

# COMPARISON OF RADIATION SAFETY PRACTICE AMONG DENTISTS IN THE UNITED KINGDOM AND PAKISTAN

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## ABSTRACT

**Objectives:** This study aims to investigate the radiation safety awareness, attitudes and practice amongst dentists practicing in the U.K and compare them to dentists practicing in Pakistan.

**Materials and Methods:** This was an observational and descriptive study utilizing self-reported questionnaires consisting of 15 MCQs distributed electronically to dentists registered with G.D.C. in the U.K. and the Pakistan Medical and Dental Council, P.M.D.C. in Pakistan, and who are currently practising as a dentist in the appropriate country.

**Results:** There were 102 respondents from Pakistan and 119 from U.K. Within the U.K 84% reported that they received training regarding radiation protection within the past two years. In Pakistan only 6.9% reported receiving such training. In Pakistan 42.2% felt that the X-Ray equipment was periodically serviced whilst 95% in the U.K. indicated their equipment was periodically serviced. In Pakistan 52% responded that there was a radiation safety plan in place whilst 95.8% of U.K. respondents reported the same. In Pakistan 18% of the operators held the image receptor themselves during intra-oral X-Ray whilst none of the U.K respondents reported doing the same.

**Conclusion:** Within Pakistan there is a need for increased training regarding radiation safety for dentists. There is also room for improvement in training U.K. based dentists on radiation protection. There is a risk that Pakistani dentists are exposing themselves to un-necessary levels of radiation which may have long term consequences to their health. Maintenance of X-Ray equipment in Pakistan as well as presence of radiation protection plans are alarmingly low.

**Key words:** Radiation, protection, dentists, United Kingdom, Pakistan

## INTRODUCTION

‘Radiation protection’ concerns the implementation of practices to reduce radiation exposure among patients, workers, and the public. Intraoral and extra oral radiographs enable dentists to make diagnoses and complete treatment-planning and

follow up for their patients. However, the harmful effects of X-Rays<sup>1</sup> can pose a threat to the health of both patients and practitioners. Hence, each use of ionising radiation must be clinically justified and safe for all concerned. There should be a key principle of keeping radiation exposure ‘as low as reasonably practicable’ (ALARP), which involves performing radiographic imaging with the lowest dosage of radiation whilst obtaining the desired diagnostic effect<sup>2</sup>.

Many countries have national guidelines to

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regulate the safe use of ionising radiation. It was suggested in an Australian study that, although knowledge of certain safety parameters tends to be 'reasonably adequate', a significant percentage of dentists feel that there is a need for further awareness of radiation protection<sup>3</sup>.

In the UK, there is dedicated legislation governing the use of dental X-Ray equipment, professional guidelines relating to specifically for the protection of the patient<sup>4</sup> and another related to protection of workers and the public<sup>5</sup>. Furthermore, the General Dental Council (GDC) include radiography and radiation protection in their recommended continuing professional development (CPD) topics<sup>6</sup>. However, few published papers have explored UK dentists' level of compliance with existing guidance.

In Pakistan, the Pakistan Nuclear Regulatory Authority (PNRA) published national regulations on radiation safety in 2004. The PNRA ordinance makes it essential for any facility undertaking procedures involving radiation to ensure there is a programme of training and re-training related to radiation safety for all individuals performing such procedures<sup>7</sup>. Despite this, one published Pakistani study concludes that radiation safety practices of dental surgeons in Karachi, Pakistan, is 'inadequate'<sup>8</sup>.

The aim of this study is three-fold. First, it was designed to contribute to the literature by determining dental practitioners, in U.K, methods regarding implementation of radiation protection. Secondly, it aimed to assess the practice of dental practitioners in Pakistan regarding the implementation of radiation protection in their routine practice. Thirdly, it was designed to compare the respective dental radiation safety practices in one developing country and one economically developed country.

## MATERIALS AND METHODS

This study utilised a quantitative methodology in an observational and descriptive fashion. It was conducted in accordance with the Declaration of Helsinki, 1964. Convenience sampling technique was used to draw the sample. We included dentists age greater than 23 years who held registration with the country's dental registration body (the G.D.C. in the U.K. and the Pakistan Medical and Dental Council, P.M.D.C. in Pakistan), and who are currently practising as a dentist in their respective country.

Non-practising or retired dentists were excluded, along with undergraduates. Data collection was conducted using an online questionnaire distributed on online study group platforms and sent via emails to participants with subsequent reminders to complete the questionnaire. It was highlighted that participation was entirely voluntary and anonymous, and completion of the questionnaire would be taken to signify consent. The questionnaire was available for completion for a period of four weeks, between June 2020 and July 2020.

