

Effect of spreader size on microleakage of roots filled with cold lateral compaction technique

Tugba Turk¹, Beyser Piskin¹, Hasan Orucoglu², Berdan Aydin³

Correspondence: Dr.Tugba Turk
Email: tugba.turk@ege.edu.tr

¹Department of Endodontics, Ege University, Izmir, Turkiye,

²Department of Endodontics, Abant Izzet Baysal University, Bolu, Turkiye,

³Department of Restorative Dentistry, University of Illinois, Chicago, USA

ABSTRACT

Objectives: To evaluate the effect of spreader size on apical leakage of maxillary incisor teeth. **Materials and Methods:** A total of 75 permanent human teeth with no carious and no fracture or crack were used for this study. After removing the crown from the cemento-enamel junction and the standardization of the root lengths, the specimens were randomly divided into five groups: Group 1 - Roots were not instrumented. Group 2 - Root canals were enlarged using the step-back technique to a #40 file and filled using cold lateral compaction (CLC) of gutta-percha (GP). Group 3 - During the filling procedure, the first spreader used was size 40. Group 4 - The first spreader used was size 35. Group 5 - The initial spreader used was size 25. The amount of leakage through the filled root canals was evaluated by computerized fluid filtration model. Statistical analyzes were done using Kruskal–Wallis test and Mann–Whitney test ($P < 0.05$). **Results:** There were statistically significant differences among the groups ($P < 0.05$). While the uninstrumented group (Group 1) had no leakage, instrumented but not filled roots (Group 2) demonstrated the highest leakage values. There were no differences between Group 3 and 4. Group 5 showed significantly less leakage than Group 3 and 4. **Conclusion:** Spreader size used during CLC of GP appeared to be a significant factor on apical leakage of roots. Using smaller size spreader during CLC may provide relatively less leakage.

Key words: Cold lateral compaction, microleakage, obturation, root canal filling, spreader

INTRODUCTION

The quality of three-dimensional filling of root canal space is a critical factor for long-term success of endodontic treatment.^[1-3] Despite newer technological innovations in endodontology, cold lateral compaction (CLC) technique is a universally accepted filling technique and is extensively used as a standard of comparison with other filing techniques.^[4-9]

The basic CLC technique, described in 1930, is commenced with a master gutta-percha (GP) cone, which is compacted by a spreader to make room for additional accessory GP cones.^[10] During the procedure, metal spreader is placed into the root canal repeatedly to compact GP laterally. More GP

cones can be placed using a spreader corresponding to the size of GP cones; it was shown that up to 80% of the canal space can be filled using the method in this way.^[11,12] According to Jerome *et al.*,^[13] compatibility of spreader and accessory cones used in CLC were shown to be a significant factor to create an adequate seal. Furthermore, it is known that apical sealing is better if the spreader is placed closer to the apex.^[13-15]

Although CLC is a universally accepted filling technique, still there is no consensus on the selection of the size of spreader used. In 2008, Piskin *et al.*^[16] stated that the size of the spreader affects the mechanical resistance of roots filled with CLC. This finding lead us to think of spreader size might be an important factor to minimize apical leakage. So far, the effect of spreader

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size on microleakage has not been investigated. The purpose of this study was to investigate the effect of stainless steel spreader size on apical leakage by a computerized fluid filtration technique.

MATERIALS AND METHODS

Sample preparation

Seventy-five maxillary incisors extracted for periodontal reasons were used in present study. A fully informed consent was obtained from all our patients under a protocol approved by the University Committee on Ethics. Teeth were kept at 4°C in 0.1% thymol solution. The surfaces of specimens were curetted and magnified at $\times 20$ using a stereomicroscope to check any crack, root caries, open apex or root resorption. Radiographs were used to determine the number of canals in each root and abnormal canal morphology. Teeth with cracks, pulpal obliterations, complex canal morphology, open apex were not included in the present study. Canal preparation and filling of roots were performed by the same endodontist.

