

An Investigation of Radiation Protection Knowledge, Attitudes and Practices of North Queensland Dentists

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ABSTRACT

Objective: Queensland has current radiation protection guidelines however with an absence of data exploring compliance and implementation, the efficacy is unknown. The aim of this study was to investigate the knowledge and attitudes on radiation protection among private North Queensland dentists.

Method: A quantitative methodology was employed in an observational and descriptive study using questionnaires for data collection.

Results: Of the 154 questionnaires distributed, 63 were completed and returned. The respondent's knowledge concerning the technical details of their equipment was limited, with 31.5% and 47% not knowing the tube voltage and current utilized for their machines respectively. 23.8% of dentists had limited knowledge about speed of conventional film they used. 90.5% of respondents agreed that the role of imaging in dentistry is important. 75.8% dentists reported thyroid as most important organ to protect during dental radiography. Their knowledge regarding position-distance rule was reasonably adequate. 80.3% of the dental practices appeared to follow the Australian Radiation Protection and Nuclear Safety Agency guidelines. 95.2% preferred taking radiographs if it was only urgent. 69.8% identified a need for spreading awareness regarding radiation protection.

Conclusions: An opportunity and need for further continuing education was identified among North Queensland dentists to ensure safety of patients.

Key Words: General dentists, Queensland radiation health, Radiation Protection, Radiation Protection Knowledge, Radiation Safety.

INTRODUCTION

Dental radiography plays an indispensable role in diagnosis and treatment planning for dental disease.^{1,2} Both intra-oral and extra-oral radiographs can be utilised in a comprehensive examination of a patient.¹ However, the potentially detrimental effects of radiography cannot be understated. Each radiation exposure can cause a temporary or permanent biologic effect to the human body, which increases the concern for the risk of cancer.^{2,3}

While radiation doses emitted in dentistry are relatively low, radiation protection practices should be utilized and implemented by all general dental practitioners (GDPs).^{2,3} Encompassing this, is the 'As Low As Reasonably Achievable' (ALARA) principle which highlights the use of radiation protection to prevent unnecessary radiation exposure.^{4,5} According to ARPANSA's (Australian Radiation Protection and Nuclear Safety Agency) *Code of Practice for Radiation Protection in Dentistry 2005* guide, the occupational dose limit is 20mSv (millisievert) per year (averaged over a consecutive 5-year period); whereas the public dose limit is 1mSv per year.⁴ These limits and principles can be adhered to by following current radiation protection guidelines and policies.

Australia and more specifically Queensland have up-to-date radiation protection guidelines. Broadly, the *Radiation Safety Act 1999* was implemented for the control of sources emitting ionizing and harmful non-ionizing radiation.⁶ However, further policies were developed to decrease the risk of adverse effects.⁶ *The Code of Practice for Radiation Protection in Dentistry 2005* created by APRANSA establishes the standard for radiation equipment, licensing and personal protection.⁴

Currently, the Queensland Government encourages the compliance to the *Radiation Safety and Protection for Intra-oral Dental Diagnostic Radiography*.⁵ This plan incorporates the adherence to the previously mentioned legislative guidelines as well as *Radiation Safety Regulation 2010* policy.⁵ According to this plan, it is compulsory for practicing Queensland dentists to hold a radiation license, maintain sufficient knowledge of radiation practices, follow the ALARA principle and remain aware of updates.⁵

These national and state guidelines help maintain safe radiation practices for Australian general dental practitioners. However, compliance to the guidelines and their successful implementation is unknown due to the absence of data. Despite overseas studies having reported consistent conclusions regarding the knowledge and attitudes of general dentists in regards to radiation protection, data is yet to be collected within Australia. This emphasizes an obvious gap in the literature and highlights the purpose of this study.

With a primary focus on North Queensland (NQ), the aim of this study was to investigate the knowledge and attitudes on radiation protection among private North Queensland dentists and determine whether they implement this in their routine practices.

