

# Evaluation of apical microleakage of teeth sealed with two different root canal sealers using two instrumentation techniques

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## ABSTRACT

**Background:** The purpose of this in vitro study was to compare, using a dye penetration test, the sealing ability of two commonly used root canal sealers, Endofil sealer (Produits Dentaires SA, Switzerland) and ZOB sealer (Meta Biodent, Korea) after preparation of the root canals with rotary protaper (crown-down) technique and hand instrumentation (step-back) technique.

**Materials and methods:** 40 single rooted freshly extracted human teeth were used in this study. The teeth were sectioned at the cemento-enamel junction and instrumented by either protaper technique or step-back technique. After that the samples were divided into 4 groups with 10 samples each. Then the samples were obturated using either ZOB sealer or Endofil sealer. All samples were stored in methylene blue with concentration of 1% for 7 days. Later on the teeth were removed from the dye and sectioned longitudinally with diamond disc and examined under stereomicroscope to measure the level of microleakage.

**Results:** The results revealed that protaper technique has higher values of microleakage than step-back technique and a significant difference was found in comparing protaper + Endofil with step-back + Endofil.

**Conclusion:** Protaper technique exhibits higher microleakage values than step-back technique regardless of type of sealer used.

**Key words:** Apical microleakage, Root canal sealers, Protaper technique. (J Bagh Coll Dentistry 2011;23(1):8-11)

## INTRODUCTION

Endodontic therapy consists of cleaning and shaping the root canal system, removing organic debris and sealing the intracanal space with permanent filling materials. The obturation must seal the pulp space both apically and laterally, thus preventing further apical irritation from either incomplete elimination of bacteria and their products or communication between apical tissues and oral cavity <sup>(1, 2)</sup>. Some authors have reported that the smear layer produced after root canal cleaning and shaping prevents the penetration of sealer into the dentinal tubules <sup>(3, 4)</sup>. Studies have shown that smear layer acts as a passage way for microorganisms and as a medium for viable bacteria entrapped into dentinal tubules <sup>(5, 6)</sup>. Despite the undisputable improvements, until today no material fulfills all requirements to hermetically seal the root canal system.

Apical leakage is still a frequent event in root-filled teeth, which raises concern regarding the quality of obturation provided by the currently available filling materials <sup>(7, 8)</sup>.

There are several methods for evaluating the apical sealing of root canal sealers, such as bacterial penetration <sup>(9)</sup>, fluid transport, dye penetration tests <sup>(10)</sup>, penetration of radioisotopes <sup>(11, 12)</sup> and gas chromatography <sup>(13)</sup>. Dye penetration tests; however, seem to be the most widely used <sup>(14-16)</sup>.

It is generally accepted that microleakage between the root canal filling and root canal walls might adversely affect root canal treatment results <sup>(17)</sup>. Therefore, complete sealing of the root canal system after cleaning and shaping is critical to prevent oral pathogens from colonizing and re-infecting the root and periapical tissues <sup>(18)</sup>. In endodontic therapy, a sealer is basically used to fill the irregularities of the root canal system, bond the core material to the root canal walls, and serve as a lubricant <sup>(19)</sup>. An ideal root canal sealer should be biocompatible, antibacterial, nontoxic, and radiopaque, and it should also hermetically seal the root canal system, be dimensionally stable, and should have good adhesion to the root canal wall <sup>(20)</sup>.

The purpose of this in vitro study was to compare, using a dye penetration test, the sealing ability of two commonly used root canal sealers (Endofil sealer and ZOB sealer) after preparation of the root canals with rotary protaper (crown-down) technique and hand instrumentation (step-back) technique.

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## MATERIALS AND METHODS

In this study we used 40 single rooted freshly extracted human teeth collected from private dental clinic. Roots with open apices, cracks, and resorptive defects were excluded. Teeth were cleaned from extraneous tissue and calculus with periodontal curette then rinsed and stored in saline solution at room temperature (31 – 33 C°) before instrumentation. All teeth were sectioned at the cemento-enamel junction using a diamond disc (Gardeschutzenweg, Berlin, Germany) on a slow speed micromotor hand piece under water cooling. Then the teeth were randomly divided for two groups with 20 samples for each instrumentation technique. .