The crowns were removed at the cemento-enamel junction using a diamond bur (Komet, Gebr Brasseler, Lemgo, Germany) while keeping the root length at 13 mm for all samples. Roots with a root canal where a size 25 file (Dentsply Maillefer, Ballaigues, Switzerland) binds well at the working length were included in the present study. Samples were instrumented, and roots were filled as described previously by Piskin *et al.*^[16] Specimens were randomly divided into groups as follows:

Group 1

Specimens ($n = 15$) were neither instrumented nor restored.

Group 2

Specimens ($n = 15$) were instrumented by step-back technique. The working length was controlled using a size 10 file (Mani, Tokyo, Japan). Enlargement of the root canal was commenced using a Hedström file size 25 (Dentsply Maillefer) which retains at the working length. Initial canal preparation was completed by larger instruments making the master apical file size 40 for all specimens. Sodium hypochlorite (Sigma-Aldrich, St Louis, MO) (2.5%, 2 mL) was used for irrigation between the instruments. The step-back was begun with the #45 file and finished with five progressively larger H-file, size #70. Final irrigation was done

with 2.5 mL of 2.5% NaOCl, and 2.5 mL of 5% ethylenediaminetetraacetic (Sigma-Aldrich). The teeth were kept at 4°C with 100% humidity until the leakage test was performed. Samples in Group 2 were kept without a root canal filling.

Group 3

The roots ($n = 15$) were prepared as described above. CLC was performed as follows: Master apical GP (size 40) was placed at the working length. Prior to the initiation of the root filling, a #40 finger stainless steel spreader (Thomas Endo, Bourges Cedex, France) was marked with a silicone stop to a length which is to be 1 mm shorter than the working length and was checked in the root canal space. Sealer (Diaket, 3M, ESPE, Seefeld, Germany) was applied on the canal walls using the master apical cone. After placing the master apical cone, #40 spreader was inserted into the root canal space to be 1 mm shorter than the working length where the spreader was kept for 10 s; next, size 35 accessory cone coated with sealer and was placed into the room left by the spreader. After using a size 40 spreader initially, compaction was continued using size 25 spreaders, and only size 20 accessory cones were placed in the room left by size 25 spreaders until spreader could not penetrate >2 mm.

Gutta-percha cones used in the present study were from the same batch of the same company (DiaDent Group International Inc., Chongju City, Korea). The excess GP was removed from the coronal cavity at the level of the cemento-enamel junction with a warm instrument (Hu-Friedy, Leimen, Germany). The roots were not restored coronally.

Group 4

The roots ($n = 15$) were prepared and filled described as Group 3, except the first spreader used was equal to size 35. After placing master apical cone to the working length, a size 35 spreader was penetrated into the root canal as described in Group 3, and a #30 GP was inserted in the space left by the spreader.

Group 5

The roots ($n = 15$) were prepared and filled as described in Group 3, except the first spreader used was size 25. After placing master apical cone to the working length, a size 25 spreader was inserted into the root canal, and a size 20 GP was placed in the space left by the spreader.

Three layers of nail varnish were applied on roots.

Next, samples were prepared for apical leakage analysis. Roots of teeth were covered with nail polish (Maybelline, NY, USA) 3 times, including the root apex in Group 1 which serves as negative control. Specimens of Group 2, unfilled and uncovered with nail varnish, served as the positive control. The rest of the specimens were coated also with three layers of nail varnish, but excluding the coronal cavity and apical foramen. The specimens were kept in at 37°C and 100% humidity for 7 days.

Evaluation of apical leakage

Samples were placed in a computerized system designed for the measurement of apical microleakage by fluid transport meter as previously described, and the tests were assisted with a PC-compatible software (Fluid Filtration'03, Konya, Turkiye).^[17] A pressure tank (1.2 atm) was used to apply 120 kPa of O₂ to the apical side of the tooth through a digital air pressure regulator (Sunx Sensors, Des Moines, USA). The software automatically measured fluid movement in each sample every 2 min for an 8 min period. Each specimen was tested four times, and leakage quantity was expressed as kPa/min.

Statistical analysis

Statistical analysis was performed using StatView 4.57 software (Abacus Concepts Inc., NC, USA). Results were analyzed using the Kruskal-Wallis test and the Mann-Whitney U-test with the Bonferroni correction ($P < 0.05$).

