

# The Effect of File Size on the Accuracy of the Raypex 5 Apex Locator: An In Vitro Study

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## Abstract

**Background and aims.** Determining the proper length of the root canals is essential for successful endodontic treatment. The purpose of this in vitro study was to evaluate the effect of file size on the accuracy of the Raypex 5 electronic apex locator for working length determination of uninstrumented canals.

**Materials and methods.** Twenty maxillary central incisors with single straight canals were used. Following access cavity preparation, electronic working length by means of Raypex 5 apex locator and actual working length were determined. Data were analyzed using ANOVA with repeated measurements and LSD test.

**Results.** There was no significant difference between electronic and actual working lengths when a size 15 K-file was used.

**Conclusion.** Under the conditions of the present study, a size 15 K-file is a more suitable size for determining working length.

**Key words:** Apex locator, root canal therapy, working length.

## Introduction

Determining the proper length of the root canals is essential for successful endodontic treatment.<sup>1-5</sup> The use of electronic apex locators (EALs) to determine working length has gained increasing popularity in recent years. Many studies on electronic apex locators using the third generation report accuracy rates of 85-95%.<sup>6-10</sup>

The initial electronic apex locator length measurement is clinically established with a small-sized file. However, it is not clear whether file size affects the accuracy of EALs. This question may particularly arise in situations where the working length is veri-

fied by EAL before instrumentation of the canals.

Ebrahim et al<sup>11</sup> studied the effects of file size on the accuracy of Root ZX apex locator in enlarged root canals and concluded that as the diameter of the root canal increased, the measured length became shorter when a smaller size file was used. In the presence of sodium hypochlorite, the Root ZX was highly accurate even when the file was much smaller than the diameter of the canal. However, in the presence of blood, a file with a size close to the prepared canal diameter should be used for root length measurement.<sup>11</sup>

There is no published study to directly evaluate the effect of file size on the accuracy of Raypex 5 before instrumentation of the canals to date. Therefore, the aim of this *in vitro* study was to evaluate the effect of file size on the accuracy of the new electronic apex locator Raypex 5 before instrumentation of the canals.

### **Materials and Methods**

Maxillary central incisors with single straight canals were used for the purpose of this study. Roots with resorption, fractures, open apices or radiographically invisible canals were excluded from the study. Canal patency was evaluated using a size 10 K-file (Mani, Japan). The size of root canal at the apical foramen was determined using the largest file fitting passively and without any force. Twenty maxillary central incisors with apical terminus size 30-35 files were chosen. The cusps were flattened to establish a level surface to serve as a stable and reproducible reference for all measurements. Standard access cavities were prepared. Pulp chambers and canals were cleansed by irrigating with 5 ml of normal saline.

#### *Actual working length determination*

The actual working length (AWL) was measured by inserting a size 10 K-file until the file tip was just visible under  $\times 3$  magnification. After adjusting silicone stopper to the coronal reference, the file was removed from the canal and its length was measured using a digital caliper to the nearest 0.01 mm. According to Kuttler's study,<sup>12</sup> 0.5 mm was subtracted from this length and the new length was considered as the actual working length.

#### *Electronic working length determination*

The teeth were soaked in normal saline for 15 min in order to be prepared for electronic working length (EWL) measurements. Then, they were embedded in an alginate mold, a model specially developed to demonstrate EWL measurement.<sup>13,14</sup> Next to the tooth, a metal rod was also inserted to be attached with the lip clip of the Raypex 5. All measurements were made within 2 hrs of the model preparation in order to ensure the

alginate was kept sufficiently humid.<sup>15</sup> Canals were irrigated using normal saline and a blunt needle placed as deep as possible without obstructing the canal. The pulp chamber was then gently dried with a cotton pellet.

Size 15-25 K-files attached to the file holder were inserted into each uninstrumented canal. Using Raypex 5 (VDW Endodontic Synergy, Munich, Germany) according to the manufacturer's instruction, each file was advanced within the root canal to just region of the apical constriction, as indicated by the linear 3-green-segment scale of the device (Apex Zoom). The silicone stop was then adjusted and the distance from the base of the silicone stop to the file tip was measured with a digital caliper to the nearest 0.01 mm. One experienced operator performed all measurements.

Data were analyzed using ANOVA with repeated measurements and Least Significant Difference (LSD) test at a significant level of  $P < 0.05$ .

