Original Article

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Dentistry Section

Evaluation of Correlation Between apical Diameter and File Size Using Propex Pixi Apex Locator

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ABSTRACT

Aim : Aim of this study is to evaluate the influence of critical diameter of apical foramen and file size using propex pixi apex locator in working length determination

Materials and Methods: In this study, ten single rooted teeth were selected. They were decoronated at cemento enamel junction. After determining the actual working length, they were embedded in alginate mold. Foramina were widened from 0.6mm to 0.8mm. The measurements were taken with electronic apex locator propex pixi with files from sizes 10 K to respective sizes. Statistical accuracy of propex pixi was calculated by using Anova test for different diameters and for the influence of file size.

Results: Results showed that propex pixi apex locator was accurate when foramen diameter is 0.6 (60k file size), its accuracy diminished with increased foramen diameter

Conclusion: Propex pixi is accurate for foramen diameter of 0.6mm, independent of file size. Its accuracy decreases as apical foramen widens, so care should be taken when using clinically.

Keywords: Apex locators, Apical widening, File size, Root length determination

INTRODUCTION

The accurate determination of working length is considered as one of the most important steps in success of root canal therapy [1].

Various methods have been proposed for determining working length which includes radiographic and non radiographic methods. Radiographs are subjected to errors like distortion, magnification etc. The main disadvantage is that radiographic evaluation is entirely subjective and therefore scantly reproducible [1]. Electronic apex locators are considered valuable tools in determining the working length accurately.

Electronic apex locators have been influenced by number of factors which include apical foramen size, file size in measuring root canal length, irrigating solution used and electro conductivity of pulp [2]. However, among all these factors the size of apical foramen and file size used play very important role in determining the electronic working length.

Thus the aim of present study is to evaluate correlation between apical diameter and file size affect on working length measurement using propex pixi apex locator.

MATERIALS AND METHODS

Ten single rooted extracted mandibular premolars are taken and stored in saline. Dental x–ray images were taken to evaluate the root canal anatomy. Teeth with mature apices and single canals were selected. Teeth were cleaned of calculus, soft tissues and debris. The crown of each tooth was sectioned using diamond disc to provide unrestricted access to root canal space and to provide a stable reference point for all measurements.

Actual canal length was calculated by introducing 10k file(Mani, prime dental products) until tip was just visible using 2.5x magnifying loupes (seiler). After adjusting stopper to that level, the distance between stopper and file tip was measured with an endodontic ruler.

Root canal was widened to size 60k file sequentially at working length of AL + 1mm. During instrumentation, irrigation done with 3% sodium hypochlorite and 16% Odonto EDTA. Teeth were then transferred to a mold filled with alginate. It is kept moist during the entire procedure.

After widening to file size 60 k propex pixi apex locator was used to determine working length by using files sizes ranging from 10k to 60k. Measurements were taken according to manufacturer instructions. When the apex locator showed reading of 0.0 adjusting stopper to that level the distance between stopper and file tip was measured with an endodontic ruler. From this length 0.5mm is subtracted to obtain working length.

All the measurements were taken in triplicate and the mean value is taken into consideration. Canal widening was continued up to an apical diameter of 0.7 mm, values are noted in triplicate with 10 k to 70k files using propex pixi apex locator. Then progressive widening done up to 0.8mm and measurements were noted in triplicate using files from 10k to 80k sizes.

From these triplicate measurements mean values are calculated at diameters of size 0.6,0.7,0.8 mm when measured with different files.

Now, mean values obtained is subtracted from actual length (i.e. the value obtained by introduction of k file and observing file tip under 2.5x magnification) for each apical enlargement.

$\Delta L = F10\text{-}80 - AL$

Here, difference in the measurements was taken as all teeth are not of same length. Thus, the data refer not to length but to increments or decrements in length.

RESULTS

Data obtained were submitted to one-way-ANOVA [Table/Fig-1-4]. All statistical analysis was done by using statistical software SPSS statistics 17.0 version. P-value less than 0.005 are considered as significant.

