ORIGINAL ARTICLE

ROLE OF ABDOMINAL ULTRASOUND IN TRAUMA PATIENTS

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PJR July - September 2011; 21(3): 97-101

ABSTRACT

BACKGROUND: To evaluate sensitivity, specificity, feasibility and accuracy of ultrasound in detecting hemoperitoneum in blunt trauma patients. **DESIGN:** A prospective and descriptive study. **PLACE AND DURATION OF STUDY:** Radiology Department, Aga Khan University Hospital, Karachi from 1st Nov 2008 to 30th March 2009. **SUBJECTS AND METHODS:** All victims of blunt abdominal trauma presenting to emergency room of Aga Khan University Hospital over the age of fifteen years were included in the study. Patients were excluded if a bedside ultrasound examination was not completed or expired in the early period before CT or other imaging examinations could be done or if injuries were not confirmed by laparotomy or autopsy. **RESULTS:** Out of the 148 adult patients, 115 were males and 33 females. Presenting age ranged from 16 to 74 years. There were 15 true positive and 131 true negative results. One case was false positive and 1 false negative. Sensitivity was 93.75%, specificity 99.24%, accuracy 98.64%, positive predictive value 93.75% and negative predictive value 99.29%. **CONCLUSION:** Ultrasound is safe, cost effective, sensitive, specific and accurate in detecting hemoperitoneum in patients with blunt abdominal trauma.
Key words: FAST (Focused ultrasound for assessment of trauma), Blunt trauma abdomen, Hemoperitoneum.

Introduction

Patients with blunt abdominal trauma undergoing clinical evaluation have equivocal features in 45% of patients.[1,2] Diagnostic peritoneal lavage (DPL) was described by Root et al[1] in 1965. This was required as the clinical examination and was not considered reliable for making management decisions. Diagnostic peritoneal lavage despite being a highly sensitive examination for haemoperitoneum has been supplanted by Focused Abdominal Sonography for Trauma (FAST). In 1982, Federle et al[2] concluded that CT was highly sensitive and specific in the evaluation of intraperitoneal and retroperitoneal injuries. However DPL and CT have certain problems limiting practicality of being employed. DPL is limited due to being invasive, having complications, and inability to determine the extent of hemoperitoneum. The severity of abdominal injuries cannot be evaluated. CT has limitations of time consumed in scanning, exposure to radiation and contrast reactions. The hemodynamic unstable patients management is delayed and expense is another issue.

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Sonography is a diagnostic modality of great value in trauma. Studies in our country have shown that ultrasound role in blunt abdominal trauma is significant.[3,4] The acronym FAST (focused assessment with sonography for trauma) was selected at the 1997 International Consensus Conference to name the diagnostic ultrasound scan performed during the initial assessment of trauma patients.[5] FAST has advantages of being safe, rapid, inexpensive, noninvasive and portable. It is increasingly being employed in cases of blunt abdominal injury at the trauma centers in North America.[6] There is a method for quantifying the fluid visualized on focused assessment with sonography for trauma (FAST). A simple scoring system correlates very well with the indication for subsequent laparotomy in adults. A score of 3 or greater is considered very accurate in predicting the requirement of laparotomy.

The purpose of this study is to evaluate sensitivity, specificity, feasibility and accuracy of ultrasound in detecting hemoperitoneum.

Patients and Methods

This study was conducted at the Emergency Room (ER) of the Aga Khan University Hospital from 1st Nov. 2008 to 30th March 2009. Its Emergency Room is a level two-trauma center and it receives all kinds of emergencies with established services of surgery, orthopedics, pediatric surgery, neurosurgery, urology and cardiothoracic surgery. According to our trauma protocol all patients meeting the trauma rush call criteria would essentially get three basic X-rays which include a chest, pelvis and cervical spine X-ray. Then they are further investigated according to their type of injuries.

