

**American College of Radiology
 ACR Appropriateness Criteria®**

Clinical Condition: Blunt Chest Trauma — Suspected Aortic Injury

Radiologic Procedure	Rating	Comments	<u>RRL</u>*
X-ray chest	9		Min
CTA chest (noncoronary)	9		Med
Aortography thoracic	8		Med
CT chest without contrast	6	Useful to detect mediastinal hematoma when contrast contraindicated.	Med
US echocardiography transesophageal	5	Invasive. Suitable for bedside use.	None
MRA chest (noncoronary) with or without contrast	5	Limited practicality. Alternative when iodinated contrast contraindicated. See statement regarding contrast in text under “Anticipated Exceptions.”	None
US intravascular aorta	4	Problem solving tool in the setting of invasive angiography	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

BLUNT CHEST TRAUMA — SUSPECTED AORTIC INJURY

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Summary of Literature Review

Trauma ranks fifth behind cardiovascular diseases, cancer, cerebrovascular diseases, and chronic lower respiratory diseases as a cause of death in the United States. There were over 117,000 accidental deaths in this country in 2005, with over 45,000 as a result of motor vehicle accidents [1]. Seventy-five percent of the deaths from blunt trauma are due entirely or in part to chest injuries. Rupture of the thoracic aorta is a common cause of death following blunt chest trauma. In more than 80% of cases, rupture is through all three layers of the aorta, resulting in exsanguination and death at the accident site. Individuals who survive have maintained the adventitia intact but are at risk for subsequent complete rupture. For these near-full-thickness injuries, 30% of initial survivors will die within 6 hours and 20% within 24 hours if the diagnosis is not made and treatment instituted. With technological advancements, a spectrum of disease is now being appreciated. Small tears of the intima can now be diagnosed, but the natural history of these “minimal aortic injuries” is not yet known [2,3]. Imaging may play a role in grading the severity of aortic injuries to help guide clinical management [4].

Pathophysiology

Traumatic injury of the aorta is thought by most investigators to result from unequal horizontal shear forces that are applied during high-speed deceleration to different parts of the thoracic aorta [5]. During rapid deceleration the mobile ascending and descending portions of the aorta lag behind the transverse aortic arch, which is relatively fixed by the brachiocephalic vessels. Injury occurs most commonly at the ligamentum arteriosum (80%) and less commonly to the ascending aorta. A mechanism involving compressive forces

between anterior and posterior bony thoracic structures has also been proposed (the “osseous pinch”) [6].

Because the adventitia remains intact as a barrier to exsanguination in survivors, the most common pathologic findings are tears of the intima and media. The mediastinal hematoma associated with these injuries is therefore most commonly due to rupture of small arteries and veins in the mediastinum [7]. Traumatic laceration of the aorta is the most common lesion seen at autopsy, although survival even from this injury has been reported. In these rare cases, a pseudoaneurysm is contained by periaortic tissue. Chronic pseudoaneurysm has been described and may present many years after the traumatic event.

Clinical Presentation

Variation in clinical presentation is the rule with thoracic aortic injuries. Patients may present in full cardiovascular collapse or complain of chest pain, midscapular pain, or shortness of breath. Almost half of patients with aortic disruption have no external signs of chest trauma. Because of the variable presentation, a high index of suspicion for traumatic rupture of the aorta must exist for any patient who has sustained high-speed rapid deceleration.

Chest Radiograph

Despite the advent of newer imaging modalities, the chest radiograph remains the primary screening method for detecting mediastinal hemorrhage following blunt thoracic trauma. It is included in most trauma center protocols in the initial evaluation of patients with polytrauma [8].

Because of the trauma setting in which chest radiographs of these patients are obtained, they are usually portable anteroposterior supine radiographs. This results in a lordotic view with a shortened focal spot-film distance, magnifying the width of the superior mediastinum and decreasing resolution. Sitting the patient upright when feasible for an anteroposterior radiograph should result in fewer falsely abnormal radiographs [9].

Most of the radiograph findings in aortic rupture are related to mediastinal hemorrhage rather than the aortic injury itself. The most common chest radiograph finding, widening of the mediastinum, has been defined as a transverse distance of 8 cm from the left side of the aortic arch to the right margin of the mediastinum. It must be emphasized that the vast majority of patients with mediastinal widening do not have aortic injuries. Angiographically confirmed aortic injury is found in only 10%-20% of these patients. Mediastinal widening has 90% sensitivity but only 10% specificity for aortic disruption.

Approximately 7% of patients with aortic rupture have a normal initial chest radiograph [10]. However, the diagnostic evaluation of patients with blunt chest trauma now includes chest computed tomography (CT) at most

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facilities. CT has proven to be very sensitive for detecting aortic injury. When no mediastinal hematoma is detected on chest CT, the probability of a significant aortic injury is very low [11].

