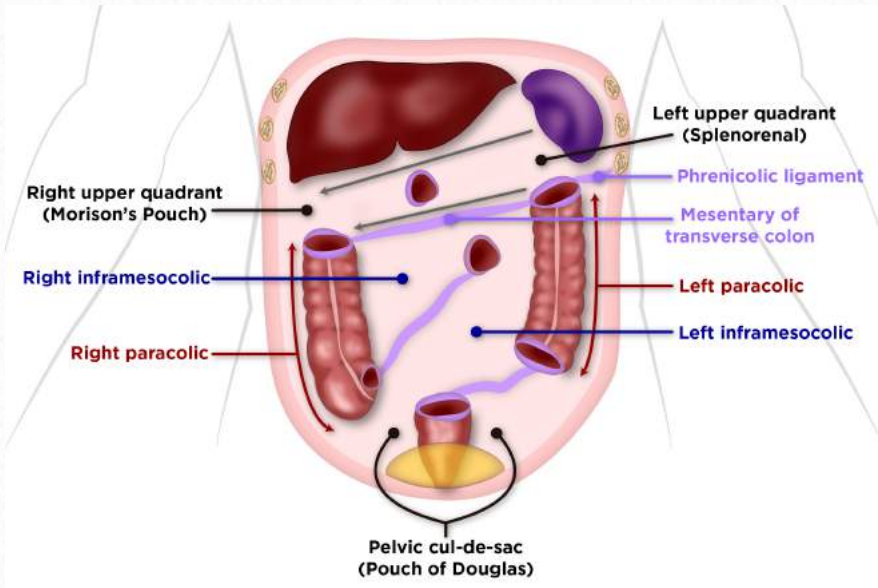
D. FAST (FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA) EXAM

Many trauma patients have injuries that are not apparent on the initial physical exam. Studies have shown that 20-40% of patients with significant abdominal injuries may initially have a normal physical examination of the abdomen. The purpose of bedside ultrasound in trauma is to rapidly identify free fluid (usually blood) in the peritoneal, retroperitoneal, pericardial, or pleural spaces. To review, the peritoneum is the serous membrane that forms the lining of the abdominal cavity and overlies most of the intra-abdominal organs. Because of this peritoneal layer, one is able to appreciate the collection of fluid between organs within the peritoneum, behind (retro-peritoneal), and below it (infra or sub-peritoneal). Peritoneal organs include: stomach, spleen, liver, pancreas (only the tail), parts of the colon, uterus, fallopian tubes, and ovaries. Retroperitoneal structures include: kidneys, IVC, aorta, and part of the colon. Infraperitoneal structures include: bladder and distal rectum.

The FAST exam has been shown to be able to very reliably detect >200ml of fluid in body cavities. Indications for the FAST exam include acute blunt or penetrating torso trauma, trauma in pregnancy, pediatric trauma (details below), and subacute torso trauma. To successfully perform the FAST exam one must have a basic understanding of hemorrhage and ultrasound. The sonographic evolvement of hemorrhage depends on time of insult. Initially, the free fluid is sonolucent (black). Clot forms in 2 to 4 hours and becomes more echogenic (more gray), and it returns to being more sonolucent (black) with fibrinolysis over 12-24 hours. On ultrasound, free fluid appears as “pointy,” not circular as if it was contained in a walled organ or structure, and forms around bowel and viscera.

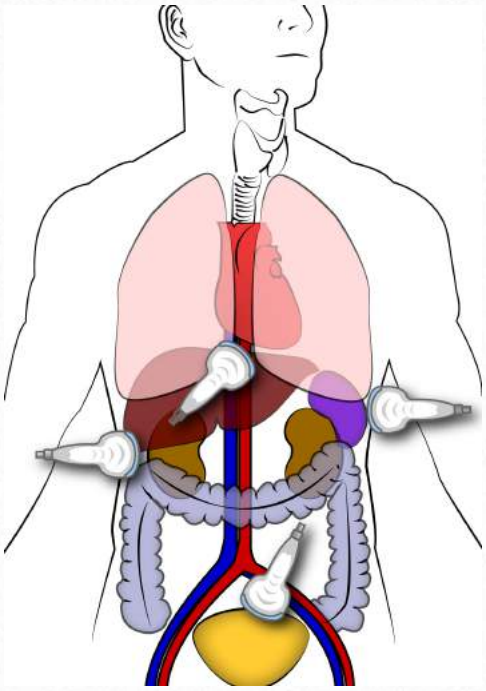
It is important to understand that free intraperitoneal fluid tends to collect in areas formed by peritoneal reflections and mesenteric attachments (paracolic gutters). Specifically, for the upper abdomen this dependent area is called Morison’s pouch. This is the collection site for abdominal injury since the paracolic gutters empty here (see picture below). This area corresponds to the interface of the liver and the R kidney. Here, blood initially develops at the tip of the liver and then progresses to separate the liver and the R kidney. Regarding LUQ injuries, free intraperitoneal fluid will tend to accumulate in the left subphrenic space first (not the splenorenal recess) due to the phrenicocolic ligaments; only on rare occasions, when large amounts of fluid are present, will free fluid occur between the spleen and the kidney. However, because of the paracolic gutters LUQ injuries will still produce a free fluid collection in R Kidney/Liver Interface (Morison’s pouch). *Again, the phrenicocolic ligament restricts the flow of free fluid between the left paracolic gutter to the (LUQ, so fluid actually spreads across the midline into the RUQ.* This is why the RUQ view is the most important in the assessment of upper abdominal injuries.

