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Optimization of Doses During the Front Lumbar Spine X-Ray Examination in Eastern Côte d'Ivoire

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Abstract

Our work aims to optimize the doses received by patients during examinations of the frontal lumbar spine in the eastern region of Cote d'Ivoire. The site of our study is the radiology room of the regional capital, Abengourou. Thirty adult patients were involved.

Using the DAP- meter that we brought with us, we measured the Dose in the air and the product dose –surface (DSP) when the technician sent the beam at each patient from the desk. We then calculated the Entrance Surface Dose (ESD) by weighting the dose in air by the BSF backscatter factor. The Diagnostic Reference Level (DRL) of ESD 2.98 mGy and DSP 280.62cGycm2 were calculated by the 75th percentile method on the 30 patients. We also calculated the arithmetic mean of ESD and DSP, we find respectively ESDm = 2.517 mGy and DSPm = 294.83cGycm^2.
By comparing the DRL with the average values we find that the input dose is optimized but the DSP is not. Corrective measures must be taken in the Abengourou X-ray room to prevent patients from being unnecessarily exposed to ionizing radiation by reducing the beam field. An analysis of the voltage and the average load used tells us that the dose can be reduced further with good image quality by choosing the values recommended by French Society of Radiology (FSR).

Keywords: Optimization, DRL, ESD, DSP

I. Introduction

The use of ionizing radiation in the medical field significantly contributes to the irradiation of patients. It is therefore necessary to take precautions in the use of X-rays during radiological examinations to avoid stochastic deleterious effects [1]. In medical imaging, the prescribing physician needs a quality image to make a diagnosis. This must be done by seeking a balance between a quality image and an appropriate dose [2]. The dose of X-rays received by the patient must be as low as possible while seeking a quality image, that is to say that which will allow the diagnosis to be made. However, a study carried out in 1986 by the IAEA [3] showed that patients of the same build often received different doses for the same examination. This is abnormal and calls out to the ICRP, which in 1996 recommended [4] the establishment by member countries of a reference dose called Diagnostic Reference Levels in order to strengthen the optimization of the dose received by patients during exams. The set of radiological practices in a room or in the country should be compared to the DRL and this set should be less than the DRL [5]. If this is exceeded, corrective action must be taken. The objective of our study is to evaluate the optimization of the doses for the examination of the lumbar rachis face in Abengourou, capital of the Eastern region of the Cote d’Ivoire.

II. Materials and methods

1. Materials
The high voltage generator associated with the X-ray tube, the desk, the wall stand, the X-ray viewer and the lead aprons are the materials we needed and found on our study site. We brought with us the M4KDK type11017 DAP- meter initially calibrated in the Secondary Calibration Laboratory in Freiburg Germany [6]. This device consists of an ionization chamber that is fixed at the exit of the tube on rails and an electrometer that we have placed next to the desk behind the screen. This is where we stood next to the technician. When the beam passes through the ionization chamber, there is ionization of the gas molecules in it. The ions formed move and create a current which is carried through two leads on the electrometer which converts it into a dose in the air (Dair) and Dose-Surface Product (DSP) [6].

2. Method
In our study, we took into account 30 adult patients, all of whom came for a frontal lumbar spine examination confirmed by the prescription form they had. The examination took place in the radiology room meeting the standards set by Ivorian laws [7]. Before our study, this room was visited by the departments responsible for inspecting the radiology rooms. When the technician triggers the beam that hits the patient, we read on the electrometer, Dair and DSP We did so for each of the 30 patients. We also noted the high voltage, the charge, the distance between the focus and the detector used, the filtration of the tube.

3. Results

3.1. Determination of the Entrance Surface Dose of patients
From the Dair we determined the ESD of each patient by the formula
ESD = BSF * Dair
BSF backscattering factor equal to 1.35 [8]

3.2. Determination of the DRL and the average of ESD and DSP
The DRL was determined for each patient, for the ESD and the DSP, using the 75th percentile method [9]. We also calculated the mean Entrance Surface-dose ESDm and the mean dose-area product PDSm using the arithmetic mean [10](see table 1). These averages correspond to all the radiological practices for the examination of the lumbar spine in this room.

Table 1. DRL and mean values for ESD and DSP

DRL				Mean	
ESDcountry (mGy) [11]	ESD study (mGy)	DSP country ($cGycm^2$) [11]	DSP study ($cGy.cm^2$)	ESDm (mGy)	DSPm ($cGy.cm^2$)
4.238	2.98	289.3	280.62	2.517	294.83

