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ORIGINAL ARTICLE

Work experience influences treatment approaches in endodontics: a questionnaire survey among dentists in Western Norway

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ABSTRACT

Objectives: To collect information on endodontic treatment procedures among dentists in the public dental service (PDS) in Western Norway and relate this information to their work experience.

Materials and methods: A survey comprised of 35 questions related to personal information, frequency of endodontic treatment, endodontic procedures and treatment principles was distributed electronically to 187 dentists in PDS in two counties of Western Norway.

Results: The response rate was 74%, and 130 dentists participated. Among them, 57.0% had completed their education less than 13 years ago, and almost all were below 39 years old (95%). The majority (81.0%) had graduated in Norway. Stepwise caries excavation in primary and permanent teeth and direct pulp capping in primary teeth were more frequently performed by dentists with less than 13 years from graduation. Routine use of rubber dam was high among the responders (87%). However, use of rubber dam and master-cone radiograph uptakes were more frequent among the younger dentists. The majority used rotary instrumentation systems, and almost all participants followed the current guidelines for use of antibiotics in endodontics.

Conclusions: In general, dentists in PDS follow the current endodontic treatment guidelines. However, it seems that the more recently graduated dentists perform more endodontic procedures and tend to adhere more to the taught principles regarding rubber dam use and radiograph uptakes.

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Introduction

Contemporary endodontics involves different new instruments, materials and techniques. When root canal treatment is performed under optimal conditions, a high success rate can be expected [1]. Various studies [1–3] have evaluated the success and failure of endodontic treatment. Many were performed in institutions and/or specialist clinics, and the reported success rate may therefore be higher than in general practices [4]. A large survey from Malmø in Sweden, showed that 52.0% of the root-filled teeth in adolescents had apical periodontitis when evaluated at least one year later [5]. In a follow-up study of children and adolescents aged 9–17 years who were treated in the public dental service (PDS) in Norway, a success rate varying from 48.0% to 75.0% was reported, depending on the preoperative status of the tooth [6]. Technical quality of the root filling was correlated with treatment success, and poor quality radiographs were a frequent exclusion criteria in the study [6]. Guidelines reflecting an increased interest in quality assurance in endodontic procedures exist [7] and are regularly updated. However, we have limited information about how the guidelines are followed by general practitioners. During their undergraduate training, the dental students follow the guidelines, but we do not know if they adopt new principles and update their routines according to new guidelines after graduation.

Dentists in the PDS in Norway are responsible for dental treatment of children and adolescents (aged 3–18 years), as well as certain groups of adults. Therefore, they treat both primary and permanent teeth. The frequency of various types of endodontic procedures and protocols, equipment and materials used are important factors that may influence treatment outcomes. So far, we have limited information regarding the frequency of endodontic treatment performed by dentists in PDS in Norway and their routines regarding rubber dam use, field disinfection, radiographic protocols, irrigation protocols, use of rotary instruments, choice of temporary filling materials, and follow-up after treatment. The aim of this study was to collect information regarding endodontic treatment procedures among dentists in the PDS in Western Norway and relate this information to their work experience.

Materials and methods

A self-administered web-based survey program, SurveyXact (Ramboll, Copenhagen, Denmark), was used to create the questionnaire, which was distributed electronically to 187 dentists working in the PDS of two counties of Western

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Supplemental data for this article can be accessed here.

Norway: Hordaland ($n = 145$) and Sogn & Fjordane ($n = 42$). The questionnaire was distributed in February 2018, and two reminders to non-responders were sent. Participation and data collection were anonymous and confidential.

The questionnaire included 35 questions covering (i) dentists' personal information (age, gender and years from graduation), (ii) frequency of endodontic treatment in primary and permanent teeth and acute treatment of traumatic dental injuries and (iii) clinical procedures and treatment principles in endodontics.

Statistical analyses

Information regarding years from completion of formal education was categorized into categories: 1–12 years ('group 1') and 13–42 years ('group 2'). Years from completion of formal education were closely related to dentists' age and reflect the dentists' work experience as well. Therefore, these terms are used interchangeably throughout the text.

