

New electronic apex locator Romiapex A-15 presented accuracy for working length determination in permanent teeth

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Abstract

Purpose: The present study aims to evaluate, ex vivo, the accuracy of electronic apex locators Root ZX II and Romiapex-15, for working length (WL) determination in permanent teeth. **Materials and Methods:** Fourteen single-rooted teeth (incisors and canines), with their apices fully formed were used. The dental crowns were removed. The anatomic length of the tooth (real measurement) was visually determined through the insertion of a size 10 K-file until the tip of the instrument could be observed in the apical foramen under a microscope (20X). Teeth were fixed in a model of resin and adapted into alginate soaked with saline solution, which was used as an electrical conductor. Using a K-file, root canals were measured electronically using both devices. The results obtained for each apex locator were compared to the real measurements. The accuracy between the devices was statistically analyzed using the Bland-Altman graph, Intraclass Correlation Coefficient (ICC), and Student's t-test. **Results:** The mean difference between the measurements using the Root ZX II was 0.277mm greater than the real measurement, while the measurements from the Romiapex-15 were 0.308mm higher on average. The comparison between Root ZX II and Romiapex-15 had no significant difference ($p=0.868$). **Conclusion:** It was concluded that Root ZX II and Romiapex-15 had similar accuracy. Romiapex-15 could be an option for WL determination in permanent teeth.

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Introduction

Working length (WL) determination is a crucial step in endodontic treatment. However, the ideal WL for root canal treatment has been an issue of discussion and controversy. Sjogren et al., (1990) [1] performed an epidemiological study and observed that the endodontic treatment had a

better prognosis when the apical limit obturation was 2.0mm from the radiographic apex. These results were better explained by Ricucci and Langeland (1998) [2], who performed a microscopic study and found that the best condition of repair was when the instrumentation and root canal filling remained close to the apical constriction. Thus,

preferably, the instrumentation and the obturation should stay in the narrow portion of the root canal, i.e. in apical constriction, because it causes less damage and thus provides better conditions for repair [2].

The most popular method for the establishment of the WL is the radiographic method, which is based on the premise that

the apical constriction is located between 0.5 to 1.0mm of the radiographic apex in both permanent and primary teeth [3,4]. Determination using the radiographic method has several limitations, such as: distortion, shortening and lengthening of the image, variability of interpretation, and it can only represent dimensional structures in a two dimension image. In this way, the radiographic estimation may lead to over or under root canal instrumentation and/or obturation.

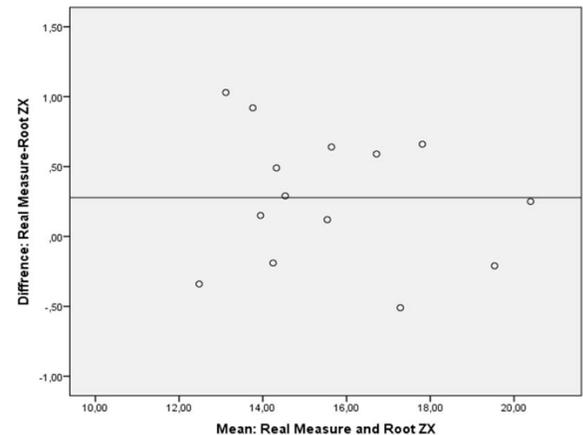
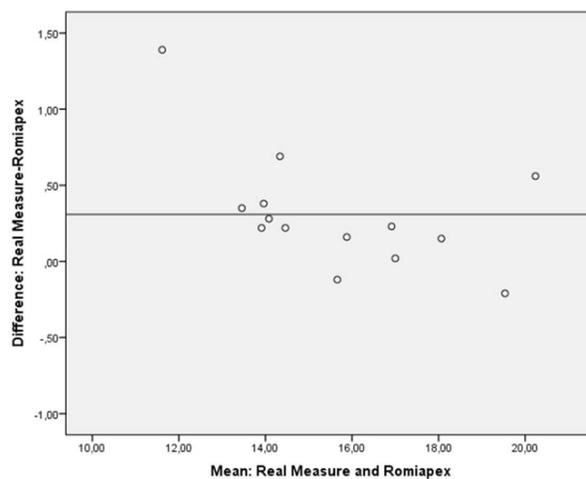
Currently, the method of WL determination considered to be more accurate is electronic, which uses Electronic Apex Locators (EAL) [5]. These devices are based on measurements of impedance ratio and are able to determine the distance between the highest foramen and the lowest foramen based on the difference in the file tip and the fluid in the channel at different frequencies through the electrical resistance of the dentin [6]. Several models of EAL use the principle of impedance to determine apical constriction and published papers have showed their effectiveness in working length determination [7-13].

