# The Results of Focused Assessment with Sonography for Trauma Performed by Third Year Surgical Residents : A Prospective Study

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**Abstract**

Focused assessment with sonography for trauma (FAST) is used as a screening tool to detect hemoperitoneum in patients with blunt abdominal injuries. The aim of this study was to evaluate the sensitivity and specificity of FAST performed by third year surgical residents.

**Patients and Method :** Data were collected prospectively in one hundred and twenty-nine blunt abdominal trauma patients admitted to King Chulalongkorn Memorial Hospital from November 2000- November 2002. FAST was used by third year surgical residents to detect intraperitoneal fluid and considered positive if such fluid was identified. Data were analyzed using the chi-square test.

**Results :** Of the 129 patients, there were 31 female (24%) and 98 male (76%) patients, with the mean age of 34 years. The mean Injury Severity Score was 13.2. 53 patients had proven intraabdominal injuries and 76 had no injuries. FAST was positive in 28 patients and negative in 101 patients. There were 3 false positive FAST. The sensitivity and specificity of FAST were 47.17 per cent and 96.05 per cent, respectively. The positive predictive value was 89.29 per cent, the negative predictive value was 72.28 per cent and the accuracy was 81.59 per cent.

**Conclusion :** FAST performed by third year surgical residents for blunt abdominal trauma had high specificity to detect hemoperitoneum. A positive FAST is a strong predictor of significant intraabdominal injury. The need for more practices to improve sensitivity is recommended.

**Key word :** Ultrasonography, Blunt Abdominal Injuries

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Early detection of significant intraperitoneal bleeding in trauma patients remains a diagnostic challenge. Patients with blunt abdominal trauma are well known for unreliable physical examination. Alteration of consciousness, spinal cord injury, pain from rib fractures and pelvic injuries affect the result of physical examination. Until recently, diagnostic peritoneal lavage (DPL) and computed tomography (CT) have been considered the standard modalities for abdominal evaluation in blunt trauma patients. However, DPL is invasive and too sensitive resulting a high rate of unnecessary exploration. CT is non-invasive but expensive and is safe only in a hemodynamically stable patient. Furthermore, CT also carries risks of aspiration and nephrotoxicity by oral and intravenous contrast. Ultrasonography is another diagnostic tool that is non-invasive, portable, rapid, inexpensive and repeatable. European surgeons and clinicians have used ultrasound to evaluate blunt abdominal trauma for 30 years[1]. It was introduced in the United States in the past decade by Tso[2] and has spread widely. The acronym FAST (focused assessment with sonography for trauma) was selected at the 1997 international consensus conference to name the diagnostic ultrasound scan that is performed during the initial assessment of the trauma patients[3].

Traditionally, abdominal sonography is usually performed by radiologists. In trauma situations, time is limited and a radiologist may not be available 24 hours in the emergency room. FAST is undertaken by trauma surgeons and senior surgical residents. The aim of this study was to evaluate the sensitivity and specificity of FAST performed by third year surgical residents to detect hemoperitoneum.

## PATIENTS AND METHOD

During the 2-year period from November 2000 to November 2002, FAST was evaluated for its utility for detection of hemoperitoneum for blunt abdominal trauma patients at King Chulalongkorn Memorial Hospital. All admitted adult patients who had blunt abdominal injuries were enrolled into the study. Patients who had obvious signs of peritonitis or any strong indication for exploratory laparotomy were excluded.

Data were gathered prospectively on FAST examinations performed, recorded and interpreted by third year surgical residents who lead the trauma team and oversaw the evaluation and resuscitation of trauma patients under the guidance of attending trauma surgeons. The third year residents performing FAST had been in the sonographic course for 1 month during the second year of the surgery board training program under supervision of experienced attending radiologists. The collected data included age, sex, duration from scene to emergency room, duration of sonographic study, vital signs, organ injuries, results of FAST and results of confirmatory studies (CT, DPL, physical examination, operative findings, or autopsy).

The standard FAST is defined as real-time sonographic scanning in 4 distinct regions of the abdomen, identified as the 4Ps: 1) pericardial; 2) perihepatic; 3) perisplenic; and 4) pelvic. The patient was in the supine position with a nasogastric tube in place and FAST was completed before Foley catheter placement or while clamping it. All the FAST examinations were performed with an "Aloka" portable ultrasound scanner (Tokyo, Japan), model SSD500 equipped with a camera and printer that were permanently available in the emergency room. Scans were applied by using the 3.5 MHz transducer. Positive FAST was defined as presence of fluid in at least 1 of 4 regions and if there was no fluid detected it was described as a negative FAST. Thus, a true positive was defined as fluid detected by FAST and confirmed by CT, a positive DPL, operative findings or autopsy. A true negative was a negative FAST followed by negative studies (CT, DPL, operative finding or negative serial physical examination). A false positive was fluid detected by FAST but not confirmed by CT, DPL or laparotomy. A false negative was a negative FAST but positive confirmatory studies. The selection of the confirmatory studies and managements depended on the patients' clinical manifestations (vital signs or the response to volume resuscitation) and surgeon preferences.