Continuous variables are expressed as median and interquartile range (IQR) and categorical variables as proportions. The Mann–Whitney *U* test and Chi-square test were used to compare dentists' characteristics between groups.

Logistic regression, ordered logistic regression and multinomial logistic regression models were used to examine the role of work experience on various aspects of clinical procedures and treatment principles. In the analyses, dentists in group 1 were used as a reference category.

We constructed two models. The first was adjusted for gender and county of residence, and the second was additionally adjusted for the country where education was completed (Norway vs. abroad). Since the results of both models were very similar, we report only the results obtained from model 2. We also considered including 'age' as a potential covariate, but decided not to do so because it was highly correlated with study's exposure (years from completion of formal education).

Statistical analyses were performed using STATA (Version 14.0; Stata Corp., College Station, TX).

The project was approved by the Norwegian Centre for Research Data (Norsk Senter for forskningsdata: NSD) with project number 54620.

Results

Of 187 dentists invited, 139 agreed to participate in the survey, yielding a response rate of 74.3%. Of these, nine dentists did not perform endodontic treatments and therefore were not included in these analyses. Hence, the study population was comprised of 130 dentists.

Baseline characteristics

Table 1 summarizes characteristics of the study population. Male dentists accounted for 24.0% of the study population. More than half of participants (54.6%) were <40 years old. The majority (80.8%) of the study population had graduated in Norway. Dentists working in Sogn & Fjordane County were younger ($p < .001$) and were recent graduates compared to dentists working in Hordaland County ($p = .023$) (Table 1).

Table 1. Characteristics of the study participants.

Participants' characteristics	All $n = 130$	Time since completing dental education: Group 1 $n = 74$	Group 2 $n = 56$	p Value[a]
Gender (male)	31 (24.0)	18 (24.7)	13 (23.2)	.849
Age group				<.001
<39 years	71 (54.6)	70 (94.6)	1 (1.8)	
40–59 years	43 (33.1)	4 (5.4)	39 (69.6)	
≥60 years	16 (12.3)	–	16 (28.6)	
Graduated				.147
Norway	105 (80.8)	63 (85.1)	42 (75.0)	
Abroad	25 (19.2)	11 (14.9)	14 (25.0)	
County				.023
Hordaland	96 (73.8)	49 (66.2)	47 (83.9)	
Sogn and Fjordane	34 (26.2)	25 (33.8)	9 (16.1)	

Group 1: participants completed dental education ≤12 years ago; group 2: participants completed dental education >12 years ago. Proportions (%) are calculated based on the number of responders.
[a]Unadjusted comparisons.

Frequency of endodontic procedures

Table 2 summarizes the frequency of endodontic procedures performed and the number of acute trauma patients treated by study participants. Overall, the proportion of dentists performing often (several times per week/on a daily basis) endodontic procedures in children and adolescents was 4.8% and in adults, 34.1%. The median (IQR) number of patients with acute trauma treated in the preceding year was 10 (5–30).

Dentists in group 1 performed stepwise caries excavation more often in both primary ($p = .017$) and permanent ($p = .025$) teeth as well as direct pulp capping in primary teeth ($p = .045$) compared to these in group 2. No statistically significant differences in the frequency of other endodontic procedures were observed between groups (Table 2).

Endodontic treatment routines

Working under aseptic conditions optimizes the results of endodontic procedures. Rubber dam was less often used by dentists in group 2 compared to dentists in group 1 (OR 0.09; 95% CI 0.02–0.43) (Table 3). About half of the responders (43.7% of group 1 and 58.8% of group 2 dentists) pointed to patient-related challenges as the main reason for not using rubber dam during root canal treatment. Technical difficulties were more often pointed out as reasons for not applying rubber dam among dentists in group 1, but the results were not statistically significant. The proportion of dentists using alternative of isolation was similar between groups (Table 3).

Work experience influences not only use, but also beliefs regarding rubber dam use. Compared to dentists in group 1, those in group 2 tend to agree more that use of rubber dam does not improve treatment outcomes (OR 4.41; 95% CI 1.39–13.99) and agree less that its use provides easier access

Table 2. Endodontic procedures performed by the study participants.

