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ORIGINAL ARTICLE

Effects of an individualised training course in endodontics on the knowledge and insights of dentists in Public Dental Service in Norway

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ABSTRACT

Objective: To evaluate the knowledge and insights of general dental practitioners regarding endodontic diagnosis and treatment principles before and after attending a 2-days continuing education course.

Materials and methods: Sixty-seven dentists employed in the Public Dental Service in Møre and Romsdal county, Norway, were invited to a continuing education course in endodontics. Before and after the course, they answered a questionnaire weighing the importance of factors influencing the prognosis of endodontic treatment. The same questionnaire was answered by specialists in endodontics ($n = 56$; Spec Group) and a reference group consisting of general dental practitioners from both private and public practice ($n = 21$; Ref Group). The Test Group answered both before and after the course, while the Spec and Ref Groups completed the questionnaire once. The responses were compared using the Wilcoxon Sign test and Mann–Whitey *U* test.

Results: Of the 67 dentists in the Test Group, 49 (73%) completed the course and answered both questionnaires. Before attending the course, the Test Group differed significantly from the Spec Group in 18 out of 27 prognostic factors ($p \leq .05$). After the course, there was only moderate improvement in the Test Group responses. On only three factors, they agreed significantly more with the specialists than before attending the course ($p \leq .05$). After the Test Group participants had attended the course, their responses were comparable to the responses of the Ref Group.

Conclusions: A two-days continuing education course only marginally improved dentists' level of knowledge and insights regarding the influence of prognostic factors in endodontics.

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Continuing education; implementation; reciprocating technique; adoption; prognostic factors

Introduction

Epidemiological studies have shown a varying prevalence of apical periodontitis in root-filled teeth, ranging from 25 to 52% in populations of adults detected by conventional periapical radiography [1–5]. Data from Norway have shown a prevalence of apical periodontitis in root-filled teeth of 25% among children and adolescents and 43% among 35-year-olds [3,6]. Similarly, 34% of root-filled teeth in adolescents treated in the Swedish Public Dental Service were diagnosed with apical periodontitis [7]. In teeth with preoperative periapical lesions, the prevalence of persistent lesions is shown to be even higher, up to 60% [6,7].

Endodontic treatment performed at dental educational institutions or in specialist practice shows a higher success rate, 75–85% in teeth with apical periodontitis, and up to 97% in teeth without preoperative apical lesions [8–10].

A favourable outcome of endodontic treatment is dependent on its technical quality [2,11–19], and quality guidelines on root canal treatment have been published by the European Society of Endodontology (ESE) [20]. However, several studies show that root canal treatments in general dental practice are not always performed by the same standard as recommended by the guidelines [15,21–26]. There may be several reasons for this, including the individual dentist's knowledge, attitudes, and skills [27–29]. Thus, there is a discrepancy between best practice from research evidence and routine dental treatment in clinical practice, which is referred to as 'the science-practice gap'. It is a well-known issue, and the challenge is claimed to be educational [30–33].

Attempts have been made to assess the impact of educational interventions on practitioners' clinical endodontic performance. It has proven possible to change and improve clinical routines and the technical quality of the root fillings [7,28,34,35], but a corresponding improvement in the treatment outcome does not necessarily follow [7,28,34]. Furthermore, poor performers at the outset seem to continue to produce endodontic treatments of substandard technical quality also after educational courses [28,34,36].

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Supplemental data for this article can be accessed here.

As part of a quality assurance program in endodontics, all dentists in the Public Dental Service (PDS) of Møre and Romsdal county in Norway were given a continuing education (CE) course designed to improve clinical understanding and practice of endodontic treatment. The purpose of the present study was to evaluate the knowledge and insights of the participants towards endodontic diagnosis and treatment principles before and after attending the course. The hypothesis was that targeted continuing education will have a positive impact on the PDS dentists' knowledge and insight in endodontics.

Materials and methods

The study was approved by the Norwegian Centre for Research Data, NSD (Ref 39991).

Study participants

In 2015 a specially designed CE course in endodontics, consisting of two full-day courses (C1 and C2), was implemented as compulsory post-graduate training to all dentists employed in the PDS of Møre and Romsdal county on the Western coast of Norway. The PDS in the county consisted of 36 urban and rural dental clinics, with a total of 67 dentists (1–5 dentists per clinic). The dentists were assigned to three different groups with separate course days.

Courses

All dentists attended two full days of lectures and hands-on training, interrupted by a period of 5 months for self-training. The course was based on the pedagogic principle that most efficient learning will take place through interactive sessions, which enhance participant activity [33,35,37–39]. During the preparation of the course, the focus was on four factors previously identified to be especially important in the process of successful change, namely disclosed motivation, allowance for individual learning, continuous professional collaboration, and a facilitating educator [7].

Thus, the participants in the present course alternated between lectures, demonstrations and practical training. During the two course days, the participants attended 12 theory lectures, two video demonstrations, 4 sessions with hands-on training (255 min), 2 sessions of quiz, and 7 sessions of information, discussions, questions, and evaluation (110 min).

