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Effect of educational intervention on adoption of new endodontic technology by general dental practitioners: a questionnaire survey

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Abstract

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Objectives To survey the clinical endodontic protocols of general dental practitioners (GDPs) in public dental clinics and to assess the effect of an educational intervention on the adoption of a nickel–titanium (Ni–Ti) rotary system.

Methods General dental practitioners in a Swedish Intervention County (IC), underwent an educational programme in endodontics. A follow-up questionnaire was posted to 98 GDPs in the IC and to 97 GDPs in a Control County (CC), where no specific training had been provided. The questionnaire concerned demographics, clinical endodontic protocols and instrumentation techniques.

Results The response rate to the questionnaire was 87%. More than 90% of all GDPs reported they always or generally used rubber dam, determined working length, used the canal irrigant 0.5% buffered NaOCl and calcium hydroxide as an interappointment dressing. Two of three GDPs reported, they generally or always informed the patient of the prognosis. Every second GDP reported routines for postoperative recall and follow-up.

The Ni–Ti rotary technique was reported to be completely adopted by 77% of the GDPs in the IC, significantly higher than in the CC (6%), $P < 0.001$. In the IC 79% of the GDPs reported they completed instrumentation in one treatment session, compared with only 32% in the CC, $P < 0.001$. The 'single-cone' mode of canal filling was reported to be significantly more frequent amongst GDPs in the IC, $P < 0.001$.

Conclusions General dental practitioners in both counties reported using contemporary clinical endodontic protocols. GDPs who had undergone an educational programme in Ni–Ti rotary instrumentation reported they had successfully integrated the technique into daily clinical practice.

Keywords: dentistry, endodontics, education, implementation, Ni–Ti rotary technique.

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Introduction

A high healing rate following root canal treatment is reported when root fillings meet optimal technical standards (Ödesjö *et al.* 1990, Sjögren *et al.* 1990, Kirkevang *et al.* 2000). However, Scandinavian studies report poor technical standards of root fillings performed by general dental practitioners (GDPs)

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(Kirkevang *et al.* 2000, Ridell *et al.* 2006). A high frequency of apical periodontitis (AP) is observed with root filled teeth in general populations and is correlated to the technical quality of the root filling; a high frequency of AP is frequently reported in teeth with inadequately filled root canals (Ödesjö *et al.* 1990, Kirkevang *et al.* 2000).

As the cause of AP is root canal infection, prerequisites for successful treatment outcomes are strict aseptic procedures and high technical standards (Bergenholtz & Spångberg 2004). Internationally, there is considerable variation in the quality of clinical endodontic procedures by GDPs. Studies have disclosed poor aseptic control, expressed as low use of rubber dam and underestimation of the microbiological factors influencing the prognosis for root canal treatment (McColl *et al.* 1999, Jenkins *et al.* 2001, Slaus & Bottenberg 2002, Hommez *et al.* 2003, Bjørndal & Reit 2005, Bjørndal *et al.* 2007).

Root canal instruments made of superelastic nickel–titanium alloy (Ni–Ti) are reported to be superior to stainless steel hand instruments in following the root canal path and reducing procedural errors, thereby providing better treatment outcomes than instrumentation with stainless steel files (Pettiette *et al.* 2001, Schäfer & Lohmann 2002, Guelzow *et al.* 2005). Ni–Ti instruments are available for both hand and engine-driven instrumentation (Ni–Ti rotary instrumentation) (Spångberg 2001). Compared with preparation with 0.02 tapered Ni–Ti hand instruments, the Ni–Ti rotary technique, however, is reported to clean and shape the root canals more effectively, particularly when used in curved canals (Sonntag *et al.* 2003, Peters *et al.* 2004). Studies confirm that adoption of the Ni–Ti rotary technique by GDPs is limited (Hommez *et al.* 2003, Parashos & Messer 2004, Bjørndal & Reit 2005). However, adoption rates as high as 80% are reported for GDPs who had attended courses in the Ni–Ti rotary technique, including hands-on training (Barbakow & Lutz 1997, Reit *et al.* 2007).

For several years, continuing education courses in endodontics in Sweden have included the concept of Ni–Ti rotary instrumentation. It is not known whether such initiatives promote sustainable change in clinical practice, or what type of intervention is the most effective.

The aim of this study was therefore to survey clinical endodontic protocols amongst GDPs employed by the Public Dental Service in two similarly organized Swedish counties. A further aim was to assess the rate of adoption of a Ni–Ti rotary system after an educational intervention in one of the counties.

