Comparison of radiation doses for patients in MDCT exams in three radiological services with different equipments.

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Aims and objectives

• To demonstrate the importance of reducing the radiation dose during the MDCT exams. Compare the radiation doses in patients during CT scans in three institutions comparing multidetector equipments with different models and manufacturers. The comparison is made from the effective dose (E) means found from DLP (dose-length product) provided by the equipment itself through the examination protocol, using the constant k normalized by the American Association of Physicists Report in Medicine (AAPM) N 96.

• We aim also to show if there are differences in the effective radiation dose for patients in different MDCT equipments, with the same number of detectors and equipments of the same manufacturer with different number of detectors.
Methods and materials

Currently the dose for patients and the collective dose resulting from CT scans is a public health problem in many countries of the world.

Studies suggest that an increase in the number of CT exams and the amount of absorbed radiation dose to which patients are exposed are associated with an increased risk of developing cancer.

The use in medical practice of MDCT equipments, brought an increase of approximately 40% of the radiation dose absorbed.

- Compare the radiation doses in patients during MDCT exams in three large hospital institutions, from different manufacturers and different models, from the average found effective dose from DLP (dose-length product) supplied by the equipment itself through the examination protocols.
- We evaluated MDCTs of the head, thorax and abdomen/pelvis of patients over 14 years, without contrast, with a single sequence of exposure selected, using different channels and different equipment manufacturers.
- A total of 1471 exams were analyzed.
- Equipments: Manufacturer 1 - 40 channels (equipment A); Manufacturer 1 - 64 channels (equipment B); Manufacturer 2 - 64 channels (equipment C) installed in tertiary hospital institutions with outpatient care, emergency and hospitalized, from low to high complexity.
- We analyzed the DLP (dose-length product) from which equipment and used the constant K to established the average effective dose (E) by type of examination and anatomic region from each type of MDCT equipment using the following formula:

\[ E (\text{mSv}) = k \times \text{DLP} \]

- Table 1 informs the K values according to the body part being scanned, according to the American Association of Physicists Report in Medicine (AAPM) No 96, 2008
- Data Analysis: After the data collection, a statistical analysis of the results was done and, subsequently, a descriptive analysis of data comparing with the values recommended by the AAPM n 96, considering the values of effective doses described in Table 2.
Fig. 1: TABLE 1: K values according to the body part being scanned. According to the American Association of Physicists Report in Medicine (AAPM) N. 96, 2008.

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Fig. 2: TABLE 2: Values of effective doses for CT (mSv) recommended by the AAPM N. 96, 2008.

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Results

We analyzed a total of 1471 MDCT exams in the three institutions:

- Head MDCT: n= 516: Equipment A (n=187); Equipment B (n=203); Equipment C (n=126).
- Chest MDCT: n= 401: Equipment A (n=173); Equipment B (n=69); Equipment C (n=159).
- Abdomen/pelvis MDCT: n=554: Equipment A (n=174); Equipment B (n=249); Equipment C (n=131) (Figs 3-6).

Are detailed in Table 3 the DLP (dose-length product) in each type of MDCT from all the equipments evaluated (Fig 7).

In all equipments, the mean effective dose (E) were in the range recommended by the AAPM No 96, but there was significant variation between MDCT equipments (TABLE 4). (Fig. 8).

- In head MDCT, the variation was 38% between the equipment B (2.1 mSv) and C (1.3 mSv).
- In Chest MDCT: variation was 52% between the equipment B (7.9 mSv) and A (3.8 mSv).
- In MDCT of the abdomen/pelvis there was a 32% variation between the average effective dose of C equipment (11.3 mSv) and the equipment A (7.7 mSv).
- The highest average effective doses were found in the equipment B (MDCT 64 channels) for the examinations of the Chest and Head and equipment C (MDCT 64 channels) for the examinations of the abdomen/pelvis.
- The A unit (MDCT 40 channels) had the lowest average effective doses in examinations of the abdomen / pelvis and chest and the C equipment (MDCT 64 channels) had the lowest average effective dose in head exams.
- Among the same equipment variations were observed in the minimum and maximum effective doses found for the same type of examination.
- The major changes were: the exams of the abdomen/pelvis, 87% in C equipment (3.25 to 25.35 mSv); in Chest MDCT 88% of the equipment C (1.6 to 13.4 mSv) and 66% for Head MDCT in the equipment B (0.9 to 2.6 mSv).
Fig. 3: FIG.3: Evaluation of 1471 MDCT exams in three institutions

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Fig. 4: Head MDCT

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**Fig. 5:** CHEST MDCT exams

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**Fig. 6:** Abdomen/pelvis MDCT exams.

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<table>
<thead>
<tr>
<th></th>
<th>Equipment A</th>
<th>Equipment B</th>
<th>Equipment C</th>
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<td><strong>DLP</strong></td>
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**Fig. 7:** Table 3: DLP (dose-length product).

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**Fig. 8:** TABLE 4: Effective doses (E) in different equipments: MDCT head, thorax and abdomen/pelvis.
Conclusion

This study identified significant variations between the average effective doses provided to patients on MDCT scans between different devices for the same exam and larger variations on the same equipment for each type of examination.
References