

## Occurrence of Persistent Post-Endodontic Pain after Single-Visit RCT Using Manual and Three Mechanical Systems in Teeth with Irreversible Pulpitis and Apical Periodontitis

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### Abstract

**Objective:** The aim of the present study was to clinically compare the effect of different NiTi shaping systems on persistent post-endodontic pain after single-visit RCT using manual and three mechanical systems in teeth with irreversible pulpitis and apical periodontitis.

**Materials and Methods:** One hundred and forty participants of 147 patients (76 women and 64 men) aged 18 - 65 years were integrated into this research. Thirty-five of 140 teeth were selected for the four enlargement techniques. Control group, TFA, WOG, and PTN groups received final flushing with 6°C 17% EDTA solution gently administered to the WL through a cold (6°C) sterile metallic micro-cannula attached to the Endovac system (Kerr Endo) for one minute.

**Results:** No significant difference ( $p > 0.05$ ) among the groups were met concerning pain. The post-endodontic pain was evaluated a day after with a significant reduction of symptoms. No statistically significant difference was seen between the four groups assessed in the research in terms of analgesic consumption ( $p > .05$ ).

**Conclusion:** The persistent pain was related to the treatment of earlier symptomatic teeth, and the use of substances with antibacterial activity is a valuable tool to control endodontic infection. Under the conditions of this study, manual and rotary Nickel-Titanium systems were safe to use.

**Keywords:** Flare-ups; Pain; Post-Endodontic Pain; Postoperative Pain

### Introduction

Persistent post-endodontic pain is a personal and subjective experience after root canal treatment (RCT) it is difficult to quantify and standardize. Persistent pain in the area of endodontically treated teeth (defined as pain in the dentoalveolar region that persists after completion of treatment) is a poorly understood phenomenon [1]. Endodontic pain is associated with a history of preoperative pain and occlusal trauma. Pain management is indispensable in clinical procedures [1,2].

Endodontic pain contains a wide-ranging field that requests to be considered appropriately before arriving at a diagnosis. Though the clinical success of an RCT is achieved by meticulous and systematic preparation and filling the canals, the primary worry for the patient is continuously about post-endodontic pain [2]. Pain in Endodontics includes a period, previous, throughout and subsequently RCT. Analyzing these limits also would help to choose the correct decision for treatment.

Management of the canals remains, and canals fluids can be projected outside the apex and can lead to post-operative problems, such as severe pain. Therefore, taking care of the working length (WL) may reduce the projection of remnants through the apical foramen (AF) [3].

Pain after RCT is a consequence of the exacerbation of chronic lesion [1,2] of a non-vital tooth [3], earlier treated teeth, or related with a flare-up. The build-up of material remnants inside and outside the apex is a common occurrence that causes obliteration of the canal. The absence of regulation in biofilm prototypes [4], controls related to post-formation biofilm exploration, and the numerous modes that NaOCl is carried in Vitro studies could explain the discrepancies encountered [5].

The reduction of microorganisms, together with the interruption of biofilms, is accomplished by mechanical instrumentation and flushing using microbicide mixes in the canal between visits [5,6].

Some scientific reports suggest clinical actions to solve this issue and can be avoided if patency of the AF is maintained [7]. Presently, keeping true WL is recommended through RCT [8,9].

To increase the management of the canal has been suggested Roane's balanced force technique [10]. The Balanced force technique reduces the chance of vary of WL, decreases root canal's transportations [7], permits maintenance of the integrity of the apical root canal anatomy [8,11].

Metallic properties and instrument design have led to the improvement of plentiful procedures in recent times. However, to date, the literature does not report any method that avoids the projection of remains outside the root [12].

A single instrument method for treating canals has been reported [13] with the promotion of Reciproc (VDW, Munich, Germany) and WaveOne™ (Dentsply Tulsa, Johnson City, TN) systems. M-Wire is a novel alloy with a thermal management procedure of the instruments [14].

The ProTaper Next files (Dentsply Tulsa Dental Specialties) work in continuous rotary motion and their center of mass or center of rotation is positioned off-center relative to the instrument's central axis of rotation. Furthermore, both kinds of device have not been thoroughly and clinically compared with those of continuous clockwise rotary motion regarding the incidence of postoperative pain.

