



Accuracy of Electronic Apex Locator in Enlarged Root Canals with Different Root Canal Irrigants: An *in vitro* Study

Sainath Dinapadu, Srikanth Pasari, Shilpa Reddy Admala, Narender Reddy Marukala
Sindhurareddy Gurram, Ravigna Peddi

ABSTRACT

Aim: To evaluate the accuracy of Root ZX-II (J Morita Corp) apex locator in enlarged root canals with different root canal irrigants.

Materials and methods: 48 freshly extracted single rooted mandibular premolar teeth were used. The apical enlargement was done up to #45 K-file as the master apical file (MAF). The teeth were randomly divided into 4 groups and mounted in an experimental apparatus. The following irrigants were used during electronic canal measurements: group 1: saline; group 2: 3% NaOCl; group 3: 2% chlorhexidine; group 4: 17% EDTA. The canal measurement was done with Root ZX-II apex locator using #10 and #45 K-file. Data were analyzed by two way ANOVA and Bonferroni multiple comparison test.

Results: Statistical analysis showed that there was statistically significant difference between #10 and #45 K-file for group 1 ($p < 0.01$).

Conclusion: Root ZX-II was accurate in the presence of 3% NaOCl and 17% EDTA when measured with smaller and larger files. However, it was accurate in the presence of saline and 2% CHX when larger files were used.

Keywords: Apex locator, Master apical file, Root canal irrigants.

How to cite this article: Dinapadu S, Pasari S, Admala SR, Marukala NR, Gurram S, Peddi R. Accuracy of Electronic Apex Locator in Enlarged Root Canals with Different Root Canal Irrigants: An *in vitro* Study. J Contemp Dent Pract 2013;14(4): 649-652.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Successful endodontic treatment depends upon accurate determination of working length.¹ It has been stated that instrumentation and obturation of the root canal should be established at the apical constriction.² Therefore locating

the exact apical constriction is an important clinical step. Kuttler³ stated that in majority of the cases the apical foramen and anatomical apex do not coincide. The distance between the minor diameter and apical foramen is 0.69 mm in adults, whereas it is 0.529 mm in young people. It is well known that apical foramen seen on the radiograph is usually not the real end of the canal, and it cannot be distinguished with two-dimension radiograph.⁴

Development of apex locators was initiated by Suzuki.⁵ The physics behind functioning of apex locators was demonstrated by Sunanda⁶ and applied this principle to clinical practice. Electronic apex locators are routinely used yet their accuracy has been reported to be 35 to 100%.⁷

The Root ZX-II (J Morita Corp, Kyoto, Japan) is an electronic apex locator that the manufactures claim to be capable of measuring canal length accurately. This device is composed of 2 modules: the canal measurement module and the slow-speed hand piece module, which is sold separately, can be easily connected to the canal measurement module to perform root canal treatment while measuring the root canal.⁸ In the present study, only the accuracy of the canal measurement module was evaluated.

Ebrahim et al⁹ observed inaccurate determination of electronically measured length with small size files in enlarged root canals. Nguyen et al¹⁰ stated that Root ZX-II apex locator was highly accurate even when smaller size file was used in enlarged root canals in the presence of sodium hypochlorite solution.

In general the initial electronic canal measurement is established with small size files that can locate the canal to its terminus. However, it has not been clear whether the

accuracy of Root ZX-II is affected in enlarged canals with different root canal irrigants. The aim of this study was to examine the accuracy of Root ZX-II apex locators in enlarged root canals with different root canal irrigants.

MATERIALS AND METHODS

Forty-eight mandibular premolar single-rooted teeth were used in this study. Digital dental X-ray images were taken in both mesiodistal and buccolingual views to verify the root canal anatomy. After creating an access opening, the actual length was determined by introducing #10 K-file (Dentsply Maillefer) in the canal until the tip of the file became visible at apical foramen under operating surgical microscope at 5× magnification (Carl Zeiss, Germany). The rubber stopper was then set to the reference level and the length was measured with a digital caliper. This direct visual measurement was reduced by 0.5 mm and recorded. Gates Glidden burs #2 and 3 (Dentsply Maillefer) were used to enlarge the coronal one-third of each canal, while middle and apical portion of the canal were enlarged using #10 to 45 K-files, with a #45 K-file as the master apical file. After the use of each instrument the canals were irrigated with 2 ml of distilled water using endodontic syringe.

