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Root canal treatment in Denmark is most often carried out in carious vital molar teeth and retreatments are rare

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Abstract

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Aim To study the reasons given by a representative sample of Danish general dental practitioners (GDPs) for undertaking root canal treatment and, to investigate their confidence in performing root canal treatment on molar teeth.

Methodology A questionnaire was sent to 600 Danish GDPs randomly selected from the roster of the Danish Dental Association. They were asked to recall various factors about their experience of the last root filling they completed, including the reason for treatment and the pulp diagnosis. Self-assessments on 100-mm visual analogue scales (VAS) were reported concerning the confidence in performing root canal treatment of a molar. End-point definitions were 'very easy' (0) and 'very difficult' (100), respectively. Time reports of molar treatments were given in categorized groups.

Results The most frequent reason for performing root canal treatment was caries within the tooth involved (55%). The majority of treatments involved teeth with vital pulps (54%). Retreatments were carried out in 2% of the cases. The confidence in performing root canal treatment varied but was relatively high, expressed as VAS-values below 50. The creation of an aseptic working field was regarded as the most difficult procedure followed by root canal preparation. Fifty-six percent of the responders stated a time frame of 46–75 min to complete root filling in a molar tooth.

Conclusions Root canal treatment in Denmark was reported to be undertaken most often because of caries. Treatment was typically performed in molar teeth with vital pulp. Even though apical periodontitis was frequently noted in root filled teeth, retreatments were rare. From a subjective perspective root canal treatment was not considered to be very difficult and was carried out relatively rapidly.

Keywords: aetiology of root canal treatment, caries, questionnaire survey, retreatment.

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Introduction

Although caries generally is regarded as the main aetiological reason for pulpal injury, the demand for root canal treatment does not necessarily decrease in a population with a decreasing caries prevalence. On the contrary, Bjørndal & Reit (2004) found a 17% increase in the annual frequency of root filled canals in Danish adults between 1977 and 2003. Essentially, this was due to (i) a drastic reduction of the tooth extraction rate, putting more teeth at risk of having pulp disease, and (ii) an increased treatment of multi-rooted teeth. In a sample obtained in Denmark from the Aarhus region in 1997–98, Kirkevang *et al.* (2001) found that molars had become the most frequently root filled tooth group. Thus, over time a change in the root canal treatment panorama was observed, from treatments mostly

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involving incisors and pre-molars to molars, hypothetically representing an increased frequency of technically demanding cases.

The reasons and indications for contemporary root canal treatment, as performed in general dental practice, are not well known. Although there is a large pool of potential retreatment cases, Reit *et al.* (1993) and Karlsson & Reit (1994) reported a low incidence of retreatment in two Swedish samples. Rather, they found that root canal treatment was most often performed as a consequence of symptoms such as pain and tenderness, and that treatment was instituted in teeth with symptomless chronic pathological processes more rarely.

The aim of the present study was (i) to study the reasons for root canal treatment as given by a representative sample of Danish general dental practitioners (GDPs), and (ii) to investigate their confidence in performing technically challenging root canal treatment of molar teeth.

Material and methods

In January 2004, a questionnaire was sent to 600 Danish GDPs. The GDPs were selected from the roster of the Danish Dental Association, which at that time listed 3293 members. The selection was carried out at random, with the acceptance of the Danish Dental Association, using a database software programme (Microsoft SQL Server 2000 Standard Edition, version 8.0.534, Minnesota, MN, USA). At present, no recognized post-graduate specialist training in Endodontology is available in Denmark; therefore, root canal treatment is almost exclusively performed by GDPs in private practice. The questionnaire was mailed, together with a letter guaranteeing confidential and anonymous processing of the data, and a stamped, coded return envelope. Nonresponders were identified by the code and approached by a second mail in March 2004. To the second-wave nonresponders phone calls were made.

The questionnaire asked for information regarding the age and gender of the responder as well as number of years in practice, employment status and the weekly number of working hours as well as the time devoted to endodontic treatments. The responder was asked to recall the last endodontic case they had undertaken and state the gender and age of the patient, the type of tooth treated, the reason for treatment and the pulpal diagnosis. In addition, the GDPs were asked to envisage root canal treatment of a mandibular molar and assess their confidence in making the access cavity preparation, providing an aseptic operating field (i.e. including the use of rubber dam), locating the canal orifices and instrumentation of the root canals. The assessments were made on 100-mm visual analogue scales (VAS), where end-points were marked as 'very easy' and 'very difficult', respectively. Furthermore, responders were asked to estimate the time taken to prepare the access cavity, perform mechanical root preparation and root filling, respectively, in a mandibular molar. The reports were categorized in five groups: ≤15, 16–30, 31–45, 46–60 and ≥61 min.

