Original research:

Comparative evaluation of the accuracy of Propex PixiTM and CanalProTM electronic apex locators in primary anterior teeth

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Abstract
Aim: To evaluate and compare in vitro, the accuracy of two different electronic apex locators, i.e., Propex PixiTM and CanalProTM in primary anterior teeth.

Methodology: A total of 60 primary teeth sample has been selected using a convenience sampling method. Samples were divided into two experimental groups in which, Group 1 belong to Propex PixiTM apex locator, and Group 2 CanalProTM. The mean values with standard deviations of electronic working length by using Propex PixiTM and CanalProTM with that of stereomicroscopic actual working length were calculated and compared

Results: There was statistically significant difference between values obtained by the two electronic apex locators and actual length Conclusion: A strong correlation was seen between the two electronic methods and AL and also in between the two EALs, showing the possibility of their use to measure the root canal length.

Keywords: Working length, Electronic apex locators, Actual length, Propex Pixi™, CanalPro™

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Introduction

To increase the success of endodontic treatment in primary teeth, the assessment of root morphology may be an issue of concern. The root canal anatomy of primary molars is difficult to predict because of the balance in resorption and hard tissue deposition.[1] The establishment of appropriate working length is one of the most critical steps in endodontic therapy. Cleansing, shaping, and obturation of the root canal system cannot be achieved in perfection without accurately determining the working length.[2] Intraoral radiographs are one of the most routinely used modalities for checking the length of the root canal. However, it may not provide exact measurements, particularly in cases with resorption and apical constriction. Furthermore, poor cooperation of children makes it difficult to take a radiograph with acceptable diagnostic value.[3,4] The development of electronic apex locators has enabled more accurate measurement of the root canal length. Several studies have reported the accuracy of these devices along with their specific measurement potentials, including but not limited to the accurate measurement in the presence of electrolytes. [5-9]

Electronic apex locators have gained more popularity in determining working length in permanent teeth in recent years, and they have helped with estimation of the working length and have increased precision rates.[9-11] However, the preference for electronic apex locators in primary teeth is not suggested universally because of the inaccuracies that may be encountered due to root resorption.[12] Despite this, the efficacy and safety of using electronic apex locators in detecting working length in primary teeth were shown by several researchers.[3,4,9,13] In addition, electronic apex locators cause no pain and prevent radiation, and of these advantages, they were recommended to be used among children during root canal treatment in clinical practice.[10,13-15]

Propex II (Dentsply Maillefer, Tulsa, OK, USA)TM is a multi-frequency based, fifth-generation apex locator that uses multiple frequencies to determine the root canal length. Preferably using the amplitude of the signal as for all electronic apex locators, it measures the energy of the signal with multi-signal frequencies.[16] CanalPro (Coltene-Whaledent, Cuyahoga Falls, OH, USA)TM is a fifth-generation electronic apex locator, based on dual frequencies that are sent from and returned to the unit after traveling along the electric circuit. The Canal Pro determines the location of the apical constriction with the help of electrical resistance and provides are liable method of confirming the working length.[17] To the best of our knowledge, there is very limited evidence on the use of apex locators on primary teeth. There are very few studies on the evaluation of the accuracy of Propex PixiTm and CanalProTM electronic apex locators in primary anterior teeth. Hence, the present in vitro study has been undertaken to evaluate and to compare the accuracy of two different electronic apex locators, i.e., Propex PixiTm and CanalProTM in primary anterior teeth.

Methodology

Tooth Selection and Preparation

Sixty extracted human primary anterior teeth with no physiological or pathological root resorption for more than one-third of total root length without any abnormality or fracture were selected for conducting the study. All the 60 specimens were segregated into two groups (1 and 2) of 30 samples each. The teeth were immersed in formalin (10% solution) for 7 days after which, surface cleaning of all the teeth was done to remove organic and inorganic deposits and stored in saline solution till further use. To create a reproducible reference point de-coronation was done at the cemento–enamel junction using a disk. Barbed broaches were used for the debridement of each root canal which was later disinfected with a 3% NaOCl solution.

Electronic determination of root canal length

All 60 teeth were embedded in an alginate impression material up to CEJ in a plastic container to simulate the periodontium and act as an electro-conductive medium thus, creating an In vivo condition. The working length of each sample was determined by Propex PixiTm and CanalProTM in the alginate medium as per the manufacturer’s instructions, using separate 20 no. K-file for each attached to the file holder was gently inserted until the display read “apex”. Root canal length measurement was done with an electronic device keeping the rubber stopper at the coronal reference point. The measurements (± 0.5 mm) were used to evaluate the accuracy of the two methods. Measurements shorter than the actual length (AL) by >0.5 mm were classified as “shorter than AL”, while measurements longer than AL by >0.5 mm were considered “longer than AL”. Two measurements were made for the respective method by the same operator and the mean value was recorded. After determining the working length, the stoppers of all
the files were stabilized by flowable light cure composite. This procedure was repeated two times, first thirty samples were embedded in an alginate medium and electronic working lengths were determined, a similar procedure was repeated for all the samples. Determination of actual working length

