Dental and Maxillofacial Radiology:

Confidence, Knowledge and Skills in the Newly Graduated Dentist

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Abstract

Introduction:
The UK General Dental Council says that the new graduate will have the range of skills required to begin working as part of a dental team and be well prepared for independent practice. This study examines the views of new dental graduates in the area of dental and maxillofacial radiology

Materials and Methods:

A questionnaire survey of newly-graduated dentists in Wales and the southwest of England asked about their experience of undergraduate education in dental and maxillofacial radiology and their confidence in the use and interpretation of imaging techniques in early independent practice.

Results:

Most survey participants were confident in the teaching they had received in dental radiography and radiology, and that they could apply their knowledge and understanding to the more common investigations used in general dental practice. They were less confident in the uncommonly used techniques such as oblique lateral and lateral cephalometric views.

Discussion:

This study is encouraging in that new dental graduates say that their undergraduate education has given them the knowledge to be able to take, interpret and make clinical diagnoses using the commonest radiological investigations. This tends to validate the undergraduate education received and identifies areas to improve.

Conclusion:

New dental graduates are confident in their knowledge and skills and apply these to the most commonly used radiological investigations used in general dental practice. (221 words)

Key words:

Dental Radiography, General Dental Practice, Early Years Graduates, Outcomes, Undergraduate

Introduction

The UK General Dental Council says that the aim of undergraduate dental education is "to develop a rounded professional who, in addition to being a competent clinician and /or technician, will have the range of professional skills required to begin working as part of a dental team and be well prepared for independent practice".[1] This study examines the views of new dental graduates in the area of dental and maxillofacial radiology.

Dental and Maxillofacial Radiology is one of the 13 dental specialties defined by the UK General Dental Council (GDC).[2] It is a small specialty with only 27 dentists on the specialist list[3] with most working in dental hospitals and schools. These specialists are responsible for delivering teaching to the dental undergraduate students.

The GDC publication 'Preparing for Practice'[1] sets the learning outcomes for dental radiography and radiology. There are relatively few in this topic area but they include:

1. Explain and apply the scientific principles of medical ionizing radiation and statutory regulations
2. Undertake relevant special investigations and diagnostic procedures, including radiography
3. Discuss the importance of each component of the patient assessment process
4. Synthesise the full results of the patient's assessment and make clinical judgments as appropriate

The British Society of Dental and Maxillofacial Radiology (BSDMFR) have also produced curricula for all members of the dental team.[4] The curricula cover three basic topic areas: (i) radiological science including radiation protection, (ii) radiographic technique, and (iii)

radiological interpretation. The curricula also describe the level of knowledge required in each topic area.

A new registrant is considered a 'safe-beginner' and they should have the range of professional skills required to begin working as part of a dental team and be well prepared for independent practice.[1] Radiography and radiology skills are vital skills to have, as it is not possible to perform many aspects of dentistry without the use of radiographs.

Dental Foundation Training (DFT) is a one-year training programme, during which the foundation dentist (FD) works independently within NHS primary care and also attends a series of study days. The primary purpose of DFT is to produce competent, caring practitioners who can consistently provide safe and effective care for patients in a primary care setting.[5]

This study sets out to explore the confidence FDs have in all areas of dental and maxillofacial radiology following their undergraduate teaching.

Materials and Methods

The study was approved by the Dental School Research Ethics Committee Ref.1833. The study was also supported by the Director of Postgraduate Dental Education for Wales, the Associate Dean for Dental Foundation Training in Wales and the Postgraduate Dental Dean at Health Education South West, England.

A paper questionnaire was designed to assess FDs confidence in various aspects of Dental and Maxillofacial Radiology. The format of the questionnaire was similar to a published questionnaire used to assess confidence in human disease/clinical medical sciences in a similar subject group.[6] The questionnaire covered four sides of A4 paper and was accompanied by an information sheet. Most of the questions involved the use of a tick-box,

and Likert-style questions[7] but there was space for free-text comments if required. In Wales there are a total of 74 FDs in 6 DFT schemes and in South West of England there are 82 FDs in 6 DFT schemes. The questionnaire was sent to the Training Programme Directors (TPDs) of the schemes for distribution to the FDs. The TPDs were asked to distribute the questionnaire at the beginning of February 2019. The completed questionnaire were returned and the data entered on an Excel spread sheet. Data for questions 21 to 40 was ordinal in the range 1 to 5 and so data was not normally distributed.

