Original Research
Endodontic Therapy

Postoperative pain after root canal filling with different endodontic sealers: a randomized clinical trial

Nadia de Souza FERREIRA[a]
Elisa Korte Fortes GOLLO[b]
Noeli BOSCATO[c]
Ana ARIAS[d]
Emmanuel João Nogueira Leal da SILVA[e]

[a]Universidade Federal de Pelotas – UFPel, School of Dentistry, Department of Semiology and Clinics,Pelotas, RS, Brazil.

[b]Universidade Federal de Pelotas – UFPel, School of Dentistry, Graduate student, Pelotas, RS, Brazil.

[c]Universidade Federal de Pelotas – UFPel, School of Dentistry, Department of Restorative Dentsitry, Pelotas, RS, Brazil.

[d]Universidad Complutense de Madrid – UCM, School of Dentistry, Conservative Dentistry Department, Madrid, Spain.

[e]Universidade do Grande Rio – Unigranrio, School of Dentistry; Endodontics Department; Rio de Janeiro, RJ, Brazil.

Declaration of Interests: The authors certify that they have no commercial or associative interest that represents a conflict of interest in connection with the manuscript.

Corresponding Author:
Nadia de Souza Ferreira
E-mail: na.soufer@hotmail.com

https://doi.org/10.1590/1807-3107bor-2020.vol34.0069

Submitted: December 11, 2019
Accepted for publication: April 20, 2020
Last revision: May 26, 2020

Abstract: The aim of this randomized clinical trial was to compare the occurrence and intensity of postoperative pain and analgesic intake after root canal treatment, using different root canal sealers. Sixty single-rooted teeth diagnosed with asymptomatic necrosis and apical periodontitis were randomly assigned to 3 experimental groups (n=20), according to the root canal sealer: AH Plus, Endofill or MTA Fillapex. Endodontic treatment was performed in two sessions, and calcium hydroxide was used as the intracanal dressing. Patients were instructed to record pain intensity as none, slight, moderate and severe. Scores from 1 to 4 were attributed to each level of pain after 24 h, 48 h and 7 days. The need for analgesic intake was also recorded. Differences in the incidence of postoperative pain and the need for an analgesic were analyzed using the chi-square test. Differences in pain intensity after treatment were analyzed using the ordinal (linear) chi-square test. No significant differences were detected among the groups in terms of either incidence or intensity of postoperative pain, or need for analgesic intake, at any timepoint ($p>0.05$). No pain was reported after 7 days. AH Plus, Endofill and MTA Fillapex used for filling root canals resulted in the same rate of postoperative pain and need for analgesic medication.

Keywords: Pain, Postoperative; Root Canal Obturation; Clinical Study.

Introduction

Endodontic postoperative pain has been defined as an unpleasant sensation of any degree of pain that occurs after initiating root canal treatment.[1] Postoperative pain after endodontic procedures occurs in 3 to 58% of the cases, depending on the individual and variables evaluated.[2] Postoperative pain is commonly related to mechanical, chemical or microbiological injury to periradicular tissues.[3,4,5,6] Knowing the variables related to postoperative pain allows the professional to choose the techniques and materials that will lower this pain incidence.[7]

Root canal systems requiring treatment are traditionally filled with gutta-percha associated to an endodontic sealer.[8] These sealers are designed to be used inside the root canal during endodontic treatment, but may come in close contact with the periapical tissues through lateral

canals, apical foramina or leaching.[8,9] Therefore, it can be expected that root canal sealers may stimulate an inflammatory response and activate sensory neurons.[10,11,12] Consequently, root canal sealers may be related to postoperative pain after root canal treatment. Ruparel et al.[10] suggested that root canal sealers might activate trigeminal nociceptors *in vitro*, and that this activation, along with the immunologic response, may trigger pain symptoms and cause flare-ups.

