EAS Journal of Dentistry and Oral Medicine
Abbreviated Key Title: EAS J Dent Oral Med
ISSN: 2663-1849 (Print) & ISSN: 2663-7324 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-5 | Issue-6 | Nov-Dec-2023 | DOI:10.36349/easjdom.2023.v05i06.004

Original Research Article

Intensity of Preoperative Pain is a Predictive Factor of Postoperative Pain Following Root Canal Treatment

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Article History
Received: 17.10.2023
Accepted: 22.11.2023
Published: 25.11.2023

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: The aim of this study was to determine whether the intensity of preoperative pain was a predictive factor for the prevalence and intensity of postoperative pain, considering demographic and clinical variables. The study involved 80 teeth with pulpal or periapical pathologies. Root canal treatment was performed in one or two sessions. Pain intensity was assessed using the visual analogue scale before treatment and then 6h, 12h, 24h, 48h, 72h and one week after root canal treatment. The sample consisted of 46 women and 34 men. This study showed that postoperative pain was statistically associated with female gender (p=0.05), tooth types (p=0.006), and its location on the mandibular arch (p=0.03). The main finding was that patients with a higher intensity of pre-operative pain had a higher incidence of post-operative pain (p<0.05). In the group of patients who had no pre-operative pain, 63% (17/27) of patients remained asymptomatic after root canal treatment, while only 7.4% (2/27) had severe post-operative pain with a significant difference (p<0.05). However, in the group with severe pre-operative pain, 100% of patients had post-operative pain, of which 75% (15/20) of patients had high levels of pain requiring analgesics.

Keywords: Preoperative pain; intensity; postoperative pain, nociceptive pain, inflammatory process, root canal treatment.

INTRODUCTION

Pain has been defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience associated with, or described in terms of, actual or potential tissue damage" [1]. This definition has been widely accepted by healthcare professionals and pain researchers. In recent years, experts have suggested that advances in the understanding of pain warrant a re-evaluation of the definition and have proposed changes. As a result, in 2018, a new definition was proposed and validated by the IASP Council, as: "an unpleasant sensory and emotional experience associated with or resembling that associated with actual or potential tissue damage" [2, 3]. It is supplemented by the addition of six key notes and the etymology of the word "pain" for even more valuable context. Pain is always a personal experience that is influenced to varying degrees by biological, psychological and social factors. Dental pain, especially endodontic pain, has a negative impact on the quality of life of many patients. Pain control, before, during and after root canal treatment, is an essential aspect of endodontic practice [4, 5]. Mild to moderate post-operative pain is common, even when the endodontist has followed acceptable standards of treatment [4, 5]. Postoperative pain in endodontics is an unwanted symptom of a physiological (first stage of tissue repair) or pathological (development of tissue damage) inflammatory process [6]. The clinical characteristics of postoperative pain in endodontics are common to the descriptions of acute apical periodontitis. It is a continuous, throbbing, well-localized pain, aggravated by occlusal pressure or periapical palpation. Postoperative pain most often occurs within the first 24-48 hours after filling, and usually subsides within a few

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hours [7, 8], although it sometimes persists for several days. A systematic review carried out in 2011 showed that the assessment of postoperative pain in endodontics has been the subject of many published conflicting studies [9]. The strong evidence for a correlation between preoperative and postoperative pain demonstrates that patients who experience preoperative pain tend to have more severe postoperative pain compared with patients who have not had preoperative symptoms [8, 10-13]. There is some disagreement in the literature about the correlation between pulpal status and postoperative pain. Some authors suggest that pulpal status has an influence on postoperative pain [8, 12], while others [10, 11] have found no evidence of any influence between these two factors. The aim of this study was to determine whether the intensity of preoperative pain was a predictive factor of the prevalence and intensity of postoperative pain, considering demographic and clinical variables.

MATERIALS AND METHODS

Study design

This prospective study was conducted in patients with pulpal and/or periapical pathologies who were scheduled for routine endodontic treatment at the restorative dentistry and endodontics clinic of the Institute of Odontology of the Faculty of Medicine, Pharmacy and Odontology (FMPO) of the Cheikh Anta Diop University of Dakar (UCAD) and at the Al Ahmadiyatou dental clinic.

