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Original Article

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Abstract

Objective: To assess the availability, practices and knowledge of radiation safety measures among invasive cardiologists in a tertiary care hospital.

Method: A cross sectional survey of invasive cardiologists working in academic institutions was conducted using a questionnaire.

Results: A total of 28 cardiologists completed the questionnaire with a mean working experience of 10.5 + 7.6 years. All were of the opinion that radiation safety is extremely important and 93% always used lead aprons. Less than half of them used other radiation protective measures including thyroid collar, lead eyeglasses and lead shields. Only 7% regularly utilized a radiation dose badge to monitor the exposure. This may be related to the availability, as lead aprons are readily available but other devices i.e. lead glasses, lead shield and radiation dose badge is available to less than a third of them. On evaluating knowledge only one fourth knew more than 60% of the answers to questions testing the basic principles of radiation safety. When working experience of cardiologists was correlated with their knowledge and practice of radiation safety surprisingly a paradoxical relationship was noted. Mean number of correct answers in those with experience of >10 years vs <10 years was 45% vs 56%, p<0.03. All of the above findings are probably because less than 50% have received any formal education in this important field.

Conclusions: There is a lack of standard radiation safety measures and equipments in cardiac catheterization laboratories. Significant lapses exist in practice and lack of knowledge of radiation safety among invasive cardiologists in this part of the world. With rapid growth in the number of cardiac catheterization laboratories in developing countries significant improvement in knowledge, practice and availability of radiation safety measures is needed (JPMA 58:119;2008).

Introduction

All living beings are exposed to background ionizing radiation. Radiation doses to the United States population from natural and man made sources have been approximately 1 m Rem / day. Fifteen percent of this radiation dose comes from man made sources.[1] The biological effects of ionizing radiation can be of two types, Stochastic (e.g. radiation induced leukaemia, genetic defects) and Non-Stochastic.

Stochastic effects are considered non-threshold. This kind of injury is defined as injury to the cellular genetic apparatus and is an all-or-none phenomenon for any individual cell. Risk is proportional to the dose but there is no safe threshold below which the risk is zero. These effects form the basis for radiation protection programmes. Non-stochastic effects in contrast are dose dependent and result in cellular injury or death. There is threshold below which these effects do not occur. These can be observed within days to years of exposure. Somatic effects of radiation injury mainly involve the most proliferating cells (skin, ocular lens, testes, intestines, thyroid, esophagus and bone marrow suppression).[2]

Interventional cardiology is on the rise in Pakistan. There is currently no structured radiation safety module in the training curriculum. Henceforth cardiologist's awareness and practice of radiation safety measures for themselves and their patient is not known. The purpose of our study was to assess the knowledge and practice of radiation safety among invasive cardiologists in Karachi.

Methods

This was a cross-sectional survey. All thirty four invasive cardiologists working in four major tertiary care centers in Karachi were asked to complete a questionnaire.

Written informed consent was taken from all cardiologists and confidentiality regarding institution and individuals cardiologists was maintained. The primary aim was to evaluate their knowledge regarding radiation safety, work experience availability of different safety appliances (e.g. thyroid collar, lead apron, lead eye glasses, lead shields and radiation dose badge), and their personal practices regarding the use of these protection devices.

Knowledge of radiation safety was assessed by asking single best choice questions regarding information about basic principles of radiation safety, radiation exposure in different angiographic views, ways to minimize radiation exposure, biological effects and units of radiation, national recommendations for radiation exposure, information regarding personal annual radiation exposure and formal training regarding radiation safety.

An informed written consent was obtained from all the study participants. The data was entered and analyzed by using SPSS Software, version 12.

Results

Out of 34 cardiologists, a total of 28 completed the questionnaire. Mean working experience of the cardiologist was of 10.5 ± 7.6 years. All were of opinion that radiation safety is extremely important. Majority (92%)of cardiologists always used lead aprons and 4% mentioned that lead aprons were available in less than 50% of procedures leading to its lack of usage.

Less than half of the cardiologists were using other protective measures such as thyroid collar and lead shield. Availability and usage of these measures are shown in (Figure A, B).68% never used lead eye glasses and these were available to 64% of the physicians.