MATERIALS AND METHODS

The present study was conducted among North Queensland (NQ) dental practitioners to investigate radiation protection practices, knowledge, attitudes and implementation. A quantitative methodology was employed in an observational and descriptive study. A self-reported questionnaire with 32 multiple choice questions (Appendix I) was constructed for data collection. The questionnaire was fabricated with the assistance of a Dental Radiology lecturer and piloted through clinical university supervisors (from outside NQ). However, the pilot study did not contribute to the final results. The questionnaire was approved by the James Cook University Ethics Research Committee before distribution. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Our study was being independently reviewed and approved by the ethics committee/ institutional review board. Informed consent was obtained from all participants for being included in the study.

The questionnaire aimed to cover four themes including radiographic equipment, radiation protection knowledge and guidelines, radiation protection practices for dentists and radiation protection practices for patients. Demographic data was established through the initial four questions of the questionnaire. The themes mentioned were covered in the remaining twenty-nine questions.

The sampling strategy employed utilized connections with the Australian Dental Association Queensland (ADAQ) to establish the approximate number of potential participants in the study. It was determined that there were an estimated 210 dental practitioners working in North Queensland. A National Statistical Service Sample Size Calculator was used to ascertain the confidence level for the study. A participation rate of at least 136 dental practitioners was required to have a 90% confidence level.

Convenience sampling was applied to recruit North Queensland private dentists. Participants were invited and encouraged to partake in the study through direct contact with the researchers or via email. Paper questionnaires were the predominate form of data collection being personally distributed in accessible areas. Electronic questionnaires were sent to inaccessible areas after phone contact with practice managers.

A total of 154 questionnaires were distributed in North Queensland. Participants were given three weeks to complete the questionnaires with reminder emails being sent by the authors and ADAQ representatives to increase response rate. Upon questionnaire collection, data was classified as re-identifiable data; replacing individual identifiers with a code. The paper questionnaires are stored securely at JCU, complying with JCU's Confidentiality Agreement and data storage guidelines.

Data was tabulated and analyzed with the statistical program SPSS (Statistical Package for the Social Sciences) 2013. A combination of numerical and categorical data analysis allowed for both demographic and hypothetical data to be recorded. Our data were evaluated using the χ^2 analysis to determine the significance of differences between two independent groups. The level of significance was set at 5%.

RESULTS

In total, of the 154 questionnaires distributed 63 were completed and returned. The response rate was therefore approximately 42% indicating a 10% margin of error throughout the results was possible.

Profile of the Respondents (Table 1)

Of the 63 respondents, 69.8% were male and 30.2% were female. The majority of responders were within the 30-39 year old category (25.4%) and only seven percent of the responders were 60 years of age or greater. Around a third (30.65%) of participants had graduated experience of five years or less and few (9) had higher qualifications than a Bachelor of Dental Surgery. 38.1% of participants recalled having undertaken radiation protection courses or training within the past two years.

Radiographic Equipment

The majority of practices within the NQ region reported using intra-oral radiographic equipment (96.8%). Most radiographic equipment appeared to be greater than six years old with 92.1% of dentists recording periodic services commonly around 12 or 24 month time period (31.7% and 31.7% respectively).

In about two thirds of the cases (61.3%), the dentist used tube voltage of 65-70 kVp however a notable number of dentists (12) did not know how much tube voltage was being used in their machine. Approximately half of the responders used a tube current of under 10 mA with 21 dentists doubtful regarding the mA values of their machines. In order to reduce scatter, a cylindrical collimator was most commonly used by participants (95.1%). Although not statistically significant ($p > 0.05$), differences were found between knowledge of tube voltage (Table 2) and tube current (Table 3), and dentists with five years or less experience. Such respondent's knowledge concerning the technical details of their equipment was limited, with 12 (31.5%) not knowing the tube voltage and 21 (47%) not knowing tube current for their machines.

As kVp and mA exposures can vary depending on the receptor used, dentists were asked what radiographic film/sensor they employ. Digital storage phosphor plates were most preferred among the respondents (58.7%) with conventional film and digital CCD-sensors less commonly reported (11.7% and 23.8% respectively). In figure 1, it can be observed that 23.8% of the dentists did not have any knowledge about speed of conventional film.

