Coronary CT Angiography

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Applications of MDCT: Ischemic Heart Diseases

- Coronary arterial morphology (angiographic display)
- Coronary plaque characterization
- Postop. Evaluation (CABG)
- Stent patency
- Coronary calcium score
- Cardiac perfusion
- Cardiac function
Techniques of 16-slice CT: Coronary Studies

- Calcium scoring: no contrast, 1.2 mm scan
- Postcontrast studies
  - Nonionic CM 80-120 ml, 4 ml/s
  - Delayed scan at 10 min for myocardial imaging
- Heart rate control by preCT medication (beta-blocker) in pt with HR > 60 bpm
  (metoprolol 50-100 mg p.o., 1 h before)
Image Acquisition and Reconstruction

- Retrospective ECG-gating
- Image reconstruction according to cardiac phases (5-95% of RR interval, 1-20 phases)
- 0.6 mm slice thickness (180-220 images during 20-25 sec breath-hold)
3D Techniques and Image Analysis

- Volume rendering
- Maximum intensity projection (MIP)
  - Vessel analysis
  - Sub-volume MIP
- Reformation in cardiac short and long axes
- Endoscopic view (fly-through)
- Source images
Volume Rendering
Vessel Analysis, Curved Reformation
Navigation
Heart Rate

HR = 70-74

HR = 61-64
LCX and RCA-PDA, 75%
Stent: Patent vs Occluded
## Plaque Characterization: IVUS vs CT

<table>
<thead>
<tr>
<th></th>
<th>Schroeder</th>
<th>Leber</th>
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<tbody>
<tr>
<td>Soft</td>
<td>$14 \pm 26$ HU</td>
<td>$49 \pm 22$ HU</td>
</tr>
<tr>
<td>Intermed</td>
<td>$91 \pm 21$ HU</td>
<td></td>
</tr>
<tr>
<td>Calcified</td>
<td>$416 \pm 194$ HU</td>
<td>$391 \pm 156$ HU</td>
</tr>
</tbody>
</table>

Schroeder et al. J Am Coll Cardiol 2001;37:1430
Fatty Plaque and Stent
16-CT vs IVUS (n = 22)

Noncalcified Plaque
Sens, 78%; Spec, 87%.

Calcified Plaque
Sens, 94%; Spec, 94%.

For Exclusively Noncalcified Plaque:
Sens = 53% (8/15).

Underestimation of plaque volume by MDCT (24 vs 43 mm$^3$, p < 0.001)

Achenbach et al. Circulation 2004;109:14-17
Multiple Calcific Lesions,
No Visible Lumen on CAG (M/73)
Multiple Calcific Lesions, No Visible Lumen on CAG
Blooming Effect of Calcium

w560/ L190  w2000/ L780
Y Graft to LAD and PDA
Vessel Analysis
Coronary Calcium Scoring
Prognostic Value of CAC Screening

- 10,377 asymptomatic subjects
- 5 y follow-up, death rate = 2.4%
- CAC was independent predictor of mortality (p<.001)
- 5-y risk-adjusted survival was 95% for score > 1,000, 99% for score < 10.
- Risk-adjusted relative risk value for CAC, compared with CAC < 10: 1.7, 2.5, 4.0 for >100, >400, >1000

Shaw et al. Radiology 2003;228:826-833
Myocardial Bridge
Kawasaki Disease (M/13y)
RCA Involvement of Aortitis
(F/55)
Collateral Circulation

Vieussens’s Ring: Conal to Conal Collateral

Shin SD, M/73
Patients with Chest Pain

Atypical Stress Tests → MDCT → Quit

Stenosis: Yes

Typical

Acute Coronary Syndrome

CAG/Intervention

Stenosis: No

Quit

Quit
Patient with Acute Chest Pain at ER

- ECG-gated CTA covering whole chest for exclusion of
  - Aortic dissection
  - Pulmonary embolism
  - Coronary artery disease
  - Myocardial infarction
MDCT Evaluation of Myocardial Perfusion and Viability
Reperfusion Model