For *lower abdominal* injuries, the pelvic (suprapubic) view is the most useful. With this view, you are trying to exam the most dependent area of the lower abdomen in the supine patient, which is in the pelvic cul-de-sac (Pouch of Douglas). A good rule of thumb volume of free fluid is 1 cm of hypoechoic space = 150ml.



Probes Used for FAST Exam:

Standard FAST Exam Views:

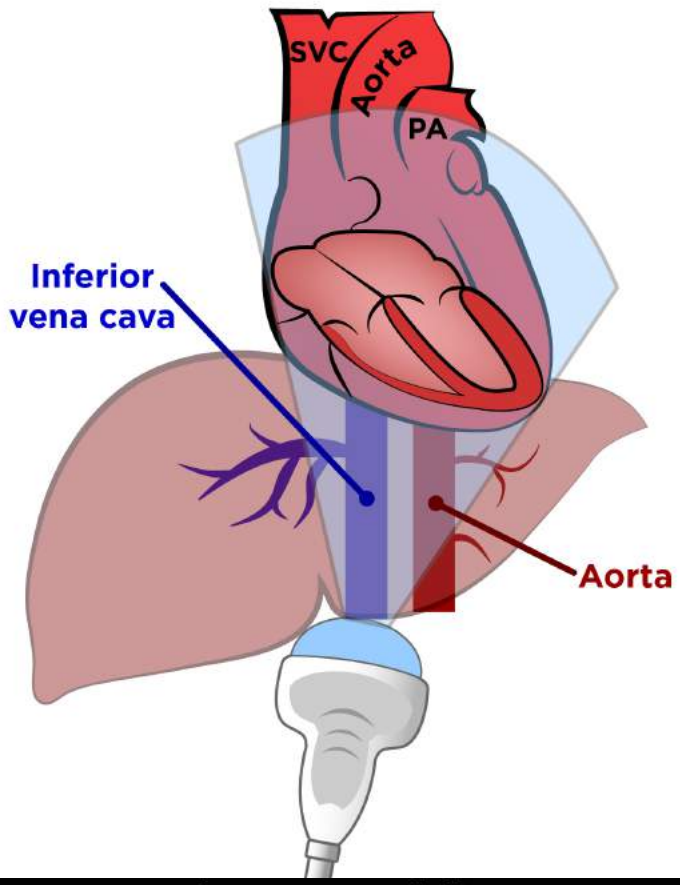


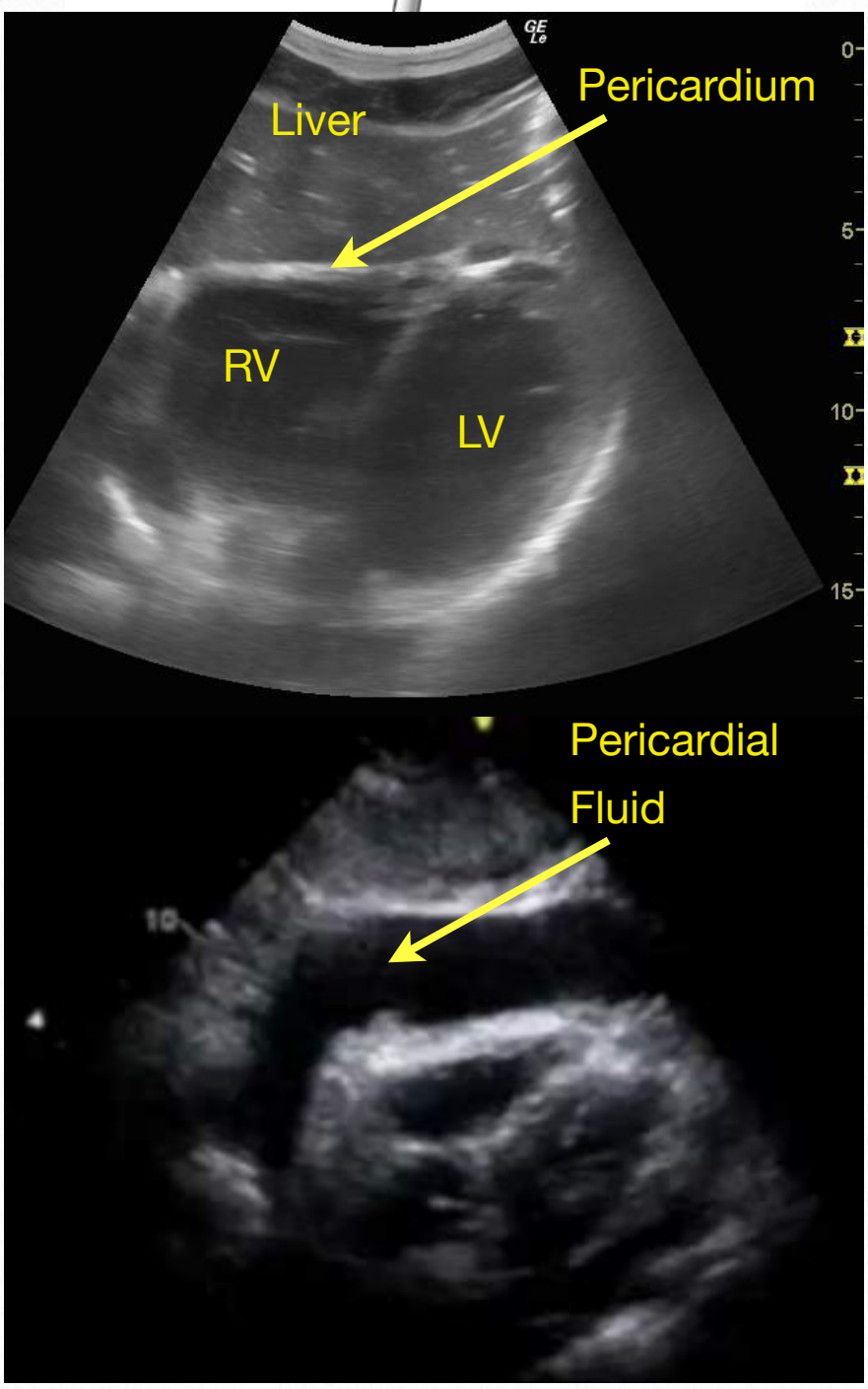
1) Pericardial View:

