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The Influence of Various Irrigants on The Accuracy of Third Generation Apex Locator And Fifth Generation Apex Locators In Locating Simulated Root Perforation: An In Vitro Study

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ABSTRACT
***AIM** : The aim of the study is to assess the accuracy of* **THIRD GENERATION APEX LOCATOR (** *DENTAPORT ZX (J.MoritaCo,Kyoto,Japan) and* **FIFTH GENERATION APEX LOCATORS (** *PROPEX II(DentsplyMaillefer,Ballaigues,Switzerland) in detecting root perforations in Dry conditions, and in presence of irrigants like-3%NaOCl,17%EDTA,2% Chlorhexidine..*
***METHOD**:20 extracted single rooted human teeth were perforated artificially in the middle 3rd of the root.The actual length of perforation were measured ,and teeth were embedded in alginate mould.The electronic length of perforation were measured by both apex locators in different canal conditions allowing tolerance of ±0.5mm.Statistical analysis were performed using Friedman test, P-values obtained using Wilcoxon signed rank test at a significance level of P>0.05.*
***RESULT:** Statistically insignificant difference existed between DENTAPORT ZX AND PROPEX II apex locators with various canal conditions.Most accurate measurement were obtained in dry conditions for both apex locators.Whereas among the irrigants 3% NaOCl showed the least accurate results.*
***CONCLUSION**: Contents of root canal irrigantsaffect the accuracy of apex locators*.

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I. Introduction

Root perforation is a non-anatomic communication between root canal and surrounding periodontal tissue occasionally occurred during endodontic procedures. These perforation may be induced iatrogenically ,by resorptive process or by caries . (1**)**

Root perforation haveanegativeeffect on the long-term prognosis of the tooth after root canal treatment (1, 2). Clinical diagnosis of the location of root perforation is the main requirement to minimize the probability of extruding irritating materials, such as irrigation solutions or sealers, into the periradicular tissues and to prevent instrumentation beyond the perforation site during endodontic treatment (3). Root canal preparation techniques aim to end the biomechanical instrumentation at the apical constriction (Kuttler 1955).

Direct observation of bleeding, indirect evaluation of bleeding with a paper point, radiographic assessment, and electronic apex locators (EALs) may be used for the identification of root perforations (1).

Radiographic evaluation is anessentialcomponent inthe detection of endodontic problems such as root perforation. However, because conventional periapical radiographs provide a 2-dimensional image of a 3-dimensional object, they do not give sufficient information when the perforation is located at the buccalorlingual surface of the root.

EALs are also useful and reliable for locating root perforations (3–5). The accuracies of EALs in fractured, resorpted root and perforation cases have been evaluated in a few studies, but confusing results have been reported.The latest generation of EALs measure alternating current impedances at 2 or multiple different frequencies; moreover, they can work in the presence of various intracanal contents and irrigants.

Dual frequency EALs ROOT ZX (Morita Co, Kyoto, Japan), simultaneoulsy uses 2 wave form, a high (8khz) and a low(400hz) frequency wave forms. (comparativeimpedence based on ratio method).They have a powerful microprocessors and are able to process mathematical quotient and algorithm calculations required to give accurate results. ROOT ZX requires no caliberation and can be used when canal is filled with a strong electrolyte. (6-8)

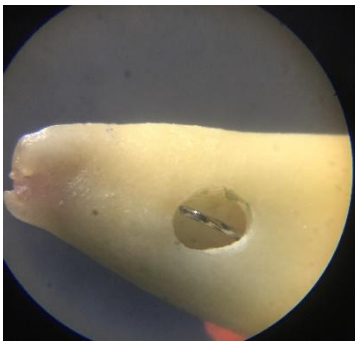
PROPEX II has the latest ,multi frequency technology incorporated into this generation and an extended apical zoom function ,which activates when the file reaches the apical area. However, there is still a concern as to whether high electroconductiveirrigants such as NaOCl can affect these new-generation.
Therefore, this study was conducted to evaluate the influence of various irrigation solutions on the accuracy of different generations of Electronic Apex Locators in locating simulated root perforation.

