Prevalence of and factors affecting post-obturation pain in patients undergoing root canal treatment

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Abstract

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Aim This longitudinal, prospective study (1) investigated the prevalence of post-obturation pain after root canal treatment and (2) evaluated the influence of factors affecting the pain experience.

Methodology Twenty practitioners, comprising general dental practitioners, MSc graduates and Endodontists, participated in this study. The patient sample ($n = 415$) was derived from consecutive patients attending the practitioners' surgeries for root canal treatment on a single tooth. Demographic, medical history, preoperative and intra-operative data as well as pain experience on day 1 and day 2 after root canal obturation were recorded. Intensity of pain experienced was recorded on a visual analogue scale (VAS) of 0–5. The data were analysed using logistic regression models.

Results The prevalence of post-obturation pain within 48 h after treatment was 40.2% ($n = 167$) but less than 12% of patients experienced severe pain (VAS 4 or 5) on either day 1 or day 2. The factors that significantly influenced post-obturation pain experience were: gender (OR = 0.434, $P < 0.001$), tooth type (OR = 1.733, $P = 0.007$), size of periapical lesion (OR = 0.493, $P = 0.004$), history of post-preparation pain (OR = 4.110, $P = <0.001$) or generalized swelling (OR = 3.435, $P = 0.005$) and number of treatment visits (OR = 2.604, $P < 0.001$).

Conclusions The prevalence of post-obturation pain was high (40.2%). The important prognostic determinants of post-obturation pain were female, molar tooth, size of periapical lesion smaller than 3 mm, history of post-preparation pain or generalized swelling and single-visit treatment.

Keywords: pain, root canal treatment, post-obturation pain.

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Introduction

Development of pain after completion of root canal treatment may undermine patients' confidence in the clinician and acceptance of the procedure. The ability to predict its prevalence and forewarn the patient may go some way towards enabling coping strategies. It has also been used as an outcome measure to justify single as opposed to multiple-visit root canal treatment (Mulhern *et al.* 1982, Yesilsoy *et al.* 1988, Fava 1989, Albashaireh & Alnegrish 1998). This subject has attracted considerable attention by researchers since 1970s (Table 1). The reported prevalence of post-obturation pain ranges widely from 0% (at 30 days) to 65% (at 1 day), generally declines over time and should therefore be qualified by duration after last treatment episode (Table 1). Although most of the studies were either randomized controlled trials (Mulhern *et al.* 1982, Harrison *et al.* 1983, Morse *et al.* 1987a,b, Koba *et al.* 1999) or prospective studies (Fox *et al.* 1970, Alaçam 1985, Pisano *et al.* 1985, Yesilsoy *et al.* 1988, Fava 1989, 1991, Albashaireh & Alnegrish

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Table 1 Summary of studies of prevalence of pain experienced by patients after canal obturation

Study	Sample size	Study design[a]	Medical status of patient and preoperative status of teeth controlled	Variables recorded[b]	Timing of recording pain after obturation	Prevalence of post-obturation pain	Prognostic factors identified	Statistical method
Fox *et al.* (1970)[c]	247 teeth	R	None	1, 2, 6, 8, 12, 13, 18, 19, 20, 21	1, 2, 7 days	62% (1 day) 45% (2 days) 11% (7 days)	Gender, periapical lesion	χ^2
O'Keefe (1976)[c]	55 patients (only those cases with treatment completed in one visit were included in this summary)	P	None	1, 2, 3, 5, 6, 7, 8, 9, 12, 21	Not mentioned	49%	Age, tooth type, preoperative pain, medical problem, previous painful dental experience	χ^2
Mulhern *et al.* (1982)	60 teeth	RCT	Healthy patient, not taking medication Asymptomatic, necrotic pulp, single rooted teeth	1, 2, 8, 15, 16, 18, 19, 20, 21	2, 7 days	22% (2 days) 8.3% (7 days)	None	χ^2
Harrison *et al.* (1983)	229 cases	RCT	No preoperative pain No pulpal exposure	6, 8, 12, 15, 16, 18, 20, 22	1, 7, 30, 60 days	38% (1 day) 19% (2–7 days) 6% (8–30 days) 1.7% (31–60 days)	Inter-appointment pain, type of irrigant or medicament	χ^2
Alaçam (1985)[c]	212 teeth	P	Irreversible pulpitis	15, 18	3, 7, 30 days	14% (3 days) 2.3% (7 days) 0% (30 days)	None	χ^2
Pisano *et al.* (1985)	74 patients	P	None	18	Immediate, 1, 2 days	38% (immediate) 27% (1 day) 24% (2 days)	Not analysed	Not carried out
Genet *et al.* (1986)[d]	1204 patients	R	None	15, 16, 21	Immediate to 7 days	30%	None	Not carried out
Genet *et al.* (1987)[d]	443 patients	R	None	2, 6, 8, 9, 15, 16, 21	Immediate to 7 days	27%	Gender, pulpal status, preoperative pain, size of periapical lesion, number of canals	Multiple logistic regression models
Morse *et al.* (1987a)[c]	106 patients	RCT	Asymptomatic, necrotic pulp, presence of periapical lesion	1, 2, 3, 4, 5, 12, 13, 15, 17	1, 7 days	43.3%	None	χ^2
Morse *et al.* (1987b)[c]	315 patients	RCT	Asymptomatic, necrotic pulp, presence of periapical lesion	1, 2, 3, 4, 5, 12, 13, 15, 17	1, 7 days	32.1%	None	χ^2

