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Establishment of a Danish endodontic practice-based research network: baseline data

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ABSTRACT

Objective: Clinical studies in endodontics are primarily performed in highly controlled environments using strict treatment protocols, inclusion and exclusion criteria, and high success rates have been reported. Most endodontic treatments are, however, performed in private practice, where is has been difficult to obtain similar high success rates. The aim of this pilot project was to evaluate the feasibility of performing practice-based research and to describe baseline information on endodontic procedures used in general practice in Denmark.

Materials and methods: The baseline data included information from dental practitioners, collected during 2017–2018. The dentists used the procedures and materials they normally would use. Data were systematized and analysed at Aarhus University.

Results: Seventeen dentists provided information on 581 endodontic treatments. Half of the teeth had initially a necrotic pulp, 20% had a vital pulp and 28% were previously root-filled. Adaptation of contemporary technology such as mechanized instrumentation, use of magnification, seems to be well integrated among the participating dentists.

Conclusions: Overall, the endodontic treatments performed by the participating dentists follow international guidelines for good quality endodontic treatments. It is anticipated, that among Danish dentist there is basis for further practice-based research, but logistic issues need to be addressed.

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Introduction

Dentist want to provide modern, evidence-based endodontic treatment to their patients, and dentists in private practice invest considerably in new technology for endodontic treatments. New root canal treatment systems, with new files, new sealers and obturation techniques continuously promise that root canal treatments can be performed faster and better. Despite this development, cross-sectional studies of endodontic treatments in general practice repeatedly demonstrate that a large proportion of endodontic treatments are of inadequate quality and a large proportion of root-filled teeth have apical periodontitis [1]. A Danish study with 10 years of radiological follow-up shows apical periodontitis in 40% of the root-filled teeth [2]. The epidemiological studies often have relatively large study populations, but limited information on intra-operative factors.

In patient-based cohort studies carried out in dental schools, universities and specialist practices the overall success rate for endodontic treatment is 80% or higher [3]. These studies are carried out on highly selected patient groups and teeth, treated according to a precisely defined treatment protocol, often by a dedicated specialist, so a high success rate is not surprising [1]. To improve the endodontic status in general dental practice there is a need for studies, which systematically record the treatment procedures and follow the results over time.

Furthermore, it has been proposed that there is a problem with the translation of knowledge from one environment to another, which delays implementation of new knowledge from research in general practice [4–6]. In an attempt to address these issues, clinicians have been engaged in research through practice-based research network.

In 2005, three practice-based networks were initiated in the United States, in order to bring research closer to the daily clinical practice. The initiative proved successful and the networks have been expanded and are now fully supported by the National Institute of Dental and Craniofacial Research (NIDCR) [7]. In other countries, similar practice-based networks have been established by dedicated general dental practitioners, who are willing to spend time and energy on generating new knowledge [8].

In 2017, a feasibility project was initiated in Denmark: Danish endodontic practice-based research network, organized as a collaboration between Aarhus Dental School and dentists working in private general practice. The purpose of the project was to clarify the possibilities of establishing and operating a practice-based research network in Denmark and to investigate and describe endodontic procedures used by Danish practitioners.

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Materials and methods

Establishing the network

Danish endodontic practice-based research network is a collaboration between Aarhus University and dentists from general practice in Denmark. The project was described and sent to the Science Ethics Committee region Midtjylland (notification number: 57871) and the Danish Data Protection Agency. The project was financially supported by the Danish Endodontic Society.

Inclusion of dentists

In spring of 2017, all members of the Danish Endodontic Society ($n = 197$) were invited to join the network. This society includes dentists from private practice, referral practice and from the dental schools, having a special interest in endodontics. In addition, the intention was to invite all dentists in private practice through the five regional parts of the Danish Dental Association. However, the invitation was not extended successfully in all five regions due to problems with the registered e-mail addresses and mailing lists. Thus, a final response rate could not be calculated.

Initially, 42 dentists responded to the invitation. Two introduction meetings were held, one at the School of Dentistry in Aarhus and one at the Dental Clinic Fredensborghus in Fredensborg. The meetings included review of studies from other practice-based research networks, clinical research methodology and a discussion among the participants on selection of items to be registered during the clinical examination and subsequent endodontic treatment. Further, a plan of the logistics of the project was developed. Some of the dentists decided not to be involved further in the project, mainly because of personal and/or logistic problems. Eventually, the 32 dentists participated in the introductory meetings (17 men and 15 women), who came from all over the country and represented general practice, referral practice and dental schools. The mean age of the dentists was 55.3 years (range 38.4–68.3 years).

