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ORIGINAL ARTICLE

Dentists' use of digital radiographic techniques: Part I – intraoral X-ray: a questionnaire study of Swedish dentists

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ABSTRACT

Objective: The present study aims to gain knowledge about the dentist's use and choice of digital intraoral imaging methods.

Materials and methods: A questionnaire sent to 2481 dentists within the Swedish Dental Society contained questions about the type of X-ray technique used, problems experienced with digital radiography, and reasons for choosing digital technology, and about indications, clinic size and type of service. Response rate was 53%.

Results: Ninety-eight percent of the dentists had made the transition to digital radiography; only 2% used film technique, and solid-state detector (SSD) was the most used digital technique. More years in service decreases the likelihood of applying individual indications for performing a full mouth examination. More retakes were done with SSDs compared to storage phosphor plates. Reasons for choosing digital techniques were that work was easier and communication with the patients improved. However, dentists also experienced problems with digital techniques, such as exposure and projection errors and inadequate image quality. The Swedish Radiation Safety Authority states that all radiological examinations should be justified, something not always followed.

Conclusions: This study showed that 98% of the respondents, Swedish dentists within the Swedish Dental Society, used digital techniques, and the most used was the solid-state technique.

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Continuing dental education; operating rooms; radiography; dental; digital; selection criteria

Introduction

Intraoral radiography is the most widely used imaging technique in dental practice, and since the introduction of digital radiography in dentistry in the late 1980s [1], intraoral digital radiological imaging technologies have evolved and become increasingly common around the world and have replaced analogue film technology to varying extents [1–8]. In a study from Germany, digital techniques were used by 36% of dentists [7], in a study from England, 49% [8], and in the region of Flanders, Belgium, 38% [2]; different digital imaging technologies were used.

Basically, there are two types of digital imaging technologies available for intraoral digital radiography, the indirect technique comprising storage phosphor plate (SPP) and the direct technique. The direct technique comprises a charged coupled device (CCD) and complementary metal oxide semiconductor (CMOS), which in this paper will be referred to as solid-state detectors (SSDs). The SPP technology is in a number of countries the most common choice for intraoral digital techniques, and about two-thirds of dentists have chosen an SPP system [2,4,7–9] to replace analogue technology with digital. The quality of the digital images should be at least as good as with film, and in addition, there should be some advantages to using digital technology.

Digital intraoral imaging systems were introduced during the late 1980s [1] as an alternative to conventional radiography. A recent study showed that 45% of the dentists using film-based systems objected to changing to a digital system. The main reason was 'the cost' (67%), 'the complexity of the system' (50%) and 'no advantage to change' (25%) [7]. However, other reports from different countries showed that the use of intraoral digital techniques varied [2–4,7,8].

A number of advantages of digital intraoral radiography have been described, claiming that the transition from film technology to digital technology would lead to several improvements [1,10,11]. Although some of the expected benefits seem not to have been accomplished, one can conclude that time is saved and work is simplified, and communication is also simplified [12]. In a couple of studies, it was reported that there were some drawbacks, since it is more difficult to get acceptable X-ray images with an SSD [10,13]. More images were exposed, and more retakes required compared to working with film [14]. Retakes were more common with an SSD than with film [15] and solid-state users found that there were difficulties in detector positioning and thus more retakes [7]. There seem to be fewer problems with detector positioning and retakes with SPP systems. Dentists using SSD stated that they took more periapical radiographs than

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Supplemental data for this article can be accessed here.

dentists using SPP systems [14]. The greater number of exposed radiographs would contravene the ALARA (as low as reasonably achievable) principle [16].

However, the ALARA principle is not always followed, as could be shown in a number of studies [17–19]. Dental radiological examinations should only be performed on individual indications, meaning that, for example, bitewing examinations should not be performed unless there are reasons to do so. This is not always followed, which may indicate lack of knowledge. The level of knowledge was associated both with the use of low-dose techniques and with a high level-of-risk attitude. A high level of knowledge reflected those using 'low-dose techniques' and those having a 'high-risk attitude'. Thus, 79% of the dentists using 'low-dose techniques' and 62% of the dentists having a 'high level-of-risk attitude' had a 'high' level of knowledge [20].

Knowledge about the use of digital intraoral imaging systems among general dentists in Sweden is scarce, and no study of this topic has been performed. Neither is there any collective information on the use of digital technology or digital techniques most used, nor how the technology is perceived within the dental profession. Nor do we know whether postgraduate education in oral radiology has any impact on the use or whether professional experience affects the transition to digital technology.