This view is used to look at the interface between the right ventricle and the liver to identify pericardial fluid; the goal for this portion of the FAST exam is the identification of cardiac tamponade. Please note that a small (less than 0.3 cm) collection of fluid may be normal. Normal pericardium is seen as a hyperechoic (white) line surrounding the heart. Also, please note that if a pericardial or subxiphoid view is not obtainable one can assess for tamponade in the parasternal long axis and short axis views (to be discussed in the cardiac section). Scans may be limited secondary to obesity, protuberant abdomen, abdominal tenderness, gas, as well as pneumoperitoneum/pneumothoraces.

Patient Position: Supine with knees/hips flexed in to decrease tension on the subxiphoid space.

Probe Position: Probe (either phased array or curved linear) in the subxiphoid area and angled toward the patient's left shoulder, with the pointer at 3 o'clock position. To visualize the heart, the transducer should be almost parallel to the skin of the torso. Also, to view the heart you may need to press firmly just inferior to the xiphoid process. You may need to move the transducer further to the patient's right in order to use the liver as an acoustic window. The image may be optimized by asking the patient to take a breath in and "hold it". This causes the diaphragm to flatten and decreases the depth of penetration required to produce the image.



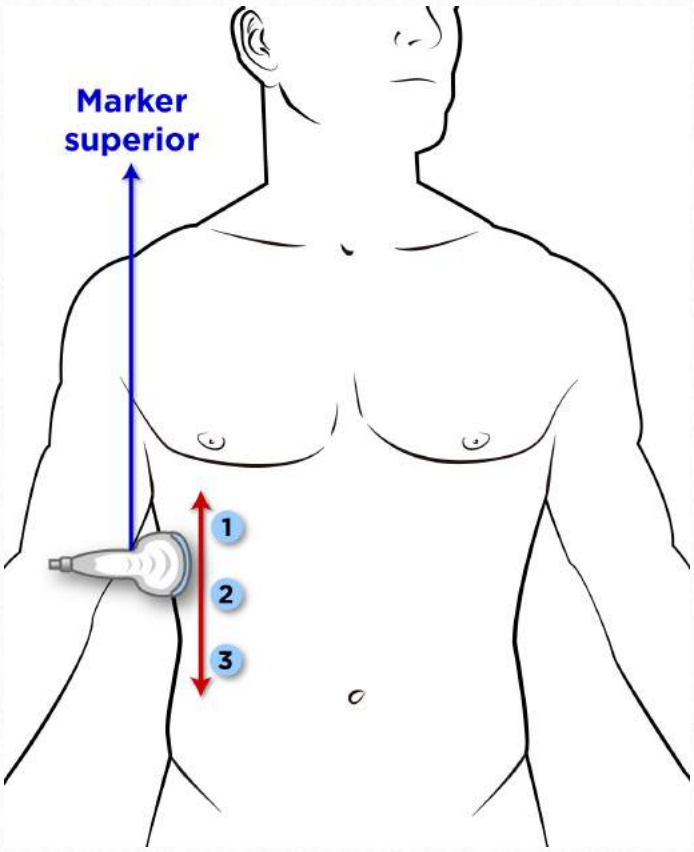


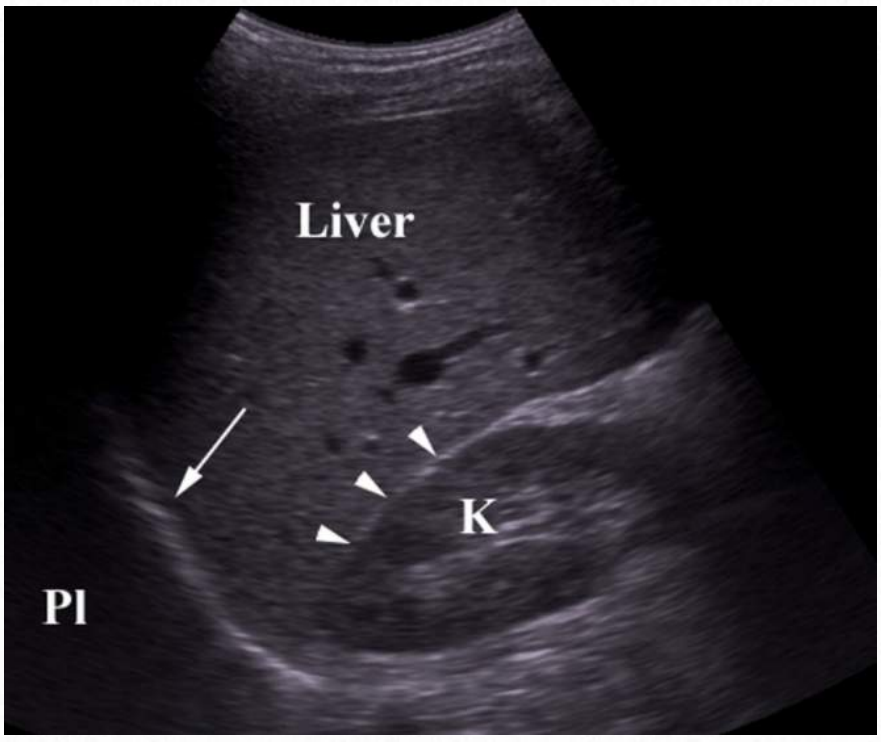
2) Perihepatic (RUQ) View:

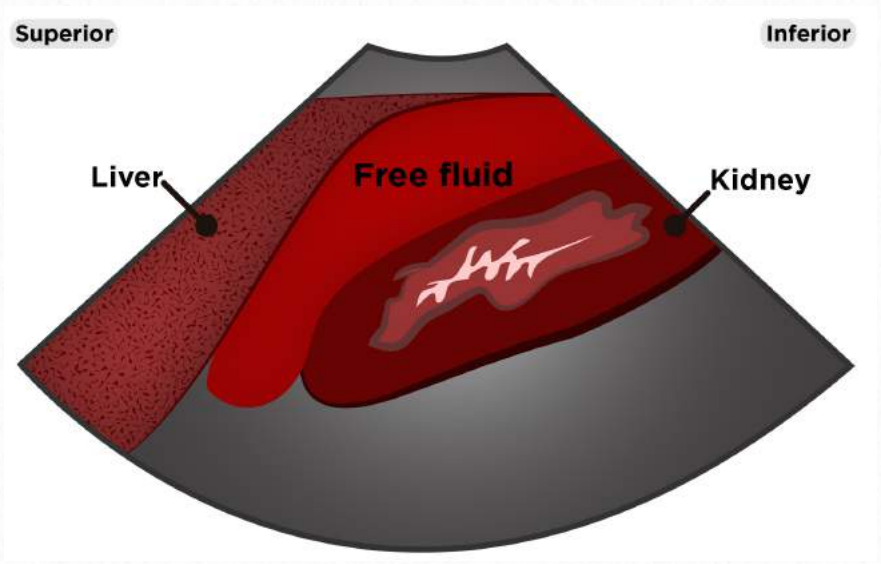
As stated above, this view is the most important view of the FAST exam pertaining to the assessment of abdominal injury secondary to the way free fluid drains in the abdomen. Here, we are evaluating Morison's pouch, which is the *potential space* between the liver and the right kidney. In this location there are 4 areas that you want to evaluate for free fluid: 1) Pleural Space, 2) Infra-diaphragmatic space, 3) Hepatorenal Interface (Morison's Pouch), and 4) Caudal Liver Tip.

