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DOSES IN PEDIATRIC PATIENTS UNDERGOING CHEST AND ABDOMEN CT EXAMINATIONS ï PRELIMINARY RESULTS

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ABSTRACT

Computed tomography (CT) is a non-invasive method of image production that imparts significant doses to a patient, it is expected that pediatric CT examinations will increase the risk of induced cancer in children. In this study the effective doses in a five year-old child submitted to chest or abdomen CT scans were assessed for comparison purposes. The CT-EXPO computed program was used with data from routine protocols of a 0 to 13 year-old children in two public hospitals in Belo Horizonte. Hospital A used a Siemens Dual-Slice unit with 80 kV, 41 mA and pitch 2 for chest or abdomen; hospital B used a Multislice GE unit with 120 kV, 45 mA and pitch 1 for chest and 120 kV, 55 mA. and pitch 1 for abdomen. Results of effective doses in a five year-old child were 1.7 and 1.0 mSv in hospital A and 9.1 and 7.2 mSv in hospital B, for chest and abdomen, respectively. Results were compared to the reference effective doses of 7.2 and 5.0 mSv for chest and abdomen respectively that were derived from the air kerma length product values given in ICRP publication 87. Results of hospital A showed that low dose exposures also can be achieved in CT scans of children. Results showed that even a hospital with a modern facility (hospital B) can provided doses higher than reference values if protocols are not adjusted for children. Preliminary results suggested that there is a room for optimizing children exposure submitted to CT scans.

1. INTRODUTION

The use of computerised tomography (CT) in pediatric diagnosis has presented a significant growth in the last few decades; currently, 35% of the CT examinations undergone by children are thorax and abdomen [1]. The contribution of CT to diagnosis include many possibilities, amongst them the detection and assessment of inflammation, the discovery and progression of tumour sites, the visualisation of renal calculus and appendicitis [2], thus providing the doctor with a better reliability in the report.

Given a high life expectancy, the risks of late damaging effects of ionising radiation are higher in children than in adults, such factor contributes to reduce the boundary between risk and benefit. The preoccupation with the dose in pediatric CT is highlighted in some of the studies [3,4,5] as published in literature, and improper use of its technique may expose the pediatric patient to high levels of radiation.

The recommendations concerning pediatric radiology safety started in 1978 with the publication of NCRP [6] nº 68, this recommendation highlights that children are more likely to develop leukemia than adults, by a factor 2, and regulation nº 87 sets reference values for the DLP (Dose length product) for pediatric CT examinations [7]. In radio diagnostic practice, an important tool for optimization is the Diagnostic Level of Reference (DLRs), which is used in the identification of activities with high radiation doses where the dose reduction concept would have a high impact [8]. The DLRs in computed tomography are expressed in terms of Computed Tomography Dose-Index (CTDI), Dose-lenght product (DLP) and Effective Dose (*E)*. The effective dose *E* is a dose quantity used to compare different radiographic practices applied to patients in order to compare different radio diagnostic practices the patients are subjected to, comparative between technologies, hospitals or countries [9], the risk/benefit associated with this practice and the exposure of patient is expressed in terms of Equivalent Dose or Absorbed Dose by the tissue or organ irradiated (H_T).

The recurring effects of the exposure to high ionizing radiation doses and its power to damage the cells is well known, however for low doses the procedure adopted is the (LNT) –Linear No Threshold Model" where the minimum exposure to radiation is enough to increase the risk of developing cancer. Given existing concerns about the amount of radiation dose in the population [10] when performed a CT scan is necessary to have protection program to avoid unnecessary exposure when a not justified CT scan is performed, when a CT is performed in children with protocols of adults and also have a control and estimate the dose in CT examinations.

The routine of examinations acquisition in almost all the radio diagnosis facilities makes use of parameters pre established by manufacturers or the ones modified by the machine operators, the term –acquisition protocol" denotes a set of parameters necessary to provide a tomographic image, amongst them are the voltage applied to the tube (kV), the miliamperage (mA), the exposure time (s), the thickness and the increment of the cut are pre established parameters for each type of examinations if the patient is considered an adult.

The main objective of this work is to provide knowledge of the Effective Dose and the Equivalent Dose in CT examinations of thorax and abdomen in pediatric patients, bearing in mind the fact that so far such values are not known the protocols of internal use in two hospitals in the city of Belo Horizonte were investigated.

2. MATERIALS AND METHODS

The current work was developed with the use of two tomographs one a Siemens Dual-Slice and the other a Multislice GE, both installed and under operation in public hospitals in the city of Belo Horizonte. A collection of data was carried out with a view to analyzing the protocols for acquisition of CT scans addressed to the pediatric public. With the results of this survey at hand, it was possible to estimate the doses that the pediatric public has been subjected to.

