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Commentary

Estimation the Doses of Patients Resulting from Diagnostic Cardiac Imaging Modalities

Shaban Alramlawy*, I Maamoun

Department of Critical Care Medicine, Cairo University Hospitals, Cairo, Egypt

ABSTRACT

Evaluating the hazards and beneficiary of cardiac imaging for patients is considered of high concern. There is a lack of information about the harm associated with cardiac modalities.

Aim: Comparison of different cardiac imaging modalities in terms of patient dose.

Method: 120 patients (weight=85 ± 10 Kg and Age=50 ± 10) are divided into three groups according to cardiac diagnostic procedures (A): n=40, SPECT (Siemens Symbia), Injected activity=950 MBq for stress/rest on two days); (B): n=40, Fluoroscopy (Siemens), The fluoroscopy average time and cine-modes was 4.2 ± 1.8 min and 10.7 ± 2.9 min respectively) and (C): n=40, CT Coronary (Philips 256), KV=120, MA=300).

Results: CT Coronary (Gp.C) is highly significant patient dose ($p<0.005$) than SPECT (Gp.A). Where the average effective doses of groups C and A are 32.0 ± 10.5 mSv and 13.5 ± 1.7 mSv respectively. The effective dose of ICA (Gp. B) is 49.1 ± 2.5 mSv which is highly significant ($p<0.05$) than A and C groups.

Conclusion: Our results concluded that there is evidence supportive of high effective dose which reflects an increased risk of cancer incidence at levels of radiation commonly received by cardiac diagnostic imaging modalities.

Keywords: Cardiac imaging modalities; CT coronary; Interventional cardiology (ICA)

INTRODUCTION

There is a significant effect on public health from the growing use of imaging procedures that rely on ionizing radiation [1].

The potential health risks of ionizing radiation are rarely highlighted in the patterns of use of medical imaging and the uncertainties about the magnitude of risk of cancer [2]. The radiation risk is classified into non-stochastic and stochastic effects. Deterministic effects are radiation dose-dependent [3]. While stochastic effects do not dose-dependent. This occurs at all times and the damage does not depend on the dose obtained Ionizing radiation-induced cancer and genetic changes are among the stochastic impacts. Previous trials, however, have indicated that increasing the amount of radiation may increase the opportunity of developing cancer. Estimates of the radiation dose for cardiac CT tests are best expressed as the CT Dose Volume Index (CTDIvol), Dose-Length Product (DLP) and effective dose (E) [4].

Saving strategies have been put in place to reduce radiation [2] exposure from coronary CT angiography to patients with effective doses ranging from 10 mSv to as low as 1 mSv [5]. Based on the results published by the Scientific Committee of the United Nations on the impacts of atomic radiation Interventional Radiology and Interventional Cardiology (ICA) adds 10% of the complete radiation dose in the diagnostic imaging and 10% of the complete radiation dose [6]. Long Fluoroscopy time and a large number of images are the main cause of high radiation dose levels to cardiac patients.

For Single Photon emission Computed Tomography (SPECT) myocardial perfusion, the mean radiation dose is 10.9 mSv, while the lowest dose is 7.9 mSv in Europe [7,8].

The effective doses of patients from cardiac imaging procedures (SPECT, CT Coronary and Fluoroscopy) are the highest radiation dose among all imaging procedures [1]. This paper concern with an effective dose of patients who referred to cardiac imaging procedures in a short period. This concern to shed light on the hazards for these patients in our developing country (EGYPT).

This study concern with radiation dose estimation of patients who are referred to do three cardiac diagnostic procedures (SPECT, CT Coronary and Fluoroscopy).

Correspondence to: Shaban Alramlawy, Department of Critical Care Medicine, Cairo University Hospitals, Faculty of Medicine, Cairo, Egypt, E-mail: shabanwmr@hotmail.com

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Materials and Methods

120 patients (weight=85 ± 10 Kg and Age=50 ± 10) are divided into three groups according to cardiac diagnostic procedures (A): n=40, SPECT (Siemens Symbia), Injected activity=950 MBq for stress/rest on two days); (B): n=40, Fluoroscopy (Siemens), The average time of fluoroscopy and cinemodes was 4.2 ± 1.8 min and 10.7 ± 2.9 min respectively and (C): n=40, CT Coronary (Philips 256), KV=120, MA=300).