C1 contained lectures on endodontic aetiology, pathogenesis, diagnosis, prognostic factors, aspects of root canal treatment (treatment planning, field isolation including the use of rubber dam, preparation, irrigation, obturation), and a practical training session with the use of a reciprocating file system (Reciproc file system VDW, Munich, Germany). The file system was presented in detail, and root-canal preparation was demonstrated in a video. The obturation technique was with a single cone supplied when necessary with cold lateral condensation, demonstrated in a video, and one-to-one teaching sessions. A manual was prepared for the course, based on the ESE guidelines [20]. All dentists practiced root canal instrumentation and filling in plastic molars (VDW, Munich, Germany). Practical training sessions were held under guidance by two experienced endodontists with academic as well as clinical background (DØ & KJ). The PDS provided the necessary equipment including engines and files ('Dentsply X-Smart Plus Wave one' engine with 'Reciproc' files) to all clinics.

During the 5 months between courses, all participants performed the endodontic treatment on at least two teeth with the reciprocating technique and were asked to answer a questionnaire sent to them by e-mail. The questionnaire survey gave information on the topics where the participants had the least knowledge, and these topics were emphasised in the second course day to make the course as targeted as possible.

C2 contained lectures with a focus on orthograde retreatment, acute endodontic treatment, treatment of immature teeth, sealing of perforations, and repetition of practical training with the reciprocating file system.

Handouts of all lectures from C1 and C2, a manual describing the clinical procedures, as well as a new case report presented every week in the inter-course period, were available online by the course holders. The case reports were meant to give inspiration to the participants and keep up their interest. One of the course holders (KJ) was available for questions by e-mail throughout the time of the project. The participants were also encouraged to evaluate and provide feedback on the course content and format during the course, face to face, or by e-mail and in an anonymous course evaluation form after completing C2.

Questionnaires

Before C1, all Test Group participants answered a questionnaire regarding background factors such as gender, number of years in dental practice, the average number of root canal treatments normally performed per week and working procedures for endodontic treatment. In addition, the participants received a pre-education questionnaire (Q1) before C1 and an identical post-education questionnaire (Q2) after completion of C2. These questionnaires had a focus on the knowledge and insight related to pre-, per-, and post-operative factors perceived to influence the prognosis of endodontic treatment, and these topics were dealt with extensively in the course. The responses were scored on a 10-point continuous rating scale with a higher score indicating higher importance of the item. The answers from these questionnaires form the basis of this article. The course participants are referred to as the Test Group.

For comparison, Q1 was also sent to all 76 members of the Norwegian Society of Endodontology, of which 56 (74%) responded. These are referred to as the Spec Group. In addition, 21 post-graduate candidates in other dental specialties at the Faculty of Dentistry, University of Oslo also completed the questionnaire. These were all relatively recent graduates from dental schools with a minimum of 2 years of experience

in general dental practice including endodontics. They are referred to as the Ref Group.

Statistical methods

The data was analysed using SPSS version 26 software (SPSS, Chicago, IL, USA), and Python software was used to plot figures. Continuous and categorical variables were presented as mean (standard deviation) and frequency (percentage), respectively. The data was not normally distributed, and therefore non-parametric tests were performed. Wilcoxon Sign test and Mann–Whitey *U* test were used on paired and unpaired data, respectively. Snake-plots and heatmaps were used to highlight results obtained with the questionnaires to assess the effects of the training course. The significance level was set at $p < .05$.

Results

Eight of the 67 dentists in the Test Group were on leave or unable to attend the course and were excluded from the study. The remaining 59 participants in the Test Group were assigned to three subgroups – a pilot group of 12, and two separate groups of 23 and 24 participants. Of these, 49 (73%) completed the course and answered both questionnaires (Figure 1). The pilot course was judged satisfactory by the instructors and attendants, and no substantive change was introduced in the following two courses. The results from all three course subgroups were pooled and used in the analyses, i.e. answers from 49 participants were included.

Response to the background questionnaire

Background characteristics of PDS dentists are presented in Table 1. The majority of dentists were female; 45% had graduated less than 10 years ago, and 59% were educated in Norway.

A majority of clinicians performed endodontic treatment less than once a week, and 22% reported that 'it may take months between each time'. Thirty-seven percent of dentists reported that they always used rubber dam, and 31% reported to have routines for clinical and radiographic follow-up one year after root filling. Nearly half of the participants considered endodontic treatment to be difficult or very difficult.

Data overview

Endodontic prognostic factors were ranked according to their perceived significance. Mean scores with corresponding 95% confidence interval (CI) for pre-, per- and post-operative prognostic factors are presented in 'snake-plot' in Figures 2, 3 and 4, respectively. Numerical values of mean scores with 95% CI, and for the changes in scores for Test Group Q1 and Q2 are presented in the Supplementary section (Tables SII and SIII).