## RESULTS

One hundred and twenty nine patients were enrolled into the present study. There were 31 female (24%) and 98 male (76%) patients, ages ranged from 15 to 78 years, with a mean of 34 years (Table 1). Systolic blood pressure measured in the emergency room was $116 \pm 27.9$ (mean $\pm$ SD) mmHg, heart rate was $93.6 \pm 13.6$, and respiratory rate was $21.6 \pm 4.3$. Injury severity score was $13.2 \pm 10.7$. The mechanisms of injuries were motorcycle accident 49 patients (38%), car accident 16 (12%), pedestrian *versus* vehicle 16 (12%), assault 10 (8%), falling 28 (22%), hit by object 3 (2%), and found lying down 7 (6%) patients (Table 2). The median duration from scene to emergency room was 60 minutes and the median time after arrival

until FAST started was 20 minutes. The time used for FAST examination was 5:45 ± 4:27 minutes. Fluid was detected at the perihepatic, perisplenic and pelvic regions in 16, 12 and 12 patients, respectively. No patient in this study had any abnormality at the pericardial area (Table 3). FAST was positive in 28 patients and negative in 101 patients. In the positive FAST group, there was 1 region positive in 17 patients, 2 regions in 10 and 3 regions in 1 patient.

DPL was used as a diagnostic tool for 39 patients resulting in 17 negative and 22 positive outcomes (gross blood > 10 ml = 19, RBC > $10^5/mm^3$ = 2 and WBC > $500/mm^3$ = 1). CT was performed in 35 patients, showing 20 negative and 15 positive results. The positive CT revealed 9 liver injuries, 5 kidney injuries, 3 splenic injuries, 1 pancreatic injury, and 2 retroperitoneal hematoma (Table 4). Operative interventions were performed in 34 patients; the injured organ findings were 10 livers, 9 spleens, 1 duodenum, 4 small bowels, 3 colons, 1 rectum, 2 urinary bladders, 3 mesentery, 2 abdominal vessels, 1 pancreas and 1 kidney (Table 5). Other investigations, such as intravenous pyelography and cystography were done in 4 cases with negative results. The total number of patients who had positive and negative confirmatory studies (CT, DPL, operation, and close observation) were 53 and 76, respectively. There were 178 associated extraabdominal injuries found in this study; rib fractures 29 (22.5%), head injuries 28 (21.7%), pelvic fractures 16 (12.4%), pneumothorax 13 (10.1%), hemothorax 12 (9.3%), spine and spinal cord injuries 11 (8.5%), fractures of the extremities 40 (31%), retroperitoneal injuries 6 (4.7%), lung contusion 4 (3.1%), flail chest 1 (0.8%), aorta 1 (0.8%), larynx 1 (0.8%), and brachial plexus 1 (0.8%) (Table 6).

Three patients with positive FAST had no intraabdominal injury and one of them had pelvic fracture. Of the 101 patients with negative FAST, there were 28 patients who had significant injuries; liver (10), spleen (5), kidney (2), small bowel (3), colon (2), and retroperitoneal hematoma (2) (Table 7).

The results of FAST associated with the presence of intraabdominal injuries are described in Table 8. This $\chi^2$ table was used for analysis. The sensitivity of FAST was 47.17 per cent, specificity was 96.05 per cent, positive predictive value was 89.29 per cent and negative predictive value was 72.28 per cent. The $\chi^2$ was 34.3, with a p-value < 0.001. False positive and false negative were 3.95 per cent and 52.83 per cent, respectively. The accuracy was 81.59 per cent.

