

APR 24, Summit TCT Asia Pacific 2008

JUST A FEW STEPS INTO THE ERA OF CORONARY CT ANGIOGRAPHY

Byoung Wook Choi
Yonsei University, Seoul

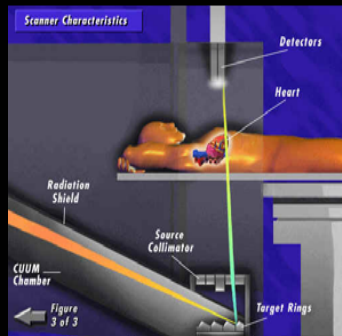
Cardiovascular Computed Tomography

CT
(1971)

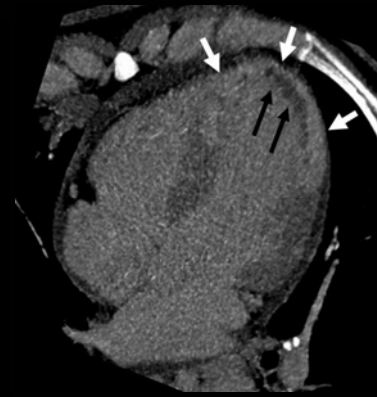
Electron Beam CT
(1984)

Multi-detector CT (late 1990s)
From 4 to 64 detectors

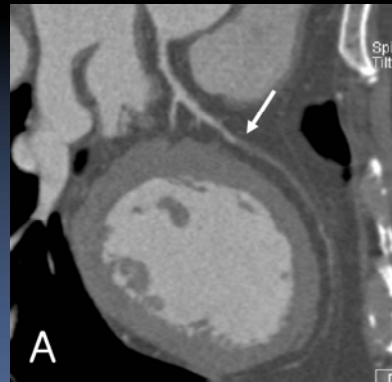
Next Generation



Bypass graft



Viability



Coronary Artery



Stent

- **Dual-Source CT**
Improved Temporal Resolution
- **256 to 320 detector CT**
Large coverage allows one rotation imaging of the whole heart
- **Faster Gantry Rotation**
With air-cushion
- **Flat-Panel CT**
Extreme high spatial resolution

Current status of Cardiac CT

- 64-slice MDCT: most widely used
- Accuracy more than 90% for CAD
- Insufficient Resolution necessitates beta blocker
- Appropriateness criteria (2006) provides narrow scope of appropriate indications of CT
- Time consuming post-processing & reviewing



Accuracy of 64-slice CT

- 64-slice CT
 - Sensitivity 90-99%
 - Specificity 93-97%
 - Negative predictive value 98-100%
 - Subjects 35-82
 - Exclusion 0-12%
- Dual-Source CT (Leber et al. Klinikum Grosshadern Ludwig Maximilians University Munich, Germany, SCCT 2007)
 - Sensitivity 95%
 - Specificity 91%
 - Positive predictive value 64%
 - Diagnostic quality in 88/90
 - 48 patients > 65 bpm
 - No difference in accuracy between <65 bpm & > 65 bpm
 - Exclusion rate due to fast heart rate is low
 - Constant diagnostic image quality



Accuracy in real world

- YUMC (RSNA 2007): 580 patients, CTA & CAG, No exclusion (mean HR 56.7bpm), CTA: CAD + 457, CAD – 123

	Per-patient	Per-segment
Sensitivity	91%	50%
Specificity	59%	95%
PPV	87%	63%
NPV	69%	93%

- Columbia University, SCCT 2007, 41 patients,

	Per-vessel	Per-segment
Sensitivity	86%	77%
Specificity	84%	93%
PPV	95%	61%
NPV	65%	97%



CTA in real world

- Factors affecting accuracy
 - Lots of motion artifacts
 - Limitations in evaluation of small vessels
 - Overestimation of mild stenosis due to calcification
 - Underestimation or neglecting significant stenosis

- 64-slice CT has relatively high sensitivity and positive predictive value in detecting significant stenoses on a per-patient basis in everyday practice and it is useful in selecting patients who need invasive coronary angiography.



Future direction and issues

- Future technology should be
 - Higher spatial resolution
 - More coverage
 - Lower radiation dose
 - Faster post-processing
 - Dual-energy
- Study
 - Validation, clinical outcome, cost-effectiveness
- Future Issues
 - In-Stent Restenosis Evaluation
 - Quantification and Characterization of Plaques
 - Function/Perfusion/Viability



Appropriateness Criteria (2006)

- 39 practical indications
 - 13 appropriate/12 uncertain/14 inappropriate
 - Scoring appropriate 7-9, uncertain 4-6, inappropriate 1-3
- Endorsed by
ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SC
AI/SIR



Evaluation of Chest pain syndrome

- **Appropriate**
 - Intermediate pre-test probability of CAD & ECG uninterpretable or unable to exercise (7)
 - Uninterpretable or equivocal stress test (8)



