Myocardial CT Perfusion: Optimization of Protocol

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Recent Developments of CT

- Wide detector coverage
- Model-based image reconstruction
- Improved detector function
- Decreased radiation dose

Myocardial CT Perfusion
Selection of Patients

• Patients with intermediate degree of stenosis on prior imaging studies.
• Patients with heavy calcifications in coronary arteries
• Patients with stents and chest pain
• Patients with CT imaging artifacts
Pharmacologic Stress: Contraindications

- Asthma or active bronchospasm
- Severe COPD with rest hypoxia
- Recent use of theophylline/caffeine
- Advanced AV block
- Severe hypotension
- Sick sinus syndrome
- Very early (within 2 days) after acute MI or unstable angina
Preparation

- Caffeine, theophylline: discouraged 12-24 hours before CTP (coffee, tea, chocolate)
- Dipyridamole: discontinued 24 hours before exam
- Separate routes (arm/leg) of adenosine, contrast agents, and BP cuff to minimize the risk of heart block
Precaution and Tips

• Secure 3 extremities for IV routes/BP cuff to avoid abrupt increase in flow of stressor drug.
• Monitor heart rate response to stressor drug and ensure that adequate stress is achieved.
• Ensure sufficient anatomical coverage of myocardium.
• Coronary spasm may develop during and after adenosine stress.
CTP Methods and Protocols

- Static scan or Snapshot imaging
  - Single-energy CTP
  - Dual-energy CTP
- Dynamic CTP

- Stress first or rest first protocol
- Rest CCTA vs. rest dynamic perfusion
- Delayed imaging
- Use of Regadenoson
CTP = MRP
1-vessel Disease: Color Map Better
Timing of CT Initiation

- Predetermined scan start time OR
- The 300 HU trigger threshold may be used to start stress scan.
- Scan should start before contrast arrival for dynamic scanning.
## Contrast Injection Protocol

<table>
<thead>
<tr>
<th>Weight</th>
<th>Weight (lb)</th>
<th>Contrast</th>
<th>Saline</th>
<th>Injection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 60 kg</td>
<td>&lt; 130 lb</td>
<td>40 mL</td>
<td>50 mL</td>
<td>4 mL/s</td>
</tr>
<tr>
<td>60–100 kg</td>
<td>130–220 lb</td>
<td>50 mL</td>
<td>50 mL</td>
<td>5 mL/s</td>
</tr>
<tr>
<td>&gt; 100 kg</td>
<td>&gt; 220 lb</td>
<td>60 mL</td>
<td>50 mL</td>
<td>6 mL/s</td>
</tr>
</tbody>
</table>
**Dynamic CT Perfusion Protocol**

<table>
<thead>
<tr>
<th>Adenosine Infusion</th>
<th>Dynamic CT</th>
<th>Rest CCTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 min 54 sec</td>
<td>6 sec</td>
<td>30 sec</td>
</tr>
</tbody>
</table>

Adenosine on, IV contrast

Adenosine off, NTG, IV contrast

Determination of Half-scan Interval

Protocol with scan for 14 seconds (corresponding to 12.0–26.0 seconds of original dynamic scan)
Dynamic CTP (21-sec Scan Duration)
Dynamic CTP with Variable Scan Interval

Courtesy of GE
Dynamic CT Perfusion Imaging with 80 kV, Adapted Fixed Tube Current and 400 mgI/mL

Dynamic CTP with 3-5 mSv (1300 mA, 70 kV), 66 ms temporal resolution, 110 mm coverage

Courtesy of Siemens
Stress Perfusion with IMR

Courtesy: Dr. Ghaye, Prof. Coche, UCL, Brussels, Belgium
Sub-mSv Static CT Perfusion and Color Map

Courtesy of Toshiba
Beam Hardening Artifact Reduction

Conventional 120 kVp

MonoE 110 keV
Myocardial Artifacts on Iodine Density Image

Conventional 120 kVp

Iodine Density Image

Av. 90.2 HU
Av. 121.2 HU
Av. 131.9 HU
Av. 3.2 mg/ml*
Av. 3.0 mg/ml*
Av. 3.1 mg/ml*

PHILIPS
Summary

- Recent CT techniques enable dynamic and static CTP with better image quality and less radiation dose.
- One should choose CTP methods tailored to individual CT scanner and patient.
- Standard CTP protocol with optimization should be proposed in the cardiac imaging societies.