ORIGINAL ARTICLE

Evaluation of focussed assessment with sonography in trauma (FAST) by UK emergency physicians

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Objectives: To evaluate the introduction of a focussed assessment with sonography in trauma (FAST) scan into the early assessment of trauma patients in the UK.
Methods: The setting was an inner city teaching hospital emergency department (annual attendance 100 000). All patients aged 16 or over admitted to the resuscitation room after blunt trauma were included in a prospective observational study. Patients had a FAST scan performed at the end of the primary survey. Results were compared to results of other investigations, laparotomy, postmortem examination, or observation.
Results: 153 patients were entered into the study. The sensitivity of the FAST scan was 78% and specificity was 99%.
Conclusion: FAST is a highly specific ''rule in'' technique and is useful in the initial assessment of trauma patients. Emergency physicians can perform FAST after a brief training period.

Ultrasound has been used in the early assessment of abdominal trauma in countries outside the United Kingdom for the past 30 years. Over the last 15 years increasing evidence of the utility of the technique has been published. However, although Chambers and Pilbrow published a report in 1988 on the use of ultrasound,[1] there has been little other evidence published from the UK. There is growing interest in ultrasound use by emergency physicians in this country with the increasing availability of affordable systems and Brooks *et al* have published a recent evaluation of the technique by a small group of sonographers among trauma staff.[2]

Emergency physician performed ultrasound is a focussed, limited technique to answer a single question. The purpose of ultrasound in the initial assessment of abdominal trauma is solely to document the presence of free intra-peritoneal fluid. In the context of trauma this is assumed to be blood. There is no attempt to visualise specific organ injuries as ultrasound is not accurate in the early assessment of solid organ or hollow viscus injury.[3] The absence of free fluid does not exclude serious intra-abdominal injury. Ultrasound has the advantage of being non-invasive, rapidly performed, and readily repeatable. Further management is dictated by the clinical condition of the patient. Ultrasound is designed to complement other investigations: diagnostic peritoneal lavage (DPL) is very sensitive, but not without disadvantages, while CT will remain the gold standard, but there is usually some delay in obtaining a scan and transfer out of the department necessitates a haemodynamically normal patient.

In this paper we have evaluated the introduction of the FAST (focussed assessment with sonography in trauma) protocol into the initial management of trauma patients in a UK emergency department.

METHODS

This was a prospective observational study. A four view FAST scan was performed at the end of the primary survey in all adult patients admitted as a result of blunt trauma to the resuscitation room in a large teaching hospital. The results of the scan were non-contributory to further management unless free fluid was seen in a patient who would otherwise have undergone no further investigations. Verbal or written consent was sought from the patient if possible. Ethical approval was obtained. A standardised report form was completed on each patient detailing clinical condition and mechanism of injury. The results of the FAST scan were compared to DPL, CT, laparotomy, or postmortem examination. If none of these were performed and the patient was discharged within 7 days, the general practitioner (GP) was contacted to confirm the absence of abdominal injury at 1 month following attendance. It was considered that if a significant intra-abdominal event had been missed the GP would have been informed. The revised trauma score (RTS), injury severity score (ISS), and probability of survival were calculated using the UK TARN website.

Training of emergency physician sonographers

Review of published literature shows that there is no agreed FAST training schedule with programmes varying widely from a 1 h lecture and 1 h practical training to over 500 supervised scans.[4–6] Shackford *et al* suggested that the error rate stabilised after 10 scans.[7] We developed a training programme which included two half day sessions of formal training including lectures and supervised practice on normal volunteers and simulated patients (continuous ambulatory peritoneal dialysis (CAPD) patients with free fluid). Participants were then required to perform 10 videoed scans on normal volunteers which were reviewed by an expert sonographer. Feedback was given on machine settings, image quality, and views obtained. Emergency physicians were then accredited to enter patients into the trial. The emergency physician sonographer was required to rate the quality of the views obtained as either good, poor, or inadequate for further interpretation and document the presence or absence of free fluid. FAST trial scans were videoed and a proportion were later reviewed by the expert sonographer.

Abbreviations: 95% CI, 95% confidence interval; DPL, diagnostic peritoneal lavage; FAST, focussed assessment with sonography in trauma; GP, general practitioner; ISS, injury severity score; RTA, road traffic accident; RTS, revised trauma score

Table 1 Mechanism of injury

Mechanism of injury	Patients, n (%)	Abnormal investigations, n (%*)
Assault	11 (7)	0 (0)
Fall <2 m	13 (9)	0 (0)
Fall >2 m	24 (16)	3 (12)
RTA, driver	31 (21)	5 (16)
RTA, front seat passenger	10 (7)	4 (40)
Motorbike rider	11 (7)	2 (18)
Cyclist	6 (4)	0 (0)
RTA, pedestrian	35 (23)	4 (11)
RTA, rear seat passenger	2 (1)	1 (50)
Others	6 (4)	0 (0)

*Percentage of patients in that group with abnormal abdominal investigations.
The average probability of survival was 0.89, average revised trauma score (RTS) was 7.09, and average injury severity score (ISS) was 13 (range 0–75). RTA, road traffic accident.

