Cardiac CT using GE Healthcare CT systems

2011

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Many thanks to...

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Maarten Spinhoven
Thijs Van der Zijden
Joachim Maes
Michael Camerlinck
Christoph Kenis
Anatomy of a Cardiac CT

Three primary stages

1. Know your patient
2. Accurate patient selection & preparation
3. Know you scanner
4. Technical strengths & weaknesses
5. Interpret your data
6. Post-processing & reporting
Selecting & preparing the patient
Who do we like to scan?

- Patient with inconclusive clinical & technical results
  - Low pre-test probability of significant coronary stenosis
  - reassurance of patient & cardiologist
  - coronary anatomy variations

- Pre-operative planning
  - TAVI: transcatheater aortic valve implantation
  - Pulmonary vein isolation: atrial fibrillation, ....

- Stents & bypasses
  - not routine
  - decision on case-by-case basis
  - mentioning of limitations in report
Who we don’t like to scan!

- **Arrhythmia's**
  - atrial fibrillation, very frequent extrasystoles, ...
  - stable & sinusal rhythm is required

- **Patient with extensive atherosclerosis**
  - e.g. 80-year old diabetic patient with chronic hypertension
  - review on a case-by-case basis
  - education of prescribing clinician is critical!
Patient preparation

Patient registration
one hour before examination
always take cardiac medication
(2-3 hour fasting)

ECG & Blood pressure

Risk score parameters
age, BMI & waist-hip ratio, smoking habit, ...

CT Scanner

Evaluation of hearth rhythm

Arrhythmia: STOP

- dedicated nurse for patient preparation
- CT technologist
- engineer
- radiologist & cardiologist
What about heart rate?

• Absolute heart rate is not everything!

  • a stable & sinusal rhythm is as or even more important than a faster heart rate

![Heart Rate Graph](image)

- **BEST**
  - 65

- **AVOID**
  - 70

- **OK**
  - 80
  - 90

try to correct with medication
Medication

• To avoid heart rates between 70-80 and >90 BPM
  • beware of contra-indications*
  • but don’t overestimate complications...
  • preparation by prescribing clinician is critical!

• B-blockers
  • up to 30 % of patients receive medication on-site
  • >9000 scans without complications
  • Patient & blood pressure check 30 minutes after end of scan

* Pannu et al β-Blockers for Cardiac CT: A Primer for the Radiologist AJR 2006 186:S341-S345
What we use

• **B-blockers**
  - Seloken IV 5 mg / 5 ml (metoprolol tartrate) - AstraZeneca
    - increments of 2.5 cc depending on weight & medical history (ECG!)
  - administered while patient on CT table
    - continuous ECG-monitoring
  - rule of thumb: maximum 10 ml !

• **Ca-antagonists**
  - take longer for clinical effect
  - decision on case-by-case basis
Understanding our equipment
Lightspeed VCT - GE Healthcare
2 dedicated AW workstations
Discovery CT750HD
0.23 mm spatial resolution - better contrast resolution - spectral imaging
Relevant technical data

- **Temporal resolution**
  - 350 ms
  - mono-, 2- & 4-segment reconstruction modes
  - Step & Shoot (Snapshot pulse)

- **Spatial resolution**
  - VCT Lightspeed: 0.625 mm - 0.3 mm in plane
  - Discovery HD: 0.23 mm - better contrast resolution

- **Detector coverage**
  - 4 cm / rotation
  - Average scan time: 6 seconds
What we scan & review

- Coronary calcium measurement
  - Agatston-score
  - Equivalent Ca mass
  - Ca volume
  - Not for CABG & stents

- CT angiography
  - cardiac morphology
  - coronary tree

- Extracardiac findings at full FOV
Too much Calcium?

