Stress CT myocardial perfusion imaging

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Ki Seok Choo
Introduction

Coronary CT angiography (CCTA) has been known as a good modality for the detection of coronary artery disease (CAD).

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<th>Author</th>
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<th>PPV</th>
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<td>Mollet NR</td>
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<td>Including high heart rate &amp; &lt; 1.5 mm diameter</td>
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Myocardial perfusion imaging (MPI)

- Single photon emission computed tomography (SPECT)
- Positron emission tomography (PET)
- Magnetic resonance imaging (MRI)
CT myocardial perfusion

- Single Energy with adenosine stress
- Dual Energy
  - Without adenosine stress
  - With adenosine stress
CT myocardial perfusion

The agreement between MDCT and MPS was 83% (p<0.05).

Assessability in CT coronary angiography

Resting vs stress (89% vs 48%, p< 0.05)

*MPS: myocardial perfusion scintigraphy*
Dual Energy Mode

→ 140 kV

Tube A

→ 80 or 100 kV

Tube B
Principle of DECT

Three material decomposition: quantification of iodine
80 kV

140 kV

Mixed 80 kV + 140 kV

80 kV

140 kV

Courtesy of Ko SM, KUH
64 yrs / M
Myocardial perfusion imaging using adenosine-induced stress dual-energy computed tomography of the heart: comparison with cardiac magnetic resonance imaging and conventional coronary angiography

MR: sensitivity (89%), specificity (78%)
CCA: sensitivity (89%), specificity (83%)
Single scan adenosine-induced stress low dose CT myocardial perfusion imaging using 128 slice dual source MDCT: Comparison with fraction flow reserve

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Fractional Flow Reserve

\[ \text{FFR} = \frac{(P_d - P_v)}{(P_a - P_v)} \]

if, central venous pressure \( \approx 0 \) (negligible)

(mean RA pressure)

\[ = \frac{P_d}{P_a} \]

Diagram:

- \( P_a = 100 \)
- \( P_d = 70 \)
- \( P_v = 0 \)
- \( \Delta P = 30 \)
- myoc. perfusion press. = 70 mm Hg
Introduction

◆ CCTA incorporating resting and stress MPI together with dual-64 slice MDCT has an important potential role in MPI for detection of myocardial ischemia.

◆ High radiation dose: 11.2 mSv

J Am Coll Cardiol 2009:1072–1084

◆ Dual-128 slice MDCT with very high temporal resolution and low radiation dose technique was developed and it is supposed that dual-128 slice MDCT indicate myocardial perfusion status and coronary artery anatomy simultaneously
Purpose

To investigate the feasibility of single scan adenosine-induced stress low dose CT myocardial perfusion imaging (MPI) using 128 slice dual-source MDCT for diagnosis of ischemic heart disease (IHD)
Material and method

Approved in IRB
chest pain in consecutive 95 pts. with low to intermediate
probability of CAD.
Underwent low dose stress MDCT

28 pts. (more than 50% stenosis on CCTA)
underwent CAG and measured FFR

Compare FFR with CCTA and CTMPI
Patients

◆ Exclusion criteria
  – Myocardial infarction Hx
  – Stent, bypass graft Hx
  – Atrial flutter or fibrillation
  – A-V block (>1)
  – Severe obstructive pulmonary disease, bronchial asthma
  – Valvular heart ds.
  – Impaired renal function, pregnancy, hyperthyrodisim
  – Known allergy to iodinated contrast
  – Severe LV dysfuntion or heart failure
Adenosine stress CT MPI protocol

- **Start adenosine infusion**: 0 min
- **Adenosine infusion**: 140 µg/kg/min
- **CM 80 ml followed by 20 ml N/S + 40 ml CM**: 3 min
- **Start MDCT scan with smart flap**: 3 min
- **Stop adenosine Infusion**: 3 min
- **Stop MDCT scan**: 3 min
MDCT protocol

◆ Dual 128-slice MDCT (Siemens medical solution, Germany) with ECG dependent tube current modulation for radiation saving

300 msec  400 msec
Interpretation

◆ CCTA
  – Read by one radiologist and cardiologist with consensus
  – MIP series (short axis, 2, 4 chamber, curved)
  – VR
  – Per vessel analysis
  – > 50% stenosis: +
Interpretation

◆ CTMPI
  – Read by one radiologist and cardiologist with consensus
  – 10 mm thick short axis MPR
  – Window width: 200, level: 100
  – 17-segment model
FFR

◆ vessel with > 50 % luminal stenosis on CCTA or CAG
◆ < 0.75 cut off value
  - < 0.75 : positive
  - > 0.75 or < 50 % luminal stenosis on CAG : negative
Result

◆ FFR was measured in 40 vessels of 28 patients
◆ male: 18, mean age: 61.7 ± 20.5, mean heart rate: 74.6 ± 2.8 bpm
◆ Diagnostic acceptable image quality of CCTA and CTMPI was obtained in all 28 patients
◆ The effective radiation dose was 4.63 ± 2.57 mSv
Diagnostic accuracy

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<th>CCTA</th>
<th>CTMPI</th>
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<tr>
<td>Sensitivity</td>
<td>93.1</td>
<td>93.1</td>
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<tr>
<td>Specificity</td>
<td>85.2</td>
<td>91.8</td>
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<tr>
<td>PPV</td>
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<td>NPV</td>
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CCTA(+/+), CAG (-/-)
CTMPI (+/-), FFR (+/-)
CCTA(+), CAG(+)

[Images of medical scans]
CTMPI(-), FFR (-)
CCTA(+), CAG(+)

![CT scan image]

![Angiogram image]
CTMPI (+), FFR (+)
Conclusion

◆ Single scan adenosine-induced stress low dose CTMPI using 128 slice dual-source MDCT could provide more specific information on myocardial perfusion than CCTA alone with low radiation dose
Thank you...