Previous studies have evaluated postoperative pain after application of different root canal sealers, and have found contrasting results. A study by Ates et al.[13] found no differences when a resin-based (AH Plus; Dentsply-Sirona, Ballaigues, Switzerland) and a calcium silicate-based (iRoot SP; Innovative BioCeramix Inc., Vancouver, Canada) root canal sealer were compared regarding postoperative pain. Similar results were observed by Graunaite et al.[14] when comparing AH Plus and Total Fill BC Sealer (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland). In contrast, Shashirekha et al.[15] found a statistically significant difference when two resin-based root canal sealers: AH Plus (Dentsply, DeTrey, Konstanz, Germany) and ResinoSeal (Amrith Chemicals and Mineral Agency, India) were compared to two calcium-hydroxide root canal sealers: Sealapex (SybronEndo, Orange, USA) and Apexit Plus (Ivoclar Vivadent, Liechtenstein). Thus, the contrasting results found in endodontic literature on this topic, and the limited evidence, prompted us to further explore the relationship between postoperative pain and different endodontic sealers used for filling root canals.

The aim of this randomized, controlled and prospective clinical trial was to compare the occurrence and intensity of postoperative pain and analgesic intake after root canal treatment, using different root canal sealers: AH Plus (Dentsply, DeTrey, Konstanz, Germany), EndoFill (Dentsply, Petrópolis Ind. e Com., Rio de Janeiro, Brazil) and MTA Fillapex (Angelus, Londrina, Brazil). The null hypothesis tested was that there are no differences in the occurrence and intensity of postoperative pain and the analgesic intake using different root canal sealers for the same root canal filling protocol.

Methodology

Study design

This study was a randomized clinical trial comparing three endodontic sealers (AH Plus, EndoFill and MTA Fillapex), and was registered at www.clinicaltrial.gov (ClinicalTrials.gov Identifier: NCT03841877) and reported according to the guidelines of CONSORT clinical trials.[16]

This research project was approved by the local research ethics committee (number 2.516.565) and was performed in compliance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Sample size calculation was based on a previous study.[17] It considered an error of alpha = 0.05 and a power of 0.9, and indicated a required sample size of 18 in each group. Assuming possible loss, 60 patients were included in the study.

Participant selection

Patients referred for endodontic treatment to the Dental School of the Federal University of Pelotas (Brazil) between September 2017 and December 2018 were invited to participate in this study. They were given complete information on the purpose and methods of the study, and those who agreed to participate signed an informed consent form.

Inclusion criteria: patients older than 18 years, referred to undergo endodontic treatment and diagnosed with pulp necrosis in anterior teeth and premolars. Participants who presented more than one indication for endodontic treatment were included more than once in the sample; however, the treatments were not performed at the same time, but rather, at an interval of 14 days between the end of one treatment and the beginning of another.

Exclusion criteria: teeth with previous endodontic treatment or positive response to pulpal sensitivity test, presence of a root fracture, teeth that could not be isolated with a rubber dam, or whose root length could not be reached, and patients who had complications during previous treatments. Patients who were younger than 18 years, or had cognitive difficulties, and who were pregnant, or had uncontrolled systemic diseases, were also excluded.

Randomization and blinding

Stratified randomization was performed according to the different dental groups (anterior or premolars), using a table of computer-generated random numbers (www.randomization.com). Allocation was concealed using opaque envelopes numbered consecutively. The envelopes were opened by an assistant not involved in the research, but only when the endodontic sealer was going to be inserted into the root canal. Patients were randomized for the endodontic sealer used (AH Plus, EndoFill and MTA Fillapex). Table 1 states the endodontic sealers used and their composition. The operator knew which sealer would be used only right before filling the root canal. The patients were blinded to the sealer.

