Postoperative Pain Intensity after Single- versus Two-visit Nonsurgical Endodontic Retreatment: A Randomized Clinical Trial

Yelda Erdem Hepsenoglu, PhD, Tan F. Eyuboglu, PhD,* and Mutlu Özcan, PhD†*

Abstract

Introduction: The aim of this study was to evaluate postoperative pain after single-visit and 2-visit non-surgical endodontic retreatments with 2 different intracanal medicaments. **Methods:** A total of 150 patients with asymptomatic root canal–treated teeth in need of nonsurgical endodontic retreatment were randomly divided into 3 groups (n = 50). Patients were selected randomly from among those without preoperative pain. Patients in group 1 (single visit) were treated in a single visit. Patients in group 2 and group 3 were treated in different visits with calcium hydroxide and chlorhexidine (CHX) as intracanal medicaments. The presence of postoperative pain was assessed 1, 2, 3, and 7 days and 1 month after treatment. All 2-visit treatments were completed 1 week after the initial visit. Data were analyzed using the Mann-Whitney U, Kruskal-Wallis, and Pearson chi-square tests ($\alpha = 0.01, 0.05$). **Results:** Postoperative pain was significantly higher in the CHX group in comparison with the single-visit group ($P \leq .05$) on the first day of assessment. On the second day, postoperative pain was significantly less in the single-visit group ($P < .05$) than in the other 2 groups. There were no significant differences among the groups on the third and seventh days of assessment. At the 1-month assessment, postoperative pain was significantly higher in both the calcium hydroxide group ($P < .05$) and the CHX group ($P < .05$) in comparison with the single-visit group. **Conclusions:** Single-visit nonsurgical endodontic retreatment presented fewer incidences of postoperative pain in comparison with 2-visit nonsurgical endodontic retreatment based on assessments ranging from 1 day to 1 month. *(J Endod 2018;44:1339–1346)*

Key Words

Intracanal medicament, multiple-visit root canal treatment, postoperative pain, retreatment, single-visit root canal treatment

Significance

The present study helps to better understand the effects of single-visit and multiple-visit retreatment methods on postoperative pain.

Root canal treatment (RCT) is a dental procedure that consists of the removal of infectious tissue followed by cleaning and shaping of the remaining tooth structure based on the original root canal. With novel techniques and materials, RCT can be completed safely in a single visit instead of multiple visits. Retreatment is a type of procedure that is applied when previous RCTs have failed. Postoperative pain after endodontic retreatment is an undesirable occurrence for patients and clinicians (1).

Postoperative pain is the result of acute inflammation in the periradicular tissue caused by the penetration of microorganisms from the root canal during endodontic retreatment (2). Postoperative pain is associated with the number of visits as well as preoperative factors, preoperative complications, the periapical index (PAI) score, the size of the radiolucency, the quality of the coronary restoration, intraoperative factors, the intracanal medications, tooth localization, inadequate instrumentation, extrusion of intracanal medicament, age, sex, periapical pathosis, and apical debris extrusion and irrigant extrusion (3, 4).

Calcium hydroxide ($Ca[OH]_2$) has been recommended as a very effective intracanal medicament to control infection. It reduced the incidence of interappointment symptoms more effectively than traditional medications, such as camphorated paramonochlorophenol iodine, potassium iodide, and formocresol. The exact mechanism of action of $Ca(OH)_2$ is not clearly understood. Most of its favorable properties have been correlated with its high alkalinity (5, 6). However, $Ca(OH)_2$ is not effective against all microorganisms found in the root canal system (7). It has been reported that *Enterococcus faecalis* shows a resistance to elevated pH; it has the ability to penetrate dentinal tubules and to adapt to different environmental conditions (8). Therefore, different intracanal medicaments have been used inside the root canal to overcome the disadvantages of $Ca(OH)_2$.

Chlorhexidine (CHX) is another commonly used intracanal material in endodontic therapy that has significant antibacterial effects on intracanal microorganisms (9). The gel form of CHX was introduced as a root canal medicament because of its wide ranging antimicrobial activity and low toxicity, which makes it an ideal medicament for endodontic purposes (2).

Over the past several years, there has been a growing concern about the urgency of multiple appointments in endodontic treatments because no significant differences in antimicrobial efficacies have been reported between single-visit and multiple-visit

From the *Department of Endodontics, School of Dentistry, Istanbul Medipol University, Istanbul, Turkey; and †Dental Materials Unit, Center for Dental and Oral Medicine, Clinic for Fixed and Removable Prosthodontics and Dental Materials Science, University of Zürich, Zürich, Switzerland.

