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Research Article

Reduction of Post-Endodontic Pain After Single-Visit RCT Using Balanced force and Two Reciprocating System when Intra-Canal Cryotherapy is Used

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Abstract

Objective: The goal of this research was to evaluate the reduction of post-endodontic pain after one-visit RCT using Balanced Force and two mechanical Systems when intra-canal Cryotherapy is used.

Materials and Methods: All 219 patients had teeth selected for conventional RCT for prosthetic purposes detected with only vital pulps. For hand instrumentation, BF was used. All canals were cleaned and shaped with hand K files (Moyco/Union Broach, York PA, USA). For mechanical shaping, all instruments were used with a micro motor (VDW, Munich Germany). WaveOne and Reciproc instruments. Final irrigation with cold (6oC) liquid EDTA served as irrigant.

Results: The average age of all participants included in this project was 50 - 65 years. No statistically significant difference ($p > .05$) among the groups were found regarding degree or duration of pain shown in table 3 and 4. There was no statistically significant difference ($p > .05$) among the three groups.

Conclusions: The outcome of this study indicates no differences between groups evaluated and the use of intra-canal cryotherapy technique with negative pressure irrigation is an aid to reduce post-endodontic pain after single-visit RCT.

Keywords: Flare Ups; Post-Operative Pain; Post-Endodontic Pain; Pain; Apical Healing

Introduction

Post-endodontic pain is reported by more than 35% of patients regardless of the preoperative periapical condition of the tooth treated. Therefore, prevention and management of post-endodontic pain are essential in endodontic practice [1].

Remains, necrotic tissue, microorganisms, and irrigants solutions extruded beyond the apical foramen during root canal treatment, will initiate inflammation and post-operative problems, such as mild to severe pain. It must be noticed that the amount of extruded material (debris and/or irrigant) varies widely in the reported studies which indicates problems and inconsistencies in treatment methodologies [2-4].

Additionally, the composition and the degree of bacterial contamination of the debris and the reactions of the patient`s immune system will play an important role in post-operative pain. Meticulous determination and maintenance of working length may reduce the extrusion of any kind of debris through the apical foramen but may not avoid this entirely [5].

Accumulation of tissue and dentin in the apical constriction is usual and can produce obliteration of the canal [6,7]. This condition can be prevented if patency of the apical foramen is maintained [8]. Presently, maintaining apical patency during root canal instrumentation is controversial [9].

To improve shaping the root canal, the Balanced Force technique was proposed by Roane., *et al*. [10]. The benefits of this technique are reduced possibility of canal modifications, apical ledging [11] and preservation of the integrity of the apical constriction [12].

Highest progresses in rotary shaping and in the metal goods of endodontic instruments have improved root canal preparation [6].

The single-file concept for root canal preparation was introduced with the promotion of Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Tulsa, Johnson City, TN) Ni-Ti instruments [13].

Canal preparation methods to some degree cause apical extrusion; however, the quantity of projection may vary as well as the composition and microbial contamination of the extruded material [14,15]. This is true also for single-file-system such as Reciproc and WaveOne [16]. Data for post-operative pain using a patency technique are controversial [9].

Some researchers pointed that preserving apical patency would not generate some post-endodontic difficulties [17]. A newly issued *in vitro* study exhibited that intracanal carriage of cold irrig-

ant at 2.5°C with negative pressure irrigation decreased the exterior surface temperature for about 10°C, preserving such a temperature for 5 minutes, which, according to the aforementioned scenario, would be enough to produce a local anti-inflammatory beneficial consequence in peri radicular tissues.

The goal of this study was to relate the reduction of post-endodontic pain after single-visit root canal treatment using the Balanced Force technique and two mechanical system when cryotherapy is used.

Materials and Methods

This study was performed at the Autonomous University of Baja California, School of Dentistry, Tijuana, Mexico. The study protocol was approved by the Ethics Committee of the University (number: 33/2018 and registered under the ClinicalTrials.gov Identifier: NCT03448263) and conducted in accordance with ethical principles of the last update of the Helsinki Declaration [18].

3 certified endodontists competent in the methods, strategies, and tested systems participated in the study. All experts were trained and calibrated in a pre-established procedure for the Balanced Force technique, WaveOne, and Reciproc instrument systems.

The patients´inclusion parameters were absence of apical periodontitis and a diagnosis of irreversible pulpitis established by pulp sensitivity testing with heat and cold.

Thermal pulp inspection was performed by the principal author, and radiographic conclusion was recognized in agreement by 3 certified endodontists. Further clinical requirements for patients´ inclusion were: 1) The objectives and requirements of the study were agreed and accepted. 2) Patients in well physical and mental condition. 3) Sufficient coronal structure for rubber dam isolation. 4) No previous root canal treatment. 5) No intake of analgesics or antibiotics 7 days prior to the root canal treatment.