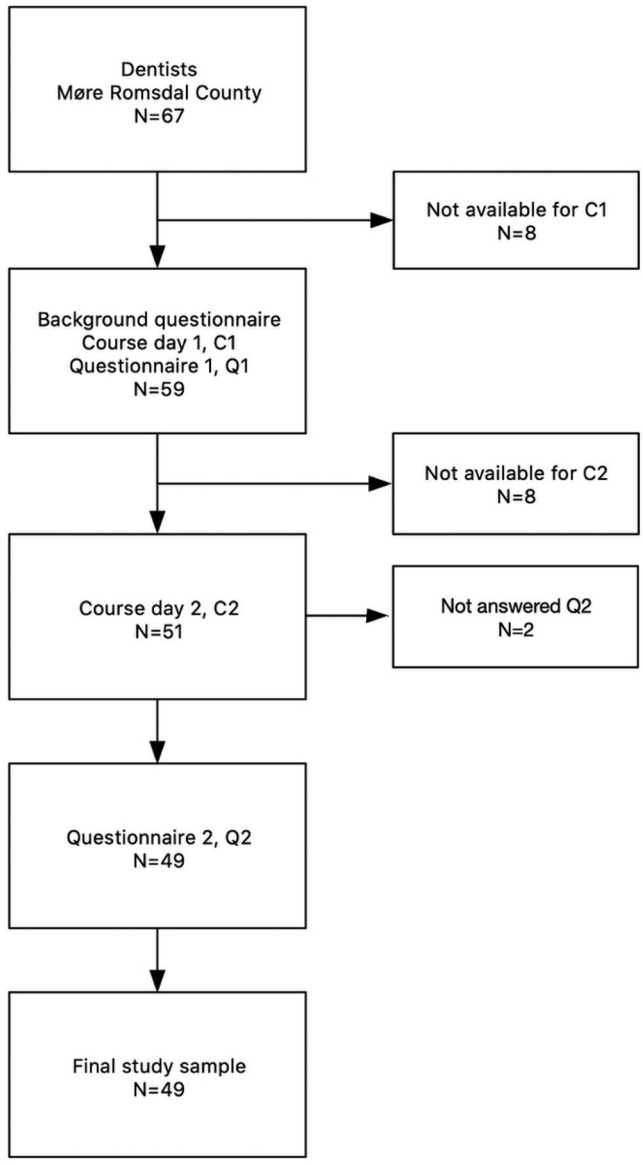

Figure 1. Flow-chart of study participants in the Test Group. Recruitment of participants, attendance at courses and completion of questionnaires by the Test Group.

Test-group response versus reference-group and specialists

Before training (Q1), the Test Group significantly over-evaluated 16 and under-evaluated 2 of the 27 prognostic factors perceived to influence the endodontic outcome compared to the Spec Group (Figure 5).

The Test Group was quite similar to the Ref Group in that only 7 responses in Q1 were different from the Ref Group before the course (Figure 5), but the Ref Group was somewhat closer to the Spec Group in that only 10 of the 27 issues differed significantly.

Test group responses before vs after the course (Q1 vs Q2)

After the course, only five of the 27 prognostic factors had changed significantly ($p \leq .05$) for the Test Group (Q1 vs Q2)

Table 1. Baseline characteristics of the Test Group participants.

	No	%
Baseline characteristics:		
Female	35	71
Age <40	25	51
<10 years since dental exam	22	45
Place of education:		
Oslo	14	29
Bergen	15	31
Abroad	20	41
Have you participated in theoretical endodontic training the last 5 years?		
Yes	17	35
No	31	63
Missing	1	2
Have you participated in practical endodontic training the last 5 years?		
Yes	12	24
No	37	76
How often do you perform endodontic treatment?		
About 1 time, or more, in a regular week	11	22
1–3 times a month	27	55
It may take months between each time	11	22
Which root filling technique do you use?		
Only manual technique	30	61
Both manual and mechanical technique	14	29
Mainly mechanical technique	5	10
Which of the following three claims suits your treatment procedures best?		
Regardless of diagnosis; dressing and filling in a later session	30	61
One-step in vital teeth, dressing in necrotic teeth	18	37
Regardless of diagnosis; one-step	1	2
Do you discuss the expected treatment outcome with the patient?		
Always	26	53
Almost always	15	31
Often	5	10
Rare	2	4
Almost never	1	2
Never	0	0
I take an initial preoperative radiograph:		
Always	40	82
Almost always	6	12
Often	2	4
Rare	1	2
Almost never	0	0
Never	0	0
I use rubber dam:		
Always	18	37
Almost always	17	35
Often	4	8
Rare	5	10
Almost never	1	2
Never	4	8
I take working length radiograph:		
Always	29	59
Almost always	9	18
Often	6	12
Rare	2	4
Almost never	1	2
Never	2	4
I use apex locator:		
Always	20	41
Almost always	8	16
Often	5	10
Rare	6	12
Almost never	1	2
Never	9	18
I take finishing radiograph:		
Always	38	78
Almost always	6	12
Often	3	6
Almost never	1	2
Never	1	2
Which of the following claims suits your treatment procedures best?		
I usually need more treatment sessions to prepare single-rooted teeth	1	2
I usually need more treatment sessions to prepare multi-rooted teeth	29	59
Regardless of the number of canals I usually finish in one session	19	39
How difficult do you think endodontics are?		
Very easy	0	0
Easy	0	0
Medium	25	51
Difficult	21	43
Very difficult	3	6