Inclusion criteria

Patients over 18 years of age scheduled for endodontic treatment and in good general health, as assessed by a self-administered questionnaire, were included in the study.

The study did not include endodontic restorations, patients with immature teeth, patients with a history of intolerance to NSAIDs and paracetamol, paracetamol-caffeine or codeine combinations, or patients with pacemakers. All patients had given informed consent.

Exclusion criteria

Patients whose root canal treatment was deemed insufficient and whose endodontic treatment procedures were not followed were excluded from the study.

Sample size

The study was carried out on 80 teeth in 80 patients. For each patient, only one tooth was counted.

Experimental procedure

Patient characteristics and clinical data

Before root canal treatment, the patient's data were recorded: age, sex, telephone number, type of teeth involved, location on the arch and reason for consultation, analgesic medication taken before and after root canal treatment.

Pulpal and periapical diagnosis

The pulp and periapical diagnosis and all stages of endodontic treatment were carried out by a single endodontist. An interview, followed by a full clinical examination were used to characterise the pain and diagnose the pulp and periapical pathologies. Pulpal vitality tests and preoperative retroalveolar radiography were used to confirm the presumptive diagnosis based on the clinical signs. The teeth tested were classified first as vital and necrotic, and then into different sub-groups before root canal treatment: teeth with irreversible pulpitis; teeth with necrotic pulp; teeth with acute apical periodontitis; teeth with chronic apical periodontitis; teeth with acute apical abscess (or phœnix abscess).

Root canal treatment

Root canal treatment was carried out by a single endodontist.

After analysis of the preoperative radiograph. All stages of root canal treatment were strictly adhered to. A postoperative radiograph was taken to confirm the quality of the root canal treatment (Figures 1-3). A watertight coronal filling was made after the root canal filling, to maintain the hermeticity of the crown and root. Root canal treatment was carried out in one or two sessions, depending on the complexity of the treatment. All teeth with insufficient root canal filling, excess cement and/or gutta-percha and poor filling density were excluded from the study.

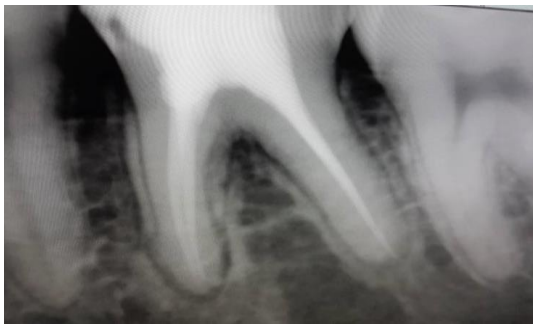

Figure 1: Control radiograph showing the quality of the root canal filling on a molar treated for chronic apical periodontitis

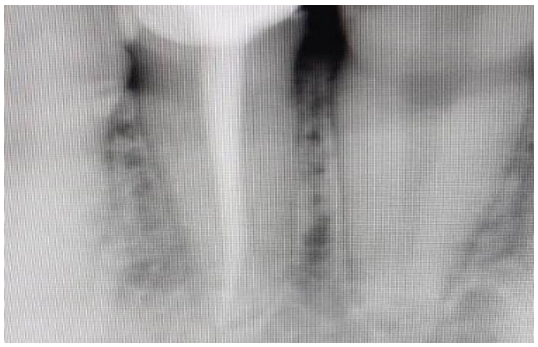

Figure 2: Control radiograph showing the quality of the root canal filling on an incisor with acute irreversible pulpitis

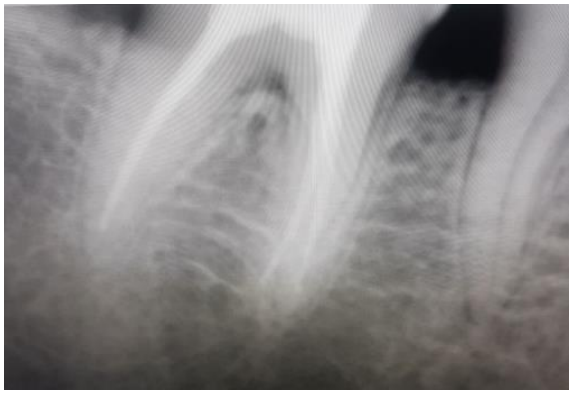

Figure 3: Control radiograph showing the quality of the root canal filling on a molar treated for acute apical periodontitis