Address requests for reprints to Dr Yelda Erdem Hepsenoglu, Istanbul Medipol Üniversity, Unkapanı, Atatürk Bulvarı, No: 27 Fatih, 34083 İstanbul, Turkey. E-mail address: yeldaerdem1@gmail.com

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treatments (9). The recent novelty of rotary nickel-titanium systems and developments in the understanding of irrigation dynamics have simplified the mechanical instrumentation and disinfection of the root canal, which makes a single-appointment treatment a more practical and acceptable treatment regimen than multiple appointments.

Single-visit RCT has been recommended for use in cases with purulent inflammation, traumatic pulpal exposure, or necrotic pulp with a present sinus tract (10). Single-visit RCT is more advantageous than multiple-visit RCT in terms of time and cost. Thus, it is a treatment plan that is more amenable to the needs of busy patients (11, 12).

In addition, RCT performed over the course of multiple visits has negative clinical consequences, such as the inability of the intracanal medicament to come into contact with the residual microorganisms within the dentinal tubules, isthmus, or lateral canals because of the complicated anatomic structure of the root canal or the ineffectiveness of the medicament to fight these microorganisms even if the medicament comes into contact with them (6). Moreover, dentin resistance is reduced in multiple-visit RCT because of the fragile state of the crown with a temporary filling and the caustic effect of some intracanal medicaments, such as $Ca(OH)_2$. This can result in a high risk of fractures during or after the treatment procedure (13).

Therefore, the present study aimed to compare the incidence of postoperative pain for single-visit and multiple-visit primary nonsurgical endodontic retreatments with 2 different intracanal medicaments, $Ca(OH)_2$ and CHX, in asymptomatic teeth. The hypothesis is that the intensity of postoperative pain is lower in single-visit retreatments than in multiple-visit retreatments.

A number of confounding factors were evaluated, including sex, age, number of visits, dental arch (upper or lower), tooth position (anterior or posterior), PAI score, preoperative periapical radiolucency, preoperative coroner restoration quality, preoperative root canal filling density and length, and sealer and gutta-percha extrusion, with different intracanal medicaments in asymptomatic teeth.

Materials and Methods

This clinical study was approved (10840098-604.01.01-E.14947) by the Research Ethics Committee at the Medipol University of Science and Technology, Istanbul, Turkey. The study population was selected from those patients requiring conventional endodontic retreatment who presented at the Medipol University Endodontics Clinic from January 21, 2015, through November 11, 2015. All the patients read and signed forms giving their consent to participate before they were included in the study.

A patient was excluded from the study if 1 or more of the following conditions were observed: complicating systemic disease, severe pain and/or acute apical abscess, under 18 years of age, antibiotic or corticosteroid use, and multiple teeth that required pretreatment to eliminate the possibility of pain referral. In total, this study included 150 teeth from 150 patients between the ages of 18 and 75 years. The patients were consecutively distributed into 3 different groups as follows:

1. Group 1: single-visit retreatment ($n = 50$)
2. Group 2: multiple-visit retreatment with the interappointment application of $Ca(OH)_2$ ($n = 50$)
3. Group 3: multiple-visit retreatment with the interappointment application of CHX gel ($n = 50$)

Radiographic Evaluation

The diagnoses of the relevant teeth were made using panoramic radiographs (Kodak 9000; Carestream Health, Inc, Rochester, NY) and periapical radiographs (Kodak RVG 5100, Carestream Health, Inc) with a paralleling technique, an exposure time of 0.16 seconds, and an exposure dose of 1.22 mGy. A periapical radiograph of the relevant tooth was taken immediately after the retreatment using a paralleling technique with the same digital radiograph. The postoperative and control film data were recorded in the database.

PAI

The PAI is a basic radiographic method of interpretation consisting of a scale from 1 to 5. It was first described by Ørstavik et al in 1986 (14). For each subject, the periapical tissue was assessed radiographically using the PAI as follows:

1. PAI 1: normal periapical structure
2. PAI 2: small changes in the bone structure not pathognomonic of apical periodontitis
3. PAI 3: changes in the bone structure with mineral loss characteristic of apical periodontitis
4. PAI 4: well-defined apical radiolucency characteristic of apical periodontitis
5. PAI 5: severe periodontitis with exacerbating features and bone expansion

The quality of the existing root canal fillings and the status of the periapical tissues were determined according to the PAI by 1 author using the periapical radiographs. The measurements were taken using the paralleling technique. The PAI scores were dichotomized to reflect the absence (PAI ≤ 2) or presence (PAI >2) of apical periodontitis (15). Those teeth with multiple root canals were scored based on the root canal with the highest PAI score.

