INTRODUCTION

The determination of working length and its maintenance during cleaning and shaping procedure is a key factor for successful endodontic treatment. The measurement of instrument finishing level is of primary importance associated with resolution of an endodontic infection both clinically and histologically. Failure to accurately determine the length of the tooth may lead to apical perforation, incomplete instrumentation and obturation with resultant problems such as persistent pain, discomfort, ledge formation and difficulty in retreatment.

One of the main concerns in root canal treatment is to determine how far working instrument should be advanced within the root canal and at what point the preparation and obturation should be located. In 1955, Kuttler, suggested that the ideal place to end root canal treatment was cement-dentinal junction. This is where pulp tissue changes into periapical tissue. It is a histological landmark, which cannot be felt clinically or seen radiographically. From clinical point of view it is advantageous to end all preparation at apical constriction because it is a morphologic point that can be felt by the clinician. Traditionally the generally accepted method for root canal length determination is the radiographic interpretation of an instrument placed in the canal. To establish the working length many methods including mathematical equation, predetermined normal tooth length, tactile sense, apical periodontal sensitivity and other techniques have been used. Many authors are in agreement that subtraction of 1mm from tooth length as measured by a radiograph would give consistent results.

The use of electronic devices to determine working length has gained increasing popularity in recent years. Electronic apex locators have become an integral component of modern endodontic armamentarium, therefore they are recommended to complement conventional radiographic working length determination.

COMPARISON OF RADIOGRAPHIC AND ELECTRONIC WORKING LENGTH IN ANTERIOR TEETH

*HALIMA SADIA QAZI, BDS, FCPS-II (Trainee in Operative Dentistry)
**ANSER MAXOOD, BDS, MSc. (London), FRACDS (Sydney)
*SAEEDA ABDULLAH, BDS, FCPS-II (Trainee in Operative Dentistry)

ABSTRACT

The aim of this study was to compare the endodontic working length of anterior teeth by electronic apex locator and conventional radiographic method to determine the accuracy and reliability of latest generation electronic apex locator (Sybron Endo). The study was carried out in the dental department of Pakistan Institute of Medical Sciences, Islamabad from April 2004 to January 2005. The use of electronic devices to determine working length has gained increasing popularity in the recent years particularly after introduction of latest generation of apex locators. An in vivo study was conducted on 30 permanent single rooted anterior teeth that were indicated for root canal treatment. First the working length was taken by electronic apex locator followed by conventional radiographic (Ingle’s method).

After recording both measurements, the difference between the two results were compared to evaluate the diagnostic efficacy and ability of an electronic apex locator for accurate determination of working length. In 23 among 30 root canals, (76.6%) electronic measurement coincided with the radiographic measurements. In 4 cases (13.3%) it was short of radiographic measurements by 0.5mm. Both these results were considered acceptable however, in the remaining 3 cases the results were considered unacceptable, as in 2 cases (6.67%) it was more than radiographic measurement by 0.5mm and in 1 case electronic measurement was more than radiographic by 1.5mm. It has been concluded from the present study that the electronic apex locator is an effective device with an accuracy of more than 90%; hence it can be used as adjunct to conventional radiography but cannot replace it.

Key words: working length, electronic apex locator, root canal therapy.

* PIMS, Islamabad, Email: cluelessqazi@yahoo.com
** Assoc. Professor/ Head of Dental department, PIMS, Islamabad, Email: ansermaxood@gmail.com
In Pakistan no in vivo or in vitro study has been so far conducted on electronic apex locator and electronic working length determination, although worldwide these devices have gained great popularity and enormous success in recent years after introduction of latest generation electronic apex locators.

Use of an electronic apex locator as an aid to endodontic therapy could potentially reduce the number of diagnostic radiographs required for working length determination.15 The most important advantage over radiography is that it can measure the length of the root canal to the end of the apical foramen, not to the radiographic apex.16

The purpose of this project was to determine endodontic working lengths in anterior by radiographic and electronic methods and then to compare which method produces accurate results.

MATERIALS AND METHODS

The study was conducted in the dental department of Pakistan Institute of Medical Sciences, Islamabad from April 2004 to January 2005. This in vivo study included 30 permanent single rooted maxillary and mandibular anterior teeth, which were mature having closed apices with symptoms of irreversible pulpitis and indicated for root canal treatment in patients between the age group of 18-60 years of both sexes.

