Postoperative pain in teeth endodontically treated by dental students, using manual and reciprocating techniques

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ABSTRACT

This study determined the frequency and/or intensity of postoperative pain and factors associated with such occurrence in endodontic treatments and retreatments performed by manual and reciprocating techniques, by undergraduate dental students at the Federal University of Pelotas. For that purpose, data were collected from the records of patients treated by last-term undergraduate students, in the period between January 2017 and July 2019, adding up to 182 treatments. Pain was recorded by the Numerical Pain Rating Scale (NPRS). The following predictive variables were considered in the outcome of postoperative pain: tooth, number of canals, symptoms, dental crown, indicated treatment and radiographic periapical index. The variables related to the treatments included the instrumentation techniques, number of sessions and apical limit of instrumentation. There was report of pain during treatment in 28% of records, while 11.5% did not report previous pain. In 149 cases (81.9%) included in this study there were no reports of postoperative pain, while mild pain was reported in 17 cases (9.3%), moderate in 6 (3.3%) and intensive in 10 (5.5%). In 67.4% of cases, the teeth were treated up to mark “0” of the apex locator, while in 32.6% the length was established at 1mm from this mark. There was no association between the type of treatment performed and the occurrence of postoperative pain (p=0.206). It was concluded that, among the evaluated factors, only the previous symptomatology was associated with higher frequency of postoperative pain.

Descriptors: Dental teaching. Endodontics. Root canal treatment. Toothache.

1 INTRODUCTION

Endodontics acts in regions inaccessible to the human eye, demanding from professionals an accurate level of sensitivity, skill and experience, as well as a long learning curve for dental students[1]. Most Brazilian dental schools still use the instrumentation technique with manual files, which due to the complexity and need for high tactile sensitivity, contributes to a natural rejection of Endodontics[2], consequently with low quality of endodontic treatment performed by recently graduated students and professionals[3,4]. The introduction of reciprocating movement in Dentistry courses opens a new educational perspective, leading professionals to achieve preparations with an excellent modeling pattern, even in more complex cases[5], allowing even students with little experience to perform the treatment of more complex cases[6].

In addition to the clinical and radiographic success, the postoperative comfort of patients is one of the desired factors when performing endodontic treatment or retreatment. In this context, the occurrence of postoperative pain is a relatively frequent problem for patients submitted to endodontic procedures and has been widely studied[7-11]. A systematic literature review[7] evaluated studies on the prevalence of pain before, during and after endodontic treatment, with a mean prevalence of 24% and 11% after one and seven days, respectively. This results from a multifactorial process and is influenced by aspects related to the patient, the tooth to be treated and the dentist's skills and interventions[12].

Some technical factors have been shown to influence the occurrence of pain after root canal treatment, including insufficient instrumentation and/or obturation, outflow of irrigating solution, apical extrusion of debris and foraminal enlargement during root canal preparation[13]. The main causes related to postoperative pain include the extrusion of debris present in the root canal to the periapical tissues[14,15]. The amount of extruded debris and neuropeptides released in the periodontal ligament differ according to the instrumentation technique employed[16], which has been related to the different levels of pain intensity and frequency reported by patients.

Thus, this study aimed to determine the frequency and/or intensity of postoperative pain and the factors associated with this occurrence in endodontic treatments and retreatments performed by manual and reciprocating instrumentation techniques, by undergraduate dental students at the Federal University of Pelotas (UFPel).

2 METHODOLOGY

Experimental design

This retrospective study surveyed information available on the medical records of patients treated by last-term dental students at the Dental School of UFPel, in the period between January 2017 and July 2019, approved by the Institutional Review Board (CAAE : 06198819.6.2001.5317).

The study included data from the anamnesis and clinical and radiographic exams of treated patients, pre- and postoperative pain levels. Data obtained from the medical records related to diagnosis, treatment and pain scales were tabulated and stored in a database.