Exclusion parameters were previously RCT, pregnancy, impracticality to get patient's approval, patients who didn't complete inclusion criteria, a history of medication for chronic pain, patients younger than 17 years or less. Non-vital teeth and teeth with apical periodontitis, endodontic retreatment, root resorption, undeveloped apex, or a root canal with severe curvature (> 35o) or a radiographically untraceable canal path were all rejected from the study. Mishaps or difficulties during root canal treatment also resulted in exclusion of patients from the study.

The diagnosis of vital pulp was confirmed by the presence of bleeding after gaining access to the pulp chamber. If the thermal test was positive and there was bleeding following pulp exposure, the tooth was established as vital. Presence or absence of pre-operative pain or discomfort 7 days previous to the event (yes/no) was noticed.

Clinical selection

Two hundred and nineteen of 248 patients (121 women and 98 men) aged > 17 and < 66 years were included in this study while 29 were excluded as not meeting the inclusion criteria (Figure 1). Sample size estimate was achieved according with a method for this specific purpose (Cochran's method, 1986). Therefore, the 73 teeth assigned to each group were suitable to approve a necessary model.

All patients presented with a vital maxillary or mandibular molar, premolar or anterior tooth selected for conventional root canal treatment for prosthetic purposes.

Patients refusing to accept the study or rejecting single-visit root canal treatment, consuming analgesics or NSAIDs were rejected also. All participants were informed on the aims, hazards and methodology of the research, and written informed consent were obtained previous to the treatment.

Random Selection

An investigator who had not contributed in the study made the randomization arrangement using a computer random table generator (www.random.org). Of the sample of 219 teeth, 73 were randomly assigned to each one of the three preparations methods.

Clinical Protocol

Patients were anesthetized with 2 carpules of articaine 2% with epinephrine 1:200,000 (Septodont, Saint-Maur des-Fosses, France). Isolation was done using rubber dam, the tooth was disinfected with 5.25% sodium hypochlorite.

Preparation of the access cavity was performed using # 331 and #2 round burs (Dentsply International, York, PA), with high-speed. NaOCl was employed to sanitized coronal cavity. The root canals were carefully probed with #10 K-type hand files (Flex-R files, Moyco/Union Broach, York PA, USA).

REDTA (Roth International, Chicago, IL) lubricant was placed at the entry of the canals. Working length was calculated with a #15 k-file and the Root ZX electronic device (J Morita, Irvine CA, USA), followed by withdrawing 0.5 mm from the measurement, which was confirmed radiographically (Schick Technologies, NY, USA). A glide path to the WL was then established.

Balanced Force technique was used with Flex R files. All root canals were shaped with hand Flex-R files (Moyco/Union Broach, York PA, USA). Gates-Glidden drills (Dentsply Maillefer) sizes #2 and #3 were employed at the orifice of the root canals. For rotary preparations, were used with a micro motor (VDW Silver Motor, VDW, Munich Germany). Force and cycle were preset for each Reciproc or WaveOne instrument. Rotary Ni-Ti instruments were used according manufacturers´ recommendation.

Dentinal debris was removed from the instruments with a gauze, simultaneously to the instrument change (WaveOne) or after 2 - 3 in-and-out movements (Reciproc) following manufacturers' recommendations. Each root canal was flushed with 2.5 mL 2.5% NaOCl. Flush the canals was performed using a 24-gauge needle (Max-I-Probe; Tulsa Dental, York, PA) and a 31-G NaviTip needle (Ultradent Products Inc, South Jordan, UT) when reaching the WL after each instrument insertion.

Group A. For the hand preparation group, the root canals were shaped using a #10-#40 instrument for thin or curved canals and a #15-#55 file for wide canals.

Group WON. For the WaveOne group, a file size 25/.08 was used to prepare narrow, straight and curved canals, and a file size 40/.08 was used for large and wide canals.

Three in-and-out pecking motions were used with an amplitude of not more than 3 mm until reaching the estimated working length.

Group REC. The R25 (size 25/.08) was used in tinny and arched root canals, and R40 files (40/.06) were used in broad root canals. Three in-and-out pecking motions were used with an amplitude of not more than 3 mm until reaching the estimated working length.

Both files and instruments were used in one tooth only.