Early phase (18 sec)  Late phase (10 min)  TTC-staining
Time Course: CT vs MRI in Occlusion Model

Early  5 min  10 min  15 min  23 min
Human Study

• 55 patients underwent MDCT and MRI in the acute stage (within 2 weeks, n = 34) and/or chronic stage (1-36 months, n = 24) of MI
First-pass and 5-min and 15-min delayed myocardial MR imaging was performed using an 1.5 T scanner (GE Signa CVí) with injection of 0.15 mmol/kg Gd-DTPA.

Within 24 hours after MR imaging, ECG-gated MDCT was performed using GE 4-slice (n = 12) or 16-slice (n = 46) scanner at 25-sec and 10-min delay with injection of 120 ml nonionic contrast at 4 ml/s.
Results

- MDCT showed areas of MI on early phase images in all cases except one (4.1%) and in all cases on late phase images.
- Myocardial abnormalities on CT correlated well (94.9%) with those on MRI except 3 exam sets without visible lesions on early CT (n = 1) or perfusion MRI (n = 2) in terms of location and depth of the lesions.
Comparison of Infarct Volume (%) between CT and MRI

<table>
<thead>
<tr>
<th></th>
<th>ECT</th>
<th>PMRI</th>
<th>LCT</th>
<th>DMRI</th>
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<tbody>
<tr>
<td>P</td>
<td>0.27</td>
<td></td>
<td>0.005</td>
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</table>

**P = 0.27** for ECT and PMRI vs DMRI.
Correlation of Infarct Volume (%) between CT and MRI

- ECT vs PMRI: $r = 0.59$
- LCT vs DMRI: $r = 0.81$
AMI, Persistent Perfusion Defect on Late Phase, CT = MRI

Early

CT

MRI

Late
2-vessel Lesions in AMI,
CT = MRI = PET
MRI vs CT in AMI: Multiple Areas of Delayed Hyperenhancement
Color-coded Images with LV Function Assessment in AMI
Stenting Complication
## MDCT Assessment of Coronary Artery Stenosis (> 50%)

<table>
<thead>
<tr>
<th></th>
<th>Slice (DR)</th>
<th>Assess (%)</th>
<th>Sens</th>
<th>Spec</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ropers (n = 77)</td>
<td>16</td>
<td>88</td>
<td>92</td>
<td>93</td>
<td>79</td>
<td>97</td>
</tr>
<tr>
<td>Nieman (n = 58)</td>
<td>16</td>
<td>100</td>
<td>95</td>
<td>86</td>
<td>80</td>
<td>97</td>
</tr>
<tr>
<td>Achenbach (n = 64)</td>
<td>4</td>
<td>68</td>
<td>85</td>
<td>76</td>
<td>59</td>
<td>98</td>
</tr>
<tr>
<td>Knez (n = 44)</td>
<td>4</td>
<td>94</td>
<td>81</td>
<td>97</td>
<td>81</td>
<td>97</td>
</tr>
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</table>
Limitations of Coronary CTA

- Extensive calcifications
- Stents: spatial resolution
- Heart rate: temporal resolution
- Radiation (3.5-5.9 mSv)
- Small branches/septal branches
Cardiac Function Analysis

• Volume ejection fraction
• Wall motion analysis
• Wall thickness and thickening
New Developments

• 40-slice and 64-slice CT (rotation ~0.33 s, 4-5 s scan)

• Volume CT (flat panel CT)
Summary

- MDCT allows reliable coronary angiography.
- One-stop shop imaging of ischemic heart disease is feasible using MDCT.
Conclusion

• MDCT can exclude or prove significant coronary stenosis.

• Only MDCT can detect early coronary atherosclerosis noninvasively and help start preventive medication in time.
Thank You