A single-sample non-parametric test (i.e., Wilcoxon signed-rank test) was used to test if the confidence across the entire set of subjects was different to the middle of the range on our five-point Likert scale, i.e., "3" (e.g., "neither agree nor disagree" for Q21 to Q40). For Q20 to Q40, the Mann-Whitney test was used to test for differences between two groups of subjects, e.g., gender (male/female) or previous degree (yes/no) etc. The Kruskal-Wallis test (non-parametric one-way ANOVA) was used to compare results as a function of month completed (i.e., January, March, April, or May). In all cases, Monte Carlo (MC) simulation with 10^6 replicates was used to find *P*-values accurate to (approximately) three decimal places as sample sizes were sometimes low for some groups. MC estimates should provide a more reliable estimate of *P*-values than "asymptotic" values when sample sizes are low. Furthermore, multiple comparisons were carried out, i.e., 21 comparisons for questions 20 to 40, and so an additional consideration of "Bonferroni corrections" was made. Bonferroni corrections reduce the boundary for "statistically significance," namely to $\alpha/21 = 0.05/21 = 0.0024$ in our case. This correction strongly reduces the chances of a false-positive result occurring in any of the 21 comparisons. All statistical analyses were carried out using SPSS (V25).

Results

In total, out of the 156 questionnaires distributed, 130 were returned giving a response rate of 83%. The response rate was better from the FDs working in Wales (66/74, 89%) compared to the South West of England (SWE) (64/82, 78%).

Although the TPDs were asked to distribute the questionnaire for completion in February 2019 they were completed between January and May 2019 with the majority being completed in April 2019.

There were 51 males (39.2%) and 78 females (60%) in the study sample. One FD (0.8%) was not willing to provide their gender. The male: female ratio was 1:2 in England and approached 1:1 in Wales (Table 1).

All the FDs graduated in 2018 with the majority graduating from UK dental schools (121/130, 93%), with the rest graduating from European dental schools in Hungary, Spain, Latvia and the Czech Republic (9/130, 7%). 14 of 16 UK dental schools were represented in the study sample with the most commonly represented schools being Cardiff (31 FDs), King's College, London (23 FDs) and Peninsula (15 FDs). 22 (17%) of the FDs had a previous degree before doing dentistry and 10 (7.7%) entered a dedicated graduate-entry dental programme.

The subjects were asked whether they had received a radiological science course, a practical radiography course and a radiographic interpretation course. The results of these questions are shown in Table 2.

The main reported method of delivery of the radiological science was lecture based learning and e-learning. The radiological interpretation teaching was delivered mainly by lecture based and small group teaching. The results of this question are shown in Table 3.

The radiographic techniques the FDs were taught during their undergraduate course are shown in Table 4.

The FDs were asked to indicate the degree of confidence the teaching/training in relation to dental radiography and radiology had given the FD in their current post working as an independent dentist in dental foundation training. The results are shown in Table 5. The mean 'confidence score' was 1.86 and the median 'confidence score' was 2, so most FDs were reasonably confident. This score was significantly different (even after Bonferroni correction) from the middle answer of 'don't know' (Table 6). In this table a score of 1 indicates 'very confident' and a score of 5 indicates 'very little confidence', with a range of confidence in between.

The final set of questions (Q21-40) asked the FD to indicate how strongly they agreed with a series of statements regarding the teaching in dental radiography and radiology. The options were 'strongly agree', agree', 'neither agree or disagree', 'disagree' and 'strongly disagree'. Overall the FDs were confident or very confident in all areas apart from being able to carry out cephalometric radiography and oblique lateral radiography. The scores for these two subject areas were significantly different (even after Bonferroni corrections in most cases) from a score of 3 ("neither agree or disagree"). The results of these questions are shown in Table 6.

Note that examination of descriptive statistics did not show any consistent or strong pattern of differences in results by gender, although there was some evidence that those subjects trained outside the UK had a different pattern of (and possibly very slightly lower) confidence levels. However, sample sizes were low in this case as only 8 subjects were trained outside the UK. Indeed, there were no significant differences in responses for questions 21 to 40

between those students who were educated within the UK and those who were educated outside of the UK and also by gender after Bonferroni correction. Even without Bonferroni correction, there were no significant differences in responses for questions 21 to 40 between those students who entered the graduate scheme and those who did not, and there were no significant differences in responses for questions 21 to 40 between those students who had a previous degree and those who did not.

Discussion

This study showed that FDs overall were reasonably confident the teaching they had received in dental radiography and radiology had allowed them to work as a competent independent dentist. This is a very encouraging result and shows that the undergraduate teaching provided across the UK and parts of Europe is generally good. A total of 14 UK dental schools out of 16 were represented, and the sample included graduate entry dentists and a number of dentists who qualified in Europe. The study sample is large enough that it can be supposed that this is a representative sample.

