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Research Article

### IN VITRO COMPARISON OF THREE ELECTRONIC APEX LOCATORS IN PRESENCE OF 3% SODIUM HYPOCHLORITE

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#### ABSTRACT

**Introduction:** The purpose of this was to compare the accuracy of the Dentaport ZX (J. Morita Mfg Corp; Kyoto Japan), Mini Apex Locator (Sybron Endo, glendora, CA, USA) & EMF DELUXE (S Deisty Co, Ltd, Korea) in presence of 3% sodium hypochlorite.

**Method:** Fourty permanent single-rooted extracted teeth were decoronated and the root canals coronally flared. Actual canal lengths were determined by inserting a #15 file until the tip was visualized (2.5x magnification) just within the apical foramina. Electronic working length determination was done using ex vivo model using alginate as electroconductive medium.

**Results:** Statistically significant difference was observed between control group and readings given by Mini apex locator. No statistically significant difference was observed between control group & reading given by Dentaport ZX & EMF DELUXE.

**Conclusion:** The results of the present study confirm that Dentaport ZX and EMF DELUXE can accurately determine the root canal length within  $\pm 0.5$  mm from the apical foramen. Mini Apex Locator cannot accurately determine the root canal length within  $\pm 0.5$  mm from the apical foramen.

**Keywords:** Electronic apex locators, Dentaport ZX, EMF DELUXE, Mini apex locator.

#### INTRODUCTION

Success or failure of endodontic treatment depends on various factors out of which one of the most important factor is determination of the working length. According to American Association of Endodontists, working length has been defined as "distance from the coronal reference point to the point which canal preparation & obturation should terminate". Cleaning and shaping of the root canal system is one of the fundamental parameters for endodontic success which depends on correct establishment of the working length. Asymmetrical root canal opening is the phenomenon where major foramen of root canal is not located at the tip of the anatomic apex<sup>1,2</sup>. The degree of deviation of major foramen is unpredictable and may vary considerably from average<sup>3,4</sup>. Improper working length determination can affect overall prognosis of the endodontic treatment.

Traditionally many methods have been used to determine working length, which include use of paper points, tactile sensation & radiographic methods<sup>5</sup>. Although radiographic

method is most commonly used method, its disadvantages make further research in this field mandatory<sup>6</sup>.

Suzuki (1942) discovered that, the electrical resistance of 6.5 ohms exists between oral mucous membrane & periodontium<sup>7</sup>. Sunadastated that electrical resistance values between the periodontal ligament and the oral mucosa can be determined by electronic means<sup>8</sup>. The first & the second generation apex locators were resistance based & impedance based respectively. Main shortcoming of these apex locators was their inability to work in presence of oral fluids<sup>9</sup>.

To overcome shortcomings of these apex locators, Kobayashi introduced Root ZX (J. Morita Mfg Corp; Kyoto Japan), a third generation apex locator, which is dual frequency based (0.4 kHz and 8 kHz) & works on the ratio method<sup>10</sup>.

Dentaport ZX (J. Morita Mfg Corp; Kyoto Japan), the updated version of original Root ZX has original electronic components with new casing. This device measures impedance values at two frequencies simultaneously & calculates quotient that expresses the position of the tip in the canal<sup>9</sup>. This apex locator has become gold standard against

which other recently introduced apex locators have been compared<sup>11</sup>.

Mini apex locator (Sybron Endo, Sybron Dental, Anaheim, CA), another apex locator used in this study is multifrequency based fourth generation apex locator & is also claimed to be accurate in presence of various intracanal conditions. The third apex locator compared in this study is EMF DELUXE (S Deisty Co, Ltd, Korea), is dual frequency (500 Hz & 5 KHz) based, fifth generation apex locator which also works on ratio method. The purpose of this in vitro study was to compare the accuracy of Dentaport ZX, Mini Apex Locator & EMF DELUXE in presence of 3% sodium hypochlorite.

## MATERIALS AND METHODS

Fourty permanent single-rooted extracted teeth were selected for this study. Selection criteria included teeth with fully formed apices without vertical or horizontal root fracture. Teeth were kept in 5.25% sodium hypochlorite for 2 hours (to dissolve periodontal ligament) & then stored in normal saline until use. All teeth were used within 1 week from the time of extraction. Teeth were decoronated at CEJ (to get the flat reference points) using diamond disk. Coronal third preparation was done using Gates Glidden Drills number 3, 2 & 1.

