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# Factors Associated with Post-Endodontic Treatment Pain Performed by Students in an Endodontic Graduate Program

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ABSTRACT

**Introduction:** The aim of this study was to evaluate the possible associations between pre-established clinical variables and manifestation of postoperative pain after endodontic treatments performed by graduate students in endodontics, from June 2016 to December 2017. **Methods and Materials:** A total of 998 dental patient charts were included in the study. All the patients underwent the same clinical protocol. Possible associations between postoperative pain and clinical variables were investigated, including age, gender, type of tooth, type of treatment, pulpal diagnosis, periradicular diagnosis, instrumentation system used, number of sessions, previous symptom, procedural accident, and endodontic sealer extrusion. Patients were contacted by telephone 24 h and 7 days after treatment completion and were asked about the degree of postoperative pain they had experienced, using a four-level scoring system: 0, no pain; 1, mild pain (no medication was needed); 2, moderate pain (an analgesic or anti-inflammatory was needed); 3, severe pain. Fischer's exact test, Pearson's test, and logistic regression were used for the statistical analysis of the data. A significance level of 0.05 was used. **Results:** A total of 8.6% of the patients reported having experienced postoperative pain, 50% of which reported mild pain, 47.7%, moderate pain, and 2.3%, severe pain. The only variable significantly associated with postoperative endodontic pain was pre-endodontic treatment symptoms (Pearson's test, $P$=0.0047). The logistic regression analysis indicated that the association between use of the Reciproc system and sealer extrusion posed a significant risk for postoperative endodontic pain. **Conclusion:** Based on this retrospective cohort study, the incidence of moderate and severe pain after endodontic treatment was low, and the only variable associated with a higher frequency of patients reporting postoperative endodontic pain was previous pain/symptoms. Therefore, in these cases, pain management methods such as the use of analgesics before treatment or immediately after treatment should be considered.

**Keywords:** Multivariate Analysis; Postoperative Pain; Root Canal Therapy

## Introduction

The possibility of postoperative pain occurring as a result of clinical procedures causes concern for both patients and clinicians. Therefore, it is essential to investigate and understand the conditions under which pain following endodontic treatment may occur [1]. The occurrence of postoperative endodontic pain is the result of an acute inflammatory response that occurs in the periradicular tissues. Several factors may be involved in the development of pain, such as the patient's age and gender, contamination, preoperative pain, presence of apical periodontitis, number of treatment sessions, use and concentration of irrigating solutions or intracanal medication, and quality and extent of the root canal filling [1, 2].

Advances in the kinematics and metallurgy of endodontic

instruments have led to the introduction of several root canal preparation systems, including reciprocating systems. These systems involve alternating clockwise and counterclockwise movements, allowing a single instrument to perform the tasks of root canal cleaning and shaping while spending less working time [3, 4]. Reciprocating nickel-titanium systems Reciproc (VDW, Munich, Germany), WaveOne (Dentsply Maillefer, Ballaigues, Switzerland), and ProDesign R (BassiEndo, Belo Horizonte, Brazil) involve the use of a single instrument for the complete chemical-mechanical preparation of the root canal. Despite these advances, preparation remains invariably associated with some degree of apical extrusion of dentin and pulp debris that, whether contaminated or not, exert an irritating action on the periradicular tissues, and may cause postoperative complications [5-7].

Non-surgical retreatment is the first option when the original root canal treatment has been unsuccessful. However, filling materials, necrotic cell tissues, irrigation solutions, and microorganisms can also be extruded into the periradicular tissues during the gutta-percha removal procedure involved in endodontic re-intervention, and this may result in considerable postoperative pain and periradicular inflammation [8].

One of the main challenges to the feasibility of conducting a reliable evaluation of postoperative pain is the level of subjectivity involved. Each person's pain threshold is unique, and its nature is multifactorial; it is influenced by factors inherent to the specific conditions of each patient and each tooth, and strongly depends on the cultural, individual and socioeconomic context of the patient [9].

Assuming that postoperative endodontic pain is a multifactorial symptom, the aim of this study was to evaluate the possible causes of postoperative pain after treatments performed by students in an endodontics graduate program, from June 2016 to December 2017, through an investigation of the possible associations between clinical factors and manifestation of the symptoms. The considered null hypothesis was that there would be no difference between the clinical factors investigated, as to their association with postoperative endodontic pain.

## Materials and Methods

This study was approved by the research ethics committee, School of Dentistry, São Leopoldo Mandic Research Center (registration no. 2.379.991). All of the patients were instructed on the purpose of the research, and signed a free and informed consent form.