The current role of CTA

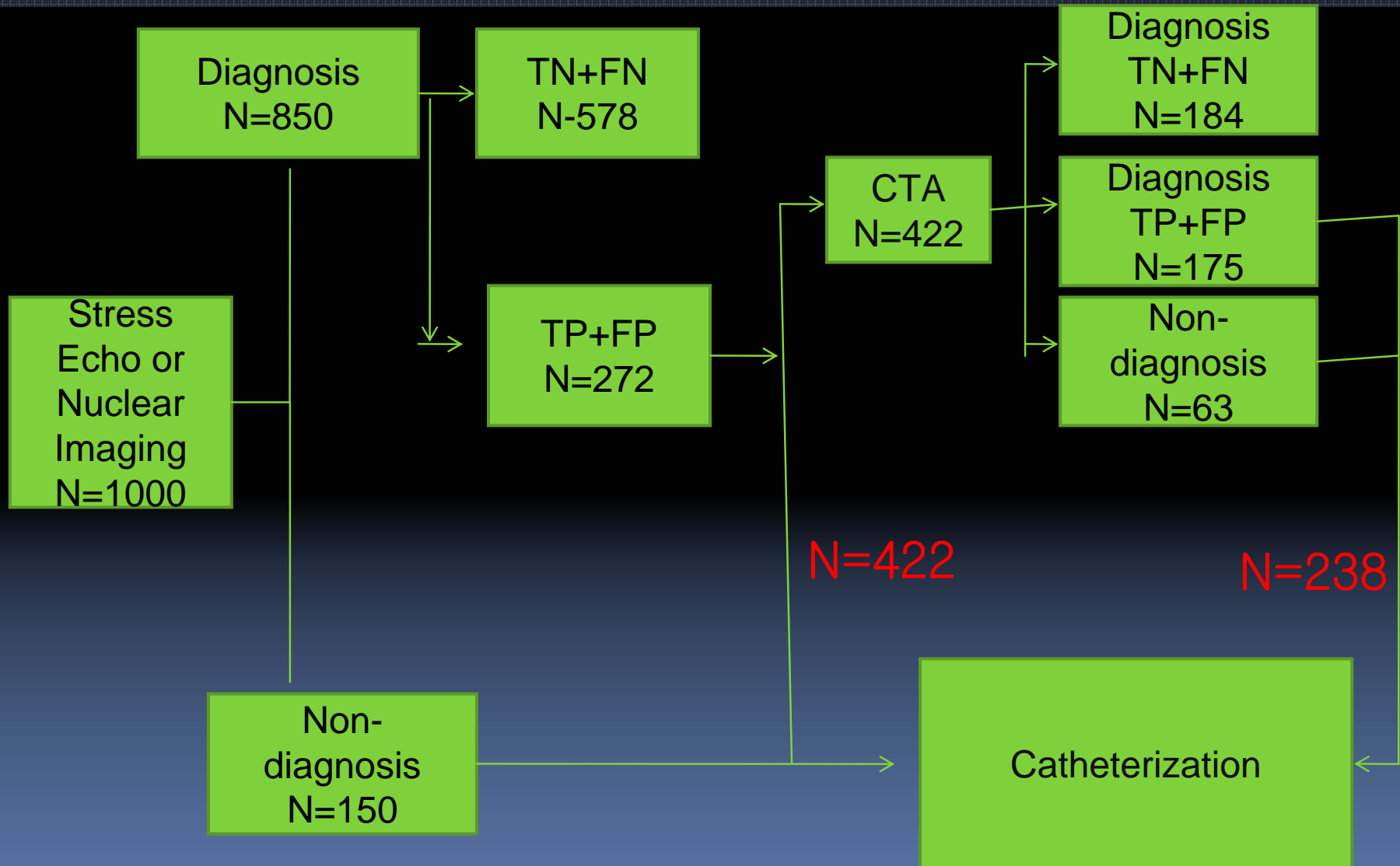
	Pre-MDCT Strategy (n-)	MDCT strategy (n=75)
Need for further stress tests or invasive coronary angiography	58	11
Unnecessary cardiac catheterizations	23	6

Walter Reed Army Medical Center, Washington DC, SCCT 2007



Cost Saving effect

Cleveland Clinic, SCCT 2007



Is appropriateness criteria appropriate?

- NIH, NHLBI, SCCT 2007
 - 172 patients undergoing cardiac CTA
 - Appropriate 72%
 - Uncertain 6%
 - Inappropriate 14%
 - **Not-classifiable 8%**
- Cleveland clinic
 - 613 consecutive outpatients
 - **Well classified as appropriate or inappropriate (66%)**
 - **Uncertain (30%)**
 - Not-classifiable (4%)



Evaluation of Chest pain syndrome

- **Uncertain**
 - Intermediate pre-test probability of CAD & ECG interpretable AND able to exercise (5)
 - High CHD risk (4)
- **Inappropriate**
 - Evidence of moderate to severe ischemia on stress test (2)
 - High pre-test probability of CAD (2)



