

Indicazioni e limiti della MSCT

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Indicazioni MSCT

**Non ancora codificate delle vere e proprie
linee guida**

ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR APPROPRIATENESS CRITERIA

ACCF/ACR/SCCT/SCMR/ ASNC/NASCI/SCAI/SIR Appropriateness Criteria for Cardiac Computed Tomography and Cardiac Magnetic Resonance Imaging*

A Report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology

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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**

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(*Circulation*. 2006;114:1761-1791.)

Cardiac computed tomography: indications, applications, limitations, and training requirements

Report of a Writing Group deployed by the Working Group Nuclear Cardiology and Cardiac CT of the European Society of Cardiology and the European Council of Nuclear Cardiology

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Indicazioni MSCT

- **Imaging coronarico**
- **Imaging non coronarico**

Imaging coronarico

- **Stenosi coronarica**
- **Stent coronarici**
- **By pass aorto coronarici**
- **Anomalie coronariche**
- **Quantitativa calcio coronarico (Calcium Score)**
- **Caratterizzazione della placca coronarica**

Valutazione stenosi coronarica

Table 1 Diagnostic performance of 64-slice computed tomography and dual-source computed tomography for the detection of significant coronary stenosis (luminal diameter >50%) on a per-segment basis

Author	Number of patients	Not evaluable (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Leschka et al. ⁵³	67	0 (0/1005)	94 (165/176)	97 (805/829)	87 (165/189)	99 (805/816)
Leber et al. ⁴⁴	55	0 (0/732)	76 (57/75)	97 (638/657)	75 (57/76)	97 (638/656)
Raff et al. ⁴⁹	70	12 (130/1065)	86 (79/92)	95 (802/843)	66 (79/120)	98 (802/815)
Mollet et al. ⁴⁶	51	0 (0/725)	99 (93/94)	95 (601/631)	76 (93/123)	99 (601/602)
Ropers et al. ⁵⁰	81	4 (45/1128)	93 (39/42)	97 (1010/1041)	56 (39/70)	100 (1010/1013)
Schuijff et al. ⁵¹	60	1.4 (12/854)	85 (62/73)	98 (755/769)	82 (62/76)	99 (755/766)
Ong et al. ⁴⁸	134	9.7 (143/1474)	82 (177/217)	96 (1067/1114)	79 (177/224)	96 (1067/1107)
Ehara et al. ⁴³	69	8 (82/966)	90 (275/304)	94 (545/580)	89 (275/310)	95 (545/574)
Nikolaou et al. ⁴⁷	72	9.5 (97/1020)	82 (97/118)	95 (762/805)	69 (97/140)	97 (762/789)
Weustink et al. ⁵²	77	0 (0/1489)	95 (208/220)	95 (1200/1269)	75 (208/277)	99 (1200/1212)
Leber et al. ⁴⁵	88	1.3 (16/1232)	94 (38/42)	99 (1165/1174)	81 (38/47)	99 (1165/1169)
Total	824	4.5 (525/11690) (95% CI 4.1–4.9)	89 (1290/1453) (95% CI 87–90)	96 (9350/9712) (95% CI 96–97)	78 (1290/1652) (95% CI 76–80)	98 (6350/9513) (95% CI 98–99)

All values are expressed as per cent with absolute numbers in parentheses. Sensitivity and specificity were calculated only for evaluable segments. 95% CI, 95% confidence interval; NPV, negative predictive value; PPV, positive predictive value.

Table 2 Diagnostic performance of 64-slice computed tomography and dual-source computed tomography for the detection of significant coronary stenosis (luminal diameter >50%) on a per-patient basis

Author	Number of patients	Not evaluable (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Leschka et al. ⁵³	67	0	100 (47/47)	100 (20/20)	100 (47/47)	100 (20/20)
Leber et al. ⁴⁴	59 ^a	23.7 (14/59)	88 (22/25)	85 (17/20)	88 (22/25)	85 (17/20)
Raff et al. ⁴⁹	70	0	95 (38/40)	90 (27/30)	93 (38/41)	93 (27/29)
Mollet et al. ⁴⁶	52	1.9 (1/52)	100 (38/38)	92 (12/13)	97 (38/39)	100 (12/12)
Ropers et al. ⁵⁰	84	3.6 (3/84)	96 (25/26)	91 (50/55)	83 (25/30)	98 (50/51)
Schuijff et al. ⁵¹	61	1.6 (1/61)	94 (29/31)	97 (28/29)	97 (29/30)	93 (27/29)
Ehara et al. ⁴³	69	2.9 (2/69)	98 (59/60)	86 (6/7)	98 (59/60)	86 (6/7)
Nikolaou et al. ⁴⁷	72	5.6 (4/72)	97 (38/39)	79 (23/29)	86 (38/44)	96 (23/24)
Weustink et al. ⁵²	77	0	99 (76/77)	87 (20/23)	96 (76/79)	95 (20/21)
Leber et al. ⁴⁵	90	2.2 (2/90)	95 (20/21)	90 (60/67)	74 (20/27)	99 (60/61)
Total	701	3.8 (27/701) (95% CI 2.6–5.6)	98 (394/404) (95% CI 95–99)	90 (263/293) (95% CI 86–93)	93 (394/424) (95% CI 90–95)	95 (263/273) (95% CI 93–98)