3.3. Comparison of the mean value to the DRLs

3.3.1. Comparison of the ESDm of Abengourou to the DRL of Abengourou and Cote d'Ivoire

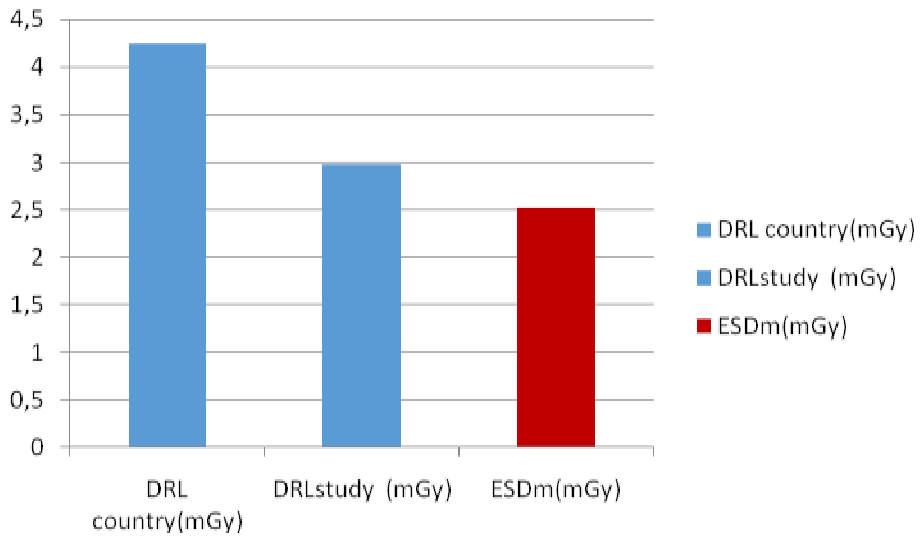

Figure 1. comparison of ESDm to DRL of our study and DRL of Côte d'Ivoire

The mean value of the dose received by Abengourou patients is smaller than the DRL of Abengourou and Cote d'Ivoire (see figure 1)

3.3.2. Comparison of DSPm of Abengourou to the DRL of Abengourou and DRL of Cote d’Ivoire

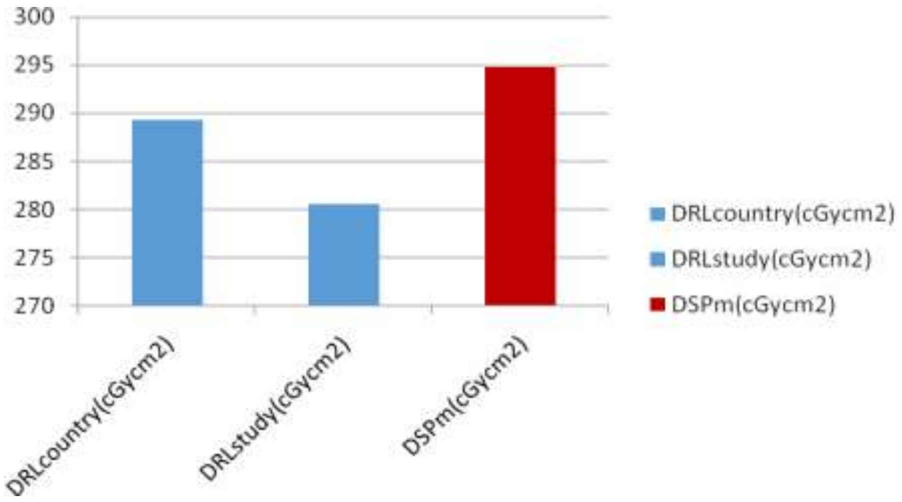

Figure 2. comparison of DSPm to DRL of our study and DRL of Côte d'Ivoire.

The average value of the Dose-Surface Product received by Abengourou patients is greater than the DRL of DSP in Abengourou and Cote d'Ivoire. (see figure 2)

3.4. Voltage and charge used for our study

From the voltage and charge set by the technician to perform the examination of each patient, we calculated the average voltage and the average charge used in Abengourou to perform the examination of the lumbar spine (see table 2).

Table 2. Average voltage and charge used in Abengourou

Mean voltage (kV)	Mean charge (mAs)
97.3	39.03

4. Discussion

The ESDm is lower than the DRL of Abengourou and that of the Cote d'Ivoire (table 1, figure 1) which means that the dose is optimized for the examination of the frontal lumbar spine in Abengourou[12]. This can be explained by the existence of the 2.5mm filtration present in the X-ray tube. However, the voltage and load values tell us that efforts can be made to avoid unnecessary irradiation of patients. The voltage of 97.3kV (see table 2) is very high exceeding the limits recommended by the French Society of Radiology (FSR) which is [65-80] kV and the charge of 39.03 mAs can be reduced further in the range of [30-70] mAs. Very high voltage beyond the limits may deteriorate the expected image quality. The voltage and the charge must be adapted to each region explored [13]. A very high charge exposes patients more to unnecessary doses [14].
From Figure 2 and table 1, the average dose-area product is greater than the DRL of the dose-area product. The surface dose product is not optimized [12]. This quantity takes into account not only the dose but also the irradiated surface. The product dose area being the multiplication of the dose by the exposed area, since the dose is optimized (see fig 1), we can say that the exposed area of patients to X-rays is unnecessarily large and therefore exposes patients to risks potential for stochastic deleterious effects. Indeed, global irradiation can be fatal while the same irradiation over a small area would only cause erythema [15]. Corrective measures must be taken into account by practitioners of Abengourou to optimize the product dose surface by reducing the beam field by a good adjustment of the diaphragm of the X-ray tube [14].

5. Conclusion

Our study concerning the optimization of the doses made it possible to find that in Abengourou the doses used for the examination of the front lumbar spine are optimized and that this can be explained among other things by the existence of a total filtration of the 2.5mm tube, recommended value. However, efforts can be made to further optimize the choice of radiological parameters by further reducing

the charge and avoiding increasing the voltage so as not to go outside the recommended range.
Our study shows us that the Dose Surface Product is not optimized and therefore corrective measures must be taken by properly using the diaphragm to expose just the part of the body to be examined.

Conflict of interest. The authors declare that they have no conflict of interest.

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