Aim

The aim of the present study was to give insight into the use of and distribution and application of digital intraoral radiographic techniques in general dental and specialist practices in Sweden with focus on the type of digital technique used, frequency of use, and perceived problems with an intraoral digital X-ray system. The reasons for choosing digital techniques or not and indications for performing intraoral examinations are also studied.

Materials and methods

Design and data collection

The study was approved by the Regional Ethical Review Board in Uppsala, Sweden (Dnr 2016/246), and was conducted according to the principles described in the Declaration of Helsinki.

Official figures regarding the number of dentists in the Nordic countries show that in the year 2015 there were around 7700 dentists in Sweden; 54% ($n = 4137$) work in the Public Dental Health Service (PDHS) and 46% ($n = 3562$) in private practice (PP) [21]. At the planning of the study, we were given access to email addresses of dentists who were affiliated with the Swedish Dental Association (SDA) but not to dentists affiliated with the private practitioners' organization. We got access to data of 5209 registered dentists within the SDA. Thus, 1072 PP dentists were affiliated with the SDA. The proportion of PDHS dentists in this study is therefore greater than it otherwise would have been. Selected were dentists between 23 and 70 years old and having valid email addresses, resulting in 4962 dentists. Fifty percent of the 4962 dentists were randomly selected to participate, using the IBM SPSS Statistics (ver. 22, IBM Corp., Armonk, NY), resulting in 2481 dentists of whom 850 (68%) worked in PDHS and 394 (32%) worked in PP.

A web-based survey tool, Esmaker NX3 (Entergate AB, Halmstad, Sweden), was used to create the survey. The survey was sent by email to all selected dentists, together with a covering letter in which it was emphasized that all respondents would be treated anonymously. The survey tool was programmed to automatically send two reminders at one-week intervals to non-responders. The questionnaires were distributed during the autumn 2016.

Questionnaire

The questionnaire contained a number of questions concerning demography, intraoral radiography, panoramic radiography and cone beam computed tomography (CBCT). In the present study, we focus on demographic data and intraoral radiography. The first question was: 'Do you work daily with diagnostic radiology?' If the answer was 'no', the respondent was referred, automatically by the web program, to the demographic section, comprising questions concerning gender; clinic size; type of employment, public or private, specialist or not; years in practice; and post-graduate education in oral radiology. The intraoral radiography section comprised questions concerning type of intraoral technique, film and/or digital; type of digital system, SPP and/or SSD; perceived problems concerning intraoral digital radiography; reasons for not having changed from analogue to digital intraoral radiography; reasons for the choice of examinations; and indications for performing an X-ray examination – full mouth examination (FMX) and bitewing examination on new patients (BTWn) and bitewing examination on recall patients (BTWr). A total of 1310 questionnaires were answered, response rate 53%. Sixty-six respondents answered only the first question and were then referred to the demographic section. In total, there were 1244 valid responses for the entire questionnaire. Figure 1 shows a flowchart displaying the total number of dentists in Sweden compared with the number of dentists who were included in the study.

Non-response analyses

A non-response analysis was made and showed no statistically significant differences with respect to gender ($p = .49$), age ($p = .14$), or type of service ($p = .07$). Mean age among the non-respondents was 47.5 ± 13.1 years, and for respondents, 48.2 ± 12.6 years. The number of answers to the different questions varied and was not analysed any further.

Measurement methods and variables

A battery of questions was designed to study the application of intraoral digital radiology practices. Some of the questions could be answered with either yes, no or an open alternative. For some of the questions several answers could be given; others were designed as an array of claims using a rating

scale from 'disagree' to 'fully agree'. The questionnaire is shown in the Supplementary Appendix.

Data processing and statistics/statistical methods

IBM SPSS Statistics ver. 22 was used for the analyses (IBM Corp., Armonk, NY). The data were first processed by descriptive statistics and then cross tables, using Chi squared test. Logistic regression analysis was performed to analyse the effects of the independent variables type of practice (general dental practitioner (GDPs) or specialist), counties with specialists in oral radiology, continuing education in oral radiology, gender, clinic size and years in service on the dependent variables only on individual indications for FMX, only on individual indications for BTWn, only on individual indications for BTWr. A regression analysis was also performed to analyse the effects of the independent variables gender, type of practice (GDP or specialist), counties with specialists in oral radiology, clinic size and years in service on the dependent variable continuing education in oral radiology. Data were checked for multicollinearity. *p* Values were considered statistically significant at the .05 level.