Sospetta malattia coronarica

Tc coronarica :

Alto Valore Predittivo negativo (98- 100%)

RULE OUT

- Nei pz. **asintomatici** come test di screening per aterosclerosi: **non raccomandato**.

Table 1. Detection of CAD: Symptomatic

Indication		Appropriateness Criteria (Median Score)
Evaluation of Chest Pain Syndrome (Use of CT Angiogram)		
1.	<ul style="list-style-type: none"> • Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise 	U (5)
2.	<ul style="list-style-type: none"> • Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise 	A (7)
3.	<ul style="list-style-type: none"> • High pre-test probability of CAD 	I (2)
Evaluation of Intra-Cardiac Structures (Use of CT Angiogram)		
4.	<ul style="list-style-type: none"> • Evaluation of suspected coronary anomalies 	A (9)
Acute Chest Pain (Use of CT Angiogram)		
5.	<ul style="list-style-type: none"> • Low pre-test probability of CAD • No ECG changes and serial enzymes negative 	U (5)
6.	<ul style="list-style-type: none"> • Intermediate pre-test probability of CAD • No ECG changes and serial enzymes negative 	A (7)
7.	<ul style="list-style-type: none"> • High pre-test probability of CAD • No ECG changes and serial enzymes negative 	U (6)
8.	<ul style="list-style-type: none"> • High pre-test probability of CAD • ECG—ST-segment elevation and/or positive cardiac enzymes 	I (1)
9.	<ul style="list-style-type: none"> • “Triple rule out”—exclude obstructive CAD, aortic dissection, and pulmonary embolism • Intermediate pre-test probability for one of the above • ECG—no ST-segment elevation and initial enzymes negative 	U (4)

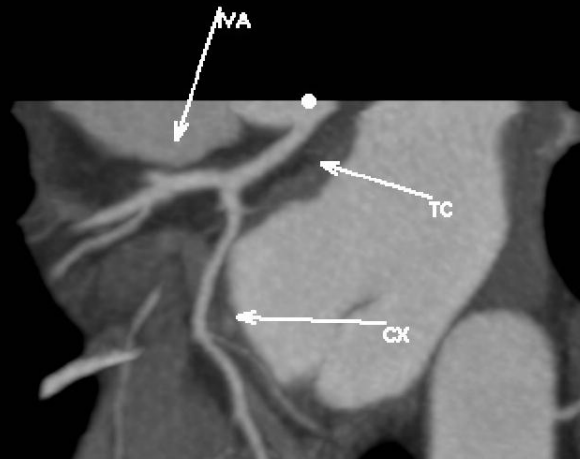
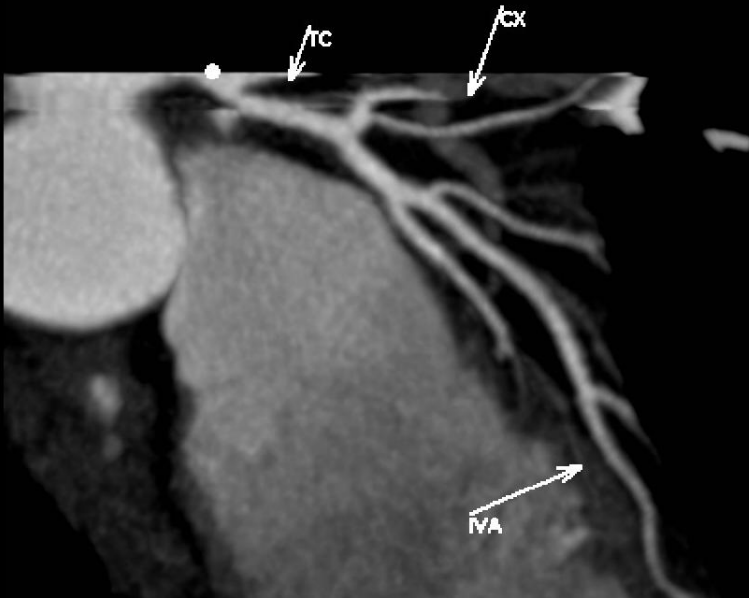
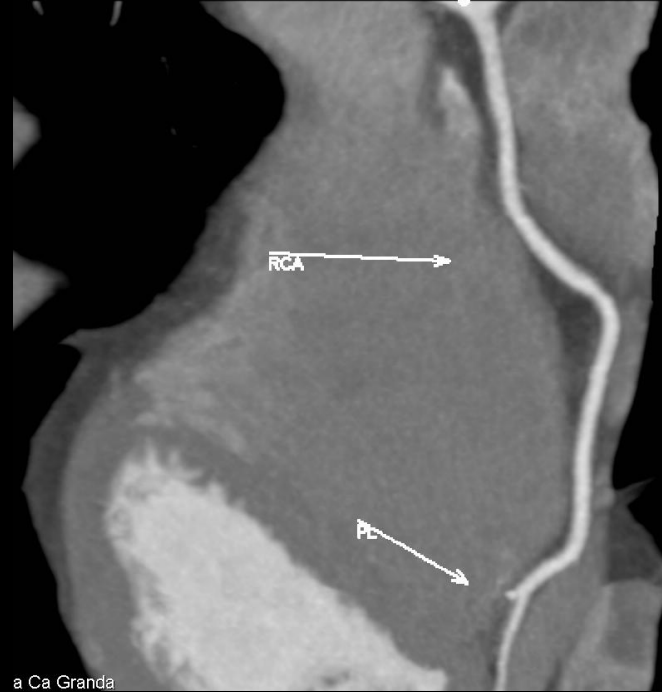
Table 4. Detection of CAD With Prior Test Results

