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The Influence of Various Irrigants on the Accuracy of 2 Electronic Apex Locators in Locating Simulated Root Perforations

Dr. Devi Priya[1], Dr. Afroz Syed[2], Dr. Madhur Arora[3], Dr. Dasarathi Alivelu[4], Dr. Haranath Danda[5]

[1] MDS, Assistant Professor, Government Dental College, Vijayawada.

[2] MDS, Oral Pathology and Microbilogy, Medical Writer, Tenali

[3]Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital, Chandigarh

[4]MDS, Assistant Professor, Government Dental College, Vijayawada

[5]MDS, Oral Pathology and Microbilogy, Private Practioner, Guntur.

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Corresponding author: B. Devi Priya
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Abstract

Introduction: Root perforation is a common procedural error that may lead to the endodontic failure. There are various apex locators available that are commonly used for the endodontic preparations. We aimed to study the efficiency of irrigants on the accuracy of 2 electronic apex locators in locating simulated root perforations.

Method: We piloted an invitro observation study among 40 single rooted extracted human teeth that were perforated intentionally at the apex. The actual length of perforation was calculated, and teeth were mounted in alginate. The electronic length of perforation was calculated by both two different apex locators in different canal settings for three irrigants allowing tolerance of ±0.5mm. The data was noted and various statistical tests were applied while considering $p<0.05$ as significant.

Result: We observed no statistical variation between the two apex locators difference existed between ROOT ZX AND ELEMENT apex locators with various canal conditions. The dry conditions were suitable the most for the accurate measurement of perforation. Among the various irrigants, the saline performed poor in aiding the apex locator for an accurate measurement of the perforation.

Conclusion: Within the limitations it can be stated that the contents of the canal will significantly influence the apex locators in the accuracy of the detecting the perforations.

Key words: Root perforations, Irrigants, Accuracy, Apex locators

Introduction

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

Root perforation may on the long-term effect the prognosis of the tooth after root canal treatment (1, 2). Clinical diagnosis of the location of root

perforation is the chief obligation to lower the likelihood of extruding irritating materials, such as irrigation solutions or sealers, into the periapical and the periodontal tissues and to prevent instrumentation beyond the perforation site at the time of the endodontic treatment (3).

There are a multitude of the methods to detect the root perforations like the, direct observation of bleeding, indirect evaluation of bleeding with a paper point, radiographic assessment, and electronic apex locators (EALs) (1). The most common is the Radiographic assessment that is a vital component in the identification of endodontic problems such as root perforation. Though, since conventional periapical radiographs provide a 2-dimensional image of a 3- dimensional object, they lack sufficient picture when the perforation is located at the buccal or lingual 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 simultaneously uses two wave forms, a high (8khz) and a low (400hz) frequency wave forms. They have potent microprocessors and can process mathematical quotient and algorithm calculations obligatory to give precise results. They require no graduation and may be applied when canal is filled with a strong electrolyte. (6-8)

On the other hand ELEMENTS^{TM} has the latest, multi frequency technology combined into this generation and an extended apical zoom function, which activates when the file reaches the apical area. Though, there is still a concern as to whether high electroconductive irrigants such as NaOCl can affect these new-generation.

Hence we aimed to study the efficiency of irrigants on the accuracy of 2 electronic apex locators in locating simulated root perforations.

Material and Methodology

We piloted an invitro observation study among 40 single rooted extracted human teeth that were perforated intentionally at the apex. Radiographic imaging was done at the bucco-lingual and mesio-distal angles. Later the crowns were removed at the cemento-enamel junction to obtain constant reference point. The roots were intentionally perforated 5mm from the apex on the proximal root surface at 90^0 with inverted cone bur. Before electronic measurements, the actual lengths up to perforation were calculated under stereomicroscope with 20X magnification.

The specimens were mounted in the alginate. Electronic measurements of the perforations were calculated by the two electronic apex locators Root ZX and the ELEMENTS^{TM} in dry conditions and applying chlorhexidine 2%, EDTA 17%, NaOCl 2.5%, permitting the tolerance of ±0.5mm.

Each canal was irrigated with distilled water and later dried using paper points for all the three irrigants. For the ROOT ZX device, a size 20 K-file with a rubber stop was placed into the canal until an APEX reading was obtained; it was then withdrawn until the last green bar was reached. Similarly for the ELEMENT electronic apex locator file was placed in the canal and the cursor on the tooth showed the progression of file inside the canal by a numerical value on the graphical scale when it reaches the 0.0 orange bar signifying the apex.

The rubber stop was altered, the file was taken out, and the electronic length of the perforations was recorded for different canal conditions. All teeth were calibrated by single researcher, who was aware of the application in the EALs. The differences between the Electron lengths and the actual lengths of the apex perforations were measured. For statistical analysis chi square test

was performed, and P-less than 0.05 was considered as significant.

Results

We observed that there was no significant variation between the two kinds of the apex locators and for the various irrigants. The difference between electronic and actual length of perforations were calculated. Table 1 Most accurate measurement was obtained in dry conditions with accuracy of 75% for ROOT ZX and 60% for ELEMENT apex locators, whereas among the irrigants 3% NaOCl showed the least accurate results. Negative and positive values indicated measurement short and long of actual length. 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 2.