Preoperative procedure

The Huskinsson Visual Analogue Scale (VAS) [14] was used to assess pain levels (intensity). Patients were shown how to use a 10 cm VAS to record their pre- and post-operative pain intensity. Prior to the administration of local anaesthetic, patients were asked to mark their pre-operative pain using the VAS scale. This was undertaken in the presence of the experimenter to ensure that they understood the instructions. The patient had to position a cursor on a continuous 10 cm horizontal line with a discriminant at each end, "no pain" at the left end and "maximum imaginable pain" at the right end. On the other side of the scale, not visible to the patient, there is a ruler graduated in cm (from 0 to 10 cm); the clinician can take and record the measurement. Preoperative pain scores were recorded.

Numerical values between 0 and 10 were converted into a scale: "no pain", "mild pain", "moderate pain" and "severe pain".

Pain intensity was defined as follows: 0 = no pain; 0.1-2.9 = mild pain, not requiring analgesics; 3-6.9 = moderate pain that was relieved with analgesics; 7-10 = severe pain, pain not relieved by analgesics.

Analgesic medications (non-narcotic analgesics, narcotic analgesics, NSAIDs) were also recorded (molecules used and dosage).

Postoperative procedure

After root canal treatment, patients were given a VAS scale on which they were asked to assess their pain at home, at 6h, 12h, 24h, 48h, 2h and one week after treatment.

The scores were recorded in the same way as for postoperative pain using the VAS. Pain intensity was collected by telephone call after root canal treatment.

Although none of the patients received immediate treatment for postoperative pain, each had been given information and explanations about the possible development of pain. The recommended drug for postoperative pain control, if necessary, was ibuprofen 600 mg every 8-12 h. The patient was advised to take analgesics if postoperative pain was moderate or severe.

Statistical analysis

The data were analysed using SPSS software (Statistical package of social science, version 20.0). The Mann Whitney test was used to analyse results between groups of patients with: acute irreversible pulpitis, necrotic pulp, acute apical periodontitis, chronic apical periodontitis, acute apical abscess.

The Chi-square test was used to determine the relationship between the intensity of preoperative pain and the persistence of postoperative pain, considering the clinical variables (sex, type of teeth, dental arch and number of visits). The significance level was set at 5% ($p<0.05$).

RESULTS

Patient characteristics and clinical data

A total of 80 patients took part in the study: 34 men (42.5%) and 46 women (57.5%). Patients ranged in age from 16 to 68 years. The average age was 33±8 years. Pain was the primary reason for consultation for 66.25% (n=53) of the sample. Of the remainder, 14 patients (17.5%) consulted for food blockages and 13 (16.25%) for difficulty chewing.

Tooth type treated were distributed as follows: Incisivocanine group, n=17 (21.25%), premolars, n=29 (36.25%) and molars, n=34 (42.50%). Of the 80 teeth treated, 46 were in the maxilla and 34 in the mandible.

The distribution of patients according to the diagnosis of pulpal and periapical pathologies was as follows: 41 (51.25%) suffered from acute irreversible pulpitis (AIP), 14 (17.50%) from pulpal necrosis, 5 (6.25%) from acute apical abscess (AAA), 7 (8.75%) from acute apical periodontitis (AAP) and 13 (16.25%) from chronic apical periodontitis (CAP).

Preoperative pain

Before root canal treatment, the mean pain intensity was 4.54±3.60 with a minimum of 0 (VAS=0) and a maximum of 10 (VAS=10). Preoperative procedure: 27 (33.75%) of patients had no pain; 9 (11.25%) had mild pain; 24 (30%) complained of moderate pain and 20 (25%) had severe pain.

Relationship between preoperative pain and clinical parameters

Table 1 shows the mean values and standard deviation (SD) of preoperative pain intensity and its relationship to clinical parameters. Preoperative pain was statistically associated with sex (in men, VAS=3.39±3.66; in women, VAS=4.21±3.75; p= 0.01), tooth type (p=0.001) and location on the mandibular arch (p=0.02). However, it was not positively associated with

pulp diagnosis (p=0.77). The Mann-Whitney test carried out between the different groups: teeth with irreversible pulpitis, teeth with pulpal necrosis, teeth with acute apical periodontitis, teeth with chronic apical periodontitis, teeth with acute apical abscess showed no significant difference between the groups (p>0.05).

