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Evaluation of Apical Extent of Root Canal Instrumented Manually Using FlxoFile and Rotary Using ProTaper by the Aid of Dental Operating Microscope (An In Vitro Study)

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ABSTRACT

Purpose: This study was designed to evaluate the influence of different apical limits of working lengths, electronic and radiographic methods of working length determination, maual and rotary root canal instrumentation on the apical extent of root canal filling material. **Materials and Methods:** Forty five roots of maxillary central incisors with mature apices were selected and divided into two groups: Group I (30 roots), and Group II (15 roots) according to the method of working length determination (electronic or radiographic respectively). Each main group was divided into three equal groups according to the apical limit of working Each group at main group (I) were subdivided into two equal subgroups: 1 and 2 (5 each) according to instrumentation system; rotary proTaper system or Flex-o-file while all roots at group (II) were cleaned & shaped with Flex-o-file. Each canal was obturated. The roots were longitudinally splitting .Under a surgical microscope, the integrity of apical constriction was observed and photographed. The distance between the apical terminus of the root canal filling and the apical foramen were measured and photographed by stereomicroscope. **Results:** ANOVA test revealed significant difference on the distance between the apical terminus of the root canal filling and the apical foramen were preserved at the three apical limits when working length and rotary canal preparation were carried by Tri Auto ZX headpiece, and when root canal were prepared by Flex-O-file after radiographic working length determination. Under different variables of this study, the integrity of apical constriction showed no significant difference. **Conclusion**: Electronic working length determination method is more accurate than radiographic method. Tri Auto ZX apex locating headpiece is a reliable method for electronic working length determination, and rotary root canal preparation.

KEYWORDS

Flex-o-file, ProTaper, root canal

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INTRODUCTION

Several methods have been used to determine the endodontic tooth length; radiographic method, electronic apex locators, tactile sensation and apical periodontal sensitivity. The exact apical terminus of the root canal preparation has always been a subject of concern.The foraminal openings always ended short of the apices[1]. The distance of the main foramen from the anatomic apex never exceeds 1mm[2]. The root canal should be filled to within 2mm of the radiographic apex [3,4] or between 1.5 and 2 mm from the apical vertex to prevent overfilling of the root canal[5]. All the radiographic techniques resulted in canal lengths that were significantly different from the true canal length[6]. Therefore radiographic working length measurements should be combined with electronic working length determination using modern apex locators[7,8]. The Root ZX can be used conveniently to locate the apical foramen[9,10]. The Root ZX can accurately detecting the location apical constriction [10,11]. Studies showed that Root ZX can accurately determine the canal length within +/-0.5 mm from the apical constriction [12,13]. Tri Auto ZX was accurate to +/-0.5 mm in locating apical foramen[14]. Using electronic apex locator in the determination of working length is useful and reliable with no statistical difference of the radiographic extent of root canal filling [15.16] when using apex locator alone or in combination with working length radiograph. Tooth Length obtained by Root ZX were closer to actual length than those obtained radiographically. No statistical differences were found between measurements in comparing the electronic, radiographic and actual tooth length measurements, although the radiographic measurements were longer than the electronic ones[17,18]. The ability of apex locator to locate the apical constriction showed significantly less deviations than that for the radiographic method. Thus, the method using the apex locator was slightly more reliable [19]. Location of the apical foramen using a combination of an electronic apex locator and radiographs to determine working length is more accurate than using radiographs alone [20,21] .

Root canal can be prepared manually or with the aid of rotary device. Preparing the root canal manually is highly technique sensitive. The shaping ability of stainless steel K-Flex-o-files using a reaming motion maintained a good working distance [22] .