### Group I: Crown-down (rotary protaper) technique:

Canal length and patency for each tooth were determined by passing size 15 K-File (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until the tip was just visible from the apical foramen. Working length was established by subtracting 1mm.

Instrumentation was performed with a “Crown Down” technique using rotary protaper system (Dentsply-Maillefer, Ballaigues, Switzerland). This system composed of six individual files including shaping files (SX, S1 and S2) and finishing files (F1, F2 and F3). The speed of the hand piece was fixed on 250 rpm. The sequence of the preparation was started with S1 file with brushing movement until the resistant was felt, then S1 file was removed followed by insertion of SX file into the canal with the same brushing movement till the resistant was felt. This action performed to remove any cervical interference. Then S1 file reused in the same motion action to the full working length followed by S2 file. The apical portion of the canal then prepared with finishing files starting with F1 followed by F2 and finally with F3, all of them to the full working length. The canal was irrigated between each instrument with 3 ml of 5.25% sodium hypochlorite solution (NaOCl) using a 27 gauge needle. Irrigant was seen passing through the patent foramen. After final rinse of NaOCl, 17 % EDTA was used for 1 minute after the completion of instrumentation to remove the smear layer. Finally the canal was rinsed with 10 mm distilled water. Then the canal was dried with multiple paper points.

### Group II: Hand instrumentation (step-back) technique:

The canal patency and working length were established in the same manner done for group I. The step-back instrumentation was performed with hand Ni-Ti K-Files (Dentsply Maillefer, Ballaigues, Switzerland) which started with # 15 file that

introduced to the full working length in watch-winding action followed by # 20, # 25 and # 30 K-Files in the same motion action. The # 30 file was considered the master apical file. Then the canal was flared coronally with the sequence of # 35, # 40 and # 45 files.

The irrigation, removal of smear layer and dryness of the canals were done in the same manner for group I

Samples in group I and group II were subdivided into two groups with 10 samples each according to the type of sealer used in the obturation as follows:

**Table 1: Grouping of samples according to the type of sealer.**

groups	Obturation technique
<b>Group A</b>	Samples prepared by protaper technique and obturated with ZOB sealer
<b>Group B</b>	Samples prepared by protaper technique and obturated with Endofill sealer
<b>Group C</b>	Samples prepared by step-back technique and obturated with ZOB sealer
<b>Group D</b>	Samples prepared by step-back technique and obturated with Endofill sealer

### Sealer mixing and application:

The powder and liquid of the two sealers were mixed on a cold, dry and clean glass slab. The powder/liquid ratio was used in accordance to the manufacturer instruction.

### Obturation of the canals:

**Group I:** Canals were obturated using a single ProTaper Gutta-percha Point (Dentsply Maillefer) size F3 that prefitted to the working length. A finger spreader size 25 was used to apply the sealer inside the canal. Next, the prefitted master-cone was coated with sealer and introduced apically into the canal and this repeated until the sealer extruded through the apex. The cone was subsequently seared off with a hot plugger at the level of canal orifice. The excess sealer was wiped of with piece of cotton.

**Group II:** Canals were obturated using lateral condensation technique that performed in the usual way. A master cone prefitted in the canal to the working length. A finger spreader size 25 was used to apply the sealer inside the canal. Then the master cone coated with sealer and introduced apically to the full working length. The sealer must be seen extruded through the apex. Next a finger spreader size 20 was introduced apically inside the canal to reach about 1-2 mm shorter from the working length to perform lateral compaction for the gutta-percha followed by insertion of an accessory cone. The technique was considered completed when the spreader had no more space to penetrate the canal

orifice. Then the gutta-percha cones were seared of with hot plugger at the level of canal orifice.

