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The effect of educational intervention on the adoption of nickel–titanium rotary instrumentation in a Public Dental Service

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Abstract

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Aim To study the influence of two educational programmes on the adoption of nickel–titanium rotary instrumentation (NTRI) amongst general dental practitioners in a short-term as well as a long-term perspective.

Methodology All dentists employed in the Gothenburg Dental service ($n = 148$) were enrolled in the study. The clinics in the organization were randomly assigned to one of two educational programmes. In the first programme a 4-h lecture on root canal instrumentation was given. In the second programme the lecture course was supplemented by a 6-h hands-on training session. The short-term effect was measured by a questionnaire distributed 6 months after completed education. The long-term effect was evaluated 4 years later.

Results The overall utilization rate of NTRI increased from 4% to 73%. However, lectures in combination with hands-on training resulted in a better short-term acceptance rate (94%) than if teaching was given only in lecture-format (53%) ($P = 0.000$). As a consequence, all staff were offered hands-on training. The long-term adoption rate was 88%. Reasons for accepting the new technology usually were found within the 'relative advantage' category. Common reasons for dentists not to adopt NTRI were that they could not get started or that they found no advantage over the old technology.

Conclusions The short-term adoption of a new technology might be influenced by the design of an introductory educational programme. For clinical procedures, such as root canal instrumentation, the inclusion of hands-on training sessions seems to be important to reach a high acceptance rate.

Keywords: adoption, education, general dentists, nickel–titanium rotary instrumentation, root canal preparation.

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Introduction

Dental caries is regarded as the major cause for pulpal disease (Trowbridge 2002) and consequently the main reason to perform pulp therapy and root canal treatment. Despite a marked decline in caries prevalence in several western countries (Marthaler 2004) an expected corresponding decrease in the frequency of performed root fillings has not been observed. On the contrary in Denmark, for example, a 17% increase was registered between 1977 and 2003 (Bjørndal & Reit 2004). Essentially this was due to a drastically reduced tooth extraction rate and the consequence of putting more teeth at risk of being pulpally injured. Also in Denmark, an increased treatment of multi-rooted teeth was observed over time. In an Aarhus (Denmark) based sample, from 1997–98, Kirkevang *et al.* (2001) found

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that molars had become the most frequently root-filled tooth group. Thus, to be able to perform technically demanding endodontic treatment procedures continues to be a pre-requisite for the general dental practitioner. However, epidemiological studies have often reported high frequencies of substandard root filling quality in general dental practice. Kirkevang *et al.* (2000), for example, found 59% of root-filled teeth to lack adequate seal and 40% to lack adequate length.

Factors that influence root filling quality in general dental practice have not systematically been investigated (McColl *et al.* 1999, Bjørndal & Reit 2005) but studies indicate that the adoption of nickel–titanium rotary instrumentation (NTRI) might facilitate root canal preparation and make it easier to produce good quality root fillings (Baumann & Roth 1999, Gluskin *et al.* 2001, Park 2001, Peters *et al.* 2001, Schäfer 2001, Schäfer & Florek 2003, Sonntag *et al.* 2003). Walia *et al.* (1988) suggested the use of nickel–titanium alloy to fabricate root canal files and soon after NTRI with hand-piece driven instruments at low speed, was introduced. However, data on the adoption rate of the Nickel Titanium (NiTi) technology in general dental practice are scarce. NiTi hand instrumentation was found to be used by 47% (Slaus & Bottenberg 2002) and 50% (Hommez *et al.* 2003) in two Flemish samples and by 35% in a Danish sample (Bjørndal & Reit 2005). In an Australian survey 22% of the general practitioners reported using NTRI (Parashos & Messer 2004) and 10% of Danish dentists in the Copenhagen area had adopted the rotary instrumentation technology (Bjørndal & Reit 2005). Thus, according to the technology diffusion curve suggested by Rogers (1983), the acceptance of NTRI still seems to be in an early phase.