Radiographic Knowledge

Since practitioner's attitudes and radiographic knowledge can heavily influence imaging outcome, the dentists were asked for their opinion regarding the role of radiography in dentistry. An overwhelming majority (90.5%) of respondents agreed that the role of imaging in dentistry was very important. The dentists' opinion of exposure transfer from a panoramic image versus full mouth periapical radiographs was however less unanimous, with 13 dentists reporting panoramic and 45 recording full mouth.

The respondent's knowledge concerning the most important organ to protect during dental radiography was divided. Figure 2 shows that 75.8% of the dentists reported thyroid and of the rest, 17.7% answered gonads, 1.6% skin and 4.8% did not answer the question correctly. While not statistically significant ($p > 0.05$), a positive correlation was found between the correct answer (thyroid) and dentists with five or less years' experience (89.4% of 'thyroid' respondents were from this age group).

Respondents' knowledge regarding position-distance knowledge was reasonably adequate with the majority of dentists reporting a distance of 2-3 or greater than 3 meters between the primary source of radiation and themselves (28.6% and 58.7% respectively).

As a result of the inconsistency among radiation knowledge, the majority of dentists within the NQ region identified a need for spreading awareness regarding radiation protection (69.8%). Though not statistically significant ($p > 0.05$), when comparing the wiliness to improve on radiation hazards and protection knowledge and age, the 30-39 and over 60 years of age groups were the most willing.

Radiographic Protection Practices

In order to protect the patient and practitioner, 56 dentists detailed a current radiation safety plan within their practice. Most of the dental practices appeared to follow the ARPANSA guidelines (80.3%) and the rest followed either ADA or other guidelines. Furthermore, 74.6% of dentists reported maintaining a radiographic record/log book with 54 dentists wearing exposure badges while in their dental practices. Use of digital storage phosphor plate rather than a conventional film, reducing the exposure

parameters and use of lead barriers (0.5mm lead equivalent which is an adequate protection according to ARPANSA's guidelines) were some of patient protection methods utilized by the GDP's.

Figure 3 shows the number of intraoral radiographs taken per week. No statistically significant difference ($p > 0.05$), was found between the years of experience and number of radiographs taken per week. The majority of dentists (37) reported varying the exposure time depending on the place of interest with the average of exposure time being less than 0.160 seconds (79.4%).

There was a general consensus among the respondents that aiming devices were the safest option for positioning the film/sensor (71.4%). Of the remaining, 14.3% reported using aiming devices or patient's finger. Although not statistically significant ($p > 0.05$), there was a relationship between years of experience and positioning. Dentists with five years or less experience were most likely (89.47%) to use aiming devices and dentists qualified for 25 years or more were more likely to use the patient's finger (31.25%).

In order to reduce self-exposure, three quarters of the dentists reported precautionary protocols including standing behind a protective barrier during radiation exposure (40 responses) followed by the use of the lowest exposure setting as possible (15 responses). Interestingly, just over half the dentists reported offering radiation protection precautions to the patient (50.8%).

Although female practitioners reported a slightly higher response to patient protection (61% compared to males 48%), a higher number of male practitioners illustrated procedural changes for pregnant patients. The most preferred procedural change for pregnant patients was to only take intraoral radiographs if urgent for diagnosis (95.2%). While not statistically significant ($p > 0.05$), a relationship was found between this procedural change for pregnant patients and the sex of the practitioner: 89.4% of females and 97% of males reported implementing the aforementioned change (Table 4).

Of the respondents, 21 dentists reported seeking existing intraoral radiographs upon examination of a new patient and equal numbers reported immediately requesting an Orthopantomogram (OPG). Despite being statistically insignificant ($p > 0.05$), a relationship was found between intraoral radiograph protocol and years of experience. Dentists with five or less years' experience were more likely to take new intraoral radiographs (37.84%) however, dentists with 25 years or more experience were most likely to request previous intraoral radiographs (33.3%).

DISCUSSION

Dental practitioners need adequate training and sufficient knowledge of radiation, radiation equipment and radiation protection. This requires an understanding of current guidelines, equipment, operator position and personal shielding.¹ Currently data has never been collected on Australian dental practitioners regarding radiation protection. This highlights an obvious gap in the literature and a need for such research to be implemented. This study not only aims to fulfill this gap in the literature but open the conversation regarding radiation protection in Australia.

