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ELECTRONIC APEX LOCATOR: A REVIEW

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ABSTRACT
The establishment of a correct working length is one of the fundamental parameters for endodontic success. Traditionally this has been determined using radiography, but electronic apex locators are increasingly being used. The use of an electronic apex locator in combination with the radiograph is greater precision in the determination of root canal length. This review highlighted about various generation of apex locator and it uses in root canal determination.

KEYWORDS: Electronic apex locator (EAL), endodontics, root apex, working length.

INTRODUCTION

Electronic apex locators (EALs) have been used clinically for more than 40 years as an aid to determine the file position in the canal. These devices, when connected to a file, are able to detect the point at which the file leaves the tooth and enters the periodontium. An electronic method for root canal length determination was first investigated by Custer. Although the term "**apex locator**" is commonly used and has become accepted terminology, it is a **misnomer**. Some authors have used other terms to be more precise such as **electronic root canal length measuring instruments** or **electronic canal length measuring devices.**[1]

The success rate of conventional root canal treatment is predictably high, as long as the basic principles of endodontic treatment are followed. Accurate determination of root canal length is particularly important to the success of root canal treatment: cleaning, adequate shaping and complete filling of the root canal system cannot be accomplished unless the correct working length is established and if the canal length is known, damage to the periapical tissues and procedural accidents such as ledging can be avoided by confining instruments and root filling materials within the root canal system.[2]

HISTORY OF ELECTRONIC APEX LOCATORS

An electronic method for root length determination was first investigated by Custer (1918). The idea was revisited by Suzuki in 1942 who studied the flow of direct current through the teeth of dogs. He registered consistent values in electrical resistance between an instrument in a root canal and an electrode on the oral mucous membrane and speculated that this would measure the canal length (Suzuki 1942). Sunada took these principles and constructed a simple device that used direct current to measure the canal length. It worked on the principle that the electrical resistance of the mucous membrane and the periodontium registered 6.0 kX in any part of the periodontium regardless of the persons age or the shape and type of teeth (Sunada 1962). Using direct current caused instability with measurement and polarization of the file tip altered the measurement.[3]

GENERATIONS OF APEX LOCATOR

FIRST GENERATION ELECTRONIC APEX LOCATORS

Also known as **resistance apex locators**, they measure opposition to the flow of direct current or resistance. When the tip of the file reached the apex in the canal, the resistance value is 6.5 kΩ (current 40 µA).

The disadvantage of 1st generation EAL devices is the pain was often felt due to high electric currents. Today, most 1st generation EAL devices are off the market.[4]

SECOND GENERATION ELECTRONIC APEX LOCATORS (2GEALS)

Also known as **impedance apex locator**, they measure opposition to the flow of alternating current or impedance. In 1972, **Inoue** developed **Sono-Explorer** (Hayashi Dental Supply, Tokyo, Japan), one of the earliest of the 2nd generation EALs.

The major **disadvantage** of 2nd generation EALs is that the root canal has to be reasonably free of electroconductive materials to obtain accurate readings.[5]

The presence of tissue and electroconductive irrigants in the canal changes the electrical characteristics and leads to inaccurate, usually shorter measurements.[6]

THIRD GENERATION ELECTRONIC APEX LOCATORS (3GEALS)

Third-generation EALs are similar to the 2GEALs except that they use multiple frequencies to determine the distance from the end of the canal. These units have more powerful microprocessors and are able to process the mathematical quotient and algorithm calculations required to give accurate readings.[7]

The Endex/Apit

Endex (Osada Electric Co., Tokyo, Japan) In Europe and Asia, this device is available as the Apit. The device operates most accurately when the canal is filled with electrolyte such as saline or sodium hypochlorite. The disadvantage of this device needs "reset" or "calibrated" for each canal.[8]

The Root ZX

The Root ZX (J. Morita Co., Kyoto, Japan), a 3GEALs that uses dual-frequency and comparative impedance principles, was described by Kobayashi & Suda7. The electronic method employed was the "ratio method." The Root ZX simultaneously measures two impedances at two frequencies (8 and 0.4 kHz) inside the canal. A microprocessor in the device calculates the ratio of the two impedances. The quotient of the impedances is displayed on a liquid crystal display meter panel and represents the position of the instrument tip inside the canal. The Root ZX mainly detects the change in electrical capacitance that occurs near the apical constriction.[9]

FOURTH GENERATION ELECTRONIC APEX LOCATORS (4GEALS)

Fourth Generation EAL's (Example: Elements Diagnostic, Sybron Endo, Orange, CA) measure resistance and capacitance separately rather than the resultant impedance value (impedance being a function of resistance and capacitance).[10]

Bingo 1020/Ray-Pex 4

The Bingo 1020 (Forum Engineering Technologies, Rishon Lezion, Israel) claims to be a fourth generation device and the unit uses two separate frequencies 400 Hz and 8 kHz similar to the current third generation units. The manufacturers claim that the combination of using only one frequency at a time and basing measurements on the root mean square values of the signals increases the measurement accuracy and the reliability of the device.[11]

Elements Diagnostic Unit and Apex Locator

A new unit to the market in 2003 is the Elements Diagnostic Unit and Apex Locator (Sybron Endo, Anaheim, CA, USA). The device does not process the impedance information as a mathematical algorithm, but instead takes the resistance and capacitance measurements and compares them with a database to determine the distance to the apex of the root canal.[12]

FIFTH GENERATION EIECTRONIC APEX LOCATORS (5GEALS)

They measure the resistance and capacitance separately rather than the resultant impedance value. There can be different combination of values of capacitance and resistance that provides the impedance thus the same foraminal reading.[13]

Currently, fourth and fifth generation devices are mostly employed. What is typical of the fourth generation devices is that they measure and compare the complex electrical characteristic features of the RC through two or more frequencies of electrical impulses.[14]

Raypex 5 (VDW, Munich, Germany).

