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Original Research Article

Evaluation of Patient and Staff Doses in Brain Interventional Radiography

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Abstract: Interventional Radiology (IR) improved the diagnosis and treatment of many of pathologies. This study aimed to evaluate the patient ESAK in brain IR procedures. A total of 100 patients were examined in Royal Care hospital, Khartoum, Sudan. Patients ESAK was calculated using patients imaging parameters and X ray tube output. Patient individual exposure parameters were recorded. The mean exposure parameters values were 70.0 kV for the tube voltage, mAs=10.3 for the tube current time product. The mean patient age was 41.0. The mean ESAK was 11.5 and dose value in terms of dose area product (DAP) was 1238.8 and the mean fluoroscopic time (f.t) was 4.22±.86 minute. and D.O.P (32.75±1.893, 34.50±6.05). The correlation coefficient which is defined as a measure of the degree of linear relationship between two variables, usually labeled X and Y used in this study to describe the relation between two variables affect patient dose ESD(mGy) against tube current time product(mAs) and floro time(f.t) and dose area product (DAP) . And (DAP) against duration of procedure (D.O.P) Positive correlation coefficients were obtained between these values. This means if the value of mAs or kV increases the value of the ESD increases.
Keywords: Interventional radiography, image intensify screen, pacemaker, dose area production, patient dose, optimization

INTRODUCTION

Interventional Radiology (IR) refers to a range of techniques which rely on the use radiological image guidance (X-ray fluoroscopy, ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI]) to precisely target therapy. Most IR treatments are minimally invasive alternatives to open and laparoscopic (keyhole) surgery. As many IR procedures start with passing a needle through the skin to the target it is sometime called pinhole surgery .These procedures are usually performed using needles and narrow tubes called catheters, rather than by making large incisions into the body as in traditional surgery [1]**.** The concept behind interventional radiology is to diagnose and treat patients using the least invasive techniques currently available in order to minimize risk to the patient and improve health outcomes. The first global statement defining interventional radiology—one designed to benefit medical treatment for individuals. The statement addresses the evolution, impact and future direction of this minimally invasive specialty, emphasizing the worldwide availability of this specialized medical care. Many conditions that once required surgery can now be treated non-surgically by interventional radiologists. By minimizing the physical trauma to the patient, peripheral interventions can reduce infection rates and recovery time, as well as shorten hospital stays [2,3].

Risk of radiation and over exposure

It is important to know the radiological doses involved in medical imaging, because the radiological dose is directly and linearly related to risk. There is always a risk of damage to cells or tissue from being exposed to any amount of ionizing radiation. Over time, exposure to radiation may cause cancer and other health problems. But in most cases, the risk of getting cancer from being exposed to small amounts of radiation is small. The chance of getting cancer varies from person to person. It depends on the source and amount of radiation exposure, the number of exposures over time, and your age at exposure. In general, the younger you are when you are exposed to radiation, the greater the risk of cancer. The benefits of properly performed interventional fluoroscopy almost always outweigh the radiation risk experienced by an individual. However, unnecessary exposure to radiation can produce avoidable risk[4].

Risk to patients

The short-term risk to patients is radiation-induced skin damage, which can result from acute radiation doses of >= 2Gy. The extent of the skin injury may not be known for weeks after the procedure. Repeated procedures increase the risk of skin injury, because previous radiation exposure sensitizes the skin.

Long term effects include the potential risk of cancer. It is generally accepted that there is probably no low dose "threshold" for inducing cancers, i.e. no amount of radiation should be considered absolutely safe. Recent data from the atomic bomb survivors [5] and medically irradiated populations [6] demonstrate small, but significant increases in cancer risk even at the level of doses that are relevant to interventional fluoroscopy procedures. The increased risk of cancer depends upon the age and sex of the patient at exposure. Children are considerably more sensitive to radiation than adults, as consistently shown in epidemiologic studies of irradiated populations [7].

Risk to health care providers

Health care providers are also at risk of radiation damage from chronic exposure to radiation from these procedures. There are an increasing number of case reports of skin changes on the hands and injuries to the lens of the eye in operators and assistants [8]. Although cancer is uncommon, cancers associated with radiation exposure in adults may include leukemia and breast cancer [4].

Patient and Staff Exposure

According to the 'as low as reasonably achievable' (ALARA) and optimization principles it is necessary to minimize patient dose in order to outweigh the radiation risk by the benefit of the interventional procedure. We must balance the risks with the benefit. It is something we do often. We want to go somewhere in a hurry, we accept the risks of driving for that benefit. We want to eat fat foods; we accept the risks of heart disease. Radiation is another risk which we must balance with the benefit. The benefit is that we can have a source of power, or we can do scientific research, or receive medical treatments. The risks are a small increase in cancer. Risk comparisons show that radiation is a small risk, when compared to risks we take every day nearly. It is not a mysterious source of disease, but a well-understood phenomenon, better understood than almost any other cancer causing agent to which we are exposed.