Yesilsoy *et al.* (1988)	186 patients	P	Healthy patient, not taking medication, no drug allergy	1, 2, 3, 4, 6, 8, 9, 12, 15, 16, 18, 20, 21	1, 4, days	25.3% (1 day) 8.6% (4 days)	Preoperative pain, inter-appointment pain, tooth type, extent of root filling, number of treatment visits	χ^2
Fava (1989)	60 teeth	P	Healthy patients Asymptomatic, necrotic pulp, upper central incisors	1, 2, 16, 18, 21	2, 7 days	1.7% (2 days) 1.7 % (7 days) (moderate – severe pain)	None	Not mentioned
Fava (1991)	60 teeth	P	Healthy patients Asymptomatic, nonvital, upper central incisors	1, 2, 18	2, 7 days	5% (2 days) 5% (7 days) (pain requiring medication)	None	Not mentioned
Trope (1991)[c]	226 teeth	P	Not taking medication 1 week prior to treatment	7, 8, 9, 13, 14, 15, 16	Not specified	1.8% (pain intolerable or existing pain not improving or swelling developed)	History of previous root canal treatment	χ^2
Albashaireh & Alnegrish (1998)	300 patients	P	Asymptomatic teeth	1, 2, 6, 8, 9, 12, 15, 16, 18, 21	1, 2, 3, 7, 30 days	65% (1 day)	Pulpal status, preoperative pain, number of treatment visits	χ^2
Koba *et al.* (1999)	44 teeth	RCT	Asymptomatic, nonvital teeth with periapical lesion	1, 2, 12, 13, 15, 18, 20	1, 7, 90, 180 days	34% (1 day) 27% (7 days) 9% (90 days) 7% (180 days)	Use of laser treatment after chemo-mechanical debridement	Not mentioned

[a]P, prospective; R, retrospective; RCT, randomized controlled trial.
[b]1 = Age, 2 = gender, 3 = medical history, 4 = history of allergy, 5 = preoperative medication, 6 = pulpal vitality, 7 = previous root canal treatment, 8 = periapical lesion, 9 = preoperative pain, 10 = preoperative sinus, 11 = preoperative swelling, 12 = tooth type/location, 13 = extent of instrumentation, 14 = size of apical preparation, 15 = irrigant, 16 = medicament, 17 = postoperative medication, 18 = root filling material, 19 = pre-obturation culture results, 20 = extent of root filling, 21 = number of treatment visits, 22 = history of inter-appointment pain.
[c]Root canal treatment was completed in one visit for all cases.
[d]Data contaminated with post-preparation pain.