Wrbas et al. compared the accuracy of two EALs: Root ZX and Raypex 5, under clinical conditions, in detecting the minor diameter in the same tooth. They reported that the minor diameter was located within the limits of ±0.5 mm in 75% of the cases with the Root ZX and 80% of the cases with Raypex 5.

SIXTH GENERATION APEX LOCATORS

The sixth generation apex locator is manufactured in compliance with the requirements of ISO 13 485. A series of comparative tests have been made to confirm conformity. Due to modern technology, the sixth generation adaptive apex locator is a pleasant, small-sized device no larger than a dentists palm. The measuring mode provides for graphic information to be displayed on colour multimedia displays.[15]

USES OF ELECTRONIC APEX LOCATOR

- 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 measurement.[17]
- Working length estimation with electronic apex locator help to avoid overestimation beyond the apical foramen.
- Electronic apex locator measurements may help to avoid overestimation beyond apical foramen in premolars. All modern apex locators are able to detect root perforations to clinically acceptable limits.[2O]

CONCLUSION

No individual technique is truly satisfactory in determining endodontic working length. The CDJ is a practical and anatomic termination point for the preparation and obturation of the root canal and this cannot be determined radiographically. Modern electronic apex locators can determine this position with accuracies of greater than 90% but still have some limitations. Knowledge of apical anatomy, prudent use of radiographs and the correct use of an electronic apex locator will assist practitioners to achieve predictable results.

REFERENENCES

1. American Association of Endodontists (1984) An Annotated Glossary of Terms Used in Endodontics. Chicago, IL: American Association of Endodontists, 1–3.
2. Apex Locator Bingo – '1020' (1999) User Manual Revised. Rishon Lezion, Israel: 5–7M Forum Engineering Technologies (96) Ltd.
3. Arora RK, Gulabivala K (1995) An in vivo evaluation of the ENDEX and RCM Mark II electronic apex locators in root canals with different contents. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics, 79: 497–503.
4. Aurelio JA, Nahmias Y, Gerstein H (1983) A model for demonstrating an electronic canal length measuring device. Journal of Endodontics, 9: 568–9.
5. Azabal M, Garcia-Otero D, de la Macorra JC (2004) Accuracyof the Justy II apex locator in determining working length in simulated horizontal and vertical fractures. International Endodontic Journal, 37: 174–77.
6. Baggett FJ, Mackie IC, Worthington HV (1996) An investigation into the measurement of the working length of immature incisor teeth requiring endodontic treatment inchildren. British Dental Journal, 181: 96–8.
7. Beach CW, Bramwell JD, Hutter JW (1996) Use of an electronic apex locator on a cardiac pacemaker patient. Journal of Endodontics, 22: 182–4.
8. Berman LH, Fleischman SB (1984) Evaluation of the accuracyof the Neosono-D electronic apex locator. Journal of Endodontics, 10: 164–7.
9. Blank LW, Tenca JI, Pelleu GB Jr (1975) Reliability of electronic measuring devices in endodontic therapy. Journal of Endodontics 1, 141–5.
10. Campbell D, Friedman S, Nguyen HQ, Kaufman A, Keila S (1998) Apical extent of rotary canal instrumentation with an apex-locating handpiece in vitro. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics, 85: 319–24.
11. Cederberg RA, Tidwell E, Frederiksen NL, Benson BW (1998) Endodontic working length assessment. Comparison of storage phosphor digital imaging and radiographic film.Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics, 85: 325–8.
12. Chandler NP, Bloxham GP (1990) Effect of gloves on tactile discrimination using an endodontic model. International Endodontic Journal, 23: 97–9.
13. Chandler NP, Koshy S (2002) Radiographic practices of dentists undertaking endodontics in New Zealand. Dento maxillofacial Radiology, 31: 317–21.
14. Chong BS, Pitt Ford TR (1994) Apex locators in endodontics: which, when and how? Dental Update, 21: 328–30.
15. 15,Chunn CB, Zardiackas LD, Menke RA (1981) In vivo root canal length determination using the Forameter. Journal of Endodontics, 7: 505–20.
16. Clarke M (2003) Personal Communication. Dento-Legal Adviser Dental Protection Society, Leeds, UK.
17. Cox VS, Brown CE Jr, Bricker SL, Newton CW (1991) Radiographic interpretation of endodontic file length. Oral Surgery, Oral Medicine, Oral Pathology, 72: 340–4.
18. Custer C (1918) Exact methods for locating the apical foramen. Journal of the National Dental Association, 5: 815–9.
19. Czerw RJ, Fulkerson MS, Donnelly JC (1994) An in vitro test ofa simplified model to demonstrate the operation of electronic root canal measuring devices. Journal of Endodontics, 20: 605–6.
20. Czerw RJ, Fulkerson MS, Donnelly JC, Walmann JO (1995) In vitro evaluation of the accuracy of several electronic apex locators. Journal of Endodontics, 21: 572–5.