The questionnaire used in this study was based on a previous questionnaire used to survey foundation dentists in relation to teaching in human diseases/clinical medical sciences.[6] The response rate was good and comparable to other questionnaire studies.[6,8,9] The questionnaire comprises a series of questions most of which required the participant to tick a box to indicate their answer. This makes it easier to collate the results.[10] Although the questionnaire was long (4 sides of A4), it was designed to take no longer than 5-10 minutes to complete. The TPDs were asked to distribute the questionnaires in February as that is approximately halfway through the dental foundation training. However due to difficulties the TPDs had in distributing the questionnaires they were distributed over a 4-month period. However this is

unlikely the affect the validity of the results. Indeed, after Bonferroni correction, there were generally no significant differences (Kruskal-Wallis test: $P >> 0.05$) in responses for questions 21 to 40 with respect to the month that the questionnaire was administered.

All the FDs reported they had undertaken a formal radiological science course, and the majority also received a formal practical radiography and radiological interpretation course. The radiological course normally includes topics such as X-ray production, radiation dose, radiation protection and the relevant legislation. In most cases the FDs had received training through lectures, e-learning and problem-based learning. A systematic review showed that e-learning in oral radiology is at least as effective as traditional learning methods.[11] The interpretation courses were delivered mainly through lectures and small group teaching. Interpretation lends itself to small group teaching where radiographic findings can be discussed. One study showed students performed better in radiological interpretation if blended learning was used (face-to face learning and online teaching) rather than traditional face-to-face methods.[12]

The majority of the questions asked in Table 6 arise directly from the BSDMFR curriculum. There were no differences between males and females (Mann-Whitney test with Bonferonni correction, $P >> 0.05$). It is encouraging that the FDs were most confident in the practical aspects of dental radiography (undertaking bitewing radiography, periapical radiography and panoramic radiography) which are the most common radiographic views taken in general dental practice. The FDs were also very confident in recognising common dental diseases such as caries, periapical disease and periodontal disease.

FDs were less confident with undertaking occlusal radiography, which is not a commonly taken view. Only 62.3% of FDs stated they had received training in this technique, which

would account for the lower score. FDs were also less confident in the differential diagnosis of radiolucencies and radiopacities of the jaws. These are much more difficult topics so it is not surprising that the FDs felt less confident.

The BSDMFR curriculum states that only limited knowledge of CBCT is required, as this area is likely to be outside the scope of practice of a new graduate. However, the FDs still felt that the teaching they had received gave them the reasonable confidence in the indications for this technique. This is encouraging as it is likely the use of CBCT will only increase in the coming years. In a recent survey it was concluded that if dentists were to install CBCT equipment in their practices, then CBCT teaching must be included in dental education.[13]

However, there were two areas were the FDs did not feel confident, namely undertaking oblique lateral radiography and lateral cephalometric radiography. Only one third of FDs stated they had received training in these areas. The BSDMFR curriculum states that the dentist should have knowledge of cephalometric techniques, but this would not be sufficient to for the dentist to perform the technique. This is because cephalometric radiography is normally only performed in complex cases often undertaken in specialist dental practice. Therefore, it is not surprising that FDs score their confidence low for this technique. However the curriculum states that the dentist should be competent at carrying out oblique lateral radiography. This radiographic view is a useful view as either an alternative the periapical radiography if the patient is unable to tolerate intraoral radiography or as an alternative to panoramic radiography if the imaging modality is not available. Therefore, dental educators need to be aware of this finding and amend the teaching in the area appropriately.

Conclusion

This is the first study of dental foundation dentists in England and Wales looking at their confidence in the use of radiology and radiographic techniques learned as dental undergraduates and their application in the early part of independent dental practice.

Most of the DFs had received a blended learning in radiology and radiography comprising lectures, e-learning, small group and problem-based learning.

Most DFs were confident in their understanding and use of the most common radiographic investigations (bitewing, periapical, panoramic) and CBCT, and less confident in undertaking lateral cephalometric and oblique lateral radiography.

One interesting outcome of the study was that the FDs felt confident regarding the indications for CBCT, despite there being fewer of these units currently used in general dental practice. However, as this is likely to change in the future with the cost reducing and accessibility of CBCT units increasing, their popularity and use in general dental practice is likely to rise.

We hope this study will help those involved in undergraduate education to reflect on areas taught well and those areas that may require further development.

Tables

Table 1. Gender distribution of the FDs in the Welsh and English Schemes.

Location	Male	Female	Not Willing to State	Total
South West England	21	42	1	64
Wales	30	36	0	66
Total	51	78	1	130

Table 2. Number of FDs who reported undertaking a radiological science course, a practical radiography course and a radiographic interpretation course.