Retreatment

Endodontic retreatment was conducted according to the contemporary standards of endodontic therapy. Each patient was anesthetized with 40 mg articaine hydrochloride + 0.006 mg/mL epinephrine hydrochloride (Ultracaine DS Forte; Aventis Pharma, Istanbul, Turkey). All the patients were anesthetized to provide maximum comfort. The standard procedure for each group at the first appointment included rubber dam isolation and the removal of the previous coronal restorations and root canal filling materials. We achieved patency in all the canals. After gaining access to the previously obturated root canals, #1, #2, and #3 Gates Glidden burs (Mani Inc, Tochigi, Japan) were used on the coronal two thirds of the canal, whereas a #15 Kerr file (Dentsply Maillefer, Ballaigues, Switzerland) was used to gain access to the apical third of the root canal. During the removal of the root canal filling material, a copious amount of a 2.5% sodium hypochlorite (NaOCl) solution was used as irrigation. No chemical solvents were used to remove the gutta-percha or the sealer. Apical patency was achieved in all root canals before cleaning and shaping, which were performed by using a crown-down technique using hand files and nickel-titanium rotary instruments (Revo-S; Micro-Mega, Besançon, France). After measuring the root lengths with an apex locater (Apex Pointer, Micro-Mega), each tooth was prepared up to an AS 40 file 0.5 mm short of the apex. Irrigation was performed with 2.5% NaOCl (Wizard; Rehber Chemistry, Istanbul, Turkey) after the use of each instrument in all cases. At the end of instrumentation, the final irrigation was performed using 2.5 mL 5% EDTA (Wizard, Rehber Chemistry), 2.5 mL 2.5% NaOCl, and 5 mL distilled water, respectively, and the root canals were dried with paper points.

In the $Ca(OH)_2$ group, after removing the excess irrigant with paper points, $Ca(OH)_2$ (Vision Calcium Hydroxide; USP, Darmstadt, Germany) medication was introduced into the root canal using a Lentulo spiral as the 7-day interappointment medication. In the third group, the root canals were medicated with a 2% CHX gel (GLUCO-CHeX 2%

gel; PPH Cerkamed, Stalowa Wola, Poland) for 7 days. The teeth in this group were closed with a sterile dry cotton pellet and a minimum of 3 mm temporary restorative material (Cavit; ESPE Dental, Seefeld, Germany). When the patient came in for the second visit after 7 days, the medicaments in the root canal walls were removed mechanochemically. At the end of instrumentation, the final irrigation was performed using 2.5 mL 5% EDTA, 2.5 mL 2.5% NaOCl, and 5 mL distilled water, respectively. All the root canals were dried with paper points (SU 40, Revo-S, Micro-Mega) before the root canal filling procedure. The root canal filling paste (AH Plus; Dentsply DeTrey, Konstanz, Germany) was introduced into the root canal with master cones using a brushing motion. Accessory gutta-percha cones (SU 40, Revo-S, Micro-Mega) were used, when needed, via a noncompaction technique.

A total-etch technique (Single Bond 2; 3M ESPE, St Paul, MN) was used according to the manufacturer's instructions for the coronal restorations. A flowable resin composite (Filtek Ultimate, 3M ESPE) was introduced into the pulp chamber as a base material in order to seal the root canal orifices before incrementally building up the permanent restoration with composite filling material (Filtek, 3M ESPE). If needed, the tooth was treated using a fiber post (Cytec Blanco HT-Glasfiber; E Hahnenkratt GmbH, Königsbach-Stein, Germany), luting agent, and composite core (RelyX U200 self-adhesive resin cement; 3M Deutschland GmbH, Neuss, Germany) before the prosthetic restoration. Periapical x-rays were taken before and immediately after the retreatment.

Postoperative Pain Analysis

At the beginning of the second appointment, each patient was asked about the presence or absence of pain between visits as well as its intensity. The postoperative pain was recorded using a verbal rating scale (VRS) with well-defined categories at the 5 time intervals after obturation: 1, 2, 3, 7, and 30 days. The postoperative pain assessment was defined as no pain, mild pain, moderate pain, and severe pain or flare-up, suggesting the acute exacerbation of an asymptomatic pulpal and/or periradicular pathological condition occurring after root canal treatment (16). With regard to the level of discomfort, each patient was asked to categorize their pain according to the following criteria:

1. No pain: the treated tooth felt normal.
2. Mild pain: the tooth involved was slightly painful for a time, regardless of the duration, but there was no need to take analgesics.
3. Moderate pain: the tooth involved caused discomfort and/or pain, which was either tolerable or was rendered tolerable by analgesics.
4. Severe pain: the pain caused by the treated tooth disturbed normal activity or sleep, and analgesics had little or no effect.

For the purposes of this study, a specific questionnaire was designed, including the patient's name, sex, age, preoperative complications (file separations and perforations), tooth type, preoperative PAI score, size of the periapical radiolucency, and quality of the coronary restoration. It also included intraoperative factors, such as the apical extrusion of the sealing material and gutta-percha. The patients were informed about the possible occurrence of pain after the procedure, and analgesics were suggested for mild to moderate pain. In cases of severe pain that did not respond to analgesics or swelling, the patients were advised to immediately report back to the clinic. The postoperative pain scores were recording using a VRS. Each patient was recalled and asked about the occurrence of postoperative pain 1, 2, 3, 7, and 30 days after the initial appointment.

