

# Assessment of Apical Leakage of Different Endodontic Sealers -In Vitro Study

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## Abstract

**Aim:** The aim of this prospective study was to assess in vitro the comparison between apical leakage of Apexit Plus (calcium hydroxide based), Roth 801 (Zinc oxide eugenol based) and Perma Evolution (epoxy resin based) sealers in lateral condensation technique using linear dye leakage penetration method.

**Material and methods:** In this study 70 freshly extracted maxillary central incisors and canines with straight root canals were used. Teeth were decoronated and step back root canal preparation using Gates Glidden drill and stainless steel hand K files was performed with size 45 being the master apical cone. After preparation, the teeth were randomly divided into 5 groups. Three groups with 20 teeth for experimental and two groups with 5 teeth as positive and negative control. Obturation was done with lateral condensation in three groups with Roth 801, Apexit plus and Perma Evolution sealers. The obturated specimens were then stored in 2% Basic fuchsin dye for 72 hours. After splitting the teeth longitudinally, each tooth has been placed on a standardized scaled paper under the microscope and digital images have been captured by this microscope. Then the digital images were processed by Analyzing Digital Image software.

**Results:** The results showed that Roth 801 sealer leaked significantly higher than both Apexit plus and Perma Evolution sealers ( $p < 0.05$ ) and no statically significant difference has been found between Apexit plus and Perma Evolution sealers ( $p > 0.05$ ).

**Conclusion:** According to the methodology proposed and based on the results of this study, it may be concluded that Roth 801 showed the most leakage but Perma Evolution and Apexit plus showed similar sealing ability. However, further in vivo studies requirement should be done to find the best root canal filling material.

**Key words:** Sealer, Apexit plus, Perma Evolution, Roth 801, Microleakage

## Introduction

Root canal filling materials should create a hermetic seal between the root canal system and the periapical tissues. Apical leakage is a common cause of clinical failure of root canal treatment<sup>1,2</sup>. Therefore, microleakage studies of the sealing properties of endodontic materials are important<sup>2</sup>. Various materials are available as sealers such as zinc oxide eugenol based sealers, calcium hydroxide based sealers, resin based sealers and those materials have been tested from time to time to evaluate their sealing abilities to fulfill the objective of obtaining a hermetic apical seal.

Although many new root-canal sealers have been introduced in the market, the sealers with the widest use today are the zinc oxide eugenol based sealers and they remain the "gold standard" in this category of materials<sup>3</sup>, but these do not fulfill all of the ideal characteristics advocated for endodontic sealers. Another group of endodontic sealers which are in wide use are calcium hydroxide based sealers which could also stimulate the deposition of hard tissue at the root apex forming a biologic seal that would be advantageous in root canal therapy. Recently, Perma Evolution sealer has been introduced in the market as a new root canal sealer. This sealer claims to have a multitude of exceptional features and has many interesting characteristics.

The sealing ability of endodontic materials has been assessed by various methods such as dye or bacterial penetration, electrical methods, fluid filtration technique, radioisotope tracing and marginal adaptation by SEM; in vitro dye penetration studies have been carried out for decades as a simple effective method to evaluate the leakage<sup>4</sup>.

Considering that there are few studies analyzing the sealing capacity of these new endodontic sealers and due to their different conclusions, the aim of this study is to present an investigation regarding the in vitro comparison of apical leakage of Apexit Plus (Calcium hydroxide based sealer) and Roth 801 (Zinc Oxide Eugenol based sealer) and Perma Evolution (Epoxy resin based sealer) sealers in lateral condensation technique using dye leakage method with new method for the leakage measurement.

## Material & Method

In this study 70 freshly extracted maxillary central incisors and canines with straight root canals were used. After extraction the teeth were stored in 10% formalin. Before preparation all teeth were mechanically cleaned with hand scaler to remove surface soft tissue and calculus.

The coronal portions of all teeth were removed with a round disc bur using straight micromotor handpiece (ULTIMATE XL, NSK, Japan) so that each root specimen was 15 mm long. A size 15 file was inserted into the root canal until the tip became visible at the apical foramen; this distance minus 1 mm was taken as the working length<sup>5</sup>.

Step-back root canal preparation was performed in which the apical portion of canals were prepared to, a size 45 file (Tg, Germany). During instrumentation 5.25% NaOCl was used as irrigant for all specimens. Once the final apical size was reached, the smear layer was removed by using 5 ml of 17% EDTA (MD-Cleanser, META BIOMED, Korea) followed by 5 ml of 5.25% NaOCl and 5 ml of distilled water.

After completion of the instrumentation, the specimens were randomly divided into three groups with twenty specimens in each group. The groups were identified by labelling them as Group A, B and C. Five teeth are taken in group of positive control and five teeth are taken in group of negative control.

The canals were finally dried with paper points (Tg, Germany). All teeth were obturated to the working length by lateral condensation of guttapercha cones (Gapadent, China) and sealer.