In order to calculate the dose, the computer programme CT – EXPO 7.1 was used and the parameters of acquisition were extracted from the protocols (table 1). The estimate of the

Effective Dose E is the derivative of the DLP, obtained by CT ï EXPO 7.1, adopting a *K* conversion factor for different organs and ages (table 3).

Table 1. Protocols for routine CT acquisition of thorax and abdomen

Parameters	Hospital A				Hospital B			
	Pediatric		Adult		Pediatric		Adult	
	Chest	Abd	Chest	Abd	Chest	Abd	Chest	Abd
Kv	80	80	130	130	120	120	120	120
mA	41	41	190	170	45	55	240	200
Pitch	2	2	0.5	0.5	1	1	0.6	0.6

3. RESULTS E DISCUSSIONS

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The following results are presented for five year old patients, notwithstanding the gender.

Table 2 shows the values of the DLPs obtained through the CT- EXPO in each hospital, in A, the values found were 94 mGy.cm and 54 mGy.cm for thorax and abdomen respectively; in B the DLPs met remained 5 and 7 times higher than in A, showing a higher dose in children.

Still analyzing table 2, for dose H_t, the organs under study were thyroid, stomach and adrenal glands; the choice was based on three defined possibilities: the thyroid, for it is the most radio sensitive organ of the body, the stomach, given the fact that there is non-distinction between gender in the present research, and the adrenal glands, which represent the scattered radiation. For hospital A, the doses absorbed by the organs under study did not exceed 0.5mSv, whereas in hospital B, the Ht values were 7.2 mSv for the thyroid, 4.9 mSv for the stomach and 5.4 mSv for the adrenal glands. According to Maria T. Raissaki [11], the relation between dose and risk of developing solid tumours pediatric patients run when undergoing a CT present an increasing range, between 0 and 0.1 Sv, making it necessary to reduce the ionising radiation in these organs in hospital B. One alternative is to reduce the mA in the CT acquisition protocols, where the H_t dose has a linear behaviour with to the mA (figure 2).

Table 2. DLP and dose absorbed by the organ

Hospital	DLP mGy.cm		H_T mSv		
	Chest	Abd	Thyroid	Stomach	Adrenal
A	94	54	0.5	0.4	0.3
B	505	360	7.2	4.9	5.4

Dose E was obtained through the thorax and abdomen DLPs by applying a conversion factor K. Such magnitude allows the comparative study between protocols for CT acquisition in different hospitals, there are no reference level for dose E in pediatric CT in literature, its value can be estimated by using values of dose restriction references for pediatric CT (table 4), as well as conversion factors K. The E dose in hospital A was 535% lower for a thorax CT and 720% lower for abdomen CT in relation to hospital B (table 3). Taking into consideration the data in the table 4, the dose restriction for pediatric CT is 7.2 mSv for thorax and 5.0 mSv for abdomen, values below dose E in hospital B, demonstrating an overexposure of the patient to ionising radiation, which is a cause of concern because the risk associated and damage caused by radiation rises as the dose increases.

Table 3. Equivalent dose and conversion factor [12]

Hospital A	DLP $_{mGycm}$	K $_{mSv.mGycm-1}$	*E* $_{mSv}$
Chest Abd	94 54	0.018 0.020	1.7 1.0
Hospital B	DLP $_{mGycm}$	K $_{mSv.mGycm-1}$	*E* $_{mSv}$
Chest Abd	505 360	0.018 0.020	9.1 7.2

Currently the use of adult protocol to get the CT scan of children is still applied [13].With a view to obtaining information about the amount of exposure a child is being submitted to if an adult protocol is used for CT acquisition, parameters of CT acquisition were used in adult patients for thorax and abdomen. What was obtained was a 20 mSv dose E in the thorax and 18 mSv in the abdomen in hospital B and 14.6 mSv and 14.0 mSv in the thorax and in the abdomen (abd) respectively in hospital A. In both hospitals such procedure denotes a considerable increase in the dose, in hospital A the child would be subjected to a dose corresponding to 14 CT for abdomen and in hospital B approximately 3 CT for abdomen (Fig.1).

Table 4. Reference Values for CT in pediatric patients

Test	Age of Patient	DLP per CT examinations (mGy.cm)
Chest	5	400
Abd	5	250

a.Adapted from: Annals of the ICRP, publication 87 [7].

