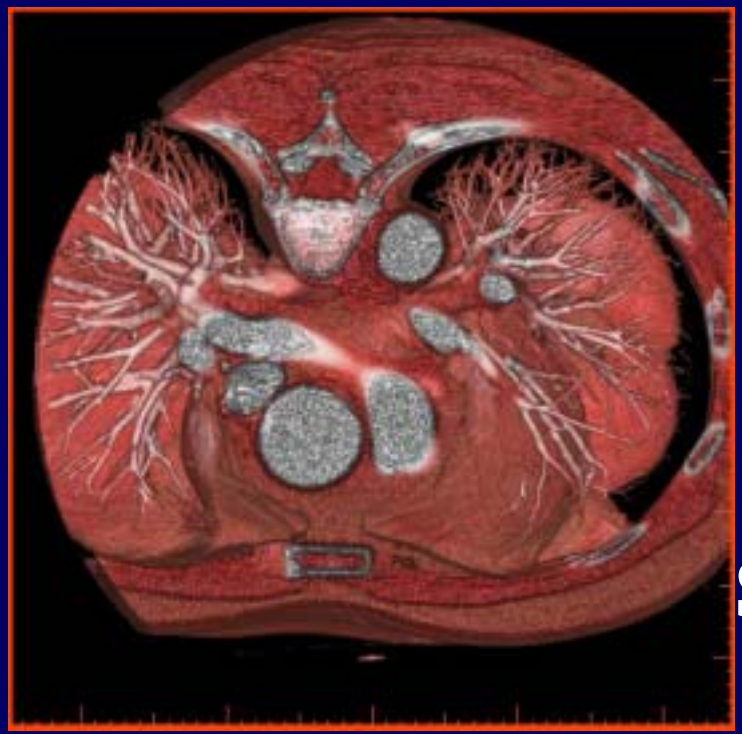
# Coronary CT Angiography



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**Department of Radiology,**
**Samsung Medical Center,**
**Sungkyunkwan University**

# 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

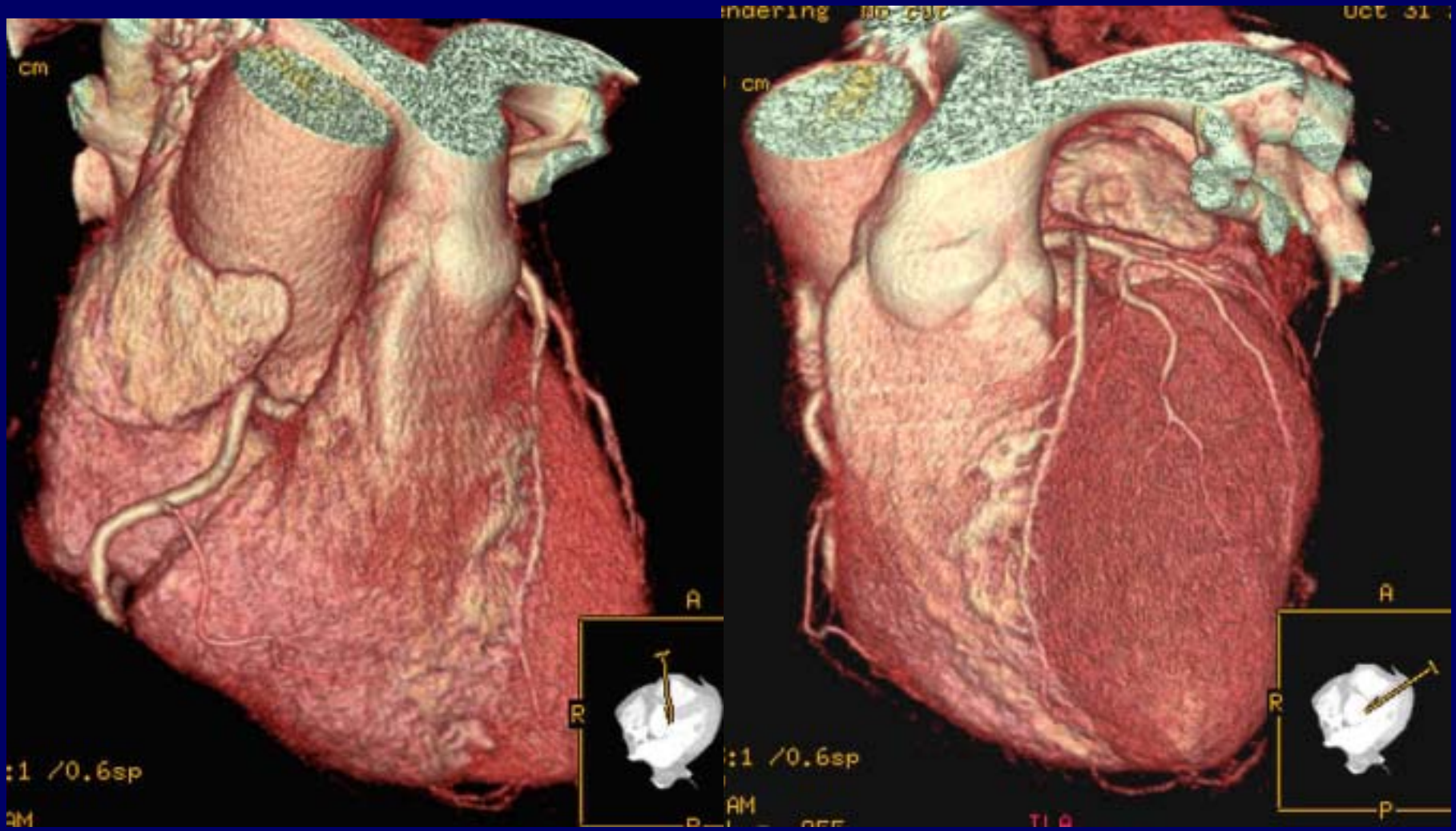
- Retrospective ECG-gating
- Image reconstruction according to cardiac phases (5-95% of RR interval, 1-20 phases)
- 0.6 mm slice thickness (180-220 images during 20-25 sec breath-hold)

# 3D Techniques and Image Analysis

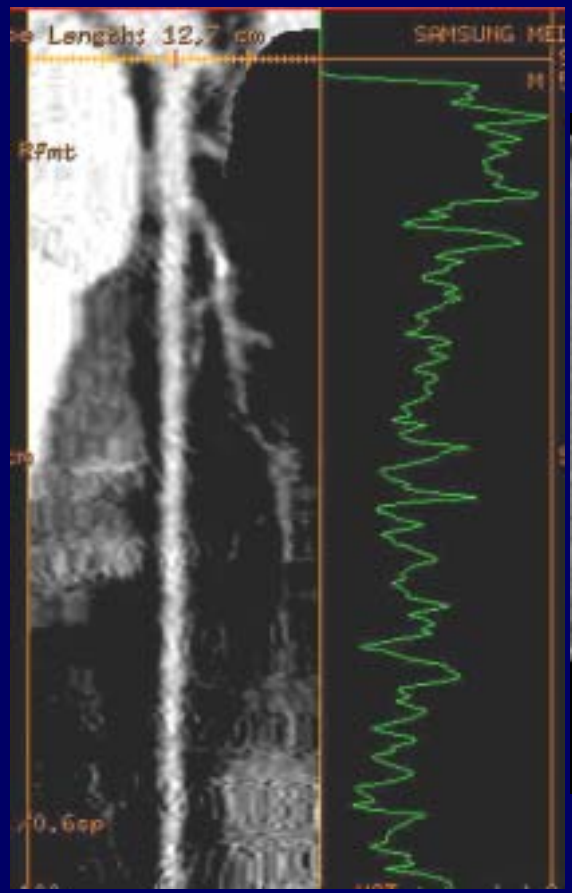
- Volume rendering
- Maximum intensity projection (MIP)
  - Vessel analysis
  - Sub-volume MIP
- Reformation in cardiac short and long axes
- Endoscopic view (fly-through)

