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71.1 Indications

- Blunt abdominal or chest trauma
- Penetrating abdominal or chest trauma
- Undifferentiated hypotension
- The “E” in EFAST refers to the “extended” ability to detect lung pathology such as a pneumothorax or hemothorax during the otherwise standard trauma FAST exam using the same equipment with or without an additional transducer probe.
- Specific findings that can be detected on extended focused assessment with sonography for trauma (EFAST):
 - Pericardial fluid
 - Pleural fluid
 - Free intraperitoneal fluid
 - Pneumothorax
- Free fluid appears as anechoic or black.

71.2 Contraindications

- Need for immediate operative intervention

71.3 Materials and Medications

- Ultrasound machine
- Probe(s): phased array probe (5 to 1 MHz) or curved array probe (5 to 2 MHz)
 - Phased array has a smaller footprint, allowing easier access between intercostal spaces (Fig. 71.1); however, curved array provides better resolution of images



Fig. 71.1 Phased array transducer (P17) with a small footprint that is helpful to fit between the ribs and can be used for focused assessment with sonography for trauma (FAST) examination

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(Fig. 71.2). The linear array transducer (L38, 10–5 MHz) is good for lung images.

- Gel
- Skilled ultrasound operator
- ± Laboratory work, cardiac monitor, and two large-bore intravenous (IV) needles
 - All trauma alerts and unstable patients must have all of these.



Fig. 71.2 Curved array transducer (C60) with a larger footprint and better resolution for deeper imaging that can be used for FAST examination as well as lung examination

71.4 Procedure

1. Ultrasound machine in the abdominal preset.
2. Patient in the supine position.
3. Phased array or curved array probe for focused assessment with sonography for trauma (FAST) and linear array for lung.
4. Begin scanning the patient in a systematic fashion.
 - All the views should be scanned by thoroughly sweeping through the area in question in order to maximize the information obtained.
 - All views should be obtained in the same order every time.
 - Obtain all four views, five views if pneumothorax is included.

71.4.1 Subxiphoid Four-Chamber View (Fig. 71.3)

1. Examine for free pericardial fluid.
 - Anechoic (black) stripe seen between the myocardium and the pericardium
2. Probe is placed in the subxiphoid area.
3. Indicator is to the patient's right.
4. Probe is directed toward the patient's left shoulder.
5. Use a shallow angle in the head to feet direction.
6. Should adequately visualize the following:
 - Liver edge superficially
 - Right ventricle
 - Left ventricle
 - Right atrium
 - Left atrium
7. If unable to obtain this view, proceed to *parasternal long-axis view*:
 - Probe is placed perpendicular at the left parasternal border.
 - Third to fourth intercostal space.
 - Indicator is to the patient's right shoulder.
 - Coronal section through the heart's long axis should adequately visualize the following:
 - Right ventricle most superficially
 - Left ventricle
 - Mitral valve
 - Left atrium
 - Aortic valve
 - Aortic outflow tract



Fig. 71.3 (a) Image shows how to obtain the subxiphoid four-chamber view of the heart using the curved array transducer (C60) (Photograph courtesy of F. Eike Flach, MD). (b) Ultrasound image of four-chamber view of the heart (Used with permission from First aid for the emergency medicine clerkship 3rd Ed, McGraw Hill, 2011.) *RV* right ventricle, *LV* left ventricle, *RA* right atrium, *LA* left atrium

71.4.2 Right Upper Quadrant View (Fig. 71.4)

1. Examine for free fluid in all of the following areas:
 - Right intrathoracic space
 - Anechoic area above the diaphragm
 - Morison's pouch: hepatorenal space
 - Anechoic stripe between the liver and the kidney
 - Right paracolic gutter
 - Anechoic collection surrounding the inferior tip of the kidney
2. Probe is placed in the midaxillary line on the right.
3. Indicator is directed toward the patient's head.
4. Probe is in the coronal plane, angle can be aimed obliquely while scanning anterior to posterior.