Once the working lengths of all the samples were determined with both the apex locators, the teeth were then extracted, and the files were re-introduced up to the anatomic apex as observed under the dental operating stereomicroscope and this canal length was measured and designated as the anatomic working length (AWL). The files were fixed at actual working length using a flowable composite and the apical 4 mm of the roots were longitudinally shaved away using a fine diamond disc until the outline of the canal was visible under a stereomicroscope. The distance from the tip of the file to the reference point where the rubber stop was adjusted was measured by

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>SD of Error Mean</th>
<th>Mean Difference</th>
<th>“t”</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propex PixiTMT</td>
<td>30</td>
<td>9.55</td>
<td>2.24</td>
<td>0.40</td>
<td>0.18</td>
<td>0.36</td>
<td>0.71</td>
</tr>
<tr>
<td>Actual Length</td>
<td>30</td>
<td>9.37</td>
<td>1.17</td>
<td>0.21</td>
<td>0.06</td>
<td>1.19</td>
<td>0.8</td>
</tr>
<tr>
<td>CanalProTM</td>
<td>30</td>
<td>9.29</td>
<td>1.19</td>
<td>0.22</td>
<td>0.06</td>
<td>1.19</td>
<td>0.8</td>
</tr>
<tr>
<td>Actual Length</td>
<td>30</td>
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<td>0.06</td>
<td>1.19</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Independent “t” test; p value <0.005 statistically significant

The working length that was measured using Propex PixiTMT (group 1) and CanalProTM (group 2) had been compared and their ranges of difference from the actual length estimated using stereomicroscope were tabulated. It is observed that about five (29.4%) of the samples belonging to (group 1) and twelve (70.6%) belonging to (group 2) have no difference from the actual working length. Fourteen (66.7%) an endodontic ruler keeping an accuracy of 0.5 mm. The actual working length of all the 60 specimens was similarly measured and further divided into two groups (1 and 2) of 30 specimens each. All analyses were performed using a statistical software package (SPSS version 22.0; SPSS Inc., Chicago, Ill., USA). A comparison of study parameters between the groups was carried out using analysis of variance, Independent “t” test, and Chi-square test. For all tests, a p-value of 0.05 or less was considered to be statistically significant.

**Results**

The accuracy of the electronic apex locator working length by Propex PixiTMT with actual working length was compared using the stereomicroscope. It has been observed that the working length determined using Propex PixiTMT has a higher mean score as compared to the stereomicroscopic actual working length revealing that there was no statistically significant difference between electronic working length by using Propex PixiTMT and CanalProTM apex locator and stereomicroscope actual working length. (Table 1)
Comparative evaluation of the accuracy of Propex PixiTm and CanalProTm electronic apex locators in primary anterior teeth

Dr. Dinesh Rao

Table 2: Range of difference in working length

<table>
<thead>
<tr>
<th>Groups</th>
<th>Range of difference from actual length</th>
<th>n (%)</th>
<th>p (%)</th>
<th>&gt;0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propex PixiTm</td>
<td>14(66.7)</td>
<td>5(29.4)</td>
<td></td>
<td>11(50)</td>
</tr>
<tr>
<td>CanalProTm</td>
<td>7(33.3)</td>
<td>12(70.6)</td>
<td></td>
<td>11(50)</td>
</tr>
<tr>
<td>Total</td>
<td>21(100)</td>
<td>17(100)</td>
<td></td>
<td>22(100)</td>
</tr>
</tbody>
</table>

Pearson chi-square value = 5.216; p value = 0.74

Pearson’s bivariate correlation showed a very positive association among electronic measurement methods and stereomicroscopic actual length which provided the potential for their use as a method to measure the working length. Both before and after regression, the mean difference in stereomicroscopic Propex PixiTm. Stereomicroscopic actual length when compared with both the techniques, the mean difference was found to be statistically significant. A comparison between Propex PixiTm and CanalProTm showed the mean difference to be insignificant. (Table 3)

Table 3: Correlation between stereomicroscopic actual working length with electronic working length of both (Propex Pixi) Tm and (CanalPro) Tm apex locators by Karl Pearson’s correlation coefficient method

<table>
<thead>
<tr>
<th>Variables</th>
<th>r-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual working length (Stereomicroscopic) with Propex PixiTm</td>
<td>0.627</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>Actual working length (Stereomicroscopic) with CanalProTm</td>
<td>0.858</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>Propex PixiTm with CanalProTm</td>
<td>0.064</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Discussion