Materials and methods

Study design

In the Swedish county of Sörmland, denoted the Intervention County (IC), an educational programme in endodontics was conducted over 2 years, targeting all GDPs employed in public dental clinics in the county. The education included seminars and hands-on training in Ni–Ti rotary technique. It was followed by a post-intervention questionnaire to all the participants. For comparison, the same questionnaire was sent to all GDPs in the county of Västmanland, denoted the Control County (CC), where no educational programme had been provided. The specialist dental clinics, (departments of endodontics) in the two counties were similarly organized, with one Senior Consultant in Endodontics. The counties were equally exposed to the advertising of the technique, continuing education courses run by the Swedish Dental Association and by the manufacturers, and lectures held at The Annual Scientific Congress of the Swedish Dental Society.

The educational programme

The educational programme was conducted in the IC by the district Senior Consultant in Endodontics, during 2003 and 2004. At the time there were 16 public dental clinics in the county. Because of staff turnover, the exact number of GDPs varied, but at the time of the post-intervention evaluation, 87 GDPs had participated in the education.

To promote incorporation of the new technique, the intervention comprised a number of implementation strategies, as shown in Table 1.

The introductory visit to each public dental clinic lasted 2 h. To ensure that all GDPs had the opportunity to attend, the one-day seminar was conducted four times during a one-year period. The practical training was carried out at the participants' home-clinic, where the concept of the Ni–Ti rotary technique was also presented to assisting personnel, who were encouraged to make practical contributions with respect to adoption of the new technique, such as organization, time-planning and hygiene. A list including descriptions and prices of the equipment was made available to the clinic's purchasing officer.

Table 1 Intervention elements in the educational programme

Step	Aim
Initial meeting to inform heads of Public Dental Service	To ensure organizational co-operation
One introductory outreach visit to each Public Dental Clinic	To ensure compliance with the educational programme
A one day seminar for all GDPs, covering the pathogenesis of apical periodontitis, root filling technique and the theory underlying the Ni–Ti rotary technique	To update GDPs' knowledge
Introductory seminar for assisting personnel in theory of Ni–Ti rotary technique	To promote understanding among the staff
Educational outreach visits including hands-on practical training of Ni–Ti rotary technique on extracted teeth with the ProFile®-system	To establish basic practical skills in the technique
One follow-up visit to each clinic	To ensure sustained incorporation by repeated feed-back and reminders
Initiation of personally chosen individual interventions by all participants	To emphasize GDPs' individual control of the change
Reminder e–mails	To promote compliance
Monthly presentation of a practical endodontic recommendation	To improve clinical practice
Publication of guidelines on management of endodontic emergencies	To prevent procedural errors

Each dentist was instructed in the practical application of the ProFile® Ni–Ti rotary system (Dentsply Maillefer, Baillagues, Switzerland) on extracted teeth. After access cavities were prepared, working length of the canals was determined with radiographs and stainless steel K-files, size 10. The canals were manually instrumented with stainless steel K-files to apical size 20. The ProFile instruments were used in a crown–down sequence (30.06, 25.06, 25.04) in a 128 : 1 hand piece (WD74M, W&H, Bürmoos, Austria) until working length was reached. A final apical size of 35, taper 0.06 was recommended and achieved in a step-back mode with the instruments (30.04, 30.06, 35.04, 35.06). Depending on root anatomy, a greater apical size was sometimes required and achieved with a size 40.06 instrument. The canals were filled in single-cone mode using greater taper points cut to the appropriate apical size in a Maillefer Gauge tester (Dentsply Maillefer, Ballaigues, Switzerland), and sealer. Radiographs were taken postoperatively to check the quality of the root filling. At the end of the session there was a general discussion about the participants' experience of using the technique. This training session lasted for 4 h. The individual interventions covered a range of issues, e.g. suggestions for rationalizing the instrumentation or adjustments in time-planning.

Throughout the intervention, practical recommendations and guidelines were published monthly on the Public Dental Service Intranet.

As participation in the education was compulsory for all public dental clinics in the IC, loss of production and the cost of educational materials were financed by the Public Dental Service, Sörmland County Council.

Post-intervention evaluation

In 2005, 1 year after completion of the educational programme, a postal questionnaire and a return address envelope were sent to 195 GDPs in the IC and CC, preceded by a personal letter to each dentist, explaining the purpose of the study. Each questionnaire was marked with identification numbers. After 4 weeks, nonresponders received a reminder questionnaire, sent by a person unrelated to the study, in order to guarantee anonymity. No further reminders were sent.

