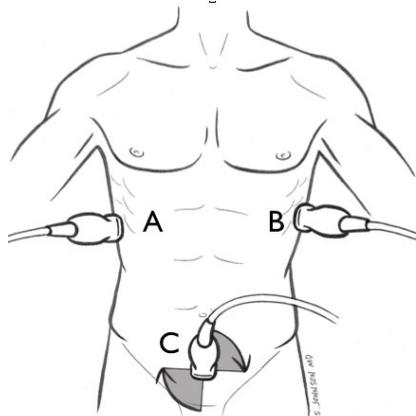


Rapid Ultrasound in SHock: The RUSH Protocol

Figure 1. Evaluation of the Tank
FAST Exam Views



- A. Right upper quadrant
(add pleural view)
- B. Left upper quadrant
(add pleural view)
- C. Suprapubic

FAST = focused assessment with sonography
in trauma

EVALUATION FOR “LEAKINESS OF THE TANK”

Last month, we discussed part 2 of the RUSH protocol, the evaluation of the “tank,” focusing on “tank fullness.” This month, we look at “leakiness of the tank,” or how the core vascular volume circuit may be compromised by extravasation of fluid into the abdominal/pelvic or thoracic compartments (Figure 1). We present two clinical cases to highlight the utility of this part of the RUSH exam.

CASES

A 21-year-old man presents to the ED with abdominal pain, nausea, and weakness. He reports that 2 days prior, he was sparring in karate practice and fell several times; however, he did not immediately notice any undue pain. To complicate matters, he has had a sore throat and chills for the past 2 weeks. His vital signs include a blood pressure of 88/70 mm Hg; heart rate, 110 bpm; respiratory rate, 20 breaths/min; and temperature, 37.8°C. His abdomen is tender to palpation in all quadrants with guarding.

A 54-year-old woman presents with abdominal pain, weakness, and shortness of breath. She has a history of liver disease (hepatitis C) and kidney disease. She seems confused on evaluation and is slow to respond to your questions. Her

vital signs include a blood pressure of 80/58 mm Hg; heart rate, 120 bpm; respiratory rate, 24 breaths/min; and temperature, 38.3°C. Rales are present on auscultation, and abdominal examination reveals tenderness in all quadrants, but with no rebound or guarding.

Both of these patients have abdominal pain and appear to be in shock. They require a rapid evaluation that will correctly diagnose their condition and classify their shock state into one of the four main categories: hypovolemic, distributive, cardiogenic, or obstructive. To facilitate the evaluation, you bring the ultrasound machine to the bedside and perform the RUSH exam, beginning with part 1: evaluation of the “pump.” On evaluation, the left ventricles of both patients appear to be contracting vigorously. This finding, coupled with the tachycardia found in both patients, denotes a hyperdynamic heart. No pericardial effusion is found, and in each patient the right ventricle appears smaller than the left ventricle. Moving to part 2 of the RUSH protocol, evaluation of the “tank,” you assess the “fullness of the tank,” performing sonography of the inferior vena cava and jugular veins. The findings are consistent with



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a low central venous pressure (CVP) in the first patient and a high CVP in the second. This sets the stage for step 2 of the evaluation of the “tank,” or “assessment of tank leakiness.”