Variables included in the study

The predictive variables for the outcome of postoperative pain were: tooth (dental group: anterior, premolars or molars), number of canals, symptoms (absent, absent with history or present), dental crown (intact, restored, carious, previously treated tooth), treatment indicated (vital pulp therapy, non-vital pulp therapy or retreatment) and radiographic periapical index (PAI) (1: normal periapical bone structure; 2:

small changes in bone structure, without demineralization; 3: changes in bone structure, with diffuse mineral loss; 4: apical periodontitis, with a well-defined radiolucent area; 5: severe apical periodontitis, with radiographic characteristics of exacerbation). The variables related to the treatment considered: instrumentation technique (manual or reciprocating), number of sessions (single, 2 sessions, 3 or more sessions) and apical instrumentation limit (1 mm below mark "0" of the apex locator – with or without patency, or at mark "0" of the apex locator).

Endodontic treatment

All procedures were performed under standardized conditions and under supervision by an Endodontics professor.

The root canals were prepared using one of the following techniques: manual (crown-down technique with stainless steel manual instruments) or reciprocating (WaveOne Gold or Reciproc systems, following the manufacturer's instructions). Irrigation during biomechanical preparation was performed with 2.5% sodium hypochlorite (NaOCl) and 17% ethylenediamine tetraacetic acid (EDTA) for 3 to 5 minutes at completion of preparation. In cases requiring more than one session, intracanal calcium hydroxide dressing was used. Obturation was performed by the single cone technique of the WaveOne Gold or Reciproc systems, or gutta-percha lateral condensation technique in case of manual instrumentation.

Pain assessment

The presence and intensity of pre- and postoperative pain was assessed by the Numerical Pain Rating Scale (NPRS) validated to Portuguese language[17]. The NPRS consists of a scale of 11 points, often presented in closed boxes in increasing order of whole numbers from left to right from 0 to 10, in which the extreme points mean "no pain" for 0 and "worst pain imaginable" for 10. The participants were asked to mark with an "x" the only number that best represented the pain intensity. The scale was applied at different times: at the first consultation during complete clinical examination and anamnesis; after biomechanical preparation and placement of intracanal dressing (if treatment was not completed); and after root canal obturation.

On the first consultation, after complete clinical examination, the patients were asked about the intensity of pain of dental origin in the last 48 hours (preoperative pain), being instructed and asked to record the number corresponding to the pain intensity on the scale. After completion of this consultation, the patients received a printed scale and were instructed to fill it at home concerning the presence and intensity of symptoms in the first 24 and 48 hours after each clinical session. When there was no face-to-face consultation, the patients were contacted by telephone at preestablished times. For statistical purposes, the numerical data referring to postoperative pain were categorized as 0 = absent; 1 to 4 = mild pain; 5 to 7 = moderate pain; 8 to 10 = severe pain).

Data analysis

Statistical analysis was performed using the software SPSS v. 22.0 (SPSS Inc, Chicago, IL). Descriptive analyses were performed on data related to the teeth included in the study and- pre and postoperative pain indices, besides association tests between variables and the endodontic outcome.

3 RESULTS

The frequency and intensity of postoperative pain and its association with the main variables analyzed is described in table 1.

Table 1. Frequency of postoperative pain and its association with the main variables evaluated