Frequency of treatment/procedures	All $n = 130$	Group 1 $n = 74$	Group 2 $n = 56$	p Value[a]
Root canal treatment in patients <18 years				.165
Daily or several times/week	6 (4.8)	5 (7.3)	1 (1.8)	
<1/week	118 (95.2)	64 (92.7)	54 (98.2)	
Missing	6	5	1	
Root canal treatment in patients >18 years				.288
Daily or several times/week	42 (34.1)	26 (38.2)	16 (29.1)	
<1/week	81 (65.9)	42 (61.8)	39 (70.9)	
Missing	7	6	1	
Procedures in primary teeth				
Stepwise caries excavation				.017
Never/rarely	76 (62.3)	36 (52.9)	40 (74.1)	
Often	46 (37.7)	32 (47.1)	14 (25.9)	
Missing	8	8	–	
Direct pulp capping				.045
Never/rarely	110 (92.4)	60 (88.2)	50 (98.0)	
Often	9 (6.9)	8 (11.8)	1 (2.0)	
Missing	11	8	3	
Pulpotomy				.698
Never/rarely	119 (93.7)	66 (93.0)	53 (94.6)	
Often	8 (6.3)	5 (7.0)	3 (5.4)	
Missing	3	3	–	
Pulpectomy				.211
Never/rarely	120 (98.4)	67 (97.1)	53 (100.0)	
Often	2 (1.6)	2 (2.9)	–	
Missing	8	5	1	
Extraction due to endodontic problems				.180
Never/rarely	84 (68.3)	43 (63.2)	41 (74.6)	
Often	39 (31.7)	25 (36.8)	14 (25.4)	
Missing	7	6	1	
Procedures in permanent teeth				
Stepwise caries excavation				.025
Never/rarely	60 (48.8)	27 (39.7)	33 (60.0)	
Often	63 (51.2)	41 (60.3)	22 (40.0)	
Missing	7	6	1	
Direct pulp capping				.480
Never/rarely	115 (94.3)	65 (95.6)	50 (92.6)	
Often	7 (5.7)	3 (4.4)	4 (7.4)	
Missing	8	6	2	
Pulpotomy				.663
Never/rarely	116 (95.1)	62 (92.5)	54 (98.2)	
Often	6 (4.9)	5 (7.5)	1 (1.8)	
Missing	8	7	1	
Pulpectomy				.974
Never/rarely	93 (77.5)	52 (77.6)	41 (77.4)	
Often	27 (22.5)	15 (22.4)	12 (22.6)	
Missing	10	7	3	
Treatment of necrotic pulp				.541
Never/rarely	86 (69.9)	46 (67.7)	40 (72.7)	
Often	37 (30.1)	22 (32.3)	15 (27.3)	
Missing	7	6	–	
Re-treatment				.437
Never/rarely	118 (97.5)	66 (98.5)	52 (96.3)	
Often	3 (2.5)	1 (1.5)	2 (3.7)	
Missing	9	7	2	
Endodontic surgery				.375
Never/rarely	120 (99.1)	67 (98.5)	53 (100.0)	
Often	1 (0.8)	1 (1.5)	–	
Missing	9	6	3	
Extraction due to endodontic problems				.208
Never/rarely	102 (82.9)	59 (86.8)	43 (78.2)	
Often	21 (17.1)	9 (13.2)	12 (21.8)	
Missing	7	6	1	
Number of acute patients treated due to dental trauma last year Median (IQR)	10 (5–30)	10 (5–30)	10 (5–20)	.813

IQR: interquartile range.
Group 1: participants completed dental education ≤12 years ago; group 2: participants completed dental education >12 years ago. Proportions (%) are calculated based on the number of responders; the number of non-responders (missing) is given for each analysis.
[a]Unadjusted comparisons.

Table 3. Use of rubber dam during endodontic treatment and attitudes towards its use.

