EMERGENCY ULTRASOUND UK

Focused Assessment with Sonography for Trauma (FAST)

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Introduction

Physical examination of the abdomen in blunt trauma is subjective and often yields equivocal results. A Dutch retrospective study found an incidence of equivocal physical examination of 45% in multiply injured trauma patients, rising to 84% in those with lower rib fractures[1]. For this reason, most abdominal trauma patients go on to receive further imaging and investigations in order to rule out clinically significant intra abdominal pathology. Traditionally these investigations have consisted of either a diagnostic peritoneal lavage (DPL) or a computed axial tomography (CT) scan, performed with varying combinations of intravenous, oral and rectal contrast. The focused abdominal sonogram in trauma (FAST) is a focused, goal directed, sonographic examination of the abdomen aimed at detecting the presence or absence of haemoperitoneum. It provides a viable alternative to other investigations in the blunt abdominal trauma patient, and can be integrated into the primary survey in patients with signs of haemorrhagic shock or suspicion of intra abdominal injury. It has the additional advantages of being non invasive, reproducible, and is capable of being rapidly performed at the patient's bedside by the Emergency Physician. Indeed, the FAST scan is often regarded as being a simple extension of clinical examination rather than a definitive diagnostic investigation. A standard 4 view examination can be completed in approximately 2 minutes.

	Sensitivity	**Diagnostic Ability**	**Ease / Speed**	**Safety**	**Repeatability**
Clinical Examination	++	+	+++	+++	+++
DPL	+++	+	+	++	+
CT	+++	+++	++	++	++
FAST	+++	++	+++	+++	+++

Table 1. Comparative data for different imaging modalities and techniques in blunt abdominal trauma.

History

Ultrasound has been extensively used by physicians in Germany and Japan for over 20 years, after initial experience in the early 1970's, and has been in widespread use in the United States of America for over 10 years. A major influence on the increased use of ultrasound at the trauma bedside was the development of portable, low-cost and high-quality machines in the 1990's. This portability and low cost has led to increased roll out of bedside ultrasonography in Emergency Departments around the world.

Physics

Ultrasound is a spectrum of sound frequencies above the human hearing range. When emitted as waves through the human body, ultrasound is variably transmitted or reflected by the differing tissues, providing each structure with an "echogenicity", dependent on the physical characteristics of the transmitting organ. This transmission and reflection depends on the difference in acoustic impedance at the organ interface. The greater the difference in impedance, the more sound is reflected back rather than being transmitted. The transducer of the machine contains many piezoelectric crystals, approximately 1% of which emit the ultrasound waves, and 99% of which listen for the corresponding echo returns. A coupling gel between the transducer and the body is necessary to initiate transmission of the ultrasound waves into the body. Most transducers are capable of a range of frequencies, with higher frequencies leading to increased image resolution but lower penetration of the beam into the human body. The reflected ultrasound waves can be displayed on a screen as a 2 dimensional image. These properties result in varying appearances of different tissues in the image. Bone and calculi appear as a white surface with an acoustic shadow beneath. Blood, urine and water appear black, whilst solid organs appear in varying shades of grey. Interface enhancement may occur, in which the interface between organs appears as bright grey or white.

Indications

Several studies have demonstrated FAST scanning to have a sensitivity between 86 and 99% compared to various other imaging modalities[2-7].

Author	**Patients**	**Sensitivity**	**Specificity**	**Design**
Lucciarini[2]	726	92	97	Retrospective
Healey[3]	796	88	98	Prospective
McKenney[4]	1000	88	99	Prospective
Glaser[5]	1151	99	98	Retrospective
Porter[6]	1631	93	90	Retrospective
Dolich[7]	2576	86	98 (NPV 98)	Prospective

Table 2. Comparative findings of sensitivity and specificity in FAST studies

FAST scanning is indicated in any patient who has sustained blunt abdominal trauma, whether haemodynamically unstable or not. In our ED it is used purely as a rule in test for the presence of haemoperitoneum and/or haemopericardium. The algorithm for the blunt trauma patient used in our ED is shown below.

