

COMPARISON OF ELECTRONIC ROOT CANAL MEASUREMENTS USING ROMIAPEX A-15 AND BINGO 1020 FORAMEN LOCATORS. AN IN VITRO EVALUATION.

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SUMMARY

The purpose of this study was to determine the capacity of Bingo 1020 (Forum Engineering Technologies, Israel) and Romiapex A-15 (Romidan, Israel) to locate the foramen exit position correctly, fundamental data for working length determination. Forty recently extracted (single-rooted) human teeth, were used in this experiment. Measurements were executed at the point "0.0" of the new Romiapex A-15 apex locator unit (Romidan, Israel) and at point "0.0" of the Bingo 1020 (Forum Engineering Technologies, Israel) 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 scanning microscope. The results indicated that, on average, Romiapex A-15 indicated measures 0,05mm short of the apical foramen, and Bingo 1020 0,02mm, 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. The working

length, based on subtracting 1mm from the electronic measurements of the two devices, would be inside of the biological limits clinically acceptable.

INTRODUCTION

Accurate working length determination has a profound influence on ideal canal preparation, microbial disinfection, and hermetic sealing of the root canal system. However, the location of the appropriate apical position has constituted a persistent challenge in clinical endodontics, although different opinions exist regarding the ideal apical limit of the root canal instrumentation and obturation¹⁻⁴.

Radiographs are used to determine the working length. However, radiographic assessments of the working length may prove inaccurate, depending on the direction and the extent of the root curvature and the position of the apical foramen in association with the anatomic apex⁵.

By measuring the electrical properties of the apical part of the root canal, such as resistance and impedance, it should be possible to detect the canal terminus. The root canal system is surrounded by dentine and cementum that are insulators to electrical current. At the minor apical foramen, however, there is a small hole in which conductive materials within the canal space (tissue, fluid) are electrically connected to the periodontal ligament that is itself a conductor of electric current.

Thus, dentine, along with tissue and fluid inside the canal, forms a resistor, the value of which depends on their dimensions, and their inherent resistivity. When an endodontic file penetrates inside the canal and approaches the apical foramen, the resistance between the endodontic file and the foramen decreases, because the effective length of the resistive material (dentine, tissue, fluid) decreases. As well as resistive properties, the structure of the tooth root has capacitive characteristics. Therefore, various electronic methods have been developed that use a variety of other principles to detect the canal terminus. Whilst the simplest devices measure resistance, other devices measure impedance using high frequency, two frequencies, or multiple frequencies². In addition, some systems use low frequency oscillation and/or a voltage gradient method to detect the canal terminus⁶.

Now, many new electronic foramen locators have become available, resulting that their accuracies need to be ascertained and compared. The purpose of this in vitro study was to compare the accuracies of 2 different electronic foramen locators.

MATERIALS AND METHODS

Teeth selection

This study was performed in accordance with the guidelines issued by the Department of Health, State of Paraná, Brazil, and after approval by its Ethics in Research Committee.

Recently extracted (single-rooted) human teeth stored in 2.5% gluteraldeid solution were used. After evaluating the canal shape with mesiodistal and buccolingual radiograph films, teeth with complicated anatomy, external root resorption, immature root and apical foramen diameter up to $4,0 \times 10^{-2}$ mm were excluded. Forty teeth were selected for the study and immersed in 5.25% sodium hypochlorite (NaOCl) solution for 15 minutes before calculus and soft tissue debris were removed with a scaler. They were then washed thoroughly with tap water. All teeth were cut horizontally at the cemento-enamel junction with a high-speed diamond bur. The selected teeth were contained in two groups for verification of the electronic measurements. Twenty teeth were used for each group.

Root canal preparation

Root canals were prepared by one operator. After access cavities were made, canal orifices were flared with Gates Glidden drill (size 4, VDW, Germany). Canal patency was established by placing a size 12 CC plus file (VDW, Germany) into the canal until the tip was flush with the external root surface at the apical foramen. The coronal two thirds of the canal was instrumented with an Intro Flexmaster rotary instrument (VDW, Germany), at a constant speed of 350 rpm.

Measuring lengths

Canal orifice at the cemento-enamel junction cut was taken as the reference point for all measurements. The teeth were then embedded in an alginate pool that was developed to test apex locators. Alginate (Alginplus, Dentsply, Brazil) was mixed according to the manufacturer's instructions and packed in a plastic box. Within 2 hours after model preparation, the two groups were measured, each one with one of the two devices by one operator.