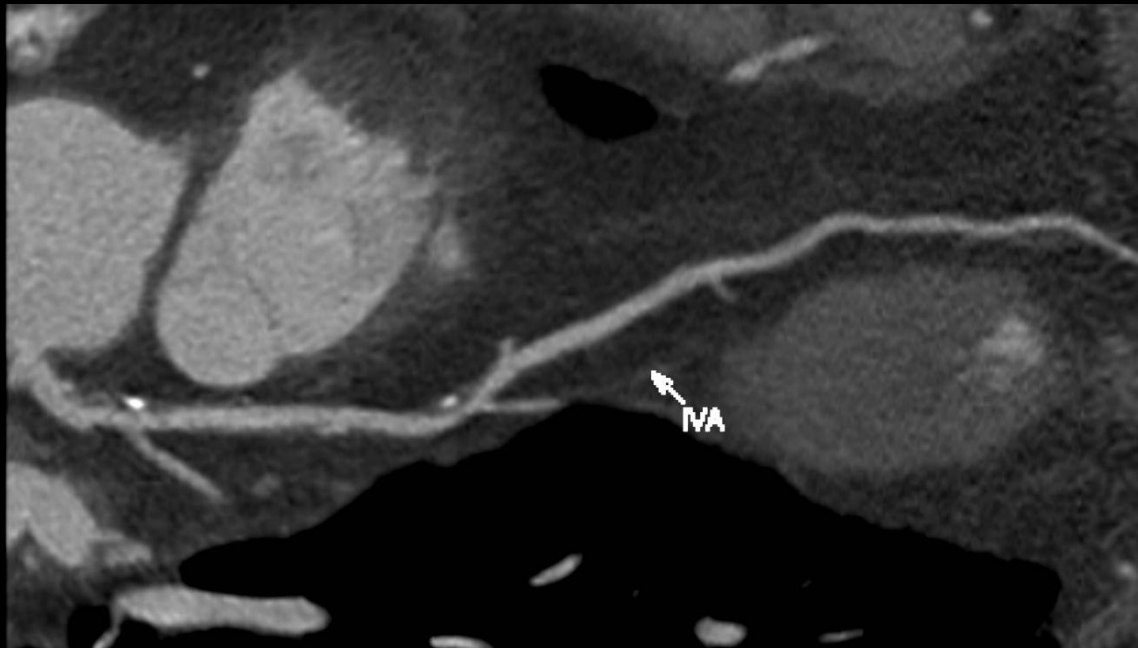
Indication		Appropriateness Criteria (Median Score)
Evaluation of Chest Pain Syndrome (Use of CT Angiogram)		
16.	<ul style="list-style-type: none"> • Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo) 	A (8)
17.	<ul style="list-style-type: none"> • Evidence of moderate to severe ischemia on stress test (exercise, perfusion, or stress echo) 	I (2)

Sospetta malattia coronarica

Tc coronarica Alto Valore Predittivo negativo

- Pz. che devono essere sottoposti ad intervento di sostituzione valvolare
- Pz con miocardiopatia dilatativa per escludere causa ischemica







Valutazione stenosi coronarica

- **Permangono alcune restrizioni tecniche**
 - **calcificazioni (sovrastima)**
 - **esatta quantificazione del grado di stenosi**
 - **effettiva capacità di valutare segmenti di calibro più piccolo (esili)**

