



## EVALUATION OF ACCURACY OF TWO DIFFERENT APEX LOCATORS FOR DETERMINING THE WORKING LENGTH DURING ROOT CANAL RETREATMENT WITH TWO DIFFERENT FILE SYSTEMS: AN IN VITRO STUDY

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**(ABSTRACT)** **Aim:** The aim of this study is to evaluate accuracy of two different apex locators for working length determination during root canal retreatment with two different file systems.

**Materials and methods:** 40 extracted single-rooted human teeth with mature apices were selected for the study. Tooth length was measured with a file, followed by biomechanical preparation and the teeth were obturated using sealer and gutta-percha. Retreatment was performed on the samples prior to determination of working length. Two different rotary files ProTaper retreatment files and R-endo were used for retreatment. After removal of gutta percha working length was determined. The samples were divided into two groups. Working length was measured using two different apex locators; Root ZX and iRoot.

**Results:** Significant difference was found in Root ZX and ProTaper retreatment files. No significant difference was seen in both Root ZX and i-Root with R-Endo files.

**Conclusion:** Root ZX apex locator was more accurate as compared to i-Root apex locator in determining the working length during retreatment.

**KEYWORDS:** Root, ProTaper Retreatment, R-Endo, Root ZX

### INTRODUCTION:

Endodontic retreatment requires regaining access into the root canal system through complete removal of the endodontic obturating material. Thorough chemomechanical instrumentation and disinfection of the root canal system is the pre-requisite for successful retreatment.<sup>1</sup> Accurate working length determination is a crucial part of successful endodontic treatment.<sup>2</sup>

Apical constriction, which is the narrowest part of the root canal and the connection site of periodontal and pulpal tissues is the recommended point for the apical terminal of working length.<sup>3</sup> There are different methods for determining the working length like radiography, tactile method and electronic apex locators (EALs). To date, radiographs are the most commonly used technique but they are subjected to distortion, magnification, lack of three-dimensional representation, increased radiation exposure to the patient and it is time-consuming.<sup>4</sup> However, with the introduction of the electronic apex locators, this problem can be solved as it works on the electronic principle and can determine the treatment and retreatment working length up to the minor foramen.<sup>5</sup>

An accurate working length determination during the retreatment process will make it easier for an operator to completely remove the primary root canal filling material.<sup>6</sup> It has been shown that root canal preparation and root canal filling materials affect root canal impedance which is a sharp change at the apical terminus that is recognized by recent EALs as the apex.<sup>7</sup> As per our knowledge, there are few studies that have evaluated the accuracy of different EALs during endodontic retreatment of canals obturated with different endodontic materials.<sup>6,8,9</sup> However, there are very few studies which have evaluated accuracy of EALs during retreatment using two different file systems.<sup>10</sup>

The aim of this study is to evaluate accuracy of two different apex locators for working length determination during root canal retreatment with two different file systems.

### MATERIALS AND METHODS:

A total of 40 extracted, single-rooted premolars were selected for the study. Teeth with single canals, morphologically normal, and no evidence of fracture or resorption were included in the study while teeth with carious roots, external or internal root resorption, and open apex roots were excluded from the study. External debris was removed using ultrasonic scaler. Access cavity preparation was done using high-speed diamond fissure bur (Mani, Tochigi, Japan). The occlusal surface was grounded slightly to flatten it so as to achieve a stable reference point for accurate measurements. Size #15 K-file (Mani,

Tochigi, Japan) was used for pulp debridement. 15-K file was introduced into the canal until it became visible at the apex. Silicon stop was accustomed at the reference point and the length between stop and tip was calculated using Vernier caliper to the nearest 0.5 mm. The measurements were repeated three times and mean was calculated. This length achieved is called as tooth length (TL) and after deducting 1 mm, the length established is the actual working length (AWL).

Biomechanical preparation was done using ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland) upto D2 using manufacturer's instructions. Irrigation was done using 5.25% Sodium hypochlorite (Dentpro, India). Paper points were used to dry the canals. The teeth were obturated using gutta-percha with Sealapex (Sybron Endo, Sybron Endo Specialities, Glendora, CA, USA) using single cone technique. Cavity was sealed with temporary restorative material and the samples were incubated for 7 days.

After 7 days, the samples were divided into two groups and underwent retreatment with two different file systems.

**Group I (n=20):** In this group, the obturating material was removed using ProTaper retreatment files (Dentsply Maillefer, Baillagues, Switzerland). Removal from coronal third was done with D1 file while D2 file was used for the removal from the middle and D3 to the working length.

**Group II (n=20):** In this group, the obturating material was removed using R-Endo (Micro-Mega, Besancon, France). Re is the orifice opener, R1 was used till the cervical third, R2 till the middle third and R3 upto working length.

Sodium hypochlorite was used for irrigation after removing the obturating material. With the help of radiographs, amount of gutta percha remained in the canal was calculated.

Alginate was used as the conducting media so as to simulate periodontal ligament for measuring the working length. The roots of the teeth and the lip clip of the apex locator were embedded into alginate so as to complete the circuit.

### These groups were further divided into subgroups:

- Subgroup IA: Root ZX (J. Morita Co., Kyoto, Japan) apex locator was used for the measuring the working length
- Subgroup IB: i-Root (S-Denti, Seoul, Korea) apex locator was used for measuring the working length.
- Subgroup IIA: Root ZX (J. Morita Co., Kyoto, Japan) apex locator

was used for the measuring the working length

- Subgroup IIB: i-Root (S-Denti, Seoul, Korea) apex locator was used for measuring the working length.

