CE 2.0 ANCC Contact Hours

Diving Into Blunt Aortic Injury: A Case Review

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ABSTRACT

Although many advances in trauma care have occurred, traumatic aortic injuries remain a leading cause of death in trauma patients. For those who survive long enough to receive treatment, rapid identification of injuries, surgical intervention, and definitive care are critical. Assessment findings and diagnostic imaging are both necessary to rapidly identify aortic injury and select the proper intervention. Surgical options are now available that, for the appropriate patient with aortic injury, can eliminate the need for invasive surgery, decrease complications, and decrease recovery time.

Key Words

Aortic dissection, Blunt aortic injury, TEVAR, Traumatic aortic injury

Traumatic aortic injury is one of the leading causes of death in trauma patients. Although the majority of patients with this injury die on scene, about 20% survive long enough to receive treatment (Karmy-Jones, Jackson, Long, & Simeone, 2009; National Highway Traffic Safety Administration National Center for Statistics and Analysis, 2007). The majority of patients are young and, if they survive, can face significant morbidity for the remainder of their lives (National Highway Traffic Safety Administration National Center for Statistics and Analysis, 2007). Rapid identification and treatment are critical.

CASE REVIEW

A 40-year-old man participating in an air show was parachuting over a lake. He was falling at approximately 45–50 miles per hour and, at about 30 feet above water, cut his parachute loose. He fell to the water, landing chest first. He swam to the water surface and was taken to shore by a rescue swimmer. He complained of mild chest pain, worse with palpation, but no head, neck, or back pain. Breath sounds were clear. The patient reported a change in sensation in the right lower extremity. No deformities were noted by the medic, but pulses were absent and the limb was cool and pale. In contrast, the left lower extremity had strong pulses, good color, and sensation. The patient's initial blood pressure (BP) in the field was 88/60; an intravenous (IV) drip was started and crystalloid bolus was given. His vital signs en route were as follows: BP, 93/68; heart rate (HR), 100.

Upon arrival in the emergency department (ED), primary assessment findings included a Glasgow Coma Scale score of 15, absent breath sounds on the left side, and cool, pale, clammy skin. His vital signs were as follows: BP, 86/42; HR, 93; respiratory rate (RR), 28; O_2 saturation (sat), 97% on O_2; and temperature 36.3 °C (97.3 °F). The patient was able to share additional details regarding the incident—while doing a planned parachute jump, he wanted a more dramatic landing and so he cut his parachute lines. He had no medical history or allergies.

A second large-bore IV drip was placed, and a rapid infuser was used to infuse fluids. The trauma surgeon performed a bedside FAST examination, which was negative for hemoperitoneum. An initial portable chest radiograph showed diffuse opacification of the left hemithorax and vascular pedicle prominence. No pneumothorax was noted. The surgeon inserted a 36-French chest tube, which immediately drained 800-ml bright red blood. Autotransfusion was initiated, and 400 ml of blood was immediately collected and retransfused. His vital signs improved to BP, 140/76; HR, 81; and RR, 24. The patient was then taken for computed tomography (CT), and the chest/abdomen/pelvis CT scan revealed a traumatic aortic injury in the distal aortic arch and proximal descending thoracic aorta with left-sided hemorrhagic pleural effusion (Figures 1 and 2). Also present was a circumferential aortic wall intimal hematoma extending to the renal arteries, with nonperfusion of the lower pole of the right kidney.