The foramen locators used in this study were Bingo 1020 (Forum Engineering Technologies, Israel, Fig. 1) and Romiapex A-15 (Romidan, Israel, Fig. 2). The devices were used in order to determine the canal length from a reference point to the supposed "0" mark, as indicated on the devices. Although some devices are designed to measure canal lengths at varying distances from the apical foramen, measurements to the "foramen" mark were taken so as to standardize the procedure for the two devices. All the teeth were irrigated abundantly with 2,5% sodium hypochlorite and aspirated excess of liquid of the cervical third before the measurement, according to the manufacturer's orientation.



Figure 1. Bingo 1020 (Forum Engineering Technologies, Israel)



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

The electronic foramen locator Romiapex A-15 (Romidan, Israel) was installed, being positioned the electrode of the mucous membrane in the alginate, and the electrode of the file in the intermediate of the instrument to be introduced in the canal. For the electronic measurement, a K file (VDW, Germany) that better adjusted to the foramen anatomical diameter was introduced towards the radicular apical third part, until that the viewfinder of the Romiapex A-15 showed the indication 0.0 (Fig. 3).

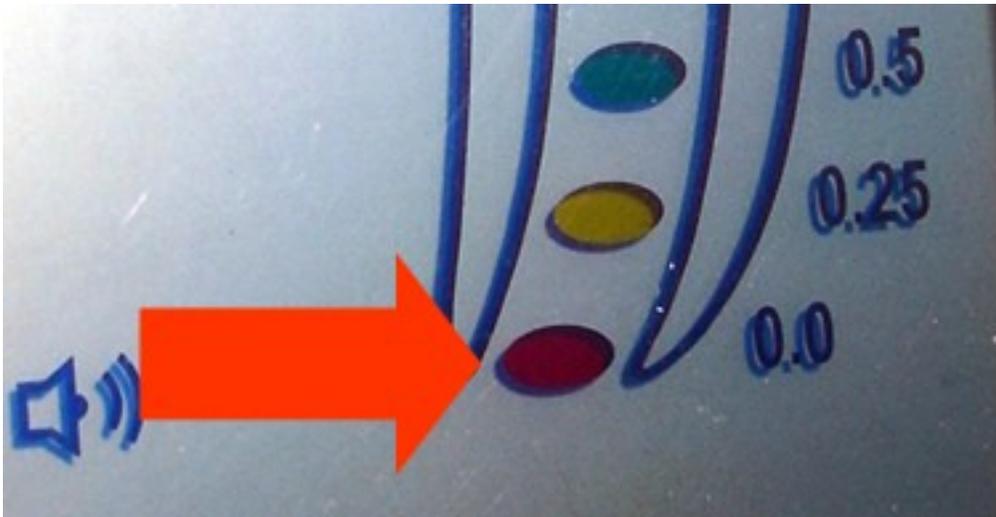


Figure 3. Position corresponding to point 0.0 of the Romiapex A-15 device (red arrow).

The same procedure was accomplished with Bingo 1020 foramen locator (Forum Engineering Technologies, Israel) in group 2. Using the Bingo 1020, the file was advanced to just beyond the foramen (red light), and withdrawn until all flashing bars had been reached, corresponding to point 0.0 (Fig. 4).



Figure 4. Position corresponding to point 0.0 of the Bingo 1020 device (red arrow).

File fixation and surveying the measures

The instrument in position was firmly fixed being used cyanoacrylate (Henkel, Brasil) through a microbrush insert. The exit of the apical foramen 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 an ultrasonic diamond coated point (CV Dentus, V1-E, Brazil). 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 nº 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 (Fig. 1) was executed using an electronic scanning microscope (JSM - 6380LV, JEOL®, Japan). The measure was checked digitally (SEM Control User Interface Version 7.06 Copyright © 2004, JEOL TECHNICS LTD., Japan). 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.