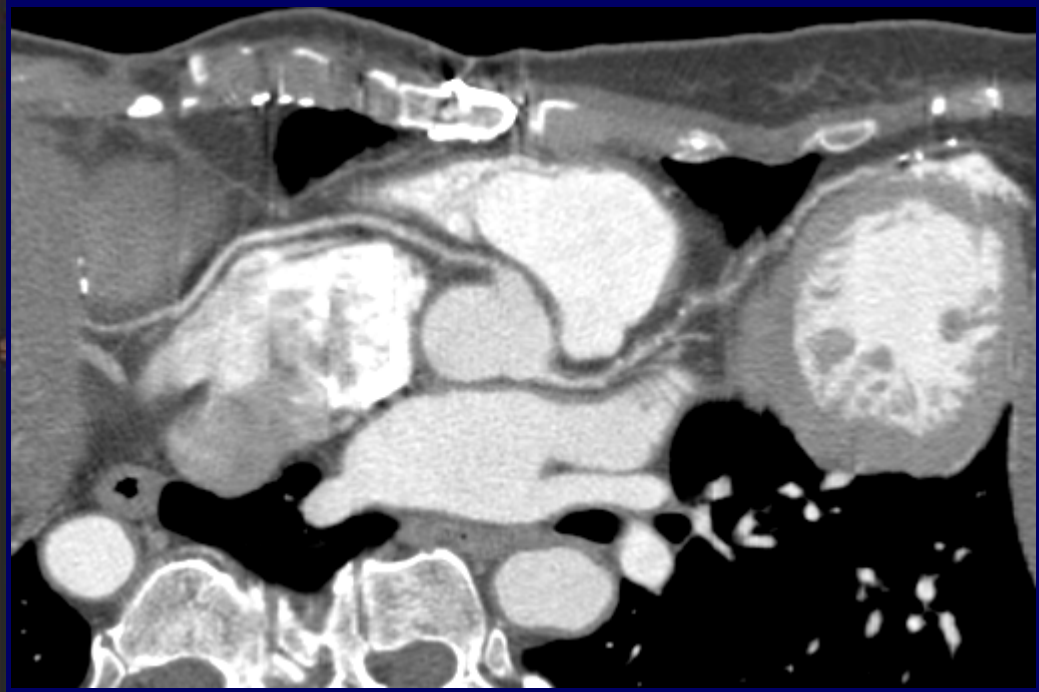
- Source images

# Volume Rendering

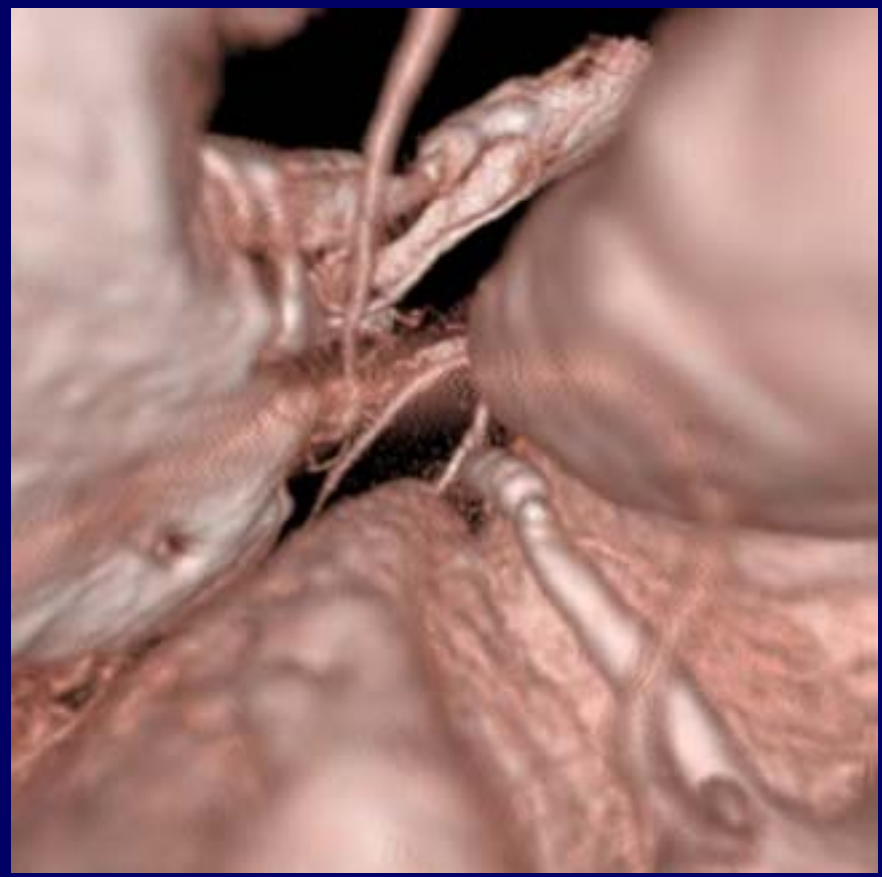


# Vessel Analysis, Curved Reformation

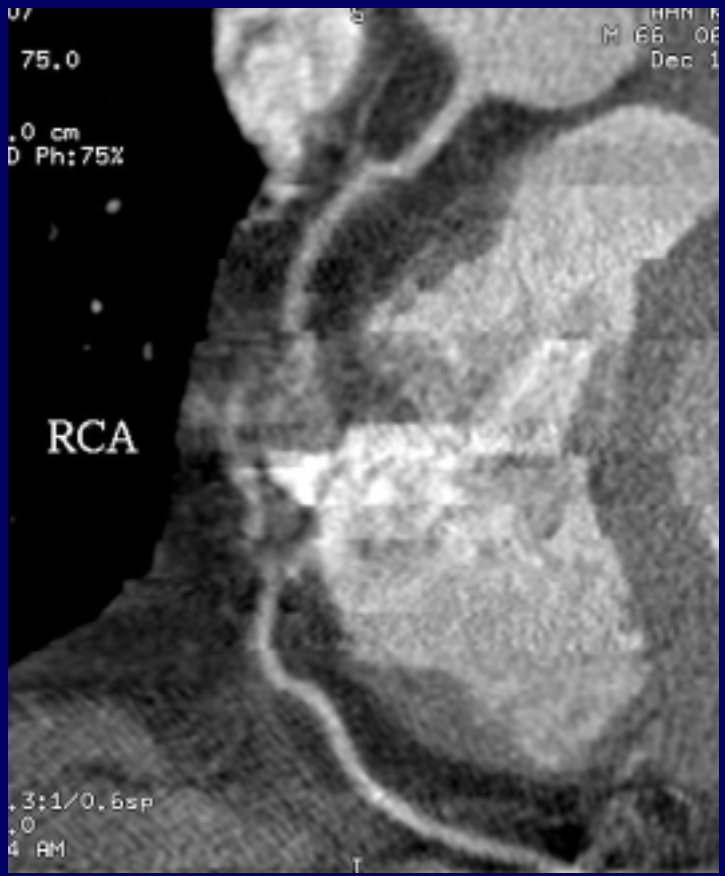


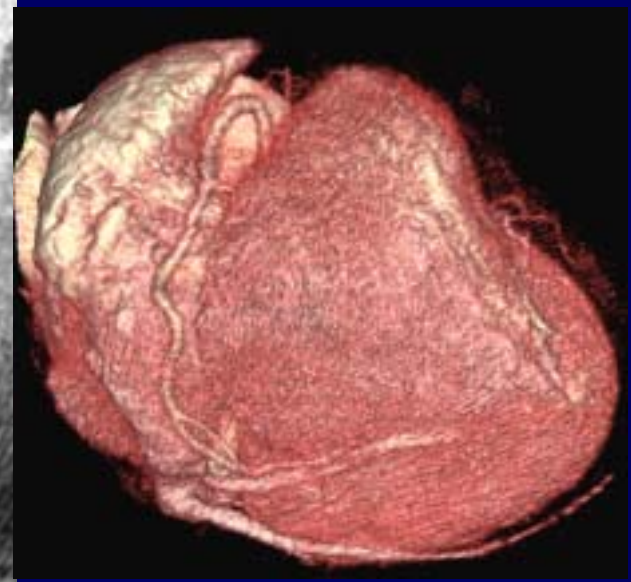
# Navigation



# Heart Rate





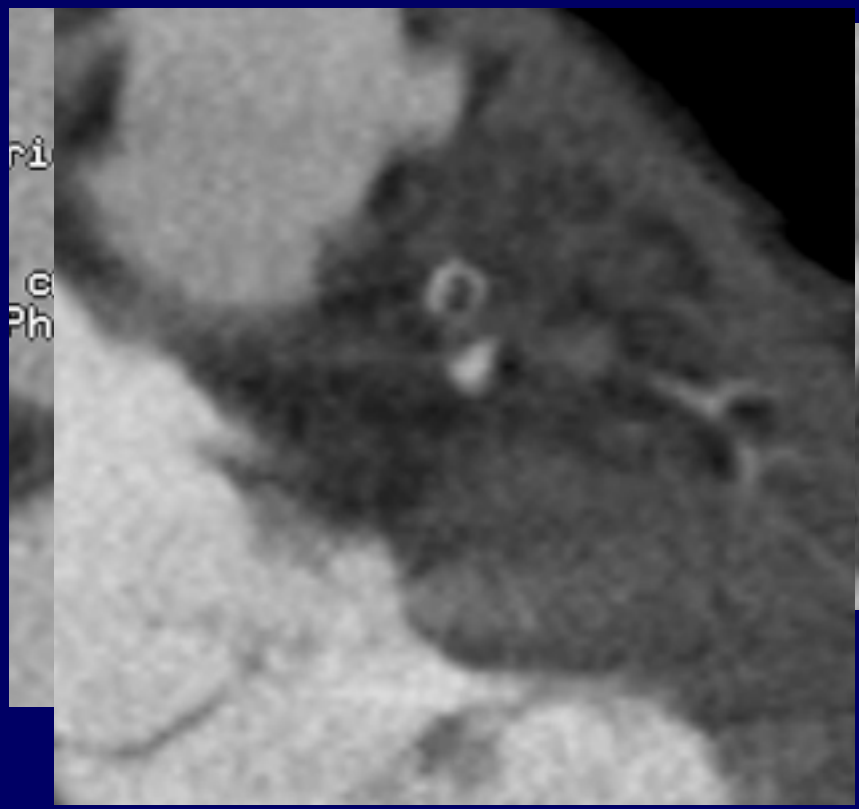


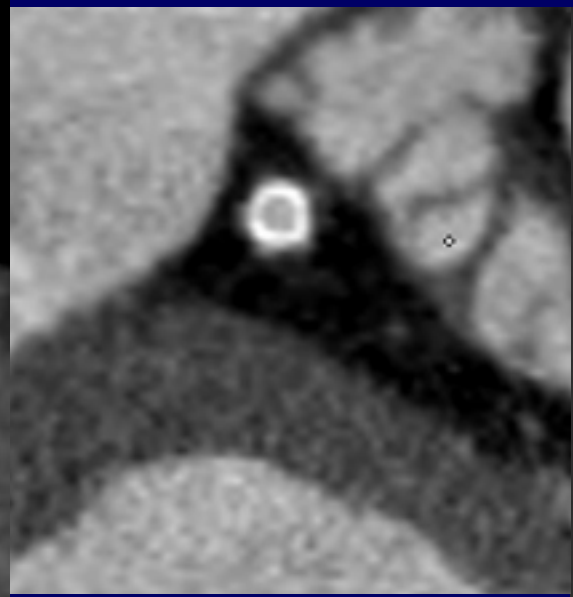
HR = 70-74

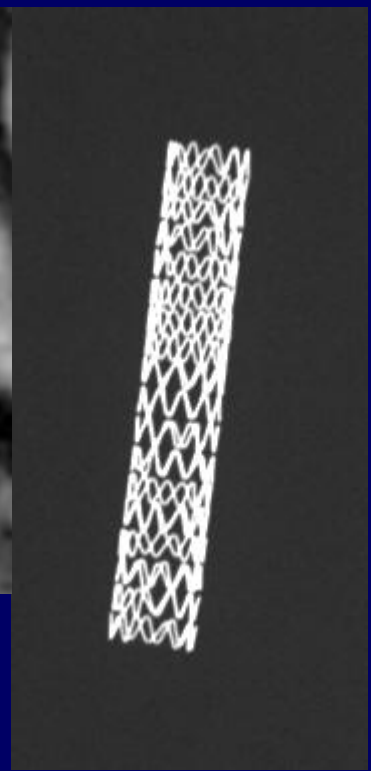
HR = 61-64

# LCX and RCA-PDA, 75%

# Stent: Patent vs Occluded







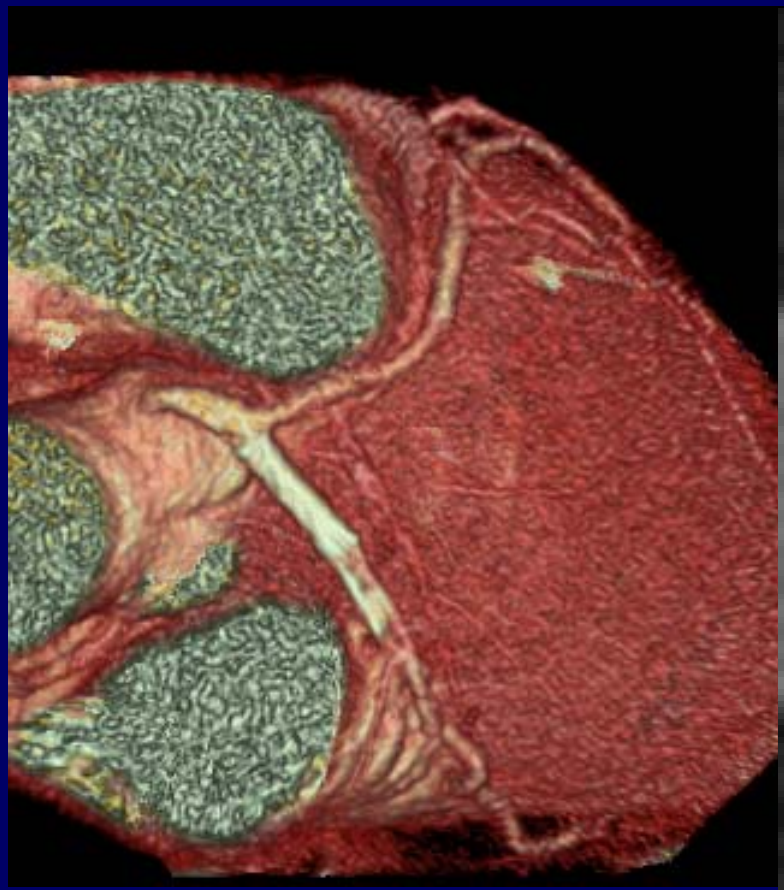
# Plaque Characterization: IVUS vs CT

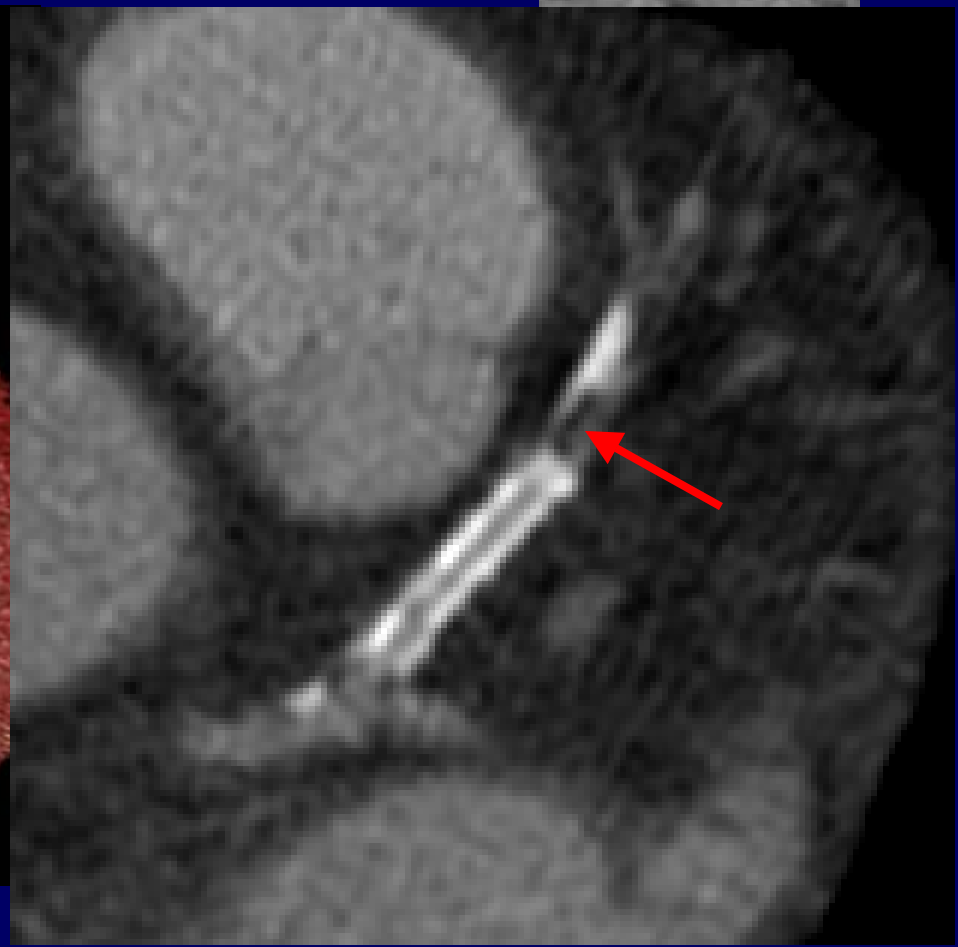
| | *Schroeder* | *Leber* |
|---|---|---|
| Soft | 14 ± 26 HU | 49 ± 22 HU |
| Intermed | 91 ± 21 HU | |
| Calcified | 416 ± 194 HU | 391 ± 156 HU |

*Schroeder et al. J Am Coll Cardiol 2001;37:1430*

*Leber et al. J Am Coll Cardiol. 2004;43:1241*

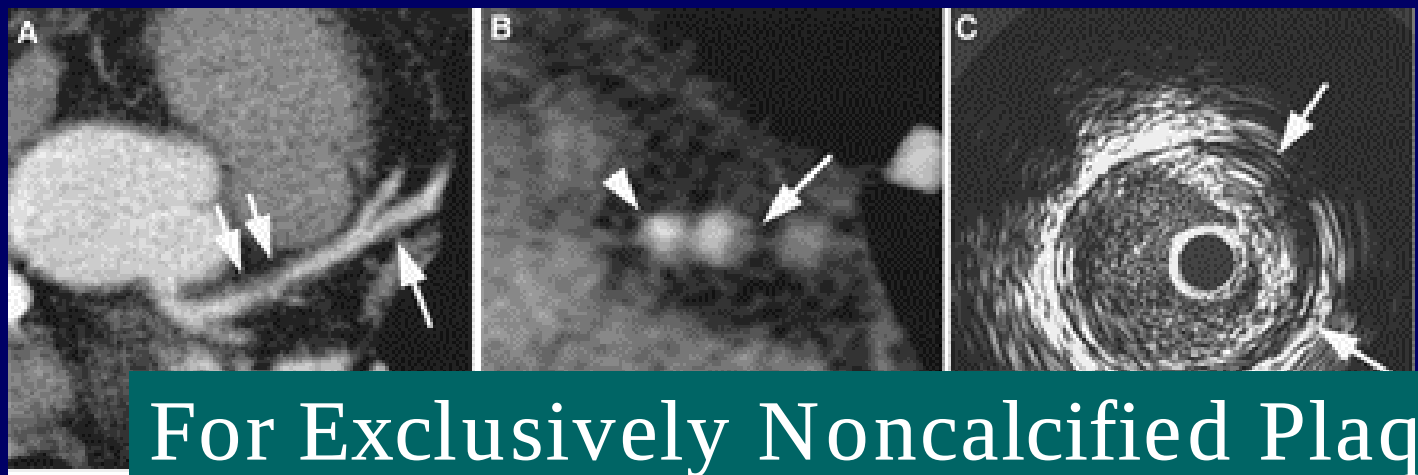
# Fatty Plaque and Stent

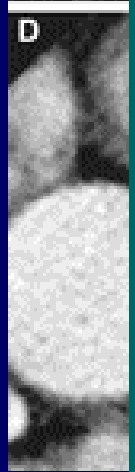




LeeYS

# 16-CT vs IVUS (n = 22)




Sens, 78%;

Spec, 87%.