	Group 1 $n = 74$	Group 2 $n = 56$	Odds ratio (95% CI)
Use of rubber dam			
Never/rarely	2 (3.0)	14 (25.5)	0.09 (0.02–0.43)
Often/always	65 (97.0)	41 (74.5)	
Missing	7	1	
Agreement with the following statements			
1. 'Use of rubber dam does not influence the endodontic treatment outcome'			
Disagree	55 (91.7)	29 (69.1)	4.41 (1.39–13.99)
Agree	5 (8.3)	13 (30.9)	
Missing	14	14	
2. 'Rubber dam provides easier access to intervention site during endodontic treatment'			
Disagree	2 (3.2)	6 (13.6)	0.19 (0.03–1.05)
Agree	61 (96.8)	38 (86.4)	
Missing	11	12	
3. 'Rubber dam reduces the risk of mucosal damage during endodontic treatment'			
Disagree	3 (5.9)	7 (18.9)	0.24 (0.05–1.09)
Agree	48 (94.1)	30 (80.1)	
Missing	23	19	
Reasons for not using rubber dam[a]			Relative risk ratio (95% CI)
Reasons related to patients	7 (43.7)	20 (58.8)	1^{ref}
Technically challenging	5 (31.3)	5 (14.7)	0.32 (0.06–1.62)
Alternative ways of isolation (e.g. isolation with cotton rolls)	4 (25.0)	9 (26.5)	0.78 (0.17–3.57)
Missing	9	2	

CI: confidence interval.
Group 1: participants completed dental education ≤12 years ago; group 2: participants completed dental education >12 years ago. Proportions (%) are calculated based on the number of responders; the number of non-responders (missing) is given for each analysis.
[a]In all, 67 study participants (49 from group 1 and 18 from group 2) reported that they always used rubber dams and were therefore excluded from these analyses.

to the site of intervention (OR 0.19; 95% CI 0.03–1.05) (Table 3).

Eleven participants did not respond to questions dealing with instrumentation methods used during endodontic treatment and were therefore excluded from these analyses. The majority of responders (90 out of 119) used rotary instrumentation systems during endodontic treatment. The reciprocating system WaveOne was the most frequently used rotary system (79.6% and 53.3% in groups 1 and 2, respectively). However, dentists in group 2 more often used Protaper system (RRR 8.79; 95% CI 1.74–44.30) compared to group 1 (data not shown).

Two-thirds of the responders routinely used electronic apex locator during root canal treatment, and no difference was found between the two groups (data not shown).

The majority of the dentists (90.8%) used several irrigation solutions. Low concentrations of NaOCl (0.5–1%) and 17% EDTA were the most common components. As many as 93.2% of the dentists used $Ca(OH)_2$ as inter-appointment dressing, and IRM was the most preferred temporary filling material, either alone or in combination with other alternatives (e.g. glass-ionomer cement or Cavit®) (data not shown).

Use of radiographs

We also asked the participants about their routines regarding uptake of radiographs during endodontic treatment (Tables 4 and 5). Dentists in group 2 used master-cone (OR 0.05; 95% CI 0.02–0.19) radiographs less often compared to dentists in group 1, while no statistically significant differences between groups were observed with regard to preoperative and working length radiographs (Table 4).

Dentists reported frequent use of Eggen holder or having the patients hold the film during radiographic examination. Moreover, it was common that the dentists or dental assistants held the film themselves while taking radiographs. However, no statistically significant differences with regard to these routines were observed between groups (Table 5).

Check-up routines

Almost all dentists (128 out of 130) performed periodic check-ups following endodontic procedures varying from up to one year (21.7% of responders) to three years (17.4% of the responders), whereas 33.1% answered that they followed up the patients until they were free of symptoms. Longer follow-up periods (up to three years) were more common in dentists of group 2 compared to those in group 1 (25.5 vs. 11.0%), but the differences between groups were not statistically significant ($p = .087$) (data not shown).

Use of antibiotics

In recent years, attention has been directed towards antibiotic use due to the risk of developing antibiotic resistance. Therefore, we also included questions regarding antibiotic use during endodontic treatment. None of the responders in PDS prescribed antibiotics during symptomatic pulpitis, and few dentists prescribed antibiotics when patients had acute apical abscesses without fever. The majority of dentists prescribed antibiotics in patients with periapical abscess accompanied with fever (Appendix – Table S1). Overall, we observed statistically significant differences between groups

Table 4. Use of radiographs during endodontic treatment.