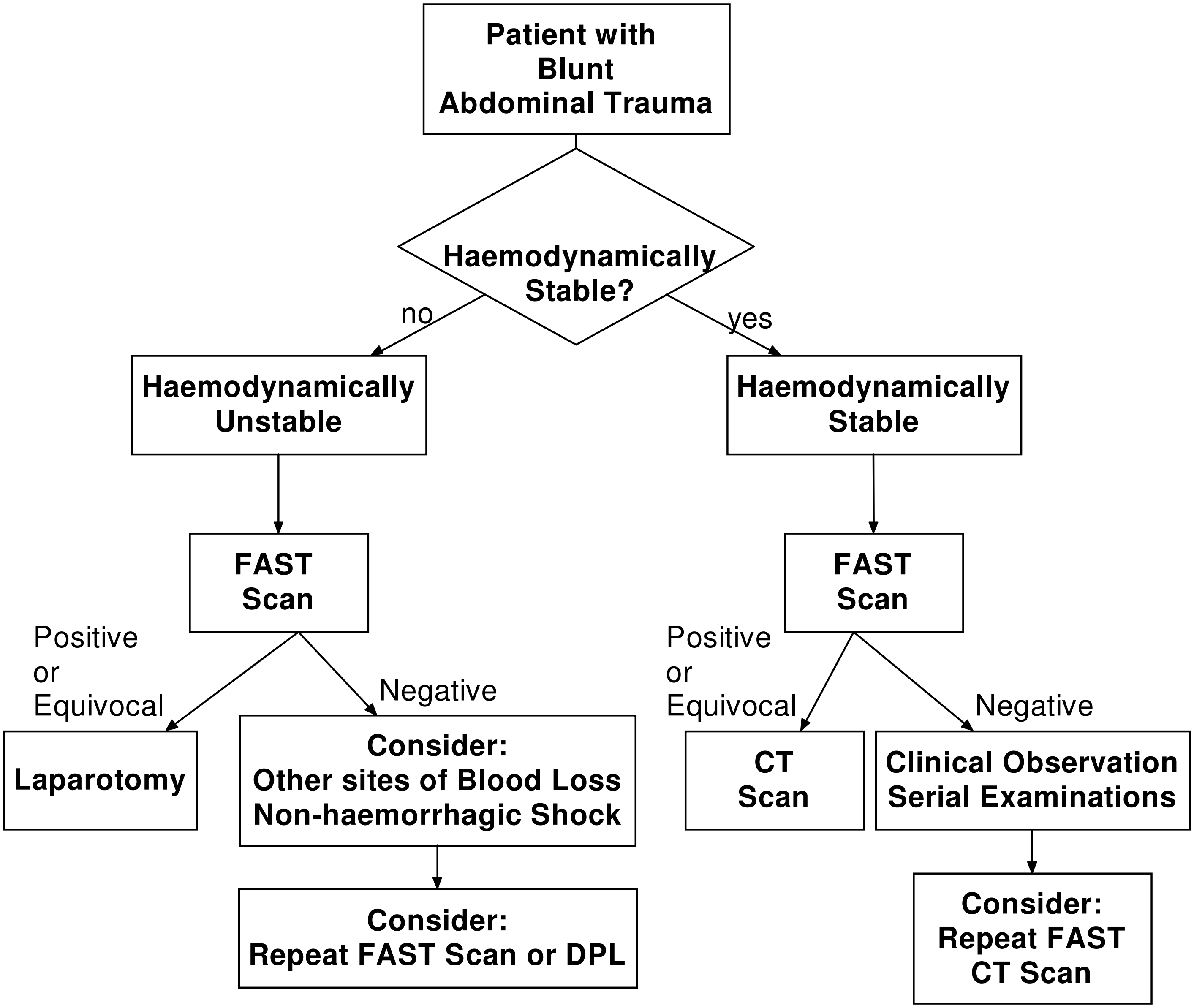

Fig 1. Algorithm for the management of adults with blunt abdominal trauma in the Ipswich ED.

The Scan

The FAST scan is a 4 view scan reliant on detecting the presence of fluid within the pericardium and most dependent zones of the peritoneum in the horizontal patient. It is capable of detecting more than 100-250ml of free fluid[8]. CT scanning, in comparison, is capable of detecting more than approximately 100ml of free fluid in the abdominal cavity[9]. As a "rule of thumb", a rim of 0.5cm of fluid in Morison's pouch represents approximately 500ml of free fluid, and a 1cm rim represents approximately 1000ml.

The Views

1) Subcostal view

The transducer is placed in the subxiphoid region of the chest with the ultrasound beam projecting in the coronal plane. Moderate pressure against the abdominal wall with the whole of the transducer may be required to direct the beam retrosternally to obtain the image. This should demonstrate both the live and heart, in a 4 chamber view. The heart is easily recognizable, due to its characteristic motion. The heart will be surrounded by a rim of echogenic pericardium.

