Il contributo della cardio TC nella gestione del paziente con cardiopatia ischemica cronica

Daniele Andreini, MD

Centro Cardiologico Monzino, IRCCS, Milan, Italy
Department of Cardiovascular Sciences, University of Milan

ELSEVIER

European Journal of Radiology 65 (2008) 449–461

EJR

www.elsevier.com/locate/ejrad

A systematic review on diagnostic accuracy of CT-based detection of significant coronary artery disease

Bertrand Janne d'Othée[a,*], Uwe Siebert[b,c], Ricardo Cury[d], Hossein Jadvar[e], Edward J. Dunn[f], Udo Hoffmann[d]

Abstract

Objectives: Systematic review of diagnostic accuracy of contrast enhanced coronary computed tomography (CE-CCT).

Background: Noninvasive detection of coronary artery stenosis (CAS) by CE-CCT as an alternative to catheter-based coronary angiography (CCA) may improve patient management.

Methods: Forty-one articles published between 1997 and 2006 were included that evaluated native coronary arteries for significant stenosis and used CE-CCT as diagnostic test and CCA as reference standard. Study group characteristics, study methodology and diagnostic outcomes were extracted. Pooled summary sensitivity and specificity of CE-CCT were calculated using a random effects model (1) for all coronary segments, (2) assessable segments, and (3) per patient.

Results: The 41 studies totaled 2515 patients (75% males; mean age: 59 years, CAS prevalence: 59%). Analysis of all coronary segments yielded a sensitivity of 95% (80%, 89%, 86%, 98% for electron beam CT, 4/8-slice, 16-slice and 64-slice MDCT, respectively) for a specificity of 85% (77%, 84%, 95%, 91%). Analysis limited to segments deemed assessable by CT showed sensitivity of 96% (86%, 85%, 98%, 97%) for a specificity of 95% (90%, 96%, 96%, 96%). Per patient, sensitivity was 99% (90%, 97%, 99%, 98%) and specificity was 76% (59%, 81%, 83%, 92%). Heterogeneity was quantitatively important but not explainable by patient group characteristics or study methodology.

Conclusions: Current diagnostic accuracy of CE-CCT is high. Advances in CT technology have resulted in increases in diagnostic accuracy and proportion of assessable coronary segments. However, per patient, accuracy may be lower and CT may have more limited clinical utility in populations at high risk for CAD.

64-Slice CT for Diagnosis of Coronary Artery Disease: A Systematic Review

Paul D. Stein, MD,[a,b] Abdo Y. Yaekoub, MD,[a] Fadi Matta, MD,[a] H. Dirk Sostman, MD[c]

[a]St. Joseph Mercy Oakland Hospital, Pontiac, Mich; [b]Wayne State University School of Medicine, Detroit, Mich; [c]Office of the Dean, Weill Cornell Medical College and Methodist Hospital, Houston, Tex.

ABSTRACT

PURPOSE: The purpose of this systematic review was to assess the accuracy of 64-slice CT coronary angiography for the diagnosis of coronary artery disease.

METHODS: We attempted to identify all published trials in all languages that used 64-slice CT to diagnose coronary artery disease. Results of 64-slice CT coronary angiography were compared with invasive coronary angiography or intravascular ultrasound.

RESULTS: Sensitivity of 64-slice CT for significant (≥50%) stenosis, based on pooled data from all studies, was ≥90% in patient-based evaluations, named vessels, segments, and coronary artery bypass grafts, except the left circumflex (sensitivity 88%), distal segments (80%), and stents (88%). Specificity was 88% in patient-based evaluations, and ≥90% at individual sites. Positive predictive values for patient-based evaluations, left main coronary artery, and coronary artery bypass grafts ranged from 91% to 93%, but elsewhere ranged from 69% to 84%. Negative predictive values were 96% to 100%. Positive likelihood ratios for patient-based evaluations were 8.0 and, at specific sites, were ≥9.7. Negative likelihood ratios, except for distal segments, were <0.1.

CONCLUSION: Negative 64-slice CT reliably excluded significant coronary disease. However, the data suggest that stenoses shown on 64-slice CT require confirmation. Combining the results of 64-slice CT with a pre-CT clinical probability assessment would strengthen the diagnosis. Due to the risk of radiation-induced cancer, patients should be selected carefully for this test, and scan protocols should be optimized to minimize risk.

 • *The American Journal of Medicine (2008) 121, 715-725*

KEYWORDS: Computed tomography; Coronary angiography; Coronary artery disease

Table 3 Appropriate clinical indications for the use of computed tomography coronary angiography and cardiac computed tomography imaging according to an expert consensus document endorsed by several professional societies and published in 2006[70]

Detection of CAD with prior test results—evaluation of chest pain syndrome (use of CT angiogram)

- Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)

CLINICAL RESEARCH

Coronary Computed Tomography Angiography for Early Triage of Patients With Acute Chest Pain

The ROMICAT (Rule Out Myocardial Infarction using Computer Assisted Tomography) Trial

Detection of CAD: symptomatic—evaluation of intra-cardiac structures (use of CT angiogram)

- Evaluation of suspected coronary anomalies

Structure and function—morphology (use of CT angiogram)

Cardiac Imaging

Diagnostic Accuracy of Multidetector Computed Tomography Coronary Angiography in Patients With Dilated Cardiomyopathy

Daniele Andreini, MD, Gianluca Pontone, MD, Mauro Pepi, MD, Giovanni Ballerini, MD, Antonio L. Bartorelli, MD, FACC, Alessandra Magini, MD, Carlo Quaglia, MD, Enrica Nobili, MD, Piergiuseppe Agostoni, MD, PhD

Structure and function—evaluation of intra- and extra-cardiac structures (use of cardiac CT)

- Evaluation of cardiac mass (suspected tumour or thrombus)

  Patients with technically limited images from echocardiogram, MRI, or TEE

- Evaluation of pericardial conditions (pericardial mass, constrictive pericarditis, or complications of cardiac surgery)

Patients with technically limited images from echocardiogram, MRI, or TEE

- Evaluation of pulmonary vein anatomy prior to invasive radiofrequency ablation for atrial fibrillation
- Non-invasive coronary vein mapping prior to placement of biventricular pacemaker
- Non-invasive coronary arterial mapping, including internal mammary artery prior to repeat cardiac surgical revascularization

Structure and function—evaluation of aortic and pulmonary disease (use of CT angiogram[a])

- Evaluation of suspected aortic dissection or thoracic aortic aneurysm
- Evaluation of suspected pulmonary embolism

Centro Cardiologico Monzino

Centro Cardiologico Monzino

Detection of CAD with prior test results—evaluation of chest pain syndrome (use of CT angiogram)

- Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)

- Intermediate pre-test probability of CAD
  ECG uninterpretable or unable to exercise

Detection of CAD: symptomatic—acute chest pain (use of CT angiogram)

- Intermediate pre-test probability of CAD
  No ECG changes and serial enzymes negative

Detection of CAD: symptomatic—evaluation of intra-cardiac structures (use of CT angiogram)

- Evaluation of suspected coronary anomalies

Structure and function—morphology (use of CT angiogram)

- Assessment of complex congenital heart disease including anomalies of coronary circulation, great vessels, and cardiac chambers and valves
- Evaluation of coronary arteries in patients with new onset heart failure to assess aetiology

ACCURACY OF MDCT: pretest likelihood of CAD

Clinical Radiology (2007) 62, 978–985

Accuracy of multidetector spiral computed tomography in detecting significant coronary stenosis in patient populations with differing pre-test probabilities of disease

G. Pontone*, D. Andreini, C. Quaglia, G. Ballerini, E. Nobili, M. Pepi

Centro Cardiologico Monzino, IRCCS, Milan, Italy

Received 25 June 2006; received in revised form 19 February 2007; accepted 23 February 2007

ACCURACY OF MDCT: pretest likelihood of CAD

116 PATIENTS

GROUP 1
Prevalence < 50% → **MDCT** → **ICA**

Chest Pain features
Gender
Age

Diamond GA N Engl Med 1979

GROUP 2
Prevalence ≥ 50% → **MDCT** → **ICA**

ACCURACY OF MDCT: pretest likelihood of CAD

PATIENTS	NUMBER	TP	TN	FP	FN	Se	Sp	NPV	PPV	ACCURACY
ALL POPULATION	116	66	43	7	0	100%	86%	100%	90%	94%
Agatston Score	197±176									
No CAD/CAD	50/66									
GROUP 1	69	28#	36#	5	0	100%	88%	100%	85%	93%
Agatston Score	152±147									
No CAD/CAD	41/28									
GROUP 2	47	35§@	7§@	5	0	100%	58%§*	100%	87%	89%
Agatston Score	261±196									
No CAD/CAD	12/35									

MDCT: multidetetctor computer tomography; QCA: quantitative coronary angiography; CAD: coronary artery disease; TP: true positive; TN: true negative; FP: false positive; FN: false negative; Se: sensitivity; Sp: specifity; NPV: negative predictive value; PPV: positive predictive value.
#: $p<0.05$ Group 1 vs all population; §: $p<0.05$ Group 2 vs all population; *: $p<0.05$ Group 2 vs Group 1; @: $p<0.01$ Group 2 vs Group 1.

Sp: TN/(TN+FP)

Centro Cardiologico Monzino

Pontone G, Andreini D. et al, Clinical Radiology 2007

ACCURACY OF MDCT: complementary role of stress test

Diagnostic work-up of unselected patients with suspected coronary artery disease: complementary role of multidetector computed tomography, symptoms and electrocardiogram stress test

Gianluca Pontone, Daniele Andreini, Giovanni Ballerini, Enrica Nobili and Mauro Pepi

Coron Artery Dis 18:265–274

Centro Cardiologico Monzino

ACCURACY OF MDCT: complementary role of stress test

144 (pts) with angina pectoris

↓

Exercise-stress test (Ex-ECG)

↓

MDCT

↓

Coronary angiography (QCA)

	Atypical Angina	Typical Angina
Ex-ECG negative	Group 1	Group 2
Ex-ECG positive	Group 3	Group 4

Centro Cardiologico Monzino

Pontone G, Andreini D. et al, Coronary Artery Disease 2007

ACCURACY OF MDCT: complementary role of stress test

GROUP 1
Atypical Angina
Ex-ECG negative

Diagnostic Work-up without CT
- 71% ICA useless

Diagnostic Work-up with CT
- Reduction ICA 70%
- 10% ICA useless

GROUP 2
Typical Angina
Ex-ECG negative

Diagnostic Work-up without CT
- 30% ICA useless

Diagnostic Work-up with CT
- Reduction ICA 16%
- 16% ICA useless

GROUP 3
Atypical Angina
Ex-ECG positive

Diagnostic Work-up without CT
- 27% ICA useless

Diagnostic Work-up with CT
- Reduction ICA 24%
- 12% ICA useless

Centro Cardiologico Monzino

Pontone G, Andreini D. et al, Coronary Artery Disease 2007

ACCURACY OF MDCT: complementary role of stress test

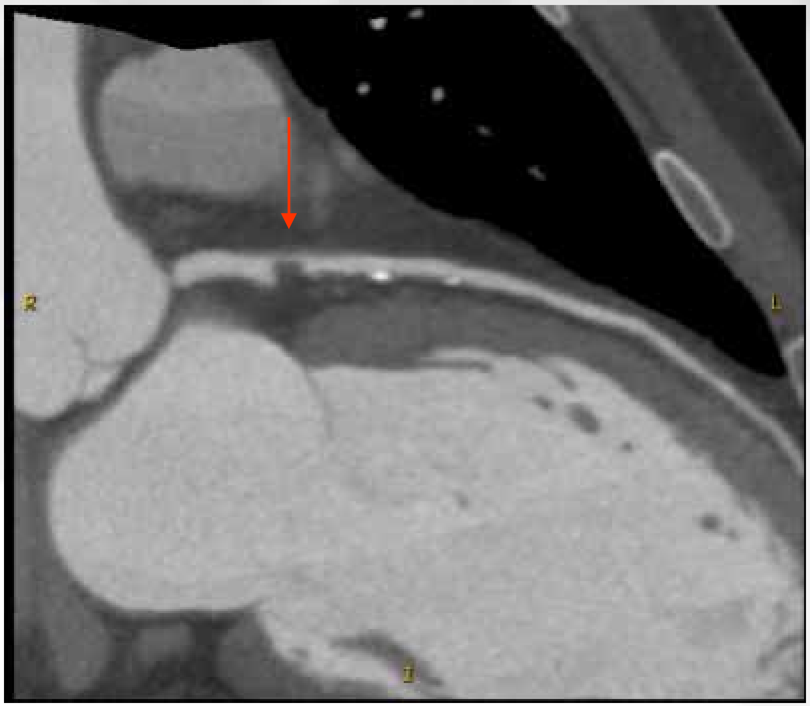
Male, 40 years old, symptomatic for typical angina with Ex-ECG and Echo stress test negative

