CTA FOR ACUTE CHEST PAIN IN THE EMERGENCY ROOM

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No Disclosures
OBJECTIVES

● Clinical background of ED chest pain
● Conventional imaging options for ED CP
● ED CTA
  » Technique
  » Practice
  » Literature
  » Future
Diagnosis of chest pain in the ED remains challenging

ACS (acute coronary syndrome) vs. other cardiac, non-cardiac causes

ACS definition

» Transmural MI
» Subendocardial MI
» Unstable angina
EPIDEMIOLOGY

- 6+ million ED visits yearly for CP in US
- Work-up often >12 hours
- Only 10-15% have ACS
- 50% of patients admitted, many with normal biomarkers/ECG
- ~30% “gap”
- >$8B spent per year
- Goal: Speed work-up, improve accuracy
BACKGROUND

ACS Diagnosis Triad

- History
- ECG
- Cardiac enzymes (CK, troponin)
TRIAGE / ROLE OF NON–INVASIVE IMAGING

- **Group 1:** Clear ACS (acute ECG, elevated biomarkers) – immediate cath
- **Group 2:** Minimal risk – early D/C
- **Group 3:** Equivocal – Non-invasive imaging useful
  - Atypical history
  - Normal or nonspecific ECG
  - Normal early troponins
FURTHER OPTIONS FOR ED TRIAGE

Standard
- ETT (non-imaging)
- Radionuclide Perfusion
- Echocardiography

Potential
- Rb-PET
- CT scan (for cardiac causes)
RADIONUCLIDE IMAGING

Myocardial Perfusion Study

- Image 45-60 minutes after injection of $^{99m}$Tc-Sestamibi
- Can do stress/rest
- Sensitivity – 92% for ED chest pain
- NPV – 99% (for ED pts.)
- Disadvantage: Typically requires movement of patient out of ED suite
RADIONUCLIDE PERFUSION IMAGING

Baseline

ED

99mTc-sestamibi

RCA occlusion

Courtesy: V. Dilsizian
ED CARDIAC CTA

JUSTIFICATIONS

- Rapidly improving scanner technology
- CT proximity to ED
- Widely used for non-cardiac ED indications
  - Pulmonary embolism
  - Aortic dissection
  - Trauma, headache, abd pain
- Track record for reducing ED cost
  - Appendicitis
Two approaches

- Cardiac-focused
- One-stop shop or “triple rule-out” (Cardiac and Non-cardiac)
  - CAD/ACS
  - Aortic dissection
  - Pulmonary embolism
DEDICATED CTA vs TRIPLE RULE-OUT

Dedicated
- Coronaries only
- Better spatial res. of cor arteries
- Less radiation
- Less contrast (3-ph)
- 8 secs
- Craniocaudal

Triple R/O
- CAD, PE, Ao diss.
- Lesser spatial res. of cor arteries
- More radiation
- More contrast (2-ph)
- 15 secs
- ?Caudalcranial with 64D
ED CT CP PROTOCOLS

COR CTA
Recon 10 cardiac phases

TRIPLE R/O
Recon 10 cardiac phases +
Full field-of-view
IMAGE QUALITY COMPARISON

Rahmani et al. Acad Rad 2009;16:604

P = NS
CONTRAST ADMINISTRATION

COR CTA
- Test injection
  » 20 ml @ 6 cc/sec
- Injection protocol
  » 80 ml (100%) @ 6 cc/sec
  » 40 ml (50/50) @ 5 cc/sec
  » 50 ml (saline) @ 5 cc/sec
- Bolus tracking
- 100 CC

TRIPLE R/O
- Test injection
  » 20 ml @ 6 cc/sec
- Injection protocol
  » 80 ml (100%) @ 6 cc/sec
  » 50 ml (100%) @ 2 cc/sec
  » 50 ml (saline) @ 5 cc/sec
- Bolus tracking
- 130 CC