For Exclusively Noncalcified Plaque:

Sens = 53% (8 / 15).

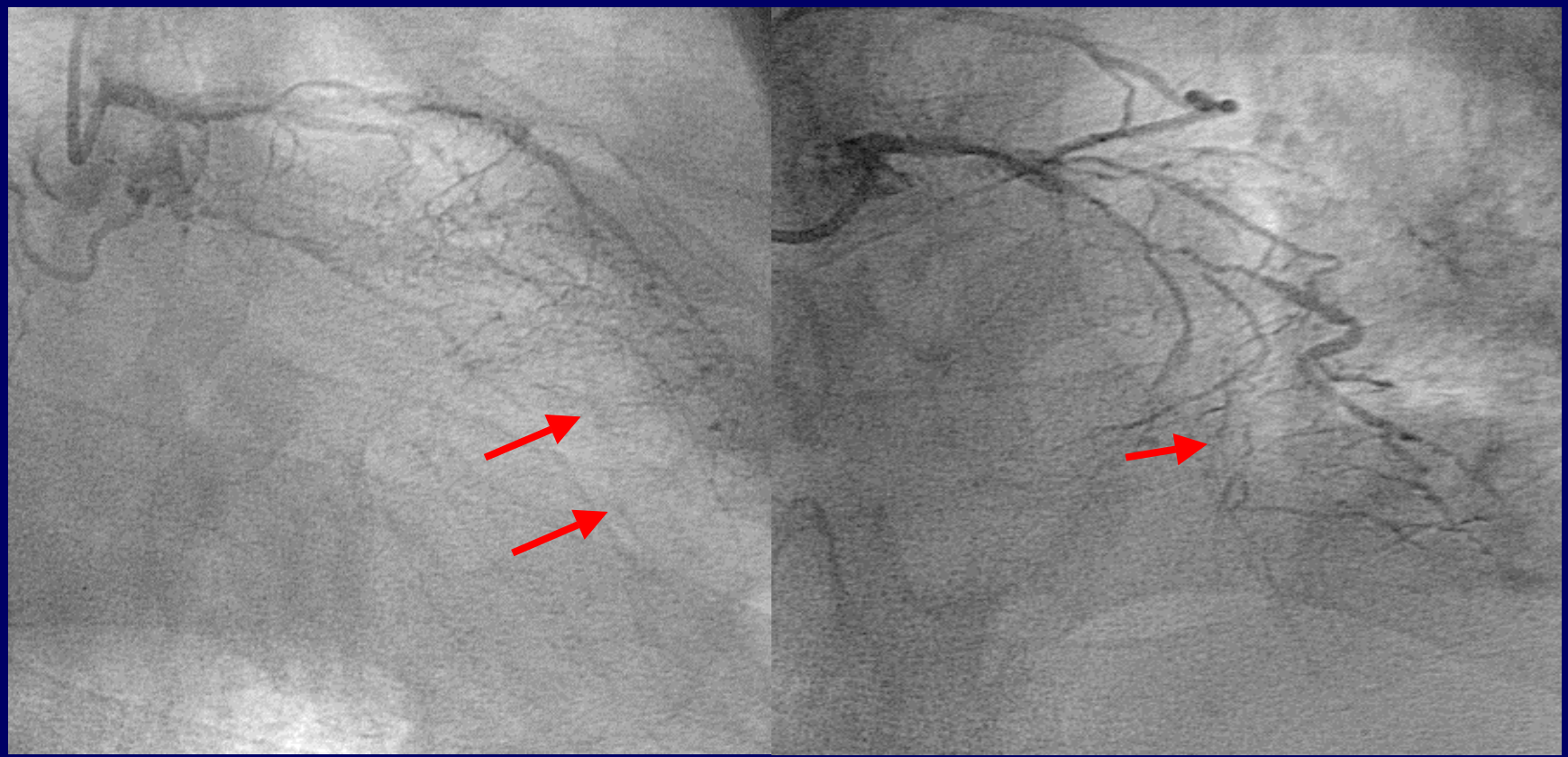
Underestimation of plaque volume by MDCT (24 vs 43 $mm^3$, p <.001)

, 94%;

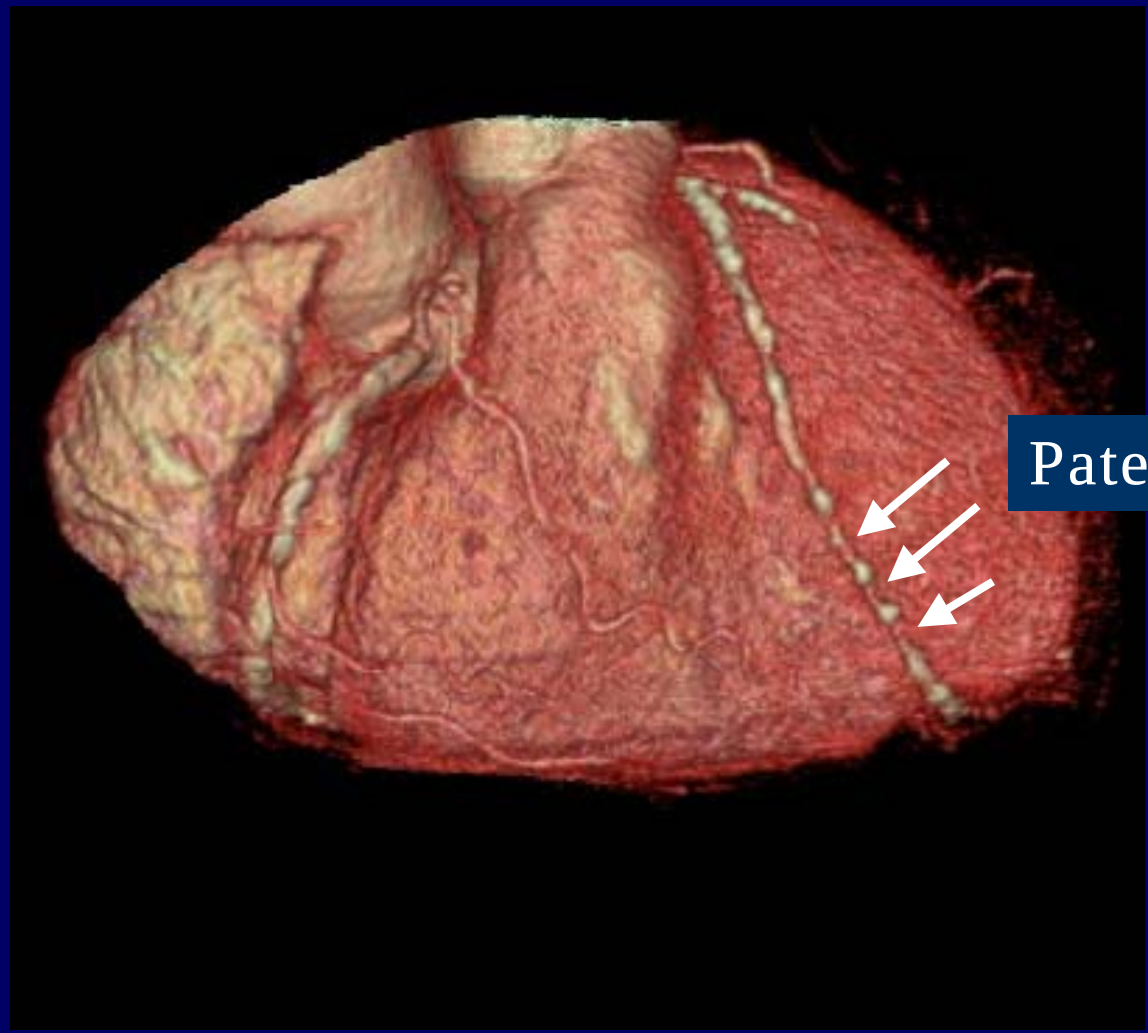
, 94%.

Achenbach et al. Circulation 2004;109:14-17

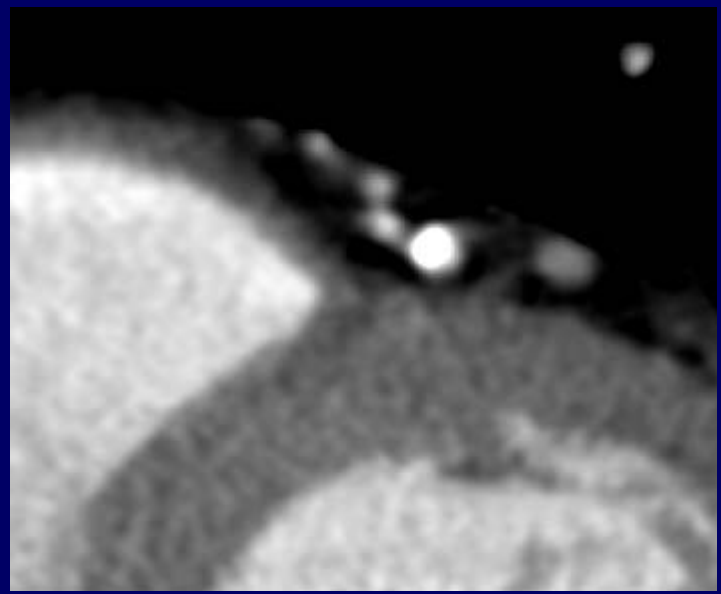
# Multiple Calcific Lesions, No Visible Lumen on CAG (M/73)



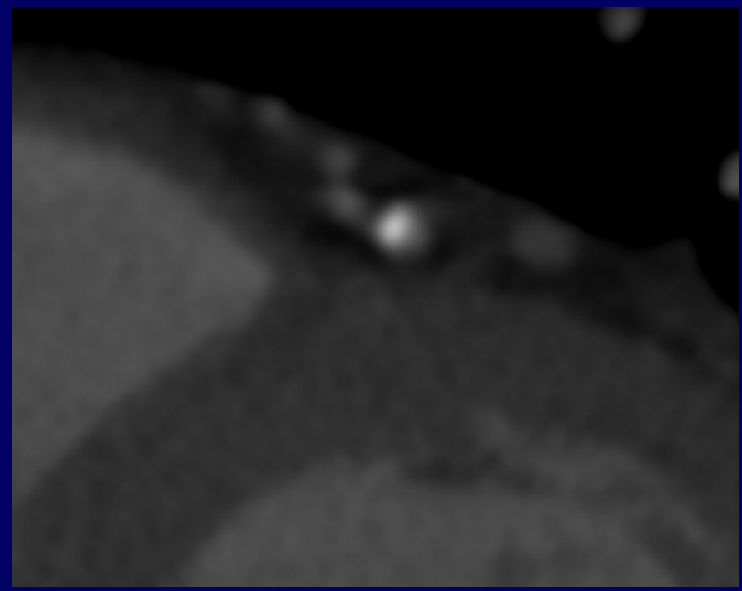
# Multiple Calcific Lesions, No Visible Lumen on CAG