Determining the precise working length is an important aspect while endodontically treating deciduous teeth for better preparation and cleaning of root canals. In pediatric patients, it is necessary to preserve the deciduous tooth until it is naturally exfoliated to maintain the integrity of the dental arch. Endodontic treatment of the deciduous teeth involves the removal of both the coronal and radicular pulp and restoring it with a resorbable obturating material. The evaluation of the root canal anatomy of a deciduous tooth is difficult because of the constantly ongoing resorption, shape of a root canal, and shifting of the position of the root apex.[18] In an In vitro study, the extracted teeth in the model should be placed in a alginate which was used in this study medium that provides a similar electrical resistance to that of the periodontium.[19] The model prepared with actual length was higher in CanalProTm and Propex was found to be precise, providing ease of use, and the operator remained ‘blinded’ while locating the file tip in the canal this technique has been shown to be effective in previous studies.[5,13, 20-24] In the present study, all the samples were embedded in a plastic container containing freshly mixed alginate to simulate periodontium which acts as an electroconductive medium. All electronic length measurements (groups 1 and 2) were made within 2 hours.

The standard for determining the stage of root resorption in deciduous teeth is not well explained. It has been estimated subjectively in previous studies.[13,14] The most widely accepted criterion for pulpectomy in deciduous teeth is that root resorption
should not be beyond one-third of root length.\textsuperscript{[25,26]}

Therefore, in the present study teeth having more than two-thirds of the average root length were selected. As the root canal in deciduous teeth with root resorption typically has a decreasing taper towards the defect, the electronic apex locator is thus capable of functioning accurately in them. Primary teeth with a root length between 7 and 10 mm were associated with round, regular apices, or multiple apices with intact apical deltas and apical diameters. In the current study, root lengths were in between 7 to 12 mm. The results in the current study was in accordance with the previous studies, which showed the accuracy of electronic apex locators in deciduous and in permanent teeth with root resorption.\textsuperscript{[3,4,14]}

The main objective of all working length determination techniques is the correct measurement from file tip to the coronal reference point. Weiger et al.,\textsuperscript{[27]} recommended that a fixed coronal landmark should be prepared and suggested the use of stable rubber stops and taking a mean of repeated measurements. In the present study, the crown was incisally decorated with a diamond disc to provide a flat stable reference point. Conflicting measurements in in-vitro studies that have evaluated electronic apex locators may be explained by errors in procedure, by bias that results from the improper adjustment of the stopper to the reference point, or by the movement of the stopper during the measurement procedure.\textsuperscript{[28,29]} In the current study, the file was fixed in position by using a flowable light-cured composite resin. Furthermore, in the current study the actual length (AL) and distance between the tip of the file in relation to apical resorption level was measured under stereomicroscope after doing the longitudinal grinding of the tooth only at the apical third area measuring 3mm from the apical foramen with diamond cutting bur that had been performed after obtaining the electronic length measurements because it reduces the number of variables involved and enables a more accurate calculation. Correct comparison of the accuracy of different types of electronic apex locators in evaluating the working length is possible only if the same teeth are assessed by all the devices. Therefore, we followed the protocol used by Wrbas et al.,\textsuperscript{[30]} which allowed us to calculate the accuracy of the two electronic apex locators in the same teeth.

The first study on the use of apex locator in primary teeth was in 1996 and reported that the root effect of root resorption on the accuracy of EAL is not clear. Shabahang et al.,\textsuperscript{[31]} demonstrated that Root ZX located the root end accurately even in cases with resorption. In the current study, the accuracy of CanalPro\textsuperscript{TM} in primary teeth with root resorption was 70\%, and in Propex PixiT\textsuperscript{TM} it was 29\%. This result is in accordance with that of Katz et al.,\textsuperscript{[32]} and Angwaravong and Panitvisai.\textsuperscript{[33]} They compared the canal length of primary teeth obtained with the Root ZX and with conventional radiography in a laboratory setting. When comparing both methods with the actual length, no statistically significant differences were found. On the other hand in a study by Tusan et al.,\textsuperscript{[34]} the accuracy of Root ZX (±0.5) was 83\% in resorbed primary teeth and 89\% in teeth with no resorption. They also found a statistically insignificant difference between the resorbed and non-resorbed root canals measured by the Root ZX apex locator.

\textbf{Conclusion}

The introduction of the newer electronic apex locators put the practitioner in the dilemma of choosing the better one. Hence, it is crucial to compare the efficiency and accuracy of the recently introduced electronic apex locators. Further research is recommended to assess the accuracy of these electronic apex locators in various clinical situations. In summation, within the limitations inherent to the methodology of the present study, the following conclusions can be made:

1. A strong correlation was seen among the two electronic methods indicating the effectiveness of their use in the measurement of root canal length.
2. Two different types of electronic apex locators used in the current study i.e. Propex PixiT\textsuperscript{TM} and CanalPro\textsuperscript{TM} were equally effective in doing the same.
3. The electronic apex locators are an invaluable tool in determining the position of apical constriction or apical resorption level of primary teeth.

\textbf{The Author}

\textbf{Dr. Gaurav Shukla}

\textbf{Prof. Sunil Panwar}
References

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