The instrument used was a questionnaire adapted from an earlier version employed in an Australian study to investigate radiation protection practice, knowledge, attitudes, and implementation<sup>3</sup>. It was a self-report questionnaire consisting of 15 multiple-choice questions, beginning with four questions to elicit demographic data. The remaining questions covered four themes of radiographic equipment, radiation-protection knowledge and training, radiation-protection practices for dentists, and radiation-protection practices for patients. Modifying the original questionnaire, 18 questions related to knowledge were removed, as the aim of this study was to investigate clinical practice. The reliability of the research was conducted with a "Cronbach's alpha" value of 0.7, the data were analysed using SPSS software, and descriptive statistics method was used to calculate frequencies and percentages of responses. The Pearson Chi-Square was the statistical test applied to assess associations at a significance level of <0.05.

## RESULT

In the Pakistani study, there were 102 respondents, 66.7% of whom were female and 33.3% male (Table 1). Approximately two-thirds (61.8%) of participants had fewer than five years' experience (Table 2), and a third (32.4%) had postgraduate qualifications (Table 3).

In the UK study, there were 119 respondents, 59.7% of whom were female and 40.3% male (Table 1). The range of experience was diverse, with 19.3% having fewer than five years of postgraduate experience and 28.6% having 15-25 years of experience (Table 2). More than a third (37.8%) had qualifications higher than a bachelor's degree in dental surgery (Table 3).

In the UK, the GDC has a 5-year cycle for recommended CPD, including 5 hours of ‘radiography and radiation protection’. In our study we choose to adhere to the research paper ‘Investigation of radiation-protection knowledge, attitudes, and practices of North Queensland dentists’ ‘questionnaire, specifically surveying the 2 years as the period in which dentists may have received radiation protection training. Most participants in the UK survey (84%) has such a training but only a very small minority in the Pakistan survey (6.9%) reported being taught radiation protection and dosage in the last two years. The difference between the two countries was statistically significant ( $p < 0.05$ ) (Table 4).

Radiation protection practices for dentists and patients

Servicing is part of X-ray equipment maintenance. Most UK respondents stated that radiographic equipment is periodically serviced (95%); while in Pakistan, less than half of the respondents felt that this was true (42.2%). This difference was statistically significant ( $p < 0.05$ ). Within the UK, most respondents reported that there was a radiation safety plan in place at their dental practice (95.8%). This contrasted with the Pakistani respondents, of whom just 52% felt that there was a radiation safety plan in place. Most respondents – in both countries – recognised the radiation protection symbol (63.7%

**Table 1: Gender of participants in the surveys of Pakistani and UK dentists**

Country	Female	Male	Total
Pakistan	66.7%	33.3%	100.0%
United Kingdom	59.7%	40.3%	100.0%

**Table 3: Highest qualifications attained by the dentists in the Pakistani and UK surveys**

Country	Bachelor of Dental Surgery	PhD	P G Qualification	Total
Pakistan	67.6%		32.4%	100.0%
United Kingdom	62.2%	0.8%	37.0%	100.0%

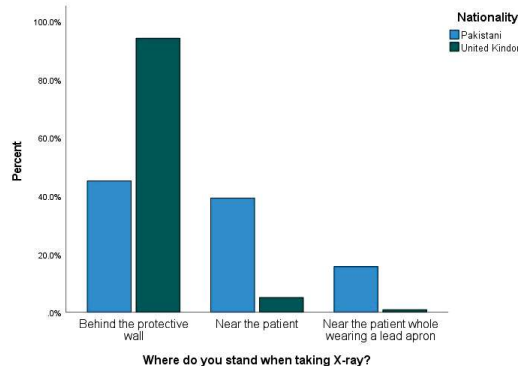
**Table 2: Postgraduate dental experience (years) of Pakistani and UK survey respondents**

Country	Years of graduated experience in dental experience					Total
	<5	>25	10-15	15-25	5-10	
Pakistan	61.8%		11.8%	5.9%	20.6%	100.0%
United Kingdom	19.3%	17.6%	17.6%	28.6%	16.8%	100.0%

in Pakistan and 83.2% in the UK) and most felt that imaging was ‘very important’ in dentistry (98.0% in Pakistan and 95.8% in the UK;  $P$ -value = 0.343). A majority in both countries felt that exposure to radiation duration varied (64.7% in Pakistan and 80.7% in the UK). Most respondents would only take intraoral radiographs for pregnant women if a diagnosis were urgent (98% in Pakistan and 89.9% in the UK;  $P$ -value = 0.013).

In the UK, while carrying out intraoral imaging distance is kept by most standing behind a protective wall (94.1%), with a very small minority standing near the patient – either with (0.8%) or without (5.0%) a lead apron. In Pakistan, however, the dentists are more evenly distributed between the three positions, with the largest group being behind a protective wall (45.1%), the second largest standing ‘near the patient’ (39.2%), and the smallest group being ‘near the patient while wearing a lead apron’ (15.7%;  $P$ -value 0.00) (Figure 1).

