated several times until all the 0.4 ml sealer was transferred into the canal. These teeth were then placed in a vacuum mixer (Rainforest, Germany). The vacuum provides the best coverage of canal walls with the sealer. Next, #35 gutta percha cone reached the working length and lateral cones soaked in a thin layer of sealer were introduced into the canal and the canals were filled using lateral condensation technique. These three teeth simulated complete filling of the entire canal with gutta percha and sealer and comprised our negative control group. The remaining 3 teeth in the control group were filled with gutta percha using a hand spreader (Dentsply, Switzerland) and lateral condensation technique. But, sealer was not used. In the mentioned 3 teeth, #35 gutta percha reached the working length, lateral cones were added and canals were filled using lateral condensation technique. These 3 teeth showed the possibility of filling the canals without sealer and comprised our positive control group. The teeth were stored in 100% humidity at 37°C for 5 days. The teeth were horizontally sectioned. To parallelize the sections and standardize them, a cutting machine was created by fixing a straight hand piece on a stainless steel jig. Sections were made under high pressure water and air spray. Using a micromotor hand piece and special cutting discs (Top Dent, Switzerland), each root was cut into ± 0.5 mm apical, middle and coronal (at 2, 5.5 and 9 mm from the apex) thirds. Sections were photographed by an operator blinded to sample allocation under a digital microscope (Dino Lite, Chosen, Thailand) at 150X magnification. The images were directly transferred to a computer and percentage of voids to the respective cross section was measured and calculated using 2008 AutoCAD software (version 1, serial number: 653-12354321). The obtained percentages were entered to SPSS version 10 software (SPSS, Chicago, IL, USA). Kruskal Wallis and Bonferroni tests were used to compare the percentage of voids at coronal, middle and apical sections. F test was applied to compare the overall percentage of voids between groups.

Results

Evaluation of sections revealed no statistically significant difference between the 4 techniques of sealer placement (P=0.14). The lowest mean void percentage was 0.95% and belonged to placement of sealer with Lentulo followed by ultrasonic file, gutta percha master cone and K file with a mean void percentage of 1.29%, 1.71% and 2.17%, respectively.

The mean percentage of voids is demonstrated in Table 1. Overall, the negative control group had the lowest percentage of voids with a mean value of 0.12%. The positive control group had the highest void percentage with a mean rate of 6.60%; which indicates the accuracy of steps performed in this study. Also, the three sections were compared in the 4 groups and the following results were obtained:

Coronal section: In this cross-section, the lowest void percentage belonged to placement of sealer with Lentulo with a mean value of 0.6% followed by gutta percha master cone, ultrasonic file and K file with a mean value of 1.78%, 1.82% and 1.83%, respectively. No significant difference was noted in this cross section between the 4 techniques of sealer placement.

Middle section: In this cross section, the lowest void percentage belonged to Lentulo group with a mean value of 0.96%. K file, ultrasonic file and gutta percha master cone ranked next with a mean value of 1.38%, 1.58% and 1.85%, respectively. In this cross section, no significant difference was found between the 4 groups.

Apical section: In this cross section, the lowest void percentage was observed in the ultrasonic file group with a mean value of 0.47%. Lentulo, gutta percha master cone and K file ranked next with a mean void percentage of 1.31%, 1.50% and 3.31%, respectively. No significant difference was detected between the 4 groups in this cross-section.

Discussion

This study showed that void percentage was not significantly different between the 4 sealer placementtechniques. Statistical comparison of the 4

Table 1. The mean and standard deviation of void percentage in different sections

	K file	Lentulo	Gutta percha	Ultrasonic file	P value
All sections	2/17±2/63	0/95±1/43	1/71±1/98	1/29±1/35	0/276
Apical section	3/31±3/8	1/31±2/14	1/5±2/14	0/47±0/46	0/218
Middle section	1/37±2/09	0/96±0/98	1/85±2/08	1/58±1/51	0/837
Coronal section	1/83±1/13	0/6±0/9	1/78±1/91	1/82±1/5	0/159

groups showed that in the apical section, sealer placement with ultrasonic file and in the coronal section, sealer application with Lentulo were more effective than other techniques.