After and hand rotary preparations, the root canals were flushed with 5 mL 2.5% NaOCl, using ultrasonic activation. Ultrasonic was performed using an Irrisafe ultrasonic 20.00 tip (Satelec, M erignac, France) at 50% power of the MiniEndo ultrasonic unit (Kerr Endo) with the tip placed 3 mm from the working length for 30 seconds per root canal. Each tooth received a final irrigation with cold (6oC) 17% EDTA softly transported to the working length by means of a cold (4oC) steel micro cannula attached to the Endovac negative pressure irrigation system (Kerr Endo) for 3 - 5 minutes to remove debris and decrease post-endodontic pain. Carefulness was taken to confirm that the metallic cannula would suction properly by noticing the system's transparent clearing tube. In case there was any obstacle, the micro cannula was promptly replaced.

Recapitulation of working length was performed again by using EAL as described before using #35, #40 and # 45 files.

The Canals were dried with sanitized paper cones and obturated in one-visit. Gutta-percha cones (Dentsply Maillefer) were laterally compacted with #20 nickel-titanium spreaders (Dentsply Maillefer) and AH-plus as the sealer (Dentsply Maillefer). The access cavities of anterior and posterior teeth were etched and repaired with Fuji IX (GC Corp, Tokyo, Japan).

Statistical Analysis

Patients were noticed of the probable occurrence of discomfort for days subsequent RCT and received an examination form to be completed and returned 3 days after. In it, they checked the presence/absence of post-endodontic pain. The pain level was measured using a validated pain scale known as the VAS [19]. The pain VAS is a continuous scale composed of a horizontal line, which is 10 cm in length. For pain intensity, the VAS is anchored by ''no pain'' (score of 0) and ''pain as bad as it could be'' (score of 10). VAS scale is widely used because of its simplicity and patient's friendliness that includes: no pain, mild pain, moderate pain, and severe pain [20]. The pain VAS was completed by the patients. The patients were asked to put a mark perpendicular to the pain VAS line at the point that indicated their pain severity during the 3 days after the endodontic treatment.

210 of the two hundred and sixteen examinations were returned properly returned. Of these, 70 belonged to the Balanced Force group, 71 to WaveOne group and 72 to the Reciproc group. The missing 6 questionnaires were returned one day later and were included in the data analysis.

The outcomes for the groups Balanced Force, WON and REC related to occurrence (yes/no), level (mild, moderate, severe), and interval (days) of post-endodontic pain were assessed and related to the following diagnostic factors: condition of tooth (all vital), occurrence or nonappearance of pre-operative pain, group of teeth (molar/premolar or anterior), or location (Maxillary, Mandibular).

The results were statistically evaluated with the Chi-Square test for the occurrence of post-endodontic pain, and Mann-Whitney U test for duration of post-endodontic pain, both with a level of significance of p=0.05.

Results

The structure of the study is shown in table 1 and figure 1. The standard age of the 219 patients registered in this research was 55 years. No statistically relevant dissimilarity ($p > .05$) between the groups were encountered concerning grade or length of pain. The post-endodontic pain results were observed 24-72 hours later in the 3 groups with a significant regression consequently (Table 3).

No statistically difference was observed among the 3 groups assessed in the research in terms of quantity of analgesic medication utilization ($p > .05$, Table 2-3). In general, analgesic consumption was limited to the next 24 hours after RCT in all the groups evaluated. None of the 219 patients stated acute pain or flare-ups during the duration of the research (Table 4).

In situations with informed occurrence of pre-operative pain, periods of post-endodontic pain were considerably more. There was no statistically significant difference ($p > .05$) among Balanced Force, WON and REC groups in relation to the rate of post/endodontic ache at any of the three period facts evaluated (Table 3).

No differences were encountered among the 3 groups about existence, score, or measurement of post-endodontic pain between front and posterior teeth.

Clinical features	Balanced Force (GA) (n = 73) (%)	Wave One (WON) (n = 73) (%)	Reciproc (R) (n = 73) (%)	Total (n = 219) (%)
Female	39 (53.24)	41 (56.16)	41 (56.16)	121 (54.33)
Male	34 (47.22	32 (44.44)	32 (43.83)	98 (44.74)
Maxillary teeth	37 (17.3)	37 (17.3)	37 (17.3)	111 (51.39)
Incisors and canines	2 (2.73)	3 (4.10)	2 (2.73)	22 (30.56)
Bicuspids	12 (16.67)	11 (15.28)	11 (15.28)	18 (25.00)
Molars	23 (31.94)	23 (31.94)	24 (33.33)	11 (15.28)
Mandibular teeth	35 (16.20)	35 (16.20)	35 (16.20)	105 (48.60)
Incisor and canines	3 (4.10)	2 (2.73)	1 (1.36)	6 (1.00)
Bicuspid	11 (15.28)	12 (16.67)	11 (15.28)	34 (47.22)
Molars	21 (29.17)	21 (29.17)	23 (31.94)	65 (90.28)
p= 0.05				

Table 1: Distribution by group of teeth.

