

Comparison of Two Different Integrated Apex Locators with Radiovisigraphy to Determine the Working Length: An In vivo Study

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ABSTRACT

Background: This study compared the accuracy of two different apex locators integrated in endomotors (Triauto root Zx2 and Micro Mega) with that of radiovisigraphy in vivo under clinical conditions.

Materials and methods: On 30 patients undergoing root canal treatment, the access opening was done and the working length was determined using radiovisigraphy (RVG). The working length was again determined for the same patients using two different rotary integrated apex locators (Triauto Root Zx2 and Micro Mega). The numerical values were documented and subjected to statistical analysis.

Results: Statistical analysis revealed that there was no significant difference between the results of the two apex locators when compared to each other. Similarly when these results were compared with the measurements determined with the help of RVG, no statistically significant difference was observed.

Conclusion: This study concluded that integrated apex locators used for this study are as good in working length determination as RVG and hence can be used as a reliable option during root canal treatment. This may prevent the doctor and patient from unnecessary radiation exposure and may also enhance the convenience of the procedure.

Keywords: Apex locators, Radiovisigraphy, Working length, Triauto root Zx2, Micro Mega.

INTRODUCTION

The success of any root canal treatment is not possible without the complete removal of pulp, necrotic tissue, debris, and microorganisms from the root canal system. This can be achieved only if the working length (WL) is determined accurately (1). Studies have shown that short measurements of the working length, especially in cases of infected necrotic pulps and chronic apical periodontitis have led to significantly lower success rates compared to cases where an accurate WL was

achieved(2). If the WL is established beyond the apical constriction (AC), it may cause apical perforation and overfilling. This may increase postoperative pain and delay or prevent healing.

Working length is defined as “the distance from a coronal reference point to the point at which canal preparation and obturation should terminate (3). It has been stated that the WL for instrumentation and obturation of the root canal system should be established at the apical constriction (4). The apical constriction, also referred to as a minor diameter,

Received: Sep. 22, 2018: Accepted: Oct. 16, 2018

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represents the transition between the pulpal and the periodontal tissue at the cement-dentinal junction. The cement-dentinal junction has been suggested as the position of termination of the canal filling (5). Anatomic studies have shown the apical constriction is usually located 0.5 to 1.0 mm from the external or major foramen (4).

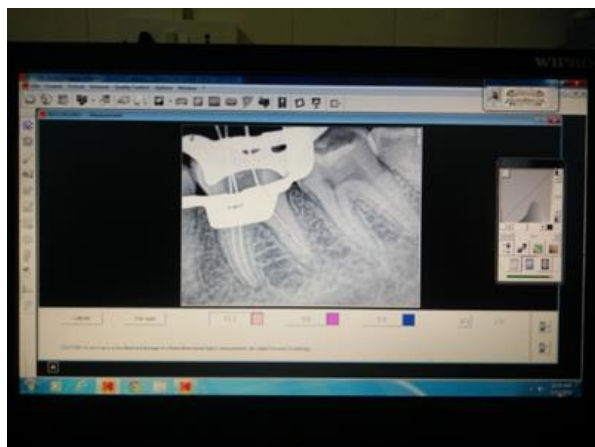


Fig 1: Determination of the working length using a Kodak software on radiovisiography.



Fig 2: Triauto root Zx2 endomotor with integrated apex locator used for this study.

Common methods of determining WL include the use of radiographs, tactile sensation, and electronic apex locators. Many clinicians still practice tactile sensation as an adequate means to detect the working length. But in cases of narrow canals, excessive curvatures and root resorption, this technique is usually inadequate. The conventional radiographic technique is one of the most common diagnostic tool for determining WL in endodontics. However, radiographs are subject to distortion, magnification, interpretation variability, and lack of

three dimensional representations. The accuracy achieved is doubtful, especially in presence of lateral canals /foramina. WL determined from radiographs is generally measured about 0.5 to 1 mm short of the radiographic apex. Pratten and McDonald (6) showed that the assumption of the apical constriction being 1 mm short of the radiographic apex will result in an underestimation of WL. Advancements in radiography in dentistry have led to an advent of digital radiography. The Radiovisiography (RVG) is an intraoral radiographic imaging system which uses software for acquisition of the x-ray on a computer screen. RVG has now become a viable option in determination of endodontic working length due to its various advantages over the conventional radiography technique.



Fig 3: Micro Mega control endomotor with integrated apex locator used for this study.

In addition to radiographic measurements, electronic root canal WL determination with the help of apex locators has become increasingly important (7). This shift to electronic measurement is dictated by the difficulty on some teeth in obtaining a radiograph that can be exploitable clinically due to the presence of dental and/or anatomical obstacles blocking or blurring the view of the root apex on the radiograph. Electronic apex locators' most important advantage over radiography is that they can measure the length of the canal to the end of the apical foramen, not to the radiographic apex (8). Since their discovery in 1942 by Suzuki et al, several generations of apex locators have been developed to improvise on their performance. These apex locators are now being integrated with the endomotors by various

manufacturing companies. This results in a lot of convenience for the operator.