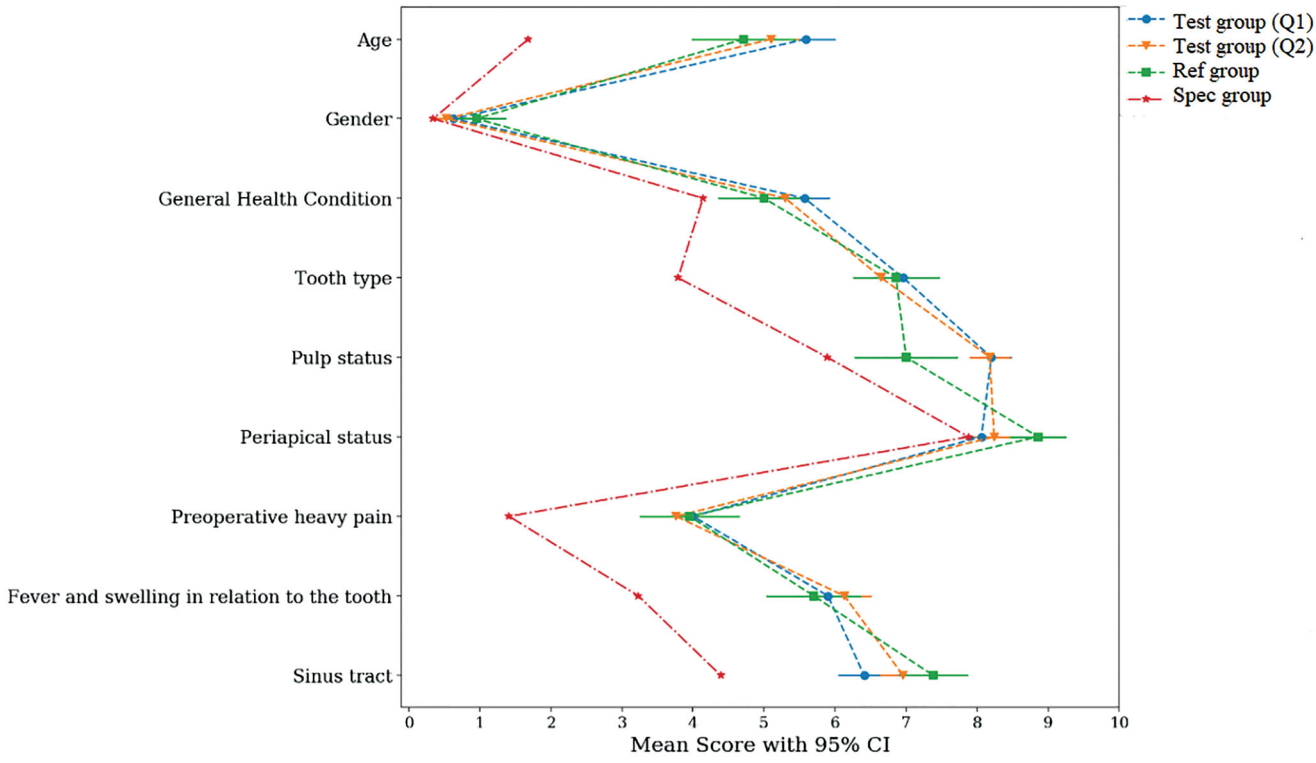

Figure 2. Snake plot of responses by the Test Group (Q1 and Q2), the Ref Group and the Spec Group to preoperative factors perceived to influence endodontic treatment outcome.