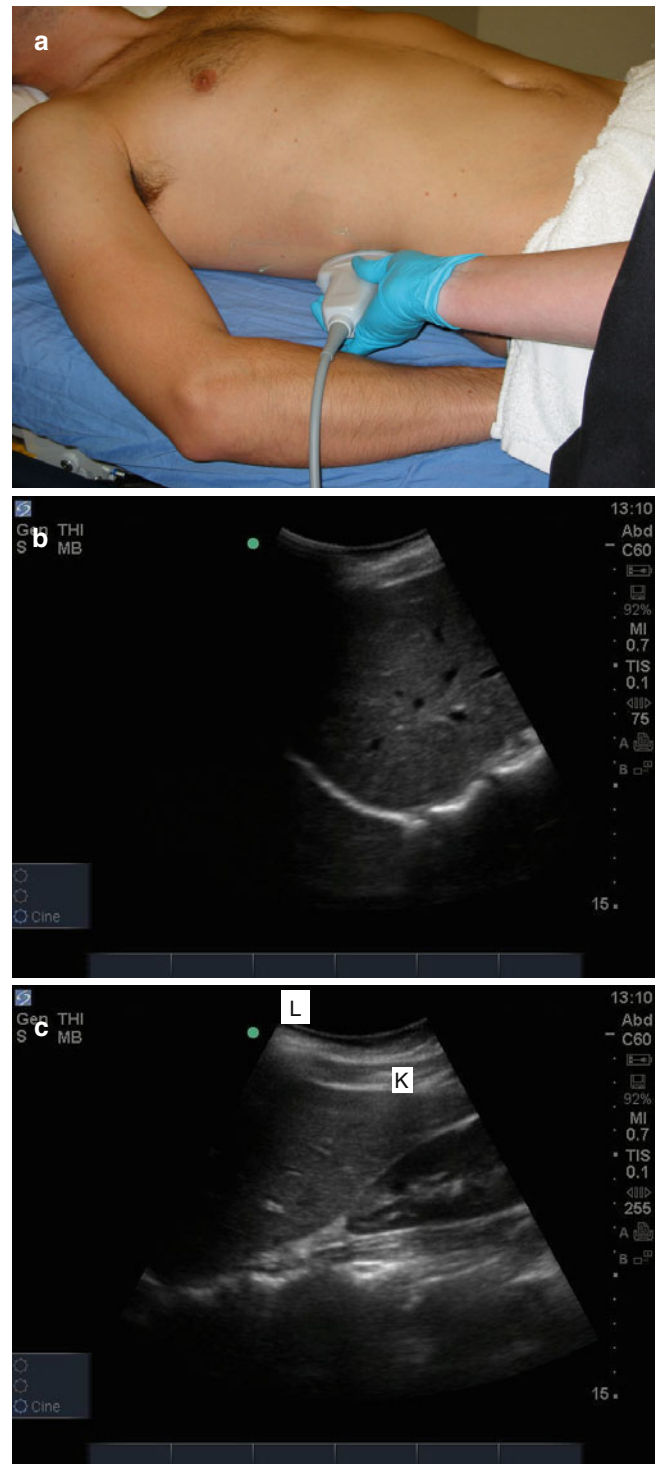


Fig. 71.4 (a) Image shows how to obtain the right upper quadrant view of the FAST exam using the curved array transducer (C60). The probe is aimed slightly obliquely in the coronal plane to get a better view between the ribs (Photograph courtesy of F. Eike Flach, MD). (b) Ultrasonographic view of the liver. (c) Ultrasonographic view of the liver–kidney interface (Morrison's pouch). *L* liver, *K* kidney

71.4.3 Left Upper Quadrant View (Fig. 71.5)

- Examine for free fluid in all of the following areas:
 - Left intrathoracic space
 - Anechoic area above the diaphragm
 - Subphrenic space
 - Anechoic stripe below the diaphragm and above the spleen
 - Splenorenal space
 - Anechoic stripe between the spleen and kidney
 - Left paracolic gutter
 - Anechoic collection surrounding the inferior tip of the kidney
- Probe is placed in the midaxillary line on the left.
- Indicator is directed toward the patient's head.
- Probe in the coronal plane, angle can be aimed obliquely while scanning anterior to posterior.

