E-FAST
EXTENDED FOCUSED ABDOMINAL SONOGRAPHY FOR TRAUMA

INTRODUCTION (DAVID KESSLER, M.D., 9/2016)

Focused abdominal sonography for trauma (FAST) was one of the earliest applications of point of care ultrasound in the emergency department setting and remains one of the most common bedside studies performed with ultrasound. It is typically utilized in the trauma setting to help identify certain types of internal bleeding. Blood in the abdominal compartment (hemoperitoneum) or pericardial space (hemopericardium) appears anechoic or black on ultrasound. In the extended FAST exam examination, assessment of pneumothorax and hemothorax are included. The FAST exam is typically performed at the end of the primary survey. See PEM Guide: Trauma: Trauma Primary Survey, PEM Guide: Trauma: Abdominal Trauma Overview)

FAST: BENEFITS
Non-invasive
Uses no ionizing radiation
Can be performed in unstable patient (who can't be transported to CT)
Can be repeated multiple times
Children are much easier to image than adults

FAST: CAUTIONS
A negative FAST does not rule out intra-abdominal injury. Repeat if high clinical suspicion
Children are more likely than adults to have solid organ injury without bleeding
At least 150-250 ml of is blood required before it is apparent on ultrasound
Clotted blood (1-4 hours) of variable echogenicity
Free fluid does not necessarily indicate blood, e.g. ascites, ruptured cyst
Does not identify bowel, diaphragm or retroperitoneal injuries
Might not change management, regardless of findings
Low grade injuries (I or II) are usually managed conservatively, even with bleeding
More severe injuries are usually managed with embolization, necessitating CT

PERFORMANCE

The test performance of the FAST has been variable from study to study. The test performance is dependent on user training and experience. In addition, the FAST examination is subject to spectrum bias. A population with a large amount of blood will have a higher sensitivity than a population with less blood.

The Cochrane Database of Systematic Reviews published a manuscript critical of the FAST examination. The primary outcome measures were mortality, laparotomy rates, and abdominal/pelvic CT and diagnostic peritoneal lavage use. They concluded that "there is insufficient evidence from randomized controlled trials to justify promotion" of

FAST in patients with blunt abdominal trauma (Stengel D, Cochrane 2005, PubMed ID: 26368505, updated in 2010, 2015).

A systematic review utilizing different outcomes than the Cochrane review, including 11 studies and 2755 patients, determined a pooled sensitivity of 90.6% and specificity of 98.6% in detecting “any amount of free fluid’ by ultrasound. The pooled sensitivity was 94.2% and specificity 98.1% for an outcome of “need for operating room” (Melniker, Crit US J 2009, PubMed ID:).

The clinical utility of FAST in children is still debated, and few quality studies exist that support routine widespread use. A retrospective review of 513 children (< 18 years) undergoing a FAST examination yielded sensitivity of 50% and specificity of 88% for detecting free peritoneal fluid. FAST examination in those less than 2 years yielded lower sensitivity (36%) and specificity (78%). (Ben-Ishay, World J Emerg Surg 2015, PubMed ID: 25155302).

Data suggests that the FAST it is much more accurate in hypotensive or otherwise symptomatic patients. For example, a hemodynamically unstable patient with a grossly positive FAST exam could go straight to laparotomy, bypassing CT. Combined with physical exam, some report 100% sensitivity and specificity for identifying clinically significant bleeding. In adults with penetrating trauma, FAST may lead to quicker interventions (e.g. pericardial window)

INDICATIONS
1. Need for urgent evaluation of blunt or penetrating trauma patient where rapid determination of intra-abdominal bleeding or pneumothorax is needed
2. May be used to re-evaluate a trauma patient serially

CONTRAINDICATIONS
1. The primary survey should precede the FAST examination
2. The FAST exam should not delay definitive diagnostic or therapeutic interventions

EQUIPMENT
Ultrasound machine, preferably with curvilinear, mid or lower frequency probe (for better penetration), ultrasound gel.

COMPLICATIONS
Incorrect diagnosis. False positive results leading to overuse of CT scans. False negative results leading to a delay in injury identification and definitive care.