#### Working length determination using apex locators:

For Root ZX apex locator, #15 K-file was used for the measurement of working length till the lowermost part of the green bar on the apex locator screen. For i-Root apex locator, the measurements were made when the screen showed 'apex'. The length between the stopper and the tip was measured. Three measurements were made and mean was calculated. The values were compared with AWL.

Data were calculated in the tabulated form and were subjected to statistical analysis. One-way ANOVA test was used to evaluate the values which revealed the mean difference values of all the groups followed by post-hoc test.

#### RESULTS:

One-way ANOVA showed significant values in group IA and group IB in determining the working length that were treated with ProTaper retreatment files and no significant difference was seen in GroupII A and group IIB that were treated with R-Endo retreatment files.(Table 1)

**Table 1: Mean difference between retreatment working length in subgroups where working length was measured using Root ZX and i-Root apex locator.**

Group Name	Components	N	Mean	SD	F	df	P value
Group IA	Root ZX	10	19.182	1.41051	6.16	2	0.003; significant
	i-Root	10	17.525	2.02259			
	Digital Calliper	10	19.377	2.01189			
Group IB	Root ZX	10	18.486	2.64184	4.52	2	0.021; significant
	i-Root	10	18.006	2.63253			
	Digital Calliper	10	18.690	2.72020			
Group IIA	Root ZX	10	19.466	0.97190	1.57	2	0.227; Not significant
	i-Root	10	19.005	0.85308			
	Digital Calliper	10	19.738	0.97822			
Group IIB	Root ZX	10	18.486	2.64184	0.17	2	0.842; Not significant
	i-Root	10	18.006	2.63253			
	Digital Calliper	10	18.690	2.72020			

**Table 2: Accuracy of the apex locators within 1mm of direct visual assessment after retreatment**

Accuracy (Difference between DC & Root ZX) and (Difference between DC & i-Root)	Frequency		Percentage	
> 1 mm	2	11	5	27.5
0.5 to 1 mm	9	17	22.5	42.5
0.01 to 0.5 mm	26	9	65	22.5
0 mm	0	0	0	0
-0.01 to -0.5 mm	3	3	7.5	7.5
-0.5 to -1 mm	0	0	0	0
> -1 mm	0	0	0	0
Total	40	40	100	100

#### DISCUSSION:

Electronic apex locators work on a principle that the electrical resistance of the mucous membrane is registered  $6k\Omega$  in any part of the periodontium regardless of the person's age. (Sunada 1962).<sup>5</sup> Removal of filling materials is an important phase in root canal retreatment because it requires chemomechanical re-instrumentation and re-disinfection of the root canal system.<sup>11</sup> EALs are used to determine working length in primary root canal treatment and in cases of retreatment.<sup>12</sup>

In this study, primary root canal treatment was performed up to the working length achieved by direct visual measurement. Flattening of the occlusal surface was done to achieve a stable reference point.<sup>13</sup> ProTaper Next files were used as it allows to obtain a fully tapered canal with less number of files and also it has greater resistance to cyclic fatigue.<sup>14</sup> Obturation was done using single cone technique, the advantage of using this technique is that the master cone matches the geometry of the nickel titanium rotary files. Sealing the canal with single cone and sealer helps in formation of a single mass that does not result in failure as seen in multiple cone technique.<sup>15</sup> To ensure the complete set of the sealer and simulate oral conditions, the samples were placed in 100% humidity.<sup>16,17</sup>

Wilcox et al showed that if solvents are used the removal of obturating material deposited on the walls of root canals becomes difficult. Also, it might alter the antimicrobial properties of the irrigants.<sup>18</sup> In this study, two file systems, ProTaper retreatment files and R-Endo retreatment files were used for removing the obturating materials. ProTaper retreatment files have been introduced to facilitate removal of the filing material faster and safer. The D1 instrument has an active tip that aids an initial entrance into the obturating materials. Also, it has long pitch angle which allows higher cutting efficiency and more efficient debris removal.<sup>19</sup> D2 and D3 are more flexible, present longer lengths since they are meant to reach the apical thirds.<sup>19</sup> R-Endo instruments have cross-section which is characterized by three equally spaced cutting edges and has neither radial lands nor active tips.<sup>20</sup> Alginate is an electroconductive material, which simulates periodontal ligament with its colloidal consistency. The present study utilized alginate as a conductive media.<sup>21</sup>

The Root ZX is a fifth generation EAL that uses dual frequencies (0.4 and 8 kHz) and comparative impedance principle, was described by Kobayashi and Suda in 1994. The change in the electrical capacitance at apical constriction is the basis for the operation of Root ZX and its accuracy. i-Root is a fifth generation EAL which uses multiple frequencies to enable accurate detection of the apical constriction.<sup>22</sup>

In the present study, Root ZX showed better results as compared to i-Root, possibly because the residual root filling material occluding the dentinal tubules predisposes to a reduction in electrical conductivity and an increase in impedance, a factor which is responsible for enhancing the electrical detection of the apical file.<sup>10</sup> When the result of ProTaper and R-Endo retreatment system was combined with that of the Root ZX and i-Root apex locator, Root ZX with ProTaper retreatment files proved to have better results as compared to i-Root with R-Endo retreatment files with significant values. The accuracy of Root ZX was found to be 65% while that of i-Root apex locator was 22.5%±0.5 mm from the actual length.

#### CONCLUSION:

Within the limitations of our study, the apex locators can be successfully used to determine the working length in endodontic retreatment. Under the parameters of our study, Root ZX apex locator was more accurate as compared to i-Root apex locator in determining the working length in teeth after removing the root canal obturating material.

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