Effect of different endodontic solvents on the effectiveness of two electronic apex locators – An in vitro study

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ABSTRACT:

Aim: *The aim of this in vitro study was to determine the influence of different endodontic solvents on the accuracy of two electronic apex locators in locating the apical foramen.*

Materials and Method: *Eighty human permanent maxillary central incisor teeth were divided into four groups (N=20) according to solvent used and two subgroups according to apex locator used viz; Propex II and Root ZX mini, Group I-Endosolv R, Group II-RC solve, Group III- Eucalyptus oil, Group IV- Chloroform.*

Results: *Statistical analysis using Cochran's Q test and Mann-Whitney U test showed insignificant difference between four endodontic solvents for both electronic apex locators.*

Conclusion: *Within the limitations of this study, Solvents used do not interfere with the functional ability of both the electronic apex locator with no difference between the ability of them to locate the apicalforamen.*

Key Words: *Electronic Apex locator, Working length, Radiographic apex, Apical foramen, Endodonticsolvent.*

INTRODUCTION

The persistance of clinical signs and symptoms along with radiographic evidence of periapical bone destruction indicates the need for endodontic retreatment. The most common cause of retreatment is the incomplete debridement of the root canal space along with defective root canal space obturation(1-3).Therefore the aim of retreatment is similar to the primary treatment that is debridement of the root canal space and to shape it, so as to receive an obturation(4,5). The extent of the chemo-mechanical debridement should be within the root canal and should extend up to minor apical constriction (6). Hence electronic root canal length measurement devices are used as an adjunct to the radiographic techniques(7). The limit is usually located approximately 0.5-1 mm from the anatomic apex(8,9). During conventional tooth length determination the radiographic apex is considered a reference point for establishing canal length. But in most cases, anatomic apex doesn't coincide with the radiographic apex because of 2D imaging in the radiograph which is the limitation.

Since the 1st apex locator introduced by Custer (10) in 1918, a number of different generations of apex locators have been introduced broadly. The 3rd generation apex locators which are based on multiple frequency impedance are accurate in presence of blood, pus, pulp tissue and electrolytes. As the apical constriction is reached in root canal, there is a drastic change in the impedance and capacitance which will be indicated by beep sound by the apex locator.

In retreatment cases the old gutta-percha filling needs to be removed followed by through debridement of the root canal space. Various options for the removal of guttapercha:- (1) K- files or H-files, (2) Gutta-percha solvent, (3) Gates Glidden drill / Peeso reamer, NiTi rotary instruments (4) ProTaper Universal retreatment instruments, M two retreatment files (5) Heat carrier tips, Ultrasonic tips, (6) Soft tissuelaser. In cases where the filling material is difficult to remove, solvents are worthy allies in promoting its dissolution. Several studies have demonstrated the effectiveness of apex locators in determining the working length in retreatment cases(11) but the possible correlation between the apex locators function and use of endodontic solvents has not been investigated. So the aim of this in vitro study was to determine the influence of different endodontic solvents on the accuracy of two electronic apex locators in locating the apical foramen.

MATERIALS AND METHODS

Eighty human permanent maxillary central incisor teeth were divided into four groups (N=20) according to solvent used and two subgroups according to apex locator used.

Table 1: Groups

Sr. no.			
Groups (N=20)	**Subgroups**		
	Electronic apex locators		
		Root ZX mini	Propex II
1	Endosolv-R	(N=10)	(N=10)
2	RC Solve	(N=10)	(N=10)
3	Eucalyptus oil	(N=10)	(N=10)
4	Chloroform	(N=10)	(N=10)