Statistical Analysis

The 2007 Number Cruncher Statistical System (NCSS Statistical Software, Kaysville, UT) was used for statistical analysis. During the evaluation of the study data, regarding the quantitative data comparisons and descriptive statistical methods (mean, standard deviation, median, frequency, and ratio), the Kruskal-Wallis test was used for the intergroup comparisons of the parameters without normal distributions. The Mann-Whitney *U* test was used in determining the group causing the difference and in the evaluation of 2 groups. The Yates correction for continuity test, chi-square test, Fisher exact test, Fisher-Freeman-Halton test, and Pearson chi-square test were used to compare the qualitative data. The results were evaluated using 95% confidence intervals, and the level of significance was $P < .05$.

Results

The results obtained from the study are summarized in Tables 1–3. A total of 150 teeth of 150 patients who were diagnosed and scheduled for nonsurgical retreatment were divided into 3 different treatment groups ($n = 50$). Several different factors were taken into consideration while evaluating postoperative pain throughout the groups (Table 1).

With regard to age, the pain incidence was higher in women ≤45 years old than in those >45 years old at 30 days ($P < .05$) (Table 2). On the first day of observation, postoperative pain was significantly higher in females than males ($P < .05$) (Table 2). Moreover, the postoperative pain results were significantly higher on the first day of measurement in teeth with preoperative pain than in teeth with no preoperative pain ($P < .05$). With regard to the tooth type and pain incidence, there were no significant differences among the 5 groups ($P > .05$). Additionally, there was no correlation between the PAI score (PAI ≤2 indicated no signs or symptoms or presence of apical periodontitis and PAI >2 indicated signs or symptoms) and postoperative pain in the study ($P > .05$).

Periapical lesions with diameters larger than 2 mm showed significantly higher postoperative pain than lesions smaller than 2 mm ($P < .05$). On the first day, with regard to the root filling length, the incidence of pain was higher in the short root filling teeth than in the adequate root filling and over teeth ($P < .05$) (Table 2). The root filling material density and gutta-percha extrusion exhibited no significant effects on postoperative pain ($P > .05$). On the third day, with regard to the quality of the coronal restoration, postoperative pain incidence was higher in the teeth with marginal defects in the coronal restorations ($P = .007$) (Table 2). When considering sealer extrusion, postoperative pain incidence was high on the second day ($P < .05$) (Table 2).

In the single-visit group, 28 (56%) patients reported no pain after 24 hours, 9 (18%) experienced mild pain, and 13 (26%) reported moderate pain, but none of the patients reported severe pain. After 48 hours, 35 (70%) patients reported no pain, 8 (16%) reported mild pain, and 7 (14%) reported moderate pain, but none of them reported severe pain. After 72 hours, 40 (80%) patients reported no pain, 6 (12%) reported mild pain, and 4 (8%) reported moderate pain, but none reported severe pain. Seven days after the retreatment, 45 (90%) individuals reported no pain, 3 (6%) reported mild pain, and 2 (4%) reported moderate pain. Thirty days after the retreatment, 49 (98%) patients reported no pain, and only 1 (2%) reported mild pain (Table 3).

In the two-visit CHX group after 24 hours, 15 (30%) patients reported no pain, 16 (32%) reported mild pain, 13 (26%) reported moderate pain, and 6 (12%) reported severe pain. After 48 hours, 22 (44%) patients reported no pain, 17 (34%) reported mild pain, 6 (12%) reported moderate pain, and 5 (10%) reported severe pain. After 72 hours, 29 (58%) patients reported no pain, 11 (22%) reported mild pain, 7 (14%) reported moderate pain, and 3 (6%) reported

TABLE 1. The Distribution of Prognostic Factors, Inception Cohort, Study Sample, and *P* Values (Univariate Analysis)

