

## An In vitro Comparative Study to Evaluate The Apical Seal of Root Canals Prepared by Rotary Versus Reciprocating Wave-One Nickel Titanium System

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### الخلاصة

**الأهداف:** إن هدف هذه الدراسة هو لتقييم قدرة الختم القمي لقنوات الجذر المحضرة بوساطة تقنيتي تحضير مختلفتين (تقنية موجة الملف الوحيدة و تقنية الموجة التقليدية الدوّارة). **المواد وطرائق العمل:** أستعمل أربعون سنناً إنسانياً مقلوعاً (قيل الضرسى الأوطأ) ذو الجذر الواحد في هذه التجربة بعد أن يبرئت تيجان الأسنان الى منطقة إتصال المينا-الملاط. وقد أجدد الطول الكامل للأسنان كلها، ثم قُسمت الأسنان الى مجموعتين، كل منها مكون من (20) سن للمجموعة الواحدة. المجموعة الأولى: حُضرت الأتية اللبية لهذه الأسنان باستعمال تقنية الموجة التقليدية الدوّارة (( Wave-One، المجموعة الثانية: حُضرت الأتية اللبية لهذه الأسنان باستعمال تقنية موجة الملف الوحيدة (Wave-One). ثم حشوها باستعمال تقنية المخروط الوحيدة. وقد أستعمل أكسيد خارصين euginol بوصفه سمناً للقناة اللبية في هذه الدراسة، ثم أستعملت طريقة تغلغل الصبغة لتقييم الختم القمي وباستعمال المجهر المحسّم بقوة تكبير (10) درجة وأخيراً تم توضيح الأسنان، وبعد ذلك أُجرئت التحليلات الإحصائية للنتائج بإختبار (T) للعينتين. **النتائج:** طبقاً لإيجادات الدراسة الحالية من الممكن أن نستنتج انه عند استخدام لوح ملف واحد بتقنية موجة الملف الوحيدة قد اختلفت معنوياً عن الموجة التقليدية الدوّارة في تحضير القناة الجذرية. حيث سجلت تقنية موجة الملف الوحيدة نتائج أفضل لقدرة الختم القمي مقارنة بتقنية الموجة التقليدية الدوّارة. **الاستنتاجات:** إن قدرة الختم القمي لتقنية موجة الملف الوحيدة وتقنية الموجة التقليدية الدوّارة كانت بشكل ملحوظ مختلفة. حيث سجلت تقنية موجة الملف الوحيدة درجة أفضل لقدرة الختم القمي مقارنة بتقنية الموجة التقليدية الدوّارة.

### ABSTRACT

**Aims:** The aim of present study is to assess the apical seal of root canals prepare by two different preparation techniques (Rotary and reciprocating technique). **Materials and Methods:** Forty extracted human, single-rooted lower premolar teeth were decoronated at the cement-enamel junction (CEJ). The working length was determined for each tooth. The samples were divided into 2 experimental groups, each one consisted of 20 prepared teeth: group 1, rotary conventional preparation by using Wave-One file. group2, reciprocate instrumentation with Wave-One file. After instrumentation was completed then the teeth obturated with Single-cone technique related to this systems. Zinc oxide euginol (ZOE) sealer was used as a root canal sealer in this study. A dye penetration method was used to evaluate the apical seal and the teeth were cleared then apical leakage was measured using a stereomicroscope at (x10 magnification). The statistical analysis performed by Independent t-test. **Results:** Wave-One file instrumented by Reciprocation instrumentation technique was significantly differ from Rotary instrumentation technique for root canal preparation. The Reciprocation group registered better apical seal than Rotary group. **Conclusions:** Apical seal with the Wave-One Reciprocation technique and conventional Wave-One rotary approach were significantly difference. The Wave-One Reciprocation technique was markedly registered better apical seal than Wave-One rotary technique.

**Key words:** Rotary instrumentation, root canals preparation, Wave-One file.

Al-Shamaa RM, Chakmakchi MN, Thiab KA. An In vitro Comparative Study to Evaluate The Apical Seal of Root Canals Prepared by Rotary Versus Reciprocating Wave-One Nickel Titanium System. *Al-Rafidain Dent J.* 2014; 14(2):288- 293.

