ACUTE CHEST PAIN — LOW PROBABILITY OF CORONARY ARTERY DISEASE

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Summary of Literature Review

Patients with signs and/or symptoms [1] of acute coronary syndrome (ACS) are not included in this discussion as the evaluation and treatment algorithms have been well defined in the Scientific Statements and Practice Guidelines of the American Heart Association [2]. The classic patient with suspected ACS presents to emergency departments with substernal chest pain, diagnostic ST segment changes, and elevated cardiac enzymes suggesting myocardial infarction [3]. For those patients who do not present with classic ACS signs, symptoms, or electrocardiogram (ECG) abnormalities the differential diagnosis needs to include pulmonary, gastrointestinal (GI), or musculoskeletal pathologies [4,5]. In these patients, noninvasive imaging methodologies are essential for diagnosis.

The following imaging modalities are available in evaluating patients presenting to the emergency departments with low probability of coronary artery disease (CAD): chest radiography, multidetector computed tomography (MDCT), magnetic resonance imaging (MRI), ventilation/perfusion (V/Q) scans, cardiac perfusion scintigraphy, transesophageal and transthoracic echocardiography, positron emission tomography (PET), spine and rib radiography, barium esophageal and upper GI studies, and abdominal ultrasound [6,7].

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Chest Radiography

The chest radiograph is the recommended initial imaging study [8]. Chest radiographs can diagnose pneumothorax, pneumomediastinum, fractured ribs, acute and chronic infections, and malignancies. Other conditions producing chest pain, such as aortic aneurysms/dissections and/or pulmonary emboli, may be suspected from the chest radiograph, but the overall sensitivities are less.

Thoracic calcifications, if present, may indicate pericardial disease, ventricular aneurysm, intracardiac thrombi, or aortic disease. The presence of a Hampton hump, Westermark sign, or pulmonary artery enlargement may suggest pulmonary embolism, while mediastinal air may indicate a ruptured viscus or subpleural bleb.

Multidetector Computed Tomography

MDCT has very high accuracy in demonstrating pneumothorax, pneumonia, malignancies, and pulmonary airspace disease. CT angiography (CTA) is the imaging modality of choice for suspected pulmonary embolism and aortic pathology such as dissection or aneurysm. Pericardial effusions, thickening, and/or calcifications are seen far more readily than with radiographs alone [9-12]. ECG gated MDCT can be used in dedicated cardiac protocols for coronary CTA. This examination has a very high negative predictive value for CAD. When coronary CTA is performed with retrospective ECG-gating, wall motion and valve abnormalities can be identified via cine evaluations of CT images acquired throughout the cardiac cycle. Both prospective and retrospective ECG-gated cardiac CT can define ventricular aneurysms and cardiac thrombi [13]. MDCT is also the primary method for diagnosing coronary anomalies [12,14-16]. A coronary calcium score of zero can be useful in excluding CAD.

Transthoracic and Transesophageal Echocardiography

Transthoracic and transesophageal echocardiography with or without pharmacologic stress are frequently used to define abnormalities of ventricular wall motion as an indicator of cardiac disease. [17]. In addition, echocardiography can readily demonstrate pericardial effusion, valve dysfunction, and cardiac thrombus. Aortic pathology can be identified [18,19], but the findings of intramural hematoma, dissection, pulmonary embolus, and aneurysm are better seen with MDCT or MRI (discussed below).

Magnetic Resonance Imaging

Magnetic resonance angiography (MRA) can be performed with either noncontrast (eg, time-of-flight, balanced gradient-echo) or contrast-enhanced (eg, 3D arterial-phase fast gradient-echo) protocols that are useful in identifying vascular pathology. These techniques can be used to identify aortic as well as pulmonary artery pathology [20]. MRA is typically more time-consuming and less available in the emergency setting, but is an

important alternative noninvasive imaging strategy in patients with a contraindication to CTA. Cardiac MRI is uncommonly used in the emergency setting because of the relatively long scan times and the limited number of trained physicians, technologists, and MR resources.

Radiography of the Ribs, Cervical Spine, or Thoracic Spine

Rib or spine radiographs are indicated in patients with a clinical suspicion of skeletal pathology.

Radionuclide Studies

Radionuclide myocardial perfusion studies with thallium 201, technetium 99m sestamibi, or tetrofosmin are frequently used in identifying perfusion abnormalities as a cause for the chest pain, especially when a cardiac etiology is suspected [21-27]. A normal stress perfusion scan may be used to exclude the diagnosis of coronary artery disease in patients who have ruled out myocardial infarction by enzymes.

PET is an alternative method for evaluating myocardial perfusion deficits, using N13 ammonia or rubidium 82 agents. However, these examinations are less commonly used because they are time consuming and resources are not readily available.

V/Q lung scintigraphy can be used in patients with clinically suspected pulmonary embolism, but this study has been largely replaced by MDCT.

Cardiac Catheterization

Cardiac catheterization with coronary digital subtraction angiography remains the gold standard in demonstrating CAD and can permit immediate therapeutic intervention. Catheterization has traditionally served as the definitive diagnostic test, although the high negative predictive value of coronary CTA enables it to be used alone to exclude CAD.

Barium Swallow or Endoscopy

Esophageal disorders can be the cause of chest pain. A barium swallow or endoscopy may be helpful in establishing esophageal spasm or reflux as an etiology of the chest pain [28].

Abdominal Ultrasonography

Abdominal ultrasound may be indicated in documenting cholecystitis as a cause for the chest pain. Ultrasound is also helpful in evaluating pancreatitis and/or intra-abdominal abscesses and fluid collections.

Summary

The patient's history is important in establishing the etiology in patients presenting to emergency departments with a low probability of a cardiac etiology for their chest pain, and a number of imaging modalities may be required to establish the diagnosis. The chest radiograph is almost universally obtained. Traditionally, cardiac echo, stress perfusion scanning, and coronary angiography have been the mainstays for diagnosing coronary heart disease. MDCT is increasingly used in the evaluation of coronary disease. CTA, MRA, ventilation-perfusion scanning, barium swallow, and spine or rib radiographs play a role in evaluating noncoronary causes of chest pain.

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/1.73m^2), 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/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [29].

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. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). 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*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).		

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Contrast Information
- Evidence Table

References

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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.