Complete Summary

GUIDELINE TITLE

Blunt chest trauma - suspected aortic injury.

BIBLIOGRAPHIC SOURCE(S)

Holtzman SR, Bettmann MA, Casciani T, Gomes AS, Grollman JH, Polak JF, Sacks D, Stanford W, Jaff M, Moneta GL, Expert Panel on Cardiovascular Imaging. Blunt chest trauma--suspected aortic injury. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 5 p. [35 references]

GUIDELINE STATUS

This is the current release of the guideline.

It updates a previous published version: Kelley MJ, Bettmann MA, Boxt LM, Gomes AS, Grollman J, Henkin RE, Higgins CB, Needleman L, Pagan-Marin H, Polak JF, Stanford W. Blunt chest trauma--suspected aortic injury. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):35-9. [29 references]

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

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SCOPE

DISEASE/CONDITION(S)

Blunt chest trauma, suspected aortic injury

GUIDELINE CATEGORY

Diagnosis

CLINICAL SPECIALTY

Cardiology
Emergency Medicine
Internal Medicine
Radiology
Surgery

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for blunt chest trauma-suspected aortic injury

TARGET POPULATION

Patients with blunt chest trauma, suspected aortic injury

INTERVENTIONS AND PRACTICES CONSIDERED

1. X-ray
    - Chest
    - Chest, oblique
    - Esophagus, esophagram
2. Invasive (INV), chest, aortography
3. Chest computed tomography (CT) (helical or multidetector) with contrast
4. Ultrasound (US)
    - Intravascular
    - Transesophageal echocardiography (TEE)
    - Transthoracic echocardiography (TTE)
5. Magnetic resonance imaging (MRI) of the chest
    - Without contrast
    - With contrast
6. Magnetic resonance angiography (MRA) of the chest

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals, and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table

and narrative as developed by the topic leader(s). Questionnaires are completed by participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Blunt Chest Trauma, Suspected Aortic Injury

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, chest	9	CXR is part of the initial screening in blunt chest trauma. It may increase the probability of an aortic injury based on findings suggestive of a mediastinal

Radiologic Exam Procedure	Appropriateness Rating	Comments
		hematoma.
INV, chest, aortography	9	If there is suspicion of aortic injury, thoracic aortography, if rapidly accessible, remains the gold standard for evaluating the aorta.
CT, chest, (helical or multidetector), with contrast	8	CT scanning is a reliable way to evaluate the mediastinum for possible blood. Multislice scanners can provide exquisite detail of the aorta and may replace thoracic aortography as the "gold standard." The decision of whether to go directly to the angio suite or CT after the initial chest radiograph will depend on availability and local expertise.
US, heart, echocardiography, transesophageal (TEE)	6	
MRI, chest, without contrast	4	Access to critically ill patients poses a problem.
US, heart, echocardiography, transthoracic (TTE)	2	
US, intravascular	2	
MRI, chest, with contrast	2	
MRA, chest	2	
X-ray, esophagus, esophagram	1	
X-ray, chest, oblique	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the table are listed at the end of the "Major Recommendations" field.

Trauma ranks fifth behind cardiovascular diseases, cancer, cerebrovascular disease, and chronic lower respiratory diseases as a cause of death in the United States. There were greater than 100,000 accidental deaths in this country in

2003. 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% by 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. Imaging may play a role in grading the severity of aortic injuries to help guide clinical management.

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. 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").

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 hemomediastinum associated with these injuries is therefore most commonly due to rupture of small arteries and veins in the mediastinum. 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.

Because of the trauma setting in which chest radiographs of these patients are obtained, they are usually portable anteroposterior supine films. 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 for an anteroposterior film should result in fewer falsely abnormal films.

Most of the radiograph findings in aortic rupture are related to mediastinal hemorrhage rather to the aortic injury itself. The most common chest film 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 a 90% sensitivity but only a 10% specificity for aortic disruption.

