

IN VITRO COMPARISON OF TWO ELECTRONIC APEX LOCATORS

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SUMMARY

The purpose of this study was to determine the capacity of the studied equipments to locate the foramen exit position correctly, fundamental data for working length determination. Twenty extracted superior central incisors, totaling twenty canals, were used in this experiment. Measurements were executed at the point "0.5" of the new Romiapex A-15 apex locator unit (Romidan, Israel) and at the second green mark indication of the Root ZX II (J. Morita, USA) apex locator unit. Once obtained the electronic reading, the file used as electrode was fixed in position. The gauging of the results was accomplished by wearing one of the external radicular walls of the root apical third, and direct visualization with aid of a surgical microscope. The results indicated that, on average, Romiapex A-15 indicated measures 0,24mm ($\pm 0,30$) short of the exit of the apical foramen, and Root ZX II 0,21mm($\pm 0,25$), not presenting significant differences between the two devices. The analysis of the results indicated that all measurements were inside of an acceptable clinical limit, demonstrating that the tested devices are precise and reliable in the determination of the foramen exit position.

INTRODUCTION

The establishment of the correct apical limit of instrumentation is accepted as one of the most important operative procedures in Endodontics. Significant evidences show that the instrumentation until the limit of the radiographic apex or above and beyond this, it can commit in a irreversible way the success of the clinical endodontic therapy.

Although the main radicular canal is limited for the apical foramen, also known as larger foramen, the point of smaller diameter of this canal is found usually in the apical constriction, equally call of smaller foramen, being located, on average, approximately 1mm short of the apical foramen, being able to, still, to vary its position from zero to 2mm short of the foramen. This point contains the pulpal tissue, communicating it to the apical periodontal ligament. The operative procedures in Endodontics should be contained in such limit that doesn't cause damages to the periapical tissue, favoring the cure and repairing of this area after the treatment. It is accepted that the apical constriction should be the ideal limit of instrumentation and filling.

Some techniques of determination of the endodontic working length were described and checked scientifically, among them the digital tactile sensibility, methods based in radiographic analysis, and electronic methods. The third generation of apex locators (APIT, ENDEX, APEX FINDER, JUSTY II, ROOT ZX and ROOT ZX II, BINGO 1020, NOVAPEX, among others), were checked in past studies and

indicated reliable and precise measurements of the position of apical foramen. The presented positive results were shown superior to the of the INGLE radiographic technique. The present study intends to identify if the new Romiapex A-15 and Root ZX II presents necessary and reliable measurements for the position of the foramen, indispensable point in the calculation of the working length.

MATERIALS AND METHODS

- Selection of extracted teeth

Twenty extracted superior central incisors stored in 2.5% glutaraldehyde solution, extracted for different reasons, were selected for the experiment. Initial radiographic exam was accomplished in the sense of detecting perforations, lacerations, previous endodontic treatment, or fragments of instruments fractured inside the canal, calcifications and complete formation of the apex. The teeth that presented situations to make unfeasible the experiment were discarded of the sampling. The apparent length of the tooth in the x-ray was measured being used a endodontic ruler, and calculated the temporary working length. The radicular portion of the teeth was submerged in agar saline phosphate buffered solution (Figure 1). The selected teeth were contained in two groups for verification of the electronic measurements. Ten teeth were used for each group.



Figure 1. Group of teeth submerged in agar saline phosphate buffered solution with the electrode in position.

- Electronic determination of the working length

After the location of canals opening using an endodontic probe, the initial instrumentation was executed with type K number 10 or 15, until approximately 3mm back of the temporary length of work, established for the measurement of the length of the tooth in the initial x-ray. Abundant irrigation of 2, 5% sodium hypochlorite was accomplished in the pulp chamber. In all of the cases was accomplished the Crow-down technique. All the teeth were irrigated abundantly with 2,5% sodium hypochlorite and aspirated excess of liquid of the pulp chamber before the measurement, according to the manufacturer's orientation.

The electronic foramen locator Romiapex A-15 (Figure 2, Romidan, Israel) was installed, being positioned the electrode of the mucous membrane in the agar saline phosphate buffered solution, and the electrode of the file in the intermediate of the instrument to be introduced in the canal.



Figure 2. New Romiapex A-15 (Romidan, Israel).

For the electronic measurement, a K file that better adjusted to the foramen anatomical diameter was introduced kindly towards the radicular apical third part, until that the viewfinder of the Romiapex A-15 showed the indication 0.5 (Figure 3). The same procedure was accomplished with the Root ZX II (Figure 4) apex locator, accomplishing the measurement until the second green mark indication in the screen (Figure 5).

