

# Obturation of Lateral Canals by a New Reciprocating Spreader and a Conventional Finger Spreader by Lateral Condensation Technique: *in vitro* Comparative Study

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## ABSTRACT

**Aim:** The aim was to evaluate post-obturation extensions of the gutta-percha/sealer in apical/coronal simulated lateral canals using a new manufactured nickel–titanium (NiTi) reciprocating spreader (experimental) compared with a conventional finger spreader (control).

**Materials and methods:** Ten endodontic plastic training blocks were divided into two groups (I and II), each block containing two main, two coronal, and two apical lateral canals. All main canals were prepared from size 10 to 30 using K-file and rotary handpiece (W&H; Austria) with a torque 1:4 at 15 mm working length using a surveyor to position the file perpendicular to the surface of the block. The preparation time for each size was 1 minute with 15-second irrigation with isopropyl alcohol. The prepared main canals were filled with size 30 master gutta-percha and sealer (Endofill, PD, Switzerland) and condensed using the control and experimental spreaders for 30 seconds in groups I and II respectively, followed by insertion and condensation of auxiliary gutta-percha till no more auxiliary can be applied. The lateral extension of gutta-percha/sealer within the apical/coronal lateral canals was measured from the base of attachment of lateral canal with the main canal using digital stereomicroscope (Leica MZ 12.5, Heerbrugg, Germany). Analysis of variance (ANOVA) and paired t-test were used to assess the results statistically at significance level  $\alpha = 0.05$ .

**Results:** The highest extension of gutta-percha/sealer was in the coronal lateral canal in group II, while the lowest extension of gutta-percha and sealer was in the apical and coronal lateral canals in group I. There was a significantly higher extension of gutta-percha/sealer in the coronal/apical lateral canals in group II compared with that in group I ( $p < 0.05$ ).

**Conclusion:** The use of the new NiTi reciprocating spreader results in a higher extension of gutta-percha/sealer in lateral canals compared with the use of the conventional finger spreader.

**Clinical significance:** Application of the new NiTi reciprocating spreader may result in a more precise three-dimensional obturation of root/lateral canal space.

**Keywords:** Gutta-percha, Lateral canals, Reciprocating, Spreader.

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## INTRODUCTION

Obturation of the prepared root canal space is the final step in the completion of an endodontic treatment. Regardless of whether the treatment was undertaken to remove a vital pulp (pulpectomy), a necrotic and/or infected pulp (root canal therapy), or a previous root canal filling (retreatment), the primary objective of the root filling is to prevent microbial organisms from entering, growing, and multiplying in the empty space that resulted from the instrumentation procedure.<sup>1</sup>

There are many techniques for obturating the root canal system: Cold lateral condensation, warm lateral condensation, warm vertical condensation, thermo-compaction (ultrasonic and mechanical), injection of thermos-plasticized gutta-percha, and chloro-percha warm vertical condensation of the root canal space.<sup>2</sup> Lateral condensation technique of the gutta-percha with sealer had been used for many years and surveys have indicated that it is the most popular method for canal obturation. It is relatively uncomplicated, requires a simple armamentarium, and seals and obturates as well as any other technique in the conventional situations.<sup>3</sup>

A major advantage of lateral condensation technique over most other techniques is length control. With an apical stop and careful use of the spreader, the length of the gutta-percha filling is managed well. Additional advantages include ease of retreatment, adaptation to the canal walls, positive dimensional stability, and the ability to prepare post space. There are no major disadvantages to lateral condensation other than difficulties in obturating severely curved canals, an open apex, and canals with internal resorption defects.<sup>4</sup>

In recent years, NiTi rotary techniques have been developed to improve root canal preparation/filling. It has been shown that NiTi spreaders penetrate to a

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significantly greater depth than stainless steel spreader in curved canals.<sup>5</sup> Schmidt et al<sup>6</sup> demonstrated that NiTi spreaders penetrated deeper with standardized force and required less force to penetrate to a standardized distance than do stainless steel spreaders, therefore, using NiTi spreaders may minimize the potential for vertical root fracture in curved canals during lateral compaction.

In a previous study, a new NiTi endodontic spreader with a reciprocation motion by an endodontic engine was constructed to be an alternative to a conventional finger spreader to decrease the time and effort in their application, more control of apical introduction inside the prepared canal and to provide tighter seal of gutta-percha at apical one third.<sup>7</sup>

The aim of this comparative study was to evaluate the obturation of the coronal and apical lateral canals by measuring the extension of gutta-percha and sealer in these lateral canals after cold lateral condensation with the new NiTi reciprocating spreader (experimental) and compared with that of the conventional finger spreader (control). The null hypothesis was that there is no difference in the extension of gutta-percha/sealer in the apical/coronal lateral canals after spreading with the experimental and the control spreaders.