- ***NULL HYPOTHESIS*** :- Null hypothesis of the present study was that irrigating solutions did not affect the accuracy of electronic apex locators in locating simulated root perforations.
- **AIM : "**The aim of the study was to assess the accuracy of Third generation apex locator **DENTAPORT ZX** and fifth generation apex locator **PROPEX II** in detecting root perforation in **Dry canal Conditions** & in presence of irrigants like-**3%NaOCl, 17%EDTA, 2% Chlorhexidine liquid**".

II. Material and Methodology

20 Single rooted mandibular premolars selected.X-ray are taken from bucco-lingual and mesio-distal angles.All the teeth were decoronated at thecemento-enamel junction to obtain constant reference point.

The roots were artificially perforated 5mm from the apex on the proximal root surfaceat 90^0 with inverted cone bur. Before electronic measurements, the actual lengths(ALs) upto perforation was measured under stereomicroscope (20X magnification).



The teeth were embedded in the alginatemould. Electronic measurements of the perforations were obtained by each electronic apex locators in dry conditions and in presence of 2.5% NaOCl, 17% EDTA , 2% chlorhexidine ,allowing tolerance of ±0.5mm.

Each canal was irrigated with distilled water and then dried with the help of paper points in between the measurements with each irrigant. For the DENTAPORT ZX device ,a size 20 K-file with a rubber stop was advanced into the canal until an ''APEX'' reading was obtained; it was then withdrawn until the last green bar was reached. Whereas for the PROPEX II electronic apex locator file was inserted in the canal and the cursor

on the tooth indicates the progression of file inside the canal by a numerical value on the graphical scale when it reaches the 0.0 orange bar indication the file at the " APEX".

The rubber stop was adjusted, the file was withdrawn, and the electronic length(EL)of the perforations was recorded for different canal conditions. All teeth were measured by the same operator, who was experienced in the use of EALs. The differences between the ELs and the ALs of the perforations were calculated.

III. Results

The measurement for various canal condition with the 3rd generation apex locators are shown in table 1 .The difference between electronic and actual length of perforations were calculated. There was a Statistically insignificant difference existed between DENTAPORT ZX AND PROPEX II apex locators with various canal conditions. Most accurate measurement were obtained in dry conditions with accuracy of 75% for DENTAPORT ZX and 60% for PROPEX II apex locators (P>0.05) . Whereas among the irrigants 3% NaOCl showed the least accurate results.

Negative and positive values indicated measurement short and long of AL.

TABLE 1: Measurement of Third generation Electronic Apex Locators with different irrigating solution .

TOOTH NO.	WORKING LENGTH	Actual legth of perforation.	Dry	EDTA 17%	3% NaOCl	2% Chlorhexidine
1	14.65mm	10.92mm	11.10mm	11.03mm	11.62mm	11.14mm
2	12.87mm	10.57mm	10.10mm	11.09mm	12.10mm	10.81mm
3	14.55mm	10.58mm	10.65mm	10.70mm	9.90mm	10.81mm
4	14.56mm	9.92mm	9.29mm	9.20mm	11.58mm	8.82mm
5	15.56mm	8.91mm	8.56mm	8.55mm	9.60mm	8.82mm
6	13.87mm	8.92mm	10.50mm	10.34mm	11.07mm	11.21mm
7	11.30mm	7.34mm	7.19mm	7.15mm	9.63mm	8.64mm
8	13.32mm	8.90mm	8.50mm	8.16mm	7.66mm	9.49mm
9	15.62mm	11.33mm	10.46mm	10.23mm	10.29mm	10.04mm
10	14.30mm	10.84mm	10.59mm	10.48mm	10.05mm	10.51mm
11	15.60mm	10.85mm	10.02mm	10.48mm	10.27mm	10.29mm
12	14.46mm	10.79mm	10.64mm	10.23mm	9.23mm	9.85mm
13	13.76mm	8.56mm	8.65mm	8.95mm	9.50mm	8.56mm
14	14.10mm	9.72mm	9.86mm	9.90mm	10.18mm	9.35mm
15	13.18mm	8.04mm	8.11mm	7.69mm	7.67mm	8.69mm
16	12.93mm	8.05mm	8.61mm	8.04mm	8.61mm	9.89mm
17	12.56mm	8.08mm	8.10mm	8.09mm	8.50mm	8.65mm
18	13.45mm	8.65mm	8.60mm	8.62mm	9.01mm	8.70mm
19	11.71mm	7.24mm	7.20mm	7.22mm	8.01mm	7.30mm
20	13.97mm	8.60mm	8.62mm	8.63mm	8.20mm	8.70mm

IV. Statistical Analysis

For statistical analysis Friedman test was performed ,and P-value obtained using Wilcoxon signed rank test at a significance level of P>0.05. The values for mean and standard deviation between the electronic length and actual length of perforation for each electronic apex locator in different canal conditions are given in table 3 and 4 .

