## ORIGINAL ARTICLE

# RADIATION EXPOSURE IN DIFFERENT CARDIAC CATHETERIZATION PROCEDURES IN CATH LAB

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**Background:** Interventional procedures render cardiologolists and their team members to high doses of radiations. This study was conducted to assess the radiation exposure in various cardiac catheterization procedures. **Methods:** This descriptive cross sectional study was conducted at the catheterization laboratory of Lady Reading Hospital Peshawar from November 2008 to December 2009. Patients were categorized into four groups for procedures a. coronary angiography, b. percutaneous coronary intervention (PCI), c. permanent pacemakers (PPM) and d. percutaneous transvenous mitral commisurotomy (PTMC), two groups for operators (consultants and trainees), and three groups for various accesses (femoral, radial and sub-clavian). **Results:** A total of 99 patients undergoing cardiac catheterization were studied. Coronary angiography was performed in 52 (52.5%) patients, PCI in 32 (32.3%)), pacemakers in 6 (6.1%), and PTMC in 9 (9.1%) patients. Consultants did 72(72.7%) procedures and trainees did 27(27.3%) procedures. Through radial access, 22(22.2%) procedures were performed, 71(71.7%) through femoral, and 6 (6.1%) through sub-clavian. The mean radiation dose for coronary angiography was (4907.862±15231.6358 µGym$^2$), PCI (10375.16±16083.4385 µGym$^2$), pacemakers (1406.823±785.489 µGym$^2$), and PTMC (1157.91±760.437 µGym$^2$). The mean radiation dose for radial (6147.33±8480.37 µGym$^2$), femoral (6512.58±16566.73 µGym$^2$), and sub-clavian was (1406.82±785.48 µGym$^2$). While for various operators consultants (7489.5±16925.55 µGym$^2$), and trainees (2475.25±1178.86 µGym$^2$). The mean time for radial (8.59±7.28 min), femoral (6.95±6.43 min) and sub-clavian was (8.24±4.81 min). The mean time for coronary angiography (4.56±5.32 min), PCI (11.44±6.92 min), PPM (8.24±4.81 min), and PTMC (8.28±5.01 min). **Conclusions:** Radiation dose varies substantially across different groups by different operators and different routes.

**Keywords:** Radiation exposure, Radiation dose, cardiac catheterization procedures

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## INTRODUCTION

Radiation used in catheterization laboratory is x-rays. X-ray beam is a stream of particles; each contains a defined amount of energy. Each X-ray photon contains thousands of times the energy of a photon of visible light. This quality of X-ray is due to its very short wavelength and very high frequency.[1–3]

Severe Radiation injuries have occurred as a result of prolonged interventional procedures with fluoroscopy times more than 30 minutes. Therefore, safety of the patient and operator became utmost important.[4–6]

There are many ways to measure radiation units and a full explanation of all the current dose definitions and those of related older units is available in literature.[7–9] Exposure is the radiation level at a point in space, commonly measured with an ionizing chamber in units of air karma, which is defined as energy released in material; dose delivered to air. Exposure doesn't give direct information regarding how much radiation energy is delivered to a person or the biologic effects that radiation might have.[7–9]

Dose refers to the local concentration of energy absorbed by tissue from the X-ray beam. More specifically dose is the amount of energy absorbed from the radiation field by a small volume of tissue, divided by the mass of the tissue. This is currently measured in gray (Gy or 1 J/kg), which corresponds to a very large radiation dose. Dose is most often expressed as centigray (cGy) or milligray (mGy).

In interventional Cardiology, radiation dose is best measured by the Dose Area Product (DAP), which is the absorbed dose to air multiplied by the X-ray beam cross sectional area at the point of measurement and it is expressed in Gycm.[2] Most currently used and interventional fluoroscopes include a DAP meter.[10]

According to a recent statement of the American College of Cardiology and American Heart Association (ACC/AHA), the radiation dose delivered to a patient during a procedure is both a measure of stochastic risk and a potential quality indicator. Physicians should be made aware of the exposure they deliver to their patients and how they compare to established norms.[3] Unfortunately radiological awareness is largely suboptimal in the real world, even among radiologist.[11–14.] To add to it, the national efforts are not very encouraging regarding radiation exposure. The present study is an effort to plead for and make patient and operator safety more realistic.

