ACCURACY OF ROOT LENGTH DETERMINATION USING ENDOPILOT ELECTRONIC APEX LOCATOR

Thesis

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بسم الله الرحمن الرحيم

﴿قالوا سبحانك لا علم لنا إلا ما علمتنا
انك أنت العليم الحكيم﴾

صدق الله العظيم

سورة البقرة ﴿٣٢﴾

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Mai Ibrahim Hamdy

Dedication

To my dear parents whom I owe everything I ever did and will achieve. May god bless their soul.

To my beloved husband who gave me support whenever I needed and encouraged me all the way.

To my little angels, I LOVE U.

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INTRODUCTION

Total removal of all pulpal tissues, necrotic materials and microorganisms from the root canal system is essential for endodontic success which should include root canal preparation and filling that is not extending beyond the apex nor leaving an untouched area inside the root canal.

It was stated that the proper point to which root canals should be filled is the junction of the dentin and the cementum and that the pulp should be severed at the point of its union with the periodontal membrane.(***Kuttler)*** [1] studied the anatomy at apical foramen region and concluded that a root canal had two main sections, a longer conical section in the coronal region consisting of dentine and a shorter funnel-shaped section consisting of cementum located in the apical portion. The shape of the apical portion is considered to be an inverted cone; its base being located at the major apical foramen. The apex of the inverted cone is the minor foramen that is often thought to coincide with the apical constriction regarded as being at or near the cemento-dentinal junction. (***Kuttler)*** [2]

The location of the cemento-dentinal junction is widely accepted as being 0.50–0.75 mm coronal to the apical foramen

(Ricucci et al) [3] but, the exact location of it is impossible to identify clinically (Fig.1). In general, the cemento-dentinal junction is considered to be co-located with the minor foramen ***(Stein et al)*** [4].

Radiographic determination has been used for many years. Recent studies have proved that neither the radiograph nor the manual approach allowed a precise location of the apical constriction. Even when a paralleling technique is used as elongation of images has been found to be approximately 5**%** ***(Van de Voorde HE, Bjondahl AM)*** [5]. Besides that, periapical radiographs are two-dimensional image of a three dimension structure, which maybe obscured by superimposed structures.

Thus, the accuracy of conventional imaging to adequately locate the apical foramen is limited and required the use of a more specific diagnostic tool for more accurate detection of apical constriction. This has led to the introduction of electronic methods for working length determination.

The electronic method for root length determination was first investigated by ***(Custer)*** [6]**.** He depended on the fact that the electrical conductivity of the tissues surrounding the apex of the root is greater than the conductivity inside the root canal system, coronal to the canal terminus. He located the position of the

'foramen' by applying a voltage between the 'alveolus opposite the root apex' and the 'broach inside the pulp' and measuring the value of the electrical current (with a 'milliammeter' a negative and a positive electrode).Then was revisited again by ***(Suzuki)*** [7]. In his experimental study on iontophoresis in dog's teeth indicated that the electrical resistance between a root canal instrument inserted into a canal and an electrode applied to the oral mucous membrane registered consistent values. ***(Sunada)***[8] Reported that a specific value of the resistance would determine the position of the root canal terminus. He determined that when the tip of an endodontic instrument had reached the periodontal membrane through the 'apical foramen', the electrical resistance between the instrument and the oral mucous membrane was approximately equal to 6.5 kΩ (kilo ohm). Thus, he constructed a device that uses direct current to measure the canal working length. Subsequently different generations were developed where devices that use multiple frequencies to determine the distance from the end of the canal are considered the latest. The accuracy of this generation has been the focus for many studies especially their reliability under different root canal conditions.

REVIEW OF LITERATURE

Electronic Apex Locators:

Determining the root canal length accurately had been a challenge in endodontics. Introduction of apex locators have definitely served as an effective adjuvant to radiographs. Locating the appropriate apical position always with different apex locators is the purpose of this study.

The Cemento-dentinal Junction (CDJ) where the pulp tissue changes into the apical tissue is the most ideal physiologic apical limit of the working length. It is also referred to as the minor diameter or the apical constrictors. According to**, (*Stein et al and McDonald)***[4, 9] the endodontic working length should be measured to the CDJ, which is a point that was considered analogous to the apical constriction. On the other hand, ***(Lee et al)***[10] reported that almost all file tips end at the major foramen, regardless of the existing detectable CDJ However, the CDJ and apical constrictors do not always coincide, as reported by ***(Hassanien et al)***[11].that CDJ and apical constriction are not the same point. This is more evident in senile teeth as a result of cementum deposition, which alters the position of the minor diameter. Therefore, setting the apical constriction as the apical limit of the working length, where it is easy to clean and shape or obturate the canal is recommended.

In an *in vitro* study designed to determine the exact location of the apical constriction, (***Kuttler***) [2] Found that the apical constriction was microscopically visible in 96% of the cases, located between 0.524 and 0.659 millimeters (mm) short of the apical foramen. Mean distances from the apex to the foramen (A-F) and from the apex to the constriction (A-C) were measured by ***(Dummer et al)*** [12]. The authors evaluated 270 extracted human teeth and found a mean A-F distance of 0.38 mm and a mean A-C distance of 0.89 mm.

The **1st generation** apex locator was discovered by ***(Sunada)***[8]. It was known as "resistance apex locators". It was supplied by single frequency of direct current. Pain was often felt with this type of apex locator. In addition, these devices gave unreliable measurements in case of wet canals (***Suchde)*** [13]

The **2nd generation** apex locator was supplied by single frequency of alternating current to detect changes in the canal impedance. So, it was called "impedance apex locators" (***Suchde)*** [13]**.** This generation contains 2 types of apex locator: low frequency and high frequency apex locator. Low frequency AL is based on the assumption that the impedance between the oral mucous membrane and the depth of the gingival sulcus closely resembles the impedance between the canal terminus and the oral

mucous membrane ***(Inoue)*** [14]. While high frequency AL used an insulator to cover most of the surface of the file (***Hasegawa)*** [15]

The **3rd generation** apex locator has been called "frequency dependent" apex locators. This type was supplied by 2 frequencies to measure the impedance in the canal. There are 2 types of the 3rd generation ALs: impedance difference type and impedance ratio type. Impedance difference AL measures the impedance value at two different frequencies and calculates the difference between the two values ***(Saito et al)*** [16]. While impedance ratio type measured the position of the file from the ratio between these two impedances ***(Kobayashi et al)*** [17]

The 4th **generation** apex locator measures the impedance characteristics using more than two frequencies ***(Welk et al)***.[18] A significant disadvantage of the fourth generation devices is that they need to perform in relatively dry or in partially dried canals ***(Vera et al)*** [19]

The **5th generation** apex locator was developed in 2003. It measures the capacitance and resistance of the circuit separately. It is supplied by diagnostic table that includes the statistics of the values at different positions to diagnose the position of the file ***(Gordon et al)*** [20]. Devices employing method experience