Abstract—Background: Thoracic aortic aneurysms (TAAs) are less prevalent than abdominal aortic aneurysms. Symptomatic TAAs need to be identified quickly by the emergency physician (EP) since mortality rates increase dramatically once complications such as rupture or dissection occur. Compared with validated EP-performed ultrasound of the abdominal aorta, EP-performed focused cardiac ultrasound that includes evaluation of the thoracic aorta is relatively unreported. Objective: Two cases illustrate EP-performed focused cardiac ultrasound and evaluation of the thoracic aorta for aneurysmal dilation. Case Reports: (1) A 60-year-old man presented to the emergency department (ED) after a blunt traumatic injury to his back while at work. During the focused cardiac ultrasound examination, the aortic outflow tract distal to the aortic valve appeared enlarged and the aortic root measured 5.49 cm. (2) An 82-year-old man with hypertension presented to the ED with 1 month of chest pain radiating to the back. During the focused cardiac ultrasound examination, the aortic outflow tract distal to the aortic valve appeared enlarged and the aortic root measured 5.49 cm. Conclusion: EPs performing focused cardiac ultrasound can visualize regions of the thoracic aorta that may reveal an aneurysm, particularly in the parasternal long axis view. © 2014 Elsevier Inc.

Keywords—focused cardiac ultrasound; thoracic aortic aneurysm; emergency department

INTRODUCTION

Patients present to the emergency department (ED) less commonly with complaints related to thoracic aortic aneurysms (TAAs) than with those related to abdominal aortic aneurysms (1). A multistaged classification system for asymptomatic TAAs based on anatomic location, size, underlying familial genetic mutations, and rate of growth determines the timing of elective surgical repair. The emergency physician (EP) is most concerned with identifying the acutely symptomatic patient with a TAA who subsequently requires emergency cardiothoracic surgical intervention, given life-threatening and time-sensitive complications such as rupture and dissection. Traditional imaging modalities employed by the EP to evaluate for TAA include computed tomography angiography (CTA), magnetic resonance imaging (MRI), and transesophageal echocardiography (TEE). More recently, indications for EP-performed focused cardiac ultrasound have been expanded beyond the assessment for pericardial effusion and organized left ventricular activity to include evaluation of the thoracic aorta. One recent study and the 2010 Consensus Statement on Focused Cardiac Ultrasound in the Emergent Setting recognize that thoracic aortic disease, including a TAA, can be visualized.
by the EP while performing a focused cardiac ultrasound (2,3). We present two cases in which the EP visualized a TAA on the parasternal long-axis view of the heart. This expedited the time-sensitive management of the patients, which is noteworthy given the high mortality rate of TAA complications.

CASE REPORTS

Case 1

A 60-year-old man presented to the ED after a blunt injury to his back while at work. The patient reported that a large piece of ceiling plaster fell onto his back and right shoulder, and he complained of pain in that area. The patient denied any contributory medical, surgical, or medication history. On review of systems, the patient denied previous musculoskeletal trauma, chest pain, shortness of breath, abdominal pain, or neurologic symptoms.

The triage vital signs included a blood pressure of 140/80 mm Hg, heart rate of 90 beats/min, respiratory rate of 30 breaths/min, room air pulse oxygenation of 97%, and oral temperature of 36.7°C (98°F). On physical examination, breath sounds were equal bilaterally, and results of the cardiac examination were normal. There was tenderness on palpation of the right posterior hemithorax and scapula. Results of the neurovascular examination of the extremities were unremarkable.

The trauma team was consulted. In the trauma resuscitation room, a chest radiograph demonstrated a right scapula fracture. The cardiomediastinal silhouette was indeterminate in size owing to the anteroposterior technique of the film. A focused assessment of sonography in trauma (FAST) was performed by an attending EP who is fellowship-trained in emergency ultrasound. No free fluid was visualized in the peritoneum or in the pericardial space. A focused cardiac ultrasound was then performed. On the parasternal long axis cardiac view, the aortic outflow track just distal to the aortic valve appeared enlarged. The aortic root measured 5.49 cm in cross-section (Figure 1).

Given the bedside ultrasound findings in the setting of thoracic trauma, the patient underwent CTA of the chest with intravenous contrast. The ascending aorta was found to be markedly aneurysmal, measuring 5.6 cm at the level of the aortic root (Figure 2). There was no aortic dissection or intramural hematoma identified. A comminuted scapula fracture was present with no other intrathoracic injuries. The TAA was thought to be an incidental finding unrelated to the traumatic event. The patient was admitted to the trauma surgery service for observation and cardiothoracic surgery consultation. The patient subsequently underwent an elective TAA repair during his inpatient stay.