ARPANSA are the governing body regarding radiation protection in Australia and have a code of practice and safety guide that is encouraged to be implemented.⁴ Favorably, close to 80% of respondent's followed such guidelines with the remaining reporting other or their own practice guidelines. Such positive results indicate the majority of NQ practices appreciate the need for radiation safety guidelines.

It is a requirement of the Radiation Safety Act 1999 that all practices employ an approved radiation safety plan to minimize health risks from radiation.⁴ Unfortunately, nearly 10% of participants did not report having a radiation safety plan, signifying either noncompliance of the radiation regulations or genuine oblivion to such plans within their practice. Irrespective of the reason, the results indicate a deficiency in radiation protection within these practices potentially placing themselves or patients at risk.

It is also a requirement for practices to maintain a radiograph log sheet.⁴ A quarter of participants reported not maintaining a logbook, again defying the regulations which

can affect radiation protection of patients. Overseas studies have limited reporting on logbooks reflecting the differences in national guidelines throughout the world.

The majority of North Queensland dentists carried out periodic maintenance of radiograph equipment (92.1%). This is considerably better than results reported overseas; between 16%-26% reported regular maintenance.⁷⁻⁹ Australia may evidently have clearer regulations regarding maintenance proven by increased compliance.

In order to examine radiation knowledge and practices participants were tested on their knowledge of radiation equipment in their surgeries. One cannot claim to have a thorough knowledge on radiation if unaware of their equipment and its parameters as evidenced by similar studies investigating this aspect.^{8,9,10} Being unaware of machine settings can lead to unnecessary excess radiation exposure to patients and practitioners. Examination of the exposure parameters of intraoral radiograph equipment revealed more than half of participants reportedly used tube voltage setting of 65-70 kVp; comparable with overseas studies.^{11,12} Worryingly 19% of dentists reported they did not know the tube voltage setting of their machines and a third did not know the mA of their equipment. This is a far better result compared to a 2015 Indian study reporting 89% of participants not knowing these values.¹⁰ The majority of these responses came from participants with less than five years' experience. This may be attributed to a lack of education or newly graduated dentists having failed to familiarize themselves with different equipment in private practice compared with equipment used at a university level. These results were a significant improvement compared to overseas results that found more than 75% of dentists not knowing these values.^{8,12}

Despite the potential to reduce exposure by 60%, rectangular collimation use was only employed by 5% of participants. This is equivalent to overseas studies also finding very limited usage of rectangular collimation.^{8,11,13-16} A possible explanation is that rectangular cones need to be separately purchased and installed which may be seen as an unnecessary hassle or practitioners are unaware of their benefits. These results are an improvement from a 2016 study where 73% of dentists were unaware what type of collimation was used.¹⁰ Dentists need to be educated on these benefits to increase the usage of rectangular collimators. This gives an insight into the current practices of GDP regarding their radiation equipment.

Results for panoramic versus full mouth radiation were comparable to existing literature.^{7,15} Previous studies reported 30% of respondents incorrectly believed panoramic radiation produced more exposure, with this study finding 30.8%.^{7,14} This may be due to an imbalance of knowledge between intra and extra oral radiology and a reliance on intra oral radiographs.

This study found significantly better results in regards to the use of aiming devices to position a film during exposure (71%). Overseas studies reported up to 60% never using an aiming device including a recent Indian study reporting their usage as only 17%.^{11,15,17} This would mean NQ dentists would likely require less retakes of radiographs and avoid unnecessary exposure to patients.