Clinical interventions

The operators were last-year undergraduate students and a graduate student, trained for the procedures and techniques used, and always supervised by the responsible researcher. Diagnosis of pulpal necrosis was determined by negative response to the cold test, and confirmed by absence of bleeding when entering the pulp chamber. After receiving local anesthesia (2% lidocaine with epinephrine 1:100,000 – Nova DFL, Rio de Janeiro, Brazil), an access cavity was made using a spherical high-speed diamond bur. Upon reaching the pulp chamber, a rubber dam was placed, and the operating field was disinfected. Abundant initial irrigation with 5 ml 2.5% NaOCl was performed, followed by exploration of root canals with a size #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland). The root canal length was determined using an apex locator (RomiApex A-15; Romidan Dental Solution, Israel), and root canals were prepared by using Wave-one Gold files (Dentsply Maillefer, Ballaigues, Switzerland), according to the manufacturer's directions. These files were chosen based on the anatomy of the root canal, and were used with a gentle in-and-out pecking motion at 2–3 mm amplitude. The instrument was removed from the root canal after 3 in-and-out movements. These movements were repeated until the working length was reached. The root canals were irrigated with 5 mL 2.5% NaOCl, and apical patency was achieved with a size #10 K-file. After instrumentation, the root canals were flooded with 5 mL17% EDTA for 3 minutes. Next, a final rinse was performed with 5 mL 2.5% NaOCl. An aliquot of approximately 40 ml of NaOCl was used during the treatment. Then the root canals were dried with sterile paper points, filled with a calcium hydroxide-based dressing, and sealed with composite resin.

After 7 days, infiltrative anesthesia and rubber dam isolation were performed, and the intracanal dressing was removed with manual files and irrigation with 5 mL 2.5% NaOCl. Root canals were filled using the single cone and vertical compaction technique with gutta-percha compatible with the root canal preparation system, and the envelopes were opened to allocate the teeth into different groups, according to the endodontic sealer: AH Plus; EndoFill and MTA Fillapex. Endodontic sealers were manipulated according to the manufacturer's recommendations. The teeth were radiographed to test the gutta-percha cone and to determine if the entire canal should be filled. Then, the obturation material was cut with a heated instrument, the pulp chamber was cleaned with

Table 1. Endodontic sealers tested and their compositions.

Endodontic sealer	Composition	Batch number
AH Plus (Dentsply, DeTrey, Konstanz, Germany)	Paste A: Bisphenol-A epoxy resin, Bisphenol-F epoxy resin, calcium tungstate, zirconium oxide, silica and iron oxide pigments.	1609000660
	Paste B: Dibenzyldiamine, aminoadamantane, tricyclodecane diamine, calcium tungstate, zirconium oxide, silica and silicone oil.	1609000660
MTA Fillapex (Angelus, Londrina, Brazil)	Base Paste: Salicylate Resin, Natural Resin, Calcium Tungstate, Nanoparticulated Silica, Pigments;	42500
	Catalyst Paste: Diluting Resin, Mineral Trioxide Aggregate, Nanoparticulated Silica, Pigments.	41897
EndoFill (Dentsply, Petrópolis Ind. e Com., Rio de Janeiro, Brazil)	Powder: Zinc oxide, hydrogenated resin, bismuth subcarbonate, barium sulfate and calcium borate. Liquid: Eugenol, almond oil and *butylated hydroxytoluene*	336206J

alcohol, until the endodontic sealer was completely removed, and a composite resin restoration was made. The rubber dam was removed, and a final radiograph was taken.

No medication was prescribed for the patients; they were instructed to take only ibuprofen (600 mg every 8 hours) in the event of pain sensation.

Postoperative pain evaluation

Postoperative pain intensity was registered 24 h, 48 h and 7 days after obturation. Patients were instructed to record pain intensity as none, slight, moderate and severe. Scores from 1 to 4 (1-none, 2-slight, 3-moderate and 4-severe) were attributed to each level of pain at each timepoint. Patients were contacted by telephone at convenient and prescheduled times.[17,18] Any need for analgesics was recorded.

Statistical analysis

Differences in the incidence of postoperative pain and the need for analgesic medication after 24 h and 48 h among the three groups were analyzed using the chi-square test. Differences in pain intensity among the groups, 24 h and 48 h following treatment were analyzed using the ordinal (linear) chi-square test. No statistical analysis was performed to assess differences in the incidence, intensity or analgesic intake among the groups 7 days after treatment, since no incidence of postoperative pain or analgesic consumption was reported for any of the different groups.

