

Comparative Evaluation on the Success of Root Canal Preparation using Different Endomotors with Inbuilt Apex Locators: An In vitro Study

Research Article

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Abstract

Background: Dental endo motors are pieces of equipment that make the endodontic process easier by allowing mechanically operated files to be used. In order to keep track of the working length during root canal instrumentation, an endodontic motor with a built-in apex locator would be extremely useful. It is successful because of its high precision and safety features, such as auto stop mechanism and reciprocation, that prevents over-instrumentation of the root canal.

Aim: The aim of this study was to evaluate efficiency of root canal preparation using Vdw gold and Propex IQ integrated endo motors with conventional X Smart Plus endo motor.

Materials And Methods: The analysis included thirty extracted single-rooted mandibular teeth with mature apices that were divided into three study groups at random. The canal patency was determined by inserting #10 file into the canal until it reached the apical foramen after the access was opened. To achieve an 18 mm standard length and a flat reference point, the incisal edge of each tooth was balanced. The teeth were then embedded in an alginate model to demonstrate electronic working length and to perform instrumentation procedures. The root canals were instrumented with subjective equipment according to manufacturer's instructions till apical constriction. Root canal treated teeth were obturated and then mounted in wax models and subjected to CBCT analysis. Measurements were taken from tip of obturating material to apical foramen. Statistical analysis was done using SPSS software version 23. Mean and standard deviations were obtained and one-way ANOVA followed by post hoc analysis was done.

Results: There is a statistically significant difference between Vdw gold and X Smart Plus ($P=0.020$). On the other hand, there is no statistically significant difference between Propex IQ & Vdw gold ($P=0.229$) and between Propex IQ & X Smart Plus (0.466).

Conclusion: The values obtained from three study groups are clinically acceptable. Within the limitations of this in vitro analysis, the Vdw Gold endomotor integrated apex locator outperforms traditional endomotor. It can be put to good use because of its increased accuracy and time-saving capabilities.

Keywords: Apical Constriction; Endomotor; Integrated Apex Locator; Root Canal Preparation; Working Length.

Introduction

Root canal procedure is important because root canal therapy aids the patient in overcoming pain and infection in the mouth by relieving pressure from inflammation in the pulp of the tooth [1]. The standard of disinfection, instrumentation, and filling procedures (antimicrobial methods, root canal shaping, and coronal and apical seal), as well as recovery management, decide the lon-

gevity of an endodontically treated tooth [2]. The longevity of an endodontically treated tooth is determined by the quality of disinfection, instrumentation, and filling procedures (antimicrobial techniques, root canal shaping, and coronal and apical seal), as well as recovery management. The performance characteristics of RCT, such as the absence of pain [3], the regression of AP [4], the tight seal of canal and coronal spaces, and the recovery of tooth function, must be measured over time. Enlargement and shaping of the complex endodontic space, as well as disinfection,

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are all part of root canal system preparation. The main goal of root canal therapy is to keep the amount of microorganisms and pathological debris in the root canal system within a strict apical limit [5]. The apical limit is usually set near the apical constriction of the canal, which is the narrowest section with the smallest diameter of blood supply in the canal. As a result, the wound site is minimised and the optimal healing conditions are achieved [6]. Apical constriction can be broken iatrogenically due to incorrect working length determination, which allows for increased apical extrusion of dentinal debris, endodontic irrigants, and filling materials, all of which can trigger an inflammatory response and cause healing to be delayed [7]. Working length is defined as the distance from a coronal reference point to the point at which canal preparation and obturation should terminate," - according to Glossary of Endodontic terms [8]. Electronic apex locators (EALs) are believed to be capable of accurate measurement and giving the exact position, while neither radiographic nor tactile methods can accurately determine the constriction. An electronic apex locator is an endodontic device that determines the location of the apical constriction (AC) and thus the length of the root canal space [9]. Electronic working length determining instruments are a great complement to radiographs for more precisely identifying apical foramina, root resorptions, and fractures [10, 11]. But the working length determination with electronic apex locators may be hampered by canal form, lack of patency, accumulation of dentine debris, and calcifications. The use of root canal prefacing in modern crown-down preparation techniques would improve reading accuracy [12]. Presence of vital pulp tissue, inflammatory exudates, and blood can all conduct electricity, resulting in inaccurate readings [13]. Also the presence of irrigant solutions in the root canal interferes with accurate working length determination [14, 15]. Modern generation EALs use two or three frequencies to measure the impedance and works well even in the presence of irrigating solutions like saline and sodium hypochlorite, while previous generation apex locators were unreliable in the presence of irrigating solutions because they were dependent on measuring resistance between the root canal and the periodontal ligament. Advances in technology have led to the development of apex locators that can be used in conjunction with endo motors to evaluate the working length simultaneously during root canal instrumentation [16].

