FAST as a predictor of clinical outcome in blunt abdominal trauma

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Abstract

Background. Peer-reviewed literature demonstrates increasing support for the use of focused abdominal sonography in trauma (FAST) in the setting of blunt trauma, one study demonstrating the sensitivity and specificity of FAST for the detection of free fluid to be 0.64 - 0.98 and 0.86 - 1.00, respectively, compared with abdominal CT. Utilising ultrasound in trauma triage increases efficiency and cost-effectiveness and reduces reliance on CT, compared with using CT alone. There is little evidence to support relying solely on a negative FAST and physical examination for patient management.

Method. A retrospective descriptive study of 172 adult patients who received FAST for the evaluation of blunt abdominal trauma between 22 July 2007 and 21 January 2008 at Tygerberg Hospital was performed. Ultrasound findings were correlated with CT scan findings, operative findings if managed surgically, clinical outcomes whether managed surgically or conservatively, as well as postmortem findings in deceased patients.

Results. FAST was negative in 147 (85.5%) patients. Twenty-four (16.3%) of these patients died from all-cause mortality, none of which was due to intra-abdominal injury.

Seven patients with negative FAST underwent CT scan owing to change in clinical course, and 3 patients with negative FAST underwent laparotomy owing to change in clinical course, with positive findings in 2 patients – a bowel injury requiring resection (not seen on CT) and a diaphragmatic rupture seen on CXR. A negative FAST was shown to be an excellent predictor for the absence of significant intra-abdominal trauma.

The mortality rate among 25 FAST positive patients was 24% (*N*=6). Only one of these patients (with a splenic rupture) was suspected to have died from abdominal pathology.

Introduction

Peer-reviewed literature demonstrates an increasing trend of support for focused abdominal sonography for trauma (FAST) in the setting of blunt trauma. It is used as the initial screening tool to detect the presence of intra-abdominal free fluid and to indirectly confirm abdominal injury as the source of haemorrhage in haemodynamically unstable patients who would then require emergency laparotomy before further time is spent on imaging. Previous studies have demonstrated the sensitivity and specificity of FAST for the detection of free fluid to be 0.64 - 0.98 and 0.86 - 1.00, respectively, compared with abdominal computed tomography (CT).[1] Some authors in fact argue that FAST is more sensitive than CT for free fluid.[2] Randomised controlled trials now show that triage pathways incorporating ultrasonography result in increased efficiency, cost-effective evaluation and reduced reliance on CT, compared with pathways that exclusively utilise CT.[3-6] However, there is much less evidence to support sole reliance on a negative FAST scan and physical examination for patient management.[7,8]

Haemodynamically stable, negative FAST patients routinely receive CT scans out of literature-based concern that ultrasonography may miss solid organ injury. The sensitivity of ultrasonography for solid organ injury ranges from 0.4 - 0.8, even after the administration of intravenous contrast agent.[9] Despite evidence that the missed solid organ injuries are not clinically significant, or would be detected during observation without incurred morbidity, much of the trauma community maintains the necessity of routine whole-body CT imaging, even without obvious signs of injury.[10] Attributable factors include over-investigation by clinicians motivated by a fear of litigation, institutional financial gain from CT scanning, and patient demand for advanced imaging to rule out injury.

Routine whole-body CT imaging is costly and exposes millions of patients to ionising radiation that could have immediate and long-term consequences, including the development of fatal cancers. CT has become central to the evaluation of trauma, with improvements in speed and resolution leading to lower thresholds for the use of CT.[11,12] According to the report by the National Council on Radiation Protection and Measurements (NCRP) on population exposure, Americans were exposed to more than seven times as much ionising radiation from medical procedures in 2006 as was the case in the early 1980s, with CT and nuclear medicine studies being the most significant contributors, with the effective radiation dose from all sources per individual in the USA population nearly doubling from 3.6 to 6.2 millisievert (mSv) over this period.[13]

Longstanding controversy exists about the level of carcinogenic risk attributable to low-level ionising radiation.[14] The seventh Biologic Effects of Ionizing Radiation report (BEIR VII) predicts that, for a standardised US population, an average lifetime attributable risk exists of one radiation-induced cancer per 1 000 patients receiving a 10mSv effective dose (average abdominal CT), with approximately half of these cancers expected to be fatal.[15] The number of CT scans performed in the US increased from 3.6 million in 1980 to 67 million in 2006.