The teeth were then randomly distributed into four groups of 12 teeth each. Each tooth was then fixed to cap of specimen bottle with autopolymerizing resin. A stainless steel wire (30 mm length, 1mm diameter) screwed into the specimen bottle, which acted as neutral electrode. The specimen bottles were then filled with 1% concentration of heated agar and the model assembly was then refrigerated for 2 hours to allow the agar to set (Fig. 1). The following

irrigants were used during electronic canal measurement: group 1 = 0.9% Saline (IE Utagay Drug Industry, Istanbul, Turkey); group 2 = 3% NaOCl (Prime dental products); group 3 = 2% CHX (Dentochlor, Ammdent); group 4 = 17% EDTA (Prime dental products).

Electronic measurements were made for each group with instrument sizes 10 and 45 K-type files (Dentsply Maillefer). The files was connected to the apex locators and gradually introduced in to the canal. The terminal points used in this study were the Root ZX-II's flashing bar on the meter designated by the manufacturer as the apical constriction. These measurements were noted and were considered valid if the instrument remained stable for at least 5 seconds. A rubber stop was then carefully adjusted to the reference level and the distance between the rubber stop and file tip was measured with a caliper.

RESULTS

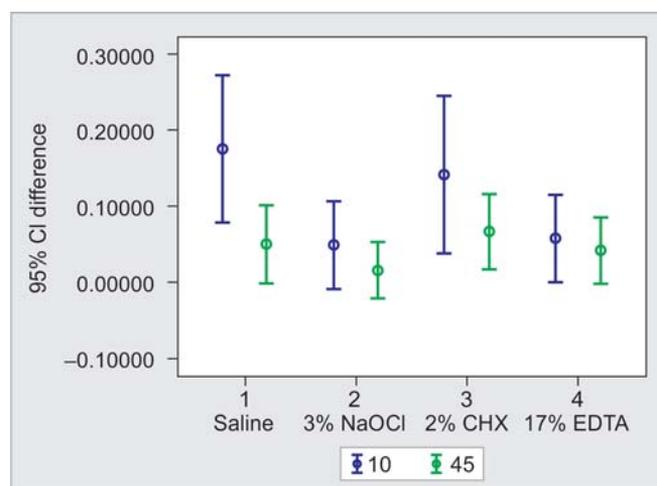
Descriptive statistics including mean and standard deviation were analyzed for each group. Results from four groups were compared and analyzed using two-way Analysis of variance and Bonferroni multiple comparison test. A statistically significant difference was determined at a 95% confidence level.

Graph 1 shows the mean and standard deviation of absolute difference from actual canal length for all groups when measured with #10 and #45 K-files for Root ZX-II.

There was no statistically significant difference between groups 2 and 4 but a significant difference was observed for groups 1 and 3 ($p < 0.05$) when measured with #10 K-file and #45 K-file.



Fig. 1: Experimental model assembly for determination of electronic working length



Graph 1: Mean and standard deviation of absolute difference from actual canal length for all groups when measured with #10 and #45 size file for Root ZX-II

DISCUSSION

The objective of this study was to evaluate the accuracy of Root ZX-II apex locator in enlarged root canals with different root canal irrigants. *In vitro* studies on apex locators make use of electro conductive materials in which the teeth are embedded, thus allowing closure of the electrical circuit, simulating the clinical situation and provide valuable information on the function of apex locator. The materials most often used are alginate, agar, saline and gelatin.¹¹

The apex locators are frequently used with smaller size files. However, the effects of file size relative to canal diameter with different root canal irrigants on the measurement are not very conclusive. In the present study root canals were enlarged to #45 K-files and length were measured with Root ZX-II apex locators with different root canal irrigants (group 1—saline, group 2—3% NaOCl, group 3—2% CHX, group 4—17% EDTA).

Pommer et al¹² concluded in their study that there was no significant relationship between the values from apex locators and the relative moisture content in the canal. Other studies also showed that irrigants did not make a significant difference, although accuracy was greater with EDTA followed with saline. In contrast to these studies Kang et al¹³ demonstrated that, presence of NaOCl gave rise to significant differences in the measurement of different apex locators. Herrera et al¹⁴ reported that higher accuracy tendency was not observed with any of the apex locators as the instrument size increased and further unstable measurements were caused by the root canal content and the individual characteristics of the apex locators tested.

In the present study Root ZX-II was accurate in the presence of 3% NaOCl and 17% EDTA and the electronic canal length measurement with smaller and larger size files was comparable except for saline and 2% CHX group where the length measurement with smaller sized files was longer.