Questionnaire

The questionnaire had been modified following testing of a pilot questionnaire in which four GDPs participating in the final study had been included. The final version could be completed in approximately 20 min. There were 25 questions about demographics, quality protocols applied in clinical endodontics and experience of and attitudes to different endodontic techniques.

The demographic variables included: gender, age, years in profession, experience of continuing education and if endodontic treatments were either regularly, or not/very seldom, part of everyday clinical practice.

The following variables relevant to quality protocols in endodontic practice were evaluated: the assessment

of prognosis, the use of rubber dam, determination of working length, the use of irrigation and interappointment dressing and routines for postoperative recall and follow-up.

Adoption of the new endodontic technique was assessed in terms of the following variables: instrumentation technique, number of treatment sessions needed to complete instrumentation, root filling technique and attitudes to conventional and Ni–Ti rotary techniques.

The closed-format questions offered six responses: always, generally, frequently, sometimes, rarely or never. In the open-format questions there were choices as well as space for the participants to make additional comments in case their usual practice had not been adequately covered. The last page of the survey offered space for the participant to make additional remarks.

Statistical analysis

Descriptive data were presented as percentages. Differences between the Intervention and Control Counties were tested with Pearson's chi-squared test and Fischer Exact Test. Statistical tests were two-tailed at the 5% significance level. All data analysis was performed in the SPSS version 13 (SPSS, Chicago, IL, USA).

Results

Of the original 195 GDPs in the two counties, 11 had relocated, retired or become specialists. Of the remaining 184, 12 declined to participate in the study, for unknown reasons. The response rate to the questionnaire was 92% of GDPs in the IC ($n = 91$) and 83% ($n = 81$) in the CC. The questions were answered by 99–100% of the participants. The frequency of answers to questions about reasons for using different techniques, 0–85%, depended on the participant's attitudes and clinical experience. There were no significant differences between the counties regarding distribution of gender, mean age or mean years in profession (Fig. 1). In the IC 100% and in the CC 94% of the participants regularly undertook endodontic treatment procedures.

Quality procedures in clinical practice

The frequency of quality procedures in endodontics applied by general dental practitioners in the IC and CC is shown in Table 2.

Two of three GDPs in both counties reported, they always used rubber dam. Another 20% used rubber dam routinely, but made exceptions occasionally. GDPs in both counties who did not inform their patients of the prognosis reported that they were constrained by time pressure or put the patient's needs first in an emergency situation, or that they didn't know what outcome they could expect or that they forgot to inform the patient.

Postoperative radiographic control was not routine, but restricted mainly to two indications: before crown therapy or in cases of clinical symptoms.

Patterns of rotary Ni–Ti use

Rate of adoption

The reported use of Ni–Ti rotary instrumentation amongst GDPs differed significantly between the two counties ($P < 0.001$) (Fig. 2). The technique was reported to be used at all public dental clinics in the IC: 77% of the GDPs reported full integration of the technique, and another 12% used a combination of techniques.

Treatment sessions and root filling technique

With respect to the number of treatment sessions required to complete instrumentation, significantly fewer sessions were reported by GDPs in the IC ($P < 0.001$) (Fig. 3).

The use of sealer was established in both groups. However, due to different instrumentation methods, the root filling technique differed between the groups. Canal filling with a single gutta-percha cone was significantly more frequent in the IC than in the CC ($P < 0.001$), where the use of sealer was combined with the cold lateral compaction technique ($P < 0.001$) (Fig. 4).

Reasons for using different techniques

Respondents using conventional and mixed techniques gave the following main reasons: the conventional technique offered a sense of control over instrumentation, fear of Ni–Ti-instrument fracture and the lack of practical education in rotary techniques (Table 3).

Respondents using the Ni–Ti rotary technique and mixed techniques gave the following reasons: greater root filling quality, less physically tiring technique, fast and easy procedures. They agreed that adoption of the rotary technique was dependent on practical education (Table 4).

