

**Blunt Chest Trauma-Suspected Aortic Injury  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Murphy SL, Xu JQ, Kochanek KD. Deaths: Final data for 2010. National vital statistics reports; vol 61 no 4. Hyattsville, MD: National Center for Health Statistics. 2013; Available at: <a href="http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf">http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf</a> . Accessed June 24, 2014.	Review/Other-Dx	N/A	To present final 2010 data on U.S. deaths, death rates, life expectancy, infant mortality, and trends by selected characteristics such as age, sex, Hispanic origin, race, state of residence, and cause of death.	In 2010, a total of 2,468,435 deaths were reported in the United States. The age-adjusted death rate was 747.0 deaths per 100,000 standard population, lower than the 2009 rate (749.6) and a record low rate. Life expectancy at birth rose 0.2 year, from 78.5 years in 2009 to a record high of 78.7 in 2010. Age-specific death rates decreased for each age group under 85, although the decrease for ages 1–4 was not significant. The age-specific rate increased for ages 85 and over. The leading causes of death in 2010 remained the same as in 2009 for all but 1 of the 15 leading causes. Pneumonitis due to solids and liquids replaced Assault (homicide) as the 15th leading cause of death in 2010. The infant mortality rate decreased 3.8% to a historically low value of 6.15 deaths per 1,000 live births in 2010.	4
2. Parker MS, Matheson TL, Rao AV, et al. Making the transition: the role of helical CT in the evaluation of potentially acute thoracic aortic injuries. <i>AJR Am J Roentgenol.</i> 2001;176(5):1267-1272.	Observational-Dx	142 patients	To evaluate the accuracy and potential cost savings of CT vs aortography in the setting of blunt chest trauma.	142 patients examined with CT aortography. Sensitivity and NPV for CT and aortography was 100%. There was an approximate 50% cost savings if CT was used to exclude AI.	1
3. Parmley LF, Mattingly TW, Manion WC, Jahnke EJ, Jr. Nonpenetrating traumatic injury of the aorta. <i>Circulation.</i> 1958;17(6):1086-1101.	Review/Other-Dx	296 cases reviewed	To present a review of the clinical and pathologic features of AI caused by non-penetrating trauma.	This classic natural history study describes the most common site of aortic rupture (the isthmus); suggests that early and late survival is dependent on hematoma formation followed by surgical intervention; and stresses early detection with CXR.	4
4. Beel T, Harwood AL. Traumatic rupture of the thoracic aorta. <i>Ann Emerg Med.</i> 1980;9(9):483-486.	Review/Other-Dx	N/A	To review traumatic rupture of the thoracic aorta.	A high index of suspicion from history and physical examination and liberal use of aortography are key in diagnosis.	4

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5. Baque P, Serre T, Cheynel N, et al. An experimental cadaveric study for a better understanding of blunt traumatic aortic rupture. <i>J Trauma</i> . 2006;61(3):586-591.	Review/Other-Dx	human cadavers 19 tests	To examine the comportment of the heart and the aorta during a frontal deceleration.	The deceleration recorded in the isthmus of the aorta was always higher than the 1 recorded in the heart ( $P<0.05$ ). The difference of deceleration was 17% and increased with the speed's fall (extremes 5%–25%). There was no significant difference of deceleration between the bony structures of the thorax. These results experimentally demonstrate for the first time that the fundamental mechanism of blunt traumatic aortic rupture is sudden stretching of the isthmus of the aorta.	4
6. Crass JR, Cohen AM, Motta AO, Tomashefski JF, Jr., Wiesen EJ. A proposed new mechanism of traumatic aortic rupture: the osseous pinch. <i>Radiology</i> . 1990;176(3):645-649.	Review/Other-Dx	10 consecutive patients	To describe a series of experiments using models to test the hypothesis that aortic isthmus lacerations result from a pinch of the aorta between the spine and the anterior bony thorax.	Thoracic compression experiments using CT, geometric CT analysis and animal aortic compression experiments support the osseous pinch mechanism of aortic rupture.	4
7. Ayella RJ, Hankins JR, Turney SZ, Cowley RA. Ruptured thoracic aorta due to blunt trauma. <i>J Trauma</i> . 1977;17(3):199-205.	Review/Other-Dx	3,500 patients, 36 ruptured thoracic aortas	To describe a coordinated system of handling the blunt trauma patient and to determine survival rate.	A 5-year review of experience: 149 mediastinal hematomas were detected on radiograph and 36 had thoracic aortic rupture at aortography. Survival rate was 75% in these patients. The authors describe an erect tilted AP CXR technique.	4
8. Lamarche Y, Berger FH, Nicolaou S, et al. Vancouver simplified grading system with computed tomographic angiography for blunt aortic injury. <i>J Thorac Cardiovasc Surg</i> . 2012;144(2):347-354, 354 e341.	Review/Other-Dx	48 patients	To characterize all retrospectively blunt AI diagnosed by MDCT angiographic scanning in patients being treated at a single center to create a new, simplified classification of blunt AI.	48 patients were identified. Two had minimal AI (grade I), 7 had an intimal flap >1 cm (grade II), 32 had traumatic pseudoaneurysm (grade III), 6 had active contrast extravasation (grade IV), and 1 could not be rated. Survivals were 100%, 90%, and 33% for grades I and II, III, and IV, respectively. Of grade III injuries, 14% were medically managed, 68% repaired endovascularly, and 18% repaired with open surgery. Interrater correlation was best with the simplified score, with only 0.5% of cases unable to be classified.	4