Courtesy: MedRad
CONTRAST ADMINISTRATION

COR CTA

TRIPLE R/O
DEDICATED CTA vs TRIPLE RULE-OUT
DEDICATED CTA vs TRIPLE RULE-OUT

?Frequency of PE miss on dedicated CTA

- 96 patients (46 with PE) Dx’d on chest CT
- Scans masked to mimic dedicated cor CTA
- Two blinded readers assessed cor CTA for PE
- 37/46 (80%) of PE diagnosed
- 20% of PE missed

Huard et al. STR 2007
ER CHEST PAIN ON MDCT

MARYLAND CLINICAL PROTOCOL

- Available 7A-5P weekdays
- Prelim reading at night
- Low-intermediate risk non-admitted pts
- ED physician orders ECG-gated study
  » Triple R/O vs Cardiac only
  » Patient given 100 mg po metoprolol immediately
U OF MARYLAND FLOW CHART

ED Presentation → CT Tech → 3D Tech → Radiologist

Initial evaluation → Scans pt. → Advanced recons → Independent assessment - interpretation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CTA</th>
<th>CTA Lg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick/Incr</td>
<td>0.9@0.45</td>
<td>1.5@0.7</td>
</tr>
<tr>
<td>kVp</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>mAS</td>
<td>800</td>
<td>900</td>
</tr>
<tr>
<td>RISK CATEGORY</td>
<td>CT INTERPRETATION</td>
<td>CLINICAL GUIDELINE</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>High</td>
<td>Coronary calcifications &gt;400</td>
<td>Admission</td>
</tr>
<tr>
<td></td>
<td>Hard or Soft Plaque</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Stenosis &gt;70% in any vessel</td>
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</tr>
<tr>
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</tr>
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<td>Low</td>
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<td>Patient to follow with Preventive Cardiology</td>
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<tr>
<td>Negative</td>
<td>Normal scan</td>
<td>Follow up with regular MD</td>
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CASE EXAMPLES
CTA-CATH (46 yo F)
CTA-CATH (49 yo M)
CTA-PERFUSION (55 yoM)
64-slice CT (ROMICAT1)

- 368 admitted patients (39%F, mean – 53 yrs)
- Prospective with 6 mo F/U for MACE
- Caregivers and patients blinded
- Low-intermediate risk (neg biomarkers)
- Significant stenosis ≥ 50%

Hoffmann JACC 2009;53:1652
RESULTS

- 8% ACS
- 50% no plaque, 41% nonobs/indet plaque, 9% stenosis
- Sens = 100%, NPV = 100% (no plaque)
- Increasing plaque → increased ACS
- Conclusion: May dec unnecessary admissions
AGE AND GENDER

- ROMICAT1 population
- ACS occurrence increased with age
- Looked at decrease in risk category
- CTA most effective (decrease in risk category)
  - Men < 55 years
  - Women < 65 years

Bamberg AJC 2009;104:1165
ED CP - DEDICATED CORONARY CTA

Hoffmann Circ 2006
64-slice CT

- 197 patients completed protocol
- Low to moderate risk**
- 22/197 (11%) had >50% stenosis
- NPV - 99.4% at 30 day F/U
- Non-CAD clinically important findings explained CP in 22/197 (11%) patients
## Alternative findings explaining CP

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of Cases</th>
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<tbody>
<tr>
<td>Pneumonia</td>
<td>5</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>3</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>3</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>2</td>
</tr>
<tr>
<td>Hiatal hernia</td>
<td>2</td>
</tr>
<tr>
<td>Aortic dissection</td>
<td>1</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>1</td>
</tr>
<tr>
<td>Metastatic pulmonary mass</td>
<td>1</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>1</td>
</tr>
<tr>
<td>Esophagitis</td>
<td>1</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>1</td>
</tr>
<tr>
<td>Anomalous coronary artery</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
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Takakuwa Rad 2008:248:438
CHALLENGES