Statistical analysis

Summary statistics, including cross-tabulation tables, were carried out. ANOVA of the VAS-assessed confidence level was performed on the basis of mean values of each of the four questions. A stepwise model was applied. Model 1 addressed whether demographical factors such as gender, age and the year when dental qualification was obtained had any effect on the response pattern. Model 2 contained the variables employment status (clinic owner or associate), the number of clinical working hours per week, and the number of endodontic treatment sessions per week. Initially a model 1 analysis was performed followed by a step-by-step removal of nonsignificant variables. If significant variables were found, they were incorporated in model 2. Tests of independence were performed as Monte Carlo simulated exact tests using Digram (Kreiner 2003) for variables with categorical scales and with data not showing a normal distribution. Partial γ-coefficients (a nonparametric rank correlation, Upton 1999) were used to characterize the degree of association in these cases.

Results

The overall response rate was 79.2% ($n = 475$). Five questionnaires were returned blank and 18 were only partially completed. The major reason given for not responding was that the dentists felt too busy to complete the form. Also, 10 practitioners questioned the anonymity (the return envelope was coded) and did not want to take part in the study. The number of forms used in the final analysis was 452 (75.3%).

Fifty-three per cent of the responders were men. However, amongst younger dentists, a majority were women (Fig. 1). Seventy per cent of the GDPs were practice owners, and 88% worked 27 h or more per

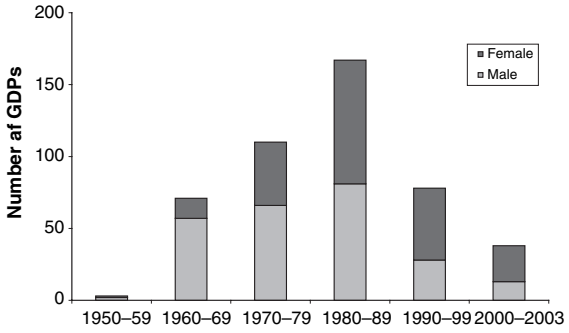

Figure 1 Distribution of gender and the year when dental qualification was obtained by the GDPs.

week. Fifty-two percent reported to have two to four endodontic treatment visits per week, and 28% had more than five.

The cases were most often associated with caries (55%, 95% CI: 50; 59%) and most treated teeth were molars (60%, 95% CI: 55; 65%) (Table 1). In a majority, the pulp was vital (54%, 95% CI: 49; 59%) (Table 2). Teeth with nonvital pulps were negotiated in 41% (95% CI: 36; 46%) and retreatments carried out in 2% (95% CI: 2; 2%). The typical patient was reported as being between 30 and 59 years of age (70%) (Table 3).

The confidence in performing root canal treatment varied amongst the GDPs (Table 4). The variation could not be explained by gender, years in practice or employment status, but GDPs working few hours with only one weekly endodontic treatment session found the negotiation of canals more difficult than colleagues spending ≥5 sessions with root canal problems per week (ANOVA, $P = 0.0385$). If mean VAS-values were compared, the creation of an aseptic working field (i.e. including the use of rubber dam) was regarded as the most difficult procedure (VAS 44) and preparation of the access cavity the easiest (VAS 24). However, the difference was not statistically significant.

When the root canal treatment of a mandibular molar was divided into access cavity preparation, mechanical preparation of the root canal and root filling, the GDPs reported spending most time with the canal preparation (Table 5). Females did use significantly more time than the men for any procedure, as expressed by the positive γ-coefficients (Table 5). Seventy per cent of the dentists reported that they needed

Table 1 Distribution of number of root filled teeth in relation to tooth type and the aetiology of the root canal treatment

	Caries	Dentine cracks	Pain[a]	Trauma	Defective restoration	Prosthetic retention	Inadequate seal	Old/large restoration	Apical radiolucency	[b]	*n* (%)
Incisors	23	0	6	21	3	11	3	0	0	1	68 (15)
Pre-molar	73	7	6	8	5	4	0	2	4	1	110 (24)
Molar	152	52	25	6	11	3	10	7	3	2	271 (60)
No inf.	2	0	0	0	0	0	0	0	0	1	3 (1)
n (%)	250 (55)	59 (13)	37 (8)	35 (8)	19 (4)	18 (4)	13 (3)	9 (2)	7 (2)	5 (1)	452

[a]When pain could not be placed in relation to the other reasons listed.
[b]Other information.