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9. Ungar TC, Wolf SJ, Haukoos JS, Dyer DS, Moore EE. Derivation of a clinical decision rule to exclude thoracic aortic imaging in patients with blunt chest trauma after motor vehicle collisions. <i>J Trauma</i> . 2006;61(5):1150-1155.	Observational-Dx	1,096 patients	To assess which patients with blunt chest trauma do not need aortic imaging. This article talks about a clinical decision rule.	The decision rule incorporates findings on the CXR: sensitivity of 86% (95% CI, 65% to 97%), a specificity of 77% (95% CI, 75% to 80%), a PPV of 7% (95% CI, 4% to 11%), a NPV of 99.6% (95% CI, 99.0% to 99.9%), a positive likelihood ratio of 3.8 (95% CI, 1.1-12.9), and a negative likelihood ratio of 0.18 (95% CI, 0.05-0.61). This would potentially reduce aortic imaging by 76% (95% CI, 74% to 79%). This study is a more recent example in the literature showing the continued importance of the CXR in the initial evaluation of this group of patients.	3
10. Kaiser ML, Whealon MD, Barrios C, Jr., et al. Risk factors for traumatic injury findings on thoracic computed tomography among patients with blunt trauma having a normal chest radiograph. <i>Arch Surg</i> . 2011;146(4):459-463.	Observational-Dx	2435 patients	To identify risk factors that might predict acute traumatic injury findings on TCT among patients having a normal initial CXR.	Multivariate logistic regression demonstrated that an abdominal Abbreviated Injury Score of 3 or higher ( $P=.001$ ; odds ratio, 2.6), a pelvic or extremity Abbreviated Injury Score of 2 or higher ( $P<.001$ ; odds ratio, 2.0), age >30 years ( $P=.004$ ; odds ratio, 1.4), and male sex ( $P=.04$ ; odds ratio, 1.3) were significantly associated with traumatic findings on TCT. No aortic injuries were diagnosed in patients with a normal CXR. Limiting TCT to patients with 1 or more risk factors predicting acute traumatic injury findings would have resulted in reduced radiation exposure and in a cost savings of almost \$250,000 over the 2-year period. Limiting TCT to this degree would not have missed any clinically significant vertebral fractures or vascular injuries.	3

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11. Brink M, Kool DR, Dekker HM, et al. Predictors of abnormal chest CT after blunt trauma: a critical appraisal of the literature. <i>Clin Radiol</i> . 2009;64(3):272-283.	Review/Other-Dx	10 articles	To identify and to evaluate predictors that determines whether chest CT is likely to reveal relevant injuries in adult blunt trauma patients.	Of 147 articles initially identified, the observers included 10 original studies in consensus. Abnormalities at physical examination (abnormal respiratory effort, need for assisted ventilation, reduced airtentry, coma, chest wall tenderness) and pelvic fractures were significant predictors (diagnostic odds ratio: 2.1–6.7). The presence of any injuries at conventional radiography of the chest (8 articles) was a more powerful significant predictor (diagnostic odds ratio: 2.2–37). Abnormal chest ultrasonography (4 articles) was the most accurate predictor for chest injury at CT (diagnostic odds ratio: 491-infinite).	4
12. Kea B, Gamarallage R, Vairamuthu H, et al. What is the clinical significance of chest CT when the chest x-ray result is normal in patients with blunt trauma? <i>Am J Emerg Med</i> . 2013;31(8):1268-1273.	Observational-Dx	36,39 participants	To determine the proportion of patients with normal CXR result and injury seen on CT and abnormal initial CXR result and no injury on CT and to characterize the clinical significance of injuries seen on CT as determined by a trauma expert panel.	Of 3,639 participants, 2,848 (78.3%) had CXR alone and 791 (21.7%) had CXR and chest CT. Of 589 patients who had chest CT after a normal CXR result, 483 (82.0% [95% CI, 78.7–84.9%]) had normal CT results, and 106 (18.0% [95% CI, 15.1%–21.3%]) had CTs diagnosing injuries-primarily rib fractures, pulmonary contusion, and incidental pneumothorax. 12 patients had injuries classified as clinically major (2.0% [95% CI, 1.2%–3.5%]), 78 were clinically minor (13.2% [95% CI, 10.7%–16.2%]), and 16 were clinically insignificant (2.7% (95% CI, 1.7%–4.4%)). Of 202 patients with CXRs suggesting injury, 177 (87.6% [95% CI, 82.4%–91.5%]) had chest CTs confirming injury and 25 (12.4% [95% CI, 8.5%–17.6%]) had no injury on CT.	3
13. Woodring JH. The normal mediastinum in blunt traumatic rupture of the thoracic aorta and brachiocephalic arteries. <i>J Emerg Med</i> . 1990;8(4):467-476.	Review/Other-Dx	656 patients from 52 articles	To review articles dealing with blunt traumatic injury to the thoracic aorta and brachiocephalic arteries to determine how often a normal mediastinum is reported.	Of 656 patients studied, 608 (92.7%) had an abnormal mediastinum while 48 (7.3%) showed no signs of mediastinal abnormality. Accessory findings detect all but 1.7% of patients. Serial CXR for follow-up.	4