Table 2: The mean difference with standard deviation between the electronic length and actual length of perforation for each electronic apex locator in different canal conditions

Electronic Apex Locators	Canal conditions [Mean ± SD]				
	Dry conditions	17%EDTA	3%NaOCl	2%chlorhexidine	P value
DENTAPORT ZX (mm)	-0.07 ± 0.52	-0.11 ± 0.54	0.29 ± 1.11	0.17 ± 0.91	0.261
PROPEX II (mm)	0.08 ± 0.55	-0.15 ± 1.11	0.02 ± 0.98	0.19 ± 0.75	0.620

Table 3: Distance between AL and EL with various canal conditions for DENTAPORT ZX and PROPEX II

Distance in mm	DENTAPORT ZX [No. (%)]				PROPEX II [No. (%)]			
	Dry conditions	17% EDTA	3% NaOCl	2% chlorhexidine	Dry conditions	17% EDTA	3% NaOCl	2% chlorhexidine
< -0.5 mm	3 (15.0)	4 (20.0)	6 (30.0)	4 (20.0)	3 (15.0)	6 (30.0)	8 (40.0)	3 (15.0)
-0.5 mm – 0.5 mm	15 (75.0)	14 (70.0)	5 (25.0)	10 (50.0)	12 (60.0)	9 (45.0)	4 (20.0)	10 (50.0)
> 0.5 mm	2 (10.0)	2 (10.0)	9 (45.0)	6 (30.0)	5 (25.0)	5 (25.0)	8 (40.0)	7 (35.0)

Table 3 provides the distribution of measurements of DENTAPORT ZX and PROPEX II with various canal conditions. Although statistically insignificant differences existed among the canal conditions, the majority of the readings were within the acceptable range ± 0.5 mm for both apex locator.

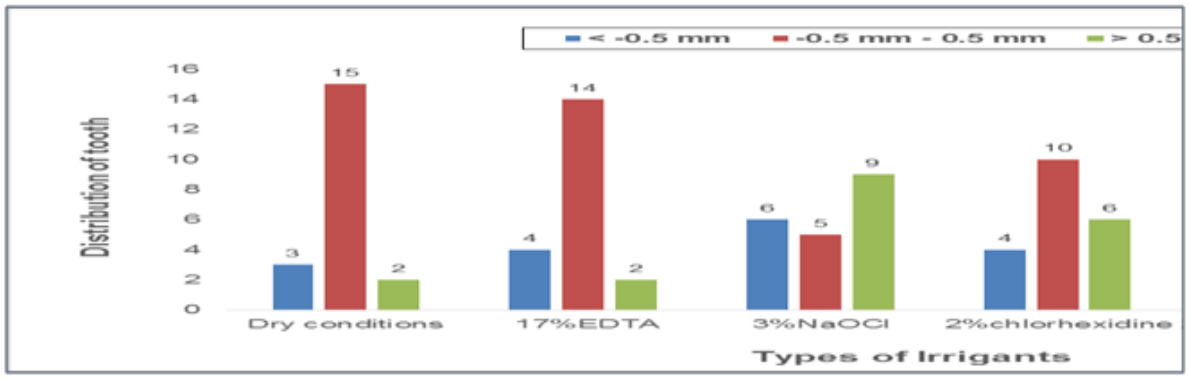


Figure 1: Distribution of tooth on the basis distance between AL and EL with various canal conditions for DENTAPORT ZX

V. Discussion

Successful treatment of root perforations depends on the location and size of the defect, the time between perforation and treatment, an accurate determination of the location, and the sealing of the perforationsite(1). It has been suggested that EALs can precisely determine the location of the apical constriction, apical foramen, horizontal root fracture ,and apical rootresorption(9-13).Furthermore, the efficacy of apex locators as an aid in pinpointing root perforations has been tested experimentally in previous studies; the results have shown that EAL is an acceptable method for detecting root perforations under in vitro conditions (3–5, 14).

