Doses to the Operating Staff during Interventional Cardiology Procedures

F. R. A. Lima; H. J. Khoury; C. A. Hazin and L. P. Luz.
Departamento de Energia Nuclear-UFPE- Brazil
Av. Prof. Luiz Freire, 1000 – 50740-540 Recife PE Brasil

INTRODUCTION

Invasive cardiac studies require the generation of radiographic and fluoroscopic images for both documentation and diagnostic studies. During these lengthy procedures, radiologists must remain close to the radiation field, being therefore prone to receive significant doses of radiation. According to previous studies, this type of examination effectively results in one of the highest radiation exposure sources for radiologists (1, 2). The magnitude of the dose received in each procedure depends on a series of factors, such as the type and age of X-ray equipment, availability of protective devices and, of course, on the approach adopted by the radiologist to perform the examination. Consideration should be given also to the physiological characteristics of the patient, as these characteristics will guide the radiologist in deciding which technique will be used for catheter insertion.

The objective of this study was to estimate the dose received by physicians during angiographic examinations performed in radiological clinics in Recife, the capital of the State of Pernambuco, one of the most important cities in northeastern Brazil. It is hoped that the results of this study will call the attention of radiologists to the importance of using protective devices and personal radiation monitors while performing cardiac characterization.

MATERIALS AND METHODS

The survey was carried out in the Hemodynamic Sector of the *Hospital de Beneficência Portuguesa de Pernambuco*, in Recife and included examinations performed with a Philips Poly Diagnost angiographic equipment by six radiologists. The clinical procedure selected for this study was cineangioagraphy with catheter insertion through the brachial route. The most common variation of this cardiac procedure, with catether insertion through the femoral route, was not included in this research.

The dose received by each cardiologist in a single examination was determined by placing thermoluminescent dosimeters in selected points on the body. The choice of sites for the measurements was made in such a way that they could represent the doses to important parts of the body, such as the lenses of the eyes, thyroid, trunk, legs and hands of the operator. All radiologists included in this study were wearing lead aprons and thyroid shields while performing the examinations. Five wore lead aprons with a thickness equivalent to 5 mm of lead. The sixth radiologist wore a lead apron with 2.5 mm of lead equivalent material.

Measurements in each of the points indicated in Figure 1 were performed by using two TLD chips sealed in a polyethylene envelope. The average of the readings of the two TLDs was used to determine the dose in each of the selected points. As indicated in Figure 1, dosimeters were fastened to the center and to both sides of the aprons at all selected points, excluding the hands. This was done to take into account the fact that the radiologist may change position in relation to the radiation field during the examination. Therefore, a more representative value of the dose received by the radiologist at a given point was obtained by taking the average of the doses determined by the three sets of dosimeters.

The measurements at the thyroid, trunk and legs were determined from dosimeters fixed underneath either the lead apron or the thyroid shield. The measurements at the eyes and hands, however, were determined from dosimeters fixed with adhesive tape at the face and on the wrists of the operator. These TLDs and the ones that were fixed to the aprons and collar shields before the beginning of each procedure were retrieved for processing after the end of the examination.

The measurements were carried out with 3 mm x 3 mm x 0.9 mm - LiF thermoluminescent chips (TLD-100, Harschaw Chemical, Inc.), which were read in a Victoreen 2800M TLD Reader, at the Dosimetry Laboratory, Nuclear Energy Department, UFPE.

