Recent Advances in Apex Locators- A Review

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Abstract

Apex locator is an electronic device used in endodontics that determines the position of the apical construction and it determines the root canal space length. Usually the correct working length determination is identified by using radiograph ,but electronic apex locators are being used increasingly nowadays. These electronic apex locators reduce the number of radiographs required and assist where radiographic methods create difficulties. Detection of root canal perforation is also considered as one of the roles of an apex locator. The benefit of apex locators include that these devices are much less affected by fluid conductive media in the canal. Some experience in the use of the apex locator will allow the clinician to recognize the differences immediately. It is used to find the working length determination, cementing the file in place, extracting the tooth and locating the file under magnification in the root canal . This review assesses the advantages and advances that would enable the use in dentistry and determination of working length.

Keywords: *Apex locators; Root canal; Radiograph; Apical foramen.*

Introduction

Apex locator is an electronic device used to measure the length of the root canal space. Removal of pulp tissue, necrotic material and microorganisms from the root canal is essential for the endodontic therapy. The development of the electronic apex locator has helped to make their assessment of the working length more accurate and predictable. The use of any electronic apex locator in combination with other radiographs is of greater precision in the determination of length of the root canal [1]. First generation apex locators use the resistance method for determining working length. This instrument measured the opposition of flow of current and was named as resistance-based apex locators. There are some modifications made under new machines that use the less than 5 microA were introduced. New machine is an endodontic meter S II [2]. Some of the previous researches have evaluated intracanal medications used, instrumentation methods on postoperative pain [3,4] Second generation apex locators use the impedance method for working length determination. These instruments measure an opposition of flow of alternating current and are named as impedance based apex locators. This utilises the current of a single sequence. Few examples are Formatron IV, Sono explorer and Endocater[5]. The determination of endo motor integrated apex locators is used [6] .Third generation apex locators use frequencies instead of a single one to measure the impedance in order to determine the working length. This is called comparative impedance type apex locator and frequency-based apex locators. Examples are Endex and Root ZX apex locators[7].

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Root ZX can be used to safely and conveniently locate the apical foramen and this will reduce the number of radiographs taken. There will be a reduction or decrease in the impedance when the instrument reaches the apical constriction[8]. Fourth generation apex locators use multiple frequencies to measure the impedance to find the working length. Multi frequency measurement system is used to calculate the distance from tip of the file to foramen by measuring the changes in the impedance between the electrodes. Examples are canal pro apex locators [9]. Although certain development of fifth and sixth generation apex locators are coming up.Negotiation of canals is mostly reported in case of endodontic therapy [10,11]. Veneers and laminates help in enhancing the shape of the teeth [12,13]

GENERATIONS	EXAMPLES	OPERATIVE BASE
FIRST GENERATION	Root canal meter, Endodontic meter, Dentometer, Endo radar.	Measurements of electrical resistance.
SECOND GENERATION	Sono explorer, Endocater, Digipex, Formatron IV, Endodontic meter S II.	Measurements of electrical impedance.
THIRD GENERATION	Endex or Apit, Root ZX, Dentaport ZX, Endod, Mini apex locators, Endy, Apex finder.	Using two different frequencies at the same time in order to measure difference or ratio between two currents.
FOURTH GENERATION	Bingo 1020, Raypex 4, Propex apex locators, Novapex, Ipex, Apex DSP.	Using two or more non-simultaneous continuous frequencies in order to measure the difference or ratio between two currents.
FIFTH GENERATION	Propex II, Apex locator joypex 5, I-Root, Raypex 5.	Measures the capacitance and resistance of the circuit separately.

Materials and Methods

A systematic review was done in manuscript preparation. The systems and databases search from relevant articles from Pubmed and Google scholar. Databases of intended journals were searched for keywords in this review.

Discussion

BINGO 1020 APEX LOCATORS

Bingo 1020 claims to be the fourth generation apex locating device and its unit uses two separate frequencies of 400 Hz and 8 kHz similar to the current third generation units [14]. The study found that bingo 1020 is found to be as reliable as the Root ZX and also user-friendly. It is also accurate as Root ZX , that is easier for a beginner to use briefly in the canals. Bingo and apex finder model instruments or more accurately without flaring [15,16].

PROPEX APEX LOCATORS

Propex is a multi frequency-based apex locator that is based on the same principle of other such modern devices that use multiple frequencies to determine the root canal length. One of the important characteristics of a propex is that the calculation is based on the energy of the signal, whereas other apex locators use the amplitude of the signal [17]. Propex is the most clinically suitable apex locator. In the majority of the cases, propex determined the apical constriction with high accuracy. After extirpation of the pulp, the smallest distance to the apex locator is obtained, determining that it is more accurate [18].

IPEX APEX LOCATORS

The ipex apex locators claimed to be a fourth generation apex locator, but it can measure the capacitance and resistance simultaneously to determine the location of their file tip of the canal [19]. Ipex apex locators were able to determine the accuracy of the working length in multi rooted primary teeth[20].