Only 11% of practices used conventional films with most being either E or F speed. This is less than that reported overseas with one study finding 45% usage and another 72%.^{7,13} It is encouraging that NQ dentists are mainly using digital sensors that reduce exposure by up to 50%.¹⁸

Data on thyroid protection was slightly better than previous studies that reported 35% failed to appreciate its importance.^{7,14} Meanwhile 24.2% of NQ dentists failed to acknowledge the thyroid as the most important organ for radiography protection. Most incorrect responses believed the gonads to be the most important organ especially among male participants. This may be equated to a lack of education or lack of awareness of the thyroid gland among males. Interestingly Chaudhry et al reported females were more likely to underestimate the importance of thyroid protection; a contrast to findings in this study.⁷

The position distance rule states practitioners should stand at least 2 meters away from the primary x-ray beam for sufficient protection.¹¹ Encouragingly 87% of participants believed their position should be 2+ meters from the tube head. These results are comparable with a Belgium study that also found the majority of practitioners followed the rule.¹¹ However, an Indian study in 2015 reported 78% GDP's not allowing 2 meters between them and the primary beam, while a 2016 study of the same area concluded an

improved 41% of practitioners stood near the patient during exposure clearly ignoring the rule.^{10, 13}

Positively, all dentists ensured their own protection from radiation through various measures. Two thirds of dentists stood behind a protective barrier while 24% used the lowest exposure settings. This is an improvement on previous studies with a Belgian study reported only one quarter stood behind a protective wall.¹⁵ Sadly, further details regarding the protective barrier was not sort, a potential improvement for future research. Realistically, the lowest exposure possible should always be applied so this may highlight a deficiency in radiation protection.

Interestingly a new finding was a higher incidence of male NQ dentists changed procedures for pregnant women compared to female participants. This may be due to female practitioners understanding pregnancy personally and not being as concerned compared to males. A recent advancement paper from 2017 reported the use of extra protection for pregnant patients is unnecessary.¹⁹

On average, knowledge based questions were answered incorrectly by 27% of dentists. This highlights a generalised deficiency in knowledge of private dentists in NQ. Whilst not statistically significant, practitioners with the least experience had the highest rate of incorrect knowledge questions, with the exception of which organ is most important for protection. Females were slightly more likely to always offer extra precautions for patient's safety. However, females were more likely to not know the characteristics of their radiographic machines. This may indicate females are more patient orientated rather than equipment based.

Response rate for this study was somewhat poor; this non-participation can be attributed to many reasons. Firstly, although anonymous, dentists may have felt an incorrect response would reflect negatively on them. Considering this was student research, dental practitioners may have felt it was not significant or worth their time to engage in the study. This population may also feel over studied as student research is conducted annually as part of the Bachelor of Dental Surgery degree. It must also be acknowledged that practitioners are busy and have tight appointment schedules to maintain throughout the day and may simply have not had enough time to complete the questionnaire.

Considering this, the data may not entirely reflect the population studied and results may therefore be an over or underestimation. Additionally, 70% of responders were male meaning the data may be an underrepresentation of the female dental population or an indication of unequal gender distribution within the profession in North Queensland.

This response rate poses a limitation of the research in that it may be a stretch to generalize it to the population of NQ. Further research may be required in this population group to confirm current findings. However, one must note, for student research a response rate of 40% is reasonable. A similar research study on doctors only had a response rate of 50%.²⁰

Other limitations of student research include time and money, limiting the opportunities of this research project. Finally, because the questionnaires were not completed immediately in front of researchers there was the possibility some practitioners researched their answers either by checking their equipment, asking other practitioners or utilizing the internet. Therefore, knowledge reported may be an overestimation.

This research investigates a previously unstudied area of dentistry and radiation within Australia. Therefore, allowing additional research to be conducted to further investigate the issue. The research could also be extended to compare different areas of dentistry and radiation for example comparing the differences in radiation equipment, knowledge and attitudes of rural and metropolitan practitioners.

The need for further education established from this data indicates the need for continued radiation education throughout the career of practitioners. The fact some knowledge questions were answered incorrectly mostly by recently graduated dentists also highlights a requirement for more radiograph education as part of university curriculums.

Conflict of interest – All the above authors declare that they have no conflict of interest.

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Human rights statements and informed consent - All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Our study was being independently reviewed and approved by the ethics committee/ institutional review board. Informed consent was obtained from all participants for being included in the study.