The crowns of the teeth were sectioned with diamond disk to facilitate canal access and establish a flat reference point. Initial root length was established using a 15# k file until its tip was visible at apical foramen using optical microscope at 8X magnification and after adjusting silicon stop at cervical limit, the file was removed and the distance was measured with the help of endodontic ruler (Dentsply). This initial root length was compared with a corresponding electronic measurement with a safety margin of ±0.5 mm. Canals were sequentially instrumented with rotary protaper system S1, S2, F1, F2 till F3. After instrumentation, canal length was again directly measured by visualizing the apex and the file. This was recorded as actual working length. For electronic root measurement the roots were immersed in plastic container containing freshly mixed alginate (Jeltrate, Dentsply, Brazil). The file was placed in the roots and electronic working length was recorded. They were calculated as AWL – EWL(AWL-Actual Working length, EWL- Electronic Working Length). The negative value is considered as beyond and positive value as short. Samples were divided into four groups with 20 samples each (n=20). Each canal was again filled with 0.2ml of different endodontic solvent. Working length was again measured. The file was introduced into canal until the 'APEX' position of device went on. Silicon stop was adjusted at cervical limit, the file was removed and the distance was measured with the help of endodontic ruler (Dentsply) like previously.

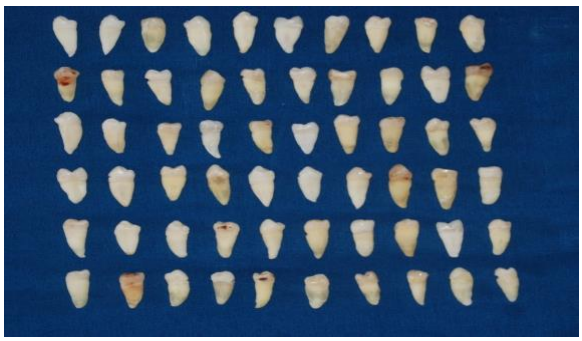


Fig. 1: Samples

Fig. 2: Root ZX mini

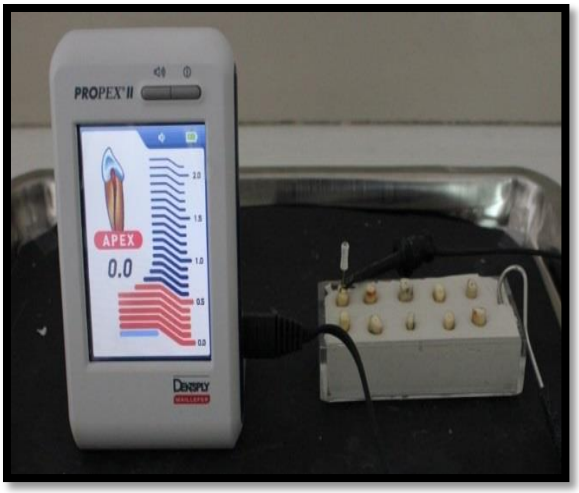


Fig. 3: Propex II

RESULTS

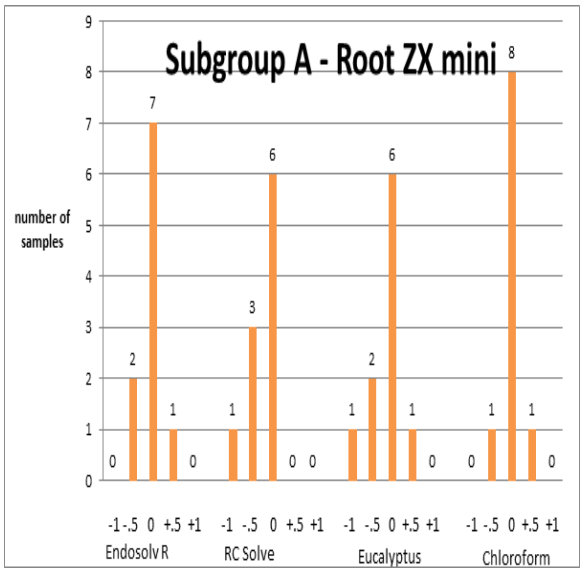
The electronic and visual measurement of both the apex locators coincided with 90% of the times with RC Solve and Eucalyptus oil and 100 % with Endosolv R and Chloroform solvents when tolerance limit set to±0.5. Statistical analysis using *Cochran's Q* test showed insignificant difference between the four endodontic solvents for both electronic apex locators. (Cochran's *Q = 1.222, p = 0.748* for both the apex locators). Statistical analysis using *Mann-Whitney U* test showed insignificant difference between the ability of two electronic apex locators to locate the apex for a given solvents.*(p = 0.423, 1.000, 0.518, 1.000)* respectively.

