RESEARCH ARTICLE

Comparison of the effect on postoperative pain between instrumentation with and without connected electronic apex locator: a randomized clinical trial [version 1; peer review: 1 not approved]

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Abstract

Background: The aim of the present study was to evaluate the postoperative pain between root canal instrumentation with unconnected electronic apex locator and instrumentation with connected electronic apex locator.

Methods: Forty-two patients were randomly divided into two groups (n=21). Group 1 was treated using the traditional endodontic motor with unconnected electronic apex locator (EAL) and group 2 was treated using the endodontic motor with connected EAL. All teeth were treated in single-visit endodontic therapy. Postoperative pain levels at 6, 24, 48, 72 h and 1 week were recorded by patients. The data were collected and analyzed using the χ^2 , and Mann-Whitney U tests with significance at 0.05.

Results: Postoperative pain levels were significantly reduced by half at 6 hours in both experimental groups; however, no significant differences were found in postoperative pain levels between the two groups at all considered times. The postoperative pain levels using a percussion test were reduced on day 7 in both groups, and there was no significant difference in this variable between two groups.

Conclusions: Both groups have a similar effect on reduction of the postoperative pain for endodontic patients undergoing root canal.

Keywords

nickel-titanium, electronic apex locator, single-visit endodontic, postoperative pain

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view

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Any reports and responses or comments on the article can be found at the end of the article.

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Introduction

One of the most important stages in endodontic therapy is root canal preparation, which required a working length (WL) determination.¹ Therefore, the measurement of root canal WL is one of the most important factors in root canal instrumentation and can affect the success of the endodontic treatment.¹ The complexity of the situation is that the WL is not constant, it changes during root canal preparation.² Because the root canal space cannot be shaped and cleaned appropriately if the WL is not exactly determined, this value must be controlled, measured, and adjusted continuously during the preparation. This task is time consuming and can cause procedural errors as it can produce more stress for the operator. Although the electronic apex locator (EAL), a device for WL determination, has shown high accuracy and facilitation,¹ such as ProPex PiXi (Dentsply Sirona, Ballaigues, Switzerland), it is still hard to satisfy the operator's demand for continuous monitoring of the WL in root canal preparation. The E Connect S motor combined with E-Pex Pro EAL (Changzhou Eighteenth Medical Technology Co., China) is a solution for continuous control of WL. This motor offers very special function for the operator when the instrument reaches the WL, that is, the motor automatically decreases the speed of, stops and/or reverses the instrument. Using such strictly controlled WL, this is expected to reduce the postoperative pain caused by apical extrusion. Postoperative pain is one of the most sensitive consequence in root canal therapy and there are many efforts to reduce the postoperative pain to enhance the patient's comfort, cooperation, and trust. The unremitting efforts of manufacturers and advancements in technology and materials have led to improved rotary nickel-titanium (NiTi) instruments.^{3,4} An offset cross-sectional design has become dominant in recent years because of its multi-advantages, such as larger envelope movement and good debris collection, facilitating its utilization.⁴ ProTaper Next (PTN, Dentsply Sirona, Maillefer, Ballaigues, Switzerland) possesses this offset design and is made of M-Wire.

The aim of the present study was to evaluate the postoperative pain after root canal treatment between utilization of a traditional endodontic motor with unconnected EAL and the motor with connected EAL. The null hypothesis was that there would be no differences in pain intensities between the two experimental groups.

Methods

This trial was registered at Thai Clinical Trials Registry with identification number of TCTR20200118001. The trial was registered retrospectively, as the study was started directly after receiving ethical approval; application for registration occurred after the enrollment of the first participant. The design of this study was a parallel group randomized, controlled trial with two arms, from May 2019 to March 2020.

Sample size

According to the data of a previous study,⁵ the sample size was calculated as 36. The sample size was calculated as the following formula for comparison of means from two independent samples:

$$n = \frac{\left(Z_{1-\beta} + Z_{1-\frac{\alpha}{2}} \right)^2 (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2}$$

With the power of 80%, significance of 0.05, the $Z_{1-\frac{\alpha}{2}} = 1.96$, $Z_{1-\beta} = 0.84$.

Considering the number of lost patients during follow-up, 42 patients were aimed to be included in the study with allocation ratio of 1:1.