### *Selection of teeth*

The study involved 998 teeth from patients who were included in the study sequentially, as they were treated in the endodontic graduate clinic at the institution where the study was conducted, from June 2016 to December 2017.

Teeth with vertical root fractures and/or indicated for extraction for periodontal or other reasons were excluded. The number of specimens used was based on the studies previously published in the literature.

### *Endodontic treatment technique*

After performing anesthesia using a 2% lidocaine solution with 1:100,000 adrenaline (Alphacaine, DFL, Rio de Janeiro, RJ, Brazil), conventional coronal access was gained with a spherical diamond bur of a caliber compatible with the tooth being treated. Rubber dam isolation and access refinement with a no. 3082 high-speed diamond bur (KG Sorensen, São Paulo, SP, Brazil) and/or an Endo Z drill (Angelus Prima Dental, Londrina, PR, Brazil) were then performed. The operative field was decontaminated with gauze soaked in a 2.5% sodium hypochlorite (NaOCl) solution.

Instruments size 25/0.08 of the Reciproc system (VDW, Munich, Germany), 25/0.06 of the ProDesign R system (Easy Equipamentos Odontológicos, Belo Horizonte, MG, Brazil), or 25/0.07 of the WaveOne system (Dentsply-Maillefer, Ballaigues, Switzerland) were used for the mechanical preparation of the root canals. The preparations were complemented with manual files of a caliber compatible with the canals being treated. The instruments were driven by a VDW Silver (VDW) motor, operated in the WaveOne All mode for WaveOne system files, and in Reciproc All mode for Reciproc and ProDesign R files.

In all cases, instrumentation followed the clinical sequence described below. After locating the root canal orifice, a #10 K-type hand file (Dentsply-Maillefer, Ballaigues, Switzerland) was used to explore the initial two thirds of the canal, followed by instrumentation of the cervical and middle thirds with the reciprocating instrument of the selected system, using in-and-out movements with an amplitude of 3 mm, and complemented with Gates-Glidden burs no. 4, 3, and 2 (Dentsply-Maillefer, Ballaigues, Switzerland), in that order. The foramen was located with a Romiapex A15 electronic locator (Romidan, Kiryat Ono, Israel), and the established measurement was considered the actual working length. K-type files #10, #15 or #20 (Dentsply-Maillefer, Ballaigues, Switzerland) were used for initial preparation of the apical third, and the selected reciprocating system was used to complete the instrumentation procedure. At every three in-and-out movements, the files were removed from the canal, cleaned with sterile gauze and reinserted until the

working length was reached. Throughout the instrumentation procedure, after each three-movement cycle, the canals were irrigated with 3 mL of 2.5% NaOCl using a 5-mL disposable syringe and a 22G disposable needle (Becton Dickinson, Curitiba, PR, Brazil), for an average final volume of 20 mL. After the preparation was completed, final irrigation was performed with 5 mL of 2.5% NaOCl, 5 mL of 17% ethylenediaminetetraacetic acid (EDTA), and another 5 mL of 2.5% NaOCl. Each of these solutions was mechanically agitated for 20 sec using the Easy Clean instrument (Easy), coupled to the Silver Reciproc motor (VDW) and operated in WaveOne All mode. The canals were dried with sterile absorbent paper points (Dentsply-Maillefer, Ballaigues, Switzerland), and the root canal was filled using Tagger's hybrid technique [10], with gutta-percha cones calibrated to the final instrument used, and AH-Plus sealer (Dentsply, Konstanz, Germany). Finally, the coronal chamber was cleaned, and the endodontic access cavity was sealed with P60 composite resin (3M ESPE Dental Products, St. Paul, MN, USA).

In all the retreatment cases with the same inclusion/exclusion criteria described above for non-retreatment cases, instrumentation followed the clinical sequence described below. After locating the orifices of the filled canals, the existing gutta-percha was removed from the cervical third with no. 2 Gates-Glidden drills, complemented with the reciprocating instrument selected for each case; no solvent was used. After removing the filling material completely, the canals were re-instrumented following the same sequence described above. Whenever needed, patients were instructed to take Dipyrone 500 mg, or Ibuprofen 600 mg, in case of allergy to Dipyrone, every 6 h.

### *Evaluation of the treated teeth*

Patients were called by telephone 24 h and 7 days after treatment to collect up-to-date on their symptoms. A four-level verbal scale, adapted from the studies conducted by Comparin *et al.* [9] and Erdem Hepsenoglu *et al.* [2], was used for this purpose:

Score 0-no pain; Score 1 - mild pain, no medication was necessary; Score 2-moderate pain, an analgesic or anti-inflammatory drug was necessary, but no clinical re-intervention; Score 3-Severe pain, presence of intense and acute pain or edema, with possible need for clinical re-intervention.

