Original Article

Comparison of root canal sealer distribution in obturated root canal: An *in-vitro* study

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Abstract

Background and Objectives: Endodontic sealer is currently regarded with such importance in the root canal treatment that it is often considered to be more important than the core obturating material itself. Sealer with the least film thickness is favorable for minimizing microleakage. The aim of the study is to compare sealer distribution in root canal using three different sealers with three different obturation techniques. **Materials and Methods:** AH plus, Fuji-1, Tubliseal Extended Working Time (EWT) was placed into the prepared root canals of 90 maxillary central incisors using a lentulospiral. Thereafter, the canals were obturated using three different gutta-percha root filling techniques (single cone, lateral condensation, vertical condensation). Horizontal sectioning was carried out at 3 mm and 6 mm from the apex with a diamond disk. The two specimens thus obtained were examined for sealer distribution using a stereomicroscope and the percentage of sealer coating the perimeter (PSCP) was calculated using a digital imaging system. **Results:** A significant difference existed in the mean PSCP values of three different sealers ($P < 0.000$), where Tubliseal (EWT) had the highest PSCP values followed by the AH plus and Fuji-1. Also, between techniques, differences were observed ($P < 0.00$), where a single cone technique had the highest mean values followed by lateral condensation and vertical condensation. Between the 3 mm and 6 mm sections a non-significant difference was observed ($P < 0.945$). **Conclusion:** Tubliseal EWT showed highest PSCP value and Single cone technique showed the higher PSCP value then lateral and vertical condensation technique at 3 mm and 6 mm sections.

Key words: *Lateral condensation, percentage of sealer coated perimeter, root canal wall, vertical condensation*

INTRODUCTION

Currently, the rationale for use of an endodontic sealer is to attain a fluid-tight seal and barrier, apically, laterally, and coronally, between the dentin and gutta-percha.[1] Endodontic sealer is currently regarded with such importance in root canal treatment that it is often considered to be more important than the core obturating material itself.[1,2] The sealer performs several functions during the obturation of a root canal system with a gutta-percha cone. It acts as a lubricating agent and aids in the seating of the master gutta-percha cone. The sealer also acts as a binding agent between the gutta-percha and the canal. Various types of the sealers are currently being used in dentistry, for example, the epoxy resin-based AH Plus, calcium hydroxide-based Apexit plus, Zinc oxide eugenol–based Tubliseal, and Glass Ionomer–based Ketac endo. Gutta-percha alone will not seal the canal space as it has no adhesion to the dentin. Several researchers have studied the sealer distribution patterns in root canal by assessing the different sealers, with different condensation techniques, but the results obtained are conflicting.[1,3]

Studies have shown that a sealer may also play a role in the prevention of root fractures, but the thickness and uniform distribution of the sealer is more important because less thickness will have fewer voids, less microleakage, and long-term stability.

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Several researchers have previously stated that sealers with a thinner film thickness should be used with gutta-percha.[3,4] Minimum sealer thickness leading to fewer voids are good measures for long-term sealing ability.[5] It has been theorized that the sealer occupies all spaces not occupied by the gutta-percha, which includes forming a thin coating between the gutta percha and the dentin walls.[2] So, this study was undertaken to compare the sealer distribution in the root canal using three different kinds of sealers and three different obturating techniques.

MATERIALS AND METHODS

Ninety freshly extracted maxillary central incisors with straight and single root canal were selected. Teeth were decoronated to adjust the length to 12 mm. All teeth were enlarged up to their working length to size 70 K file. Copious irrigation was provided throughout the procedure with 2.5% sodium hypochlorite and normal saline solution. On completion of instrumentation the smear layer was removed using 17% Ethylenediaminetetraacetic acid (EDTA) solution for one minute. Following instrumentation, the teeth were divided into three groups of 30 teeth each depending on the technique of obturation. The three groups were further divided into three subgroups of ten teeth each depending on the type of the sealer used for obturation [Table 1]. The sealers used for obturation were AH Plus (Dentsply), Tubliseal EWT (Kerr), and Fuji-I (Fuji). All sealers were mixed according to the manufacturer's instructions.

Table 1: Control and experimental groups

Group I	AH plus sealer (Dentsply) with single-cone technique	Control
Group II	AH plus sealer (Dentsply) with lateral condensation technique	Experimental
Group III	AH plus sealer (Dentsply) with vertical condensation technique	Experimental
Group IV	FUJI-1 (Fuji) with single-cone technique	Control
Group V	FUJI-1(Fuji) with lateral condensation technique	Experimental
Group VI	FUJI-1(Fuji) with vertical condensation technique	Experimental
Group VII	Tubliseal – EWT (Kerr) with single-cone technique	Control
Group VIII	Tubliseal – EWT (Kerr) with lateral condensation technique	Experimental
Group IX	Tubliseal – EWT (Kerr) with vertical condensation technique	Experimental

EWT=Extended working time

Single-cone technique obturation

The teeth were divided into three groups of ten each. A standard size ISO 70 gutta-percha cone (Dentsply) was fitted to working length with tug back. The sealers were mixed and placed into the canal with a lentulospiral. After placing the sealer, the master cone was coated with the sealer and seated to working length.