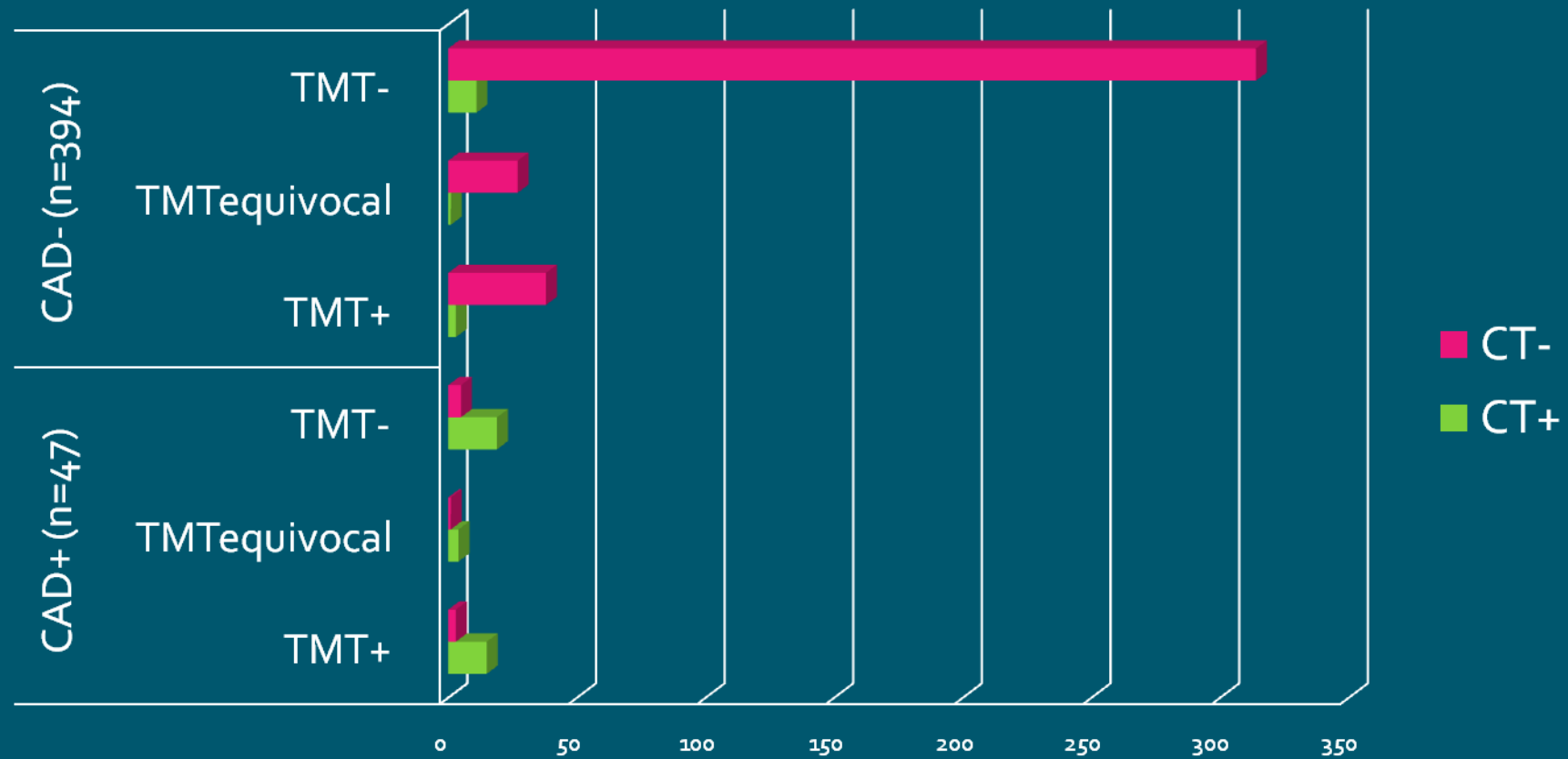
Intermediate pre-test probability

- **441** patients (187 men, 254 women) with intermediate pre-test probability
- CCA revealed CAD in 47 patients (10.7%).

	CAD +	CAD-	Total
TMT+	18	41	59
TMT: equivocal	5	28	33
TMT-	24	325	349
total	47	394	441

	CAD+	CAD-	Total
CT+	38	15	53
CT-	9	379	388
total	47	394	441

Intermediate Pre-test Probability



	CAD+ (n=47)			CAD- (n=394)		
	TMT+	TMTequivoca	TMT	TMT+	TMTequivocal	TMT-
CT+	15	4	19	3	1	11
CT-	3	1	5	38	27	314
	18	5	24	41	28	325



Intermediate pre-test probability

	TMT	CT
Sensitivity	49%	81%
Specificity	82%	96%
Positive Predictive Value	25%	72%
Negative Predictive Value	93%	98%

- In patients with intermediate pre-test probability of CAD, cardiac CT angiogram was useful to exclude presence of CAD when the result of exercise ECG testing was positive and to detect presence of CAD when the result of exercise ECG testing was negative.