***Table 1***. Statistical analysis of the association between postoperative pain and the clinical variables assessed in the study (Pearson's and Fischer's exact tests, $P<0.05$)

| Clinical variable | *P*-value | Statistical test used |
|---|---|---|
| **Previous symptom (with versus without pain)** | 0.0047* | Pearson's |
| **Number of treatment sessions (single versus multiple)** | 0.0992 | Fischer's exact |
| **Type of treatment (primary versus retreatment)** | 0.2075 | Pearson's |
| **Periradicular diagnosis (presence versus absence of lesion)** | 0.2194 | Pearson's |
| **Patient gender** | 0.2789 | Pearson's |
| **Instrumentation system (Reciproc versus WaveOne versus ProDesig R)** | 0.6434 | Fischer's exact |
| **Treated tooth** | 0.7251 | Fischer's exact |
| **Extrusion of endodontic sealer (presence versus absence)** | 0.8165 | Pearson's |
| **Procedural accident (with versus without accident)** | 0.8190 | Fischer's exact |
| **Pulpal diagnosis (vital versus necrotic)** | 0.8222 | Pearson's |
| **Patient age** | 0.8409 | Fischer's exact |

*: *Statistically significant*

***Table 2.*** Association between the independent variables studied and the reporting of postoperative pain using a logistic regression model

| Independent variables | Coefficient | Standard deviation | z-value | *P*-value |
|---|---|---|---|---|
| **Intercept** | -2.0007 | 0.1855 | -10.7866 | 0.0000* |
| **Reciproc system** | -0.8862 | 0.3168 | -2.7972 | 0.0052* |
| **WaveOne system** | -0.4561 | 0.6295 | -0.7245 | 0.4688 |
| **Sealer extrusion** | -0.7605 | 0.3620 | -2.1007 | 0.0357* |
| **Interactions** | | | | |
| **Reciproc and sealer extrusion** | 1.7015 | 0.5015 | 3.3931 | 0.0007* |
| **WaveOne and sealer extrusion** | 0.6915 | 1.0163 | 0.6804 | 0.4963 |

*: *Statistically significant*

All the data pertaining to the patients and treatments performed were recorded in specific charts and tabulated at treatment completion in an Excel worksheet (Microsoft Corporation, Redmond, WA, USA). After data collection, the patients' responses were correlated with data obtained from their clinical charts pertaining to the following variables: age (<20 years, 20 to 40 years, 40 to 60 years, >60 years), gender (male or female), type of tooth treated (maxillary anterior, mandibular anterior, maxillary premolar, mandibular premolar, maxillary molar, mandibular molar), type of endodontic treatment (primary or retreatment), pulp diagnosis (vital or necrotic), periradicular diagnosis (presence or absence of apical periodontitis), number of treatment sessions (single or multiple), previous symptom (with or without pain), procedural accident (perforation, deviation or instrument separation), instrumentation system used (Reciproc, WaveOne, or ProDesign R), and extrusion of endodontic sealer (presence or absence).

***Statistical analysis***

Initially, a descriptive analysis was performed to assess the data distribution with respect to the postoperative pain variable, which involved the presence or absence of pain, and, when present, the level of pain experienced according to the scoring scale used in the study. Fischer's exact test and Pearson's test were used to analyze the correlation of each pre-established clinical variable with the presence or absence of pain. Logistic regression model was used to investigate possible correlations among these clinical variables and the presence or absence of pain. All the tests were performed using a significance level of 0.05.

## Results

Eighty-six (8.6%) of the 998 treated patients experienced postoperative pain in the first 24 hours. Of these patients, 43 (50%) reported mild pain (Score 1), 41 (47.7%) reported moderate pain (Score 2), and 2 (3%) reported severe pain (Score 3). All of the patients were asymptomatic one week after treatment completion. Previous symptoms was the only variable significantly correlated with the occurrence of postoperative endodontic pain ($P$<0.05) (Table 1).

The logistic regression model showed that only the instrumentation system and sealer extrusion variables were significantly associated with postoperative pain, and that the association between the Reciproc system and the presence of sealer extrusion was an aggravating factor (model coefficient>0) significantly correlated with the risk of postoperative endodontic pain ($P$<0.05) (Table 2).

## Discussion

The null hypothesis was rejected because there was a difference among the clinical variables studied, regarding their association with postoperative endodontic pain.

Postoperative pain is defined as discomfort of any degree that occurs after treatment completion. One of the main obstacles to a reliable evaluation of postoperative pain found in clinical studies performed for this purpose is the subjectivity involved in this evaluation, and the inherent difficulty in measuring pain [11]. In this study, evaluation was based on a verbal report by the patients 24 h and 1 week after treatment completion, using a 4-level pain scale (0, no pain; 1, mild pain; 2, moderate pain; and 3, severe pain), adapted from previous studies. A telephone call was the method chosen to collect the data, because it has been found to have the highest response rates by patients.

