
Ultrasound in Emergency Medicine

THE DIAGNOSIS OF AORTIC DISSECTION BY EMERGENCY MEDICINE ULTRASOUND

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□ **Abstract**—A series of five cases of aortic dissection are presented that were diagnosed by emergency physicians using ultrasound to search the abdominal and thoracic aorta for pathology. Aortic dissection is a vascular emergency with a high morbidity and mortality, yet its presentation can be varied and subtle. This article reports the use of Emergency ultrasound in a series of five aortic dissections discovered with a limited, yet timely viewing of the aorta and heart by emergency physicians. © 2007 Elsevier Inc.

□ **Keywords**—aortic dissection; Emergency Medicine; ultrasound

INTRODUCTION

Aortic dissection (AD) is a vascular emergency arising from a tear in the intima of the aorta, usually at the right lateral wall of the ascending aorta or the descending aorta at the ligamentum arteriosum. The dissection propagates within the media of the aortic wall as a result of the shearing forces of the aortic pulsations. The dissec-

tion can propagate in an antegrade or retrograde direction. In the latter case, it can cause acute aortic regurgitation, occlusion of the coronary ostia resulting in acute myocardial infarction, or rupture into the pericardium, leading to acute tamponade. It can extend through the adventitia into the pleural or peritoneal cavities, continue within the media, or re-enter the lumen of the aorta.

The extent of the dissection is classified by Daily et al. into those involving the ascending aorta (Stanford type A) and those that spare the ascending aorta (Stanford type B) (1). The incidence of AD is 1–4/100,000 per year, with 54–72% of AD identified as Stanford type A (2–6). Acutely, the mortality approaches 1–2% per hour over the first 24–48 h of Stanford type A dissection with an overall survival rate of 70% (1,5–7). Classically, the symptoms of AD are described as sudden “tearing or ripping” chest or interscapular back pain. Typically, 61–74% of patients present with chest pain, yet 10–35% present with abdominal or flank pain, and 8–15% of patients can present with no pain (2,7). Patients with AD are more often male (2–3: 1), with a mean age of 59–64 years (8). Risk factors include hypertension (HTN) (58–78%), Marfan’s syndrome (4–12%) and arteriosclerosis (9% type A, 80% type B) (2,8,9). Up to one-third of patients may present with secondary symptoms caused by occlusion of branch arteries or compression of local structures, including cerebral or spinal neurological deficits, myocardial ischemia, abdominal pain,

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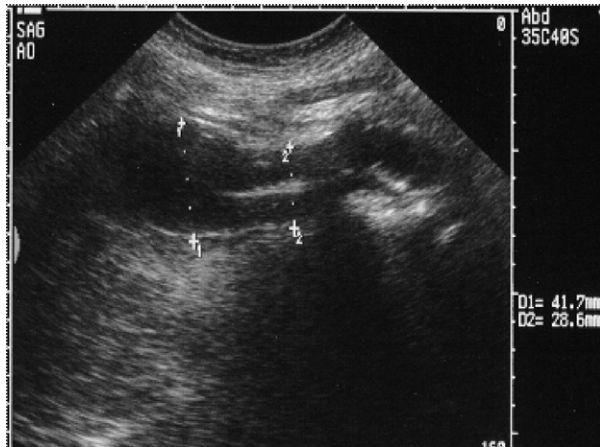


Figure 1. Longitudinal image of distal aorta showing intimal flap. In real time the flap demonstrated the classic pulsatile, systolic flutter pattern.

flank pain, dysphagia, hoarseness, and hematuria (7,9). Conventional chest radiography (CXR) is poor at diagnosing AD. CXR is normal in 12–18% of AD and only 10–18% of AD shows a widened mediastinum (8,10). The majority of the findings on CXR are abnormalities within the aortic knob: increased aortic diameter, tracheal deviation to the right, and aortic knob double density. Historically, the primary diagnostic modality has been aortography, but this has been replaced by fourth generation spiral computed tomography (CT), multi-planar transesophageal echocardiography (TEE), and magnetic resonance imaging (MRI), due to their higher accuracy and decreased complications. The sensitivity and specificity of CT, TEE, and MRI range from 94–100% (11–14).