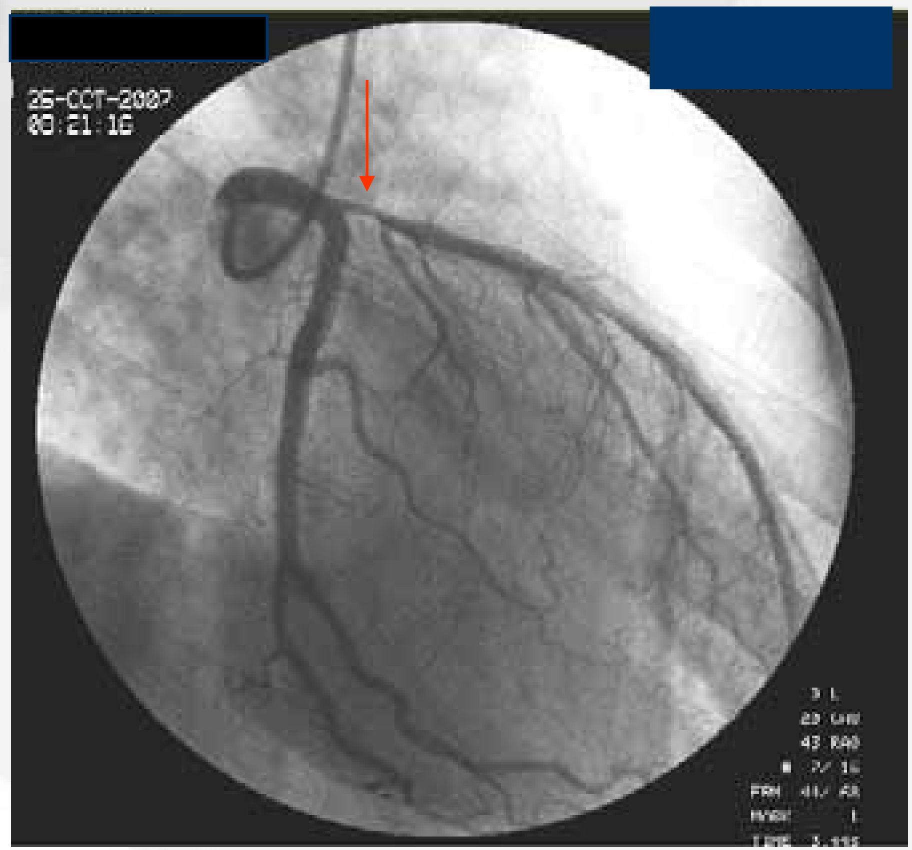
Centro Cardiologico Monzino

Pontone G, Andreini D. et al, Coronary Artery Disease 2007

ACCURACY OF MDCT: complementary role of stress test

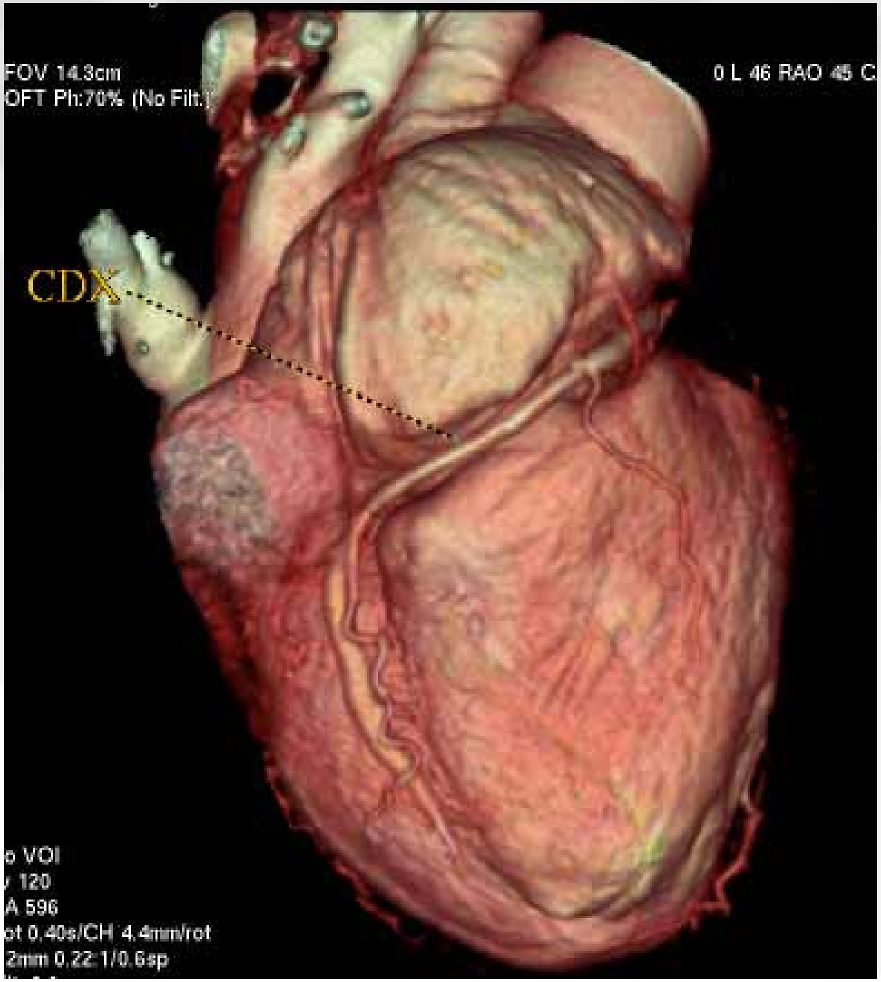
Male, 40 years old, symptomatic for typical angina with Ex-ECG and Echo stress test negative



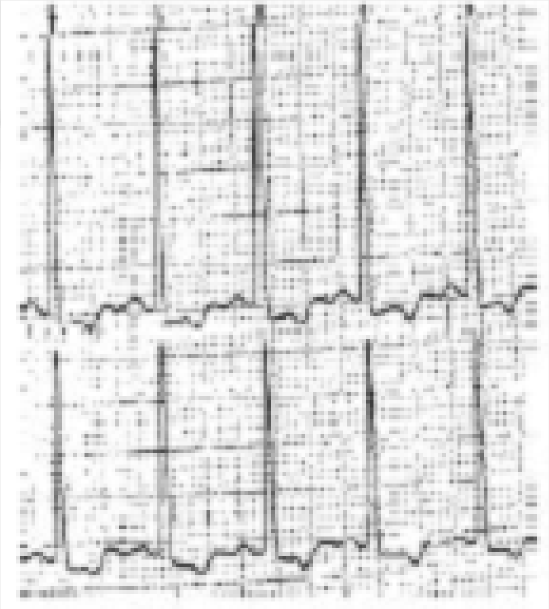


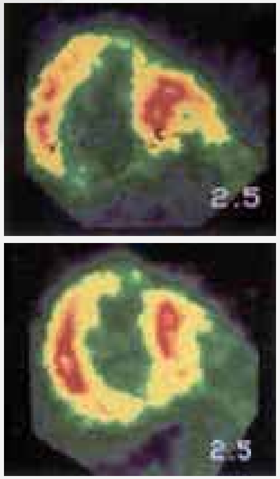
Centro Cardiologico Monzino

ACCURACY OF MDCT: complementary role of stress test



Female, 44 years old with hypertension, atypical angina, ex-ECG positive and stress nuclear test positive in inferior wall of LV





Centro Cardiologico Monzino

ACCURACY OF MDCT: complementary role of stress test

Group	Diagnostic work-up	Result
GROUP 1 Atypical Angina Ex-ECG negative	*Diagnostic Work-up without CT*	• 71% ICA useless
	Diagnostic Work-up with CT	• Reduction ICA 70% • 10% ICA useless
GROUP 2 Typical Angina Ex-ECG negative	*Diagnostic Work-up without CT*	• 30% ICA useless
	Diagnostic Work-up with CT	• Reduction ICA 16% • 16% ICA useless
GROUP 3 Atypical Angina Ex-ECG positive	*Diagnostic Work-up without CT*	• 27% ICA useless
	Diagnostic Work-up with CT	• Reduction ICA 24% • 12% ICA useless
GROUP 4 Typical Angina Ex-ECG positive	*Diagnostic Work-up without CT*	• 5% ICA useless
	Diagnostic Work-up with CT	• Reduction ICA 5% • 5% ICA useless

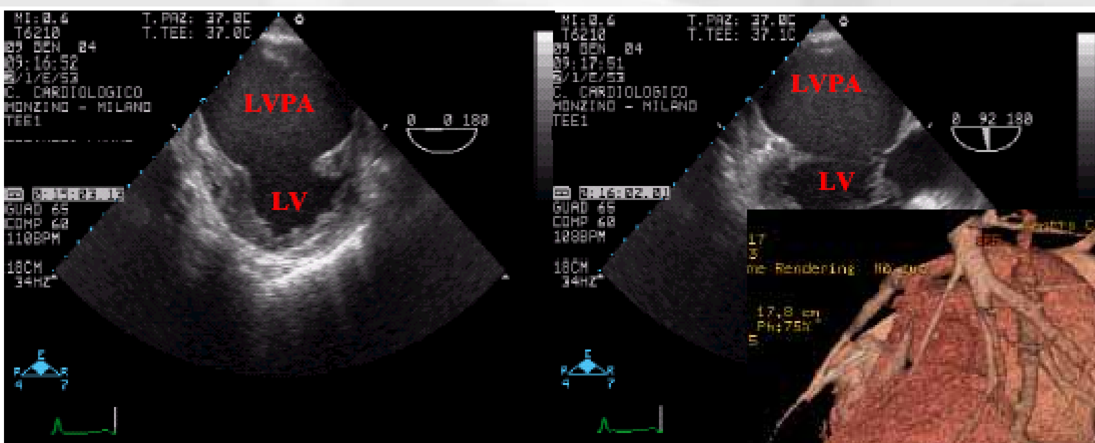
ACCURACY OF MDCT: complementary role of stress test

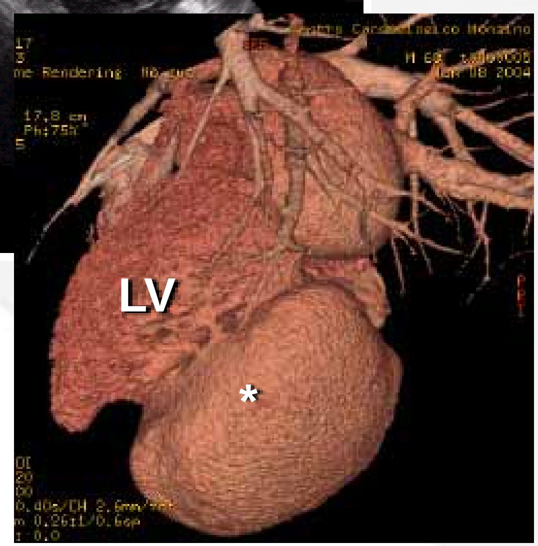

ELSEVIER

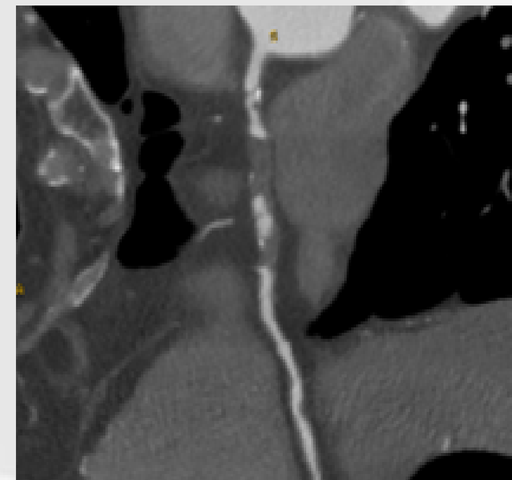
An unusual case of large left ventricular aneurysm: Complementary role of echocardiography and multidetector computed tomography in surgical planning

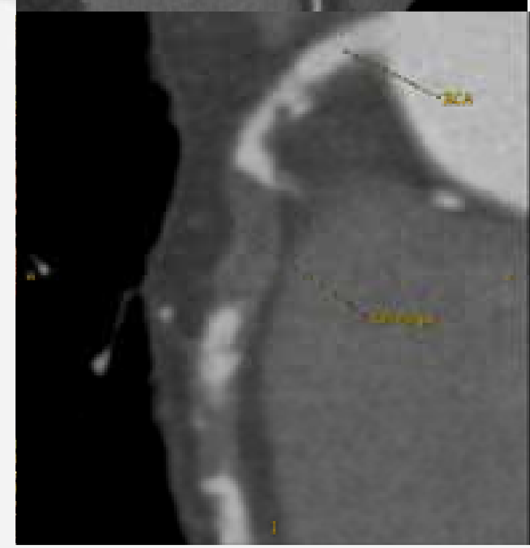
Gianluca Pontone[a,*], Daniele Andreini[a], Giovanni Ballerini[a], Giulio Pompilio[a], Francesco Alamanni[a], Enrica Nobili[a], Franco Casazza[b], Mauro Pepi[a], Paolo Biglioli[a]

Male, 65 aa with history of myocardial infarction of inferior wall of LV



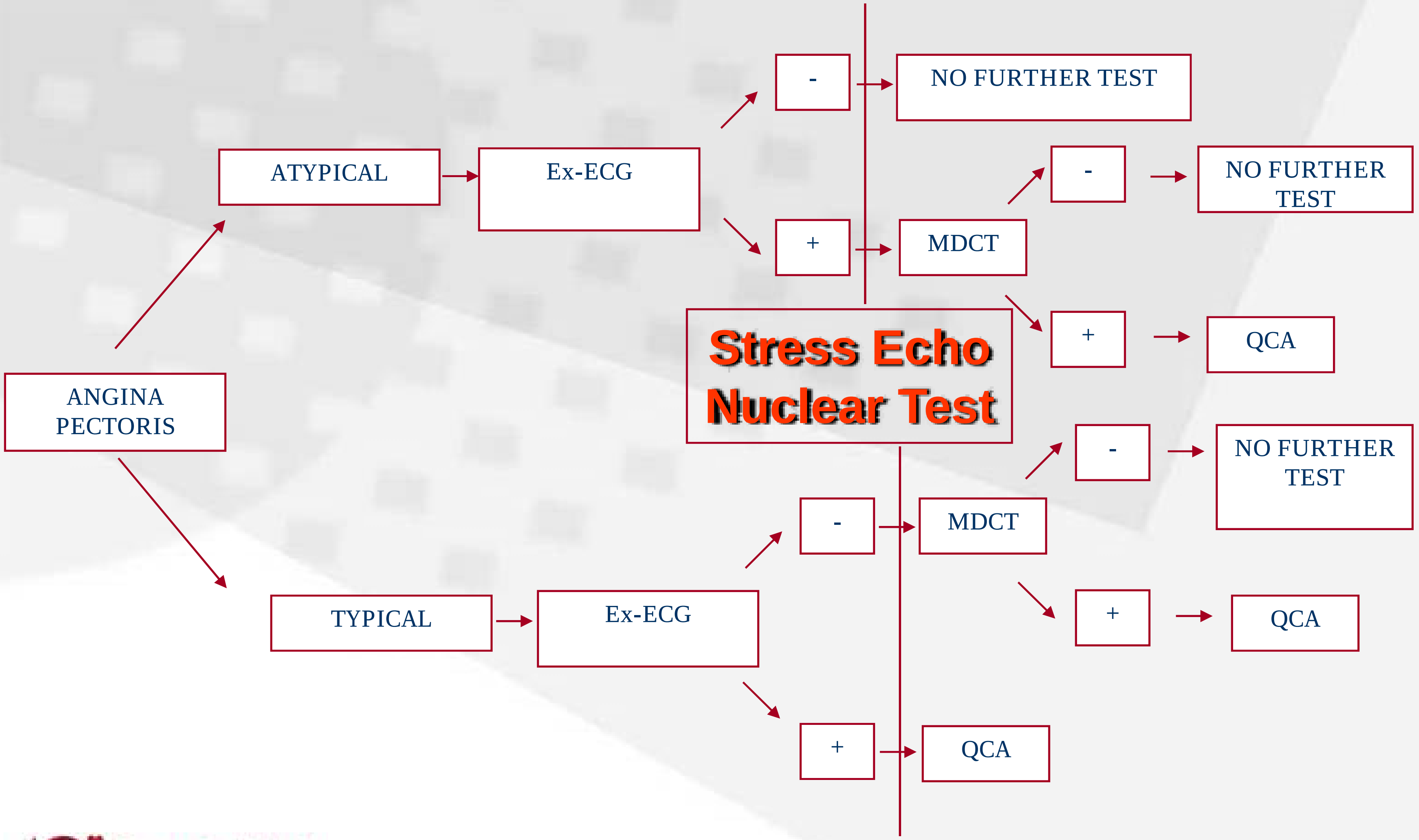






Centro Cardiologico Monzino

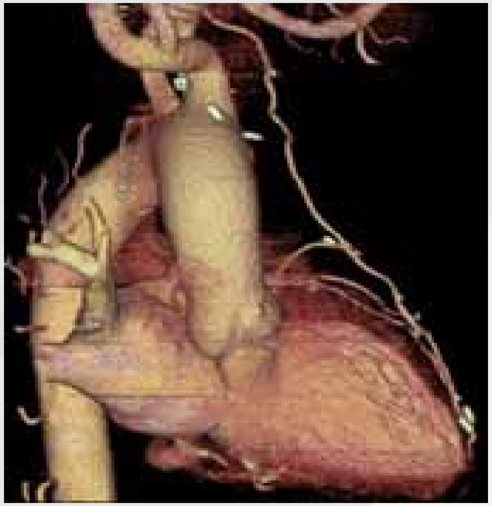
ACCURACY OF MDCT: complementary role of stress test