Recently, electronic equipment has been popularized and the device Root ZX II (J. Morita, Tokyo, Japan) has been proven to be a reference for new equipment testing due to its good results [14-17]. However, new devices have been introduced to the market and it is mandatory to assess their accuracy to determine WL. Thus, considering that there are few studies evaluating the Romiapex A-15 [18-20], this ex vivo study aimed to evaluate the accuracy of Romiapex-15 in the determination of the WL of permanent teeth in comparison to Root ZX II - a standard method used in literature.

Materials and Methods

This study was approved by the Research Ethics Committee of the University Center of Maranhão, Brazil (protocol number 00519/11).

Fourteen extracted human teeth, both upper and lower, with a single root (incisors and canines) and with apices fully formed, were selected. The teeth were stored in 2.5% sodium hypochlorite solution for 6 hours and then stored in sterile saline solution. The crowns of the teeth were sectioned horizontally at the cementum-enamel junction in order to simplify access to the root canal and to obtain a reliable occlusal reference point. The canals were irrigated with saline solution and patency was checked with K-file size 10. If remnants of pulp were presented, they were removed. The real measurements of the root canal length were performed using a K-file



hypochlorite solution (Biodynamics, São Paulo, Brazil). Cotton pellets were used eliminate excess saline from the pulp chamber.

The root canal of all teeth was measured using the electronic apex locators Romiapex A-15 (Romidan Ltd, Kiryat Ono, Israel) and Root ZX II (J. Morita USA, Irvine, CA -USA). Initially, a file was gently inserted into the root canal until the appliance emitted a continuous audible tone and the word "APEX" flashed on the Root ZX II display and "0.0" on the display of the Romiapex A-15.

Then, the file was retracted until the display of both pieces of equipment indicated the position stabilized at 0.5. At this time, the silicone stopper was adjusted in occlusal reference, the file removed from the root canal, and the distance from the tip of the instrument to the stopper was recorded using an electronic caliper with an approximation of 0.01mm (Mitutoyo Digimatic, Kyoto, Japan). The measurements, in millimeters, were made by a calibrated examiner (Kappa = 0.9) and were recorded in specific charts.

For WL determination with the electronic devices, the teeth were fixed in a model of resin and soaked up to 2mm below the cementum-enamel junction in alginate molding (Jeltrate II Dentply, Petropolis, Brazil). The alginate was prepared according to the manufacturer's recommendations. Root canals were filled

with a silicone stopper passively introduced into the root canal until the tip was visible in the apical foramen. At this time, the silicone stopper was adjusted in occlusal reference and the file was removed from the root canal. The distance from the tip of the instrument to the stopper was recorded using an electronic caliper with an approximation of 0.01mm (Mitutoyo Digimatic, Kyoto, Japan). The measurements, in millimeters, were made by a calibrated examiner (Kappa = 0.9) and were recorded in specific charts.

All of the measurements were carried out by a single calibrated examiner and the results (in millimeters) obtained from the two pieces of equipment were tabulated.

The results were statistically analyzed using the Bland-Altman graph and the Intraclass Correlation Coefficient (ICC) in order to test the null hypothesis that there is no correlation between the measurements and to compare the accuracy between the two

Figure 2. Graphical representation of the difference in values obtained using the electronic apex locator Romiapex A-15 and the real measurements.

Figure 1. Graphical representation of the difference in values obtained using the electronic apex locator Root ZX II and the real measurements.

with 1.0% sodium

devices and the real measurements. To assess whether there was a difference between both apex locators, Student's t-test was used. All analyses were carried out using the statistical program SPSS version 19.00 (SPSS Inc., Chicago, IL, USA) with a significance level of 5%.