In Pakistan, only 12.9% used rectangle colli-



**Fig 1: The location of the dentist(s) when taking an X-ray in dental practice**

**Table 4: Percentage of Pakistani and UK survey respondents who report completing radiation protection training in last 2 years**

Have you undertaken any courses/training on radiation protection in the past two years?			
Country	No	Yes	Total
Pakistan	93.1%	6.9%	100.0 %
United Kingdom	16.0%	84.0%	100.0 %

mation to limit the dose of X-ray, compared to 67% in the UK. More than 80% of the Pakistani dentists reported using the cylindrical-shaped tube head of radiographic equipment in practice. This is in stark contrast to UK dentists, most of whom reported using the rectangular tube head radiographic equipment. Less than 40% of UK dentists use the cylindrical option, with a minority using the pointed tube head (Figure 2).

Our study found that 18% of operators in Pakistan held the image receptor themselves during intraoral radiographic examinations. Only 24% of Pakistani dentists used a beam aiming device, compared with 97% of UK dentists (the remainder of UK respondents requested their patient to use their own finger) (Figure 3).

## DISCUSSION

X-ray imaging is a vital part of the diagnostic process for dental practitioners. In a dentate patient one might take bitewings and selected periapical images. Some dentist uses a panoramic radiograph occasionally. The harms of radiation exposure are well recognised – with cancer being a consequence<sup>9</sup>. It is therefore vital that all staff are appropriately trained and well acquainted with the safety procedures to maximise diagnostic benefit and minimise radiation exposure<sup>2</sup>.

Of the Pakistani respondents, 33% were unaware of radiation symbol and just over half (51%) reported a safety plan in place at their practice. In this study, 95% of the UK responders have radiation safety plans in their surgeries and approximately 20% were unaware of the radiation symbol. There must also be a radiation protection supervisor, who is an appropriately trained and sufficiently senior member of staff with the authority to ensure compliance with the local rules<sup>2</sup>. According to the Ionising Radiation Regulations, it is the responsibility of the employer to ensure a safe working environment for their employees and patients<sup>11</sup>. Additionally, a sign is to be posted in areas and rooms where X-ray equipment is being used, and this may include the radiation symbol<sup>12</sup>. It might be the case that the symbol is present on the X-Ray machinery, but the staff are unaware of the symbol. These results highlight a need for additional training in both the U.K as well as Pakistan to ensure that staff are aware of the symbol. In Pakistan there is a clear need for ensuring that a radiation protection

plan is in place in all practises where X Ray equipment is utilised and mandatory training for all staff utilising the equipment as well as regular updates to this training. A recent study conducted in Pakistan<sup>8</sup> concluded that radiation safety practises were inadequate in their sample of dentists in Karachi, Pakistan. Our results in another province of Pakistan mirror their findings and therefore the issue of poor dental radiographic practises may be a national one rather than a regional one in Pakistan. This highlights a need for national dental bodies in Pakistan to make dental radiation safety a priority, particularly with the increasing use of digital radiography.

A thyroid collar attenuates 92% of scattered radiation<sup>13</sup>, thyroid being most radiosensitive in the head and neck region and is frequently exposed to scattered radiation during dental x-ray procedures. Rectangular collimation for intraoral radiography offers a similar level of thyroid protection to lead shielding, in addition to its other dose-reducing effects. Rectangular collimation combined with beam-aiming devices and film holders is preferred as it is an easy way to instantly reduce the beam dimension and therefore the patient dose<sup>14</sup>. One study found that unwanted thyroid dose can be reduced by 64% by rectangular collimation<sup>15</sup>.

Our study found that, in Pakistan, only 12.9% used rectangle collimation to limit the dose of X-Ray, compared to 67% in the UK. More than 80% of the Pakistani dentists reported using the cylindrical-shaped tube head of radiographic equipment in practice. It is unclear if this is due to lack of resources or lack of awareness. Less than 40% of UK dentists use the cylindrical option, with a minority using the pointed tube head. Our results are in keeping with another studies in Pakistan, Korea, Belgium, Turkey and India which also report low usage of rectangle collimation<sup>8,16-19</sup>. This may represent regional variation around the world with respect to radiation protection within dental practice. The high percentage usage of rectangle collimation is an increase in the UK when compared to a previous study conducted in England and Wales which showed that only 18% always used rectangular collimation<sup>20</sup>. This may reflect changes in undergraduate or postgraduate education which has increased awareness of radiation protection or it could be due to the fact that our study was not limited to England and Wales but open to participation from all nations within the U.K.