# Blooming Effect of Calcium

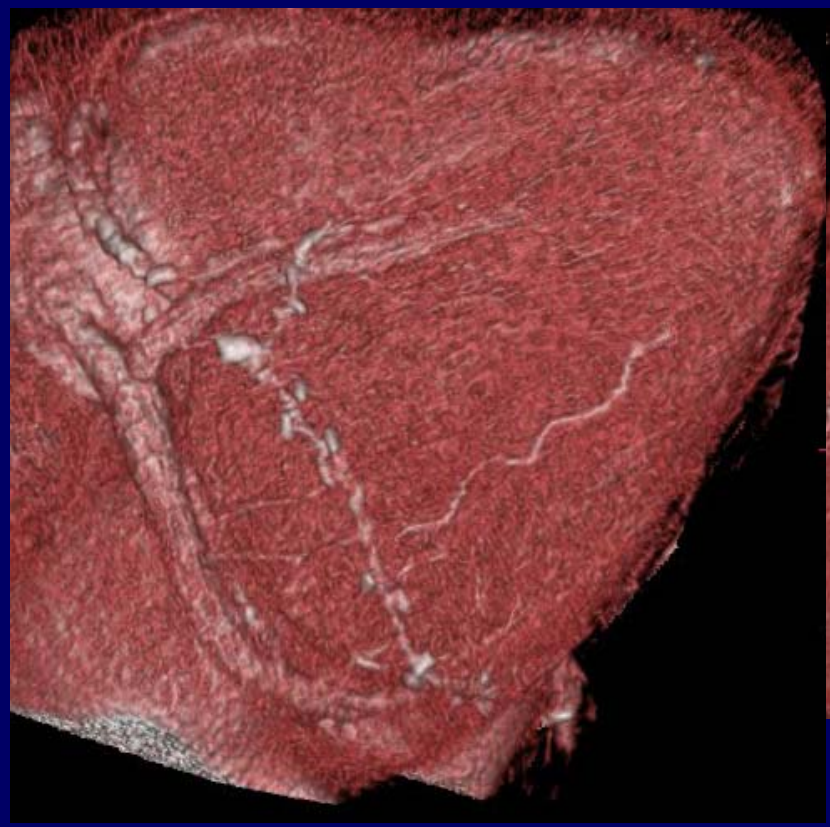


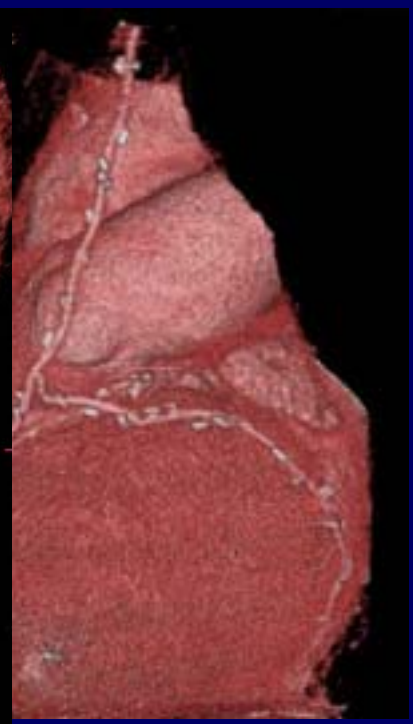
*W*560 / *L*190

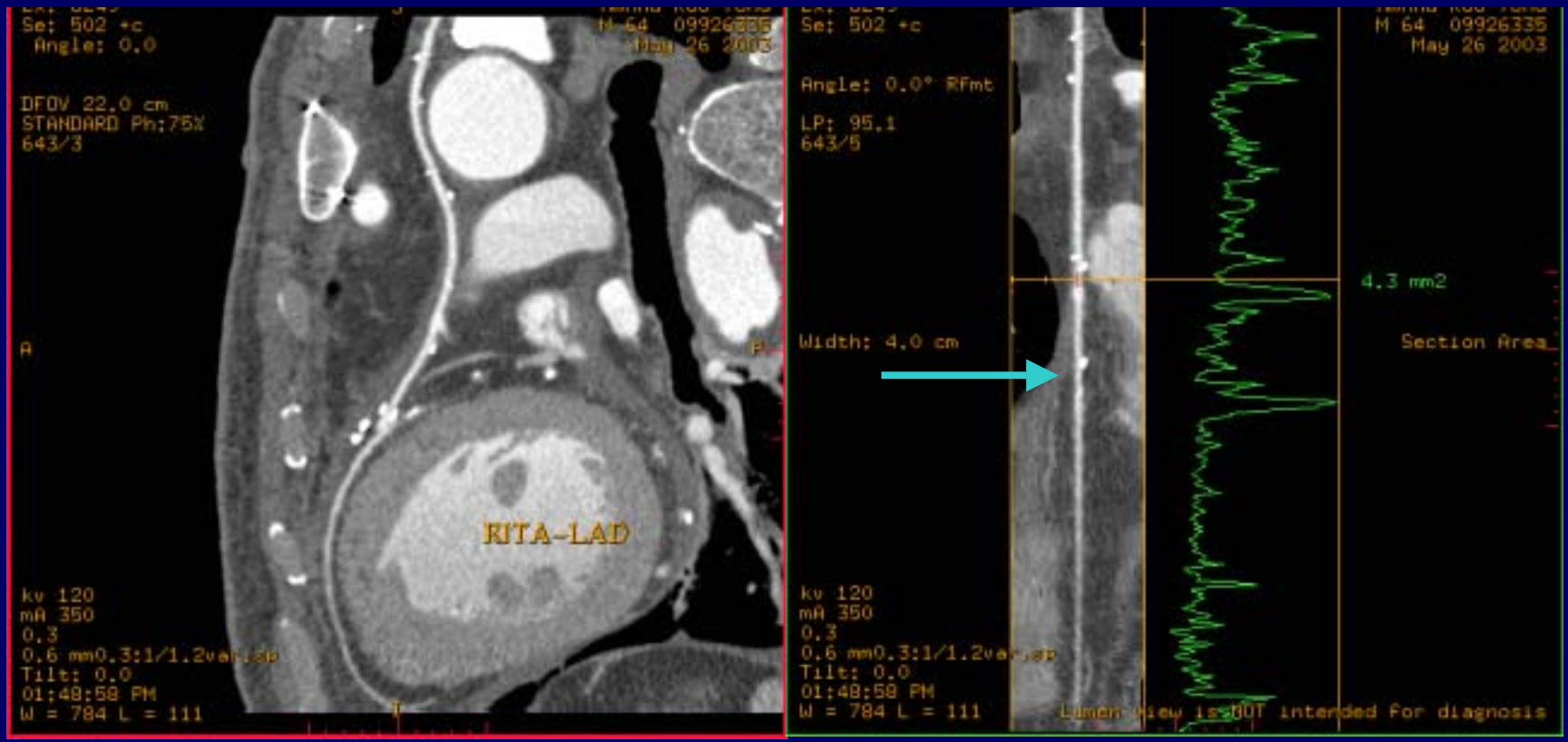


*W*2000 / *L*780

# Y Graft to LAD and PDA

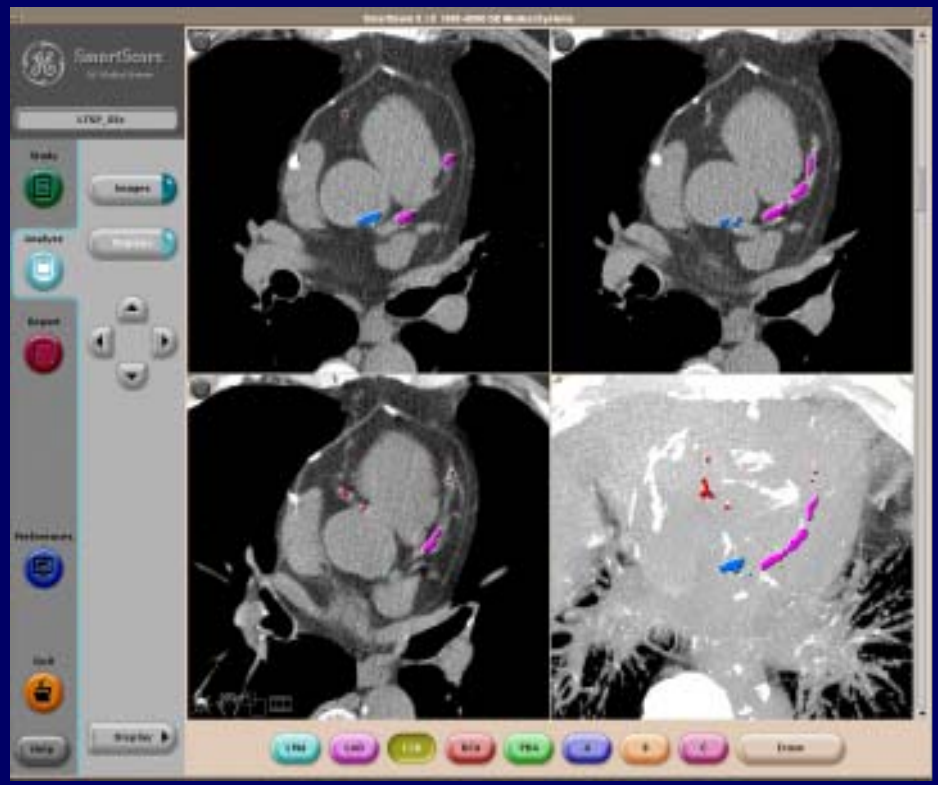








Vessel Analysis

# Coronary Calcium Scoring

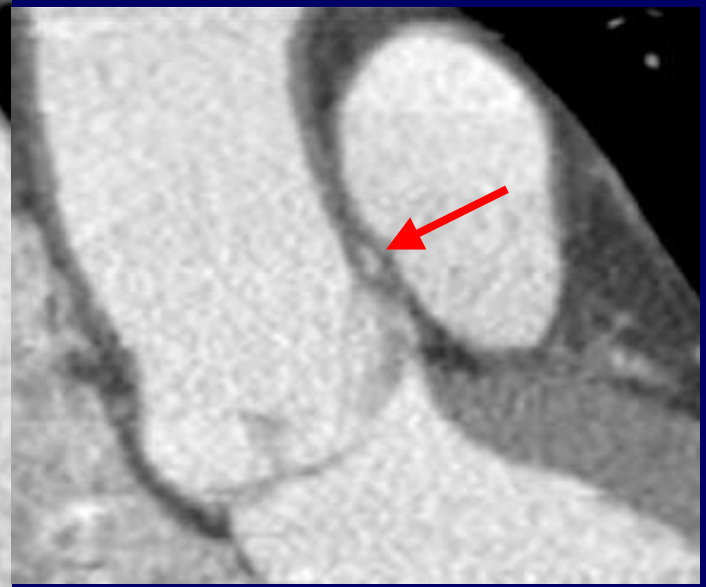


# Prognostic Value of CAC Screening

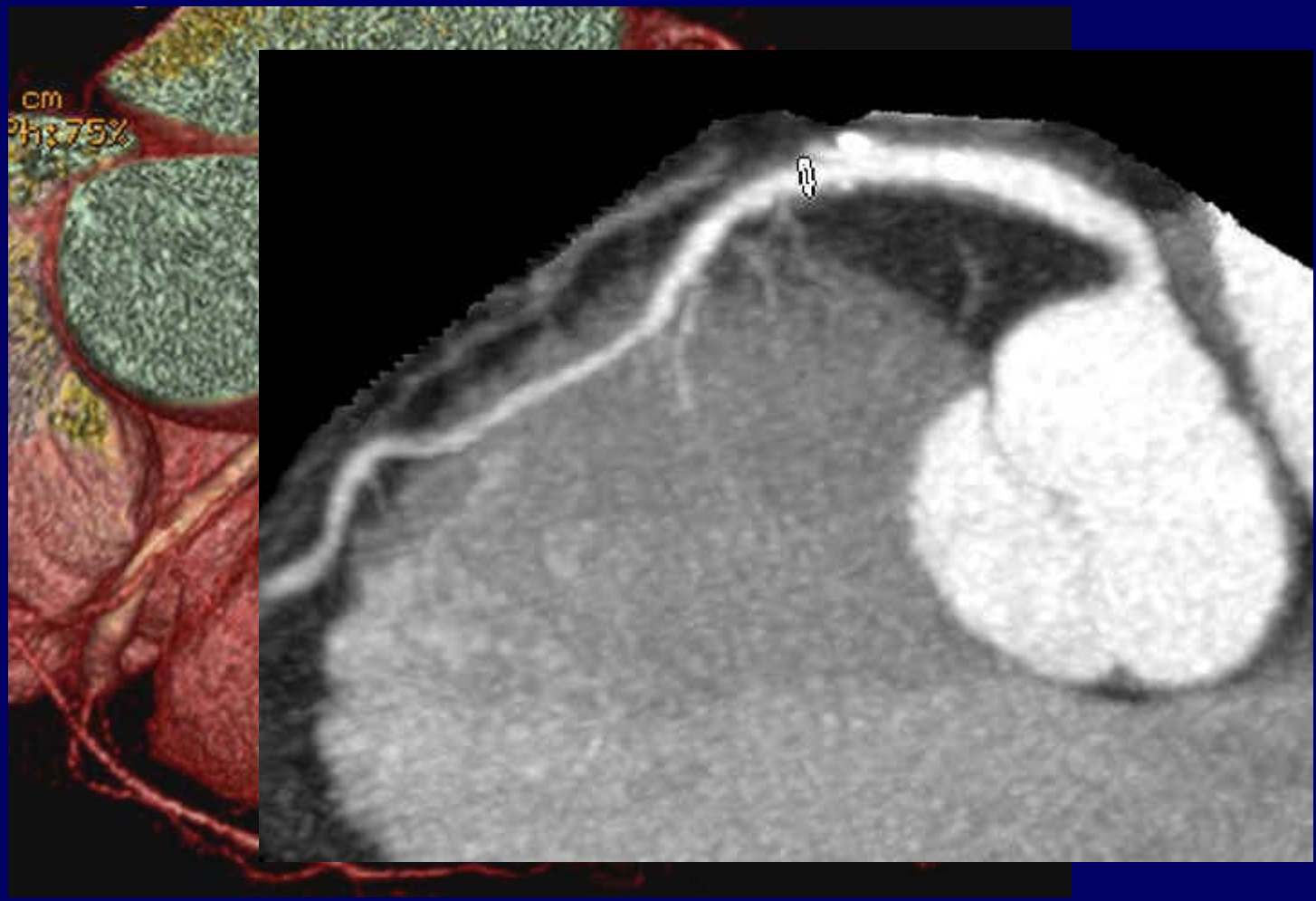
- **10,377 asymptomatic subjects**
- **5 y follow-up, death rate = 2.4%**
- **CAC was independent predictor of mortality (p<.001)**
- **5-y risk-adjusted survival was 95% for score > 1,000, 99% for score < 10.**
- **Risk-adjusted relative risk value for CAC, compared with CAC < 10 : 1.7, 2.5, 4.0 for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