Dose level

During long procedures the threshold of the deterministic effects might be reached. Since the severity of the lesion is dose dependent one should define a DAP level (for example 100Gy.cm^2) after which a particular care on patient exposure is exercised. One could try for Example to change incidences to distribute the dose. A DAP threshold where the patient should be recalled to check for skin lesion should also be defined (for example 500 Gy.cm^2) [9].

MATERIAL & METHOD

A total of 10 patients were examined in Royal hospitals in Khartoum state. The data were collected using a sheet for all patients in order to maintain consistency of the information. The following parameters were recorded age and exposure parameters were recorded.. The dose was measured for interventional radiography procedure. The data were collected according to the availability.

Imaging technique

In addition to planar X-ray imaging, there are a number of different imaging techniques which use X-rays. These include angiography, which uses injected iodinated contrast agents; fluoroscopy, which is a real-time imaging method often used in conjunction with barium contrast agents; and dual-energy imaging, which can produce separate images corresponding to bone and soft tissue.

Patient preparation

The steps carried out by the process of the catheter pass three phases, namely the introduction of a catheter (a supportive plastic tube) into the artery and then inject the pigment inside the catheter is during imaging scans and finally withdrawn from the artery catheter tube and the details are as follows.

Table 1 Type and main characteristics of X-ray machine

Center	Manufacturer	Manufac tu-ring Date	Type	Focal spot (mm)	Total Filtration	Max KVp	Max mA	Max time (s)	Year install
RCH	Shimadzu	Jan 2003	Fixed (SFR)	0.5	1.5	150	500	2.2	2005

RCH= Royal Care Hospital

Absorbed Dose calculations

ESAK which is defined as the absorbed dose to air at the centre of the beam including backscattered radiation, measured for all patients using mathematical equation in addition to output factor and patient exposure factors. The exposure to the skin of the patient during standard radiographic examination or fluoroscopy can be measured directly or estimated by a calculation to exposure factors used and the equipment specifications from formula below.

$$ESAK = OP.\left(\frac{kVp}{80}\right)^2 .mAs.\left(\frac{100}{SID}\right)^2 .BSF$$

Where:

(OP) is the output in mGy/ (mA s) of the X-ray tube at 80 kV at a focus distance of 1 m normalized to 10 mA s, (kV) the tube potential,(mA s) the product of the tube current (in mA) and the exposure time(in s), (SID) source to image receptor distance (in cm). (BSF) the backscatter factor, the normalization at 80 kV and 10 mAs was used as the potentials across the X-ray tube and the tube current are highly stabilized at this point. BSF is calculated automatically by the Dose Cal software after all input data are entered manually in the software. The tube output, the patient anthropometrical data and the radiographic parameters (kVp, mA s, SID and filtration) are initially inserted in the software.

RESULTS

THIS STUDY INTENDED IN RORYAL CARE HOSPITAL IN KHARTOUM - SUDAN

Patient's measurements

The results were tabulated in the Tables (mean ± standard deviation (SD)) and the range of the readings in parenthesis. The dose values in diagnostic radiology are small, therefore the dose were presented in milli-Gray. The mean and the standard deviation were calculated using the excel software & SPSS program. For dose calculation, patient individual exposure parameters were recorded (tube voltage (kV), tube current and exposure time product (mAs) and source to image distance (SID) ,age and ESD. The correlation coefficient which is defined as a measure of the degree of linear relationship between two variables, usually labeled X and Y used in this study to describe the relation between two variables affect patient dose ESD(mGy) against tube current time product(mAs) and floro time(f.t) and dose area product (DAP) . And (DAP) against duration of procedure (D.O.P) Positive correlation coefficients were obtained between these values. This means if the value of mAs or kV increases the value of the ESD increases. As shown in tables (1,2 and 3).

Table 1: show number and age of patient, D.O.P, N.O.E, ESD and DAP for gender of patient

Gender	D.O.P	N.O.E	ESD	DAP
Male	32.75±1.893 (30-34)	2.25±1.50 (1-4)	10.25±7.55 (3.33-19.92)	1025±755.03 (332.79-1991.5)
Female	34.50±6.05 (30-44)	3.67±1.36 (2-5)	12.3884±11.23067 (1.43-28.55)	1238.8±1123.06 (142.66-2854.95)
Total	33.80±4.73 (30-44)	3.10±1.52 (1-5)	11.53±9.50224 (1.43-28.55)	1153.3±950.22413 (142.66-2854.95)