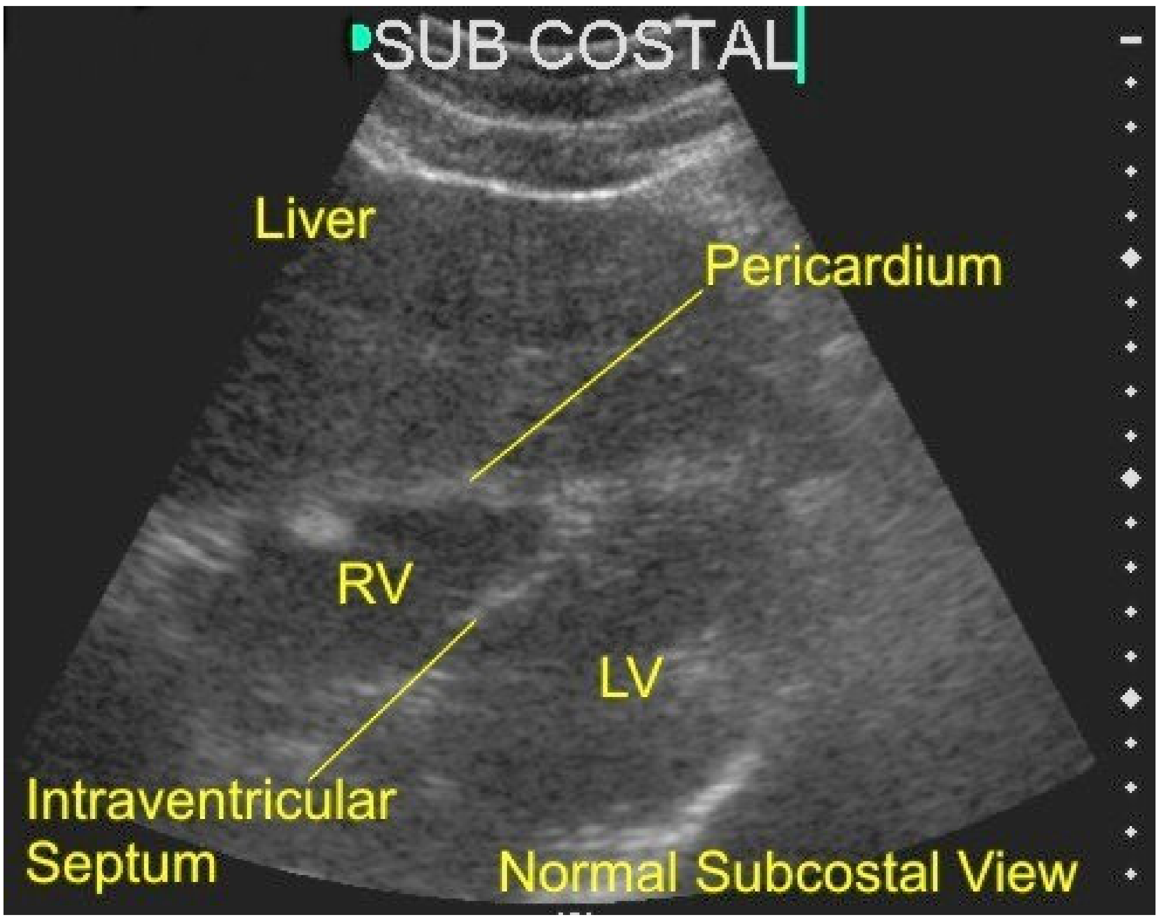

Fig 2. Normal Subcostal FAST View

Any discrete blackness between this rim and the heart wall represents fluid in the pericardial sac.

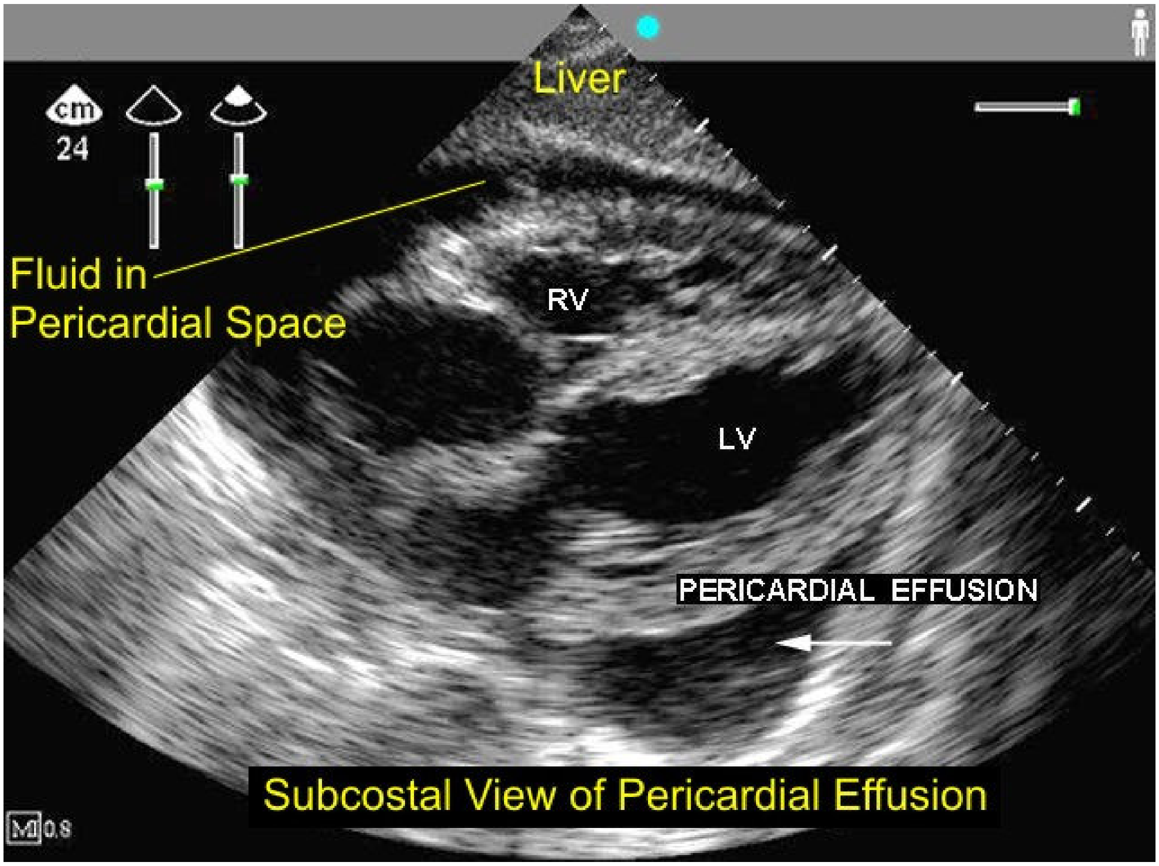

Fig 3. Abnormal Subcostal FAST View.