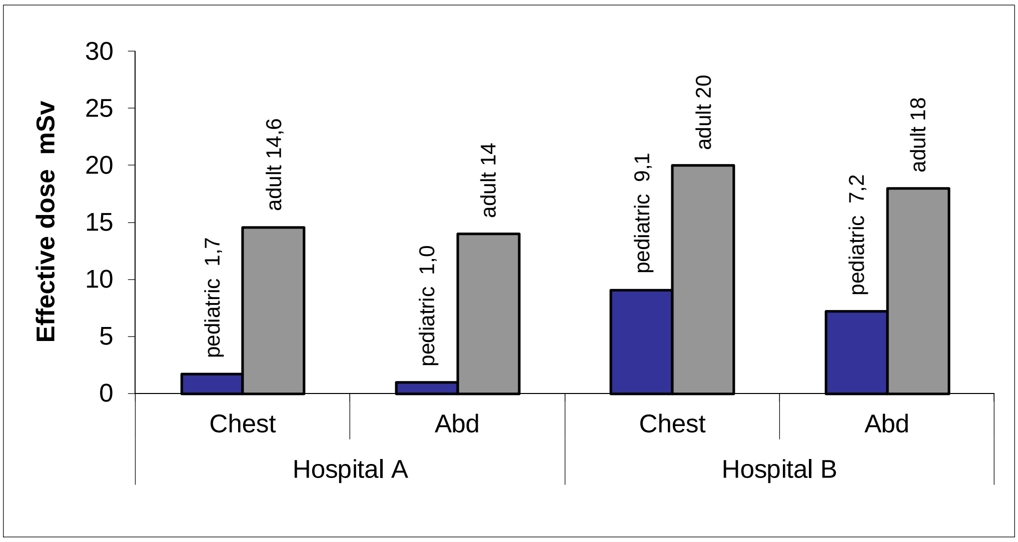

Figure 1. Comparison amongst protocols.

The reduction of the mA in the acquisition of the pediatric CT helps in the reduction of exposure of the patient to ionising radiation (Fig.2), the correlation coefficient (Cv) between dose *E* and mA is 0.9986, this is only one of the techniques that can be employed for the optimisation of the dose. Rutger A. J. et al suggest the study of the collimation, pitch and voltage of the tube (kVp) as an instrument of optimisation [14], some authors suggest that the protocol should be adopted for each patient, taking into consideration the age group and the physique [15].

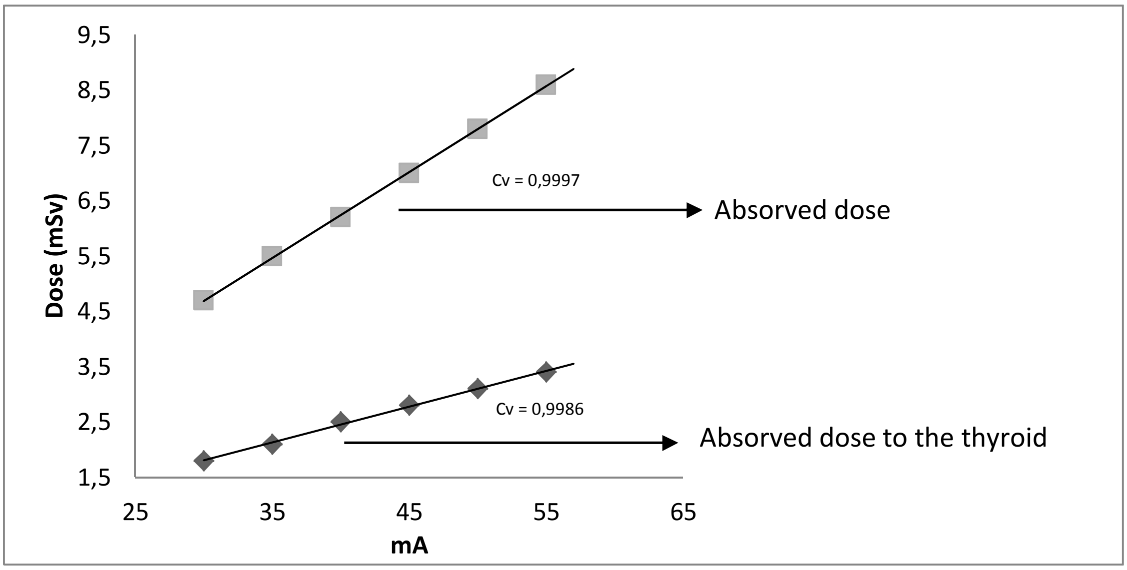

Figure 2. **Relation between dose and mA.**

4. CONCLUSION

The Results showed the difference between the protocols to acquire pediatric CT between hospitals, resulting in a high dose in the patient in hospital B, such result owes to poor preparation and lack of knowledge of the tools in the practice of pediatric CT. Hospital A has a less modern tomograph, and limited resources; however it achieves good diagnostic image quality and gives the patient undergoing a CT scan smaller dose than hospital B, which has a more modern tomograph.

It is conspicuous that there is room for the optimization of the dose in hospital B, what should be done is the adequacy of acquisition protocols for the pediatric public and in special the creation of basis to introduce a policy of radiological protection and avoidance of unnecessary exposure of ionizing in children.

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