The one-way-ANOVA test revealed significance difference between the groups [p=0.000]. Here in this study as the foramen diameter is increased from 0.6-0.8 mm there is gradual increase in the difference between actual working length and electronic working length. Values obtained with smaller size files were shorter than actual length and they gradually approached working length as the file size is increased. However with foramen size of 0.6mm values obtained are nearer to actual working length with whatever may be the file size used. With apical diameter of 0.7, 0.8mm on using file

	10	15	20	25	30	35	40	45	50	55	60
1	0.5	0.45	0.47	0.40	0.44	0.38	0.29	0.28	0.27	0.28	0.23
2	0.52	0.44	0.48	0.41	0.41	0.37	0.28	0.25	0.24	0.29	0.22
3	0.55	0.45	0.43	0.40	0.40	0.36	0.28	0.25	0.24	0.24	0.21
4	0.58	0.43	0.42	0.40	0.42	0.35	0.27	0.26	0.25	0.27	0.23
5	0.51	0.44	0.41	0.40	0.41	0.36	0.25	0.27	0.24	0.26	0.22
6	0.52	0.45	0.44	0.41	0.44	0.36	0.28	0.27	0.26	0.25	0.21
7	0.51	0.43	0.42	0.41	0.45	0.37	0.27	0.26	0.24	0.26	0.22
8	0.53	0.45	0.44	0.43	0.48	0.35	0.28	0.27	0.23	0.24	0.23
9	0.54	0.44	0.43	0.42	0.41	0.40	0.28	0.25	0.22	0.29	0.21
10	0.50	0.45	0.44	0.42	0.41	0.35	0.28	0.25	0.21	0.26	0.22

[Table/Fig-1]: N=1 Difference between actual length of tooth and electronic working length(mean value of triplicate) for ten teeth measured with files of size ranging from 10 to 60 when tooth enlarged to 0.6 mm apical diameter

	10	15	20	25	30	35	40	45	50	55	60	70
1	1.01	0.75	0.75	0.74	0.70	0.65	0.59	0.49	0.45	0.38	0.42	0.28
2	1.02	0.79	0.74	0.73	0.65	0.64	0.58	0.45	0.41	0.37	0.37	0.26
3	1.03	0.80	0.74	0.72	0.68	0.63	0.55	0.44	0.43	0.36	0.35	0.24
4	1.04	0.80	0.74	0.71	0.64	0.64	0.54	0.43	0.44	0.37	0.34	0.29
5	1.01	0.76	0.73	0.72	0.68	0.62	0.51	0.43	0.42	0.36	0.35	0.24
6	1.05	0.74	0.73	0.71	0.64	0.62	0.45	0.43	0.42	0.36	0.34	0.26
7	1.04	0.75	0.72	0.71	0.67	0.64	0.51	0.42	0.41	0.37	0.36	0.27
8	1.01	0.74	0.75	0.74	0.71	0.63	0.59	0.49	0.41	0.36	0.35	0.28
9	1.04	0.75	0.74	0.73	0.71	0.62	0.54	0.41	0.42	0.35	0.34	0.29
10	1.04	0.74	0.79	0.78	0.74	0.61	0.54	0.41	0.42	0.37	0.34	0.29

[Table/Fig-2]: Difference between actual length of tooth and electronic length (mean value of triplicate) for same ten teeth measured with files of size ranging from 10 to 70 when tooth enlarged to 0.7 mm apical diameter

sizes greater than 45 and 70 respectively resulted in working length nearer to actual working length.

DISCUSSION

Determination and maintenance of accurate working length are critical steps in endodontic therapy [2].

An electronic method for root length determination was first investigated by Custer. The idea was revisited by Suzuki who studied the flow of direct current through the teeth of dogs. He registered consistent values in electrical resistance between an instrument in a root canal and an electrode on the oral mucous membrane and speculated that this would measure the canal length. Sunada took these principles and constructed a simple device that used direct current to measure the canal length. It worked on the principle that the electrical resistance of the mucous membrane and the periodontium registered 6.0 kΩ in any part of the periodontium regardless of the person's age or the shape and type of teeth (Sunada 1962). Using direct current caused instability with measurement, and polarization of the file tip altered the measurement [3].

