

CME Article

What is the Role of Abdominal Computerized Tomography (CT) in Children with Head Injury?

Thomas Spentzas, MD; Stephanie A. Storgion, MD

Editor's Note: This is the first of four articles to be published in 2007 for which up to four Category 1 credit hours can be earned. Instructions on how credit hours can be earned appear inside the front cover of the journal. Exam questions follow the article.

Address correspondence and reprint requests to: Thomas Spentzas, MD, Assistant Professor of Pediatric Critical Care, University of Tennessee at Memphis, Lebonheur Children's Medical Center, 50 N. Dunlap Street, Memphis, TN 38103-2800. The author received no financial support for this paper. Copyright © 2007 Miami Children's Hospital

Target Audience

This CME activity is intended for physicians, medical students and nurse practitioners. Emergency Department physicians and nurse practitioners will find this information especially useful.

Learning Objectives

After completion of this article, the reader should be able to:

1. state the most accurate way to evaluate for abdominal trauma in head injury patients
2. discern how much a positive abdominal exam increases the odds of having a positive abdominal CT
3. state the most common abdominal CT finding in pediatric patients with severe head injuries

Objective: To analyze the current practice of abdominal computerized tomography (CT) scans in children with severe head injury, during the initial evaluation in the Emergency Department (ED).

Design: Retrospective cohort 2-year period study.
Setting: Pediatric critical care unit of a tertiary care, children's university hospital.

Patients: All patients admitted with the diagnosis of severe head trauma during the time period 2001 to 2003 had their records screened for the following parameters: abdominal physical examination, order and results of an abdominal and head CT during the admission. The data were marked as positive or negative and the radiological results were graded according to the depicted severity. The cases with exsanguination and/or emergency abdominal surgery needs were marked.

Measurements and Main Results: 1612 patients registered as "trauma" in the Emergency Department, 54 (3.35%) were admitted into the PICU due to severe head injury. Of those, forty four (81.5%) had an abdominal CT ordered. Four cases (7.5%) did not have CTs, although they were

ordered due to hemodynamic instability, thirty one (57.5%) had CTs done, but they did not indicate trauma, and nine (16.5%) had CTs done and the results indicated traumatic pathology. The decision to obtain an abdominal CT correlated with the severity of the head CT as well as, with the abnormal abdominal examination results at $p < 0.05$. Having an abnormal abdominal examination, it increased by 21 times the odds of traumatic abdominal CT findings ($p < .05$) and predicted all the cases with exsanguinations and/or abdominal surgery requirements.

Conclusions: Abnormal abdominal examination can be used as a screening test in patients with head injury as it identifies exsanguinations and/or abdominal surgical necessities at triaging. Abdominal CT, offers detailed report and confirmation of the abdominal injuries.

KEY WORDS: abdominal computerized tomography; children with head injury; abdominal examination; pediatrics; head injury; trauma

Abdominal CT practically replaced the diagnostic peritoneal lavage (DPL) in hemodynamically stable pediatric blunt trauma patients. It is non-invasive, readily

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available and accurate. It is however expensive and exposes children to radiation.¹

The available literature does not offer guidelines for ordering an abdominal CT in pediatric trauma but suggests its use in cases where therapeutic interventions are contemplated. Furthermore, there is challenging adult trauma literature suggesting that possible excessive use of abdominal CT in blunt trauma.²

Beaver³ reported that 23% of children with head injury and Glasgow Coma Scale (GCS) less than 10 had intraabdominal injury. Taylor⁴ found in a study of 25 children with a Glasgow coma scale (GCS) less than 8 that every child with abdominal injury had consistent physical and laboratory signs.

The abdominal examination during severe head injury could be misleading especially when sedative or paralytic medications were used. With the present study we are describing the current practice rate of performing abdominal CT in critically head injured pediatric patients in a tertiary pediatric center. We are comparing the abdominal examination findings with the abdominal and head CT severity graded reports, as well as, the abdominal examination findings in concordance with exsanguinations or emergency abdominal surgery needs.