We included all victims of blunt abdominal trauma presenting to emergency room of Aga Khan University Hospital over the age of fifteen years, meeting the trauma rush call criteria. Patients with neurological injuries like head injury and high spinal injuries, where abdomen cannot be evaluated by a simple clinical examination were also included. We also included patients, which required abdominal clearance prior to other procedures like orthopedic bone fixations etc.

For analysis of the use of ultrasound, patients were excluded if a bedside ultrasound examination was not completed. All patients who expired in the early period before CT or other imaging examinations could be done or if injuries were not confirmed by laparotomy or autopsy were excluded from the study. We also excluded those patients who have been transferred from other hospital with prior diagnostic work up.

Our hospital has developed a detailed blunt abdominal trauma management algorithm (Fig.1) and all the trauma patients were managed according to this algorithm. This algorithm was developed in accordance to international consensus conference on FAST. According to this protocol all patients who were included in the study had a quick primary and secondary trauma survey followed by a Focused abdominal sonographic assessment for hemoperitoneum. Then depending on the findings of ultrasound, patients were divided into three different groups

- Patients with the negative FAST examination
- Patients with the positive FAST examination
- Patients with the indeterminate FAST examination

After the FAST examination all patients were managed according to their vital stability. FAST was repeated whenever it was felt necessary during the subsequent stay of the patient in the hospital. Patients who were stable and had negative ultrasound abdomen were admitted in the wards for 24 to 48 hours observation. Ultrasound abdomen was repeated in patients who were unstable and their initial ultrasound was negative. Patients who were unstable and their FAST was positive for the free fluid in the abdomen were directly taken to the OR for laparotomy. Stable patients with positive FAST were subsequently evaluated with CT scan abdomen.

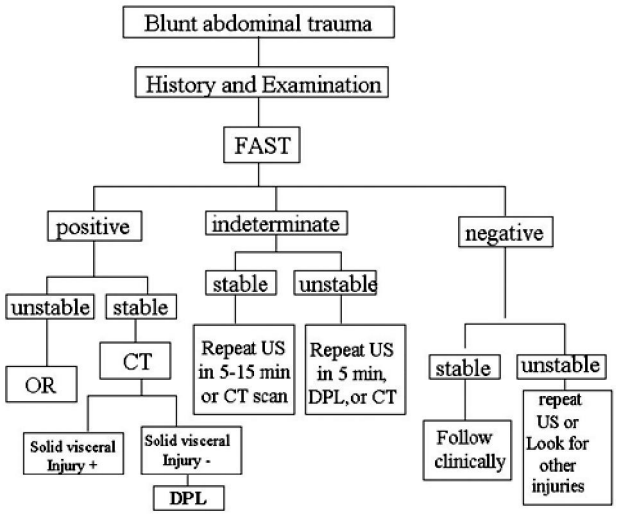

Figure 1: Algorithm used for managing blunt abdominal trauma victims

Most of the times FAST was performed by senior on call radiology resident. Nemio (Toshiba) ultrasound machine was used for diagnosing hemoperitoneum. Objective was to evaluate presence of free fluid in three dependant abdominal areas Morrison's pouch, splenorenal recess and pelvis. Presence of the free fluid on ultrasound in any of these areas was labeled as positive FAST examination and similarly absence of the free fluid is labeled as negative FAST examination (Fig.2). And whenever radiologist was in doubt, that ultrasound was labeled as indeterminate.

All patients in the study having positive FAST were confirmed to have intra-peritoneal free fluid by subsequent laprotomy or diagnostic imaging techniques such as CT, or repeat US. If the findings were tallying with each other i.e. if the patient had free fluid on initial ultrasound and follow up CT, ultrasound or laprotomy further confirmed the presence of free intraperitoneal fluid then such patient was taken as true positive.