DISCUSSION

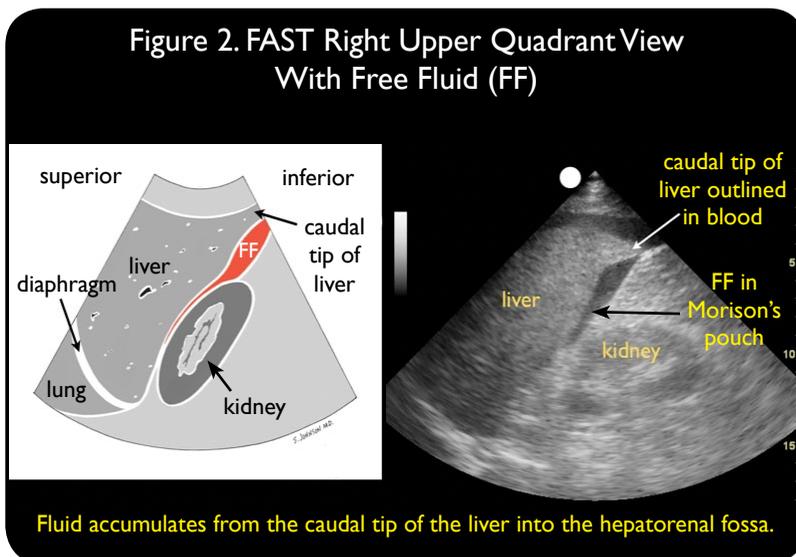
This part of the RUSH protocol assesses for free fluid within the abdominal/pelvic and chest cavities by using the standard FAST exam (focused assessment with sonography in trauma) in combination with additional views looking for pleural fluid; this combination is referred to

as the *extended FAST (E-FAST) exam*. The FAST exam traditionally comprises four ultrasound views: the right and left upper quadrant, suprapubic, and cardiac views. The cardiac views were described in the “Emergency Ultrasound” installments discussing evaluation of the “pump” (see the September–November 2009 issues). The E-FAST views are easily added to the standard FAST exam by angling the probe superiorly from the right and left upper quadrant positions to look above the diaphragm into the thoracic cavity for fluid, a technique that will be further described below.

The right upper quadrant view traditionally has been termed the *Morison’s pouch view*. Optimally, this exam is performed using a small footprint probe, which can easily be positioned between the ribs. The probe is placed in a long-axis configuration, with the marker oriented superiorly, at about intercostal space 8 in the anterior axillary line. Once the liver comes into view, the probe can be angled posteriorly to investigate the hepatorenal space. This interface between the liver and kidney represents a potential space, known as Morison’s pouch, where fluid may accumulate. Fresh fluid in Morison’s pouch appears as a dark, or anechoic, stripe, while clotted blood may appear brighter, or more hyperechoic.

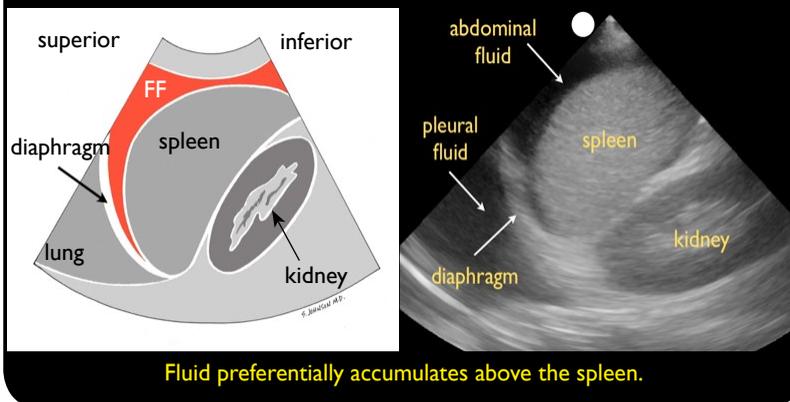
The need to evaluate Morison’s pouch is commonly emphasized; however, it is also important to closely examine the area surrounding the caudal tip of the liver. This area represents the start of the right paracolic gutter, and fluid may be seen here before it pools in Morison’s pouch (Figure 2). Additionally, the probe should be moved superiorly from Morison’s pouch to allow visualization of the area between the liver and the diaphragm. Since fluid may not be visible in Morison’s pouch until a relatively large amount has accumulated (thought to be about 600 cc), these alternate areas of the right upper quadrant should not be overlooked, as their evaluation may allow a lesser amount of fluid to be identified. The probe should next be angled upwards above the diaphragm to detect thoracic fluid.