MATERIALS AND METHODS

The PICU at the LeBonheur Children's Medical Center is a tertiary pediatric critical care unit in Memphis Tennessee. The patients' age ranged from neonate to 18 years old.

Patients

The study was approved by the Institutional Review Board (IRB). All patients admitted to the PICU between January 1, 2001 and December 31, 2003 with the primary diagnosis altered mental status due to traumatic head injury were included in the study.

We excluded patients with possible traumatic but unclear injury, e.g. possible shaken baby syndrome and those with main admitting diagnosis other than altered mental status due to head injury.

The admission of a head trauma patient into the PICU is a complex decision involving the following services: pediatric emergency, pediatric surgery and pediatric neurosurgery and pediatric critical care. Since Glasgow

Coma Scale (GSC) Score varies throughout the admission process time, it was not included as a study admission criterion, however all patients in the group had GCS 8 or less documented in the time period between the event and the admission into the PICU.

Measurements

The abdominal examination data were categorized as positive for traumatic injury or negative. The positive findings included mainly significant distention (viewed as not gaseous), tenderness or guarding. It was marked as abnormal by at least one of the examiners before the patient's arrival in to the PICU.

The abdominal CT findings were also marked as negative or positive. The negative findings were subdivided as:

- neg when normal,
- neg when with non specific increased fluid collection,
- neg 2 with not traumatic pathology.
- The positive findings were subdivided as:
- *pos 1* with liver laceration findings,
- *pos 2* with hepatic contusion,
- *pos 3* with spleen laceration,
- *pos 4* with splenic fracture.

The diagnostic value of the abdominal CT was contrasted not ordered, ordered and had positive results, ordered and had negative results and ordered but not performed due to patient instability. We also marked the cases of significant exsanguination (defined as acute anemia with hemodynamic instability).

The head CT was analyzed as normal (neg) and abnormal (pos) with grading severity from pos to pos 6:

The positive findings were subdivided as:

- *pos1* findings when with skull fractures only,
- *pos2* with fractures and adjacent hemorrhages,
- *pos3* with fractures more extensive than 2 hemorrhages and some edema,
- *pos4* as with generalized hemorrhages,
- *pos 5* generalized edema,
- *pos 6* as with diffuse axonal injury.

For the analysis we utilized Fischer's exact and Mantel Hansel test. The software was SPSS 13 (Chicago IL) and SAS 9.1.

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RESULTS

There were 742 and 870 pediatric trauma patients in 2002 and 2003 respectively admitted with trauma in the emergency department. Fifty four patients (~3.35%) met the inclusive study criteria of severe head injury. Five (9.3%) were younger than 1 year, twenty two (40.7 %) between 1 and 7 years, and twenty seven (50 %) between 7 and 18 years. There were 24 females (44.4%) and 30 males

(55.6%) . All had mental status changes (GCS 8 or lower) during the time period from the field to the admission.

Forty four (81.5% ~ 4/5) of had an abdominal CT ordered. The CT was negative for abdominal traumatic findings in 31 patients (57.4%), it was positive in 9 cases (16.7%) and was ordered but not performed in 4 (7.4%) cases due to hemodynamic instability.