Course	Yes	No	Did not answer
Radiological Science Course	130 (100%)	0 (0%)	0 (0%)
Practical Radiography Course	125 (96.2%)	5 (3.8%)	0 (0%)
Radiographic Interpretation Course	122 (93.8%)	7 (5.4%)	1 (0.8%)

Table 3. Methods of delivery of teaching reported by the FDs for the radiological science course and the radiological interpretation course

Course	Method of delivery	Yes	No	Missing answer
Radiological Science Course	Lecture-based	116 (89.2%)	12 (9.2%)	2 (1.5%)
	e-learning	52 (40%)	76 (58.5%)	2 (1.5%)
	Small group	0 (0%)	0 (0%)	0 (0%)
	Problem based learning	26 (20%)	102 (78.5%)	2 (0%)
	Symposium based teaching	0 (0%)	0(0%)	0 (0%)
	Other	4 (3.1%)	124 (95.4%)	2 (1.5%)
Radiological Interpretation Course	Lecture-based	100 (76.9%)	22 (16.9%)	8 (6.2%)
	e-learning	34 (26.2%)	88 (67.7%)	8 (6.2%)
	Small group	87 (66.9%)	35 (26.9%)	8 (6.2%)
	Problem based learning	35 (26.9%)	87 (66.9%)	8 (6.2%)
	Symposium based teaching	0 (0%)	0(0%)	0 (0%)
	Other	27 (20.8%)	96 (73.8%)	7 (5.4%)

Table 4. Summary of the radiographic techniques the FDs reported they were taught.

	Yes	No	Did not answer
Periapical radiography	128 (98.5%)	0 (0%)	2 (1.5%)
Bitewing radiography	126 (96.9%)	2 (1.5%)	2 (1.5%)
Occlusal radiography	81 (62.3%)	46 (36.2%)	2 (1.5%)
Panoramic radiography	120 (92.3%)	8 (6.2%)	2 (1.5%)
Cephalometric radiography	43 (33.1%)	85 (65.4%)	2 (1.5%)
Oblique lateral radiography	45 (34.6%)	83 (63.8%)	2 (1.5%)

Table 5. Raw scores for overall degree of confidence the training had given the DFs in relation to dental radiography and radiology.

Degree of confidence	'Score assigned'	Number
Very confident	1	24
Reasonably confident	2	101
Don't know	3	2
Little confidence	4	2
Very little confidence	5	0
Not answered	0	1
Total		130

Table 6. Results of a series of questions asking how strongly the FDs agreed with a series of statements following their undergraduate radiography/radiology teaching.

Question number	All subjects	*n*	Mean	Q_1	Q_2 (i.e., median)	Q_3	z	P (2-tailed)
28	Undertake bitewing radiography	129	1.27	1	1	1	10.372	< 0.001
29	Undertake periapical radiography	129	1.27	1	1	1	10.253	< 0.001
38	Confident at recognising periodontal disease	129	1.44	1	1	2	10.123	< 0.001
37	Confident at recognising Periapical disease	129	1.53	1	2	2	10.056	< 0.001
36	Confident at recognising Caries	129	1.7	1	2	2	9.755	< 0.001
26	Confident at using Selection criteria	129	1.75	1	2	2	10.025	< 0.001
24	Know the principles of Radiation protection	129	1.84	2	2	2	10.048	< 0.001
20	Overall degree of confidence the teaching/training in relation to dental radiography and radiology has given you:	129	1.86	2	2	2	10.236	< 0.001
31	Undertake Panoramic radiography	127	1.87	1	2	2	8.301	< 0.001
22	Know doses and risks from dental radiography	129	2.05	2	2	2	9.867	< 0.001
23	Know the statutory requirements	128	2.07	2	2	2	8.998	< 0.001
35	Carry out radiology/radiography audit or quality improvement project	129	2.1	2	2	2.5	8.515	< 0.001
39	Confident at providing a differential diagnosis for a radiolucency in the jaws	129	2.1	2	2	2	9.028	< 0.001
40	Confident at providing a differential diagnosis for a radiopacity in the jaws	129	2.2	2	2	2	8.571	< 0.001
25	Know about the image receptors	129	2.24	2	2	3	7.869	< 0.001
21	Understand radiation physics as it relates to dentistry	129	2.32	2	2	3	7.548	< 0.001
27	Know the indications for Cone Beam Computed Tomography	129	2.41	2	2	3	6.472	< 0.001
30	Undertake occlusal radiography	129	2.65	2	3	3.5	3.561	< 0.001
34	Able to undertake practical quality assurance tests	128	2.66	2	2	3.75	3.662	< 0.001
32	Undertake oblique lateral radiography	129	3.33	3	3	4	3.493	< 0.001
33	Undertake cephalometric radiography	128	3.51	3	4	4	5.102	< 0.001

Wilcoxon Signed-Rank test compared to a test value of 3 (z-value and P-value given from this test). (Q1 = first quartile; Q2 = median = second quartile; Q3 = third quartile).

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