		Pain n (%)				
	Total	**Absent**	**Mild**	**Moderate**	**Severe**	**p value**
Instrumentation						
Manual	46(100)	36(78.3)	6(13)	2(4.3)	2(4.3)	0.733
Reciprocating	132(100)	110(83.3)	11(8.3)	4(3)	7(5.3)	
Tooth						
Anterior	72(100)	64(88.9)	3(4.2)	2(2.8)	3(4.2)	0.135
Premolar	40(100)	32(80)	4(10)	2(5.0)	2(5.0)	
Molar	69(100)	52(75.4)	10(14.5)	2(2.9)	5(7.2)	
Treatment						
Vital pulp therapy	57(100)	44(77.2)	5(8.8)	3(5.3)	5(8.8)	0.206
Non-vital pulp therapy	88(100)	75(85.2)	7(8.0)	2(2.3)	4(4.5)	
Retreatment	37(100)	30(81.1)	5(13.5)	1(2.7)	1(2.7)	
Initial symptoms						
Absent	107(100)	97(90.7)	8(7.5)	1(0.9)	1(0.9)	0.000
Present	54(100)	36(66.7)	6(11.1)	3(5.6)	9(16.7)	
Previous pain	21(100)	16(76.2)	3(14.3)	2(9.5)	0(0.0)	
Initial PAI						
1	91(100)	75(82.4	8(8.8)	4(4.4)	4(4.4)	0.484
2	29(100)	24(82.8)	3(10.3)	0(0.0)	2(6.9)	
3	27(100)	24(88.9)	1(3.7)	1(3.7)	1(3.7)	
4	32(100)	24(75.0)	5(15.6)	0(0.0)	3(9.4)	
5	3(100)	2(66.7)	0(0.0)	1(33.3)	0(0.0)	
Number of sessions						
Single session	110(100)	95(86.4)	6(5.5)	2(1.8)	7(6.4)	0.541
2 sessions	58(100)	43(74.1)	9(15.5)	3(5.2)	3(5.2)	
3 or more session	14(100)	11(78.6)	2(14.3)	1(7.1)	0(0.0)	

* χ^2 test

During the evaluation period, 182 endodontic treatments were completed by last-term dental students. In 149 (81.9%) no pain was reported in any of the postoperative periods, while mild pain was reported in 17 cases (9.3%), moderate in 6 (3.3%), and intense in 10 (5.5%). Of the total cases, 57 (31.1%) were teeth with vital pulp, 88 (48.4%) teeth with necrotic pulp and 37 (20.3%) were cases of retreatment.

A total of 54 patients (28%) reported pain during treatment, while 21 (11.5%) reported previous pain. The presence of pain in the 48h before the initial consultation, either during treatment or before, showed statistically significant relationship ($p<0.000$) with the report of postoperative pain of any intensity.

In 132 (72.5%) cases, the students chose to use reciprocating instruments for root canal preparation and in 46 (25.3%) conventional manual instruments were used. The instrumentation technique employed did not interfere with the occurrence of postoperative pain, and similar rates of mild, moderate or severe pain were reported for teeth instrumented by manual and reciprocating techniques ($p=0.733$).

With the introduction of mechanical techniques in undergraduate teaching, there was also an increase in the frequency of utilization of apex

locators, which allowed 122 (67.4%) cases to be treated until mark "0" of the apex locator, cleaning the entire length of the root canal. The instrumentation limit used, either at mark "0" of the apex locator or 1 mm below this measurement, did not influence the occurrence of postoperative pain (p=0.729).

There was no association between the occurrence of pain and the dental group treated, even though there was a higher percentage of mild or moderate pain in molars and premolars (p=0.135). Also, the number of canals was not associated with higher occurrence of postoperative pain (p=0.235).

The frequency and intensity of postoperative pain varied according to the treatment performed: there was no pain in 44 (77.2%) cases of vital pulp therapy, 75 (85.2%) cases of non-vital pulp therapy and 30 (81.1%) retreatments; however, there was no statistically significant association between the treatment performed and the occurrence of postoperative pain (p=0.206). There was no association between the condition of the dental crown at the moment of treatment (restored, previously treated, carious, intact), the initial PAI or the number of sessions required for treatment completion with the occurrence of postoperative pain (p>0.05).

4 DISCUSSION

This study aimed to determine the frequency of postoperative pain and the factors associated with this occurrence in patients who received endodontic treatment performed by undergraduate students. Due to the subjective and multifactorial nature of pain, many difficulties can arise in the assessment of postoperative pain levels and in controlling the several confounding factors involved.