Studies that evaluated the occurrence of pain after endodontic treatment observed an incidence ranging from 1.9% to 58%. Mild pain is relatively common, even when the treatment complies with the highest technical and clinical standards, and should be expected and informed to patients in advance. However, a flare-up -characterized by severe pain and/or edema occurring after endodontic procedures- is an uncommon occurrence, and studies have reported frequencies ranging from 1.4% to 16% [4, 6]. In the present study, the incidence of postoperative pain was 8.6%, and, of the patients who experienced pain after 24 h, 50% reported mild pain, with no need for analgesics, 47.7%, moderate pain, and 2.3%, severe pain. Patients with severe pain were instructed to return to the clinic for reassessment. Two cases were diagnosed as acute abscess in the initial phase, received an antibiotic (amoxicillin 500 mg, every 8 h) and underwent an occlusal adjustment procedure. There was no need for drainage or endodontic re-intervention. All of the patients were asymptomatic after one week.

Based on our results, the only clinical variable significantly correlated with postoperative pain was previous symptoms. The presence of previous pain is indicative of a preexisting inflammatory process in the periapical tissues. In such cases, it is likely that the clinical procedures performed will potentiate symptoms. The results of the present study are compatible with those of some studies in the literature reporting the existence of positive associations between certain factors and the development and maintenance of pain, such as chemical irritation, physical irritation, and the presence of microorganisms. Moreover, they corroborate reports that certain factors may predispose patients to

postoperative pain, such as preoperative pain. El Mubarak *et al.* [12] evaluated the incidence of postoperative pain associated with teeth with and without previous symptoms, and showed that teeth with previous symptoms were significantly more frequently associated with postoperative pain, thus corroborating the results of the present study. On the other hand, these authors observed a higher rate of postoperative pain related to non-vital teeth (13.7%) than to vital teeth (7.8%), contrasting with the findings of the present study regarding this variable. This discrepancy may be due to the use of different treatment protocols, in terms of working length, instrumentation system, and of whether or not a supplementary irrigation protocol was used.

None of the other variables studied (age, sex, type of tooth, type of treatment, pulp diagnosis, periradicular diagnosis, number of sessions, procedural accident, instrumentation system and endodontic sealer extrusion) were significantly associated with the occurrence of postoperative pain when analyzed separately. The finding that no significant correlation was observed between the occurrence of postoperative pain and the number of treatment sessions in the present study was similar to that of previous studies in the literature [2, 12-14]. On the other hand, other studies have found a greater association between postoperative pain and treatments performed in multiple sessions [15, 16]. In 1995, Imura and Zuolo [17] stated that cases performed in multiple sessions are generally more complex, subject to more complex maneuvers, and, therefore, to accidents. In this sense, the introduction of new concepts in the treatment of endodontic patients, including treatment in a single session, has provided greater safety and predictability to endodontic therapy.

In the present study, no significant correlation was observed between postoperative pain and either the instrumentation system or the extrusion of sealer, when evaluated individually. However, the logistic regression analysis revealed a higher risk of postoperative pain when the Reciproc system was associated with sealer extrusion. Endodontic procedures whether for primary treatment or retreatment tend to cause the extrusion of dentin shavings, filling material, irrigants, remaining pulp tissue, and microorganisms into the periradicular tissues [18, 19], irrespective of the instrumentation system used. Frota *et al.* [20] compared the extrusion of debris promoted by the same systems used in the present study and observed significantly more extrusion associated with the Reciproc system due to its higher cutting power, which also resulted in a more substantial deformation of the apical foramen [21]. In the present study, all the teeth were instrumented up to the apical foramen; this may have led to the extrusion of sealer, dentin debris and pulp tissue, resulting in more severe periapical inflammation and a higher risk of postoperative pain. This risk may be reduced by carefully controlling all of the steps involved in these procedures [5].

## Conclusion

Based on the results obtained in this retrospective cohort study, it can be concluded that the incidence of moderate and severe pain after endodontic treatment was low, and only the preoperative symptom/pain variable was associated with a higher frequency of patients reporting postoperative endodontic pain. Therefore, in these cases, pain management methods such as the use of analgesics before treatment or immediately after treatment should be considered.

Care must be taken with the instruments used to prepare the apical foramen, in as much as they may increase the extrusion of material into the periapical region, and thus increase the risk of postoperative pain.

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Conflict of Interest: 'None declared'.

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