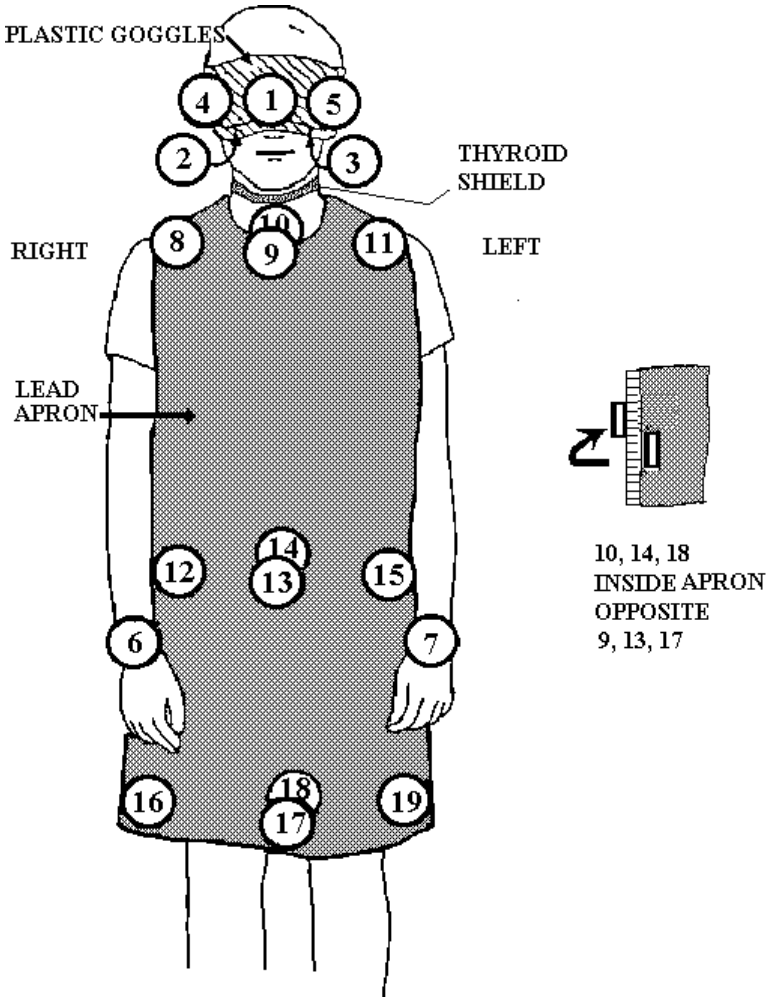

Figure 1- Dosimeter sites used for this study

RESULTS

The data presented include the doses measured in examinations carried out by physicians wearing aprons with equivalent lead thickness of either 2.5 or 5 mm, as no significant difference was noticed between the doses measured at the same point of the body with TLDs fixed underneath the aprons, regardless of their thickness. These findings are corroborated by the data presented by Faulkner and Marshall (3), who measured the effective dose equivalent received by an individual as a function of apron thickness.

Table 1 shows the mean and median values of the doses measured in each of the points selected for this study. The results show that the hands of the operators receive the highest radiation doses, followed by the lenses of the eyes. The discrepancy between the mean and median values in each point, mainly in the unshielded area, show that the measured values do not fit a normal distribution. Therefore, the median, and not the mean, values must be used to characterize the distribution of doses derived from these examinations.

Table 1 – Mean and median values of the doses (μSv) measured in selected parts of the body.

	Eyes	**Thyroid**	**Gonads**	**Knees**	**Right Hand**	**Left Hand**
Mean	360	140	120	110	330	530
Median	240	100	100	110	150	300

Figure 2 shows a box and whiskers diagram of the doses measured in the selected body locations. This kind of graphic representation has the advantage of showing the distribution of doses measured in each of the monitored points. Each of the rectangles shown in Figure 2 is limited on the upper and lower sides by lines that represent the first and third quartile of the distribution of doses. Therefore, the rectangle encompasses 50% of the doses measured in each point. The length of the lines that extend upwards and downwards from each rectangle give the exact idea of how the 25% highest and the 25% lowest doses are distributed around the median.

