The annual frequency of root fillings, tooth extractions and pulp-related procedures in Danish adults during 1977–2003

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Abstract

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Aim To investigate a hypothesized long-time decrease of endodontic treatment in a population with low caries prevalence.

Methodology A Danish nationwide database including almost all dental diagnostic, prophylactic and therapeutic procedures performed in Danish adults was available. Data on the annual frequencies of root fillings, extractions, pulpotomies, direct pulp cappings and stepwise excavations between 1977 and 2003 were analysed. Data on pulpal and periapical diagnoses were not available and on patients age and gender only from 1996.

Results Between 1977 and 2003 the annual number of root filled canals increased from 268 223 to 364 867 (36%). The annual number of root filled teeth increased from 160 119 to 191 803 (20%). During the period, the annually registered patients increased by 16%. Calculated per 1000 patients, the number of root fillings showed a statistically significant

increase of 17%. In root filled teeth the canal/tooth ratio increased from 1.67 to 1.96. Root fillings were frequently recorded in all age groups with the bulk of treatments performed on patients between 40 and 60 years of age. At a total population level, the rate of root fillings decreased among younger individuals and increased among older. The annual number of tooth extractions was more than halved from 656 624 in 1977 to 346 490 in 2003. Pulpotomies decreased markedly over the period and less than 10 treatments per 1000 patients were noted for pulp capping as well as stepwise excavation procedures.

Conclusions The present study failed to show a long-time decrease of endodontic treatment in a population with low caries prevalence. On the contrary, an increase of root filled canals was observed between 1977 and 2003, which was probably due to a reduction of the tooth extraction rate and an increased treatment of multi-rooted teeth.

Keywords: endodontic epidemiology, frequency of root fillings, pulp capping, stepwise excavation, tooth extractions.

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Introduction

Pulpal injury may be caused by several factors such as caries, trauma and dental procedures. Bacteria and bacteria-derived products may reach the pulp via carious lesions, leaking restorations or tooth fractures. Among these factors caries (including its sequelae) has traditionally been regarded as the main aetiological reason for pulpal disease (Trowbridge 2002). Within the last few decades, several western countries have seen a marked decline in caries activity in children and adolescents (Marthaler 2004) as well as in adults (Hugoson *et al.* 1986). Hypothetically, the decline in caries prevalence should imply a decrease in the incidence of pulpal disease and subsequently a decrease in the need for endodontic treatment in such

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populations. However, endodontic epidemiological surveys have mainly reported on the number of root filled teeth in various populations, while the time trend, in terms of annual treatment frequency, has attracted only scarce interest (for a review see Eriksen *et al.* 2002).

The prevalence of caries among Danish children has followed the international trend and decreased during the last three decades (Bille *et al.* 1986). Poulsen & Malling Pedersen (2002), for example, found that the mean of decayed, missed and filled surfaces (DMFS) in 15-year-old boys and girls changed from 6.68 in 1988 to 3.24 in 2001. The oral health status of the adult Danish population has also improved considerably during the past 15 years using the number of natural teeth present and the frequency of dental visits as oral health indicators (Petersen *et al.* 2003).

As a result of an economic agreement between the Danish Dental Association (DDA) and the Danish National Health Insurance (DNHI) in 1973, a nation-wide database was established. This database includes registrations of almost all dental diagnostic, prophylactic and therapeutic procedures performed in Danish adults since 1977. The aim of the present report was to explore the hypothesized long-time decrease of endo-dontic treatment frequency in a population with low caries prevalence, by analysing data from 1977 to 2003 in the register of the DNHI.

Materials and methods

The database

In 1973, an economic agreement was made between the DDA and the DNHI, implying that parts of the dental treatment costs for adult patients were to be funded by the DNHI. In order to receive government fees, dentists had to make a report to a central register. In 1977 a database became available, reflecting the dental service pattern from almost all general dental practitioners (GDP) treating adult patients in Denmark (Schwarz 1996). From 1977 to 1999, the fees for dental treatments were fixed, and the NHI-funded part for endodontic treatments accounted for about 40%. From 1999, only the part funded by the NHI was fixed. The annual number of actual and potential users (in this study defined as individuals ≥ 20 years of age) of the DNHI system is displayed in Fig. 1 (Danmarks Statistik - http://www.statistikbanken.dk). Over the years, the number of actual users increased by 16% and the potential users by 14%. In the first 10-year period of the database (1977–1987), only the number of performed treatments was recorded. Therefore, the number of patients in the files had to be estimated. Each patient, who actually went to a dentist during these years, received an average of 1.5 dental examinations, and on this basis the number of patients was estimated (Schwarz 1996).