A logistic regression was also used to assess the incidence of postoperative pain 24 h and 48 h after treatment among the groups, and to control other possible confounding factors. Apart from the sealer used for obturation (AHPlus/EndoFill/MTA Fillapex), patient gender, tooth position (anterior or posterior) and arch (maxillary or mandibular) were also included in the analysis to ensure a correct estimation. A stepwise protocol was used to statistically enter and exclude factors from the logistic regression model, to obtain a better global fit.

Results

The study included 60 teeth of 57 patients (30 anterior and 30 premolars), 40 women and 17 men, having a mean age of 41 years (18–80 years) (Figure). Table 2 shows the demographic and clinical features of the patients in the study groups.

Overall, postoperative pain occurred in 11.6% of the cases (7 patients), at different intensities, after 24 h, dropping to 8.3% (5 patients) after 48 h. The results (n) for the incidence and intensity of postoperative pain in each group 24 h and 48 h after treatment are shown in Table 3. No pain was reported after 7 days in any of the groups.

No significant differences were detected among the groups either in incidence or intensity of postoperative pain, or in analgesic intake, at any of the timepoints. Moreover, no significant association of patient- or tooth-related factors composing the regression analysis was found ($p > 0.05$).

Discussion

The aim of this randomized, controlled and prospective clinical trial was to assess the occurrence and intensity of postoperative pain and analgesic intake after endodontic treatment performed with different root canal sealers used for filling root canals: AH Plus, Endofill and MTA Fillapex. The results of the study suggest that the root canal sealers used in the present study had no influence on postoperative pain and analgesic intake during endodontic treatment procedures. Therefore, all three root canal sealers used in the study are predictable concerning short-term follow-up of postoperative pain. Given the present results, the tested null hypothesis was accepted. *In vitro* studies reported differences among the tested root canal sealers regarding cytotoxicity and inflammatory response.[19,20,21,22] In addition, a previously published study demonstrated that root canal sealers can directly activate trigeminal nociceptors, leading to a robust release of calcitonin gene-related peptide, and may therefore lead to pain and neurogenic inflammation.[10] However, these differences and findings did not seem to have a clinical impact, since the different sealers tested did not influence the postoperative pain in the present study. This result corroborates the findings of previously published studies, which also found no difference in postoperative pain when different sealers were used to fill root canals.[13,14]