E-FAST QUESTIONS
Hemopericardium?
Hemoperitoneum?
Hemothorax?
Pneumothorax?
ANSWERS: Yes, No, Indeterminate

TECHNIQUE

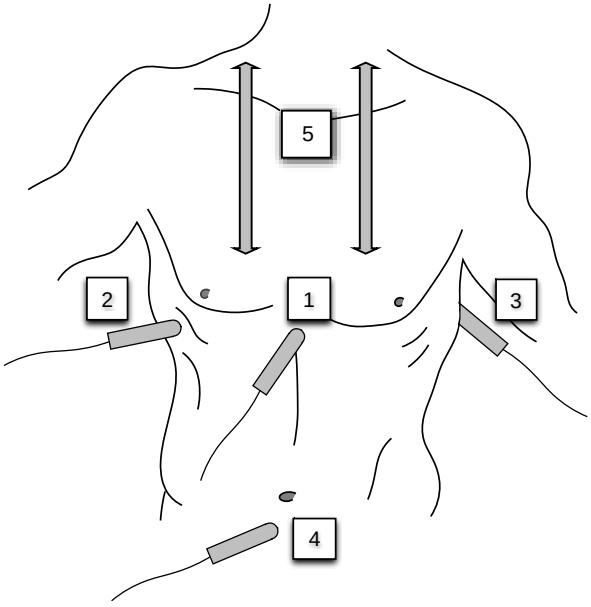
1. There are 4 views for the standard FAST exam, and many recommend an extended FAST or “E-FAST” that also involves examining the lung for pneumo/hemothorax.
2. Some start with the sub-xiphoid view because it is the most immediately life threatening if hemopericardium is detected. This is also the most sensitive view (will be positive with the least amount of blood).
3. The most common site of blood in adults is the right upper quadrant view (Morrison’s pouch). In children, the pelvic/bladder view is more commonly positive.
4. Trendelenburg position (head down, feet up) will improve visualization in the RUQ and LUQ. Reverse Trendelenburg position (head up, feet down) will improve visualization in the pelvis.

<u>FAST</u>

1. SUB-XIPHOID
2. MORRISON’S POUCH (RUQ)
3. SPLENORENAL RECESS (LUQ)
4. PELVIS

<u>E-FAST (ABOVE +)</u>

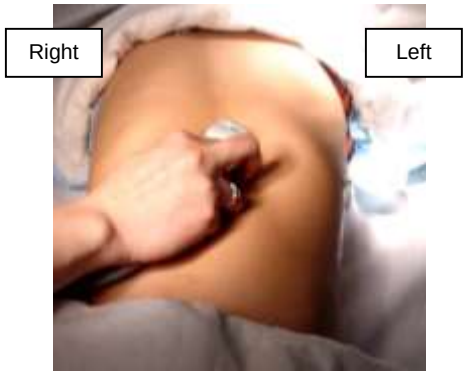
5. EVALUATE FOR LUNG SLIDING (EVIDENCE OF PNEUMOTHORAX**)**



1. SUB-XIPHOID VIEW

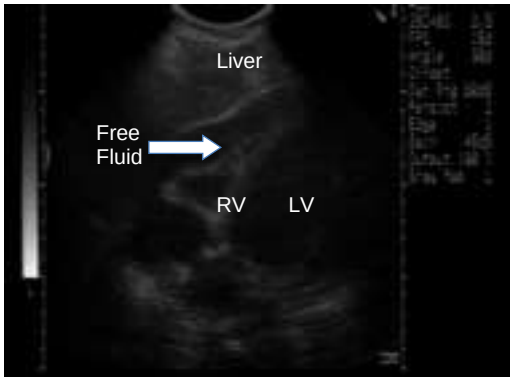
- Subxiphoid view with marker dot to the right and probe at 15 degrees to the plane of the patient (parallel to the abdominal wall). Angle towards the right shoulder
- Use the liver as a sonographic window to visualize the heart. If there is a lot of stomach or bowel gas, move the probe slightly to the right in order to use more of the liver as acoustic window.
- Cardiac tamponade: right ventricular collapse