1998), direct comparison between them is complicated by differences in study design, preoperative condition of the root treated teeth, treatment protocol, duration after treatment episode when pain experience was recorded, index of pain measurement used and the threshold of pain used to judge prevalence. Subjective synthesis of the data reveals no consistency in putative factors affecting the development of pain after root canal obturation (Table 1). The factors reported to have significant effects on post-obturation pain included gender (Fox *et al.* 1970, Genet *et al.* 1987), tooth type or location (Yesilsoy *et al.* 1988), the presence and severity of preoperative pain (Yesilsoy *et al.* 1988, Albashaireh & Alnegrish 1998), pulpal status (Genet *et al.* 1987, Albashaireh & Alnegrish 1998), presence and size of periapical lesion (Fox *et al.* 1970, Genet *et al.* 1987), number of root canals present (Genet *et al.* 1987), intra-canal irrigant and medicament (Harrison *et al.* 1983), presence of inter-appointment pain (Harrison *et al.* 1983, Yesilsoy *et al.* 1988), extent of root filling (Yesilsoy *et al.* 1988) and number of treatment visits (Yesilsoy *et al.* 1988, Albashaireh & Alnegrish 1998). The majority of previous studies (Table 1) have analysed the potential associations of pain with individual factors using the chi-square test, which does not allow several independent variables to be considered simultaneously, a more realistic clinical scenario.

The aim of this study was to determine the prevalence of post-obturation pain after root canal treatment and to evaluate its association with various clinical factors using multiple logistic regression models.

Materials and methods

This study was carried out between November 1993 and June 1994 by practitioners based in United Kingdom. Consecutive patients ($n = 1200$) attending the participating dental practitioners ($n = 20$) for primary root canal treatment or root canal re-treatment on only one tooth with periapical radiolucent lesion, were invited to participate in this prospective study. The dental practitioners included Endodontists ($n = 5$), MSc postgraduates in the Departments of Conservative Dentistry and Periodontology ($n = 6$) and general dental practitioners ($n = 9$) with a special interest in Endodontics but with no formal postgraduate training. A total of 504 patients consented to participate and were included for analyses in this study, consent was not given by the rest of the patients ($n = 696$). The participating dentists and patients were supplied written instructions on how to assess and record the prevalence, severity and characteristic of pain at 1 and 2 days post-obturation. The written instructions were followed-up by a telephone call to establish if there were any difficulties in understanding or using the data collection forms. Preoperative (Table 2) and intra-operative (Table 2) data were collected by the operators. The presence and severity of pain over the first 2 days (Table 2) following root canal obturation were recorded by the patient in a questionnaire and returned to the operator by post. The severity of pain was recorded on a visual analogue scale (VAS) of 0–5.

Table 2 Data recorded for each case

Preoperative data
Age and gender
Relevant medical history
Chronic debilitating disease[a]
Diabetics type I (diet controlled)
Diabetics type II (insulin controlled)
Topical steroid therapy
Systemic steroid therapy
Chemotherapy
Radiotherapy
Asthma
Drug allergy
Food allergy
Hay fever
Eczema
Tooth type
Preoperative clinical signs and symptoms associated with the tooth studied
History of pain (before and within 24 h)
History of swelling (before and within 24 h)
Presence of sinus (at time of treatment)
Size of periapical radiolucent area
History of previous root canal treatment
Intra-operative data
Operator qualification
Size of apical preparation
Irrigant used (NaOCl, local anaesthetic solution, EDTA + NaOCl, others)
Medicament used [$Ca(OH)_2$, Ledermix, Ledermix + $Ca(OH)_2$, formocresol, others]
Post-preparation pain
Post-preparation swelling
Type of sealer
Extrusion of root filling material
Number of treatment visits
Post-obturation pain
Presence and intensity of pain in the first 12–24 and 24–48 h

[a]Respiratory disease, Crohn's disease, sarcoidosis, cardiac disease, myalgic encephalomyelitis, gout, thyroid disease, kidney disease, rheumatoid disease, ocular disease, depression.

The relationship between possible factors influencing the pain experienced by patients after root canal obturation was analysed using logistic regression models with a statistical package (SPSS version 11; SPSS Inc., Chicago, IL, USA).