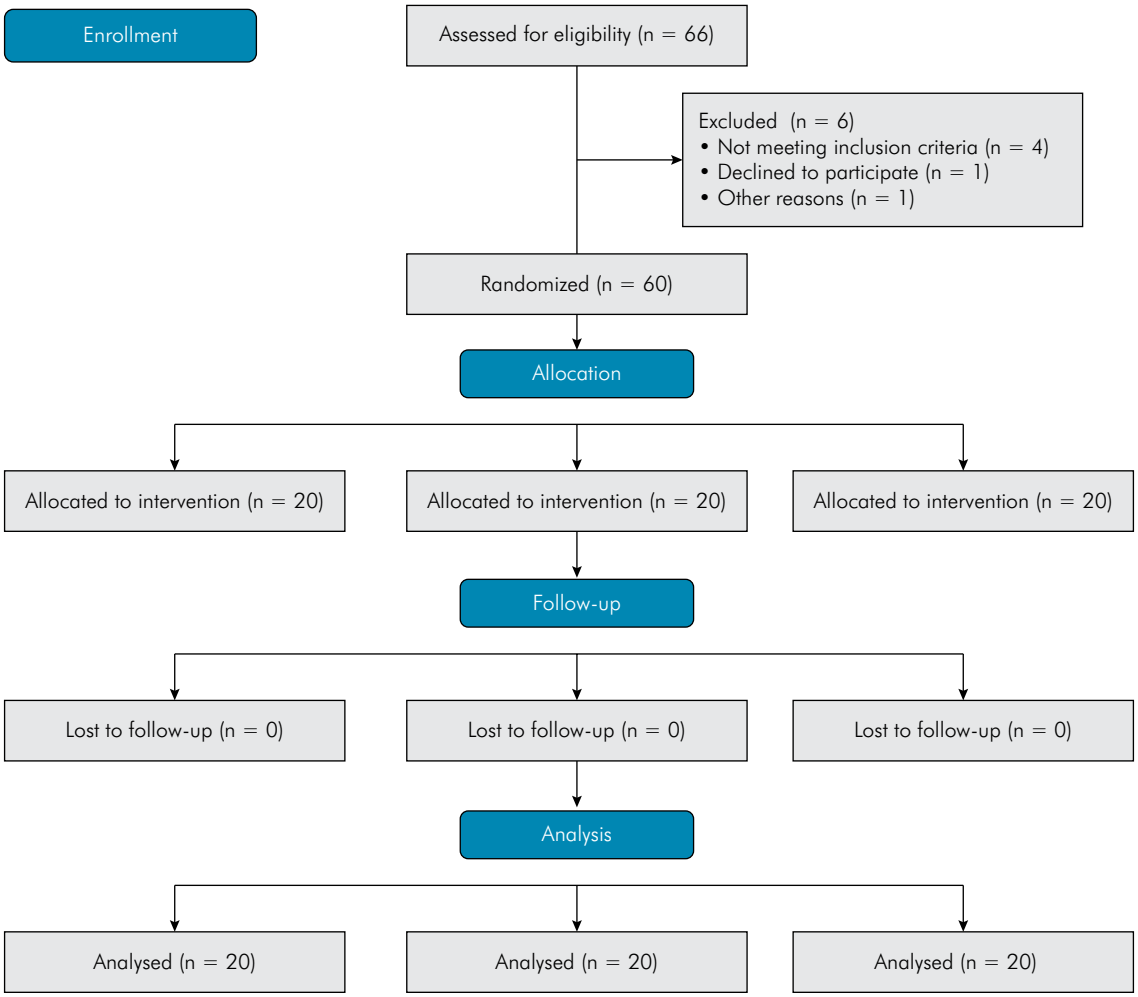

Figure. Flow diagram of the progress of the patients at each stage of the clinical trial, according to CONSORT.

Table 2. Baseline demographic and clinical features of patients in the study groups.

Variable	AH Plus	EndoFill	MTA Fillapex
Gender			
Male	4	8	7
Female	16	12	13
Age (year)			
< 30	1	7	8
30–50	11	8	8
> 50	8	5	4
Teeth			
Anterior	10	10	10
Premolar	10	10	10
Arch			
Upper teeth	14	13	17
Lower teeth	6	7	3

Table 3. Incidence and intensity of postoperative pain in each group 24h and 48h after treatment.

Sealer	24h			48h		
	No pain	Slight	Moderate	No pain	Slight	Moderate
AHPlus	17	2	1	19	1	0
EndoFill	19	0	1	19	1	0
MTA Fillapex	17	2	1	17	2	1

The incidence of postoperative pain was low in this randomized clinical trial (11.6% in 24 h and 8.3% in 48 h). The literature indicates a great variability of postoperative pain results that can range from 3–58%.[2] This great variability can be explained by striking differences observed among the studies in regard to the postoperative evaluation

method, the pulp and the periradicular condition during treatment, as well as the treatment protocol performed. Among the studies evaluating the influence of root canal sealers on postoperative pain, that by Graunaite et al.[14] (2018) conducted a split-mouth randomized clinical trial in patients with asymptomatic apical periodontitis in previously endodontically treated single-rooted teeth, and found that 35% of the patients perceived pain. Ates et al.[13] included vital and non-vital mandibular premolars and molars in a randomized controlled clinical trial, and detected a 68% and 59% prevalence of patients with pain in teeth filled with AH Plus and iRoot, respectively. Shashirekha et al.[15] evaluated pain in apically extruded sealers in vital and non-vital teeth, but did not report the percentage of patients with postoperative pain. Pain is expected after root canal treatment, and includes slight discomfort referred to as sensitivity, caused either by clamp placement or by physical trauma caused by instrumentation and chemical solutions.[1] In the present study, an electronic apex locator was used to determine the apical constriction precisely, and thus avoid overinstrumentation and overfilling. Intentional sealer extrusion was not performed in any of the cases. However, it occurred unintentionally in 2 of them, but these few cases could not have influenced the outcome of postoperative pain.[23,24]