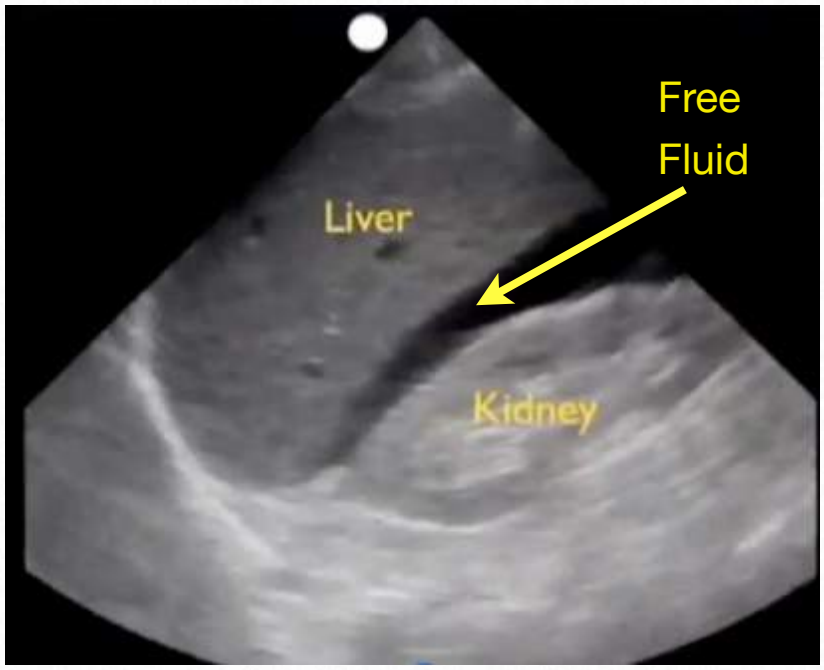
Patient Position: Supine, if possible, tilting the patient slightly toward their left side may make sonography easier.

Probe Position: Probe (either phased array or curved linear) should be placed with the indicator pointing around the 10 to 12 o'clock position perpendicular to last true rib (right costal margin) at the right mid-clavicular line, then sliding down to the midaxillary line. *Final probe position should be mix-axillary line - 10th rib space.* One should then move the probe inferiorly to the to liver/kidney interface (Morison's pouch). Following this movement pattern one rib space above and below will allow you to see the infra-diaphragmatic space and caudal liver tip, respectively. The liver appears homogenous, with medium-level echogenicity, and the kidneys have a brightly echogenic surface with hy-poechoic core.









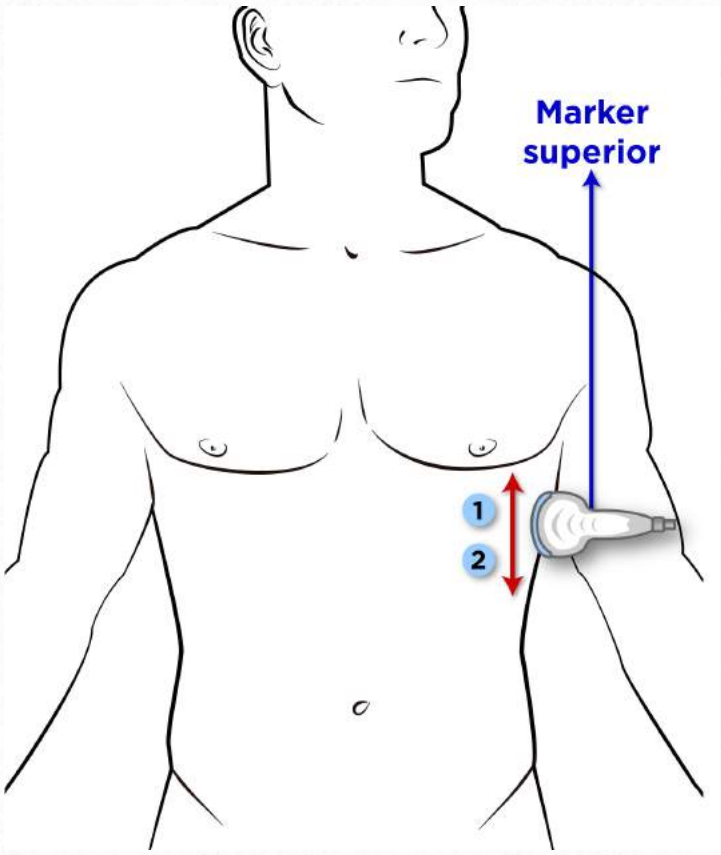
3) Perisplenic (LUQ) View:

