ORIGINAL ARTICLE

Shahriar Shahi[1] *DDS, MS*, **Saeed Rahimi**[2] *DDS, MS*, **Amin Salem Milani**[3*] *DDS, MS*, **Mohammad Asghari Jafarabadi**[4] *PhD*, **Gholam Reza Djoorabbaf Naghsh**[5] *DDS*

Comparison between the accuracy of NovApex apex locator and radiographs in determining radiographic apex

1. Associate Professor of Endodontics, Dental and periodontal disease research center, Dental School, Tabriz University of Medical Sciences, Tabriz, Iran.
2. Associate Professor of Endodontics, Dental School, Tabriz University of Medical Sciences, Tabriz, Iran.
*3. Assistant Professor of Endodontics, Dental and Periodontal disease research center/Dental School, Tabriz University of Medical Sciences, Tabriz, Iran. *Correspondence author E-mail: Amin.salemmilani@gmail.com*
4. Assistant professor of Statistics and Epidemiology, Health and Nutrition School, Tabriz University of Medical Sciences, Tabriz, Iran.
5. Dentist, Private Practice.

INTRODUCTION: Determination of the canal working length with radiographs has many drawbacks. Electronic apex locators have been developed to overcome some of these problems. Recently, a newly designed apex locator called NovApex has been introduced. All the studies conducted to determine the accuracy of NovApex have been carried out *in-vitro* on extracted teeth. The aim of this *in vivo* study was to evaluate the accuracy of NovApex compared with traditional radiographic method.

MATERIALS & METHODS: Twenty-five patients whose lower molars that were candidates for extraction were selected. The teeth were accessed, and the radiographic working length was determined by measuring the length of the initial file 0.5mm short of the radiographic apex. Then, NovApex apex locator was used to measure the electronic working length. Subsequently, the tooth was extracted, and the actual working length was measured by introducing a size #15 K-file into each canal until the file tip was visible at the apex, then 1.5mm was subtracted to attain the working length. Cohen's Kappa was computed for each of the methods versus actual working length as a measure of reliability. The accuracies were compared using Chi-square test.

RESULTS: The accuracy of NovApex apex locator and radiographic method in detecting the apical end point within ±0.5mm was 74.7% and 68%, respectively; this was not significantly different (P<0.001).

CONCLUSION: The NovApex apex locator is useful in detecting the apical end point with the accuracy similar to radiographic method. However, neither technique is fully reliable in detecting the apical end point of the canal.

KEYWORDS: Electronic apex locator, NovApex, Radiographic Image Interpretation.

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INTRODUCTION

Adequate cleaning and disinfection of the root canal system is required for successful treatment. Therefore, accurate detection of apical end point of the canal is a crucial step in endodontic treatment. Sjogren *et al.* showed that teeth filled within 0 to 2mm from the apex enjoyed 94% success rate, falling to 76% in over-filled teeth and to 68% in under-filled teeth (≥2mm) (1). Several methods have been used to determine the working length. Radiographic method is the most widely used technique. However, this method gives a two-dimensional image of the roots, and determination of the working length by this method is not always accurate (2).

Furthermore, superimposition of other structures usually makes working length determination difficult (3,4). Tooth inclination and angulation of the x-ray tube also influence the results (5). Custer for the first time proposed an electronic method to determine root canal length (6), and later, another researcher invented the first electronic apex locator (EAL) (7). Since then, different generations of EALs have been developed. The main concern in using EALs is the accuracy of the measurements. The measurements made by early devices were influenced by canal contents, remnants of pulp tissue, bleeding or pus (8,9). However, new generations claimed to have more accuracy and less sensitivity to canal contents. Recently, a newly designed EAL NovApex (Forum Technologies, Rishon Le-Zion, Israel) has been introduced. This device utilizes voltage differences and operates on the principle that impedance differs between two electrodes, depending on the frequencies used, and also differs greatly on the apical constriction (4). Since the introduction of NovApex, several studies have been carried out to evaluate its accuracy which showed that the accuracy of NovApex in detecting the apical end point of the canal is more than 80% (4,10,11). However, all of these studies were carried out *in vitro* on extracted teeth, and the condition in which the measurements were performed did not completely simulate the clinical situation. The aim of this study was to evaluate the accuracy of the Nov Apex *in vivo* and compare it with traditional radiographic method.