During the root canal instrumentation, it is critical to keep track of the working length, particularly in curved canals [17]. The endodontic instrument straightens the root canal by removing more dentine from the inner wall of curved canals. Thus in this case, an endodontic motor with a built-in apex locator would be extremely useful in this situation. The Vdw gold is an endo motor with a built-in fourth-generation apex locator that measures the working length using two frequencies of 5.5 kHz and 500 Hz [18]. It is effective due to its high precision and safety features that avoid over-instrumentation of the root canal. The Propex IQ Endomotor is the most recent generation of Endo Motors with an integrated apex locator. It is cordless and has constant and reciprocating movements. The motor is powered by Dentsply Sirona's Apple iOS IQ programme, which is designed to give the operator more flexibility when shaping, assist the operator during the endodontic procedure, and allow for easy data capture and transfer. In comparison to using two types of equipment separately, all inbuilt apex locators make measuring the working length faster and easier.

A thorough search of the literature revealed no studies that compared the accuracy of these two apex locators in determining the position of the apex. So, the aim of this in vitro study was to compare periapical radiographs with endo motors with built-in apex locators to determine the accuracy of working length measurement of an endo motor with integrated apex locator so that it may be useful in future for performing safe and effective root canal treatment. The null hypothesis is there is no significant difference between these different endomotors with inbuilt apex locators.

Previously our team has a rich experience in working on various research projects across multiple disciplines [19-33]. Now the growing trend in this area motivated us to pursue this project.

Materials And Methods

Tooth with fully developed apices and sufficient crown structure to provide a stable reference point were included in the study. Tooth with multiple canals or incompletely formed root apex, tooth with root fracture, carious tooth and restored tooth were excluded in this study. Thirty single-rooted mandibular anterior teeth were taken and examined under a Dental Operating Microscope at 2.5 magnification to confirm apex formation and rule out fractures and apical resorption; they were then radiographed with RVG to confirm the existence of a single canal. Until being washed in saline, the teeth were preserved in a 10% formalin solution. The access cavities were prepared to reveal the root canal system with copious irrigation with 3 percent sodium hypochlorite, which was then negotiated to patency with a no. 10 K-file. The teeth were standardised and randomly allotted into three study groups.

Group I: The working length determination and biomechanical preparation were done with Propex IQ (Figure 1,6,7).

Group II: The working length determination and biomechanical preparation were done with Vdw gold (Figure 2,5).

Group III: The working length was determined with periapical radiographs and biomechanical preparation was performed with X Smart plus (Figure 3).

The teeth were embedded in an alginate model that was created to show electronic working length and conduct instrumentation procedures. Tooth from each group were put in a container filled with alginate to simulate the conduction of electricity in an oral setting. The wire from the apex locator was attached to the file, and the lip clip was inserted into the alginate (Figure 4). They simulated the periodontal ligament in the clinical situation since the roots were covered by alginate. All of the measurements were taken within one hour of the model being ready.

The endomotors were used as per the manufacturer's instructions and working length was determined using the respective endo motors with integrated apex locator and radiographs; then biomechanical preparation was performed in a crown down technique with ProTaper Gold files (Dentsply Maillefer). The preparations were made to end in F2 finishing file at the determined working length. In radiographic working length determination, instrumentation was done using X Smart Plus endo motor without inbuilt apex locator. After drying the canals with paper points, all the instrumented teeth were then obturated using Gutta percha and Zinc oxide based sealer.

Figure 1-3. Tooth groups embedded in wax models after standardisation.

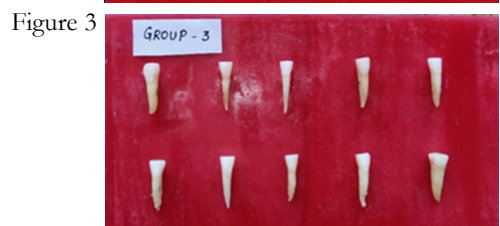
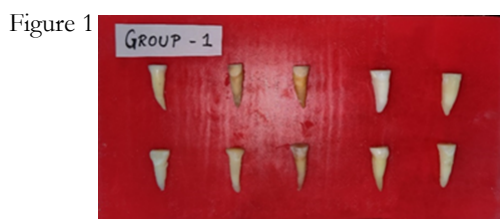


Figure 4. Tooth embedded in alginate for simulation of oral cavity.



Figure 5. Root canal preparation using VDW Gold apex locator integrated endomotor.