## MATERIAL AND METHODS

This descriptive cross sectional study was conducted at catheterization Laboratory of Lady Reading Hospital Peshawar from November 2008 to December 2009. This study was approved by Hospital ethical committee and informed consent was taken from all patients included in the study. Patients of either gender and of any age undergoing elective cardiac catheterization procedures were included in the study. Radiation exposure time was measured in minutes from time of onset of fluoroscopy till the end of procedure. Radiation dose was calculated in microgrey square meter, using Flouroscopy machine software.

All the procedures were performed on Siemen advance Fluoroscopy Machine, Model Axiom Artis FC Machine. Procedures were performed by different operators with different level of expertise and were grouped into two (consultants and trainees). Procedures were categorized into four groups depending on the nature of procedure (coronary angiography, PCI, permanent pacemakers and PTMC), and 3 groups on basis of accesses sites (femoral, radial and sub-clavian). Statistical analysis was performed using SPSS-12.

## RESULTS

A total of 99 patients undergoing cardiac catheterization were studied. Coronary angiography was performed in 52 (52.5%) patients, PCI in 32 (32.3%), pacemakers in 6 (6.1%), and PTMC in 9 (9.1%) patients. Consultants did 72 (72.7%) procedures and trainees did 27 (27.3%) procedures. Through radial access, 22 (22.2%) procedures were performed, 71 (71.7%) through femoral, and 6 (6.1%) through sub-clavian.

The mean radiation dose for coronary angiography was (4907.862±15231.6358 μGym$^2$), PCI (10375.16±16083.4385 μGym$^2$), pacemakers (1406.823±785.489 μGym$^2$), and PTMC (1157.91±760.437 μGym$^2$). The mean radiation dose for radial (6147.33±8480.37 μGym$^2$), femoral (6512.58±16566.73 μGym$^2$), and sub-clavian was (1406.82±785.48 μGym$^2$). While for various operators consultants (7489.5±16925.55 μGym$^2$), and trainees (2475.25±1178.86 μGym$^2$). These are shown in Figure 1 and 2. The mean time for radial (8.59±7.28 min), femoral (6.95±6.43 min) and sub-clavian was (8.24±4.81 min). The mean time for coronary angiography (4.56±5.32 min), PCI (11.44±6.92 min), PPM (8.24±4.81 min), and PTMC (8.28±5.01 min).

## DISCUSSION

The radial route is widely used to perform coronary angiography and percutaneous coronary interventions in order to reduce vascular peripheral arterial complications, to improve patient comfort and lower costs.[1–3] when specific radiation protection devices were barely used in clinical practice, previous studies have reported that the radial route was related to increased operator and patient radiation exposure when compared with femoral route.[1–3,7.]

However, in logic of reinsurance, such differences have reported to be inversely related to increasing operator exposure, leading many operators to believe that special radiation exposure practices were unnecessary with greater experience in the radial techniques.[8,9]

This study demonstrates that radiation dose varies significantly among different groups by different operators and different routes. Type of procedure has significantly affected the radiation dose. In terms of quantity, the maximum dose utilized was in PCI group, followed by Coronary angiography, Permanent pacemaker and then PTMC. In this study, fluoroscopy time was higher for radial route than femoral route. Similar findings have already been reported when the use of special devices for radiation protection was uncommon.[2]

Lang has recently reported in a single-operator and randomized study that operator radiation exposure was higher during coronary angiography and PCI by the radial approach when compared with the femoral approach. However, the radiation protection strategy was divergent between both groups since the additional 7 inches upper protection shield flap was used only in femoral cases, where it was flipped down in the radial cases. Ours is the first study which showed that radial experience almost balance radiation exposure between radial and femoral approaches especially for coronary angiography. This is a good sign as better experience has gained with radial route. Another encouraging aspect of the study is that the trainees did a fairly large quantity of procedures that is 27.3%. Increased radiation exposure time using the radial route is related to increase in fluoroscopy time, which reflects technical difficulties and the slightly closer operator position relative to the X-ray source and patient during the radial procedures when compared with the femoral route.[15] Similarly, radiation exposure is related to procedural duration for both operators and patients.