Results

Of the 504 patients who consented to participate in this study, properly filled questionnaires were returned by 415 patients (82.3% response rate). Of the 415 patients studied, 167 (40.2%, 95% CI: 35.6–45.0%) patients experienced some level of pain on either day 1 or 2 post-obturation. The level of reported pain on a VAS is presented in Table 3. Of the 167 patients who experienced post-obturation pain, the majority ($n = 90$, 21.7%) had pain on both day 1 and 2, whilst 62 (14.9%) and 15 (3.6%) patients presented with pain only on day 1 or day 2 post-obturation, respectively. McNemar tests showed that these differences are highly significant ($P < 0.05$). The number of patients with higher, identical and lower pain scores on day 1 relative to day 2 are 97, 293 and 25 of 415, respectively. The difference between 97 and 25 of 415 is 17.3%, with 95% CI 12.4–22.4% (Tango 1998). Severe pain (VAS 4 and 5) was reported by 20 (12.0%) and 13 (7.8%) patients on day 1 and day 2, respectively.

The frequency distribution of the key explanatory variables and the prevalence of post-obturation pain within 48 h after the obturation visit are presented in Tables 4 and 5.

The results were analysed using logistic regression models with the odds of 'post-obturation pain on day 1 or day 2' as the dependent variable. The multiple categories of some independent factors such as tooth type (molar versus nonmolar), irrigant used (NaOCl versus all other types) and type of sealer (Roth's sealer versus all other types) were merged into two categories before further analyses due to small numbers. When each explanatory variable was analysed separately in single logistic regression models (Table 6), the odds of prevalence of post-obturation pain for a male patient was significantly lower (57%) than a female patient (OR: 0.434, 95% CI: 0.289–0.652, $P < 0.001$). Single-visit root canal treatment (OR: 2.604, 95% CI: 1.619–4.188, $P < 0.001$), presence of post-preparation pain (OR: 4.110, 95% CI: 2.363–7.149, $P < 0.001$) and presence of post-preparation generalized swelling (OR: 3.435, 95% CI: 1.452–8.126, $P = 0.005$) appeared to significantly increase the odds of post-obturation pain by two to fourfold. However, the odds of post-obturation pain was significantly decreased by 51% when there was a periapical lesion larger than 3 mm in diameter. Treatment of molar teeth appears to significantly increase the odds of post-obturation pain by 1.7-fold (OR: 1.733, 95% CI: 1.165–2.577, $P = 0.007$) when compared with other tooth types.

Chi-square tests showed that some of these potential predictive factors were significantly ($P < 0.05$) associated with each other (Table 7) and interpretation of the multiple logistic regression models should take account of these associations. The factors 'post-preparation pain' and 'post-preparation swelling' are not applicable to those cases receiving single-visit endodontic treatment, therefore these two factors could not be analysed in the same model as the factor 'single-visit treatment'.

Model 1 (Table 8) illustrates the effect of simultaneously entering age and all the potential predictive factors except those not applicable for single-visit treatment (post-preparation pain and post-preparation generalized swelling) for all 415 cases. Three factors (gender, single-visit treatment, molar tooth) remained significant at the 5% level. However, the factor 'periapical lesion greater than 3 mm' only achieved significance at the 10% level. Model 2 (Table 9) illustrates the effect of simultaneously entering age and all the potential predictive factors for those cases ($n = 324$) receiving multiple-visit treatment. Four factors (gender, post-preparation pain, post-preparation generalized swelling and molar tooth) remained significant at the 5% level but 'periapical lesion greater than 3 mm' only achieved significance at the 10% level. 'Age' appeared to have no significant influence on the prevalence of post-obturation pain.

Table 3 The prevalence and severity of pain reported by patients on 1 and 2 days post-obturation

		Day 2						
	VAS	0	1	2	3	4	5	Total
Day 1	0	*248*	13	0	2	0	0	263
	1	40	*27*	5	0	0	0	72
	2	11	12	*5*	0	2	0	30
	3	7	4	8	*9*	2	0	30
	4	3	1	0	3	*1*	1	9
	5	1	1	3	0	3	*3*	11
Total		310	58	21	14	8	4	415

Values in italic represent number of patients with the same pain intensity on days 1 and 2. Cells above the italic values represent number of patients with higher pain intensity on day 2 than on day 1. Cells below the italic values represent number of patients with lower pain intensity on day 2 than on day 1.