All samples then stored at room temperature (31 – 33 C°) in dry condition to allow for complete setting of the sealer. The external surface of all roots was double coated with nail varnish except at the tip of the root (2 mm) so to allow detection of any leakage at the root ends.

After 1 hour when the nail paint had completely dried, the teeth were immersed in a solution of 1% methylene blue for 7 days at room temperature (31-33 C°). The teeth were then removed from the dye and washed under running tap water. Nail paint was scraped from the tooth surface using a scalpel. Then the teeth were splitted longitudinally (mesiodistally) into two halves using a diamond disc on a slow speed handpeice with the aid of chisel. Both halves of the split samples were evaluated under a stereomicroscope at magnification of 10x. The apical dye penetration was measured in millimeter.

**Table 2: Types of sealers used in this study.**

Type of sealer	powder	liquid
ZOB	Zinc oxide, Calcium phosphate, Rosin	Eugenol
Endofill	Dexamethasone acetate, Hydrocortisone acetate, Polyoxymethylene, Thymol iodide	Eugenol

## RESULTS

The means and standard deviations for all groups are presented in table 2.

**Table 3: Means and standard deviations (SD) for all groups.**

groups	Group A	Group B	Group C	Group D
mean	4	3.8	2.8	2.1
SD	± 0.37	± 0.1	± 0.27	± 0.22

It is clear from the table 3 that groups A and B (samples instrumented by protaper technique) showed higher means of microleakage than groups C and D (samples instrumented by step-back technique). Also samples obturated with ZOB sealer showed higher means of microleakage than samples obturated with Endofill sealer regardless of type of instrumentation technique.

Further more the results were statistically analyzed by student paired t-test (table 4) to confirm the level of significance. Regarding the differences in the type of sealer the results shows a non significant differences ( $p = 0.178$ ) between ZOB and Endofill sealers for samples instrumented by protaper technique. While the difference was significant ( $p = 0.025$ ) between samples

instrumented by step-back technique. In addition to that t-test showed a non significant difference ( $p = 0.178$ ) between groups A and C (samples obturated with ZOB sealer) and a significant difference ( $p = 0.018$ ) between groups B and D (samples obturated with Endofill sealer) regardless of the type of instrumentation.

**Table 4: student paired t-test comparing between groups.**

groups	t- value	p- value	significance
A vs B	1.63	0.178	Non significant
C vs D	3.5	0.025	Significant
A vs C	1.63	0.178	Non significant
B vs D	3.9	0.018	Significant

## DISCUSSION

Root canal microleakage is a complex subject because many variables may influence infiltration, such as root filling techniques, physical and chemical properties of sealers and presence or absence of smear layer<sup>(21)</sup>. In this study, the smear layer was removed from the specimens with 17% EDTA. By doing so, the surface contact between the intracanal walls and the filling material is increased and apical seal may be improved.

In this study the hand files served as the control treatment, which is the standard, while rotary instrumentation served as the intervention treatment. The results of the present study showed samples that instrumented by protaper technique exhibit higher microleakage values than samples instrumented by step-back technique for both types of sealers. This may be related to the single cone technique that used for obturation of samples prepared by protaper files. This type of obturation used just the master cone with sealer without lateral condensation and this may leave a large space between the gutta-percha and the canal wall. This large space occupied only by the sealer which can be easily penetrated with time by the dye due to the dissolution of the sealer by the water. In contrast, samples that prepared by step-back technique were obturated with a lateral condensation method in which the master cone and the accessory cones of gutta-percha will compact along the wall of the canal to the level 1-2 mm shorter from the apex leaving a narrow space for the sealer and this will minimize the amount of sealer that in contact with dye solution leading to smaller amount of microleakage.

In the present study the results revealed a significant difference between ZOB and Endofill sealers for samples instrumented by the step-back technique. This could be related to the polymer content of the Endofill sealer that makes the

material more resistant to water disintegration. While this polymer effect was not significantly recognized in samples prepared by protaper method and this may be related the large amount of sealer between the gutta-percha and the canal wall which make the dye solution contacting large amount of sealer component which are soluble in water.

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