IN VIVO EVALUATION OF THE ACCURACY OF FIRST BOUND LENGTH AND FOUR DIFFERENT ELECTRONIC APEX LOCATORS IN WORKING LENGTH ESTIMATION

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Introduction

Endodontic treatment has been an extremely successful and time tested treatment option in maintaining non vital teeth in the oral cavity as a functional unit. Many studies have shown the success rate of endodontic treatment as being 85-98% over a five year period (Pitt Ford, 2004). The working length is defined as the distance from a coronal reference point to a point at which canal preparation and obturation should terminate (D'Assunção et al., 2006). Accurate working length determination is considered an essential step in successful root canal therapy and proper canal length preparation is a significant predictor of success(Ingle et al., 2002).

The apical constriction is the landmark at which endodontic instrumentation should preferably end (Gordon et al., 2004). Methods of working length determination include detecting the apical constriction by tactile means, using a periapical radiograph, or by electronic apex locators (EAL) (Pitt Ford, 2004). Although locating the apical constriction by tactile means, may detect the ideal end point of canal preparation it can pose many problems (Gordon et al., 2004). EALs, introduced by Sunada in 1962 have been developed and refined and has been shown to give good accuracy in many studies (D'Assunção et al., 2006 ; Gordon et al., 2004).

The aim of the present study is to compare the working lengths estimated using different methods with the working length estimated by means of a radiograph. The objective was to compare the working lengths estimated by the first bound length and four different electronic apex locators, with the working length estimated by a working length radiographs in terms of error, the variability of measurements, accuracy and reliability.

Materials and methods

Eighty two consecutive patients who attended the endodontic clinic of the Department of Restorative Dentistry, Faculty of Dental Sciences were selected for endodontic treatment, based on clinical symptoms and signs, vitality testing using electronic pulp testers and radiographic evidence. First bound file length (FBL) was estimated using a ISO size 20 file inserted progressively into the canal until apical resistance was felt. All canals were irrigated with 2% Sodium hypochlorite and dried with paper points prior to using the four different EALs. The electronic apex locators (Root ZX, Solfy ZX, Foramatron II, Dentronics) were used next according to the manufacturers recommendations. Radiographs were taken with file inserted to the first bound length and the radiographic length determined. Teeth where first bound length or any one of the apex locator readings could not be obtained were excluded. The results were analyzed to determine the standard error of mean (SEM), 95% confidence interval of the difference (CI), correlation with the radiographic working length using the Pearson correlation coefficient and reliability using the Intra-class correlation coefficient.

Results

Ninety six teeth consisted of 52 incisors and canines, 34 premolars & 10 molars which had a total of 127 root canals. Correlation of the working lengths determined by the first bound length and the four EALs with the radiographic working length, using the

Pearson correlation test showed the first bound length to have an r value of 0.730 (p=0.01). Of the EAL's, Root ZX to have an r value of 0.932(p=0.01), followed by Solfy ZX (r=0.918, p=0.01), Formatron II (r=0.908, p=0.01) and Dentronics (r=0.675,p=0.01). TheSEM was 0.0700 for Root ZX (CI= -0.071 to 0.206), 0.0770 for Solfy ZX(CI= -0.192 to 0.112), 0.0837 for Formatron II (CI=-0199 to 0.113) and 0.1727 for Dentronics (CI=-0.791 to -0.107). Reliability analysis using the Intraclass correlation coefficient showed that Root ZX had a reliability of 0.9321 followed by Solfy ZX (0.9179) Formatron II (0.9076) and Dentronics (0.6679). The SEM for the first bound length was 0.19767 (CI -0.5178 to 0.2641) and the reliability was 0.6892.

Discussion

The FBL although more reliable than the first generation apex locators did not show good accuracy. Studies done in this regard have determined that its accuracy depends on many factors as mentioned in the introduction, with an accuracy of 70-80% in experienced hands (Gordon et al., 2004).

Of the EALs, the first generation works on the principle of detecting the resistance of periodontal tissue. The accuracy of these were very low (55-65%) and considered unreliable in many studies (Gordon et al., 2004). An example of this generation of apex locator is the Root Canal Indicator (Dentronics inc). In this study too the first generation EAL's proved inaccurate and unreliable when compared with radiographs (r=0.675,p=0.01, CI=-0.791 to -0.107, ICC=0.6679).

The second generation uses a measurement of impedance between the oral mucosa and the periodontal membrane. The accuracy has been shown to be around 83% within 1mm of the apical constriction (Gordon et al., 2004). The second generation Formatron II used in this study gave a better correlation (0.908) with radiographs than seen in other studies (Gordon et al., 2004). Although studies have shown it to be accurate in the presence of electrolytes within the root canal this aspect was not assessed in this study. The third generation EAL's use more than one frequency in determining the impedance and has shown an accuracy of between 90-100% in many studies (D'Assunção et al., 2006; Venturi et al., 2005). They are self calibrating and Root ZX and Solfy ZX (J Morita Co Japan) are the examples. Of the EALs used in the study the Root ZX gave the closest correlation, best reliability, narrowest variation and a minimum error compared to the length as determined by the radiographs. This generation of EALs are also considered reliable in the presence of electrolytes.

Conclusion

Root ZX, Solfy ZX and Formatron II could be used to accurately determine working length in root canal treatment.

References

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