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Valuation of Radiation Dose in Lumbosacral Examination

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Abstract: ***The biological damage produce by radiation is closely related to the amount of energy absorbed in the case of x-rays. Measurement of produced ionizing is provided a useful assessment of the total energy absorbed. This study was performed in Khartoum teaching hospital in period of January to June 2014. This study performed to assess the effective dose (ED) received in lumbosacral radiographic examination and to analyze effective dose distributions among radiological departments under study. The study was performed in Khartoum teaching hospital, covering two x-ray units and a sample of 50 patients. The following parameters were recorded age, weight, height, body mass index (BMI) derived from weight (kg) and (height (m)) and exposure factors. The dose was measured for lumbosacral x-rays examination. For effective dose calculation, the entrance surface dose (ESD) values were estimated from the x-ray tube output parameters for Lumbosacral Spine AP and lateral examinations. The ED values were then calculated from the obtained ESD values using IAEA calculation methods. Effective doses were then calculated from energy imparted using ED conversion factors proposed by IAEA. The results of ED values calculated showed that patient exposure were within the normal range of exposure. The mean ED values calculated were 2.49 $\pm$ 0.03 and 5.60 $\pm$ 0.22 for Lumbosacral Spine AP and lateral examinations, respectively. Further studies are recommended with more number of patients and using more two modalities for comparison.***

Keywords: radiation dose, radiation protection, lumbosacral imaging

1. Introduction

Worldwide the number and range of x–ray facilities and x–ray equipment is increasing rapidly, in recent years, diagnostic radiology has witnessed and enormous rise in the number of types of interventional radiology [1-2]. In addition Computed tomography scanning has become widely available with some center now possessing machines capable of helical scanning which have potentially high patient through put. All these factors have contributed to a large increase in frequency of x – ray examination. In Europe, diagnostic radiology represents largest man. Made contribution to population doses [3-4]. This observation is also applies to both developing countries alike. Patient dosimetry is now regarded as an integral part of quality assurance program. National Radiological Protection Board guidance levels or reference doses have been recommended by various organization as a means of patient dose reduction. International commission on radiation units measurements defined absorbed dose as the amount of energy deposited in a medium per unit mass [5-8]. When the medium is air and photon energies with in the diagnostic range, air kerma and absorbed dose are almost equal. However, this does not apply when other media such as tissue or water are considered. It is common practice to attach dosimeters to the skin during a patient dose survey. These dosimeters may measure either entrance surface dose (ESD) in a given media or entrance surface air kerma (ESAK) if entrance surface dose is specified in air then [9-10]. Digital flouroscopy, digital subtraction angiography, digital spot imaging and conventional fluoroscopy system present particular problems for patient. Examination performed on these type of equipment are almost in variably under taken under some degree of automated control of technique factors. as a result, the technique factor stand to change continually during the examination. In addition the area irradiated by the primary beam also changes during the examination. In this dose area product or air kerma area product correlate reasonably well with radiation risk, as the number of interactions with in the patient is proportional to both dose or air kerma and field size [11-14].

2. Methods and Materials

This study involved 50 patients undergoing lumbar spine radiographic examinations in different radiology departments at Khartoum teaching Hospital in period of June to December 2014. The radiographic equipment used was Toshiba and shimadzu imaging system. The target angle for the X-ray tube was 12°, and the measured ripple for tube potential was in the region of 1%. Total filtration for the X-ray system measured as 2.7 mm of aluminum equivalent. ESDs in this study were calculated using the following equation:

$$ESD = OPx\left(\frac{kV}{80}\right)^2 xmAsx\left(\frac{100}{FSD}\right)^2 BSF$$

Where:
(OP) is the output in mGy/ (mA) 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) the product of the tube current (mA) and the exposure time(s), (FSD) the focus-to-skin 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. The results were tabulated in the Tables (Mean ± Standard Deviation (SD).

3. The Results

For the group of patients where age distribution was measured, 24 % of patients were within the 15-25 years age range, 12 % of patients were within the 26-35 years age range, 16 % of patients were within the 36-45 years age range, 28 % of patients were within the 46-55 years age range, 20 % of patients were within the 56-65 years age range. The key parameters for this group are shown in Fig. 1.

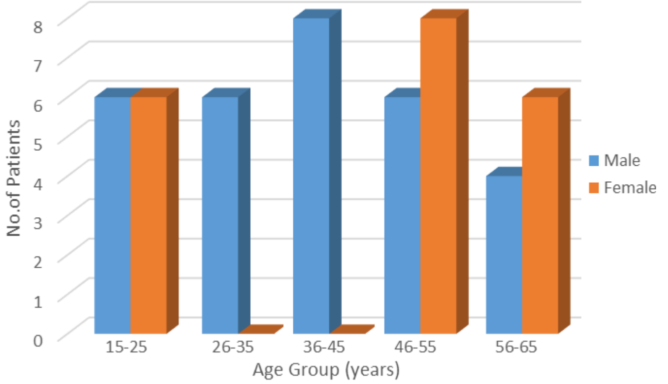

Figure 1: Age Distribution in Sample

For the group of patients where Body Mass Index (BMI) was measured, 24 % of patients were within the 1.9 + .44 (male), 2.07 + 0.78 (female) BMI ratio range, 12 % of patients were within the 2.08 + 0.50 (male) BMI ratio range, 16 % of patients were within the 2.6 + 0.28 (male) BMI ratio range, 28 % of patients were within the 2.6 + 0.28 (male) and 2.8 + 0.59 (female) BMI ratio range, 20 % of patients were within the 3.2 + 0.21 (male) and 3.14 + 1.44 (female) BMI ratio range. The key parameters for this group are shown in Fig. 2.