Recorded treatment procedures

1. Root filling: In the register treatments were basically recorded per canal and not per tooth. However, a specific fee was received for the first canal of a tooth allowing a distinction to be made between the annual number of treated teeth and treated canals. In the number of 'root fillings', cases treated with endodontic surgery are also included. Information was not available regarding pulpal and periapical diagnosis.

2. Tooth extraction: Surgically removed teeth were not included.

3. Pulpotomy.

4. Pulp capping: DNHI funding started 1992.

5. Stepwise excavation: This treatment was included in the economic agreement in 1999, and was recommended when a deep carious lesion was clinically judged to lead to pulp exposure.

Patient characteristics

From the register, patient characteristics as gender and age were available as total counts in 1996, and as relative counts (per 1000 patients) in 1998.

Statistics

Time trends were statistically examined by linear regression analysis. Using the slope of the line of the regression (β) the analysis produced an estimate of growth per year and a 95% confidence interval ($\beta \pm 2$ SD). The null hypothesis (no growth) was rejected when *P* was less than 0.05. Positive values of β indicate positive growth, whereas negative values of β indicate negative growth.

Results

Root fillings

The DNHI recorded 268 223 root filled canals in 1977 and 364 867 in 2003, corresponding to a 36% increase. The number of root filled teeth increased



Figure 1 The annual number of potential (dark bars) and actual users (grey bars) of the DNHI system. The number of actual users are estimated up to 1987.

from 160 119 to 191 803 during the registered period (20% increase). The added number of annually performed root fillings was partly explained by an increased number of individuals (16%) using the NHI system (Fig. 1). As calculated per 1000 patients, the number of root fillings showed a statistically significant increase of 17% ($\beta = 1.1 \pm 0.24$; P = 0.000) (Fig. 2).

The ratio between the number of root filled canals and teeth increased continuously from 1.67 to 1.96 ($\beta = 0.014 \pm 0.000$; P = 0.000) indicating that more and more multi-rooted teeth were treated during the period.

The distribution of annually recorded root fillings over age and gender is displayed in Tables 1–3. Endodontic treatment was frequently recorded in all age groups with the bulk of treatments performed on patients between 40 and 60 years of age. During the last 6–8 years, small changes in the treatment pattern



Figure 2 The number of root fillings and extractions is observed per 1000 patients from 1977 to 2003. Data on number of patients are based on estimates (1977–1987) and actual figures reported (1988–2003).

were observed. The number of root fillings increased significantly among patients (actual users) in the youngest age group, and decreased among patients 60–69 years of age and over 80 (Table 2). When calculations were based on all potential users of the system, a contrasting picture emerged: decreasing rate of root fillings among younger people and increasing among older (Table 3).

Tooth extractions

The number of tooth extractions was more than halved during the period of the study, from 656 624 in 1977 to 346 490 in 2003 (Fig. 2). The reduction rate was most obvious during the first 10 years of the period. However, on a total population basis a continuous decreased rate of extraction was observed in the later years of the period, 1996–2003, among individuals below 70 years of age. Among older persons the rate increased (Table 4).

Pulpotomies, direct pulp cappings and stepwise excavations

The frequency of pulpotomies was substantially reduced through the period of the study, from 30 616 in 1977 to 2357 in 2003. In 2003, the total number of direct pulp cappings reached 15 090, and 18 610 stepwise excavations were recorded. Recorded treatment procedures, counted per 1000 patients over the years, are displayed in Fig. 3.