Results

Table 1 shows the differences between both EAL and the real measurement, including the Intraclass Correlation Coefficient (ICC) and p values. It was observed that the mean of the differences between the measurements using the Root ZX II was 0.277mm greater than the real measurements, while the Romiapex-15 measurements were 0.308mm higher on average.

Figures 1 and 2 are a graphical representation of the differences between the measurement of linear distances obtained from both devices and real measurements. The vertical line represents the mean of the differences. The closer the vertical line is to zero, the greater the accuracy of the devices.

The mean of the differences between the measurements obtained with the Root ZX II and the Romiapex A-15 was 0.030. The Student's t-test showed that there was no statistically significant difference between the measurements performed with Root ZX II and the Romiapex A-15 ($p=0.868$).

Discussion

The evaluation of different endodontic equipment is important to guide clinicians in their dental practice. Thus, in this study we evaluated two electronic apex locators ex vivo in comparison to real measurements of root canals.

In order to maintain the experimental condi-

study, the alginate was also used for maintenance of teeth and allowed electrical conduction in the ex vivo evaluation.

Several studies assessed the accuracy of the EAL Root ZX II to determine the WL in deciduous and permanent teeth [14-17; 24-26], and, due to the excellent results found, this device has been used as parameter for comparison with other equipment. Although other previous studies attempted to evaluate Romiapex A-15 [18-20], our study adds important information to endodontic literature confirming the accuracy of both tested apex locators.

It is recommended to use the technique of apical setback to establish the WL using EAL. This consist of the introduction of the file to the foramen (which appears on the devices' screen as "0.0" or "APEX"), and then performing the setback until the apical constriction is reached. This technique allows the user to identify the first constriction toward the apex-crown. According Ricucci (1998) [27], this constriction is located 0.5 to 1.0mm coronal to the foramen and is considered an ideal spot for instrumentation and obturation of the root canals.

The average difference between the measurements obtained with the Romiapex A-15 and the real measurements (0.308mm) was greater than the mean difference obtained with the Root ZX II and the real measurements (0.277mm). The variation of ± 0.5 mm in WL is acceptable to avoid over-instrumentation [28]. Therefore, we can conclude that both devices were within the recommended standards.

Romiapex A-15 presented a lower dispersion (standard deviation = 0.391mm) compared to the Root ZX II (standard deviation = 0.472). In addition, the error ranging

when the difference in measurements obtained with both devices was assessed, no statistical difference was found. It is important to emphasize that the difference found in this study is not clinically significant for endodontic treatment, which corroborates with Vasconcelos et al. (2013) [28].

Conclusion

Although ex vivo studies have some limitations, it is possible to conclude that the electronic apex locator Romiapex-15 presented accuracy in the determination of the WL in single-rooted permanent teeth and had results similar to the Root ZX II.

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Table 1. Data obtained after the comparison between the differences in measurement of electronic apex locators Root ZX and Romiapex A-15 and real measurements.

Diferences	Min.	Max.	Average Difference	Standard Deviation	Range Error	ICC	p
Root ZX II - Real	-0.51	1.03	0.277	0.472	± 0.654	0.981	<0.001
RomiApex A-15 -Real	-0.21	1.39	0.308	0.391	± 0.542	0.990	<0.001

tions with the smallest number of possible variables, total removal of the dental crown was performed to design a more reliable reference [21]. Canals were irrigated with 1.0% sodium hypochlorite and excess in the pulp chamber was removed by aspiration, while keeping the root canals wet, in order to use the devices according the manufacturers' instructions [22]. Also, according to the literature, alginate was used for electrical conduction in ex vivo studies with EAL [23]. In this

was 0.542 for the Romiapex A-15, while it was 0.654 for the Root ZX II. This means that the measurements obtained with the Romiapex A-15 showed a lower oscillation pattern. Measurements obtained with the Romiapex A-15 were closer to the vertical line than the measurements from the Root ZX II. The smallest variation of measurements obtained with Romiapex A-15 represents the high correlation with the real measurement showed by the interclass test. However,

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