Surprisingly, radiation exposure time was higher in radial procedures but radiation dose was lower. It may be due to several reasons. Femoral route angiographies were most of the times followed by PCI, but in radial routes, it was not the usual case. Secondly the lack of randomization as most complex lesions was treated through femoral routes.

Another important aspect of the study was that the operator was unaware of the radiation time and dose. So it has removed the psychological bias of being observed for time duration and radiation exposure time.

Although the radial route decreases peripheral arterial complications rate, increased radiation exposure of both patients and operators thru this route is currently a growing problem for the interventional Cardiologist health. Specific protection devices are available to minimize radiation exposure and they have to gain widespread acceptance in the interventional community. Indeed, radial route indications should be promptly reconsidered in the light of present findings, especially when a long procedure fluoroscopy time is expected. Finally effective radiation exposure of operators needs to be assessed using accurately located dosimeters.

## CONCLUSIONS

Radiation dose varies substantially across different groups by different operators and different routes. Radiation exposure dose was highest in PCI group with increased exposure time.

## REFERENCE


1. American Board of Internal Medicine. Interventional Board Requirements. Available at: http://abim.org/resources/eiblue.shtm.
2. Hirshfeld JW, Balter S, Brinker JA. ACCF/AHA/HRS/SCAI clinical competence statement on optimizing patient safety and image quality in fluoroscopically guided invasive cardiovascular procedures. J Am Coll Cardiol 2004;44:2259–82.
3. European-Union. Guidelines for Education and Training in Radiation Protection for Medical Exposures. Brussels: 2000. Available at: http://europa.eu.int/comm./environment/radprot/116/rp-116-en.pdf
4. Shope TB. Radiation-induced skin injuries from fluoroscopy. Radiographics 1996;16:1195–9.
5. Park TH, Eichling JO, Schechtman KB, Bromberg BI, Smith JM, Lindsay BD. Risk of radiation induced skin injuries from arrhythmia ablation procedures. Pacing Clin Electrophysiol 1996;19:1363–9.
6. Dehen L, Vilmer C, Humiliere C, Corcos T, Pentousis D, Ollivaud L, *et al*. Chronic radiodermatitis following cardiac catheterization: a report of two cases and a brief review of the literature. Heart 1999;81:308–12.
7. Balter S, editor. Interventional Fluoroscopy, Physics, Technology, Safety. New York: John Wiley; 2001.
8. Hall EJ, Giaccia AJ, editors. Radiobiology for the Radiologist. 4thed. Philadelphia: Lippincott Williams and Wilkins; 1994.
9. Bushberg J, Seibert JA, Ledidholdt EM, Boone JM. The Essential physics of Medical Imaging. 2nd ed. Baltimore: Lippincott Williams and Wilkins; 2002.
10. Hershfeld JW Jr, Balter S, Brinker JA, Kern MJ, Klein LW, Lindsay BD, *et al*. ACCF/AHA/HRS/SCAI Clinical competence statement on physician knowledge to optimize patient safety and image quality in fluoroscopically guided invasive cardiovascular procedures: a report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training. Circulation 2005;111:511–32.
11. Finestone S, Schesinger T, Amir H, Richter E, Milgrom C. Do physicians correctly estimate radiation risks from medical imaging? Arch Enrviron Health 2003;58:59–61.
12. Shiralkar S, Rennie A, Snow M, Galland RB, Lewis MH, Gower-Thomas K. Doctors knowledge of radiation exposure: questionnaire study. BMJ 2003;327:371–2.
13. Lee CI, Hairms AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. Radiology 2004;231:393–8.
14. Correia MJ, Hellies A, Andreassi MG, Ghelarducci B, Picano E. Lack of radiological awareness in a tertiary care cardioilogical centre. Int J Cardiol 2005;103:307–11.
15. Andreassi MG. The biological effects of diagnostic cardiac imaging on professionally exposed physicians: the importance of being non-ionizing. Cardiovasc Ultrasound 2004;2:25–7.



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