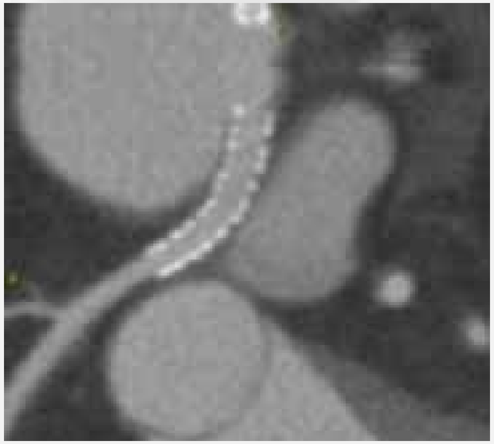
Centro Cardiologico Monzino

Paziente Rivascolarizzato

-By-pass Ao-coronarici



-Stent coronarici



Centro Cardiologico Monzino

By-pass aorto-coronarici

Vaso "ideale"

- Grosso calibro

- Minor influenza dei movimenti cardiaci

- Di solito privi di marcate calcificazioni

Centro Cardiologico Monzino

1. Brundage BH, Lipton MJ, Herfkens RJ, et al. Detection of patent artery bypass grafts by computed tomography: a preliminary report. *Circulation*. 1980;61:826–831.
2. Kahl FR, Wolfman NT, Watts LE. Evaluation of aortocoronary bypass graft status by computed tomography. *Am J Cardiol*. 1981;48:304–310.
3. McKay CR, Brundage BH, Ullyot DJ, et al. Evaluation of early postoperative coronary artery bypass graft patency by contrast-enhanced computed tomography. *J Am Coll Cardiol*. 1983;2:312–317.
4. Moncada R, Salinas M, Churchill R, et al. Patency of saphenous aortocoronary-bypass grafts demonstrated by computed tomography. *N Engl J Med*. 1980;303:503–505.
5. Daniel WG, Dohring W, Stender HS, et al. Value and limitations of computed tomography in assessing aortocoronary bypass graft patency. *Circulation*. 1983;67:983–987.

TC Spirale: Valutazione limitata alle occlusioni dei graft venosi

Engelmann MG, Knez A, von Smekal A, et al. Non-invasive coronary bypass graft imaging after multivessel revascularization. *Int J Cardiol*. 2000;76:65–74.

4 strati: buona accuratezza per occlusioni di graft venosi ed arteriosi, inadeguata per valutazione stenosi (Se, Sp < 60%)

Centro Cardiologico Monzino

Author	Journal	Year	Modality	Pts	n.e.	Sens	Spec
Martuscelli	Circ	2004	CT-16	96	0%	97%	100%
Schlosser	Jacc	2004	CT-16	51	0%	96%	95%
Chiurlia	Am J Card	2005	CT-16	52	0.6%	96%	100%
Salm	Am Heart J	2005	CT-16	25	0%	100%	94%
Ropers	Circ	2006	CT-64	50	0%	100%	94%
Andreini	Ann Thor Surg	2007	CT-16	96	1.9%	100%	98%
Onuma	Am Heart J	2007	CT-16	54	5.5%	100%	98%

AHA Scientific Statement

Assessment of Coronary Artery Disease by Cardiac Computed Tomography

A Scientific Statement From the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology

Matthew J. Budoff, MD, FAHA; Stephan Achenbach, MD; Roger S. Blumenthal, MD, FAHA; J. Jeffrey Carr, MD, MSCE; Jonathan G. Goldin, MD, PhD; Philip Greenland, MD, FAHA; Alan D. Guerci, MD; Joao A.C. Lima, MD, FAHA; Daniel J. Rader, MD, FAHA; Geoffrey D. Rubin, MD; Leslee J. Shaw, PhD; Susan E. Wiegers, MD

3.4.3. Follow-Up After Bypass Surgery

Numerous studies have shown that EBCT and MDCT permit assessment of coronary bypass graft occlusion and patency with high accuracy. In most studies, the accuracy to detect bypass occlusion approached 100%.[211–226] Clinically, however, it might be reasonable in most cases to not only assess the patency of the bypass graft but also the presence of coronary stenoses in the course of the bypass graft or at the anastomotic site, as well as in the native coronary artery system (**Class IIb, Level of Evidence: C**). This is more difficult, owing to the smaller caliber of these vessels, the presence of artifacts caused by metal clips, and the often pronounced coronary calcification. Recent data suggest a high sensitivity for both coronary stenosis as well as assessment of bypass patency versus occlusion. A study of 52 patients using 16-detector MDCT demonstrated 99.4% assessibility of grafts, with a sensitivity and specificity of 100% (54/54) for occlusion and 96% sensitivity and 100% specificity for detecting high-grade stenoses in patent grafts.[227] Although more data are necessary, newer scanners may have the spatial resolution to overcome some of the earlier problems with graft assessment.

Circulation. 2006;114:1761-1791.

Daniele Andreini, MD, Gianluca Pontone, MD, Giovanni Ballerini, MD, Erika Bertella, MD, Enrica Nobili, MD, Alessandro Parolari, MD, PhD, and Mauro Pepi, MD

Bypass Graft and Native Postanastomotic Coronary Artery Patency: Assessment With Computed Tomography

Table 3. Multidetector Computed Tomography Diagnostic Accuracy in Evaluating All CABG and Native Postanastomotic Coronary Arteries

	CABG	Native Coronary Arteries
Sensitivity	100%	100%
Specificity	98.5% (96.7–100%)[a]	97.7% (95.5–99.9%)[a]
Positive predictive value	96.5% (92.8–100%)[a]	85 (70.1–99.9%)[a]
Negative predictive value	100%	100%
True positive	56	19
True negative	158	179
False positive	2	3
False negative	0	0
Area under ROC	0.994	0.995

[a] 95% Confidence interval.

Centro Cardiologico Monzino

Andreini, Pontone et Al, Ann Thor Surg. 2007

Diagnostic Accuracy of Noninvasive Coronary Angiography in Patients After Bypass Surgery Using 64-Slice Spiral Computed Tomography With 330-ms Gantry Rotation

Dieter Ropers, MD; Falk-Karsten Pohle, MD; Axel Kuettner, MD; Tobias Pflederer, MD; Katharina Anders, MD; Werner G. Daniel, MD; Werner Bautz, MD; Ulrich Baum, MD; Stephan Achenbach, MD

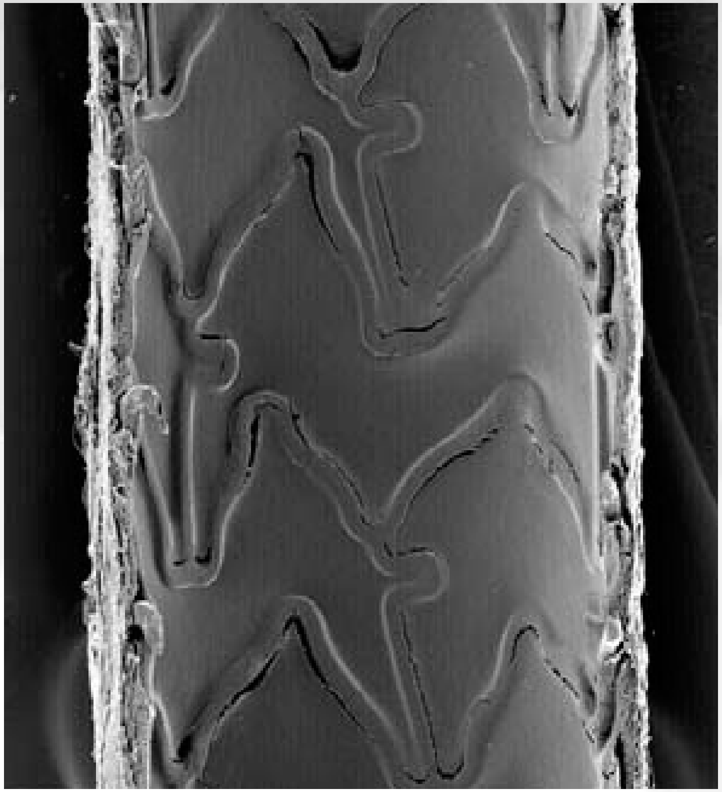
Background—Multidetector computed tomographic angiography (MDCT) has been shown to allow detection of coronary artery bypass graft (CABG) occlusions and stenoses. However, the assessment of native coronary arteries in addition to CABG has thus far not been sufficiently validated.

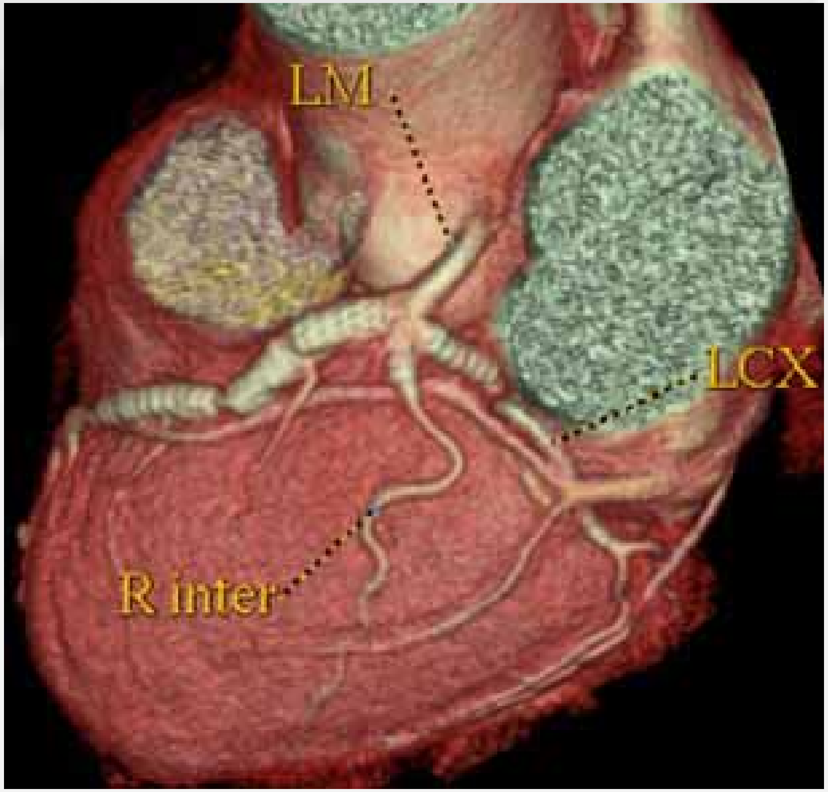
Methods and Results—Fifty patients with a total of 138 CABG (34 mammary grafts, 3 radial grafts, 101 venous grafts) were investigated by MDCT (0.6-mm collimation, 32 detector rows, 2 focal points, 330-ms rotation) 9 to 252 months (mean, 106 months) after surgery. CABG and all native coronary arteries with a diameter of >1.5 mm were evaluated for the presence of significant stenoses (≥50% diameter reduction). Results were compared with quantitative coronary angiography. By MDCT, all CABG were evaluable and were correctly classified as occluded (n=38) or patent (n=100). Sensitivity for stenosis detection in patent grafts was 100% (16/16) with a specificity of 94% (79/84). For the per-segment evaluation of native coronary arteries and distal runoff vessels, sensitivity in evaluable segments (91%) was 86% (87/101) with a specificity of 76% (354/465). If evaluation was restricted to nongrafted arteries and distal runoff vessels, sensitivity was 86% (38/44) with a specificity of 90% (302/334). On a per-patient basis, classifying patients with at least 1 detected stenosis in a CABG, a distal runoff vessel, or a nongrafted artery or with at least 1 unevaluable segment as "positive," MDCT yielded a sensitivity of 97% (35/36) and specificity of 86% (12/14).

Conclusions—We found that 64-slice MDCT permits the evaluation of bypass grafts and the assessment of the native coronary arteries for the presence of stenosis. (*Circulation*. 2006;114:2334-2341.)

Centro Cardiologico Monzino

Stent coronarici

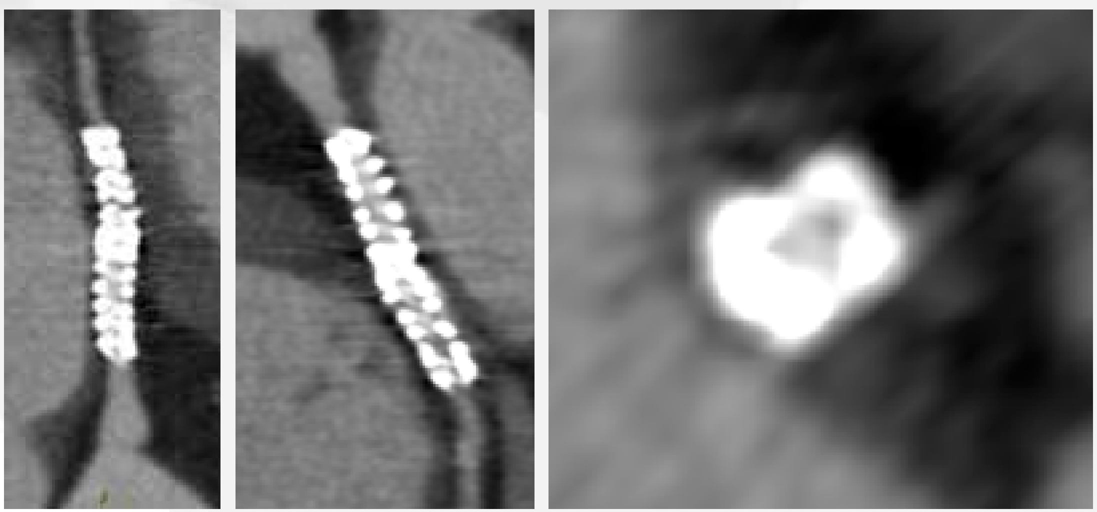




Centro Cardiologico Monzino

Artefatti causati da struttura metallica dello stent:

- -Volume parziale
- -Beam hardening



Centro Cardiologico Monzino

AHA Scientific Statement

Assessment of Coronary Artery Disease by Cardiac Computed Tomography

A Scientific Statement From the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology

Matthew J. Budoff, MD, FAHA; Stephan Achenbach, MD; Roger S. Blumenthal, MD, FAHA; J. Jeffrey Carr, MD, MSCE; Jonathan G. Goldin, MD, PhD; Philip Greenland, MD, FAHA; Alan D. Guerci, MD; Joao A.C. Lima, MD, FAHA; Daniel J. Rader, MD, FAHA; Geoffrey D. Rubin, MD; Leslee J. Shaw, PhD; Susan E. Wiegers, MD

3.4.2. Follow-Up of Percutaneous Coronary Intervention

Several smaller studies have assessed the value of EBCT and MDCT to detect restenosis after stent placement. With EBCT, 4-detector MDCT, and 16-detector MDCT, artifacts caused by the stent material prevented, in many cases, adequate visualization of the coronary lumen within the stent. Thus, in-stent restenosis could not be reliably detected in most cases.[201–206] The ability to visualize in-stent restenosis depends on stent design and material, stent size, and scanner technology.[207–209] Thus, further studies may prove that a certain combination of stent type and scanner technology may permit the detection of in-stent restenosis. In a first study performed by 64-slice CT, sensitivity for detection of in-stent restenosis was 83%, but only 8 stenoses were present in the overall study group.[210] Thus, based on current data, imaging of patients to follow up stent placement cannot be recommended (**Class III, Level of Evidence: C**).