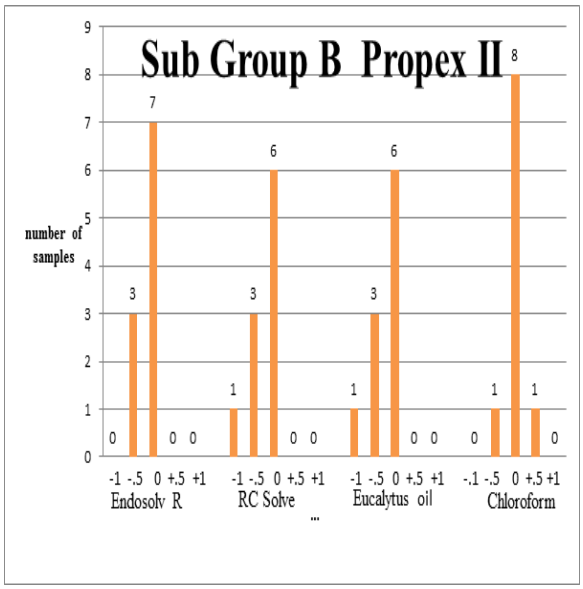
Table 2:

Sr no.					
Groups(N=20)	Subgroups				
	Electronic Apex Locators				
		Root ZX mini (A)		Propex II (B)	
		Value frequency		Value frequency	
		0	1	0	1
1	Endosolv-R	7	3	7	3
2	RC Solve	6	4	6	4
3	Eucalyptus oil	6	4	6	4
4	Chloroform	8	2	8	2

*Cochran's Q = 1.222 , p = 0.748

0 is value frequency at 0 and 1 is value frequency other than 0





DISCUSSION

The cemento-dentinal junction (CDJ) where the pulp tissue changes into the apical tissue is the most ideal physiologic apical limit of the working length. It is also referred to as the minor diameter or the apical constriction. This position may vary but is usually 0.5 to 1.0 mm short of the centre of the apical foramen.(8,9) However, It must be pointed out that the cementodentinal junction is a histologic landmark that cannot be located clinically or radiographically. So radiographic apex is most widely accepted.

Langeland (12) reported that the cementodentinal junction does not always coincide with the apical constriction. Locating the appropriate apical position always has been a challenge in clinical endodontics. There has been debate as to the optimal length of canal preparation and the optimal level of canal obturation. Most dentists agree that the desired end point is the apical constriction, which is not only the narrowest part of the canal but a morphologic landmark that can help to improve the apical seal when the canal is obturated. Once the apical restriction is established, it is extremely important to monitor the working length periodically since the working length may change as a curved canal is straightened. That's why single rooted straight teeth have been chosen in thisstudy.

In the present study, the crowns of the teeth were sectioned to establish a steady reference for measurement taking. The orifices of the roots were enlarged using Gates-Glidden as suggested in many studies. Single operator performed the measurement to reduce possibility of variation while interpreting the readings. Several studies have demonstrated the effectiveness of apex locator in determining the working length(11), however not enough studies were available investigating whether endodontic solvents might interfere with proper functioning of different apex locators. Hence this study wastaken.

The methodology used during EWL determination was modified from Alves et al (11) and Kaufman et al (13). An insulating mould was filled with freshly mixed alginate (Jeltrate, Dentsply, Brazil). The electrical resistance of the periodontal ligament is same as that of alginate. So, To achieve complete electrical circuit, alginate is used in the mould to simulate the periodontal ligament in this study.

Chloroform and Eucalyptol have been used as solvents since 1850 (14). Chloroform, although an excellent solvent (15). Studies confirm that substances when placed in the tooth pulp chamber, have access to periapical tissue and the circulatory system (16). Evaluation of chloroform use in dental practice showed that controlled and careful use can be valuable. The Food and Drug Administration does not have jurisdiction to prohibit the use of chloroform by dentists and does not have proof that it is carcinogenic to humans (17). Chutich et al. (18) demonstrated that it does not have a toxic risk in patients when a minimal quantity of solvent is used. It should be noted, however, that much larger amounts of chloroform must be used than other solvents studied due to its volatility.