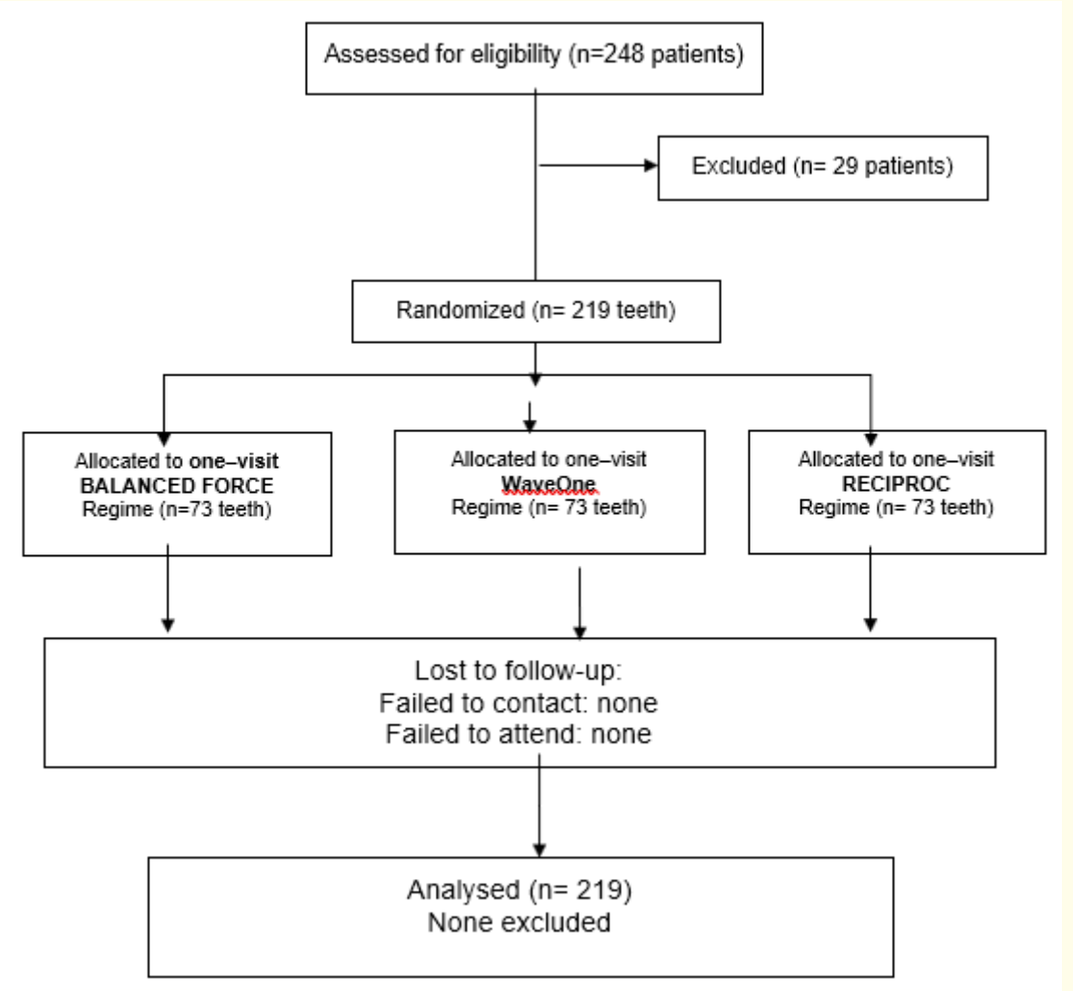

Figure 1: Flow diagram of the progress of phases of the study.

Clinical Factor	Condition	n	P value
Pulpal diagnosis	Vital	219	
Pre-operative pain	Yes	73	.005
	No	146	.44
Group of teeth	Anterior	16	.41
	Posterior	203	.11
Position of teeth	Maxillary	114	.021
	Mandibular	105	.019

Table 2: Mann-Whitney, U Test in Analysis of Duration of post-endodontic pain.

Instrumentation Technique	n	Mean	Standard deviation
Pain after 24h			
Balanced force	73	0.58	0.82
WaveOne	73	0.65	0.81
Reciproc	73	0.87	0.96
Pain after 48h			
Balanced force	73	0.24	0.43
WaveOne	73	0.23	0.42
Reciproc	72	0.21	0.59
Pain after 72h			
Balanced force	73	0	0.82
WaveOne	73	0.03	0.81
Reciproc	73	0.04	0.96
p= 0.05			

Table 3: Kruskal/Wallis test applied to the post-endodontic pain.