## MATERIALS AND METHODS

Ten plastic endodontic blocks were used in this study (Endo Thermafil training bloc; Dentsply-Maillefer, Ballaigues, Switzerland). Each block has two main canals and four simulated lateral canals. The lateral canals were apical (A) and coronal (B), as shown in Figure 1.

### Instrumentation

All 10 endodontic plastic blocks were prepared for endodontic filling by using K-file (Dentsply, Switzerland)

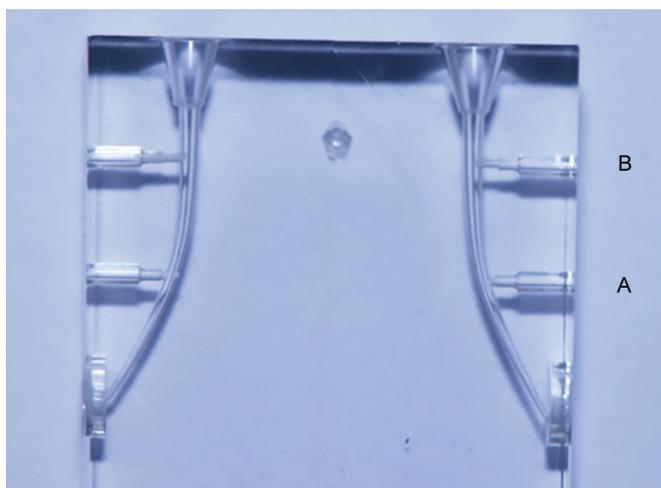


Fig. 1: Endodontic Thermafil training block: A: Most apical lateral canal; B: Most coronal lateral canal

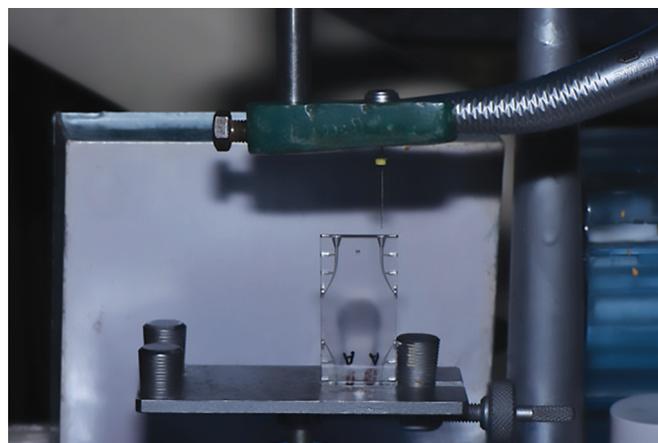


Fig. 2: Endodontic handpiece (W&H) arranged to get right angle access to the outer surface of endodontic training block

starting from size 10 till size 30 in a sequential order at a working length of 15 mm (standardized endodontic preparation). The preparation was performed using a rotary handpiece (W&H; Austria) that can accept K-file with torque of 1:4; the handpiece with reaming action (rotation movement) and plastic endodontic block was arranged in a surveyor in such a way that the file was at a right angle to the surface of endodontic block as shown in Figure 2. The preparation time for each size was 1 minute; irrigation with isopropyl alcohol for 15 seconds before and after using each file was performed.

### Obturation

All the 10 endodontic blocks were obturated by the lateral condensation technique with a master gutta-percha cone size 30, and auxiliary gutta-percha size 20. The ten endodontic blocks were divided into two groups according to the type of the spreader used in the spreading of gutta-percha/sealer (Endofill, PD, Switzerland). Time used for the lateral condensation by different types of endodontic spreaders was 30 seconds; while the insertion time for the auxiliary gutta-percha inside the prepared canal was within 30 seconds after application of the endodontic spreaders, the application of auxiliary gutta-percha was continuing till no more auxiliary can be introduced to the 3 mm of cervical end of prepared canal.

### Sample Grouping

The 10 endodontic blocks were divided into two groups:

1. Group I (10 simulated canal) was filled with gutta-percha by lateral condensation technique by using finger spreader with hand use (control):
  - Group IGA: measuring the gutta-percha extension in first (most apical) lateral canal.
  - Group IGB: measuring the gutta-percha extension in second (most coronal) lateral canal.

- Group ISA: measuring the sealer extension in first (most apical) lateral canal.
  - Group ISB: measuring the sealer extension in second (most coronal) lateral canal.
2. Group II (10 simulated canal) was filled with gutta-percha by lateral condensation technique using NiTi rotary spreader attached to a handpiece of an endodontic engine with reciprocation motion (X smart plus; Dentsply, Switzerland) (experimental):
- Group IIGA: measuring the gutta-percha extension in first (most apical) lateral canal.
  - Group IIGB: measuring the gutta-percha extension in second (most coronal) lateral canal.
  - Group IISA: measuring the sealer extension in first (most apical) lateral canal.
  - Group IISB: measuring the sealer extension in second (most coronal) lateral canal.