Registrations

For all participating dentists, information about gender, age, year and place of education, and if they received referrals in endodontics was recorded. The dental practices were categorized according to number of dentists working in the clinic (single-unit practice, group practice), and patient type: municipal clinic (children and elderly/disabled patients), private clinic (adult patients) or combination clinics (all types of patients).

The clinical registration forms were discussed and adjusted to ensure a general understanding of the structure and content of the questions. The practical use of the registration form was tested by two dentists; one working in general practice and one working in an endodontic referral practice. During testing of the registration form, it was assessed that completion of the registration form would take 5–10 min.

The final registration form included 61 questions with up to five different answer options for each question (available on request). The registration form included information on: (1) age, gender, treatment date, (2) pre-operative factors (e.g. number of root canals, diagnosis, symptoms and residual tooth substance), (3) intra-operative factors (e.g. aseptic measures, use of magnification tools, irrigation, number of treatment sessions and root canal filling techniques and (4) post-operative factors (e.g. pain and post-operative restoration of the tooth). Pain was reported on a 10-step visual analogue scale (VAS).

Inclusion of patients

Patients received verbal and written information about the project, and were informed that they could withdraw their consent to participate at any time. The baseline data were collected during the period November 2017 to July 2018. During this period, all patients in need of endodontic treatment were offered to participate. Each patients could contribute with one or more teeth. Patients gave written consent to participate and consented to be scheduled for a control visit after one year.

Processing of data and statistical analyses

All registration forms and radiographs were sent to the Department of Dentistry and Oral Health, Aarhus University where they were recorded, systematized and coded. All variables, except age were categorical. For each tooth, the number of root canals was recorded. Within each tooth group, a threshold for extra root canals was defined: molars >3 root canals, lower premolars >1 root canal, upper premolars >2 root canals and front teeth >1 root canal.

When describing the intra-operative factors, the surgical treatments were excluded, since intra-operative procedures, e.g. irrigation protocol, root canal filling materials and techniques, differ considerably between surgical and non-surgical endodontic treatments.

Association between 'use of microscope' and 'number of extra root canals', was assessed by a chi-square test and Wilcoxon's signed rank test was used to assess the change in pain score. Stata (StataCorp, College Station, TX; release 15) was used for data management and statistical calculations.

Results

Dentists

Data in the baseline study were collected by 17 dentists, nine women and eight men. About half of the dentists were educated at the Dental School in Copenhagen and the rest at the Dental School in Aarhus. The participants represented primarily general dentistry and referral practices. A few of the participants also worked at the Universities. Four of the participating dentists were members of the Danish Dental Association, and 13 were members of both the Danish Dental Association and of the Danish Endodontic Society. The 17 dentists came from 15 practices (Figure 1). All



Figure 1. Geographical distribution of participating dentists and clinics. Some dentists work in two different practices and some practices have more than one participating dentist.

dentists worked in private practice, most in group practices and only three in single practices. Half of the dentists received referrals in endodontics. The median number of teeth treated by each dentist was 18.5, but the number varied considerably. Six dentists contributed with less than 10 teeth, and one dentist contributed with more than 100. The following sections describe data collected from 581 endodontic treatments performed on 551 patients.

Patients

The patient cohort included more women than men 55.2% and 44.8%, respectively. The median age of the patients was 57 years (range 10–96 years). Approximately, 60% of the patients were between 40 and 70 years old. When asked, the majority of patients (76.0%) answered that they were healthy, and almost just as many (69.3%) answered that, they did not take medication regularly.

Preoperative swelling was recorded in 54 cases (9.5%) (Table 1). In relation to half of the treated teeth, the patient experienced some degree of preoperative pain, and in 3.4% of the cases, the pain was characterized as unbearable (VAS 10). After treatment, fewer patients reported pain and if reported it was usually a mild pain (Figure 2). The change in pain from before to after root canal treatment was statistically significant ($p<.001$). Furthermore, flare-up between sessions was rare (6%).

Table 1. Pre-operative swelling: *n* (%).