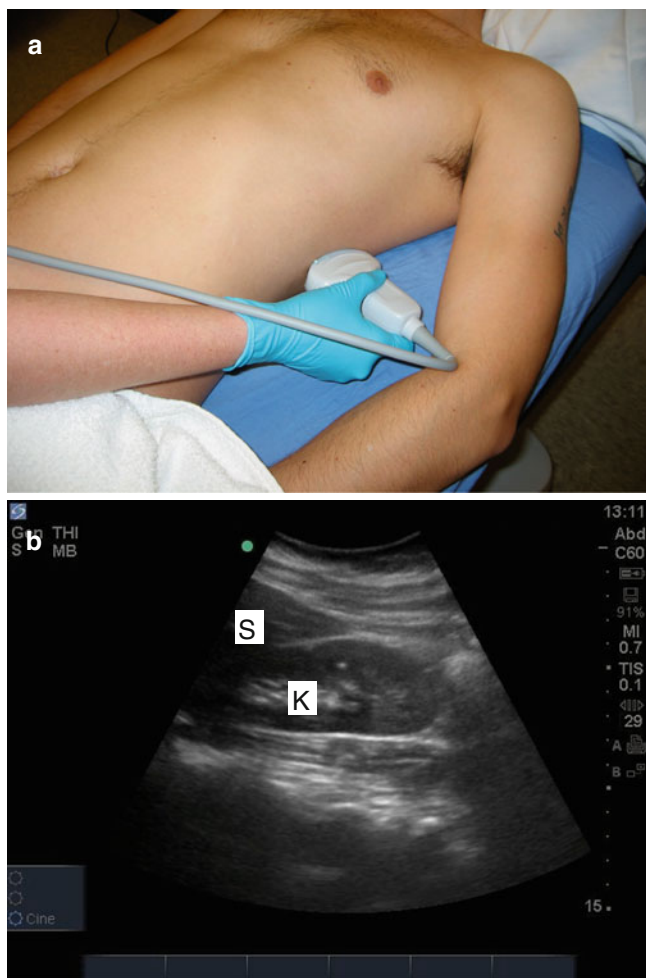


Fig. 71.5 (a) Image shows how to obtain the left upper quadrant view of the FAST examination using the curved array transducer (C60). Again, the probe is aimed slightly obliquely and is placed more superiorly in the midaxillary line (Photograph courtesy of F. Eike Flach, MD). (b) Ultrasonographic view of spleen–kidney interface. *S* spleen, *K* kidney

71.4.4 Pelvic View (Figs. 71.6 and 71.7)

- Examine for intraperitoneal free fluid in the pelvis:
 - Anterior pelvis, above the bladder
 - Anechoic fluid above the bladder
 - Posterior cul-de-sac (pouch of Douglas)
 - Anechoic fluid posterior to the bladder or uterus
- Probe is placed above the pubic symphysis over the bladder.
- Scan through in both planes:
 - Transverse plane (Fig. 71.6)
 - Indicator is to the patient's right.
 - Scan through the bladder in the head to feet direction.
 - Sagittal plane (Fig. 71.7)
 - Indicator is aimed to the patient's head.
 - Scan through the bladder in a right to left direction.



Fig. 71.6 Transverse pelvic view of the FAST examination using the phased array transducer (P17). With gentle force, the probe is pressed downward in order to look back behind the pubic symphysis and view the bladder (Photograph courtesy of F. Eike Flach, MD)

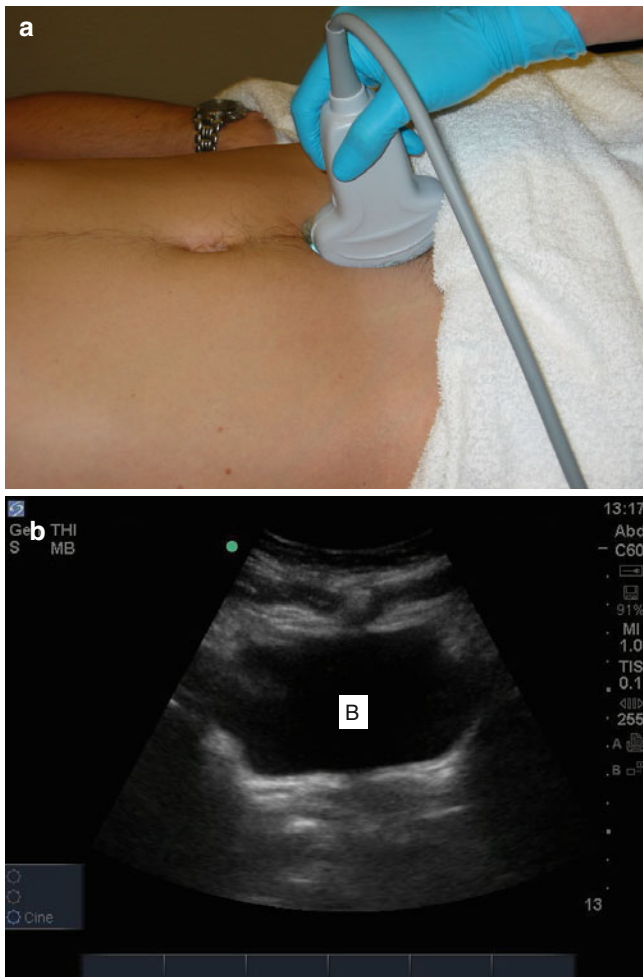


Fig. 71.7 (a) Sagittal pelvic view of the FAST exam using the curved array transducer (C60). With gentle force, the probe is pressed downward in order to look back behind the pubic symphysis and view the bladder (Photograph courtesy of F. Eike Flach, MD). (b) Ultrasonographic view of the bladder. *B* bladder