24 hrs. after	Balanced Force (GA) (n = 73) (%)	WaveOne (WON) (n = 73) (%)	Reciproc (REC) (n = 73) (%)
Quantity			
None	51 (69.86)	51 (69.86)	54 (73.97)
One tablet	12 (16.43)	13 (17.80)	11(15.06)
Two tablets	9 (12.32)	7 (9.58)	7 (9.58)
Three tablets	0	1 (1.36)	0
p= 0.05			

Table 4: Distribution of teeth by Randomization Factors.

In upper and lower teeth, differences between groups did not found relevant concerning existence, level, or length of post-endodontic pain.

In lower teeth, post-endodontic pain was suggestively longer (P .016; Table 3) than upper teeth.

Discussion

Ache is hard to comprehend and evaluate particularly when it occurs unexpectedly in clinical practice. The main trouble in knowing pain and distress is the participant's particular characteristics. For this objective, development the valuation form has to be wholly understood by patients.

In our study, a single arrangement was monitored in the feedback procedure with four levels: No pain, mild, moderate and severe pain. These levels were undoubtedly understood by patients and were defined by the presence or abscence of the necessity for pain-relieving protocol.

Pre-operative pain is one of the main factors of post-endodontic problems [21]. Thus, only teeth with irreversible pulpitis indicated for vital root canal treatment because of prosthodontic reasons were selected for this study.

Clinical procedures were performed in one-visit to avoid any influence can producing pain. WL was estimated with an EAL and confirmed with a radiograph. Root ZX EAL was employed because its exactitude has been established in two clinical environments [22-25]. Herrera., *et al.* [26], recommend that electronic WL dimension was repetitive after coronal and middle thirds shaping.

Clinicians can combine radiographic interpretation and digital RC dimensions for better outcomes. In case of inconsistency between both scales, the electronic assessment would be selected [27-29], as occurs in this research.

In a recent study [30] the dimension of the file used to preserve AF open varied. We methodically used a #10 width file to maintain AP. Operating wide widths to maintain apical patency can generate harm of nearby tissues. All of these situations predispose the existence of pain.

Forcing of endodontic instruments outside the apical foramen can project a considerable amount of toxic materials to the adjacent tissues, which can generate post-endodontic pain [31]. Georgepoulou., et al. presented a suggestively main incidence of pain if over the shaping procedure, tools or material were uncontrolled placed outside the apical foramen instead of preserving them inside the canal space [32]. In our study, caution was kept and no over instrumentation was presented, WL was maintained in all cases. Nonetheless, apical patency does not look to be correlated to post-endodontic pain in vital pulp tissue because of its control during RCT [33]. In this study, we used only one time the small instrument (K file size #10) after instrumentation phase.

Moreover, Torabinejad., *et al.* [5] detailed that unintentional over-passage of tool can happen although calculating WL, but it doesn't affect with the occurrence of pain. Our protocol was related to theirs, because also we used only tinny files to determine the working length. Though, it varies from our research in that they didn't maintain AP during all the RCT.

Siqueira., *et al.* [34] establish low frequency of intensive pain following RCT in teeth with necrotic tissue or teeth with previous

root canal treatment if apical patency was preserved. They found that maintenance of AP does not affect post-endodontic pain. In our study, we did not include cases for retreatment and flare-ups were not evaluated also.

In our study, we did some variations in procedures following protocols based on recommendations by authors and manufacturers. Although successful endodontic treatment depends on various factors, one of the most significant factors is the shaping of the root canal system. Proper cleaning and filling of the root canal system is fa¬cilitated by the maintenance of its origi¬nal shape from the coronal to the apical thirds, without any iatrogenic event.

This study is in agreement with that of Yaylali., *et al.* [35] who reported that the incidence of postoperative pain was significantly lower when AP was maintained but in non-vital teeth.

In our study clean and shape procedures were achieved using brushing and reciprocating movements respectively followed a final irrigation with cold (6ºC) 17% EDTA softly delivered to the WL using a cold (6ºC) metallic micro cannula attached to the Endovac supported in an early scientific report [36-41]. The standardized and controlled procedures used in this study may also have contributed to reduce of post-endodontic pain.

Conclusion

According to the conditions established for this study, there was no statistically significant difference among the instrumentation systems assessed. Cold irrigating solution employed is an aid to reduce post-endodontic pain.

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Conflict of Interest

The author denies any conflicts of interest related to this study.

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