**Received:** 24/4/2013

**Sent to Referees:** 28/4/2013

**Accepted for Publication:** 30/6/2013

## INTRODUCTION

The major goal of root canal therapy is to remove microorganisms from the root canal system to prevent or heal apical periodontitis.<sup>(1)</sup> This is currently done by mechanically shaping and chemically cleaning the root canal system; subsequent root canal filling and an adequate apical seal prevent apical leakage and exclude potential remaining microorganisms from nutrients. Cleaning and shaping of root canals successfully require high volumes of irrigation solutions that can only be applied to the apical root canal third after enlargement with instruments.<sup>(2)</sup> Nickel-titanium (NiTi) rotary instruments have become an important adjunct for root canal shaping. The nickel titanium rotary instrumentation that results in consistent, predictable, and reproducible shaping. This predictability of shaping has not only influenced instrumentation, but obturation results as well.<sup>(3)</sup>

Rotary instrument designs have changed at a rapid period for the past two decades. There have been tremendous advances in the design of these instruments to improve the quality of root canal preparation, which leads to better obturation, apical seal, and eventually to better prognosis for the treated tooth.<sup>(4)</sup>

reciprocation, defined as any repetitive back-and-forth motion, has been clinically utilized to drive stainless steel files since 1958. Initially, all reciprocating motors and related hand piece rotated files in large equal angles of 90° clockwise (CW) and counter clockwise (CCW) rotation. Over time, virtually all reciprocating systems began to utilize smaller, equal, angles of CW/CCW rotation. Today, the M4 (SybronEndo), Endo-Eze AET (Ultra dent), and Wave-One (VDW) are examples of reciprocating systems that utilize small, equal 30° angles of CW/CCW rotation.<sup>(5)</sup>

There are 3 Wave One instruments are termed Small (yellow), Primary (red), and Large (black). The Small 21/06 file has a fixed taper of 6% over its active portion. The Primary 25/08 and the large 40/08 Wave One files have fixed tapers of 8% from D1-D3, whereas from D4-D16, they have a unique progressively decreasing percentage tapered design. This design

serves to improve flexibility and conserve remaining dentin in the coronal two-thirds of the finished preparation, From D1-D8, the Wave One files have a modified convex triangular cross-section, whereas from D9-D16, these files have a convex triangular cross-section. Also, they have non cutting modified guiding tips, which enable these files to safely progress through virtually any secured canal. Together, these design features enhance safety and efficiency when shaping canals that have a confirmed, smooth, and reproducible glide path.<sup>(5)</sup>

The purposes of present study to assess the apical seal of root canals prepared by two different preparation techniques (Rotary and reciprocating technique).

## MATERIALS AND METHODS

### *Sample Selection*

A total sample of 40 freshly extracted human, single-rooted lower premolar teeth for orthodontic treatment were placed in distilled water. The soft tissue remnants and calculus on external root surface were removed mechanically with piezon Master 400scaler (EMS, Swiss). All specimens were inspected to identify any defect or root fractures and to confirm the complete formation of apices under stereomicroscope (x10 magnification) (Motic, China).

Each tooth was decoronated at the level of cement-enamel junction (CEJ) using a low-speed, water-cooled, diamond sectioning disc (Brasseler, Germany). Pulp tissue was removed with a barbed broach, then root canal patency was confirmed with No.10 K-type file (Mani, Inc. Japan).

The working length of each root canal was determined by No-10 K-type file, which inserted inside the root canal under stereomicroscope at (x 10 magnification) until the tip of the file was just visible at the apical foramen and then subtracting 1.0 mm from the measured length of the file<sup>(6)</sup>, nearly all the roots length were standardized to about 12 mm .

Root canal irrigation was performed at the beginning of the instrumentation and after each instrument size with (2 ml) of 2.5% sodium hypochlorite (NaOCl) solution.<sup>(7)</sup>

### *Sample Grouping*

The total number of samples was (40) divided randomly into (2) experimental groups each one, including (20) teeth, and instrumented with one of two different preparation techniques. All teeth were placed in block made of silicon impression material.