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14. Schwab CW, Lawson RB, Lind JF, Garland LW. Aortic injury: comparison of supine and upright portable chest films to evaluate the widened mediastinum. <i>Ann Emerg Med.</i> 1984;13(10):896-899.	Review/Other-Dx	55 patients	To compare the supine and upright CXR in evaluating the widened mediastinum that suggests aortic rupture in patients sustaining blunt chest injury.	21/55 patients had a widened mediastinum on supine CXR only. 12/55 had widened mediastinum on both supine and upright CXR. These 12 underwent aortography and 4 had aortic rupture (confirmed at surgery). The remainder were followed and discharged.	4
15. Khosla A, Ocel J, Rad AE, Kallmes DF. Correlating first- and second-rib fractures noted on spine computed tomography with major vessel injury. <i>Emerg Radiol.</i> 2010;17(6):461-464.	Review/Other-Dx	185 patients	To determine whether first- and second-rib fractures diagnosed on CT, which is of greater sensitivity than CXR for rib fractures, are associated with traumatic vascular injury.	Incidence of major vessel injury was similar between patients with and without first- and/or second-rib fractures (7% vs 9%, respectively; $P=0.59$ ). No subset of type of rib fracture was associated with greater incidence of AI. First- and second-fractures are not associated with greater incidence of AI. Thus, the previous axiom that first- and second-rib fractures should result in increased examination for AI may not hold true.	4
16. Barrios C, Malinoski D, Dolich M, Lekawa M, Hoyt D, Cinat M. Utility of thoracic computed tomography after blunt trauma: when is chest radiograph enough? <i>Am Surg.</i> 2009;75(10):966-969.	Observational-Dx	200 consecutive blunt trauma patients	To identify the utility of TCT in blunt trauma patients with a normal admission CXR.	143 patients had a normal screening CXR; 36 of these patients (25%) had an abnormal TCT. TCT changed the management in only 9 of these patients (6%): 2 required serial CXR for occult pneumothorax, 4 received additional imaging of the spine, and 3 were admitted to a monitored bed. 57 patients had an abnormal initial CXR. Of these, 41 (81%) had an abnormal TCT. TCT changed management in 21 (37%) of these patients: 2 aortic injuries identified, 12 aortic injuries excluded, 2 chest tubes placed, 1 patient taken to the operating room, and 4 patients required further diagnostic evaluation. TCT was significantly more likely to alter management in patients with an abnormal admission CXR (6% vs 37%, $P<0.001$ ).	4
17. Dyer DS, Moore EE, Ilke DN, et al. Thoracic aortic injury: how predictive is mechanism and is chest computed tomography a reliable screening tool? A prospective study of 1,561 patients. <i>J Trauma.</i> 2000;48(4):673-682; discussion 682-673.	Observational-Dx	1,561 patients	To evaluate CT as a screening tool for AI.	30 (1.9%) cases of AI out of 1,561 patients. CT had sensitivity and NPV of 100%. Recommend liberal use of chest CT in blunt chest trauma. Guidelines for determining the need for aortic imaging are outlined.	2

