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Cardiologist's Hand Dose Measurements in Interventional Radiology

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Abstract : An evaluation was performed to determine the distribution of the radiation dose received by vascular/interventional radiologists, henceforth called cardiologists, to their hands and arms during interventional radiology procedure. Measurements of the radiation dose to the hand were conducted using thermoluminescent dosimeters for individual interventional radiology cases to determine the distribution of dose to the hands and forearms. Measurements were made on a finger, the palm, wrist and the elbow of both hands and arms. Results suggested that a non-uniformity of dose with the maximum dose being measured on the hypothenar and elbow of both hands. The left hand receives a higher dose than the right hand due to positioning of the radiologist with respect to the patient. Due to variable hand positions during clinical examinations, fluoroscopy time was not found to be a good indicator of hand dose.

Key words : Hand dose, exposure, radiation, x-rays,

Introduction :

Precision placement of interventional devices within the body is typically performed using the x-ray fluoroscopic imaging [1]. Interventional radiology requires personnel to remain close to the fluoroscopic radiation field for extended periods of time. Even though the hand is considered relatively insensitive to irradiation, radiation dose is of concern for radiologists whose hands are not shielded and must remain close to the radiation field on a daily basis.

The purpose of this study is to determine hand dose during interventional fluoroscopic procedures [2]. These data was acquired from four radiologists conducting procedures in the same fluoroscopic suits. Eight cases were examined for this study, including cardiac angiography. The data were analyzed to determine the average hand dose over all studies and to determine if there was a correlation between hand dose and fluoroscopy time used for each procedure [3, 4, 5, 6]. In this study, the measurements were made with TLDs on a finger, thenar, hypothenar, wrist and the elbow of both hands during each of the eight cases.

Materials and Methods :

This study was performed to analyze the dose to the hands and arms of radiologists and to determine the most appropriate placement of monitoring devices. This study analyzed some areas of both hands, the finger and the hypothenar eminence (fleshy side of the palm), thenar, wrist and the elbow. TLDs were placed in small, sealed packets for protection and then taped to the radiologist's marked places [1]. Radiologists for each case of this study ranged from a second-year radiology residents to attending radiologists

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with many years of experience. This mixture represented a range of skill levels and allowed for variability techniques among the radiologists.

This study involved measurements during eight patient procedures. Two were performed by attending radiologists, four by fellows and two by second year radiology residents. All the studies were done by right-handed radiologists. Fluoroscopy times ranged from 6.4 min to 13 min with an average of 9.8 min. The radiologists wore a packet of two TLDs on both right and left hypothenar, thenar, finger, wrists and the elbows.

During a procedure the fluoroscopy output varies depending on the part of the body being visualized. Also, the radiologist's distance from the x-ray beam varies over the course of a procedure and varies among the radiologists. The variations in fluoroscopy output and distance from the beam make the use of fluoroscopy times a poor indicator of doses received by radiologists in this study [7, 8].

The TLDs used for this study were TLD-100, a lithium fluoride (LiF) formulation with a magnesium impurity, manufactured by Bicron/Harshaw. Two TLD chips were paired at each measured location on the

Table 1. Radiation dose to left hand from interventional radiology procedure

	Left small finger (mGy)	**Left hypothenar** (mGy)	Left thenar (mGy)	Left wrist (mGy)	Left elbow (mGy)
Average	.12	.18	.19	.20	.12
S. D.	.03	.03	.09	.08	.03
Min.	.09	.11	.14	.11	.07
Max.	.15	.20	.36	.27	.16

Table 2. Radiation dose to right hand from interventional radiology procedure

	Right small Finger (mGy)	Right Hypothenar (mGy)	Right Thenar (mGy)	Right Wrist (mGy)	Right Elbow (mGy)
Average	.11	.13	.13	.06	.14
S. D.	.02	.07	.05	.02	.06
Min.	.08	.05	.08	.04	.08
Max.	.13	.20	.19	.08	.19

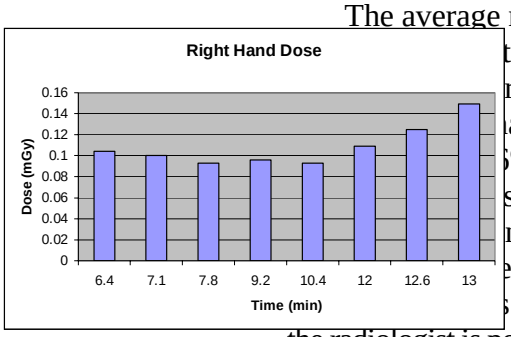

Figure 1 : Right Hand Dose

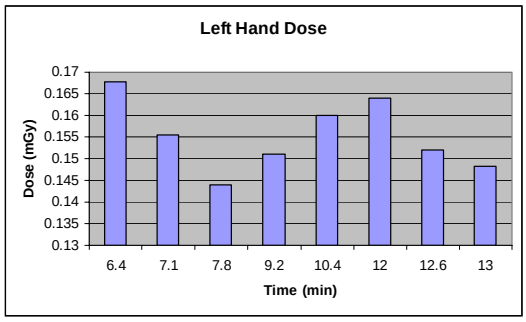

Figure 2 : Left Hand Dose

radiologist, and each data point was cross checked for reproducibility. After each study the packets were opened and the TLDs were read. Background TLD measurements were subtracted from the hand dose TLD measurement. The patient weight, x-ray technique and fluoroscopy time were recorded for each examination.

Results :

The average radiation doses received tional radiology procedure re shown in Table 1. The at the fingers received a % than the palm of the st likely due to the hand neuvering near the beam. eived 37% more dose than is due to the way in which the radiologist is positioned in comparison to the patient during the catheterization procedure. Table2. Lists the average radiation doses received during each procedure by the right hand. Again the hypothenar received the highest dose. As expected, there was a gradual decline in close up the arm and away from the x-ray beam. In both studies, the standard deviation is large due to the different procedures performed, the difficulties encountered during the procedures, and the variation in experience level of the radiologists.

Discussion :

Significant hand position variation throughout a typical interventional procedure explains, in part, the lack of correlation between hand dose and fluoroscopy time. In addition, average hand radiation dose is dramatically affected by the patient size and x-ray tube geometry. While a difficult procedure may increase the hand dose by approximately a factor of three, the estimated dose to the hands for an average procedure is .138 mGy (13.8 mrad) per procedure.

Radiologists should make every attempt to keep their hands out of the radiation field. When this is impossible, then in discussing the potential hand dose, whether their hand is on the entrance or exit side of the x-ray field should be considered. These exit hand dose data reflect a clinical interventional procedure schedule for an under table x-ray tube configuration with variable hand proximity to the radiation field, patient size,and fluoroscopy time.

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