- **Group 1 (Rotary Wave-One Technique)**

A glide path was established by using a size 10 and 15 K-file to predetermined working length. Subsequently, rotary instrumentation was accomplished according to the manufacturer's instructions. The instruments were used: Wave-One 25/.08; Wave-One 40/.08. The instruments were used to the full length of the root canal, as for the single-length technique at 250 rpm. The 'lateral brushing' movement used on the removal of the instrument to avoid its tip from forced and prevents breakage. After each instrument, canals were irrigated with 2 mL of 2.5% NaOCl, and apical patency was verified by using a size 08 K-file. <sup>(8)</sup>

- **Group 2 (Reciprocating Wave-One Technique)**

The root canal preparation was performed with primary 25/08 Wave-One file was used first in any canal that has a confirmed, smooth, and reproducible glide path equivalent to at least a loose 10 file. The Large 40/08 Wave-One file was used to complete the shape in larger diameter canals like bicuspid canals in clockwise (CW) and counterclockwise (CCW) motion with lateral brushing motion in order to enlarge the root canal entrance and to achieve easier advancement of the instrument. The Wave-One system utilizes an engaging angle that is 5 times the disengaging angle. Fortunately, after three engaging/disengaging cutting cycles, the Wave One file will have rotated 360°, or turned done CCW circle. This unique reciprocating movement enables the file to more readily advance toward the desired

working length. <sup>(8)</sup>

At the end of the biomechanical preparation, the dentinal smear layer was removed from all specimens using 2 ml of 17% ethylene diamine tetra-Acetic acid (EDTA) for 1 minute followed by 2 ml of 5.25% NaOCL solution. <sup>(6, 9)</sup>

### *Obturation*

The teeth in all experimental groups were obturated using Matched-taper Single cone technique and ZOE sealer with gutta-percha related to these systems, then the canal orifice was sealed coronally with Tetric Ceram composite resin. After complete preparation and obturation, all teeth were incubated in numbered containers at 100% humidity, in 37°C for 1 week to allow complete setting of the sealer.

In all experimental groups, all root surfaces except the apical 2 mm were covered with two coats of nail polish. Then they were placed in numbered containers which were filled to identical levels with 2% methylene blue dye for 24 hours. After that all the teeth were thoroughly washed under running tap water, and allowed to dry, then the nail polish was removed <sup>(10)</sup>. A trace amount of wax then flowable compomer restorative material used over the apical foramen.

### *Clearing Technique*

Teeth were rendered transparent by the following technique: Decalcification in 5% nitric acid for 7 days, dehydration in ethanol 85%, 90%, 99%, successively for 12 hours, 1 hour, and 3 hours respectively. Then the teeth were cleared using methyl salicylate solution for 6 hours. <sup>(7, 11, 3)</sup>

After clearing technique was completed Figure (1), the wax and flowable compomer restorative material was removed then the linear extent of dye penetration from the apical root ends was measured using a stereomicroscope at (x10 magnification) by two observers in millimeters. <sup>(7)</sup>



Figure(1): Show Clearing Technique of Reciprocation (Right) and Rotary Groups (Left) under digital camera.

**RESULTS**

Table (1) demonstrated the descriptive statistics of both Rotary and

Reciprocation groups including mean, standard deviation (SD), standard error (SE), minimum and maximum value.

Table (1) Group statistics.

Code	N	Maxi.	Min.	Mean	SD	SE of Mean
<b>Technique</b>						
(Rotary) 1.00	20	2.52	2.00	2.2715	0.16429	0.03674
(Reciprocation) 2.00	20	1.00	0.20	0.7285	0.26599	0.05948

The data were collected after instrumentation by Wave-One files (Rotary and Reciprocation instrumentation techniques), then measured the apical seal by stereomicroscope at (x10 magnification). Figure (2-A) was shown Reciproca-

tion sample and measured by stereo microscope at (x10 magnification), while Figure (2-B) was shown Rotary sample and measured by stereomicroscope at (x10 magnification).