### Objective of the Study

The objective of this study was to clinically compare the influence of different NiTi shaping systems on persistent post-endodontic pain after single-visit RCT using manual and three mechanical systems in teeth with irreversible pulpitis and apical periodontitis.

The null hypothesis tested was that there is no difference in the occurrence of post-endodontic persistent pain after single-visit RCT using manual and three mechanical systems in teeth with irreversible pulpitis and apical periodontitis.

### Materials and Methods

This study was developed at the Facultad de Odontología, Tijuana, México. The study was managed in agreement with ethical principles (including the World Medical Association Declaration of Helsinki).

Four certified endodontists experienced in the courses, aids, and methods investigated took part in this research. The endodontists selected tracked a pre-established method for the Balanced Force technique, Twisted File Adaptive, WaveOne™ and Protaper Next instrument systems.

The inclusion limitations were: 1) nonappearance of radiographic proof of apical inflammation. 2) irreversible pulpitis recognized by the positive reaction to thermal tests and 3) persistent pre-operative pain due to the pulpal condition.

The principal author completed a thermal pulp test, and four endodontists recognized radiographic procedures. Clinical necessities were established as follows: 1) The needs of the investigation was spontaneously accepted. 2) Patients must be in physical and emotional wellbeing. 3) Patients with vital teeth participated. 4) EndoIce (Hygenic Corp, Akron, OH) were used for thermal tests. 5) Teeth with sufficient healthy dentinal structure. 6) No endodontic treated teeth. 7) Any drug used seven days' previous study.

Exclusion parameters were: Endodontic treated teeth, pregnancy, impossibility to obtain patient's consent, patients younger than 18 years. Necrotic teeth and teeth with periapical lesions, resorption, immature root, or teeth with unexpected curvature (> 38°) excluded too.

**Patient collection**

One hundred and eighty of 189 patients (96 women and 84 men) aged 18 - 65 years were incorporated in this research. Sample size estimation was accomplished, rendering with a system for this objective (Cochran's method, 1986). Therefore, the 45 teeth distributed to each group were acceptable to approve an elemental sample.

All applicants were knowledgeable of the aims and plan of the research, and printed permissions and patient consent forms for this study was obtained before their addition. The study strategy included four experts; each expert prepared 45 teeth (Table 1 and 2).

Clinical features	Control Group (CG)	Twisted FA (TFA)	WaveOne™ (WON)	Protaper Next (PTN)	Total
	n = 45	n = 45	n = 45	n = 45	180
Female	24 (53.33)	24 (53.33)	24 (53.33)	24 (53.33)	96 (53.33)
Male	21 (46.66)	21 (46.66)	21 (46.66)	21 (46.66)	84 (46.66)
Maxillary teeth	31 (68.88)	31 (68.88)	31 (68.88)	31 (68.88)	124 (68.88)
Incisors and canines	3 (6.66)	4 (8.88)	3 (6.66)	5 (11.11)	15 (8.33)
Bicuspid	7 (15.55)	6 (13.33)	7 (15.55)	5 (11.11)	25 (13.88)
Molars	21 (46.66)	21 (46.66)	21 (46.66)	21 (46.66)	84 (46.66)
Mandibular teeth	14 (31.11)	14 (31.11)	14 (31.11)	14 (31.11)	56 (31.11)
Incisor and canines	1 (2.22)	0	1 (2.22)	1 (2.22)	3 (1.66)
Bicuspid	3 (6.66)	4 (8.88)	3 (6.66)	2(4.44)	12 (6.66)
Molars	10 (22.22)	10 (22.22)	10 (22.22)	11 (24.44)	41 (22.77)

**Table 1:** Distribution by group of teeth.  
*p* = 0.05.

### **Treatment procedure**

For each procedure, two carpules of Mepivacaine Hydrochloride 2% with Levonordefrin 1: 20,000 (Septodont, Cambridge, Ontario, Canada) were managed. In circumstances in which additional anaesthesia was required, intraligamental Mepivacaine 2% was administered. After absolute isolation, the tooth was sanitized with 5.25% NaOCl.

Cameral access was achieved by using # 331 bur (Dentsply International, York, PA), with high-speed. 5.25% NaOCl was used for flushing the coronal cavity and the cervical third of each canal. The canals were located with #10 K-type hand files (Flex-R files, Moyco/Union Broach, York PA, USA) according to the initial diameter of the foramen, using a watch-winding movement.