PROPEX II APEX LOCATORS

Propex II apex locators are the multi frequency based apex locator that is based on the fifth generation apex locator that uses multiple frequencies to determine the length of the root canal. It measures the energy of the signal with multi signal frequencies [21,22]. Propex II was more accurate than the radiographic method in determining the working length of the root canal [23]. In certain studies, it was concluded that propex II and Root ZX apex locators were able to determine the position of the apical foramen accurately [24].

RAYPEX 5 APEX LOCATORS

Raypex 5 apex locators are the fourth-generation device that uses two units that are 400 Hz and 8 kHz . It is performed equally well irrespective of the irrigant used. Irrigant solutions did not affect the accuracy of the working length[25] . Previous study based on the comparison of accuracy of Raypex 5 and Root ZX determined . There observed a slight decrease in both apex locators in the presence of blood in the root canal. It is considered that clinicians consider the possibility of a decrease. Therefore Raypex 5 and a Root ZX electronic apex locators are not influenced by the presence of blood in the root canal space [26]

SIXTH GENERATION APEX LOCATORS

Sixth generation apex locators served as the efficient diagnostic tool for detecting root perforations as they are based on impedance principle rather than the conventional gradient method [27]. The method of measuring the working length of the canal depending on the canal's moisture, implemented in the first Bulgarian apex locator . It is so called a sixth generation that is an adaptive type. Measurement with an adaptive apex locator provides for eliminating the necessity of drying or moistening the canal .This adaptive apex locator overcomes the disadvantage of popular fourth generation lower accuracy on working with canals and also devices of fifth generation difficulty in working dry canals. They continuously define humidity of the canal and immediately adapt to the dry or wet canal [28].

WORKING LENGTH DETERMINATION

Working length is the distance from the coronal reference point to the point in which the canal preparation terminates. Working length for instrumentation should be established at the level of apical constriction[29]. Accurate determination of working length is one of the key factors

in endodontic therapy. Electronic apex locators reduce the number of radiographs required and also helps in assisting the radiographic methods of working length determination [30,31]. One of the previous studies compared the accuracy of Dentaport ZX, Raypex 5 and elements of diagnostic units in establishing the working length. It is concluded that none of the tested devices or electronic apex locators show the full accuracy on working length determination [32]. The anatomical variations in apical constriction location, size, type of tooth and age makes the working length determination unreliable [33,34]. One of the reasons about the radiographic rate determination of the working length is, it lacks accuracy based on radiographic apex rather than the terminus. Working length is obtained with the radiograph by positioning the tip of the file from the radiographic apex . It is found that working length is based on the location of the minor foramen rather than the apex[35].

CLINICAL FEATURES AND PATIENTS USE

Root perforation is a serious dental complication that occurs in 3 to 10 percent of the root canal treatments. Perforations at the periodontal ligament are diagnosed and detected earlier and immediate treatment is required for those conditions. New generation electronic apex locators may be considered as the reliable aid in detecting the root perforations [36,37]. Patients with resin modified glass ionomer restoration have no sensitivity. Endoactivator influences postoperative pain than the endodontic needle.[38,39] Calcifications and dental shavings interfere with the performance of the apex locator and it is shown that packing of the debris in the apical third of the canal will affect the accuracy of these electronic apex locating devices. It is considered that pre-flaring of the can also improve the efficacy of the Apex locators[40]. Protaper as rotary instruments are used in CBCT root canal preparation Apex locators can reduce the patient's radiation exposure and better determine the working length.[41] Electromagnetic interference from dental instruments including electronic apex locators has the potential to interfere with the cardiac pacemakers [42,43].

Table : 2 : Comparison of apex locators and technique of working length determination based on the previous studies

STUDY	TYPE OF EALs STUDIED	AIM OF THAT STUDY	RESULTS
Saatchi M et al.,2016 25	Raypex 5 apex locators	Comparison of Raypex 5 with radiography in determination of working length.	No significant difference seen.
Weiger R et al., 1999 23	Propex II Apex locators	Comparison of Propex II and radiography in working length determination.	Propex II is more accurate than the radiography.
Tinaz AC et al.,2002 17	Propex	Comparison of propex and radiography in the working length determination.	propex is more accurate than the radiography.
Cianconi L et al.,2010 29	Root ZX and Propex apex locators	comparison of EALs and radiography in working length determination.	It is found that Root ZX and propex is more accurate than radiography.
Stober EL et al.,2011 20	Root ZX	Comparison of Root ZX and radiography in working length determination.	No significant difference seen.
Plotino G et al.,2006 18	Root ZX, Elements diagnostic, precision AL and Raypex 5.	Comparison of EALs and other methods of working length determination.	EALs are more accurate than others.

Conclusion

From this type of review study, some advances, clinical efficacy and generations of apex locators are included. Proper data for this study is not fully available. Future research should elaborate on the advanced techniques in using apex locators clinically and use of the patient is mostly required. Apex locators generation should be elaborately required.

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