Studies have demonstrated a significant cancer risk to the pelvic and abdominal organs as a result of trauma whole-body imaging, although the risk-benefit is yet unclear. In addition, CT is a much more expensive investment than ultrasound – a notable factor in countries with limited resources. It is important, both from a clinical and cost-effectiveness perspective, to not only establish the utility of ultrasound, but also to demonstrate when CT incurs risk and expense without compensatory benefit in patient outcomes.

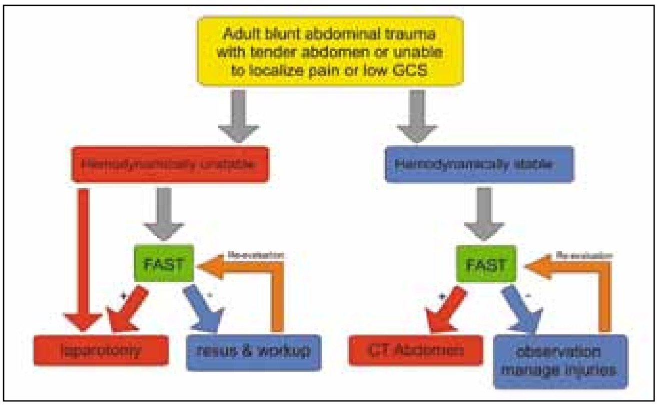

Fig. 1. Diagram showing triage pathways for patients with blunt abdominal trauma. Patients with stable vital signs and no sign of intra-abdominal injury underwent serial FAST and physical examination without undergoing CT. Patients with positive FAST scans received CT if they remained haemodynamically stable. At any point in the triage pathway, unstable patients underwent immediate exploratory laparotomy.

This is a preliminary investigation of a triage pathway that relies on the FAST exam to rule out the need for further imaging or intervention. It establishes, in a retrospective manner, that this triage pathway accurately predicts good clinical outcome without CT.

Methods

A retrospective study was done of 172 patients receiving FAST for blunt abdominal trauma at Tygerberg Hospital, the academic tertiary referral centre of Stellenbosch University. Tygerberg Hospital is the second-largest hospital in South Africa, with 22 500 trauma cases per year. The Trauma (Emergency) Department is staffed by full-time medical officers, with urgent referrals available 24 hours a day to in-house radiology residents for ultrasonagraphy and CT, and a general surgery trauma service for operative intervention. Patients requiring urgent CT are prioritised and scanned promptly.

Emergency medicine is a nascent specialty in South Africa, with formal recognition in 2003 and the first residency programme established in 2004. Residents in emergency medicine rotate among various services at the Universities of Cape Town and Stellenbosch, but were not an integral part of the current study.

All patients from the Trauma (Emergency) Department between 22 July 2007 and 21 January 2008 who received a FAST scan as part of the triage protocol were retrospectively enrolled in the study by utilising the ultrasound request forms submitted by Trauma Department personnel. Patients sustaining blunt abdominal trauma are evaluated using a diagnostic tree (Fig. 1), designed to triage the use of CT to those who would obtain the most clinical benefit, based on peer-reviewed literature.[1] Patients with blunt abdominal trauma, stable vital signs and no obvious injury underwent serial FAST and physical examinations for 24 hours without undergoing CT. Patients with positive FAST scans received a contrasted CT of the abdomen as long as they remained haemodynamically stable,to identify injuries which would require surgical management. At any point in the triage pathway, unstable patients underwent immediate exploratory laparotomy.

Inclusion criteria included patients who were 18 years and older who suffered blunt abdominal trauma and received a FAST scan within 24 hours of presentation. Charts were reviewed for operative findings, CT findings and patient outcome, including postmortem data. Patients were excluded if chart review, including patient outcome, could not be completed. Institutional approval was obtained from Stellenbosch University's Committee for Human Research.

The primary outcome in this investigation was safe discharge or transfer without mortality or morbidity attributable to abdominal pathology. Secondary outcomes included need for laparotomy, surgical findings and CT findings.

Patients enrolled by ultrasound request forms were recorded by medical record number into a Microsoft Excel spreadsheet that was matched to locate patient charts and record outcome data. These results were then provided to the primary author, who analysed the outcome information and categorised patients' morbidity and mortality according to aetiology.

Results

A total of 172 patients met inclusion criteria during the selection period. The predominant population involved was young males, with 131 (76%) male and 41 (24%) female patients. There were 118 (68.6%) patients between the ages of 20 and 39. Racial characteristics and socio-economic status were not recorded.