	Extra-oral swelling		
Intra-oral swelling	No	Yes	Total
No	526 (91)	1 (2)	527 (91)
Yes	37 (6)	17 (3)	54 (9)
Total	563 (97)	18 (3)	581 (100)

Teeth

Pre-operative conditions and diagnoses

Figure 3 shows the distribution of the treated teeth according to tooth type. The most frequently treated teeth were first molars, followed by second molars and premolars. About half of the treated teeth had a direct coronal restoration, and 22% had an indirect coronal restoration (Table 2).

The most frequent pulp diagnosis was necrotic pulp, and the most frequent periapical diagnosis was chronic apical periodontitis. Less than 10% of the teeth had acute apical periodontitis and/or periapical abscesses (Table 3). Additional diagnoses included fistula (10%), carious lesions (16%), marginal periodontitis (10%), infraction (8%), fracture (2%), resorption (2%) and trauma (4%).

Intra-operative factors

More than half of the treatments were treatments of necrotic root canals, vital root canal treatments accounted for one-fifth of the treatments and one-third of the treatments were retreatments (Table 4). The number of treatment sessions

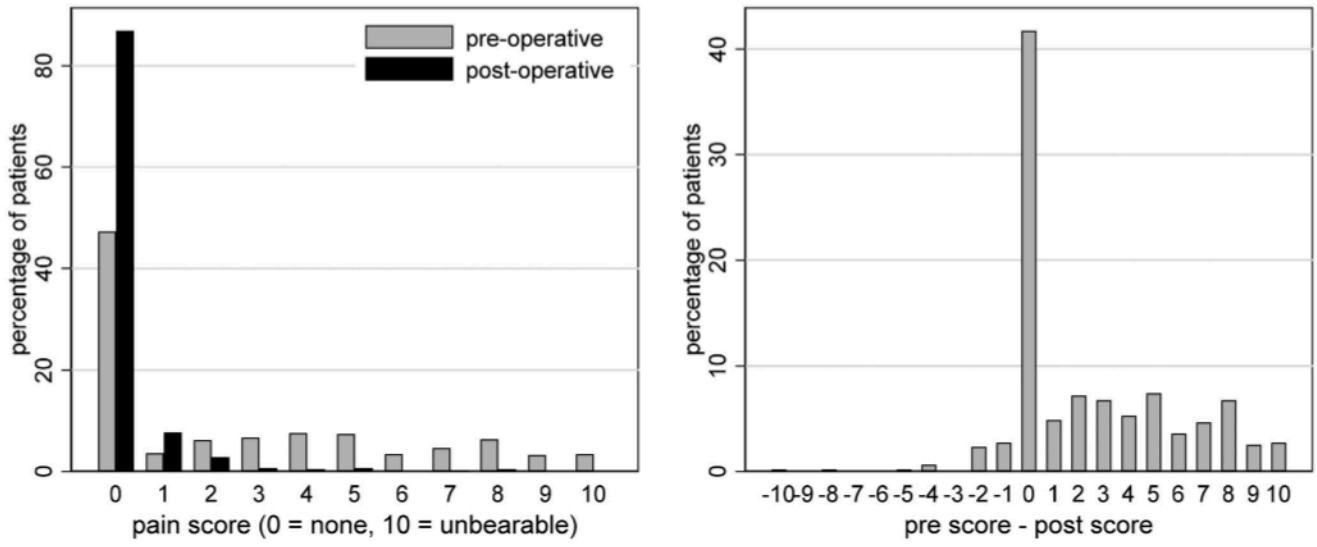


Figure 2. Left panel: pre- and post-operative pain score. Right panel: change in pain score (pre–post).

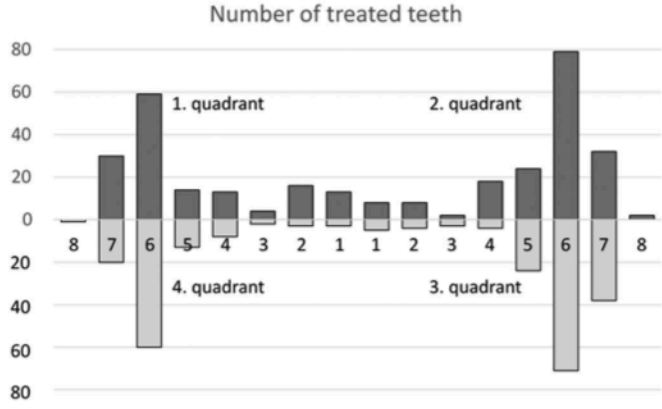


Figure 3. Distribution of endodontically treated teeth according to jaw and tooth number.