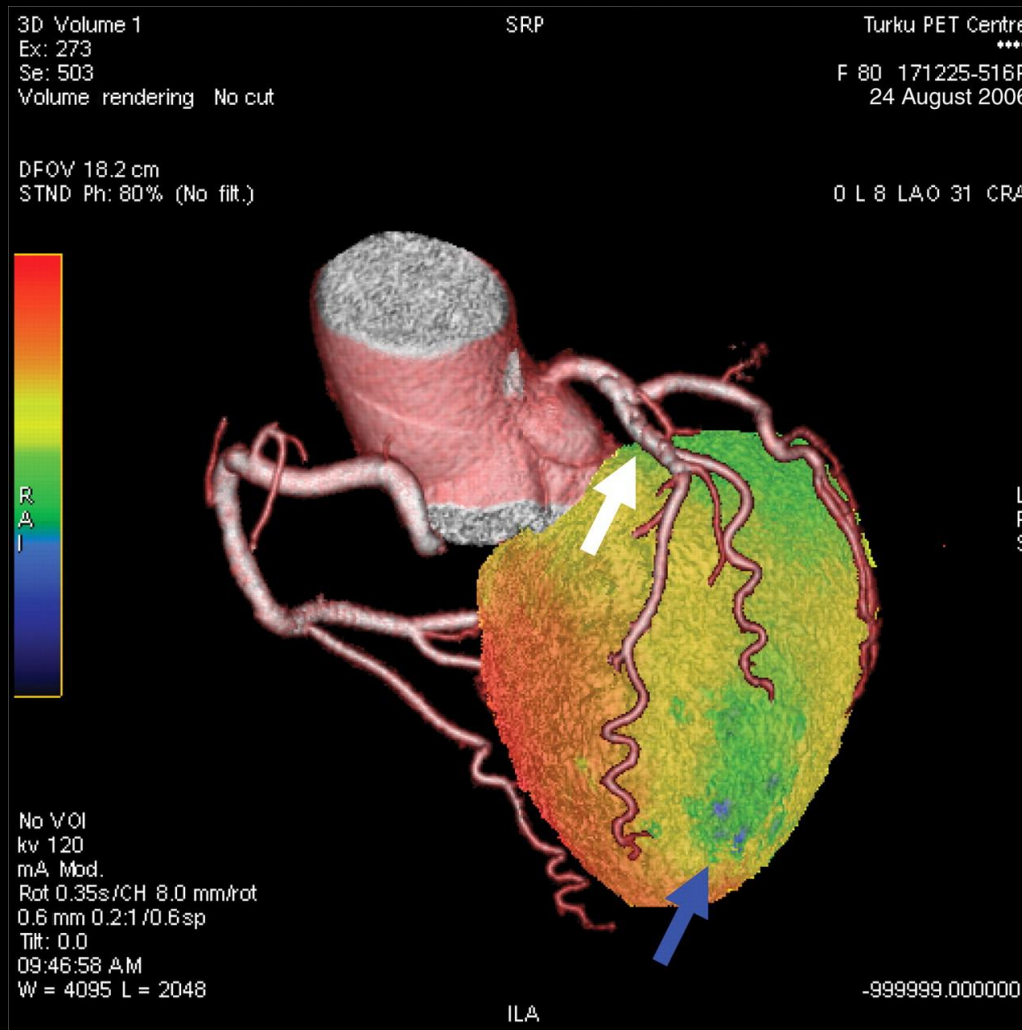
Tc coronarica

- Alto Valore Predittivo negativo (98- 100%) **RULE OUT**
- Possibilità di valutare oltre che il lume anche la parete (rimodellamento positivo)
- Valutazione **anatomica** non funzionale

PET/CT, Spect/CT

	Sens.	Spec.	PPV	NPV
MDCT	96	63	31	99
SPECT/CT	96	95	77	99

Hybrid imaging by positron emission tomography-computed tomography



Schroeder, S. et al. Eur Heart J 2008 29:531-556;

Stent e by pass

Table 7. Detection of CAD: Post-Revascularization (PCI or CABG)

Indication		Appropriateness Criteria (Median Score)
Evaluation of Chest Pain Syndrome (Use of CT Angiogram)		
23.	• Evaluation of bypass grafts and coronary anatomy	U (6)
24.	• History of percutaneous revascularization with stents	U (5)
Asymptomatic (Use of CT Angiogram)		
25.	• Evaluation of bypass grafts and coronary anatomy • Less than 5 years after CABG	I (2)
26.	• Evaluation of bypass grafts and coronary anatomy • Greater than or equal to 5 years after CABG	I (3)
27.	• Evaluation for in-stent restenosis and coronary anatomy after PCI	I (2)

Stent coronarici

- **Valutazione:**
 - pervietà
 - ristenosi endoluminale
- **Blooming:** artefatto che fa vedere lo stent più spesso di quello che sia in realtà **sottostima del lume intra - stent**
- **Indurimento del fascio:** ombre da iperattenuazione del fascio nel lume dello stent

