CTA of Chest Pain in the Emergency Department

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Objectives

- **Review**
  - Most current methods of work-up and management of chest pain in the ED
    - Including Cardiac CTA

- **Discuss**
  - Future Directions
    - Technology
    - Training
    - Practice of Radiology

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CARDIAC CT IN THE ED

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Chest Pain

- 8 Million chest pain ED visits/year
  - 2nd largest group by chief complaint

- 15-30% patients with non-traumatic chest pain have ACS
  - 10% of these patients die within 30 days

Presentation

- History: atypical/vague symptoms
  - GERD
  - Risk factors considered but not predictive

- Physical exam: Not predictive

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Chest Pain

- Symptoms often nonspecific
  - Majority (70-85%) not having ACS

- ACS can be lethal
  - $8 to 10 billion admissions/year

- 5% ACS patients inappropriately discharged from ED
EKG

Biomarkers

• Ideal:
  – Highly sensitive and high NPV
    • Safe to discharge home
  – Highly specific and high PPV
    • Prompt aggressive management

• Multiple Markers:
  – CK, CK-MB, Troponins
    • Not always elevated in ACS
    • Troponin may be elevated with PE, myocarditis, HF

Risk Stratification

• Goldman Risk Score – Considers ECG and CP
  – Stratifies risk, but not below 1% threshold
  – 5% adverse outcomes even in low risk, troponin negative group

• Thrombolysis in MI (TIMI) - 7 parameters
  – Negative biomarkers AND TIMI 0 = Safe discharge
    • 10% ED patients

TIMI

1 point each:
Age 65
3 risk factors for CAD
Known 50% stenosis
ASA use past 7 days
2 episodes angina within 24 hours
0.5 mm ST changes
+ Biomarker

HEART Score

• History, ECG, Age, Risk factors, Troponin
• Strong predictor of event-free survival
• Strong predictor of future events
  – Low risk score – 0.9 % MRE
  – Intermediate score – 12% MRE
  – High Score – 65% MRE

Alternative Diagnosis?

• Miller
  – Patients discharged from ED with noncardiac diagnosis – 6.8% possible and 2.6% definite adverse events within 30 days

• Disla
  – Patients diagnosed with costochondritis (rheumatology confirmed) – 6% had MI

• Hollander
  – Patients with definite noncardiac diagnosis had 4% event rate at 30 days
This is hard – What should we do?

Everyone else

Observation?

- Admission to chest pain/observation unit
- Serial EKG
- Serial Biomarkers
- Nuclear Stress
- Discharge

SPECT MPI

- Tech-99m sestamibi
  - Taken up in myocardial blood flow
  - Retained in myocardial mitochondria
  - Little redistribution
  - Inject while symptomatic
  - Image after stabilized

SPECT MPI

- Strong NPV
- Shorter length of stay
- Fewer admissions
- Reduced health care costs

SPECT MPI - BUT
CCTA

• Widely available – CT in the ED
• Hemodynamically significant stenosis or not?
  – If not - discharge

CCTA – Appropriate use in ED

• Suspected ACS
• No known CAD
• Normal EKG and biomarkers
• Uninterpretable EKG
• Nondiagnostic EKG or equivocal biomarkers

Calcium Scoring?

• Ca Score of 0 – low rate of events
• However – fewer calcified plaques:
  – Younger patients
  – Diabetics
  – Patients with ACS vs. stable CAD
• So, Ca scoring alone may miss CAD
• No added value once CCTA performed
• Extra radiation

Calcium Scoring?

• Q: What about high calcium scores causing problems with interpreting CCTA?
  – Score > 400 associated with blooming
  – A: The technology has improved AND if you choose your ED patients to scan correctly, this will not be a problem.

CCTA

• Hollander
  – Patients with low TIMI scores, Neg EKG, Neg biomarkers, and neg CCTA had no adverse events at one year
• ROMICAT I
  – High NPV ACS with neg CCTA
  – Decreased 2 year risk of major adverse event

CCTA

• ROMICAT II
  – CCTA in low-risk patients resulted in quicker discharge and no undetected ACS at 28 days
• CT-STAT
  – Randomized patients to CCTA or SPECT MPI
  – No difference in major adverse events
• Litt
  – Randomized patients to CCTA or observation
  – CCTA safe for low and intermediate-risk ED patients
CCTA – Premedicate?