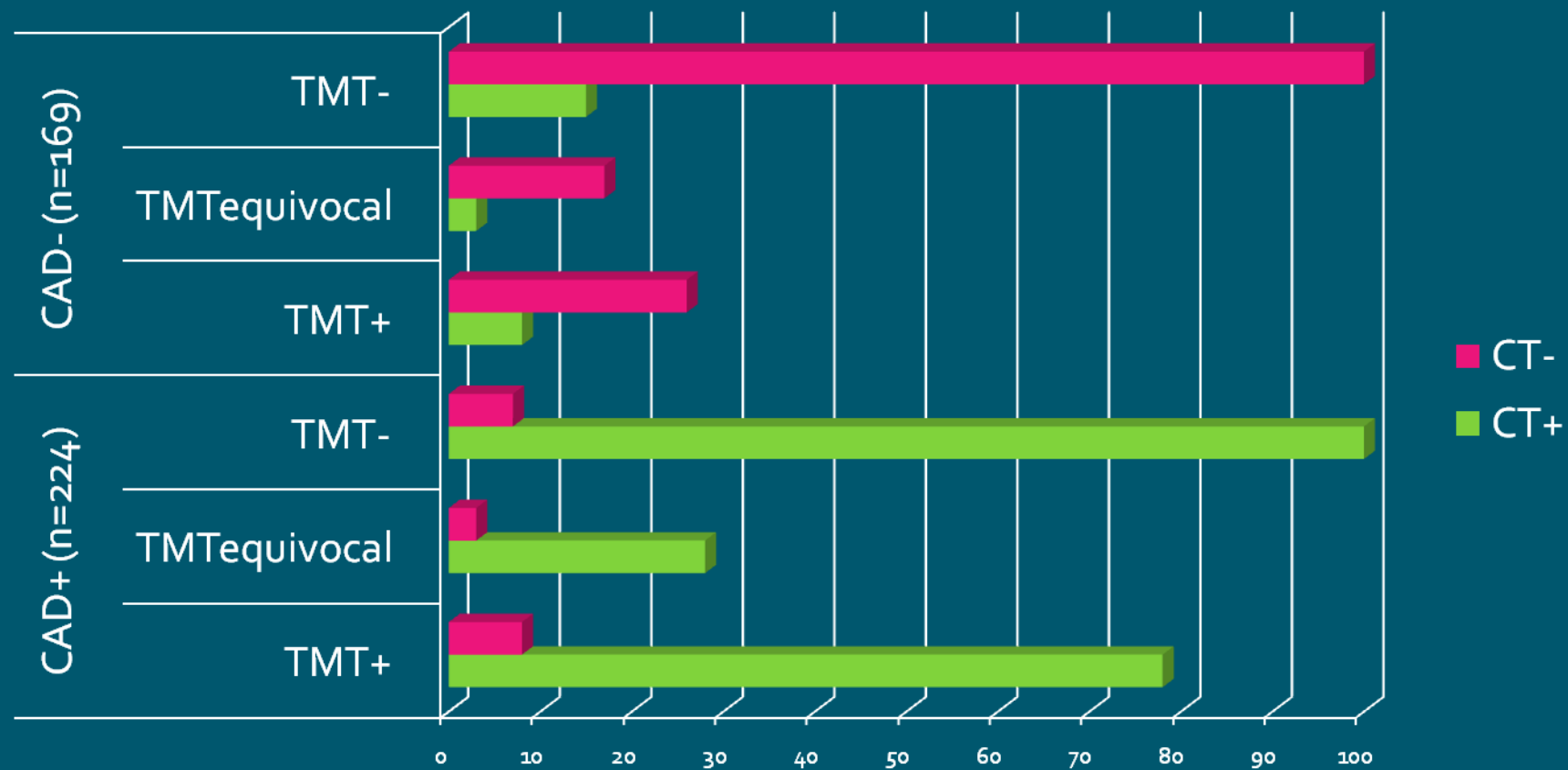
High pre-test probability

- 393 patients with high pre-test probability
- CCA revealed CAD in 224 patients (57%).

	CAD +	CAD-	Total
TMT+	86	34	120
TMT: equivocal	31	20	51
TMT-	107	115	100
total	224	169	393

	CAD+	CAD-	Total
CT+	181	26	207
CT-	43	143	186
total	224	169	393





	CAD+ (n=224)			CAD- (n=169)		
	TMT+	TMTequivoca	TMT	TMT+	TMTequivocal	TMT-
CT+	78	28	100	8	3	15
CT-	8	3	7	26	17	100
	86	31	107	34	20	115