**Table 1. Patient demographic data (mean ± SD).**

| | |
|---|---|
| Age (year) | 34.04 ± 15.38 |
| Sex | |
| Male | 98 (76%) |
| Female | 31 (24%) |
| SBP (mmHg) | 116 ± 27.9 |
| HR | 93.6 ± 19.6 |
| RR | 21.6 ± 4.3 |
| Injury severity score | 13.2 ± 10.7 |

SBP = systolic blood pressure
HR = heart rate, RR = respiratory rate

**Table 2. Mechanism of injury.**

| Mechanism | Number | % |
|---|---|---|
| Motorcycle accident | 49 | 38 |
| Falling | 28 | 22 |
| Car accident | 16 | 12 |
| Pedestrian *vs* vehicles | 16 | 12 |
| Assault | 10 | 8 |
| Found lying down | 7 | 6 |
| Hit by object | 3 | 2 |

**Table 3. Locations of positive FAST.**

| Location | Number |
|---|---|
| Perihepatic | 16 |
| Perisplenic | 12 |
| Pelvis | 12 |
| Pericardium | 0 |

**Table 4. Organ injuries in CT findings of 35 patients.**

| Results | Number of patients | % |
|---|---|---|
| Negative | 20 | 57 |
| Positive | 15 | 43 |
| Liver | 9 | 60 |
| Kidneys | 5 | 33 |
| Spleen | 3 | 20 |
| Retroperitoneal hematoma | 2 | 13 |
| Pancreas | 1 | 7 |
| Total | 35 | 100 |

**Table 5. Organ injuries in operative findings of 34 patients.**

| Organ | Number |
|---|---|
| Liver | 10 |
| Spleen | 9 |
| Small bowel | 4 |
| Colon | 3 |
| Mesentery | 3 |
| Abdominal vessels | 2 |
| Bladder | 2 |
| Duodenum | 1 |
| Pancreas | 1 |
| Rectum | 1 |
| Kidney | 1 |
| Total | 36 Organs |

**Table 6. Extraabdominal organ injuries.**

| Organ | Number | % |
|---|---|---|
| Rib fractures | 29 | 22.5 |
| Head injuries | 28 | 21.7 |
| Pelvic fracture | 16 | 12.4 |
| Facial injuries | 13 | 10.1 |
| Pneumothorax | 13 | 10.1 |
| Hemothorax | 12 | 9.3 |
| Spine | 11 | 8.5 |
| Femoral fracture | 9 | 7 |
| Retroperitoneal injuries | 6 | 4.7 |
| Lung contusion | 4 | 3.1 |
| Blood vessels | 2 | 1.6 |
| Flail chest | 1 | 0.8 |
| Aorta | 1 | 0.8 |
| Larynx | 1 | 0.8 |
| Brachial plexus | 1 | 0.8 |
| Fracture of other extremities | 31 | 24 |
| Total | 178 organs | |

**Table 7. Intraabdominal organ injuries and FAST results.**

| Organ | FAST +ve | FAST -ve | Total |
|---|---|---|---|
| Liver | 6 | 10 | 16 |
| Spleen | 6 | 5 | 11 |
| Retroperitoneal hematoma | 4 | 2 | 6 |
| Kidney | 3 | 2 | 5 |
| Colon | 2 | 2 | 4 |
| Urinary bladder | 2 | 0 | 2 |
| Pancreas | 1 | 0 | 1 |
| Duodenum | 1 | 0 | 1 |
| Small bowel | 1 | 3 | 4 |
| Mesentery | 1 | 1 | 2 |

**Table 8. Results of FAST and presence of injury.**

| | With injury | Without injury | Total |
|---|---|---|---|
| Positive FAST | 25 | 3 | 28 |
| Negative FAST | 28 | 73 | 101 |
| Total | 53 | 76 | 129 |

$\chi^2 = 34.3$; $p < 0.001$

## DISCUSSION

Ultrasonography has decreased the time and expense used in the evaluation of patients with suspected blunt abdominal trauma. During the international consensus in 1997, it was recommended that a complete FAST examination consists of visualization of Morison's pouch (perihepatic), the perisplenic region, the pelvis (pouch of Douglas), and the pericardium[3]. The presence or absence of fluid in one or more of any of these regions was considered as a positive or negative, respectively. FAST is a clinically useful objective means of screening for hemoperitoneum.

Increasing numbers of surgeons are using FAST as the choice of diagnostic tool in the initial assessment of patients with blunt abdominal trauma. FAST has more advantages than other investigations such as CT and DPL in availability, noninvasiveness and rapid to detect hemoperitoneum. DPL has been proved to have a high sensitivity that may lead to an unnecessary laparotomy. Its disadvantages include invasiveness, and potential complications. CT is noninvasive and suitable for non-operative management. It is a time-consuming and expensive procedure appropriate for hemodynamically stable patients. It also contains risks of aspiration and renal failure by contrast media.

Whether performed by a radiologist or well-trained surgeon, FAST is a reliable test. Surgeon-performed sonography has comparable results to radiologist-performed sonography in Western countries. Rozycki[4] reported 97.5 per cent accuracy for surgeon-performed ultrasound comparable to 97.8 per cent accuracy for radiologist- performed ultrasound. But the result of FAST performed by a senior surgical resident, who is going to be a young surgeon, may not be equal. In our institution, third year surgical resident is in charge as a trauma team leader taking care of trauma patients for primary survey, resuscitation and secondary survey initially, including FAST.