For the second view of the FAST exam, the left upper quadrant view, the probe is placed into intercostal space 7 in the midaxillary line, with the probe marker oriented superiorly.



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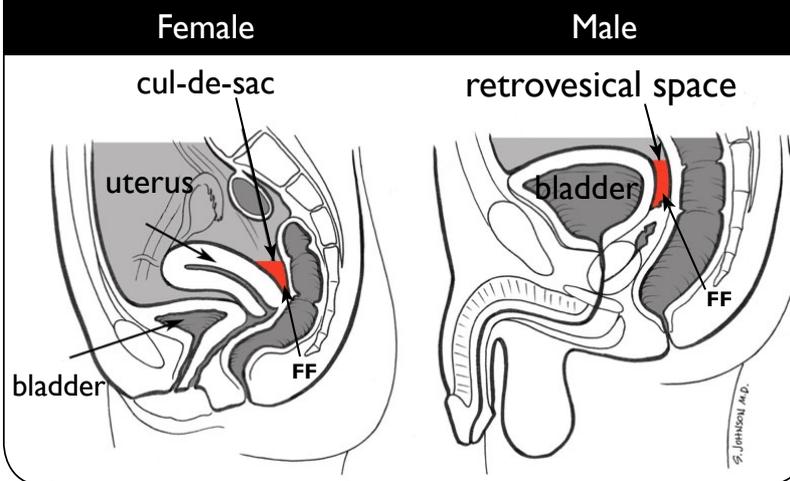
Figure 3. FAST Left Upper Quadrant View With Free Fluid (FF)



In this view, the spleen offers less of an acoustic window than the liver does on the right side; therefore, the probe should be positioned more posteriorly, with the examiner's "knuckles down to stretcher." Once the spleen is identified, the probe should be moved superiorly to examine the area above the spleen and below the diaphragm, as that is where fluid commonly accumulates in the left upper quadrant (Figure 3). Next, the probe can be moved inferiorly to look at the area between the spleen and kidney. From the left upper quadrant, the sonographer can examine the thoracic cavity for fluid by angling the probe superiorly to look above the diaphragm.

The final view of the FAST exam, the suprapubic view, is best performed when the patient has a full bladder, which provides an optimal acoustic window. This view has two steps, with the probe positioned in both short axis (with the marker oriented to the right) and long axis (with the marker oriented to the head). In female patients, fluid will initially be seen in the pelvic cul-de-sac area behind the uterus (Figure 4).

Figure 4. FAST Suprapubic View With Free Fluid (FF)



In male patients, fluid will initially be seen in the retrovesical space, behind the bladder. The pelvis is the most dependent area of the overall abdominal/pelvic cavity, and smaller amounts of fluid (100 to 200 cc) may be detected by close inspection from this view.

CASE ANALYSIS

The E-FAST exam is performed on both patients. The young man is found to have a positive FAST exam, with free fluid present in all views. Intravenous fluids and blood are infused, and a surgical consult is immediately requested because of the history of occult trauma. Due to his abnormal vital signs and positive findings on the FAST exam, the

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patient undergoes immediate laparotomy, which reveals a ruptured spleen. Interestingly, a test for infectious mononucleosis comes back positive, which may explain why his spleen was prone to injury with minimal trauma.

In the second patient, the FAST and left thoracic cavity views are positive for the presence of fluid. A liver panel shows worsening liver function; this, along with a high serum ammonia concentration and elevated creatinine level, suggests hepatorenal dysfunction and encephalopathy. Paracentesis is performed using ultrasound guidance, and laboratory analysis of the fluid shows spontaneous bacterial peritonitis. Because the patient had an elevated CVP on bedside ultrasound, denoting a relatively “full tank,” she is optimally resuscitated from her septic shock state with IV antibiotics and administration of a relatively small IV fluid bolus, followed by early initiation of pressors.

>> Look for the next installment of “Emergency Ultrasound,” which will examine “compromise of the tank.”

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