Participants

Subjects of the study were enlisted from patients sent to the Department of Operative Dentistry and Endodontics of the University of Medicine and Pharmacy at Ho Chi Minh City for endodontic treatment from May 2019 to March 2020. Patients were asked prior to making an appointment for taking part in the study. Every patient was thoroughly informed about the study by the investigators, and each patient signed an informed consent form. The patients were blind to the modalities used for the endodontic treatment.

Patients were randomly distributed into two groups ($n = 21$ per group) using an online randomiser program (available at www.randomizer.org). Group 1 was treated using the traditional endodontic motor with unconnected EAL and group 2 was treated using the endodontic motor with connected EAL. In total, 26 women and 16 men with maxillary and mandibular molars indicated for endodontic therapy (as assessed with preoperative radiographs) were included in the present study. For each patient, one molar was treated for the study (a total of 42 molars for the study).

Table 1. Criteria for inclusion or exclusion of patients.

Inclusion criteria	Exclusion criteria
Healthy patients without systemic diseases Healthy patients without allergic reactions Symptomatic irreversible pulpitis Symptomatic apical periodontitis First or second molar	Systematic diseases Sinus tract Swelling Clenching or bruxism Severely damaged tooth Severe periodontal disease Resorption in related tooth Previously endodontic treated related tooth Root crack Taken analgesics during past 24 hours Absence of opposing tooth to the related tooth

Eligibility criteria

Criteria for subjects included in the present study were healthy patients without systemic diseases with symptomatic pulpal or periapical pathology of the first or second molar. Criteria for subjects excluded from the study were those with systematic diseases and other conditions, and those aged less than 18 years. The inclusion and exclusion criteria of patients for the present study were displayed in the [Table 1](#).

Data collection

Patient preoperative pain was recorded using the Heft Parker visual analogue scale (VAS) of Heft & Parker.⁶ The VAS was 170 mm in length and divided into four categories: 0 mm, no pain; 0-54 mm, mild pain (within this category: faint pain = 23 mm; weak pain = 36 mm); 55-113 mm, moderate pain; 114-170, severe pain (within this category: strong pain = 114 mm; intense pain = 144 mm).⁷ The patients had the VAS explained to them so that they knew how to record their pain on the line without any numerical markings, but with various descriptive words. The patients could place a mark anywhere on the line and use the verbal descriptors as a guide. Each patient's mark was assigned a value between 0 and 170 mm on the scale by measuring the distance from the left end to the mark with a ruler.

The patients were required to record their own pain level at 6, 24, 48, 72 hours and one week after treatment was complete using the VAS. The patient was scheduled for an appointment at one week after treatment for recording the postoperative pain by percussion test and for collecting the VAS. The age, gender, number of teeth, diagnosis, preoperative and postoperative pain levels at 6, 24, 48, 72, one week, preoperative and postoperative pain levels at one week on percussion using the Heft & Parker VAS (HP-VAS), and the analgesic intake after procedure were recorded.

Interventions

All endodontic treatments were performed by one endodontist (C.M.H.). The indicated tooth was anesthetized using local anesthetic solution containing 2% lidocaine with 1:100,000 epinephrine (Lignospan Standard, Septodont, France). Inferior alveolar nerve block and buccal infiltration anesthesia technique were used for the mandibular molars and buccal and palatal infiltration anesthesia technique was used for the maxillary molars. After 10 minutes, the access cavity was prepared under the rubber dam and explored for all possible canal orifices. The canals were filled with 3% sodium hypochlorite (Canal Pro, Coltene Whaledent, Altstätten, Switzerland) and explored by the 10 ISO K-file (Dentsply Sirona, Maillefer, Ballaigues, Switzerland). The coronal third of the canals were pre-enlarged using the PTN X1 to the estimated lengths (determined by the preoperative digital X-ray images).

For subjects of the group 1, group of instrumentation with unconnected EAL, the root canal lengths were measured using ProPex Pixi EAL and teeth were treated using WaveOne endodontic motor with Proglider and PTN instruments (Dentsply Sirona, Maillefer, Ballaigues, Switzerland). After WL was determined and confirmed radiographically (short of the apex from 0.5—1 mm), rubber stop on the shaft of the Proglider was set at the WL, then the instrument was inserted into the handpiece of the WaveOne motor (velocity: 300 rpm; torque: 2 N.cm) and used in slow in-and-out pecking motions inside the canal until it reached the determined working length. The Proglider was replaced by the PTN X1 with the rubber stop on the shaft at working length. The PTN X1 was used in slow in-and-out pecking motion inside the canal until reaching the determined WL. This same procedure was used for the next PTN X2 (upper buccal or lower mesial canals) and PTN X3 (upper palatal and lower distal canals).