Table 2. Pre-operative coronal restoration.

Coronal restoration	*n*	%
None	106	18
Direct restoration	270	46
Indirect single tooth restoration	127	22
Bridge, abutment	34	6
Provisional restoration	44	8

Table 3. Pre-operative diagnoses: *n* (%).

	Periapical diagnosis				
Pulp diagnosis	Normal	Acute AP	Chronic AP	Abscess	Total
Normal pulp	11 (2)	0 (0)	1 (2)	0 (0)	12 (2)
Pulpitis	83 (14)	14 (2)	9 (2)	0 (0)	106 (18)
Pulp necrosis	41 (7)	34 (6)	130 (22)	16 (3)	221 (38)
Previously root-filled	7 (1)	10 (2)	150 (26)	5 (1)	172 (30)
Root canal treatment initiated	17 (3)	2 (3)	47 (8)	4 (1)	70 (12)
Total	159 (27)	60 (10)	337 (58)	25 (4)	581 (100)

AP: apical periodontitis.

ranged from 1 to 6, but most treatments were performed in one (46%) or two (42%) sessions.

Figure 4 shows the number of treated root canals according to tooth type and jaw. The instrumentation technique was glide path combined with either reciprocating or rotary files. In a few cases, only hand files were used (Table 4). In 14 cases, a file fracture (2.4%) was recorded. The use of rubber dam was by far the most common aseptic measure during treatment (Table 4). Sodium hypochlorite (NaOCl) 1–2.5% was used for irrigation in almost all cases (97%). Smear-layer was removed with EDTA (78%) or citric acid (14%).

Table 4. Intra-operative aspects of treatment.

Intra-operative factor	*n*	%
Type of endodontic treatment		
Root canal treatment, vital pulp	116	20
Root canal treatment, necrotic pulp	299	51
Non-surgical retreatment	114	20
Surgical retreatment	45	8
Other	7	1
Aseptic measures[a]		
None	8	1
Cotton rolls, suction	95	18
Rubber dam	432	82
Visual aids[a]		
None	31	6
Loupes	12	2
Loupes with light	195	37
Microscope	292	55
Instrumentation technique[a]		
Hand files only	8	2
Glidepath + rotating	204	38
Glidepath + reciprocating	318	60
NaOCl concentration[a]		
0.1	1	0.2
0.5	57	11
1	91	17
2.5	237	45
3	39	7
5	101	19
Root filling technique[a]		
Cold lateral condensation	22	4
Single point	218	41
Warm vertical/backfilling	276	52
MTA	12	2
Sealer[a]		
None	9	2
Epoxy-resin	269	51
$CaOH_2$	54	10
Zinc oxide	56	11
Silicate	98	19
Other	42	8

[a]Surgical revisions excluded. The sum differs from 536 due to missing values.

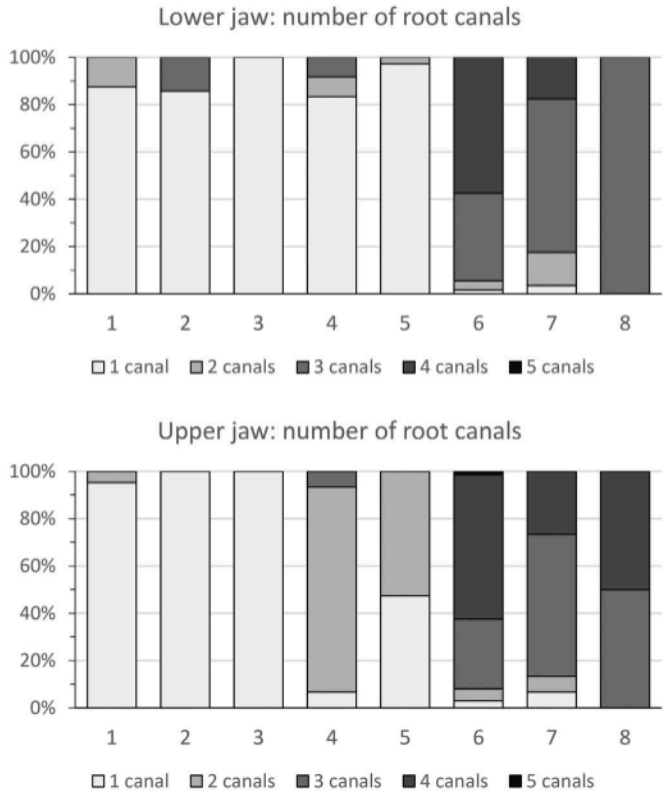


Figure 4. Distribution of detected root canals.