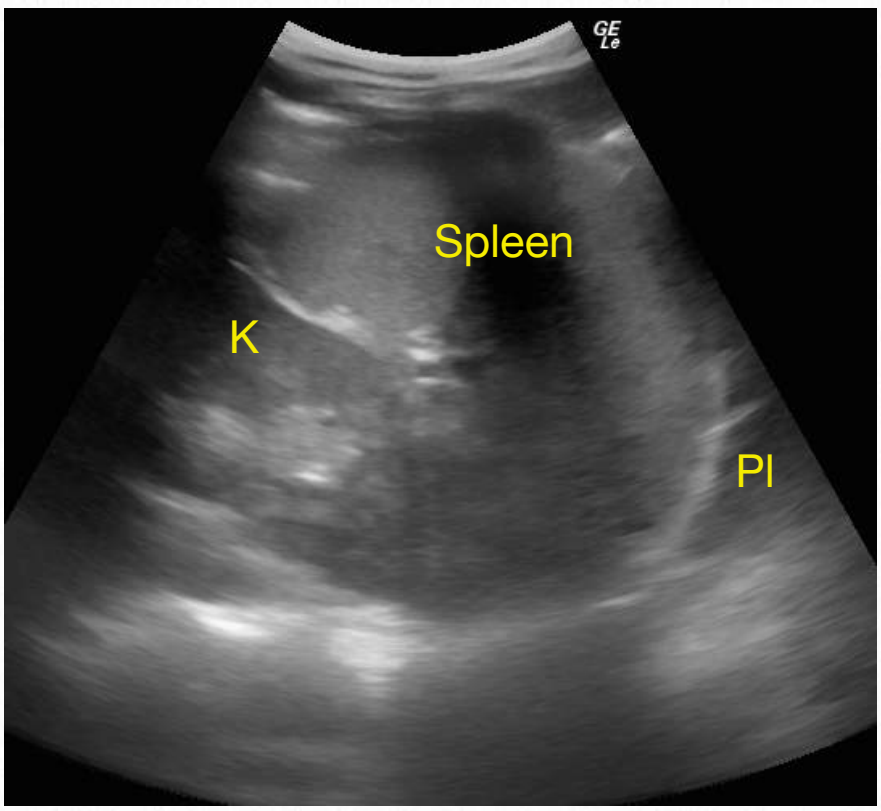
This view can be the most challenging to obtain in the FAST exam. As stated, with LUQ injuries free intraperitoneal fluid will tend to accumulate in the *left subphrenic space first* (not the splenorenal recess) due to the phrenicocolic ligaments; only on rare occasions, when large amounts of fluid are present, will free fluid occur between the spleen and the kidney. Also, the phrenicocolic ligament restricts the flow of free fluid from the left paracolic gutter to the LUQ, so fluid actually spreads across the midline into the RUQ. This is why the RUQ view is the most important in the assessment of upper abdominal injuries. Regarding LUQ ,there are 4 areas that you want to evaluate for free fluid: 1) Pleural Space, 2) Infradiaphragmatic space, 3) Splenorenal recess, and 4) Inferior pole of the kidney/paracolic gutter.

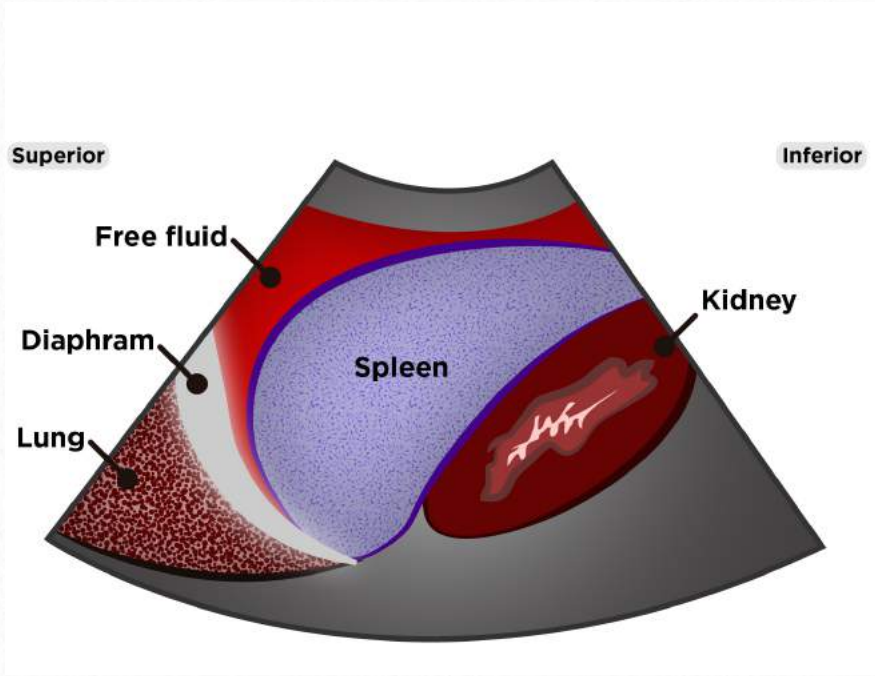
Patient Position: Supine, if possible, tilting the patient slightly to their right side may make sonography easier.

Probe Position: Probe (either phased array or curved linear) should be placed with the indicator pointing around the 12 to 2 o'clock position perpendicular to ribs at the posterior axillary line - 8th rib space (always angle probe *with the ribs)*. One should then move the probe posteriorly to the spleen/kidney interface at the posterior axillary line. Once the interface is obtained scan one rib space above and below; remember that the spleen sits a little more posterior and superior than the liver. If unable to visualize spleen/kidney one usually needs to aim the probe more posterior (your hand should be on the bed). The spleen is much more homoge-

nous on US then the kidney and it contains a echogenic (bright) capsule.