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18. Gavant ML. Helical CT grading of traumatic aortic injuries. Impact on clinical guidelines for medical and surgical management. <i>Radiol Clin North Am.</i> 1999;37(3):553-574, vi.	Review/Other-Dx	N/A	To discuss the helical CT findings in AI. Describes a grading system to define the spectrum of AI.	Helical CT used to grade severity of AI to help guide clinical management decisions.	4
19. Wicky S, Capasso P, Meuli R, Fischer A, von Segesser L, Schnyder P. Spiral CT aortography: an efficient technique for the diagnosis of traumatic aortic injury. <i>Eur Radiol.</i> 1998;8(5):828-833.	Observational-Dx	487 spiral CT scans	To assess the accuracy of CT in the evaluation of AI with blunt chest trauma.	14 (2.9%) cases of AI. 12 went to surgery with 1 false positive. 2 patients died from brain injury. CT was 100% sensitive and 99.8% specific for the diagnosis of AI. Spiral CT aortography is an accurate diagnostic method for the assessment of AI in blunt thoracic trauma patients.	2
20. Schertler T, Glucker T, Wildermuth S, Jungius KP, Marincek B, Boehm T. Comparison of retrospectively ECG-gated and nongated MDCT of the chest in an emergency setting regarding workflow, image quality, and diagnostic certainty. <i>Emerg Radiol.</i> 2005;12(1-2):19-29.	Observational-Dx	32 consecutive patients	To assess the influence of ECG-gated acquisition on workflow and to compare image quality and diagnostic certainty for retrospectively ECG-gated and nongated MDCT of the chest in the emergency suite.	Motion artifacts were significantly reduced with ECG gating resulting in improved diagnostic certainty. However, the quality of lung and bone structures was reduced. Performing ECG gating in the emergency room did not slow down the diagnostic workup. ECG-gated acquisition performed better in the assessment of the aorta, but image quality for lung and bone structures was slightly reduced. Further studies are required to assess the influence of the imaging technique on the diagnostic outcome.	3
21. Wall MJ, Jr., Tsai PI, Gilani R, Mattox KL. Challenges in the diagnosis and management of unusual presentations of blunt injury to the ascending aorta and aortic sinuses. <i>J Surg Res.</i> 2010;163(2):176-178.	Review/Other-Dx	4 patients	To address patients with injury to the ascending aorta for which standard screening techniques may be inadequate.	4 patients were identified who survived to hospitalization with an injury to the ascending thoracic aorta. Two were to the ascending aorta and 2 to the aortic sinuses. Two presented with closed head injury complicating management. One patient presented with aortic valve insufficiency. Motion artifacts at the aortic sinus made screening by CT challenging. These injuries were managed with primary repair (1), tube graft replacement (2), and aortic root replacement with reimplantation of the coronaries (1), all with cardiopulmonary bypass.	4

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22. Sammer M, Wang E, Blackmore CC, Burdick TR, Hollingworth W. Indeterminate CT angiography in blunt thoracic trauma: is CT angiography enough? <i>AJR Am J Roentgenol.</i> 2007;189(3):603-608.	Observational-Dx	107 patients	A retrospective study to determine whether catheter angiography is needed to exclude aortic and intrathoracic great vessel injury when CTA findings show a mediastinal hematoma but no direct evidence of AI.	107 patients had a mediastinal hematoma and no direct signs of AI. 72 patients had catheter angiography and 35 had clinical, radiologic or pathologic follow-up. No aortic injuries were identified. When CTA is indeterminate in blunt thoracic trauma, conventional angiography is unlikely to show an aortic or intrathoracic great vessel injury and may be unnecessary. A grading system for mediastinal hematomas could help triage patients to conventional angiography when further imaging is desired.	2
23. Mirvis SE, Shanmuganathan K, Miller BH, White CS, Turney SZ. Traumatic aortic injury: diagnosis with contrast-enhanced thoracic CT--five-year experience at a major trauma center. <i>Radiology.</i> 1996;200(2):413-422.	Observational-Dx	677 patient cases reviewed	To review the literature and the authors' experience with contrast enhanced CT in patients admitted with blunt trauma.	For AI and mediastinal hemorrhage specificity for traumatic AI was 99% and 87% and sensitivity was 90% and 100%. CT finding of mediastinal hemorrhage alone is sensitive for traumatic AI. The finding of direct signs of AI is more specific.	3
24. Ng CJ, Chen JC, Wang LJ, et al. Diagnostic value of the helical CT scan for traumatic aortic injury: correlation with mortality and early rupture. <i>J Emerg Med.</i> 2006;30(3):277-282.	Observational-Dx	53 patients	To retrospectively evaluate the value of CT for diagnosing AI.	Direct signs of AI were identified in 25 cases. 22 were confirmed to have AI at surgery. Intimal flap and intraluminal thrombus was present in all cases of confirmed AI. Intimal flap on helical CT of the thorax (HCTT) is both the most specific and sensitive sign for traumatic AI. Traumatic AI patients with $\geq 3$ direct signs, including periaortic contrast material extravasation, may not require aortography before immediate surgery.	3
25. Methodius-Ngwodo WC, Burkett AB, Kochupura PV, Wellons ED, Fuhrman G, Rosenthal D. The role of CT angiography in the diagnosis of blunt traumatic thoracic aortic disruption and unsuspected carotid artery injury. <i>Am Surg.</i> 2008;74(7):580-585; discussion 585-586.	Review/Other-Dx	29 patients	To review management and outcomes of traumatic thoracic aortic disruption and associated carotid artery injuries. CTA was used to evaluate all patients with suspected traumatic thoracic aortic disruption from blunt trauma.	CTA and endovascular repair provide accurate diagnostic and therapeutic results in the management of blunt traumatic thoracic aortic disruption. Furthermore, CTA should include arch and cervical views to detect an unsuspected, concomitant carotid artery injury.	4