Lateral condensation technique

The teeth were divided into three groups of ten each. A standard size ISO 70 gutta-percha cone (Dentsply) was fitted to the working length with a tug back. The sealers were mixed and placed into the canal with lentulospiral. After placing the sealer, the master cone was coated with the sealer and seated to working length. Fine finger spreaders from sizes 15-40 (Mani) were selected and introduced within 2 mm of the working length. Fine accessory cones coated with the sealer were laterally condensed until they could be introduced no more than 3 mm into the root canal.

Vertical condensation technique

The teeth were divided into three groups of ten each. A standard size ISO 70 gutta-percha (Dentsply) was selected. The apical portion of the cone was kept short of the working length by 1-2 mm. After placement of the sealer, a primary cone was inserted into the prepared root canal. The coronal portion of the master cone was removed with heated pluggers and the master cone that remained in the canal was compacted in the apical direction, with the largest plugger that was pre-fitted in the canal. Subsequently the heated pluggers were used to remove the additional two to three segments of gutta-percha followed by compaction of the softened gutta-percha remaining in the canal. This was continued until the entire root canal was packed.

All teeth were stored in 100% humidity at 37°C for seven days, to allow the sealer to set. After incubation, the teeth were sectioned horizontally at 3 mm and 6 mm from the apex, with a diamond disk.

The internal aspects of the sealer-coated canals were then examined using a stereomicroscope at 50x magnification and a total percentage of the sealer-coated perimeter of canal was calculated using the image pro plus software.

The results were statistically analyzed by the Independent sample '*t*' test, three-way analysis of

variance (ANOVA), and the Duncan's Multiple Range test, using SPSS 18.0.

RESULTS

Tables 2 and 3, show a significant difference in the mean PSCP values of three different sealers ($F = 11.385$; $P < 0.05$) where the Tubli-seal had the highest PSCP values followed by the A-H plus and Fuji-1 sealers. This was further confirmed by the Duncan's multiple range test. Also, between the two techniques, a significant difference was observed in their mean PSCP values ($F = 22.356$; $P < 0.05$), where SCT had the highest mean value followed by the lateral condensation technique and vertical condensation technique. Between the sections, a non-significant difference was observed ($F = 0.005$; $P < 0.945$), where mean PSCP values of 3 mm and 6 mm were statistically equal.

DISCUSSION

Perhaps there is no technical operation in dentistry where so much depends on conscientious adherence to high ideals as that of pulp canal filling. Regardless of the technique of condensation or plasticizing or softening, using gutta-percha without a sealer will not seal the canal space. Gutta-percha does not adhere to the dentin, it is slightly elastic and will rebound back and pull away from the canals.[2]

Thus, a sealer must be used to fill the canal space. The ability of the sealer to flow to minute spaces not occupied by solid core material becomes an important factor in obtaining a fluid tight seal. Also, the desirable root canal sealers must be plastic enough at the time of insertion, to conform to the various shapes of root canal, and must exhibit sufficient fluidity to penetrate the lacunae left by the limited adaptation of core material to the canal walls.[4,6]

Various studies reported that the thickness of the sealer is an influencing factor on the sealing ability and that a thinner film thickness should be used with the various condensation techniques.[3,4] A thin layer of sealer should be applied to the canal walls before placement of the core filling material.[5]

Sections of 3 mm and 6 mm were preferred, because it was in this area that most accessory canals communicated with the periodontal membrane and could create a periodontic–endodontic pathway for potential bacterial penetration to and from the periodontium. Several studies had reported failure of endodontic therapy due to patent accessory canals in these regions.[7,8] The method of sealer placement was the same for the three obturation techniques — with a lentulospiral, as other studies had shown that the lentulospiral gave the best result for sealer placement at different levels.[9-12]

In the present study the lateral and vertical condensation techniques were considered as experimental groups and the single-cone technique was included as a control group. These methods were widely used methods of obturating root canals. Various studies reflected that the lateral condensation method was often considered the best because of its predictability; it was relatively easy to use, control in placement of material, length control, and ease of re-treatment. The disadvantages

Table 2: Mean PSCP values in different sections of different techniques and different sealers