Information about new technology may reach the potential adopter in many ways, including continuing education courses, conference meetings, scientific and clinical journals, or through informal discussions with practising colleagues. The influence or the effect of various information channels on NiTi technology adoption has rarely been studied. In the seemingly only published study on this issue Barbakow & Lutz (1997) reported on the effect of a series of hands-on training courses on the adoption of the Lightspeed technique. Questionnaires were posted to 305 participants and 58% were returned. Among the responders 80% had accepted the technique.

In the present investigation NTRI technology was introduced to all general practitioners employed by Gothenburg Public Dental Health Service. Mandatory education was arranged either as (i) a 4-h lecture course, or (ii) that same course plus a 'hands-on' training session. The aims were (i) to try to increase the utilization rate of NTRI , (ii) to study the influence of two educational programmes on the short-term adoption or rejection of the technology, (iii) to study the effect of education on long-term adoption rates, and (iv) to register the effect on root filling quality (reported in a separate publication).

Materials and methods

The Gothenburg Public Dental Health Service (DHS) organizes general dentistry at 25 clinics. All dentists employed at theses clinics in April 2000 ($n = 148$) were enrolled in the first part of the study. The clinics were randomly assigned to one of two educational programmes. The organization made participation in the study mandatory for the employed dentists. Each clinic had control over their own budget and paid for new instruments, materials and equipment.

Programme 1: lecture course

In a 4-h lecture, root canal instrumentation and the concept of the NTRI technology was discussed by an experienced endodontist (AM). The GT Rotary System (DentsplyMaillefer, Ballaigues, Switzerland), used as the main rotary system in the undergraduate and postgraduate training programme at the Gothenburg university clinic, was presented in detail and canal preparation was demonstrated on video. Essentially the technique included the use of GT instruments (corresponding to the current 20-series) for crown-down instrumentation of the root canal in combination with ProFile .04 (Dentsply Maillefer) instruments for apical stop preparation. The participants received hand-outs of slides shown during the course and a manual describing the recommended procedures. Detailed information was given where and how the instruments could be purchased and training acrylic blocks were sold on demand. The practitioners were urged to train on extracted teeth or simulated canals before they started to use the instruments clinically.

Programme 2: hands-on training course

All dentists in this group initially participated in the lecture course. In addition, they undertook a 6-h practical training course. Six or seven dentists at a time practiced the GT Rotary System on simulated canals and extracted teeth. All sessions were led by an

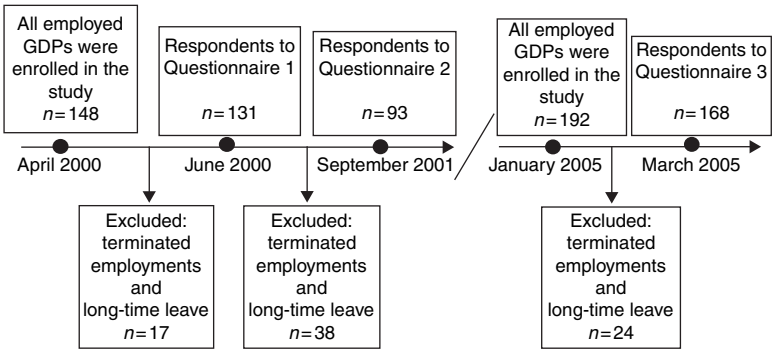

Figure 1. Flow diagram of the progress of the study.

experienced endodontist with academic as well as clinical background (AM).

Lectures and hands-on courses started in August 2000 and went on through March 2001. All dentists received a pre-education questionnaire (Q1) in June 2000.