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26. Scaglione M, Pinto A, Pinto F, Romano L, Ragozzino A, Grassi R. Role of contrast-enhanced helical CT in the evaluation of acute thoracic aortic injuries after blunt chest trauma. <i>Eur Radiol.</i> 2001;11(12):2444-2448.	Review/Other-Dx	1,419 consecutive chest CT exams	To determine the value of helical CT for detecting and managing acute AI.	Direct findings of injury by CT->surgery (23 cases with 2 false positives). 54 had isolated mediastinal hematoma. All had negative angiograms. 8 months of follow-up showed no adverse outcomes. Direct CT signs of acute thoracic AI do not require further diagnostic investigations to confirm the diagnosis: Isolated aortic bands or contour vessel abnormalities should be first considered as possible artifacts or related to nontraumatic etiologies especially when mediastinal hematoma is absent. In cases of isolated mediastinal hematoma other possible sources of bleeding should be considered before directing patients to thoracic aortography.	4
27. Deunk J, Brink M, Dekker HM, et al. Routine versus selective multidetector-row computed tomography (MDCT) in blunt trauma patients: level of agreement on the influence of additional findings on management. <i>J Trauma.</i> 2009;67(5):1080-1086.	Observational-Dx	50 patients, 3 surgeons	To determine the agreement between and within surgeons concerning the influence on treatment plan of routine vs selective MDCT findings in blunt trauma patients.	The agreement on the influence of routine MDCT findings on patient management between surgeons was moderate ([kappa] = 0.46) in the first procedure and substantial in the second ([kappa] = 0.67). The agreement within surgeons ranged from moderate ([kappa] = 0.60) to excellent ([kappa] = 0.87). All surgeons agreed that the traumatic injuries additionally found by routine MDCT, frequently resulted in a change of treatment plan. There was a moderate-to-excellent agreement between and within surgeons that these additional findings resulted in a change of treatment plan.	2



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28. Bruckner BA, DiBardino DJ, Cumbie TC, et al. Critical evaluation of chest computed tomography scans for blunt descending thoracic aortic injury. <i>Ann Thorac Surg.</i> 2006;81(4):1339-1346.	Observational-Dx	206 patients	A retrospective study with emphasis on the critical evaluation of CT in the evaluation for possible AI.	CT had sensitivity of 95% and a specificity of 40%. The high sensitivity resulted in a change in the trauma imaging algorithm. 114 cases showed "possible AI." Only 3 of these patients turned out to have a true AI. Chest CT is an acceptable screening tool based on prerequisite high sensitivity and ease of performance in the trauma patient suspected of having a descending thoracic AI. Although the excellent NPV resulted in an algorithm change at this institution, there were a significant number of equivocal scans that required subsequent aortography. 3D software reconstruction of the aorta can aid in diagnosing blunt AI when findings are equivocal, but there will continue to be artifacts and limitations that require aortography for clarification.	3
29. Ellis JD, Mayo JR. Computed tomography evaluation of traumatic rupture of the thoracic aorta: an outcome study. <i>Can Assoc Radiol J.</i> 2007;58(1):22-26.	Review/Other-Dx	278 consecutive patients	To assess the outcome of patients suspected of aortic or great vessel injury evaluated with chest CT with contrast.	230 patients had a negative chest CT and another 42 had isolated mediastinal hematomas. No patients died from delayed aortic or great vessel injury on median follow up 615 days. Computerized searches of medical databases found no evidence of missed thoracic aortic or proximal great vessel injury in blunt trauma patients who were evaluated with contrast-enhanced chest CT.	4
30. Link KM, Lesko NM. The role of MR imaging in the evaluation of acquired diseases of the thoracic aorta. <i>AJR Am J Roentgenol.</i> 1992;158(5):1115-1125.	Review/Other-Dx	N/A	To review the role of MRI in acquired diseases of the thoracic aorta.	MRI currently does not have a role in the initial evaluation of the unstable patient following deceleration injury but is useful in the evaluation of chronic aortic pseudoaneurysms.	4

