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A Comparative Evaluation Of Efficacy Of Apex Locators Vs Radiovisiograph In Determining The Working Length Of Single Rooted Teeth - An In-Vitro Study

Research Article

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Abstract

Introduction: Root canal treatment is a gold standard procedure in dentistry for treatment of pulp diseases and dental injuries In Endodontic therapy, establishing the working length is one of the most important step for the success of the endodontic treatment. Electronic apex locators are gaining popularity for assessing the root canal length as they help in eliminating problems associated with radiographic measurements.
Aim: To Compare and evaluate the efficacy of Apex locators in determining the working length versus a standard radiograph.
Materials & Methods: This study included 20 single rooted teeth. 20 pre-operative images were obtained by radiovisiography. Access cavity was prepared for all the tooth. Working length radiograph was taken. Tooth were placed in an alginate medium as a substitute to periodontium and Propex-PIXI apex locator was used to calculate the working length and was compared to the per-operative working length. The Statistical analysis was done using the Statistical analysis package SPSS (Statistical package for social science).
Results: The obtained results from apex locator were measured using Verniercallipers (19.8±0.76) and were compared to the pre-operative working length determined using Radiovisiograph (19.47±0.89). P value obtained was greater than 0.05.
Conclusion: Under the limits of the study, the obtained results have shown negligible difference in working length determination between the fourth generation electronic apex locator (PROPEX-PIXI) and conventional radiograph. This study concludes that apex locators can be used in determining the working length without any compromises and hence helps in decreasing the radiation exposure and chair time of the patient.

Keywords: Electronic Apex locator; Radiovisiography; Working Length.

Introduction

Root canal treatment is a gold standard procedure in dentistry for treatment of pulp diseases and dental injuries In Endodontic therapy, establishing the working length is one of the most important step for the success of the endodontic treatment [1]. Electronic apex locators are gaining popularity for assessing the root canal length as they help in eliminating problems associated with radiographic measurements. Working length is defined as, "the distance from a coronal reference point to the point at which canal preparation and obturation should terminate."[2] The root canal preparation and obturation should be performed is the narrow apical part of the root canal called the apical constriction (AC) which is located 0.5–1.0 mm coronal to the apical foramen. Some authors, even believe that root canal preparation and obturation up to the level of the apical foramen is also acceptable, if it does not cause irritation of periapical tissues or overfilling of the root canal with the obturation material. Insufficient working length results in residual tissue in the root canal, improper root canal preparation and obturation, formation of periapical lesions, post treatment pain, and the spread of infection [2-4]. Under instrumentation and over instrumentation affect the outcome of

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root canal treatment negatively as it may cause injury to the periapical tissues, bleeding, pain, extended treatment period resulting in reinfection, and a possibility of canal overfilling and extrusion of endodontic material beyond the apical region [5]. It is extremely difficult to determine a standard tooth root canal length. Therefore, verification of the root canal length plays a major role in root canal treatment and the success of the treatment [6].

Traditional methods for establishing root canal length include the use of radiographs, knowledge of anatomy and anatomical averages, tactile sensation and presence of moisture on a paper point are widely used but has their own limitations.he original idea of using electronics to determine WL was introduced in 1918 by Custer. An investigation by Suzuki in 1942, reported that the electrical resistance between the periodontal ligament and the oral mucosa in vivo was a constant value of 6.5 kΩ. This led to the development of the first electronic apex locators (EALs) by Sunada in 1962 [2, 3].

The first-generation apex locators relied on the principle that electrical resistance between oral mucous membrane and periodontal ligament remained constantly 6.5 kΩ, regardless of the age of patient and type and shape of teeth [7].

The second generation EALs was characterized by a single frequency of alternating current to detect changes in the canal impedance, but the canal needed to be reasonably free of electrically conductive material for an accurate readinG [8].

The third-generation apex locators based on dual frequencies were then introduced. These units still use impedance measurement to measure the location within the canal but have more powerful microprocessors. It determines the position of the minor diameter by simultaneous measurement of impedance at two different frequencies (8 and 0.4 kHz). A quotient of impedance ("ratio method") is then calculated, which expresses the position of the file in the canal [9-10].

Fourth generation apex locators have been developed to further increase the accuracy of apex locators. These apex locators take the resistance and capacitance measurements simultaneously to determine the location of the file tip in the canal [11, 12].

Fourth generation based, pocket sized electronic apex locator Propex-PIXI (PIXI, DentsplyMaillefer, Ballaigues, Switzerland) has been introduced which uses multiple frequencies, in addition to calculating the root mean square (RMS) values of the electric signals but has not been extensively investigated [13, 14].

The aim of this study is to compare and to evaluate the accuracy of fourth generation (Propex-PIXI) apex locator in determining the working length to a radiovisiograph, at a position 0.5 mm short of the apical foramen.Our research experience has prompted us in pursuing this study [15-24].

Materials And Methods

This study included 20 extracted, straight, single-rooted permanent human teeth with mature apices. Pre-operative radiographs were taken prior to the access opening. Residual soft tissue on root surface was removed by soaking the teeth in 5% Sodium hypochlorite for 2 hours. Teeth were preserved using thymol. The teeth were decoronated to 20mm with a diamond disc to allow unrestricted access to the root canal and to provide a stable reference for all measurements. A straight-line access to all the 20 tooth were gained and the coronal third of each canal was preflared using sequential Gates Glidden drills. The samples were then embedded up to the cemento-enamel junction in a plastic container containing freshly mixed alginate to simulate periodontiumAll measurements were made within 2 hours with the alginate model kept sufficiently humid [25, 26]. The readings were taken by placing the lip clip in the alginate and the file clip into the root canal. For electronic measurement, a size 15 SS K-file connected to the EAL was used, with the lip electrode inserted into the alginate model. At first, canals were irrigated using 5% NaOCl and then cotton pellets held in tweezers were used to dry the tooth surface and eliminate excess irrigating solution.