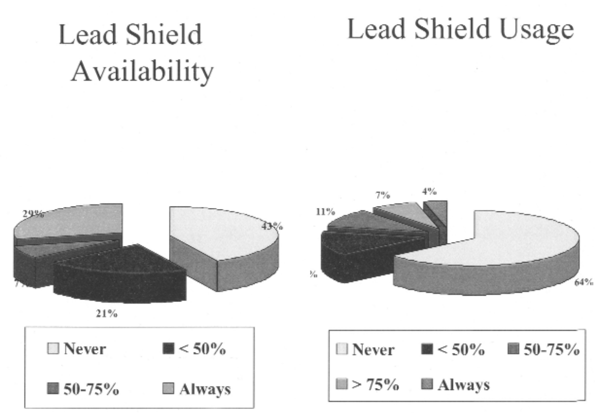

Figure A. Lead Shield availability and its usage.

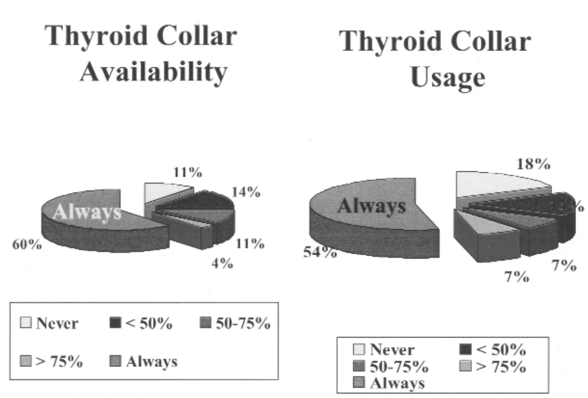

Figure B. Thyroid Collar availability and its usage.

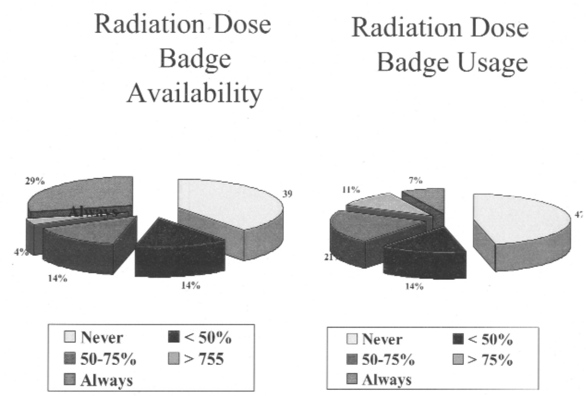

Figure C. Radiation Dose Badge availability and its usage.

Only 39% had radiation badge available and 7% cardiologists used it on regular basis (Figure C).

Regarding radiation safety knowledge, 79% of cardiologists were aware of three basic principles of radiation safety i.e. shielding, exposure time and distance. One third did not know about the best place to apply the radiation dose monitoring badge. Half of them did not know the x-ray tube position which exposed them to maximum radiation (Cranial LAO). Similarly less than half of the cardiologists were aware of radiation dose limit of Pakistan Nuclear Regulatory Authority i.e. 2 Rem / year (20 mSv). More than half never received any formal education in radiation safety.

Only one fourth of the cardiologists knew more than 60% of the asked questions correctly. When working experience of cardiologists was correlated with knowledge and practice of radiation safety, a paradoxical relationship was noted. Mean number of correct answers in those with experience of more than 10 years as compared to those with less 10 years was 45% vs. 56% respectively.

Discussion

The primary source of radiation for an interventional cardiologist is scatter radiation from the patient during fluoroscopy and cine acquisition. Modern cardiac interventional procedures (coronary angiography and PCI) produce effective doses of 4 to 21 mSv and 9 to 29 mSv respectively and are therefore, relatively high risk in terms of radiation exposure (1 mSv is the equivalent of approximately 10 chest x-rays).[3] The three common principles for protecting the operator against radiation exposure are time, distance and shielding.[4] During an average interventional cardiac catheterization procedure, the physician operator receives about 0.004 to 0.016 rem of exposure.[5] In one review, this exposure was between 0.2 to 6.0 rems per year, the nurses received from 0.8 to 1.6 rem per year and the technologists about 0.2 rem per year, as documented by collar and waist badges.[6]