MATERIALS & METHODS

The study protocol was in accordance with the Declaration of Helsinki, as revised in 2004 (12). Twenty-five patients whose lower first or second molar with the diagnosis of irreversible pulpitis was candidate for extraction were selected. The diagnosis was confirmed by thermal tests. Written informed consent was obtained from the volunteers. A periapical radiograph with paralleling technique was obtained as the initial radiograph. If there was any sign of previous root canal therapy or canal obliteration, the case would not be included. The tooth was anesthetized with inferior alveolar nerve block injection of 1.8 mL of 2% lidocaine with 1:80,000 epinephrine. After access cavity preparation and tooth isolation, the coronal pulp was removed using a spoon excavator. If the pulp looked non-vital or partially necrotic, again the case was not included. The canals were negotiated with a size #15 K-file (Maillefer, Ballagius, Switzerland). The radiographic working length (RWL) was estimated from the initial radiograph 0.5 mm short of the radiographic apex and confirmed with another radiograph with a proper initial file in place. Then, another operator measured the electronic working length (EWL) using NovApex apex locator (Forum Technologies, Rishon Le-Zion, Israel). For this purpose, the access cavity was dried with cotton pellets. Then, the EWL was measured using a size 20 Flexofile (Maillefer, Switzerland) attached to the file holder of the apex locator. The file was advanced apically until the signal indicated the apical foramen. The file was retracted until the digital display read 0.5mm. The measurements were made twice, and the mean was recorded as the EWL of the canal. Subsequently, the tooth was extracted and cleaned with a periodontal curette under running water. A size #15 K-file (Maillefer, Ballagius, Switzerland) was inserted into each canal until the file tip was visible at the apex under stereomicroscope (Carl Zeiss, CITY Germany) at ×20 magnification. One half millimeter was subtracted from this length and recorded as the actual working length (AWL).

Statistical analysis

Statistical analysis was performed by SPSS for windows (SPSS Inc, Chicago, IL). The significance level was set at 0.05. The accuracy of the NovApex apex locator and radiographic method was calculated within ±0.5mm. Chi-square test was used to compare the accuracy of the two methods. Cohen's Kappa was computed for each of the methods versus actual working length as a measure of reliability (agreement). Values over 0.75 confirm a fair reliability of the results.

RESULTS

The accuracy of NovApex apex locator and radiographic method within ±0.5mm was 74.7% and 68%, respectively which was not significantly different (χ^2=.815, df=1, P=0.367) (Table 1).

Table 1. Accuracy of electronic and radiographic methods vis-à-vis actual working length method

Method	Accurate (n)	Accurate (%)
EWL[§] vs. AWL[¶]	56/75	(74.7%)
RWL[#] vs. AWL	51/75	(68%)

§ Electronic working length; ¶ actual working length; #radiographic working length
χ^2=0.815, df=1, p=0.367. Cohen's Kappa = .773, P<0.001

DISCUSSION

The determination of working len gth is a key factor for successful endodontic treatment. The electronic working len gth measurement has become increasingly popular because it eliminates many of the problems associated with traditional radiographic methods (13). Since the introduction of electronic apex locators, various studies have evaluated the accuracy of these devices (13). These studies analyze a range of brands of apex locator and the methods to measure the accuracy (2,10,11, 13-23). Most of these studies were carried out *in-vitro* on extracted teeth (2,10,11,14, 16-28). The present study was performed in an *in-vivo* condition to increase clinical relevancy of the results. This study showed that accuracy of NovApex apex locator within ±0.5mm was 74.7%. We used a tolerance limit of ±0.5 as it is considered to be the strictest acceptable range (29). However, some older studies rely on a more flexible clinical range of ±1.0mm (30). An *ex vivo* study carrie d out by Dبـ Assuncao *et al.* on extracted teeth showed that the accuracy of NovApex in determining the apical foramen within ±0.5mm was 82.1% (4). The apical end point used in that study was the apical foramen. However, in our study, 0.5mm short of the apical foramen was considered as the apical end point, and the electronic measurements were performed *in-vivo*. In another *in-vitro* study, the electronic measurements obtained with NovApex in retreatment cases showed an accuracy of 85% (within ±0.5mm of the apical constriction) (11). Although the accuracy value obtained in our study is less than above mentioned *in vitro* studies, it has relatively high accuracy similar to the radiographic method (Table 1). One study showed that NovApex is able to detect the position of the horizontal root fracture in extracted teeth with accuracy of 70% within ±0.5mm of the fracture line (10). Because our study was performed in a real clinical situation, the clinical validity of the results is greater than the above mentioned studies. Previous studies showed no statistically significant difference between NovApex and Root ZX (4,10,11). It is recommended that this conclusion also be confirmed in real clinical situations.

The results of our study demonstrated that the accuracy of NovApex apex locator in detecting the apical end point of the canal is more than traditional radiographic technique (74.7% *vs.* 68.0%); although the difference was not statistically significant (P>0.05). This result is in accordance with other studies that compared the accuracy of electronic apex locators with radiographic technique (13,31).

CONCLUSION

It can be concluded that NovApex is useful for measuring the working length with accuracy similar to traditional radiographic methods. However, neither technique has 100% reliability in detecting the apical end point of canals.

Conflict of Interest: 'none declared'.

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