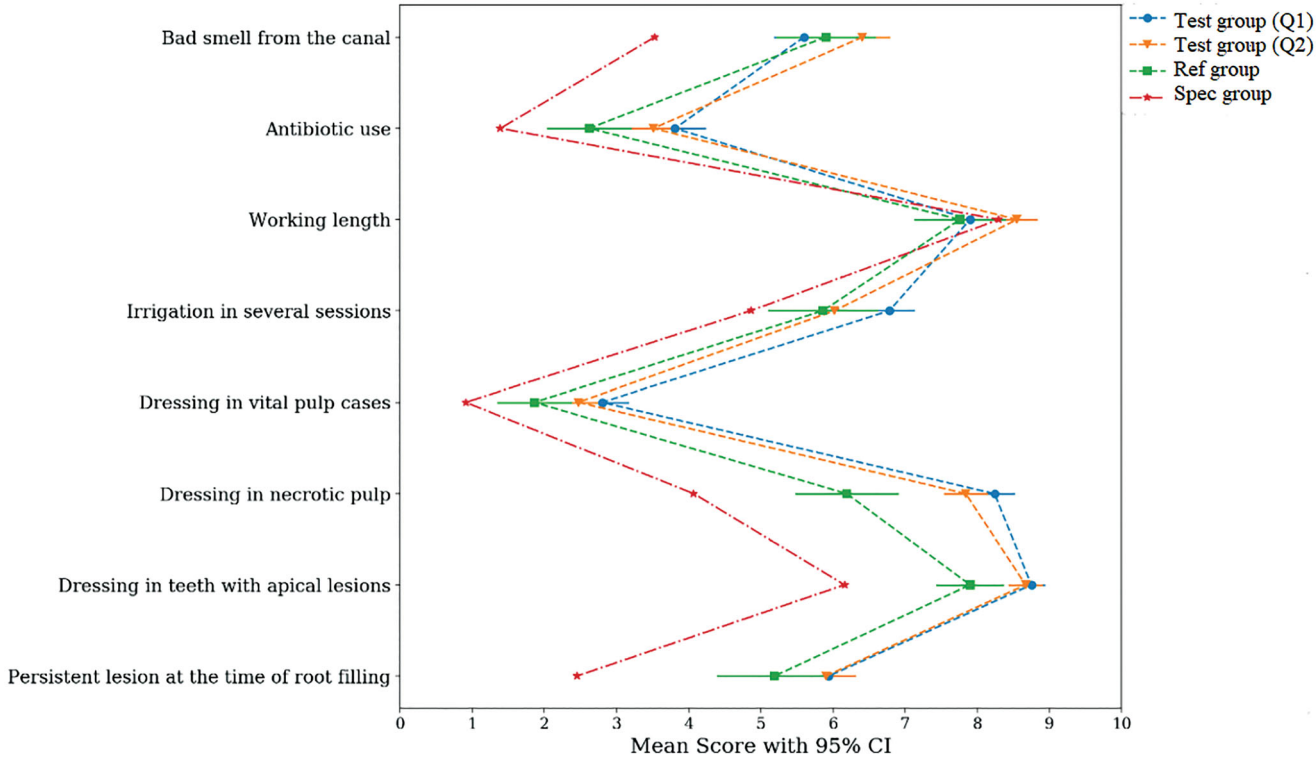

Figure 3. Snake plot of responses by the Test Group (Q1 and Q2), the Ref Group and the Spec Group to peroperative factors perceived to influence endodontic treatment outcome.

(Figure 5). Two of these five factors, use of tooth as an end abutment in a bridge and lack of approximate contacts, changed to become even more divergent from the Spec Group after the course (Figure 4). The three factors that changed to become more aligned to the Spec Group, overfilling with sealer, a plug in the root canal opening and top filling quality, had an average change of 0.9 on a continuous scale of 0–10. The lack of change in the response of the Test Group before- and after the course was especially evident for the preoperative prognostic factors (Figure 2).