Circulation. 2006;114:1761-1791.

Journal of the American College of Cardiology
© 2007 by the American College of Cardiology Foundation
Published by Elsevier Inc.
Vol. 49, No. 22, 2007
Cardiac Imaging

Usefulness of 64-Slice Multislice Computed Tomography Coronary Angiography to Assess In-Stent Restenosis

Filippo Cademartiri, MD, PhD,*† Joanne D. Schuijf, MSc,‡§ Francesca Pugliese, MD,*

Results A total of 14 (7.3%) stented segments were excluded because of poor image quality. In the interpretable stents, 20 of the 178 (11.2%) evaluated stents were significantly diseased, of which 19 were correctly detected by 64-slice MSCT. Accordingly, sensitivity, specificity, and positive and negative predictive value to identify in-stent restenosis in interpretable stents were 95.0% (95% confidence interval [CI] 85% to 100%), 93.0% (95% CI 90% to 97%), 63.3% (95% CI 46% to 81%), and 99.3% (95% CI 98% to 100%), respectively.

Conclusions In-stent restenosis can be evaluated with 64-slice MSCT with good diagnostic accuracy. In particular, a high negative predictive value of 99% was observed, indicating that 64-slice MSCT may be most valuable as a noninvasive method of excluding in-stent restenosis. (J Am Coll Cardiol 2007;49:2204–10) © 2007 by the American College of Cardiology Foundation

Journal of the American College of Cardiology
© 2007 by the American College of Cardiology Foundation
Published by Elsevier Inc.
Vol. 49, No. 9, 2007
ISSN 0735-1097/07/$32.00
doi:10.1016/j.jacc.2006.10.065

Diagnostic Accuracy of Coronary In-Stent Restenosis Using 64-Slice Computed Tomography

Comparison With Invasive Coronary Angiography

Mariko Ehara, MD, Masato Kawai, RT, Jean-François Surmely, MD, Tetsuo Matsubara, MD,

Results By ICA, 24 ISRs were diagnosed. Sensitivity, specificity, positive predictive value, and negative predictive value were 92%, 81%, 54%, and 98% for the overall population, whereas values were 91%, 93%, 77%, and 98% when excluding unassessable segments (15 segments, 12%). For assessable segments, CTCA correctly diagnosed 20 of the 22 ISRs detected by ICA. Six lesions without ISR were overestimated as ISR by CTCA. As the grade of neointimal proliferation by CTCA increases, the median value of percent diameter stenosis increased linearly.

Conclusions Binary ISR can be excluded with high probability by CTCA, with a moderate rate of false-positive results. (J Am Coll Cardiol 2007;49:951–9) © 2007 by the American College of Cardiology Foundation

Comparison of Feasibility and Diagnostic Accuracy of 64-Slice Multidetector Computed Tomographic Coronary Angiography Versus Invasive Coronary Angiography Versus Intravascular Ultrasound for Evaluation of In-Stent Restenosis

Daniele Andreini, MD*, Gianluca Pontone, MD, Antonio L. Bartorelli, MD, Daniela Trabattoni, MD, Saima Mushtaq, MD, Erika Bertella, MD, Andrea Annoni, MD, Alberto Formenti, MD, Sarah Cortinovis, MD, Piero Montorsi, MD, Fabrizio Veglia, PhD, Giovanni Ballerini, MD, and Mauro Pepi, MD

- **100 pazienti: MDTC, QCA**
- **24 pazienti: IVUS**
- **179 stent, Ø medio: 3,14 ± 0,59 mm**
- **Età 64 ± 10 anni**
- **88 M, 12 F**
- **FC 58 ± 9 bpm**
- **Seloken ev: 76 pazienti**
- **Dose media (mg): 13,4 ± 5,7**

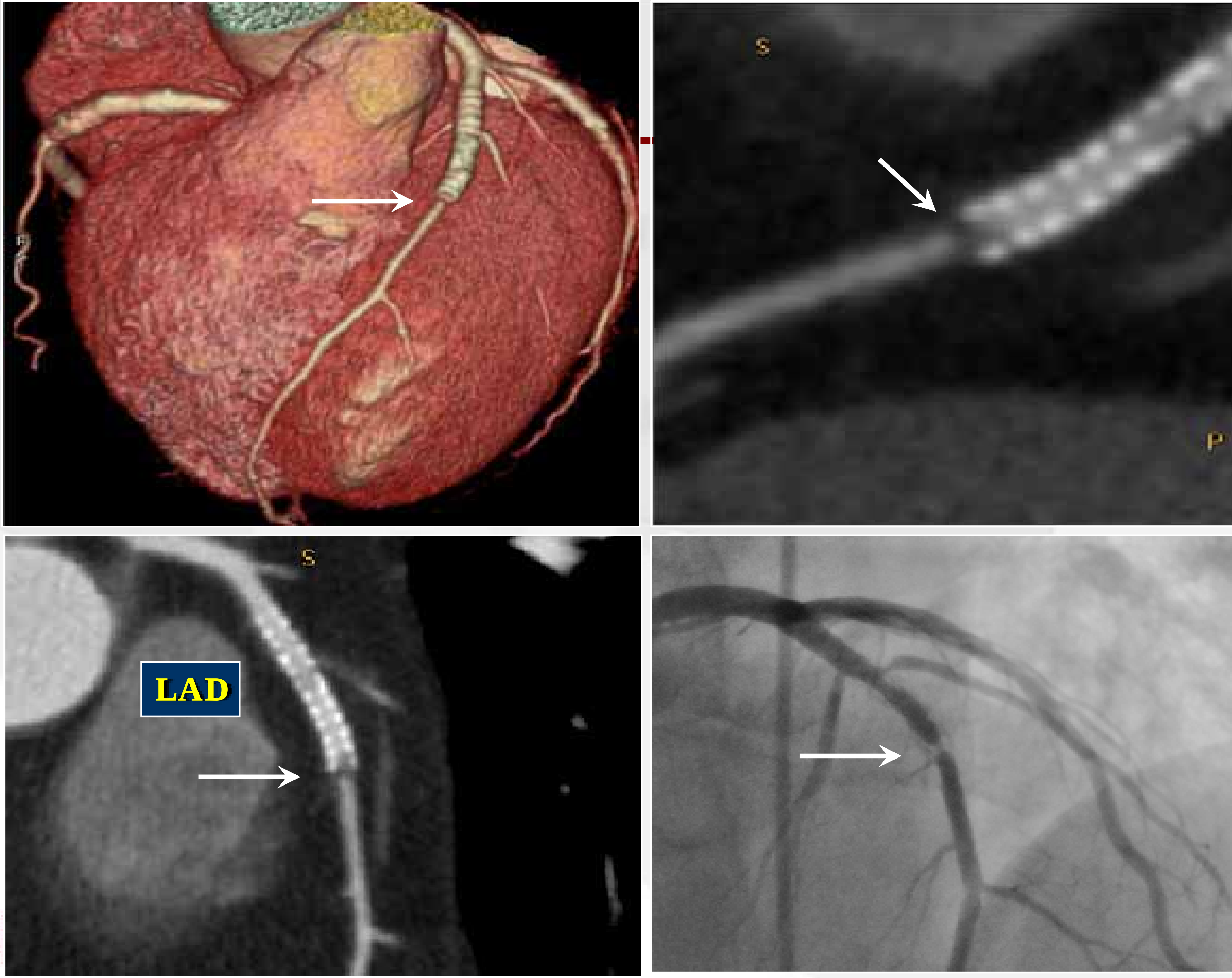
Andreini D, Pontone G. et al, Am J cardiol 2009

179 segmenti: 128 VN, 34 VP, 3 FP, 5 FN, 9 NV

	Segment-based analysis	Patient-based analysis
Feasibility	95%	91%
Sensitivity	87%	85%
Specificity	98%	96%
PPV	92%	93%
NPV	96%	92%
Accuracy	95%	92%

Centro Cardiologico Monzino

Andreini D, Pontone G. et al, Am J cardiol 2009


S
P
S
LAD

Multidetector Computed Tomography Coronary Angiography for the Assessment of Coronary In-Stent Restenosis

Daniele Andreini, MD*, Gianluca Pontone, MD, Saima Mushtaq, MD, Mauro Pepi, MD, and Antonio Luca Bartorelli, MD

Pre-specified inclusion criteria:

1) English language literature
2) Prospective or retrospective studies
3) Human studies

Studies that did not report raw numbers of diagnostic accuracy for the detection of in-stent restenosis (ISR) were excluded.

The data of 24 studies are reported, 6 performed with old generation scanners (4-16-40-slice MDCT) and 18 performed with 64-slice MDCT or DSCT

Centro Cardiologico Monzino

Andreini, Pontone et al, Am J Cardiol 2010

Table 2. Technical background, data acquisition and effective dose of 64-slice computed tomography for the detection of in-stent restenosis

Authors	Journal (Y)	Brand	Source	Number of Slices/Slice Thickness (mm)	Gantry Rotation Time (msec)	Tube Current (mAs)	Tube Voltage (KVp)	β-blockade/Nit rates	ECG Gating	Modulation Dose	Contrast Agent Protocol	Sharp Kernel	Type of analysis	Effective Radiation Dose (mSv)
Rixe et al. (17)	EHJ (06)	Siemens	Single	32x2/0.6	330	850	120	Or-IV/Yes	Retrospective	Yes (34 pts)	Test Bolus	No	Qualitative	NR
Van Mieghem et al. (18)	Circ (06)	Siemens	Single	32x2/0.6 (43 pts)	330	900	120 Kv	Or/No	Retrospective	No	Bolus Tracking	Yes	Semi-quantitative Quantitative	15.2-21.4
Rist et al. (5)	Ac R (06	Siemens	Single	32x2/0.6	330	850	120	IV/No	Retrospective	Yes	Bolus Tracking	Yes	Semi-quantitative	8-10
Oncel et al. (19)	Rad (07)	Siemens	Single	32x2/0.6	330	900	120	IV/Yes	Retrospective	No	Bolus Tracking	Yes	Qualitative	NR
Ehara et al. (20)	JACC (07)	Siemens	Single	32x2/0.6	330	800	120	Or/Yes	Retrospective	No	Bolus Tracking	Yes	Semi-quantitative	12.1
Cademartiri et al. (21)	JACC (07)	Siemens Toshiba	Single Single	32x2/0.6 64/0.5	330 400	900 712	120 120	Or/No	Retrospective Retrospective	No No	Bolus Tracking	Yes Yes	Quantitative	15-20
Carabba et al. (22)	AJC (07)	Philips	Single	64/0.6	400	600-850	120	No/No	Retrospective	No	Bolus Tracking	No	Quantitative	12.8±2.3
Das et al. (23)	Rad (07)	Siemens	Single	64/0.6	370	750-850	120	Or-IV/No	Retrospective	No	Bolus Tracking	Yes	Semi-quantitative	NR
Schuijf et al (8)	Rad (07)	Toshiba	Single	64/0.5	400-500	350	120	No/No	Retrospective	Yes	Bolus Tracking	Yes	Semi-quantitative	10-15
Pugliese et al. (24)	Heart (08)	Siemens	Dual	32x2/0.6	330	412	120	No/No	Retrospective	Yes	Bolus Tracking	Yes	Quantitative	12.1–16.7
Oncel et al. (25)	AJR (08)	Siemens	Dual	32x2/0.6	330	390	120	No/Yes	Prospective	No	Bolus Tracking	Yes	Semi-quantitative	12.3
Carbone et al. (26)	Eur R (08)	Siemens	Single	32x2/0.6	330	800	120	Or/No	Retrospective	No	Bolus Tracking	Yes	Semi-quantitative	15.0
Manghat et al. (27)	AJC (08)	GE	Single	64/0.6	350	900	120	Or/No	Retrospective	No	Bolus Tracking	Yes	Semi-quantitative	NR
Hecht et al. (28)	AJC (08)	Philips	Single	64/0.6	-	600-1000	120-140	Or-IV/No	Retrospective	No	Bolus Tracking	Yes	Qualitative Quantitative	13-18
Nakamura et al (7)	IJC (08)	GE	Single	64/0.6	350	300-750	120	Or/No	Retrospective	Yes	Bolus Tracking	Yes	Qualitative	NR
Andreini et al. (29)	AJC (09)	GE	Single	64/0.6	350	650	120	IV/No	Retrospective	Yes	Bolus Tracking	Yes	Semi-quantitative Quantitative	NR
Pontone et al. (30)	JACC (09)	GE	Single	64/0.6	350	700	120	IV/No	Retrospective Prospective	Yes Yes	Bolus Tracking	Yes Yes	Quantitative	5.7 20.5
Pflederer et al. (31)	AJC (09)	Siemens	Dual	64x2/0.6	330	400	120	Or-IV/Yes	Retrospective	Yes	Test Bolus	Yes	Semi-quantitative	14.8±4.8

Or: oral administration; IV: intravenous administration; NR: not reported.