For subjects of the group 2, group of instrumentation with connected EAL, the teeth were treated using E Connect S endodontic motor combined with the E-Pex Pro EAL with Proglider and PTN instruments. The WL of each root canal was confirmed radiographically. The Proglider was inserted into the handpiece of the E Connect S motor (velocity: 300 rpm;

torque: 2 N.cm) connected with the E-Pex Pro EAL (set at the apex, 0.0). The hook wire of the motor was hung into the corner of the patient's mouth, and the preparation was started. The instrument was inserted into the canal and used in slow in-and-out motion toward the apex until it was automatically stopped and reversed from the apex. This same procedure was used for the next PTN X2 (upper buccal or lower mesial canals) and PTN X3 (upper palatal and lower distal canals).

For the subjects of both groups, the 10 ISO K-file was used for patency file during the preparation after every instrument change. The file was inserted just past the apical foramen, with the amplitude of less than 0.5 mm.

The root canals were irrigated a final time using 5 mL 3% sodium hypochlorite following 5 mL 17% EDTA solution, then dried using matched paper cones and obturated with matched single gutta percha cones with AH Plus (Dentsply Sirona, Maillefer, Ballaigues, Switzerland). Digital radiograph was taken to check the quality of obturation. If the root canal treatment acquired all requirements of good obturation, without extrusion of material, the tooth was treated for the next step. The access cavities were restored using SDR flowable composite and Ceram X SphereTec composite resin (Dentsply Sirona, Konstanz, Germany).

A total of 400 mg ibuprofen (Stada, Vietnam) was prescribed for cases of unbearable pain.

Data analysis

Data were imported and stored in the Statistical Package for Social Sciences (SPSS) (IBM, Armonk, NY, USA) version 25.0. Data were first checked for normality of distribution using the Shapiro-Wilk test, however, almost all variables had not been distributed normally. Data transformation was performed using many arithmetical functions, however, there was not any successful transformation. Therefore, the Mann-Whitney U test was used for comparison between the two groups. Age, gender, tooth number, and analgesic intake data were analyzed using the χ^2 test. All statistical analyses were performed at the significance of 0.05.

Ethical considerations

This study was approved by the Research Ethics Committee of the University of Medicine and Pharmacy at Ho Chi Minh City with the approval number of 306/ĐHYD-HĐĐĐ. Written informed consent was obtained from all subjects involved in the study. Written informed consent was obtained from the patients to publish the article.

Results

There was not any loss of patients during follow-up (Figure 1). Demographic data, preoperative and post-operative pain levels, and pain levels on percussion are displayed in the Table 2.

Mean age of patients was 28.24 and 30.52 years for the group 1 and group 2, respectively. There were no significant differences in the age, gender, tooth number between the groups ($P > 0.05$). The preoperative pain levels and those on percussion were around the moderate level (85 mm) in both groups, and no significant differences were found in preoperative pain levels and these on percussion between two groups ($P > 0.05$). The postoperative pain levels were significantly reduced by half at 6 hours for both groups (greater than 50 mm); however, no significant differences were found in postoperative pain levels between two groups at all considered times ($P > 0.05$). The postoperative pain levels on percussion were reduced on day 7 in both groups, and there was no significant difference in this variable between two groups. There was only one patient who needed to use analgesics postoperatively in the instrumentation with unconnected EAL group (group 1). There was no patient who needed to use analgesics in the instrumentation with connected EAL group (group 2). There were not any signs of swelling, sinus tract, or palpation pain in the patients, and there were not any unscheduled appointments for the patients in the study.