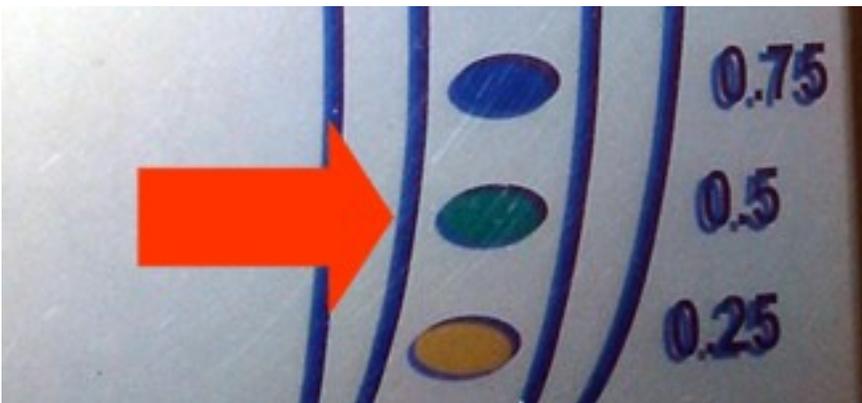


Figure 3. Romiapex A-15 screen at 0,5 corresponding position (red arrow).

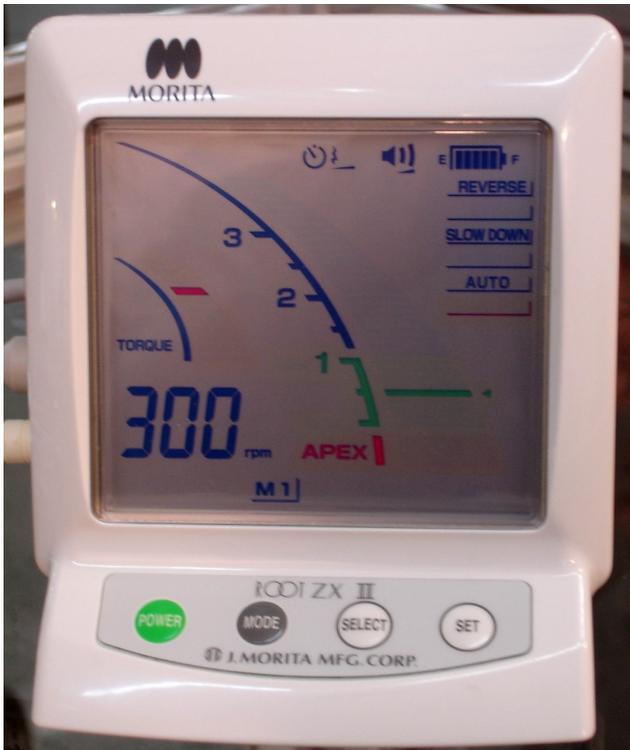


Figure 4. Root ZX II (J. Morita, EUA).

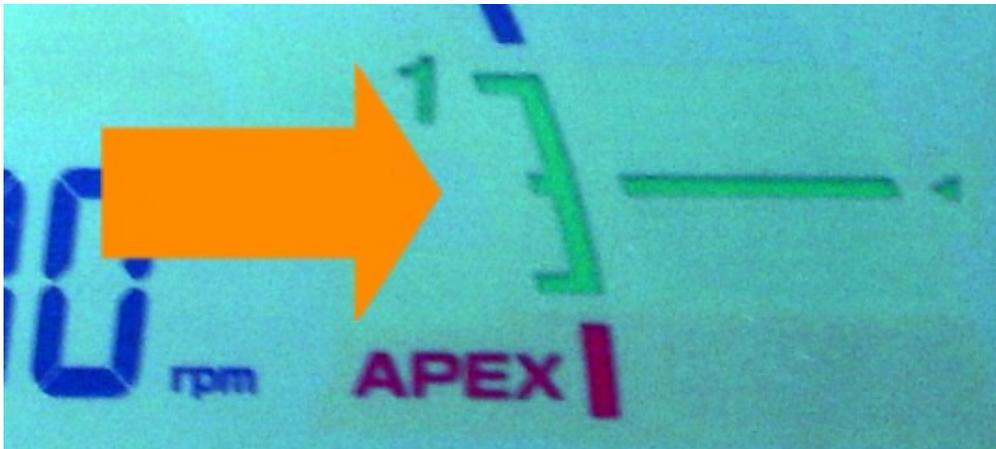


Figure 5. Figure 3. Root ZX II screen at 0,5 corresponding position (orange arrow).