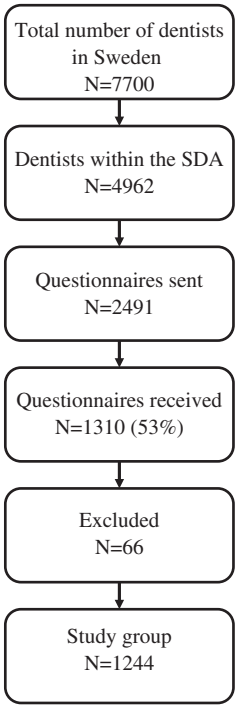

Figure 1. Flowchart displaying the selection process from the total number of dentists in Sweden to dentists included in the study.

Results

Profile of respondents and demographics

Out of 1244 dentists, 83% were working in general dental practice and 17% as specialists. Among the GDPs, there were 65% working within the PDHS and 35% in PP.

Intraoral techniques

In total, 98% of the respondents used digital intraoral techniques and 2% ($n = 17$), used dental X-ray film. For the digital technique, SSD was used by 67%, and an SPP by 27%, and 6% used both. Within the PDHS, 32% used SPP, 63% SSD and 6% used both; within PP, 19% used SPP, 76% SSD and 5% used both. The SSD technique is the most used in PP, while the SPP is nearly twice as frequently used in the PDHS compared to PP ($p = .000$). In Figure 2, reasons for using digital technology are shown. Some of the reasons are 'work is made easier', 91%, and 'image quality to be improved', 66%. Among the few ($n = 11$) still working with analogue technique, some of the reasons for not having taken the step into the intraoral digital world were 'too big an investment', 38% ($n = 6$), and 'do not have a digital patient record', 31% ($n = 5$). None of the dentists lacked computer skills or were lacking 'knowledge of digital technology'.

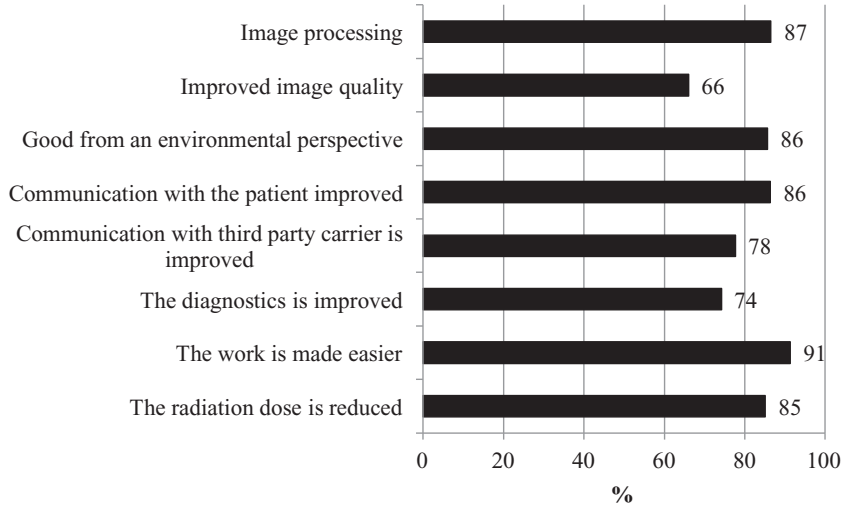

Figure 2. Reasons for choosing digital techniques for intraoral radiography. Multiple answers could be given.