In engine driven mechanical preparation, the operator loses most of his tactile sense, and it is hard to know the exact position of the file tip during the preparation procedure. ProTaper provides a good centered apical preparation [23] and maintained working length in curved canals[16.24.25] with minimal transportation and loss of working length[23]. The present study was designed to compare the apical extent of root canal instrumented by ProTaper file in an apexlocating headpiece and manually by Flex-o=file. The tooth length will be determined by using apex locating headpiece (Tri Auto ZX) and radiograph at apical foramen, 0.5 coronal to apical foramen and 1mm coronal to apical foramen.

MATERIALS AND METHODS

Forty five recently extracted human maxillary central incisors with mature apices were collected for this study .Each root was examined radiographically (periapical x-ray film) from buccal and proximal views and under the stereomicroscope[1] to discard any teeth showing apical or lateral root resorption. The crown of each tooth was horizontally decapitated at 3 mm coronal to the proximal cemento-enamel junction. The decapitated teeth were randomly divided into two unequal groups: Group I (30 roots), and Group II (15 roots) according to the method of working length determination. Group (I): The working length was measured with the Tri Auto ZX in its electronic manual recording (EMR) mode. Group (II): The working length was measured with the conventional radiograph. Each main group was divided into three groups according to the apical limit of working length as shown in table (1). Each group at main group (I) were subdivided into two equal subgroups: 1 and 2 (5 each) according to instrumentation system; rotary proTaper system or

Flex-o-file while all roots at group (II) were prepared with Flex-o-file. Subgroup (I- a1), subgroup (I- b1), and subgroup (I-c1) were prepared with Rotary ProTaper files mounted in Tri Auto ZX handpiece. Subgroup (I- a2), subgroup (I- b2), and subgroup (I-c2) and all roots at Group II were prepared with Flex-o-file using the balanced force technique.

Each sample was placed in an in vitro model which consists of plastic cylinder filled with alginate. A layer of mixed self-curing acrylic resin was poured over the alginate surface to the level of cemento-enamel junction to avoid any movement during instrumentation.

Table(1): *Samples classification according to the apical limit of the preparation.*

Groups / Divisions	Group (I) 30 roots	Group (II) 15 roots
Apical foramen(a)	**10 roots (I-a)**	5 roots (II-a)
0.5mm coronal to apical foramen(b)	**10 roots (I-b)**	5 roots (II-b)
1mm coronal to apical foramen(c)	10 roots (I-c)	5 roots (II-c)

The electronic working length for the selected groups was determined by using the Tri Auto ZX in its (EMR) electronic apex locating function based on the manufacturer's recommendations. The radiographic root canal length was measured by inserting Flex-o-file into each canal until the tip become visible through the foramen and then the tooth was radiographed. All canals in subgroup (I- a1), subgroup (I- b1), and subgroup (I-c1) were prepared with rotary ProTaper files mounted in Tri Auto ZX headpiece. The Tri Auto ZX adjusted to the Low mode, and AAR settings were selected according to the following sequence: the setting marked "Apex" was used subgroup (I- a1), the setting marked "0.5" was used subgroup (I- b1), and the setting marked "1" was used for subgroup (I-c1). Main-Group (II) was prepared by Flex-o-files. Each prepared canal was filled with vertically compacted warm gutta-percha using System B. The root canal and the apical constrictions were exposed by carefully splitting the root apices in a longitudinal direction. Under a surgical microscope, the canal was observed for the presence or absence of a relative constriction at the level of the cementum-dentin junction, and photographed. The distance between the apical terminus of the root canal filling and the apical foramen were measured to the nearest 0.1mmand photographed at X4 magnification in the stereomicroscope.

RESULTS

Effect of working length determination method and root canal preparation on the extent of the root canal filling:

At the apical foramen, ANOVA test showed that there was a difference between the three mean value. Duncan's test found a significant difference between canals prepared by ProTaper file and canals prepared by Flex-o-file when working length were determined electronically. No significant difference between root canal prepared by Flex-o-file when working length were electronically or radiographically determined.