75-year-old man, extensive calcification

⚠ Overall scan & image quality is as important as absolute Ca-score
Sequential CT-A techniques

Work best < 65 BPM
## Retrospective Scan modes

<table>
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<th>Heart rate</th>
<th>Rotation time</th>
<th>Recon mode</th>
<th>Pitch</th>
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<td>30-35</td>
<td></td>
<td></td>
<td>0,16</td>
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<tr>
<td>36-44</td>
<td>350 ms</td>
<td>2-segment</td>
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<tr>
<td>45-52</td>
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<td>monosegment</td>
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<tr>
<td>53-60</td>
<td>350 ms</td>
<td>2-segment</td>
<td>0,24</td>
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<tr>
<td>61-74</td>
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<td>2-segment</td>
<td>0,24</td>
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<td>75-85</td>
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<td></td>
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<tr>
<td>86-95</td>
<td>350 ms</td>
<td>2-segment</td>
<td>0,22</td>
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<tr>
<td>96-113</td>
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<td></td>
<td>0,24</td>
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<tr>
<td>&gt; 114</td>
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<td>4-segment</td>
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Avoid heart rates around 75 BPM
What to choose?

- Pre-scan breath-hold
- Indication of heart rate during CT scan examination
- Heart rate during Ca-score measurement also indicative
- But...
  - Heart rate can change for different reasons
  - Physical sensation during IV contrast injection
  - Anxiety, stress, ...
- Heart rate during CT scan is sometimes plain unpredictable!
- Initial chosen scan method was in retrospect not the best
- Attempted dose-reduction may result in suboptimal quality!!
Low dose CT options

• **Sequential CT-technique**
  - Step & Shoot (Snapshot Pulse)
  - <65 BPM
  - achieved doses as low as 3 mSv

• **ASiR**
  - Adaptive Statistical iterative Reconstruction: 30-50% setting
  - average 30-40% dose reduction without loss of image quality

• **Optimal scan protocol design**
  - kV, mA and contrast volume adapted to weight
Scan protocol

- IV contrast
  - Iomeprol 400 mg I/ml (Iomeron, Bracco)
  - 3-phase injection protocol

<table>
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<tr>
<th>Weight</th>
<th>kV</th>
<th>mA</th>
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<th>Phase 2</th>
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<td>80</td>
<td>500</td>
<td>60 cc - 5 cc/sec</td>
<td>30 cc contrast - 2,5 cc/sec</td>
<td>30 cc fys - 5 cc/sec</td>
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<td>30 cc fys. - 2,5 cc/sec</td>
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<td>60-85 kg</td>
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<td>650</td>
<td>100 cc - 5 cc/sec</td>
<td>30 cc contrast - 2,5 cc/sec</td>
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<td>30 cc fys. - 2,5 cc/sec</td>
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In practice
always manual start
Interpreting the Data
Post-processing

• **Value of post-processing is often underestimated**
  - significantly determines speed of patient throughput
  - can increase your diagnostic confidence
  - presentation of relevant images to referring clinician

• **Always one dedicated engineer present**
  - specially trained engineers
  - cardiac chambers reformating & tracking of coronary tree
  - post-processing work saved for second-view review if necessary

• **Workload**
  - average of 8 patients/day
  - > 9000 scans on GE LightSpeed 64-slice
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Difference with HD Discovery

Images courtesy of Dr. Olivier Ghekiere
Difference of HD Discovery

Images courtesy of Dr. Olivier Ghekiere
Reporting

- Joint Venture Cardiology - radiology
  - Structured reporting in consensus with pre-defined template
  - uniform reporting with Cardiology Cath Lab
  - integrated in hospital electronic patient medical files

- Database
  - Filemaker Pro (Windows & Mac environments)
  - inclusion of all patient data (BMI,...) and CT data
  - cross-linking with consultation & cath lab data

- Overall post-processing & reporting time
  - 5 minutes to 25 minutes!
  - multiphase examinations, amount of post-processing
no stenosis
wall irregularities
30%
50%
>50%

no plaque
calcified plaque
non-calcified plaque
mixed plaque
In conclusion
Careful patient selection means education of prescribing clinician
Key Point II

An inadequate heart rate often remains an issue
We like image quality, flexible & fast software
Key Point IV

Dose reduction from different angles
Structured reporting
Thank you for your attention!