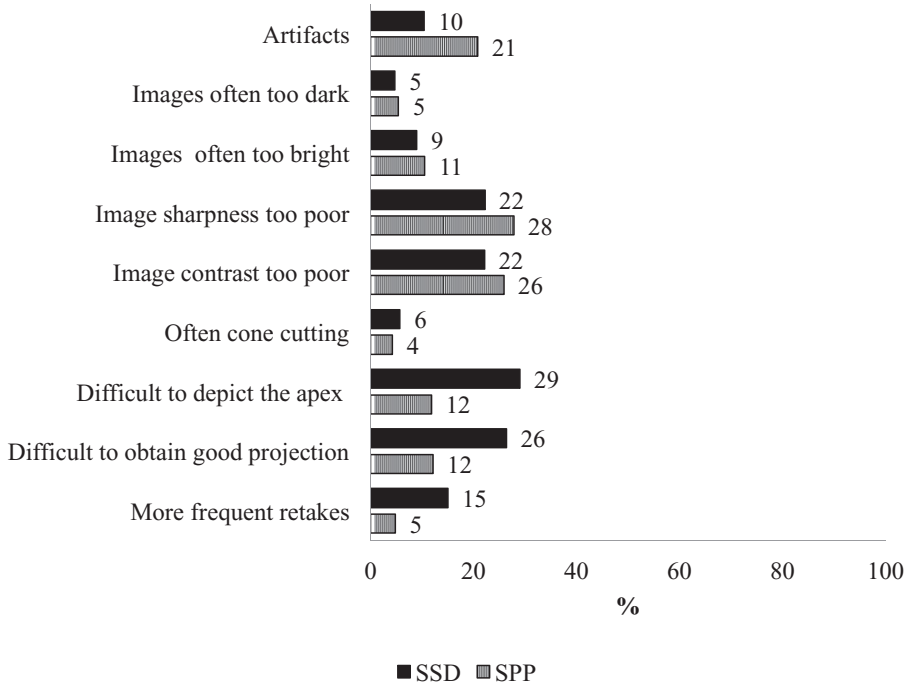

Figure 3. Reasons for not choosing digital techniques. The main reasons for not having taken the step into the intraoral digital world are displayed. Multiple answers could be given.

Perceived problems with digital intraoral imaging systems

Around 86% of the dentists reported having problems with their digital system: 76% of the SPP users and 75% of the SSD users recounted occasional problems with their digital systems. SSD users experienced frequent problems more often, 12% compared to 7% for the SPP users ($p = .042$). In total for the digital imaging systems, four main problems were experienced: image sharpness too poor (24%), image contrast too poor (23%), difficulties displaying the apex (24%) and difficulties obtaining good projection (23%). With the SPP techniques the main problems were 'image sharpness too poor' (28%) and 'image contrast too poor' (26%), while the main errors for the SSD technique were 'difficult to depict apex' (29%), and 'difficult to obtain good projection' (26%) (Figure 3).

Digital image system artefacts accounted for a total of 13% and were more common with the SPP at 21%, while the corresponding figure for SSD was 10% ($p < .001$). The digital intraoral systems in total accounted for 12% 'more retakes', and the SSD system, 15%, while the SPP system accounted for 5% more retakes ($p < .001$). When summing the different types of errors, the following could be noted: there were in total 36% projection errors with digital techniques, whereof SSD accounted for 43% compared to 20% for SPP ($p = .001$). In total, there were 45% quality errors for digital techniques, and they were more common with the SPP technique, 50% compared to 42% for SSD ($p = .08$).

Indications for examinations

It may be noted that 76% of the dentists performed an FMX only on individual indications, 6% took an FMX of every new patient, and 6% reported that they avoided FMX. Bitewing examinations were taken on a majority of the patients; thus, 64% of the dentists performed one on every new patient, while 25% only took bitewings on individual indications and 60% of the dentists performed one on every recall patient, while 26% only took bitewings on individual indications.

Our Chi squared analyses showed that of those who used individual indications for FMX, 75% used SPP and 69% SSD technology ($p = .132$), and 71% used digital technology while 47% used film technology ($p = .035$).

Table 1 displays the results of the multiple logistic regression analyses for the association between different factors' impacts on using individual applications for FMX, bitewings on new patients (BTWn), and bitewings on recall patients (BTWr). Specialists had 45% lower odds for applying individual indications when taking an FMX compared to GDPs (OR 0.55; 95% CI 0.39–0.78). It was also observed that more years in service decreased the likelihood of applying individual indications for FMX; the odds for 11–20 years and >20 years in service compared to <5 years were 0.51 (95% CI 0.30–0.88) and 0.30 (95% CI 0.19–0.47), respectively. The odds for applying individual indications for BTWn patients were five-fold higher for specialists compared to GDPs (OR 5.09; 95% CI 3.43–7.50). Specialists also had higher odds of applying individual indications for BTWr patients compared to GDPs (OR 4.19; 95% CI 2.81–6.25). Furthermore, dentists with 11–20 years in service had 43% lower odds of applying individual indications for BTWr patients compared to dentists with >5 years in service (OR 0.57; 95% CI 0.33–0.99). All other variables in the table showed non-statistically significant results.