It was a cross-sectional comparative study using non-probability convenient sampling. After proper evaluation of patient, proper diagnosis was made for each individual patient followed by a preoperative radiograph (E.speed calibrated intraoral radiograph) which was taken by using standardized paralleling technique with an intraoral film holder. The tooth was then anaesthetized followed by isolation with a rubber dam. Access cavity was prepared using a high speed water cooled diamond bur. The coronal 3rd was widened with sequential Gates Glidden burs, canals then located followed by irrigation with 5% sodium hypochlorite.

The working length was first taken by the fourth generation electronic apex locator (SybronEndo Diagnostic Unit). A K type endodontic file, the largest that could be accommodated at the apex was placed in the canal while attached to appropriate electrode of the electronic apex locator. The other electrode (lip clip) was attached to the oral mucosa by a lip j-hook. A digital read out on the screen showed the electronic working length, 1mm was then subtracted from this reading to get the final working length.

Then the working length was taken by conventional radiographic (Ingle’s method) by measuring the tooth on the preoperative radiograph then 1mm ‘safety allowance’ was subtracted for possible image distortion or magnification, then endodontic ruler was set at this tentative working length and silicon stopper was adjusted on # 15 or # 20 K file at this level. The instrument is then advanced in canal until the stop is at the plane of reference and another radiograph was taken, and on the radiograph, the difference between the end of the root and end of the instrument was measured and added to the original measured length, however if the exploring instrument has gone beyond the apex, the difference is subtracted. From this adjusted length 1mm ‘safety factor’ is subtracted. The endodontic ruler is then set at this new corrected working length and stop is readjusted on the exploring instrument. A confirmatory radiograph of the adjusted length is finally taken.

When the length of the tooth has been confirmed accurately, the ruler is reset at this measurement. The final working length and coronal point of reference is noted on patient’s record.

### TABLE 1: COMPARISON OF ELECTRONIC AND RADIOGRAPHIC WORKING LENGTH

<table>
<thead>
<tr>
<th>Number of teeth examined</th>
<th>EWL=RWL</th>
<th>EWL&lt;RWL by 0.5 mm</th>
<th>EWL&gt;RWL by 0.5 mm</th>
<th>EWL&gt;RWL by 1.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>30(100%)</td>
<td>23(76.6%)</td>
<td>4(13.3%)</td>
<td>2(6.67%)</td>
<td>1(3.33%)</td>
</tr>
</tbody>
</table>

EWL = Electronic working length
RWL = Radiographic working length

### TABLE 2: COMPARISON OF MEAN VALUE, STANDARD DEVIATION AND P VALUE OF THE ROOT CANAL WORKING LENGTH OBTAINED BY EAL AND RADIOGRAPHIC METHOD

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>p.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EWL</td>
<td>21.4167</td>
<td>1.30703</td>
<td>.23863</td>
<td>0.42</td>
</tr>
<tr>
<td>RWL</td>
<td>21.4500</td>
<td>1.38558</td>
<td>.25297</td>
<td></td>
</tr>
</tbody>
</table>

EAL = Electronic apex locator
The results were analyzed based on the difference between the working lengths determined by electronic apex locator and radiographic method. Computer package SPSS version 10 was used for computation analysis of the data.

RESULTS

In 23 among 30 root canals, (76.6%) electronic measurements coincided with the radiographic measurements. In 4 cases (13.3%) it was short of radiographic measurements by 0.5mm. Both these results were considered acceptable however in the remaining 3 cases the results were considered unacceptable, as in 2 cases (6.67%) it was more than radiographic measurement by 0.5mm and in 1 case electronic working length was more than radiographic working length by 1.5mm.

Therefore when the %age acceptance of the Sybron Endo in measuring root canal working length was assessed, it was found to be 90% (76.6%+13.3%). The 10% variation in working length measurements obtained by electronic device was concluded to be statistically not highly significant.

The calculated p-value of means of the two methods is 0.42 which is also non-significant.

DISCUSSION

The electronic apex locator is very reliable in determining the position of Apical Constriction. The percentage acceptance of Sybron Endo in measuring root canal working length in this study was 90% (76.6%+13.3%). The 10% variation in working length determination was not found to be highly significant.

Several studies have demonstrated that latest generation electronic apex locator can accurately determine working length of root canals with mature apices between 75%-96% which is in accordance with results of present study.10, 18, 21 The fourth generation electronic apex locator shows remarkable advancement as the results are not tampered with the presence of moisture, pulp, hemorrhage, i.e., exudates or sodium hypochlorite in the canal. In addition pulpal & periapical conditions don’t influence the efficacy of the device.