Although TEE has a well-established role in the diagnosis of AD, the role of transthoracic and transabdominal sonography is less certain. Limited studies suggest that AD can be detected by either transthoracic or transabdominal ultrasound with a sensitivity of 67–80% (15–18). Emergency ultrasound (EUS) has been shown to be useful in the diagnosis of abdominal aortic aneurysm (AAA) (19–21). Ultrasound of the aorta is included as a primary study for emergency ultrasound by the American College of Emergency Physicians (22). As emergency physicians ultrasound the abdominal aorta to evaluate for aneurysm, other pathologies may be found. We present five cases of AD that were diagnosed by emergency physicians using EUS (while searching for aortic pathology) before any other imaging studies.

BACKGROUND

All scans were performed with Siemens (Erlangen, Germany) Sonoline ultrasound machines (Adara, Prima,

Versapro) with 3.5 MHz curvilinear transducers. The scans were obtained by both Emergency Medicine residents and attending physicians who met American College of Emergency Physicians (ACEP) recommendations for emergency ultrasound training (22). All cases were verified by CT scan or TEE. Images were obtained via the standard views of the abdominal aorta and heart. These included transverse and sagittal continuous real-time scanning of the aorta from the diaphragm to the iliac bifurcation and real-time views of the heart, pericardium, and aortic root using subxiphoid and parasternal windows. Where possible, suprasternal views were also obtained.

CASE REPORTS

Case 1

A 74-year-old woman with a past medical history of hypertension (HTN) and depression presented to the Emergency Department (ED) with 3 days of intermittent, non-radiating epigastric pain. The pain “felt like gas” and was associated with nausea and vomiting. Orthostatic vital signs showed a pulse (P) of 100 beats/min and a blood pressure (BP) of 124/68 torr while supine, and P = 129 beats/min and BP = 80/60 torr while standing. The patient was in mild distress with pale conjunctiva and dry mucous membranes. Physical examination revealed a soft abdomen with normal bowel sounds and mild epigastric tenderness, but no pulsatile masses or bruits were detected. The electrocardiogram (EKG) revealed sinus tachycardia with left ventricular hypertrophy (LVH) and the CXR was unremarkable. Transabdominal EUS of the aorta was performed to evaluate for AAA and revealed an extensive, mobile intimal flap throughout the entire abdominal aorta with a maximal diameter of 5.5 cm (Figures 1, 2).

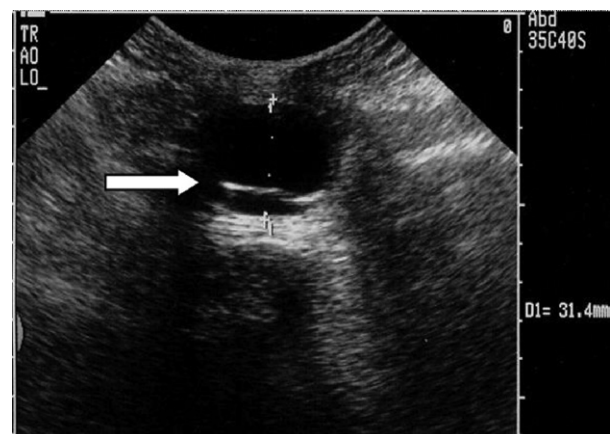


Figure 2. Transverse image of distal aorta showing intimal flap (arrow). In real time the flap was mobile with a systolic flutter pattern.

A CT scan and later a TEE confirmed a Type B AD from the left subclavian artery to the aortic bifurcation with a thrombosed false lumen. The patient was treated with medical therapy and discharged home after an uneventful hospital stay.

Case 2

A 48-year-old man with a past medical history of HTN, nephrolithiasis, and smoking presented to the ED with a sudden onset of sharp lower back pain. The pain radiated down the left flank and into the groin similar to his previous kidney stone. The pain was associated with diaphoresis, dyspnea, and nausea. His vital signs were normal with a pulse oximetry reading of 99% on room air. Physical examination revealed the patient to be in moderate distress. His chest and cardiac examinations were unremarkable. The abdomen was soft and non-tender with normal bowel sounds and no masses or bruits. The patient had left costovertebral angle tenderness. The rest of his physical examination was normal. Laboratory tests showed a hemoglobin level of 14 gm/dL and normal creatinine, CPK, and troponin. Urinalysis was normal. Because the patient's urine had no blood and the back pain continued, an emergency ultrasound of the aorta was performed. This demonstrated an aorta with a maximum diameter of 2.8 cm with a fluttering, mobile intimal flap with thrombosed false lumen (Figure 3). A CT scan verified a type A AD extending from the ascending aorta to the renal arteries with infarction of the superior pole of the left kidney. The patient was placed on a sodium nitroprusside drip and the AD was emergently repaired in the operating room. He was subsequently discharged home in good condition.