Trying to minimize this conflict between effectiveness and toxicity, eucalyptol, a widely used substance for flavoring and fragrance, has been used as a solvent without harmful effects (19). Eucalyptol is the most commonly used solvent by professionals. However, studies testing the performance of some alternatives to chloroform conclude that, at room temperature, eucalyptol dissolves very slowly in comparison to other solvents(19). When it is heated, its dissolution effect increases(20).

RC solve is a gutta-percha & zinc oxide eugenol cement solvent. It has controlled penetration to avoid apex seal. RC solve contains orange oil

which was initially presented as an essential oil as disintegration solvent of Zinc Oxide Eugenol sealer(21). Pécora et al.(19) reported that orange oil softened gutta-percha cones in endodontic retreatment with results similar to xylol and could be used as an alternative solvent.

Endosolv R contains 66.5 % Formamida and 33.5 % phenylethylicalcohol. It helps to remove phenolic resin-based root canal sealers. It is an efficient solvent which has high softening potency for saving of time. It reduces the risks associated with use of power driven instruments during mechanical gutta-percha removal.

Since different guttapercha solvent has different chemical structure with different properties, they may have variable accuracy in determining the working length with the Propex II and Root ZX mini. But in our study shows no any significant change in working length with the both above used apex locators.

The electronic apex locator (EAL) machine has attracted a great deal of attention because it operates on the basis of the electrical impedance rather than by a visual inspection. Indeed, EALs currently are being used to determine the working length as an important adjunct to radiography. EALs help to reduce the treatment time and the radiation dose which may be higher with conventional radiographic measurements. However, some questions still exist as to whether the accuracy of EAL can be affected by the different types of electrolytes the types of electronic working mechanism, and the conditions of the root canal.

Propex II apex locator (Dentsply, Maillefer, France), a multi-frequency–based electronic root canal length measurement device differs from Root ZX mini (J Morita Corp, Tokyo, Japan) in terms of number of sine wave frequencies used. The calculation of the impedance is based on the energy of the signal in contrast to amplitude of the signal which is used by Root ZX mini. Both of the electronic root canal length measurement devices work independently of the canal contents. The results of the present study showed that there was no statistically significant influence of different endodontic solvents on the accuracy of both electronic root canal length measurement devices. Also there was no difference between Root ZX mini and Propex II during retreatment.

It has been shown in the literature that the distance between the apical constriction and the apex ranges from± 0.5–1.0 mm.(8,9) Therefore in the present study, the AWL was recorded by subtracting 0.5 mm from the measurement obtained when file appeared at the foramen. During EWL determination, the file was advanced to penetrate the apex and get a warning signal and then retract the file to get a consistent 0.0 (Root ZX mini) and 0.0 (Propex II) signal.

The working length was electronically obtained before and after biomechanical preparation. The success of both electronic root canal length measurement devices was obtained for tolerance limits of ±0.5 mm and ±1.0 mm. The apical zone can have a wide range of shapes and the distance between the apical constriction and the apex ranges from 0.5–1.0 mm.(8,9) Various authors have taken an error range of 0.5 mm to assess the accuracy of the electronic root canal length measurement devices whereas some have relaxed the limit to 1.0 mm. In the previous studies, Root ZX mini (J Morita Corp, Tokyo, Japan) and Propex II (Dentsply, Maillefer, France) gave 83% and 93% success rates respectively for a tolerance limit of 0.5 mm(13). These values were comparable with results in our study.

There are studies done by several authors showing the accuracy of apex locators; namely the Root ZX mini, the Mini Apex Locator, the Root ZX and the Elements Diagnostic Unit and these were not affected by the type of retreatment solution present in the root canal. In addition, the accuracy of these apex locators was similar in the presence of each of the tested solution; viz. chloroform, orange solvent or eucalyptol. These study results are similar to our study result but the apex locators used are different.

CONCLUSION

Within the limitations of the present study, Solvents used do not interfere with the functional ability of both the electronic apex locators. There is insignificant difference between the ability of Propex II and Root ZX mini to locate the apex for solvents used which in turn indicating that both apex locator would measure the working length accurately in presence of above used endodontic solvent.

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