At 0.5 mm from the apical foramen, ANOVA test showed that there was a statistically significant difference between the three groups ($P = 0.002$). Duncan's test results showed that radiographic working length determination followed by manual root canal preparation showed the statistically significantly highest mean. There was no statistically significant difference between rotary or manual root canl preparation followed by electronic working length which showed the statistically significantly lowest means.

The effect of different working lengths on the apical extent of root canal filling:

A significant difference on the distance between the apical terminus of the root canal filling and the apical foramen were found at the three apical limits

when working length and rotary canal preparation were carried by Tri auto ZX handpiece and when root canals were prepared by Flex-O-file after radiographic working length determination with the highest mean value at 1mm and the lowest mean value at apical foramen . No significant difference were showed when root canals were prepared by Flex-O-file after electronic working length determination when the 0.5mm coronal to the apical foramen or the apical foramen were selected Fig(1).

Effect of apical extent of root canal preparation on the integrity of the apical constriction:

Under different variables of this study, the integrity of apical constriction showed no significant difference.

Table (1): *Mean values, Standard deviation, and P-value of the distance between the apical terminus of the root canal filling with different working length determination methods and root canal preparation instruments .*

Group / Length	Electronically determined working length followed by rotary root canal preparation		Electronicaly determined working length followed by manual root canal preparation		Radiographically determined working length followed by manual root canal preparation		P value
	Mean	SD	Mean	SD	Mean	SD	
Apical foramen	0.07 [b]	0.04	0.45 [a]	**0.2**	0.3 [a]	0.12	**0.003***
0.5	0.38 [b]	0.18	0.5 [b]	**0.18**	0.82 [a]	0.07	**0.002***
1	0.72	0.36	0.77	**0.04**	0.93	0.05	**0.292**

Table (2): *Mean values, Standard deviation, and P-value of the distance between the apical terminus of the root canal filling at different working lengths.*

Groups / Length	Electronically determined working length followed by rotary root canal preparation		Electronicaly determined working length followed by manual root canal preparation		Radiographically determined working length followed by manual root canal preparatio	
	Mean	SD	Mean	SD	Mean	SD
Apical foramen	0.07 [c]	0.04	0.45 [b]	0.2	0.3 [c]	0.12
0.5	0.38 [b]	0.18	0.5 [b]	0.18	0.82[b]	0.07
1	0.72 [a]	0.36	0.77[a]	0.04	0.93[a]	0.05
P value	**<0.001***		**0.002***		**<0.002***	

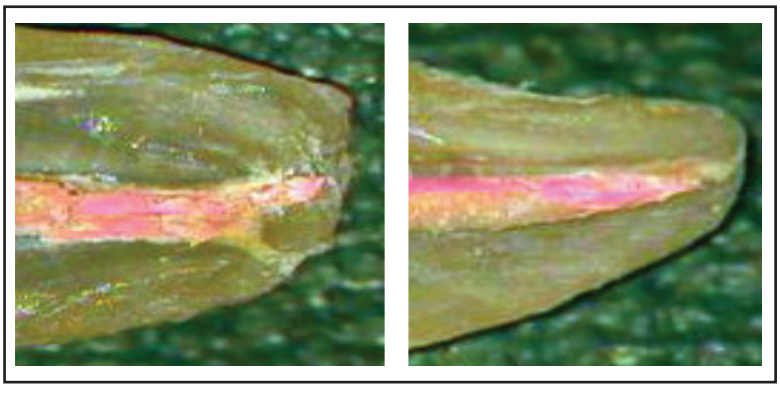

Fig.(1): Photomicrograph showing exposed canals after electronic working length determination, instrumentation with Flex-o-file. a) canal was cleaned & shaped to the apical foramen. The photomicrograph shows 0.4mm distance between the apical terminus of root canal filling and the apical foramen. b) canal was cleaned and shaped to 0.5mm coronal to the apical foramen. The photomicrograph shows 0.6mm distance between the apical terminus of root canal filling and the apical foramen.