2) Right Upper Quadrant View (Morison's Pouch)

The transducer is positioned in the right mid-axillary line between the 11th and 12th ribs with the beam in a cranio caudal plane. Some panning of the beam in this plane should demonstrate the liver, kidney and diaphragm. Morrison's pouch represents the potential space between the capsule of the liver and the fascia around the kidney.

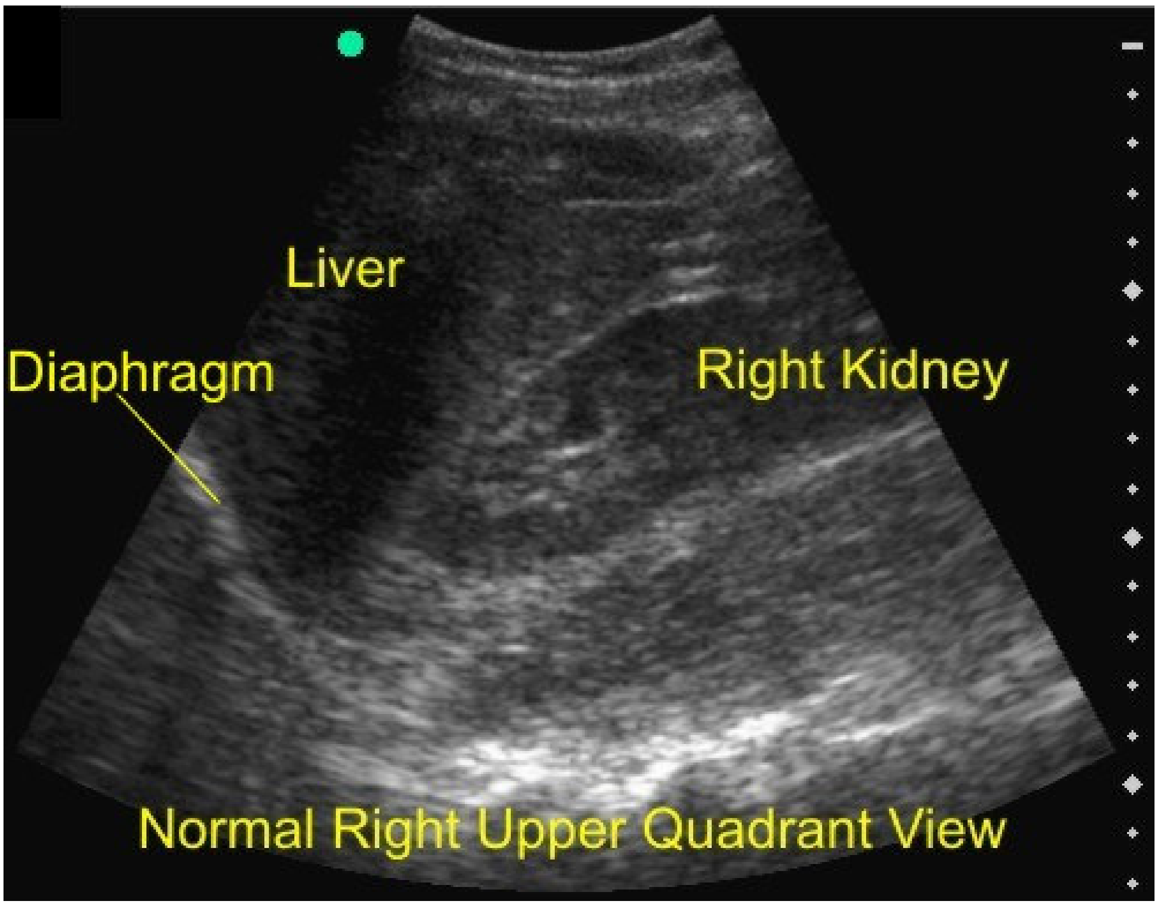

Fig 4. Normal Right Upper Quadrant FAST View.

A black rim between the 2 organs represents free intraperitoneal fluid.