The first part of Q1 asked for information regarding gender, number of years in practice and the average number of root canal treatments performed per week. In the second part, the difficulty of various critical steps in root canal treatment was subjectively assessed on numerical scales graded from 1 to 6 with 'very easy' and 'very difficult' as end points. The general satisfaction with the technical result of molar treatments was assessed on a similar scale with 'very pleased' (1) and 'very displeased' (6) as end-points. The third part investigated the instrumentation technique in current use by the respondent. In September 2001 a post-education questionnaire (Q2) was given to participants. Q2 was almost identical to Q1 except there were additional questions about the adoption or rejection of NTRI.

After completion of the first phase of the study the dentists randomized initially to the lecture programme (Programme 1) went through the hands-on training session. Such courses were also offered to new dentists in the organization. A total of 53 dentists participated up to November 2004.

In March 2005 another questionnaire (Q3) was mailed to all general dental practitioners (GDPs) within the organization (At that time almost all dentist working in the organization had participated in the educational programme). The form was similar to Q2. Questions were added regarding reasons for acceptance or rejection of NTRI.

Statistical methods

All data were computerized and analysed using SPSS software (SPSS Inc. Chicago, IL, USA). Statistical significance tests were performed with Pearson's Chi-square.

Results

At the start, 148 general dentists were employed at DHS and enrolled in the study (Fig. 1). Q1 was returned by 131 (89%). The majority of the responding group (67%) was women and the mean number of years in general practice was 19 (SD = 8). Most practitioners (63%) performed one to four root canal treatments per week, 15% less than one and 22% had five or more treatments per week. Root canal instrumentation was mainly carried out by means of stainless steel hand instruments of reamer (50%) or Hedström type (23%). NiTi hand instruments were used by 23% and NiTi rotary instrumentation by 4%.

Q2 was returned by 93 of the individuals that submitted Q1 (71%). The dentists that did not respond had either terminated their employment or were on long-time leave (Fig. 1). From two clinics no follow-up data were available. Fifty-eight per cent of the responders often used NTRI and 15% used it sometimes. The technology was initially rejected by 27%.

Among participants who received hands-on training 94% adopted NTRI. In the group of dentists that took

Table 1 The use of nickel–titanium rotary instrumentation amongst the general practitioners as stated in the three questionnaires

	Never %	Sometimes %	Often %
Q1 (2000) $n = 93$	98		2[a]
Q2 (2001) $n = 93$	27	15	58
Q3 (2005) $n = 168$	12	14	74

The year of the questionnaire distribution is given within parenthesis.
[a]Distinction between 'Sometimes' and 'Often' was not made in questionnaire 1.

part only in the lecture course a significantly less acceptance rate (53%) was observed ($P = 0.000$). The number of root canal treatments carried out per week was found to have bearing on the adoption ($P = 0.004$), with dentists completing more root canal treatments being more likely to be adopters (Table 2). Adoption rate was not significantly associated with the gender of the dentist ($P = 0.47$) or the number of years in practice ($P = 0.10$) (Table 2). The individual's behaviour seemed to be influenced by the other dentists working at the same clinic. At 16 of 23 clinics all dentists either accepted or rejected NTRI (Table 3).

Table 2 The use of nickel–titanium rotary instrumentation (NTRI) in relation to data as stated in questionnaires 1 and 2. The influence of studied variables on the adoption of NTRI was tested using Pearsons chi-square test

Treatments/week	Never (%)	Sometimes (%)	Often (%)	*P*
0 ($n = 1$)	100	0	0	0.004
<1 ($n = 9$)	78	22	0	
1–4 ($n = 72$)	19	13	68	
>5 ($n = 10$)	30	30	40	
Gender				
Females ($n = 63$)	30	13	57	0.47
Males ($n = 30$)	20	20	60	
Year of practice				
0–10 ($n = 9$)	33	0	67	0.10
11–20 ($n = 39$)	23	18	59	
21–32 ($n = 41$)	29	17	54	

Table 3 Number of dentists per clinic using nickel–titanium rotary instrumentation as stated in questionnaire 2

