Reducing radiation dose (RD) in children who underwent computed tomography (CT) does not bring harm to the diagnosis, motivates continuing education and promotes radioprotection campaign

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Aims and objectives

Radiological examinations, particularly computed tomography (CT), have increased dramatically over the past two decades [1]. In children, CT is often requested during the evaluation of traumatic brain injury (TBI), because the exam guarantees the tranquillity of family and clinical team. Recent studies, however, indicate a higher incidence of cancer particularly in children undergoing CT compared to those without exposure [1]. Some countries already promote campaigns to avoid unnecessary exposure to radiological exams and to reduce the dose of radiation applied in those exams actually needed [1,2]. Recent retrospective study in the United Kingdom analyzed 180,000 youngsters who made tomographies with current radiation dose and the authors observed a positive association between radiation dose from CT scans and leukaemia and brain tumour in this population [3]. Another study that included the data from 11 million children and adolescents in Australia showed an increased risk of cancer of 24% after one year of exposure to CT scans in relation to the unexposed population. The younger the child the greater the incidence of cancer, that was also proportional to the number of CT scans performed [4]. Thus, the aims of this study were: 1. to reduce the radiation dose of CT scans in children with TBI without losing radiograph quality and without jeopardizing the diagnosis. 2. to promote, at the work place and for the children's family, discussions about strategies to reduce the radiation dose received by children who need health care.
Methods and materials

We have selected two series of CT scans from children with TBI. Initially we identified the last 30 CT scans performed with the usual standard dose of radiation that was being used at the hospital. To the 30 subsequent CT scans we applied the protocols of the American College of Radiology (Alliance for Radiation Safety in Pediatric Imaging) according to the child's age and weight, directing the examination to the specific area of interest and avoiding multiple radiological sequences. These changes have resulted in an average 50% reduction of radiation load. Both CT series were presented to 19 pediatricians from the emergency unit, to seven radiologists and to two neurosurgeons who were unaware of technical differences between the two CT series. Each participant received three CT scans with the standard dose and three exams with reduced radiation doses. Each group of CT evaluated had one exam without radiological alterations and two exams with the most common radiological diagnoses observed in both series. Participant doctors answered if they observed any technical differences between exams; if they had difficulty in making the radiological diagnosis and defining the clinical conduct; if they had the necessity for a training to adequately evaluate the observed CT scans and finally, if they considered useful the creation of a radioprotection record for each child, where their individual radiological exams would be recorded.

Figure 1 shows examples of CT scans of children with TBI performed with standard doses and reduced radiation doses. Arrows indicate most common observed lesions in CT scans performed with standard and reduced radiation doses.
**Fig. 1:** A and B correspond to computed tomography (CT) performed with standard radiation dose (A), and reduced radiation dose (B). The arrows point to the presence of extra-axial hematomas. C and D correspond to CT performed with the standard radiation dose (C) and reduced radiation dose (D). The arrows point to the presence of bone fractures.
Results

Table 1 shows the characteristics of the two series of head CT scans from children with TBI. Observe that the two groups were similar, except for the total radiation dose (p<0.01). The following radiological diagnosis was most commonly observed in the altered exams: intracerebral hemorrhage, extra-axial hemorrhage, subgaleal hemorrhage, skull fracture, nasal or orbital fracture.

The study participant physicians were 14 men and 14 women, average age of 50 years and average practice time of 22 years.

Four out of 28 participant doctors observed differences between the CT series and reported greater "noise" in those with reduction of radiation load. None had difficulty in making a radiological diagnosis to guide the clinical conduct. All but one would like to have training and preventive education, and all agree that the Radioprotection Record would be helpful for the education and supervision by parents and health professionals to avoid that children have unnecessary radiation exposure (figure 2).

The supervisor from Unimed Medical Care system has stated: "I believe that this project overcomes the main challenge of any scientific research: crossing the academy's walls and making part of the reality of people and community, transforming habits by proposing feasible solutions".
Figure 2.
Radioprotection Record was introduced by the Unimed Medical Care system.

**Fig. 2**

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Table 1. Characteristics of the two series of head computed tomography from children with traumatic brain injury.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Gender</th>
<th>Age (months)</th>
<th>Clinical Diagnosis</th>
<th>Radiological Diagnosis</th>
<th>Average of Radiation Dose (DLP) (mGy X cm)</th>
<th>Standard deviation (mGy X cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard dose</td>
<td>17 M</td>
<td>13 F</td>
<td>122</td>
<td>TBI</td>
<td>16 altered 14 normal</td>
<td>1867.7</td>
</tr>
<tr>
<td></td>
<td>(n=30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced dose</td>
<td>12 M</td>
<td>18 F</td>
<td>82</td>
<td>TBI</td>
<td>10 altered 20 normal</td>
<td>537.1*</td>
</tr>
<tr>
<td></td>
<td>(n=30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DLP = Dose length product; TBI = Traumatic brain injury; * = p< 0.01 (Student “t” test).

Table 1

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Conclusion

The study made possible to demonstrate that the reduction of radiation dose in CT scans performed in accordance with the protocol proposed by the American College of Radiology and the American Pediatric Society permitted maintaining the quality of the exams without interfering with the diagnosis and clinical conduct of the professionals involved in the care of children with TBI. This model may also be extended to other areas of pediatric care and even to adults. Furthermore, the study design encouraged health professionals to modify their work environment with initiatives to promote awareness to physicians and families about the effects of ionizing radiation in children and establishing a true preventive project and health promotion. As an extension of the project, Unimed Health Care is investing in a new system for storing radiographic images and information related to the dose emitted by the equipment that will be sent directly to a database with a system of analysis and alerts to physicians and patients.

The entire project was very well accepted and had a great impact in the community, among physicians, health professionals, and administrative workers and also extended to the clients of Unimed Health Care. The project served as basis for the implementation of a protocol and a campaign of radioprotection and seems to be the first step to a greater future project towards better control of radiation exposure from radiological examinations. Thus, the project contributed to the awareness of the medical and technical staff, ensuring greater safety and quality of care for the benefit of patients. Also as a result, Unimed Health Care will provide the images and reports of the exams to physicians in their offices via electronic medical records, avoiding unnecessary exams repetition. This measure associated with Radioprotection Report delivered to children less than 12 years, will allow doctors to access previous exams and decide the indication of new tests.
Personal information

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References