- File fixation and surveying the measures

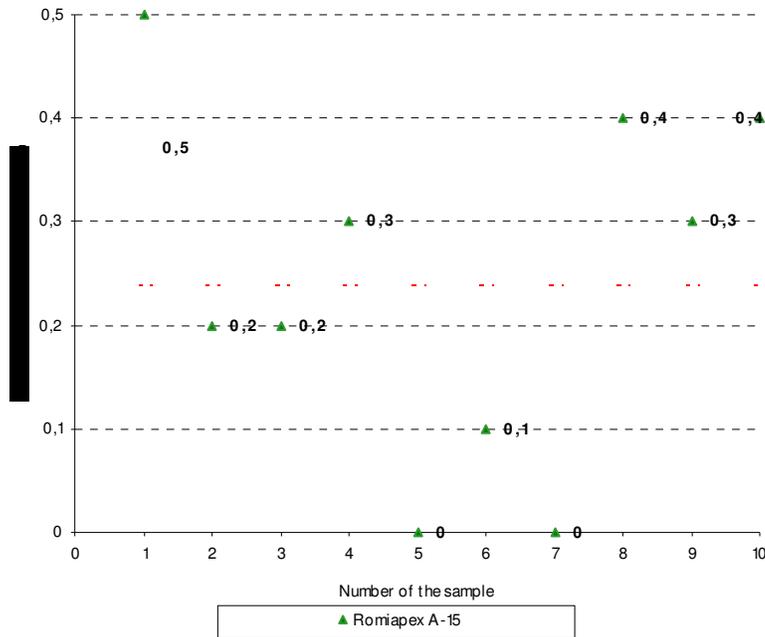
The instrument in position was firmly fixed being used composite through a syringe of appropriate insert. To each incremental layer of resin, inserted in the pulp channel, the light cure was done by one minute.

The real position of the apical foramen exit was identified visually, inserting the tip of a K file 08 in its external portion. The last 5mm of the external faces of the root were removed delicately, through wear and slice with a fine granulation paper disk. When a fine dentine layer was noticed between the executed wear and the tip of the fastened instrument, the remainder was removed being used bistouries' blade n 15, aiming at to visualize the tip of the instrument and the continuity of the canal to the apical foramen.

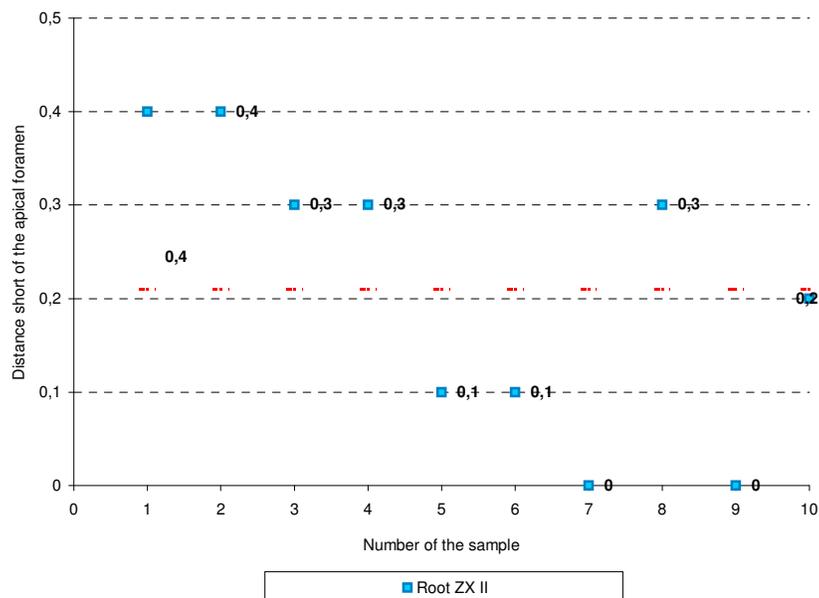
The visualization of the distance between the tip of the file and the foramen was executed using a surgical microscopic. The measure was checked putting one of the extremities of a digital paquimeter in contact with the tip of the instrument and the other, in the imaginary tangent line of the exit of the apical foramen. The values were tabulated according to the number of the tooth in the experiment and the corresponding canal, and the distance between the tip of the instrument and the exit of the apical foramen.

RESULTS

The presented results are demonstrated in the Graphs 1 and Graphs 2.



Graphic 1. Results of the Romiapex A-15 group studied canals.



Graphic 2. Results of the Root ZX II group studied canals.

The obtained electronic measures were compared with the real measure of the point, aimed by this research, through the statistical test *T Student*. The results showed no significant differences ($P>0,05$) among the measurements obtained by the two devices, in the conditions of the experiment. The results indicated that, on average, Romiapex A-15 indicated measures 0,24mm ($\pm 0,30$) short of the apical foramen, and Root ZX II 0,21mm ($\pm 0,25$) short of the apical foramen.

CONCLUSION

Considering the results of this study, it can be concluded that new Romiapex A-15 and Root ZX II presented precise and reliable measurements in the executed experimental conditions, being shown efficient in the determination of the foramen exit position at clinical limits.