Table 1: Range of difference in working length from RVG in two methods being tested.

Range of difference (mm)	Triauto Zx		MM Control	
	No.	%	No.	%
0	4	9.76	7	17.07
0-0.5	31	75.60	29	70.73
>0.5	6	14.63	5	12.19

Table 2: Range of difference in working length between Triauto Zx and MM Control methods.

Range of difference (mm)	Triauto Zx Vs MM Control	
	No.	%
0	13	31.70
0-0.5	17	41.46
>0.5	11	26.83

Table 3: Mean $\pm$ standard deviation of range of difference between the three groups.

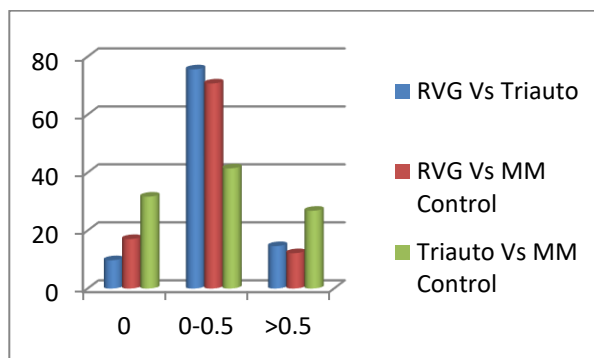
Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	
RVG_Vs_Triauto	41	.00	1.50	.4634	.04923	.31524
RVG_Vs_MMControl	41	.00	1.50	.4317	.05161	.33048
Triauto_Vs_MMControl	41	.00	1.20	.4024	.05527	.35390
Valid N (listwise)	41					

Table 4: Chi Square Test.

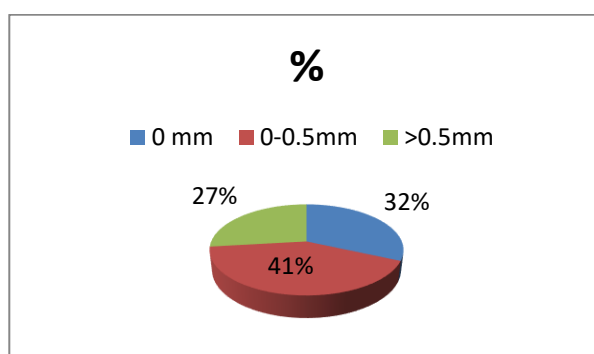
RVG_Triauto			
	Observed N	Expected N	Residual
1	4	13.7	-9.7
2	31	13.7	17.3
3	6	13.7	-7.7
Total	41		

RVG_MMControl			
	Observed N	Expected N	Residual
1	7	13.7	-6.7
2	29	13.7	15.3
3	5	13.7	-8.7
Total	41		

Triauto_MMControl			
	Observed N	Expected N	Residual
1	13	13.7	-.7
2	17	13.7	3.3
3	11	13.7	-2.7
Total	41		



Graph 1: Graphical representation for range of difference from RVG in two methods being tested for working length.



Graph 2: The two Apex locators showing Range of difference.

The purpose of this *in vivo* study was to compare the efficiency of two different apex locators integrated in endomotors ie Micro Mega control and Triauto root Zx 2 with Radiovisiography in order to determine the working length.

MATERIALS AND METHODS

The present study was conducted in the Department of Conservative Dentistry and Endodontics, Meghna Institute of Dental Sciences, Nizamabad, Telengana, India, after gaining clearance from the Institutional Ethical Committee and written consent from patients.

Thirty adult patients (aged 18-40) undergoing root canal treatment for various diagnoses were randomly selected for this study. First, they were administered local anesthesia (2% Lignocaine, Lignox, Indoco Remedies) in the required quadrant and the tooth was isolated using a rubber dam. Access opening of the teeth was done using a number 4 carbide round bur under water irrigation; an Endo Z bur (Dentsply Maillefer, Ballaigues,

Switzerland) was used to refine the pulp chamber walls. The Canal debris was removed with GG drills and irrigation was done with 3 % NaOCl followed by Saline. The Initial apical file (15K file, Mani) was placed and the WL was determined using Radiovisiography (Kodak Dental Imaging software 6.12.32.0)(Fig. 1). Then the WL was determined with 2 different apex locators: Group 1: Triauto root Zx 2(J. Morita Mfg Corp, Kyoto, Japan) (Fig. 2), and Group 2: MicroMega control (Micro Mega, France) (Fig. 3). The numerical values were documented and subjected to statistical analysis.