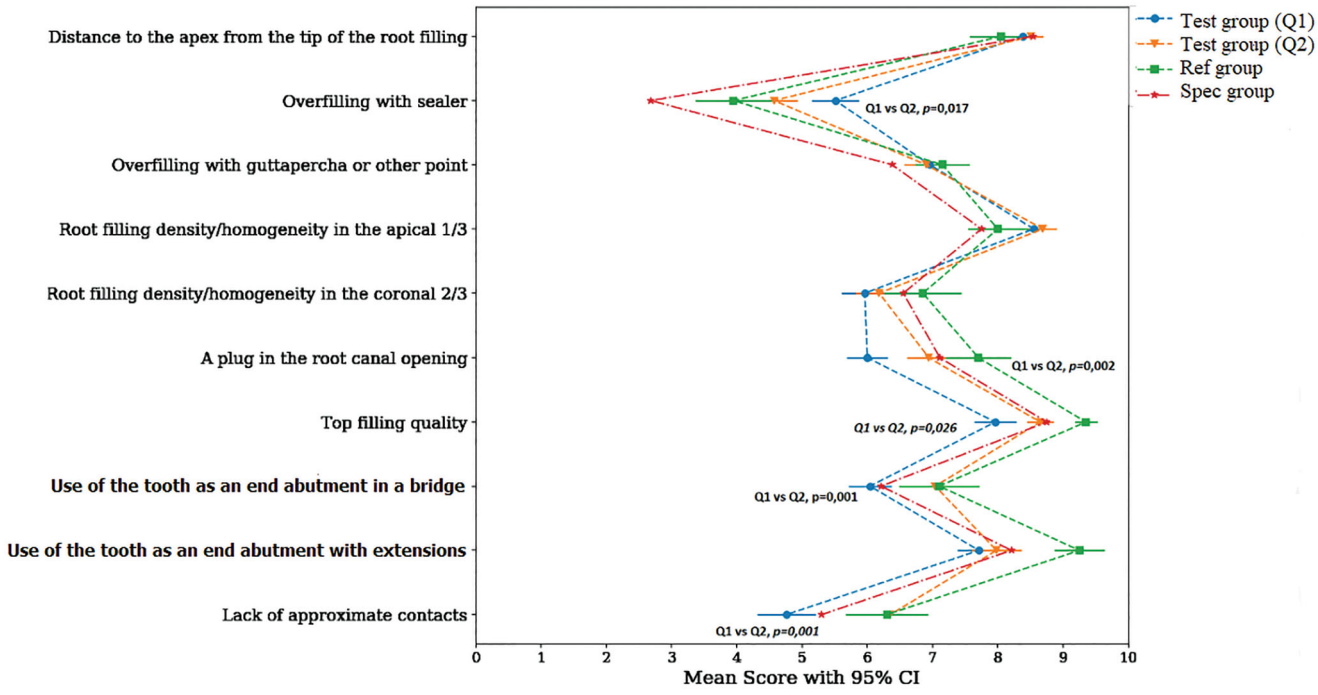

Figure 4. Snake plot of responses by the Test Group (Q1 and Q2), the Ref Group and the Spec Group to postoperative factors perceived to influence endodontic treatment outcome.

There were no significant changes in mean values of the responses on preoperative prognostic factors among course participants (Figure 2).

Test-group responses in relation to background characteristics

There were minor differences in the knowledge before and after course among Test Group in relation to gender, years in practice, place of education and use of rubber dam (Figure 6).

Discussion

Forty-nine of the 67 dentists (73%) employed at the PDS in Møre and Romsdal county completed the course and answered all questionnaires. Dropout was due to changes in employment and should not bias the validity of the study. The response rate is considered high enough to draw some conclusions, albeit with caution.

It was hard to find true scores for value-laden questions of the type used in the present study. Bjørndal et al. [40] used a pool of teachers and academicians to identify 'true scores' in a similar assessment of relative importance of prognostic factors. We chose the Norwegian community of formally trained endodontists as a valid and relevant source of up-to-date knowledge and insight. They are supposed to provide optimal clinical services to the public, and one may consequently assume that this is based on optimal use of theoretical and practical knowledge.

The reference group consisted of postgraduate candidates in dental specialty programs. Dentists admitted to specialist education are relatively recent graduates who should have up-to-date knowledge and insight, but who have had some exposure to clinical practice and attitudes prevalent in non-academic, non-specialist environments. Based on the answers from the background questionnaire, the Test Group appeared to be representative of practitioners in the PDS in other parts of Norway [41,42]. The background-questionnaire revealed that several generally accepted clinical routines were not routinely applied by a large proportion of dentists. Only 37% reported that they always use rubber dams during treatment; a procedure which is widely accepted as a standard of care according to the quality guidelines of the European Society of Endodontology [20]. Previous studies have indicated that many dentists abandon the use of a rubber dam for endodontic procedures as soon as they have finished dental school [43–45]. Myrhaug et al. [46] also found varying adherence to standard endodontic practices among Norwegian dentists.

The responses from the Test Group before attending the course were different from specialists in 18 out of 27 questions, demonstrating a quite large discrepancy in knowledge. From the pre-course questionnaire, it would seem that there is a potential for improvement by a structured course with emphasis on the issues reflected in the questionnaire. However, the results from the questionnaire responses test held after the course showed that there was only a very limited effect on the responses of the participants, which only marginally moved towards the specialists' responses. There appeared to be only small or negligible differences among subgroups within the Test Group, be it gender, age or place of education (Figure 6).

Seven responses from the Test Group differed from the Ref Group before the course. This was reduced to one after the course (Figure 5). Even though it is difficult to achieve the level of specialists, the course seemed to have brought