RESULTS

Positive control specimens leaked significantly more than the specimens of the experimental groups did ($P < 0.05$). Mean microleakage measurements and standard errors in kPa/min at 1.2 atm are shown in Table 1 for all groups. Group 5 (spreader size 25) demonstrated the least amount of microleakage among the experimental groups ($P < 0.05$). Group 3 showed greater leakage compared with Group 4, but there were no statistically significant differences ($P > 0.05$).

Table 1: Mean microleakage (kPa/min) values and SD

Groups	Mean microleakage×10 ⁻⁵ (kPa/min)	SD×10 ⁻⁵
G1: Negative control	No leakage ^a	
G2: Positive control	48.75 ^b	0.725
G3: First spreader size 40	4.422 ^c	1.729
G4: First spreader size 35	3.632 ^c	1.020
G5: First spreader size 25	2.244 ^d	1.235
Same superscript letters indicate no significant difference ($P > 0.05$). SD: Standard deviation		

DISCUSSION

In the present study, the effect of spreader selection on sealing ability of root filling was assessed by computerized fluid filtration technique and significant differences were observed between groups. The computerized fluid filtration technique which has a digital air pressure arrangement and computerized control is an upgraded model of conventional fluid filtration technique, this upgraded model was used to evaluate apical leakage in many studies.^[17-19] Computerized fluid filtrate method has some advantages over conventional leakage tests; so that, the samples are not affected from the test procedures, the measurements can be repeated.

A previous study evaluated the effect of spreader selection on the mechanical resistance of teeth showed that size of spreader is crucial to lessen applied forces and greater spreader sizes diminish the mechanical resistance of teeth.^[16] On the other hand, using size 25 spreader does not affect the mechanical properties of teeth.^[16] In present study, method of root canal filling and selection of spreader size were in accordance with the study by Piskin *et al.*^[16] Likewise, favorable results were observed with size 25 spreader which resulted in the least amount of microleakage among the experimental groups.

Using a smaller size of spreader than the size of the master apical file may allow the deeper penetration of accessory GP cones. As a result, deeper penetration of accessory GP cone may reduce the ratio of sealer to GP. It is known that maximizing the volume of GP in root canal space provides a better sealing performance; since, root canal sealers are not impermeable against leakage.^[9,12,20-22] Nonetheless, it was reported that the percentage of GP in the root canal filling depends on the number and the depth of the accessory GP cones placed in the canal.^[12] Accordingly, accessory cones should be placed in the canal as deeper as possible. Apical third of the root canal filling may possess a large quantity of sealer if the number of the placed GP cones is not sufficient and does not penetrate the proper depth. In the present study, using smaller spreader size enhanced the sealing ability of root canal filling. Group 4 where size 35 spreader was used showed lower leakage values compared to those of Group 3 where size 40 spreader was used. On the other hand, selection of the three size smaller spreader (size 25) showed the best apical sealing performance.

In a previous study, spreader penetration depth was investigated against the amount of apical microleakage; a size 35 K file as a master apical file and a size 25 spreader were used throughout the compaction.^[23] Significant differences in apical leakage were observed between the groups when size 25 spreader was used to penetrate either the full working length or 1 mm shorter of it. In the present study, always one size smaller cone was inserted into the room made by the spreader in order to place the accessory GP cones deeper. Apart from the deep penetration of spreaders, cracks in dentin may result in more leakage. It is reported that using larger size spreader may result in cracks in root dentin.^[16] In Group 3 and 4, higher leakage values may be associated with higher crack formation.

While many recent root canal filling materials and techniques have been introduced, lateral compaction is still a gold standard to compare the performance of the new techniques; yet, there is no consensus on the selection of the size of the spreader and accessory GP cones.^[9,16,24] It is known that using spreaders with excessive force may result in vertical root fractures.^[16,25] Incomplete root fractures occurred during CLC may lead tooth fractures during the restorative procedures or occlusal stresses during mastication.^[26-28] Hence, the clinician can utilize the better sealing performance while using a safer modification of the technique against a potential fracture.

CONCLUSION

According to the results of the present study, size 25 spreader can be recommended throughout the lateral compaction of GP to minimize the leakage.

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