The Journal of Trauma: Injury, Infection, and Critical Care
Issue: Volume 42(4), April 1997, pp 626-628

Publication Type: [Article]
ISSN: 0022-5282
Accession: 00005373-199704000-00007

[Article]

Prospective Study Investigating Routine Usage of Ultrasonography as the Initial Diagnostic Modality for the Evaluation of Children Sustaining Blun Abdominal Trauma

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Abstract

In this prospective study, 217 children sustaining blunt abdominal trauma were initially evaluated with ultrasonography (US) and those with any abnormal ultrasonographic findings were further evaluated with computed tomography. Results of ultrasonographic examination were normal in 157 children and showed abnormalities such as free intraperitoneal fluid (FIF), intra-abdominal organ injury, and intrapleural fluid in 60 children. Computed tomographic examination of the 42 children with organ injury, the seven children with minimal FIF of no definite source, and the three children with intrapleural fluid revealed findings consistent with ultrasonographic findings. Computed tomographic examination of the eight children with more than minimal FIF of no definite source detected by US showed the source as liver injury in one and spleen injuries in two patients. The source of FIF could not be identified with computed tomography in five patients. After clinic follow-up examination, one of these five patients was operated on for abdominal tenderness, fever, and air-fluid levels detected on plain abdominal radiographs, and duodenal perforation was encountered. Clinical courses of the patients with normal ultrasonographic findings were uneventful. We conclude that US, aside from being a screening tool, is alone sufficient in the evaluation of the majority of the children sustaining blunt abdominal trauma. Although this is a preliminary study with further work needed to be done, we propose that further evaluation with computed tomography should be performed on those children in whom more than minimal FIF of no definite source is detected with US.

Key Words: Trauma, Blunt abdominal trauma, Ultrasonography, Computed tomography.

Because of the unreliability of clinical findings, several diagnostic modalities are used for the detection of intraabdominal organ injuries after blunt abdominal trauma (BAT) in children. [1-9] After a retrospective analysis of our data, we advocate the routine use of ultrasonography (US) as the first diagnostic modality and screening procedure of choice. [2] We propose use of US for selecting stable children with BAT for further diagnostic evaluation with computed tomography (CT). [2] We have been using this approach since 1990 and herein report our experience with it.

MATERIALS AND METHODS

Prospective study of 217 patients (145 boys and 72 girls), ages ranging from 1 month to 17 years (mean +/- SD, 7.5 +/- 4.3 years), who sustained BAT between January of 1991 and January of 1996 compose the basis of this report.

US was used in a routine manner on all children sustaining BAT except those with insignificant history of injury plus normal clinical findings. Patients who were hemodynamically unstable necessitating immediate operative intervention were excluded from the study. After primary survey in the emergency room, patients underwent abdominal ultrasonographic examination. Patients were monitored closely throughout the examination period in the radiology suite.

Ultrasonographic scans were performed by the radiology residents and radiologists using a Siemens Sonoline SL-2 (Siemens, Erlangen, Germany), with either a 3.5, 5.0, or 7.0 Mhz probe depending on the patient's body size. Intraperitoneal and retroperitoneal organs were explored and free intraperitoneal fluid (FIF) was searched for in the following spaces: hepatorenal pouch (Morison's pouch), perisplenic space, perihepatic space, left and right paracolic gutter, and cul-de-sac of pelvis. Also searched for was bilateral intrapleural fluid. FIF of 1 to 2 mm in thickness found in only one of these space was regarded as minimal fluid collection.

All patients with the following ultrasonographic findings underwent computed tomographic examination: FIF, intrapleural fluid, and intra-abdominal (intraperitoneal and retroperitoneal) organ injuries. All patients were hospitalized for a minimum period of 48 hours, regardless of the result of diagnostic examinations, and were monitored during this time period. Because the study did not affect patient care and did not place the children at any additional risk, the study was not presented to the Institutional Review Board. The mechanisms of injury, pediatric trauma scores, additional injuries, and clinical outcome were recorded.

RESULTS

The most common mechanism of injury causing BAT was motor vehicle crashes affecting pedestrian (n = 118) and passenger (n = 33) children, followed by falls from heights (n = 53), falls from moving vehicles (n = 10), and human assault (n = 3).

While 47 patients (22%) had only blunt abdominal trauma, 170 patients (78%) had additional injuries. Additional injuries included central nervous system injuries in 87 patients, orthopedic injuries in 71 patients, and both types in 12 patients. Average Pediatric Trauma Score of our patients is 9.6 +/- 2.4 (mean +/- SD) (173 patients, PTS > or = to 9; 44 patients, PTS < or = to 8).