Postgraduate education in oral radiology

Forty percent of the dentists had participated in postgraduate education in oral radiology during the last five years;

Table 1. Multiple logistic regression models for the dependent variables; individual indications for full mouth examination (FMX), individual indications for bitewing examination on new patients (BTWn), and individual indications for bitewing examination on recall patients (BTWr) or not.

	Model 1 Individual indications for FMX			Model 2 Individual indications for BTWn			Model 3 Individual indications for BTWr		
Independent variable	*p*	OR	CI	*p*	OR	CI	*p*	OR	CI
Service category									
GDP (reference)									
Specialist	.001	0.55	0.39–0.78	<.001	5.07	3.43–7.50	<.001	4.19	2.81–6.25
Access to specialist in oral radiology									
No (reference)									
Yes	.476	0.84	0.52–1.35	.604	0.87	0.52–1.47	.588	0.865	0.51–1.46
Postgraduate education									
Yes (reference)									
No	.627	0.94	0.71–1.23	.461	0.89	0.65–1.21	.328	0.860	0.63–1.16
Gender									
Female (reference)									
Male	.795	0.97	0.74–1.26	.561	0.90	0.66–1.23	.493	0.89	0.66–1.22
Working situation									
1–2 treatment rooms (reference)									
3–6 treatment rooms	.621	1.09	0.77–1.54	.999	1.00	0.67–1.49	.478	1.15	0.78–1.69
>6 treatment rooms	.571	1.09	0.80–1.49	.857	0.97	0.68–1.38	.454	1.14	0.81–1.61
Years in service									
>5 years (reference)									
5–10 years	.148	0.66	0.38–1.16	.463	1.24	0.70–2.21	.376	0.79	0.47–1.33
11–20 years	.015	0.51	0.30–0.88	.610	1.16	0.65–2.09	.045	0.57	0.33–0.99
>20 years	<.001	0.30	0.19–0.47	.147	1.43	0.88–2.32	.319	0.81	0.53–1.23

Significance levels (*p*), odds ratios (OR) and confidence intervals (CI) given.

Table 2. Multiple logistic regression model for the dependent variable having attended a postgraduate education or not.

	p Value	OR	95% CI
Gender			
Female (reference)			
Male	.441	0.90	0.67–1.17
Service category			
GDP (reference)			
Specialist	.002	1.7	1.21–2.38
Access to specialist in oral radiology			
Yes (reference)			
No	.234	1.30	0.84–2.02
Working situation			
1–2 treatment rooms (reference)			
3–6 treatment rooms	.315	1.18	0.85–1.64
>6 treatment rooms	.930	1.01	0.76–1.36
Years in service			
<5 years (reference)			
5–10 years	<.001	4.63	2.77–7.72
11–20 years	<.001	4.09	2.44–6.85
>20 years	<.001	3.75	2.39– 5.87

Significance levels (*p*), odds ratios (OR) and confidence intervals (CI) given.

78% were GDPs and 22% specialists, and 66% were PDHS and 34% PP dentists. Of dentists who had participated in postgraduate education, 58% had been in service for more than 20 years, and of those in service less than 11 years, 18% had participated in postgraduate educations ($p = .001$). Of dentists within the age group 21–30 years, around 19% had participated in a postgraduate course in oral radiology compared to 39% ($p = .001$) in the oldest age group.

Table 2 presents the results of the multiple logistic regression analyses for the association between different factors' impacts on having attended postgraduate education in oral radiology. It was found that specialists were 1.7 times more likely to have attended postgraduate education compared to GDPs (95% CI; 1.21–2.38). Dentists with 5–10 years in practice had 4.6 times higher odds of attending a postgraduate course compared to dentists with <5 years in practice (OR 4.63; 95% CI; 2.77–7.12), and dentists with 11–20 and >20 years in practice were four times more likely to have attended a postgraduate course compared to dentists with <5 years in practice.

Discussion

The literature does not give any information about the usage of intraoral or extraoral radiography in Swedish dental practices. The present work was intended to give an overview of the state of the art in dental intraoral digital radiography in Sweden.

To find out how and to what extent intraoral digital radiography is used among Swedish dentists, we conducted an email survey of 2481 dentists who were listed in the register of the SDA. The selection contains too many PDHS dentists in relation to the total number of dentists in Sweden. We noted that, in our study, 65% were working within the PDHS and 35% in PP, while we observed in the SDA register that the correct proportions of dentists in the PDHS and in PP are 56% and 46%, respectively [21].