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REFERENCES

1. Whaites E, Drage N. Essentials of dental radiography and radiology. 5th ed. Edinburg; New York: Churchill Livingstone; 2007.
2. Rout J, Brown J. Ionizing radiation regulations and the dental practitioner: 1. The nature of ionizing radiation and its use in dentistry. Dent Update. 2012; 39(3):191-2, 195-8, 201-3.
3. Australian Dental Association (ADA). The Practical Guides. 7th Edition ed. St Leonards, Australia: Australian Dental Association; 2009.
4. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Code of practice and Safety Guide – Radiation Protection in Dentistry. Radiation Protection Series. 10th Series. Radiation Health Committee; 2005. Australia: p 71.
5. Queensland Government. Radiation Safety and Protection Plan: Intra-oral Dental Diagnostic Radiography. Queensland Government; Australia: 2011. p 11.
6. Queensland Government. Radiation Safety Act 1999. Australia: Queensland Government; 1999. Reprint no 4A. p 166.
7. Chaudhry M, Jayaprakash K, Shivalingesh KK, Agarwal V, Gupta B, Anand R et al. Oral Radiology Safety Standards Adopted by the General Dentists Practicing in National Capital Region (NCR). J Clin Diagn Res. 2016 Jan;10(1):Zc42-45.
8. Ilguy D, Ilguy M, Dincer S, Bayirli G. Survey of dental radiological practice in Turkey. Dentomaxillofac Radiol. 2005 Jul;34(4):222-227.
9. Sheikh S, Pallagatti S, Singla I, Gupta R, Aggarwal A, Singh R, et al. Survey of dental radiographical practice in states of Punjab and Haryana in India. J Investig Clin Dent. 2014 Feb;5(1):72-77.
10. Agrawal B, Dosi T, Hazari A, Maheshwari C, Rajput R, Yadav N . Evaluation of Radiation Protection Awareness amongst General Dental Practitioners of Western Rajasthan in India. J Int Oral Health. 2015; 7(12):51-55.
11. Jacobs R, Vanderstappen M, Bogaerts R, Gijbels F. Attitude of the Belgian dentist population towards radiation protection. Dentomaxillofac Radiol. 2004 Sep;33(5):334-339.
12. Aps JK. Flemish general dental practitioners' knowledge of dental radiology. Dentomaxillofac Radiol. 2010 Feb;39(2):113-118.
13. Kasat VO, Ladda R, Joshi S, Giri PA, Pandya M, Shaikh S. Knowledge and practice regarding safety standards of oral radiology among dental practitioners in western Maharashtra, India. Oral Radiol. 2016; 33(1): 1-7.

14. Shahab S, Kavosi A, Nazarinia H, Mehralizadeh S, Mohammadpour M, Emami M. Compliance of Iranian dentists with safety standards of oral radiology. *Dentomaxillofac Radiol.* 2012 Feb;41(2):159-164.
15. Gijbels F, Dabaveye D, Vanderstappen M, Jacobs R. Digital radiographic equipment in the Belgian dental office. *Radiat Prot Dosimetry.* 2005;117(1-3):309-312.
16. Lee BD, Ludlow JB. Attitude of the Korean dentists towards radiation safety and selection criteria. *Imaging Sci Dent.* 2013 Sep;43(3):179-184.
17. Aravind BS, Joy ET, Kiran MS, Sherubin JE, Sajesh S, Manchil PR. Attitude and awareness of general practitioners toward radiation hazards and safety. *J Pharm Bioallied Sci.* 2016 Oct;8(Suppl 1):S54-S58.
18. Okano T, Sur J. Radiation dose and protection in dentistry. *Jpn Dent Sci Rev.* 2010;46(2):112-121.
19. Tsapaki V, Radiation protection in dental radiology - recent advances and future directions. *Phys Med.* 2017 Dec; 44:222-226.
20. Ditkofsky N, Shekhani HN, Cloutier M, Chen ZN, Zhang C, Hannah TN. Ionizing radiation knowledge among emergency department providers. *J Am Coll Radiol.* 2016Sep;13(9):1044-1049.