Table 1: Relationship between preoperative pain intensity and clinical parameters

Clinical parameters	Average preoperative VAS (± SD)	*P*-value
Gender		
Men	3.39 ± 3.66	0.01
Women	4.21 ± 3.75	
Tooth type		
Molars	4.42 ± 3.69	0.001
Premolars	3.71 ± 3.75	
Incisivocanine	2.69 ± 3.51	
Arch		
Maxilla	3.30 ± 3.69	0.02
Mandible	4.45 ± 4.42	
Pulp diagnosis		
Vital pulp∗	3.78 ± 3.66	0.77
Necrotic pulp∗	3.91 ± 3.81	

∗Vital pulp = teeth with irreversible pulpitis

∗Necrotic pulp = teeth with pulp necrosis, teeth with acute apical periodontitis, teeth with chronic apical periodontitis, teeth with an acute apical abscess

Preoperative drug prescription

Preoperatively, apart from patients who came to the clinic because of food blockages (17.5%) or difficulty chewing (16.25%), all the other patients (66.25%) had self-medicated. Paracetamol was used most often (53.6%), followed by paracetamol + codeine (24.5%) and paracetamol + ibuprofen (21.9%).

Postoperative pain

Figure 4 summarises the intensity of postoperative pain at 6h, 12h, 24h, 48h, 72h and 1 week after root canal treatment. Mean pain intensity was highest at 24 hours (VAS=3.22±3.28) and 48 hours (VAS=3.02±3.50) after root canal treatment.

Pain intensity had decreased in patients at 6h and 12h after root canal treatment with respectively: at 6h, 10 (12.5%) had severe pain, 16 (20%) moderate pain and at 12h, 12 (15%) had severe pain, 18 (22.5%) moderate pain (Figure 5) compared to 20 (25%) who had severe pain and 24 (30%) moderate pain before root canal treatment. However, the level of post-operative pain increased, peaking 24 hours after root canal treatment (18.75% with severe pain and 26.25% with moderate pain) (Figure 5).

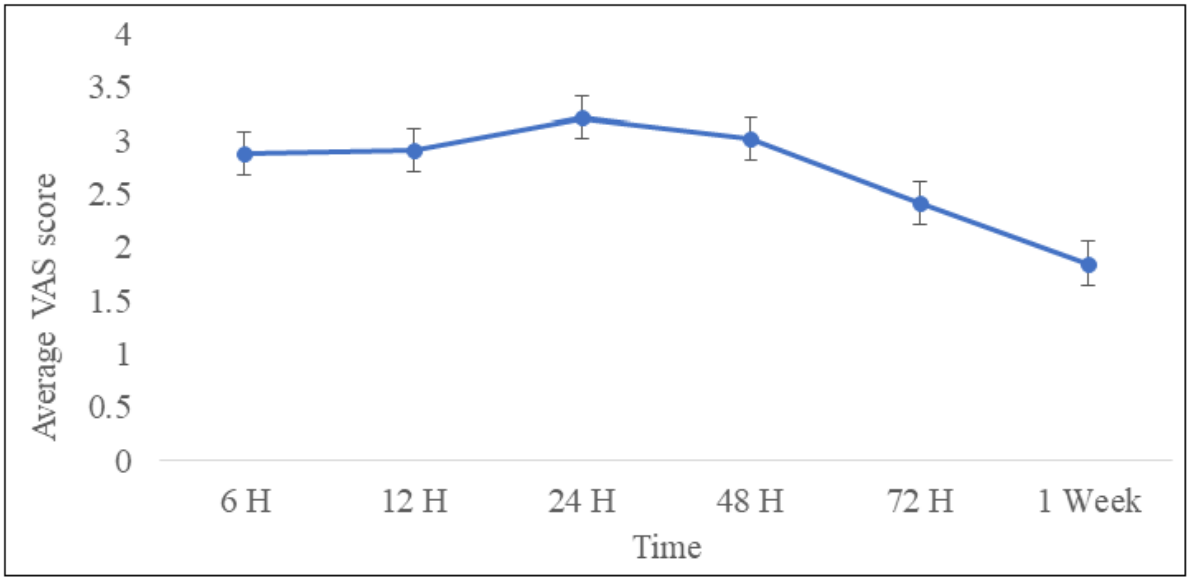

Figure 4: Average pain intensity at 6h, 12h, 24h, 48h, 72h and 1 week after root canal treatment