Approximately 7% of patients with aortic rupture have a normal initial chest radiograph. However, the diagnostic evaluation of patients with blunt chest trauma now includes chest CT at most facilities. CT has proven to be very sensitive for the detection of aortic injury. When no mediastinal hematoma is detected on chest CT, the probability of a significant aortic injury is very low.

Thoracic Aortography

Thoracic aortography is widely accepted as the gold standard for evaluating patients with suspected aortic injury. 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. 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.

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. Thoracic aortography is a safe procedure; the reported mortality rate is 0.03%.

Intra-arterial thoracic digital subtraction angiography is less expensive, uses less contrast material, and is faster than conventional aortography. The sensitivity, specificity, and diagnostic accuracy of digital subtraction angiography are equivalent to those of cut film arteriography.

Computed Tomography

With the increasing availability of spiral CT, the technique is playing a more prominent role in the assessment of patients with suspected aortic injury. CT´s strength lies in its ability to distinguish mediastinal blood from other causes of mediastinal widening detected on initial chest radiographs, e.g., artifacts of magnification, mediastinal fat, or anatomic variation. Also, CT may demonstrate the intimal tear or pseudoaneurysm of the traumatized aorta. Technological advancements with helical and, more recently, multidetector CT scans have placed CT at the forefront of evaluating the aorta in cases of blunt thoracic trauma. If no mediastinal hematoma is detected on CT, the probability of a

significant aortic injury is very low, and aortography is generally not needed. If direct signs of aortic injury are identified on CT, patients are sometimes taken to aortography for confirmation or occasionally taken directly to surgery. Many case series show low but consistent false positive examinations.

Magnetic Resonance Imaging of the Thorax

Although MRI of the thorax can demonstrate acute and subacute mediastinal hematoma, 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 the evaluation of chronic traumatic aortic pseudoaneurysms. At the present time, there has been insufficient experience with other MR techniques to recommend their use in the trauma setting. Access to critically ill patients in the MR scanner also poses a potential problem.

Transesophageal Echocardiography

TEE is a relatively new technology that 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.

Recent studies have reported excellent diagnostic accuracy using TEE for the recognition of aortic injury. 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.

Other Modalities

There is no support in the literature for the use of esophagrams, oblique chest films, or intravenous digital subtraction angiography in the evaluation of suspected aortic injury.

The literature supports the continued use of the plain chest radiograph as the initial screening exam 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. The possible role of IVUS and TEE in the setting of suspected thoracic aortic injury awaits further investigation. The overall accuracy of multidetector CT compared with aortography as the gold standard remains incompletely defined at this time.

Abbreviations

- CT, computed tomography
- INV, invasive
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- TEE, transesophageal echocardiography
- TTE, transthoracic echocardiography
- US, ultrasound

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evalutaion of patients with blunt chest trauma of suspected aortic injury

POTENTIAL HARMS

Many case series of computed tomography (CT) show low but consistent false positive examinations

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (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

exams 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 U.S. Food and Drug Administration (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.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Holtzman SR, Bettmann MA, Casciani T, Gomes AS, Grollman JH, Polak JF, Sacks D, Stanford W, Jaff M, Moneta GL, Expert Panel on Cardiovascular Imaging. Blunt chest trauma--suspected aortic injury. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 5 p. [35 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1995 (revised 2005)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Cardiovascular Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Names of Panel Members: Stephen R. Holtzman, MD; Michael A. Bettmann, MD (*Panel Chair*); Thomas Casciani, MD; Antoinette S. Gomes, MD; Julius H. Grollman, MD; Joseph F. Polak, MD, MPH; David Sacks, MD; William Stanford, MD; Michael Jaff, MD; Gregory L. Moneta, MD

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

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GUIDELINE AVAILABILITY

Electronic copies: Available (in Portable Document Format [PDF]) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on February 20, 2001. The information was verified by the guideline developer on March 14, 2001. This summary was updated by ECRI on March 6, 2006.

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