RESULTS

The 30 teeth selected had 41 canals. The working length determined for each canal using RVG, Triauto root zx2 and Micro Mega was noted down. Table 1 shows the range of difference in working length from RVG in the two methods being tested .Table 2 shows the range of difference in working length observed by Triauto Root Zx2 and MM control. For majority of cases the range of difference was between 0-0.5 mm.

The chi square test was performed which revealed a p value equal to 0.549 (>0.05), indicating that there was no statistically significant difference between the two apex locators. Then a paired t-test was done between RVG and the two apex locators, which also revealed that there was no statistically significant difference ($p>0.05$) between the results determined using RVG and the two apex locators.

A very strong correlation between electronic measurement methods and RVG length was observed (graph 1 and graph 2), thus showing the possibility of their use as a method to measure the actual length.

DISCUSSION

Unless and until the working length of the tooth is determined correctly, a good biomechanical preparation is not possible in a root canal treatment. Any technique to be used in working length determination of root canals of permanent teeth should give precise and reproducible results. Radiation hazard concerns, time taking chemical processing and observer's bias in radiographic interpretation have put digital radiography in the front seat when compared to the conventional

radiography. Studies have shown that the reliability of digital radiography is seemingly comparable to or even better than that of conventional radiography (9)

Electronic apex locators (EALs) are electronic devices developed for determining the working length by comparing the electrical resistance of the periodontal membrane with that of gingiva surrounding that of tooth, both of which should be similar. The first and second generation EALs were unable to give accurate measurements in the presence of irrigation solutions, blood, pus, and pulpal tissue (necrotic or vital) (7). However, recently developed EALs determine the WL by measuring the impedance with two or more different frequencies, and they can work in the presence of various electrolytes (10). Thus, current EALs have a high reliability and high accuracy in locating the apical foramen (11). A recent advance in this aspect is the integration of apex locators in the rotary endomotors which has helped to increase convenience of the doctor. Previous studies have shown apex locators to be more accurate and more reliable than radiography for determining working length. This is primarily due to the fact that electronic measurement is an objective technique, whereas radiography is a subjective technique.

As this study was conducted in vivo, on the basis of ethical principles, many different brands of apex locators could not be tested and compared as that would cause a lot of inconvenience for the patient and dealy in their treatment. For this purpose, only two standard endomotors with integrated apex locators ie Triauto root Zx2 and Micro Mega were selected and their comparison was done with a commonly used radiovisiography software. The reason for chosing RVG as a comparative parameter was because it is the one of the most reliable method used to determine the working length in urban cities in India. It has been shown that calibrated digital measurements are more accurate than uncalibrated measurements (12). Both anterior and posterior teeth were tested in this study to rule out any doubts. The same standard protocol of isolation, access opening and irrigation was followed in all the cases.

During this study, from the adjusted length of tooth radiographically, 0.5 mm was subtracted as a

“safety factor” to conform the apical termination of the root canal at the apical constriction. It has been well documented that accepting clinically a 0.5mm discrepancy between the actual tooth length and lengths estimated on the radiographs, 60% of the measurements obtained with conventional or RVG images were considered equivalent to the actual tooth lengths. (13)

A lot of studies have been done comparing the efficiency of different apex locators. However, the amount of literature regarding apex locators integrated in endomotors is limited and a direct comparison between Triauto Root Zx2 and Micro Mega has not been reported (as far as the author’s knowledge is concerned). The advantage of incorporating apex locators within the endomotors is that they are very convenient for the operator in terms of usage and transportation.

Statistical analysis of this study revealed that the results obtained from Triauto Root Zx2 and Micro Mega were similar to each other. This indicated both had an equal efficiency and accuracy when compared to each other and either one of them could be used as an aid in WL determination. Similarly the values of these EALs were not statistically different from the values obtained from RVG software. This leads to a possible indication of using EALs as the only method of WL determination as radiation exposure is a great concern for the clinician as well as the patient. In special cases such as pregnant women, lactating mothers, patients with debilitating diseases and geriatric patients, this may prove to be very useful. Moreover, in apprehensive, fearful or non cooperative patients and patients with a very shallow vestibule, where the placement of the X-ray film or the RVG sensor may be problem, the use of these EALs may be very beneficial. Another major advantage of EALs over radiography is that they may rule out the superimposition on the image of the root apices, resulting in interpretive error. (Large tori, dense maxillary bone, or the zygoma). In spite of all these advantages, the complete replacement of radiography with electronic aids remains a debatable topic.

CONCLUSION

Within the limitations of this study, on the basis of our observation made during the course of study

and their analysis, it was seen that apex locators are an effective tool in determination of working length in permanent teeth. Two different varieties of integrated apex locators used in the present study were equally effective in doing the same. Moreover, they were as effective as RVG for working length estimation. Although radiographs have been a hallmark in working length determination, the use of apex locators may prove indispensable as far as endodontic diagnosis, comfort of the patient, and radiation exposure are concerned.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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