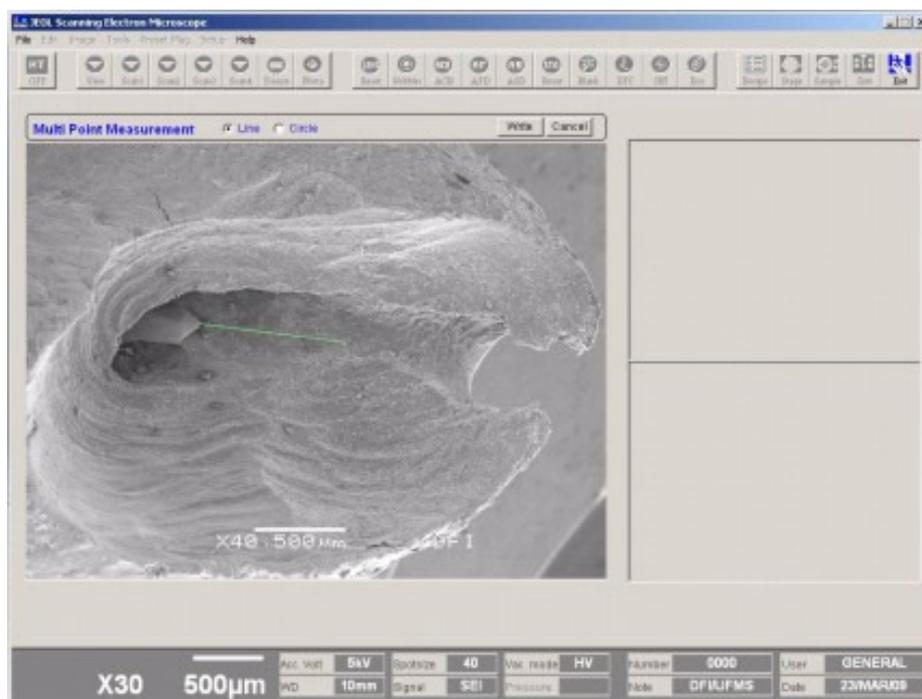


Fig. 1. Image of one sample being measured digitally (SEM Control User Interface Version 7.06 Copyright © 2004, JEOL TECHNICS LTD., Japan).

Statistical analyses

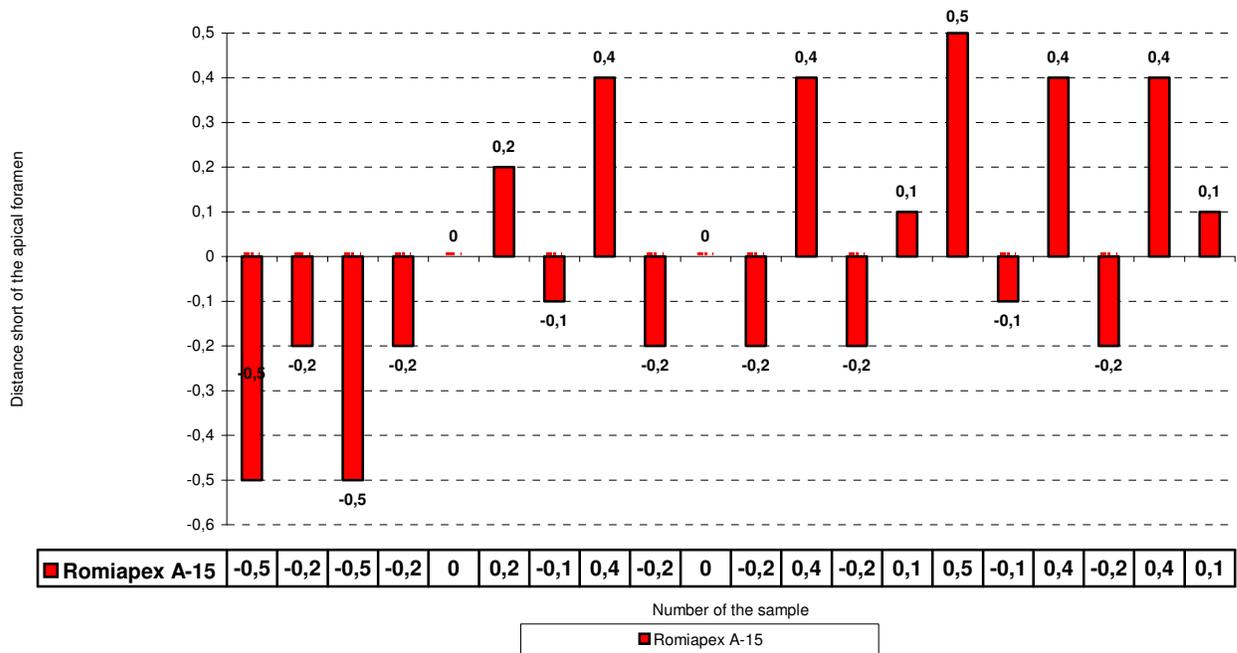
A positive discrepancy value indicated a longer than the actual position of the apical foramen, i.e., beyond the apical foramen. A negative discrepancy value indicated a shorter than actual position of the apical foramen. The mean value of the measurements indicated a general tendency of the foramen locators toward a short or a long reading. The absolute values of the measurements were analyzed statistically using 1-way analysis of variance (ANOVA). A P value of less than .05 was regarded as statistically significant.

