Trauma: The FAST Approach

An Introduction to Bedside Trauma Ultrasound

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Abstract:

Since the 1980's the *Focused Assessment with Sonography for Trauma* (FAST) exam has been one of the most widely used applications in emergency bedside ultrasound, and has become a standard part of the initial assessment and resuscitation of the trauma patient. This article, the second in a series, discusses the role of the FAST exam in the initial trauma resuscitation.

MeSH Words: abdominal Injuries, complications, ultrasonography, radiography, trauma, peritoneal lavage

Introduction

Since the 1980's the *Focused Assessment with Sonography for Trauma* (FAST) exam has been one of the most widely used applications in emergency bedside ultrasound, and has become a standard part of the initial assessment and resuscitation of the trauma patient[1,2] *(see figure 1 and 2)*

The FAST exam is a tool to evaluate the trauma patient for pericardial and peritoneal hemorrhage. By utilizing four simple sonographic 'windows', the clinician can assess for pericardial or peritoneal bleeding at the bedside in less than 5 minutes[3-6,25]. Although the FAST exam has traditionally been used in the

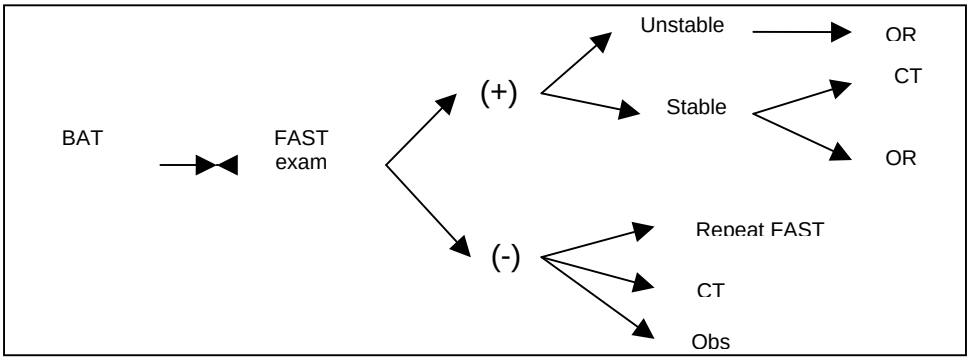


Figure 1: ***Algorithm utilizing FAST for blunt abdominal trauma (BAT)***

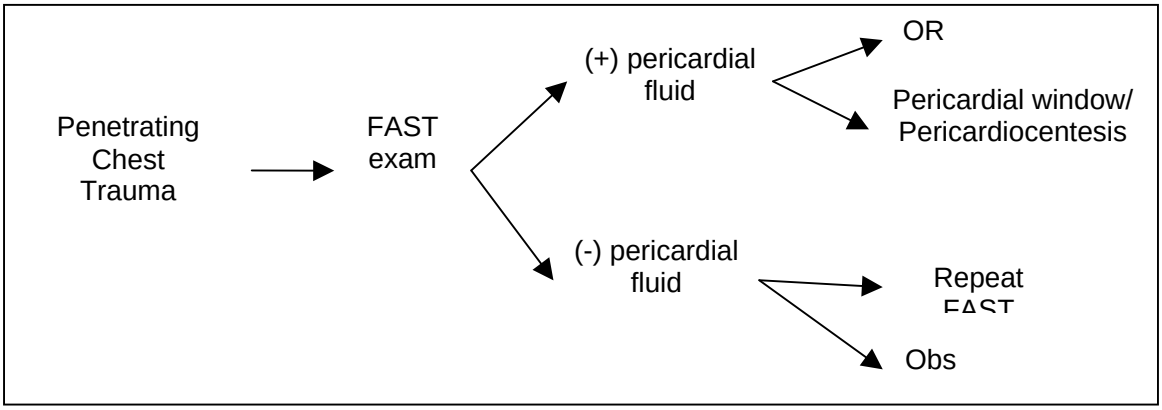


Figure 2: ***Algorithm utilizing FAST for penetrating chest trauma***

evaluation of blunt abdominal trauma (BAT) patients, subgroup and independent analysis has demonstrated its utility in penetrating abdominal trauma[7,8], and the exam is being modified to evaluate the non-trauma patient with undifferentiated hypotension[9].

