

Comparison of Various Current Electronic Apex Locators to Determine the Working Length by Using the Clearing Technique

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ABSTRACT

Background: To evaluate the accuracy of Dentaport ZX, Woodpex Electronic Apex Locators in establishing the major foramen using clearing technique

Methods: Thirty Maxillary and Mandibular human extracted teeth with a single root straight canal were used and decoronation were done up to CEJ with a diamond disc, 15 samples of teeth from each group were embedded in a dentulous model and alginate was placed in it to stimulate periodontium. Working length estimation was done by “Woodpex, Dentaport ZX Electronic Apex Locators” – models placed in 5% Nitric acid for 24, 48 and 72 hours, then transferred to ethanol solution of concentration (80, 90, 100%) and stored in 0.2% Methyl salicylate. Distance between tip of file and major foramen was measured by using image analysis and values were listed to statistical analysis. Statistical analysis was carried out by using tests of chi square test, kruskal-wallis test, Z test to compare results between two groups. All the data was expressed as Mean \pm SD and the difference of $p \leq 0.05$. Values obtained were analyzed by using image analysis software program

Result: Accuracy were 100% for the Denta port ZX compared to Wood pex in detecting major foramen

Conclusion: Accuracy of Dentaport ZX was higher compared to wood pex. Dentaport ZX located the major foramen with 100% accuracy within the range of 0.5mm. There is greater distance from the major foramen in woodpex group when compared to dentaport ZX.

Keywords: Clearing Technique, Image Analysis, Electronic Apex Locator, Working Length, Major Foramen

Introduction

Successful endodontic therapy depends on measurement of correct working length (WL), which is achieved by removal of necrotic debris, microorganisms and pulp tissue from root canal.¹ Grossman defined working length as distance from a coronal reference point to the point at which canal preparation and obturation should terminate.² Apical terminus of the root canal termed as minor constriction or minor diameter of apical foramen.^{3,4}

Working length can be estimated by radiographic method and non radiographic methods.⁵ Radiographs provide two dimensional image, it is difficult to locate exactly the position of apical constriction and apical foramen depending on basis of radiographs alone.⁶

Custer, investigated an electronic method for root canal length determination.⁷ Electronic devices have been developed for determining the working length of a root canal without resorting to radiography.⁸ Recently introduced electronic apex locators can estimate the length of canal from orifice to end of apical foramen.^{9,10} Apical constriction can be defined as apical portion of root canal having narrowest diameter, it is usually 0.5-1mm short of apical foramen.¹¹ Apical foramen can be defined as opening of root canal which may be located away from anatomic or radiographic apex.¹¹

Electronic Apex Locators (EAL) determine the working length by measuring the impedance with two or more different frequencies and work in presence of various irrigants. These are not an alternative to the use of radiographs in Endodontics but they are useful adjunct to radiographs in accurate clinical measurement of root canal working length.¹² “Most advantages over EAL, they can” measure length of root canal from canal orifice to the end of apical foramen not to the radiographic apex.¹³

Materials and Methods

The present in vitro study was conducted in Department of Conservative Dentistry and Endodontics, Mamata Dental College, Khammam.

Thirty maxillary and mandibular human extracted teeth with a single root and straight canal were used in this study (Fig 1). Teeth were randomly assigned into 2 groups of 15 teeth each. All teeth decoronated at Cemento-enamel junction with a diamond disc to gain access to root canal (Fig 2,3).

Pulp was extirpated by using broaches and actual working length determined with a size 15 k-file fitted with a rubber stop and patency of canal was checked (Fig 4,5). Irrigation was done by using sodium hypochloride (5.25%) and saline with 2ml and 5ml syringes respectively (Fig 6).

Dentulous mold was used to establish an alginate model (Fig7,8). Teeth were embedded in alginate model and irrigated with saline using 5ml syringe (Fig9, 10, 11). Working length was determined using Woodpex and Dentaport ZX EAL according to manufacturer's instructions for detecting major foramen (Fig 12,13). For Dentaport ZX device, Size 15 K- file was stabilized within the canal. When file was advanced into the canal to just beyond the foramen it is indicated by flashing APEX bar and thereby withdrawn until last green bar had been reached. For Woodpex EAL the same procedure was carried out and at particular green bar area fixation of file by rubber stopper was done.