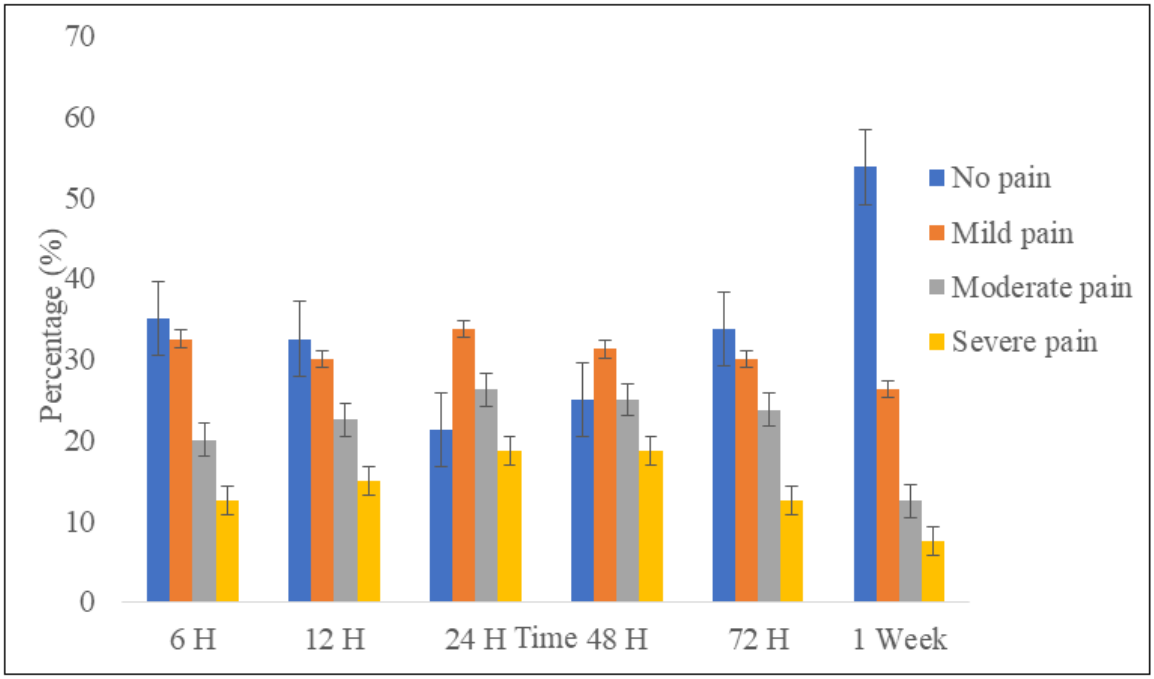

Figure 5: Distribution of patients according to postoperative pain intensity at 6h, 12h, 24h, 48h, 72h and 1 week after root canal treatment.

Relationship between postoperative pain and clinical parameters

Table 2 shows the mean values and standard deviation (SD) of postoperative pain intensity and its relationship with clinical parameters. Postoperative pain was statistically associated in women (p=0.05), tooth type (p=0.006) and location on the mandibular arch (p=0.03). However, it was not positively associated with pulp diagnosis (p=0.63), nor with the number of sessions: 1 session versus 2 sessions (p=0.71). The Mann-Whitney test also showed no significant difference between the pulpal and periapical pathology groups (p>0.05).

Table 2: Relationship between postoperative pain intensity and clinical parameters

Clinical parameters	Average preoperative VAS (± SD)	*P*-value
Gender		
Men	2.47 ± 2.93	0.05
Women	3.29 ± 3.33	
Tooth type		
Molars	3.36 ± 3.38	0.006
Premolars	2.64 ± 3.21	
Incisivocanine	2.06 ± 2.39	
Arch		
Maxilla	2.24 ± 2.69	0.03
Mandible	2.80 ± 3.03	
Pulp diagnosis		
Vital pulp	2.91 ± 3.28	0.63
Necrotic pulp	2.80 ± 3.17	
Number of visits		
1 visit	2.37 ± 2.78	0.71
2 visits	2.41 ± 2.87	

Relationship between preoperative pain and postoperative pain

In the group of patients who had no pre-operative pain, 63% (17/27) of patients remained asymptomatic after root canal treatment, while only 7.4% (2/27) had severe postoperative pain with a significant difference (p<0.05). However, in the group with severe preoperative pain, all patients suffered pain after root canal treatment, with 75% (15/20) of patients having high levels of pain requiring analgesics. When assessing changes in preoperative pain intensity, the results showed that patients with higher preoperative pain intensity had a statistically significant higher incidence of postoperative pain (p<0.001) (table 3).