- Technical/Labor
- Radiation dose
- Economics
TECHNICAL/LABOR

- Need minimum 64-slice CT for triple R/O
- 3D-tech supportable with 3D codes
- Off-hours options
  - residents
  - in-house 24/7 staff
  - remote portal, client-server/nighthawk
  - prelim reads (dual-mode) – wait until AM for final disposition if pos
LABOR ISSUES

- Restricted to low-intermediate risk pts

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## OFF-HOURS

- The dual mode triage option

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| High          | Coronary calcifications >400  
Hand or Soft Plaque  
- Stenosis >70% in any vessel  
- Stenosis >50% in Left Main | Admission |
| Med           | Coronary calcification 100-400  
Stenosis 30-70% in any vessel | Cardiology consultation |
| Low           | Coronary calcification <100 | Patient to follow with Preventive Cardiology |
| Negative      | Normal scan | Follow up with regular MD |
## RADIATION EXPOSURE

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Dose (mSv)</th>
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<tbody>
<tr>
<td>Background - Yearly</td>
<td>3.6</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>0.05</td>
</tr>
<tr>
<td>Sesta/Thal – rest/stress</td>
<td>1.5-5/6-25</td>
</tr>
<tr>
<td>Cardiac Cath</td>
<td>3-15</td>
</tr>
<tr>
<td>Chest CT (conventional)</td>
<td>5</td>
</tr>
<tr>
<td>Gated CT</td>
<td>9-15</td>
</tr>
<tr>
<td>Gated CT – dose modulated</td>
<td>6-9</td>
</tr>
<tr>
<td>Triple Rule-out</td>
<td>20-30</td>
</tr>
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</table>
Fig 1(c). Prospectively-gated Step & Shoot scans
256 SLICE TRIPLE RULE-OUT

PROSPECTIVE-GATING
Whole-Chest 64-MDCT of Emergency Department Patients with Nonspecific Chest Pain: Radiation Dose and Coronary Artery Image Quality with Prospective ECG Triggering Versus Retrospective ECG Gating

Retrospective: 31.8 ± 5.1 mSv (range, 27.3–40.5 mSv).
Prospective: 9.2 ± 2.2 mSv (range, 7.2–11.6 mSv)
= 71% dose savings
## RADIATION EXPOSURE

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</tr>
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<td>Gated CT – dose modulated</td>
<td>6-9</td>
</tr>
<tr>
<td>Gated CT- prospective axial</td>
<td>3-4</td>
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<tr>
<td>Triple R/O</td>
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<tr>
<td>Triple R/O-prospective axial</td>
<td>7-10</td>
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### ECONOMIC CONSIDERATIONS

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<tr>
<th>Procedure</th>
<th>Cost (USD)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest radiograph</td>
<td>$35</td>
</tr>
<tr>
<td>Sestamibi – rest/stress</td>
<td>$500-$700</td>
</tr>
<tr>
<td>Stress Echo</td>
<td>$300-$500</td>
</tr>
<tr>
<td>Cardiac Cath</td>
<td>$2000 and up</td>
</tr>
<tr>
<td>Cardiac (Chest) CT</td>
<td>$500-$600</td>
</tr>
</tbody>
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*Based on 2007 Medicare rates*
MULTI- SITE TRIAL (CT STAT)

- 700 pts, 15 centers (50:50 – CTA:SOC)
- CTA Triage: <25% D/C, 26%-70% MPI, >70% Cath
- Stenosis: None – 82%, Mid – 9%, Sig. – 8%
- Cath rate: CTA – 5.1%, SOC 4.6% p=ns
- ACS rate: CTA – 3.2%, SOC 3% p=ns
- Time to Dx: CTA- 3 hrs, SOC 6.2 hrs p<.01
- Cost of care: CTA-$2,000, SOC ~$3,500

AHA 2009
FINAL THOUGHTS

- Suggestions to avoid overuse, NEED GATEKEEPER
  - ? Chest pain unit criteria
  - Within that, only low-intermediate risk

- Dedicated vs Triple R/O
  - Depends on PE suspicion

- Larger studies
  - CT-STAT, ROMICAT2, ACRIN
THANK YOU