Discussion

The result of the present study showed that postoperative pain levels of patients were lower than the "weak" level. Because the root canal length is changed during root canal preparation, therefore, it must be measured, controlled and maintained continuously.² This makes the operator fatigued and exhausted. Using a common, separate EAL, the operator must use a reference from the remaining tooth structure on the occlusal surface, incisal edge or even the root surface in teeth missing structure. This reference can be lost during treatment, especially in multiple-appointment treatment. In addition, using the rubber stop on the shaft of the instrument is improper in certain circumstances. This rubber stop can be displaced or worse than that, the rubber stop can be overpassed because of its elastic property without notice from the operator if the instrument is sucked into the canal (screw-in tendency). Instrumentation with a connected EAL device will overcome these shortcomings of previous methods in WL determination, control, and maintenance. Although there are many *in vitro* studies on the WL determination of EALs,^{1,8-10} there are few studies on endodontic motors with built-in or connected EAL up to now and therefore, there is not much data on the effect of an endodontic motor on root canal

CONSORT 2010 Flow Diagram

Figure 1. CONSORT flow diagram.

treatment.^{5,11} EAL connected to the endodontic motor in the present study has been investigated in a previous study, which shows that accuracy was at the highest level when compared with other EAL and cone beam computed tomography.¹ In the present study, we showed that EAL's accuracy is still at a high level when using with the endodontic motor.

The PTN is made of M-Wire with special offset design and unique dimensions in order to reduce operator's fatigue and exhaustion, and procedure complexity and enhance effectiveness.^{4,12} In the two previous studies on causing apical extruded debris of PTN and other rotary NiTi instruments, the results showed that PTN caused significantly less apical debris extrusion than ProTaper Universal and PTN caused significantly more apical extruded debris than HyFlex CM.^{13,14} These studies of comparison between the continuous rotary NiTi and reciprocating instruments showed that

Table 2. Demographic and pain data according to the two treatment groups.

	Instrumentation with unconnected EAL (group 1)	Instrumentation with connected EAL (group 2)
Age	28.24 ± 10.40 ^a	30.52 ± 12.66 ^a
Gender		
Male	9	7
Female	12	14
Tooth number		
16	1	1
17	0	4
26	2	1
27	4	2
36	1	2
37	5	3
46	3	1
47	5	7
Pain		
Preoperative pain after treatment	96.95 ± 41.63 ^a	97.14 ± 45.08 ^a
Postoperative pain levels at 6 h	44.14 ± 41.51 ^a	43.86 ± 36.89 ^a
Postoperative pain levels at 24 h	29.43 ± 38.37 ^a	23.48 ± 26.67 ^a
Postoperative pain levels at 48 h	21.33 ± 34.38 ^a	13.62 ± 18.85 ^a
Postoperative pain levels at 72 h	14.67 ± 27.84 ^a	11.10 ± 18.36 ^a
Postoperative pain levels on day 7	08.00 ± 17.32 ^a	06.11 ± 15.62 ^a
Pain on percussion		
Preoperative	84.95 ± 45.29 ^a	82.19 ± 41.30 ^a
Postoperative on day 7	20.48 ± 24.41 ^a	17.00 ± 31.60 ^a

Same superscript letters showed no significant differences on the same row ($P > .05$).

there were not significant differences in apical extruded debris.^{13,15} Other authors reported that the continuous rotary NiTi instruments produced less apical extruded debris than the reciprocating instruments.¹⁶ These conflicting results may be due to differences in study design, setup, or type of teeth.

Root canal preparation techniques cause apical extrusion of dentine debris, pulp tissue, microorganisms, and irrigation solutions through apical foramen, leading to inflammation, resulting in postoperative pain.¹⁷ The instrument's designs or modes of movement (continuous or reciprocating rotary) are considerable factors that influence the apical extrusion of debris and therefore, postoperative pain of the patient.¹⁸⁻²¹ Instruments with the reciprocating movement induce more debris through apical foramen when compared with instruments with continuous rotary movement.^{16,22} This affects the choice of instruments among a great array of nickel-titanium root canal instruments.

Sodium hypochlorite concentration of 3% was used for the present study, that is similar to that of a previous study.¹¹ A lower concentration of sodium hypochlorite has been considered to reduce the postoperative pain in one study,²³ however, that result was different from another study.²⁴ Although the standard concentration of 5.25% was used in other studies,^{23,24} there was still one study that used a higher concentration of 8.25% with no significant differences of postoperative pain among other lower concentration groups.²⁵

Because the first 48 hour after endodontic therapy is the most common period when postoperative pain is felt by patient, five time-points (right after treatment, after 6, 12, 24, 48 hours) were used for evaluation.²³ Longer periods are also selected to further collect the data after 72 hours and 7 days.²³