The authors have used FAST as screening tool in patients with suspected intraabdominal injuries since 1999. The advantage of surgeon-performed ultrasound relates to the rapidity with which the examination can be performed and the integration of results into patient treatment decisions by the physicians who is responsible for the patients' care.

Unlike CT or DPL, ultrasound is an operator-dependent diagnostic investigation, and the result depends on the operator's competence. Although the teaching can be obtained from surgeon to resident, a number of sonograms for learning and practice may be necessary. Thomas reported the improvement of accuracy after 50 cases had been performed(5).

The sensitivity of FAST performed by the third year residents in the present study was 47.17 per cent, lower than previously published injury detection rates of 79-98 per cent(6-10) for ultrasounds done by radiologists, sonographers or surgeons. The difference in the sensitivity rate could be explained by the operators' experiences. However, the specificity of 96.05 per cent and the accuracy of 81.59 per cent are comparable to previous studies. Even performed by the residents, FAST was completed within the mean of 5 minutes and 45 seconds. This time consuming would be less if the operator gained more practice. Free fluid detected was most likely located in the perihepatic region (57.14%). It is well recognized that an ultrasound can detect fluid as little as 100 ml and the most likely area to discover free fluid is in the hepatorenal space(11), similar to the present study.

Although the false negative was as high as 52.83 per cent, the false positive rate was as low as 3.95 per cent. If the surgeon integrates the FAST result and the clinical manifestations, this information would be very useful. When FAST is positive, the patient may have a high possibility for intraabdominal injuries and may be taken to the operating room. But if FAST is negative, further diagnostic tools or close observation should be followed according to the patient's clinical status. The authors recommend further practice for surgical residents to improve the sensitivity and accuracy of FAST examination.

## SUMMARY

FAST performed by third year surgical residents for blunt abdominal trauma had a high specificity to detect hemoperitoneum. This diagnostic tool may be helpful for the decision making of further management. The need for more practice to improve sensitivity is recommended.

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# การศึกษาผลของอัลตราซาวด์แบบ FAST ทำโดยแพทย์ประจำบ้านศัลยกรรมในผู้ป่วยบาดเจ็บช่องท้อง

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เป็นการศึกษาแบบไปข้างหน้า (prospective study) ของการทำอัลตราซาวด์แบบ FAST (Focused Assessment with Sonography for Trauma) โดยแพทย์ประจำบ้านในผู้ป่วยบาดเจ็บช่องท้อง จำนวน 129 ราย ที่เข้ารับการรักษาที่โรงพยาบาลจุฬาลงกรณ์ ตั้งแต่เดือนพฤศจิกายน พ.ศ. 2543 ถึง เดือนพฤศจิกายน พ.ศ. 2545 มีผู้ป่วยหญิง 31 ราย (ร้อยละ 24) และผู้ป่วยชาย 76 ราย (ร้อยละ 76) อายุเฉลี่ย 34 ปี ค่า Injury Severity Score (ISS) เฉลี่ย 13.2 ผู้ป่วย 53 ราย มีการบาดเจ็บต่ออวัยวะในช่องท้อง ส่วนอีก 76 รายไม่พบการบาดเจ็บ ผลการตรวจอัลตราซาวด์พบว่าให้ผลบวก (positive) 28 ราย ผลลบ (negative) 101 ราย ในจำนวนนี้มีผลบวกลวง (false positive) 3 ราย มีค่า sensitivity ร้อยละ 47.17, specificity ร้อยละ 96.05 และ accuracy ร้อยละ 81.59 จากการศึกษานี้แสดงให้เห็นว่า การทำอัลตราซาวด์แบบ FAST ในผู้ป่วยที่ได้รับบาดเจ็บช่องท้อง หากให้ผลเป็นบวกบ่งถึงผู้ป่วยมีโอกาสสูงที่จะมีการบาดเจ็บในช่องท้อง แต่ถ้าผลเป็นลบอาจต้องสังเกตอาการโดยใกล้ชิดตัวหรือส่งตรวจพิเศษเพิ่มเติม และควรมีการฝึกฝนเพิ่มเติมเพิ่มประสิทธิภาพของการทำอัลตราซาวด์ของแพทย์ประจำบ้านให้มีความถูกต้องแม่นยำมากขึ้น

**คำสำคัญ** : อัลตราซาวด์, การบาดเจ็บช่องท้อง

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