Shaw et al. Radiology 2003;228:826-833

# RCA from Lt Coronary Sinus

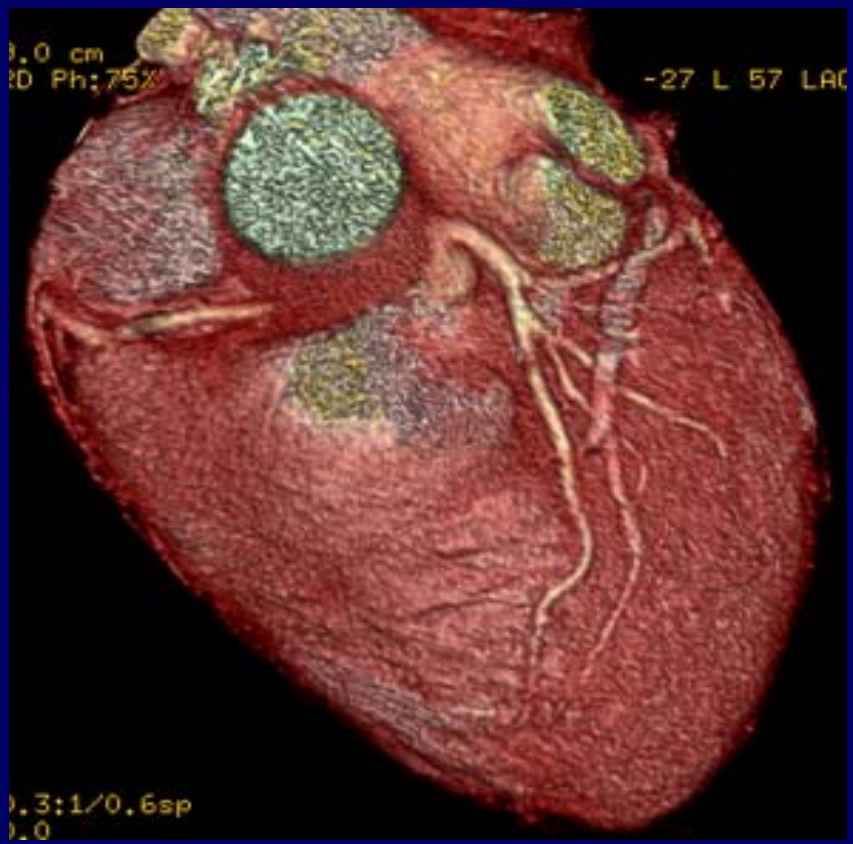


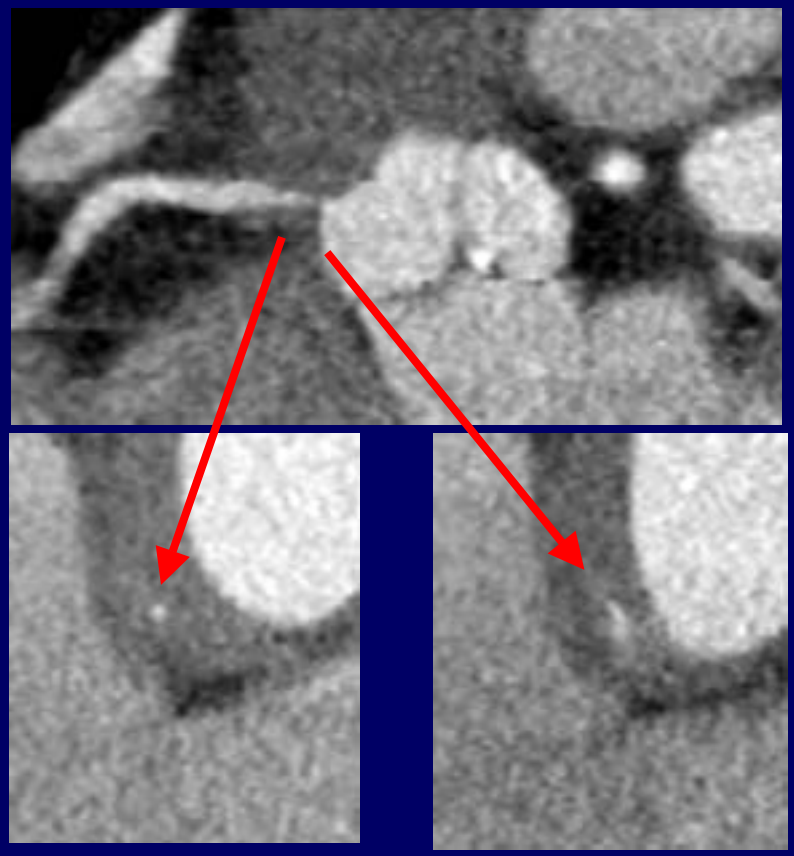
# Myocardial Bridge



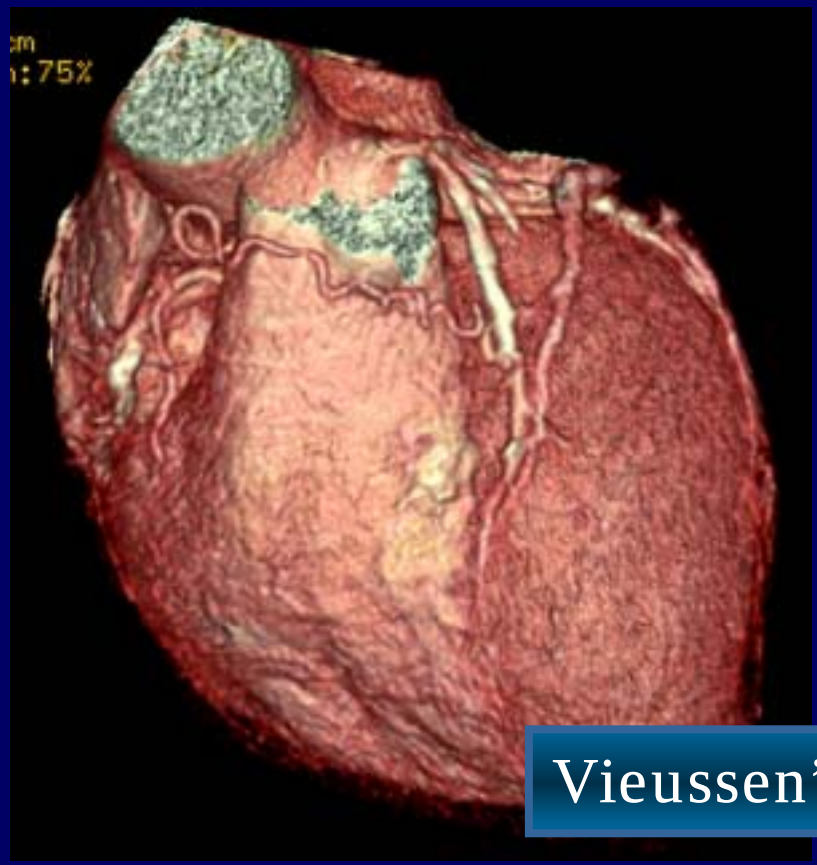
# Kawasaki Disease (M/13y)

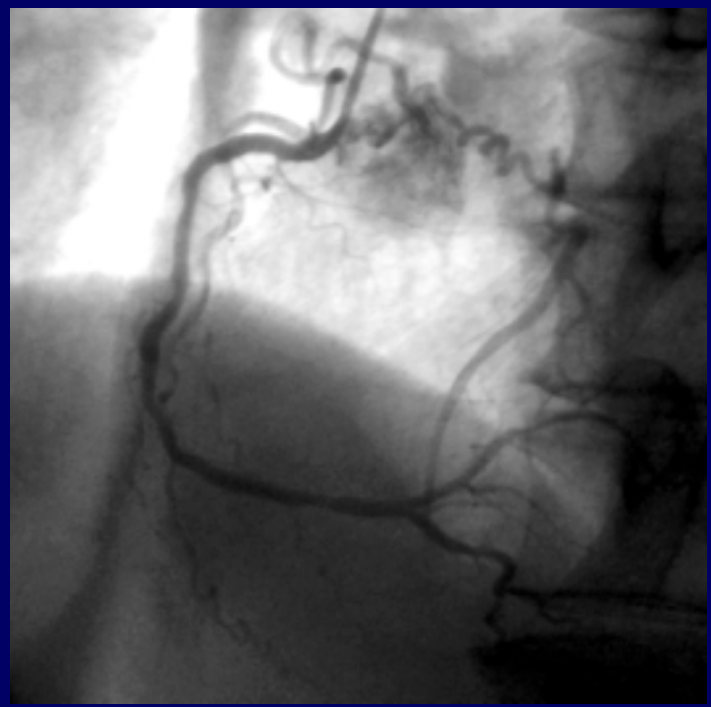
# RCA Involvement of Aortitis (F/55)