A standardized guttapercha cone of the same size as the master apical file was placed into the root canal up to the working length and the tug back was verified, for each specimen. In the first group (Group A) Roth 801 sealer (Roth International, Chicago, IL) was used as the sealer; Apexit plus sealer (Vivadent, Germany) was used in the second group (Group B) and Perma Evolution sealer (Alfred Becht GmbH, Germany) is used in the third group (Group C). Each material was

prepared and used according to the manufacturer's instructions.

Radiographs were taken from the bucco-lingual aspects of each tooth to assess the quality of the root canal filling. Teeth showing evidence of questionable obturation were refilled. All the specimens were placed in separate containers with wet gauze to maintain 100% humidity and maintained at 37°C for seven days during the complete setting of the sealers.

The root surfaces of all specimens of experimental group were coated with three layers of nail varnish and sticky wax leaving only the apical 2 mm exposed.

For positive controls (n=5), the root canals were prepared and filled with guttapercha only. While in the negative controls (n=5), the root canals were prepared, filled with both guttapercha and sealer and completely covered with nail polish varnish.

All roots were stored in 2% solution of Basic Fuchsin dye 72 hours to allow adequate time of penetration. The specimens were removed from the dye, and washed under running tap water. The specimens were then dried and the nail polish scrapped off with a scalpel.

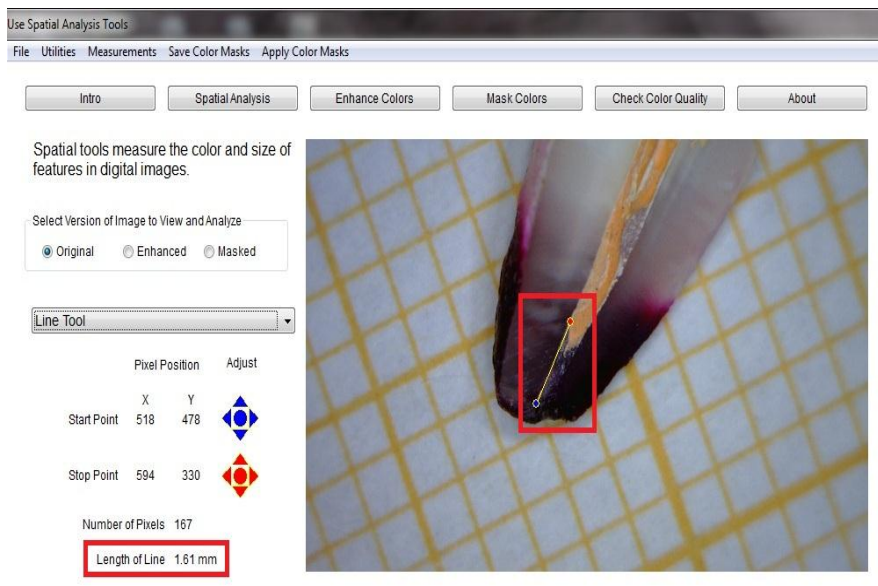
A longitudinal groove from the coronal to the apical aspect was cut into the labial and lingual surfaces of each root; the roots were then split with a chisel. Linear dye penetration was measured along the canal filling interface, from the most apical extent of guttapercha to the most coronal point of dye penetration. Each tooth has been placed on a standardized scaled paper under the digital microscope (Dino-lite, Taiwan) and digital images have been captured by this microscope.

By using Analyzing Digital Images software, the pre-measurement of 1 mm on the standardized graph paper has been performed. Then, the pre-measurement scale has been checked in different position of the image (both vertically and horizontally) to ensure that the pre-measurement scale shows us the same scale in different positions of image. At the end, the leakage measurement is measured from the most apical extent of gutta-percha to the most coronal point of dye penetration ( figure 1).

To minimize possible bias in measurements, two examiners measured the linear dye leakage for each sample. Linear measurements of the most coronal extent of dye penetration were recorded in mm up to two decimals and the average was recorded. To determine any statistical difference, the data were subjected to Kruskal-Wallis and Mann-Whitney U Tests using SPSS Software Version 21.

## Results

Leakage of the Basic Fuchsin dye was observed in all the groups except in the teeth with negative controls where no dye penetration had occurred. Complete leakage all over root filling material of positive control group has been observed. The overall data (Table 1) showed that the experimental groups exhibited



**Figure 1: Measuring Leakage using Analyzing Digital Image Software**

different degrees of dye leakage (Figure 2).

**Table 1: Mean and standard deviation of dye leakage between experimental groups**

Group	N	Mean ± SD
<b>A (Roth 801)</b>	20	2.3335 ± 0.85121
<b>B (Apexit Plus)</b>	20	0.7280 ± 0.53364
<b>C (Perma Evolution)</b>	20	0.7635 ± 0.29955

Although In our study the result of comparison of the three sealers showed the least Mean leakage for Apexit plus sealer followed by Perma evolution sealer and Roth 801 sealer with a with the most leakage mean, but the differences between Apexit plus and Perma Evolution sealers were not seen to be statistically significant using Mann-Whitney Test, but both Apexit plus and Perma evolution sealers showed statistically significant difference when compared with Roth 801 sealer using the same test (Table 2).