True negative patients were also confirmed not to have free intra-peritoneal fluid by imaging techniques or clinical observation i.e. all those patients who were

labeled as FAST negative were subsequently evaluated clinically or by subsequent CT or ultrasound. If CT or follow up ultrasound failed to show any free intraperitoneal fluid then such patients were taken as true negative patients. Clinical evaluation included complete monitoring of the patient in ER or ward for at least 24 hours. If the patient was stable and initial ultrasound was negative for free fluid such a patient was taken as true negative patient.

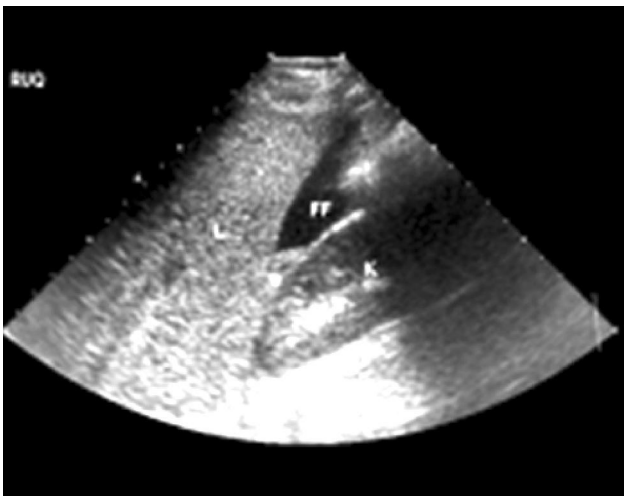

Figure 2 : Ultrasound showing free fluid in Morrison's Pouch. L-Liver, FF-Free Fluid, K-Kidney.

Results

Total number of patients studied was 154 and out of these 6 patients were excluded from the study. Out of the 148 adult patients, 115 were males and 33 females. Presenting age ranged from 16 to 74 years. One hundred and twelve patients were victims of road traffic accidents and 22 had falls from heights, both at work place and homes. Fourteen patients had other mechanisms of injury like physical assault. Time duration between the injury and presentation to hospital was variable, and a majority of patients were initially managed at nearby hospitals and then referred to AKUH. Thirty seven patients came to Aga Khan University Hospital directly. A majority (n=117) of our patients reached the emergency room within six hours of injury, while 31 patients came later then six hours. Six patients arrived after 20 hours of the initial injury. One hundred and thirty one patients were either vitally stable or they became vitally stable within 10 to 20 minutes of initial resuscitation. 17 of our patients remained vitally unstable in spite of this initial standard resuscitation.

A total of 132 patients had a negative FAST examination. Out of these 108 patients were vitally stable in the emergency room, so these patients were admitted to the ward and managed according to their associated injuries. All of these patients were followed till their discharge. Average hospital stay was 30.5 hours ranging between 24-48 hours. No clinically significant abdominal injury was detected in these patients during their stay in hospital.

Twenty four patients with negative FAST examination were found to be vitally unstable in the emergency room. All of these patients had significant associated injuries, which were the cause of vital instability. FAST examination was repeated in 4 patients and found negative. The average hospital stay in these patients was 11 days ranging between 3 days to 24 days.

In one patient, CT performed after five hours showed mild to moderate hemoperitoneum and laceration in tail of pancreas. So this case was false negative.

Sixteen patients had positive FAST examinations. The average hospital stay of these positive FAST cases was 6 days with a range of 3 days to 16 days. These patients underwent CT abdomen afterwards and 2 patients had liver and 4 patients had splenic injury. Three patients had minimal free fluid in the pelvic cavity on CT scan but did not have any evidence of viscus injury.

Two patients had intraperitoneal rupture of bladder. Initial CT showed hemoperitoneum without any evidence of solid visceral injury. Patients were managed accordingly and bladder repair was carried out surgically.

Four patients were directly taken to operating room after initial FAST examination because they were vitally unstable. Hemoperitoneum was found on laprotomy in all 4 patients.

CT of One patient did not reveal any intraperitoneal fluid and the scan was normal.

