Acute chest pain: the role of noninvasive imaging

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Acute chest pain

Clinical history, risk factors and physical examination, 12-lead ECG (serial), an initial Troponin assay, baseline laboratory testing

Non-cardiac chest pain
Stable angina pectoris
Suspected Myocardial Infarction
Confirmed Myocardial Infarction
Patients with acute chest pain, clinically suspected acute coronary syndrome

Anderson et al. 2007
Acute coronary syndromes

- **Plaque rupture** or **erosion** - the main initiating mechanism of ACS.
- **Inflammation** - a key role in plaque disruption.
- **Platelet activation** and **aggregation** onto the exposed thrombogenic surface of a ruptured plaque - early important event in the pathogenesis of ACS.
- **Coronary atherothrombosis** - dynamic process.
- **Focal** or **diffuse** spasm of normal or atherosclerotic coronary arteries - cause ACS.
Acute coronary syndrome

- Spectrum of clinical presentations - *ST elevated MI, non-*ST elevated MI, unstable angina pectoris;
- Almost always associated with rupture of an atherosclerotic plaque and partial or complete thrombosis of the infarct-related artery;
- Myocardial ischemia;
- Myocardial necrosis.
Biomarkers for myocardial necrosis

- **Creatine-Kinase-MB**

- **Cardiac Troponin assays** - after the year 2000, cardiac specificity and superior sensitivity to detect myocardial damage.

- **High Sensitive Troponin assays** - the detection of troponins at almost 10-fold lower concentrations and with higher precision.
  - High NPV
  - Low specificity and PPV
Elevated HS-cTr

*Indicate myocardial injury*

*Nonspecific*

- **Type 1 AMI** (related to plaque rupture or thrombotic occlusion)
- **Type 2 AMI** (secondary to supply-demand mismatch with or without CAD)-
tachycardia, hypertension, anemia, sepsis.
- **Nonspecific AMI**- permyocarditis, stress cardiomyopathy
- **Extracardiac AMI** - AAD or PE.

Hs-cTn levels - interpreted as quantitative rather than qualitative values.
The terms positive and negative troponin should be avoided.
European Society of Cardiology recommended algorithm

**HS-c Tr baseline + 1h absolute changes**

- **A rule – out group**
  - 60% of patients
  - Safely discharged

- **A rule – in group**
  - 17% of patients
  - Invasive testing treatment

- **An observe group with substantial diagnostic uncertainty**
  - (23% of patients)
  - Additional testing and characterization of myocardial injury
Acute coronary syndrome

- **Morphologic diagnostic tests** – detection and characterization of atherosclerotic changes on the vessel wall.
- **Functional diagnostic tests** – complex assessment of myocardial demands.
ECG gated MDCT in ACS

Anatomy + Function

1. Clear visualization of the coronary arteries.
2. The degree of stenosis.
3. AS plaque characterization.

4. Left ventricular function analysis.

✓ Triple-rule out protocols.
✓ Non cardiac pathology.
Diagnostic and prognostic accuracy of MDCT

- **CT coronaryography** – high sensitivity and NPV for significant coronary stenosis

- **ROMICAT (2006)** 368 patients with low to moderate risk.

- **CT-STAT (2011)**– 699 patients with CTC or myocardial nuclear scintigraphy.

- **ROMICAT II (2012)** 1000 patients.

*N* Limited PPV
Technical limitations of ECG gated coronary MDCT

- Tachycardia, arrhythmia.
- Obese patients (BMI>30).
- Can not follow the breathing instructions.
- Severe calcification on coronary artery wall - Ca score>800.
- Renal insufficiency.
- Allergy to contrast.
Assessment of the degree of stenosis

Sens 90%  Spec 97%
NPV 99%   PPV 76%
Assessment of the degree of stenosis
Novel techniques for CT coronary assessment

- **TAG** - Transluminal Attenuation Gradient
  Gradually decreased density in coronary lumen from ostia to vessel periphery

- **FFR\textsubscript{CT}** - Fractional Flow Reserve
  Specially designed softer for assessment of coronary flow and pleasure.
Coronary wall atherosclerosis - plaque composition

- Size and localization.
- Plaque composition.
Atherosclerotic plaque composition

Active investigation, development and clinical implementation
Atherosclerotic plaque composition
Recognition of AS plaque at risk

- Very thin fibrous cap <65 μm.
- Large, necrotic core.

CT criteria
1. Low density.
2. Dot calcifications.
3. Ring enhancement.
4. Positive remodeling.
5. Superficial ulcerations.
Recognition of AS plaque at risk

Positive remodeling

Dot calcifications
CT assessment of LV volume and function
MDCT myocardial perfusion

Complex evaluation = Morphologic + Functional information
Functional information - hemodynamic significance of coronary luminal stenosis

Morphologic coronary assessment ≠ Myocardial ischemia
MDCT myocardial perfusion

- Very important additional information interpreted with degree of stenosis.
- Iodine myocardial distribution.
- Perfusion defects - low density myocardial area.
MDCT myocardial perfusion

- **Static myocardial perfusion** – myocardial evaluation in early arterial phase.
MDCT myocardial perfusion
Late myocardial enhancement

- Acute myocardial infarction
- After revascularization
- ECG gated MDCT without contrast
- Areas of late enhancement = areas of myocardial necrosis

Boussel L. et al AJR 2008
Triple rule out protocols
Guidelines: MDCT in acute chest pain

- **2010- AHA, ACR, SCCT** – low and moderate risk for ACS and nondiagnostic biomarkers.
- **2011 ESC Non-STE-ACS** – no diagnostic cardiac biomarkers.

**Future role of cardiac MDCT**

Detailed morphologic plaque assessment and functional assessment of myocardial demands.