The first generation apex locators were developed in 1969. It used the resistance method. Second generation apex locators were of the single frequency impedance type which used impedance measurements instead of resistance to measure location within the canal. Third generation apex locators are similar to the second generation except that they use multiple frequencies to determine the distance from the end of the canal. These units have more powerful microprocessors and are able to process the mathematical quotient and algorithm calculations required to give accurate readings. Fourth generation device and the unit use two separate frequencies 400 Hz and 8 kHz similar to the third generation units [3]. Fifth generation apex locator was developed. It measures the capacitance and resistance of the circuit separately. It is supplied by

	10	15	20	25	30	35	40	45	50	55	60	70	80
1	1.42	1.21	1.15	1.24	1.14	1.01	1.01	0.89	0.81	0.75	0.70	0.5	0.51
2	1.49	1.24	1.14	1.25	1.16	1.02	1.02	0.85	0.82	0.74	0.72	0.51	0.52
3	1.45	1.24	1.15	1.27	1.17	1.03	1.01	0.87	0.87	0.75	0.73	0.52	0.51
4	1.42	1.23	1.14	1.27	1.14	1.04	1.02	0.85	0.82	0.74	0.72	0.53	0.51
5	1.39	1.19	1.13	1.26	1.13	1.01	1.01	0.86	0.83	0.73	0.72	0.51	0.52
6	1.38	1.22	1.07	1.27	1.12	1.02	1.02	0.84	0.82	0.72	0.71	0.52	0.51
7	1.41	1.23	1.09	1.21	1.19	1.05	1.01	0.83	0.82	0.72	0.72	0.51	0.52
8	1.42	1.24	1.11	1.29	1.12	1.04	1.02	0.85	0.83	0.73	0.72	0.52	0.52
9	1.49	1.22	1.13	1.28	1.21	1.06	1.01	0.84	0.82	0.72	0.72	0.53	0.51
10	1.47	1.23	1.14	1.29	1.21	1.07	1.02	0.85	0.81	0.71	0.71	0.52	0.55

[Table/Fig-3]: Difference between actual length of tooth and measured length(mean value of triplicate) for same ten teeth measured with files of size ranging from 10 to 80 when tooth enlarged to 0.8 mm apical diameter.

File Size	Foramen Diameter						p Value
	0.6		0.7		0.8		
	Mean	SD	Mean	SD	Mean	SD	
10	0.526	0.025	1.029	0.016	1.434	0.039	0.000 S
15	0.443	0.008	0.762	0.025	1.225	0.017	0.000 S
20	0.438	0.023	0.743	0.010	1.125	0.028	0.000 S
25	0.410	0.011	0.729	0.012	1.263	0.024	0.000 S
30	0.427	0.026	0.682	0.028	1.159	0.032	0.000 S
35	0.365	0.016	0.630	0.011	1.035	0.018	0.000 S
40	0.276	0.011	0.540	0.046	1.015	0.005	0.000 S
45	0.261	0.011	0.440	0.029	0.853	0.018	0.000 S
50	0.240	0.015	0.423	0.014	0.825	0.017	0.000 S
55	0.264	0.019	0.365	0.009	0.731	0.012	0.000 S
60	0.220	0.009	0.356	0.025	0.717	0.008	0.000 S
70	-	-	0.270	0.019	0.517	0.010	0.000 S
80	-	-	-	-	0.518	0.005	-

[Table/Fig-4]: Mean and standard deviation values of difference between actual length and electronic working length of ten teeth measured at three different diameters with different file sizes., P-value less than 0.005 is considered as significant

diagnostic table that includes the statistics of the values at different positions to diagnose the position of the file.

The accuracy of canal length measurement using electronic apex locators is in range of 80% to 100% as shown by in vitro and clinical studies [2].

However, various factors shown to be influencing the working length determination using apex locators, of which size of the canal at the apical terminus plays a major role [4-6]. A root canal with a large apical foramen resulted in underestimation of the root canal length and consequently in short working lengths [6].

Many studies have evaluated the accuracy of EALs in laboratory studies or in vivo with respect to the Apical constriction(AC) or Apical foramen(AF) and indicated that the AF could be determined more precisely and consistently than the AC by more recent generation of EALs. They generally concluded that it would be more objective to evaluate the accuracy of EALs in relation to the major foramen or AF, which seems to be a more reliable and reproducible land mark than the minor foramen or AC [7].