Table 3: Relationship between preoperative pain and postoperative pain

Preoperative pain level n (%)	Postoperative pain level n (%)
No pain 27 (37.75%)	No pain: 17 63%) Mild pain: 6 (22.2%) Moderate pain: 2 (7.4%) Severe pain: 2 (7.4%)
Mild pain 9 (11.25%)	No pain: 3 (33.3%) Mild pain: 4 (44.5%) Moderate pain: 2 (22.2%) Severe pain: 0
Moderate pain 24 (30%)	No pain: 3 (12.5%) Mild pain: 8 (33.3%) Moderate pain: 11 (45.8%) Severe pain: 2 (8.4%)
Severe pain 20 (25%)	No pain: 0 Mild pain: 5 (25%) Moderate pain: 6 (30%) Severe pain: 9 (45%)

∗Statistically significant relationship between severe preoperative pain and prevalence and severe postoperative pain ($p<0.001$)

Postoperative drug prescription

Of the 80 patients, 47 (58.75%) with moderate to severe pain reported taking analgesics between 6 and 72 hours after root canal treatment. The most prescribed analgesics were ibuprofen 400 mg taken 3 times a day by 34 (42.5%) of patients and paracetamol + ibuprofen taken 3 times a day by 13 (16.25%) of patients. The mean level of postoperative pain in these patients was 3.87±3.28 who had taken analgesics, whereas patients who had not taken analgesics had a mean level of postoperative pain of 1.04±2.65.

DISCUSSION

The aim of this study was to determine whether the intensity of preoperative pain was a predictive factor of the prevalence and intensity of postoperative pain, considering demographic and clinical variables. The study involved 80 patients and 80 treatments. Before root canal treatment, the mean pain intensity was 4.54±3.60. This initial pain is an expression of an acute inflammatory reaction following bacterial attack or trauma. Inflammation involves vascular and nervous processes. The dental pulp contains nociceptors that are sensitive to various types of stimuli: mechanical, chemical and thermal. Inflammation is maintained and amplified by a chain of positive retrocontrols which, over time, can lead to hyperalgesia [15, 16]. This explains the severe pain described by patients with acute irreversible pulpitis, acute apical periodontitis or acute apical abscess. The mean value for postoperative pain intensity was 2.71±2.99. This value is close to the study by Ali *et al*., [10] who found a mean of 2.58±2.80. However, these results differ from those obtained by Segura-Egea *et al*., [11], who found a lower pain intensity (1.2±0.8). The results showed that moderate to severe postoperative pain was present in 42.5% of patients. Gotler *et al*., found an incidence of postoperative pain of 50.37% [8]. In their study, the incidence and severity of post-endodontic pain after root canal treatment in vital and necrotic pulps and after retreatment were assessed. Participants (n=274) had undergone a Randomised Clinical Trial (RCT) on teeth with a vital pulp, a necrotic pulp or a vital pulp that had been treated for symptomatic irreversible pulpitis or had received root canal retreatment, by a clinician, over an eight-month period. Patients were asked to rate their pain 6 hours and 18 hours post-treatment on a 1–5-point scale. RCT of teeth with vital pulp induced a significantly higher incidence and severity of post-endodontic pain (63.8%; 2.46±1.4) than RCT of teeth with necrotic pulp (38.5%; 1.78±1.2) or reprocessed teeth (48.8%; 1.89±1.1) [8]. El Moubarak *et al*., reported that the incidence of postoperative pain after conventional root canal treatment was low (9.0% at 12 hours and 24 hours). However, postoperative pain occurred in 15.9% of patients with a history of preoperative pain, while 7.1% of patients without a history of preoperative pain experienced postoperative pain [13].