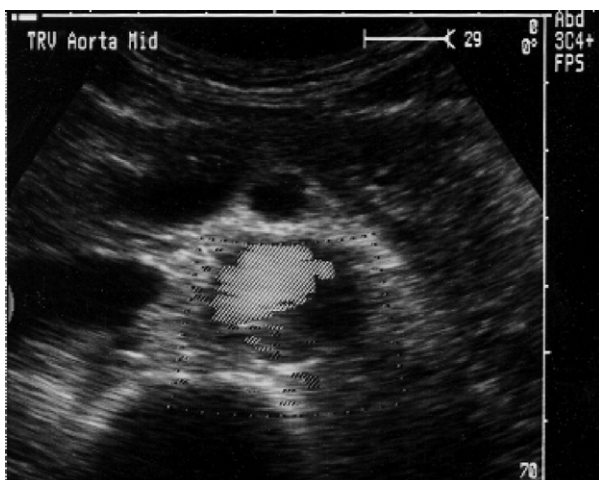


Figure 3. Transverse aorta showing color Doppler flow through true lumen only.

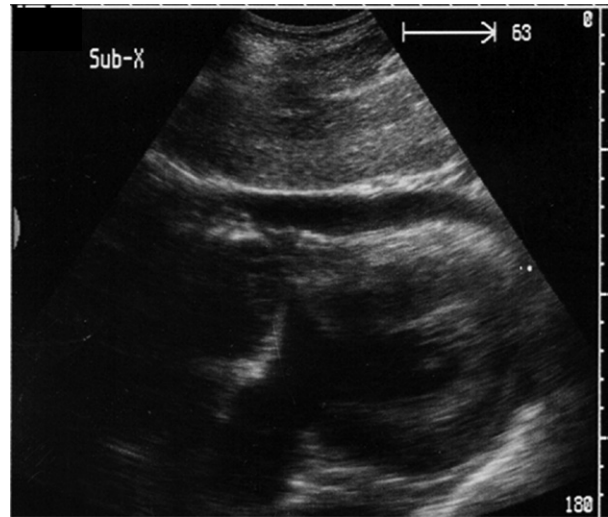


Figure 4. Transverse subxiphoid view of the heart showing pericardial effusion between liver and left ventricle. The right ventricle is being compressed and is not easily seen in this view.

Case 3

A 53-year-old man with no past medical history except for cigarette smoking presented to the ED with the acute onset of crushing chest pain radiating into the left arm. The pain was associated with nausea, dyspnea, diaphoresis, and paresthesia in both legs. The patient received 162 mg aspirin and two sublingual nitroglycerin tablets by pre-hospital paramedics with no relief. His vital signs were: BP right arm = 85/50 torr, BP left arm = 95/52 torr, respiratory rate = 32 breaths/min, P = 82 beats/min, pulse oximetry 96% on room air (RA). The patient was in moderate distress with pallor, diaphoresis, and tachypnea. Lungs were clear, but cardiac examination revealed a 2/6 systolic ejection murmur without a rub or gallop. The abdomen was soft, non-tender, without palpable mass or bruits. The strength, sensation, and pulses were equal and normal in all extremities. A CXR revealed cardiomegaly with a normal mediastinum. An EKG showed non-specific ST-T wave abnormalities with intermittent episodes of junctional bradycardia. Due to the patient's hypotension, an ultrasound of the abdominal aorta and heart were performed and revealed a mobile, intimal flap of the aortic root, with a large pericardial effusion with early tamponade findings of absence of diastolic atrial filling (Figure 4). EUS of the abdominal aorta also demonstrated AD with true and false lumens verified by color flow Doppler (Figures 5, 6). A stat TEE confirmed a type A AD with pericardial effusion. The patient underwent immediate, successful aortic repair, but had a long and complicated hospital course, dying 3 months later.