For pain assessment, an attempt was made to turn a phenomenon that is essentially subjective and subject to high individual variability into something objective, highlighting the complexity of measuring results related to pain assessment. The present study used the NPRS to measure pre- and postoperative pain; this scale is one of the most used tools for this evaluation in clinical procedures[18-20], previously validated for Portuguese language[17].

Pain after root canal treatment can be related to variable causes. However, one of the predictive factors for its occurrence seems to be the inflammation caused by debris extruded into the periapical tissues[7,21-23]. Even though the literature indicates that the manual technique seems to extrude greater amount of debris than the reciprocating technique, the present study did not observe any significant difference in postoperative pain between the different instrumentation techniques (manual and reciprocating). In disagreement with this result, several studies[24-28] have shown a higher occurrence of postoperative pain when manual instrumentation is used, compared to mechanical instrumentation. These results can be assigned to the fact that, in the present study, the crown-down manual technique was used, while most studies demonstrating a higher occurrence of postoperative pain in cases treated by manual techniques used the step-back technique[26- 30]. In the step-back technique, there is a tendency that the instrument may act as an embolus, directing debris and forcing their extrusion through the apical foramen[31], probably worsening the periapical inflammatory condition and consequently the pain.

The literature addressing the association between the pulp condition and the occurrence of postoperative pain still provides inconsistent data. Several studies report that the pulp condition contributes to postoperative pain[32,33], while others do not[8,23,34,35]. However, the present results demonstrated significant association between the initial symptoms and the occurrence of postoperative pain, which agrees with results

previously reported in the literature[23,36,37]. Patients who have pain before endodontic treatment already have some degree of inflammation of the pulp and/or periapical tissues, and after root canal preparation and obturation, even if anti-inflammatory drugs are used, the inflammation and consequently the pain is gradually reduced, justifying the results described.

It was also observed that the dental group did not influence the postoperative pain, although it has been reported that molars are most likely to present postoperative pain[38]. This association is probably due to the fact that molars present a more complex anatomy, with a greater number of canals and more pronounced curvatures, as well as anatomical variations that can contribute to the maintenance of uncleaned walls and consequently persistent infection and tissue inflammation, even after biomechanical preparation[37-40].

The number of sessions of endodontic treatment did not influence the postoperative pain in this study, which agrees with previous studies, which indicate that the result of endodontic treatment in a single session or in several sessions was similar concerning the occurrence of pain, without flare-ups and complications[41-43]. However, the available literature is also controversial regarding these results. Some authors mention a lower rate of postoperative pain in endodontic treatments performed in a single session[44-45], while others report a lower rate of postoperative pain in multiple sessions[46-47]. The lower rate of postoperative pain in root canal treatment in a single session could be assigned to immediate filling, thus avoiding the passage of drugs, repeated instrumentation and irrigation. In addition, endodontic treatment in a single session could also prevent the occurrence of pain resulting from reinfection of the root canals as a result of bacterial penetration through an unsatisfactory provisional restoration[48].

The rates of postoperative pain were relatively low in the present study. This may be associated with the operators who performed the endodontic treatments, who were undergraduate students. Previous studies[12,49] indicate lower prevalence of postoperative pain in endodontic treatments performed by undergraduate students compared to graduate students. Such findings cannot be directly explained and should consider the limitations of the present study, that included multiple operators, which can imply a great variation in relation to other studies.

5 CONCLUSION

The results of the present study showed no association between postoperative pain in teeth endodontically treated by undergraduate students and the instrumentation technique used, either manual or reciprocating. Among the factors evaluated, only previous symptomatology was associated with a higher frequency and intensity of postoperative pain.

RESUMO

Dor pós-operatória em dentes tratados endodonticamente por estudantes de Odontologia, utilizando técnicas manual e reciprocante

O objetivo do presente estudo foi determinar a frequência e/ou intensidade de dor pós-operatória e os fatores associados a esta ocorrência em tratamentos e retratamentos endodônticos realizados pelas técnicas de instrumentação manual e reciprocante, por estudantes de graduação em Odontologia da Universidade Federal de Pelotas. Para tal, utilizou-se informações dos prontuários de pacientes atendidos por estudantes do último ano de graduação, no período compreendido entre janeiro de 2017 e julho de 2019, totalizando 182 tratamentos. A dor foi registrada por meio da Escala de Avaliação Numérica da Dor (EAND).