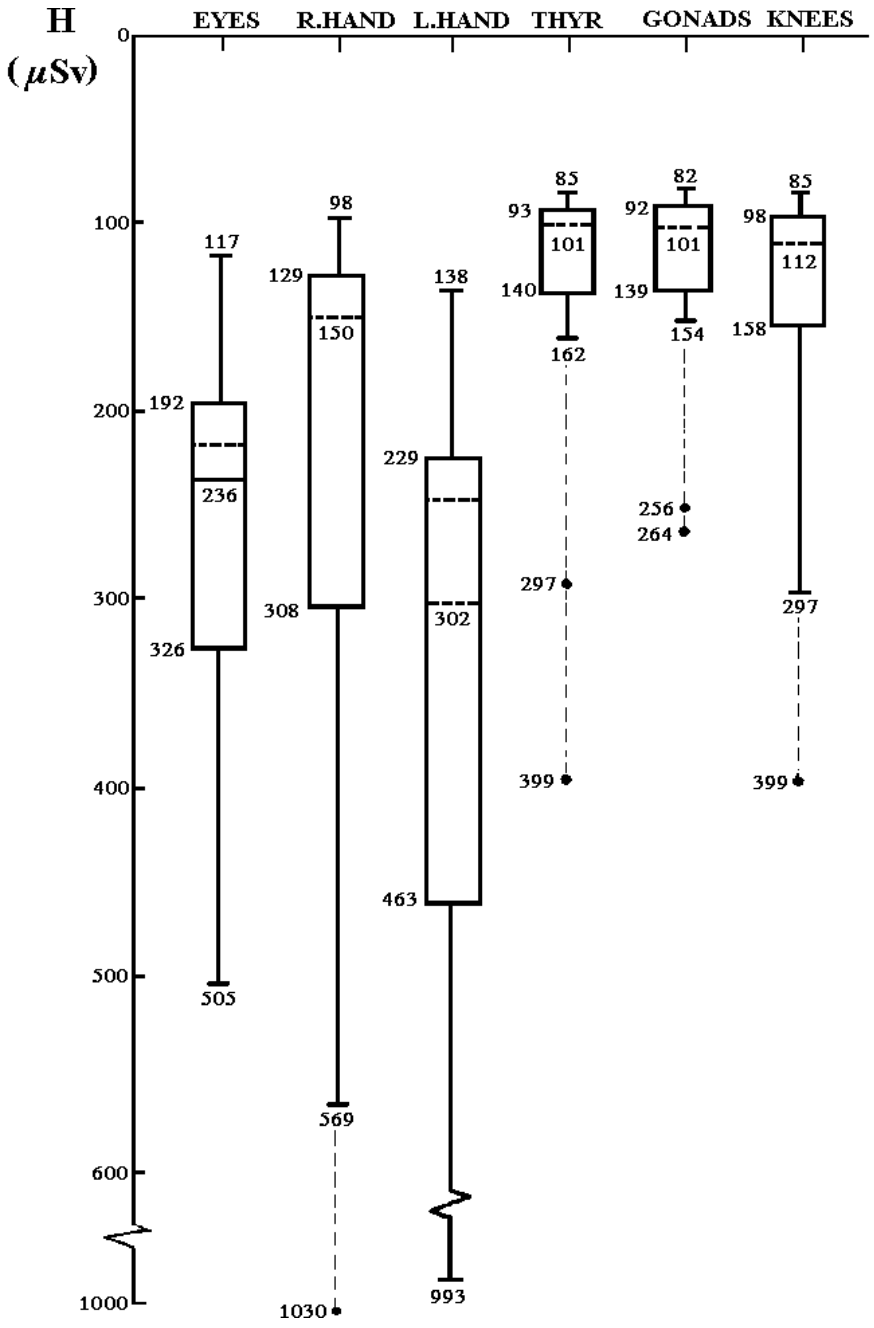

Figure 2- A box and whiskers diagram of the doses measured in the selected body locations

A detailed analysis of Figure 2 shows that the data can be separated in two groups: the first group includes the doses received by the eyes and hands of operators, and is characterized by a great dispersion of doses and by the high values of their median values. It represents the set of doses measured in areas of the body

that were not protected by either the apron or the collar shield. The second group of data represents the doses measured at the thyroid, trunk and knees, which were protected by lead shields. The data in this group present less dispersion than those in the first one, and the median value for each monitored point is roughly the same, showing the importance of the shielding in reducing the dose received by the operator.

CONCLUSION

The results of this study indicate that the lenses of the eyes receive the highest doses as a result of cardiac catheterization examinations. It is therefore recommended that radiologists wear protective goggles while performing this type of examination. The fact that all the shielded parts of the body receive roughly the same low dose of radiation shows the importance of using the appropriate protective equipment during the examination. Based on the calculated dose values, it can be concluded that each radiologist should, on the average, perform no more than nine examinations per week, without exceeding the dose equivalent limits recommended by ICRP-26 (4).

REFERENCES

1. S. Balter, F. M. Sones e R. Brancato, *Radiation Exposure to the Operator Performing Cardiac Angiography with U-arm Systems*. Circulation, 58, 925-932 (1978).
2. L. T. Kosnic, *Personnel Exposure in the Cardiac Catheterization Laboratory*. Health Phys. 50, 144-147 (1986).
3. K. Faulkner e N. W. Marshall, *The Relationship of Effective Dose to Personnel and Monitor Reading for Simulated Fluoroscopic Irradiation Conditions*. Health Phys., 64, 502-508 (1993).
4. International Commission on Radiological Protection. *Recommendations of the International Commission on Radiological Protection*. ICRP Publication 26 (1997).

Interventional Cardiology Fellowship Program. Program Director: Sohail Ikram, M.D., FACC Program Coordinator: Karen House.Â Fellows also participate in one weekly outpatient clinic during their year of their training. This important aspect of the training will allow Fellows to apply what they are learning in their clinical training to the actual practice of medicine, under the guidance and supervision of their clinical mentor.Â Fellows also participate in peripheral vascular procedures that with our interventional and vascular surgery staff with exposure to hybrid surgical/endovascular techniques. Our staff perform well over 1500-1700 interventions each year. Each fellow will participate in more than 450 cases.