Clinical reproducibility of a low cost electronic apex locator

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Abstract

Aim: To evaluate the clinical reproducibility of three electronic apex locators (EALs), Joypex 5, RomiApex A-15 and Novapex. Methods: Twenty-five patients requiring endodontic treatment were selected. Sixty root canals were measured by the three EALs to determine their respective working length, which was defined as a zero reading on the EAL. A new K-file of the same size was used for each measurement. The file length was fixed with a rubber stop and measured with a caliper to an accuracy of 0.1 mm. Data were analyzed statistically using paired t-tests with the Bonferroni correction and Bland-Altman plot to determine the reproducibility of clinical data among the EALs. Significance level was set at 5%. Results: Mean and standard deviation values measured by the three EALs showed no statistically significant differences. Identical readings by all three EALs were found in 38% of root canals. Fifty percent differed by less than ± 1.0 mm and only 1.3% exceeded a difference of 2.0 mm. Conclusions: The clinical reproducibility of the three devices was confirmed with no significant differences among them, indicating that they are effective for clinical use.

Keywords: apex locator, working length, working length determination.

Introduction

The determination and maintenance of the working length (WL) is an important step in root canal treatment, ensuring an efficient chemomechanical preparation and a hermetic seal of the root canal system, both of which are necessary to avoid damage to the periradicular tissues¹. Several methods have been proposed for determining the length of the root canal, such as the patient’s response to pain caused by the passing of the instrument through the apical foramen and the use of conventional or digital radiographs²-³. The advent of electronic apex locators (EALs) provides an additional feature to the endodontic arsenal for determining the correct WL determination.

The latest generation of EALs operates by measuring changes in impedance (alternating current). For this, two or more different frequencies are used and processed using different mathematical algorithms⁴. Many studies report a high efficacy achieved by new generations of EALs, even in adverse situations like the presence of irrigating solutions, blood, and the existence of large forams²⁻⁴.
With the necessity of effective techniques to locate the root apex, EALs are being widely used and many models have been imported and commercialized in the international market. Recently, various brands of inexpensive EALs were launched in the dental market. Although these EALs have proven accurate in determining the correct WL, there is little evidence regarding the clinical reproducibility of these devices. Reproducibility indicates whether or not two or more techniques used to measure a given variable, in identical circumstances, produce the same result. Thus it is reasonable to expect that the WL measured by an EAL should be reproducible by similar EALs in the same root canal under the same clinical conditions.

The aim of this study was to evaluate the reproducibility of the EALs Joypex 5 (Denjoy®, China), RomiApex A-15 (Romidan, Israel) and Novapex (Forum, Israel) under clinical conditions. The null hypothesis is that there is no significant difference in clinical reproducibility between the low cost EAL (Joypex 5) and the other trademarks.

Material and methods

Twenty-five patients from the State University of Rio de Janeiro, including 13 men and 12 women, aged between 18 and 60 years, were selected. Informed consent was obtained from all patients, and the study was conducted in compliance with the ethical principles of the Helsinki Declaration and Good Clinical Practice. Inclusion criteria were pulpal pathosis with or without radiographically confirmed periapical lesions in incisors, canines, premolars, and molars. Teeth with previous endodontic treatment, internal or external root resorption, and/or intracanal calcification were excluded. Patients with active systemic disease and physical or mental disability were also excluded.

Thirty-one teeth were treated including 11 incisors, 7 premolars and 13 molars, totaling 60 root canals. In each case, the diagnosis was based on the patient’s history, clinical examination, and radiographs. Local anesthesia was applied in all cases. Access cavities were prepared with a round diamond bur (Dentsply Maillefer, Ballaigues, Switzerland) and refined with an Endo Z bur (Dentsply Maillefer) using a high-speed handpiece. Where necessary, all remaining occlusal cusps were flattened using a high-speed conical diamond bur (Dentsply Maillefer) to achieve a flat reference plane. After verifying the initial patency of the root canal with a size 10 K-file (Dentsply Maillefer), pulp tissue was removed using 5.25% sodium hypochlorite as an irrigant. The file was achieved (difference of 0.0 mm) and, only in three cases, a difference greater than 2.0 mm was verified.