4) Pelvic (Suprapubic) View:

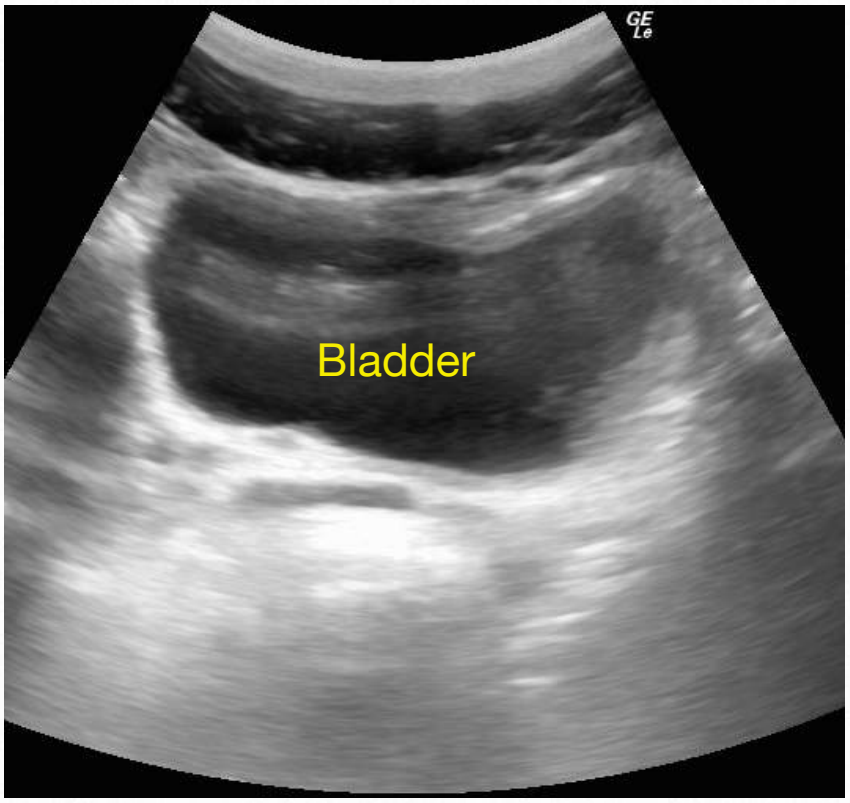
This view is used to assess for free fluid in lower abdomen by scanning the most dependent area of the abdomen, which is the area around the bladder (Pouch of Douglas). Because this is the most dependent area, this view can detect the least amount of fluid. However, note that RUQ is still the most sensitive given the system of paracolic gutters and the ease of identification. It is very important to scan this view in both the long and short axis (see below) to assess the entire Pouch of Douglas. In addition to the assessment of free fluid, one can use these views to determine bladder volume by the following equation: 0.7 x (supero-inferior diameter) x TS (maximum transverse diameter) x AP (maximum anteroposterior diameter).

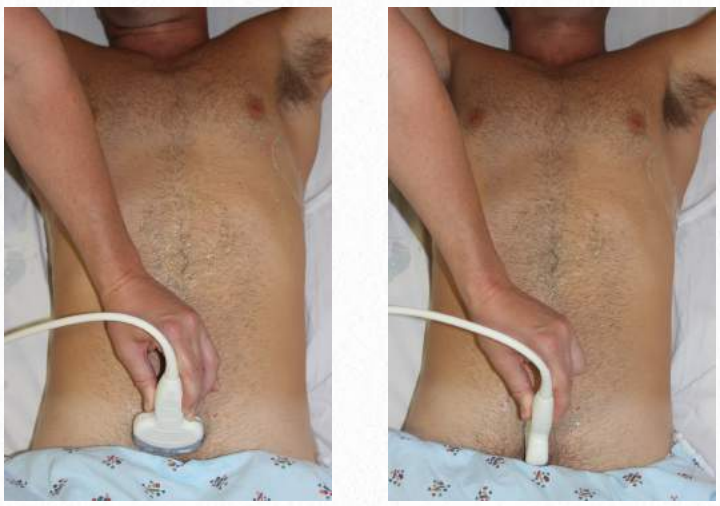
There are many findings that can cause one to inaccurately diagnose free pelvic fluid, making this view difficult. For example, fluid within a collapsed empty bladder or an ovarian