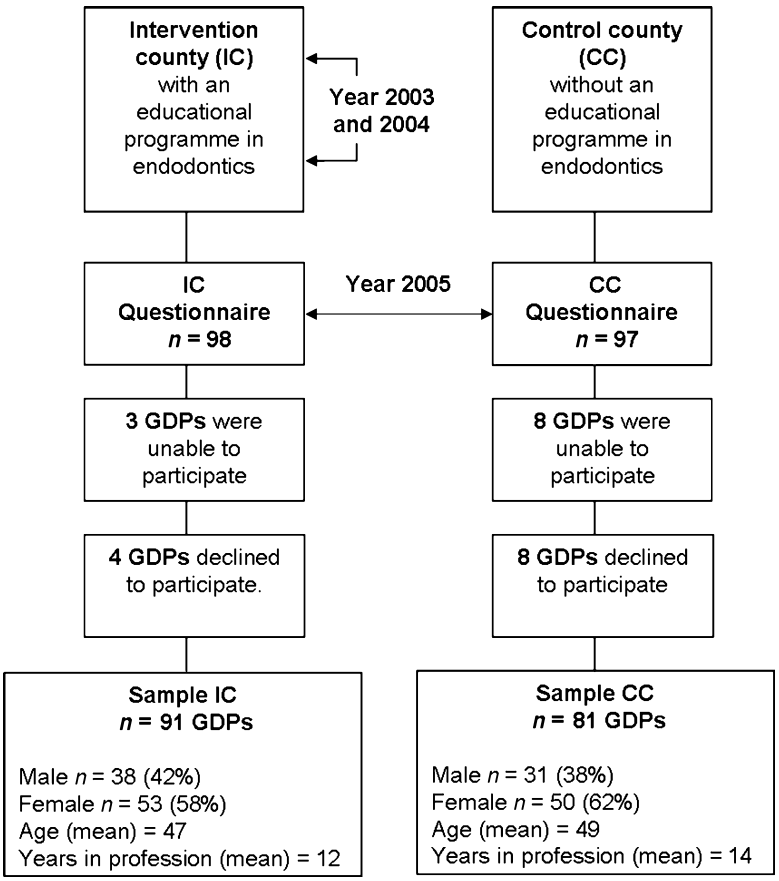

Figure 1 Flow-chart of the study. Gender, mean age and mean years in profession among public general dental practitioners (GDPs) in the Intervention and Control Counties.

Table 2 Frequency of quality procedures in endodontics

Quality procedures	*n*	IC (%)	*n*	CC (%)
Inform patient of the prognosis	91	54 (59)	80	58 (73)
The use of rubber dam	90	81 (90)	80	73 (91)
Determination of working length	90	90 (100)	80	78 (98)
0.5% NaOCl (Dakin's solution) as canal irrigant	91	90 (99)	80	79 (99)
Calcium hydroxide as intra canal dressing	90	90 (100)	80	80 (100)
Routine postoperative control	91	46 (51)	79	38 (48)

Comparison, %, between public general dental practitioners (GDPs) in the Intervention County (IC) who underwent an educational programme in endodontics and public GDPs in the Control County (CC) where no organized training had been provided. The frequency (%) of responses is shown in parentheses.

Discussion

The results are based on self-reported endodontic routines by 172 GDPs in two Swedish counties. A possible explanation for the very high response rate to the questionnaire in general and to all the questions in particular, might be that the survey offered an opportunity to express everyday practical experiences, besides a growing interest in Ni–Ti rotary instrumentation. The answers can thus be regarded as representative for the GDPs in both counties.

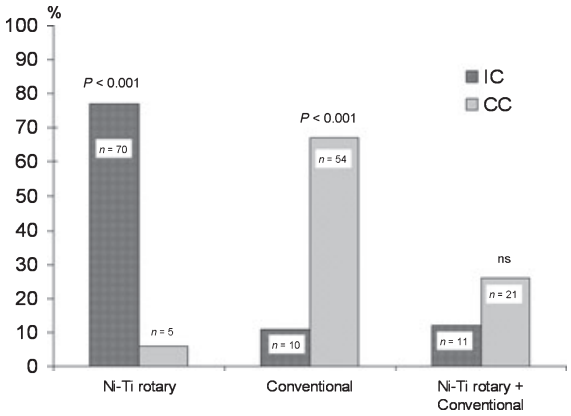

Figure 2 The use of different techniques. Comparison (%) between public general dental practitioners in the Intervention County (IC) and in the Control County (CC), where no programmed education had been provided.