Table 2. Absolute difference distribution of working length measurements by different pairs of electronic apex locators (EALs).

<table>
<thead>
<tr>
<th>Pairs of EALs</th>
<th>Mean absolute difference (mm)</th>
<th>SD absolute difference (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joypex vs. Romiapex</td>
<td>0.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.48</td>
</tr>
<tr>
<td>Joypex vs. Novapex</td>
<td>0.40&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.44</td>
</tr>
<tr>
<td>Romiapex vs. Novapex</td>
<td>0.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Table 2 shows the difference between the WL values measured by different pairs of EALs, with a high reliability between the EALs. In 38% of the canals full precision was achieved (difference of 0.0 mm) and, only in three cases, a difference greater than 2.0 mm was verified.

Figure 1 shows Bland-Altman plots of the differences in WL measurements in all patients with mean values and limits of agreement. Limits of agreement indicated the range that contained 98% of the differences between pairs of EALs and were between 0 and 2.0 for the three pairs of EALs. Bland-Altman plots with differences randomly scattered around a mean value close to zero confirmed the reproducibility of the three EALs. A random scatter of points along the Y-axis on all three plots indicated that the inter-EAL reproducibility was independent of the length of the root canals. A random scatter of points along the Y-axis on all the three plots indicated that none of the three EALs showed predominantly longer or shorter WL measurements compared to the other EALs.
Discussion

The apical foramen location is extremely important to endodontic treatment success. In general, 0.5-1.0 mm short to the radiographic apex is used as a reference for the foramen location and the working length. Apex locators have been developed to improve the accuracy of apical constriction determination and consequently increase the success rates of endodontic treatment.

Several studies have reported the accuracy of EALs in determining the WL, validating its clinical use as a simple and effective alternative and optimizing endodontic therapy. Although these studies have showed the clinical efficacy of EALs, the cost of this technology hinders their wider dissemination and use. Recently, new EALs were released with more accessible prices. A previous study has shown the efficacy of these EALs in vitro, but this is the first clinical study comparing the reproducibility of a less costly EAL, Joypex 5, in relation to other EALs such as Novapex and Romiapex. The choice for Novapex and Romiapex was based on previous studies that have shown a good efficacy and accuracy of both EALs.

All measurements were made by the same experienced and trained operator, thus eliminating the possibility of operator bias. Although the issue of how the operator’s skill influences EAL accuracy has not yet been described in the literature, extensive training and practice are required to ensure familiarity with these devices and consequently accurate measurements.

Fig. 1. Bland-Altman plots of differences in WL measurements in all teeth. (a) Joypex X Romiapex (b) Joypex X Novapex (c) Romiapex X Novapex. X-axis shows the mean length (mm) of a certain root canal measured by each pair of electronic apex locators.

The null hypothesis was upheld because no significant difference was observed in reproducibility among the tested EALs. This result confirms the clinical reliability of these devices to determine the WL, as in 69 out of 180 measurements there was no difference (0.0mm) and in 92 measurements the differences were approximately ± 0.5mm and ± 1.0 mm. A previous study showed that even the same EAL can have differences in the repeatability coefficient, showing different measurements values using the same sample. Also, during the measurement of files with the caliper, small differences could result in non-identical results. In addition, only 3 cases showed a greater difference than 2.0 mm, demonstrating high reproducibility among the EALs.

There is no study in the literature comparing the reproducibility of Joypex 5, Romiapex A-15 and Novapex either in vitro or in vivo, although several studies have shown the accuracy of Novapex and Romiapex A-15. It is impossible to compare reproducibility and accuracy results as the former may be perfect even when the EALs are inaccurate. Furthermore, comparison of an accurate to inaccurate EAL results in unacceptable reproducibility. The accuracy of each EAL needs to be determined in order to differentiate which device is responsible for wide limits of agreement. The aim of study was not to determine which device was more or less accurate than others but to examine the reliability of various EALs in reproducing “APEX” readings under same clinical conditions. The results obtained in this study confirmed the clinical reproducibility of the EALs Joypex 5, Romiapex A-15 and Novapex.
References