POSITION



NORMAL

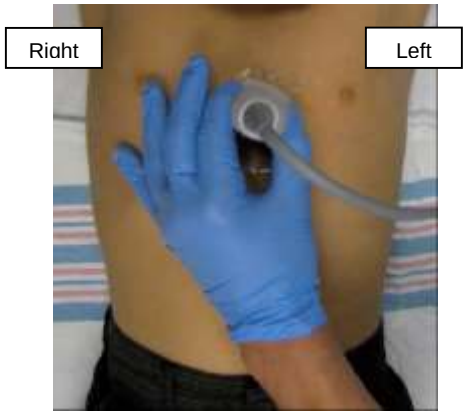
ABNORMAL



1b. PARASTERNAL LONG AXIS VIEW

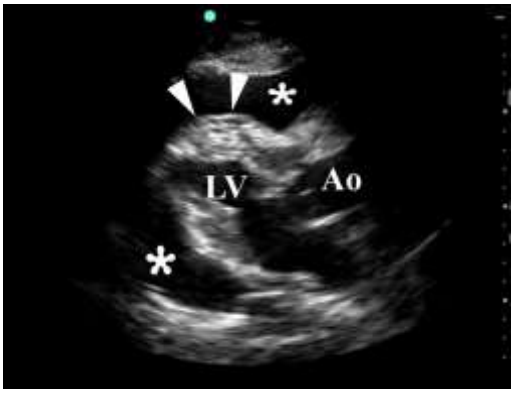
- The transducer is placed just lateral to the sternum at the 3-4th intercostal space and is oriented with the probe marker toward the patient's left hip/right shoulder (4:00 / 11:00 o'clock position), perpendicular to the patient's chest wall. Fluid superior to the transverse aorta indicates hemothorax.

POSITION



NORMAL

ABNORMAL



2. MORRISON'S POUCH (RIGHT UPPER QUADRANT)

- Positioning children: Anterior axillary line at the 7-9th intercostal space
- Positioning adults: Mid-axillary line at the 8-10th intercostal space
- Trendelenburg position (head down, feet up) may improve visualization. Avoid if suspicion of intracranial injury.
- The marker dot oriented toward posterior axillary line (obliquely). This improves visualization of the space above and below the diaphragm and avoids rib shadows.
- Rock the probe up and down to visualize the lower pole of the liver and kidney. This is the first location of fluid accumulation as it is the most posterior.
- Diaphragm and sub-phrenic space. In the supine position, hemothorax can be detected with a sensitivity and specificity in the high 90's. May detect as little as 20 ml of fluid (Supine chest XRAY > 175 ml, Upright chest XRAY > 50-100 ml). Positive spine sign above the diaphragm indicates hemothorax.

VISUALIZE	IDENTIFY
Morrison's pouch	Hemoperitoneum between liver and kidney
Inferior pole of kidney	Hemoperitoneum
Sub-phrenic space	Hemoperitoneum between diaphragm and liver
Pleural space	Pneumothorax, hemothorax

POSITION

NORMAL

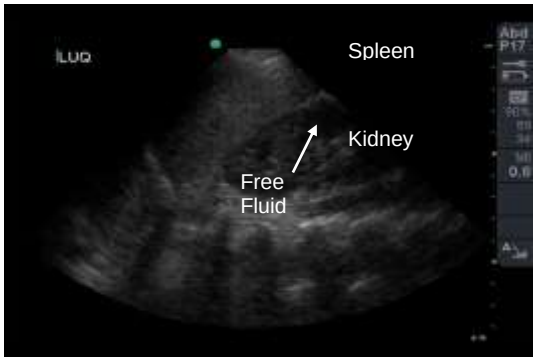
ABNORMAL

3. SPLENO-RENAL RECESS (LEFT UPPER QUADRANT)

- This is the most difficult view to obtain
- Positioning children - 5-7th intercostal space, very posterior (post axillary line)
- Positioning adults - 7-9th intercostal space, very posterior (post axillary line)
- In the LUQ view you typically need to hold the probe lower to the table (with your knuckles practically touching the table) and around one to two finger breadths more superiorly than on the right side.
- Trendelenburg position (head down, feet up) may improve visualization. Avoid if suspicion of intracranial injury.
- May need to move the probe in several intercostal spaces to visualize the entire recess and the diaphragm.
- If you cannot visualize the entire sub-phrenic region in LUQ, the study is incomplete and may lead to false negatives.
- Blood tends to accumulate in the sub-phrenic area first (due to obstruction from the phrenico-colic ligament) and not in the spleno-renal recess. Always scan the diaphragm.
- In adolescents and adults, blood from LUQ will overflow more to the RUQ and R paracolic gutters rather than in the pelvis. Therefore the RUQ is the most common site for fluid collection with both liver and spleen injury.
-

VISUALIZE	IDENTIFY
Space between spleen/kidney	Hemoperitoneum
Inferior pole of kidney	Hemoperitoneum
Sub-phrenic space	Hemoperitoneum between diaphragm and spleen
Pleural space	Pneumothorax, hemothorax