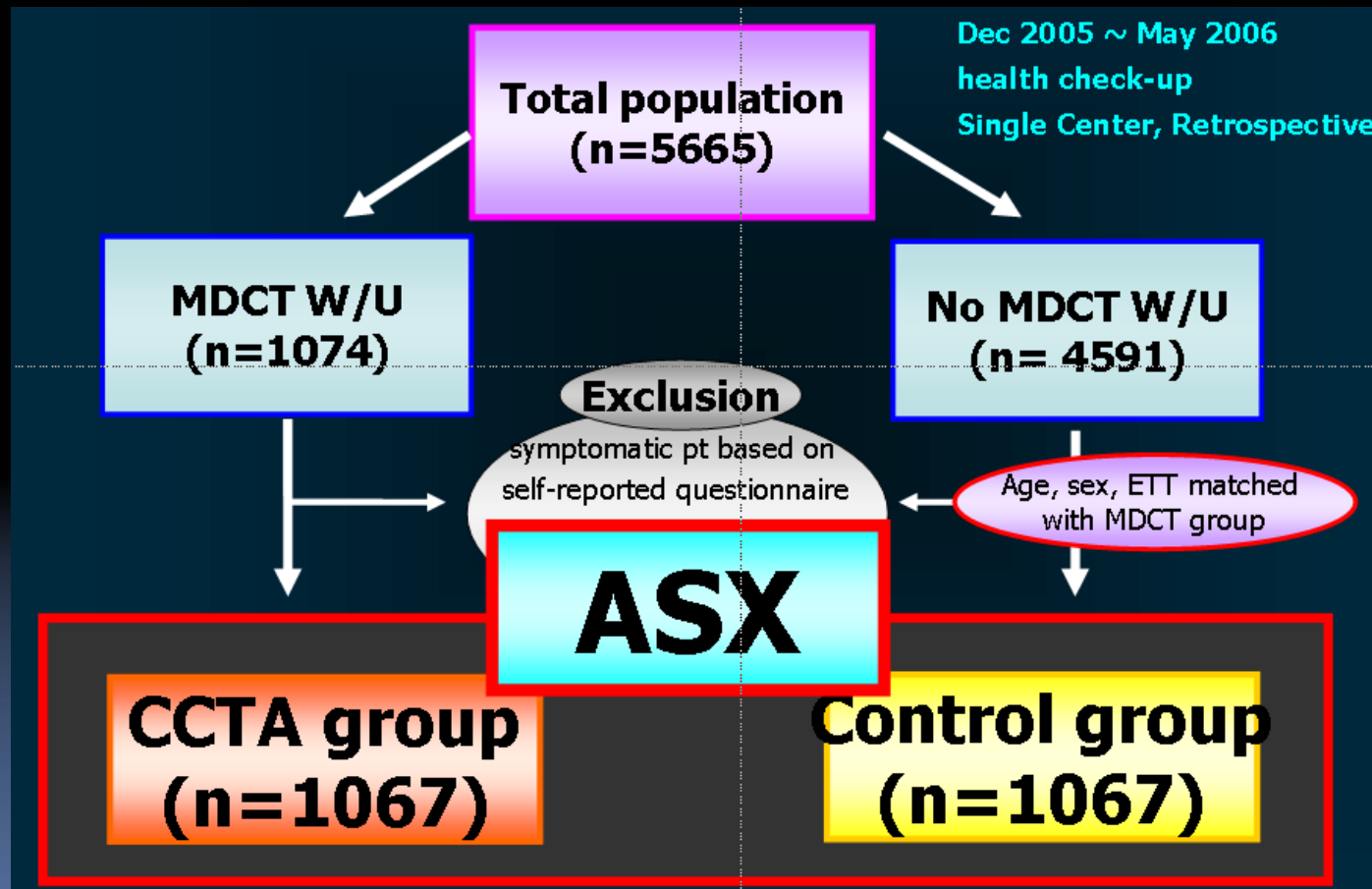
High pre-test probability

	TMT	CT
Sensitivity	52%	92%
Specificity	68%	85%
Positive Predictive Value	68%	87%
Negative Predictive Value	52%	77%

- The CTA yields high diagnostic accuracy in detecting CAD and precisely identifies patients who require CAG from those who do not in high pre-test probability patients, despite CTA being classified as an inappropriate indication according to the Appropriateness Criteria 2006.

Screening CT in Asymptomatic Patient ?

Choi EK et al 2006, AHA
JACC (In Press)



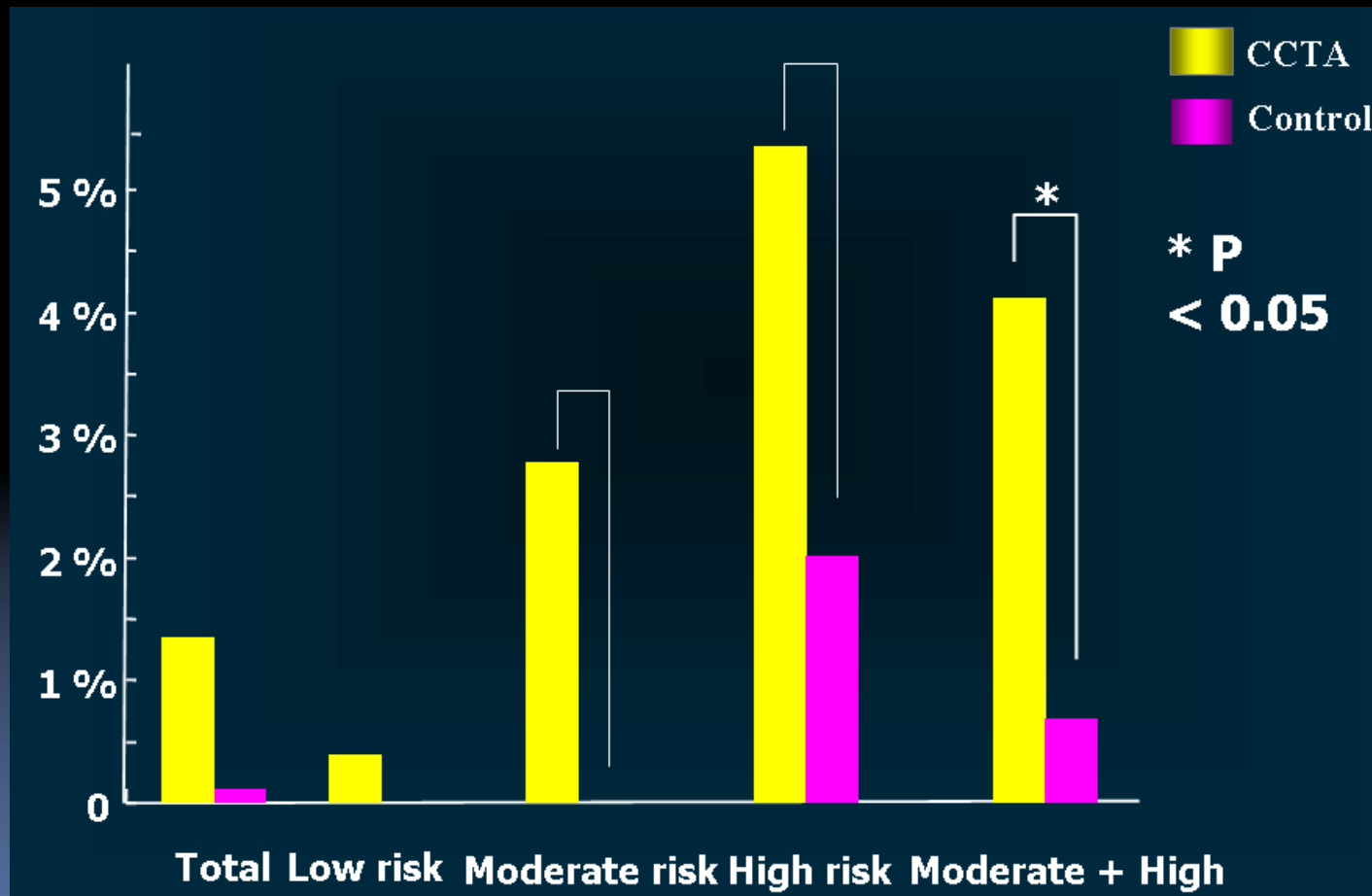
Coronary CTA: Screening test in Asymptomatic Patient ?