Discussion

With only small variations over time, 70% of the potential users of the system were annually recorded in

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Table 1	The total	number of 1	root filling:	s performet	d in relatio	n to age aı	nd gender									
Age	1996		1997		1998		1999		2000		2001		2002		2003	
groups	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
20–29	25 975	27 654	26 036	27 035	23 843	25 345	24 636	27 154	22 213	24 236	22 974	25 467	21 500	25 055	21 325	23 778
30–39	38 620	42 306	40 7 04	43 817	40 217	43 711	40 087	43 746	35 876	40 686	37 167	40 905	36 788	40 632	36 535	40 566
40-49	43 076	46 099	42 757	45 643	42 698	45 564	41 601	45 077	38 164	41 923	39 673	43 086	39 255	43 114	39 722	43 106
50-59	38 504	36 809	40 564	38 7 13	43 525	41 722	42 413	41 909	40 445	40 184	41 433	41 196	42 296	41 303	43 210	41 205
69-09	19 919	17 535	20 208	17 972	22 388	19 312	22 274	19 015	21 703	18 729	22 818	20 063	24 370	20 106	24 924	21 559
70–79	9362	9193	9497	9409	10 234	9963	9914	9377	9753	9046	10 031	9754	10 120	9586	10 468	9660
80+	2296	2880	2252	2851	2613	3396	2517	3230	2549	3335	2670	3304	2774	3591	2793	3630
Total	177 752	182 476	182 018	185 441	185 518	189 013	183 442	189 508	170 703	178 139	176 766	183 775	177 103	183 387	178 977	183 504

the DNHI database. In a questionnaire, Petersen et al. (2003) found that eight of 10 Danish adults reported that they made regular visits to the dentist and that only 9% had not seen a dentist through the past 5 years. In an international perspective, Danish adults are very frequent users of the dental health services (Petersen & Holst 1995). Within a major part of the observed period the DNHI funded about 40% of the total cost of an endodontic treatment. Hence, the economic incitement was high enough to believe that almost all endodontic treatments were reported.

The present study could not support the hypothesis that endodontic treatment frequency will decrease in a population with decreasing caries progression. Among Danish adults, 36% more root canals were filled in 2003 as compared with 1977. This addition can partly be understood as an expansion of the patient population (16%), and expressed as the number of root canals treated per 1000 patients the increase reached 17%. This observation can probably be explained by (i) the drastically reduced extraction rate, which has put substantially more teeth at risk of being pulpally injured, and (ii) the increased treatment of multi-rooted teeth. During the period, canal/tooth ratio increased from 1.67 to 1.96. The latter time trend was also found in a comparison of two radiographically examined samples from Aarhus, Denmark. In the later sample (1997-1998) molars were root filled more often than in the earlier studying period (1974-1975) and had become the most frequently root filled tooth group (Kirkevang et al. 2001).

A marked improvement of the oral health among Danish children and adolescents took place at the end of the 1970s and through the 1980s (Poulsen & Scheutz 1999). Ten years ago, in a study of Danish 20-year-old males, Ekstrand et al. (1994) reported a very low occurrence of endodontic treatment and concluded that the provision of dental health care to children had a remarkable long-term effect on the dental health status of young adults. However, from an endodontic point of view, data from the DNHI register show a somewhat different picture. Endodontics still seems to be an important part of the dental service provided. Although the bulk of root fillings is associated with middle-aged patients, endodontic treatment is common among younger as well as older individuals (Tables 2 and 3).

In recent years, some small but statistically significant changes were found. Based on the total Danish population ('potential users' of the DNHI), the number of annually provided root fillings decreased among individuals below 60 years of age, and

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Age groups	1998	1999	2000	2001	2002	2003	$\beta \pm 2 \text{ SD}$	<i>P</i> -value
20–29	102	110	103	113	114	116	2.6 ± 0.8	0.038
30–39	143	145	135	141	142	144	0.1 ± 1.8	0.955
40–49	156	154	144	150	150	151	-0.9 ± 2.0	0.429
50–59	156	151	141	143	145	146	-1.9 ± 2.2	0.175
60–69	139	132	124	127	125	123	-2.8 ± 1.6	0.029
70–79	113	106	102	106	103	101	-1.9 ± 1.4	0.057
80+	96	88	85	83	84	81	-2.5 ± 1.3	0.018

Table 2 The number of root fillings per 1000 patients (actual users) in relation to age. β denotes the slope of the line of regression, representing an estimate of growth per year