Contrastingly, the root canal filling technique used in this study was different from that used in others, and might have influenced the low incidence of postoperative pain reported in this study. Therefore, it is more likely that post-obturation pain is related to the root canal filling technique rather than the root canal sealer. At the same time, immunological responses that might be linked to postoperative reactions to sealers were minimized, since the presence of systemic diseases was considered an exclusion criteria for ethical purposes.

In the present study, a notable decrease in the incidence of postoperative pain was also observed. Moreover, after 7 days no patient presented pain and no participants scheduled reintervention during the observation period. Both outcomes are commonly observed in most postoperative pain studies.[14,25,26,27]

Postendodontic pain is multifactorial in nature, and is influenced by factors inherent to patients and tooth conditions.[7,28,30] In the present study, molars were not included intentionally, since it is already known that this group of teeth presents a higher incidence of postoperative pain.[7,29,30] In addition, only asymptomatic patients were enrolled in the present study, since preoperative pain is known to be a strong predictor of postoperative pain.[7,23,30] Moreover, stratified randomization was performed so that all groups would present the same number of anterior and premolar teeth, to avoid interference of this factor. Randomization also ensured similar distribution of demographic variables among the root canal sealer groups. This similarity, associated to the adequate sample size, resulted in the high internal and external validity of the present study. Even so, a logistic regression was applied to control any other possible confounding factor caused by the complexity of the pain process.

Some studies have shown that men and women differ in their responses to pain, and point out that women are at a substantially greater risk for many clinical pain conditions, such as tooth pain.[32,33] In terms of postendodontic pain, data are controversial; whereas some studies have reported a higher incidence and longer duration of postoperative pain in women,[7,23] others[31] have found that the duration of the pain was significantly longer for males than for females. In the present study, no significant association of patient-related factors was found with postoperative pain, including gender, as also observed by Ates et al.[13]

One of the main concerns about studying pain is the subjectivity of the evaluation. Each person's pain threshold is unique, and heavily dependent on his cultural, individual, and economic background. Several endodontic postoperative pain studies have used the Visual Analogue Scale (VAS) as an instrument to evaluate pain;[13,14,15,24,25,34,35] however, in the present study the occurrence and intensity of postoperative pain was measured using a simple descriptive scale. It is noteworthy to mention that both VAS and the method used herein are comparable, as evaluated earlier[18]. In addition,

the scale used herein was very responsive, and averted patient loss to follow-up, probably because it allowed patients to be contacted by phone, an advantage recognized by this study and others found in the literature.[17,31]

Conclusion

Root canal filling using AH Plus, MTA Fillapex and Endofill resulted in the same postoperative pain occurrence and intensity, and need for analgesic intake.