Centro Cardiologico Monzino

Andreini, Pontone et al, Am J Cardiol 2010

Table 4. Diagnostic performance of 64-slice computed tomography

Author	Journal (Y)	Number of patients/stents	Not evaluable (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Acc (%)
Rixe et al. (17)	E H J (06)	64/102	42 (43/102)	86 (6/7)	98 (51/52)	86 (6/7)	98 (51/52)	97 (57/59)
Van Mieghem et al. (18)	Circ (06)	70/162	-	100 (10/10)	91 (55/60)	67 (10/15)	100 (55/55)	93 (65/70)
Rist et al. (5)	Ac R (07)	25/46	2 (1/46)	75 (6/8)	92 (34/37)	67 (6/9)	94 (34/36)	89 (40/45)
Oncel et al. (19)	Rad (07)	30/39	0 (0/39)	89 (17/19)	95 (19/20)	94 (17/18)	90 (19/21)	92 (36/39)
Ehara et al. (20)	JACC (07)	81/125	12 (15/125)	91 (20/22)	93 (82/88)	77(20/26)	98 (82/84)	93 (102/110)
Cademartiri et al. (21)	JACC (07)	182/192	7 (14/192)	95 (19/20)	93 (147/158)	63 (19/30)	99 (147/148)	93 (166/178)
Carrabba et al (22)	AJC (07)	41/87	0 (0/87)	84 (11/13)	97 (73/74)	92 (11/12)	97 (73/75)	96 (84/87)
Das et al. (23)	Rad (07)	53/110	2.7 (3/110)	97 (31/32)	88 (66/75)	77 (31/40)	98 (66/67)	91 (96/107)
Schuijf et al (8)	Rad (07)	50/76	14 (11/76)	100 (6/6)	100 (52/52)	100 (6/6)	100 (52/52)	100 (58/58)
Pugliese et al. (24)	Heart (08)	100/178	5 (9/178)	94 (37/39)	92 (128/130)	77 (37/48)	98 (128/130)	98 (165/169)
Oncel et al. (25)	AJR (08)	35/48	15 (7/48)	100 (17/17)	94 (29/31)	89 (17/19)	100 (29/29)	96 (46/48)
Carbone et al. (26)	Eur R (08)	41/74	19.5(21/74)	75(12/16)	86(32/37)	71 (11/14)	89(32/36)	83 (44/53)
Manghat et al. (27)	AJC (08)	40/114	9.6 (11/114)	85 (17/20)	86 (68/79)	61 (17/28)	96 (68/71)	83 (85/103)
Hecht et al. (28)	AJC (08)	67/132	0 (0/132)	94 (16/17)	74 (85/115)	39 (16/46)	99 (85/86)	77 (101/132)
Nakamura et al. (7)	IJC (08)	49/75	14.6 (11/75)	67 (2/3)	92 (56/61)	29 (2/7)	98 (56/57)	91 (58/64)
Andreini et al. (29)	AJC (09)	100/179	5 (9/179)	87 (34/39)	98(128/131)	92 (35/38)	96 (128/133)	95 (162/170)
Pontone et al. (30)	JACC (09)	*80/48 #80/66	8 (4/48) 6 (4/66)	92 (11/12) 73 (8/11)	94 (30/32) 96 (49/51)	85 (11/13) 80 (8/10)	97 (30/31) 94 (49/52)	93 (41/44) 92 (57/62)
Pflederer et al. (31)	AJC (09)	112/150	10 (15/150)	84 (16/19)	95 (110/116)	73 (16/22)	97 (110/113)	93 (126/135)
Total	-	1300/2003	9.6 (178/1841)	89.7 (296/330)	92.2 (1294/1399)	72.5 (296/408)	97.4 (1294/1328)	91.9 (1590/1729)

Centro Cardiologico Monzino

Andreini, Pontone et al, Am J Cardiol 2010

Feasibility and Image Quality

Stent Diameter: - *Andreini (<3 mm;≥3 mm)*
- *Rixe (3.28 mm vs 3.03)*
- *Oncel (<3 mm;≥3 mm)*
- *Oncel (<3 mm;≥3 mm)*
- *Carbone (<3 mm;≥3 mm)*
- *Pflederer (3.3 mm vs. 3 mm)*
- *Pugliese (< 2.75 mm)*

Strut thickness: - *Rixe (<100 µm; >100 µm)*
- *Andreini (<100 µm; >100 µm)*

Stent Material: - *Oncel (Cobalto Cromo)*
- *Maintz (Cobalto Cromo)*
- *Maintz (Tantalum)*

Overlapping: - *Schuijf*

Heart rate: - *Ehara (<60 bpm; ≥60bpm)*
- *Andreini (<60 bpm; ≥60bpm)*
- *Schuijf (55 bpm vs 72 bpm)*

Centro Cardiologico Monzino

Andreini, Pontone et al, Am J Cardiol 2010

Diagnostic Accuracy

Stent Diameter: *- Andreini (<3 mm;≥3 mm)*
- Manghat (<3 mm;≥3 mm)
- Carbone (<3 mm;≥3 mm)
- Pugliese (<3 mm;≥3 mm)

Strut thickness: *- Carbone (<100 μm; >100 μm)*
- Andreini (<100 μm; >100 μm)

Stent Material: *- Andreini (Cobalto Cromo)*

Overlapping: *- Pugliese*
- Andreini

Centro Cardiologico Monzino

Andreini, Pontone et al, Am J Cardiol 2010

PROGNOSTIC VALUE OF MDCT

Journal of the American College of Cardiology

Published by Elsevier Inc.

Vol. 49, No. 1, 2007
ISSN 0735-1097/07/$32.00
doi:10.1016/j.jacc.2006.07.070

Cardiac Imaging

Prognostic Value of Multislice Computed Tomography Coronary Angiography in Patients With Known or Suspected Coronary Artery Disease

Gabija Pundziute, MD,*† Joanne D. Schuijf, MSc,*‡ J. Wouter Jukema, MD, PhD,*‡
Eric Boersma, PhD,§ Albert de Roos, MD, PhD,‖ Ernst E. van der Wall, MD, PhD,*‡
Jeroen J. Bax, MD, PhD*

Leiden, Utrecht, and Rotterdam, the Netherlands; and Kaunas, Lithuania

A total of 100 patients (73 men, age 59 ± 12 years) who were referred for further cardiac evaluation due to suspicion of significant CAD underwent additional MSCT coronary angiography to evaluate the presence and severity of CAD. Patients were followed up for the occurrence of: 1) cardiac death, 2) nonfatal myocardial infarction, 3) unstable angina requiring hospitalization, and 4) revascularization.

Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT

Table 4 Multivariate Predictors of Events, Corrected for Baseline Variables

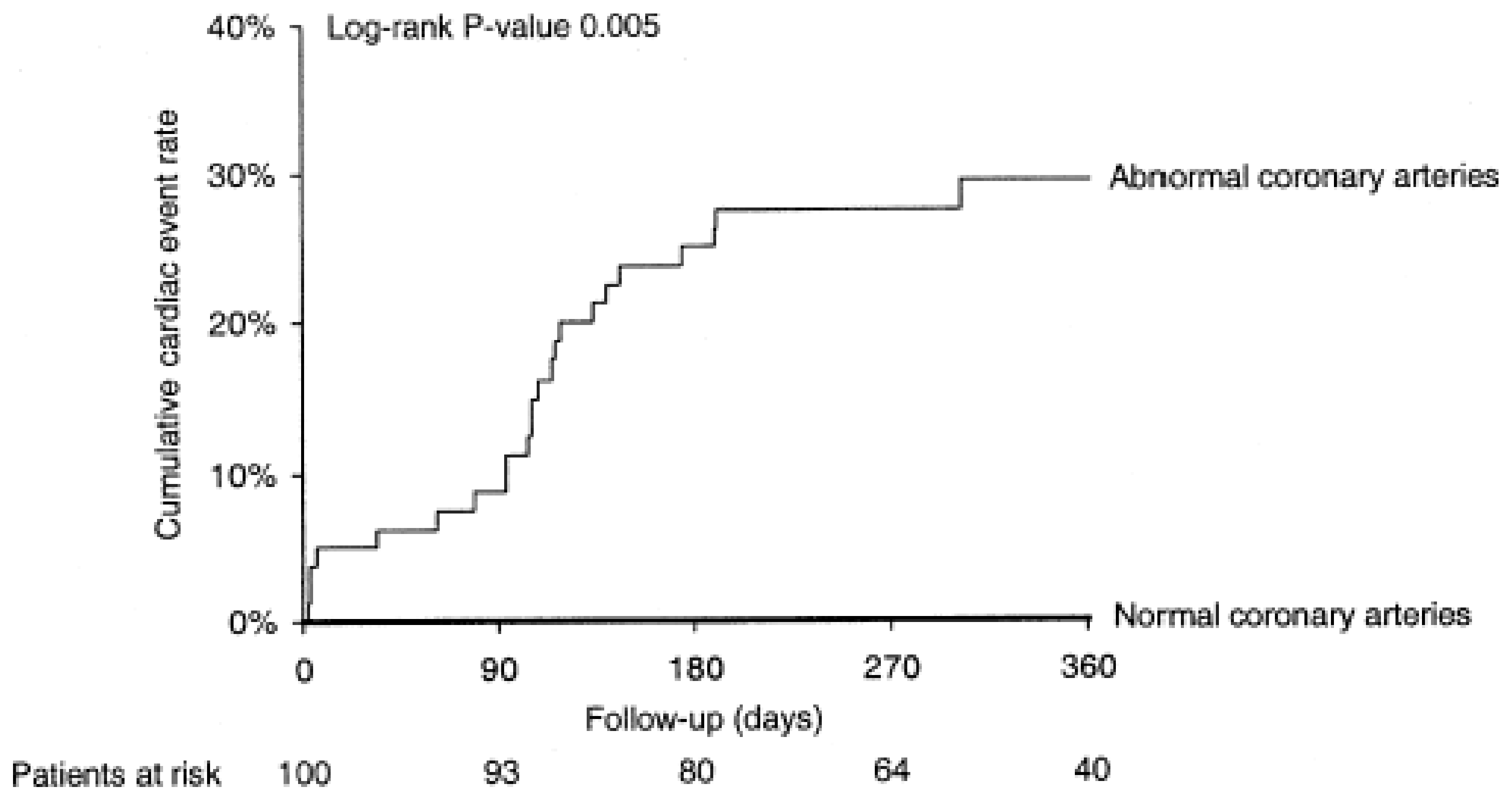
MSCT Characteristics	Multivariate	p Value
Presence of coronary plaques on MSCT ←	8.8 (1.1–70)	0.04
Obstructive CAD	28 (3.3–239)	0.002
Obstructive CAD in LM/LAD	35 (4.3–288)	0.0009
Segments with plaques* ←	1.3 (1.1–1.6)	0.0009
Segments with obstructive plaques*	1.8 (1.5–2.2)	<0.0001
Segments with mixed plaques* ←	1.6 (1.2–2.0)	0.0003

Data are Cox's proportional hazard ratios (95% confidence intervals). *Ratio per segment. Abbreviations as in Tables 1 and 3.

Centro Cardiologico Monzino

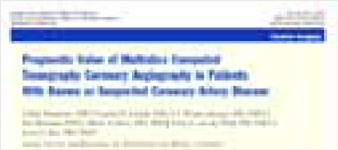
PROGNOSTIC VALUE OF MDCT

Abnormal patients: presence of ≥ 1 coronary plaque



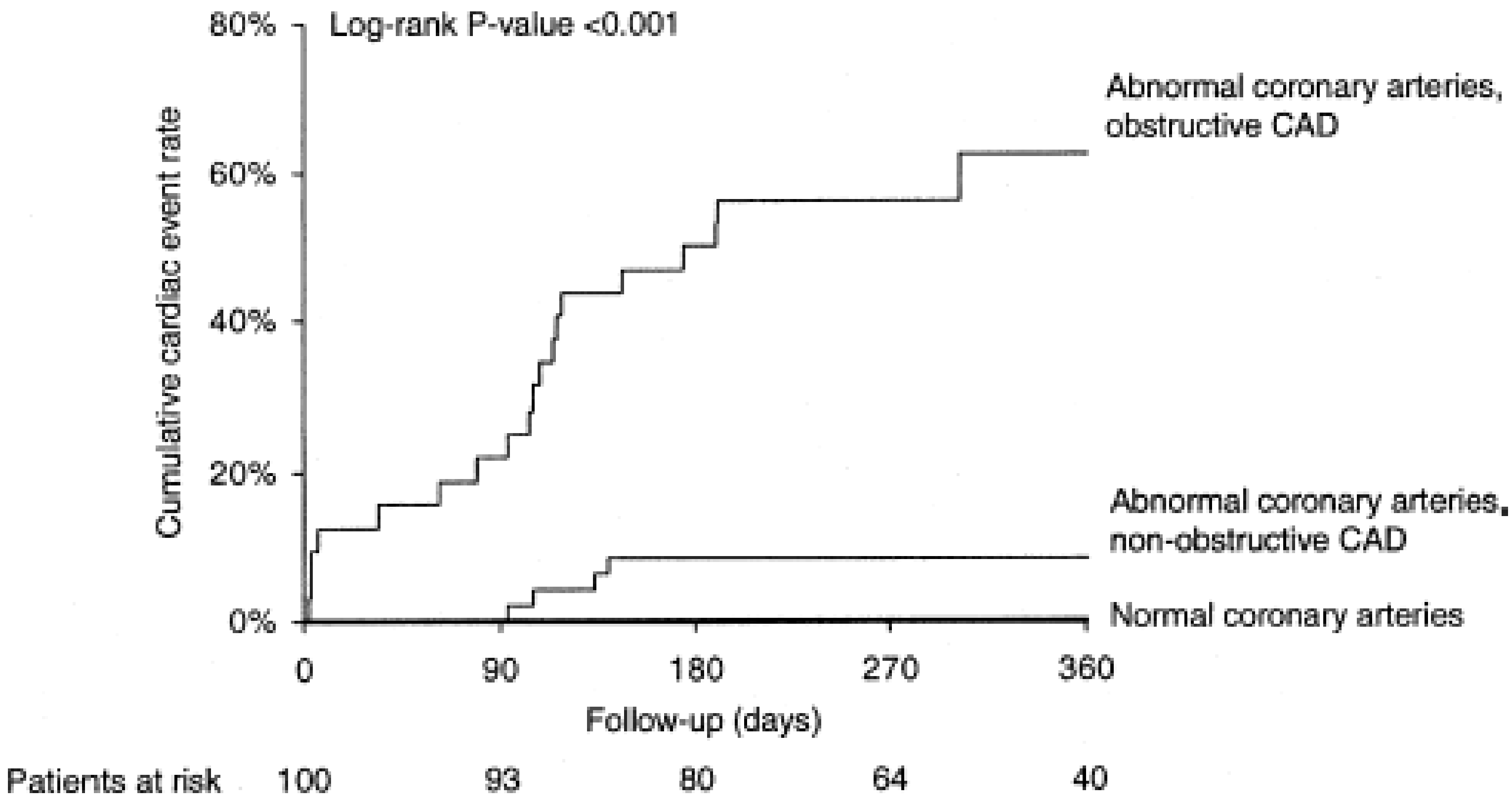
Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT



Non obstructive CAD: 0-50%

Obstructive CAD: ≥ 50%



Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT

Journal of the American College of Cardiology
Published by Elsevier Inc.
Vol. 50, No. 12, 2007
ISSN 0735-1097/07/$32.00
doi:10.1016/j.jacc.2007.03.067

Cardiac Imaging

Prognostic Value of Multidetector Coronary Computed Tomographic Angiography for Prediction of All-Cause Mortality

James K. Min, MD,*† Leslee J. Shaw, PHD,‡ Richard B. Devereux, MD,* Peter M. Okin, MD,* Jonathan W. Weinsaft, MD,* Donald J. Russo, MD,† Nicholas J. Lippolis, MD,† Daniel S. Berman, MD,‡ Tracy Q. Callister, MD†

New York, New York; Hendersonville, Tennessee; and Los Angeles, California

We examined a single-center consecutive cohort of 1,127 patients ≥45 years old with chest symptoms. Stenosis by CCTA was scored as minimal (<30%), mild (30% to 49%), moderate (50% to 69%), or severe (≥70%) for each coronary artery. Plaque was assessed in 3 ways: 1) moderate or obstructive plaque; 2) CCTA score modified from Duke coronary artery score; and 3) simple clinical scores grading plaque extent and distribution. A 15.3 ± 3.9-month follow-up of all-cause death was assessed using Cox proportional hazards models adjusted for pretest CAD likelihood and risk factors. Deaths were verified by the Social Security Death Index.

Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT

Duke Prognostic CAD Index which details the expected 5-year survival by the "extent" and "severity" of CAD

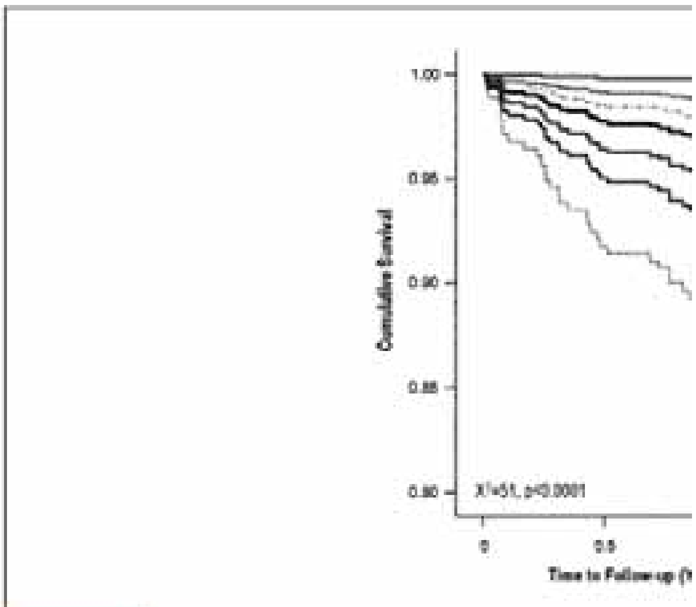


Figure 6 Cumulative Survival in Patients Exhibiting F

Risk-adjusted p < 0.001 (controlling for age, family history, and dysl

None or Mild (<50%) Plaque (n=422)

≥2 Mild (30%-49%) Plaque with Proximal Plaque in 1 Artery (n=64), p=0.192

1 Moderate (50%-69%) Plaque (n=212), p=0.065

2 Moderate (50%-69%) Plaque or 1 Severe (≥70%) Plaque (n=101), p=0.013

3 Moderate (50%-69%) Plaque or 2 Severe (≥70%) Plaque or Severe (≥70%) Proximal LAD Plaque (n=145), p=0.002

3 Severe (≥70%) Stenoses or 2 Severe (≥70%) Stenoses with Proximal LAD (n=86), p=0.001

Moderate or Severe (≥50%) Left Main Plaque (n=106), p<0.0001

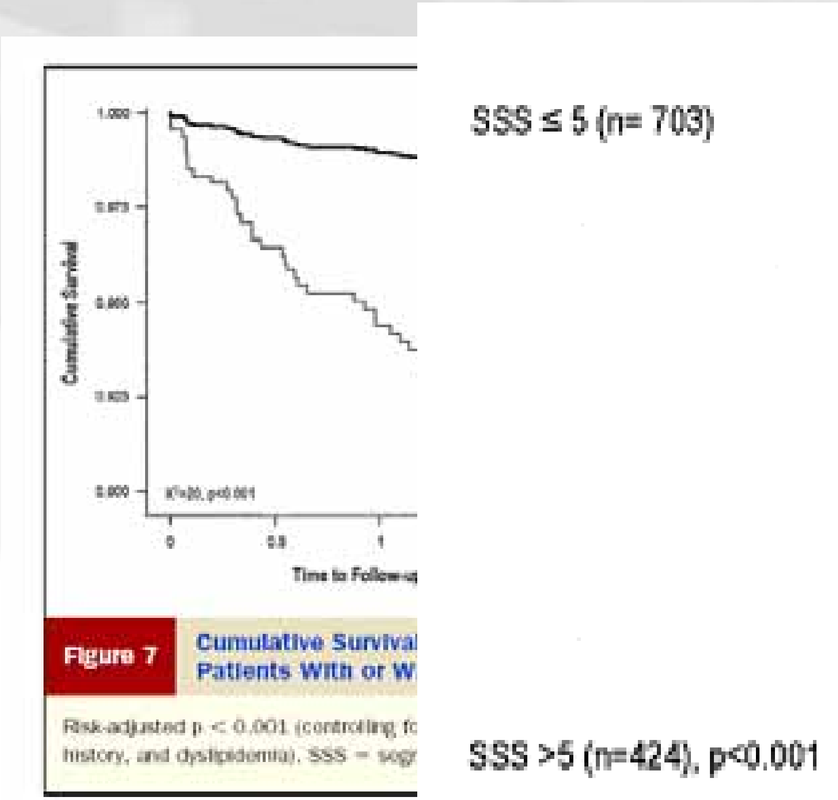
Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT

Segment Stenosis Score

0 → 3 for each segment

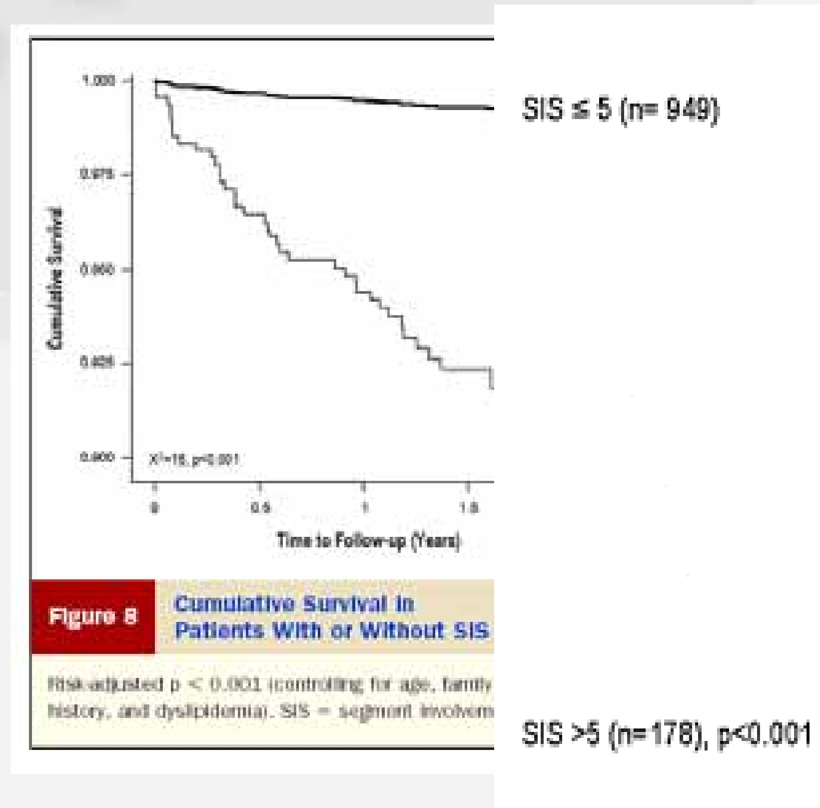
Total Score: 0 → 48



Segment Involvement Score

segments exhibiting plaque, irrespective of the degreee of stenosis

Total Score: 0 → 16



Centro Cardiologico Monzino

PROGNOSTIC VALUE OF MDCT

" Vulnerable plaques may occur across the full spectrum of severity of stenosis, underlining that also nonobstructive lesions may contribute to coronary events "

Giroud D Am J Cardiol 1992; Davies MJ Br Heart J 1985

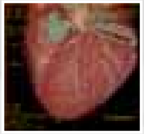
" … 68% of myocardial infarctions were attributable to so-called angiographically silent lesions (narrowing<50%), whereas only 14% could be assigned to a severe stenotic lesion (>70%)…"

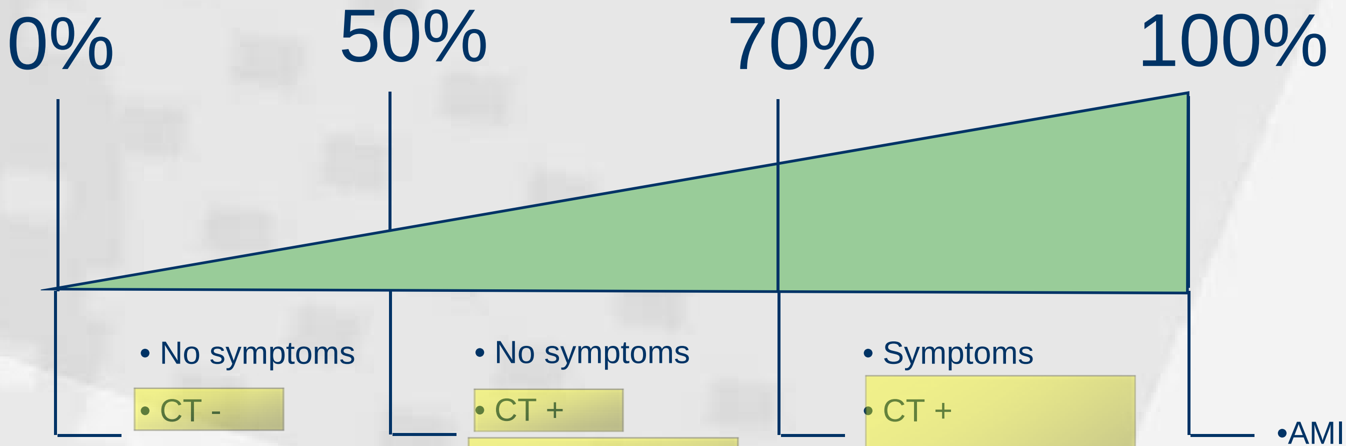
Falk E Circulation 1995

Centro Cardiologico Monzino

CONCLUSIONS

Patient





- No symptoms
- CT -
- Stress Test –
- Good prognosis
- No therapy

- No symptoms
- CT +
- Stress Test –
- Worse prognosis
- Therapy (?)

- Symptoms
- CT +
- Stress Test +
- Worse prognosis
- Therapy

Early identification of these patients could be crucial:
- to reduce the cardiovascular risk factor
- to decide the exact timing of follow-up
- to optimize medical therapy
- to optimize revascularization therapy (?)

Centro Cardiologico Monzino

Journal of Cardiovascular Computed Tomography (2009) 3, 224–232

Journal of Cardiovascular Computed Tomography

Original Research Article

International, multidisciplinary update of the 2006 Appropriateness Criteria for cardiac computed tomography

Salvatore Carbonaro, MD, MS[a,*], Todd C. Villines, MD[a], Jörg Hausleiter, MD[b], Patrick J. Devine, MD[a], Thomas C. Gerber, MD[c], Allen J. Taylor, MD[a]

Table 3 Proposed new clinical indications for CCT

New clinical indication	No. of raters proposing, n (%)
Use of CCTA for CAD evaluation before valve surgery	11 (25.5)
Anatomical assessment before percutaneous device closure of ASD or VSD or percutaneous aortic valve replacement	9 (20.9)
Use of CCTA in the evaluation of complex lesions before PCI (ie, chronic total occlusions, bifurcating lesions)	7 (16.2)
Assessment of myocardial viability by late enhancement	6 (13.9)
Assessment of RV function and morphology (in suspected ARVD and pulmonary embolism)	6 (13.9)
Myocardial perfusion assessment	5 (11.6)
Coronary plaque characterization	4 (9.3)
Evaluation of unknown graft anatomy before conventional coronary angiography or PCI	2 (4.6)
Evaluation of pacer lead placement	2 (4.6)
In lieu of serial invasive coronary angiography following heart transplantation	1 (2.3)
Other miscellaneous	9 (20.9)

Total number of experts submitting proposed new indications was 43. ASD, atrial septal defect; VSD, ventricular septal defect; PCI, percutaneous coronary intervention; RV, right ventricular; ARVD, arrhythmogenic right ventricular dysplasia.