DISCUSSION

This study was to compare the effect of working length determination using apex locator with working length radiograph on the apical extent of root canal filling after manual and rotary root canal preparation at different apical limits. Establishing and maintaining adequate working lengths throughout the shaping procedure are considered challenging and controversial in root canal shaping [23]. It has been suggested that electronic apex locators operate on electrical principles rather than being dependent on biological properties of the tissue involved. Therefore, several authors preferred to use alginate as conducting medium for electronic apex locators [12,26,27].Rotary instruments used for root canal instrumentation of teeth mounted in alginate may bind and loosen the teeth. The acrylic resin poured over the alginate surface effectively prevented dislodgment of the teeth during experimental procedures [26]. Many studies have been conducted to evaluate the efficiency and the reliability of electronic apex locators and radiographic method of determining tooth length. Those studies showed a wide scale of disagreements; some recommended the use of the electronic devices instead of conventional radiographic method [18,19,28] while others were against the replacement of radiographs with electronic devices [29]. Some authors suggested the combination of radiographs and apex locators as a good compromise [7,20,21], while Martinez-Lozanoetetch et al [30] suggested that non one of the techniques were totally satisfactory in establishing working length. This study was showed that similar results of microscopic extent of root canal fillings with no statistical significant difference between the radiographic and electronic methods after manual root canal preparation to the apical foramen or 1mm coronal to the apical foramen. A significant difference was showed when the preparation end at 0.5 mms coronal to the apical foramen. The results showed that the use of Flex-o-file for root canal preparation produce loss of working length more than produced by ProTaper files when the apical foramen was selected as an apical limit of the preparation. The difference was significant ($P \leq 0.05$). Both Flex-o-file and ProTaper files maintained the working length when the apical limit of the preparation was 0.5 or 1mm coronal to the apical foramen. The difference at the apical foramen may be due to the reliability of apical-automatic-stop mechanism of the Tri Auto ZX handpiece. Loss of the working distance reported with Flex-o-file may probably due to lack of the length control by the operator [22] . These findings are similar to other investigators who observed only small mean changes in working distance occurring with Flex-o-file [31,32], while ProTaper files maintained the working length[24,25,33]. This finding is in disagreement with other authors who showed that Flex-o-file maintained working length, while loss of working distance was observed with ProTaper files [34,35].

Based on the investigation of this study it seems that the Tri Auto ZX apex locating handpiece is an acceptable device for determining root canal length and instrumentation. This was in agreement with other studies [26,36,37],while Kobayashi et al [38] suggested that it might not be correct to claim that all instrumentation procedures should be prepared by this handpiece.

No difference in the distance between the apical terminus of the root canal filling and the root apex when preparation end at the apical foramen or 0.5mm coronal to the apical foramen . In contrast, a significant difference was observed when preparation end 1mm coronal to the apical foramen. These results were not consistent with OUnsi&Naaman [39], who found that Root ZX is not capable of detecting the 0.5mm from the foramen position. AlsoLucena- Martin et al [31] showed that Root ZX reliability in detecting the apical foramen was 85%. This controversy may be due to the difference in the method of the evaluation, as in this study the effect was examined after root canal preparation & obturation. A significant difference

was present between the three apical limits of the radiographic working length prepared manually. Under the different variables of this study, the integrity of the apical constriction was affected by the apical limit of the preparation with high present of nascent of apical constriction when preparation end at the apical foramen or 0.5mm coronal to the apical foramen. This may be due to the presences of apical constriction at about 0.6 mm from the apex at the central incisors[40]. These results are in agreement with those achieved by Campbell et al [26] who found a presence of relative constriction in half number of the canals instrumented with the AAR set at 1.

CONCLUSIONS

According to the method of working length determination; Electronic method is more accurate than radiographic mthod.

Tri Auto ZX apex locating handpiece is a reliable method for electronic working length determination, and rotary root canal preparation.

As the distance from the apical foramen increased, the integrity of the apical constriction is more preserved.

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