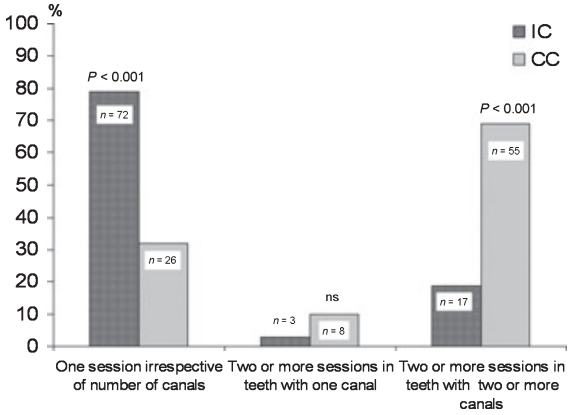

Figure 3 The frequency (%) of treatment sessions required to complete instrumentation, depending on number of canals, by public general dental practitioners in the Intervention County (IC) and in the Control County (CC), where no programmed education had been provided.

A significantly higher adoption of the Ni–Ti rotary technique was reported by the GDPs who had undergone an educational programme in its application.

Participation in the above programme does not seem to have influenced the already high standard of clinical endodontic routines reported by GDPs in both counties. It was satisfying to note that the routines reported comply with the consensus report of quality standards of root canal treatment (European Society of Endodontology 2006): more than 90% of the GDPs in both counties reported they used rubber dam routinely, irrigated with Dakin's solution (NaOCl), used calcium hydroxide as an interappointment medicament, and determined the working length of the root canals. However, although a majority of the GDPs in this study informed their

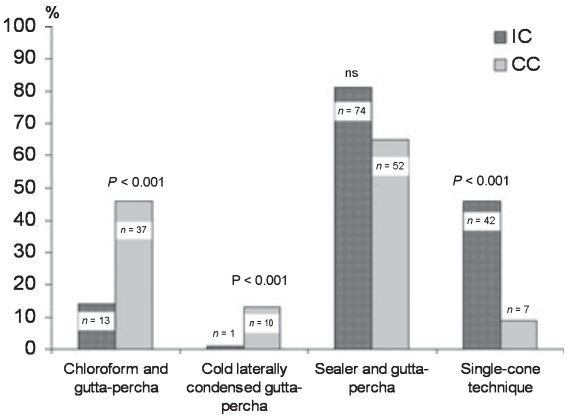

Figure 4 The frequency (%) of choice of medicament and obturation technique in root filling procedures among public general dental practitioners in the Intervention County (IC) and in the Control County (CC), where no programmed education had been provided.

Table 3 Reasons for using conventional hand instruments

Reasons for use of hand instruments	IC *n* = 21 (%)	CC *n* = 75 (%)	Difference between groups *P*-value
It offers a feeling of control	10 (48)	41 (55)	–
No practical education in rotary technique	2 (10)	24 (32)	0.05
Concern about file fractures with rotary technique	5 (24)	18 (24)	–
Satisfied with the present quality of my root fillings	5 (24)	16 (21)	–
No theoretical education	3 (14)	15 (20)	–
Still dubious about the Ni–Ti rotary technique	1 (5)	11 (15)	–
Been advised not to adopt the Ni–Ti rotary technique	1 (5)	2 (3)	–
I perform endodontics too seldom to change technique	2 (10)	3 (4)	–
Other reasons	7 (33)	11 (15)	–
Equipment unavailable at my clinic	0 (0)	6 (8)	–

Comparison between public general dental practitioners (GDPs) in the Intervention County (IC) who had undergone a supervised educational programme in endodontics and GDPs in the Control County (CC) where no programmed education had been provided. The frequency (%) of responses is shown in parentheses. The respondents were free to choose multiple answers.

Table 4 Reasons for using Ni–Ti rotary technique

Reasons for use of Ni–Ti rotary technique	IC *n* = 81 (%)	CC *n* = 26 (%)	Difference between groups *P*-value
Improved quality of the root filling	69 (85)	15 (58)	0.05
Less physically demanding	67 (83)	21 (81)	–
Easier canal filling	65 (80)	13 (50)	0.05
Converted after theoretical education	40 (49)	10 (38)	–
Canal preparation is faster	53 (65)	14 (54)	–
Fewer treatment sessions required	40 (49)	3 (12)	0.05
Converted after practical instruction	56 (69)	10 (38)	0.05
Equipment is available at my clinic	35 (43)	7 (27)	–
Not satisfied with the quality that the conventional technique offers	26 (32)	10 (38)	–
Colleagues recommended the technique	11 (14)	8 (31)	–
Other reasons	3 (4)	0 (0)	–