# Collateral Circulation

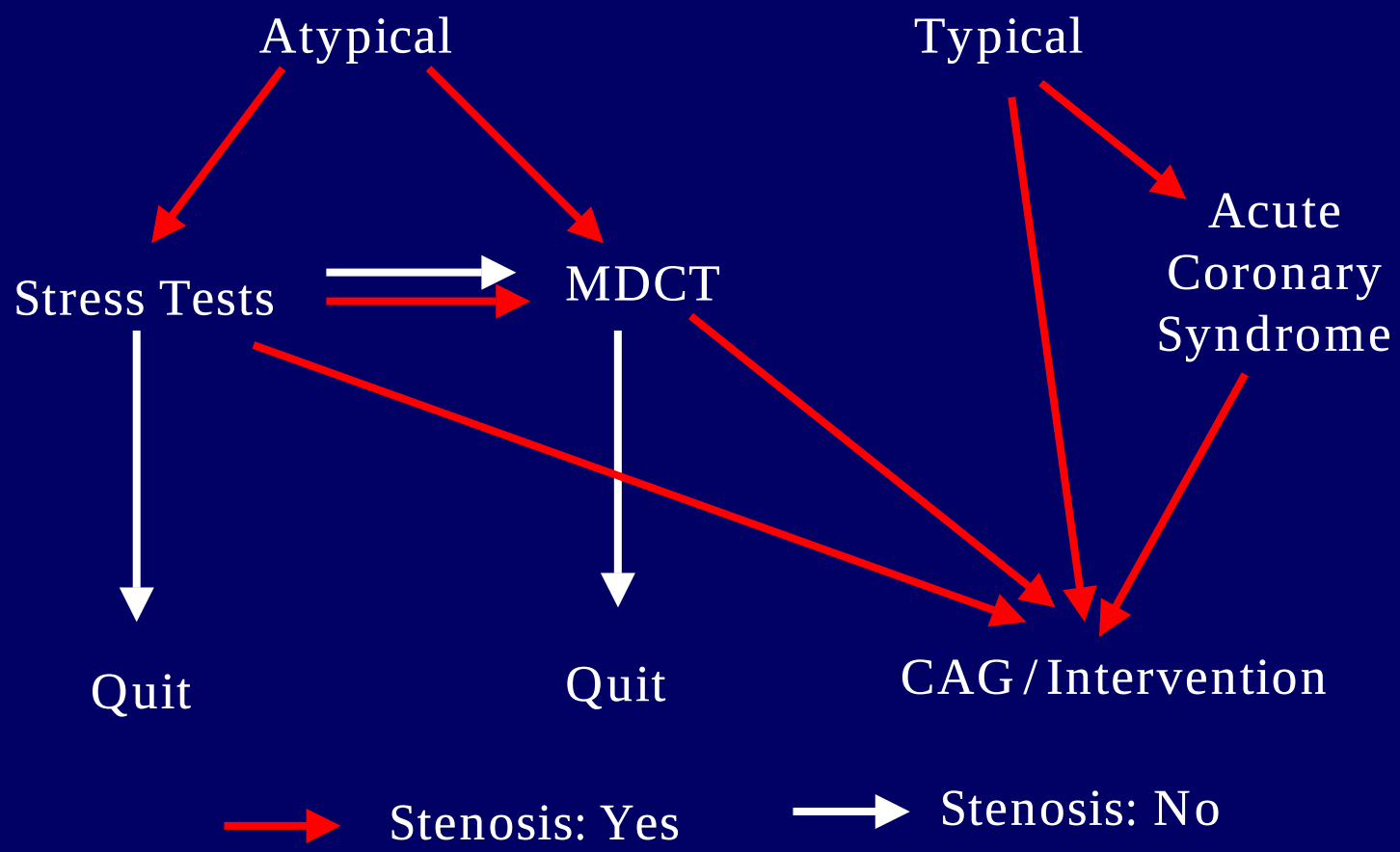


Vieussen's Ring: Conal to Conal Collateral

Shin SD, M / 73

# Patients with Chest Pain

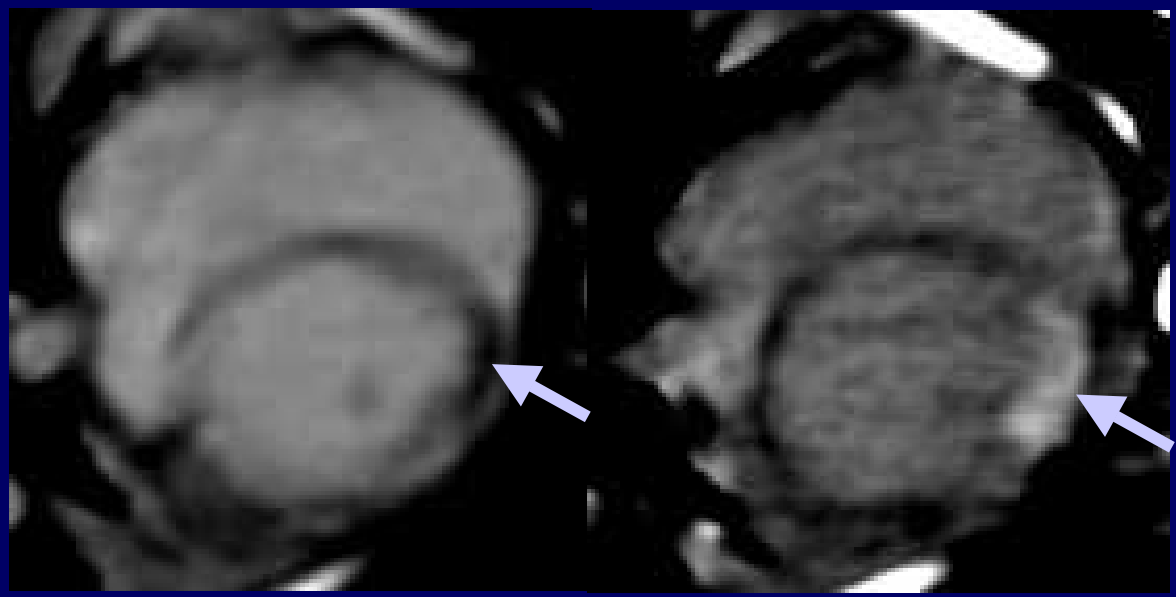


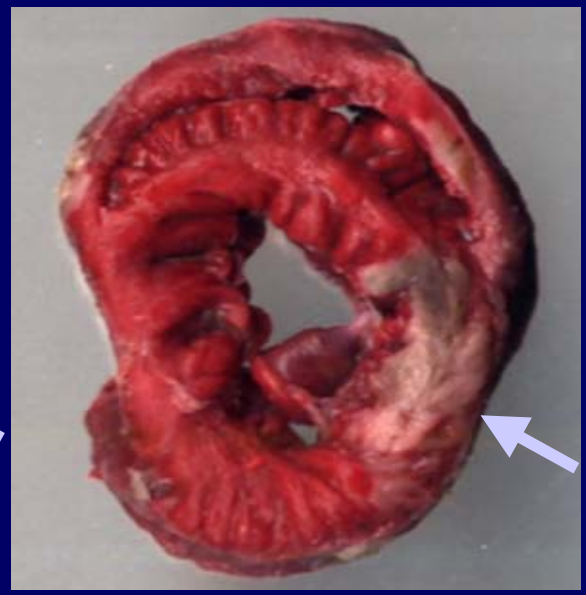
# Patient with Acute Chest Pain at ER

- **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

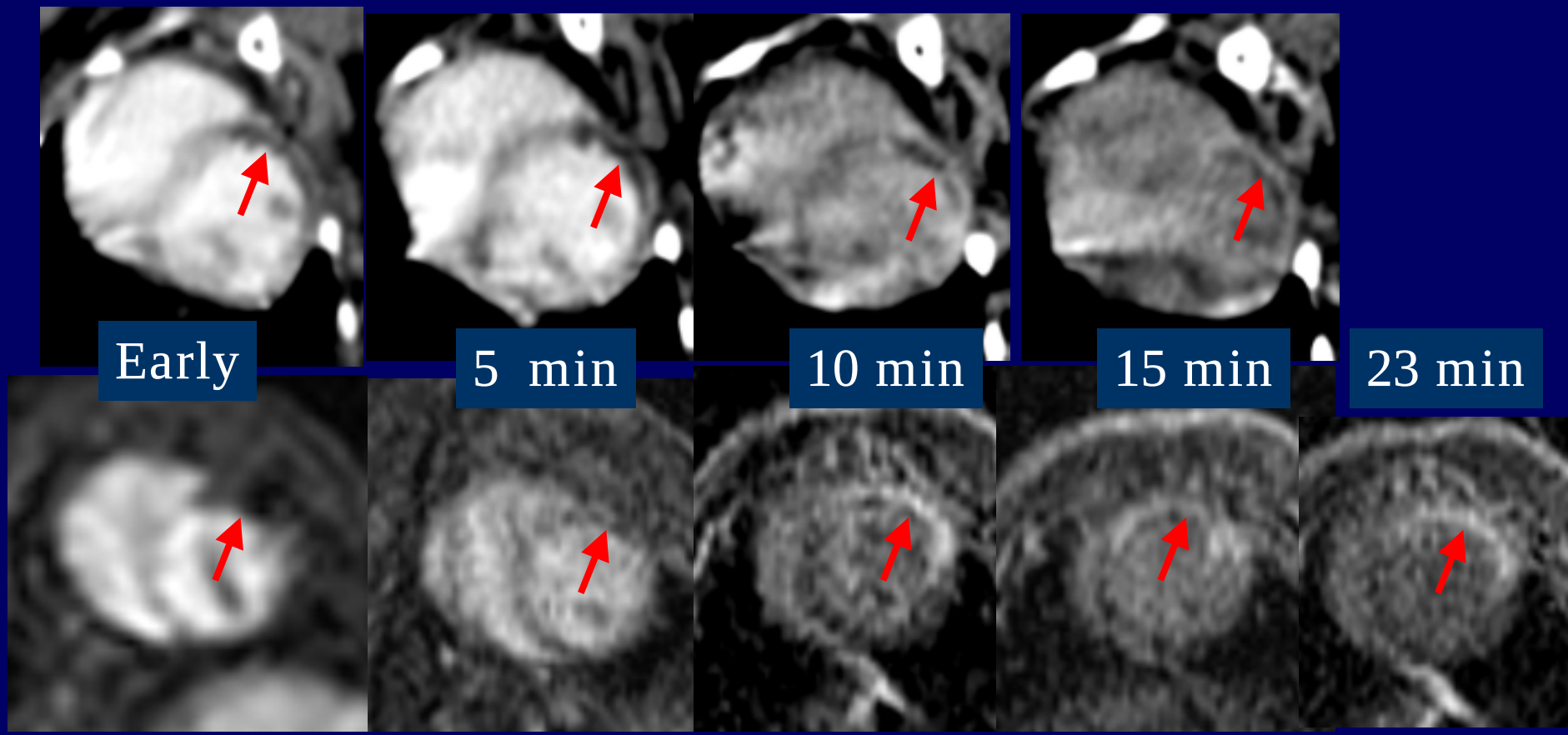
# Reperfusion Model





Early phase (18 sec)  Late phase (10 min)  TTC-staining

# Time Course: CT vs MRI in Occlusion Model



# 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**

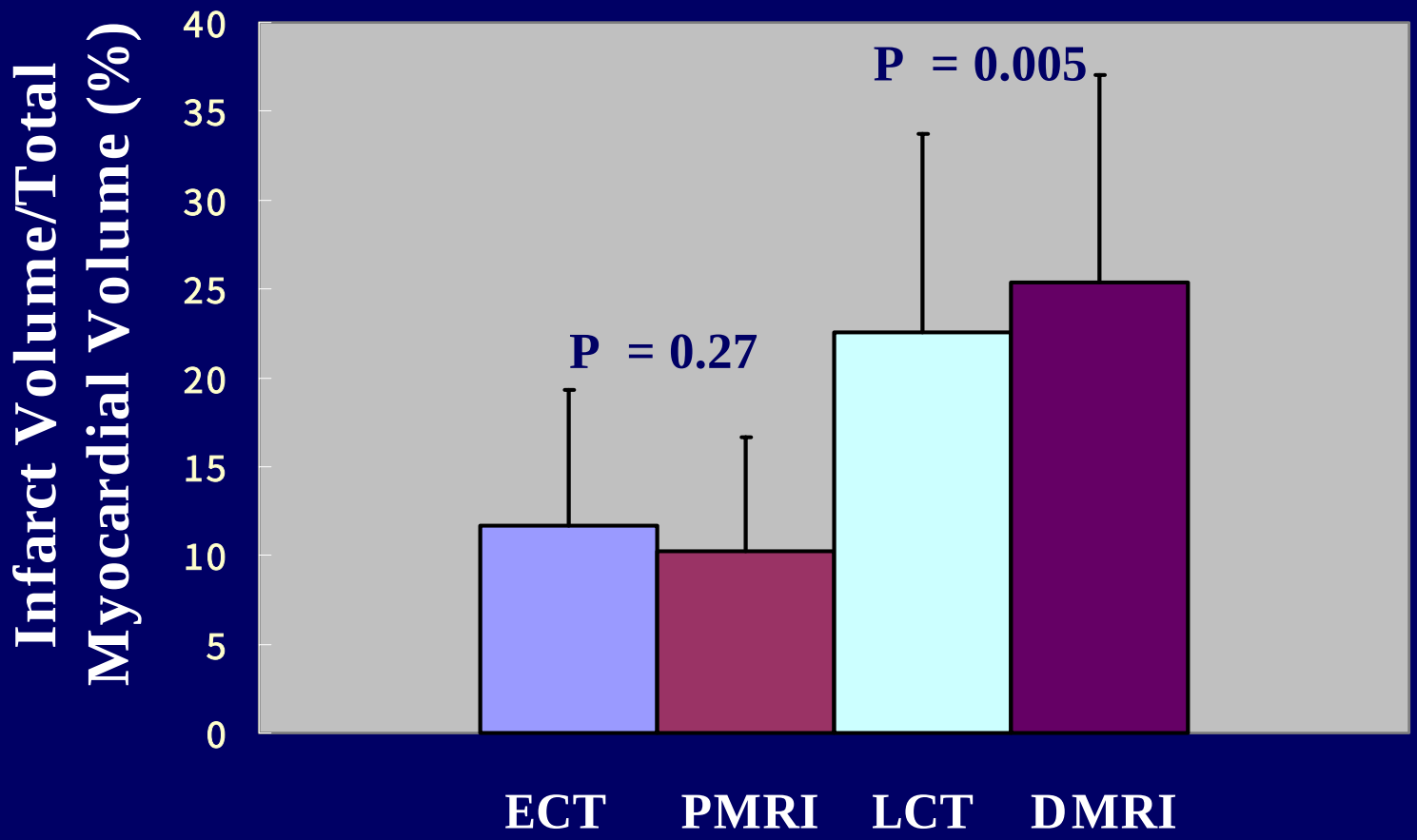
# MR Imaging and MDCT

- First-pass and 5-min and 15-min delayed myocardial MR imaging was performed using an 1.5 T scanner (GE Signa CV*i*) 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.