Table 1: Comparison of the three irrigants for the two apex locators.

Type of the apex locator	Irrigants used				
	Dry canal	EDTA 17%	NaOCl 3%	Chlorhex 2%	P value
ROOT ZX (mm)	-0.06 ± 0.51	-0.12 ± 0.51	0.28 ± 1.10	0.16 ± 0.90	0.260
ELEMENT (mm)	0.07 ± 0.54	-0.16 ± 1.12	0.019 ± 0.97	0.17 ± 0.74	0.621

Table 2: Number of the teeth for the accuracy of the two apex locators

	ROOT ZX				ELEMENT			
Distance	Dry conditions	17% EDTA	3% NaOCl	2% chlorhexidine	Dry conditions	17% EDTA	3% NaOCl	2% chlorhexidine
<-0.5	6	8	12	8	6	12	16	6
-0.5 to 0.5	30	28	10	20	24	18	8	20
>0.5	4	4	18	12	10	10	16	14

Discussion

The location and size of the defect, the period between perforation and treatment, a precise evaluation of the location, and the sealing of the perforated site all play a role in the successful treatment of root perforations (1). EALs may be able to precisely pinpoint the site of the apical constriction, apical foramen, horizontal root fracture, and apical root resorption, according to some research (9-13). Furthermore, the effectiveness of apex locators as a tool for locating root perforations has been investigated experimentally in earlier research, with the findings demonstrating that EAL is an adequate approach for detecting root perforations in vitro (3–5, 14).

Perforated teeth have a prognosis that is determined by the location, size, and duration of the perforation, as well as the possibility of sealing the perforation. The ability to accurately diagnose the site of root perforation is critical for successful therapy.

The ROOT ZX's reliability/accuracy is compared to that of the ELEMENT in finding root canal perforations under dry canal circumstances and in several irrigating solutions routinely used in root canal therapy, such as NaOCl, EDTA, and Chlorhexidine.

For in vitro investigation of EALs in perforated teeth, several electro-conductive materials such as agar, alginate, gelatin, and a saline solution have been utilised (4, 5, 15, 16). Alginate was chosen as the embedding medium to model the

periodontium in this investigation because it is easy to handle, stays around the root, has a colloidal consistency that mimics the periodontal ligament, and has enough electro-conductivity (17).

In prior investigations, perforations of 0.60, 0.40, 0.30, and 0.27mm were employed (3, 4, 14, 15). The perforation size in this study was around 1.50 mm, which is bigger than the perforation size in the previous investigations.

The accuracy of the ROOT ZX AND ELEMENT in finding perforated teeth is impacted by varied canal conditions in the current investigation, which is comparable to Shin HS, et al (15), who found that measuring accuracy was related to the contents of the canal.

The results of this study contrast with those of Kaufman AY et al (14) who found that the irrigants utilised had no effect on the accuracy of different EALs in finding root canal perforations.

The varying instruments, techniques, and irrigants utilised in the various research might explain the disparity.

In the current investigation, ROOT ZX and ELEMENT provided the most accurate findings in dry canal circumstances, with 75% and 60% accuracy, respectively. This is comparable to the study done by Altunbas et al, who found the most accurate measurements in dry canals.

The current investigation, however, contrasts with that of Venturi and Breschi (18), who found that Root ZX readings were erroneous and unstable under low conductive circumstances (DRY CANALS).

In the current investigation, DENTAPORT AND ELEMENT gave 70% and 45 percent accuracy with 17 percent EDTA, respectively, which is similar to Kaufman et al (19), who found that ROOT ZX offered more accurate findings in the presence of EDTA.

In this investigation, 2 percent chlorhexidine gave 50 percent accuracy with both apex locators, in contrast to Erdemir et al's earlier work, in which the findings were identical to those of NaOCl, which delivered the least accurate results (20) In the current investigation, 3 percent sodium hypochlorite delivered the least accurate result, with only 25% with ROOT ZX and 20% with ELEMENT, which is similar to the study done by Shabahang S et al., which revealed a higher departure from the real value.

However, it differs from the findings of Duran-Sindren et al (22) who found that NaOCl had no effect on Root ZX and Ipex readings (NSK, Tochigi, Japan).

The use of liquid endodontic irrigants improves the accuracy of root perforation detection. Because the proximal root plane was simulated perforated, good flowing liquid types were beneficial for reaching the outside proximal root surface. According to Shabahang et al., a tolerance of 1.0mm is therapeutically appropriate. (21)

Conclusion

Both technologies identified the root canal perforation within an acceptable range of 0.5mm from the coronal border of the perforation site, notwithstanding the study's limitations. The accuracy of both EALs may be affected by various canal irrigants with varied electrical conductivities. In dry canal conditions, the most precise readings were achieved, with both apex locators falling within ±0.5mm tolerance limits. 3 percent NaOCl produced the least accurate findings among the irrigants, whereas 17 percent EDTA produced the most accurate results. Further research is needed to back up our results.

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