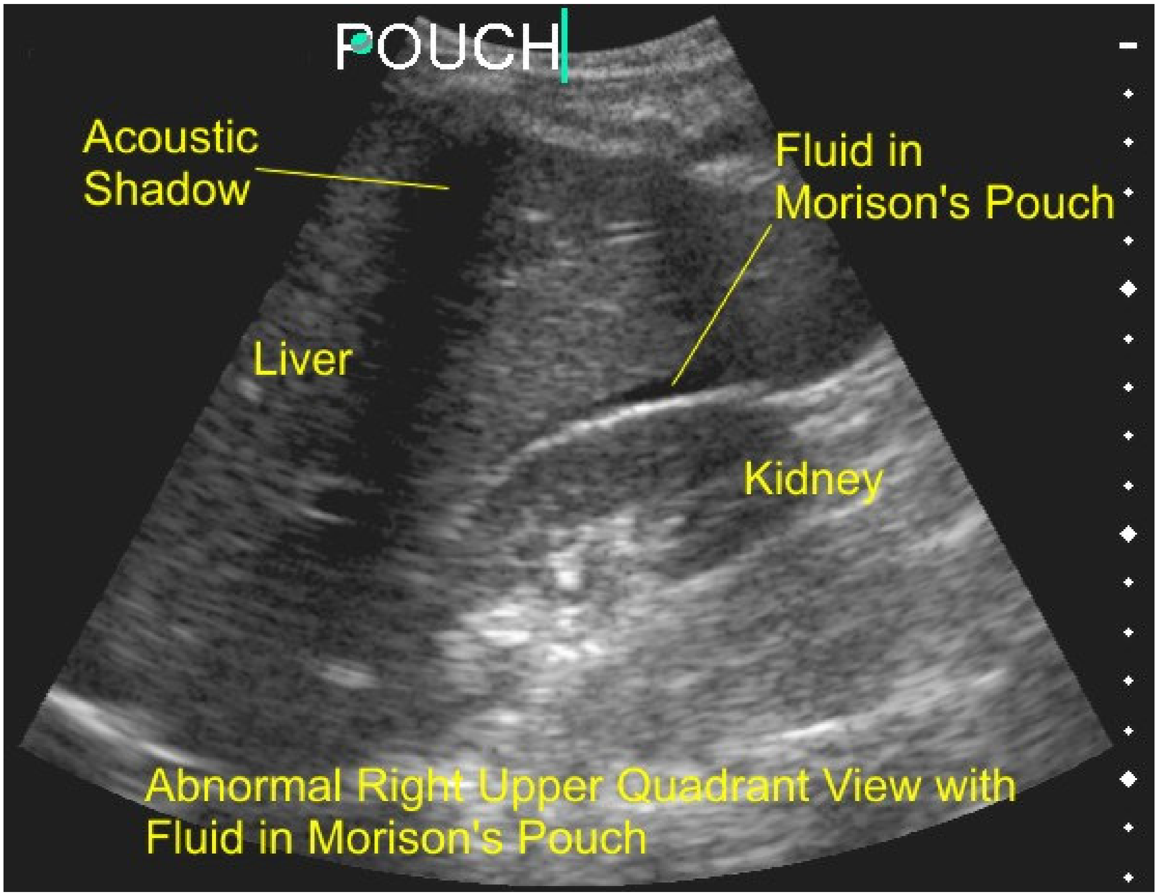

Fig 5. Abnormal Right Upper Quadrant FAST View.

3) Left Upper Quadrant View

The transducer is positioned in the left mid-axillary line between the 10th and 11th ribs with the ultrasound beam in a cranio caudal plane. This demonstrates the spleen, kidney and diaphragm. Rotating the transducer to obtain longitudinal and transverse planes should demonstrate the presence of any fluid between the spleen and kidney. This view may be marred by acoustic shadows projecting over the image from the ribs. In the compliant patient, this may be improved by imaging the patient whilst in full inspiration.