Patients' effective doses are calculated using the conversion factor 0.01 mSv/MBq for SPECT Cardiac Scan, while the radiation dose in ICA was represented by dose-area product (DAP), measured in $\mu Gy.m^2$ which is collected from the summary pages. The effective doses due to CT Coronary are calculated by multiplying the dose length product (DLP) time's tissue weighting factor (0.016 mSv/mGy.cm) [9,10].

DLP is the embedded radiation dose for a complete CT exam and is calculated by equation [10]:

DLP=CTDIvol × length irradiated

The formula equation Effective dose (E) may be connected with DLP.

$DLP = E_{DLP} \times DLP$

Where EDLP is a conversion factor specific to the body region, measured in units of mSv/(mGycm).

The effective dose of ICA is calculated by multiplying DAP by conversion factor 0.22 $mSv/(Gycm^2)$ according to the National Radiological Protection Board [11].

The patient doses of all groups (A, B and C) are statistically studied using Statistical Package for the Social Sciences (IBM SPSS) 2015.

RESULTS AND DISCUSSION

The strong diagnostic and risk stratification information supplied by these processes play a key role in clinical cardiology and have led to the reduction in coronary heart disease morbidity and mortality, However, the efficiency of any diagnostic test needs thorough evaluation of the hazards and advantages of the test and protocol optimization to minimize patient hazards. Procedures using ionizing radiation should be conducted in accordance with the philosophy of As Low As Reasonably Achievable (ALARA) [12].

CT Coronary (Gp.C) is highly significant patient dose ($p<0.005$) than SPECT (Gp.A) as shown in Table 1. Where the average effective doses of groups C and A are 32.0 ± 10.5 mSv and 13.5 ± 1.7 mSv respectively.

The mean effective dose of ICA (Gp. B) patients is 49.17 ± 2.5 which is highly significant ($p<0.05$) than A and C groups (Table 1).

The results of the SPECT study are in an agreement with the ICRP (103) report (effective dose=12.1 mSv) [13], while the estimated effective doses and DLP of CT coronary (Gp.C) are in expected values over 30 mSv and 2000 mGy.cm respectively. Our results are satisfying with the published study evaluating radiation dose from 50 sites worldwide [14]. We had a study before provides more insights into a quantitative basis on the distribution of radiation burden in nuclear cardiac laboratory [15]. The connection between cardiac exposure and subsequent cancer risk has been dose-dependent. With every 10 mSv of radiation exposure from cardiac imaging and therapeutic procedures, the risk of cancer increases by 3% (Table 1) [16].

Table 1: Shows the patient dose values of different cardiac diagnostic modalities.

Procedure	DLP mGy.cm	DAP $\mu Gy.m^2$	Effective dose mSv
SPECT (GP.A) N=20	*****	*****	13.5 ± 1.7 ($p<0.005$)
ICA (GP.B) N=20	*****	4917 ± 255	49.17 ± 2.5 ($p<0.005$)
CT Coronary (GP.C) N=20	1974.5 ± 661.8	*****	32.0 ± 10.5 ($p<0.005$)

This study is a technical note to all cardiac physicians to be aware of the radiation risk followed by their referring to diagnostic cardiac procedures. S. Alramlawy showed that the patient dose from cardiac procedures depends on personal and technical parameters In addition, the significant differences among different cardiac diagnostic procedures. The dose reduction importance will be based on a radiobiological model for risk estimation in cardiac modalities. This would enhance the performance of cardiac techniques using low radiation dose [17,18].

CONCLUSION

Our results concluded that there is evidence supportive of high effective dose which reflects an increased risk of cancer incidence at levels of radiation commonly received by cardiac diagnostic and therapeutic imaging modalities. For that we must had concerned with all modalities, and must have careful attention to technique, including the medical physicist use all physics parameters such as dose-reduction strategies, can minimize dose to patients Also Selection of protocols for individual patients and for laboratories needs to be determined from an ALARA approach, and understanding the dosimetry of cardiac imaging protocols or that we must had concerned with all modalities, and must have careful attention to technique, including the medical physicist use all physics parameters such as dose-reduction strategies, can minimize dose to patients.

Also Selection of protocols for individual patients and for laboratories needs to be determined from an ALARA approach, and understanding the dosimetry of cardiac imaging protocols is the first step towards a test selection approach that minimizes patient danger while offering ideal diagnostic data. We concluded that risk is small but from some cardiac imaging procedures non-trivial. There exist internationally accepted principles of radiation protection, namely justification and optimization, designed to optimize the balance of benefits and risks from radiation.

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