Considerou-se como variáveis preditivas no desfecho de dor pós-operatória: dente, número de canais, sintomas, coroa dentária, tratamento indicado e índice periapical radiográfico. Como variáveis relativas aos tratamentos, técnica de instrumentação, número de sessões e limite apical de instrumentação**.** Havia relato de dor no momento do tratamento em 28% dos prontuários, enquanto 11,5% não reportaram dor prévia. Em 149 casos (81,9%) incluídos neste estudo não foi relatada a ocorrência de dor pós-operatória, enquanto dor leve foi relatada em 17 casos (9,3%), moderada em 6 (3,3%) e intensa em 10 (5,5%). Em 67,4% dos casos dos dentes foram tratados até a marcação 0 do localizador apical, enquanto em 32,6% o comprimento foi estabelecido a 1mm desta marcação. Não houve associação entre o tipo de tratamento realizado e a ocorrência de dor pós-operatória (p=0,206). Conclui-se que, entre os fatores avaliados, apenas a sintomatologia prévia apresentou associação com a maior frequência de dor pós operatória.

Descritores: Ensino Odontológico. Endodontia. Tratamento do Canal Radicular. Odontalgia.

REFERENCES

1. Souza E, Rodrigues E, De-Deus G, Zuolo M, Silva E, Versiani M. Movimento reciprocante e a curva de aprendizagem do preparo mecânico. O Movimento Reciprocante na Endodontia. São Paulo: Quintessence Editora; 2017. p. 214-31.
2. Seijo MO, Ferreira EF, Ribeiro Sobrinho AP, Paiva SM, Martins RC. Learning experience in endodontics: Brazilian students' perceptions. J Dent Educ. 2013;77(5):648-55.
3. Abu-tahun I, Al-Rabab'ah MA, Hammad M, Khraisat A. Technical quality of root canal treatment of posterior teeth after rotary or hand preparation by fifth year undergraduate students, The University of Jordan. Aust Endod J. 2014;40(3):123-30.
4. Er O, Sagsen B, Maden M, Cinar S, Kahraman Y. Radiographic technical quality of root fillings performed by dental students in Turkey. Int Endod J. 2006;39(11):867-72.
5. Rodrigues E, De-Deus G, Souza E, Silva EJ. Safe Mechanical Preparation with reciprocation movement without glide path creation: result from a pool of 673 root canals. Braz Dent J. 2016;27(1):22-7.
6. Muñoz E, Forner L, Llena C. Influence of operator's experience on root canal shaping ability with a rotary nickel-titanium single-file reciprocating motion system. J Endod. 2014;40(4):547-50.
7. Pak JG, White SN. Pain prevalence and severity before, during, and after root canal treatment: A systematic review. J Endod. 2011;37(4):429-38.
8. Pasqualini D, Mollo L, Scotti N, Cantatore G, Castelucci A, Migliaretti G, Berutti E. Postoperative pain after manual and mechanical glide path: a randomized clinical trial. J Endod. 2012;38(1):32-6.
9. Silva EJ, Menaged K, Ajuz N, Monteiro MR, Coutinho-Filho T de S. Postoperative pain after foraminal enlargement in anterior teeth with necrosis and apical periodontitis: a prospective and randomized clinical trial. J Endod. 2013;39(2):173-6.
10. Arias A, Macorra JC, Azabal M, Hidalgo JJ, Peters OA. Prospective case controlled clinical study of post-endodontic pain after rotary root canal preparation performed by a single operator. J Dent. 2015;43(3):389-95.
11. Nekoofar MH, Sheykhrezae MS, Meraji N, Jamee A, Shirvani A, Jamee J, Dummer P. 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):575-8.
12. Walton R, Fouad A. Endodontic interappointment flare-ups: a prospective study of incidence and related factors. J