RESULTS

Demographics

Over a 2 year period 153 patients were entered into the trial. The age range was 16–89 years. The mechanism of injury was classified as in table 1. It will be seen that there are some patients for whom data collection was not complete as demographic and some clinical details were missed. The following tables show the mechanisms of injury and clinical examination features compared to any abdominal abnormality on the gold standard investigations; not all of these had free intra-peritoneal fluid (that is, would not be diagnosed on FAST scanning).

The abdominal findings on clinical examination are shown in table 2.

Scans

The average number of scans per emergency physician sonographer was eight (range 1–21). The median scan time was 5 min.

In 71 patients all views were rated by the emergency physician sonographer as good. Table 3 shows the emergency physician sonographers' rating of the quality of each view.

In 39 patients adverse factors affecting the performance of the scan were noted (table 4).

Although the expert sonographer reviewed the scans as generally of lesser quality than the rating given by the emergency physician sonographer, there were no scans where the diagnosis was disputed.

Abdominal diagnosis

Eight of the 153 patients had a positive FAST scan. In all of these patients free fluid was seen in the right upper quadrant. No patients had free fluid on other views without fluid being visible in the right upper quadrant. Three cases had fluid also visible on other views: in one case fluid was visible on the pericardial view only and in the other two cases fluid was seen in both the left upper quadrant and the pelvis. Of these eight patients, six had abnormal findings on clinical examination. One patient had a normal initial scan and free fluid was seen in the right upper quadrant when this was repeated. The gold standard used was CT in 35% of patients, laparotomy in 8%, observation in 66% (the GP was contacted in 60 cases, while the remainder were observed in hospital or had out patient follow up), and postmortem examination in 4%; in one case we were unable to contact the patient's GP.

There were three disagreements with the gold standard:

- One patient with apparent free fluid on ultrasound had a normal abdominal CT scan (sixth scan in the trial by this emergency physician sonographer).
- One patient with a normal FAST scan had a ruptured kidney and ruptured spleen at laparotomy (eighth scan by this emergency physician sonographer).
- One patient with no free fluid on ultrasound had a tear of the IVC junction, avulsion of the splenic tip, mesenteric contusion, a laceration, and subcapsular haematoma of the liver (fourth scan by this emergency physician sonographer).

In the last two patients above, there was no specific mention of free fluid on the laparotomy report.

Thus, the sensitivity of FAST is 78% (95% confidence interval (95% CI) 71% to 85%) and specificity is 99% (95% CI 97% to 100%) (table 5). The likelihood ratio is 78 for a positive result and 0.22 for a negative result.

Table 2 Abdominal examination findings

Abdominal examination	Number of patients	Number with abnormality on other investigations*
Normal	77 (53%)	3 (4%)
Abnormal†	69 (47%)	16 (23%)

*Percentage of patients in each group who have any abnormality on gold standard investigation; †includes abrasion, bruising, tenderness, rigidity, or a combination.

Table 3 Emergency physician sonographers' rating of scan view quality

View	Good	Poor	Inadequate for interpretation
Right upper quadrant	89%	9%	2%
Left upper quadrant	72%	21%	7%
Pelvic	88%	7%	5%
Pericardial	78%	17%	5%

Table 4 Adverse factors

	Number of patients
Obesity	19
Bowel gas	4
Scars	3
Skeletal	4
Uncooperative	6
Pregnant/pelvic mass	2
Other (not further specified)	1

DISCUSSION

In this study the specificity of 99% shows the appropriateness of the FAST scan as a ''rule in'' technique. The sensitivity is only 78%, but this may be influenced by the fact that the scan was performed early in the course of resuscitation and the trial protocol did not mandate a repeat scan. There is also no

Table 5 FAST results compared with other investigations

	Other investigation positive for free intra-peritoneal fluid	Other investigations negative for free intra-peritoneal fluid
FAST positive	7	1
FAST negative	2	143

specific mention in the theatre notes of the patients with false negative scans of the presence or absence of free fluid at laparotomy. It is well known that ultrasound is not accurate in the early assessment of solid organ injury[3]; however, the early recognition of free intraperitoneal fluid in these patients is helpful in expediting further management decisions. In previously published studies the sensitivity of FAST ranges from 75% to 100% and specificity from 88% to 100%.[1 8–16] In practice FAST is readily repeatable and if there is suspicion of intra-abdominal injury a repeat scan is advised.

There were a number of difficulties with the trial protocol. At the start of the trial the scan was performed by a suitably trained emergency physician who was not otherwise involved in the resuscitation of the patient. As the trial progressed it was often difficult to find a doctor available to scan because of the workload within the department. It also proved impossible to blind members of the trauma team to the results of the scan. In view of these problems it was decided to allow the team leader to act as sonographer. Results were still non-contributory to management.