Table 4 Frequency distribution of key explanatory variables applicable to both cases completed over single visit or multiple visits and post-obturation pain in the first 48 h

		Total		Post-obturation pain	
Variables	Categories	Number	%[a]	Number	%[b]
Gender	Male	193	46.5	57	29.5
	Female	222	53.5	109	49.1
Age	<20	11	2.7	5	1.2
	≥20 and <30	49	11.8	22	44.9
	≥30 and <40	87	21.0	40	9.6
	≥40 and <50	119	28.7	45	10.8
	≥50 and <60	66	15.9	24	5.8
	≥60 and <70	51	12.3	17	33.3
	≥70 and <80	24	5.8	8	33.3
	≥80	8	1.9	5	62.5
Tooth type	Incisors or canines	96	23.2	34	35.4
	Premolars	111	26.9	35	31.5
	Molars	206	49.9	96	46.6
History of allergy	Yes	154	37.1	68	44.2
	No	261	62.9	98	37.5
Topical steroid treatment	Yes	6	1.4	4	66.7
	No	4.9	98.6	162	39.6
Systemic steroid treatment	Yes	13	3.1	6	46.2
	No	402	96.9	160	39.8
Diabetic type I (diet controlled)	Yes	9	2.2	2	22.2
	No	406	97.8	164	40.4
Diabetic type II (insulin controlled)	Yes	3	0.7	1	33.3
	No	412	99.3	165	40.0
Chronic debilitating disease	Yes	29	7.0	13	44.8
	No	386	93.0	153	39.6
Preoperative pain within 24 h before treatment	Yes	212	51.1	88	41.5
	No	203	48.9	78	38.4
Preoperative pain >24 h before treatment	Yes	279	67.2	118	42.3
	No	136	32.8	48	35.3
Preoperative swelling within 24 h	Yes	53	12.8	15	28.3
	No	362	87.2	151	41.7
Preoperative swelling >24 h before treatment	Yes	72	17.3	26	36.1
	No	343	82.7	140	40.8
Preoperative sinus	Yes	40	9.6	11	27.5
	No	375	90.4	155	41.3
Periapical lesion >3 mm	Yes	107	25.8	30	28.0
	No	308	74.2	136	44.2
Previous root canal treatments	Yes	76	18.3	33	43.4
	No	339	81.7	133	39.2
Operator qualification	Endodontists	183	44.1	77	42.1
	MSc postgraduates	48	11.6	14	29.2
	GDPs	184	44.3	75	40.8
MAF size = 25	Yes	412	99.3	165	40.0
	No	3	0.7	1	33.3
Irrigant used	NaOCl	352	84.8	141	40.1
	LA	5	1.2	2	40.0
	EDTA + NaOCl	42	10.1	19	45.2
	Unknown	4	1.0	2	50.0
	Others	12	2.9	2	16.7
Type of sealer	Roth's	220	53.0	76	34.5
	Sealapex	45	10.8	22	48.9
	Tubliseal	60	14.5	28	46.7
	Unknown	9	2.2	5	55.6
	Others	81	19.5	35	43.2

Table 4 Continued

Variables	Categories	Total		Post-obturation pain	
		Number	%[a]	Number	%[b]
Extrusion of sealer	Yes	103	24.8	44	42.7
	No	312	75.2	122	39.1
Number of visits	Single	91	21.9	53	58.2
	Multiple	324	78.1	113	27.2

[a]Proportion of patients out of the total number of patients in this study ($n = 415$).
[b]Proportion of patients out of the total number of patients presenting with post-obturation pain within each category.

Table 5 Frequency distribution of key explanatory variables only applicable to cases completed over multiple visits ($n = 324$) and post-obturation pain in the first 48 h

Variables	Categories	Total		Post-obturation pain	
		Number	%[a]	Number	%[b]
Medicament used	None	150	36.1	60	40.0
	$Ca(OH)_2$	183	44.1	75	41.0
	Ledermix	23	5.5	8	34.8
	Ledermix + $Ca(OH)_2$	30	7.2	10	33.3
	Formocresol	16	3.9	10	62.5
	Unknown	7	1.7	1	14.3
	Others	6	1.4	2	33.3
Post-preparation pain	Yes	205	63.3	93	45.4
	No	119	36.7	20	16.8
Post-preparation swelling (localized)	Yes	22	6.8	9	40.9
	No	302	93.2	104	34.4
Post-preparation swelling (generalized)	Yes	24	7.4	15	62.5
	No	300	92.6	98	32.7

[a]Proportion of patients out of the total number of patients receiving multiple-visit treatment ($n = 324$).
[b]Proportion of patients out of the total number of patients presenting with post-obturation pain within each category.