This article, the second in the series, will discuss the role of the FAST exam in the initial trauma resuscitation. More specifically: why and how to perform the FAST exam, common pitfalls, accuracy, training and the role of the FAST exam in resource allocation.

The Role of the FAST exam in the trauma patient

The abdominal physical exam is an insensitive detector of abdominal injury in blunt trauma patients.[10] The three primary modalities for evaluating intraperitoneal hemorrhage are the diagnostic peritoneal lavage (DPL), CT scan, and the FAST exam. The FAST exam is distinguished from the other modalities by being a rapid, non-invasive, inexpensive bedside test that evaluates for peritoneal as well as pericardial fluid.

How to perform the FAST exam

As mentioned above, the FAST exam involves four views (*see Figure 3*):

1. Subxyphoid cardiac view to asses for pericardial fluid and cardiac motion
2. Right upper quadrant (RUQ) view to assess for free fluid in the potential space known as Morrison's pouch between the liver and the right kidney
3. Left upper quadrant (LUQ) view to assess for fluid in the splenorenal and subphrenic space
4. Pelvic view to assess for free pelvic fluid.

Although the four-view FAST as described is the most accepted manner to perform this exam, there is literature on single-view RUQ exams[11,12], 7-view exams that involve examination of the paracolic gutters, and 'extended' FAST exams that evaluate the pleural space for hemothorax and pneumothorax.

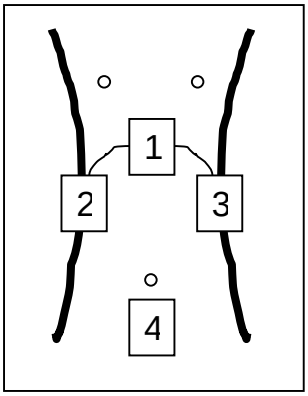


Figure 3: Probe position of the 4 views in the FAST exam

The subxiphoid view (position 1 in figure 3), also known as subcostal view, evaluates the heart and pericardial sac. The focused question is the presence of pericardial fluid. A secondary issue is the presence of cardiac motion in traumatic arrest.

The probe is placed inferior to the xiphoid process, with the probe marker to the patient's right side and angled toward the heart. Although the echocardiographic convention is to have the probe marker to the patient's left, emergency physicians maintain the machine in the abdominal mode requiring the probe marker to point to the patient's right. In this way, no cumbersome changing of settings is required and the resulting view is the same as it would be in the echo mode. The liver serves as an "acoustic window" allowing for direct penetration of the sound beam while avoiding the lungs and ribs. All four chambers of the heart are visualized with this technique. The depth of view should be maximized to allow complete evaluation of the posterior pericardium. A common mistake is to not visualize the heart secondary to lack of adequate depth.

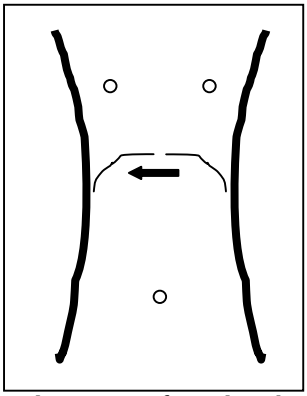


Figure 4: Probe position for Subxyphoid view.

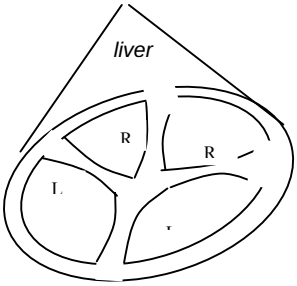
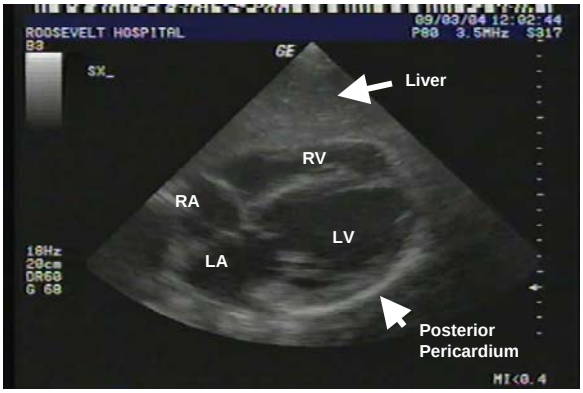