71.4.5 EFAST with Lung Views (Figs. 71.8 and 71.9)

1. Examine for pneumothorax:
 - Lung sliding
 - Absence: pneumothorax
 - Presence: normal lung
 - M mode tracing
 - Stratosphere sign: pneumothorax
 - Seashore sign: normal lung
2. Probe is placed on the anterior chest in the midaxillary line.
3. Level of the second to fourth intercostal spaces.
4. Sagittal position.
5. Center the probe over the pleural line between the ribs.
 - Find the rib and then slide the probe toward the head or feet to center the pleural line.
6. Observe for lung sliding.
7. Press M mode and move the line over the pleural line and press M mode again to get the tracing.
8. Examine multiple other areas anteriorly, moving distally, and in midaxillary line laterally, moving from superior to inferior.



Fig. 71.8 Right lung view of the extended focused assessment with sonography for trauma (EFAST) examination using the linear array transducer (L38). The probe is placed in the sagittal plane on the anterior chest in the midaxillary line approximately at the second intercostal space and centered over the pleural line (Photograph courtesy of F. Eike Flach, MD)



Fig. 71.9 Left lung view of the EFAST examination using the linear array transducer (L38) (Photograph courtesy of F. Eike Flach, MD)

71.5 Complications

- Overreliance on ultrasound to rule out abdominal injury:
 - FAST examinations do not detect retroperitoneal bleeding, solid organ injury, contained subcapsular hematomas, and bowel injuries.
- Not scanning through the object in question could lead to false-negative results.

71.6 Pearls and Pitfalls

- Always follow the ABCs (airway, breathing, circulation) first in any unstable patient.
- Always make sure the depth is set adequately.
 - Recommend starting deeper to make sure positive findings are not missed and then adjustments can be made from there.
- The curved array probe may be used throughout the entire EFAST for convenience if necessary.

71.6.1 Subxiphoid Four-Chamber View

- For larger body habitus, need to parallel the probe with the body in the subxiphoid area and use firm pressure to press the entire probe downward so as to look up under the xiphoid process at the heart.
- Moving the entire probe more to the patient's right in the subxiphoid area while still looking toward the left shoulder may improve visualization by using the liver as a window.
- Fat pad:
 - May be mistaken for pericardial fluid
 - Contains echoes and, therefore, is hypoechoic rather than anechoic
 - Should only be present anteriorly
 - Fluid should be gravity dependent, completely encircling the heart, and seen in multiple views.

71.6.2 Right Upper Quadrant View

- Normal artifacts of mirroring and loss of the spine are obscured when pleural fluid is present and, instead, the anechoic fluid is seen and there is loss of mirroring and continuation of the spine.

71.6.3 Left Upper Quadrant View

- Same as right upper quadrant view
- May be more difficult view to find than in right upper quadrant view for all of the following:
 - Spleen and kidney are more posterior and superior than in right upper quadrant view.
 - Spleen is smaller and less of a window for viewing.

71.6.4 Pelvic View

- Bowel can be mistaken for free fluid or vice versa, but holding the probe still and observing can sometimes help distinguish the two.
 - Peristalsis will occur with bowel.
 - Internal echoes may be present in bowel.

71.6.5 Lung Views

- Ultrasound is more sensitive than a supine portable chest x-ray.
 - Apex anteriorly in midaxillary line.
- Rib
 - Hyperechoic horizontal line with a dense shadow posteriorly
 - Evenly spaced along the chest

- Pleural line
 - First hyperechoic line deep to the rib.
 - Actually includes the visceral and parietal pleura, but appears as one line.
 - Lung sliding is present in normal lung.
 - Comet tail artifact.
 - M mode tracing will be the same in normal lung and pneumothorax above the pleural line and different below the pleural line.
 - Seashore sign (Fig. 27.5a):
 - Appears as waves washing up on the shore.
 - Granular appearance represents movement.
 - Stratosphere sign (Fig. 27.5b):
 - Appears as straight lines
 - Bar code appearance

Selected Reading

- Brunett P, Cameron P. Trauma in adults. In: Tintinalli J, Stapczynski J, Ma OJ, Cline D, Cydulka R, Meckler G, editors. *Emergency medicine: a comprehensive study guide*. 7th ed. New York: McGraw Hill; 2012. p. 1671–5.
- Ma JO, Mateer JR, Blaivas M. Trauma. In: *Emergency ultrasound. Course Materials*; New York, NY: McGraw Hill; 2008. pp. 7–109.
- Saul T, Rivera M, Lewiss R. Ultrasound image quality. *ACEP News*. 2011;4:24–5.