EuroIntervention

Computed Tomography in Total coronary Occlusions (CTTO Registry): radiation exposure and predictors of successful percutaneous intervention

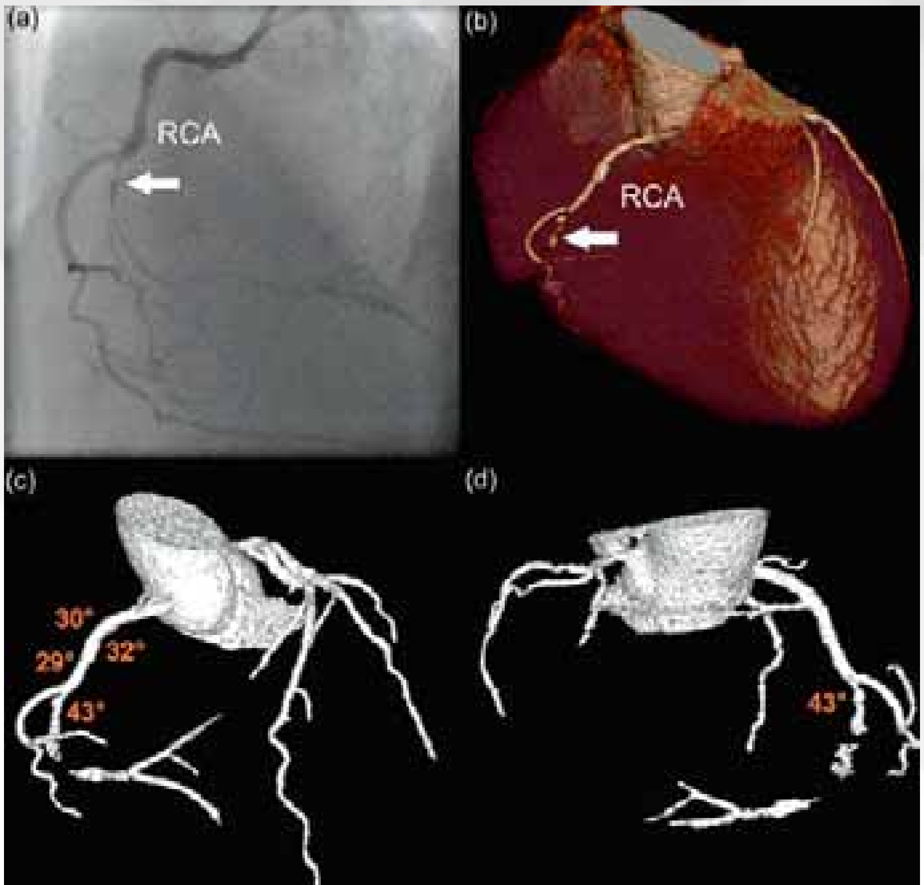
Héctor M. García-García[1], MD, MSc; Carlos A.G. van Mieghem[1], MD; Nieves Gonzalo[1], MD; Willem B. Meijboom[1], MD; Annick C. Weustink[1], MD; Yoshinobu Onuma[1], MD; Nico R. Mollet[1], MD, PhD; Carl Johann Schultz[1], MD; Emanuele Meliga[1], MD; Martin van der Ent[1], MD, PhD; Giorgios Sianos[1], MD, PhD; Dick Goedhart[2], PhD; Ad den Boer[1], PhD; Pim de Feyter[1], MD, PhD; Patrick W. Serruys[1]*, MD, PhD

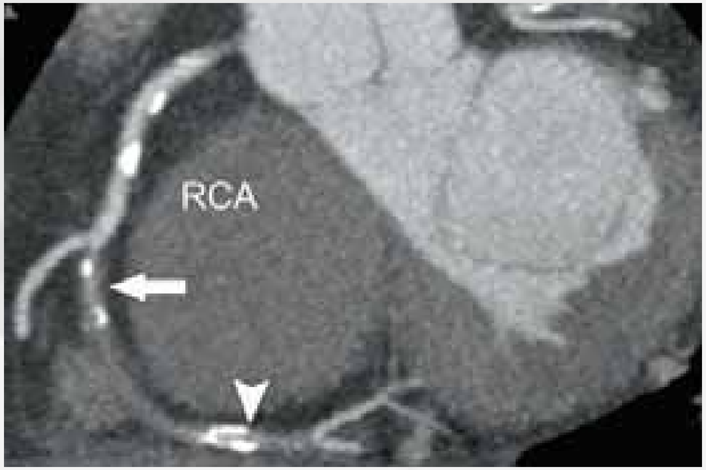
142 CTOs: overall success rate 63%

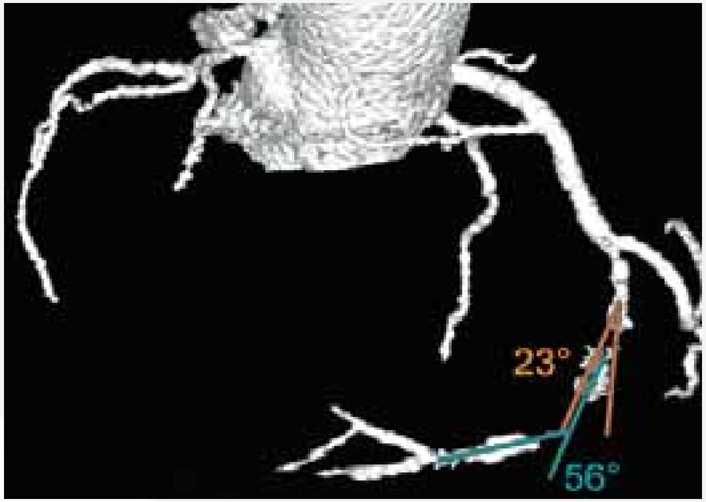
	Successful cases	Failed cases	P
Occlusion length	24.9 mm	30.7 mm	0.1
Patients with occlusion length > 15 mm	63%	87%	0.02
Severe calcification	36%	55%	0.03
Calcification at the entry of the occlusion	41%	58%	0.04
Length of calcification	5.5 mm	8.5 mm	0.02

Analisi multivariata: unico predittore indipendente di successo procedurale: assenza di severe calcificazioni alla TC

The mean effective radiation dose of the PCI was 39.3±30.1 mSv. The mean effective radiation dose of CT scan was 22.4 mSv: 19.2±6.5 mSv for contrast-enhanced scan, 3.2±1.7 mSv for calcium scoring scan. **Conclusions:** More severe calcified patterns, as assessed by CTCA, are seen in failed cases. The radiation exposure during a CT scan prior to a CTO PCI is considerable, and further studies are required to determine whether this extra diagnostic study is warranted.







Novel method for real-time hybrid cardiac CT and coronary angiography image registration: visualising beyond luminology, proof-of-concept

Ariel Roguin[1,2]*, MD, PhD; Sobhi Abadi[2], MD; Ahuva Engel[2,3], MD; Rafael Beyar[1,3], MD, DSc

1. Division of Invasive Cardiology, Rambam Medical Center, Haifa, Israel; 2. Medical Imaging Department, Rambam Medical Center, Haifa, Israel; 3. Bruce Rappaport Faculty of Medicine, the Technion, Israel Institute of Technology, Haifa, Israel

Modello 3D TC costruito da AngioCt utilizzando immagini assiali a partire dalla center line del vaso studiato. Immagini TC ed angio sincronizzate in fase diastolica nella stessa proiezione

L'operatore, grazie alla presenza di markers, può scrollare l'immagine angiografica lungo la centerline e visualizzare parete vasale e composizione di placca sulle MPR TC

Centro Cardiologico Monzino

Dose Comparison

•Chest radiographs – 2 views		0.08 mSv
•Mammogram		0.15-0.40 mSv
•Natural Background (Annual)		3-3.6 mSv
•Nuclear		
	Tc-99m (rest only)	4 – 5 mSv
	Tc-99m (rest+stress)	9 – 13 mSv
	Tl-201 (rest+stress)	~34 mSv
•CT		
	Coronary Angio w/ ECG mod	9.5 – 27.8 mSv
	Calcium Scoring	1-3 mSv
•Diagnostic Cat		6-10 mSv

C Mc Collough Radiology 2007
E L Nickoloff Brit J Radiol 2007
JF Paul Eur Radiol 2007
J Hausleiter Circulation 2006
D Coles JACC 2006
X Fei Eur J Radiol 2007
M Francone Radiol Med 2007
S Mori Eur J radiol 2007

RADIOLOGICAL RISK OF MDCT

Cardiovascular Ultrasound

Review

Economic and biological costs of cardiac imaging

Eugenio Picano*

Open Access

Estimating Risk of Cancer Associated With Radiation Exposure From 64-Slice Computed Tomography Coronary Angiography

Andrew J. Einstein, MD, PhD
Milena J. Henzlova, MD, PhD
Sanjay Rajagopalan, MD

JAMA. 2007;298(3):317-323

LAR (M, 80 y): 0.075%
1 pts in 3261

LAR (F, 20 y): 0.7%
1 pts in 143

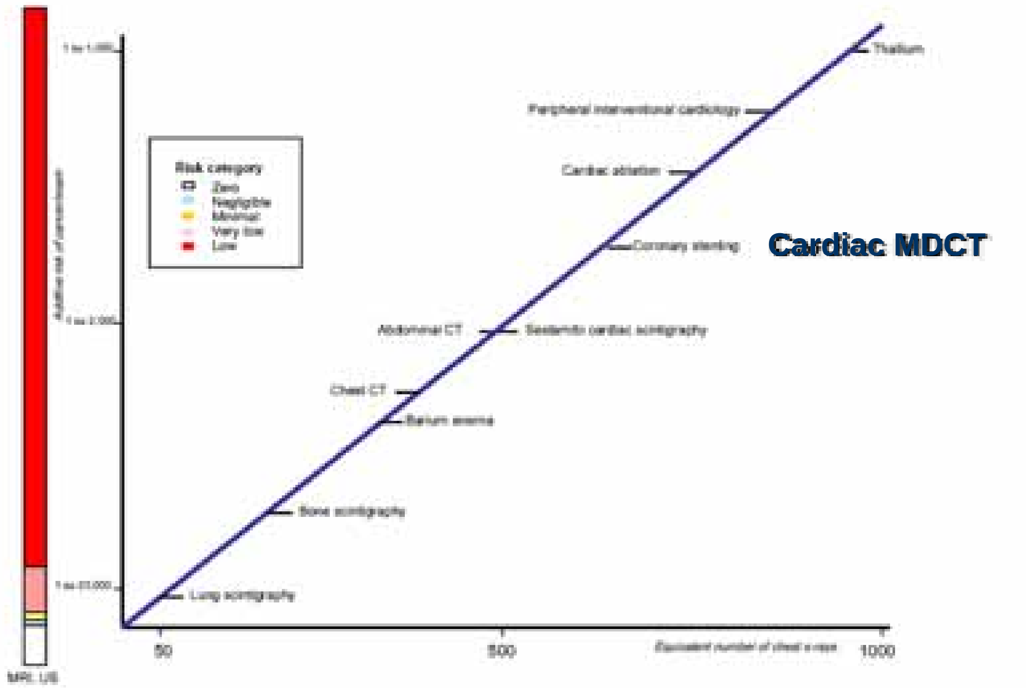


Figure 2
Presentation of cancer risk and radiation dose (in multiples of dose from a simple chest x rays) for some common radiological and nuclear medicine examinations (Modified from Picano E. ref. 37)

Centro Cardiologico Monzino

RADIATION EXPOSURE SOLUTIONS

ALARA Pri...

AUTHOR
Abada H et al
Stolzmann P et al.
Mori S et al.*
Rybicki FJ et al
Pontone G et al

Radiation Dose From Cardiac Computed Tomography Before and After Implementation of Radiation Dose–Reduction Techniques

Gilbert L. Raff, MD
Kavitha M. Chinnaiyan, MD
David A. Share, MD, MPH
Tauqir Y. Goraya, MD, PhD
Ella A. Kazerooni, MD
Mauro Moscucci, MD
Ralph E. Gentry, RT
Aiden Abidov, MD, PhD
for the Advanced Cardiovascular Imaging Consortium Co-Investigators

Context Cardiac computed tomography angiography (CCTA) can accurately diagnose coronary artery disease, but radiation dose from this procedure is of concern.

Objectives To determine whether a collaborative radiation dose–reduction program would be associated with reduced radiation dose in patients undergoing CCTA in a statewide registry over a 1-year period and to define its effect on image quality.

Design, Setting, and Patients A prospective, controlled, nonrandomized study conducted during a control period (July-August 2007), an intervention period (September 2007-April 2008), and a follow-up period (May-June 2008) at 15 hospital imaging centers participating in the Advanced Cardiovascular Imaging Consortium in Michigan, which included small community hospitals and large academic medical centers. A total of 4995 sequential patients undergoing CCTA for suspected coronary artery disease were enrolled; 4862 patients (97.3%) had complete radiation data for analysis.

Journal of the American College of Cardiology
© 2009 by the American College of Cardiology Foundation
Published by Elsevier Inc.
Vol. 54, No. 4, 2009
ISSN 0735-1097/09/$36.00
doi:10.1016/j.jacc.2009.04.027

Cardiac Imaging

Diagnostic Accuracy of Coronary Computed Tomography Angiography

A Comparison Between Prospective and Retrospective Electrocardiogram Triggering

Gianluca Pontone, MD, Daniele Andreini, MD, Antonio L. Bartorelli, MD, Sarah Cortinovis, MD, Saima Mushtaq, MD, Erika Bertella, MD, Andrea Annoni, MD, Alberto Formenti, MD, Enrica Nobili, MD, Daniela Trabattoni, MD, Piero Montorsi, MD, Giovanni Ballerini, MD, Piergiuseppe Agostoni, MD, PhD, Mauro Pepi, MD
Milan, Italy

Centro Cardiologico Monzino

RADIOLOGICAL RISK OF MDCT: prospective ECG gating

Journal of the American College of Cardiology
© 2009 by the American College of Cardiology Foundation
Published by Elsevier Inc.

Vol. 54, No. 4, 2009
ISSN 0735-1097/09/$36.00
doi:10.1016/j.jacc.2009.04.027

Cardiac Imaging

Diagnostic Accuracy of Coronary Computed Tomography Angiography

A Comparison Between Prospective and Retrospective Electrocardiogram Triggering

Gianluca Pontone, MD, Daniele Andreini, MD, Antonio L. Bartorelli, MD, Sarah Cortinovis, MD, Saima Mushtaq, MD, Erika Bertella, MD, Andrea Annoni, MD, Alberto Formenti, MD, Enrica Nobili, MD, Daniela Trabattoni, MD, Piero Montorsi, MD, Giovanni Ballerini, MD, Piergiuseppe Agostoni, MD, PHD, Mauro Pepi, MD

Milan, Italy

Centro Cardiologico Monzino

RADIOLOGICAL RISK OF MDCT: prospective ECG gating

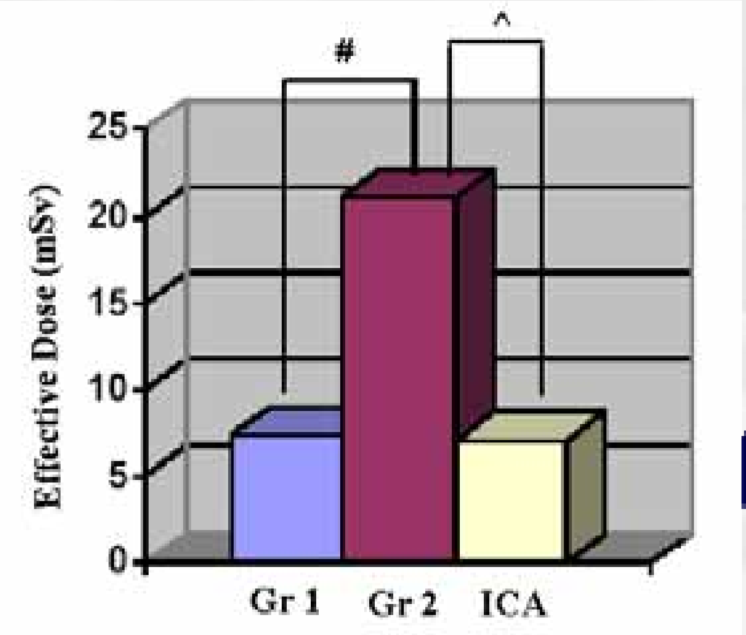
	GROUP 1 (Prospective ECG triggering)									
	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Non-stented segment-based analysis										
Diagnostic Segments	998	737	195	27	39	88 (84-92) ‡	95 (93-97) †	96 (95-98)	83 (78-88) †	93(92-95) ‡
All Segments	1044	737	209	27	71	89 (84-93) ‡	91 (89-93) ‡	96 (95-98)	75 (70-80) †	91 (89-92) †
Stented segment-based analysis										
Diagnostic segments	44	30	11	1	2	92 (76-100) ‡	94 (85-100)	97 (91-100)	85 (65-100)	93 (86-100)
All segments	48	30	13	1	4	93 (79-100) ‡	88 (77-99)	97 (91-100)	76 (56-97)	90 (81-98)
Patient-based analysis										
Diagnostic segments	80	6	72	1	1	99 (96-100)	86 (60-100)	86 (60-100)	99 (96-100)	98 (94-100)
All segments	80	6	72	1	1	99 (96-100)	86 (60-100)	86 (60-100)	99 (96-100)	98 (94-100)
	GROUP 2 (Retrospective ECG triggering)									
	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Non-stented segment-based analysis										
Diagnostic Segments	946	669	238	17	22	93 (90-96)	97 (96-98)	98 (96-99)	92 (88-95)	96 (95-97)
All Segments	973	669	247	17	40	94 (91-97)	94 (93-96)	98 (96-99)	86 (82-90)	94 (93-96)
Stented segment-based analysis										
Diagnostic segments	62	49	8	3	2	73 (46-99)	96 (91-100)	94 (88-100)	80 (55-100)	92 (85-99)
All segments	66	49	10	3	4	77 (54-100)	92 (85-100)	94 (88-100)	71 (48-95)	89 (82-97)
Patient-based analysis										
Diagnostic segments	80	8	70	1	1	99 (96-100)	89 (68-100)	89 (68-100)	99 (96-100)	98 (94-100)
All segments	80	8	70	1	1	99 (96-100)	89 (68-100)	89 (68-100)	99 (96-100)	98 (94-100)

FN: false negative; FP: false positive; NPV: negative predictive value; PPV: positive predictive value; Se: sensitivity; Sp: specificity; TN: true negative; TP: true positive. †: $p < 0.01$ Group 1 vs Group 2; ‡: $p < 0.05$ Group 1 vs Group 2.