Figure 5: Subxyphoid view of cardiac chambers



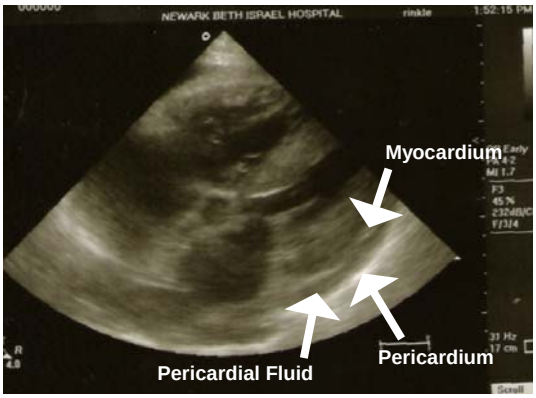


Figure 6: Normal Subxyphoid view
Fig.7: Subxyphoid view with pericardial effusion

The second view is of the hepatorenal recess, also known as Morrison's pouch. This potential space is the most dependent portion of the peritoneum in the supine patient; and consequently the first place fluid collections may be identified[12]. This view is obtained with the probe marker pointing to the patients head and placed in the midaxillary line at the level of the costal margin. The probe may need to be adjusted up and down depending on patient characteristics. Normally the kidney and liver are neatly juxtaposed next to one another. When free fluid is present an anechoic stripe may be seen between the liver and kidney. It is important to visualize the inferior pole of the kidney as early fluid may first collect there.