Results are presented in Fig. 2. The FAST exam was negative in 147 (85.5%) patients. Twenty-four (16.3%) of these patients died from all-cause mortality. The cause of death was neurological in 18 patients (intracranial injury), infectious in 4 patients (hospital-acquired pneumonia etc.), orthopaedic in 1 patient (pelvic fractures) and unclear in 1 patient, who underwent a postmortem examination that showed no abdominal organ injury or free fluid within the abdomen. Seven patients (4.8%) with negative FAST received a CT scan owing to change in clinical course. Two of these patients had CT findings, namely a splenic contusion and a kidney laceration, neither requiring surgical repair. Three patients with negative FAST underwent laparotomy owing to a change in clinical course with positive findings in 2 patients, i.e. a bowel injury requiring resection that was not detected on CT, and a diaphragmatic rupture seen on chest X-ray with no other operative abdominal findings.

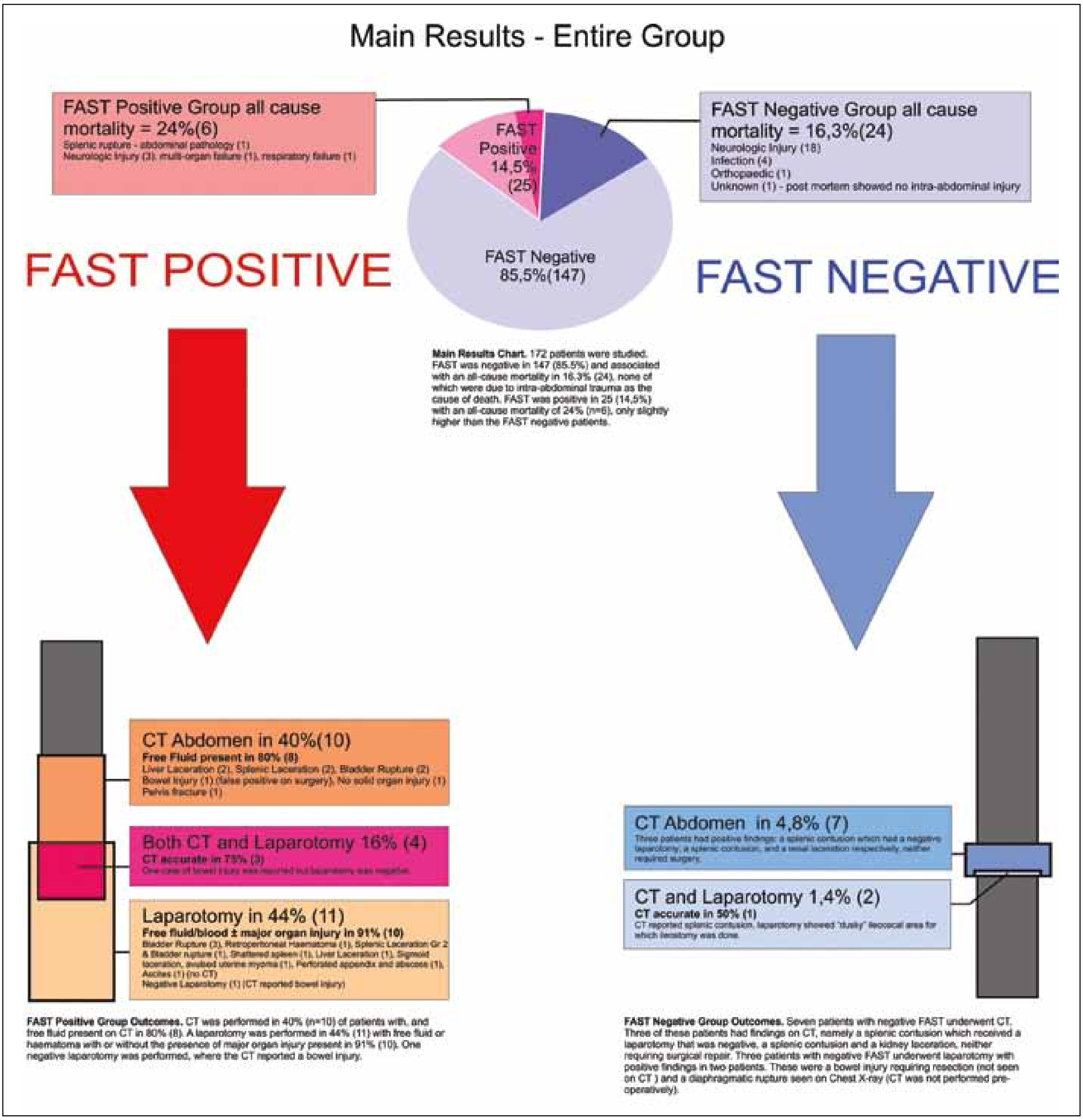

Fig. 2. Main results for the whole group, and breakdown for FAST-positive and -negative clinical outcomes.