Comparison between public general dental practitioners (GDPs) in the Intervention County (IC) who underwent a supervised educational programme in endodontics and public GDPs in the Control County (CC) where no programmed education had been provided. The frequency (%) of responses is given in parentheses. The respondents were free to choose multiple answers.

patients of the prognosis for the planned treatment, only one in two reported established protocols for postoperative recall and follow-up. Primarily, postoperative recall was limited to cases where crown therapy was planned, or because of symptoms. Without routine postoperative follow-up of all root filled teeth, asymptomatic, unhealed cases may remain undetected. In the absence of signs of symptoms, GDPs probably assume a successful outcome. This approach implies overestimation of the importance of clinical symptoms as preoperative prognostic factors (Bjørndal *et al.* 2007).

The high standard of quality control reported in the clinical routines presented above can be related to the impact of undergraduate education: the GDPs adhere to treatment principles they were taught as undergraduates. However, to translate scientific progress into clinical practice, as with the Ni–Ti rotary concept, GDPs need to be able to review their current professional knowledge and adapt their clinical practice according to new evidence (Parashos & Messer 2006). Besides the clinical reorganization that is often necessary, all personnel involved need to understand the purpose and the changes required (Shojania & Grimshaw 2004).

Evidence-based methods of implementing change are interactive and combine strategies to improve professional practice, and to overcome barriers to change (Lomas 1993, Oxman *et al.* 1995, Wensing *et al.* 1998). In this study, emphasis was therefore placed on pre-intervention acceptance of the educational programme, repeated active support and reminders to all the participants (McGlone *et al.* 2001), which may have influenced the adoption of the technique by 89% of the GDPs in the IC.

Adoption of the technique may, however, be incomplete, as disclosed by a Belgian study (Hommez *et al.* 2003) where only 1.6% used rotary instruments exclusively, i.e. without the additional use of conventional files. In the study by Barbakow & Lutz 1997, only around 50% of the adopters treated all types of teeth, and Reit *et al.* 2007 described an uneven distribution of the adopters amongst the clinics. In comparison, in the current study, the Ni–Ti-rotary technique was integrated at all clinics in the IC and a majority of the GDPs, 77% reported they completely implemented the technique. A major thrust of the educational programme was to guide the GDPs towards full adoption of the technique: the expectation was that the focus would shift from the technical difficulties of hand instrumentation to greater awareness of the biological issues underlying clinical endodontic procedures. Moreover, it was expected that complete integration of the technique would promote more sustainable change.

The benefits of the Ni–Ti rotary technique were well recognized by the adopting GDPs in this study. In both counties a majority cited ergonomic reasons for using the technique. However, in the IC the GDPs also noted such benefits as improved quality of the root filling and simplified canal filling, confirmed by the significantly higher reported use of the single-cone technique in the IC.

Quicker canal preparation with the Ni–Ti rotary technique is reported in previous studies (Barbakow & Lutz 1997, Parashos & Messer 2004, Reit *et al.* 2007) but a correlation with significantly fewer treatment sessions, as disclosed in the present study, is confirmed only in the Danish study by Bjørndal & Reit (2005) reporting that with the Ni–Ti rotary technique root treatments on molar teeth could be completed in significantly fewer sessions.

Whether the correlation between technique and treatment sessions per case was due to increased understanding in treatment planning amongst the GDPs in the IC, or improved technical skill, could not

be analysed in this study. It is, however, apparent that the GDPs in the IC were able to take full advantage of all aspects of the new technique: in contrast, the use of the Ni–Ti rotary system by GDPs in the CC was not as well-integrated.

General dental practitioner who used conventional techniques perceived no advantages with the new technique, emphasized the sense of control in using hand instruments and expressed concern about the risk of file fractures with Ni–Ti rotary instrumentation. It is apparent that the major reason why GDPs in the CC preferred conventional hand instruments is lack of supervised hands-on instruction in Ni–Ti rotary technique. This may explain the significant differences in the level of integration between the counties and the attitudes to the technique.

Hence, to encourage competence in Ni–Ti rotary instrumentation amongst graduate dentists, professional education should be provided by specialists. To achieve sustainable change, it is likely that interventional steps such as those described in this study are necessary.

Conclusions

General dental practitioners in the two Swedish counties in this study reported a high quality of clinical endodontic protocols. Following a supervised educational programme, GDPs successfully integrated the Ni–Ti rotary technique into everyday clinical practice. There was a correlation between adoption of the new technology and rational instrumentation and filling methods.

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