The prognosis of perforated teeth depends on the location,size,duration of perforation and feasibility of sealing the perforation. An accurate detection of the location of root perforation is a key factor for successful treatment.

In the present study , the reliability/accuracy of the DENTAPORT ZX is compared to PROPEX II , in locating root canal perforations with dry canal conditions, and in different irriganting solutions which are commonly used in root canal treatment such as NaOCl , EDTA and Chlorhexidine.

Variouselectroconductive materials have been used such as agar, alginate, gelatin, and a saline solution for in vitro evaluation of EALs in perforated teeth (4, 5, 15, 16). In this study, alginate was selected as the embedding medium to simulate the periodontium because it is easy to handle, remains around the root, simulates the periodontal ligament with its colloidal consistency, and presents suitable electroconductivity (17).

Perforationsof0.60,0.40,0.30,and0.27mmwereusedin the previous studies (3, 4, 14, 15). In this study, the perforation size was approximately 1.50 mm, which is larger than the size of the perforation in the studies mentioned.

In the present study , the accuracies of the DENTAPORT ZX AND PROPEX II in locating perforated teeth is affected by the different canal conditions , which is similar with the study by ***Shin HS, Yang WK, Kim***

MR, et al(Restor Dent Endod 2012) (15) that showed that measurement accuracy was related to the contents of the canal.

However, the present results differed from ***Kaufman AY, Fuss Z, Keila S et al***(IntEndod J 1997) (14) study in which the irrigants used had no impact on the accuracy of different EALs in locating root canal perforations.

This discrepency might be explained by the different devices, methodologies, and irrigants used in the various studies.

In the present study DENTAPORT ZX and PROPEX II gave the most accuarte results of 75 % and 60% in *dry canal conditions* , which is similar with the study conducted by ***(Dement Altunbas*. JOE Vol 2017)** that showed the most accurate measurements obtained in dry canals.

However, the present study differs from the study conducted by ***Venturi and Breschi*(Int. Endod J 2007)**(18) which stated that measurements were inaccurate and unstable for Root ZX in low conductive conditions (DRY CANALS) .

Among the *irrigants* DENTAPORT AND PROPEX II gave 70 % and 45 % accuracy with 17% EDTA in the present study which is similar to the studyconducted by ***Kaufman AY, Keila S, Yoshe M*.(IntEndod J 2002)**(19) in which DENTAPORT ZX gave more accurate results in the presence of EDTA.

2% Chlorhexidinegave 50 % accuracy with both apex locators in the present study which differs from the previous study *by* ***Erdemir A, Eldeniz AU, Ari H*. (IntEndod J 2007;40)** in which the results are similar to that of NaOCl giving the least accurate results. (20)

Where as , *3 % Sodium hypochlorite*gave the least accurate result with only 25 % with DENTAPORT ZX and 20 % with PROPEX II in the present study which is similar to the study conducted by ***Shabahang S et al.* (JOE 1996;22)** which showed a larger deviation from the actual canal length with NaOCl. (21)

However it differ from the study **by *Duran-Sindren et al* (IntEndod J. 2013;46)**(22) who reported that NaOCl did not influence the measurements obtained with Root ZX and Ipex (NSK, Tochigi, Japan).

Liquid type endodontic irrigants shows higher accuracy in locating root perforation. Because simulated perforation was made to proximal root plane, good flowing liquid types were advantageous to reach the outer proximal root surface. ***Shabahang et al.*** suggested that 1.0mm tolerance can be considered clinically acceptable. (21)

VI. Conclusion

Under the limitation of this study ,both devices detected the root canal perforation within a acceptable range of ±0.5mm from the coronal border of the perforation site.

- *Different canal irrigant with different electrical conductivities may affectthe accuracy of both EALs.*
- The most accurate measurements were obtained in *Dry canal condition with both the apex locators within ± 0.5mm tolerance limit.*
- *Among the irrigants 3% NaOClshowed the least accurate result and 17% EDTA showed the most accurate results.*

Further evaluation of the accuracy of different Electronic apex Locators in locating Root perforation should be carried out in Clinical andin Vitro studies .

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