Preoperative factors	Groups: Single visit, *n* (%)	Groups: Multiple-visit CHX, *n* (%)	Groups: Multiple-visit $Ca(OH)_2$, *n* (%)	*P* value (3 group)	*P* value (single-visit CHX)	*P* value (single-visit $Ca[OH]_2$)	*P* value (CHX $Ca[OH]_2$)
Age							
≤45 y	20 (40.0)	25 (50.0)	32 (64.0)	.055*	.421†	.028†,‡	.226†
>45 y	30 (60.0)	25 (50.0)	18 (36.0)				
Sex							
Female	25 (50.0)	26 (52.0)	24 (48.0)	.923*	1.000†	1.000†	.841†
Male	25 (50.0)	24 (48.0)	26 (52.0)				
Preoperative complications							
Present	6 (12.0)	7 (14.0)	9 (18.0)	.689*	1.000†	.575†	.785†
Absent	44 (88.0)	43 (86.0)	41 (82.0)				
Tooth							
Maxillary anterior	9 (18.0)	9 (18.0)	4 (8.0)				
Mandibular anterior	8 (16.0)	5 (10.0)	3 (6.0)				
Maxillary premolar	13 (26.0)	10 (20.0)	13 (26.0)				
Mandibular premolar	7 (14.0)	5 (10.0)	7 (14.0)	.329*	.278*	.177*	.499§
Maxillary molar	7 (14.0)	5 (10.0)	9 (18.0)				
Mandibular molar	6 (12.0)	16 (32.0)	14 (28.0)				
Preoperative PAI score							
1	5 (10.0)	7 (14.0)	6 (12.0)	.156*	.253*	.188*	.151*
2	19 (38.0)	12 (24.0)	14 (28.0)				
3	13 (26.0)	11 (22.0)	20 (40.0)				
4	9 (18.0)	9 (18.0)	3 (6.0)				
5	4 (8.0)	11 (22.0)	7 (14.0)				
Radioluceny							
<2 mm	25 (50.0)	24 (48.0)	19 (38.0)	.434*	.841*	.227*	.313*
≥2 mm	25 (50.0)	26 (52.0)	31 (62.0)				
Root filling density							
Good	3 (6.0)	4 (8.0)	6 (12.0)				
Poor	39 (78.0)	41 (82.0)	36 (72.0)	.722‡	.738‡	.693§	.492*
Unfilled canal	8 (16.0)	5 (10.0)	8 (16.0)				
Length of root filling							
Adequate (0–2 mm)	3 (6.0)	5 (10.0)	9 (18.0)				
Short (>2)	46 (92.0)	45 (90.0)	40 (80.0)	.230‡	.726‡	.121§	.264‡
Extensive overfill	1 (2.0)	0 (0)	1 (2.0)				
Quality of coronal restoration							
Adequate	8 (16.0)	10 (20.0)	11 (22.0)	.741*	.795†	.610†	1.000†
Marginal deficiency	42 (84.0)	40 (80.0)	39 (78.0)				
Sealer extrusion							
Yes	14 (28.0)	9 (18.0)	11 (22.0)				
No	36 (72.0)	41 (82.0)	39 (78.0)				
Gutta-percha extrusion							
Yes	10 (20.0)	8 (16.0)	9 (18.0)	.873*	.795†	1.000†	1.000†
No	40 (80.0)	42 (84.0)	41 (82.0)				

$Ca(OH)_2$, calcium hydroxide; CHX, chlorhexidine; PAI, periapical index.

*Pearson chi-square test.

†Yates Continuity Correction test.

‡$P < .05$.

§Fisher-Freeman-Halton test.

severe pain. Seven days after the retreatment, 41 (82%) individuals reported no pain, 6 (12%) reported mild pain, and 3 (6%) reported moderate pain, but none reported severe pain. Thirty days after the retreatment, 41 (82%) patients reported no pain, 6 (12%) reported mild pain, and 2 (4%) reported severe pain (Table 3).

In the two-visit $Ca(OH)_2$ group after 24 hours, 20 (40%) patients reported no pain, 18 (36%) reported mild pain, 8 (16%) reported moderate pain, and 5 (10%) reported severe pain. After 48 hours, 21 (42%) patients reported no pain, 15 (30%) reported mild pain, 6 (12%) reported moderate pain, and 5 (10%) reported severe pain. After 72 hours, 33 (66%) patients reported no pain, 11 (22%) reported mild pain, 5 (10%) reported moderate pain, and 1 (2%) reported severe pain. Seven days after the retreatment, 45 (90%) individuals reported no pain, 1 (2%) reported mild pain, 3 (6%) reported moderate pain, and 1 (2%) reported severe pain. Thirty days after the retreatment, 37 (74%) patients reported no pain, 11 (22%) reported mild pain, and 2 (4%) reported moderate pain, but none reported severe pain (Table 3).

On the third and seventh days, no specific differences between the pain categories (none, mild, moderate, or severe) were identified ($P > .05$). When the incidence of pain was compared between the single- and multiple-visit groups (Table 4), it was found that the single-visit group experienced significantly less pain than the multiple-visit group on days 1, 2, and 30 ($P < .05$). Overall, there were no statistically significant differences between the 2 medications with regard to the incidence of postoperative pain in any of the comparisons (Table 3).