References

1. Silva EJ, Menaged K, Ajuz N, Monteiro MR, Coutinho-Filho TS. Postoperative pain after foraminal enlargement in anterior teeth with necrosis and apical periodontitis: a prospective and randomized clinical trial. J Endod. 2013 Feb;39(2):173-6. https://doi.org/10.1016/j.joen.2012.11.013
2. Sathorn C, Parashos P, Messer H. The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: a systematic review. Int Endod J. 2008 Feb;41(2):91-9.
3. Siqueira Junior JF. Microbial causes of endodontic flare-ups. Int Endod J. 2003 Jul;36(7):453-63. https://doi.org/10.1046/j.1365-2591.2003.00671.x
4. Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. 1985. J Endod. 2004 Jul;30(7):476-81. https://doi.org/10.1097/00004770-200407000-00005
5. Gondim E Jr, Setzer FC, Dos Carmo CB, Kim S. Postoperative pain after the application of two different irrigation devices in a prospective randomized clinical trial. J Endod. 2010 Aug;36(8):1295-301. https://doi.org/10.1016/j.joen.2010.04.012
6. Arslan H, Güven Y, Karataş E, Doğanay E. Effect of the simultaneous working length control during root canal preparation on postoperative pain. J Endod. 2017 Sep;43(9):1422-7. https://doi.org/10.1016/j.joen.2017.04.028
7. Arias A, Macorra JC, Hidalgo JJ, Azabal M. Predictive models of pain following root canal treatment: a prospective clinical study. Int Endod J. 2013 Aug;46(8):784-93. https://doi.org/10.1111/iej.12059
8. Ricucci D, Langeland K. Apical limit of root canal instrumentation and obturation, part 2. A histological study. Int Endod J. 1998 Nov;31(6):394-409. https://doi.org/10.1046/j.1365-2591.1998.00183.x
9. Ricucci D, Rôças IN, Alves FR, Loghin S, Siqueira Junior JF. Apically Extruded Sealers: Fate and Influence on Treatment Outcome. J Endod. 2016 Feb;42(2):243-9. https://doi.org/10.1016/j.joen.2015.11.020
10. Ruparel NB, Ruparel SB, Chen PB, Ishikawa B, Diogenes A. Direct effect of endodontic sealers on trigeminal neuronal activity. J Endod. 2014 May;40(5):683-7. https://doi.org/10.1016/j.joen.2014.01.030
11. Gomes-Filho JE, Watanabe S, Cintra LT, Nery MJ, Dezan-Júnior E, Queiroz IO, et al. Effect of MTA-based sealer on the healing of periapical lesions. J Appl Oral Sci. 2013;21(3):235-42. https://doi.org/10.1590/1679-775720130089
12. Er K, Ayar A, Kalkan OF, Canpolat S, Tasdemir T, Ozan U. Neurotoxicity evaluation of three root canal sealers on cultured rat trigeminal ganglion neurons. J Clin Exp Dent. 2017 Jan;9(1):e34-9.
13. Ates AA, Dumani A, Yoldas O, Unal I. Post-obturation pain following the use of carrier-based system with AH Plus or iRoot SP sealers: a randomized controlled clinical trial. Clin Oral Investig. 2019 Jul;23(7):3053-61. https://doi.org/10.1007/s00784-018-2721-6
14. Graunaite I, Skucaite N, Lodiene G, Agentiene I, Machiulskiene V. Effect of resin-based and bioceramic root canal sealers on postoperative pain: a split-mouth randomized controlled trial. J Endod. 2018 May;44(5):689-93. https://doi.org/10.1016/j.joen.2018.02.010
15. Shashirekha G, Jena A, Pattanaik S, Rath J. Assessment of pain and dissolution of apically extruded sealers and their effect on the periradicular tissues. J Conserv Dent. 2018 Sep-Oct;21(5):546-50. https://doi.org/10.4103/JCD.JCD_224_18
16. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. PLoS Med. 2010 Mar;7(3):e1000251. https://doi.org/10.1371/journal.pmed.1000251
17. Nekoofar MH, Sheykhrezae MS, Meraji N, Jamee A, Shirvani A, Jamee J, 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 May;41(5):575-8. https://doi.org/10.1016/j.joen.2014.12.026
18. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. Pain. 2011 Oct;152(10):2399-404. https://doi.org/10.1016/j.pain.2011.07.005
19. Scarparo RK, Grecca FS, Fachin EV. Analysis of tissue reactions to methacrylate resin-based, epoxy resin-based, and zinc oxide-eugenol endodontic sealers. J Endod. 2009 Feb;35(2):229-32. https://doi.org/10.1016/j.joen.2008.10.025