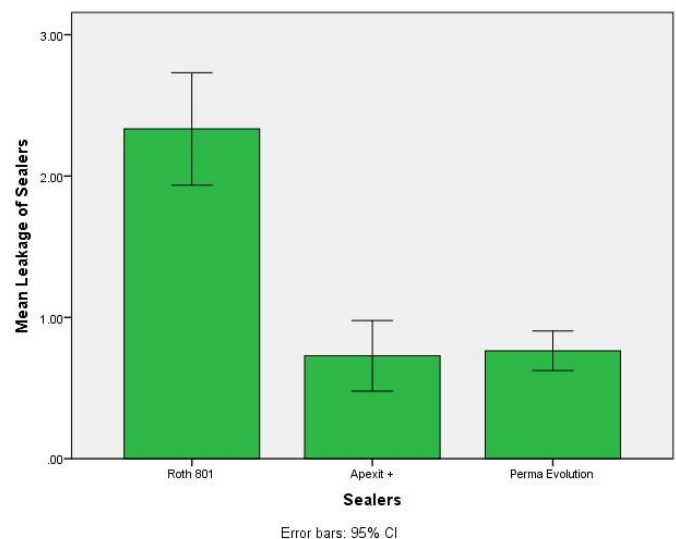
**Table 2 : Statistical analysis of linear dye penetration of experimental groups**

Group	Mean	P-value	Significant
<b>Roth 801</b>	2.3335	0.000	Yes
<b>Apexit plus</b>	0.7280		
<b>Roth 801</b>	2.3335	0.000	Yes
<b>Perma evolution</b>	0.7635		
<b>Apexit plus</b>	0.7280	0.155	No
<b>Perma evolution</b>	0.7635		

## Discussion

It is well understood that when filling root canals with a solid core material, some form of cement is required for a fluid tight seal that fills the minor gaps between the core material and the dentinal wall of the canal to prevent leakage<sup>6</sup>. According to Ørstavik, sealers play an important role in sealing the root canal system with entombment of remaining microorganisms and filling of inaccessible areas of prepared canals<sup>7</sup>. Sealer selection may influence the outcome of endodontic treatment<sup>8</sup>.

In this study, Roth 801 sealer leaked significantly more than both Perma Evolution and Apexit plus sealers. Also in this study, it has been observed from the results that there was no significant difference in apical leakage between Apexit plus and Perma Evolution sealers.



**Figure 2: Histogram representing the leakage values of experimental groups**

These findings are supported by many studies. Kumar et al<sup>9</sup>, Adanir et al<sup>10</sup> and Dultra et al<sup>11</sup> concluded in their study that resin based root canal sealers were more effective in sealing root canals than the zinc oxide eugenol based sealer. Sealer 26 (a modification of resin based sealer with the addition of calcium hydroxide, Dentsply-Brazil, RJ, Brazil) showed less leakage in a dye penetration study compared with Grossman's sealer<sup>12</sup>.

Zinc oxide eugenol based root canal sealer showed gross leakage due to poor adhesive property. Another reason for low sealing ability of zinc oxide eugenol is the sudden setting of this material (transition from paste to solid mass) which may be responsible for debonding from dentinal walls or cohesive fracture caused by shrinkage setting stresses, which may explain the higher leakage<sup>13</sup>.

The lesser leakage with the resin based sealer can be due to the epoxy resin based sealers are thought to be able to react with any exposed amino groups in collagen and when the epoxide ring opens, thus having the higher bonding to dentin<sup>14</sup>.

The good sealing ability of Calcium hydroxide based sealer might be related to the alkaline PH of calcium hydroxide that activates alkaline phosphatase that plays an important role in hard tissue formation<sup>15</sup>.

However our study does not support the finding. Although we found a good performance of calcium hydroxide based sealer in our study, Miletic et al Calcium hydroxide based sealer had poor performance by leaking significantly more in a 1-year experiment against many sealers including resin based sealer<sup>16</sup>. Another study also showed that the sealing ability of calcium hydroxide based sealer was good and similar to that of a control zinc oxide eugenol sealer<sup>17</sup>.

It can only be speculated that the differences in the results between this study and other studies are due to variations in specimens, testing procedures, operator skill and the most important thing the digital measurement method that has been used in this study.

## Conclusion

According to the methodology proposed and based on the results of this study, it may be concluded that although Apexit plus sealer has shown the least leakage mean when compared to Perma Evolution and Roth 801 sealers, There is no significant difference between apical leakage of Apexit plus and Perma Evolution sealers. Both of them have shown significantly less leakage when compared to Roth 801. So this might indicate that the newer Perma Evolution sealer is an acceptable sealer regarding sealing ability. However, further on in vivo studies are required to find the best root canal filling material.

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