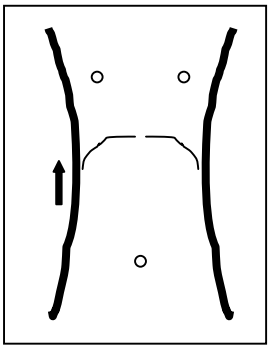


Figure 8: Probe position for RUQ view

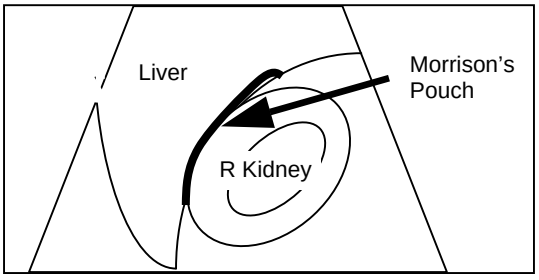


Figure 9: Schematic of RUQ view

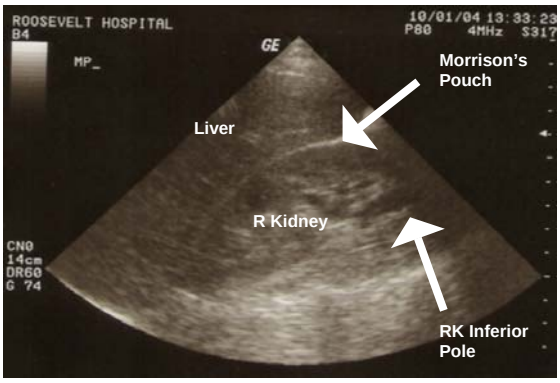


Figure 10: Normal RUQ view

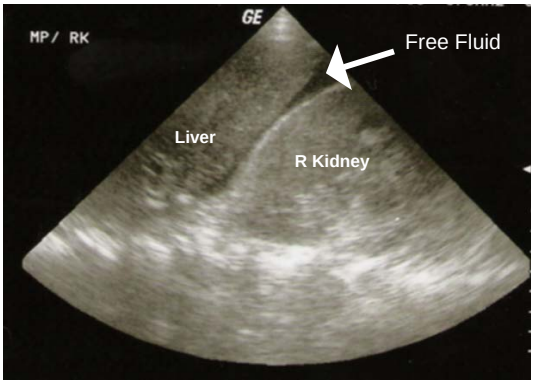


Figure 11: Free Fluid in Morrison's Pouch

The third view is of the splenorenal recess. This view is more technically challenging to obtain than the hepatorenal recess. The spleen is smaller than the liver so one must scan through the ribs, and the air in the stomach and splenic flexure of the colon produce scatter artifact. The probe, with the marker positioned toward the patient's head, is placed on the posterior axillary line high in the flank. The sonographer's hand is as far posterior on the patient as the bed will allow given the patient's supine position. The patient is to remain supine and not roll over to the right as fluid will be displaced. When the sonographer has difficulty finding this view, it is usually because the probe is not adequately superior or posterior in the patient's flank. Once again, free fluid is seen as a dark, anechoic stripe between the left kidney and the spleen.

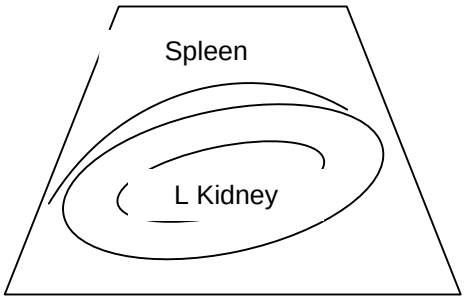


Fig 12: Schematic of LUQ view

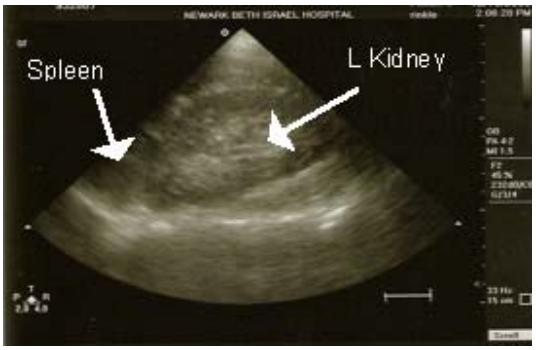


Fig 13: LUQ view showing spleen and L kidney

The final transverse suprapubic view evaluates for pelvic free fluid. The probe is placed above the pubic symphysis with the marker pointing toward the patient's right side. A sagittal view with the probe in the same location but rotated with the marker pointing toward the patients head may also be obtained. Free fluid in the pelvis is anechoic and found in the rectovesicular recess in men and the vesiculo-uterine pouch (Pouch of Douglas) in women. Trace amounts of free fluid in the Pouch of Douglas may be physiologic in premenopausal women; however, any free fluid anterior to the uterus is always a pathologic finding and suggests hemoperitoneum in the right clinical setting.

Pitfalls in performing the FAST exam

While the fast exam can provide a rapid diagnosis of hemoperitoneum in the trauma patient, there are a few key pitfalls to be avoided. The major error made by the novice sonographer is not scanning the inferior poles of the kidneys where fluid often accumulates first.

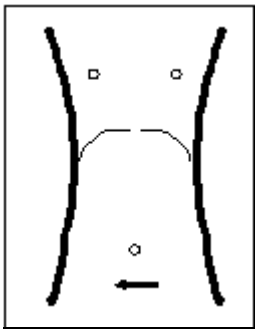


Fig 14: Probe position for pelvic view. Note probe marker points to the right.