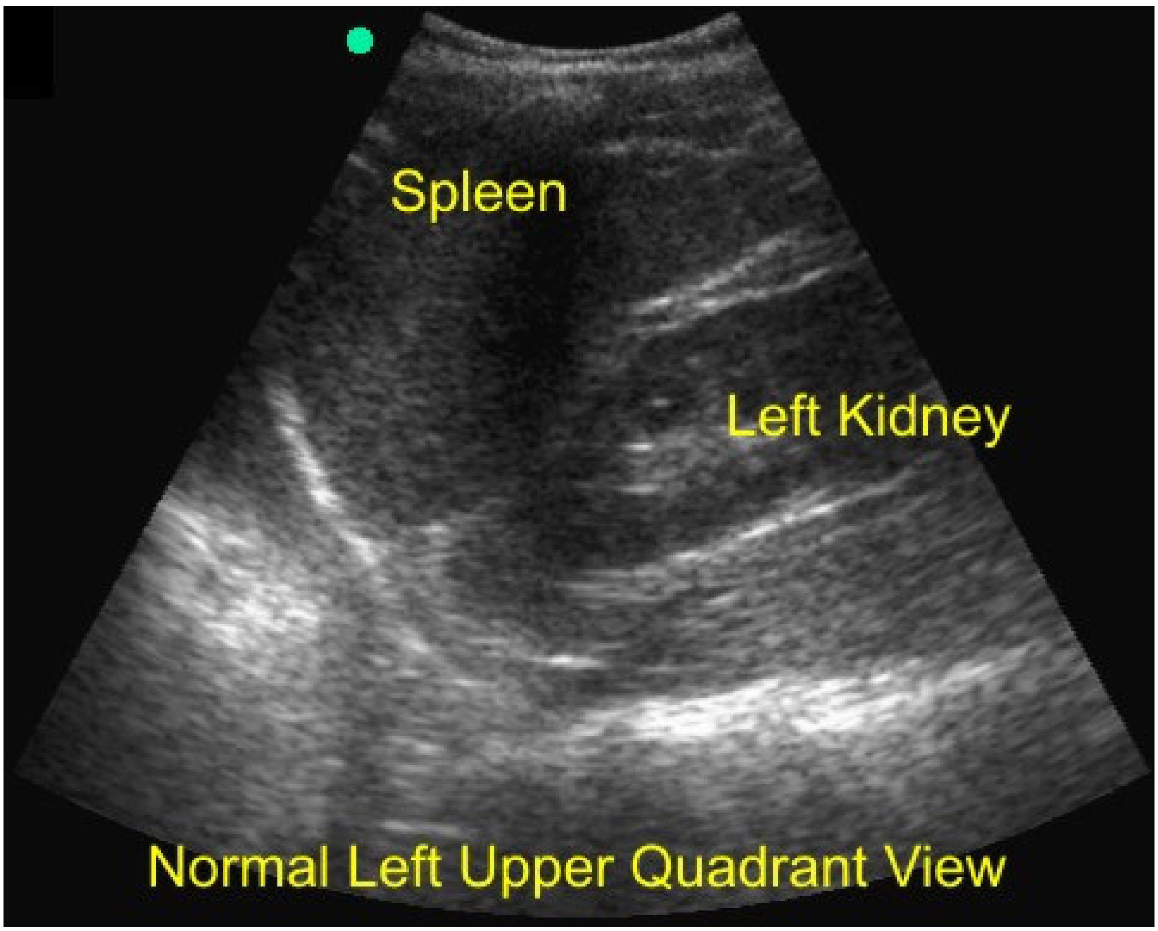

Fig 6. Normal Left Upper Quadrant FAST View.

Any evidence of a black rim between the 2 organs represents free intraperitoneal fluid. Gross injury to solid organs may sometimes also be seen.

