Radiation Dose To Pediatric Patients in Computed Tomography in Sudan

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Presentation outlines

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The largest contributor to the exposure of the population from artificial sources (95%) only exceeded world-wide by natural background as a source of exposure.

Million X-ray exams (> 300 million in children) annually worldwide.
Nowadays, computed tomography (CT) being the major source of patient exposure. It has been estimated that CT examinations make up approximately more than 10% of the number of radiologic procedures.

Radiation from CT delivers approximately 70% of the medically related radiation dose (Seeram, E. (2008))

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Introduction

- Although, the individual risk from the radiation associated with a CT scan is quite small compared to the benefits that accurate diagnosis and treatment can provide.
- However, still, unnecessary radiation exposure during medical procedures should be avoided. Unnecessary radiation may be delivered when CT scanner parameters are not suitably adjusted for patient size.

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In CT, there is no obvious evidence that the patient has been overexposed because the quality of the image may not be compromised.

The (ICRP) (5), estimated that the risk coefficients for the average population are 5% and 1.3% sv⁻¹, whereas for children they are 13% and 4% sv⁻¹ for stochastic and hereditary effects, respectively.
Absorbed dose in tissues from CT are among the highest observed from diagnostic radiology (i.e. 10-100 mGy).

These doses can often approach or exceed levels known to increase the probability of cancer.
The objectives of this study are to:

- (i) to measure the radiation dose and estimate the related risks to pediatric patients during CT for chest, abdomen and brain and
- (ii) propose a local diagnostic reference level for abdominal CT.

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Materials and Methods

In this study the data were collected from the following radiological departments:

(i) The National Ribat University Hospital, and
(ii) El Nilein Medical Diagnostic Centre - Khartoum.

- All quality control tests were performed to the machine prior any data collection.
- The tests were carried out by experts from Sudan Atomic Energy Commission (SAEC). All the data were within in acceptable range.
Materials and Methods: CT equipment

CT scanners that participated in this study are helical CT scanners in two hospitals.

The two scanners were displayed volume Computed Tomography Dose Index (CTDIvol) and Dose Length Product (DLP).

Table 1 CT scanners data

<table>
<thead>
<tr>
<th>Manufacutre</th>
<th>Model</th>
<th>Installation date</th>
<th>Detector type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALnilin</td>
<td>Siemens Somatom Emotion Duo</td>
<td>2006</td>
<td>2 slice</td>
</tr>
<tr>
<td>Alribat</td>
<td>Siemens Sensation 16</td>
<td>2004</td>
<td>16 slice</td>
</tr>
</tbody>
</table>
Materials and Methods: patient data

- A total of 80 patients were evaluated.
- The age of all children who were admitted in this study between 1 – 10 years.
- For each patient the following data were recorded: patient demographic data, exposure factors, and scan parameters were recorded.
The organ dose conversion factor $f \text{ (organ, } z\text{)}$ was obtained from the NRPB datasets (NRPB-SR250) based on the Monte Carlo simulations.

The CTDOSE software supplied by the ImPACT group was used. CTDI$_{\text{air}}$ normalized to 100 mAs ($\text{nCTDI}_{\text{air}}$) was used.
RESULTS

- Patients age were ranged between 1 to 10 years, height 30-130 cm, weight ranged between 2-30 Kg and Body mass index (BMI) were ranged between 9.05 -43.9.

Table 2 The mean values and standard division of the scan parameters

<table>
<thead>
<tr>
<th>Exam</th>
<th>EL-Nilein Hospital</th>
<th>AL-Ribat Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kVp</td>
<td>mAs</td>
</tr>
<tr>
<td>Brain</td>
<td>119.3±10</td>
<td>147.9±40</td>
</tr>
<tr>
<td>Abdomen</td>
<td>115.4±8.8</td>
<td>33.3±27</td>
</tr>
<tr>
<td>Chest</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
## Results

Table 3 Statistical summary of radiation doses values for brain in the tow hospitals

<table>
<thead>
<tr>
<th>Value</th>
<th>Min</th>
<th>Median</th>
<th>Mean</th>
<th>3rd quartile</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLP (mGy.cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-Nilein</td>
<td>113.0</td>
<td>280</td>
<td>300±117.9</td>
<td>397.5</td>
<td>492</td>
</tr>
<tr>
<td>AL-Ribat</td>
<td>72.0</td>
<td>290</td>
<td>328.8±225.9</td>
<td>323</td>
<td>995</td>
</tr>
<tr>
<td>CTDIvol (mGy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-Nilein</td>
<td>16.1</td>
<td>23.41</td>
<td>28.6±9.4</td>
<td>29.7</td>
<td>59.1</td>
</tr>
<tr>
<td>AL-Ribat</td>
<td>3.5</td>
<td>19.3</td>
<td>23.6±16.5</td>
<td>21.6</td>
<td>69.1</td>
</tr>
<tr>
<td>Effective dose (mSv)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-Nilein</td>
<td>0.5</td>
<td>1.5</td>
<td>1.7±0.9</td>
<td>1.8</td>
<td>3.6</td>
</tr>
<tr>
<td>AL-Ribat</td>
<td>0.3</td>
<td>1.8</td>
<td>2.5±1.7</td>
<td>1.1</td>
<td>8.2</td>
</tr>
</tbody>
</table>
Discussion

- There may be justifiable reasons for some variability in practice, of which the most important are the difficult to control the patient position and the difference in clinical indication. These reasons are greater if operators and practitioners are insufficiently educated in newly emerging technology.
The data showed that the dose in AL-Ribat is higher than EL-Nileinm.

This could be attributed to the technologist in AL-Ribat radiology department for pediatric patients uses the sequential technique (slice by slice) to avoid wrong patient position.

The using of the sequential technique indicate to use high mAs (high mAs high dose) and long scan time.

And sometimes pediatric patients scanning with adult protocol (scanner design, patient age >5 years or weight >20Kg is adult).
The mean radiation cancer risk was estimated to be $2.16 \times 10^{-6}$.

The radiation risks in general is lower than previous studies in the literature for abdomen and chest, while the risks for brain is higher than the previous reported studies.

This can be attributed to the different technique, operator and department protocol.
Conclusions

- The assessment of radiation dose to pediatric patient undergoing CT brain, abdomen and chest investigated.

- In general, the mean values of doses are higher for CT brain and lower for abdomen and chest compare to other studies.
Conclusions

- Both departments use Adults CT protocol for pediatric patients.

- Some Scan were repeated due to referring doctor lack of knowledge (with or without contrast, or even region of interest).

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Conclusions

- The main contributor for this high dose was the use of different techniques and use for adult protocol, which justify the important of use child protocol.

- In addition the study has shown a great need referring criteria, continuous training of staff in radiation protection concepts especially for pediatric.
Thank you for your attention


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