Stent coronarici

- **Visualizzazione della stenosi intra stent dipende:**
 - **disegno e materiale dello stent**
 - **diametro**

Valutazione Stent coronarici

- 100 pz. 178 stent
- Sens.: 94% Spec.: 92%; PPV 77%, NPV 98%
- 41 stent **diametro** < 2.75 mm.
- Sens.: 84% Spec.: 64%; PPV 52%, NPV 90%

Falsi positivi

(Pugliese F. et al.: Dual- source coronary computed tomography angiography for detecting in-stent restenosis; Heart 2007)

Stent coronarici

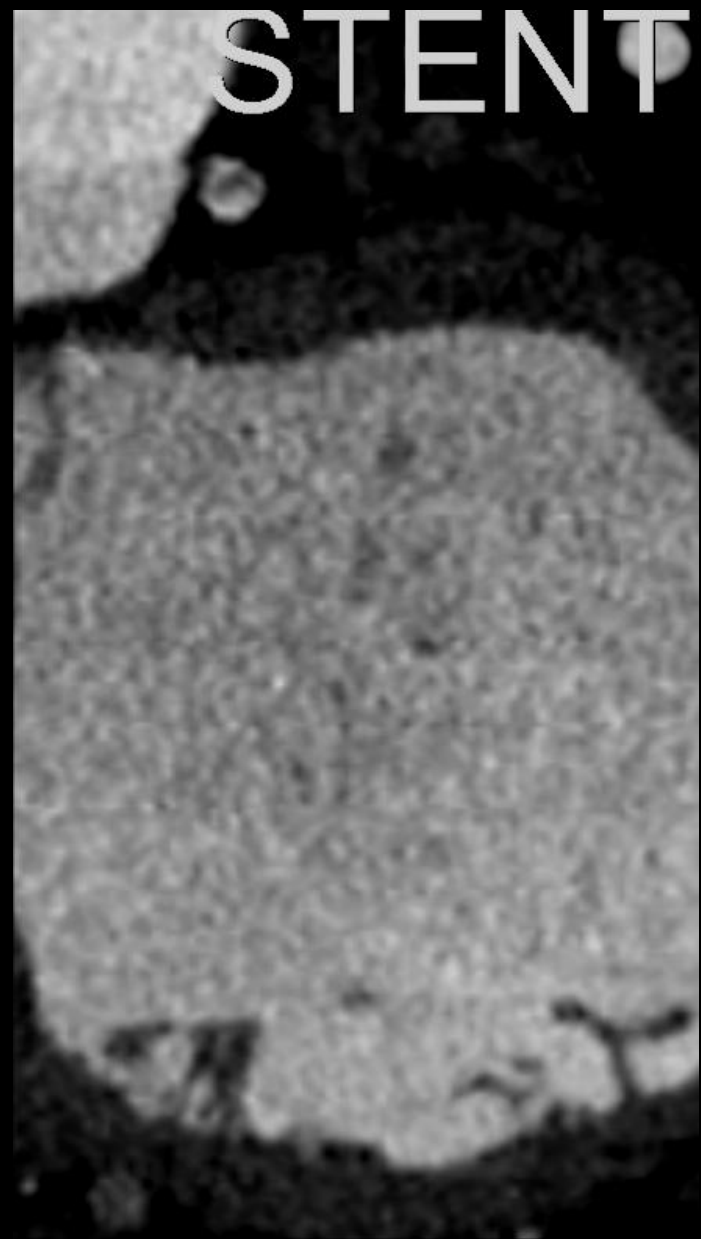
- **Attualmente non raccomandato come esame di routine**
- **Possibile in:**
 - **stent > 3 mm.**
 - **bassa e stabile frequenza cardiaca**
 - **pz. non obesi**

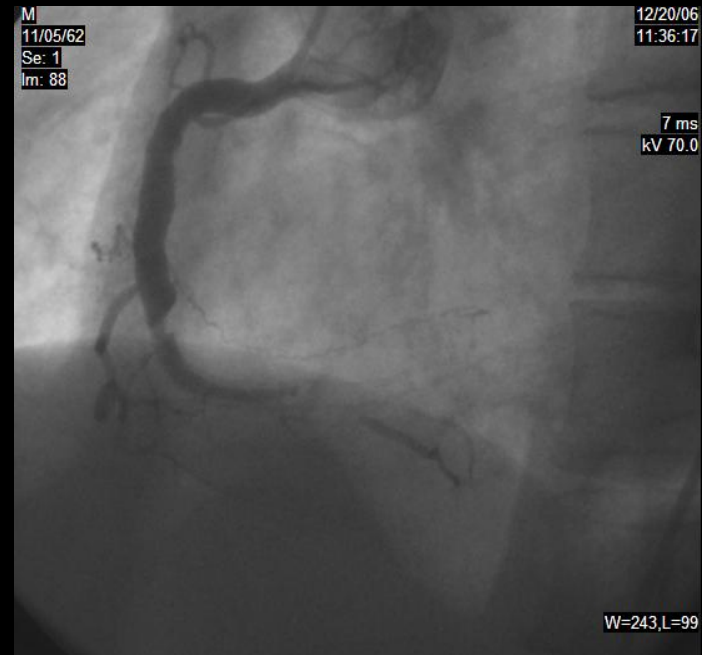
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STENT