The standard procedures involved the following steps: Access was gotten; EDTA and Cetrimide (Smear Clear Kerr Endodontics, Orange, CA) lubricant was used at the entry of the canals. Canal length was obtained with a #10 k-file and the Root ZX locator (J Morita, Irvine CA, USA), following by subtracting 0.5 mm from the measurement, which was estimated with the assistance of a metallic ruler. With radiographic confirmation (Schick Technologies, NY, USA). A glide path to the WL was then prepared.

The SmearClear was dropped at the entry of each canal, then dry the canal with a paper cone. A #15 K-file attached to the apex locator was used to measure the canal length. WL was confirmed with a digital radiograph.

For the control group (CG), Balanced Force (BF) technique was employed using hand Flex-R® files. The canals were prepared using a #40 file for tinny or curved canals and a #55 file for wide-ranging canals. The cervical segments of the canals were flared with sizes #1 to #3 Gates-Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland). The canals were then rinsed with 2 mL 2.5% sodium hypochlorite. The same files were used to a size #60 for the anterior teeth and premolars and to a size #45 - #55 for molars using SmearClear after each instrument. 17% EDTA (Roth International Ltd, Chicago, IL) was used to eliminate apical remains.

For mechanical enlargement, the rotary files were employed with a micro motor (Elements Motor, Sybron Endo, Glendora CA, USA). Spin and revolution were established individually for each rotary file system used. Twisted file adaptive™ (TFA), WaveOne™ (WOG), and Protaper Next® (PTN) systems were used in constant rpm.

Dentinal remains were removed from the instrument using alcohol-soaked gauze, continuously to the next instrument change or after 3 - 4 in-and-out (pecking) movements allowing the manufacturer's commendations. Each canal was flushed with 2.5 mL 2.5% sodium hypochlorite. Irrigation was completed using a 27-G needle (Max-I-Probe; Tulsa Dental, York, PA) and a 31-G NaviTip needle (Ultradent Products Inc, South Jordan, UT).

**Group TFA:** SM1 (size 20, .04 taper) and SM2 (size 25, .06 taper) files were used consecutively with a single meticulous motion agreeing to the manufacturer's instructions.

**Group WOG:** For the WaveOne™ group, a file (25.08) was used to prepare narrow, straight, and curved canals, and a file (40.08) was used for large and wide canals.

Three cycles of the movement were used with lengths not beyond 3 mm in the three segments of the canal until reaching the estimated WL.

**Group PTN:** For the Pro Taper Next group, Sx files, X1, and X2 (ProTaper Universal system; Dentsply, Ballaigues, Switzerland) were used for preflare and preparation of thin and curved canals and X3 and X4 (40/.06) for preparation of wide canals up to the WL. The instruments were operated using a continuous rotary motion at a 300 rpm.

### **Final irrigation protocol**

After the instrumentation phase, the pulp space was flushed with 1.5 mL 1.0% NaOCl, agitated ultrasonically with an Irrisafe ultrasonic 20.00 tip (Satelec, Merignac, France) at 50% power of the MiniEndo ultrasonic unit (Kerr Endo) to place the tip 3 mm from the WL for 30 seconds per canal. Then, BF, TFA, WOG and PTN groups received final flushing with 1cc 6°C 17% liquid EDTA gently administered to the WL through a cold (6°C) sterilized metallic micro-cannula attached to the Endovac system (Discus Dental, Culver City, CA, USA) for one minute to remove the smear layer and decrease pain using apical negative pressure [19]. Finally, 2 mL of cold (6°C) distilled water was applied in the same manner.

The root canals were then desiccated with sterile paper cones size #35 and filled at the same appointment. Gutta-percha cones (Dentsply Maillefer) were laterally condensed with #20 nickel-titanium spreaders (Dentsply Maillefer) and Sealapex® sealer (SybronEndo Endodontics, Orange, CA). Cameral openings of anterior teeth were etched and filled with Fuji IX (GC Corp, Tokyo, Japan). For posterior teeth, a building up was placed with a similar method.