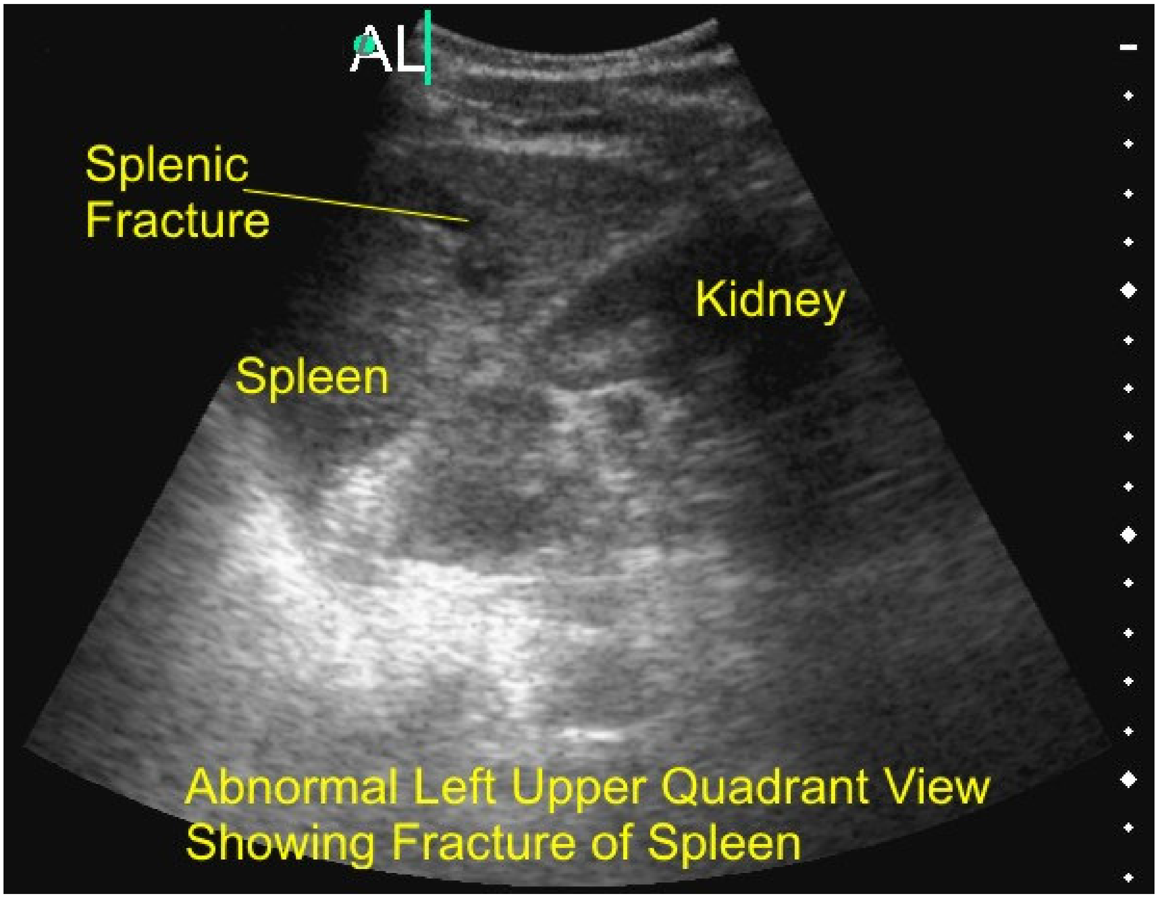

Fig 7. Abnormal Left Upper Quadrant FAST View.

4) **Suprapubic View**

The transducer is placed transversely in the abdominal midline approximately 4 cm superior to the symphysis pubis and angled downwards in to the pelvis. This demonstrates the bladder. The probe is then rotated through 90 degrees to move the beam into a sagittal plane providing a view of the bladder, rectum and rectovesical pouch.

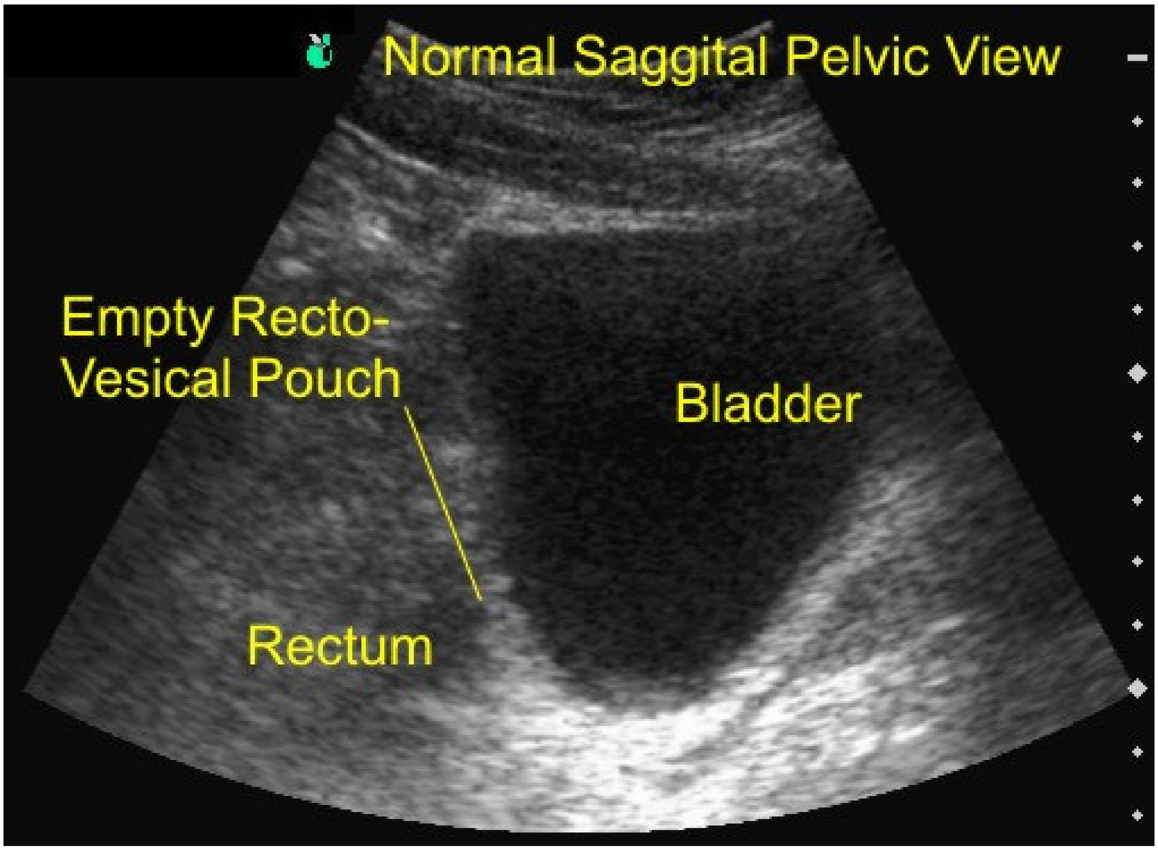

Fig 8. Normal Pelvic FAST View.