Figure 6. Propex IQ connected to smart device-IOS IQ application.



Figure 7. Working length determination using propex IQ.

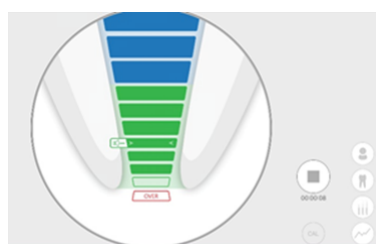
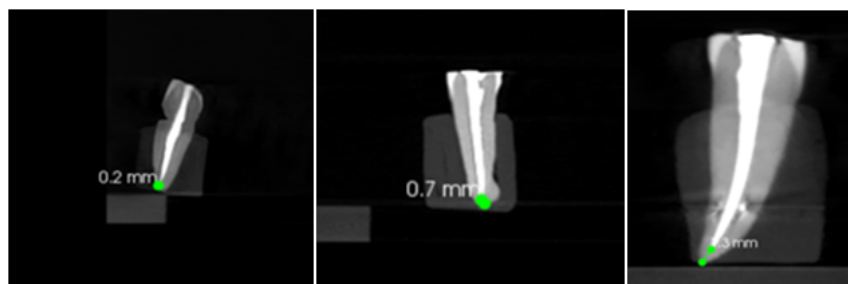


Figure 8. Obturation defect values of Group 1,2 and 3.
 Group 1 is 0.7mm short of apex, Group 2 is 0.2mm short of apex and Group 3 is 1.3mm short of apex.



Root canal treated teeth were then mounted in wax models and subjected to CBCT analysis. Measurements were taken from the tip of obturating material to apical foramen (Figure 8). The values of all groups were entered in an excel sheet and statistical analysis was done using SPSS software version 23. Mean and standard deviations were obtained and one-way ANOVA followed by post hoc analysis was done to determine any significant difference between study groups.

Results

The mean and standard deviation value for Propex IQ was 0.34 ± 0.25 , for Vdw gold was 0.10 ± 0.10 and for X Smart plus was 0.31 ± 0.35 (Table 1).

One-way ANOVA results showed that there is a significant difference between study groups ($p=0.026$) (Table 2).

The Tukey post hoc test is most commonly used for post hoc tests on a one-way ANOVA, although there are several others. There is a statistically significant difference, as seen in the table-3 below between Vdw gold and X Smart Plus ($P=0.020$). On the other hand, there is no statistically significant difference between Propex IQ & Vdw gold ($P=0.229$) and between Propex IQ & X Smart Plus (0.466) (Table 3).

Discussion

It is widely agreed that endodontic treatment should be limited to the root canal system. This is only possible if the length of the tooth is sufficient. The apical canal terminus has been determined using a variety of techniques [34]. Taking radiographs has traditionally been used to assess the end of endodontic instrumentation and obturation. The creation of electronic apex locators (EALs) has aided in the accuracy, precision, and predictability of working length (WL). The treatment outcome of root canal therapy is determined by the correct WL, which ensures that the contents of the root canal system are eliminated before filling the prepared root canal space up to the WL without the final filling material under or overextending [35]. As a result, clinicians must obtain precise measurements during WL determination in order to achieve predictable clinical outcomes. Several studies have shown that instrumentation and obturation till the apical constriction improve histological outcomes after root canal procedure, and that instrumentation and obturation to the apical constriction provide better results [36]. As a result, calculating the WL by determining the minor apical diameter is crucial for successful root canal treatment [37]. In 1918, Custer was the first to report

calculating working length using an electric current. Sunada discovered in 1962 that the electrical resistance between the mucous membrane and the periodontium is constant (6.5k ohms) and can be used to measure root length. Sunada's research system became the foundation for electronic apex locators. Haffner et al. found that apex locators are very reliable in determining working length as compared to a microscope. Another study compared apex locators to the conventional radiographic approach in straight and curved root canals and discovered that apex locators are successful in evaluating working length regardless of the curvature or lack of curvature of the root [38]. Furthermore, when it comes to determining the position of the apical foramen, double-frequency EALs are more accurate than radiographic methods. According to studies, determining working length with an electronic apex locator is a much easier and more accurate method than measuring working length with a radiograph and a file within the canal. Radiation exposure to the patient is reduced, which is an additional advantage.