Finalized the RCT patients received instructions on how to use a 10-cm visual analog scale (VAS) to record post-endodontic pain. This score was transferred to a numerical value between 0 and 10 and a verbal scale (none, mild, moderate, intense and unbearable).

### **Statistical analysis**

Patients received a survey form to be completed and returned three days after. In the form, patients proof the presence/absence of post-endodontic pain, its period, and level of distress rated as follows: 0: No pain, 1: Mild pain. Any discomfort that did not require urgent treatment. 2: Moderate pain. Illness requiring medication. 3 Acute pain. Pain that was not relieved by medication and needed palliative management. Cases with the manifestation of swelling were classified as flare-ups and treated appropriately.

The 180 surveys were returned correctly responded. Outcomes of groups TFA, BF, WOG and REC associated to existence (yes/no), level (slight, moderate, severe), and interval (days) of post-endodontic ache were evaluated, focusing to diagnostic factors: condition of tooth (all vital), manifestation or absence of pre-operative pain, group of teeth (molar/premolar or anterior), or location (Maxillary, Mandibular).

After the conclusion of RCT, patients were invited to return for final rehabilitation as quickly as possible. The primary outcome degree for this research was ordered by using a variation of the Strindberg's study (Strindberg 1956) used for radiographic healing assessment.

The complete level of post-endodontic discomfort was documented and expressed as a percentage of the total number of teeth evaluated. An  $X^2$  test was used to test trends in contingency tables using SPSS v. 25. The hypothesis tests were conducted at the 0.05 level of significance.

### **Results**

The descriptive data are shown in table 1. The average age of the 140 participants recorded in this project was 34 years. No significant variance ( $p > 0.05$ ) among the groups were met concerning the level of discomfort. The post-endodontic pain forms were analyzed a day later in the four groups with a substantial reduction.

No statistically significant difference was seen between the four groups evaluated in the research in terms of analgesic consumption ( $p > .05$ , Table 4). None of the 140 patients stated acute or severe pain (Table 3 and 4).

Instrumentation technique	n	Mean	Standard deviation
<b>Pain after 24h</b>			
Control Group	45	.55	.63
Twisted File Adaptive	45	.67	.72
WaveOne™	45	.67	.72
Protaper Next	45	.67	.74
<b>Pain after 48h</b>			
Control Group	45	.17	.43
Twisted File Adaptive	45	.18	.45
WaveOne™	45	.18	.45
Protaper Next	45	.18	.45

**Table 3:** Kruskal/Wallis test applied to the post-endodontic pain results for the groups Control group, Twisted file adaptive, WaveOne™ and ProTaper Next.  
P value = 0.05.

24 Hrs. After	Control Group (CG) (n = 45) (%)	Twisted file adaptive (TFA) (n = 45) (%)	WaveOne™ (WON) (n = 45) (%)	Protaper Next (PTN) (n = 45) (%)	Total (n = 180)
Quantity					
None	29 (82.85)	34 (97.14)	34 (97.14)	34 (97.14)	131 (93.57)
One tablet	2 (5.71)	1 (2.85)	1 (2.85)	2 (5.71)	6 (4.28)
Two tablets	2 (5.71)	0	0	0	2 (1.42)
Three tablets	1 (2.85)	0	0	0	1 (0.71)

**Table 4:** Distribution of teeth by randomization factors.  
p = 0.05.

The demographic data concerning techniques about the occurrence of the post-endodontic pain experience (Table 3).

### Discussion

Pain is tough to comprehend and measure, especially when it occurs unexpectedly in patients. The main inconvenience in learning pain and anxiety is the participant’s individual assessment and its dimension. Persistent pain in the area of endodontically treated teeth is a poorly understood phenomenon [1]. In a study conducted by Polycarpou [15] reported that the prevalence of persistent pain was 12 percent. However, discomfort after endodontic therapy could be due to odontogenic or nonodontogenic etiologies. Teeth with fractures, missed (untreated) canals, inflamed periodontal ligament, myofascial pain, and persistent infection can generate persistent pain after RCT.

The diagnosis allowed in this study to rule out external factors that generate persistent pain after endodontic treatment, and only focused on the possible eradication of pain caused by the previous pulp condition or the generation of persistent pain due to the potential force exerted on the ligament periodontal during instrumentation with the three systems used.