In different centers radiation control is either in the hands of the radiographer or a consultant cardiologist. Arthur et al.[7] in an interesting study compared whether cardiologist- or radiographer-operated fluoroscopy and image acquisition influence optimization of patient radiation exposure during routine coronary angiography. It showed that consultant cardiologists produced significantly lower screening times and radiation doses compared with registrars. And this was also found that during routine coronary angiography, radiographer-controlled radiation exposure does not reduce screening time or radiation dose and senior cardiologists produce the lowest radiation doses during coronary angiography when they are responsible for radiation exposure (contrary to the results of our study).[7]

According to American College of Cardiology the maximum allowable occupational exposure from all sources for medical workers is 5 rems per year for the whole body. Over a total career, no one should receive a cumulative exposure >1 rem X age (or 50 rems).[8] Currently recommended radiation dose limit of Pakistan Nuclear Regulatory Authority is less than 2 Rem /year.[9]

However radiation safety remains an occupational concern. The ongoing trend towards more complicated interventional procedures results in greater exposure to patients and laboratory staff.[8] Prominent role of 35-mm cine film as the recording and archiving medium has been challenged, and cine-less operation has become accepted as routine practice in many laboratories.[10]

There has been different recommendation to cut down radiation exposure in literature. X-ray scatter can be reduced by minimizing the number of magnified views, using digital-only cine acquisition, keeping the image intensifier as close to the patient as possible, by using lower framing rates and pulsed fluoroscopy and by minimizing both fluoroscopic and cine time.[8] The cranial LAO view, where the operator is closest to the x-ray tube and the bottom of the table, the operator exposure may be 2.6 to 6.1 times that observed in the caudal RAO view, where the x-ray tube is on the other side of the table.[11] Finally shielding devices and minimizing the time to exposure are important means for radiation protection.[12] Also recommendations have been made regarding image intensifiers, radiographic equipment, generators and X-ray tubes.[12]

Recently there have been certain advances in performing percutaneous interventions e.g. a recent study was designed to assess the feasibility and safety of a Remote Navigation System (RNS) in which the angioplasty guide wire, the balloon, and the stent were navigated via a computerized system. This was found to be a safe and feasible method for the treatment of patients with coronary stenosis in this small pilot study. The system offers operator radiation safety and may enhance precision of stent placement and balloon dilation strategies.[13] But this system still needs a lot of development and in future this may be an important way to prevent the operator from radiation exposure.

The results of our study are surprising and alarming. Though all of the invasive cardiologists were aware of importance of radiation safety but significant lapses were found in practice and knowledge in this regard. A grave concern was inadequate availability of standard radiation safety equipments in cardiac catheterization laboratories within the city.

There can be various reasons for the above mentioned results, with the major one being that only less than half of the cardiologists had received formal training in radiation safety. Previously Quinn et al examined radiation protection awareness in non-radiologists and found that the majority of clinicians did not receive adequate radiation protection teaching.[14] Secondly invasive cardiologists who were relatively more experienced were less aware and probably less conscious regarding radiation safety.

In addition, there was inadequate availability of standard radiation safety equipments and this may be one of the major reasons for not using them. Radiation dose badge availability and its use was also very low. There was no regular monitoring of radiation exposure per year. Therefore it is difficult to assess the average radiation exposure in tertiary care hospitals.

We conclude that there are major lapses regarding knowledge of radiation safety measures and their availability in tertiary care centers in Pakistan. This may be the representation of radiation safety practices in this part of world.

We strongly recommend that the physicians should be educated with the help of formal education regarding radiation safety during training and with continuing medical education programs. Adequate protective measures should be available in every catheterization laboratory and there use should be reinforced periodically by hospital and national regulatory authorities.

Since some of the biological effects of radiation are cumulative, physicians with growing experience should be more cautious and improve their practice and update their knowledge of radiation safety.

Summary box

Radiation safety is important. Radiation exposure can lead to stochastic and non-stochastic injuries. Knowledge regarding radiation safety is lacking. Radiation safety practices are not according to recommendations. Radiation protection devices are not routinely available everywhere.

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