Endod. 1992;18(4):172-7.
13. Alves VO. Endodontic flare-ups: a prospective study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;110(5):e68-72.
14. Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. J Endod 1985;11(11):472-8.
15. Siqueira Jr JF. Microbial causes of endodontic flare-ups. Int Endod J. 2003;36(7):453-63.
16. Caviedes-Bucheli J, Castellanos F, Vasquez N, Ulate E, Munoz HR. 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):255-70.
17. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. Pain. 2011;152(10):2399-404.
18. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs. 2005;14(7):798-804.
19. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. European Palliative Care Research Collaborative (EPCRC). Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage. 2011;41(6):1073-93.
20. Dos Santos Calderon P, Peixoto RF, Gomes VM, da Mota Corrêa, AS, de Alencar EN, Rossetti LM, Conti PCR. Concordance among different pain scales in patients with dental pain. J Orofac Pain. 2012;26(2):126-31.
21. Seltzer S, Bender IB, Ehrenreich J. Incidence and duration of pain following endodontic therapy. Relationship to treatment with sulfonamides and to other factors. Oral Surg Oral Med Oral Pathol. 1961;14:74-82.
22. Rosenberg PA. Clinical strategies for managing endodontic pain. Endodontic Topics. 2002;3:78-92 .
23. Siqueira Jr JF, Rôças IN, Favieri A, Machado AG, Gahyva SM, Oliveira JCM, Abad EC. Incidence of postoperative pain after intracanal procedures based on an antimicrobial strategy. J Endod. 2002;28(6):457-60.
24. Shokraneh A, Ajami M, Farhadi N, Hosseini M, Rohani B. Postoperative endodontic pain of three different instrumentation techniques in asymptomatic necrotic mandibular molars with periapical lesion: A prospective, randomized, double-blind clinical trial. Clin Oral Investig. 2017;21(1):413-8.
25. Pasqualini D, Mollo L, Scotti N, Cantatore G, Castellucci A, Migliaretti G, et al.Postoperative pain after manual and mecha nical glide path: a randomized clinical trial. J Endod. 2012;38(1):32-6.
26. Al-Jabreen TM. Single visit endodontics: Incidence of post-operative pain after instrumentation with three different techniques: An objective evaluation study. Saudi Dent J. 2002;14(3):136-9.
27. Kashefinejad M, Harandi A, Eram S, Bijani A. Comparison of single visit post endodontic pain using Mtwo rotary and hand K-file instruments: a randomized clinical trial. J Dent (Tehran). 2016;13(1):10-7.
28. Capar ID, Arslan H, Akcay M, Ertas H. An in vitro comparison of apically extruded debris and instrumentation times with ProTaper universal, ProTaper next, twisted file adaptive, and HyFlex instruments. J Endod. 2014;40(10):1638-41.
29. Ahmed MA, Dall AQ, Khoso NA, Jouhar R. Comparison of postoperative pain after Protaper rotary and manual step-back root canal preparation techniques in single visit

