

Emergency Ultrasound of the Abdominal Aorta

Geoffrey E. Hayden, MD
Director of Emergency Ultrasonography
Vanderbilt Emergency Medicine

Background and Anatomy:

- The diameter of the aorta is approximately 2 cm in the abdomen and tapers distally
- The upper limits of normal for aorta diameter are 2.5 cm at the diaphragm and 1.8 cm at the bifurcation
- Aortic branches:
- Celiac trunk: anterior wall approximately 1-2 cm below the level of the diaphragm; it gives off the splenic artery, the common hepatic artery, and the left gastric artery
- The splenic artery passes to the left along the superior border of the pancreas
- Superior mesenteric artery (SMA): anterior wall of the aorta approximately 2cm from the celiac trunk
- Renal arteries: off the lateral wall of the aorta just distal to the SMA
- Inferior mesenteric artery (IMA): anterior wall just proximal to the bifurcation
- Common iliac arteries arise at the bifurcation approx. at the level of the umbilicus or the level of the fourth lumbar vertebra

Pathology:

- There are progressive changes in the aorta's intimal and medial layer resulting in a gradual dilatation of the external diameter of the abdominal aorta
- This dilatation is considered aneurysmal when the external diameter becomes 1.5 times that of normal
- An aneurysm is defined as an abnormal focal dilatation of the vessel wall that measures greater than 3 cm
- Overwhelming majority of ruptures occur when an aneurysm is greater than 5 cm
- The natural history of an aneurysm is to expand at an average rate of 0.4 cm per year
- Aneurysms enlarge at an average rate of 0.4 cm per year, with a high individual variability
- Threshold for rupture tends to occur at greater than 5.0 cm in size (22% risk of rupture within 2 years)
- Risk of rupture is estimated at 1-3% per year for aneurysms 4-5 cm; 6-11% per year for aneurysms 5-7 cm; 20% per year for aneurysms greater than 7 cm
- The left retroperitoneum is most common site for rupture; with this rupture, there may be normal hemodynamics initially without significant blood loss

Demographics and risk factors:

- Multiple factors, including HTN, smoking, age, atherosclerotic vascular disease, and genetics play a role; strangely, diabetes actually decreases the risk
- Adult males over 55 years of age are considered to have aneurysms when the aortic diameter reaches 3.0 cm or greater
- The incidence of AAA is 11% in men over 65 years of age, and the average age at presentation is 75 years
- M>F at 7:1 ratio
- Over the past 3 decades, there has been a 300% increase in overall prevalence of AAA

Presentation:

- Symptoms and signs of AAA are nonspecific
- It does not reveal itself with sufficient predictive value by historical features or PE
- Symptoms range from vague abdominal and back discomfort to severe, deep back pain or abdominal pain; may also see a femoral neuropathy (causing hip and thigh pain, quadriceps muscle weakness, and positive psoas sign)
- May also produce intramural clot which can embolize to the LE, with consequent pain and vascular changes
- Clinical shock is present between 35-70% of patients but tachycardia is present in only 50%
- Triad of abd pain, pulsatile abd mass, and hypotension only present in 1/3 of patients
- In ruptured AAA, most still have normal femoral pulses
- Asymmetry or absence of femoral pulses is more commonly associated with aortic dissection
- Most common errors include diagnosing the patient with nephrolithiasis, diverticulitis, intestinal ischemia, pancreatitis, appendicitis, perforated viscus, bowel obstruction, musculoskeletal back pain, GI bleed, or AMI

Ultrasound and AAA:

- Bedside ultrasound has been reported to be 100% sensitive for the presence of an AAA
- Sensitivity for detecting extraluminal blood is around 4%
- Aneurysmal dilatation is most often confined to the infrarenal aorta and usually terminates proximal to the bifurcation
- The iliac arteries are involved in 40% of patients with AAA (iliac artery aneurysm >1.5 cm)

Sono Technique:

- Typically use a 2.5-5MHz curved array probe
- Views from the subxiphoid area to the umbilicus in the patient's midline
- Probe pointer at 9 o'clock, firm pressure to abdomen
- Step 1 is to identify the anterior vertebral body; densely hyperechoic, concave down, with posterior acoustic shadowing
- Two vascular, anechoic structures are present immediately anterior to the vertebral body; with the probe indicator pointing to the *patient's* right side, the aorta is on the right side of the U/S screen (patient's left) and the IVC is on the left side of the screen
- The aorta tends to have thicker, more echogenic walls; it also tends to be more pulsatile (not a perfectly consistent feature), and it tends not to be compressible; the IVC does not have branches as does the aorta (celiac, SMA, etc.)
- Measurements are made from outer wall to outer wall
- The ultrasound exam should involve visualization of the entire length of the abdominal aorta
- Probe must be perpendicular to the aorta, in order to maximize the angle of insonation
- Move down the abdomen in 0.5-1 cm increments in the transverse plane
- Turn the probe clock-wise to 12 o'clock to obtain a longitudinal view of the aorta
- Follow from the mid-epigastrium to the bifurcation

- May see lateral cystic shadowing (edge artifact) and shadowing from calcified plaques within the lumen of the aorta

- If there are technical limitations that restrict your exam, consider the coronal view as an alternative
- Using the liver as an acoustic window, place the probe in the mid-axillary line at 12 o'clock
- Image through the ribs, preferably below the costal margin
- "Take a deep breath and HOLD"

Look for:

- Real-time views of the entire length of the aorta both in transverse and in longitudinal
- Identify the abdominal vascular anatomy: celiac trunk, splenic vein, SMA, and IVC
- **Save images as follows:**
 - Aorta transverse HI
 - Aorta transverse MID
 - Aorta transverse LO
 - Aorta LONG
- Also save video clips of the entire length of the aorta both in transverse and in longitudinal

Pitfalls:

- Obesity, bowel gas, abdominal tenderness, positioning, wounds, etc. may all limit the aorta exam
- Longitudinal views of the aorta may be influenced by a “cylinder tangent effect” (off center slice will show a reduced diameter)
- Confusing the IVC for the aorta
- Failure to consider the diagnosis
- A small aneurysm does not preclude rupture
- If AAA is identified, it may not be the cause of the patient’s symptoms
- Saccular aneurysms are easily overlooked
- Inappropriate caliper placements (outer wall to outer wall!) may underestimate lumen diameter and under-call AAA

Pearls:

- If you identify a good sono window with great aorta visualization, fan your transducer up and down to maximize your imaging area before physically moving down the abdomen
- The elderly may have tortuous aortas that become quite eccentric....don’t rely on the midline
- Bowel gas can be displaced to the right and left with gentle pressure applied through the transducer in an anterior to posterior direction
- If bowel gas obstructs your view, the transducer can be placed in the right axillary line; this uses the liver as an acoustic window; the patient must be rolled into a left lateral decubitus position