According to Fouad et al., critical diameter of foramen found to be 0.3-0.4mm [4]. However, Manuela Herrera found that there is no change in accuracy of working length determination up to apical diameter of 0.6 mm [2]. Similar to that in the present study also there is no significant difference in working length determination at apical diameter of 0.6mm with whatever may be the file size used.

According to Huang, when the diameter of the foramen was less than 0.2 mm, it was not disturbed by highly conducting mediums. Huang has found that as the foramen size increases above 0.2 mm,

measured distances from the foramen increased. The walls of this portion of the canal are composed primarily of cellular cementum. As the probe comes in contact with more surface area of this tissue, the resistance of the apex locator circuit decreases. The circuit resistance would appear to be related to the insulating properties of the dentin in the dentinal portion of the canal, the width of the major foramen, and the area of surface contact that the probe makes with the conductive tissue; which in this case, is periodontal tissue in the cementinal portion of the canal. It would seem that as the major foramen diameter increased, the distances measured from the foramen opening increased [5].

In a study conducted by AF Fouad et al., 0.3 mm apical foramen size is used for determining working length by using endex apex locator. They stated that an apical foramen diameter larger than 0.2 mm or a glass tube (simulating the root canal) of diameter larger than 0.4 mm rendered measurements of a traditional resistance-measuring EAL inaccurate. Also, it has been shown that apical foramen diameters between 0.17 and 0.42 mm did not influence the accuracy of the Endex, whereas values over 0.62 mm gave a shorter canal length. Thus, despite the superior performance of the Endex with relatively wide apical foramina, the instrument is likely to lose this advantage if the apical foramen diameter is wider than that tested [4].

Fan et al., evaluated the accuracy of Rootzx, Propex, and Neosonoultima EZ in determining working length in glass tubules of various diameters ranging from 0.5 to 1 in dry and wet canals. They concluded that the accuracy of the Root ZX decreased as the tubule diameter increased when tubules were filled with electrolytes. The electrolytes in the tubules decreased the accuracy of Propex when the tubule diameter was large. They had no influence on the accuracy of Neosono Ultima EZ. The Propex and Neosono Ultima EZ were more accurate than the Root ZX under various conditions in this study [8].

Venturi et al., evaluated the performance of the Apex Finder and the Root ZX apex locators, with and without irrigant, in canals having different diameters(0.15, 0.20, 0.25, 0.40, 0.60 and 0.80 mm) and concluded that the accuracy of apex locators was affected by diameter of the foramen, type of EAL, distance to the apex, and by several interactions [9].

In this study we have selected Propex pixi apex locator because it uses multi-frequency apex locator technology, it works in dry and wet canals, and no calibration, no zero adjustment is necessary. Less disturbance by tangling wires, improved visual control of the file progression and also gives dual control of the file progression.

Here alginate is used as conductive medium. In vitro studies use electro-conductive materials to simulate the clinical situation. Various materials like alginate, agar, saline and gelatine have been used as electro-conducting medium in different studies [10]. However, alginate is found to be the most stable material for correct estimation of working length since it is simple, inexpensive, and stable for hours. Alginate mould is relatively stiff, so prevents fluid movement inside the canal that is responsible for premature electronic readings registered with previous models [11].

By observing results in present study we can see all values obtained are short of apex. It coincides with study conducted by Fouad et al., [4]. Difference between actual length and electrical length values are decreased as the file size is increased in all cases (0.6, 0.7, and 0.8). Propex pixi Apex locator was accurate when foramen size enlarged to 0.6mm, with whatever may be the file used (10-60). Results coincides with the study conducted by Manuela Herrera et al., [6] i.e. for foramen size of 0.7mm the difference between actual length and electrical length is less than 0.5 when the file size is 45 and above. For 0.8mm reasonable values are seen when file size is greater than 70.

CONCLUSION

Within the limitations of this study the propex pixi apex locator is accurate under a diameter size of 0.6mm with whatever file we may use. In the case of diameters of 0.7 to 0.8mm, we must adjust the files to the foramen size to maintain accuracy.

While determining the working length in wide open apex and blunder buss canals using electronic method (apex locators),when the foramen size is larger than 60 we should adjust the instrument size to larger number, to coincide with foramen size. Placement of smaller instrument in such canals may result in shorter working length.

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