Table 1: Profile of Respondents

Questions	Responses				
	Male	Female			
Gender	44 (69.8%)	19 (30.2%)			
	<29yrs	30-39yrs	40-49yrs	50-59yrs	>60yrs
Age	14 (22.2%)	17 (27.0%)	16 (25.4%)	11 (17.5%)	5 (7.9%)
	<5yrs	5-10yrs)	10-15yrs	15-25yrs	>25yrs
Years of graduated experience in dental practice?	19 (30.2%)	4 (6.3%)	8 (12.7%)	16 (25.4%)	16 (25.4%)
	Bachelor of Dental Surgery	Post Graduate Degree	PhD		
Highest Qualification?	54 (85.7%)	9 (14.3%)	0 (0.0%)		
	No	Yes			
Have you undertaken any courses/training on radiation protection in the past 2 years?	39 (61.9%)	24 (38.1%)			

Table 2 - Graduated Experience Vs. kVp

		KvP					Total
		45-55 kVp	56-64 kVp	65-70 kVp	71-80 kVp	I Don't Know	
Graduated	<5	0	2	11	0	6	19
Experience (years)	5-10	0	1	2	0	1	4
	10-15	0	2	4	1	1	8
	15-25	0	2	9	1	4	16
	>25	1	2	12	1	0	16
Total		1	9	38	2	12	63

Table 3 - Graduated Experience Vs. mA

		mA			Total
		<10 mA	10-12 mA	I Don't Know	
Graduated Experience (years)	<5	7	3	9	19
	5-10	3	0	1	4
	10-15	5	1	2	8
	15-25	9	2	5	16
	>25	8	4	4	16
Total		32	9	21	63

Table 4 - Procedures During Pregnancy

		No	Yes, I only take intraoral radiographs if urgent for diagnosis	Total
	Female	2	17	19
Total		3	60	63

Legend for figures

Figure 1: Distribution of study population according to Speed of Conventional Films used

Figure 2: The opinion of dentists in regard to “Most Important Organ for radiation protection”

Figure 3: Number of Intra-oral Radiographs taken by the dentists per week

APPENDIX: Questionnaire

1. Gender:

- Male
- Female

2. Age:

- ≤ 29 years
- 30-39 years
- 40 -49 years
- 50-59 years
- ≥ 60 years

3. Years of graduated experience in dental practice:

- <5 years
- 5-10 years
- 10-15 years
- 15 - 25 years
- ≥ 25 years

4. Highest qualification:

- Bachelor of Dental Surgery
- Post graduate degree.

Please specify.....

- PhD

Please specify.....

5. Have you undertaken any courses/training on radiation protection in the past 2 years?

- No
- Yes

6. Do you have radiographic equipment in your practice?

- No

- Yes

7. If yes, does your practice follow the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)?

- No
- The practice has its own guidelines
- The practice follows another set of guidelines i.e. ADA guidelines
- Yes

8. Do you have a radiation safety plan in place in your dental practice?

- No
- Yes

9. Do you maintain a Radiographic Record/Log Book in your dental practice?

- No
- Yes

10. How old is your radiographic equipment?

- ≤ 1 year old
- ≤ 5 years old
- > 5 years old
- > 10 years old

11. Do you have periodic services for your radiography equipment?

- No
- Yes

12. If yes, how often are your intraoral radiography equipment serviced?

- Every 12 months
- Every 2 years
- > 2 years
- I don't know

13. What is the tube voltage of your intraoral radiographic equipment?
- 45 - 55kVp
 - 56 - 64 kVp
 - 65-70 kVp
 - 71-80 kVp
 - ≥ 81 kVp
 - I don't know
14. What is the tube current of your intraoral radiographic equipment?
- <10 mA
 - 10-12 mA
 - >12 mA
 - I don't know
15. What shape does the tube head of your intraoral radiographic equipment have?
- Cylindrical
 - Pointed
 - Rectangular
16. In your opinion, how important is the role of imaging in dentistry?
- Very important
 - Important
 - Somewhat important
 - Neither important or unimportant
 - Somewhat unimportant
 - Unimportant
 - Very unimportant
17. In your opinion, which among the following radiographic techniques deliver more radiation to the patient?
- Panoramic
 - Full mouth

18. How many intraoral radiographs do you approximately take weekly?

- <20
- 20-40
- 40-80
- 80-120
- >120
- I don't know

19. What is the average exposure time for intraoral radiographs?

- ≤ 0.160 seconds
- 0.2 seconds
- 0.32 seconds
- >0.4 seconds
- I don't know
- Other.....