For Clearing technique, the teeth with alginate models (specimens) were placed in 5% nitric acid for 24 hours, 48 hours, 72 hours at room temperature and Nitric acid was changed for every 24 hours. Tooth embedded in alginate models transferred to ethanol solution of concentration (80%, 90%, 100 %) for 24hours, 48hours, 72 hours respectively and stored in 0.2% Methyl Salicylate until they become clear.(Fig14,15).

Teeth were removed from alginate model and observed under stereo-microscope. Images were captured after 24 hours, 48 hours and 72 hours (Fig 16). Distance between tip of the file and major foramen was measured using image analysis software program (Fig 18) values obtained were listed to statistical analysis.

The data were statistically analyzed using chi-square test, kruskal –wallis, Z test to compare the results between the groups. All the data was expressed as Mean \pm SD and the difference of $p < 0.05$ or more was considered significant. Values obtained were analyzed by using image analysis software program. (Table no 1, Graph no 1)

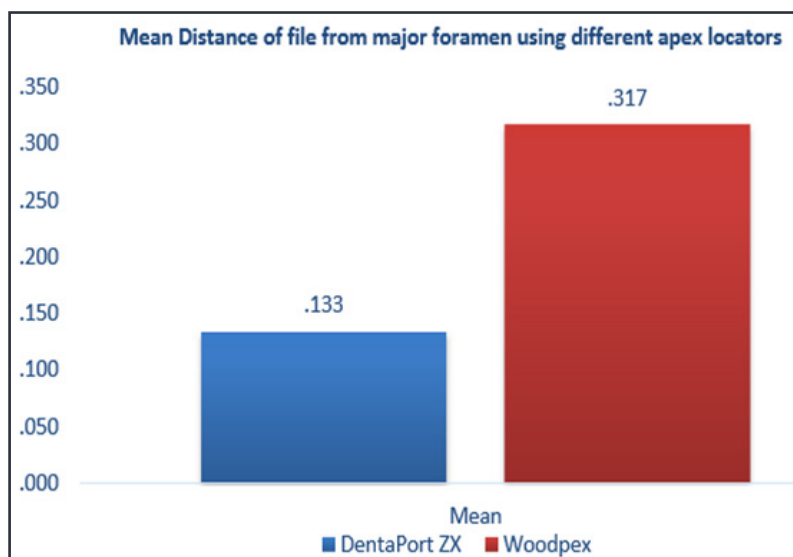
Result

Accuracy of Dentaport ZX EAL was 100% when compared to Woodpex in detecting major foramen by using image analysis software program. Mean Distance from file tip to major foramen was 0.133 for Dentaport zx, 0.317 for Woodpex. Positive values indicate the file tip was beyond major foramen (Fig 19). Negative values indicate the file tip was short of major foramen (Fig 20), Zero values indicate tip was aligned at major foramen (Fig 21).

Table I: Frequency of Distance Between File Tip And Major Foramen..

Distance from major foramen(mm)	n(%) Dentaport ZX EAL	Woodpex EAL EAL
≥ 1	0	1(16.6)
1.0-0.50	1(16.6)	1(16.6)
0.5-0.01	1(16.6)	2(33.33)
0	3(50)	1(16.6)
-0.01- -0.5	1(16.6)	1(16.6)
-0.50- -1.0	0	0
≤ -1	0	0
Total	6	6