Table 2: show number of patient, F.t, kV, mAs, and SID to gender of patient

Variable	No	F.t	Kv	mAs	SID
Male	4	4.22±.86 (3.10-5.20)	70±0 (70-70)	597.99±445.83 (201.28-1185.08)	97.20±1.64 (95-99)
Female	6	5.73±1.60 (3.50-7.30)	70±0 (70-70)	745±715.72 (121.83-1840.40)	98.23±11.154 (84-117)
Total	10	5.13±1.51 (3.10-7.30)	70.0±0.0 (70-70)	686±597.20 (121.83-1840.40)	97.82±8.384 (84-117)

DISCUSSION

In our study we took ten patients who underwent different interventional examinations. Were prescribed by referring physician and justified to done. We found the relationship between DAP and the exposure parameters to study the effect of the parameters on the absorbed dose and to compare the results by the impact of exposure parameters on dose which found in literature because the depend on the choice of technique factors that are used to perform interventional examinations .The most important of the parameters that are under the control. These factors are , tube current, time, and tube peak kilo voltage, Tube current and time are taken together as mAs in relation to radiation dose. As found in literature from previous studies, the mAs is proportional to the number of photons directed at the patient. Therefore, dose is directly proportional to the mAs. Increasing the mAs (by increasing tube current or time) increases the dose.

Therefore, significantly lower mAs are needed to achieve similar image quality.

As found in literature from previous studies, the f.t is proportional to the entrance surface dose (ESD) directed at the patient. Therefore, f.t is directly proportional to the ESD Increasing the f.t (by increasing tube current or time) increases the dose .In our study the linear relationship between f.t and ESD verified see figure 1.

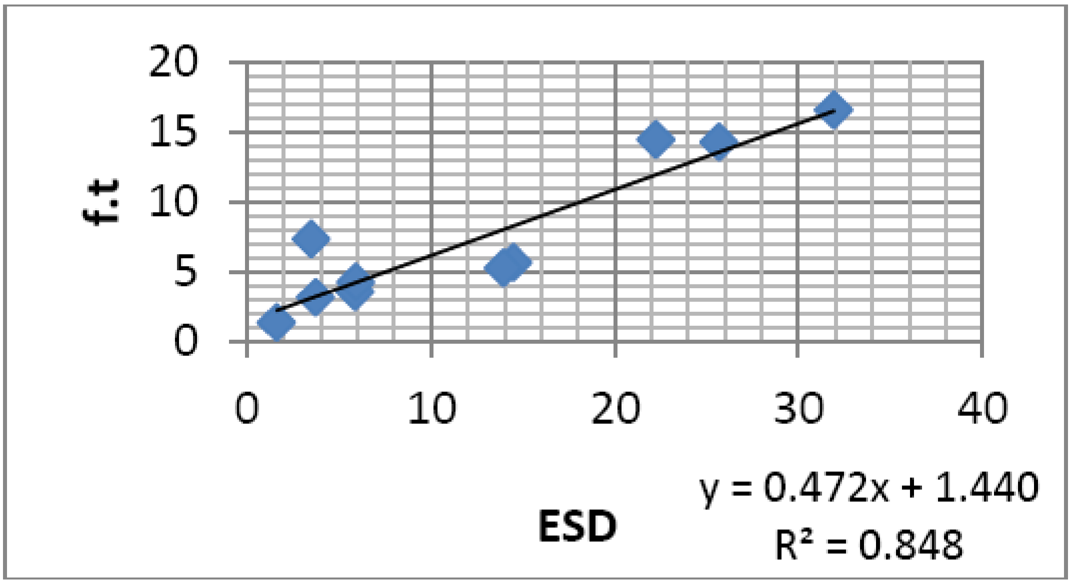

Fig 1: correlation between entrance skin dose ESD (mGy) and floro time (f.t)

Radiation risk related quantities were found, The average and range values of radiation dose were presented in different expressions: DLP (1025mGy.cm) 1238.8mGy.cm) for male and female and entrance surface dose (ESD) 10.25 cm This wide range of variation could be attributed to type of examination and patients weight. Despite these problems and the uncertainties involved, the estimation of the probability of radiation-induced cancers is needed for use in radiation protection to increase the awareness of medical personnel for further dose optimization. From comparison our study with some previous studies found entrance surface dose (ESD) and DAP comparable with other studies.

As found in literature from previous studies, the dose area product (DAP) is proportional to the entrance surface dose (ESD) directed at the patient. Therefore, DAP is directly proportional to the ESD Increasing the DAP (by increasing tube current or time) increases the dose .In our study the linear relationship between ESD and DAP verified.

There were small variations in the radiation dose to the patients comparing with the previous studies. In general these variations of doses due to differences in, tube voltages and tube current. There may be justifiable reasons for some variability in practice, of which the most important one is the difference in clinical indication. This difference is greater if operators and practitioners are insufficiently educated in newly emerging technology. Radiation doses with different scanning parameters. Further studies are highly encouraged in this field with larger samples and different interventional radiology modalities.

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