Each of the steps of the RCT was taken care of, as well as the chemo-mechanical phase to disinfect each canal. Following the basic principles of endodontics can ensure the proposed objective, comply with the manufacturers' recommendations, advise the patient to follow the instructions is teamwork.

Pre-operative pain is a predictor of post-endodontic pain [16]. Teeth with irreversible pulpitis were allocated for this investigation. The root canal treatments were performed in one-visit to avoid any the probable effect of intracanal medication or other issues causing pain and the involucrate teeth in the four groups were released of any early occlusal points after RCT so that improper painful occlusion would not interrupt the results.

WL was calculated with an EAL device and corroborated with an X-ray film. Root ZX locator was employed due its precision has been recognized in two clinical scenarios [17-20]. As recommended by Herrera, *et al.* [21], the electronic WL dimension was cyclic after coronal and middle thirds shaping.

When endodontists associate radiographic analysis and digital root canal measurements, sometimes results do not match. In the time of discrepancy between both sizes, the electronic calculation would be selected [22-25] as occur in this research.

Pressure and force in the apical direction can impulse a variety of toxic products to the neighboring tissues, which can produce pain [26-28]. Furthermore, Torabinejad, *et al.* [3] detailed that there are many factors during RCT that can affect the incidence of post-endodontic pain. Our method was similar to them because likely, we paid attention to establish the canal length.

Siqueira, *et al.* [29] discovered the little occurrence of flare-ups subsequent RCT in teeth with necrotic tissue or teeth with the previous RCT if AP was conserved. This condition did not happen in our research because only manage vital teeth.

Using final flushing with cold 6°C 17% EDTA gently delivered to the canal length and, the protocol used in the study using a cold (6°C) sterile metallic micro-cannula attached to the Endovac supported in scientific reports [30-32] reduces pain significantly.

We found that the rate of post-endodontic pain and especially of acute pain was, related to the treatment of earlier symptomatic teeth. Reports have stated that the existence of pre-operative pain can increase the possibility of post-endodontic pain [29,33-34]. Persistent pain after root canal treatment is a common occurrence, with a frequency of 5.4% [35]. The subjectivity of measurement due to the perception of pain in patients is one of the main problems in pain intensity evaluation studies. Patients who participated in the study were previously instructed to identify new pain that could occur after root canal treatment. Old illnesses related to ATM, occlusion and non-odontogenic were ruled out.

The EndoVac system was used as a negative pressure irrigation method to avoid adverse effects even when the needle reaches the apical zone. Cryotherapy was used in this study, which allowed the inflammatory process present in the three groups to have relief by applying cold at 6 degrees Celsius. A study by Nielsen and Baumgartner [36] reported that using the EndoVac technique reduces post-operative pain.

In the present study, patients treated using a reciprocal system reported higher postoperative than patients treated using the continuous rotational files. However, the current results contradict other studies that reported no significant difference in postoperative pain in patients treated using reciprocal and constant rotational files [37-39].

The discrepancy among the studies could be explained by different instrument types and study designs where only one type of teeth was used [40,41]. The present work allowed us to identify that a successful diagnosis, an effective treatment plan with clinical tools such as modern irrigators, adequate concentrations of irrigators and cryotherapy are of great value to reduce post-endodontic pain persists after a root canal treatment in a single visit.

Finally, persistent pain after endodontic therapy is to determine its origin. This is done by using clinical and radiographic examinations. CBCT is a useful aid too. Nonsurgical re-treatment or endodontic surgery is indicated if the pain is determined to be due to a non-healing periapical lesion or a missed canal.

The success of root canal treatment is dependent on mechanical preparation, irrigation, microbial control, and complete obturation of the root canal. The flushing action of the irrigation solution aids the removal of debris and organic material from the root canal, as well as helping to lubricate endodontic instruments. Properties such as antimicrobial activity, tissue dissolving ability, and nontoxicity to the periapical tissues are important.

### Conclusion

This study provided clinical evidence that an accurately instrumented one-visit root canal treatment can be as effective as a two-visit treatment. The persistent pain was related to the treatment of earlier symptomatic teeth. The use of substances with antibacterial activity is an essential tool to control endodontic infection. Under the conditions of this study, manual and rotary Nickel-Titanium systems were safe to use.

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