JOURNAL OF SURGICAL RESEARCH 192 (2014) 276–279

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Association for Academic Surgery

Radiation exposure from head computed tomography scans in pediatric trauma

Nicole E. Sharp, MD,[a] Wendy J. Svetanoff, MD,[b] Amita Desai, MD,[a] Hanna Alemayehu, MD,[a] Maneesha U. Raghavan, MD,[a] Susan W. Sharp, PhD,[a] James C. Brown, MD,[a] Douglas C. Rivard, DO,[a] Shawn D. St. Peter, MD,[a] and George W. Holcomb III, MD, MBA[a,*]

[a] Department of Surgery, The Children's Mercy Hospital, Kansas City, Missouri
[b] Department of Surgery, Creighton University, Omaha, Nebraska

ARTICLE INFO

Article history:
Received 3 February 2014
Received in revised form 16 June 2014
Accepted 25 June 2014
Available online 1 July 2014

Keywords:
Computed tomography (CT)
Pediatric
Radiation exposure
Head trauma

ABSTRACT

Background: We have previously reported that children receive significantly less radiation exposure after abdominal and/or pelvis computed tomography (CT) scanning for acute appendicitis when performed at our children's hospital (CH) rather than at outside hospitals (OH). In this study, we compare the amount of radiation children receive from head CTs for trauma done at OH *versus* those at our CH.

Methods: A retrospective chart review was performed on all children transferred to our hospital after receiving a head CT for trauma at an OH between July 2012 and December 2012. These children were then blindly case matched based on date, age, and gender to children at our CH.

Results: There were 50 children who underwent head CT scans for trauma at 28 OH. There were 21 females and 29 males in each group. Average age was 7.01 ± 0.5 y at the OH and 7.14 ± 6.07 at our CH ($P = 0.92$). Average weight was 30.81 ± 4.69 kg at the OH and 32.69 ± 27.21 kg at our CH ($P = 0.81$). Radiation measures included dose length product (671.21 ± 22.6 mGycm at OH *versus* 786.28 ± 246.3 mGycm at CH, $P = 0.11$) and CT dose index (53.4 ± 2.26 mGy at OH *versus* 49.2 ± 12.94 mGy at CH, $P = 0.56$).

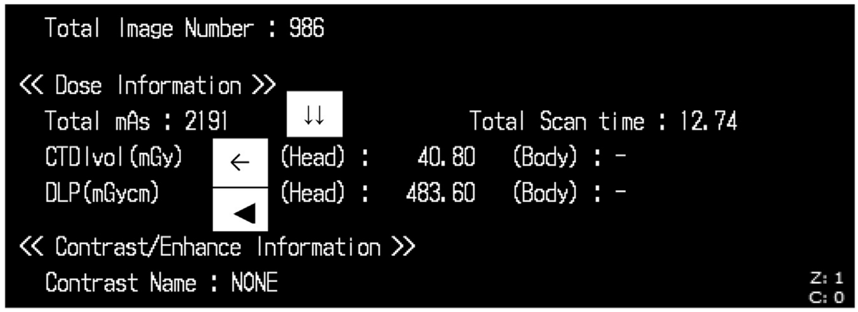
Conclusions: There is no significant difference between radiation exposure secondary to head CTs for traumatic injuries performed at OH and those at a dedicated CH.

1. Introduction

The Image Gently and As Low as Reasonably Achievable campaigns have increased awareness for the need to limit radiation exposure from imaging studies [1–6]. Radiation dose is magnified in children due to their smaller size and increased radiosensitivity [7–12]. Furthermore, their longer life expectancy amplifies the length of time available to develop radiation-induced malignancy [7,13–17]. Radiation dose from a computed tomography (CT) scan is determined by both scanner and patient factors. CT scanner settings including tube current, tube voltage, collimation, and pitch contribute to radiation exposure. Patient size also plays a role is the final radiation dose received. Scanners should be adjusted appropriately for imaging in children to minimize radiation exposure. We have previously reported that children

* *Corresponding author*. Department of Surgery, Center for Minimally Invasive Surgery, Children's Mercy Hospitals and Clinics, 2401 Gillham Road, Kansas City, MO 64108. Tel.: +1 816 234 3578; fax: +1 816 983 6885.
E-mail address: gholcomb@cmh.edu (G.W. Holcomb).