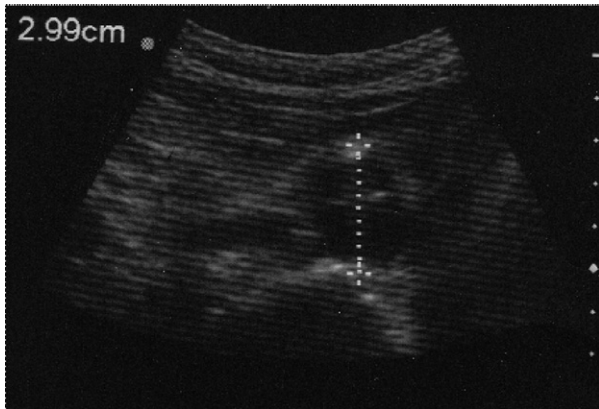


Figure 5. Transverse aorta with intimal flap.

Cases 4 and 5

A 68-year-old man with a past medical history of HTN, myocardial infarction (MI), and peptic ulcer disease presented to the ED with the acute onset of severe, sharp substernal chest pain radiating to the epigastrium. The pain was associated with diaphoresis and dyspnea. He denied nausea, vomiting, back pain, or syncope. His vital signs were: temperature (T) = 36.7°C (98.2°F), P = 63 beats/min, BP = 142/62 torr (right arm) and 140/82 torr (left arm), respiratory rate = 20 breaths/min, 97% pulse oximetry on RA. The patient was in mild distress with diaphoresis. His lungs were clear and the cardiac examination revealed a 2/6 systolic ejection murmur without rub or gallop. The abdomen was soft with mild epigastric tenderness, but had no pulsatile masses or bruits. He had normal pulses in all extremities along with normal strength and sensation. Chest x-ray showed questionable enlarged thoracic aorta and EKG showed only LVH and old inferolateral T-wave inversions. The laboratory results were normal except for a BUN/Creatinine = 5/4. In light of his age and epigastric pain, an EUS of the abdominal aorta was performed and revealed a mobile intimal flap of the abdominal aorta. Despite the reported findings of the EUS, a bedside TEE performed by the cardiologist in the ED was interpreted as showing no evidence of AD. The findings of the TEE were characterized as localized aortic wall thickening below the left subclavian artery with arteriosclerosis suggestive of layered debris, penetrating aortic ulcer, or intraluminal hematoma. The patient was admitted to the intensive care unit where an elevated lipase led to a diagnosis of pancreatitis. A CT scan with sub-optimal contrast was obtained during the patient's hospitalization; it identified an intraluminal aortic thrombus, with the recommendation for a follow-up study as they were unable to exclude AD. He was discharged home after 4 days without a follow-up study being performed.

This patient returned 1 month later with the sudden onset of sharp, epigastric pain. The pain was similar to the symptoms he had experienced previously, but this time it radiated into his left flank. His vital signs were: T = 36.6°C (98°F), P = 60 beats/min, BP = 200/110 torr (bilaterally), RR = 22 breaths/min, pulse oximetry 98% on RA. The examination and laboratory results were little changed from his first visit. An EUS of the abdominal aorta was performed before the arrival of records from the previous admission. This revealed a 3.9-cm dilatation of the proximal abdominal aorta with a pulsatile intimal flap. TEE verified a type B AD distal to the left subclavian artery and extending into the left iliac artery. The patient was admitted, treated with appropriate medical therapy, and discharged without further event.

DISCUSSION

EUS evaluation of the aorta for AAA can be performed rapidly and non-invasively by emergency physicians with a sensitivity of 92–100% (19–21). Whereas the primary use of abdominal aortic ultrasound by emergency physicians is to establish the diagnosis of acute AAA, other aortic pathology may be seen, including AD. Emergency physicians are also familiar with diagnosing pericardial effusion (23). Due to the high mortality of AD involving the aortic root with a significant pericardial effusion/tamponade, the emergency physician must act quickly to get the patient stabilized and sent quickly to the operating room under the care of a cardiothoracic surgeon. Therefore, EUS evaluation of the heart for pericardial effusion/tamponade or wall motion abnormalities due to dissection into the pericardial sac or the coronary arteries may be helpful when patients are found to have AD. Here we present five cases of aortic dissection that were discovered by EUS while evaluating patients

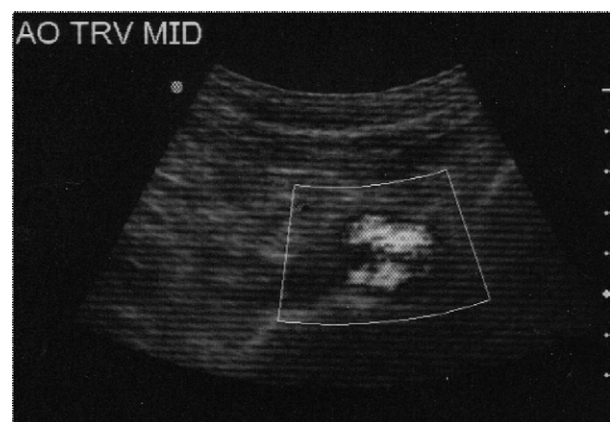


Figure 6. Same patient as Figure 5 with color Doppler demonstrating flow in both true and false lumens.