Discussion

Consecutive patients attending the participating dentists for root canal treatment on a single tooth with a periapical lesion during the study period were selected for analysis in this prospective study. If more than one tooth is root canal treated in the same patient, they cannot be assumed to behave independently from each other, for the purpose of this analysis, therefore such cases were not included.

The high prevalence (40.2%) of pain experience after root canal obturation was consistent with some (Fox *et al.* 1970, Harrison *et al.* 1983, Morse *et al.* 1987a,b) but much higher than that reported by other studies (Alaçam 1985, Pisano *et al.* 1985, Fava 1989, 1991). This discrepancy could be attributed to differences in the preoperative status of the teeth, treatment protocol and the level of pain severity included for analysis. Those studies selecting post-obturation pain levels *moderate or severe* (Fava 1989) or pain that required analgesics (Pisano *et al.* 1985, Fava 1991) have reported much lower prevalence of post-obturation pain. A VAS of 0–5 instead of 0–10 or 0–100 was selected because the smaller number of categories may provide greater clinical relevance for comparisons than using the full spectrum of measure values (Bodian *et al.* 2001).

When all the explanatory variables were considered separately to explore the potential influence that each might have on the prevalence of post-obturation pain (Table 5), six independent variables (gender, tooth type, size of periapical lesion, history of post-preparation pain, history of post-preparation generalized swelling, single-visit treatment) were identified as potentially important prognostic factors. All the variables remained significantly associated with post-obturation pain when they were considered in further multiple regression models except age (Tables 7 and 8). Although 'age' did not

Table 6 Logistic regression models for each explanatory variable given separately

Explanatory variables (test category/reference category)	Single logistic regression analyses		
	OR	95% CI for OR	*P*-value
Gender (male/female)	0.43	0.29–0.65	<0.001*
Single-visit endodontic treatment (yes/no)	2.60	1.62–4.19	<0.001*
Post-preparation pain (yes/no)	4.11	2.36–7.15	<0.001*
Periapical lesion >3 mm (yes/no)	0.49	0.31–0.80	0.004*
Post-preparation generalized swelling (yes/no)	3.435	1.45–8.13	0.005*
Molar tooth (yes/no)	1.73	1.17–2.58	0.007*
Preoperative swelling within 24 h before treatment (yes/no)	0.55	0.29–1.04	0.07
Type of sealer (any other type of sealer/Roth's sealer)	1.11	0.98–1.26	0.09
Preoperative sinus (yes/no)	0.54	0.26–1.11	0.09
Operator (GDP/specialist)	0.58	0.30–1.12	0.1
Age (per year)	0.99	0.98–1.00	0.14
Preoperative pain >24 h before treatment (yes/no)	1.34	0.88–2.05	0.17
Preoperative swelling >24 h before treatment (yes/no)	1.34	0.88–2.05	0.17
History of any form of allergy (yes/no)	1.32	0.88–1.97	0.19
Topical steroid therapy (yes/no)	3.05	0.55–16.84	0.20
Irrigant (Any other type of irrigant/NaOCl)	1.71	0.65–4.50	0.28
Diet diabetic (yes/no)	0.42	0.08–2.06	0.29
Previous root canal treatments (yes/no)	1.19	0.72–1.97	0.50
Extrusion of sealer (yes/no)	1.16	0.74–1.83	0.52
Preoperative pain within 24 h before treatment (yes/no)	1.14	0.77–1.69	0.52
Chronic debilitating disease (yes/no)	1.24	0.58–2.65	0.58
Systemic steroid therapy (yes/no)	1.30	0.43–3.93	0.65
Insulin diabetic (yes/no)	0.75	0.07–8.32	0.81
MAF size = 25 (yes/no)	1.34	0.12–14.85	0.81
Post-preparation localized swelling (yes/no)	1.32	0.55–3.19	0.54
Medicament (any other type of medicament/Ledermix)	0.74	0.41–1.36	0.34
Medicament (any other type of medicament versus [$Ca(OH)_2$])	0.99	0.67–1.47	0.97

*Significant at $P = 0.05$. Odds ratio = odds of post-obturation pain with test category/odds of post-obturation pain with reference category.