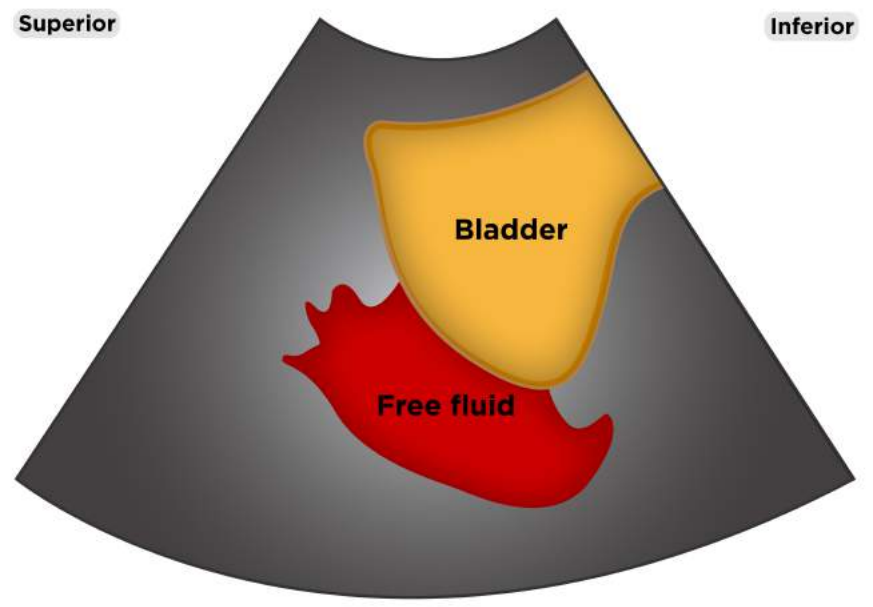
cyst may look like free fluid. Also, premenopausal females may normally have a small amount of free fluid in this area. To best identify free fluid, one needs a full bladder (which may be difficult with a trauma patient). Regarding free fluid development, the first sign of blood is often two small black triangles on either side of the rectum, the “bow tie sign,” which then connect below the bladder.

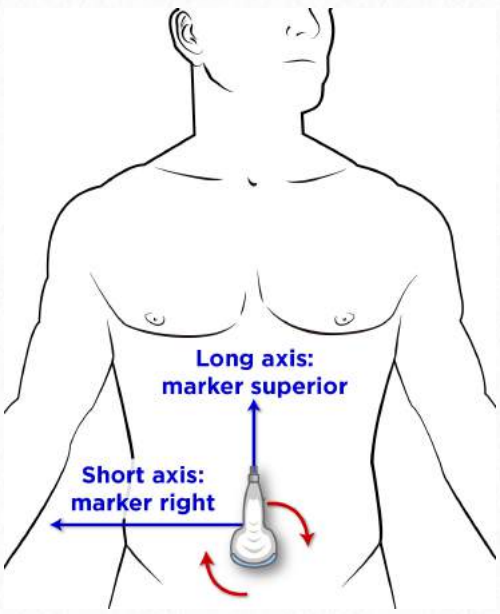
Patient Position: Supine

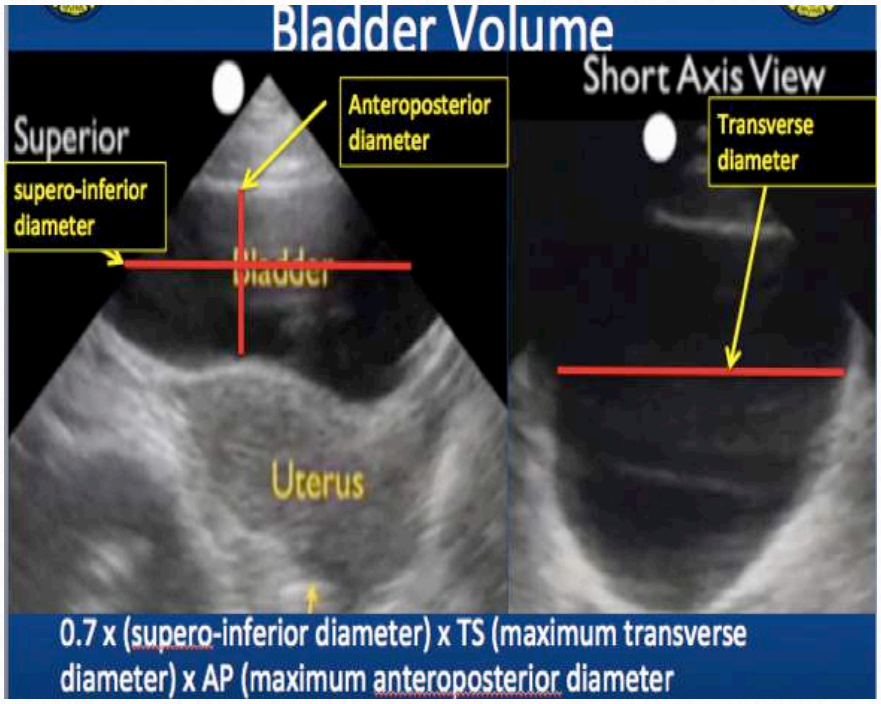
Probe Position: Probe (either phased array or curved linear) should be placed 2cm superior to the symphysis pubis along the midline of the abdomen. At this position one should sweep the bladder by obtaining both short and long axis views (see below). In the longitudinal plane, one should scan side to side to identify pockets of free fluid between bowel loops.










Bladder Volume
Short Axis View
Superior
Anteroposterior diameter
supero-inferior diameter
Transverse diameter
Uterus
0.7 x (supero-inferior diameter) x TS (maximum transverse diameter) x AP (maximum anteroposterior diameter