Positive values indicate measurements beyond the major foramen



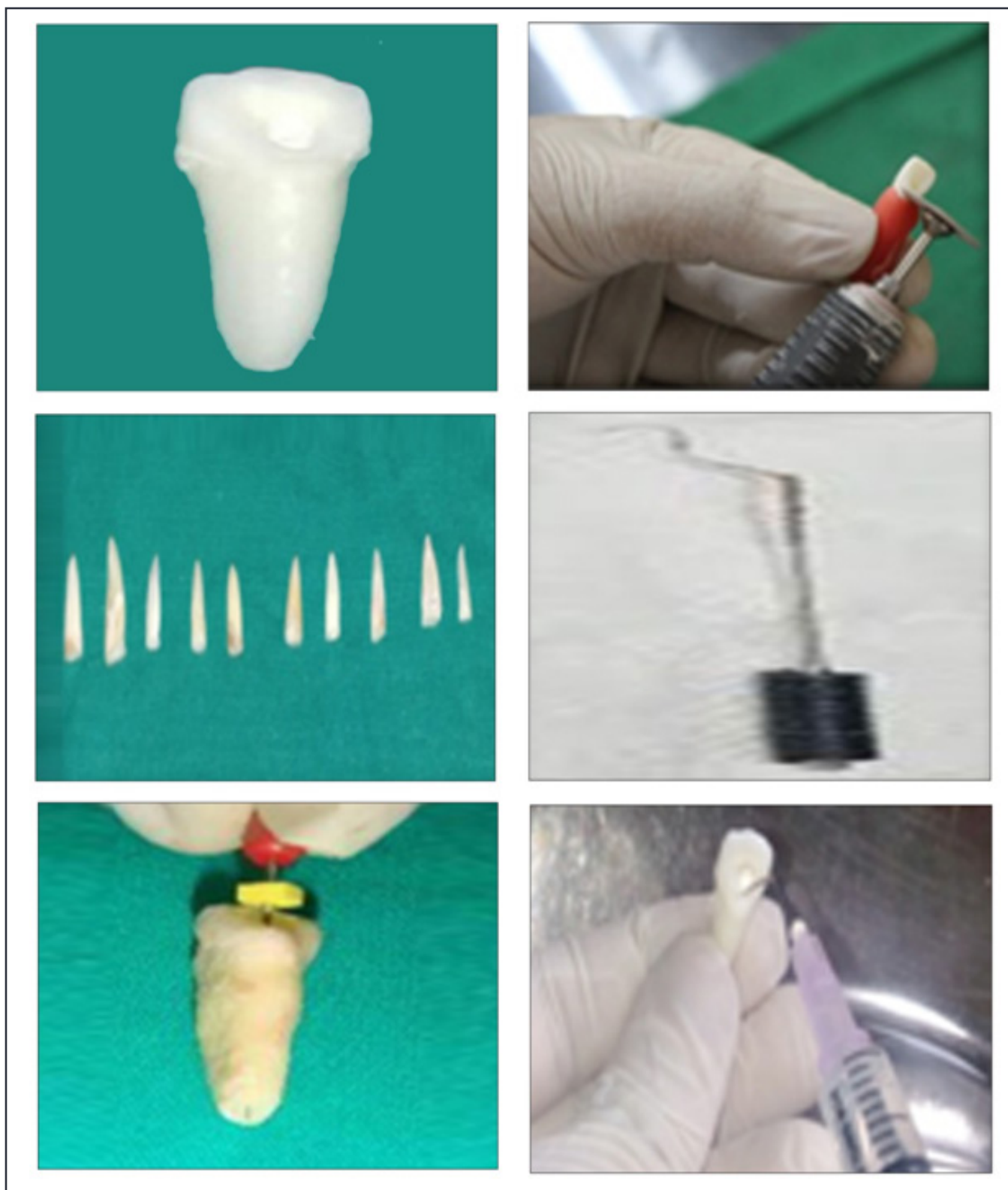


Fig. 1-6



Fig. 7-10

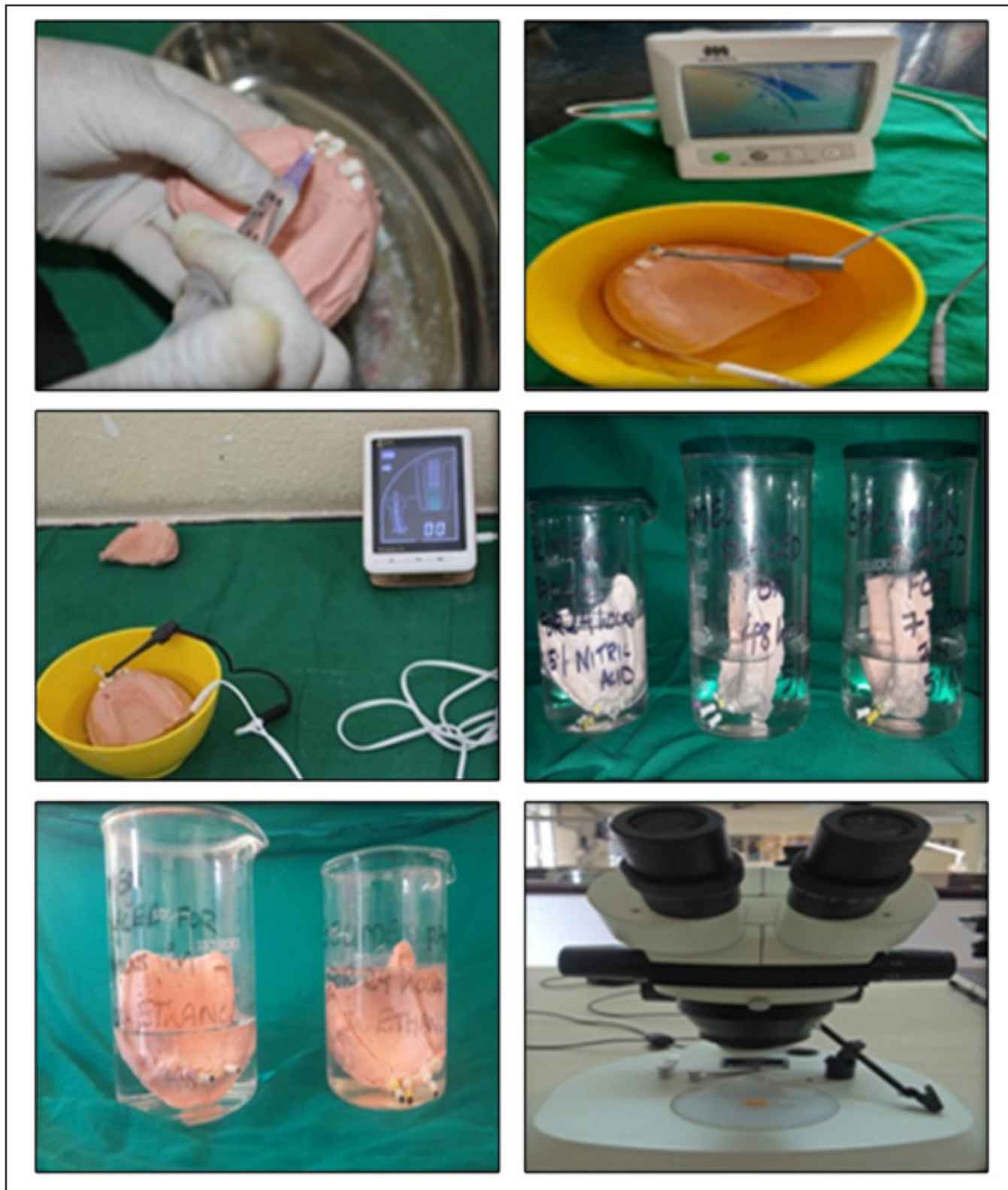


Fig. 11-16

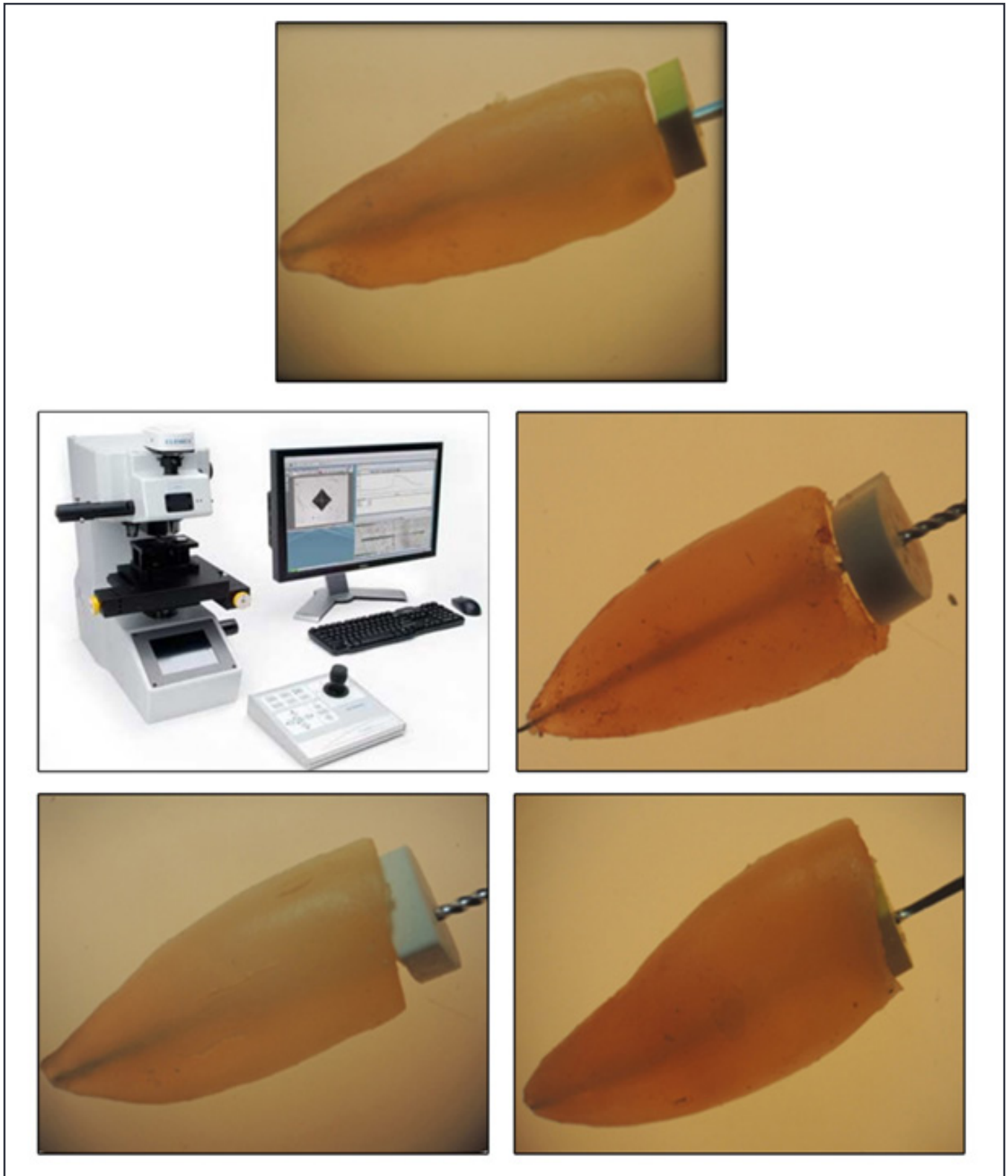


Fig. 17-21

Discussion

Determination of working length by using EAL has gaining popularity because working length from a single radiograph remains empirical.¹⁴ Sunada and Suzuki was the first to introduce the efficient clinical device for measuring working length in patients.¹⁵

Apical constriction is narrowest part of root canal, regarded as physiological apical limit for instrumentation and filling of root canal system.¹⁶ Major foramen was considered it is the reference point to access the devices.^{17, 18} Diameter of major foramen influences the functioning of EAL. Withdrawing instrument 0.5 or 1mm using EAL to ensure file tip doesnot protrude beyond WL, avoiding root canal over preparation.¹⁹

McDonald classified EAL based on type of current flow, number of frequencies involved. All apex locators work based on electrical circuit.²⁰ "Two EAL used in this study are Dentaport ZX, Woodpex". Dentaport ZX EAL calculate precisely in all temperature and moisture conditions inside the canal and helps in accurate detection of major foramen.²⁰

