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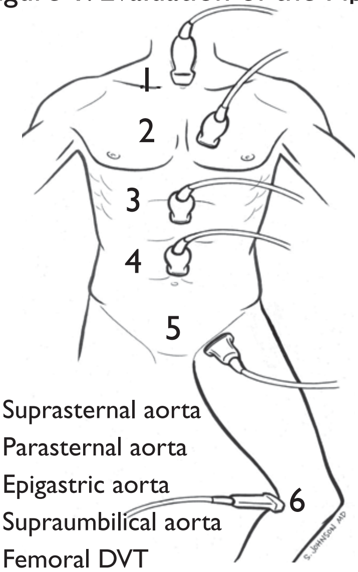
Rapid Ultrasound in SHock: The RUSH Protocol

EVALUATION OF THE ABDOMINAL AND THORACIC AORTA

This month, we discuss the final part of the RUSH exam, the evaluation of the "pipes." The term "pipes" specifically refers to the major arterial and venous structures in the body (Figure 1). On the arterial side, the primary application of bedside sonography is the evaluation of the abdominal aorta for an aneurysm (AAA). However, there are ultrasound techniques performed from both thoracic and abdominal locations that can aid in detection of thoracic aorta pathology. Thoracic aortic aneurysms and dissection may be detected from sonographic windows in the chest, and those that extend to the abdomen may be seen from the traditional abdominal views. To round out the evaluation of the pipes, one can examine the major leg veins for thrombosis as a cause of hypotension in relevant clinical scenarios. In this article, we focus on ultrasound evaluation of the aortic artery, presenting techniques for detecting both thoracic abdominal aneurysms and dissection. We begin with a case that illustrates the utility of this part of the RUSH protocol.

Figure 1. Evaluation of the Pipes



1. Suprasternal aorta
2. Parasternal aorta
3. Epigastric aorta
4. Supraumbilical aorta
5. Femoral DVT
6. Popliteal DVT

DVT = deep vein thrombosis

CASE PRESENTATION AND ANALYSIS

A 75-year-old man is referred to your ED by his primary care physician. The patient presented with abdominal and back pain earlier in the day. On palpation of the abdomen, the physician thought she detected a pulsatile mass. A call was made to EMS, and the patient was transferred to the ED. En route, the patient had an episode of intense abdominal pain accompanied by a syncopal event.

When he arrives at the ED, the patient is awake and speaking to you. His vital signs include a blood pressure of 86/50 mm Hg; heart rate, 110 beats/min; respiratory rate, 20 breaths/min; temperature, 37.2°C. He has a history of hypertension, but he did not take his medications today due to the abdominal pain. Concerned about a vascular catastrophe such as a ruptured AAA, you begin the bedside ultrasound exam, placing the probe on the abdomen.

The abdominal aorta is optimally imaged in both short- and long-axis views at several locations on the abdominal wall (Figures 2 and 3). First, the probe is placed just below the

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"Emergency Ultrasound" presents clinical cases involving the diagnostic use of bedside ultrasound in the emergency department. Cases can be explored in more detail on the Web in the SoundBytes section of CMEDownload.com, which can be accessed directly at www.sound-bytes.tv. Instructional videos detailing the components of the RUSH exam are available for download.

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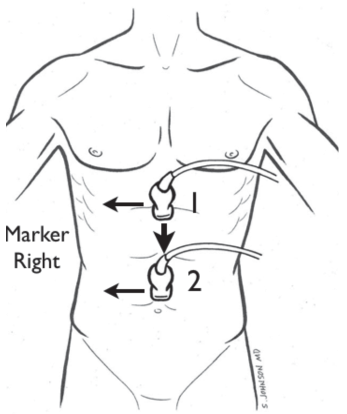
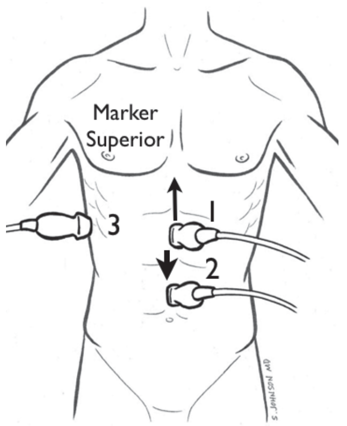
Figure 2. Aorta: Short-Axis Views



- Probe marker points to patient's right
- Position 1: Epigastric area; aim posterior to spine
- Position 2: Supraumbilical area

Figure 3. Aorta: Long-Axis Views



- Probe marker points superiorly
- Position 1: Epigastric area; aim posterior to spine
- Position 2: Supraumbilical area
- Position 3: Right hepatic window*

*Commonly used in long axis

xiphoid process of the sternum in a short-axis configuration (the probe marker points to the patient's right). In this view, the spine should appear at the posterior aspect of the ultrasound image, identified by its bright, or hyperechoic, appearance. Just anterior to the spine, the aorta should be seen to the left of the inferior vena cava. Sonographers can occasionally confuse the inferior vena cava with the aorta, but the inferior vena cava's thinner wall and compressibility with pressure from the probe distinguish it from the aorta. Doppler sonography can identify the pulsatile flow in the aorta, further marking this structure. Once the aorta is identified, the probe should be moved inferiorly along the midline in the short-axis plane to completely image the aorta all the way to its bifurcation into the iliac arteries. Bifurcation into the paired iliac arteries normally occurs at a position adjacent to the umbilicus. The major branching vessels of the aorta (celiac axis, superior mesenteric artery, and renal arteries) may be seen coming off the aorta. To complete the exam, the sonographer must examine the aorta in the long-axis plane; this is accomplished by placing the probe longitudinally in the subxiphoid position and moving it along the aorta down to its bifurcation (Figure 3).

