Noncoronary Cardiac MDCT

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Noncoronary Cardiac MDCT

• LV function
• RV function
• Cardiac valve assessment
• Perfusion and viability

Left main: functional compression

Background – LV function

• Coronary CTA: fixed delay time after R wave is chosen to freeze motion.

Background – LV function

• 90% of the cardiac CTA information (and radiation dose) is discarded
Background – LV function

Instead, keep all of the intervening time points, and create a cine loop

Axial images every 20 msec

New slide: Temporal Resolution

- 60 bpm, 1 sec or 1000 msec per heart beat. Systole takes about 300 msec.
- MRI, echo, nuclear: 50 msec or less

Temporal Resolution Determined by Gantry Rotation Time

180 degrees of data needed for reconstruction

400 ms rotation

Temporal resolution for half scan = 200 ms

Dual source MDCT: twice as fast

Only 90 degrees of rotation needed

400 ms rotation

Temporal resolution for quarter scan = 100 ms

Improving Temporal Resolution - Adaptive Segmented Reconstruction

2 – 5 segments from different heartbeats combined to produce 180 degrees of data

200 ms / 2 = 100 ms

Half vs Multisegment

Heart Rate = 93-95 bpm
Steps for LV function analysis:

1. Reconstruct cardiac phases: 20 images, or every 5% of cardiac cycle.
2. Corresponds to images approximately every 50 msec.
   (Compare to actual temporal resolution of 100-200 msec).

LV function: slice thickness

- Instead of 0.5 mm slices for CTA, use 5 mm slices (1000 images).
- MRI uses 6-8 mm slices at 1 cm intervals, ~ 250 images.

Reconstruction can be over the entire cardiac cycle for function analysis.
**LV function – reformat**

- MDCT images are acquired in the axial plane
- LV quantitative analysis usually performed in the short axis plane.

**Contouring: ED/ ES only (50 frames)**

End diastole  
End systole  

Rob van der Geest, Univ Leiden

**Reformation of the Left ventricle: Necessary?**

- LV volumes using axial MDCT were ~10% larger than those obtained by short axis
- Results in underestimation of EF with increasing dilatation of the LV
- Axial: 3 min savings in post processing time.
Papillary Muscles

- Papillary muscle mass accounts for 8.9% of the total LV mass in both men and women.
- Correlated with LV wall mass ($r=0.81$, $p<0.001$)*

Papillary Muscles

Data courtesy of Fujita Health University, Aichi, Japan

Parameters computed and displayed with ED, ES:

- (a) ESV, EDV
- (b) EF (%)
- (c) SV
- (d) CO
- (e) Myocardial mass
- (f) Filling rates
- (g) Emptying rates

Regional Wall Motion Analysis

Example: septal infarct, CHF

Body Surface Area: 1.89 m²
- ED volume: 357.65 ml
- ED volume/BSA: 189.04 ml/m²
- ES volume: 241.32 ml
- ES volume/BSA: 127.55 ml/m²
- Stroke volume: 116.33 ml
- Stroke volume/BSA: 61.49 ml/m²
- Ejection fraction: 32.53 %
Example: septal infarct, CHF

Example: aortic outflow tract

Example: CHF, AICD, inferior MI

Example: distal LAD infarction

Horizontal long axis view

Aortic outflow tract view

Example: Anterior wall motion abnormality
Pig infarct model, heart rate 72-106
Mean CT temporal resolution 150 msec

• Similar global volumes (EDV, ESV)
• Different time dependent parameters (PER, time to PER PFR, time to PFR)

Example: ARVD RV evaluation

Evaluation of myocardial structure: ARVD

Pitfall: No Contrast in the RV

Valve evaluation
**Why Evaluate Valve Function on MDCT?**

Echo: AVA is not determined directly but calculated using the continuity equation.
- Echocardiography is operator dependent.
- Underestimation of severity due to failure to obtain a parallel angle between the Doppler beam and aortic jet.

**Benign cardiac tumors**

- Myxoma 41%
- Lipom 14%
- Papillary fibroelastoma 13%
- Rhabdomyoma 11%

**4D 64 MDCT: Normal Aortic Valve**

**Aortic Valve Evaluation**

**Aortic/ Mitral Valve Evaluation**

**4D 64 MDCT: Normal Mitral Valve**
MDCT: Assessment of Aortic Valve Area

![Graph showing AVA vs. AVA}

Pathology – Calcified Aortic Valve

![Images of calcified aortic valve]

Artificial Aortic Valve Function

![Images of artificial aortic valve]

MRI: valve regurgitation

LV infarct, thrombus

MDCT Perfusion and Viability Imaging

![Imaging of LV infarct and thrombus]
Myocardial Viability by MDCT
Lower density in the area of infarction


Contrast-Enhanced Multidetector Computed Tomography Viability Imaging After Myocardial Infarction
Characterization of Myocyte Death, Microvascular Obstruction, and Chronic Scar
Albert C. Lardo, PhD; Marco A.S. Cerdá, MD, PhD; Osterria Silva, MD; Luciano C. Amado, MD; Richard T. George, MD; Anastasios P. Kiliaris, MD; Karl H. Schubert, MD; Venceslas R. Fernández, MD; Menachem Zaretzki, PhD; Namit Naraviski, MD; Henry R. Halperin, MD, MA; Katharina C. Wu, MD; Joshua M. Hao, MD; Jean A.C. Lima, MD

MDCT Viability Imaging

Lardo et al. Circulation 2005

3D Visualization of Infarct Extent

adapted from A. Lardo

MDCT Infarct Imaging
90 min occlusion/reperfusion model

2 hrs 8 weeks
Chronic Infarct Imaging

MDCT  Pathology

Infarct size = 128.8 mm²
Infarct size = 119.7 mm²

Lardo et al. Circulation 2006; 113:394

Helical MDCT Perfusion

Helical MDCT perfusion imaging in a canine model of LAD stenosis during adenosine infusion. (Gantry rotation time: 400 ms, Detector collimation: 0.5 X 32, tube current: 400 mA, tube voltage: 120 kV, Visipaque™ 2.5 ml/sec for 100 ml)

George RT, et al. AHA, 2006

Conclusions: Noncoronary MDCT

• LV and RV function “for free”
• Valve evaluation
• MDCT viability/scar imaging as well as stress perfusion have now been demonstrated

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MDCT for Cardiac Function

Thank you.

http://www.rad.jhmi.edu/mri/MRI_Info_RSNA.htm