	Group 1 $n = 74$	Group 2 $n = 56$	Odds ratio (95% CI)
Pre-operative radiograph			
Never/rarely	1 (1.6)	3 (5.7)	0.21 (0.02–2.83)
Often/always	63 (98.4)	50 (94.3)	
Missing	10	3	
Working length radiograph			
Never/rarely	7 (10.6)	11 (20.8)	0.45 (0.15–1.34)
Often/always	59 (89.4)	42 (79.2)	
Missing	8	3	
Master-cone radiograph			
Never/rarely	3 (4.7)	23 (44.2)	0.05 (0.02–0.19)
Often/always	61 (95.3)	29 (55.8)	
Missing	11	3	
Do you remove the rubber dam when you take radiographs during treatment?			
Never/rarely	62 (93.9)	44 (89.8)	0.94 (0.14–6.29)
Often/always	4 (6.1)	5 (10.2)	
Missing	8	7	

CI: confidence interval.
Group 1: participants completed dental education ≤12 years ago; group 2: participants completed dental education >12 years ago. Proportions (%) are calculated based on the number of responders; the number of non-responders (missing) is given for each analysis.

Table 5. Routines on radiograph uptakes in endodontics related to years since graduation.

When you take radiographs during endodontic treatment	Group 1 $n = 74$	Group 2 $n = 56$	Odds ratio (95% CI)
Use Eggen holder for the X-ray film/sensor			
Never/rarely	24 (37.5)	22 (42.3)	0.90 (0.40–2.01)
Often/always	40 (62.5)	30 (57.7)	
Missing	10	4	
Patient holds the X-ray film/sensor			
Never/rarely	24 (38.1)	21 (41.2)	0.63 (0.26–1.49)
Often/always	39 (61.9)	30 (58.8)	
Missing	11	5	
Dentist or dental assistant/parent or accompanying person holds the X-ray film/sensor			
Never/rarely	47 (74.6)	42 (84.0)	0.51 (0.19–1.38)
Often/always	16 (25.4)	8 (16.0)	
Missing	11	6	

CI: confidence interval.
Group 1: participants completed dental education ≤12 years ago; group 2: participants completed dental education >12 years ago. Proportions (%) are calculated based on the number of responders; the number of non-responders (missing) is given for each analysis.

in the distribution of conditions for which antibiotics were prescribed ($p = .028$).

Narrow-spectrum antibiotics were often prescribed, whereas broad-spectrum antibiotics were almost never or very rarely prescribed by the study participants. We observed no statistically significant differences between groups with regard to types of antibiotics used (data not shown).

Referral to specialist (endodontist) and need for up-to-date information

Among the main reasons for referring patients to a specialist were (i) technical challenges before treatment or emerging during treatment, (ii) lack of equipment in the clinic or (iii) a combination of both.

Finally, we asked participants whether they were interested in a hands-on course in endodontics. A lower proportion of dentists in group 2 wished to participate in such courses compared to dentists in group 1 (OR 0.16; 95% CI 0.05–0.52) (Appendix – Table S2).

Discussion

We investigated both frequencies of and routines during endodontic treatment procedures among dentists in the PDS in Western Norway because such information has been sparse in Norway. Undergraduate endodontic training in Norway follows established endodontic guidelines. However, it is unknown whether dentists abide by these guidelines after graduation, or if time after graduation plays a role in the choice of routines in daily practice and/or adaptation to new technologies and guidelines in endodontics.

According to our results, the majority of dentists in the PDS of Western Norway have graduated from Norwegian universities, which means that they have followed similar curriculums during their education. There was a difference between the two counties, with Sogn & Fjordane having a higher proportion of recent graduates compared to Hordaland County. This may be explained by the fact that urban areas are more attractive to young people, but it is easier for recent graduates to find jobs in rural areas. Bergen, the second largest city in Norway, is located in Hordaland County.

Dentists did not perform endodontic treatment on a daily basis, but when they did, it was more frequently performed in adults than in children and adolescents. The older dentists reported less use of stepwise excavation of primary and permanent teeth than their younger colleagues did. They also reported less pulp capping of primary teeth, and the findings may indicate that the dentists with the longest experience perform less treatment of primary teeth with deep caries.