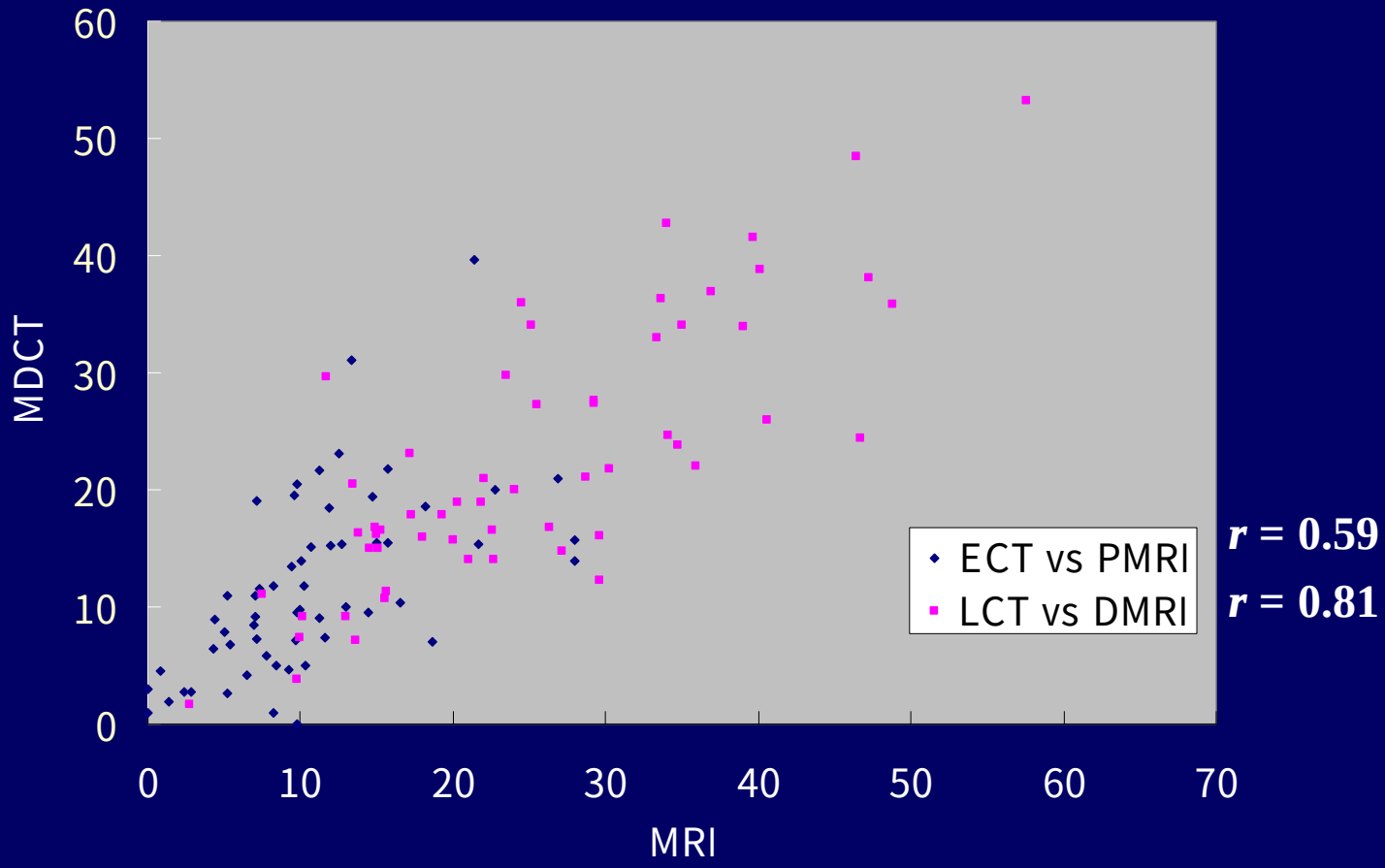
# Results

- **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.**

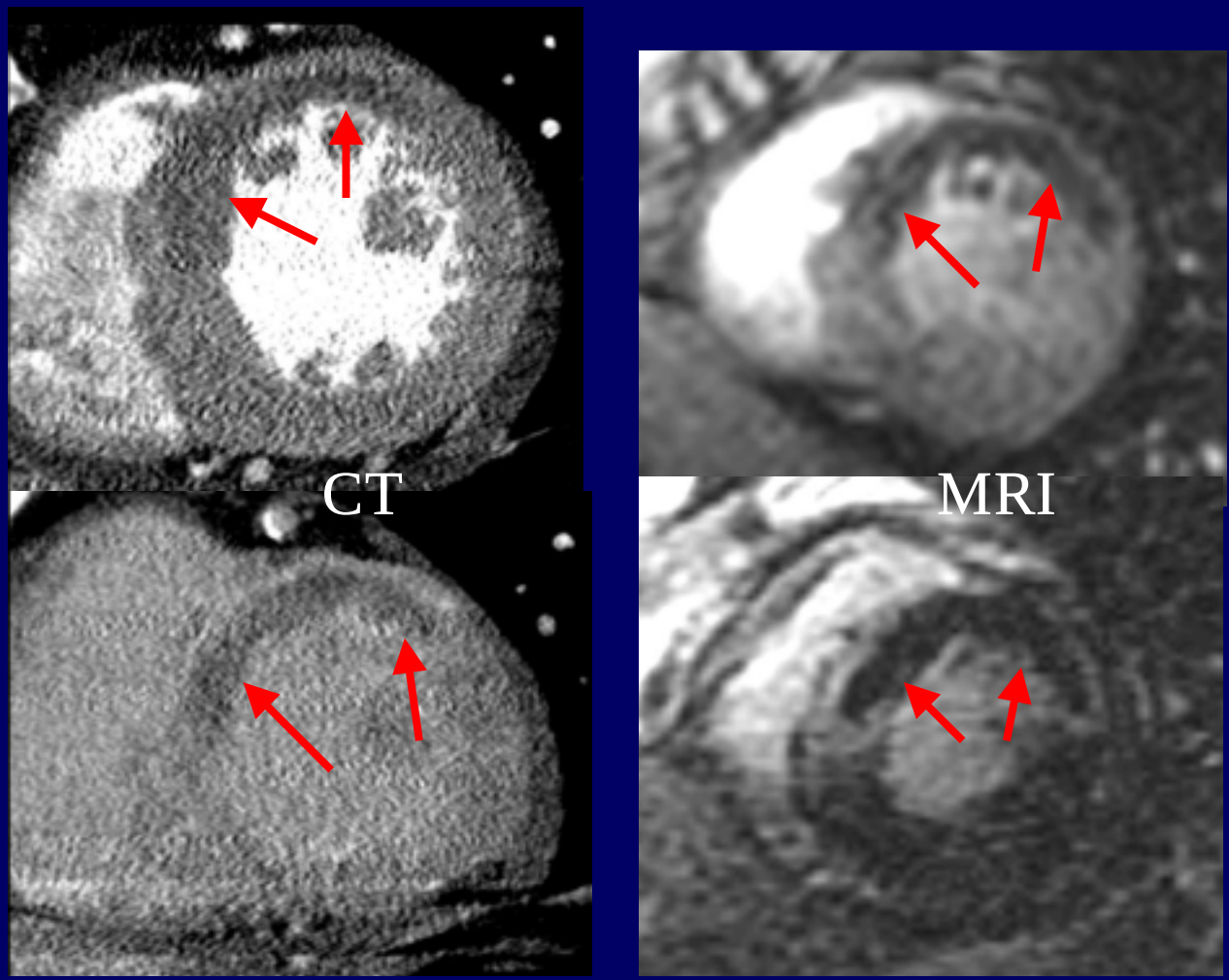
# Comparison of Infarct Volume (%) between CT and MRI



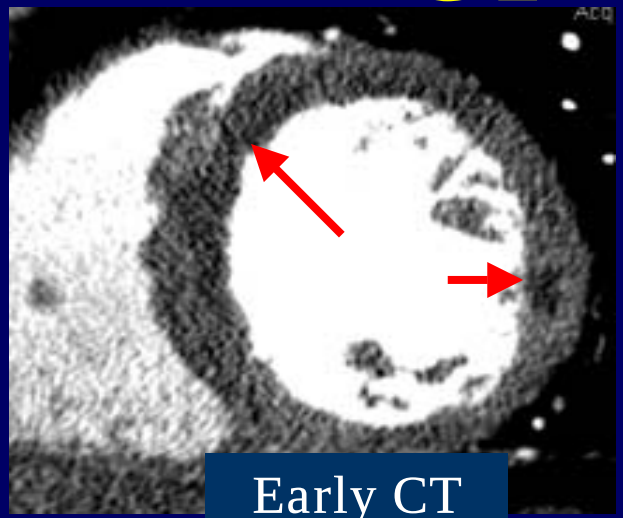
# Correlation of Infarct Volume (%) between CT and MRI



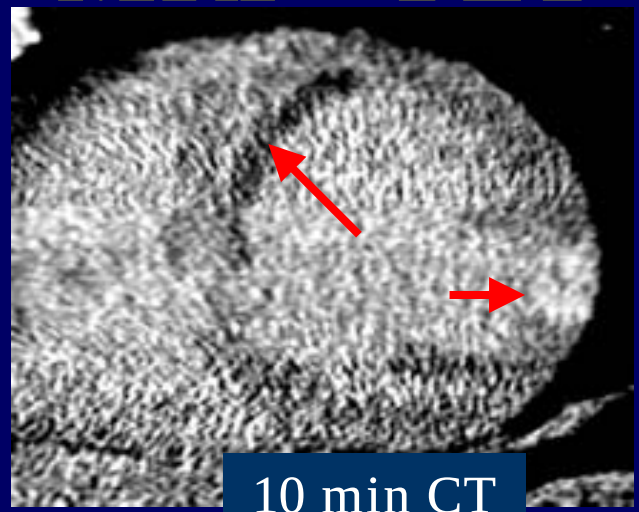
# AMI, Persistent Perfusion Defect on Late Phase, CT = MRI



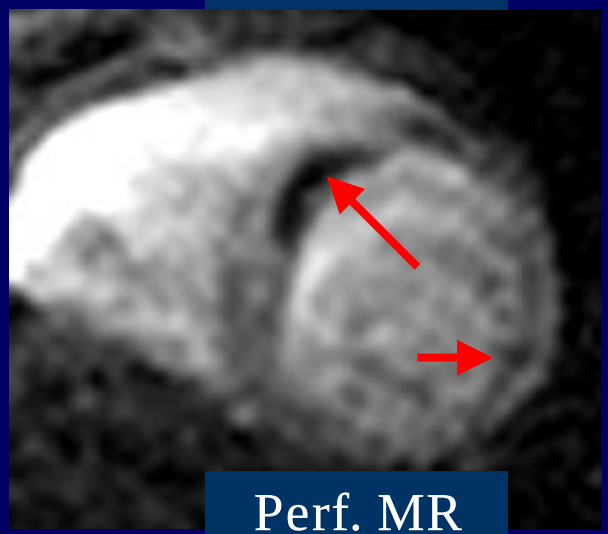
# 2-vessel Lesions in AMI, CT = MRI = PET