20. Does the exposure time vary?

- No
- Yes, depending on:
 - Place of interest
 - Film speed
 - Patient type
 - tube voltage of equipment

21. How is the radiographic film/sensor positioned during exposure?

- Aiming device
- Patient's finger
- Dentist's finger
- Assistant's finger

22. Which type of radiographic receptor do you use most often?

- Conventional film
- Digital storage phosphor plate

- Digital CCD-sensor

23. If conventional films used, what is the speed of film?

- D-speed
- D/E speed
- E-speed
- F-speed
- I don't know

24. According to you, what is the most important organ to protect during dental radiography?

- Gonads
- Bone marrow
- Skin
- Thyroid

25. At which distance from the radiation tube head should you be positioned during exposure?

- <1m
- 2-3m
- >3m

26. Do you take other precautions to protect yourself from radiation during exposure?

- No
- Yes
- I wear a lead apron
- I use a rectangular collimator
- I use the lowest exposure settings as possible
- I stand behind a protective barrier during radiation exposure
- Other.....

27. Do you wear an exposure badge while you are in the dental clinic at all times?

- No
 - Yes
28. Do you offer precautions to protect the patient from radiation during exposure?
- No
 - Yes
 - Thyroid collar
 - Lead apron
 - Only if the patient requests
29. Do your radiographic procedures change for pregnant women?
- No
 - Yes, I only take intraoral radiographs if urgent for diagnosis
30. What is your most common radiographic procedure for a new patient?
- Request radiographs from previous dentist
 - Take new intraoral radiographs
 - Request an panoramic radiograph
31. Do you think that there is a need to spread awareness regarding radiation protection?
- No
 - Yes
32. Would you be willing to improve your knowledge on radiation hazards and protection and implement the same into your dental practice?
- No
 - Yes

Thank you for your participation

Figure 1: Distribution of study population according to Speed of Conventional Films used

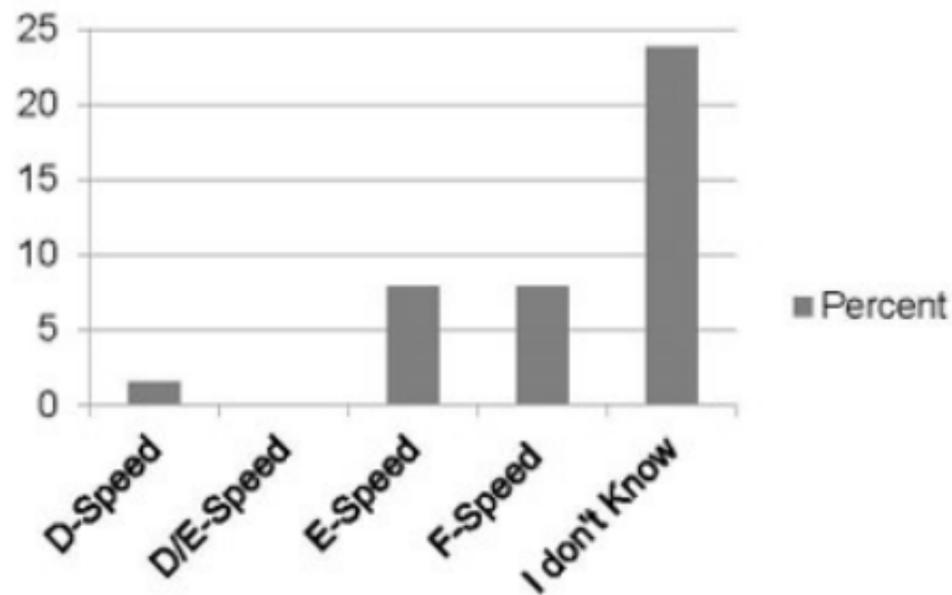


Figure 2: The opinion of dentists in regard to “Most Important Organ for radiation protection”



Figure 3: Number of Intra-oral Radiographs taken by the dentists per week