RESULTS

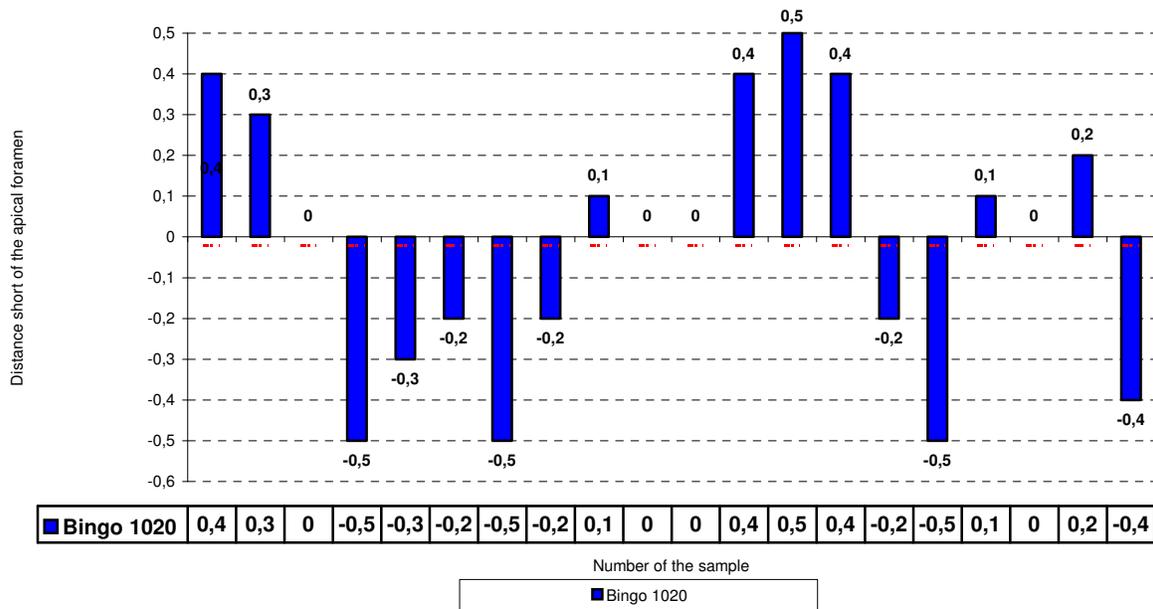
The results are shown in Table I, and Graphics 1 and 2. The mean distance measurements to the apical foramen were found to be 0,05mm±0,38mm (Romiapex A-15), and 0,02mm±0,35mm (Bingo 1020).

	Distance (mm) mean	SD
Romiapex A-15	0,05	±0,38
Bingo 1020	0,02	±0,35

Table 1. Measurements (mm) relative to the apical foramen. Negative value means the electronic measurement is shorter than actual position of the apical foramen.



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



Graphic 2. Results of the Bingo 1020 group studied canals.

DISCUSSION

This in vitro study evaluated the accuracy of two foramen locators in locating the apical foramen. Many studies evaluated foramen locators, but comparisons of results should take into account the adoption of the same parameters of apical limits and the use of similar methods. Many studies set the apical limit at the apical constriction^{7, 8}. One of the problems of using the apical constriction as a parameter for electronic measurements is that, according to several authors, the depth of this structure is not uniform, and the apical anatomy varies from apex to apex^{9, 10, 11}. Results of this study were compared to the mean distances from the tip of the files to the apical foramen. Results for the two devices would be more accurate because all electronic measurements were within the acceptable range of ± 0.5 mm. According to ElAyouti¹², this range may not be relevant clinically but might affect the results of laboratory studies, especially when a target point in the root canal is investigated (e.g. apical constriction or foramen). In this study, 2 different types of frequency-dependent foramen locators were evaluated. On comparison of the accuracies of the devices, the present study showed very similar in performance with no statistically significant difference between them.

Some foramen locators are designed to measure canal lengths at varying distances from the apical foramen, i.e., 0, 0.5, 1.0 mm, and so on. Some studies showed that foramen locators were more reliable when the file reached "Apex" mark^{13, 14}, and suggested to use devices to locate the foramen of each canal at the "0" digital reading¹⁵ and length to the major foramen¹⁶. It is important to point out that the foramen exit is not the instrumentation final point, but the reference to determine the shaping working length. Of the measure regarding the position of the foramen exit is usually subtracted 1mm, like this being determined the shaping working length. Therefore, all the electronic measures of both groups found in this study, in relation to working length determination, would be in a reference point inside of the canal, preventing overinstrumentation.

The validity of measurements made with in vitro models (i.e., the extent to which they depict the clinical accuracy of foramen locators) is unknown¹⁷. However, they

do provide a valuable insight into the function of foramen locators and enable objective examination of a number of variables that are not practical to clinical testing¹⁷.

CONCLUSION

The present study showed no statistically significant differences between the Romiapex A-15 and Bingo 1020 electronic measurements of the apical foramen. Different measurements are of little clinical significance as the readings differed by no more than 0.5 mm. It is concluded that, within the limitations of the present study, there are no differences in accuracies among the Bingo 1020 and Romiapex A-15, being considered both reliable devices. The working length, based on subtracting 1mm from the electronic measurements of the two devices, would be inside of the biological limits clinically acceptable.

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