Postoperative pain related to rotary NiTi instruments was reported by many previous studies using the randomized clinical trial design.^{5,11,21,26} Two of these studies performed single appointment endodontic therapy with separate EAL, and the results revealed that there was no difference in postoperative pain between the reciprocating and continuous instruments.^{21,26} These studies enrolled the asymptomatic patients and evaluated only the postoperative pain levels with different VAS instruments. However, postoperative pain in the single-visit endodontic treatments with NiTi instruments was at low levels in these two studies.^{21,26} Another study also recruited asymptomatic patients with postoperative pain evaluation but used multiple-visit treatment and WL determination during the root canal preparation.¹¹ There were no differences in postoperative pain among the experimental NiTi instruments with both modes of movement in the above studies. The remaining study used the same concept as the present study with the different modalities.⁵ The result of the previous study revealed that postoperative pain levels on only day 1 of the group using the traditional endodontic motor with separate WL determination were significantly higher than that of the other groups.⁵ On the other days of the study, the postoperative pain levels were not significantly different between two groups using different modalities.⁵ This result agreed with that of the present study.

There are many various scales used to record the pain levels for evaluation of the effectiveness of many endodontic treatments.^{5,6,27-29} Although the 4- and 5-point rating scales of pain are used commonly and successfully in a clinical setting because of easy instructions for use, these scales did not have enough sensitivity to record the pain experience of patients.⁶ The Numerical Rating Scale for pain evaluation has low sensitivity when compared with the VAS, and in some previous studies, the VAS proved the high sensitivity and positive correlation with treatment effectiveness. The most important advantage of the VAS among the other pain scales was the difference in pain intensity at the two different times showed the actual difference in pain level.³⁰⁻³² The Heft-Parker VAS is a line with the dimension of 170 mm with different distances on the scales to describe the pain of the patient.⁶ The VAS is used commonly in oral-facial pain studies; however, this scale confuses patients in selection of right position on the scale because there are no guides for ratings other than the two extremities.⁶ Using category word designations on the line of a VAS, the graphic rating scale of Heft and Parker offers more sensitivity than a category scale and is easier to use than a VAS.⁶

The result of the present study revealed that although the postoperative pain of patients in the instrumentation with connected EAL group was lower than that of the instrumentation with unconnected EAL group, there was no significant difference in postoperative pain levels at all points in time between the two experimental groups. Therefore, the null hypothesis was accepted.

The limitations of the present study were the small sample size, that the operator was not blinded to the applications of the two different modalities.

Within the limitations of the present study, the result revealed that the preoperative pain levels of the subjects in both groups were above the “moderate” level and those reduced after single-visit endodontic treatment with the postoperative pain levels less than the “faint” level. There was just one patient that used anti-inflammation drugs after treatment. Along with many other advantages of single-visit endodontic treatment such as reduction of appointments, exclusion of leakage through temporary restorations and removal risk of additional missing of tooth structure in previously severe structure missing tooth, this mode of treatment is tolerated and preferred better by patients and becomes common practice in many situations.²⁶ Within the limitations of the present study, the endodontic therapy with the single-visit treatment brings the benefit to the patients without increasing the pain.

Conclusions

Within the limitations of the present study, endodontic therapy with the single-visit treatment brings the benefit to the patients without increasing the pain. Both groups using the endodontic motors with unconnected or connected electronic apex locator have a similar effect on reduction of the postoperative pain for endodontic patients.

Data availability

Underlying data

Mendeley Data: Khoa Cuong PO Pain, <https://doi.org/10.17632/48ytd79w39.1>.³³

Reporting guidelines

Mendeley Data: CONSORT checklist for ‘Comparison of the effect on postoperative pain between instrumentation with and without connected electronic apex locator: a randomized clinical trial’, <https://doi.org/10.17632/48ytd79w39.1>.³³