During the radiographic exposure, the preferred method of operator protection is to stand behind a protective barrier or outside the room, while the X-Ray film or receptor is positioned in the patients mouth with help of an X-ray holder<sup>13</sup>. For intraoral radiography, beam-aiming devices and film holders can be used for bitewing and periapical radiography, this not only improves the diagnostic quality but also reduces the dose to the patient.

Our study found that 18% of operators in Pakistan held the image receptor themselves during intraoral radiographic examinations. However, operators should not hold the image receptor during exposure. Only 24% of Pakistani dentists used an aiming device, compared with 97% of UK dentists (the remainder of UK respondents asking the patient to use their own finger). Film holders are important, as they avoid unnecessary exposure to patients' fingers<sup>21</sup>. Our finding of 18% of operators using their own finger to hold the image receptor was lower than another study conducted in Pakistan which showed 39% of operators held the image receptor in the patient's mouth<sup>8</sup>. Similar results were found from other countries including India<sup>22</sup> and Turkey<sup>18</sup>. This again highlights regional differences in radiation safety and the need to highlight the dangers of radiation exposure to practitioners.

Most Pakistani and UK respondents said that they employed different radiographic procedures for pregnant patients. According to the Faculty of General Dental Practice (UK) guidance on radiation during pregnancy, they advised offering the patient the option of deferring non-urgent radiography as it is an emotive issue during pregnancy. It is not usual for an X-Ray beam to be aimed at the abdomen, however in those cases where radiography is required they advise abdominal lead protection to be used when the foetus lies in the primary beam. If this is not the case, they advise no requirement to delay the radiography until after birth<sup>9</sup>. A study conducted in Finland with an 'anthropomorphic female phantom' model of dental X-Ray in a pregnant woman showed that the foetal dose of radiation without lead shielding was <1% of annual dose limit for a member of the public<sup>10</sup>. This is reassuring and highlights the need not to delay a clinically justifiable dental radiographic examination in a pregnant woman.

The slightly concerning results of our study

showed that only 6.9% of Pakistani respondents reported radiation safety training within the past 2 years (compared to 84% in the U.K.) and that just over half of the Pakistani respondents reported a radiation protection plan being in place in their place of practice (compared to 95% in the U.K.). Less than half the Pakistani respondents reported that the radiographic equipment is periodically serviced (compared to 95% in the U.K.). These results highlight our earlier points of the need for widespread training amongst dentists for radiation safety, with formal training and mandatory servicing requirements being advised from national bodies. The P.N.R.A. in Pakistan requires dental practices to submit various documents as well as to work safely and in compliance with the regulatory requirements<sup>7</sup>. It seems that practices must ensure up to date and regular training for their staff as well as adequate maintenance of equipment. The GDC recommends radiography and radiation protection as a core subject for dentists and dental care professionals<sup>6</sup>. A similar model being implemented in Pakistan may improve radiation safety procedures in Pakistan.

Our study showed that an area for improvement within UK dental practice is in relation to radiation protection training. These findings are like a previous U.K. study in which the respondents indicated that radiation protection post-graduate education was considered insufficient by 51% of respondents with 23% having not attended any post-graduate course on radiation protection since qualifying<sup>23</sup>.

It would be remiss by not mentioning the limitations of our study. The sample may not be entirely representative of the relevant populations. Despite this, there is value in the results due to the large number of respondents and the interesting results shown which can still provide insight into the dental practices in each country. The opportunistic nature of the data collection through distribution of the survey through electronically may have excluded potential respondents who did not participate in electronic surveys. Some questions were excluded from the original questionnaire which may limit the validity and reliability of the instrument.

Radiation safety practices remain inadequate in Pakistan and there is room for improvement in the UK. It is recommended that there shall be a mandatory update on the radiation protection training every

5 years. There should also be 2.5 yearly refresher update which will not consume the practitioner valuable time. In addition, there should be regular updated training for radiation protection supervisors. Within Pakistan, we recommend that radiation protection is made a priority for undergraduate dental education as well as post-graduate dental education. For Pakistan, we recommend that radiation protection be made a mandatory part of the revalidation process to ensuring that this part of dental practice is highlighted during post-graduate practice. We also advise increased involvement from regulatory bodies within Pakistan to ensure that the maintenance of the equipment/radiation protection plans are in place. We also call on general dental practices in Pakistan to ensure their radiographic equipment and protocols are compliant with national radiation safety regulations.

## CONCLUSION

Within Pakistan there is a need for increased training regarding radiation safety for dentists. There is also room for improvement in training U.K. based dentists on radiation protection. There is a risk that Pakistani dentists are exposing themselves to un-necessary levels of radiation which may have long term consequences for their health. Maintenance of X-ray equipment in Pakistan as well as presence of radiation protection plans are alarmingly low and need to be improved.

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