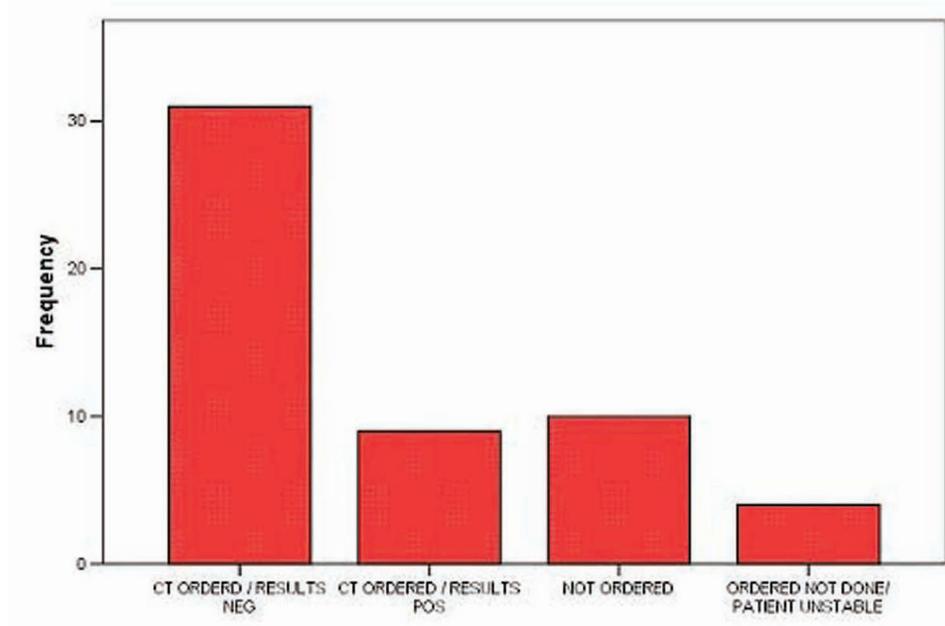
See Table 1 and Diagram 1.

Table 1: ALL CASES OF SEVERE HEAD INJURY / DIAGNOSTIC VALUE OF ABDOMINAL CT

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|--|-----------|---------|---------------|--------------------|
| Valid ABD CT ORDERED/ RESULTS NEGATIVE | 31 | 57.4 | 57.4 | 57.4 |
| Valid ABD CT ORDERED/ RESULTS POSITIVE | 9 | 16.7 | 16.7 | 74.1 |
| Valid ABD CT NOT ORDERED | 10 | 18.5 | 18.5 | 92.6 |
| Valid ABD CT ORDERED NOT DONE | 4 | 7.4 | 7.4 | 100.0 |
| Total | 54 | 100.0 | 100.0 | |

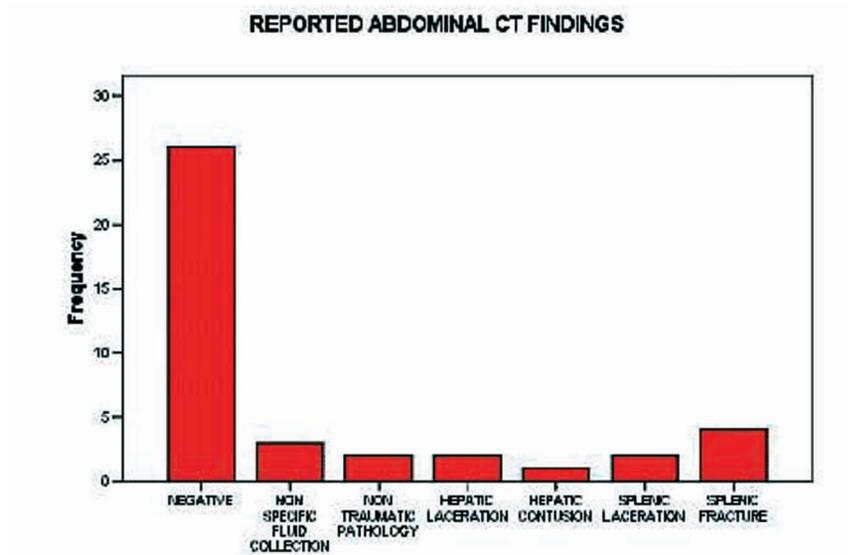
Diagram 1:

ALL CASES OF SEVERE HEAD INJURY



Role of Abdominal CT in Children with Head Injury

Diagram 2:



From the 6 patients who died during the first 24 hours 4 (66 %) were unstable to have the examination.