15 no. K file was introduced inside the canal until it became visible at the apical foramen. A file was withdrawn until magnifications of 2.5x showed its tip to lie tangential to the apical foramen. Stopper was adjusted & this length was measured. Each measurement was repeated twice & the mean value was obtained.

All teeth were embedded in the alginate model which acts as electroconductive medium (Tinaz et al, 2002). 3% sodium hypochlorite was introduced into the canal with 23 gauge needle. Excess of the irrigant was removed by soaking with cotton pellets.

For each of the apex locator, file was gently inserted into the canal until it showed apex. Stopper was adjusted at this reading & length was measured on electronic vernier caliper. Each measurement was recorded twice by a single operator & the mean value was taken as the reading given by the individual apex locator.

## RESULTS

Repeated measures ANOVA test was carried out to compare accuracy of apex locators.

Mean differences between electronic & actual lengths were 0.07, 0.17 & 0.45 mm for Dentaport ZX, EMF DELUXE & Mini Apex Locator respectively.

Statistically significant difference was noted between actual lengths & readings given by Mini Apex Locator.

No statistically significant difference was found between actual lengths & readings given by Dentaport ZX & EMF DELUXE apex locators.

Within the acceptable range of +/- 0.5mm Dentaport ZX showed 93.33% correct readings, EMF DELUXE showed 86.66% correct reading & Mini Apex Locator showed 76.67% correct readings.

## DISCUSSION

Historically, radiographs have been the primary means for determining the working length in endodontic therapy. However, radiographs have inherent limitations, the most important being they are two-dimensional images of three-dimensional objects. This is further complicated by situations in which superimposition of anatomic structures such as the zygomatic arch or adjacent roots occur over the roots of teeth requiring endodontic therapy.

Variation in root-end morphology as studied in the works of Kuttler (1955)<sup>1</sup>, Green (1956)<sup>2</sup>, and Dummer et al (1984)<sup>12</sup> showed that radiographic interpretation alone cannot be depended on to establish the working length and that electronic determination is necessary.

According to the results of this study, the readings given by Dentaport ZX were closest to the actual working lengths, followed by EMF DELUXE & then Mini Apex Locator. Statistically significant results were not seen between Dentaport ZX & EMF DELUXE. Statistically significant difference was noted between actual lengths & readings given by Mini Apex Locator.

Mini Apex Locator is the fourth generation apex locator. The significant disadvantage of the fourth generation devices is they need to perform in relatively dry or partially dried canals. In some cases this necessitates additional drying, and with heavy exudates or blood the method becomes inapplicable. This can be the possible reason for poor accuracy of Mini Apex Locator<sup>13</sup>.

It has been suggested that EALs operate on electrical principle rather than relying on the biological properties of the tissues involved. Therefore in vitro models with similar electrical resistance to the periodontium can provide valuable information. The alginate remains as a gel, which possibly allows ions to circulate. Its other advantages include good electroconductivity, low cost & easy manipulation. Therefore alginate has been used in this study to simulate periodontium<sup>14-15</sup>.

There has been a controversy as to whether EALs are able to determine the minor constriction or the major foramen. According to Naaman & Ounsi, Mayeda et al apex locators can detect major foramen & not the minor foramen<sup>16-17</sup>. Lee et al found that termination point of the file tip was in the area of the major foramen regardless of the CDJ presence and the major foramen is a better level test for EAL accuracy<sup>18</sup>. Therefore, the current study used the major foramen as the measuring point for the three EALs.

Earlier it was believed that electroconductivity of an irrigant affects the readings given by the apex locators. But it has been proved that the electroconductivity of irrigants does not affect readings given by apex locators<sup>9</sup>. Sodium hypochlorite is commonly used irrigant during root canal treatment due to its unique property of tissue dissolution. Therefore, same irrigant was used in this study.

Ibarrola et al. suggested that pre-flaring root canals before using the EALs led to an increased accuracy of the electronic apex location. For this reason the canals were carefully pre-flared with Gates Glidden in the present study<sup>19</sup>.

Limitations of this study include type of study- in vitro, presence of single irrigant with same concentration.

### CONCLUSION

The results of the present study confirm that Dentaport ZX and EMF DELUXE can accurately determine the root canal length within  $\pm 0.5$  mm from the apical foramen. Mini Apex Locator cannot accurately determine the root canal length within  $\pm 0.5$  mm from the apical foramen.

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