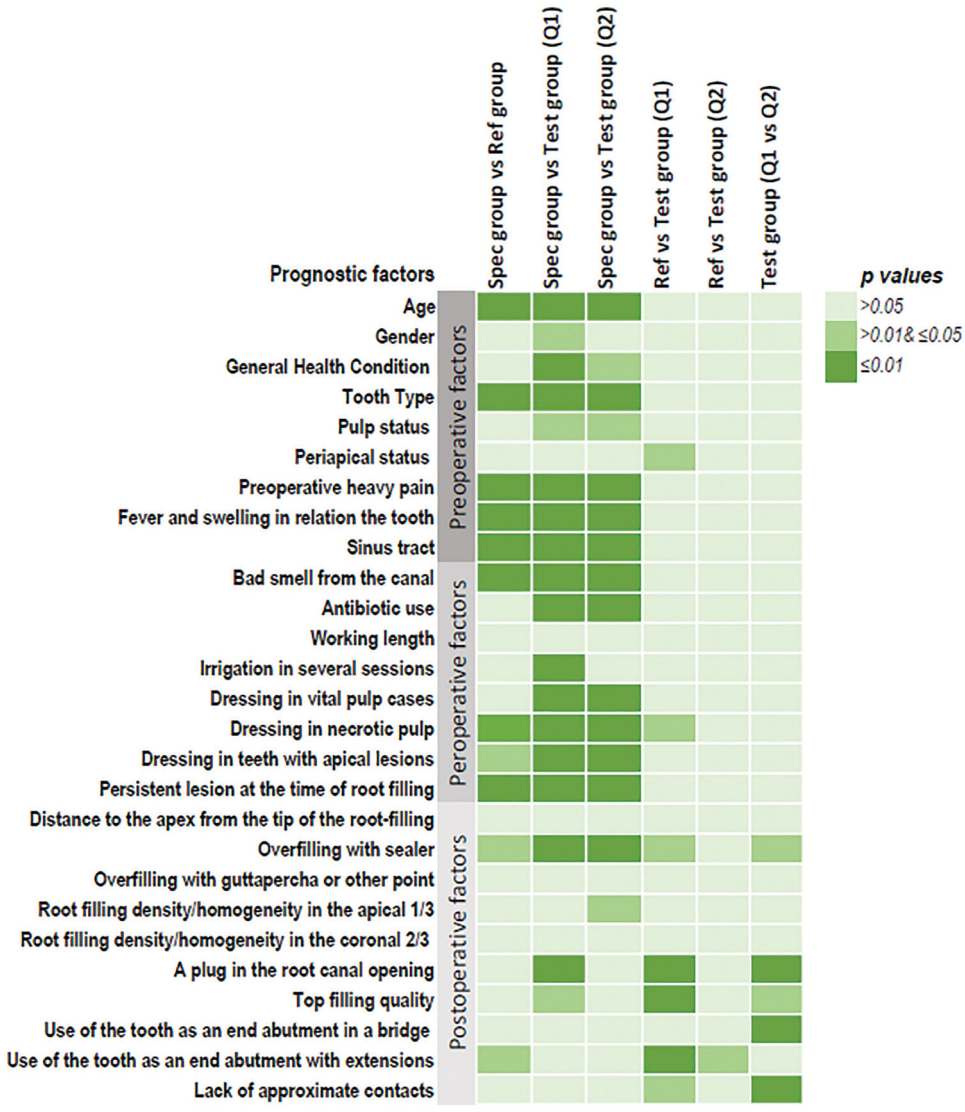

Figure 5. Differences in scores between pairs of Group scores. Significant differences between Groups are shown with bold colours.

the dentists in the Test Group to the knowledge level of the Ref Group (Figure 5).

Clinical signs and external factors such as 'preoperative heavy pain', 'fever and swelling', and 'bad smell from the canal' were overestimated as prognostic factors to influence endodontic prognosis by both the Test Group and the Ref Group compared to the Spec Group.

Apparently, general practitioners tend to believe that the prognosis of endodontic treatment is more dependent on tooth-related factors than on operator-related factors. These findings are in line with the study by Bjørndal et al. [40], who also studied differences in knowledge between general practitioners and specialists. They found that general practitioners in Denmark assigned greater influence on preoperative factors such as clinical symptoms compared to a group of academic experts. The practitioners also underestimated the microbial aetiology of endodontic disease and accepted root-fillings of low technical quality as long as symptoms were prevented [40].

In the present study, the Test Group responses continued to differ significantly from the Spec Group response also after a 2-days CE course. This was especially evident for the preoperative prognostic factors that have little to do with the treatment itself (Figure 5) and suggests that it is difficult to change knowledge and attitudes that have already been incorporated into the individuals' daily practice.

There are few examples of systematic follow-up of continuous dental education activity in the literature. Studies investigating the effect of dental CE courses are limited to evaluating the effect of implementing new root canal filling techniques or/and to evaluating the quality of root filling performed before and after the course [7,28,34–36,47]. Possible changes in understanding, attitudes, and theoretical knowledge have to the best of our knowledge not previously been reported. Although continuing education may have an effect on technical quality after adaptation to new techniques [7,28,34,36], it does not necessarily affect dentists' knowledge, insight, and attitudes. A study from Koch et al. [7] evaluated endodontic outcomes after a CE course. The findings showed improvement in the technical quality of root-fillings after the course, but no improvement in periapical conditions of root-filled teeth. [7].