PATHOPHYSIOLOGY

Blunt aortic injuries are associated with a high rate of morbidity and mortality. They are immediately fatal in approximately 80%–90% of cases (Steenburg, Ravenel, Ikonomidis, Schonholz, & Reeves, 2008) Mechanism of injury (MOI) is the main identifying factor in determining

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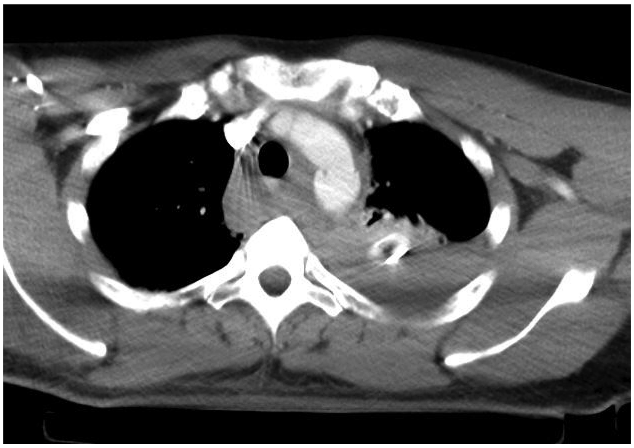

Figure 1. Lateral view of the injury to the descending thoracic aorta.

a diagnosis. The most common MOIs are falls greater than 10 feet, motor vehicle crashes greater than 30 miles per hour, unrestrained drivers, ejected passengers, and pedestrians struck by vehicles (O'Conor, 2004).

These injuries can occur in a variety of ways. Direct shearing of the thoracic aorta can be caused by a displaced thoracic vertebral fracture. A fracture of the first rib and clavicle can cause bony compression of the aortic isthmus. It can also rupture as a result of the "water hammer effect," when tremendous pressure builds within the aorta during the moment of impact (O'Conor, 2004). The most common cause of rupture, however, is the shearing force of the acceleration/deceleration process, as the descending aorta and ligamentum arteriosum remained fixed and the heart and the ascending aorta continue to move forward (Fox et al., 2014; O'Conor, 2004; Steenburg et al., 2008;).

Figure 2. Sagittal view of the injury to the descending aorta distal to the takeoff of the left subclavian artery.

Patients with traumatic aortic injuries tend to fall into three categories: dead, hemodynamically unstable, and hemodynamically stable (Karmy-Jones & Jurkovich, 2004). Aortic transections or ruptures generally leave patients dead on scene because of massive blood loss into the chest. Most patients who survive to the hospital sustain partial transections and are hemodynamically unstable. Although there have been many advancements in care, mortality for patients with traumatic aortic injuries remain fairly unchanged—Of the 15% who survive the trip to the hospital, 99% will die without surgical intervention. Fifteen percent will survive only 1 hr, and 30% will die within 6 hr. Forty-nine percent will die within a day. Seventy-two percent will die within 8 days and 90% within 4 months (O'Conor, 2004). These patients need rapid injury identification, hemorrhage control, and BP management until definitive repair can occur. Those who appear hemodynamically stable also need rapid treatment, including BP control and controlled fluid resuscitation (Fox et al., 2014).

Clinical signs of injury are not always present; many patients have no sign of injury until they suddenly become hemodynamically unstable. For example, a 25-year-old man presented to an ED 15 hr after a motor vehicle crash (MVC). He was confused and did not respond to questions but had stable vital signs, including BP of 125/58 and HR 76. Assessment of the chest, both inspection and auscultation, was normal. He was later diagnosed with a traumatic disruption of the distal aortic arch (Ho, Chua, Seth, Tan, & Pothiwala, 2014).

If patients are symptomatic, they might report retrosternal pain, interscapular pain, dyspnea, hoarseness, dysphagia, and cough (O'Conor, 2004; Steenburg et al., 2008). If clinical signs are present, they can include upper extremity blood pressure differences, upper extremity hypertension, lower extremity hypotension with weak femoral pulses, systolic murmur, chest wall injuries, paraplegia related to altered spinal perfusion, and initial chest tube output greater than 750 ml (O'Conor, 2004; Steenburg et al., 2008). A frequently occurring triad of signs is increased BP in the upper limbs, decreased BP in the lower limbs, and widened mediastinum on radiography (Symbas, Tyras, Ware, & Hatcher, 1973). Often, because of the force involved with the MOI, there are other significant injuries that might distract the provider. Diagnostic imaging can help identify and confirm traumatic aortic injury.