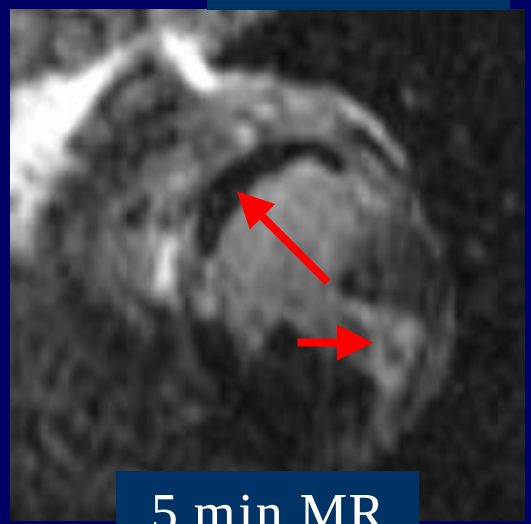
Early CT



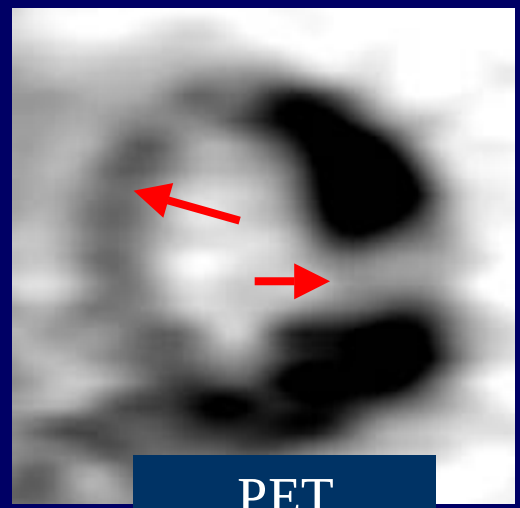
10 min CT



Perf. MR

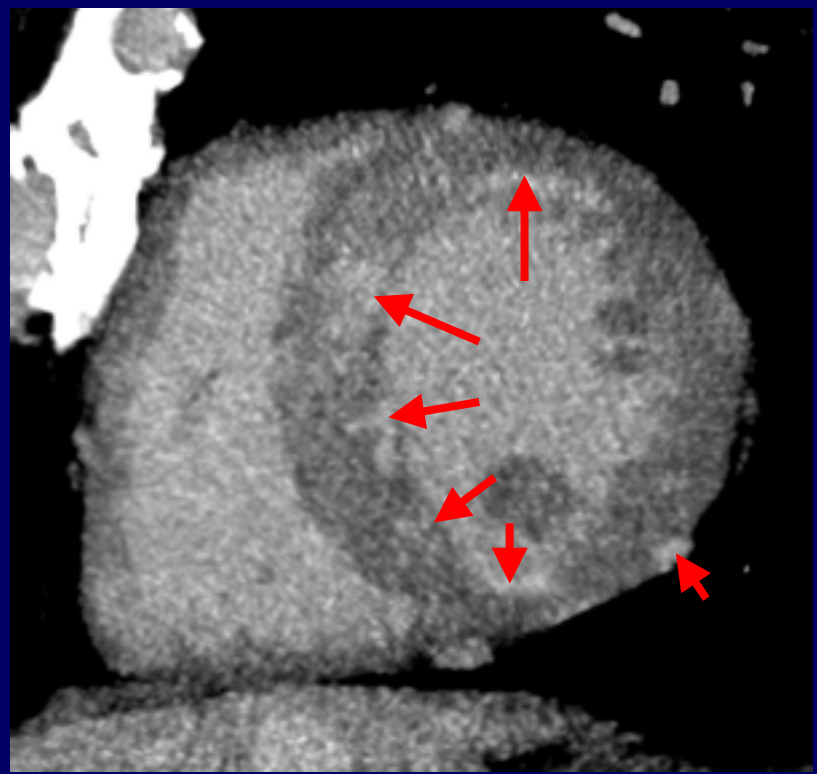


5 min MR

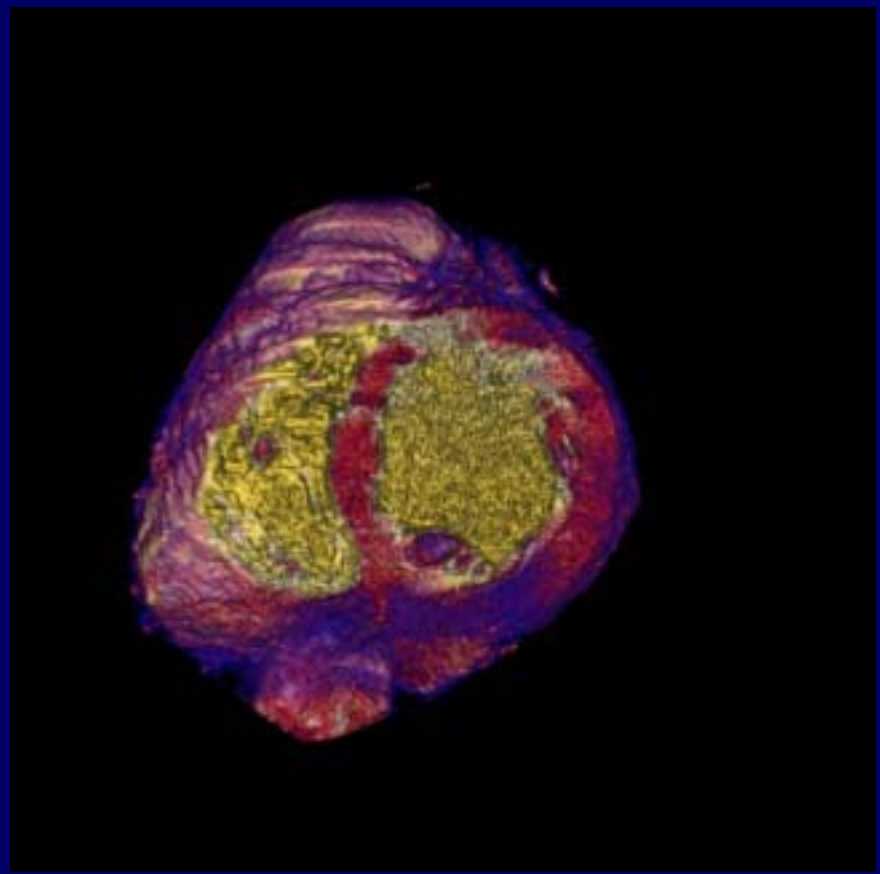


PET

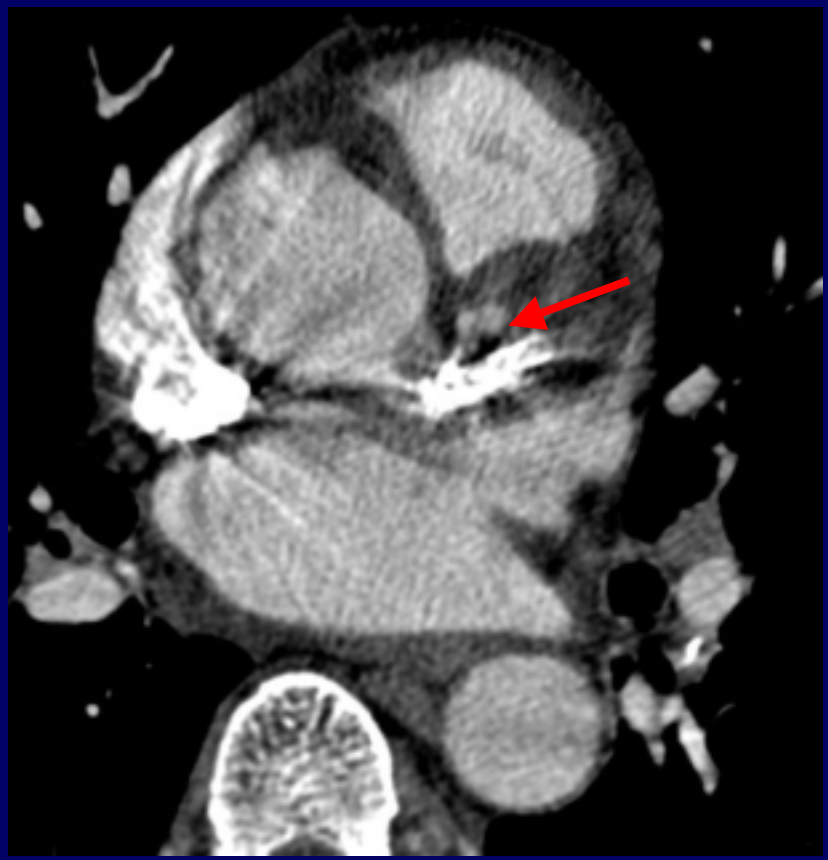
# MRI vs CT in AMI: Multiple Areas of Delayed Hyperenhancement

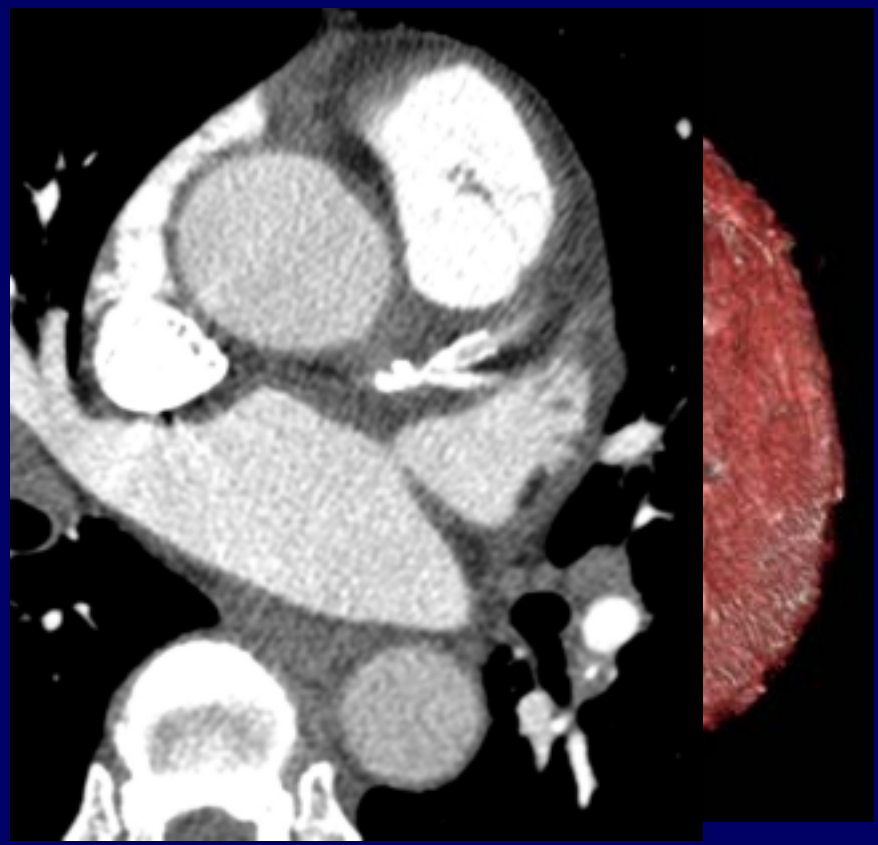


# Color-coded Images with LV Function Assessment in AMI



# Stenting Complication





# MDCT Assessment of Coronary Artery Stenosis (> 50%)

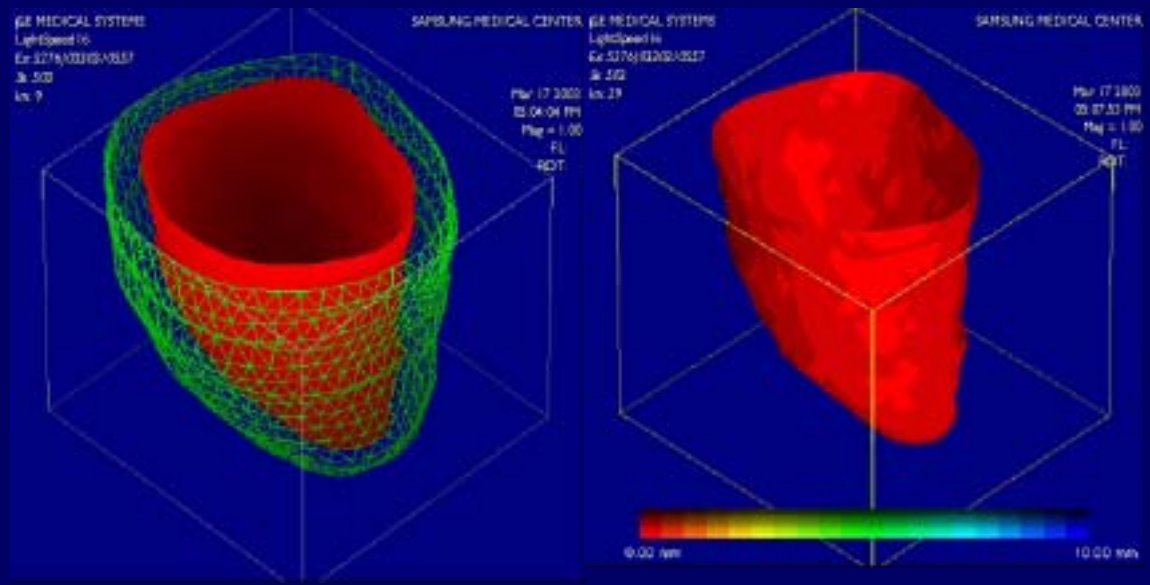
| | Slice (DR) | Assess (%) | Sens | Spec | PPV | NPV |
|---|---|---|---|---|---|---|
| Knez (n = 44) | 4 | 94 | 81 | 97 | 81 | 97 |
| Achenbach (n = 64) | 4 | 68 | 85 | 76 | 59 | 98 |
| Nieman (n = 58) | 16 | 100 | 95 | 86 | 80 | 97 |
| Ropers (n = 77) | 16 | 88 | 92 | 93 | 79 | 97 |

# Limitations of Coronary CTA

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

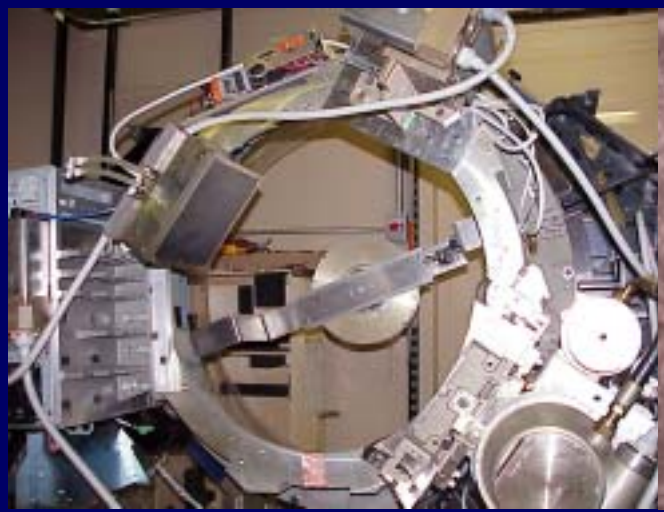
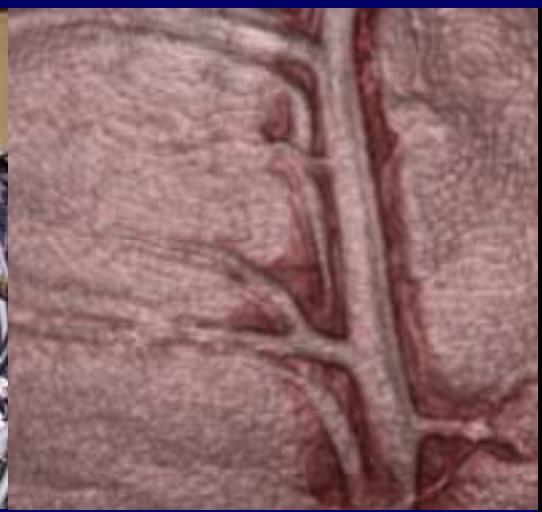
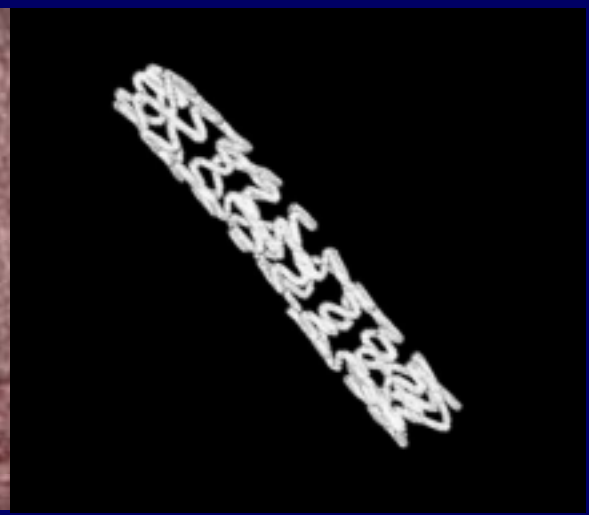
# Cardiac Function Analysis

- 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 atheroscleosis noninvasively and help start preventive medication in time.**

# Thank You