In each of these groups, the lateral extension of gutta-percha and sealer in the first (most apical) and second (most coronal) lateral canals after complete lateral condensation technique was measured from the base of attachment of lateral canal with the main canal to the most lateral extension of gutta-percha and sealer within first and second lateral canal through the translucent endodontic blocks of this study by using digital stereomicroscope. The stimulated canal blocks were fixed in the base with ruler (for accurate calibration) and a standardized distance from the digital stereomicroscope (Leica MZ 12.5, Heerbrugg, Germany) for accurate measurement of the distance of extension of the gutta-percha and sealer in the lateral canals by analysis of the image using a computer software program (Auto Desk Auto Card, 2014).

### Statistical Analysis

Descriptive (statistical tables and statistical figures) and inferential statistics (ANOVA test) were used among the groups of this study and paired t-test was used between the groups of this study at a significance level  $\alpha = 0.05$ .

### RESULTS

Table 1 shows that the group IIGB has the highest extension of gutta-percha in the second lateral canal and the

**Table 1:** Mean and standard deviation (SD) of extension gutta-percha and sealer in the lateral canal of the groups of this study

Groups	Mean (mm)	±SD
IGA	0.548	0.017
IGB	0.078	0.003
ISA	1.227	0.033
ISB	1.168	0.094
IIGA	1.249	0.041
IIGB	1.442	0.029
IISA	1.745	0.01
IISB	2.233	0.017

group IISB has the highest extension of sealer in the second lateral canal, while group IGA has the lowest extension of gutta-percha in the first lateral canal and group ISB has the lowest extension of sealer in the second lateral canal.

One-way ANOVA tests (Tables 2 and 3) showed that there was highly statistically significant difference among groups IGA, IGB, IIGA, and IIGB and among groups ISA, ISB, IISA, and IISB at  $p$ -value  $< 0.01$ .

Paired t-test (Table 4) shows that the group IGA has highly statistically significantly more extension of the gutta-percha compared with group IGB and less penetration of gutta-percha as compared with group IIGA. Also, the group IIGB has highly statistically significantly more penetration of the gutta-percha as compared with groups IGB and IIGA. On the contrary, the results showed that the group ISA has statistically less penetration of endodontic sealer as compared with group IISA and no statistically significant difference as compared with group ISB. Also the results showed that the group IISB has statistically more penetration of endodontic sealer as compared with group ISB and group IISA.

**Table 2:** One-way ANOVA test among groups IGA, IGB, IIGA, and IIGB

	Sum of squares	df	Mean square	f-value	Sig.
Between groups	11.958	3	3.986	5706.108	0.00
Within groups	0.025	36	0.001		
Total	11.983	39			

**Table 3:** One-way ANOVA test among groups ISA, ISB, IISA, and IISB

	Sum of squares	df	Mean square	f-value	Sig.
Between groups	7.469	3	2.490	966.896	0.00
Within groups	0.093	36	0.003		
Total	7.561	39			

**Table 4:** Paired t-test to compare paired groups of this study

Comparison	Mean differences (I-J)	Significance
<i>Group (I) vs Group (J)</i>		
Group IGA vs group IGB	0.471	0.00*
Group IGA vs group IIGA	-0.70	0.00*
Group IGB vs group IIGB	-1.365	0.00*
Group IIGA vs group IIGB	-0.194	0.00*
Group ISA vs group ISB	0.59	0.09
Group ISA vs group IISA	-0.517	0.00*
Group ISB vs group IISB	-1.065	0.00*
Group IISA vs group IISB	-0.489	0.00*

\*Significant at  $p < 0.01$

## DISCUSSION

The objective of obturation in root canal therapy is to create a dense and stable three-dimensional root canal filling. Filling of lateral canals plays a significant clinical role in the success of root canal therapy, especially in the presence of lateral lesions. Lateral canals ramification from the main canal frequently filled with gutta-percha and/or sealers, depending on the amount of force applied to the gutta-percha/sealer materials, flowability of the materials, and geometry of the canal.

Many studies reported success in obturating lateral canals using different filling techniques; it has been found that greater frequency of lateral canals filled with gutta-percha when using different obturation techniques.<sup>8-11</sup> However, the focus of these studies was to detect the presence of gutta-percha in lateral canals only. In this study, the focus was to measure the extension of gutta-percha/sealer in lateral canals, which may reflect the compaction force/penetration of the technique/device used to create a tighter seal and a better three-dimensional space obturation, forcing more gutta-percha into canal space.