The mortality rate among 25 FAST positive patients was 24% (N=6), only slightly higher than the FAST-negative patients. Fig. 3a shows a FAST-positive ultrasound, with Fig. 3b as a comparison of a FAST-negative ultrasound. One of the FAST-positive patients sustaining a splenic rupture was suspected to have died from abdominal trauma. Three patients died due to neurological injury – one from multi-organ failure, and one from respiratory failure. Eleven patients (44%) underwent laparotomy, which showed free fluid with or without major organ trauma in 91%, and a negative laparotomy in one patient where CT had indicated a bowel injury. Ten patients (40%) received a CT scan which reported free fluid in 80% with or without the presence of major organ trauma. Ten patients (40%) receiving CT underwent laparotomy with one negative laparotomy performed for a CT report of bowel injury.

Discussion

Our study demonstrates that the algorithm for managing blunt abdominal trauma according to current evidence (as shown in Fig. 1) at Tygerberg Hospital is safe and effective, with the appropriate use of CT as indicated by FAST and clinical parameters. CT of the abdomen was not performed routinely for FAST-negative patients who showed no clinical sign of intra-abdominal trauma, which suggests that

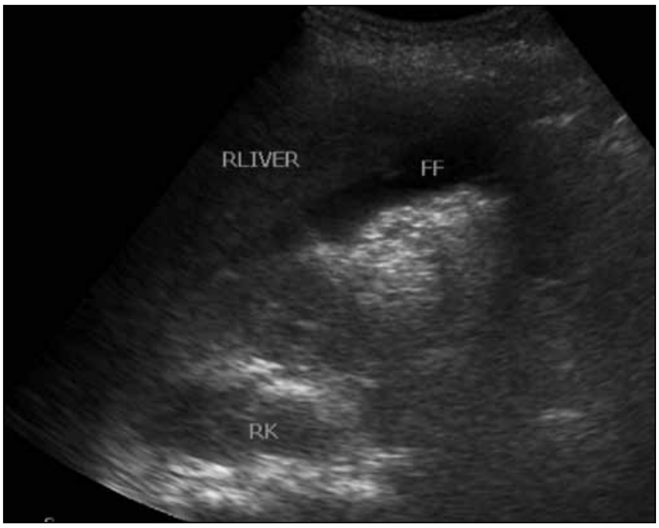

Fig. 3a. Positive FAST in a 31-year-old male patient involved in a pedestrian-motor vehicle accident shows free fluid in the hepatorenal recess (RLIVER=right liver lobe, FF=free fluid, RK=right kidney).

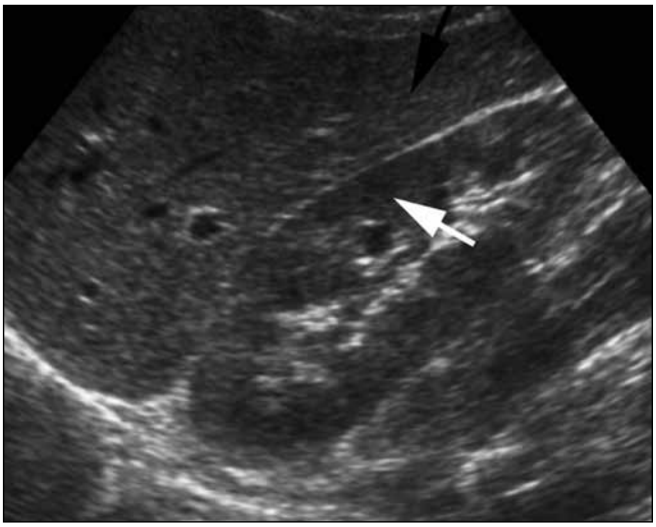

Fig. 3b. Ultrasound for comparison of a normal hepatorenal recess (Morrison's Pouch) demonstrating the absence of free fluid between the right liver lobe (black arrow) and right kidney (white arrow).

performing CT in this group would incur unnecessary cost and risk from ionising radiation, while showing no benefit to the patient.

A negative FAST scan was an excellent predictor of the absence of significant intra-abdominal injury. While the mortality rates of patients in the FAST-negative group was disconcertingly high, the cause of death, after thorough chart review, was not attributable to missed injury. Two missed injuries that were found on CT (i.e. a splenic contusion and a minor renal laceration) did not require operative intervention and were successfully managed conservatively. There were 2 injuries in the FAST-negative group that received a laparotomy: a bowel injury that was missed on CT and a diaphragmatic hernia that was found on screening chest radiography. These injuries must be kept in the differential for any patient who sustains blunt abdominal trauma, but do not obviate the triage algorithm in question.