appear to have significant influence on the prevalence of post-obturation pain in single logistic regression analysis (Table 6), it was included in the further multiple regression models because both age and gender are the two obvious measures of between subjects variations and should always be considered as influencing factors in clinical studies. Two of the potential influencing factors 'post-preparation pain' and 'post-preparation generalized swelling' were not applicable to those cases completed over one visit therefore the factor 'single-visit treatment' cannot be considered in the same model with these two factors. As a result, two approaches of further multiple regression analyses were taken: model 1 (Table 8) included all 415 patients but did not consider those variables which were only applicable to cases completed over multiple visits; model 2 (Table 9) included only the cases completed over multiple visits ($n = 324$) and consider all the potential influencing factors.

The odds of occurrence of post-obturation pain were significantly lower by 57% in males compared with female patients. This finding is in agreement with Fox *et al.* (1970) and Genet *et al.* (1987). Such difference has also been reported in other studies (Mulhern *et al.* 1982, Morse *et al.* 1987a,b, Albashaireh & Alnegrish 1998) although they could not detect statistical significance. Various hypotheses have been proposed to explain female predominance in pain prevalence. The most common argument is that women tend to seek and accept treatment more willingly, as the presence of symptoms is readily perceived as indicators of disease by females (Unruh 1996). Furthermore, physicians believe that women suffer more commonly from psychosomatic illnesses and that their pain is governed by emotional factors (Colemeco *et al.* 1983). A more legitimate explanation is based on emerging evidence that biological differences between genders

Table 7 Cross-tabulation of odds ratio and 95% CI between potential prognostic factors

Variable	Tooth type	Periapical lesion >3 mm	Single-visit endodontic treatment	Post-preparation pain	Post-preparation generalized swelling
Gender					
Male versus female	0.77 (0.52–1.13)	1.30 (0.84–2.02)	0.88 (0.55–1.40)	0.56 (0.56–0.89)*	0.43 (0.18–1.08)
Tooth type					
Nonmolar versus molar		0.70 (0.45–1.09)	0.50 (0.31–0.80)*	1.86 (1.18–2.93)*	1.24 (0.54–2.89)
Periapical lesion >3 mm					
Yes versus no			0.37 (0.20–0.70)*	0.72 (0.44–1.18)	2.18 (0.94–5.05)
Single-visit endodontic treatment					
Yes versus no				–	–
Post-preparation pain					
Yes versus no					1.13 (1.08–1.19)*
Post-preparation generalized swelling					
Yes versus no					

*Significance at $P = 0.05$.

Table 8 Multiple logistic regression models incorporating gender, single-visit treatment, molar tooth, periapical lesion >3 mm as predictors for all cases ($n = 415$)

Explanatory variables (test category/reference category)	Multiple logistic regression analyses		
	Odds ratio	95% CI for OR	*P*-value
Model 1			
Gender (male/female)	0.45	0.29–0.68	<0.001*
Single-visit endodontic treatment (yes/no)	2.81	1.68–4.70	<0.001*
Molar (yes/no)	1.88	1.23–2.89	0.004*
Periapical lesion >3 mm (yes/no)	0.62	0.37–1.01	0.06
Age (per year)	0.99	0.98–1.07	0.36

*Significant at $P = 0.05$. Odds ratio = odds of post-obturation pain with test category/odds of post-obturation pain with reference category.

Table 9 Multiple logistic regression models incorporating gender, periapical lesion >3 mm, molar tooth, post-preparation pain, post-preparation generalized swelling as predictors for cases received multi-visit treatment only ($n = 324$)

Explanatory variables (test category/reference category)	Multiple logistic regression analyses		
	Odds ratio	95% CI for OR	*P*-value
Model 2			
Post-preparation pain (yes/no)	3.26	1.83–5.81	<0.001*
Gender (male/female)	0.59	0.36–0.97	0.04*
Post-preparation generalized swelling (yes/no)	2.53	1.01–6.35	0.05*
Molar (yes/no)	1.65	1.00–2.73	0.05*
Periapical lesion >3 mm (yes/no)	0.56	0.32–1.01	0.05*
Age (per year)	0.99	0.98–1.01	0.32

*Significant at $P = 0.05$. Odds ratio = odds of post-obturation pain with test category/odds of post-obturation pain with reference category.

may explain increased pain prevalence in females (Fillingim & Maixner 1995). There are two possible explanations: (1) differences in pelvic and reproductive organs may provide an additional portal of entry of infection in females leading to possible local and distant hyperalgesia (Berkley 1997); (2) fluctuating female hormonal levels may be associated with changing levels of serotonin and noradrenaline leading to increased pain prevalence during the menstrual period (Marcus 1995, Dao *et al.* 1997) and in women receiving hormonal replacement therapy or oral contraceptives (Fillingim & Maixner 1995).