The protocol called for the inclusion of all adult patients admitted to the resuscitation area as a result of blunt trauma. We knew that this would inevitably mean we were including patients who were at little risk of significant intra-abdominal injury, and the prevalence of intra-abdominal injury in the patients included reflects this. At the start of the trial, it was unclear how we could reliably identify patients at risk of abdominal injury purely on the basis of presentation. It was also felt that by scanning all resuscitation room trauma patients, staff would become familiar with the protocol and technique, and therefore avoid missing significant injuries. However, we only managed to recruit a proportion of eligible patients; this was due in part to the workload in the department and the perception that recruitment would be time consuming. As with all trials there are enthusiasts and sceptics and despite encouragement a number of patients were not included in the trial for unknown reasons. We have no reason to suspect this was a selected group of patients; although it may be surmised that some sonographers did not enter patients who were clearly sick and needed urgent treatment because of the perceived additional work of a ''study'', others may not have entered patients less severely injured that they thought were unlikely to have significant intra-abdominal injuries. Only a proportion of the patient scans were reviewed by expert sonographers as there were intermittent technical difficulties with the video equipment. This proportion was not selected in any way. All scans that were not videoed were printed and reviewed by more experienced emergency physician sonographers.

There was variation in the number of scans undertaken by individual emergency physician sonographers. This was partly due to individual enthusiasm for the technique. Some emergency physician sonographers were rotational staff who were absent from the department for up to a year during the study period. There is no evidence from our data to suggest that there was significant skill attrition during this time.

Since the start of the trial much work has been done to define an appropriate training schedule for emergency physician sonographers both in this country and abroad. Our training programme was fairly brief and this may explain the low sensitivity of the results.

This trial was designed to evaluate the accuracy of the FAST technique performed by emergency physician sonographers. The results did not alter management (unless free fluid was seen in a patient who would otherwise have had no further investigations). A larger study would be needed to evaluate the effect on patient management and outcome.

CONCLUSIONS

Emergency physicians, after a short training programme, can use FAST in the early assessment of trauma patients with sufficient specificity. We recommend the use of the technique as a ''rule in'' procedure to expedite surgical decision making. Emergency physicians should have formalised and accredited training in order to undertake this technique.

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REFERENCES

1 **Chambers JA**, Pilbrow WJ. Ultrasound in abdominal trauma: an alternative to peritoneal lavage. *Arch Emerg Med* 1988;**5**:26–33.
2 **Brooks A**, Davies B, Smethhurst M, *et al.* Prospective evaluation of non-radiologist performed emergency abdominal ultrasound for haemoperitoneum. *Emerg Med J* 2004;**21**:580–1.
3 **Yoshii H**, Sato M, Yamamoto S, *et al.* Usefulness and limitation of ultrasonography in the initial evaluation of blunt abdominal trauma. *J Trauma* 1998;**45**(1):45–51.
4 **Ingeman JE**, Plewa MC, Okasinski RE, *et al.* Emergency physician use of ultrasonography in blunt abdominal trauma. *Acad Emerg Med* 1996;**3**(10):931–7.
5 **Glaser K**, Tschmelitsch J, Klingler P, *et al.* Ultrasonography in the management of blunt abdominal and thoracic trauma. *Arch Surg* 1994;**129**:743–7.
6 **Tso P**, Rodriguez A, Cooper C, *et al.* Sonography in blunt abdominal trauma: a preliminary progress report. *J Trauma* 1992;**33**:39–44.
7 **Shackford SR**, Rogers FB, Osler TM, *et al.* Focussed abdominal sonogram for trauma: the learning curve of nonradiologist clinicians in detecting hemoperitoneum. *J Trauma* 1999;**46**(4):553–62.
8 **Bode PJ**, Niezen RA, van Vugt AB, *et al.* Abdominal ultrasound as a reliable indicator for conclusive laparotomy in blunt abdominal trauma. *J Trauma* 1993;**34**(1):27–31.
9 **Rozycki GS**, Ochsner MG, Schmidt JA, *et al.* A prospective study of surgeon-performed ultrasound as the primary adjuvant modality for injured patient assessment. *J Trauma* 1995;**39**(3):492–8.
10 **Frezza EE**, Ferone T, Martin M. Surgical residents and ultrasound technician accuracy and cost-effectiveness of ultrasound in trauma. *Am Surg* 1999;**65**:289–91.
11 **McKenney M**, Lentz K, Nunez D, *et al.* Can ultrasound replace diagnostic peritoneal lavage in the assessment of blunt abdominal trauma? *J Trauma* 1994;**37**(3):439–41.
12 **Rothlin MA**, Naf R, Amgwerd M, *et al.* Ultrasound in blunt abdominal and thoracic trauma. *J Trauma* 1993;**34**(4):488–95.
13 **Ma OJ**, Mateer JR, Ogata M, *et al.* Prospective analysis of a rapid trauma ultrasound examination performed by emergency physicians. *J Trauma* 1995;**38**(6):879–85.
14 **Jehle D**, Guarino J, Karamanoukian H. Emergency department ultrasound in the evaluation of blunt abdominal trauma. *Am J Emerg Med* 1993;**11**(4):342–6.
15 **McElveen TS**, Collin GR. The role of ultrasonography in blunt abdominal trauma: a prospective study. *Am Surg* 1997;**63**:184–8.
16 **McKenney MG**, Martin L, Lentz K, *et al.* 1,000 consecutive ultrasounds for blunt abdominal trauma. *J Trauma* 1996;**40**(4):607–12.