Clinic	Never	Sometimes	Often	2[1]
1	0	0	3	3
2	0	1	1	2
3	2	1	2	5
4	0	1	6	7
5	3	0	0	3
7	2	1	3	6
8	0	1	1	2
9	0	2	1	3
10	0	0	1	1
11	0	0	4	4
12	3	0	0	3
13	0	1	4	5
14	1	0	3	4
15	1	2	1	4
16	5	1	0	6
17	1	1	4	6
18	0	0	3	3
19	0	0	4	4
20	3	0	0	3
21	2	0	0	2
22	2	1	2	5
23	0	0	7	7
24	0	1	4	5
Z	25	14	54	93
%	27%	15%	58%	

When assessing the difficulty of critical clinical steps on a six point scale the practitioners, as a group, gave canal instrumentation the highest rank and access preparation the lowest (Table 4). In the post-education questionnaire (Q2) the assessment of difficulty had decreased among the adopters of NTRI (Table 4). However, changes were small and did not reach statistical significance.

In January 2005, 192 GDPs were employed by DHS. Q3 was distributed to all clinics and was returned by 168 (88%) practitioners (Fig. 1). NTRI was often or sometimes used by 88% and rejected by 12% (Table 1). The reasons for adoption or rejection of the technology were given as an open-format question. Many responders stated several reasons for their choice. The responses were categorized and counted. The most common reasons for adoption were that it made root canal treatment easier and faster and that the technical quality increased (Table 5). Reasons for nonadoption included difficulties in getting started, satisfaction with the present technique, a low frequency of root canal treatment and the fear of instrument fracture (Table 6).

Discussion

In the present study the primary goal was to increase the utilization of NTRI among dentists in a public dental health organization. A secondary aim was to investigate the effect on adoption of two education methods, one with a minimum of resources spent (lectures) and the other demanding substantial resource (hands-on training). Education was made compulsory and initially the clinics were randomized to one of the two programmes. Randomization was made at a clinical level rather than at an individual level as it was expected that dentists working in the same clinic would exchange information and exert influence on each other.

The effects of the training procedures were assessed by questionnaires. The response rate was high and the nonresponses mainly due to termination of employment or practitioners being on long-time leave. Thus, the results must be regarded as representative for the organization.

At the start of the experiment only 4% of the GDP's used NTRI. Six months after implementation of the two programmes 94% of the hands-on trained dentists reported to have adopted NTRI. A statistically significant less frequency (53%) accepted the technology if

Table 4 Mean (standard deviation) scores of assessment on a six point scale of the difficulty of critical steps as stated in the three questionnaires. The end-points 1 and 6 represent 'very easy' and 'very difficult' or 'very pleased' and 'very displeased' (relevant for satisfaction with technical quality), respectively

	Q1	Q2		Q3	
	All dentists	Nonadopters	Adopters	Nonadopters	Adopters
n	93	25	68	21	147
Access cavity	2.86 (1.0)	2.9 (1.2)	3.1 (0.9)	3.2 (1.2)	3.0 (1.1)
Canal preparation	4.40 (1.0)	4.2 (1.0)	4.1 (1.2)	4.0 (1.0)	3.7 (1.0)
Root-filling	4.10 (1.0)	4.0 (1.1)	3.7 (1.1)	3.9 (1.1)	3.4 (1.1)
Satisfaction with technical quality	3.45 (1.0)	3.4 (1.2)	3.2 (1.0)	2.9 (0.9)	2.7 (0.9)

Table 5 Reasons for adopters to use nickel–titanium rotary instrumentation

Reason	*n*	% adopters
Increased quality	67	46
Easier	65	44
Faster	47	32
Improved ergonomics	46	31
More enjoyable	14	10
Other reasons	6	4
Number of responses	245	

Table 6 Reasons for nonadopters not to use nickel–titanium rotary instrumentation

Reason	*n*	% nonadopters
Never got started	10	48
No perceived advantage	5	24
Little endo	5	24
Risk for file fracture	4	19
Number of responses	24	

information was presented in lectures only. As a comparison Barbakow & Lutz (1997) found that 80% accepted the Lightspeed technology following a non-compulsory hands-on training course.