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31. Arpasi PJ, Bis KG, Shetty AN, White RD, Simonetti OP. MR angiography of the thoracic aorta with an electrocardiographically triggered breath-hold contrast-enhanced sequence. <i>Radiographics</i> . 2000;20(1):107-120.	Review/Other-Dx	49 patients, 5 healthy volunteers	To describe the technique of ECG-triggered breath-hold contrast-enhanced MRA. Also, the clinical experience with imaging the thoracic and upper abdominal aorta with this sequence is presented.	ECG-triggered breath-hold contrast-enhanced MRA was tolerated in 48 of the 49 patients. Rapid ECG-triggered breath-hold contrast-enhanced 3D MRA demonstrates the thoracic aorta and proximal arch vessels with high resolution, free from respiratory motion artifacts, and with diminished pulsation artifacts. In conjunction with cine MR and T1-weighted spin-echo imaging, ECG-triggered breath-hold contrast-enhanced MRA should be considered the technique of choice for imaging the thoracic aorta.	4
32. Chen MY, Regan JD, D'Amore MJ, Routh WD, Meredith JW, Dyer RB. Role of angiography in the detection of aortic branch vessel injury after blunt thoracic trauma. <i>J Trauma</i> . 2001;51(6):1166-1171; discussion 1172.	Review/Other-Dx	166 patients	To document the incidence of aortic branch vessel injury after blunt abdominal trauma using angiography.	24 (14%) of 166 had aortic or branch vessel injury. Isolated AI occurred in 15 (9%), and branch vessel injury occurred in 9 (5%). Angiographic findings in these patients that can at times be quite subtle. Awareness of the incidence of such injuries either in isolation or associated with AI has implications regarding evaluation of this patient population with less invasive techniques such as CT or TEE.	4
33. Chen MY, Miller PR, McLaughlin CA, Kortesis BG, Kavanagh PV, Dyer RB. The trend of using computed tomography in the detection of acute thoracic aortic and branch vessel injury after blunt thoracic trauma: single-center experience over 13 years. <i>J Trauma</i> . 2004;56(4):783-785.	Review/Other-Dx	85 patients	To examine the utilization trends of CT and aortography over a 13 year period.	Aortography was dominant before 1998. After 1998, there was a trend to using CT more often (up to 50%). Those with indirect evidence of AI (mediastinal hematoma) had a 20% chance of having AI at aortography. 98% of positive aortography patients had an AI at surgery.	4
34. Patel NH, Hahn D, Comess KA. Blunt chest trauma victims: role of intravascular ultrasound and transesophageal echocardiography in cases of abnormal thoracic aortogram. <i>J Trauma</i> . 2003;55(2):330-337.	Observational-Dx	14 patients all 14 patients evaluated with IVUS and 13 with TEE	Prospective observational study to evaluate TEE and IVUS when the aortogram is equivocal.	Overall, IVUS and TEE had sensitivities of 92% and 60% and specificities of 100% and 67%, respectively. In the 4 equivocal cases by angiography, IVUS and TEE were diagnostic. When thoracic aortography yields an abnormal and especially equivocal findings, both IVUS and TEE are helpful in further sorting this out rather than subjecting the patient to a potentially unnecessary thoracotomy. In cases of AI suspected at the lesser curvature of the arch-isthmus junction, TEE allowed better delineation because of multiplane imaging capability.	3

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35. Williams DM, Dake MD, Bolling SF, Deeb GM. The role of intravascular ultrasound in acute traumatic aortic rupture. <i>Semin Ultrasound CT MR</i> . 1993;14(2):85-90.	Review/Other-Dx	1 patient	Case report of the value of IVUS in a patient with possible AI.	IVUS has a role in clarifying the significance of subtle angiographic findings in the workup of traumatic aortic injuries.	4
36. Malhotra AK, Fabian TC, Croce MA, Weiman DS, Gavant ML, Pate JW. Minimal aortic injury: a lesion associated with advancing diagnostic techniques. <i>J Trauma</i> . 2001;51(6):1042-1048.	Review/Other-Dx	198 patients, 9 patients had minimal AI	To document the natural history of minimal AI. All patients suspected of blunt AI by screening helical CT underwent confirmatory aortography with or without IVUS.	15,000 patients had screening chest CT. 198 (1.3%) suspected as having AI. AI confirmed in 87 (44%) with 9 (10%) having minimal AI. 1 patient went to surgery, 2 died of causes not related to the AI, 2 had complete resolution, 1 remained stable and 3 developed small pseudoaneurysms. Ten percent of blunt AI diagnosed with high resolution techniques have minimal AI. These intimal injuries heal spontaneously and hence may be managed nonoperatively. However, the long-term natural history of these injuries is not known, and hence caution should be exercised in using this form of treatment.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Ferrada P, Vanguri P, Anand RJ, et al. A, B, C, D, echo: limited transthoracic echocardiogram is a useful tool to guide therapy for hypotension in the trauma bay—a pilot study. <i>J Trauma Acute Care Surg.</i> 2013;74(1):220-223.	Experimental-Dx	148 patients	To determine if limited TTE can provide meaningful information to guide therapy for hypotension in the trauma bay.	Admission diagnosis was 80% blunt trauma, 16% penetrating trauma, and 4% burn. Subxyphoid window was obtained in all patients. Parasternal and apical windows were obtained in 96.5% and 11%, respectively. Flat inferior vena cava was associated with an increased incidence of intensive care unit admission ( $P<0.0076$ ) and therapeutic operation ( $P<0.0001$ ). Of the 148 patients, 27 (18%) had limited TTE results indicating euvoemia. The diagnosis in these cases was head injury (n = 14), heart dysfunction (n = 5), spinal shock (n = 4), pulmonary embolism (n = 3), and stroke (n = 1). Of the patients, 121 had limited TTE results indicating hypovolemia. 28 hypovolemic patients had a negative or inconclusive Focused Assessment with Sonography for Trauma examination finding (n = 18 penetrating, n = 10 blunt), with 60% having blood in the abdomen confirmed by surgical exploration or CT scan. Therapy was modified as a result of limited TTE in 41% of cases. Strikingly, in patients older than 65 years, limited TTE changed therapy in 96% of cases.	3
38. Via G, Hussain A, Wells M, et al. International evidence-based recommendations for focused cardiac ultrasound. <i>J Am Soc Echocardiogr.</i> 2014;27(7):683 e681-683 e633.	Review/Other-Dx	33 experts from 16 countries	International, multispecialty, evidence-based recommendations for focused cardiac ultrasound by the World Interactive Network Focused on Critical UltraSound.	During 4 conferences (in New Delhi, Milan, Boston, and Barcelona), 108 statements were elaborated and discussed. Face-to-face debates were held in 2 rounds using the modified Delphi technique. Disagreement occurred for 10 statements. Weak or conditional recommendations were made for 2 statements and strong or very strong recommendations for 96. These recommendations delineate the nature, applications, technique, potential benefits, clinical integration, education, and certification principles for FoCUS, both for adults and pediatric patients.	4