Kaufman et al¹⁵ concluded that presence of CHX did not affect the accuracy of electronic apex locators. Fan et al¹⁵ encountered, in dry tubes that the accuracy of Root ZX was 75 to 91.7% within ± 0.5 mm and 100% within ± 1.0 mm, whereas in tubes filled with electrolyte, the accuracy of the Root ZX decreased as tubule diameter increased. However, the results of this study are in accordance with their findings. It should be stressed that in this investigation an unstable measurement does not necessarily mean a wrong (too short or too long) measurement. This tendency could be explained as a result of the higher friction experienced by the instrument in root canals with a relatively small diameter.¹⁶

Huang¹⁷ demonstrated that the moisture content was important factor influencing the accuracy of root canal measurement. As saline is strong electrolyte, In group 1 the length measured with smaller size file was greater than actual length in enlarged canals.

CONCLUSION

The Root ZX-II apex locator was accurate in the presence of 3% NaOCl and 17% EDTA in enlarged root canals and length was comparable between smaller and larger files. However, it was accurate in the presence of saline and 2% CHX when larger files were used and length measured with smaller size files was greater than actual length.

REFERENCES

1. Seltzer S, Bender IB, Turkenkopf S. Factors affecting successful repair after root canal therapy. *J Am Dent Assoc* 1963;67:651-662.
2. Kuttler Y. Microscopic investigation of root apices. *J Am Dent Assoc* 1955;50:544-552.
3. Ebrahim AK, Wadachi R, Suda H. An *in vitro* evaluation of the accuracy of the Dentaport ZX apex locator in enlarged root canals. *Aust Dent J* 2007;52:193-197.
4. McDonald NJ. The electronic determination of working length. *Dent Clin North Am* 1992;36:293-307.
5. Suzuki K. Experimental study on iontophoresis. *J Stomatol Soc (Japan)* 1942;16:411-417.
6. Sunada I. New method for measuring the length of the root canal. *J Dent Res* 1962;41:375-387.
7. Fan W, Fan B, Gutmann JL, Bian Z, Fan MW. Evaluation of the accuracy of three apex locators using glass tubules. *Int Endod J* 2006;39:127-135.
8. Cunha D'Assunção FL, de Albuquerque DS, Salazar-Silva JR. The accuracy of root canal measurements using the mini apex locator and root ZX-II: an evaluation *in vitro*. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2007;104:50-53.
9. Ebrahim AK, Yoshioka T, Kobayashi, Suda H. The effects of file size, sodium hypochlorite and blood on the accuracy of root ZX apex locators in enlarged root canals: an *in vitro* study. *Aust Dent J* 2006;51:153-157.
10. Nguyen HQ, Kaufman AY, Komorowski RC, Friedman S. Electronic length measurement using small and large files in enlarged canals. *Int Endod J* 1996;29:359-364.
11. Baldi JV, Victorino FR, Bernardes RA. Influence of embedding media on the assessment of electronic apex locators. *J Endod* 2007;33:476-479.
12. Pommer O, Stamm O, Attin T. Influence of the canal contents on the electrical assisted determination of the length of root canals. *J Endod* 2002;28:83-85.
13. Kang JA, Kim SK, Daegu. Accuracies of seven different apex locators under Various conditions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106:57-62.
14. Herrera M, Abalos C, Planas AJ, Llamas R. Influence of apical constriction diameter on Root ZX apex locator precision. *J Endod* 2007;33:995-998.

15. Kaufman AY, Keila S, Yoshpe M. Accuracy of a new apex locator: an in vitro study. *Int Endod J* 2002;35:186-192.
16. Briseno-Marroquin B, Frajlich S, Goldberg F, Willershausen B. Influence of instrument size on the accuracy of different Apex Locators: An *in vitro* Study. *J Endod* 2008;34:698-702.
17. Hung L. An experimental study of the principal of electronic root canal measurement devices. *J Endod* 1987;13:60-64.

ABOUT THE AUTHORS

Sainath Dinapadu (Corresponding Author)

Senior Lecturer, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh, India, Phone: 91-8542-271515, Fax: 91-8542-273111, e-mail: sainathreddy47@gmail.com

Srikanth Pasari

Senior Lecturer, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar Andhra Pradesh, India

Shilpa Reddy Admala

Associate Professor, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar Andhra Pradesh, India

Narender Reddy Marukala

Senior Lecturer, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar Andhra Pradesh, India

Sindhurareddy Gurram

Senior Lecturer, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar Andhra Pradesh, India

Ravigna Peddi

Reader, Department of Pedodontics, SVS Institute of Dental Sciences Mahabubnagar, Andhra Pradesh, India