References

- [1] J. T. Stein, J. F. Corcoran, A. A. Mich, "Radiographic "working length" revisited", *Oral Surgery, Oral Medicine, Oral Pathology*, vol. 74, no. 6, pp. 796-800, 1992.
- [2] A. Elayouti, R. Weiger, C. Löst, "Frequency of Overinstrumentation with an Acceptable Radiographic Working Length", *Journal of Endodontics*, vol. 27, no. 1, pp. 49-52, 2001.
- [3] A. Katz, A. Tamse, A. Y. Kaufman, "Tooth length determination: A review", *Oral Surgery, Oral Medicine, Oral Pathology*, vol. 72, no. 2, pp. 238-242, 1991.
- [4] S. Shabahang, W. W. Goon, A. H. Glusking, "An in vivo evaluation of Root ZX electronic apex locator", *Journal of Endodontics*, vol. 22, no. 11, pp. 616-618, 1996.
- [5] C. A. Dunlap, N. A. Remeikis, E. A. Begole, C. R. Rauschenberger, "An In Vivo Evaluation of an Electronic Apex Locator that Uses Ratio Method in Vital and Necrotic Canals", *Journal of Endodontics*, vol. 24, no. 1, pp. 48-50, 1998.
- [6] A. Elayouti, R. Weiger, C. Löst, "The Ability of Root ZX Apex Locator to Reduce the Frequency of Overestimated Radiographic Working Length", *Journal of Endodontics*, vol. 28, no. 2, pp. 116-119, 2002.
- [7] J. A. Jenkins, W. A. Walker, W. G. Schindler, C. M. Flores, "An In Vivo Evaluation of the Accuracy of the Root ZX in the Presence of Various Irrigants", *Journal of Endodontics*, vol. 27, no. 3, pp. 209-211, 2001.
- [8] C. Lucena-Martin, V. Robles-Gijon, M. Ferrer-Luque, J. M. M. Navajas-Rodriguez, "In Vitro Evaluation of the Accuracy of Three Electronic Apex Locators", *Journal of Endodontics*, vol. 30, no. 4, pp. 231-233, 2004.
- [9] W. A. Meares, H. R. Steiman, "The Influence of Sodium Hypochlorite Irrigation on the Accuracy of the Root ZX Electronic Apex Locator", *Journal of Endodontics*, vol. 28, no. 8, pp. 595-598, 2002.
- [10] D. H. Pratten, M. S. McDonald, "Comparison of Radiographic and Electronic Working Lengths", *Journal of Endodontics*, vol. 22, no. 4, pp. 173-176, 1996.
- [11] A. R. Welk, J. C. Baumgartner, J. G. Marshall, "An in Vivo Comparison of Two Frequency-based Electronic Apex Locators", *Journal of Endodontics*, vol. 29, no. 8, pp. 497-500, 2003.
- [12] D. Krizaj, J. Jan, V. Valencic, "Numerical Computation of Impedances of a Human Tooth for Estimation of the Root Canal Length", *IEEE Transactions on Biomedical Engineering*, vol. 49, no. 7, p. 746-748, 2002.
- [13] N. Meredith, K. Gulabivala, "Electrical impedance measurements of root canal length", *Endodontics & Dental Traumatology*, vol. 13, pp. 126-131, 1997.
- [14] M. H. Nekoofar, M. M. Ghandi, S. J. Hayes, P. M. H. Dummer, "The fundamental operating principles of electronic root canal length measurement devices", *International Endodontic Journal*, vol. 39, pp. 595-609, 2006.
- [15] I. Sunada, "New Method for Measuring the Length of Root Canal. *Journal of Dental Research*", vol. 41, no. 2, pp. 375-387, 1962.
- [16] C. Kobayashi, "Electronic canal length measurement", *Oral Surgery, Oral Medicine, Oral Pathology*, vol. 79, no. 2, pp. 226-231, 1995.
- [17] M. P. J. Gordon, N. P. Chandler, "Electronic apex locators", *International Endodontic Journal*, vol. 37, pp. 425-437, 2004.
- [18] N. J. McDonald, "The electronic determination of working length", *Dental Clinics of North America*, vol. 36, no. 2, p. 293-307, 1992.
- [19] C. Kobayashi, H. Suda, "New Electronic Canal Measuring Device Based on the Ratio Method", *Journal of Endodontics*, vol. 20, no. 3, pp. 111-114, 1994.
- [20] T. F. Pilot, D. L. Pitts, "Determination of Impedance Changes at Varying Frequencies in Relation to Root Canal File Position and Irrigant", *Journal of Endodontics*, vol. 23, no. 12, pp. 719-724, 1997.