The use of electronic apex locator during endodontic treatment of single rooted anterior teeth may potentially decrease the radiation exposure to the patient by reducing the number of radiographs required for successful endodontic therapy. The results of the present study cannot be applied to posterior teeth, as they were not included.

It can be concluded that the latest generation electronic apex locator has a definite place in endodontic armamentarium, depending on the clinical situation at hand. However, it doesn’t make one method superior to the other. No electronic device discloses the degree or direction of curvature and the presence of additional root and canal.

Therefore radiographs are the only means to visualize the crown/ root anatomy, the relationship of crown to the root, the size, shape, curvature, location of roots and initial estimation of the root length. However, it is a two dimensional image of a three dimensional structure and is technique sensitive in both exposure and interpretation. In some cases, dense bone and anatomic structures can make the visualization of root canal file impossible by obscuring the apex. The accurate determination of apical constriction is not possible with radiography alone because of anatomical variation or errors in projection.

In 1993 Frank and Torabinjed suggested that because of the technical problems and hazards of radiation, many dentists have desired alternative ways to determine the working length during root canal treatment. Attention was turned toward electronic devices for measuring root canal length. They conducted an in vivo evaluation of Endex electronic apex locator (Third generation).17 In our in vivo study, we used fourth generation Electronic apex locator, i.e, Sybron Endo which is similar to Endex in respect that both can be used in moist conditions of root canals. However Endex gives better results only in presence of normal saline and sodium hypochlorite whereas Sybron Endo is accurate even in presence of pus, exudates and blood.

The results of both studies also correlate closely therefore this study suggests that Electronic apex locator has a definite place in the endodontic armamentarium. However, like other electronic devices Electronic apex locator cannot disclose the presence, degree or direction of a curvature or the presence of additional roots or canals.

Gordon and Chandler in their review on electronic apex locator concluded that “no individual technique is truly satisfactory in determining endodontic working length”. The cementodentinal junction is a practical and anatomical termination point for preparation and obturation of root canal and this cannot be determined radiographically. The modern apex locator can determine the position with accuracies of greater than 90% but still have some limitations. Therefore knowledge of apical anatomy, prudent use of radiographs and correct use of apex locator will assist practitioners to achieve predictable results.18

Hoer and Attin carried out an in vivo study to measure the accuracy of electronic working length determination in comparison with conventional radiographic method.19 No significant difference between electronic and radiographic measurements was re-
corded. They finally concluded that under clinical conditions, the modern electronic apex locators were able to identify the region between internal apical constriction and major foramen with high degree of success 81.7%. However, the accuracy of electronic apex locator in electronic working length determination from the results of our study is 90%, therefore working length determination should be carried out using a combination of apex locator and radiography.

The current types of apex locators are accurate for determining working length provided some basic steps are followed carefully for their use. They need to have well-charged batteries which should be calibrated correctly before use. The conventional radiography and electronic digital imaging provide the clinician with the ability to manipulate, enhance and store radiographic images for immediate recall, to visualize the crown and root anatomy; the relationship of crown to the root, the size, shape, curvature, and location of he roots and to estimate the root length. This data give clinician a good baseline from which to use an apex locator. Electronic apex locators are a useful adjunct to endodontic therapy. It is also important to understand that they cannot replace the radiographs completely in treatment.

McDonald in his study on electronic working length determination summarized that electronic apex locator has an accuracy range of 83-93.4%. He also concluded that strict adherence to the principles of use of an electronic apex locator in conjunction with high quality radiographs provide the clinician with an accurate and useful adjunct to endodontic therapy.11

The materials and methods of this study were similar to our study as both were in vivo, comparison of electronic working length was made with conventional radiographic method, and only single rooted teeth were included. The results and %age accuracy were also approximately similar to ours.

CONCLUSION

It is concluded from this study that in the comparison of electronic and radiographic working lengths in anterior teeth there was statistically no significant difference between the techniques investigated. It is therefore suggested that the use of apex locators in conjunction with high quality standardized radiographs provide an accurate and useful adjunct to successful endodontic therapy.

Using an electronic estimate prior to radiographic verification enhances length control throughout treatment and reduces the number of radiographs in anterior teeth.

REFERENCES