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RESEARCH ARTICLE

FAST IS FINE, BUT ACCURACY IS EVERYTHING-A REVIEW ON ELECTRONIC APEX LOCATORS.

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Abstract

Apical constriction has been advocated as the most appropriate apical limit for the endodontic working length. Conventionally, the point of termination for the endodontic instrumentation and obturation has been determined by taking radiographs. Despite being the most used, some limitations are attributed to the radiographic method. The evolution of electronic apex locators has helped make the assessment of working length precise and predictable. The application of Electronic apex locators avoids Patient Radiation Exposure, exact diagnosing of Fractures, Less Perforation. The aim of this review was to Examine the Variety of Apex Locators available and Overview their Development**.** Electronic apex locators reduces the number of radiographs required and assist where radiographic methods create difficulty. A systematic review was performed to compare the efficacy of different electronic apex locators. This paper reviews the development, action, use and types of electronic apex locators.

Introduction:-

The apical extent of instrumentation and the final root filling have a role in treatment success, and are primarily determined radiographically[1]. Electronic apex locators reduce the number of radiographs required and assist where radiographic methods create difficulty. They may also indicate cases where the apical foramen is some distance from the radiographic apex.

The removal of all pulp tissue, necrotic material and microorganisms from the root canal is essential for endodontic success[1]. This can only be achieved if the length of the tooth and the root canal is determined with accuracy. The outcome of treatment of roots with necrotic pulps and periapical lesions is influenced significantly by the apical level of the root filling (Sjo¨gren et al. 1990). Traditionally, the point of termination for endodontic instrumentation and obturation has been determined by taking radiographs. The development of the electronic apex locator has helped make the assessment of working length more accurate and predictable (Fouad & Reid 2000). The aim of this review is to examine the variety of apex locators available and overview their development**.**

The use of electronic apex locators for working length determination eliminates many of the problems associated with the radiographic measurements (interference of anatomical structures, errors in projection such as elongation or shortening, and lack of three-dimensional representation)[2]. Its most important advantage over radiography is that it measures the length of the root canal to the apical constriction, not to the radiographic apex.

The objective of working length determination is to establish the length at which root canal preparation and subsequent obturation are to be determinated [3] . According to the American Association of Endodontists (AAE) (2003), working length is defined as "the distance from a coronal reference point to the point at which canal preparation and filling should terminate". The apical constriction is the recommended end point of instrumentation and obturation since the tooth pulp is narrow at the apical constriction, so the wound is minor, potentially providing optimal healing conditions. The location of the apical constriction is considered to be 0.5-1 mm short of the anatomical apex[4].

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 kΩ in any part of the periodontium regardless of the person's 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.

In 1970s,frequency measurements were taken through the feedback of an oscillator loop by calibration at periodontal pocket depth of each tooth.

The first-generation EALs measured resistance, second-generation EALs measured impedance. The main drawback of both types of EAL was the poor accuracy caused by electrolytes. This limitation was overcome with the introduction of third-generation EALs, such as the Root ZX (J Morita Corp, Tokyo, Japan). The Root ZX uses the ratio method to measure the root canal length. This method involves the simultaneous measurement of impedance at two frequencies (0.4 kHz and 8 kHz), and calculation of a quotient that expresses the position of the file tip in the canal [5]. The Root ZX apex locator is considered to be the gold standard against which newer EALs are evaluated . Many studies have addressed the benefits and clinical performances of the diverse range of EAL models that have been developed in recent years. However, manufacturers make contrasting claims for their products, so it remains difficult for the practitioner to choose from the EALs available.[6]

Electronic apex locators generations:-

First generation apex locators(resistance based apex locators):-

Also known as resistance based apex locators measures opposition to the flow of direct current or resistance.It is based on the principle that resistance offered by the the periodontal ligament and the oral mucosa is the same 6.5 K Ohms .Root canal meter was developed in 1969,but pain was felt while using because of high currents around 150hz in original machine hence Endometer and Endodontic meter S2 was brought into use with improved adjustments which exhibited less current around 5micro Ampere(KOBAYASHI 1995)[7].Later in 1985 dentometer and endoradar were also found to be unreliable when compared with the actual radiographic readings[8].

Second generation apex locators:-

Also called as impedence apex locators that measures opposition to the flow of alternating current or impedence.This apex locator indicates the apex when two impedence values approach each other. A major disadvantage of second generation apex locators is that root canal has to be free of all the electro conductive materials to obtain a accurate readings.Few of the second generation apex locators are endo color,endoanalyzer (combination of apex locator and pulp tester),and digipex.Hence the third generation apex locators came into existence .

Third generation apex locators:-

These are frequency based Which measures the impedence values in 2 frequencies 8 and 0.4 kHz,and hence calculates the quotient by ratio method.The ratio method works on the principle that two electric currents with different sine wave frequencies will have measurable impedences that can be measured and compared as a ratio regardless the type of the electrolyte in the canal.The capacitance increases significantly and thus increases at the apical constriction and the quotient of the impedences reduces rapidly as the apical constriction is reached.The

change in electrical capacitance at the apical constriction is the basis for the operation of Root ZX and its reported accuracy.

Since its introduction root zx has received a remarkable attention in literature,it has become the benchmark to which other apex locators are compared.The latest version of root zx is Dentaport ZX[9].

Fourth generation:-
These measure the resistance and the capacitance separately rather than the resultant impedence value.Hence better accuracy and thus less chance of occurrence of errors[10.]

RAYPEX 6 is a 4th generation apex locator which uses two separate frequencies.A significant disadvantage of the fourth generation apex locators is that they need to perform in relatively dry or partially dried canals[11].

The Fifth generation:-
To cope with problems occurred in the 4th generation ,5th generation apex locators (Dual frequency ratio type) are being used.

EMagic Finder Series as it is popularly known as,these have the best accuracy in any root canal condition(dry,wet,bleeding,saline,Edta ,Naocl …etc

These are very useful in moist canals where as in dry canals they experienced considerable difficulties .i-RooT,Emf 100 Delux ,Joypex 5 come under this category[12].

Sixth generation:-
Analysis of the advantages and disadvantages of apex locators of the so called fourth and the 5th generation have led to the invention of the sixth generation apex locators (Adaptive apex locators)Which have come up in the market just recently and its efficacy in the long term use are still under process.

A major advantage of this apex locator is that it eliminates the necessity of drying or moistening of the canal ,as well achieving high degree of measurement precision in the presence of blood ,or while manipulating dry canals.

Uses:-
They provide objective information with a high degree of accuracy.Obstruction to the apical portion of the canal system by impacted teeth,zygomatic arch,tori ,excessive bone density,overlapping roots,shallow vault etc apex locators plays a major role.

They are a valuable tool for detecting site of root perforations[13],diagnosis of external and internal root resorption that have penetrated root surface,detection of horizontal and vertical root fractures [14]and testing pulp vitality.

Use of EAL in patients with pacemakers Wilson et al. investigated the operation of the Endo Analyzer Model 8005 in patients with pacemakers and cardioverter/defibrillator devices. They demonstrated that there was no interference between the apex locator and pacemaker function.[15]

Conclusion:-
In conclusion ,the modern the newly advanced apex locators are gaining popularity because of their Predictability,Precision,and Ease of working.These Devices have definitely Increased the ideality of endodontics.

Modern electronic apex locators can determine this position with accuracies of greater than 90% but still have some restriction. Knowledge of apical anatomy, accurate use of radiographs and the correct use of an electronic apex locator will assist practitioners to achieve results.

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