Case 2

An 82-year-old man presented to the ED with 1 month of worsening chest pain. The chest pain was characterized as nonexertional and substernal in location, with radiation to his back. The patient’s past medical history was significant for hypertension, diabetes mellitus, and gastroesophageal reflux disease. His surgical history included an aortic valve repair and coronary artery bypass graft. The review of systems was positive for shortness of breath and negative for nausea, vomiting, or neurologic symptoms. The patient took daily medications that included warfarin, hydralazine, lasix, lisinopril, metoprolol, and simvastatin with unknown compliance.
The triage vital signs included a blood pressure of 215/90 mm Hg, heart rate of 61 beats/min, respiratory rate of 20 breaths/min, room air pulse oxygenation 96%, and oral temperature of 36.3°C (97.3°F). Physical examination showed no significant heart or lung findings. On examination of the extremities, the physician noted no significant calf swelling or tenderness; distal pulses were symmetrical, and neurologic examination results were normal. An electrocardiogram showed sinus bradycardia without ischemic changes.

An attending EP who was fellowship-trained in emergency ultrasound performed a focused cardiac ultrasound. She appreciated enlargement of the descending thoracic aorta. The descending thoracic aorta measured 4.82 cm in cross-section (Figure 3).

Laboratory analysis showed a hemoglobin level of 13.7 g/dL (13.5–17.5 g/dL) and troponin level of 0.044 ng/mL (0.000–0.034 ng/mL). A single-view anteroposterior chest radiograph showed a widened mediastinal silhouette.

Blood pressure control with intravenous medication was initiated, and the patient underwent a CTA of the chest with intravenous contrast to evaluate the thoracic aorta. The descending thoracic aorta was found to be aneurysmal measuring up to 4.8 cm at its widest transverse diameter (Figure 4). There was no aortic dissection or intramural hematoma identified. The patient was admitted to the internal medicine service for blood pressure management and the performance of serial cardiac enzymes and electrocardiograms to evaluate for acute coronary syndrome. The cardiothoracic surgery service was consulted for recommendations regarding the TAA. Aneurysm repair was not performed during the inpatient stay, and outpatient cardiothoracic surgery follow-up for serial evaluation was arranged.

**DISCUSSION**

A true aortic aneurysm includes all three layers of the aortic wall (intima, media, and adventitia). However, degradation of the media layer, which is responsible for the tensile strength and elasticity of the aorta, results in aneurysm formation. The normal diameter of the thoracic aorta that is accepted by the cardiothoracic surgery and radiology community is 3–4 cm, as measured on computed tomography imaging (4,5). The agreed-on definition of an aneurysm is a greater than 50% local dilatation relative to the nearest adherent vessel (6).

Media necrosis, along with elastin fragmentation and fibrosis, occurs naturally in the aorta with age (5). Multifactorial pathophysiologic processes also alter the aortic structure and function with atherosclerosis, causing approximately 70% of all TAAs (7). Risk factors such as age, hypertension, history of smoking, and underlying familial connective tissue disorders also play significant roles. Other notable causes include infection, arteritis, and post-traumatic aneurysms after blunt trauma, with a rapid deceleration mechanism (4).

TAAs are classified by anatomic location. Ascending aortic aneurysms, as depicted in case 1, comprise 60% of TAAs and occur between the aortic root and the brachiocephalic (innominate) artery. Descending aortic aneurysms, as in case 2, make up 40% of cases and occur distal to the subclavian artery (1). Aneurysmal dilatation frequently is not limited to a specific anatomic area of the aorta. Thoracoabdominal aneurysms have been reported to occur in 2.8% of cases. In addition, anatomicall
distinct and concurrent abdominal aortic aneurysms occur in 28% of patients with a TAA (4).

Asymptomatic TAAAs are further stratified by size for elective repair at 5.5 cm for ascending aneurysms and 6.5 cm for descending aneurysms. TAAAs due to familial disorders such as Marfan’s or Ehlers-Danlos syndromes, which have genetic predisposition for cystic medial necrosis, may be repaired sooner (8). These thresholds are based on certain “hinge points” in aortic size in accordance with the laws of Laplace when lethal complications such as rupture and dissection are more likely to occur. Elefteriades reported that the maximum wall tension for the thoracic aorta is reached at 6 cm, at which point 34% of patients experience a rupture or dissection (9). Other studies have suggested that 31% of patients will suffer rupture or dissection with an ascending aortic size of 6 cm and 43% of patients with a descending aortic aneurysm of 7 cm (1). A growth rate of more than 1 cm/year is also an indication for elective surgical repair (10).