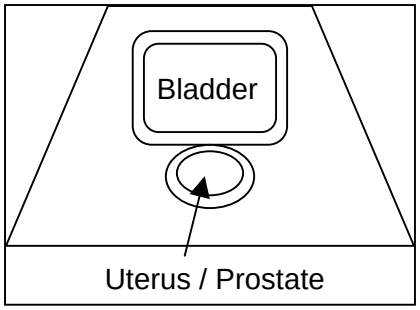


Fig 15: schematic of pelvic view

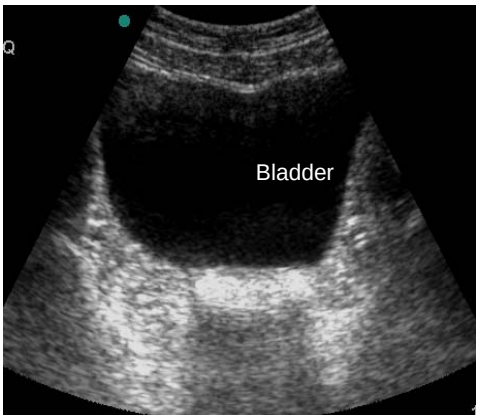


Fig 16: normal pelvic view showing bladder

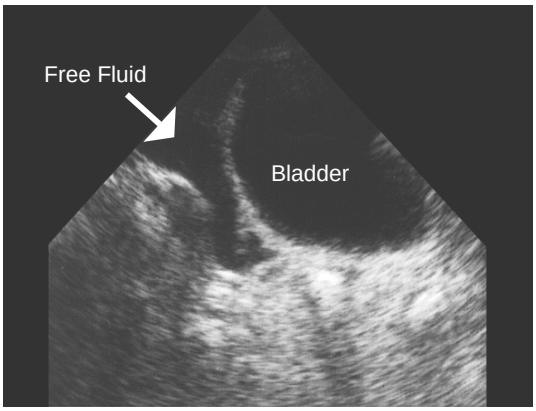


Fig 17: pelvic view showing bladder and free fluid

When the probe marker is oriented to the patient's head and the machine is in the abdominal mode, the inferior pole is on the sonographer's right-side of the screen *(see figure 10).* Furthermore, the sonographer must learn to identify clotted blood as it may appear isoechoic to renal and liver parenchyma. Perinephric fat also appears isoechoic, and therefore similar in appearance to clotted blood. The two are differentiated by their distribution: perinephric fat surrounds the entire kidney as compared to clotted blood which is unevenly distributed and found in Morrison's pouch. Lastly, the presence of ascites and other chronic causes of peritoneal fluid will have a similar black (anechoic) appearance to peritoneal blood on the FAST exam. In such cases, history and clinical exam findings will be crucial to guiding further management.

The FAST exam has limited sensitivity in identifying small amounts of intraperitoneal fluid such as may occur early after a traumatic event *(see following section).* Serial exams are recommended to improve sensitivity or to evaluate decompensation in the trauma patient.

Another key limitation in the abdominal portion of the FAST exam is that ultrasound does not visualize organ-specific injury well[1,13]. Ultrasound will indicate the presence of peritoneal hemorrhage, but not necessarily the source. Therefore, further investigation via abdominal CT scan, DPL or surgical exploration may be indicated despite a negative FAST exam, especially in cases of suspected solid organ, bowel or diaphragmatic injury[14].

There are several pitfalls in the cardiac portion of the FAST exam. First of all, it is important to adequately adjust depth of view to identify the entire posterior pericardium and its juxtaposition with the myocardium. The posterior aspect is the most dependant region and the first place pericardial fluid will collect. Secondly, the anterior pericardial fat pad may appear as an anterior hypoechoic stripe and be mistaken for pericardial fluid. Again, the ability to visualize the posterior pericardium and note the presence of fluid around the entire heart will avoid mistaking the anterior pericardial fat for fluid. Another pitfall is mistaking clotted pericardial blood (which may appear echogenic and similar to myocardium) for a normal exam. And, finally, one must carefully examine the images the FAST abdominal windows to differentiate pericardial fluid from pleural fluid.

Accuracy of the FAST exam

There is variation in the literature regarding the accuracy of the FAST exam. In the recent meta-analysis by Stengel et al[15], a review of 30 clinical trials and over 9000 patients, found an overall sensitivity of 79% and specificity of 99%, leading the authors to conclude that a negative exam does not obviate the need for further imaging such as CT scan. There is the further question of which patients with negative FAST scans and intra-abdominal injuries necessitate surgical intervention, as in the prospective study of 500 trauma patients by McGahan in which, despite the low sensitivity (63%), none of the false negative patients required laparotomy[16]. A similar study by McKenney reported that in 200 FAST scans performed, 6 injuries were missed but only 1 was considered significant[17].