Thoracic Aortography

Thoracic aortography is widely accepted as the gold standard for evaluating patients with suspected aortic injury [12,13]. The aortogram establishes the diagnosis, defines the anatomy of the lesion, and, because approximately 20% of patients have multiple tears, identifies additional sites of injury [14]. At most institutions, aortography is performed on patients who have suffered rapid deceleration injury and who have a widened mediastinum or obscure aortic knob and descending aorta on a chest radiograph, or who have indirect or direct signs of aortic injury detected by CT [15].

Various film sequences have been used, including anteroposterior, lateral, and oblique projections. It should be emphasized that more than one projection may be necessary to detect an aortic injury. Because acutely injured patients are in a hyperdynamic state, high contrast volumes of 60 to 70 cc rapidly injected are needed.

Computed Tomography

With the increasing availability of multidetector rows, CT is playing a more prominent and in many cases dominant role in the assessment of patients with suspected aortic injury [16-18]. CT's strength lies in its ability to distinguish mediastinal blood from other causes of mediastinal widening detected on initial chest radiographs (eg, artifacts of magnification, mediastinal fat, or anatomic variation) [19]. If no mediastinal hematoma is detected on CT, the probability of a significant aortic injury is very low, and aortography is generally not needed [20,21]. Studies have confirmed that patients with a negative chest CT in this setting have favorable clinical outcomes [22].

Computed Tomographic Angiography

With newer multidetector CT protocols and image postprocessing tools, angiographic images of the aorta and great vessels in multiple planes can be created [23]. In addition, imaging of the aortic root with ECG gating [24] decreases the pulsation artifact that often requires catheter-based aortography after CTA performed without ECG gating. Studies have shown high sensitivity and negative predictive value in the evaluation of suspected aortic injury when there are no signs of direct aortic injury such as an intimal flap, change in aortic contour or caliber, intraluminal irregularity, pseudoaneurysm, or intramural hematoma. Some authors have found that even in the presence of mediastinal hematoma, aortic injury is very unlikely without direct evidence of aortic injury [25]. Others have shown a high specificity for aortic injury when such direct signs are present [26]. Some centers have abandoned aortography in the initial evaluation of patients at risk of aortic injury and are instead screening these patients with CT angiography (CTA) [27].

Magnetic Resonance Imaging of the Thorax

Although magnetic resonance imaging (MRI) of the thorax can demonstrate acute and subacute mediastinal hematoma [28], it currently does not have a role in the initial evaluation of the critically ill, hemodynamically unstable trauma patient. MRI, however, has proven to be useful in evaluating chronic traumatic aortic pseudoaneurysms [29]. So far, there has been insufficient experience with other MR techniques to recommend their use in the trauma setting. The restricted access to critically ill patients in the MR scanner also poses a potential problem.

Transesophageal Echocardiography

Transesophageal echocardiography (TEE) has been used in the acute trauma setting to study both the heart (for contusion) and the thoracic aorta. It appears to be much more sensitive than transthoracic echocardiography for detecting cardiac contusions.

TEE is more operator-dependent and more invasive than CT. The procedure usually requires sedation. In some patients, blind spots created by the tracheal-bronchial bifurcation may preclude adequate visualization of portions of the aortic arch. Other blind spots for TEE are the distal ascending aorta and the aortic arch vessels, sites of traumatic injury in up to 20% of patients with blunt chest trauma [30].

Recent studies have reported excellent diagnostic accuracy using TEE for recognizing aortic injury [31-35]. This experience, however, has not been uniformly positive. Further studies are required before TEE can be recommended as part of the imaging workup in patients with blunt chest trauma.

Intravascular Ultrasound

The continued development of intravascular ultrasound (IVUS) has offered an adjunct to standard transfemoral aortography. Although the routine use of IVUS is neither indicated nor practical, in a few cases it has been found to be useful in confirming or excluding thoracic aortic injury when angiographic findings are subtle or uncertain [33,36].

Summary

- The literature supports the continued use of the chest radiograph as the initial screening examination in the patient who has sustained blunt chest trauma.
- In the appropriate clinical setting and with a chest radiograph demonstrating mediastinal widening or other signs of mediastinal hemorrhage, thoracic aortography or helical chest CT is indicated.
- CTA is emerging as a very sensitive and specific examination for aortic injury and has replaced thoracic aortography as the primary aortic imaging tool in many trauma centers.
- With this expanding role for CTA, the role of IVUS and TEE is diminishing, but they may be useful in select cases.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [37].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- Evidence table under review

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.