- Beta-blockers
  - Contraindicated for sinus bradycardia, hypotension, active and unstable small airways disease
- NTG
  - Vasodilator improves SNR
  - Contraindicated for hypotension, critical AS, recent phosphodiesterase inhibitors

CCTA Protocols

- Retrospective gating
  - All phases, functional information
  - Much more radiation
- Prospective triggering
  - No functional information
  - Much less radiation
  - Might “miss it”

CCTA Protocols

- Dual Source/High-Pitch Helical with prospective triggering
  - Even less radiation
  - Absolutely requires slow, regular heart rate (60 BPM)

CCTA Findings

- Normal
- No hemodynamically significant plaque
  - Less than 50% stenosis
- Hemodynamically significant plaque
  - More than 50% stenosis
- Other

Hemodynamically Insignificant Stenosis

Hemodynamically Significant Stenosis
Hemodynamically Significant Stenosis

Plaque Composition
- Report % stenosis and plaque composition
  - Calcified, Noncalcified, Mixed
- Motoyama
  - Plaques less than 30 HU (high risk)
    - Greater prognostic value than combination % stenosis on CCTA and Stress Difference Scores on SPECT MPI
- Pundziute
  - Plaque composition varies between patients with stable CAD vs. patients with unstable angina

Alternative Diagnosis?

Radiation Management
- Dual-Source/Dual-Energy
- Single Source:
  - Prospective Triggering
  - Dose-modulated retrospective gating
  - Reduce kVp
  - Iterative reconstruction/noise reduction
Radiation Management

• PROTECTION III
  – Prospective triggering reduced dose by 69% vs. retrospective gating
  – Considerably lower dose than conventional SPECT MPI
• 1 mSv

Criticisms of CCTA

• Hemodynamic significance of plaques?
  – Has not accounted for FFR across a plaque
  – Patient may have good collateral flow
• Faster ED discharge and reduced acute cost
  – BUT increased downstream testing results in ultimately higher costs, morbidity, and stress

Criticisms of CCTA

• ROMICAT II
  – Intermediate risk ED CCTA patients had higher rate of catheter angiography than similar patients who were observed
• Medicare patient study
  – CCTA in non-ED patients led to more catheter angiograms than SPECT MPI

Triple Rule-Out (TRO)

• Obvious appeal
• NPV > 99%
• Downsides:
  – 20-50% more contrast
  – More radiation
  • >30% more radiation than CCTA if arch through base
  • 50–125% more radiation than CCTA if entire chest
• Probably best reserved for small number of patients with low/intermediate risk of ACS and high risk of PE

CCTA Cost Effective?

• Conflicting evidence
  – Yes, if appropriate patients (<50% pretest probability) are scanned
  – No, no difference in cost when compared with SPECT MPI
  – No, more downstream testing

Future Directions

• Myeloperoxidase - ? Marker of vulnerable plaque and associated with MACE
• Dual Energy – Plaque composition
• CT FFR for 40-69% stenoses
• Adenosine Stress CCTA/CMRI/ECHO
• Computer Aided Detection
Who should we scan?

- Low to intermediate risk for ACS
- TIMI 0-2
- Typical angina <30 minutes
- Atypical symptoms
- Normal or nondiagnostic EKG
- 2 negative sets of enzymes in two hour period

Don’t scan

- Prior CABG/known CAD
- Heart rate 85+
- Atrial fibrillation
- Frequent extrasystole/irregular rhythm
- Contraindications to Beta blockers
- Inability to respond to HR lowering agents
- GFR < 45

Summary

- We should not try to divert all comers to our CT suite, but we should try to identify, scan, and discharge the negatives.

Who is going to read these studies?

- Tremendous opportunity for the emergency radiologist (emergency radiology) to demonstrate additional value
- “The cardiac radiologists”
- Good for everyone

Summary

- We should do this
- Provides an enormous service to our ED colleagues
- Provides an enormous service to our hospitals
  - Frees up beds
  - Increases throughput
  - Reduces wait times
  - Improves HCAHPS scores

Who is going to read these studies?

- ACR Certificate of Proficiency – 50 Cases
- ACR Certificate of Advanced Proficiency
  - 150 Cases in three years, 75 as primary
  - Exam – multiple choice and cases
- ABR Focused Practice
Thank you!
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