Valutazione By pass aorto coronarici

Esclusione complicazioni post- intervento:

Dolore toracico - angina ricorrente da occlusione graft

- infezione sternale
- versamento pleurico, pericardico
- tromboembolia polmonare
- pseudoaneurismi

(Frazier, Radiographics 2005)

By pass aorto coronarici

Follow up

- Occlusione by pass: Accuratezza :100%
- Stenosi (Tc 64)

	sens.	spec.
- By pass, Anastomosi	99 %	96%
- Run off coronarico distale	89 %	93%
- Vaso nativo	97 %	86%

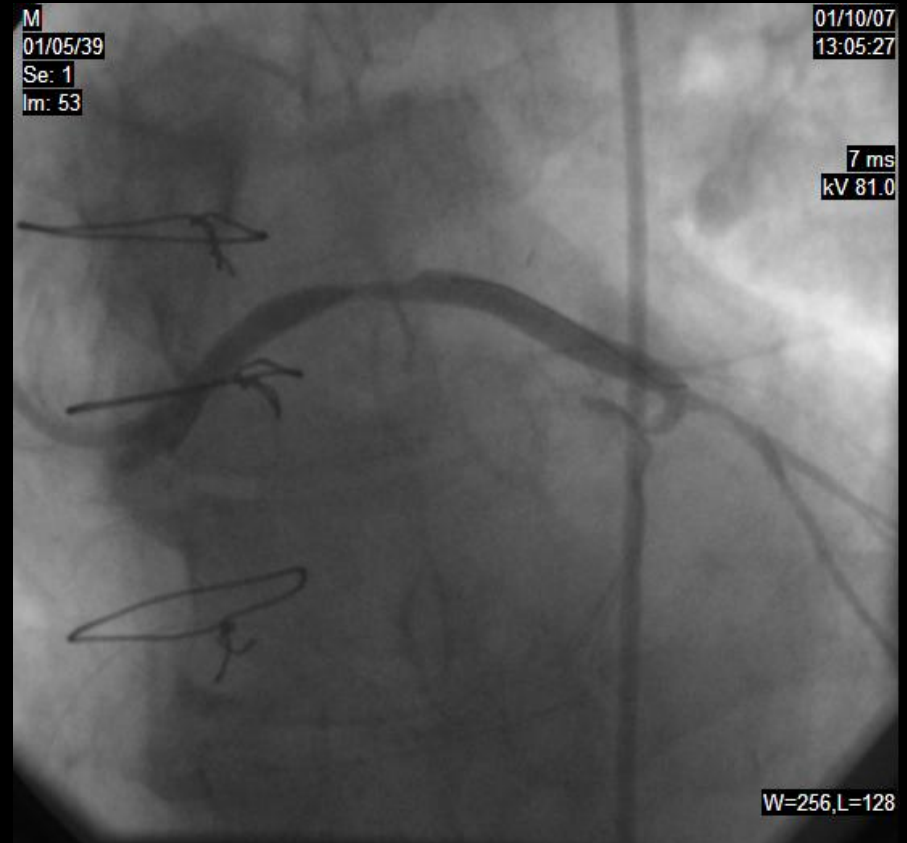
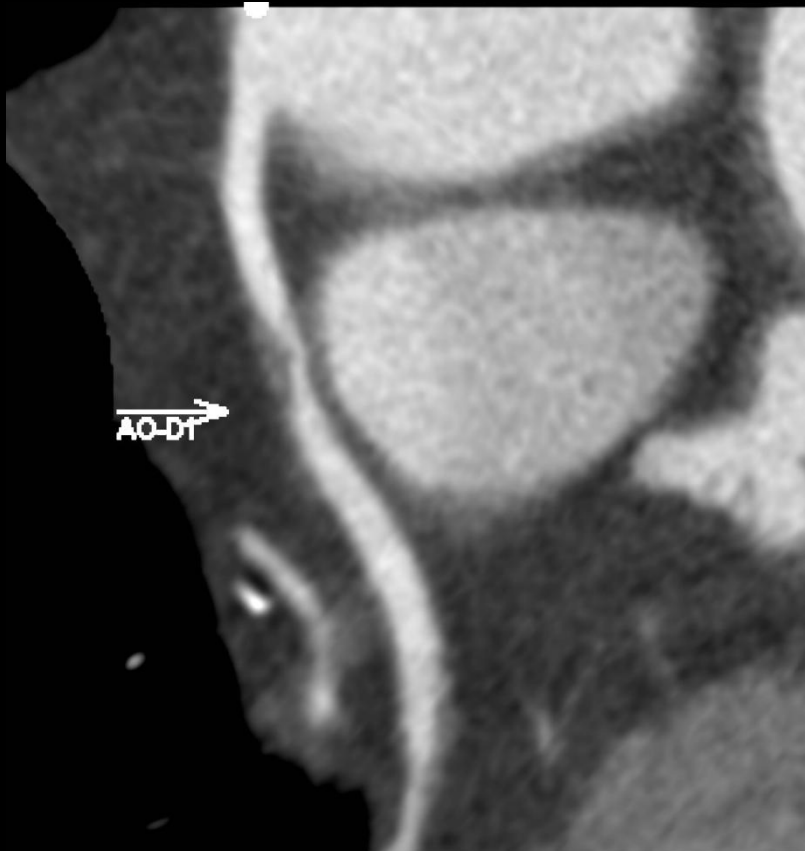
(Malagutti, European Heart Journal 2006)