The main results were that a large majority (98%) of the Swedish dentists who responded to the questionnaire use digital technology for intraoral radiography, and of those, the majority use the SSD technique. Another result was that more years in service decreases the likelihood of applying individual indications for performing an FMX.

Response rate

A shortcoming with this study is the somewhat low response rate, 53%. It may be seen as acceptable, as there was no statistically significant difference for the background variables gender, age and type of work, but a higher response rate would have been desirable. However, when surveys are sent to professional health care providers a response rate greater than 53% is rarely achieved [22]. Indeed, it has been shown

that in studies of well-educated, homogeneous populations, such as dentists, failure to respond is not a source of bias [23]. In view of that, the results can be considered as being representative for Swedish dentists. Another limitation is that we did not have access to some of the PP dentists' register information. Thus, about 11% fewer dentists in PP are included in the study than the official figure shows [21]. This may have resulted in a certain overrepresentation of PDHS dentists, and therefore, the results should be interpreted with some caution. However, on the whole, the results are valid, and it is likely that more than 90% of the dentists have switched to digital technology.

Use of radiological methods

The use of intraoral digital techniques was found to be much more frequent in Sweden than observed in other European countries [2,7,8,10]. Some 98% of Swedish dentists use digital techniques. An explanation for the high figures for using intraoral digital radiography in Sweden could be that a majority of the dentists in Sweden work within the PDHS compared to those in Denmark and Norway, where one-third work within the PDHS [21]. The PDHS dentists in Sweden do not decide for themselves what type of imaging system to use. That is usually a decision of the management of a region, meaning that only one decision is made for a region that can include as many as 1900 dentists. In the field of private dental care, each clinic decides what to use, and this may affect from one to many dentists. Below are statements from two respondents: '*Decisions are taken by our management in the Dental Public Health Service*', and '*I do not determine the choice of technology, but my employer*'. This is substantiated in a study by Wenzel and Moystad, where dentists stated that they were 'forced' to use digital radiography in the clinic where they worked [24].

The SSD technique is used by Swedish dentists more frequently than is observed in other European countries, which is not in line with what has been described in European studies, where an SPP system was chosen over an SSD system by about two-thirds of the dentists [2,4,7–9]. There may be some explanations for the discrepancy between Swedish dentists' and European dentists' choice of digital intraoral techniques. Swedish dentists may be highly interested in technology and want a system that can automatically deliver the images directly to the monitor, rather than via a detour through a scanner. It could also be that the procurement process for the digital imaging systems resulted in a lower price for SSD technology than for the SPP system, and that the SSD technology was chosen for that reason.

The conventional film technique was still used by 2% of the Swedish dentists and reasons for not changing to a digital technique were that it was 'too big an investment' and 'plans to retire soon'. These reasons were corroborated by a couple of studies [7,10,25]. Use of the conventional film technique was more frequent in clinics with few treatment rooms, 59% ($n = 10$), and a majority of dentists in PP work in small clinics and more often use dental X-ray film. Working in group practice with many colleagues may induce discussions in many areas, including the introduction of digital radiology.

Reasons for changing imaging system

In a couple of studies from the beginning of the 2000s a number of expected benefits of digital radiography that would improve image quality are mentioned, such as a reduced number of retakes, time saving, image processing, improved patient communication, improved communication with third party carriers, and reduced patient radiation dose [26]. In this study, dentists chose to work with digital radiology due to improved image quality, time saving, image processing and reduced radiation dose. According to the study by Berkhout et al., the possibility of dose reduction could encourage dentists to switch from analogue to digital [10]. A large number of dentists believed that communication with patients was facilitated and was a cause of change. However, also recently shown is that there seems to be no difference in patient satisfaction regarding the type of image method, digital or conventional [27].

Problems with digital radiography

There are problems with digital techniques irrespective of the technique chosen, and one-third of the dentists experienced image quality as worse than with film, independent of the type of digital system used, as shown in a study from the early 2000s [9]. We found that 86% of dentists have had problems with their digital imaging systems, irrespective type of system used, and the problems comprised both image quality and projection quality. Versteeg et al. demonstrated that 28% of the SSD images were not acceptable [28].