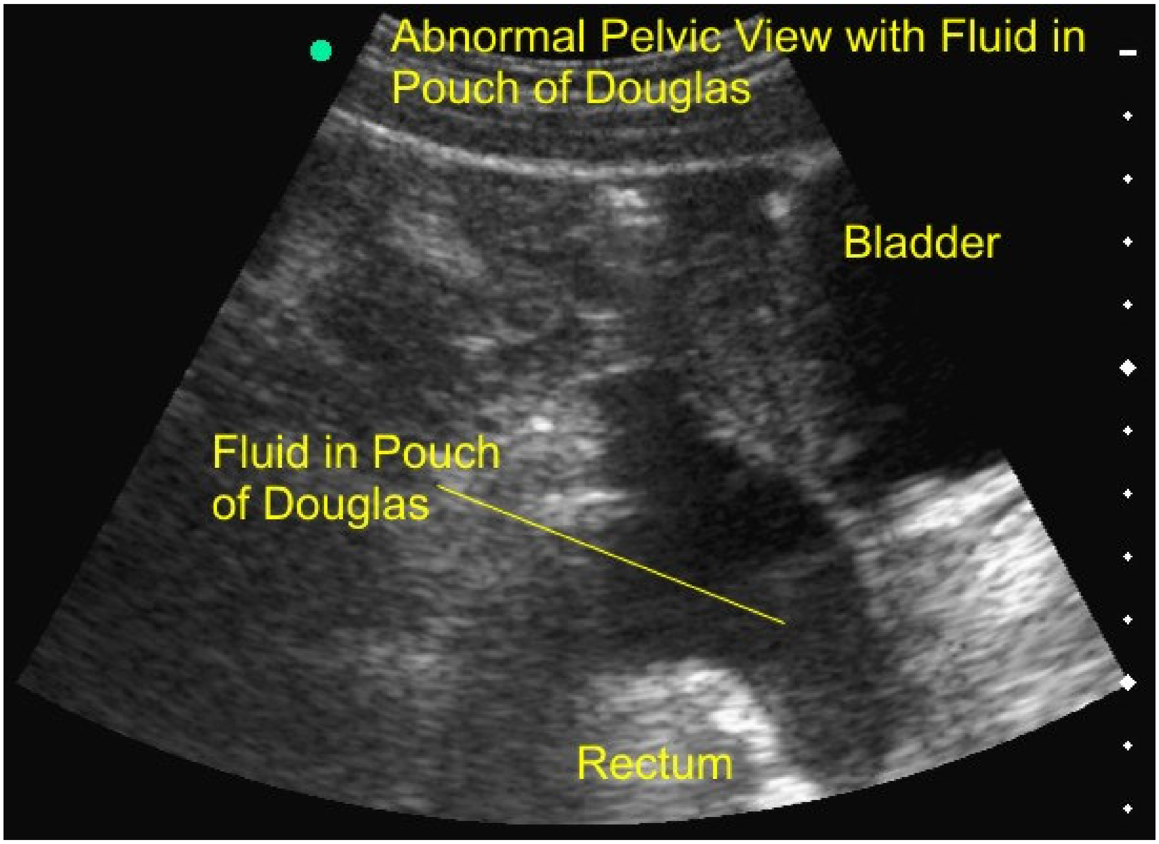

Fig 9. Abnormal Pelvic FAST View

Pitfalls

As with any investigation, FAST scanning has limitations. It is not as sensitive as CT at identifying solid organ injury, and relies on the surrogate indicator of free fluid within the peritoneum to identify significant haemorrhage. Haemoperitoneum is not present in all patients with abdominal visceral injuries, and certain injuries may not be initially detected on the FAST exam. These include perforation of a hollow viscus, bowel wall contusion, pancreatic trauma and renal pedicle injury. Therefore, over-reliance on a single FAST scan may lead to erroneous conclusions.

The scan should be repeated during the secondary survey and also if the patient demonstrates clinical deterioration, since free fluid may have accumulated in the intervening time and now be visible on ultrasound. The quality of images obtained may also be a limiting factor with patient obesity and gas in the bowel leading to degradation in image quality.

Training

In the UK, trainee radiologists perform a minimum of 300 supervised scans, and the Royal College of Radiologists states that "the minimum acceptable standard is that expected of a trainee radiologist at the time of attaining the Fellowship examination of the Royal College of Radiologists."[10]. Good evidence exists, however, that basic competency can be achieved for focused examinations with many fewer scans than this. The American College of Emergency Physicians recommends between 25 and 50 "documented and outcome reviewed ultrasound scans needed for proficiency", and studies in the literature have demonstrated that as few as 10 FAST scans may provide competence[11-14]. The technique may soon be included in ATLS courses. The Australasian College of Emergency Medicine has outlined its proposals for formal credentialing, including attendance at an Ultrasound Workshop of at least 4 hours in length, coupled with a system of proctored examinations[15].
Whichever course is chosen, it is obviously important that FAST scanning is introduced into the ED only after adequate preparation and training of personnel, as well as with rigorous quality control procedures in place.

Conclusion

It is clear that ultrasound guided assessment of trauma is rapidly becoming the internationally accepted standard of care in the Emergency Department. It provides the Emergency Physician or Suregeon with a rapid, accurate and cheap patient assessment tool, which may be easily integrated into current trauma pathways. The technique is easily learnt and has been demonstrated, in the right hands, to be both sensitive and specific for the presence of intraperitoneal free fluid.
As with any imaging modality, ultrasound has its own limitations, and so adequate training and quality control are essential.
ED ultrasound has the potential to significantly improve the delivery of care to the blunt trauma patient, and to save many lives by so doing.

References

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