Initial ultrasonographic examination showed abnormalities in 60 patients, whereas 157 were normal. Details are summarized in Table 1. With US, organ injuries were detected in 42 patients; details are given in Table 2. Computed tomographic examination of all 42 children with organ injury, seven children with minimal FIF of no definite source, and three children with intrapleural fluid did not show additional injuries. Computed tomographic examination of the eight children with more than minimal FIF of no definite source detected by US showed the source in three patients (liver injury in one, spleen injuries in two patients). The source of FIF could not be identified with CT in five patients. After clinic follow-up examination, one of these five patients was operated on for abdominal tenderness, fever, and air-fluid levels on plain abdominal radiographs, and duodenal perforation was encountered. A computed tomographic scan of this patient did not show bowel wall thickening and contrast enhancement, bowel dilation, or free intraperitoneal air, and intraluminal contrast did not leak into the peritoneal cavity.

Findings	n	%

Findings	n	%
Free intraperitoneal fluid plus intra-abdominal organ injury	32	14.7
Only intra-abdominal organ injury	10	4.6
Only free intraperitoneal fluid (no definite source)		
more than minimal	8	3.7
minimal	7	3.2
Only intrapleural fluid	3	1.4
Normal	157	72.4
Total	217	100.0

Table 1. Results of US.

Injured Organ	FIF (+)	FIF (−)
Spleen	17	
Liver	4	4
Kidney	4	3
Surrenal gland	1	1
Spleen + liver	2	
Spleen + kidney	1	
Spleen + suprarenal gland	2	
Liver + kidney		1
Urethral rupture	1	1
Total	32	10

Table 2. Organ injuries detected with US.

One of the patients with splenic trauma and another with duodenal perforation required laparotomy; other organ injuries were managed conservatively. Two patients died as a result of severe central nervous system injury. Clinical courses of the other patients were uneventful.

DISCUSSION

In a previous study, retrospectively reviewing our data of 109 children with BAT initially evaluated by US, we concluded that US is a reliable method in detecting FIF but not accurate in detecting intraperitoneal solid organ injuries. [2] This result was consistent with the only available pediatric series dealing with US in BAT at that time. [4] Thus, we proposed routine use of US in the initial evaluation of children sustaining BAT as a screening procedure and advocated further evaluation of those children with FIF or organ injuries using CT. [2] Afterward, we conducted a prospective study to compare US with diagnostic peritoneal lavage and found that US is more sensitive than diagnostic peritoneal lavage in detecting FIF in children [3] and continued using further evaluation with CT. The present series is the result of this approach.

In the present series, further evaluation of the 60 children with abnormal ultrasonographic findings by CT confirmed the injuries in 57 cases (95%) and only helped in three cases with BAT (5%). These three cases all had more than minimal FIF of no definite source during initial ultrasonographic examination and CT showed the source of FIF. For these three cases only, we performed subsequent ultrasonographic scans, and these lesions were seen easily by the experienced ultrasonographer during subsequent US on the following day. We relate the failure in these three cases to the so called "pilot failure," i.e., result of inexperience in US. The present series shows that further examination with CT should be performed for those patients with more than minimal FIF of no definite source.

In the present series, although their clinic follow-ups are uneventful, US may have missed a number of intra-abdominal solid organ injuries without concomitant FIF, which might have been detected by CT if we had used it routinely for all children. However, centers using CT as the initial diagnostic modality are using it in selected cases, and the indications of CT are not well established. [1,9] The selection criteria used by CT advocates such as "clinical signs and symptoms suggesting abdominal trauma" is a very subjective one. They may also miss a number of injuries because of this selection bias. We do not agree with such a selection. The initial diagnostic modality should be performed routinely for all children sustaining BAT. We are using US as a screening modality in all children with BAT. However, unlike US, CT is too cumbersome to be used as a screening procedure.

There is a growing body of literature advocating US as the initial diagnostic modality for BAT in adults, regarding high sensitivity and specificity rates. [10-25] Most trauma surgeons perform US on adults during the resuscitation phase in the emergency department. This approach provides the opportunity to establish diagnosis in a few minutes, which is impossible with the current computed tomographic technology.

The only intestinal perforation encountered in this series could not be detected by either US or CT. Both methods revealed only more than minimal FIF of no definite source. Further evaluation with CT of 60 children with abnormal ultrasonographic findings showed additional injuries in three patients (5%) in whom detection of additional injuries did not alter treatment. Given that further evaluation with CT does not change treatment, urgent performance of computed tomographic scans does not seem necessary. Computed tomographic scanning may be performed on the following day.

We conclude that US, aside from being a screening tool, is alone sufficient in the evaluation of the majority of the children sustaining BAT. Although this is a preliminary study with further work needed to be done, we propose that further evaluation using computed tomographic scans should be performed on those children in whom more than minimal FIF of no definite source is detected with US.

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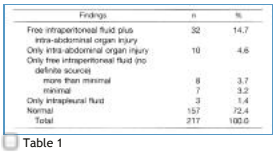

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Table 1

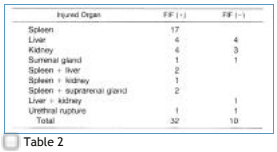

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Table 2

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