When considered together, on the first day, the results of the 150 cases revealed that 63 (42%) teeth exhibited no postoperative pain. On the second day, 78 (52%) teeth exhibited no postoperative pain. On the third day, 102 (68%) teeth exhibited no postoperative pain. On the seventh day, 131 (87%) teeth exhibited no postoperative pain, and on the

TABLE 2. The Effect of Preoperative and Intraoperative Factors on Postoperative Pain

	1-day pain *P* value	2-day pain *P* value	3-day pain *P* value	7-day pain *P* value	30-day pain *P* value
Age					
≤45 y	.439	.241	.188	.888	**.038***
>45 y					
Sex					
Female	**.013***	.251	.863	.198	.818
Male					
Preoperative complications					
Present	.039*	1.000	.220	.279	1.000
Absent					
Tooth					
Maxillary anterior	.906	.343	.947	.399	.382
Mandibular anterior					
Maxillary premolar					
Mandibular premolar					
Maxillary molar					
Mandibular molar					
Preoperative PAI score					
≤2	.395	.098	.620	.654	.911
>2					
Radiolucency					
<2 mm	.507	**.039***	.280	.503	.634
≥ 2 mm					
Root filling density					
Good	.316	.514	.286	.657	.846
Poor					
Unfilled canal					
Length of root filling					
Adequate (0–2)	**.026***	.133	.057	1.000	.614
Short (>2)					
Extensive overfill					
Intraoperative quality of coronal restoration					
Adequate	1.000	.129	**.007**†	.325	.141
Marginal deficiency					
Intraoperative quality of root canal filling					
Dense and tapered	.692	.917	.903	.583	.544
Voids present					
Poorly condensed					
Intraoperative sealer extrusion					
Present	.091	**.036***	.157	.764	.784
Absent					
Intraoperative gutta-percha extrusion					
Present	.884	.271	.936	.539	.263
Absent					

PAI, periapical index.

Pearson chi-square, Fisher exact, and Fisher-Freeman-Halton tests.

Bold values indicate statistically significant differences.

*$P < .05$.

†$P < .01$.

30th day, 127 (84%) teeth exhibited no postoperative pain (Table 3). In this study, no flare-ups were observed in any of the groups.

Discussion

It has been reported previously that the sensitivity of panoramic radiographs is lower than that of periapical radiographs, especially in the anterior region of the jaws; therefore, periapical radiographs should be used to evaluate periapical tissues (17, 18). In this study, periapical film was used when the postoperative and control films were taken.

A person's pain perception is influenced by many factors, so it varies widely according to the amount of preoperative pain, number of appointments, use of intracanal medication, tooth localization, pulpal vitality, microbial factors, change in the periapical tissue pressure, chemical mediators, change in the cyclic mediators, and various physiological factors. Many different scales and methods have been used to detect the pain that occurs after root canal treatment (1, 19–23).

The postoperative pain severity was evaluated numerically, grading the pain into none, slight, moderate, severe, and agonizing categories using a VRS (24, 25). A VRS can be used for both the identification and measurement of pain. In addition, a visual analog scale (VAS) is considered to be a valid and reliable scale for measuring pain. A VAS can accurately predict the pain intensity and effect along a ratio, not an interval. Some studies have used VASs, and some studies have used VRSs (21, 26). However, pain is affected by many different factors; therefore, in this study, the level of discomfort was measured using a VRS that was classified into only 4 categories in order to simplify the pain rating (1). With regard to the postoperative pain collection methods, the VRS was used because it is considered to be the most adequate method for reporting the pain experienced by a patient (27).

TABLE 3. The Frequency and Percentage of Postoperative Pain in Retreatment Groups

Pain levels	Groups: Single visit, *n* (%)	Multiple-visit CHX, *n* (%)	Multiple-visit $Ca(OH)_2$, *n* (%)	*P* value (3 group)	*P* value (single visit / multiple visit CHX)	*P* value (single visit / multiple visit $Ca[OH]_2$)	*P* value (CHX / $Ca[OH]_2$)
Day 1							
None	28 (56.0)	15 (30.0)	20 (40.0)	**.016***,†	**.006***,‡	**.023***,†	.489§
Mild	9 (18.0)	16 (32.0)	18 (36.0)				
Moderate	13 (26.0)	13 (26.0)	8 (16.0)				
Severe	0 (0.0)	6 (12.0)	4 (8.0)				
Day 2							
None	35 (70.0)	22 (44.0)	21 (42.0)	**.018***,†	**.008***,‡	**.010***,†	.862§
Mild	8 (16.0)	17 (34.0)	15 (30.0)				
Moderate	7 (14.0)	6 (12.0)	9 (18.0)				
Severe	0 (0.0)	5 (10.0)	5 (10.0)				
Day 3							
None	40 (80.0)	29 (58.0)	33 (66.0)	.255*	.063*	.331*	.686*
Mild	6 (12.0)	11 (22.0)	11 (22.0)				
Moderate	4 (8.0)	7 (14.0)	5 (10.0)				
Severe	0 (0.0)	3 (6.0)	1 (2.0)				
Day 7							
None	45 (90.0)	41 (82.0)	45 (90.0)	.386*	.568*	.757*	.188*
Mild	3 (6.0)	6 (12.0)	1 (2.0)				
Moderate	2 (4.0)	3 (6.0)	3 (6.0)				
Severe	0 (0.0)	0 (0.0)	1 (2.0)				
Day 30							
None	49 (98.0)	41 (82.0)	37 (74.0)	**.003***,‡	**.021***,†	**.001***,‡	.398*
Mild	1 (2.0)	6 (12.0)	11 (22.0)				
Moderate	0 (0.0)	2 (4.0)	2 (4.0)				
Severe	0 (0.0)	1 (2.0)	0 (0.0)				