Table 2 Distribution of number of root filled teeth in relation to diagnosis and the aetiology of the root canal treatment

	Caries	Dentine cracks	Pain[a]	Trauma	Defective restoration	Prosthetic retention	Inadequate seal	Large restoration /crown	Apical radiolucency	[b]	*n* (%)
HealtyPulp	0	0	0	0	0	8	0	0	0	0	8 (2)
Pulpitis	155	45	17	8	4	2	2	2	0	2	237 (52)
Pulp necr. –AP	31	7	4	8	5	4	–	2	0	0	61 (14)
Pulp necr. +AP	58	7	16	19	9	2	2	5	7	1	126 (28)
Root-filled –AP	0	0	0	0	0	0	0	0	0	0	0
Root-filled+AP	0	0	0	0	0	0	9	0	0	0	9 (2)
Other/no Infor.	6	0	0	0	1	2	0	0	0	2	11 (2)
n (%)	250 (55)	59 (13)	37 (8)	35 (8)	19 (4)	18 (4)	13 (3)	9 (2)	7 (2)	5 (1)	452

[a]When pain could not be placed in relation to the other reasons listed.
[b]Other information.

Table 3 Distribution of number of root filled teeth in relation to age of the patient and the aetiology of the root canal treatment

	Caries	Dentine cracks	Pain[a]	Trauma	Defective restoration	Prosthetic retention	Inadequate seal	Old/large restoration	Apical radiolucency	[b]	*n* (%)
0–15 years	0	0	0	3	0	0	0	0	0	0	3 (1)
16–19 years	4	0	1	1	0	0	0	0	0	0	6 (1)
20–29 years	48	3	0	4	2	2	1	1	0		61 (14)
30–39 years	73	11	12	7	4	1	1	2	1	0	112 (25)
40–49 years	51	21	8	7	4	3	5	2	2	1	104 (23)
50–59 years	48	18	10	5	6	4	2	2	2	2	99 (22)
60–69 years	15	4	5	6	3	4	2	2	2	1	44 (10)
70–79 years	9	2	1	2	0	0	2	0	0	0	16 (4)
80+ years	0	0	0	0	0	4	0	0	0	0	4 (1)
No inf.	2	0	0	0	0	0	0	0	0	1	3 (1)
n (%)	250 (55)	59 (13)	37 (8)	35 (8)	19 (4)	18 (4)	13 (3)	9 (2)	7 (2)	5 (1)	452

[a]When pain could not be placed in relation to the other reasons listed.
[b]Other information.

	Preparation of access cavity	Negotiation of root canal orifices	Preparation of an aseptic working field	Root preparation
Male dentist				
VAS-values (mean ± SD)	23 ± 16	29 ± 18	44 ± 23	40 ± 20
Female dentist				
VAS-values (mean ± SD)	25 ± 17	31 ± 18	44 ± 22	40 ± 19

Table 4 Confidence scores as assessed by visual analogue scales, are presented in relation to the treatment of a mandibular molar. The end-points of the 100-mm VAS were marked as 'very easy' and 'very difficult', respectively

Table 5 Estimated time spent on treatment of a mandibular molar

Estimated time $n = 452$	≤15 min (%)	16–30 min (%)	31–45 min (%)	46–60 min (%)	≥61 min (%)	γ–coefficient (*P*-value)
Access cavity						
Men	213 (89)	24 (10)	0	3 (1)	0	$\gamma = 0.31$ ($P = 0.014$)
Women	173 (82)	34 (16)	3 (1)	2 (1)	0	
Mechanical root prep.[a]						
Men	31 (13)	142 (59)	50 (21)	14 (6)	2 (1)	$\gamma = 0.29$ ($P < 0.0005$)
Women	21 (10)	99 (47)	61 (29)	28 (13)	2 (1)	
Root filling						
Men	84 (35)	135 (56)	17 (7)	4 (2)	0	$\gamma = 0.20$ ($P = 0.010$)
Women	61 (29)	111 (52)	32 (15)	8 (4)	0	

[a]In two cases no information.

Table 6 Total estimated time for treatment of a mandibular molar

Total estimated time	≤45 min (%)	46–60 min[a] (%)	61–75 min (%)	76–90 min (%)	91–105 min[a] (%)	>105 min (%)
Number of GDPs $n = 452$	30 (7)	106 (23)	148 (33)	75 (17)	56 (12)	37 (8)

[a]In one case no information on estimated time in relation to mechanical root preparation.

more than 1 h to complete the treatment (Table 6). The median was 61–75 min. Positive correlations were observed between the time spent on treatment and the VAS-values in the confidence score regarding access cavity preparation (ANOVA; $P < 0.0001$), mechanical root canal preparation (ANOVA; $P < 0.0022$), as well as root filling (ANOVA; $P < 0.0261$).

Discussion

In the present study, the mailed questionnaire was accompanied by a confidential guarantee letter including a coded and stamped reply envelope. Nonresponders were first approached by a reminder card and finally by a telephone call (Tan & Burke 1997). The use

of coded reply envelopes led to failed responses by at least 1.7% of the GDPs. The final response rate (75.3%) was regarded as sufficient to make valid conclusions (Parashos & Messer 2004).