By pass aorto coronarici

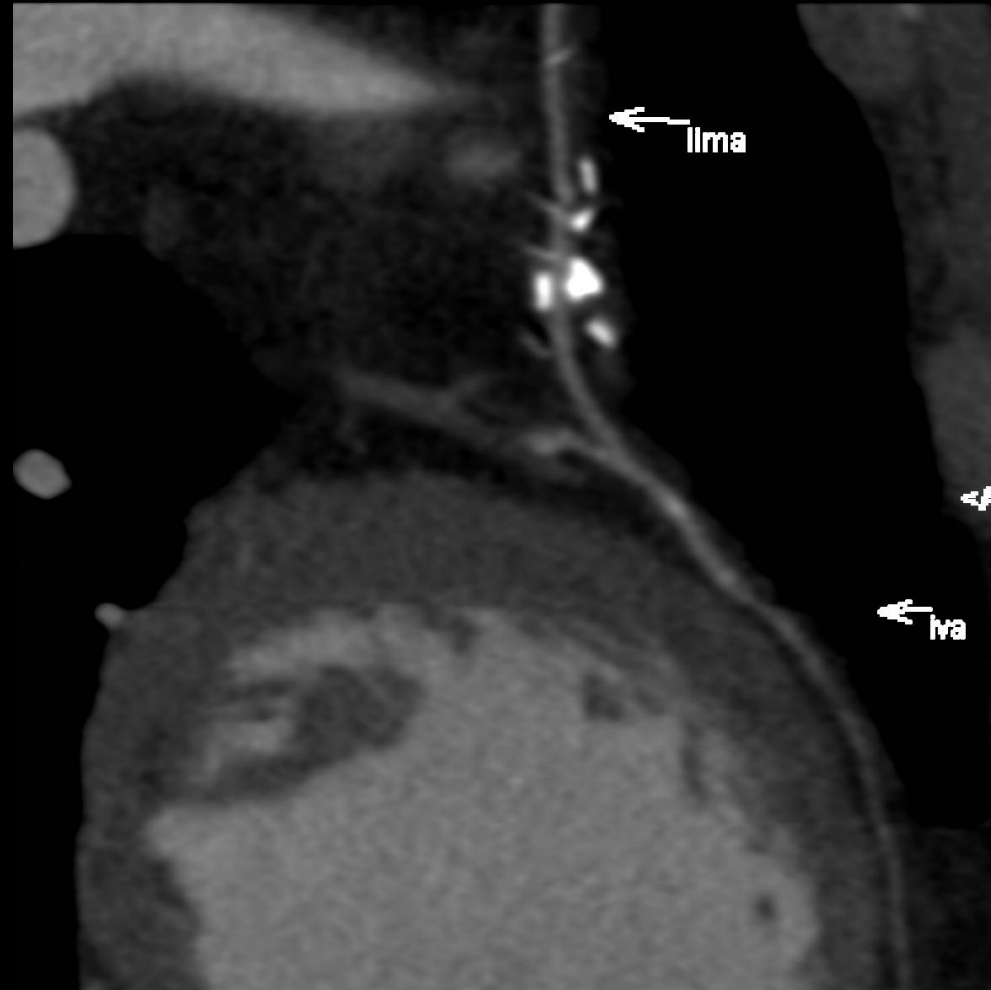
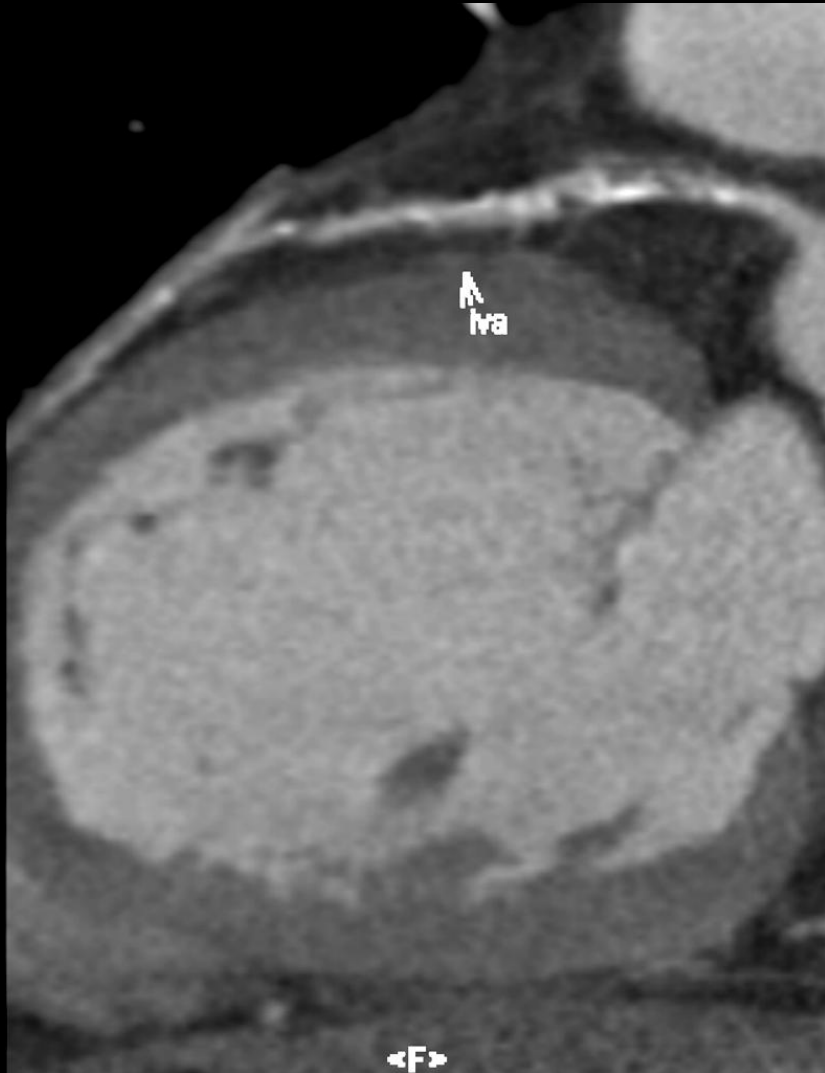
- **Difficile valutazione dei vasi nativi**
 - alto grado di malattia
 - calcificazioni