Recent evidence from randomized clinical trials significantly favours the stepwise approach as a predictable and reliable treatment for deep carious lesions in terms of avoiding pulp exposure, keeping the tooth vital and preventing development of apical periodontitis [8]. The difference in treatment approach of deep carious lesions between age/work experience groups may be because stepwise excavation has been lately included in treatment guidelines [9]. Whether the more experienced dentists choose to leave some caries in the deepest part of the dentin (partial excavation) and succeed with this approach is unknown. There is some evidence that partial excavation in young permanent teeth has higher success than stepwise excavation [10]. However, treatment variation is reported among general dental practitioners on deep caries treatment [11].

The reported use of rubber dams was high in this study (86.9%) compared to other reports. In a recent study from Denmark, only 29.0% of general practitioners used rubber dams (54.0% used apex locator) [12]. Studies from India [13] and Saudi Arabia [14] reported that only 27.0% and 21.6% of dentists used rubber dams, respectively. There are obviously large variations in rubber dam use between countries. In a survey from Norway among 105 general practitioners from both public and private sector, 81.0% reported that they always or often used rubber dams [15]. Taken together with the current findings, there is a high prevalence of rubber dam use among Norwegian dentists.

An interesting observation, however, was the more frequent use of rubber dams by young dentists compared to their older, more experienced colleagues. This was in contrast to the earlier study by Myrhaug et al. [15]. A relatively high number of dentist with $\leq$12 years of experience in our study (74 out of 130) may be an explanatory factor for this discrepancy. Moreover, this study showed that the young and more recent graduated dentists had strong beliefs about better working conditions and positive treatment outcome in relationship to rubber dam use. An influence of time since graduation on use of rubber dam has been reported, as general practitioners with more recent undergraduate training used it more often [12].

According to our findings, most of the dentists used rotary instruments for root canal instrumentation and electronic apex locator routinely, regardless of age and work experience. This finding indicates that the Norwegian dentists in PDS adapt to new technology. This is in contrast to a recent study from Denmark in which time from graduation was a negative factor in such adaptation among general practitioners [12]. The reciprocating system WaveOne was the most preferred rotary system among all dentists. However, the older dentists used more BioRace and ProTaper rotary systems. This finding is not surprising since the reciprocating system is relatively new, and older practitioners showed preference for other systems they had already learned to handle.

Radiograph uptake during endodontic treatment is critical for a good treatment result. There was a better adherence to the guidelines with more frequently reported radiograph uptakes during the different steps of the endodontic treatment procedure among dentists who graduated less than 13 years ago compared to those with more years since graduation, but a significant difference was only reached for master-cone radiographs. The reported use of apex locator was relatively high among the dentists independent of age and time from graduation, with 66.1% of the dentists using it always or often.

Complexities of the root canal systems, in addition to the dentin structure, are key challenges for effective disinfection in endodontics. Local antimicrobial agents such as NaOCl are commonly used in root canal treatment to combat microbial biofilms. Since the majority of dentists in this survey have graduated from Norwegian universities, they followed the protocols used in Norwegian dental schools for decades with low concentrations of NaOCl (0.5–1%) combined with EDTA for smear layer removal and calcium hydroxide as interappointment canal dressing. The use of calcium hydroxide dressing between appointments and IRM temporary filling material was in line with a previous report from Norway [15]. In addition, the participating dentists showed adherence to the guidelines regarding the use of antibiotics in the treatment of endodontic infections [16] and follow-ups after treatment [7].

We found that the youngest dentists within the PDS with more recent education were more eager to attend courses in endodontics, compared to their older colleagues. This may indicate that the younger practitioners consider endodontics a challenging area of dental practice and/or that they are more open for new knowledge.

Conclusions

All these findings indicate that dentists working in PDS of Western Norway generally follow the endodontic treatment guidelines and adopt new technologies. However, it seems that the dentists who graduated less than 13 years ago tend to adhere more to the taught principles in rubber dam use and radiograph uptakes during endodontic treatment. Furthermore, they perform more stepwise caries excavation in permanent teeth and deep caries treatment in primary teeth.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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