The results of the present study provide some evidence that caries is still the main cause of pulp disease and thus endodontic treatment in the Danish population. This situation is valid for all age groups except the youngest one, in which traumatic injury was a major reason for root canal treatment (Table 3). In older patients with a high frequency of restored teeth, cusp fractures and dentinal cracks might be expected to challenge caries as the major reason of pulp injury, but these possibilities were not reported frequently. Reasons for caries still being the main cause for root canal treatment could be that the teeth that were previously extracted due to caries amongst Danish children (Poulsen & Malling Pedersen 2002) might now be candidates for root canal treatments. Seventy-nine per cent of root fillings were attributed to caries and pulp disease in the 20–29-year age group in the present study (Table 3). It could be speculated that the first operative interventions in these deep carious lesions have been postponed over the years, and perhaps take place in an increasing group of so-called 'drop-out' patients, who do not attend the dental service on a regular basis (Petersen *et al.* 2003). In addition, the long-time consequences of the overall reduced caries progression (Marthaler 2004) mean that now it takes longer time for a cavity to progress to a deep stage. The level of clinical symptoms such as pain might also be reduced as the progression is slow. Taken together, the caries lesion may also become a potential candidate for root canal treatment, even without the patient has taken notice of the problem. However, the increased focus on the procedures of caries management, involving an understanding of pulp-dentinal changes in relation to rapidly and slowly progressing deep carious lesions (Bjørndal & Kidd 2005), may in the future lead to treatment of deep caries lesions that preserve pulp health (Bjørndal & Reit 2005a,b). In accordance with earlier studies (Reit *et al.* 1993, Karlsson & Reit 1994), root canal treatment was reported to be undertaken in teeth with clinical symptoms (Table 2). Pulpitis was the dominating condition, particularly amongst patients between 20 and 40 years of age (Table 3).

Epidemiological surveys have observed apical periodontitis to be associated frequently in root filled teeth (Eriksen *et al.* 2002). Also, reports from Denmark and other countries have pointed out high frequencies of sub-standard root fillings (Kirkevang *et al.* 2001, Dugas *et al.* 2003). In spite of these facts, retreatments were rarely reported (2%) by the GDPs in the present study. It is obvious that the mere diagnosis of a periapical lesion in a symptom-free root filled tooth (even if the root filling is inadequate) will not motivate a retreatment decision (Kvist *et al.* 2004).

The present study confirms recent reports stating that root canal treatment is now the most common in molar teeth (Kirkevang *et al.* 2001). Sixty per cent of the GDPs completed their latest root filling in a molar tooth. It is obvious that, over the years, the spectrum of root canal treatment has changed. Molars are now extracted less often and are preserved with root canal treatment if indicated (Bjørndal & Reit 2004). Thus, contemporary endodontic treatment will often involve technically demanding cases. Therefore, the GDPs were asked to assess the difficulty of various technical aspects of a molar treatment. Considering the high frequency of inadequate root fillings, the scores were found to be surprisingly low. All mean values were situated in the 'easy' half of the scale (Table 4). The preparation of an aseptic working field was given the highest mean VAS-value, and approached 44 when compared with 40 for root canal preparation (no statistical difference). In Denmark, as in other countries, rubber dam is rarely used by GDPs as a part of an aseptic working field (Saunders *et al.* 1999a, Jenkins *et al.* 2001, Slaus & Bottenberg 2002, Bjørndal & Reit 2005c). To produce asepsis without the use of rubber dam is difficult; and as a majority of the treated cases have vital pulps, the risk of microbial contamination is high, which, in turn, might be an explanatory factor for the high rate of periapical lesions observed in root filled teeth.

Fifty-six per cent of the responders estimated the time to treat a mandibular molar at between 46 and 75 min. Mechanical root canal preparation was reported as being the most time-consuming procedure. Compared with other self-reported time evaluations, this is relatively rapid. In a Scottish sample (Saunders *et al.* 1999b), the treatment of a single-rooted tooth was estimated to take about 70 min. It has been suggested that the attitude of working rapidly within endodontics is associated with a low economic incentive (Basmadjian-Charles *et al.* 2004). The time-cost dilemma was also elaborated by McColl *et al.* (1999).

Gender influenced the reported time spent on root canal treatment. Female GDPs reported using significantly more time to prepare an access cavity and the root canals as well as filling the canals. The impact of gender was also found in another Danish sample, in which female GDPs completed teeth with vital and

nonvital pulps in significantly more visits than males (Bjørndal & Reit 2005c).

Conclusions

The present study has found that root canal treatment in Denmark was still most often associated with caries and pulpitis. Treatment was typically instituted in vital molar teeth. Even though apical periodontitis is frequent in root filled teeth, retreatments were rare. From a subjective point of view, root canal treatment was not evaluated as 'very difficult' and was carried out rapidly.

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