In a comprehensive review of the diffusion of innovations Rogers (1983) suggested that certain attributes of a new technology will influence its rate of adoption. He proposed five attributes to be used as a general framework in an analysis: relative advantage (the degree to which a new technology is perceived as being better than the one it supersedes), compatibility (consistency with existing values, past experiences and needs of potential adopters), complexity (potential difficulties to understand and use), trialability (the degree to which experimentation is possible) and observability (the degree to which the results are visible to others). In the present study a major difference between the two educational programmes was that during the hands-on course the practitioners had opportunity to test and experiment with the new technology. Obviously this had a great impact on the acceptance level of NTRI and the results therefore support the hypothesis that trialability of a technology is positively related to its rate of adoption. In agreement Parashos & Messer (2004) found from comments made by an Australian sample of dentists that they wanted hands-on courses run by clinicians experienced in the technology.

The adoption of NTRI was positively correlated with a high number of root canal treatments performed per week, i.e. the dentists completing many procedures were more likely to adopt. Jenkins *et al.* (2001) made a similar observation in a sample of UK dentists and reported that there was a trend for practitioners carrying out more than 30 root fillings per month to use a handpiece driven instrumentation system (Giromatic). However, a correlation between a high frequency of root canal treatments and acceptance of NTRI was not found by Bjørndal & Reit (2005) in a Danish sample.

In 12 of the 23 clinics, all dentists adopted NTRI and in four clinics none accepted the new technology. This situation illustrates the central importance of inter personal networks. In deciding whether or not to adopt a new technology, we all depend mainly on the communicated experience of others much like ourselves, and information exchange is essential to behaviour change. A particular role, in the studied context, is played by the person who is head of the clinic. In relation to her or his degree of opinion leadership the behaviour of the other dentists will be influenced (Rogers 1983).

The short-term adoption of NTRI within the organization reached 73%. Between 2001 and 2005 the education programme was continued. During that period the number of employed GDPs increased from 148 to 192. Dentists that initially

were given a lecture introduction to NTRI took part in hands-on courses, as did practitioners that were new to the organization. In the 2005 questionnaire acceptance was found to remain at a high rate and 88% reported to use NTRI as an integrated part of their clinical practice.

When numerically assessing the difficulty of various technical critical steps on a scale, the dentists that adopted NTRI found procedures easier than non-adopters (Table 4). The differences between the groups were small and did not reach statistical significance. However, one of the most frequently stated reasons for adoption was that NTRI made root canal procedures easier (Table 5). It is evident that reasons to adopt NTRI essentially were found within the category of relative advantage' (easier, faster, increased ergonomics, improved quality). Also, the compulsory educational programme including hands-on training resulted in a better immediate acceptance rate (94%) than if teaching was given only in lecture-format (53%). Consequently, all staff was gradually hands-on trained. The adoption rate remained at a high level (88%) at the end of the study period. Common reasons for dentists not to adopt NTRI were that they could not get started or that they found no advantage over the old technology. It might be suggested that the degree of 'observability' of the new technology was high: improved root filling quality could be observed on the radiograph resulting in positive feed-back.

Nonadopters most often stated that they would like to switch to NTRI technology but never got started (Table 6). A few perceived no advantage with NTRI, and others thought the risk of instrument fracture was too high. These data are in line with Parashos & Messer (2004) who, in a study of Australian dentists, found that no perceived advantage of NTRI over the traditional techniques was the most commonly stated reason for nonadoption. They also observed that, for practitioners who had tried NTRI but abandoned it, the major reason was the perception of a high risk of fracture in the root canal.

Conclusions

The present study indicates that the form of an introductory educational programme might influence the short-term adoption of a new technology. For clinical procedures, such as root canal instrumentation, the inclusion of hands-on training sessions seems to be necessary to reach a high acceptance rate.

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