Age groups	1996	1997	1998	1999	2000	2001	2002	2003	$\beta \pm 2 \text{ SD}$	<i>P</i> -value
20–29	70	71	67	71	65	69	68	68	-0.2 ± 0.7	0.423
30–39	102	104	103	103	94	96	95	95	-1.5 ± 0.8	0.001
40–49	117	118	119	117	108	111	110	110	-1.5 ± 0.8	0.011
50–59	113	114	119	116	109	110	110	111	-0.8 ± 1.0	0.144
60–69	81	82	89	87	84	87	88	89	0.9 ± 0.7	0.046
70–79	50	51	55	53	52	56	54	57	0.8 ± 0.2	0.001
80+	25	25	29	28	28	28	29	29	0.6 ± 0.3	0.016

Table 3 The number of root fillings per 1000 potential users in relation to age. β denotes the slope of the line of regression, representing an estimate of growth per year

Age groups	1996	1997	1998	1999	2000	2001	2002	2003	$\beta \pm 2 \text{ SD}$	<i>P</i> -value
20–29	60	60	57	58	56	56	54	51	-1.1 ± 0.3	0.000
30–39	55	55	55	53	51	52	50	49	-0.9 ± 0.2	0.000
40–49	85	85	83	81	78	78	76	73	-1.7 ± 0.3	0.000
50–59	125	125	123	122	116	113	113	112	-2.3 ± 0.5	0.000
60–69	138	138	139	138	133	134	130	130	-1.4 ± 0.5	0.001
70–79	110	111	119	118	117	120	119	124	1.7 ± 0.7	0.004
80+	82	80	88	85	85	86	90	89	1.1 ± 0.7	0.013

Table 4The number of tooth extractions per 1000 potential users in relationto age



Figure 3 The number of pulpotomies, direct pulp cappings and stepwise excavations per 1000 patients as reported by the DNHI. The number of pulpotomies is estimated up to 1987. Data on number of patients are based on estimates (1977–1987) and actual figures reported (1988–2003).

increased among those above (Table 3). Similar changes were earlier described by Sundberg & Öwall (1989), who between 1974 and 1985 found a 51%

decrease in endodontic treatment among younger Swedish patients (20-29 years) and a 21% increase among patients older than 70 years. In the Danish population the observations might partly be explained by recent changes in the dental visiting habits of adults. In an interview study, Petersen et al. (2003) reported that in 1987, 35% of the participants at ages 65-74 years saw a dentist regularly compared with 66% in 2000. A decrease of patients regularly attending the dental service was found among young adults. In 1987, 90% of individuals at ages 25-34 reported to visit a dentist on a regular basis and 78% in 2000. In addition, studying the aetiology of endodontic treatment in a Swedish county, Reit et al. (1993) found that about one-third of the treatments performed on patients over 60 years of age were not directly aimed to cure pulpal or periapical pathosis. Frequently, root canal treatments were carried out for prosthodontic reasons.

During the period of the study, the number of pulpotomies performed was drastically reduced. This

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probably reflects that the old procedure of treating the curved root in a multi-rooted tooth with pulpotomy has become regarded as obsolete by the practitioners. Instead, the full canal is being instrumented and obturated.

Rather low frequencies of pulp capping and stepwise excavation were recorded. Studies have shown that both treatment methods can be applied with a good prognosis (Hørsted et al. 1985, Bjørndal 2002). The infrequent use among Danish dentists might be due to a preference for a more extensive pulp therapy, such as pulpectomy. However, it might also be a reflection of low caries prevalence in the population. The overall decline in the prevalence of caries can be understood as a reduced rate of disease progression (Thylstrup & Birkeland 1994). In addition, carious lesions may take longer to progress through enamel and dentine (Mejàre et al. 1998). Thus, it could be expected that a prolonged period is needed for caries to progress to the stage of causing irreversible pulp pathosis. Therefore, in the future, vital pulp therapies might change towards less radical and noninvasive methods (Murray et al. 2002, Smith 2002).

Conclusion

The present study failed to show a long-time decrease of endodontic treatment in a population with low caries prevalence. On the contrary, an increase of root filled canals was observed between 1977 and 2003, which probably was due to a reduction of the tooth extraction rate and an increased treatment of multirooted teeth.

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