*Choi EK et al 2006, AHA
JACC (In Press)*

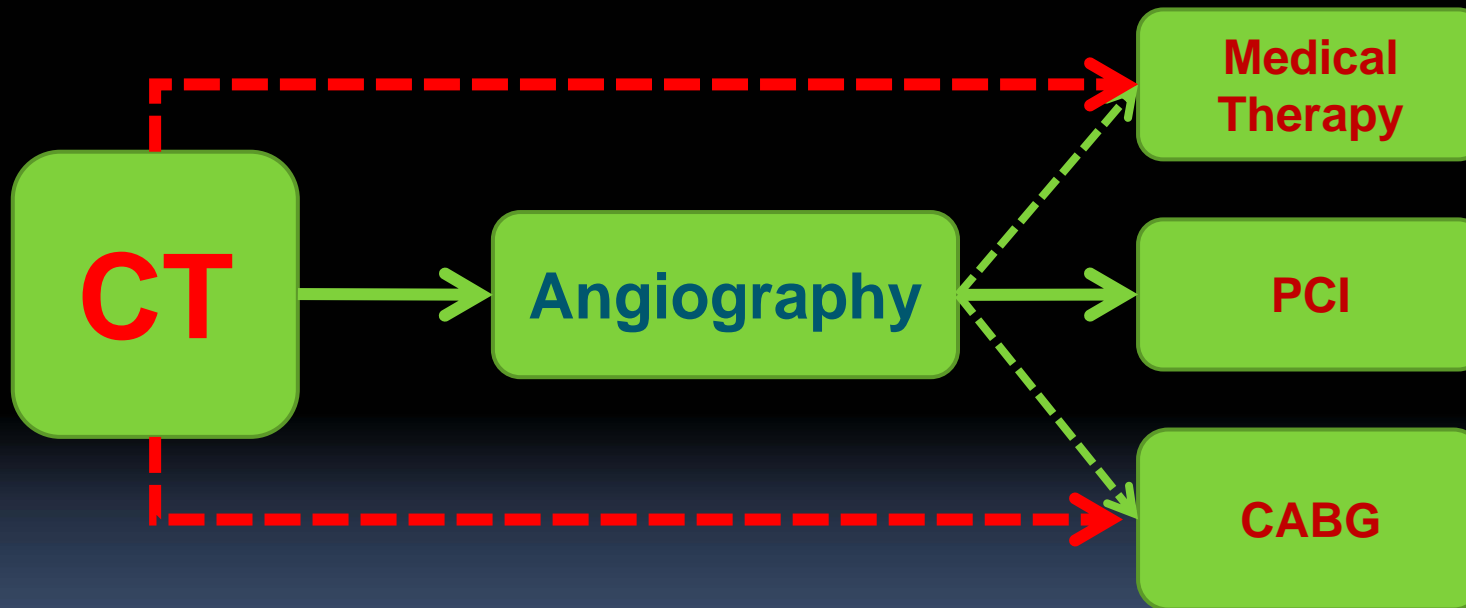
Abnormal CCTA findings	20.3% (217)
Significant luminal stenosis	5.5% (59)
Location of significant lesions	
Lt. main	0.6% (6)
LAD	4.3% (46)
LCX	1.0% (11)
RCA	1.0% (11)
Number of diseased vessel	
1VD	3.9% (42)
2VD	1.2% (13)
3VD	0.4% (4)

Coronary CTA: Revascularization

*Choi EK et al 2006, AHA
JACC (In Press)*



CT as the first and last diagnostic tool



CABG candidates

- 172 consecutive patients, who underwent both MDCT and conventional coronary angiography (CCA) (interval < two months) between January 2007 and July 2007, were enrolled.
- Eligible criteria for CABG based on ACC/AHA practice guidelines, which included three-vessel disease, left main disease, and left main equivalent disease

	3-vessel	Left main	LM	Overall
Sensitivity	81.0%	94.1%	81.8%	90.6%
Specificity	96.5%	96.1%	93.8%	92.8%
PPV	92.2%	72.7%	47.4%	90.7%
NPV	90.9%	99.3%	98.7%	92.8%
Accuracy	91.3%	95.9%	93.0%	91.9%

- Further study is warranted to decide whether CT alone can provide all the essential preoperative information for CABG.