Electronic measurements were obtained using the fourth generation Propex-PIXI. The file was measured with a Verniercalliper to the accuracy of 0.01 mm and from this length; 0.5 mm was subtracted and recorded as the "Actual Length" (AL). Measurements were repeated 3 times and the mean value was calculated and recorded for each sample and for each EAL. The recorded AL was compared with the values obtained with the EALs. The root canal lengths obtained by each method were recorded and were subjected to statistical analysis which was performed by SPSS for windows (SPSS Inc, Chicago, IL). The significance level was set at 0.05. The accuracy of the Propex-PIXI apex locator and radiographic method was calculated.

Results

The obtained results were from 20 natural single rooted teeth measured using radiograph and Fourth Generation Electronic Apex Locator Propex-PIXI.

Discussion

The establishment of the apical limit of canal preparation is an important phase of root canal treatment. It is generally accepted

Table 1. Displays the working length measured using two methods.

Groups	Working Length
Radiovisiography	19.8 ± 0.76
Propex-PIXI	19.47 ± 0.89

Working length determined using Radiovisiograph for the 20 single rooted tooth had an average of 19.8mm ± 0.76mm working length. Working length determined using Propex-PIXI for the 20 single rooted tooth had an average of 19.47mm ± 0.89mm working length. P-value obtained was greater than 0.05.

that canal preparation and filling should be limited within the root canal [26]. Thus, accurate determination of the root canal working length is one of the most important steps in endodontic therapy. Conventional radiographs are needed before, during and immediately after the endodontic treatment and then periodically to evaluate the success or failure of the therapy. Hence, there is repeated exposure to unwanted dosage of radiations. Numerous animal and human investigations have studied the adverse effects of radiation on areas in the path of ionizing radiation [27].

The development and production of electronic devices for locating the canal terminus has been a major innovation in root canal treatment. The electronic method has shown equal or higher accuracy compared with the radiographic method in determining root canal length in in vivo studies and also reduced the total number of radiographs needed and thus the radiographic exposure [14, 27, 28].

Various ways to simulate in vivo conditions to determine working length include 1% agar, gelatin, alginate, and flower sponge soaked in 0.9% saline and alginate models. The model of choice in the present study was alginate because it is acceptable and has demonstrated to have good electroconductive properties Furthermore, the periodontal ligament was simulated more efficiently due to its colloidal consistency. It is not only easy to prepare but also good in handling and has a stable set-up to test EALs for up to 45 days [29, 30] One probable disadvantage of this model is that it is not able to completely simulate the in vivo conditions. In addition, premature readings can be attained if the alginate leaks through the apical foramen although it is more common with more fluid media. To prevent any bias due to the dimensional change of the alginate, irrigation solutions and EALs were varied systematically [31].

The behaviour of EALs under various conditions have been evaluated using a variety of laboratory models that mimic the electrical characteristics of human tissues. Huang confirmed that physical properties influence root canal measurement and this formed the basis for in vitro models to test accuracy of EALs with various embedding media. In the present study, alginate was used for its various advantages like good electro-conductive properties, ease of preparation, stability, and firm consistency. Conducting solutions allow better electrical contact with the apical tissues [13]. However, the presence of any fluids may hinder the use of apex locators and obtaining accurate measurements. The opinions of researchers regarding this issue are mixed. Some authors [32] believe that the least significant impact is achieved when using the NaOCl solution regardless of its concentration. It comes from the fact that it is a solution characterized by high electrical conductivity and with the potential to penetrate into dentinal tubules and decrease electrical impedance of the root canal walls as well as generate better electrical contact with periapicaltissues [32, 33]. Khattak et al. and Khursheed et al. obtained the best results in the 0.2% chlorhexidine environment. In the environment of a 3.0% solution of NaOCl, the difference between the measured and the actual length was significantly larger.[34]

It is important to note that the methodological decision to use the '0.5' reading on the display/LED of all EALs for all measurements could also have an effect on the accuracy of EALs in the present study, since studies have reported that '0.5' reading on EAL need not always be 0.5 mm short of the apical foramen nor does it indicate the position of apical constriction.[35]

Root canals are surrounded by dentin and cementum that are insulators to electric current. At the minor apical foramen, however, there is a small hole in which conductive materials within the canal are electrically connected to the periodontal ligament that is a conductor of electric current. Meredith and Gulabivala found that the root canal acted as a complex electrical network with resistive and capacitive elements. It exhibited complex impedance characteristics having series of parallel resistive and capacitive components [35, 36]. They also suggested a complex relationship between the impedance of the smear layer and bulk dentin. Kim et al. analysed electrical property measurement of EALs from ten papers in the literature, and they concluded that using the impedance ratio between electrical impedance measurements at different frequencies was a robust method for detection of the apical constriction. These phenomena surely influence the overall accuracy of all EALs, irrespective of their technical characteristics.[11]

Conclusion

Under the limits of the study, the obtained results have shown negligible difference in working length determination between the fourth generation electronic apex locator (PROPEX-PIXI) and conventional radiograph. This study concludes that apex locators can be used in determining the working length without any compromises and hence helps in decreasing the radiation exposure and chair time of the patient.

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