Image Analysis is a computer-based process of extracting quantitative information from images. The process begins with the input of an image and ends with the output of numerical data (Figure 18). This requires specialized computer equipment fitted with an imaging device, such as a television camera, coupled to a microscope¹

Dentaport ZX is a third generation EAL based on multiple frequency and helps in assessing the apical terminus by simultaneous measurements of impedance of two different frequencies.²¹ Ebrahim et al stated that Dentaport ZX located the constriction within limits of ± 0.5 mm in 93% of cases.²¹

The study of Felipe-Moscoso et.al. stated that accuracy for Dentaport ZX was 82.3% to detect major foramen.

Woodpex EAL is a fifth generation, developed in 2003 and it measures capacitance and resistance of the circuit separately. Equipped with clear bright LCD, clear image and different colours indicate the trajectory of the file clearly.²²

The parts of the Woodpex apex locator are **autoclavable**, thereby making it possible to **reduce the risk of cross infection**. The **rechargeable battery** incorporated in the device enhances ease of use and eliminates the need for replacement of the battery repeatedly. The display can be folded to facilitate better viewing.^{11, 5}

Tinaz et al stated that Alginate model simulate periodontium, because alginate poses a electro conductive property.⁷

Irrigation done with 5.25% "NaOCL" to remove any pulp tissue present in the canal, and saline used to flush out the remaining pulpal remnants. Torabinejad et al stated that during instrumentation usage of Naocl is beneficial as working solution.²³

Clearing technique used in this study includes Ethanol, Nitric acid, and Methyl Salicylate. Ethanol concentrations of (80%, 90%, 100%) acts as fixative and helps in precipitation of proteins. Nitric acid (5%) used for demineralization, 0.2% methyl salicylate maintains transparency of tooth.

Conclusion

Accuracy of Dentaport ZX was higher compared to Wood pex. Dentaport ZX located the major foramen with 100% accuracy within the range of 0.5mm. There is greater distance from the major foramen in Woodpex group when compared to Dentaport ZX. There is statistically highly significant differences present between the measurements of both with high values in Woodpex group showing it is out of foramen many times than Dentaport ZX.

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