Myocardial Dynamic Stress Perfusion by CT

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Myocardial Dynamic Stress Perfusion by CT

WHY?

What is the physiological consequence to the myocardium: Ischemia?
And/or Cath Lab or Not

Image: courtesy of Dr DIKRANIAN
Background

- Coronary CT angiography (CCTA) has become a widely used exam in CAD assessment.
- Because limitations (large calcium, artefacts) and its semi-quantitative nature (more or less than 50% stenosis), CCTA has important limitations in the triage of candidates for cath lab.
- Perfusion defect depicting ischemia related to high grade CA stenosis has better predictive value than % of stenosis (include dynamic parameters like vascular tone, collateral linked flow,...) in patients referred to cath lab for revascularisation.
Adenosine is a strong vasodilator and is largely used since longterm to detect high grade coronary artery stenoses non invasively (stress echo, stress MRI,…)

During contrast enhanced CT, the attenuation of X-rays is proportional to the concentration of iodine in tissues, therefore iodine can be used as a marker of myocardial blood flow (MBF) and myocardial blood Volume (MBV) in stress condition.

MBF and MBV evaluation by contrast enhanced CT has been widely validated in animal models (vs microspheres) and in humans (PET and SPECT)
Attenuation of X-rays is proportional to the concentration of iodine in tissues.

Quantification of:
- Myocardial Blood Flow
- Myocardial Blood Volume
Canine Model: LAD stenosis

$y = 0.7598x + 0.7529$

$R = 0.95, p<0.001$
Myocardial Blood Flow

![Graph showing the comparison between MDCT derived MBF and Microsphere derived MBF for Ischemic and Remote regions. The graph indicates higher MBF in Remote regions compared to Ischemic regions, with error bars for each data point.](image)

George RT, et al. Invest Radiol 2007,
Typical Attenuation/Time Curves

- **LV Blood Pool**
- **Normal**
- **Ischemic**
Perfusion Dynamique Quantitative sous Stress
Quantification of acute myocardial infarct

Sténose 95% CD

Stress

Flux sanguin dans le defect:
65 cc/ 100 cc/ min

Rest

Flux sanguin dans le myocarde sain :
112 cc/ 100 cc/ min

Ho et al., Journal of Cardiovascular Computed Tomography, Vol 5, No 2, March/April 2011
Perfusion Dynamique Quantitative sous Stress
Hypoperfusion fixe vs. réversible

Flux sanguin dans le defect pré-existant :
118 cc/ 100 cc/ min

Flux sanguin dans le myocarde sain :
112 cc/ 100 cc/ min

Ho et al., Journal of Cardiovascular Computed Tomography, Vol 5, No 2, March/April 2011
MDSP by CT in St Elisabeth

- Started in 2013
- Close collaboration between radiologists and cardiologists
- 23 patients so far with CTA showing non-diagnostic images
- 9/23 had coronary angiography because suspected hemodynamically significant CAD
- 7/9 with PTCA of the lesion depicted by MDSP by CT
  - 1 patient, technical problem with non-interpretable images
  - 1 patient, lesion not significant by coronary angiography
Methodology

- Patient selection: referred for CAD detection by CTA with non conclusive images (CA++, artefacts,..)
- MDSP in a second step with patient preparation, (R/, CI to adenosine, R interfering with adenosine)
- Patient with 2 veinous lines, BP and ECG base-line, adenosine preparation 0.14g/Kg/min.
- Topogramme, flash ca scoring and test bolus
- Acquisition programmation (place the box!, limited coverage 7.5 cm)
- Adenosine injection: during 4 minutes
- Coaching the patient
- Contrast Injection
- Start scanning
- Start perfusion acquisition, last for 30 sec, step and shoot, forward and backward.
- Check patient clinic, BP and ECG post stress.
MDSP by CT: Post Processing

Rotation time: 0.28 s
Temporal resolution: 75 ms
Tube voltage: 100 kV
Prospectively triggered scans for 30 s
Dose: 9.98 mSv

Courtesy of Dr. Luiz Avila, Hospital Sirio Libanes, Sao Paulo, Brazil
• 66 years old man
• Evolutive exertional dyspnea since a couple of weeks
• Heavy smoker in the past and dyslipemia controlled by statin
• Classical examinations normal except bicycle test with dyspnea at 110 Watts with ECG abnormalities
• CTA to complete the examinations since bicycle test non contributive

Image: courtesy of Dr DIKRANIAN
**MDSP by CT: Acquisition Protocol**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scanner</strong></td>
<td>SOMATOM Definition Flash</td>
</tr>
<tr>
<td><strong>Scan area</strong></td>
<td>Heart</td>
</tr>
<tr>
<td><strong>Scan mode</strong></td>
<td>VPCT</td>
</tr>
<tr>
<td><strong>Scan length</strong></td>
<td>70 mm</td>
</tr>
<tr>
<td><strong>Scan direction</strong></td>
<td>Cranio-Caudal</td>
</tr>
<tr>
<td><strong>Scan time</strong></td>
<td>31 s</td>
</tr>
<tr>
<td><strong>Tube voltage</strong></td>
<td>100 kV</td>
</tr>
<tr>
<td><strong>Tube current</strong></td>
<td>125 eff. mAs</td>
</tr>
<tr>
<td><strong>Dose modulation</strong></td>
<td>CARE Dose4D</td>
</tr>
<tr>
<td><strong>CTDivol</strong></td>
<td>78.2 mGy</td>
</tr>
<tr>
<td><strong>DLP</strong></td>
<td>562 mGy cm</td>
</tr>
<tr>
<td><strong>Effective dose</strong></td>
<td>7.9 mSv</td>
</tr>
<tr>
<td><strong>Rotation time</strong></td>
<td>0.28 s</td>
</tr>
<tr>
<td><strong>Slice collimation</strong></td>
<td>32 x 1.2 mm</td>
</tr>
<tr>
<td><strong>Slice width</strong></td>
<td>3 mm</td>
</tr>
<tr>
<td><strong>Reconstruction increment</strong></td>
<td>2 mm</td>
</tr>
<tr>
<td><strong>Reconstruction kernel</strong></td>
<td>B23f</td>
</tr>
<tr>
<td><strong>Contrast</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>50 ml (15 ml Bolus)</td>
</tr>
<tr>
<td><strong>Flow rate</strong></td>
<td>6ml/s</td>
</tr>
<tr>
<td><strong>Start delay</strong></td>
<td>Determined by test bolus</td>
</tr>
</tbody>
</table>

Image: courtesy of Dr DIKRANIAN
Coronarography

Angioplasty

Image: courtesy of Dr DIKRANIAN
Will MDSP by CT be a new tool for efficient triage of patients before referral to cath lab?

- CAD Excluded
- Indetermined!
- CAD significant

- Stress Myocardial Perfusion with ADENOSINE

- Discharge
- Nég Discharge
- Pos Cathlab
- Cathlab

Image: courtesy of Dr DIKRANIAN