**Blunt Chest Trauma-Suspected Aortic Injury  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
39. Karalis DG, Victor MF, Davis GA, et al. The role of echocardiography in blunt chest trauma: a transthoracic and transesophageal echocardiographic study. <i>J Trauma</i> . 1994;36(1):53-58.	Observational-Dx	105 patients	To provide complete echocardiographic assessment of cardiac structure and function in patients with severe blunt chest trauma.	Myocardial contusion was diagnosed in 31 patients (30%), 22 by TTE and 9 by TEE. Cardiac complications developed in 8/31 patients (26%) with myocardial contusion compared with 2/74 patients (3%) with normal echocardiographic findings ( $P=0.001$ ). Cardiac complications required treatment in only 4 patients. Echocardiography was of value in detecting severe right ventricular dysfunction as the cause of hypotension in 2 patients with suspected cardiac tamponade. Four patients with myocardial contusion died compared with 2 patients with normal echocardiographic findings ( $P=NS$ ). No death was related to the cardiac status. In addition, TEE detected AI in 5 patients, 4 with focal intimal tears and 1 with an aortic transection.	2
40. Ahrar K, Smith DC, Bansal RC, Razzouk A, Catalano RD. Angiography in blunt thoracic aortic injury. <i>J Trauma</i> . 1997;42(4):665-669.	Review/Other-Dx	89 patients	To retrospectively assess the limitations of TEE in patients suspected of traumatic rupture of the thoracic aorta.	19% of patients had traumatic involvement of aortic arch branches. These injuries may be overlooked if TEE is the sole imaging modality in these patients.	4
41. Shapiro MJ, Yanofsky SD, Trapp J, et al. Cardiovascular evaluation in blunt thoracic trauma using transesophageal echocardiography (TEE). <i>J Trauma</i> . 1991;31(6):835-839; discussion 839-840.	Review/Other-Dx	19 patients	To prospectively evaluate the aorta with TEE in patients who had sustained blunt chest trauma.	12/19 (63%) had abnormalities of the heart. An aortic tear was seen in 1 patient and confirmed at aortography. TEE can be performed safely in the acute setting of patients sustaining severe blunt chest trauma and yield useful information with respect to cardiovascular function and the aorta.	4
42. Benjamin ER, Tillou A, Hiatt JR, Cryer HG. Blunt thoracic aortic injury. <i>Am Surg</i> . 2008;74(10):1033-1037.	Review/Other-Dx	20 patients	A review of patients with blunt thoracic AI treated at a Level I trauma center.	CXR findings were suggestive of AI in 15 patients, equivocal in 3, and showed no evidence of AI in 2. Diagnosis was made by CTA in 17 patients, TEE in 2, and formal angiography in 1. Data support aggressive use of CTA even when classic CXR findings are not present. When CT must be delayed for abdominal exploration, intraoperative TEE is useful.	4