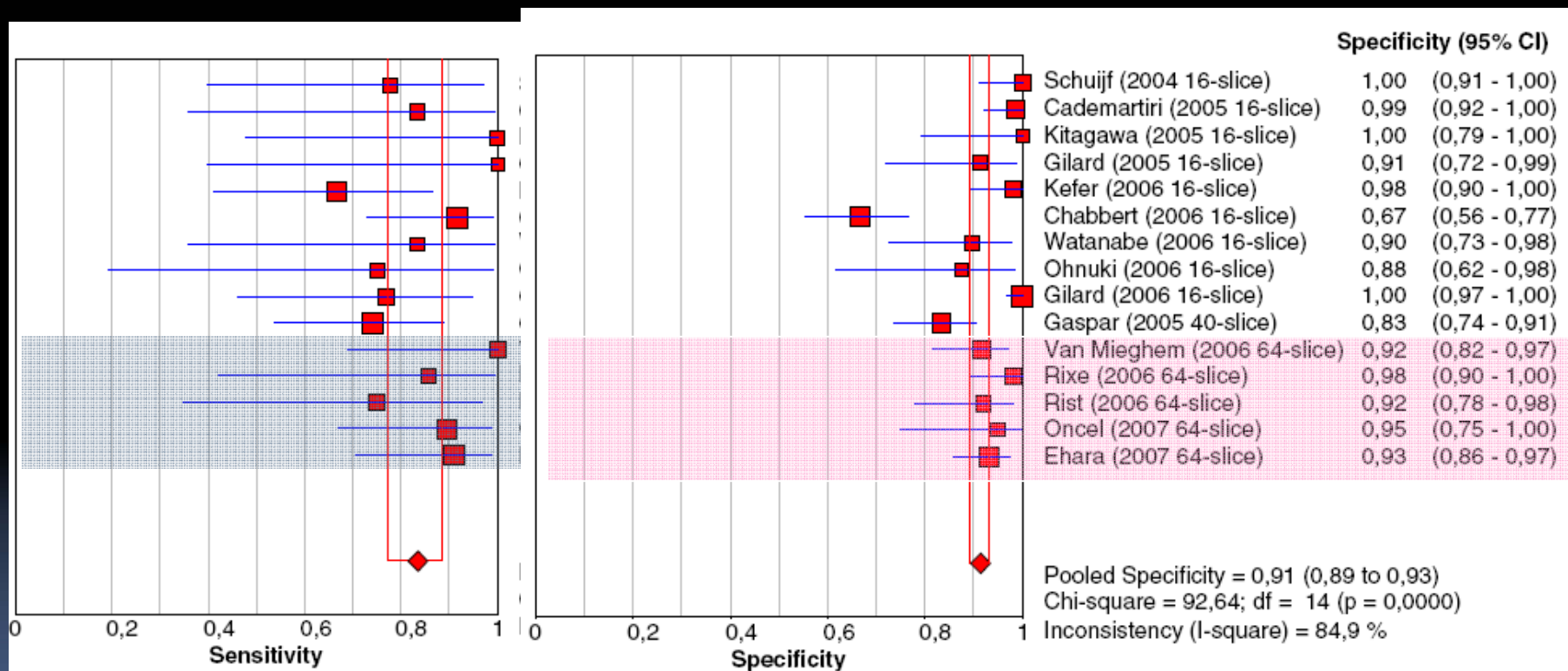
Stent

- Evaluation for in-stent restenosis and coronary anatomy after PCI in asymptomatic (2)
- History of percutaneous revascularization with stents in symptomatic (5)



Michèle Hamon
 Laure Champ-Rigot
 Rémy Morello
 John W. Riddell
 Martial Hamon

Diagnostic accuracy of in-stent coronary restenosis detection with multislice spiral computed tomography: a meta-analysis