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References

1. Pham KV, Khuc NK: **The Accuracy of Endodontic Length Measurement Using Cone-beam Computed Tomography in Comparison with Electronic Apex Locators.** *Iran Endod J.* 2020; **15**(1): 12–17.
[Publisher Full Text](#)
2. Vasconcelos BC, Bastos LM, Oliveira AS, *et al.*: **Changes in Root Canal Length Determined during Mechanical Preparation Stages and Their Relationship with the Accuracy of Root ZX II.** *J Endod.* 2016; **42**(11): 1683–1686. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
3. Pham K, Nguyen N: **Cutting efficiency and dentinal defects using two single-file continuous rotary nickel-titanium instruments [Original Article].** *Saudi Endod J.* 2020; **10**(1): 56–60.
[Publisher Full Text](#)
4. Pham K, Phan T: **Evaluation of root canal preparation using two nickel-titanium instrument systems via cone-beam computed tomography [Original Article].** *Saudi Endod J.* 2019; **9**(3): 210–215.
[Publisher Full Text](#)
5. Arslan H, Güven Y, Karataş E, *et al.*: **Effect of the Simultaneous Working Length Control during Root Canal Preparation on Postoperative Pain.** *J Endod.* 2017; **43**(9): 1422–1427. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
6. Heft MW, Parker SR: **An experimental basis for revising the graphic rating scale for pain.** *Pain.* 1984; **19**(2): 153–161.
[PubMed Abstract](#) | [Publisher Full Text](#)
7. Nusstein J, Steinkruger G, Reader A, *et al.*: **The effects of a 2-stage injection technique on inferior alveolar nerve block injection pain.** *Anesth Prog.* 2006; **53**(4): 126–130. eng.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
8. Van Pham K: **Endodontic length measurements using 3D Endo, cone-beam computed tomography, and electronic apex locator.** *BMC Oral Health.* 2021; **21**(1): 271.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
9. Van Pham K: **Endodontic length measurements using cone beam computed tomography with dedicated or conventional software at different voxel sizes.** *Sci Rep.* 2021; **11**(1): 9432.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
10. Nguyen P, Pham K: **Endodontic length measurements using different modalities: An in vitro study [Original Article].** *J Int Soc Prev Community Dent.* 2020; **10**(6): 752–758.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
11. Oliveira PS, da Costa KNB, Carvalho CN, *et al.*: **Impact of root canal preparation performed by ProTaper Next or Reciproc on the quality of life of patients: a randomized clinical trial.** *Int Endod J.* 2019; **52**(2): 139–148. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
12. Pham KV: **A Comparison of Cone Beam Computed Tomography and Periapical Digital Radiography for Evaluation of Root Canal Preparation.** *Applied Sciences.* 2021; **11**(14).
[Publisher Full Text](#)
13. Ozsu D, Karatas E, Arslan H, *et al.*: **Quantitative evaluation of apically extruded debris during root canal instrumentation with ProTaper Universal, ProTaper Next, WaveOne, and self-adjusting file systems.** *Eur J Dent.* 2014; **8**(4): 504–508. eng.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
14. Koçak MM, Çiçek E, Koçak S, *et al.*: **Comparison of ProTaper Next and HyFlex instruments on apical debris extrusion in curved canals.** *Int Endod J.* 2016; **49**(10): 996–1000. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
15. Silva EJNL, Carapiá MF, Lopes RM, *et al.*: **Comparison of apically extruded debris after large apical preparations by full-sequence rotary and single-file reciprocating systems.** *Int Endod J.* 2016; **49**(7): 700–705. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
16. Bürklein S, Schäfer E: **Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems.** *J Endod.* 2012; **38**(6): 850–852. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
17. Relvas JBF, Bastos MMB, Marques AAF, *et al.*: **Assessment of postoperative pain after reciprocating or rotary NiTi instrumentation of root canals: a randomized, controlled clinical trial.** *Clin Oral Investig.* 2016; **20**(8): 1987–1993.
[PubMed Abstract](#) | [Publisher Full Text](#)
18. Pasqualini D, Corbella S, Alovisei M, *et al.*: **Postoperative quality of life following single-visit root canal treatment performed by rotary or reciprocating instrumentation: a randomized clinical trial.** *Int Endod J.* 2016; **49**(11): 1030–1039.
[PubMed Abstract](#) | [Publisher Full Text](#)
19. Nekoofar MH, Sheykhrizae MS, Meraji N, *et al.*: **Comparison of the Effect of Root Canal Preparation by Using WaveOne and ProTaper on Postoperative Pain: A Randomized Clinical Trial.** *J Endod.* 2015; **41**(5): 575–578.
[PubMed Abstract](#) | [Publisher Full Text](#)