Almost all the dentists used magnifying aids, loupes with light or an operation microscope; therefore, most treatments were performed with the use of magnification (Table 4). The use of microscope resulted in detection of extra root canals in 41.4% of treatments, while no use of microscope resulted in detection of extra root canals in 25.1% of treatments ($p<.001$).

For obturation, the preferred techniques were either warm vertical technique and backfilling, or single cone technique. Cold lateral condensation was rarely used (Table 4). The preferred sealer was epoxy resin-based sealer (51%), followed by silicate cement-based (18%), zinc oxide eugenol-based (11%), and $CaOH_2$-based sealer (10%).

Discussion

The primary purpose of this feasibility study was to investigate the possibility of establishing a practice-based research network in Denmark, initially focussing on endodontics. Subsequently, to describe endodontic treatments performed in private practice in Denmark; patients, teeth and procedures.

The collection and transfer of data was challenged by regulations for protection of personal data. Furthermore, an extensive amount of both research and administrative resources was required to ensure a uniform labelling of radiographs and registrations sheets. Data management after data collection was considerable and included several extra contacts to the participating dentists for clarification of doubts.

It was concluded, that there was an interest and willingness to invest time in practice-based research among the participating dentists. However, practical issues regarding selection and inclusion of dentists, and the need for day-to-day management should be resolved in order to continue and expand the research network.

In Denmark, there is no recognized specialty in endodontics. In the present study, the dentists who received endodontic referrals were considered as having 'special interest in endodontics'. Since the study focussed on endodontics, it was not surprizing that about half of participating dentists received endodontic referrals. Consequently, it would be expected to find a relatively high proportion of difficult treatments, such as retreatments, among the treated teeth. In comparison, approximately one-third of teeth included in a US study were treated by specialists in endodontics [9]. Response rates ranged between 24% and 66% in the US studies [9–11], and some kind of self-selection must be expected, resulting in a high response rate among endodontists. An overrepresentation of difficult cases is a problem in all types of clinical studies, where the participating dentists have a special interest in research and/or speciality treatments.

The present study contains baseline data collected continually during the treatments. Among the advantages of concurrent data collection is the possibility to ensure a uniform data collection with few missing registrations. Accordingly, the proportion of missing registrations will be smaller compared to data from a retrospective or historical prospective study [12]. The US practice-based studies were questionnaire studies, and the gathered information was based on previous treatments, thus a higher risk of recall bias and missing information would be expected [9–11].

In the present study, the most frequently endodontically treated teeth were first molars. This was in agreement with data from epidemiological studies where the proportion of endodontically treated molars has been shown to be larger compare to premolars and front teeth [2,13–17].

Half of the patients experienced pain and/or discomfort pre-operatively, with an average of 2.7 on a scale of 0–10, where '0' corresponds to no pain/discomfort and '10' to unbearable pain/discomfort. For less than 20% of the teeth the pre-operative pain had been severe (>7). In comparison, a Swedish study found an average pre-operative pain of 3.35 on the VAS scale [17]. In the present study, the average pain was reduced to 0.5 post-operatively and only in 3% of the cases, severe pain was experienced. By comparison, the US network found that 50% of patients experienced severe pain pre-operatively, and 20% continued to have severe pain after completion of the endodontic treatment [18]. Thus, it may be concluded that endodontic treatment effectively reduces pain.

The present study included fewer teeth with a vital pulp, compared to other studies, in which about half of the endodontic treated teeth pre-operatively had a vital pulp [7,15,17,19]. The pre-operative diagnosis may affect the overall success rates, as it is known that an additional 10–20% of root canal treatments fail if a tooth preoperatively has apical

periodontitis rather than pulpitis [20]. It will be interesting to see how this will affect the overall success rate in the follow-up of present study.