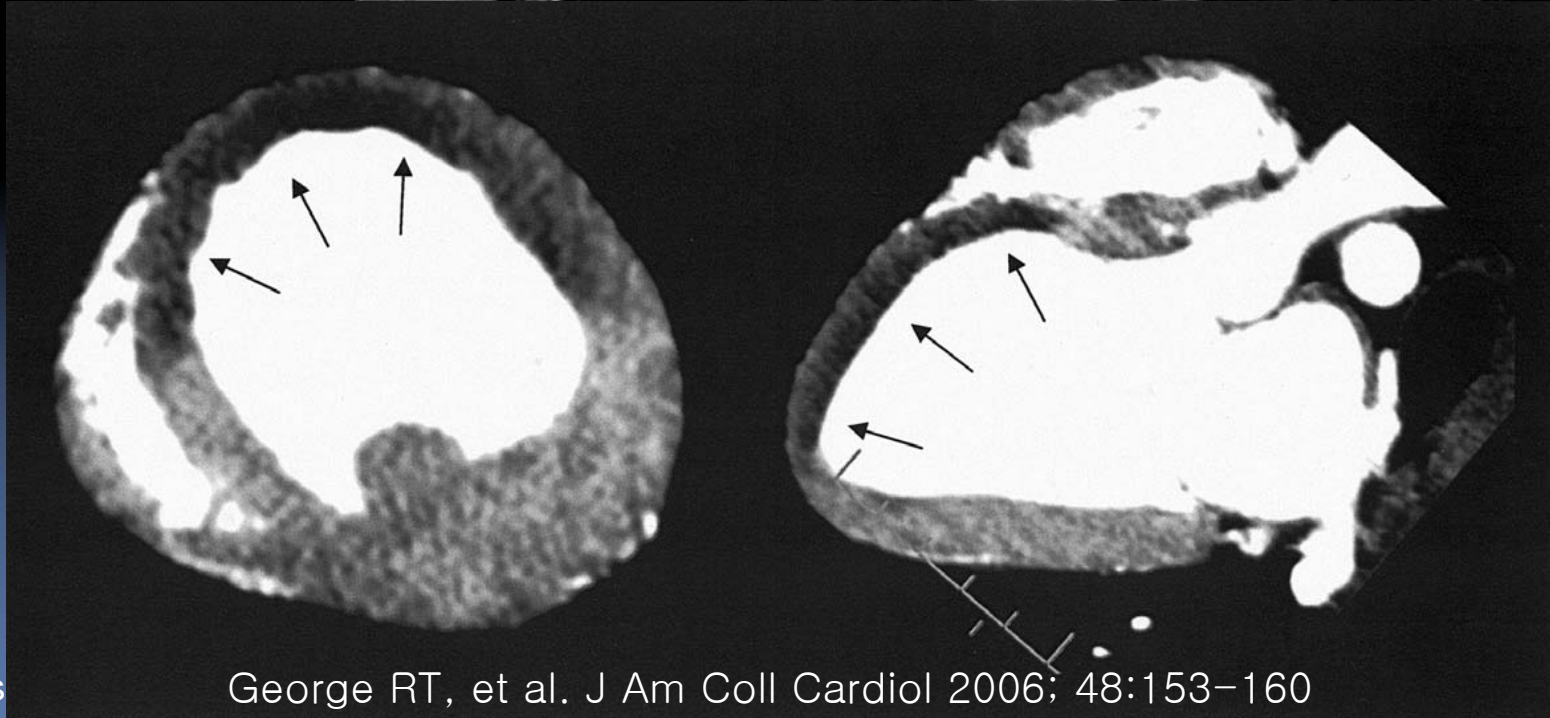
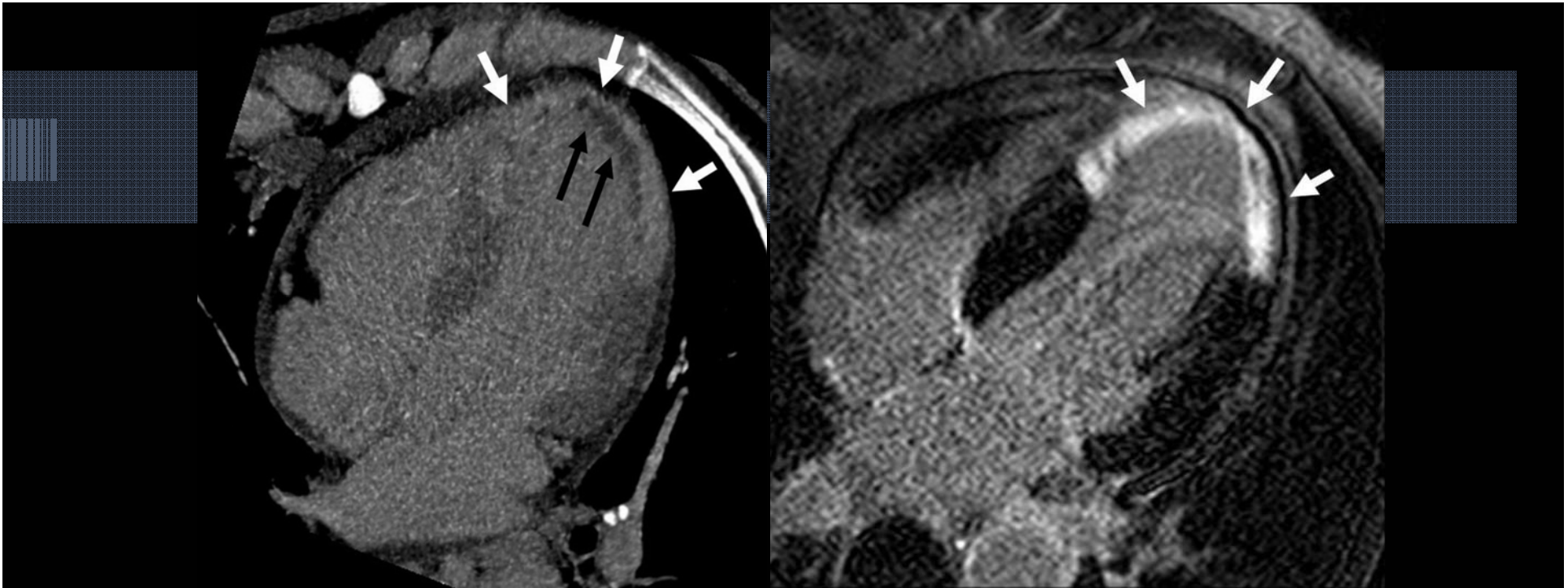
- Sensitivity and specificity are moderately high .
- MDCT has shortcomings difficult to overcome in daily practice for ISR detection

Accuracy of 64-slice CT in evaluation of In-stent restenosis

•Coronary CT angiography can depict in-stent attenuation filling defects, which appear to be a reliable sign of stent restenosis, and 64-section CT depicts such defects with a high degree of accuracy.

	Patient s	stents	Exclus i-on	sensitivi -ty	specifici -ty	PPV	NPV
Rixe	64	102	42%	50%(86)	57%(98)	(86)	(98)
Oncel	30	39	0%	89%	95%	94%	90%
Ehara	81	125	12%	92%(91)	81%(93)	54%(77)	98%(98)
Das	53	110	3.7%	96%	88%	77.5%	98.5%
Schuijf	50	76	14%	100%	100%		
Cadematiri	182	192	7.3%	95.0%	93.0%	63.3%	99.3%

- Ehara (JACC 2007)
- Oncel (Radiology 2007)
- Rixe (Eur Heart J 2006)
- Das (Radiology 2007)
- Schuijf (Radiology 2007)
- Cademartiri (JACC 2007)



Future directions

Challenges:

calcification,
stent, Irregular
heart rhythm,
resolution,
radiation dose

•256- or 320-slice CT
•Flat-panel CT
•Extreme high-speed
CT
•Multisource more
than dual-source?

•Combined with

- Myocardial Function
- Plaque
characterization
- First-pass perfusion
- Viability
- Valve function

CT as the first
and final
examination