CT showed the presence of free fluid in 80% of FAST-positive patients, with free fluid or blood in the peritoneal cavity found at laparotomy in 91% of FAST-positive patients, confirming the superior sensitivity of ultrasound to CT for detecting the presence of free fluid.

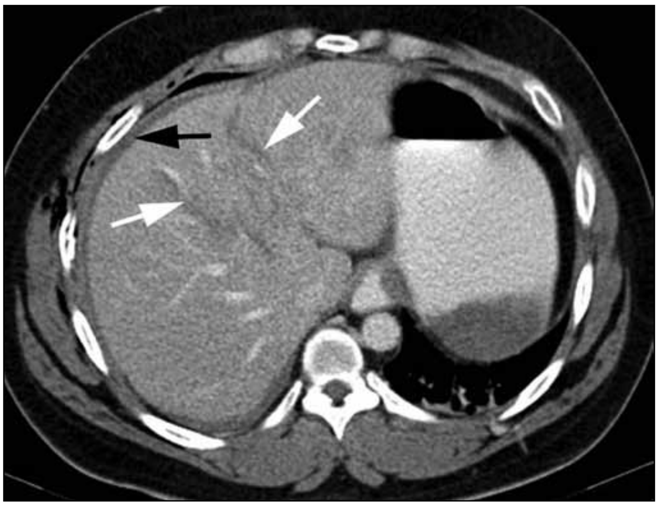

Fig. 4. Axial CT of the abdomen at the level of the superior liver segments, in the same patient whose images appear in Fig. 3, shows a grade IV liver laceration (white arrows) with free fluid surrounding the liver.

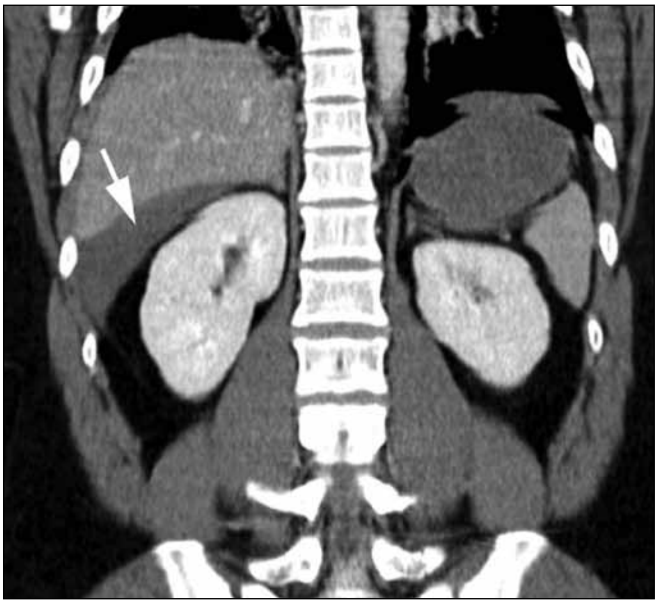

Fig. 5. CT oblique coronal reformat of the same patient whose images appear in Figs 3 and 4 shows free fluid in the hepatorenal recess (white arrow) with free fluid surrounding the liver.

Limitations

The study has several limitations that limit the generalisability of the findings: (*i*) it is a retrospective analysis. Many of the traditional biases incurred by retrospective analyses are therefore applicable here; (*ii*) the study was developed without strict guidelines of how to categorise outcome. The process of categorising the cause of mortality did not utilise predetermined criteria, which limits its scientific validity. In addition, the chart review process and the morbidity/mortality attribution process was performed by separate authors; (*iii*) the study was designed and carried out within the span of a month in a country with numerous logistical, cultural and language barriers. While various omissions were included at a later point via email communication with on-site personnel, this also incurred limitations; (*iv*) patients were not followed up after discharge or transfer to determine if any missed injuries presented at a later stage.

Future direction

This study should be repeated in a prospective, randomised manner, where the control group is triaged according to current protocol and an intervention group receives abdominal CT. In that way, one could determine which injuries are missed according to the current protocol, and if locating these injuries would improve patient outcome. The triage pathway needs to be more rigorously delineated, information collected more objectively, and outcome groupings given standard definitions. In addition, patients should be contacted at a defined, future point and interviewed using a systematic questionnaire to provide delayed outcome information.

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