Centro Cardiologico Monzino

RADIOLOGICAL RISK OF MDCT: prospective ECG gating

Radiation Dose Report



Group 1: Effective Dose padding 0 msec: 3.8 mSv
Effective Dose padding 100 msec: 5.8 mSv

Group 2: Effective Dose: 20.5 mSv

ICA: Effective Dose: 6 mSv

Centro Cardiologico Monzino

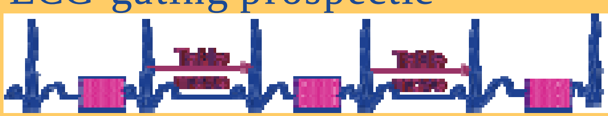
Prospective ECG-gating 64-slice Computed Tomography Coronary Angiography: Low Dose and High Diagnostic Accuracy for the Detection of In-Stent Restenosis

Authors: Daniele Andreini, MD, Gianluca Pontone, MD, Antonio L. Bartorelli, MD, Saima Mushtaq, MD, Daniela Trabattoni, MD, Erika Bertella, MD, Andrea Annoni, MD, Alberto Formenti, MD, Sarah Cortinovis, MD, Piero Montorsi, MD, Pergiuseppe Agostoni, MD, Cesare Fiorentini, MD and Mauro Pepi, MD.

168 pazienti

- 83 pazienti
- 76 maschi
- Età media 64±10 anni

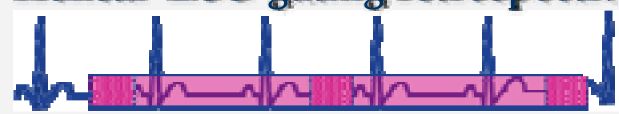
SnapShot Pulse – Axial
ECG-gating prospectic



coll 64 X 0.625mm
rot time 0.35 msec
700 mA, 120 kv
Total X-Ray exposure time 1.9 sec

- 85 pazienti
- 78 maschi
- Età media 61±10 anni

Helical ECG-gating retrospective



coll 64 X 0.625mm
rot time 0.35 msec
700 mA, 120 kv
pitch 0.2:1
Total X-Ray exposure time 6 sec

Centro Cardiologico Monzino

ESC 2009

	Nº	Feasibility n (%)	Artifacts n (%)	Bl n	MA n	SM n	S/N n
GROUP 1 Stented segments	174	162 (93%)	23 (13%)	5 *	1	16 †	1
GROUP 2 Stented segments	163	155 (95%)	18 (11%)	9	1	7	1

GROUP 1

	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Segment-based analyis	162	126	34	2	0	94% (91-98)	100%*	98% (96-100)	100%*	99 (97-100)‡
Patient-based analysis	79	49	28	2	0	93% (88-99)	100%	96% (90-100)	100%	97% (94-100)*

GROUP 2

	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Segment-based analyis	155	116	31	5	3	86% (80-92)	97% (94-100)	96% (92-99)	91% (81-100)	95% (91-98)
Patient-based analysis	77	42	28	5	2	85% (76-93)	95% (89-100)	89 (81-98)	93% (84-100)	91% (84-97)

Dose Efficace

	GROUP 1 (Prospective ECG gating)	GROUP 2 (Retrospective ECG gating)	p
DLP (Gy x cm)			
All patients, mean±SD	252.9±83.517	1088.2±225	p<0.01
Padding 0 msec, mean±SD	217.6±70	-	-
Padding 100 msec, mean±SD	329.4±104.6§||	-	-
Padding 200 msec, mean±SD	441.2±180.1¶	-	-
Effective Dose (mSv)			
All patients, mean±SD	4.3±1.4	18.5±5.5	p<0.01
Padding 0 msec, mean±SD	3.7±1.1	-	-
Padding 100 msec, mean±SD	5.6±1.8§||	-	-
Padding 200 msec, mean±SD	7.5±3.2	-	-

DLP: dose length product; SD: standard deviation; §: p<0.05 padding 100 vs 0; ||: p<0.05 padding 100 vs 200; ¶: p<0.01 padding 200 vs 0

Centro Cardiologico Monzino

RADIOLOGICAL RISK OF MDCT: MDCT-XTe

Adaptive Statistical Iterative Reconstruction

Jiang Hsieh, PhD
Chief Scientist

BMI<20	100 KVp	500 mA
BMI<25	100 KVp	550 mA
BMI<30	100 KVp	600 mA
BMI<35	120 KVp	650 mA
BMI≥35	140 Kvp	700 mA

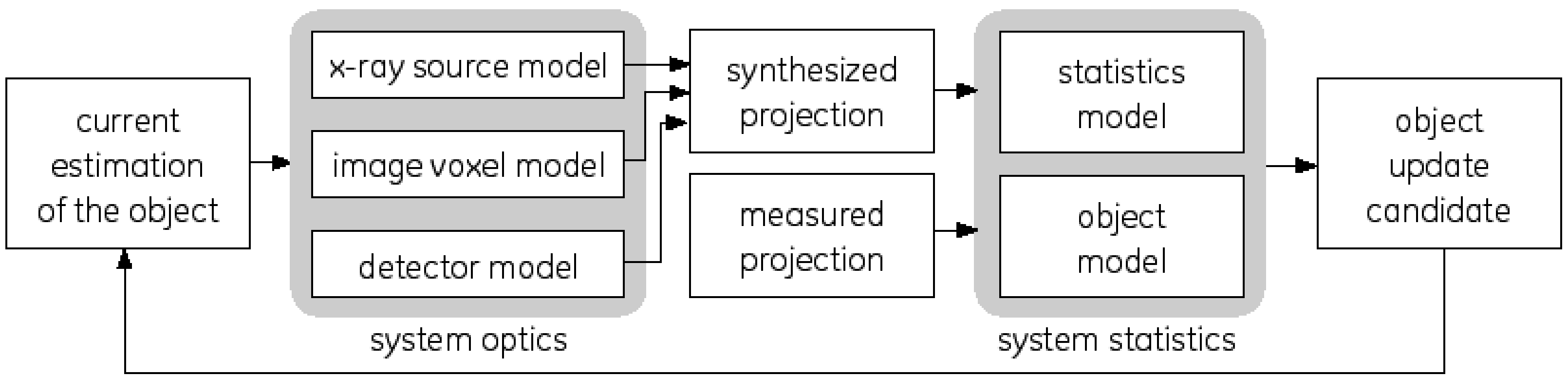


Fig. 2: Flow diagram of iterative reconstruction process

Centro Cardiologico Monzino

Evaluability and Diagnostic Accuracy of a Low Radiation Exposure Protocol for Prospective ECG-Triggering Coronary Multidetector Computed Tomography Angiography in detection of coronary artery disease

Accuracy of a Low Radiation Exposure protocol

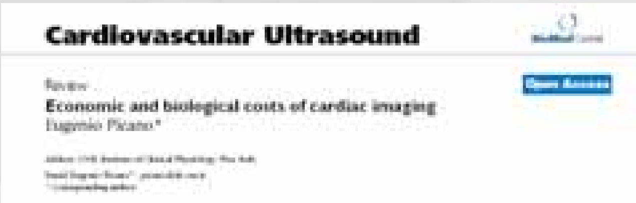
Gianluca Pontone, MD, Daniele Andreini, MD, Antonio L. Bartorelli, MD, FACC, Alberto Formenti, MD, Erika Bertella, MD, Andrea Annoni, MD, Saima Mushtaq, MD, Sarah Cortinovis, MD, Daniela Trabattoni, MD, FACC, Piero Montorsi, MD, Giovanni Ballerini, MD, Piergiuseppe Agostoni, MD, PhD, Cesare Fiorentini, MD, Mauro Pepi, MD

	GROUP 1									
	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Segment-based analysis	836	678	119	9	30	93 (89-97)	96 (94-97)	99 (98-100)	80 (73-86)	95 (94-97)
Patient-based analysis	70	14	54	1	1	98 (95-100)	93 (81-100)	93 (81-100)	98 (95-100)	97 (93-100)
	GROUP 2									
	N	TN	TP	FN	FP	Se (95%CI)	Sp (95%CI)	NPV (95%CI)	PPV (95%CI)	Accuracy (95%CI)
Segment-based analysis	858	654	152	13	39	92 (88-96)	94 (93-96)	98 (97-99)	80 (74-85)	94 (92-96)
Patient-based analysis	67	8	58	0	1	100 (100-100)	89 (68-100)	100 (100-100)	98 (95-100)	99 (96-100)

	Nº	Excellent n (%)	Good n (%)	Adequate n (%)	Poor n (%)
GROUP 1	836	766 (92%)	26 (3%)	18 (2%)	26 (3%)
GROUP 2	858	789 (92%)	17 (2%)	12 (1%)	40 (5%)

2.1±1.2 mSv

RADIOLOGICAL RISK OF MDCT: MDCT-XTe

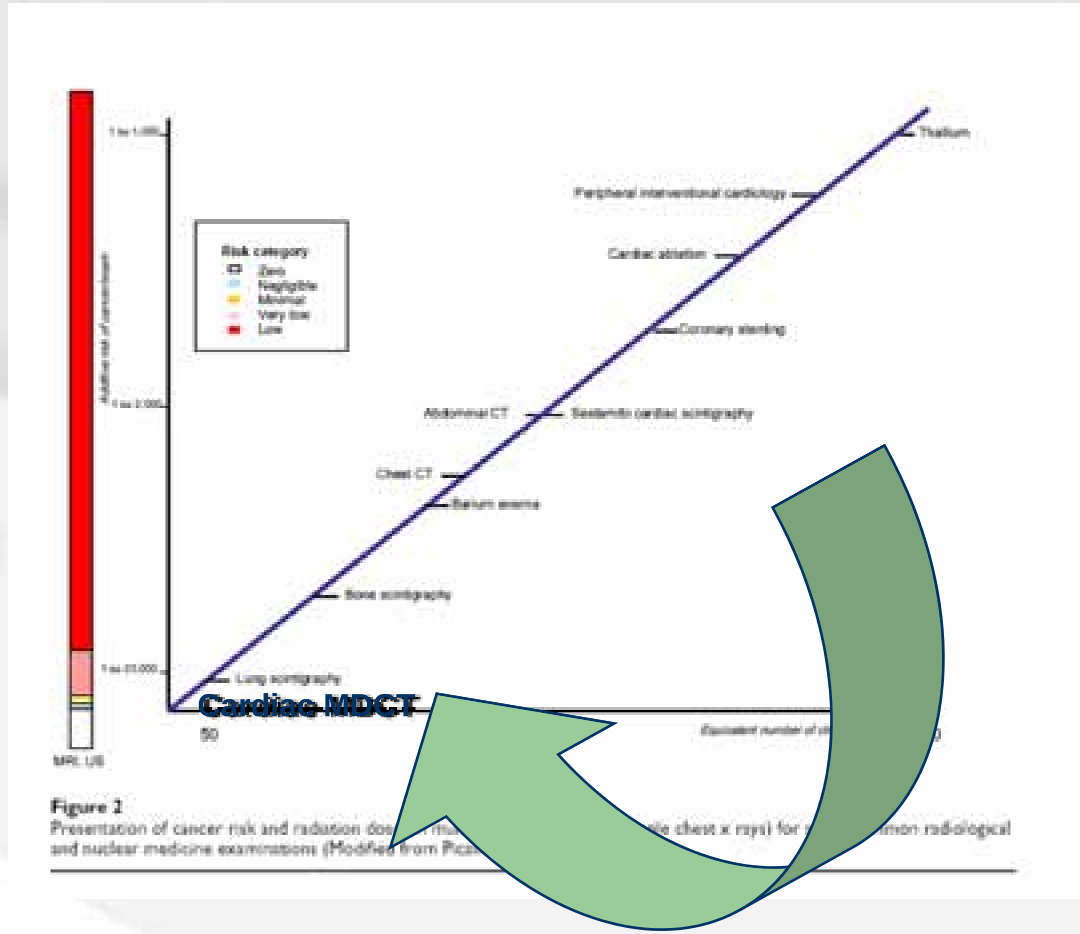

Cardiovascular Ultrasound

Open Access

Review

Economic and biological costs of cardiac imaging

Eugenio Picano*



TAC coronarica e CAD cronica

- Ruolo complementare TAC-test provocativi
- Accurata nel paziente rivascolarizzato
- Ruolo prognostico (lesioni non ostruttive)
- Guida a procedure interventionali
- Bassa Dose

Centro Cardiologico Monzino

Chief of Cardiac Imaging Department: Mauro Pepi

Chief of Radiology Unit: Giovanni Ballerini

Cardiologist and Radiologist

Daniele Andreini
Gianluca Pontone

Interventional Cardiologist

Daniela Trabattoni

Radiologist

Andrea Annoni
Alberto Formenti
Enrica Nobili

Fellows

Erika Bertella
Sarah Cortinovis
Saima Mushtaq