RADIOGRAPHY

Chest radiographs are often obtained in the acute trauma setting (O'Conor, 2004). Mediastinal widening is a finding that can suggest aortic injury. A widening greater than 8 cm, although frequently seen in traumatic aortic injuries, is not an extremely sensitive finding. In fact, most chest radiographs taken in the initial evaluation are supine films, which can magnify the mediastinal image (Gleeson, Spedding, Harding, & Caplan, 2001). Transverse aortic arch abnormality or loss of the aortopulmonary window is more discriminating (Steenburg et al., 2008). Other findings that can suggest or increase the suspicion for aortic injury are first or second rib fracture, obliteration of the aortic knob, abnormal aortic outline, tracheal or esophageal deviation, left mainstem bronchus depression, pleural or apical cap, sternal fracture, hemothorax, pneumothorax, or pulmonary contusion (Gleeson et al., 2001; Woodring, 1990). In the case of the 25-year-old MVC patient, his only radiographical finding was right tracheal deviation, likely associated with a visible thyroid mass (Ho et al., 2014). Abnormal imaging findings must be further investigated.

Depending on resources available, traumatic aortic injury can be further evaluated by CT angiography, aortography, or transesophageal echocardiography. CT angiography is immediately available in most trauma centers, and results are rapidly available. Aortography is highly accurate but is more invasive and takes longer to complete, so it might not be possible with unstable patients. In addition, the volume of dye injected has led to incidences of full rupture after injection; however, complication rates are less than 1% (O'Conor, 2004). Transesophageal echocardiogram is also rapid and can be beneficial if the patient is too unstable to transport to the CT facility. It is not, however, always available, and it is very user dependent (Saletta et al., 1995; Weiser, 2014). If the patient is unstable and there is a high degree of suspicion for aortic disruption, immediate surgery is indicated (Weiser, 2014).

TREATMENT

The two most important aspects of treatment of traumatic aortic injury are BP control and surgical repair (Fox et al., 2014). Controlled fluid resuscitation and blood product administration are indicated, but, as other sources of hemorrhage are excluded, cardiac output control should be initiated. Target vital signs are usually a HR less than 90 and a systolic BP less than 120. Measures should be taken to avoid Valsalva maneuvers or coughing and gagging during intubation. Depending on the extent of the aortic injury, surgical repair or stent placement is often required (Lee et al., 2010; Weiser, 2014). Table 1 summarizes the criteria for considering endovascular versus open repair.

Endovascular Repair

Thoracic endovascular aortic repair (TEVAR) is now recommended over open surgical repair (Lee et al., 2010). A stent graft is inserted peripherally, most commonly via femoral artery, and advanced with imaging and fluoroscopy (Kruse & Khonynezade, 2011; Lee et al., 2010). The stent graft then stabilizes the vessel and allows the rupture to thrombose. Mortality is significantly lower, as are complications such as spinal cord ischemia, end-stage renal disease, graft infection, and systemic infections including pneumonia (Lee et al., 2010). Typically, patients can be discharged within a few days and resume normal activities within a couple of weeks (Neschis, 2015). Long-term durability is a concern, however, because most patients with traumatic aortic injury are young (Xenos et al., 2008). Although there are significant benefits to the endovascular approach, it may not be the best approach for all patients. It is important to consider associated injuries, the location of the aortic injury, life expectancy, and whether or not the patient is expected to comply with long term follow-up (Neschis, 2015).

Open Repair

If endovascular repair is not possible or appropriate, open repair is another option. Under general anesthesia, one-lung ventilation is performed, allowing the left lung to collapse so that the aorta can be accessed. Depending on the extent of the injury, surgical approach may be a thoracotomy, sternotomy, or thoracoabdominal exposure

TABLE 1 Criteria for Consideration of Open Versus Endovascular Repair

Open Repair	Endovascular Repair
Anatomic features that do not allow TEVAR	Multiple severe injuries
Injury to ascending aorta or aortic arch	Right chest/lung injuries (patient may not be able to tolerate one-lung ventilation)
Other injuries requiring open thoracic surgery	Medical comorbidities
	Limited life expectancy
	Descending thoracic aorta injury