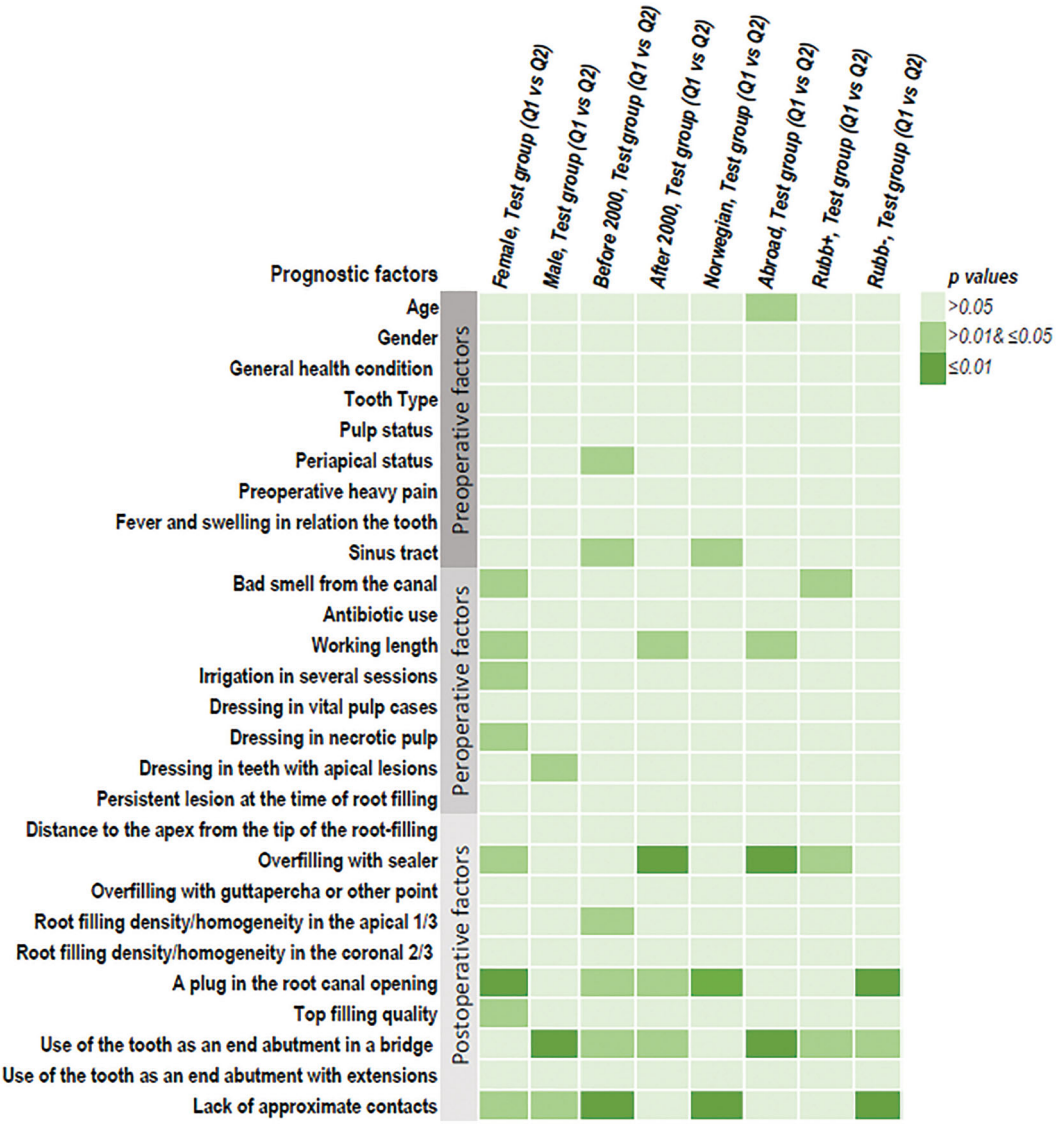

Figure 6. Changes in scores from Q1 to Q2 between subsets of the Test Group. Significant differences between subsets are shown with bold colours.

In the present study, efforts were made to prepare and plan the CE course to be of the best possible benefit to the participants. In the post-course evaluation-form, the participants' thoughts on the benefits of different aspects of the course had a mean score of 6.8 on a scale of 0–10. This relatively high score was unfortunately not accompanied by a corresponding improvement of knowledge and attitudes.

One may speculate about the reasons for the limited effect of attending a fairly standard type CE course like this. One possible explanation could be the lack of reinforcement by usage in daily practice. Most dentists in the Test Group reported that endodontic treatment was not often performed. It is also possible that a two-day course may be too limited to effectively change routines and attitudes incorporated through a professional career. Furthermore, the ratio of teacher-to-student (2–24) in the subgroups may have been too small for effective interaction, and some participants may have been uncomfortable asking 'stupid questions' in front of a large group. Finally, only two course participants took advantage of the offer to contact the course provider by e-mail for questions in the interim period. It might be that a closer follow-up of the participants in between the course sessions, e.g. with clinic visits by the course holders, would have increased the effect of the course. However, with many clinics involved, this approach was considered too resource intensive.

In conclusion, a two-days continuing education course for the dentists in PDS did not substantially improve their level of knowledge and insights regarding the influence of pre-, per-, and post-operative prognostic factors in endodontics. Findings from the present study suggest that postgraduate training of dentists is challenging, and more knowledge is needed on implementation of new knowledge and changes of established daily procedures among clinicians.

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Disclosure statement

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

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Data availability statement

Data not available due to ethical restrictions.

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