The pre-operative diagnoses were recorded with both a pulpal diagnosis and a periapical diagnosis. In some cases, this resulted in contradicting diagnoses. For example, in 14 cases, the tooth was assessed as having both pulpitis and acute apical periodontitis pre-operatively. This may be explained by the fact that it can be difficult in practice to distinguish between diagnoses which are conditions occurring in a continuum. In the above-mentioned case, the tooth would then receive the diagnosis, acute apical periodontitis.

The proportion of retreatments was comparable with findings from a longitudinal, epidemiological study of endodontic status and treatment [13], but in contrast to findings from a questionnaire study were approximately half of the performed root canal treatments were reported to be vital cases, and few retreatments had been performed [19].

The use of magnification during the treatment, in particular, the use of a microscope, resulted in an increased detection and treatment of extra root canals, which is expected to have a positive impact on the treatment prognosis. It has been shown that using a high magnification during work gives a better view of the detail, and in particular, the location of root canals and treatment of iatrogenic complications is facilitated [21].

In the present study, rubber dam was used in 82% of endodontic treatments, which is a large proportion compared to previous studies. In 2003, a study reported that 5% of Danish dentists used rubber dam [22], and in 2013 another study reported that this number had increased to 29% [23]. In data from the US networks, 53% of dentists stated that they did not always use rubber dam [11].

NaOCl was the most frequently used irrigation fluid, combined with the use of a final flush with a chelating fluid such as EDTA or citric acid. NaOCl was used in varying concentration. This follows international guidelines and is comparable to the use of irrigation fluids in the US studies [11,24,25].

Mechanical instrumentation, reciprocating or rotating, was used for almost all treatments. This was an increase compared to previous studies of Danish dentists [22,23] and also a high proportion compared to approximately 60% of dentists in the US networks using rotary instrumentation [11,22,23].

Two techniques were quite prevalent in the root canal filling procedure; warm vertical technique combined with backfilling and single point technique, whereas lateral condensation was not used very often. In the practice-based studies from US, most dentists used lateral condensation (62%) or a carrier-based technique such as Thermafil (36%), and the single-point technique was rarely used.

Lateral condensation is still considered the standard root filling technique to which other, new techniques are being compared. Lateral condensation is also the root filling technique dental students have been taught at most dental schools. Single point technique may in many cases be considered as an inadequate technique. Most root canals are oval or ribbon-shaped in cross-section, and a circular point will not be able to fill the entire lumen of the root canal, therefore, the sealing of the root canal will rely on the sealer and its stability [11,26]. The high use of single point technique in the present study is surprising.

In the long term, a practice-based network can contribute new knowledge on which factors in endodontic treatment are particularly important for the outcome of the treatment, and thus contribute to the evidence base for treatment choices in dental practice.

Conclusions

Overall, the endodontic treatments performed during this study follow the internationally recommended guidelines. Adaptation of newer technology such as mechanical instrumentation as well as the use of magnification was high among the participating dentists. Furthermore, the relatively frequent use of rubber dam and consistent used of NaOCl as irrigant indicated high awareness of the role of bacteria in relation to prognosis of endodontic treatment. There is a basis for expanding and operating practice-based research networks in Denmark, but this would require extensive funding and development of an easy and transparent data collection.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

References

[1] Kirkevang LL. Clinical epidemiology: measuring endodontic disease and treatment outcome. Textbook of endodontology. 3rd ed. Oxford (UK): Wiley Blackwell; 2018.

[2] Kirkevang L-L, Vaeth M, Wenzel A. Ten-year follow-up observations of periapical and endodontic status in a Danish population. Int Endod J. 2012;45(9):829–839.

[3] Ng Y-L, Mann V, Rahbaran S, et al. Outcome of primary root canal treatment: systematic review of the literature – part 2. Influence of clinical factors. Int Endod J. 2008;41(1):6–31.

[4] DeRouen TA, Hujoel P, Leroux B, et al. Northwest Practice-based REsearch Collaborative in Evidence-based DENTistry. Preparing practicing dentists to engage in practice-based research. J Am Dent Assoc. 2008;139(3):339–345.