Analysis of the results of the head CT severity grading with the decision to order abdominal CT, revealed a linear by linear association at $p < 0.05$ (one way - Exact Sig.).

Analysis of the grading severity of head CT and grading severity of abdominal CT did not produce significant results. In addition, the abdominal CT revealed 10 cases (18.5 %) with lung pathology primary base lobe at-

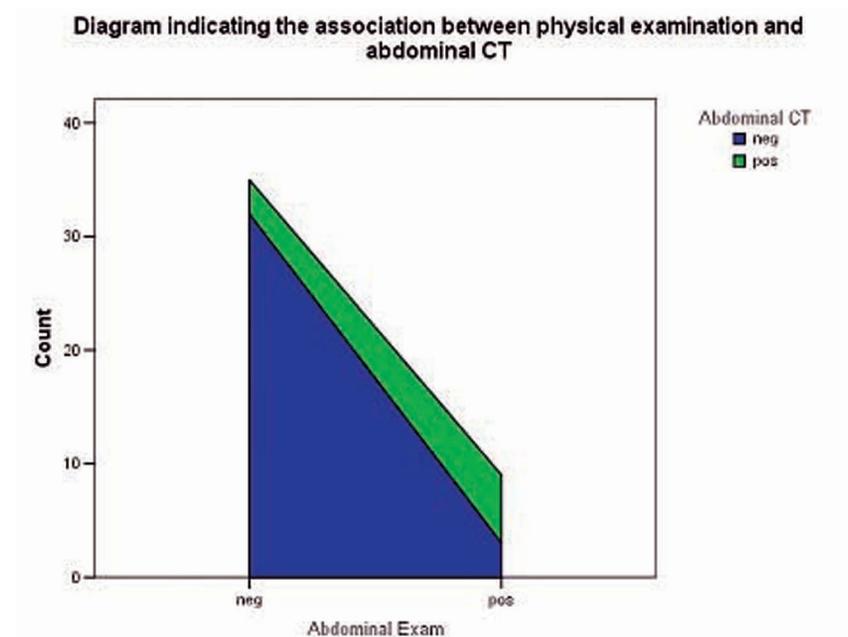
electasis (and 2 cases with lung contusions).

All the patients who had symptoms of exsanguinations had abnormal abdominal examinations.

The abdominal examination results are associated with the abdominal CT results significantly at $p < 0.05$. The Kappa index is .58 ($p < .05$ exact) with $SE = .15$. The Odds ratio is 21.3 with $LB = 3.5$ and $UB = 132$.

When the abdominal examination was marked as positive the patient had 21 (odds ratio) chances to have CT findings.

Diagram 3:



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All the cases with exsanguinations were correctly predicted by physical examination.

Table 2 depicts the distribution observed and predicted from physical examination abdominal CT findings.

Table 2: CLASSIFICATION TABLE OF ABDOMINAL CT OBSERVED VS. PREDICTED FROM A POSITIVE PHYSICAL EXAM^a

| Observed | | | Predicted | | |
|----------|--------------------|-----|--------------|-----|--------------------|
| | | | Abdominal CT | | Percentage Correct |
| | | | neg | pos | |
| Step 1 | Abdominal CT | neg | 32 | 3 | 91.4 |
| | | pos | 3 | 6 | 66.7 |
| | Overall Percentage | | | | 86.4 |

^aThe cut value is .500

The physical examination did not miss any case requiring surgical intervention.

DISCUSSION

In this study we examined the population of children with altered mental status due to head injury admitted to the PICU and described the practice of obtain abdominal CT and its correlation with the preceding physical examination. Since the study was retrospective, the abdominal examination was performed as it is usually performed without bias.

Although the abdominal examination is difficult in patients with head injury it appears that the careful clinician is able to obtain significant information. The data showed that having an abnormal abdominal examination, it increased by 21 times the odds of traumatic abdominal CT findings ($p < .05$) and predicted all the cases with exsanguinations and/or surgery requirements.