Technique	mm	Sealers							
		A-H plus		Fuji 1		Tubliseal (EWT)		Total	
		Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
SCT single cone (control)	3	97.27	3.71	93.06	7.23	96.27	1.40	95.54	4.94
	6	96.05	6.19	94.54	7.02	97.36	1.25	95.98	5.39
	Total	96.66	5.01	93.80	6.98	96.81	1.41	95.76	5.13
LCT lateral condensation (experimental)	3	88.03	10.40	84.68	10.38	92.10	4.51	88.27	9.10
	6	87.22	12.73	86.34	10.04	93.53	2.52	89.03	9.70
	Total	87.62	11.32	85.51	9.97	92.81	3.63	88.65	9.33
VCT vertical condensation (experimental)	3	88.18	10.59	84.54	6.13	92.64	4.69	88.46	8.04
	6	83.62	5.47	84.61	7.96	92.86	1.54	87.03	6.89
	Total	85.90	8.53	84.58	6.92	92.75	3.40	87.74	7.46
Total	3	91.16	9.59	87.43	8.82	93.67	4.16	90.75	8.22
	6	88.96	9.98	88.50	9.25	94.58	2.69	90.68	8.39
	Total	90.06	9.77	87.96	8.98	94.13	3.50	90.72	8.28

SCT=Single cone technique, LCT=Lateral condensation technique, VCT=Vertical condensation technique, PSCP=Percentage of sealer coated perimeter

Table 3: Results of three-way ANOVA for mean PSCP values in different sections of different techniques of different materials

Source of variation	Sum of squares	Df	Mean square	F	Sig
Sealers (A)	1177.857	2	588.928	11.385	0.000
Techniques (B)	2312.919	2	1156.459	22.356	0.000
Sections (C)	0.245	1	0.245	0.005	0.945

ANOVA=Analysis of variance, PSCP=Percentage of sealer coated perimeter

of this method were lack of homogenicity of the gutta-percha mass, increased number of voids, and less adaptation to the canal walls and irregularities. To overcome these disadvantages, the vertical condensation of warm gutta-percha was introduced, in which a more homogenous mass of gutta-percha was produced by a heated instrument and the softened gutta-percha adapted more intimately to the canal walls and irregularities. The disadvantages of the vertical condensation technique were difficulty in length control and complicated procedure.

The use of a stereomicroscope ensured the three-dimensional view of the entire space and the sealer coverage, which was measured objectively and accurately using the Image-Proplus software, in terms of the perimeter of the entire canal and the sealer-coated canal. Cross-sectional images were visualized and the PSCP was calculated. These methods of assessing sealer distribution were found to be more accurate.

The result of this study showed that Tubliseal EWT had the highest overall PSCP values followed by A-H plus and Fuji-I, which may be due to the thinner film thickness of Tubliseal EWT.[3,4] The single-cone technique used with all the three sealers showed statistically significant, different PSCP values, compared to lateral condensation and vertical condensation.[3] This was in accordance with the studies that reported that the single-cone technique was the best in terms of sealer distribution.[3,13]

A similar amount of sealer was placed in the single cone in the single-cone technique and in the master cone in the lateral condensation group. Thus, the total amount of sealer brought into the canals by the gutta-percha points was larger in the lateral condensation group than in the single-cone group. However, the canal wall was better covered in the single cone group, indicating that more sealer did not always result in better sealer coverage. No significant difference was observed in the mean PSCP values 3 mm and 6 mm from the apex for lateral condensation or vertical condensation. This was in accordance with the previous studies.[3,13] However, for AH plus, the PSCP value of lateral condensation showed a higher value than for vertical condensation, at 6 mm. This could be due to the variation in the application technique under control of the operator. None of the sealers showed a continuous layer between the gutta-percha and canal wall, nor totally filled the spaces between the cones, where the gutta-percha was laterally condensed. They closely adapted to the dentin wall, the sealer squeezed out from portion, and thus led to voids between the gutta-percha and dentin interface or to the displacement of the compressed gutta-percha, by the apical condensing force of the spreader, leaving the area without a sealer, which led to voids. The authors also stated that voids might be present in the lateral condensation technique because cones get twisted, spiraled or bent.[14]

Various studies[13,15,16] also stated that there was no statistically significant difference between lateral condensation and vertical condensation when compared with other sealers. Similar results were also obtained in this study.

CONCLUSION

Within the limits of this study, it was found that Tubliseal EWT showed a higher PSCP value than Fuji-I and AH Plus, and the single-cone technique showed a higher PSCP value compared to the lateral and vertical condensation technique at 3 mm and 6 mm, but no significant difference was observed between the lateral condensation and vertical condensation technique.

Various other parameters such as adhesion and setting time, which may affect sealer distribution, need to be studied, whereas, the present study has focused only on different types of sealers with different condensation techniques.

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