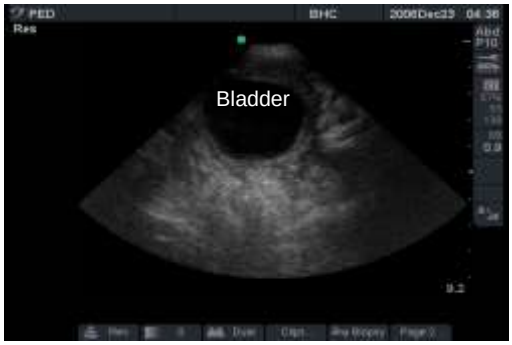
POSITION **NORMAL** **ABNORMAL**

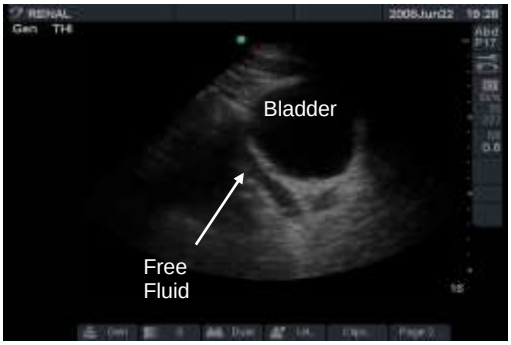


4. PELVIS / BLADDER VIEW

- Best with urine in the bladder to serve as an acoustic window
- A slight reverse Trendelenburg position (head up, feet down) can improve visualization
- Turn the gain down a bit to see fluid better. Posterior enhancement of fluid filled structures (the bladder in this case) can mask free fluid.
- Probe positioning: 1-2 cm above symphysis in both transverse and sagittal views
- Sagittal view: Female - uterus above the bladder, Male - prostate inferior (to the right on screen).
- Transverse view: scan from superior to inferior looking for free fluid anterior or posterior to the bladder. Both the uterus and prostate (and seminal vesicles) are under the bladder (angle down until you see them). Seminal vesicles can be confused with free fluid. If the bladder is over-distended, it may compress the free fluid posteriorly and displace it laterally. Don't forget to look at the sides of the bladder on transverse view.
- Location of free fluid. Most common site of free fluid in children. Pouch of Douglas in females. Retro-vesicular pouch in males. The prostate may be hypoechoic and should not be confused with free fluid.

POSITION **NORMAL** **ABNORMAL**





5. LUNG EXAMINATION FOR PNEUMOTHORAX

Lung ultrasound has been found to be more sensitive (SN 95%, NPV 100%) than chest XRAY in identifying pneumothorax in the supine trauma patient and can be performed rapidly at the bedside.

The probe is place in the midclavicular line oriented in the vertical position with the marker dot to the patient's head.

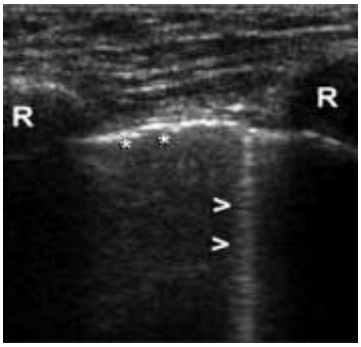
FINDINGS CONSISTENT WITH PNEUMOTHORAX	
1	Absence of lung sliding
2	Absence comet tail artifact (i.e. B lines)
3	Presence of "lung point" sign
4	In m-mode: Absence of the "sandy beach" or "waves on the "beach sign"
5	In m-mode: Presence of the "bar code" or "stratosphere"

Lung sliding indicates that the parietal pleura of the chest wall and visceral pleura of the lungs are contiguous and moving together as the lungs expand and contract with ventilation. This is seen as a moving shimmering white line. The absence of lung sliding may also be seen with apnea, chronic (e.g. fibrosis) or inflammatory pleural adherence (e.g. ARDS), atelectasis and one-lung intubation (absence of lung sliding on side of non-ventilated lung).

The lung point sign occurs when an area of lung sliding is adjacent to an area without lung sliding. This occurs at the junction of normal pleural approximation and a pneumothorax and is typically seen with a small to moderate pneumothorax

Comet tail artifact or B lines are oriented perpendicular to the pleura (due to visceral pleura intralobular septae). They are rare in children. These are absent in the presence of pneumothorax. (SN 60%, SP 60%)