In previous decades, devices that combine an electronic apex locator with an endodontic electrical motor for canal preparation were introduced. These apex-locator-controlled endodontic motors eliminate the need to verify working length with several files and prevent imprecision by stopping the rotation of the nickel-titanium (NiTi) files when the approximate end of the root canal is reached [39, 40]. These devices can be used as traditional apex locators (with manual hand files) or for motor-controlled rotary NiTi file operation. Some devices also allow the user to choose their preferred apical location and provide a reverse motion to assist in removing the file from the canal once the apex is reached or if the canal becomes blocked. The main objective of this study was to compare Propex IQ and Vdw gold integrated endo motors to standard endo motors with periapical radiographs to determine working length. In this present study, accuracy of Endomotors were tested on single rooted teeth. Endodontic motors with an integrated electronic apex locator have mostly been tested on single-rooted teeth for accuracy. This is because the readings created by the irrigation solution in the pulp chamber and additional canals may be influenced by multirouted teeth [41].

Propex IQ and Vdw gold were chosen for this study because they are endomotors with an integrated apex locator, making calculating the working length quicker and easier than if the two types of equipment were used separately. Also no other studies have compared the efficiency of these two equipment. In our findings, the difference in working length measurement between these two equipment was not statistically significant. This could be due to the limited sample size; raising the sample size could result in different outcomes. At the same time, there was a significant

Table 1. The mean value for Propex IQ was 0.34 ± 0.25 , forVdw gold was 0.10 ± 0.10 and for X Smart plus was 0.31 ± 0.35 .

Report			
Length			
Group	Mean	N	Std. Deviation
PROPEX-IQ	0.34	10	0.259
VDW GOLD	0.1	10	0.105
X SMART	0.51	10	0.475
Total	0.317	30	0.351

Table 2. One-way ANOVA results showed that there is a significant difference between study groups ($p=0.026$).

ANOVA					
Length					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.849	2	0.424	4.192	0.026
Within Groups	2.733	27	0.101		
Total	3.582	29			

Table 3. Statistically significant difference is seen between Vdw gold and X Smart Plus ($P=0.020$). On the other hand, there is no statistically significant difference between Propex IQ &Vdw gold($P=0.229$) and between Propex IQ &X Smart Plus (0.466).

Multiple Comparisons						
Dependent Variable: Length						
Tukey HSD						
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PROPEX-IQ	VDW GOLD	0.24	0.142	0.229	-0.113	0.593
	X SMART	-0.17	0.142	0.466	-0.523	0.183
VDW GOLD	PROPEX-IQ	-0.24	0.142	0.229	-0.593	0.113
	X SMART	-.41000*	0.142	0.02	-0.763	-0.057
X SMART	PROPEX-IQ	0.17	0.142	0.466	-0.183	0.523
	VDW GOLD	.41000*	0.142	0.02	0.057	0.763

*. The mean difference is significant at the 0.05 level.

*. The mean difference is significant at the 0.05 level.

difference between integrated endo motor (VdwGold) that automatically determines working length during instrumentation and conventional endo motor (X Smart plus) in which working length was determined using normal periapical radiographs. The X-Smart Plus is the endo motor preferred by the general Dental Practitioners who perform root canal procedures using the reciprocating, single file technique or conventional continuous rotation file systems. It's ease of use, as well as the excellent visibility and access provided by the miniature contra-angle attachment, enable the practitioner to fully concentrate on the patient and the treatment provided. In this study, results produced by Vdw gold were comparatively superior to X Smart Plus. The reason may be due to the safety auto-reverse mechanism of Vdw gold along with the accuracy of integrated apex locator [42]. In one study, researchers compared the accuracy of the iPex and Vdw gold apex locators in detecting simulated root perforations in curved canals in the presence of 3 percent sodium hypochlorite (NaOCl) and 2 percent chlorhexidine (CHX), finding that the Vdw gold group out-

performed the iPexgroup in dry canals, while both groups were successful in wet canals [43]. Another research compared the accuracy and auto-stop feature of the VDW. Gold RECIPROC motor, the EndoPilot motor, and manual measurement with Raypex 6 in detecting apical constriction (AC), and found that all three measurement methods were highly accurate in detecting the AC [44]. Endodontic motors with auto-stop capabilities are a valuable addition to the endodontic armamentarium. Though the results obtained from all the three study groups are different, they are still clinically acceptable. The in vitro study design may be a drawback in our research. Patient-related factors such as tooth morphology, bleeding, root canal suppuration, metallic restorations and even the irrigant used may alter the role of apex locators in the clinic.

Our institution is passionate about high quality evidence based research and has excelled in various fields [23, 45-54].

Conclusion

Within the limitations of this *in vitro* analysis, the Vdw Gold endo motor integrated apex locator outperforms traditional endo motor. It can be put to good use because of its increased accuracy and time-saving capabilities. More *in vivo* research is required to validate these findings in a clinical setting.

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