Subjective image quality

Problems with image quality were observed in the present study to occur in 45% of cases for digital systems, more commonly for the SPP system at 50% compared to the SSD system with 42%. Some of the problems were image contrast and sharpness and also artefacts, which differed and were found to be twice as frequent with the SPP system, a difference that was statistically significant.

Projection errors

In a couple of studies, it has been pointed out that dentists find it difficult to take radiographs with the SSD technique [10,13]. We observed that there were more often projection errors with the SSD systems compared to a SPP system, a statistically significant difference ($p=.001$). The projection errors consisted of 'difficult to depict the apex', 'often cone cutting' and 'difficulty in getting a good projection'. Non-optimal radiographs may lead to more radiographs being exposed and also to more retakes [14].

Retakes

The transition to a digital image receptor has increased the number of retakes due to projection errors and image quality

errors, and also due to small image receptors with the SSD. The present study showed that digital intraoral systems in total resulted in 12% retakes, for SSD 15% and for SPP 5%, a statistically significant difference. Our findings are in line with a recent study where retakes were higher with the SSD than with the SPP [15,28]. Since the SSD requires a lower radiation dose than the SPP for a single exposure, the radiation dose can be reduced, which may be an incorrect assumption, as the sensor is smaller in size, resulting in more images exposed and more retakes made [12].

Radiation doses in intraoral digital techniques

A study conducted in 1994 found that all Swedish dentists used dental X-ray film technology [29]. As shown in the present study, 98% of the respondents, who were dentists within the SDA, used intraoral digital techniques, and only 2% were using dental X-ray film. The results of a few studies have shown that the exposure time for film is twice as high as the SPP exposure time and 2.8 times higher than for the SSD system [7,9]. The transition from analogue to digital technology may have led to a reduced radiation dose to the Swedish population, and it could be assumed that the radiation dose has decreased by approximately two times. However, this may not be true, as the GDPs working with digital detectors take more radiographs due the smaller area of the SSD and the ease of taking more radiographs [8,9,14]. Thus, it is likely that the effective dose reduction is less than 25%, owing to the greater numbers of radiographs taken [14]. The ALARA principle and patient selection criteria will affect the technique and images to be taken. Not every patient needs a bitewing survey at every examination, something that may often be done. The interval for X-ray examination depends on the risk assessment and the purpose of the images.

Indications

Indications for performing X-ray examinations were investigated using logistic regression models. It was observed that more years in service decreases the likelihood of applying individual indications for performing an FMX. The result of this study can be confirmed in an article from Ericsson, where doctors working in general practice were studied. Their diagnostic accuracy was related to the level of training and experience, and the ability to correctly diagnose increased for medical students to residents and then decreased as a function of time [30]. A new study showed that younger dentists had a better radiation protection practice that is likely to be attributed to their recent undergraduate basic education [31].

Postgraduate education in oral radiology

There is a great need for further education on the subject dentomaxillofacial radiology and radiation protection [2], as confirmed in a number of studies [4,29,32–36]. If continued education had been mandatory, this could have had an effect on the use of radiation protection by GDPs [20,37]. The question should be raised as to whether such continuing education courses should be mandatory [29]. We would strongly support such proposals. However, the results of a Belgian study do not indicate that there has been an improvement where continued education in oral radiology has been mandatory for the last 10 years [2]. There are differences in the composition of the dental profession, such as the fact that the GDPs in Belgium work mainly within the private sector while in Sweden the majority of GDPs are found within the PDHS sector, something that can make strict indications easier to implement within an organization such as PDHS, where policy programs are set within the region. This is confirmed by the finding that strict indications for new patients are used by 78% of PDHS compared with 22% for PP ($p = .001$).

Studies in Sweden, Denmark and Canada have found that factors such as a dentist's age and attendance of postgraduate courses can influence radiographic practice [17,29,36,38]. In the present study, we could not substantiate that postgraduate education had any impact on radiologic practice, as dentists did not apply individual indications for performing an X-ray examination. There must be an indication to take each radiograph. Participating in postgraduate education did not mean that individual indications were applied to carry out an X-ray examination. In addition, access to a specialist in dental radiology did not affect individual indications used for X-ray examinations, either.

Conclusions

It can be concluded that around 98% of the respondents, dentists within the SDA, used intraoral digital radiographic techniques, and the SSD technique was the system used by most. There is only a minority of dentists still using the dental X-ray technique. It was also shown that dentists do not always follow individual indications for performing dental radiological examinations.

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Disclosure statement

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