COMET TAIL ARTIFACT



R = Rib

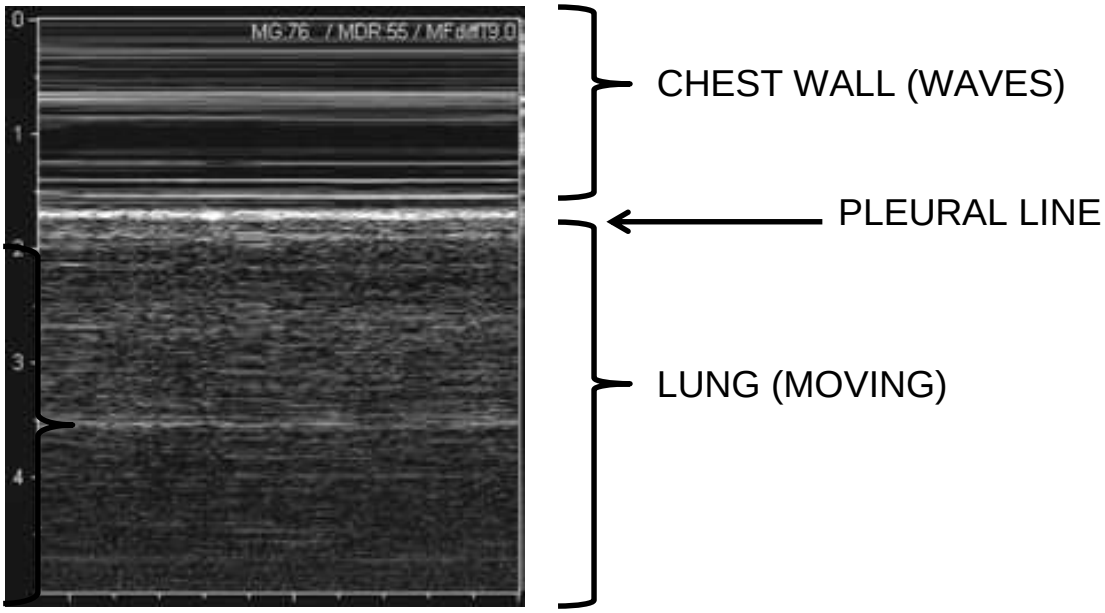
* Pleural line

> Comet tail artifact

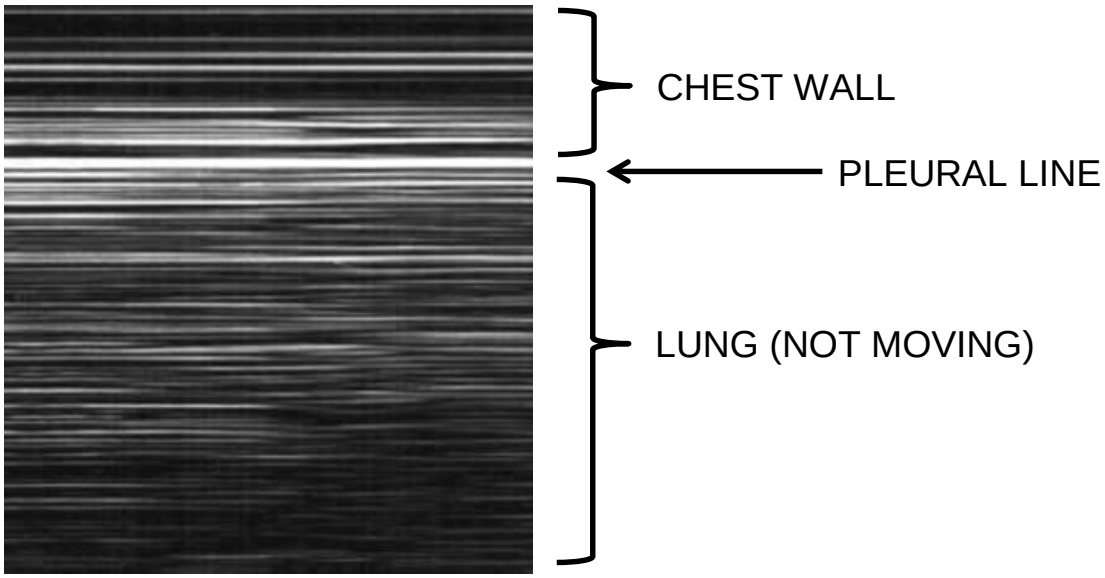
M MODE

In a normal patient the upper half of the image in m-mode is the non-mobile chest wall and the lower half of the image is the mobile lung. Normal lung sliding will result in a grainy image below (the beach of the sandy beach sign) while the non-mobile chest wall results in a wavy appearance.

WAVY OR SANDY BEACH (NORMAL)



STRATOSHERE SIGN OR BAR CODE (PNEUMOTHORAX)



IMAGING ALGORITHM: BLUNT ABDOMINAL TRAUMA