[5] DeRouen TA, Cunha-Cruz J, Hilton TJ, et al. Northwest Practice-based REsearch Collaborative in Evidence-based DENTistry (PRECEDENT). What's in a dental practice-based research network? Characteristics of Northwest PRECEDENT dentists, their patients and office visits. J Am Dent Assoc. 2010;141(7):889–899.

[6] Nixdorf DR, Law AS, Look JO, et al. National Dental PBRN Collaborative Group. Large-scale clinical endodontic research in the National Dental Practice-Based Research Network: study overview and methods. J Endod. 2012;38(11):1470–1478.

[7] National Institute of Dental and Craniofacial Research (NIDCR); 2020. Available from: https://www.nidcr.nih.gov/about-us
[8] Scottish Dental Practice Based Research Network; 2020. Available from: http://www.sdpbrn.org.uk/
[9] Bernstein SD, Horowitz AJ, Man M, et al. Outcomes of endodontic therapy in general practice: a study by the practitioners engaged in applied research and learning network. J Am Dent Assoc. 2012;143(5):478–487.
[10] McBride R, Leroux B, Lindblad A, et al. CONDOR Collaborative Group. Measuring the impact of practice-based research networks on member dentists in the Collaboration on Networked Dental and Oral Health Research, CONDOR. J Dent. 2013;41(5):393–403.
[11] Eleazer PD, Gilbert GH, Funkhouser E, et al. Techniques and materials used by general dentists during endodontic treatment procedures: findings from The National Dental Practice-Based Research Network. J Am Dent Assoc. 2016;147(1):19–27.
[12] Fletcher RH, Fletcher SW, Fletcher GS. Clinical epidemiology. The essentials. 5th ed. Philadelphia (PA): Wolters Kluwer, Lippincott Williams & Wilkins; 2014.
[13] Kirkevang L-L, Hörsted-Bindslev P, Ørstavik D, et al. Frequency and distribution of endodontically treated teeth and apical periodontitis in an urban Danish population. Int Endod J. 2001;34(3):198–205.
[14] Kirkevang L-L, Vaeth M, Wenzel A. Ten-year follow-up of root-filled teeth: a radiographic study of a Danish population. Int Endod J. 2014;47(10):980–988.
[15] Raedel M, Hartmann A, Bohm S, et al. Three-year outcomes of root canal treatment: mining an insurance database. J Dent. 2015;43(4):412–417.
[16] Fransson H, Dawson VS, Frisk F, et al. Survival of root-filled teeth in the Swedish adult population. J Endod. 2016;42(2):216–220.
[17] Wigsten E, Jonasson P, EndoReCo KT. Indications for root canal treatment in a Swedish county dental service: patient- and tooth-specific characteristics. Int Endod J. 2019;52(2):158–168.
[18] Law AS, Nixdorf DR, Rabinowitz I, et al. National Dental PBRN Collaborative Group. Root canal therapy reduces multiple dimensions of pain: a national dental practice-based research network study. J Endod. 2014;40(11):1738–1745.
[19] Bjørndal L, Laustsen MH, Reit C. Root canal treatment in Denmark is most often carried out in carious vital molar teeth and retreatments are rare. Int Endod J. 2006;39(10):785–790.
[20] Kirkevang LL. A population-based cohort study of changes in endodontic status over a 10-year period, 1997–2008. Dr. Odont. afhandling, Institut for Odontologi og Oral Sundhed, Aarhus Universitet; 2018.
[21] Jungnickel L, Kruse C, Østergaard Hjortdal J, et al. Visuelle hjaelpemidler under endodontisk behandling. Tandlaegebladet. 2017;122:900–904.
[22] Bjørndal L, Reit C. The adoption of new endodontic technology amongst Danish general dental practitioners. Int Endod J. 2005;38(1):52–58.
[23] Markvart M, Fransson H, Bjørndal L. Ten year follow-up study on the adoption of endodontic technology amongst Danish general dental practitioners. Acta Odont Scand. 2018;76(7):515–519.
[24] European Society of Endodontology. Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. Int Endod J. 2006;39:921–930.
[25] Fedorowicz Z, Nasser M, Sequeira-Byron P. Irrigants for non-surgical root canal treatment in mature permanent teeth. Cochrane Database Syst Rev. 2012;12:CD008948.
[26] Moinzadeh AT, Shemesh H. Root canal filling techniques. Textbook of endodontology. 3rd ed. Oxford (UK): Wiley Blackwell; 2018.