0022-4804/$ – see front matter
http://dx.doi.org/10.1016/j.jss.2014.06.049



DLP: dose length product; $CTDI_{vol}$: volume computed tomography dose index

Fig. 1 – CT dose report illustrating the $CTDI_{vol}$ (black arrow), DLP (black arrow head), and phantom (two black arrows).

receive significantly less radiation exposure from CT scans for acute appendicitis when performed at our dedicated children's hospital (CH) rather than at outside hospitals (OH) [18]. The purpose of this study is to compare radiation emission from head CTs for trauma performed at OH with those at our dedicated CH.

2. Methods

After the institutional review board approval, a retrospective review was performed on all children aged <18 y who were transferred to our hospital after an initial head CT was performed for trauma at an OH from July 2012–December 2012. These children were identified by an electronic search using our picture archiving and communication system. The radiation exposure from these scans was obtained from the embedded CT dose report accompanying the images (Fig. 1). Children from OH were then case matched before radiation emission data collection based on age, gender, and date of study to children from our CH. All OH images were independently read by one of our pediatric radiologists. Comparisons between the two groups included radiation measures such as dose length product (DLP) and volume computed tomography dose length index ($CTDI_{vol}$).

Two-tailed independent Student *t*-test was used for continuous variables and two-tailed Fisher exact test was used for discrete variables using chi-square with Yates correction where appropriate.

3. Results

Sixty-six children underwent head CT scans after trauma at OH during the study timeframe, of which 16 were excluded due to lack of CT dose card information (15) or because of inability to case match (1). Demographics are illustrated in Table 1. OH ages ranged from 13 d–17 y compared with 2 wk–17 y at our CH.

All CT scans were non-contrast studies. Radiation emission results are summarized in Table 2 where there were no significant differences in radiation exposure. Two children originally imaged at an OH required repeat head CT at our CH due to unacceptably poor image quality on their original OH scan. In contrast, no children at our CH required repeat imaging due to poor image quality. Twenty-seven (54%) and five (10%) children were diagnosed with a traumatic injury after imaging at OH and CH, respectively. There were no cases of delayed diagnosis or discrepancies in diagnosis in CH children who underwent subsequent follow-up imaging. In contrast, five (10%) of OH scans were found to have discrepancies in diagnosis when read by our pediatric radiologist ($P = 0.06$). Three children were diagnosed with a closed head injury (CHI) by OH radiologists that were found to have negative CT scans on arrival at our CH. One child was found to have a subdural hematoma rather than an epidural hematoma whereas another child was found to have an undiagnosed skull fracture.

4. Discussion

Computed tomography dose index (CTDI) and dose length product (DLP) were developed to provide a standardized method of comparing radiation emission between different CT scanners after appropriate calibration based on a reference phantom [11]. A reference phantom is a 16 cm or 32 cm diameter cylinder that serves as a standardized reference allowing for comparison of radiation emission between CT scanners. Originally, CTDI was defined as the average dose imparted on a reference phantom from the primary beam plus scatter from surrounding CT slices. Since then, there have been multiple variations of CTDI. Currently, $CTDI_{vol}$ is commonly used as it represents the weighted sum of two thirds of the peripheral dose and one third of the central dose of radiation to a reference phantom divided by the beam pitch

Table 1 – Demographics.

Demographics	OH	CH	P value
Gender (M:F)	29:21	29:21	1
Age (y)	7.0 ± 0.5	7.1 ± 6.0	0.92
Weight (kg)	30.8 ± 4.7	32.7 ± 27.2	0.81

Values are presented as mean ± standard deviation unless otherwise specified.