The use of the conventional lateral condensation of gutta-percha using finger spreader yielded significantly lower extension of gutta-percha/sealer in the coronal and apical lateral canals compared with that recorded after the use of the new NiTi reciprocating spreader. This might have occurred because of the amount of force created by the engine-driven reciprocating spreader, which was higher than that of finger spreader, which resulted in higher compaction force and might have plasticized the gutta-percha and increased its flowability and subsequently its extension into the lateral canals. Also, the new NiTi engine-driven reciprocating spreader made from M-wire provided better flexibility and torque compared with finger spreader, thus resulting in a greater penetration depth of the spreader tip in the main canal creating more space for the accessory cones and forcing more gutta-percha material into the canal space.

It has been found in previous studies that only sealer was detected in lateral canals but limited amount of gutta-percha using cold and warm lateral condensation techniques compared with detection of gutta-percha after warm vertical condensation techniques, which usually result in enough heat to plasticize the gutta-percha and allow its flow into lateral canals spaces.<sup>12</sup> These results agree with the results of this study, as there was very little extension of gutta-percha in apical lateral canals in the group of finger spreader cold lateral condensation compared with the higher extension of the sealer in both coronal and apical lateral canals. In this study, the new NiTi reciprocating spreader may have caused high mechanical friction, heat generation, and mechanical

compaction on gutta-percha and resulted in significantly higher extension of both sealer and gutta-percha in coronal and apical lateral canals. Also, the reciprocating spreader compacted greater amount of gutta-percha into main/lateral canal system that led to significantly greater extension of gutta-percha in lateral canals. Previously, it was found that the new reciprocating spreader led to a significantly higher weight of gutta-percha in resin blocks compared with the finger spreader and rotary stainless-steel spreader after obturating main canals.<sup>7</sup>

Results of this study showed significant differences between extensions of gutta-percha/sealer in the coronal vs the apical lateral canals in both groups. It was interesting to notice that finger spreader always resulted in a tendency for higher extensions of gutta-percha/sealer in the apical lateral canals compared with coronal ones (Table 1). In contrast, the experimental spreader resulted in higher extension of gutta-percha/sealer in the coronal vs apical lateral canals (Table 1). However, it is very clear that the experimental spreader yielded significantly higher values of extensions of gutta-percha/sealer in the apical/coronal lateral canals compared with the control spreader (Table 4). This indicates the equal distribution of force by using the experimental spreader in the main canals, resulting in forcing the gutta-percha/sealer at both coronal and apical sections of the main canal. In the control group, the extensions of sealer between coronal and apical lateral canals were not significantly different compared with the extension of gutta-percha, which was higher in apical than in coronal lateral canals, which indicate concentration of force in the apical section of the main canal.

Previous studies showed variable abilities of different obturation techniques in obturating coronal, middle, and apical lateral canals. It was observed that carrier-based thermos-plasticized gutta-percha and continuous wave of condensation techniques were significantly better in filling apical lateral canals in resin blocks compared with lateral condensation, warm vertical condensation, warm lateral condensation, and vertically condensed high temperature gutta-percha. Also, warm vertical condensation, carrier-based thermos-plasticized gutta-percha, continuous wave of condensation, and vertically condensed high-temperature gutta-percha filled the coronal and middle lateral canals significantly better with gutta-percha than lateral condensation or warm lateral condensation.<sup>9</sup>

The advantage of reciprocating motion over rotary motion is that repetitive back and forth motion or clockwise and counterclockwise rotation reduces the torsional stress by periodically reversing the rotation of the intracanal instruments,<sup>13</sup> and reduces various risks associated with continuous rotation intracanal instrument through curved canals and increases the life span of the intracanal

instrument.<sup>14</sup> This “reciprocating lateral condensation” can be more efficient and safe than rotary movement in curved canals and can distribute force of condensation equally in the main canal.

Although many studies used natural teeth root canal systems with manually created lateral canals to assess their obturation,<sup>15</sup> resin blocks have been used widely to assess the obturation of lateral canals after different obturation techniques as well. Standardization of manually created lateral canals in natural teeth may be influenced by the variability of the diameter/geometry of the main root canals among different teeth, which may result in variable amount of force needed to fill these canals and subsequently the associated lateral canals. In resin blocks, the dimensions are standardized for main/lateral canals, therefore, equal amount of internal force is needed to fill the main/lateral canals among different blocks, leaving the variability associated only to technique/device used to obturate these blocks.

In conclusion, within the limits of the present study, it has been found that the obturation with the new NiTi reciprocating spreader resulted in a better obturation of coronal and apical lateral canals compared with the control finger spreader; thus, the possibility of a tight seal and success rate of endodontic obturation may be higher. Future exploration of the quality of obturation in terms of voids/gutta-percha ratio in the main and lateral canals is needed.

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