### **Results**

For each canal the difference between AWL and EWL was calculated. Positive values indicated that the file in position passed the apical foramen, negative values indicated that the file tip was short of the apical foramen, and zero values indicated that the file tip was flush to the apical foramen.

The mean  $\pm$  SE of AWL and EWL measurements obtained with different ISO size 10-25 K-files are presented in Table 1. Frequency distribution of differences between actual and electronic working length measurements are presented in Table 2.

ANOVA with repeated measurements and LSD test showed that except for size 15 K-file, there was a significant difference between AWL and EWL ( $P = 0.004$ ).

Table 2 shows that when a size 15 K-file was used, 70% of measurements were within  $\pm 0.5$  mm and 95% were within  $\pm 1$  mm of the AWL. Using a size 10 K-file, 25% of measurements were within  $\pm 0.5$  mm and 90% were within  $\pm 1$  mm of the AWL.

**Table 1. Mean  $\pm$  SE of actual and electronic working lengths**

| AWL/EWL (file size) | Mean $\pm$ SE (mm) |
|---------------------|--------------------|
| AWL (#10)           | 19.63 $\pm$ 0.17   |
| EWL (#10)           | 19.25 $\pm$ 0.22   |
| EWL (#15)           | 19.63 $\pm$ 0.17   |
| EWL (#20)           | 19.28 $\pm$ 0.21   |
| EWL (#25)           | 19.18 $\pm$ 0.23   |

AWL, actual working length; EWL, electronic working length.

**Table 2. Frequency distribution of differences between actual and electronic working length measurements**

| Distance from actual length (mm) * | K-file #10 | K-file #15 | K-file #20 | K-file #25 |
|------------------------------------|------------|------------|------------|------------|
|                                    | n (%)      | n (%)      | n (%)      | n (%)      |
| > 1                                | 0 (0)      | 0 (0)      | 0 (0)      | 0 (0)      |
| 1 to 0.5                           | 4 (20)     | 2 (10)     | 1 (5)      | 0 (0)      |
| 0.5 to 0.01                        | 0 (0)      | 11 (55)    | 4 (20)     | 6 (30)     |
| 0.0                                | 2 (10)     | 0 (0)      | 1 (5)      | 1 (5)      |
| -0.5 to -0.01                      | 3 (15)     | 3 (15)     | 6 (30)     | 5 (25)     |
| -1 to -0.5                         | 9 (45)     | 3 (15)     | 5 (25)     | 3 (15)     |
| > -1                               | 2 (10)     | 1 (5)      | 3 (15)     | 5 (25)     |

\* Negative value indicates measurements short of the actual working length.

### Discussion

Both in vivo and in vitro experiments have been designed to test various aspects associated with the use of EALs. Alginate model with embedded extracted human teeth is one of the in vitro models developed to allow testing of the EALs.<sup>13,14</sup> It is simple, inexpensive, and stable for hours and the root apices can not be seen. The relative stiffness of the alginate mold prevents fluid movement inside the canal that is responsible for premature electronic readings registered with previous models.<sup>14,16,17</sup>

Electronic working length determination was influenced by the size of the canal at the apical terminus.<sup>18,19</sup> Maxillary central incisors

with apical terminus size 30-35 file were chosen to control this parameter. Normal saline was used as the root canal irrigant and electrical conductive medium since previous studies showed that in the presence of EDTA and saline, measurements were closer to the actual length.<sup>6</sup>

Under the conditions of the present study, there was no significant difference between electronic and actual working lengths when a size 15 K-file was used. Based on this result, it can be suggested that size 15 K-file is a more suitable size for determining working length using Raypex 5 apex locator.

The range of  $\pm 0.5$  mm to the foramen has been considered as the strictest acceptable range.<sup>16,20</sup> Thus, measurements attained within

this tolerance are considered highly accurate. On the other hand, root canals do not always end with an apical constriction, a clear minor and major diameter or an apical foramen at the exact base of the cemental zone. This is why some authors prefer the  $\pm 1$  mm as the acceptable range.<sup>21,22</sup>

According to the result of this study, Raypex 5 registered most measurements within an acceptable range (70% within  $\pm 0.5$  mm and 95% within  $\pm 1$  mm of the AWL) when a size 15 K-file was used.

The result of this in vitro study needs to be verified in an in vivo study. Clinically, a higher variation of measurements is expected because in contrast to in vitro studies, favorable circumstances for precise measurements are not available.

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