Some studies have evaluated straight canals while some others have studied curved canals with different cleaning and shaping techniques. More importantly, method of assessment of the coverage of canal walls with the sealer has been variable in different studies making it difficult to compare the results. The main common issue in all these studies is the inability of all these techniques, including the ones used in our study, to cover the entire surface of canal walls with sealer [1, 7, 16, 17]. Amato et al. concluded that the sealer delivery method does not play a role in void percentage or quality of sealer distribution [17]. However, in the mentioned study the amount of sealer applied to the canals was not standardized and method of evaluation of cross sections was not described either.

Jeffrey et al, [18] also believed that method of sealer placement had no effect on the degree of root canal wall coverage. In their study, sealer placement with gutta percha cone and Lentulo were compared. But the amount of sealer used was not standardized and the plastic model simulating the root canal was clear and therefore the operator could observe the distribution of sealer and wall coverage. This issue could affect the performance of the operator. Furthermore, smooth surfaces and lack of irregularity made it impossible to simulate clinical setting.

Hoen et al. compared hand spreaders and ultrasonic files and concluded that ultrasonic files were significantly superior to reamers in distribution of sealer to the canal walls [7]. However, they did not fill the canals and therefore, the effect of sealer movement during the placement of gutta percha points was not evaluated.

West et al, in a similar study stated that ultrasonic fileswere superior to reamers in sealer placement. However, in the mentioned two studies, the amount of sealer had not been standardized and the canals were not matched in terms of curvature [16].

In our study, similar to Hall [8] et al, and Weismann and Wilcox [2], we tried to standardize the variables. For example, the amount of sealer used was standardized and a computer analysis was carried out to assess the overall canal wall coverage. Root canal sections were evaluated in terms of void percentage and the canals were standardized in terms of curvature.

The main difference between our study and the mentioned two studies was in methodology and use of several cross sections to determine the void percentage instead of comparison with clearing technique and evaluation of longitudinal sections; because in the clearing technique, gutta percha may be superimposed on the voids and hide them from sight. Our study results (not finding a significant difference between the 4 groups) were similar to those of the two aforementioned studies and emphasize the importance of standardization of study conditions. However, the risk of apical leakage of sealer and instrument fracture [16] still remains and questions the use of these techniques.

West et al. reported that ultrasonic files were more efficient for canal wall coverage than K files [16]. In our study, although ultrasonic files in the apical section were more effective than other techniques, the difference was not statistically significant. This difference between our study result and that of West et al, may be due to the study methodology because they only evaluated the gap between canal walls and filling materials; whereas, we evaluated the percentage of voids in the entire cross-sections.

Hall et al. studied different sealer placement techniques and demonstrated that only 62.5% of the canal wall surface was covered with sealer [8]. This rate is much lower than our obtained value. After sealer placement, they did not fill the canal with gutta percha. This indicates the importance of filling the root canal with a core root canal filling material and sealer instead of filling up the entire canal with sealer as a filling paste.

Also, evaluation of only three cross sections does not allow the completethree-dimensional evaluation of voids and gaps. Another limitation of our study and those of Weismann and Wilcox [2] and

Hall et al, [8] was the unpredictable standardization of the amount of sealer that reached the apical regionand use of straight canals. However, review of limited studies available in this regard reveals the superiority of our methodology over others.

Electron microscopy and tomography methods are time consuming and the time required for preparation of micrographs causes the dehydration of tooth structure that leads to the underestimation of void areas in a section [12]. This issue further indicates the superiority of our methodology. However, we did not polish the specimens; which can result in disappearance of gutta percha margins and canals. To prevent this, specimens would better be polished in future microscopic studies [12].

Zaslansky et al. found that of 5 methods for the assessment of interfaces within root canals and filling materials, only the phase contrast enhanced tomography did not create dentinal cracks [12]. Use of this technique is recommended in future studies.