Several studies have attempted to quantify the amount of intra-abdominal fluid required to result in a positive FAST exam.[19,20] These studies utilized a model of fluid infusion via DPL into the pelvis and a RUQ Morrison's view to simulate the clinical exam in the blunt abdominal trauma patient. Although not an entirely accurate model of the trauma patient, all these studies demonstrate that in the supine patient slightly more than 600cc of fluid will result in a positive FAST, and that the addition of slight trendelenburg will increase the sensitivity to detect about 450cc of fluid.

Trauma in the Pregnant Patient

Ultrasound is the ideal imaging choice for trauma in pregnancy.[21] Not only is it safe, rapid and accurate, but ultrasound allows for rapid assessment of the fetus as well as the mother. Apart from evaluating the mother for pericardial and peritoneal fluid, one can assess fetal viability via fetal heart rate and estimate a gestational age when considering an emergency cesarean delivery.

Pediatric Trauma

Studies have shown the FAST exam to be equally accurate in pediatric patients.[22-28] Several issues must be kept in mind regarding the pediatric trauma patient. First of all, children tend to have less body fat than the adult patient, making for better resolution in sonographic imaging – thus increasing accuracy in detecting intra-abdominal hemorrhage as well as enhancing sensitivity for solid organ injury. Secondly, decreasing radiation exposure is of greater concern in pediatric patients. Lastly, children tend to have better outcomes with more conservative trauma management, resulting in less need for abdominal CT when there is a negative FAST exam. This was shown in a study by Thourani et al[25], in which 132 pediatric trauma cases with a negative FAST exam were followed by clinical observation alone and no negative outcomes were noted.

Credentialing Criteria for performing the FAST exam

Establishing criteria for the amount of training needed to ensure proficiency and for credentialing will become an issue once the FAST exam becomes an accepted part of the trauma algorithm. 3 studies[32-34] reviewed, including the 2001 ACEP guidelines[35] agree that proficiency in performing the FAST exam require an introductory didactic session of 4-8 hours, a supervised hands-on learning session, and the submission of 25-50 examinations for review to ensure competency.

Impact on the Management of the Trauma Patient

Two final yet important questions to be addressed regarding the FAST exam remain: what is the impact of trauma ultrasound on reducing unnecessary invasive testing (DPL, negative Laparotomy)? Secondly, what is the impact in reducing the cost of expensive alternative imaging (CT scan) and the management of the trauma patient.

Several studies have shown that use of the FAST has significantly decreased the need to perform DPL[29,30] and Laparatomy.[31] In terms of CT, a 2001 prospective study by Rose et al. [37] randomized 208 trauma patients to receive either ultrasound or no ultrasound. In the group receiving an initial ultrasound, the number of patients eventually requiring abdominal CT (36%) was significantly lower than the group in which no ultrasound was performed as part of the initial evaluation (54%).

A 2001 study by McKenney et al.[38] evaluated overall cost in implementing an ultrasound-based trauma algorithm. Their study showed a 43% cost reduction in per abdominal evaluation when FAST was utilized (96$/study) versus abdominal CT ($494/study) and DPL ($137/study). Annual cost savings at their trauma center, which sees about 1,000 traumas per year, was estimated at over $170,000.

Conclusion

The FAST exam has become an integral aspect in the evaluation and management of trauma. As the most widely studied area of emergency bedside ultrasound, multiple researchers have demonstrated it to be a quick, accurate and cost saving modality in identifying peritoneal and pericardial bleeding in the trauma patient. Perhaps the greatest limitation is the relatively low sensitivity, in that abdominal injuries that do not result in hemoperitoneum (contained solid organ injury, bowel/diaphragmatic injury) may not be effectively ruled out with a negative FAST exam and may still require an abdominal CT or laparatomy.

Despite these shortcomings, it ease of use, rapid bedside availability, repeatability, cost savings and enhanced benefit in special populations such as pediatric trauma and the pregnant patient make the FAST exam an invaluable tool in the acute management of the trauma patient.

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