Table 1. Aortic Dissection Case Summary

	Age (years)	Gender	Chief Complaint	Ultrasound Image	Optimal Ultrasound View
Case 1	74	Female	Intermittent epigastric abdominal pain	Mobile, abdominal intimal flap	Transabdominal
Case 2	48	Male	Sharp, left lower back pain	Mobile, abdominal intimal flap	Transabdominal
Case 3	53	Male	Crushing chest pain	Mobile, intimal flap of aortic root with large pericardial effusion	Left parasternal long axis transthoracic or transabdominal
Case 4	68	Male	Sharp, substernal chest pain	Mobile, abdominal intimal flap	Transabdominal
Case 5	68	Male	Sharp, epigastric pain	Mobile, abdominal intimal flap	Transabdominal

with a variety of symptoms (Table 1). Although AD was on the differential diagnosis for each of these patients, all the patients presented with clinical pictures that were more strongly suggestive of alternative diagnoses. These included peptic ulcer (case 1), nephrolithiasis (case 2), and acute coronary syndrome (cases 3 and 4/5). In all cases, an acute AAA was also a possibility, prompting immediate EUS evaluation of the aorta to rule out this diagnosis, which is routinely done in our departments.

The five patients who presented to our Emergency Departments received a limited abdominal aortic scan that is considered one of the primary applications of emergency ultrasound (22). This included the real-time imaging of the aorta from the diaphragm to the bifurcation in search of an abdominal aortic aneurysm. The abdominal aorta was imaged in the transverse and longitudinal planes. In addition, subxiphoid pericardial images and parasternal long axis views of the heart and aortic root were obtained. In all five patients we witnessed a thin, hyperechoic intimal flap with a systolic flutter pattern that was evident on real-time scanning. The flap was verified in an orthogonal plane on each patient. In two cases, color Doppler revealed flow in both lumens, strengthening the diagnosis of AD. Four of the patients also had a dilated abdominal aorta measuring between 3.3 and 5.5 cm.

AD remains a challenging diagnosis for emergency physicians, due to its many different presentations. Sullivan et al. concluded that emergency physicians suspected the diagnosis in only 43% of patients that presented with an AD as a result of patients' non-specific presentations, with 33% of these patients having abdominal pain as a chief complaint (24). They discovered that even if the patient presented with chest and back pain, only 86% were suspected, and if the patients had epigastric or abdominal pain, the emergency physician suspected the diagnosis in only 8% of the cases. Up to 28% are diagnosed post-mortem (8,24). In the present series, EUS identified AD that, although considered as a diagnostic possibility by the treating physicians, was not entertained as the most likely diagnosis before the EUS.

There are several case reports and studies demonstrating the utility of transthoracic and transabdominal ultra-

sound in the diagnosis of AD. The earliest report using transthoracic echocardiography to diagnose AD was in 1972 by Millward, who visualized an undulating intimal flap within the aorta (25). Since then, numerous studies have documented a sensitivity of 67–80% and a specificity of 99–100% for the diagnosis of AD by transthoracic and transabdominal ultrasound when an undulating intimal flap is visualized (15,17,18). Because one-third of the cases of aortic dissection extend into the abdominal aorta, these would be expected to be seen on transabdominal imaging of the aorta. The undulating intimal flap is highly specific, and was seen in all five of the cases presented here. A recent case series showed that emergency physicians were able to diagnose aortic dissection by transthoracic ultrasound (26). This case series extends those findings by demonstrating the ability of EUS to identify AD while being used to evaluate the abdominal aorta for AAA. Future research should focus on combining EUS of the abdominal aorta and transthoracic echocardiography for the evaluation of patients suspected of having AD.

CONCLUSION

Due to the emergent nature of AD, a timely and correct diagnosis is likely to expedite definitive care and reduce morbidity and mortality. Emergency physicians evaluating the abdominal and thoracic aorta may encounter sonographic findings of AD and should be aware of this diagnostic possibility.

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