The abdominal examination in our study was predictive at 86.4.6% of abdominal CT traumatic abdominal pathology. There was no therapeutic action (surgery) performed in the cases where the abdominal CT was only positive; however, other authors (Taylor⁵) described low incidence (3.3%) of surgical intervention in this popula-

tion. Also other authors³ describe a low incidence (33%) of blood transfusion needs in pediatric patient with multiple traumas.

The sensitivity of the abdominal examination is 66.7%. This finding creates concerns that cases where close follow up may needed (e.g. liver laceration) can be missed if a CT is not performed. Finally we noticed a tendency to divert an abdominal CT when the head injury is less serious.

It is possible that the cases with only positive CT and negative physical examination have less peritoneal irritation or simply cases over diagnosed by the CT.

Lately two other techniques have been introduced to explore the possible abdominal pathology in trauma: the abdominal ultrasonography and the spiral computerized tomography.⁶ The abdominal CT identified 7 additional cases not identified by ultrasound abdominal examination, in series of 100 cases of blunt abdominal trauma, reported by Patrick.⁷ Richardson,⁸ comparing the abdominal CT with abdominal ultrasounds found one case of injury missed by CT and three cases of injury missed by sonogram. Finely Richards⁹ described in a prospective cohort study 56% sensitivity for the ultrasounds' detection of the abdominal injury.

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CONCLUSIONS

The assessment of the abdomen in pediatric patients with severe head injury remains a challenge. The data shows a significant relationship of the between the severity grading of head CT and the decision to order an abdominal CT. Patients with dismal head CT tend to have more often abdominal CT ordered. An abnormal abdominal examination increases the odds of abnormal abdominal CT 21 times. In our data significant exsanguination due to abdominal catastrophe is associated always with an ab-

normal examination. Finally, none of our patients without abnormal examination had emergency surgery.

Are those data enough to convince us not to order an abdominal CT in a head severe injury patient with negative physical examination? The answer depends upon what the examiner is seeking at the ordering time. The abdominal examination proved to be sufficient as a triaging test, but if details or questions need to be clarified the abdominal CT is the answer. A better understanding of both tests role is the only way to prevent unnecessary CTs and not miss any necessary pathology.

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Role of Abdominal CT in Children with Head Injury

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What is the Role of Abdominal Computerized Tomography (CT) in Children with Head Injury?

By Thomas Spentzas, MD; Stephanie A. Storgion, MD

Assistant Professor of Pediatric Critical Care

University of Tennessee at Memphis

Lebonheur Children's Medical Center

50 N. Dunlap Street

Memphis, TN 38103-2800

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What is the Role of Abdominal Computerized Tomography (CT) in Children with Head Injury?

Spentzas T et al, Int Pediatr 2007;22(1) 23-31

QUESTIONS

1. In hemodynamically stable head injury patients, the most accurate way to evaluate for abdominal trauma is?
 - A. Peritoneal lavage
 - B. Abdominal X- ray
 - C. Abdominal examination
 - D. Abdominal computerized tomography.

2. In severe head injury pediatric patients the abdominal examination is correlating best with?
 - A. Abdominal CT findings
 - B. Abdominal X-ray findings
 - C. Hemodynamic stability
 - D. Peritoneal irritation.

3. Emergency physicians tend to ask more often abdominal CT in patients with?
 - A. Severe head CT findings
 - B. Evidence of exsanguination
 - C. Both
 - D. Neither.

4. Having a positive abdominal examination in a patient with head trauma:
 - A. It is unreliable and should not be used.
 - B. It is reliable to point exact pathology.
 - C. It increases 21 times the odds of having a positive abdominal CT.
 - D. Should be accompanied always by an abdominal X-ray.

5. The most common abdominal CT finding in pediatric patients with severe head injury is:
 - A. Splenic rupture.
 - B. Liver laceration.
 - C. Lung atelectasis.
 - D. Abdominal aortic rupture.

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