The annual risk of rupture and dissection is similar in patients with TAAAs greater than 6 cm (1). The prognosis for rupture with hemorrhage, however, is worse than that with dissection. One study reported that only 41% of patients with a TAA rupture reach the hospital alive (11). Rupture of the ascending aorta may occur into the pericardium, resulting in acute tamponade. Rupture of the descending thoracic aorta may cause a left-sided hemothorax (12,13). The overall in-hospital mortality for acute thoracic aortic dissection has been reported as 27.4% (14). A TAA can dissect into the aortic valve, causing aortic insufficiency, or into the coronary arteries, with the patient presenting as having an acute myocardial infarction (15).

The vast majority of patients found to have TAAAs are asymptomatic at the time of presentation, and an aneurysm is found as an incidental discovery, as in case 1 (16). Aside from the classic description of excruciating chest pain, presenting symptoms can be acute or chronic and can occur secondary to compression of or erosion through local structures or vessels. Shortness of breath and facial and arm swelling may be present from obstruction of the superior vena cava. Stridor or dyspnea may be present owing to airway compression. Hoarseness may be caused by compression of the recurrent laryngeal nerve, or dysphagia may be present because of esophageal compression (17).

Acutely symptomatic patients require emergency aneurysm resection regardless of size owing to the high mortality of complications (18). CTA, MRI and TEE have been the traditional studies of choice for assessing aortic size and pathology. EP-performed focused cardiac ultrasound has only recently begun to be reported for evaluation of the thoracic aorta.

The parasternal long-axis cardiac view allows one to visualize sections of the ascending and descending portions of the thoracic aorta, where aneurysms could occur. The anatomy and corresponding terminology of the ascending aorta, particularly the aortic root, is complex, beyond the scope of the EP, and has been well-described elsewhere (19). For the purpose of the focused cardiac ultrasound, the EP should first identify the aortic outflow arising from the left ventricle distal to the aortic valve. The aortic root includes the valve, annulus, and sinuses and extends to the sinotubular junction, the point in the ascending aorta at which aortic sinuses end and the aorta becomes a tubular structure (4). The diameter of the aortic root is measured just distal to the aortic annulus between the internal borders (intima) of the aortic walls in end-diastole, as demonstrated in Figure 1 (2).

Posterior to the heart, a cross-section of the thoracic aorta is seen as it descends through the thorax. The depth of the image on the screen may have to be adjusted to visualize this structure posterior to the pericardium. In this region, the aorta is measured from the outer wall to the outer wall of the vessel, similar to the procedure used when evaluating the abdominal aorta (2). Other portions of the thoracic aorta are difficult to visualize on transthoracic echocardiography owing to the thoracic cage and aerated lung. Evaluation of the aortic arch by placing the transducer in the suprasternal notch and imaging inferiorly, however, has been described (20).

The most recent consensus statement by the American Society of Echocardiography (ASE) and the American College of Emergency Physicians (ACEP) recognized that the thoracic aortic pathology can be identified on EP-performed focused cardiac ultrasound (3). Transthoracic echocardiography was shown to be consistent with TEE for measurement of the ascending aorta (21). Taylor et al. demonstrated that EP-performed focused cardiac ultrasound was consistent with CTA measurements for maximal thoracic aortic diameter (2). In these cases, an EP with considerable experience in ultrasound performed these studies, but many EP are trained in the use of focused ultrasound for evaluation of the abdominal aorta. Principals used in this application, such as avoiding measurements in oblique planes, measuring from outer wall to outer wall (for the descending thoracic aorta), and the use of Doppler also may be utilized in the evaluation of the thoracic portion of the aorta.

Several case studies have reported on the EP-performed focused cardiac ultrasound identification of a thoracic aortic aneurysm dissection (15,22). To our knowledge, these are the first case studies to describe thoracic aortic aneurysm identified on bedside ultrasound and later confirmed by CTA.
CONCLUSION

We presented two case studies that support the joint ASE/ACEP consensus statement on focused cardiac ultrasound, as well as a recent research study that reports that the EP can accurately image regions of both the ascending and descending thoracic aorta and measure for aneurysmal enlargement. Certain portions of the thoracic aorta are visualized on the parasternal long axis view of the heart, and concerning bedside findings can expedite further management, such as additional imaging or cardiothoracic surgery consultation. Further research is needed to determine whether assessment of the thoracic aorta should be included in focused ultrasonography assessments, such as the focused cardiac ultrasound examination in the medical patient or as part of the FAST examination of trauma patients.

REFERENCES