$Ca(OH)_2$, calcium hydroxide; CHX, chlorhexidine.

Bold values indicate statistically significant differences.

*Fisher-Freeman-Halton test.

†$P < .05$.

‡$P < .01$.

§Pearson chi-square test.

Di Renzo et al (21) evaluated postoperative pain at 6, 12, 24, and 48 hours after single- and multiple-visit root canal treatments. In addition, El Mubarak et al (28) observed postoperative pain during the first 12 and 24 hours after patients had completed their treatments. In this study, the level of discomfort was rated in only 4 categories 1, 2, 3, 7, and 30 days after root canal treatment.

In a recent study, Ertan et al (29) reported that the postoperative pain in molar teeth was greater than that in premolar and anterior teeth. Salma (30) found that the postoperative pain in premolar teeth was greater than the pain in anterior teeth. In our study, no differences were noted between the localizations and postoperative pain levels. Moreover, the incidence of pain in relation to sex was significantly higher in women than in men. In agreement with our results, Gotler (31) and Sadaf et al (32) also reported that women exhibited more postoperative pain than men. Furthermore, there was no significant association between postoperative pain and any of the tooth types included in our study. These findings are incompatible with some studies (21) but in agreement with others (22).

The age factor showed no significant relationships with postoperative pain as reported by the patients at 1, 2, 3, and 7 days. These findings are consistent with the results of another study (33). On day 30 day, although the number of patients ≤45 years old who reported postoperative pain was higher among the groups, statistically significant differences could not be shown. Overall, there was less postoperative pain because of greater sensitivity in the younger patients and reduced blood flow in the elderly patients.

Repeated endodontic treatment is a very interesting endodontic problem that requires a complex analysis of the indications and excellent procedural practice. Ørstavik et al (14) introduced the PAI system for the radiographic assessment of periapical status, and this was used in our study. This system allows for easier tracking of periodic changes and a significant comparison of the outcomes of retreatment in clinical studies.

An aseptic technique and intracanal medication with $Ca(OH)_2$ must be complemented with a 2% CHX solution in order to decrease the number of microorganisms (34). Yoldas et al (1) conducted a clinical study to compare the efficacy of 1-visit versus 2-visit retreatments using a medication that combined $Ca(OH)_2$ and a 2% CHX solution. They showed that the 2-visit retreatment was more effective for reducing postoperative pain and any potential flare-ups. In this study, there were no flare-ups observed in any of the groups. Previous studies have suggested that CHX gel is an effective intracanal medication, which is in agreement with our results. However, CHX is not an effective intracanal barrier, and it is also radiolucent, making it hard to visualize while it is inside the canal (35). Neelakantan et al (36) investigated the antimicrobial activity of several canal medicaments against *Porphyromonas gingivalis* and *Prevotella intermedia*, indicating that the effect of $Ca(OH)_2$ was significantly reduced after 48 hours, whereas the CHX gel lasted for 72 hours.

Previous studies have shown that the use of an intracanal medicament in symptomatic teeth can significantly reduce the incidence of flare-ups and postoperative pain (1). Moreover, Sjögren et al (37) showed that there may be high error rates in root canal disinfection in single-visit root canal treatments. Siqueira et al (38) and Maatscheck et al (39) found that there were no significant differences in postoperative pain between the retreatment and the primary root canal treatment in their studies. In these studies, different medicaments were used for the root canal treatments, and the teeth were treated in 2 or more visits.