The majority of AAAs are fusiform aneurysms in which diffuse dilation involves the entire circumference of the artery. Saccular aneurysms, representing a focal outpouching of the artery wall, are less common (Figure 4). An AAA is defined as an aortic lumen greater than 3 cm in width, with measurements taken from outer wall to outer wall and including any thrombus in the aneurysm. The normal aorta will also taper in size as it descends to bifurcation. The short-axis plane is considered more reliable than the long-axis plane for determining the size of most AAAs. From this plane, one can determine the true largest dimensions of the aneurysm and avoid off-center imaging of the aortic cylinder, which would result in underestimation of the size of the aneurysm. This pitfall may occur with single measurements in the long-axis plane. To most accurately determine the vessel size, measurements should be taken in the short-axis plane at several positions along the aorta, from the top down to bifurcation. If the aneurysm appears to extend inferiorly into an iliac artery, this vessel should be specifically examined; the diameter of the iliac artery normally is less than 1.5 cm. In rare cases, a saccular AAA may be best seen in long axis, so this view should be included in the full ultrasound evaluation of the abdominal aorta.

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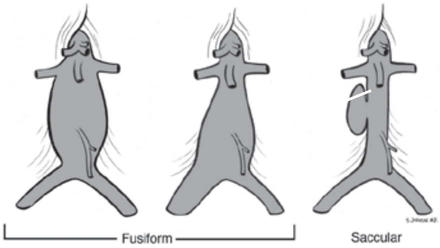
As mentioned, some aneurysms seen in the abdomen will be extensions from pathology originating in the chest cavity. Thoracic aortic aneurysms that extend into the abdomen may be imaged as descending from the chest cavity; descending thoracic aneurysms are best seen by tilting the probe superiorly to examine above the diaphragm from the subxiphoid location. Thoracic aortic dissections that continue into the abdomen (Stanford class B) may also be visualized in the abdominal compartment as an aorta with enlarged size and a flap within the lumen. Transthoracic echocardiography techniques may also have a role in diagnosing thoracic aorta pathology. In the parasternal long-axis view, the aortic root can be seen adjacent to the aortic valve. Proximal ascending dissections (Stanford class A) can tear the root and cause it to dilate to a width greater than the normal 3.8 cm. In addition, many proximal aortic dissections will cause a bloody pericardial effusion to accumulate. On the same parasternal long-axis view, the descending aorta appears as a cylinder cut in cross-section, just posterior to the mitral valve. Some descending aortic dissections (class B) may be seen in this view. A view that works best in taller and thinner persons is the suprasternal view, which is obtained by placing the

Figure 4. Abdominal Aortic Aneurysm (AAA) Types

Fusiform (More common) | Saccular (Less common)

AAA defined as aorta diameter >3 cm*



Infrarenal AAA | AAA extending into right illiac artery

*Measured from outer wall to outer wall of artery

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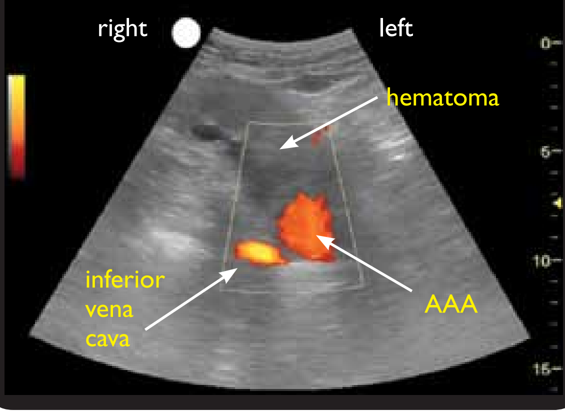
Figure 5. Color Power Doppler Sonography: AAA in Short-Axis View



probe into the suprasternal notch and angling it down into the chest cavity, with the marker pointing to the patient's right. Occasionally, arch dissections may be visualized with this view. While bedside ultrasound imaging of the abdominal aorta has been found to be an accurate tool for diagnosing AAAs, thoracic aorta pathology is more difficult to see when transthoracic techniques are used. If the patient is stable, transesophageal echocardiography should be performed by a cardiology consultant, or dedicated chest CT with aortic dissection protocol should be ordered to optimally diagnose this pathology.

CONCLUSION

In our patient, bedside ultrasound showed an AAA that had ruptured into the intraperitoneal space (Figure 5). In contrast, the majority of AAAs rupture into the retroperitoneal cavity. Many patients with retroperitoneal rupture present with both abdominal and associated back or flank pain. Patients may occasionally have associated hydronephrosis and hematuria from ureteral compression due to rupture, creating a clinical picture that mimics a kidney stone. Once the case patient's aneurysm and rupture were identified, he was emergently transferred to surgery, which resulted in successful repair of the AAA.

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