20. Silva EJ, Accorsi-Mendonça T, Pedrosa AC, Granjeiro JM, Zaia AA. Long-term cytotoxicity, pH and dissolution rate of AH Plus and MTA Fillapex. Braz Dent J. 2016 Jul-Aug;27(4):419-23. https://doi.org/10.1590/0103-6440201600735
21. Silva EJ, Rosa TP, Herrera DR, Jacinto RC, Gomes BP, Zaia AA. Evaluation of cytotoxicity and physicochemical properties of calcium silicate-based endodontic sealer MTA Fillapex. J Endod. 2013 Feb;39(2):274-7. https://doi.org/10.1016/j.joen.2012.06.030
22. Cintra LT, Benetti F, Queiroz IOA, Ferreira LL, Massunari L, Bueno CR, et al. Evaluation of the cytotoxicity and biocompatibility of new resin epoxy-based endodontic sealer containing calcium hydroxide. J Endod. 2017 Dec;43(12):2088-92. https://doi.org/10.1016/j.joen.2017.07.016
23. Sadaf D, Ahmad MZ. Factors associated with postoperative pain in endodontic therapy. Int J Biomed Sci. 2014 Dec;10(4):243-7.
24. Fonseca B, Coelho MS, Bueno CE, Fontana CE, Martin AS, Rocha DG. Assessment of extrusion and postoperative pain of a bioceramic and resin-based root canal sealer. Eur J Dent. 2019 Jul;13(3):343-8. https://doi.org/10.1055/s-0039-3399457
25. Arora M, Sangwan P, Tewari S, Duhan J. Effect of maintaining apical patency on endodontic pain in posterior teeth with pulp necrosis and apical periodontitis: a randomized controlled trial. Int Endod J. 2016 Apr;49(4):317-24. https://doi.org/10.1111/iej.12457
26. Cruz Junior JA, Coelho MS, Kato AS, Vivacqua-Gomes N, Fontana CE, Rocha DG, et al. The effect of foraminal enlargement of necrotic teeth with the reciproc system on postoperative pain: a prospective and randomized clinical trial. J Endod. 2016 Jan;42(1):8-11. https://doi.org/10.1016/j.joen.2015.09.018
27. Yaylali IE, Teke A, Tunca YM. The effect of foraminal enlargement of necrotic teeth with a continuous rotary system on postoperative pain: a randomized controlled trial. J Endod. 2017 Mar;43(3):359-63. https://doi.org/10.1016/j.joen.2016.11.009
28. Gomes MS, Böttcher DE, Scarparo RK, Morgental RD, Waltrick SB, Ghisi AC, et al. Predicting pre- and postoperative pain of endodontic origin in a southern Brazilian subpopulation: an electronic database study. Int Endod J. 2017 Aug;50(8):729-39. https://doi.org/10.1111/iej.12684
29. Nagendrababu V, Gutmann JL. Factors associated with postobturation pain following single-visit nonsurgical root canal treatment: a systematic review. Quintessence Int. 2017;48(3):193-208. https://doi.org/10.3290/j.qi.a36894
30. 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 Feb;45:39-42. https://doi.org/10.1016/j.jdent.2015.12.002
31. Comparin D, Moreira EJ, Souza EM, De-Deus G, Arias A, Silva EJ. Postoperative pain after endodontic retreatment using rotary or reciprocating instruments: a randomized clinical trial. J Endod. 2017 Jul;43(7):1084-8. https://doi.org/10.1016/j.joen.2017.02.010
32. Pieretti S, Di Giannuario A, Di Giovannandrea R, Marzoli F, Piccaro G, Minosi P, et al. Gender differences in pain and its relief. Ann Ist Super Sanita. 2016 Apr-Jun;52(2):184-9. https://doi.org/10.4415/ANN_16_02_09
33. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Williams B, Riley JL 3rd. Sex, gender, and pain: a review of recent clinical and experimental findings. J Pain. 2009 May;10(5):447-85. https://doi.org/10.1016/j.jpain.2008.12.001
34. 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 Jan;21(1):413-8. https://doi.org/10.1007/s00784-016-1807-2
35. Saini HR, Sangwan P, Sangwan A. Pain following foraminal enlargement in mandibular molars with necrosis and apical periodontitis: a randomized controlled trial. Int Endod J. 2016 Dec;49(12):1116-23. https://doi.org/10.1111/iej.12583