TABLE 4. A Comparison of Pain Levels according to the Number of Treatment Visits

Pain levels	Groups		*P* value
	Single visit, *n* (%)	Multiple visits, *n* (%)	
Day 1			
None	28 (56.0)	35 (35.0)	**.005***,†
Mild	9 (180)	34 (34.0)	
Moderate	13 (26.0)	21 (21.0)	
Severe	0 (0.0)	10 (10.0)	
Day 2			
None	35 (70.0)	43 (43.0)	**.003***,†
Mild	8 (16.0)	32 (32.0)	
Moderate	7 (14.0)	15 (15.0)	
Severe	0 (0.0)	10 (10.0)	
Day 3			
None	40 (80.0)	62 (62.0)	.141*
Mild	6 (12.0)	22 (22.0)	
Moderate	4 (8.0)	12 (12.0)	
Severe	0 (0.0)	4 (4.0)	
Day 7			
None	45 (90.0)	86 (86.0)	.950*
Mild	3 (6.0)	7 (7.0)	
Moderate	2 (4.0)	6 (6.0)	
Severe	0 (0.0)	1 (1.0)	
Day 30			
None	49 (98.0)	78 (78.0)	**.005***,†
Mild	1 (2.0)	17 (17.0)	
Moderate	0 (0.0)	4 (4.0)	
Severe	0 (0.0)	1 (1.0)	

Bold values indicate statistically significant differences.

*Fisher-Freeman-Halton test.

†$P < .01$.

Some researchers have reported that the application of intracanal medicament reduces postoperative pain. However, they found no significant differences in postoperative pain after 1 week of medicament administration between $Ca(OH)_2$ and 0.2% CHX (40). Because of postoperative pain, several intracanal medicaments are used to temporarily fill the root canal, such as CHX or $Ca(OH)_2$, and they can play important roles in suppressing the recontamination of the root canal between visits (38). However, the apical extrusion of contaminated debris and medicaments may also cause postoperative pain (1). Walton et al (20) reported that there was no statistical difference in postoperative pain with regard to the frequency and quantity of $Ca(OH)_2$ used as an intracanal medicament. Fox et al (41) and Roane et al (22) argued that the postoperative pain percentages in single-visit root canal treatments were lower than those in multiple-visit root canal treatments.

Peckruhn (42) reported that 1140 teeth of 918 patients were treated in single visits. When the patients were recalled 1 year later, there was less failure reported in the single-visit root canal treatments. In a 2008 study of dissatisfaction scores, it was reported that single-visit root canal treatment was preferred by patients to multiple-visit root canal treatment, but Australian endodontists were reluctant to accept single-visit root canal treatments (43). In this study, on the second day, the postoperative pain rate in the single-visit root canal retreatment group (30%) was significantly lower than that in the multiple-visit retreatment group (54%).

An increase in pain incidence at the 1-month follow-up was observed in patients with multiple-visit retreatments, which was not the case in the single-visit retreatments. Although the patients are still being followed up for further evaluation, it was strongly suspected that the introduction of the root canal medicaments into the root canal space may have resulted in the extrusion of some of the material into the periapical area. This may have coupled with the healing process and, therefore, resulted in the increased incidence of pain at the 1-month follow-up (20). Although the caregiver paid extreme attention and tried not to extrude any intracanal medicament into the periapical area, this may not have been the case in every patient. The disrupted periapical anatomy because of a previous root canal treatment and the status of the periapical tissue before retreatment may result in the extrusion of intracanal medicament into the periapical area (28).

The presence of a periapical lesion is a risk factor for the development of postoperative pain. In the study by de Oliveira Alves et al (16), there was more postoperative pain in the teeth with periapical radiolucency. When the full-scale PAI scores were evaluated individually, no significant correlation was recorded between the preoperative PAI scores and the incidence of postoperative pain. Even after the PAI scores were dichotomized to reflect the absence (PAI ≤ 2) or presence (PAI >2) of apical periodontitis according to previous studies (14, 15), there was still no correlation between the preoperative PAI scores and the incidence of postoperative pain. Although the baseline PAI score was reported to impair the outcome results because of the strong predictive value, this study was not an outcomes study, and the preoperative PAI scores were recorded for the purpose of determining a correlation between the preoperative PAI scores and postoperative pain. Moreover although the mentioned study criticized the PAI scores, no better method has been suggested. With cone-beam computed tomographic imaging being out of question because of ethical issues in Turkey (higher exposure values), we were left with PAI scoring for further evaluation (44).

On the second day, there was a correlation between the periapical radiolucency and postoperative pain; the teeth with periapical lesions exhibited greater postoperative pain. Our findings are compatible with the study conducted by Eyuboglu et al (15).

Sari and Durutürk (45) reported that the complete resorption of the amount of extruded AH Plus sealer in 56.09% of the successfully treated canals at the end of a 4-year follow-up showed that any excess AH Plus filling material at the periapex disappears over time. In this study, we used AH Plus as the root canal filling material. On the second day, there was a relationship between the sealing extrusion and postoperative pain, but there was no significant difference between the extruded gutta-percha and postoperative pain.

Conclusions

Based on the results of this study, it was found that postoperative pain incidence in single-visit endodontic retreatments without intracanal medicaments was less than that in multiple-visit endodontic retreatments. When the medicaments were compared among themselves, the pain intensity was higher in the CHX group.

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