endodontics. J Pak Dent Assoc. 2012;21(2):103-7.
30. Talebzadeh B, Nezafati S, Rahimi S, Shahi S, Lotfi M, Ghasemi N. Comparison of manual and rotary instrumentation on postoperative pain in teeth with asymptomatic irreversible pulpitis: A randomized clinical trial. Iran Endod J. 2016;11(4):273-9.
31. Saha SG, Gupta RK, Bhardwaj A, Misuriya A, Saha MK, Nirwan AS. Comparison of the incidence of postoperative pain after using a continuous rotary system, a reciprocating system, and a Self-Adjusting File system in single-visit endodontics: A prospective randomized clinical trial. J Conserv Dent. 2018;21(3): 333-8.
32. Iqbal M, Kurtz E, Kohli M. Incidence and factors related to flare-ups in a graduate endodontic programme. Int Endod J. 2009;42(2):99-104.
33. Gotler M, Bar-Gil B, Ashkenazi M. Postoperative pain after root canal treatment: a prospective cohort study. Int J Dent. 2012;2012:310467.
34. Alí A, Olivieri JG, Duran-Sindreu F, Abella F, Roig M, García-Font M. Influence of preoperative pain intensity on postoperative pain after root canal treatment: a prospective clinical study. J Dent. 2016;45:39-42.
35. Mattscheck DJ, Law AS, Noblett WC. Retreatment versus initial root canal treatment: factors affecting posttreatment pain. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;92(3):321-4.
36. Martín-González, J, Echevarría-Pérez M, Sánchez-Domínguez B, Tarilonte-Delgado ML, Castellanos-Cosano L, López-Frías FJ, Segura-Egea JJ. Influence of root canal instrumentation and obturation techniques on intra-operative pain during endodontic therapy. Med Oral Patol Oral Cir Bucal. 2012;17(5):e912-8.
37. Arias A, de la Macorra JC, Hidalgo JJ, Azabal M. Predictive models of pain following root canal treatment: a prospective clinical study. Int Endod J. 2013;46(8):784-93.
38. Carrotte P. Endodontics: Part 4. Morphology of the root canal system. Br Dent J. 2004;197(7):379-83.
39. Yesilsoy C, Koren LZ, Morse DR, Rankow H, Bolanos OR, Furst ML. Post-endodontic obturation pain: a comparative evaluation. Quintessence Int. 1988;19(6):431-8
40. Ng YL, Glennon JP, Setchell DJ, Gulabivala K. Prevalence of and factors affecting post-obturation pain in patients undergoing root canal treatment. Int Endod J. 2004;37(6):381-91.
41. Riaz A, Maxood A, Abdullah S, Saba K, Din SU, Zahid S. Comparison of frequency of post-obturation pain of single versus multiple visit root canal treatment of necrotic teeth with infected root canals. A Randomized Controlled Trial. J Pak Med Assoc. 2018;68(10):1429-33.
42. Wong AW, Zhang S, Li SK, Zhu X, Zhang C, Chu CH. Incidence of post-obturation pain after single-visit versus multiple-visit non-surgical endodontic treatments. BMC Oral Health. 2015;15:96.
43. El Mubarak AH, Abu-bakr NH, Ibrahim YE. Postoperative Pain in Multiple-visit and Single-visit Root Canal Treatment. J Endod. 2010;36(1):36-9.
44. Su Y, Wang C, Ye L. Healing Rate and Post-obturation Pain of Single- versus Multiple-visit Endodontic Treatment for Infected Root Canals: A Systematic Review. J Endod. 2011;37(2):125-32.
45. Erdem Hepsenoglu Y, Eyuboglu TF, Özcan M. Postoperative pain intensity after single- versus 2-visit nonsurgical endodontic retreatment: a randomized clinical trial. J Endod. 2018;44(9):1339-46.

46. Alomaym MAA, Aldohan MFM, Alharbi MJ, Alharbi NA. Single versus multiple sitting endodontic treatment: incidence of postoperative pain – a randomized controlled trial. J Int Soc Prev Community Dent. 2019;9(2):172-7.
47. Yoldas O, Topuz A, Isçi AS, Oztunc H. Postoperative pain after endodontic retreatment: single- versus two-visit treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;98(4):483-7.
48. Eleazer PD, Eleazer KR. Flare-up rate in pulpally necrotic molars in one-visit versus two-visit endodontic treatment. J Endod. 1998;24(9):614-6.
49. García-Font M, Duran-Sindreu F, Calvo C, Basilio J, Abella F, Ali A, Roig M, Olivieri JG. Comparison of postoperative pain after root canal treatment using reciprocating instruments based on operator's experience: A prospective clinical study. J Clin Exp Dent. 2017 Jul 1;9(7):e869-e874.

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