20. Neelakantan P, Sharma S: **Pain after single-visit root canal treatment with two single-file systems based on different kinematics—a prospective randomized multicenter clinical study.** *Clin Oral Investig.* 2015; **19**(9): 2211–2217.
[PubMed Abstract](#) | [Publisher Full Text](#)
21. Kherlakian D, Cunha RS, Ehrhardt IC, *et al.*: **Comparison of the Incidence of Postoperative Pain after Using 2 Reciprocating Systems and a Continuous Rotary System: A Prospective Randomized Clinical Trial.** *J Endod.* 2016; **42**(2): 171–176.
[PubMed Abstract](#) | [Publisher Full Text](#)
22. Caviedes-Buchell J, Castellanos F, Vasquez N, *et al.*: **The influence of two reciprocating single-file and two rotary-file systems on the apical extrusion of debris and its biological relationship with symptomatic apical periodontitis. A systematic review and meta-analysis.** *Int Endod J.* 2016; **49**(3): 255–270.
[PubMed Abstract](#) | [Publisher Full Text](#)
23. Mostafa M, El-Shrief YAI, Anous WIO, *et al.*: **Postoperative pain following endodontic irrigation using 1.3% versus 5.25% sodium hypochlorite in mandibular molars with necrotic pulps: a randomized double-blind clinical trial.** *Int Endod J.* 2020 Feb; **53**(2): 154–166. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
24. Farzaneh S, Parirokh M, Nakhaee N, *et al.*: **Effect of two different concentrations of sodium hypochlorite on postoperative pain following single-visit root canal treatment: a triple-blind randomized clinical trial.** *Int Endod J.* 2018; **51**(S1): e2–e11.
[PubMed Abstract](#) | [Publisher Full Text](#)
25. Demenech LS, de Freitas JV, Tomazinho FSF, *et al.*: **Postoperative Pain after Endodontic Treatment under Irrigation with 8.25% Sodium Hypochlorite and Other Solutions: A Randomized Clinical Trial.** *J Endod.* 2021 May; **47**(5): 696–704. eng.
[PubMed Abstract](#) | [Publisher Full Text](#)
26. Çiçek E, Koçak MM, Koçak S, *et al.*: **Postoperative pain intensity after using different instrumentation techniques: a randomized clinical study [Original Article].** *J Appl Oral Sci.* 2017; **25**(1): 20–26.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
27. Ramamoorthi S, Nivedhitha MS, Divyanand MJ: **Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: A randomised controlled trial.** *Aust Endod J.* 2015; **41**(2): 78–87.
[PubMed Abstract](#) | [Publisher Full Text](#)
28. Pasqualini D, Mollo L, Scotti N, *et al.*: **Postoperative Pain after Manual and Mechanical Glide Path: A Randomized Clinical Trial.** *J Endod.* 2012; **38**(1): 32–36.
[PubMed Abstract](#) | [Publisher Full Text](#)
29. ElMubarak AHH, Abu-bakr NH, Ibrahim YE: **Postoperative Pain in Multiple-visit and Single-visit Root Canal Treatment.** *J Endod.* 2010 2010/01/01; **36**(1): 36–39.
[PubMed Abstract](#) | [Publisher Full Text](#)
30. Price DD, Bush FM, Long S, *et al.*: **A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales.** *Pain.* 1994; **56**(2): 217–226.
[PubMed Abstract](#) | [Publisher Full Text](#)
31. Kremer E, Atkinson HJ, Ignelzi RJ: **Measurement of pain: Patient preference does not confound pain measurement.** *Pain.* 1981; **10**(2): 241–248.
[PubMed Abstract](#) | [Publisher Full Text](#)
32. Jensen MP, Karoly P, Braver S: **The measurement of clinical pain intensity: a comparison of six methods.** *Pain.* 1986; **27**(1): 117–126.
[PubMed Abstract](#) | [Publisher Full Text](#)
33. Pham K: **Khoa Cuong PO Pain and Consort Checklist.** *Mendeley Data, V1.* 2021.
[Publisher Full Text](#)

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The present study evaluated the occurrence of postoperative pain between instrumentation with and without connected electronic apex locator through a randomized clinical trial. In general, the article is well written with appropriate language use. However, important methodological flaws are not only a bias, but completely invalidates the results of the manuscript:

1. the sample size calculation is not adequate;
2. there was no standardization in the sampling of patients, pulp status (vital and necrotic were included) or teeth (maxillary and mandibular molars);
3. the methodology applied for the chemical-mechanical preparation of root canals is weak and can lead to several biases in addition to the pain-causing factor evaluated;
4. the statistical analysis of the data is incomplete and could be better explored;
5. The conclusion is not supported by the results.

My recommendation for this current version is 'not approved'.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

No

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

No

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Postoperative pain; randomized clinical trial.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

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