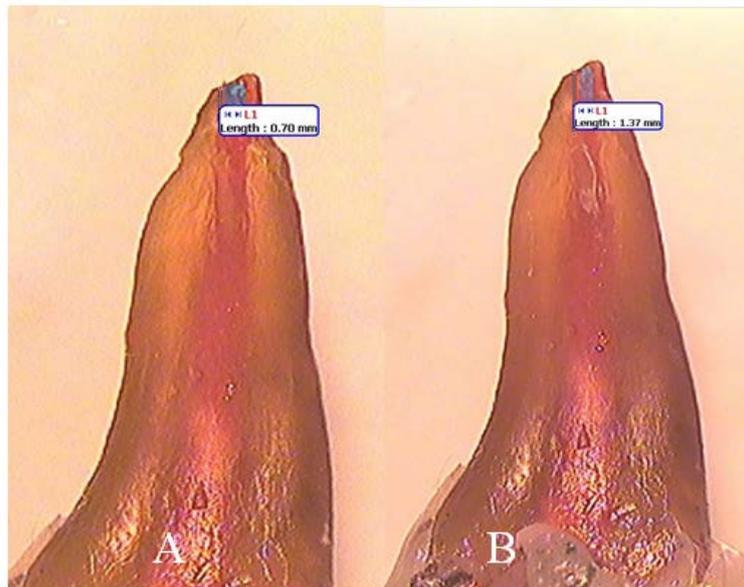


Figure (2): Show Apical micro leakage ,(A) By Reciprocation Group (B) By RotaryGroup under stereomicroscope (x10).

Independent Sample t-test was performed to compare between mean values of two experimental groups (Rotary and Reciprocation instrumentation techniques).

Also, to analyze the presences of significant differences between these two experimental groups at(p≤0.05).These results were illustrated in Table (1, 2).

Table (2): Independent T-test.

	df	Sig(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	upper
<b>Technique Equal Variances assumed</b>	38	.000	1.5430	.06991	1.40148	1.68452
<b>Equal Variances not assumed</b>	31.6	.000	1.5430	.06991	1.40054	1.68546

The Mean value of Reciprocation technique was shown less value than Mean value of Rotary technique, that was mean that the Reciprocation group registered the best value of apical seal than the Rotary one , and it was significantly differ at ( $p \leq 0.05$ ), as show in Table (1) and Figure (2) .

### DISCUSSION

Apical leakage is considered to be a common cause for endodontic failure, and is influenced by many variables such as different filling techniques, the physical and chemical properties of sealer and presence or absence of a smear layer. Microorganisms present inside root canals may remain active in the dentinal tubules even after vigorous chemo-mechanical preparation. Thus, perfect apical sealing is desirable to prevent the remaining bacteria and their end toxin from reaching the root apex. <sup>(12)</sup>

Dye penetration was commonly used to evaluate leakage due to its simplicity and cost-effectiveness. <sup>(14)</sup> Instruments that can follow the path of the canal and are able to remain centered in the canal, are good choice for root canal preparation. <sup>(13)</sup>

Zinc oxide eugenol cement was chosen in this study because it was commonly used material . Also, it gives consistent results with a good peripheral seal and produce a filling that is retrievable. <sup>(14)</sup>

The Wave-One motor is rechargeable battery operated with a 6:1 reducing hand piece. The counter-clockwise (CCW) movement is greater than the clockwise

(CW) movement. CCW movement advances the instrument, engaging and cutting the dentin. CW movement disengages the instrument from the dentin before it can taper lock into the canal. Three reciprocating cycles complete one complete reverse rotation and the instrument gradually advances into the canal with little apical pressure required. <sup>(15)</sup>

Under the condition of this in vitro comparative study leakage in Reciprocating group shows the lowest mean .7285mm, while the Rotary group shows the highest mean 2.2715mm of leakage (Table 1, 2).

In Table (1) which include mean value of Reciprocating group, this table demonstrated that there was a significant difference between Reciprocating group and Rotary group in value of apical seal. Reciprocating group produced the best apical seal. These results due to there are (3) critical distinctions with this novel, unequal bidirectional movement. One, compared to continuous rotation, there is a significant improvement in safety, as the CCW engaging angle has been designed to be smaller than the elastic metallurgical limit of the file. Two, opposed to all other reciprocating systems that utilize equal bidirectional angles, the Wave-One system utilizes an engaging angle that is 5 times the disengaging angle. Fortuitously, after three engaging/disengaging cutting cycles, the Wave-One file will have rotated 360°, or turned one CCW circle. This unique reciprocating movement enables the file to more readily advance toward the desired working length. Three, the unequal bidi-

rectional movement strategically enhances auguring debris out of the canal. Auguring debris in a coronal direction promotes the biological objectives for preparing canals, three dimension disinfection, and filling root canal systems.<sup>(15, 16)</sup>

### CONCLUSIONS

Apical seal with the Wave-One Reciprocation technique and conventional Wave-One rotary approach that used for preparation of all root canals of teeth were significantly differences. The Wave-One Reciprocation technique was markedly registered better apical seal than Wave-One rotary technique .

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