**Blunt Chest Trauma-Suspected Aortic Injury  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Brooks SW, Young JC, Cmolik B, et al. The use of transesophageal echocardiography in the evaluation of chest trauma. <i>J Trauma</i> . 1992;32(6):761-765; discussion 765-768.	Observational-Dx	58 patients	To prospectively evaluate the usefulness of TEE in the evaluation of patients with significant chest trauma.	19/21 patients with widened mediastinum had TEE and angiography. TEE identified all 3 aortic injuries and 16 normal aortas. As a diagnostic modality, TEE more accurately detected cardiac contusions than TTE (P>.001) and was a very sensitive screening tool in the early evaluation of patients with a wide mediastinum.	3
44. Kearney PA, Smith DW, Johnson SB, Barker DE, Smith MD, Sapin PM. Use of transesophageal echocardiography in the evaluation of traumatic aortic injury. <i>J Trauma</i> . 1993;34(5):696-701; discussion 701-693.	Observational-Dx	69 patients	To prospectively assess the role of TEE and to determine its predictive value in the evaluation of suspected AI.	TEE showed AI in 7 patients, 4 of these patients had positive aortograms and 2 aortograms were falsely negative. Surgery or autopsy confirmed findings in all 7 patients. TEE was more accurate than aortography and is useful in the evaluation of suspected AI.	2
45. Chirillo F, Totis O, Cavarzerani A, et al. Usefulness of transthoracic and transoesophageal echocardiography in recognition and management of cardiovascular injuries after blunt chest trauma. <i>Heart</i> . 1996;75(3):301-306.	Observational-Dx	134 patients	To assess the diagnostic potential of TTE and TEE for the detection of traumatic cardiovascular injuries in patients suffering from severe blunt chest trauma.	TTE provided suboptimal images in 83 patients, detecting 3 aortic ruptures, 28 pericardial effusions (1 cardiac tamponade), 35 left pleural effusions, and 15 myocardial contusions. TEE was feasible in 131 patients and detected 14 aortic ruptures (13 at the isthmus), 40 pericardial effusions, 51 left pleural effusions, 34 periaortic hematomas, 45 myocardial contusions, right atrial laceration in 1 patient with cardiac tamponade, 1 tricuspid valve rupture, and 1 severe mitral regurgitation caused by annular disruption. For the detection of aortic rupture TEE showed 93% sensitivity, 98% specificity, and 98% accuracy. Time to surgery was significantly shorter (30 (12) v 71 (21) min; P<0.05) for patients operated on only on the basis of TEE findings.	3

**Blunt Chest Trauma-Suspected Aortic Injury  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Goarin JP, Cluzel P, Gosgnach M, Lamine K, Coriat P, Riou B. Evaluation of transesophageal echocardiography for diagnosis of traumatic aortic injury. <i>Anesthesiology</i> . 2000;93(6):1373-1377.	Observational-Dx	209 blunt trauma patients	To determine the role of TEE in the diagnosis of traumatic AI.	Traumatic AI was diagnosed in 42 patients (20%). Angiography (aortography and/or contrast-enhanced CT) was less accurate (sensitivity, 83%; specificity, 100%) than TEE (sensitivity, 98%; specificity, 100%) for the diagnosis of AI because it failed to diagnose most minor injuries (intramural hematoma or limited intimal flap, n = 7). However, when considering only patients with major AI (n = 33; i.e., those who might need surgery), angiography (sensitivity, 97%; specificity, 100%) and TEE (sensitivity, 97%; specificity, 100%) were equivalent.	3
47. Vignon P, Boncoeur MP, Francois B, Rambaud G, Maubon A, Gastinne H. Comparison of multiplane transesophageal echocardiography and contrast-enhanced helical CT in the diagnosis of blunt traumatic cardiovascular injuries. <i>Anesthesiology</i> . 2001;94(4):615-622; discussion 615A.	Observational-Dx	110 patients	To determine the diagnostic accuracy of multiplane TEE and helical CT for the detection of traumatic cardiovascular injuries in patients with severe blunt chest trauma.	17 patients had vascular injury and 11 had cardiac lesions. TEE and CT identified all subadventitial disruptions involving the aortic isthmus (n = 10) or the ascending aorta (n = 1) that necessitated surgical repair. In contrast, CT only depicted 1 disruption of the innominate artery. TEE detected injuries involving the intimal or medial layer, or both, of the aortic isthmus in 4 patients with apparently normal CT results who underwent successful conservative treatment. All cardiac injuries but 2 were identified only by TEE.	2

## Evidence Table Key

### Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  - c) the study is an expert opinion or consensus document.

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Dx = Diagnostic

Tx = Treatment

## Abbreviations Key

AI = Aortic injury

CI = Confidence interval

CT = Computed tomography

CTA = Computed tomography angiography

CXR = Chest radiograph

ECG = Electrocardiography

IVUS = Intravascular ultrasound

MDCT = Multidetector computed tomography

MRA = Magnetic resonance angiography

MRI = Magnetic resonance imaging

NPV = Negative predictive value

PPV = Positive predictive value

TCT = Thoracic computed tomography

TEE = Transoesophageal echocardiography

TTE = Transthoracic echocardiogram