Conclusion

Overall, no significant difference was noted in void percentage between the 4 techniques of sealer placement.

REFERENCES

1- Khan FH, Rosenberg PA, Schertzer L, Korthals G, Nguyen PN. An in-vitro evaluation of sealer placement methods. Int Endod J. 1997 May; 30 (3):181-6.

2- Wiemann AH, Wilcox LR. In vitro evaluation of four methods of sealer placement. J Endod. 1991; Sept;17(9):444-7.

3- Robberecht L, Colard T, Claisse-Crinquette A. Qualitative evaluation of two endodontic obturation techniques: Tapered single-cone method versus warm vertical condensation and injection system: An in vitro study. J Oral Sci. 2012 Mar; 54 (1):99-104.

4- Bodanezi A, Munhoz Ede A, Bernardineli N, Capelozza AL, de Moraes IG, Bramante CM. Radiographic analysis of root canal fillings: Influence of two sealers on the perception of voids. Braz Dent J. 2010 Mar;21(2):142-7.

5- Somma F, Cretella G, Carotenuto M, Pecci R, Bedini R, De Biasi M, Angerame D. Quality of thermoplasticized and single point root fillings assessed by micro-computed tomography. Int Endod J. 2011 Apr;44(4):362-9.

6- Gulsahi K, Cehreli ZC, Onay EO, Tasman-Dagli F, Ungor M. Comparison of the area of resin-based sealer and voids in roots obturated with Resilon and gutta-percha. J Endod. 2007 Nov; 33 (11):1338-41.

7- Hoen M, LaBounty G, Keller D. Ultrasonic endodontic sealer placement. J Endod Apr;14(4):169-74.

8- Hall MC, Clement D, Dove S, Walker W. A comparison of sealer placement techniques in curved canals. J Endod. 1996; Dec;22(12):638-42.

9- Aguirre AM, el-Deeb ME, Aguirre R. The effect of ultrasonics on sealer distribution and sealing of root canals. J Endod. 1997; Dec;23(12):759-64.

10- Kositbowornchai S, Hanwachirapong D, Somsopon R, Pirmsinthavee S, Sooksuntisakoonchai N. Ex vivo comparison of digital images with conventional radiographs for detection of simulated voids in root canal filling material. Int Endod J. 2006 Apr; 39(4): 287-92.

11- Huybrechts B, Bud M, Bergmans L, Lambrechts P, Jacobs R. Void detection in root fillings using intraoral analogue, intraoral digital and cone beam CT images. Int Endod J. 2009 Aug; 42(8): 675-85.

12- Zaslansky P, Fratzl P, Rack A, Wu MK, Wesselink PR, Shemesh H. Identification of root filling interfaces by microscopy and tomography methods. Int Endod J. 2011 May;44(5):395-401.

13- Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: Systematic review of the literature - part 1. Effects of study characteristics on probability of success. Int Endod J. 2007 Dec; 40(12):921-39.

14- Schneider S. A comparison of canal preparations in straight and curved root canals. Oral Surg. 1971, Aug; 32(2):271-5.

15- Goldman LB, Goldman M, Kronman JH, Lin PS. The efficacy of several irrigating solutions for endodontics: A scanning electron microscopic study. Oral Surg Oral Med Oral Pathol. 1981 Aug; 52(2):197-204.

16- West LA, LaBounty GL, Keller DL. Obturation quality utilizing ultrasonic cleaning and sealer placement followed by lateral condensation with gutta-percha. J Endod. 1989; Nov;15(11):507-11.

17- Amato R, Goldman M, Tenca J, Burk G. A comparison of the efficiency of various delivery methods on sealer distribution. AAE Abstr Papers. 1984; 10: 119.

18- Jeffrey IMW, Saunders WP, Thomas GE. An investigation in to the movement of sealer during placement of gutta-percha points. Int Endod J. 1986; Jan;19(1):21-8.