Out of 148 patients there were 15 true positive and 131 true negative results. One case was false positive and 1 false negative. Sensitivity was 93.75%, specificity 99.24%, accuracy 98.64%, positive predictive value 93.75% and negative predictive value99.29%.

Disucssion

FAST is a procedure that is safe, radiation free, economical as well as available as a portable imaging.[5] Ultrasound has been used for the evaluation of

trauma patients for thirty years to screen for possibility of splenic rupture. In 1976, Asher and colleagues screened patients for suspected splenic rupture.[6] Halbfass et al detected ihemoperitoneum accurately in 25 of 25 patients and parenchymal abnormalities in 22 of 25 patient.[7] In a prospective study of 103 patients presenting with blunt abdominal trauma Strittmatter et al had 95.5% sensitivity and 97.5% specificity rates.[8] During 1997 international consensus conference, it was recommended that a complete FAST examination consist of visualization of Morrison's pouch (perihepatic), the perisplenic region, the pelvis (pouch of Douglas), and the pericardium. The presence or absence of fluid in any of these regions denoted a positive or negative FAST, respectively. In problematic cases of body habitus, subcutaneous emphysema, excessive bowel gases the presence of equivocal fluid was considered an indeterminate sonogram. This required the patient to be evaluated further by DPL, CT or echocardiography.

Ballard et al had 13 false-negative results in 70 patients with pelvic fractures and negative FAST examination results undergoing CT.[9]

There are cases in which significant intra-abdominal injury is not accompanied with prence of blood in the peritoneum. Chiu et al[10] determined in 15 of 52 patients (29%) with a blunt abdominal injury had no evidence of hemoperitoneum by the modalities of FAST or CT. They also discovered that with lower rib fractures, hematuria, pelvic fractures, and thoraco-lumbar spine fractures the likelihood of false-negative FAST increased. In such cases DPL or CT scan was required. US performs well in the detection of hemoperitoneum, however identification of organ injuries remains a problem. In hemodynamically stable patients, the value of US is mainly limited by the large percentage of organ injuries that are not associated with free fluid.[11] FAST does not detect injuries to viscera as free fluid quantity may be minimal to nil. Yoshii et al reported a 34.7% sensitivity for gastrointestinal injuries overall and 18% for injuries to the small intestine.[12] They reported greater than 90% sensitivity for parenchymal injuries to the liver, spleen, and kidneys and 71.4% for pancreas.

A group of patients undergoing FAST showed that 24% patients required a CT and 1% of patients underwent DPL. In contrast the patients without FAST, 94% required CT and 6% of patients underwent DPL.[13] CT is used in stable patients with a positive FAST to evaluate for solid organ injuries being the cause of the free fluid visualized with ultrasound. Free fluid without solid organ injury may necessitate laprotomy or DPL to exclude bowel, mesenteric, or bladder injury. Cunningham et al[14] reported a 94% laprotomy rate in patients with blunt trauma and isolated intraperitoneal fluid on CT.

Navid F et al concluded in their study that in patients who are hypotensive after blunt abdominal trauma and not hemodynamically stable enough to undergo diagnostic CT, negative US findings virtually exclude surgical injury, while positive US findings indicate surgical injury in 64% of cases.[15]

In a study by Valentino M and coworkers using contrast enhancement ultrasound was as effective as Contrast CT scan in children having injuries of solid organs.[16] Körner M and colleagues emphasized the role of rapid performance of emergency ultrasound to reduce probability of death which is increasing by 1% every 3 minutes.[17] Bierig SM and Jones A emphasized the cost effectiveness of ultrasound in comparison with other imaging modalities.[18] They concluded its cost effectiveness and ability to be performed rapidly surpasses all other imaging modalities. Time in trauma setting is a very important consideration.

Conclusion

FAST is an imaging that is safe, cost effective, sensitive, specific, rapidly performed even potably. It is an accurate imaging in detecting hemoperitoneum in patients with blunt abdominal trauma.

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