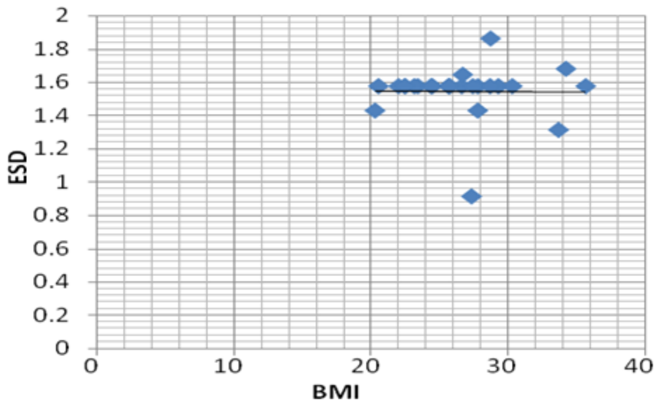

Figure 2: Relationship between entrance skin dose ESD (mGy) and body mass index BMI (Kg/m2) of patients undergoing LS X-ray

For the group of patients where x-rays exposure factors (kVp and mAs) was measured, 24 % of patients were within the 82.0 + 5.9 (kVp), 52.6 + 17.3 (mAs) exposure factors ratio range, 12 % of patients were within the 82.1 + 34.6 (kVp) and 59.6 + 16.2 (mAs) exposure factors ratio range, 16 % of patients were within the 85.6 + 8.8 (kVp) and 58.7 + 21.8 (mAs) exposure factors ratio range, 28 % of patients were within the 85.4 + 8.07 (kVp) and 79.8 + 23.8 (mAs) exposure factors ratio range, 20 % of patients were within the 87.1 + 6.8 (kVp) and 75.7 + 24.1 (mAs) exposure factors ratio range. The correlation between the entrance skin dose ESD (mGy) and tube potential kVp in (kVp) to patients undergoing LS X-ray this group were shown in fig. 3.

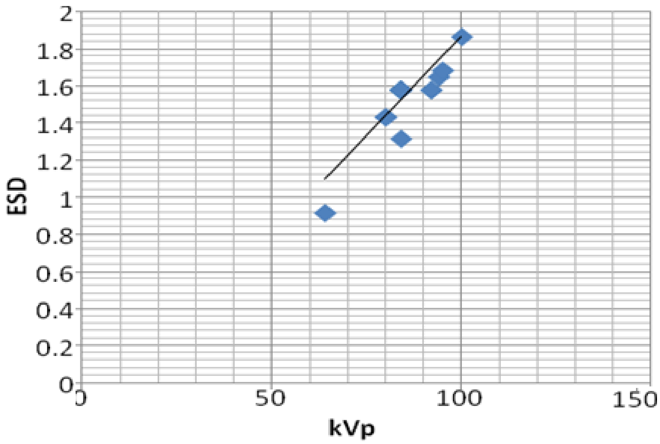

Figure 3: Relationship between entrance skin dose ESD (mGy) and tube potential (kVp).

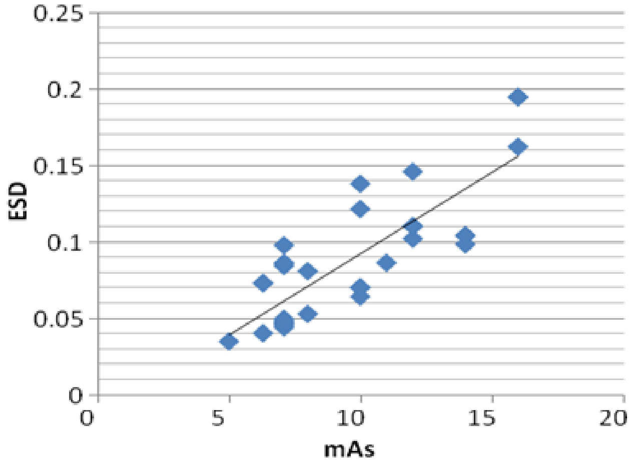

Figure 4: Relationship between entrance skin dose ESD (mGy) and tube current (mAs).

The measured dose was 2.49 +0.03 mGy and 5.60 ± 0.22 for anteroposterior and lateral projection respectively.

4. Conclusion

In this study it was found that doses for L/S for the entire examination were higher AP/LS and LA/LS respectively. Unlike other trails, the dose in L/S radiography was higher in conventional radiography compared to other techniques. Recently digital and computed radiography are becoming more popular due to the important advantage of digital imaging is cost and access. The image quality met the criteria of the departments for all investigation. Further studies are recommended with more number of patients and using more two modalities for comparison and dose optimization during CR imaging must be considered.

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