Note. TEVAR = thoracic endovascular aortic repair.
From "Surgical and endovascular repair of blunt thoracic aortic injury. Up To Date," by D. Neschis, March 2015, Retrieved from http://www.uptodate.com/contents/surgical-and-endovascular-repair-of-blunt-thoracic-aortic-injury

(Neschis, 2015). Bleeding is then controlled with direct pressure and aortic clamps. Complications from open repair include stroke, spinal cord ischemia, and graft complications such as failure, collapse, and iliac artery injury (Neschis, 2015).

NURSING CONSIDERATIONS

If chest trauma is suspected, rapid assessment and intervention are crucial. Because of the force required to generate an aortic injury, the patient might have other significant life-threatening injuries. A timely primary survey can help identify these injuries and guide interventions (Denke, 2010). The nurse should be prepared to obtain large-bore IV access, initiate controlled fluid resuscitation, and facilitate diagnostic imaging (Denke, 2010; Weiser, 2014). Continuous monitoring of cardiac rhythm, vital signs, mentation, and urine output should also occur so that the nurse can evaluate response to interventions and identify changes in patient condition. β-Blockers and antihypertensives may be required to control cardiac output. The nurse should also be prepared to rapidly transfer the patient to surgery or, if necessary, a facility that can provide a higher level of care (Denke, 2010).

Postoperatively, the nurse will want to closely monitor cardiac output. Effective BP management using β-blockers can improve the patient's prognosis. Acute lung injury and acute respiratory distress syndrome occur in up to 20% of patients, possibly due to the high incidence of concurrent pulmonary contusion (Al-Gameel, El-Tahan, Shafi, Mowafi, & Al-Ghamdi, 2014). Depending on the extent of the aortic injury, the patient could manifest signs of end-organ dysfunction. Frequent neurological, genitourinary, and gastrointestinal assessments will aid in identification of ischemic injuries distal to the aortic injury (Weigang et al., 2008).

The nurse should also be prepared for significant patient and family education needs. Patients with traumatic aortic injury tend to be young, so long-term surgical durability is a concern (Xenos et al., 2008). Routine, timely follow-up will be necessary to ensure the injury does not progress (Weigang et al., 2008). In addition, these patients have significant alterations in their daily life. Those suffering from traumatic aortic injury are twice as likely to experience significant functional disability (feeding, locomotion, and expression) as those with head or abdominal trauma. They are also less likely to be fully independent. One study showed that only 19% of patients were fully independent in all three functional categories (Arthurs et al., 2009). The patient and his or her family may need significant support and resources to prepare for life after discharge.

PATIENT OUTCOME

Upon return from the CT scan, the trauma surgeon started the patient on labetalol and esmolol to control BP and cardiac output. Transfer via helicopter was arranged to the closest trauma center with cardiothoracic vascular surgery services. Contrast nephropathy prophylaxis was initiated because of the right kidney injury. In addition to the autotransfused blood, he received fresh frozen plasma and isotonic crystalloids. He remained awake, alert, and oriented throughout. He was transferred out in less than 2 hr, and at the time of departure his vital signs had stabilized to the following: BP, 107/49; HR, 71; RR, 25; and O_2 sat, 100%.

Instead of invasive surgery, the patient underwent TEVAR. A thoracic endograft was inserted through his femoral artery. His diagnoses included Grade 4 aortic transection, distal to the left subclavian artery; right renal pole infarct; splenic infarct; and bilateral pleural effusions, which did not require thoracentesis. He is expected to make a full recovery and plans to return to skydiving.

KEY POINTS

- Traumatic aortic injury remains a leading cause of death in trauma patients; survival is dependent on rapid identification and intervention.
- Diagnostic imaging does not eliminate the need for clinical assessment findings in the patient with traumatic aortic injury.
- Surgical options are available that, based on the patient's history and extent of injury, can allow the patient to make a full recovery.

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