Similar to the findings by two previous studies (Harrison *et al.* 1983, Yesilsoy *et al.* 1988), a history of post-preparation pain or swelling appeared to be significantly associated with a higher prevalence of post-obturation pain in the present study. The latter was not just a continuation of the former; in the

present and other two studies, root canal obturation would only be carried out when the tooth was completely free of signs and symptoms. It may be hypothesized that the patients experiencing post-preparation pain may have a lower pain threshold or they may have been psychologically preconditioned to post-obturation pain. Another explanation may be that there is a biological basis for pain based on extrusion of factors during operative intervention.

In disagreement with Yesilsoy *et al.* (1988) and Albashaireh & Alnegrish (1998), the present study found a significantly higher prevalence of post-obturation pain associated with single-visit than with multiple-visit treatment. The former study could not detect any statistically significant difference whereas the latter study reported the opposite. The discrepancy may be attributed to the fact that inter-appointment root canal medicament was not used in these two studies. Thus, there was effectively no biological difference between single-visit and multiple-visit treatment because surviving bacteria could rapidly re-colonize the systems (Byström & Sundqvist 1985).

This study found that molar teeth were significantly more susceptible to post-obturation pain, consistent with the finding by O'Keefe (1976) and Yesilsoy *et al.* (1988). It may be hypothesized that the complex root canal morphology of molar teeth especially apically, is more difficult to debride thoroughly and may therefore be predisposed to post-obturation complications. In addition, it may be simply a function of the higher number of root canals exits.

Most of the previous studies (Fox *et al.* 1970, O'Keefe 1976, Mulhern *et al.* 1982, Harrison *et al.* 1983, Yesilsoy *et al.* 1988) investigating the association with periapical lesions on post-obturation pain have studied the effect of their presence or absence. Only one study (Genet *et al.* 1987) analysed the influence of size of periapical lesion and found that teeth with a periapical lesion larger than 5 mm were associated with higher prevalence of pain than those with no or a smaller lesion. In contrast, the present study found that teeth with a periapical lesion larger than 3 mm were associated significantly with less post-obturation pain than those teeth with a smaller lesion. This discrepancy could be explained by the fact that some of the teeth had no periapical lesion in the former study whereas all teeth were associated with a periapical lesion in the present study. A larger periapical lesion may act as a 'buffer' against pressure build-up by exudate during the inflammatory response to mechanical or chemical injuries during root canal treatment and therefore be associated with lower prevalence of post-obturation pain. However, the influence of 'periapical lesion greater than 3 mm' on the prevalence of post-obturation pain only achieved significance at 10% level in multiple regression models (Tables 7 and 8). This may be due to the fact that this factor was confounded by the factor 'one-visit treatment' in model 1. Whereas, out of the 324 cases treated over multiple visits included in model 2, only a small proportion ($n = 95$, 29%) had periapical lesion greater than 3 mm.

Other reported potential influencing factors such as the presence and severity of preoperative pain (Genet *et al.* 1987, Yesilsoy *et al.* 1988, Albashaireh & Alnegrish 1998), history of previous root canal treatment (Trope 1991), intra-canal irrigant and medicament (Harrison *et al.* 1983) and extent of root filling (Yesilsoy *et al.* 1988) did not appear to have any significant effects on the prevalence of post-obturation pain in this study. The other reported significant influencing factor: pulpal status (Genet *et al.* 1987, Albashaireh & Alnegrish 1998) was not investigated in the present study.

Conclusions

The prevalence of some level of post-obturation pain after root canal treatment was high and was significantly influenced by gender, tooth type, size of preoperative periapical lesion, history of post-preparation pain or swelling and single- or multiple-visit treatment.

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