The main finding of this study was that the intensity of preoperative pain was strongly associated with the prevalence and intensity of postoperative pain ($p<0.001$). In the group of patients who had no pre-operative pain, 63% of patients remained asymptomatic after root canal treatment ($p<0.05$), while only 7.4% had severe post-operative pain. Whereas in the group with severe pre-operative pain, all patients suffered pain after root canal treatment, with 75% of patients having high levels of pain requiring analgesics.

These results are consistent with those of other studies [7, 8, 10-13, 17, 18]. According to Ali *et al*., [10], the presence of pre-operative pain significantly increases the frequency and degree of post-operative pain. The statistical results of the prospective longitudinal study by Glennon *et al*., show that preoperative pain is the most

predictive factor of postoperative pain (OR=2.841; p<0.001) [19]. Interprocedural pain occurring in the 48 hours following root canal preparation is closely correlated with pain in the 24 hours preceding endodontic treatment. Various explanations have been proposed: any pre-existing inflammation in the periapical tissues, reflecting pre-operative pain, may be aggravated by endodontic treatment [18, 20]; patients who already have experience of endodontic pain tend to suffer more post-operative pain because they expect to feel it. One of the main concerns of pain research is that pain assessment is subjective. Each person's pain threshold is unique, so their decision whether or not to take analgesics will depend on this subjectivity [21]. The results of this study show that the need to take analgesics suggests high levels (moderate or intense) of postoperative pain.

Postoperative pain was statistically associated with female gender (p=0.05), tooth type (p=0.006) and location in the mandibular arch (p=0.03). Pulpal vitality was not associated with preoperative pain and also did not affect the intensity and frequency of postoperative pain.

Several hypotheses explain the prevalence of postoperative pain in women. Women more commonly suffer from psychosomatic illnesses and their pain is influenced by emotional factors. In addition, women are subject to significant hormonal fluctuations during the menstrual cycle, which may be associated with changes in serotonin and noradrenaline levels, increasing the prevalence of pain. Ng *et al*., have shown that gender influences postoperative pain significantly (OR= 0.434; p< 0.001), with men having significantly less postoperative pain than women postoperative pain than women [22]. These results are consistent with those of other authors [7, 8, 10, 18, 22]. The type of tooth was significantly associated with postoperative pain (p<0.05).

The results of this study showed statistically significant differences between premolars and molars compared to anterior teeth (p<0.05). According to Ng *et al*., molars have a more complex anatomy and root canal morphology, particularly in the apical third. This makes complete debridement more difficult and predisposes to postoperative complications [22].

In addition, this study showed that the level of postoperative pain in mandibular teeth was significantly higher than in root canals (2.80 ± 3.03) compared to maxillary teeth (2.24 ± 2.69). The mandible has a thicker and denser cortex than the maxilla, which may explain the more intense pain in the mandible [20]. High bone density in the mandible means reduced blood flow and therefore more potential sites of infection and inflammation, which can lead to delayed healing [18]. The thick mandibular cortex may explain the susceptibility to accumulate inflammatory exudate, which would favour the increase in pressure and therefore pain [18]. The results agree with previous studies [7, 18].

Analysis of postoperative pain showed no statistically significant difference between vital pulp (2.91±3.28) and necrotic pulp (2.80±3.17) with (p=0.63). These results are similar to those obtained by other authors [10, 11, 18, 23].

On the other hand, other studies had found a significant difference in levels of intensity postoperative pain intensity according to pulp vitality [8, 12].

CONCLUSION

This study showed that patients with higher levels of preoperative pain had a higher incidence of postoperative pain (p<0.05). In the group of patients with severe preoperative pain, 100% of patients had postoperative pain, with 75% of patients having high levels of pain requiring analgesics. In addition, postoperative pain was statistically associated with women, tooth type and location in the mandibular arch. While the prevention of postoperative pain depends above all on compliance with good practice recommendations during endodontic procedures, the identification of risk factors enables pharmacological management to be adapted to the clinical situation.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite This Article: Lecor, P. A, Diagne, M, Diene, M. G, Dieng, S, Niang, S. O, Toure, B (2023). Intensity of Preoperative Pain is a Predictive Factor of Postoperative Pain Following Root Canal Treatment. *EAS J Dent Oral Med, 5*(6), 162-169.