Severe restrizioni all'uso generale della Tc coronarica

Stenosi graft venosi

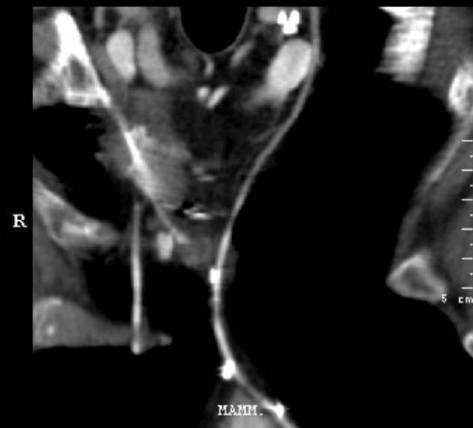
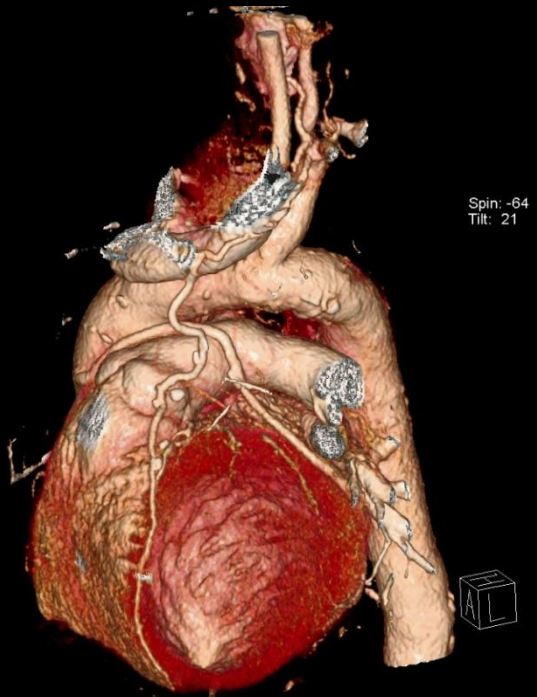
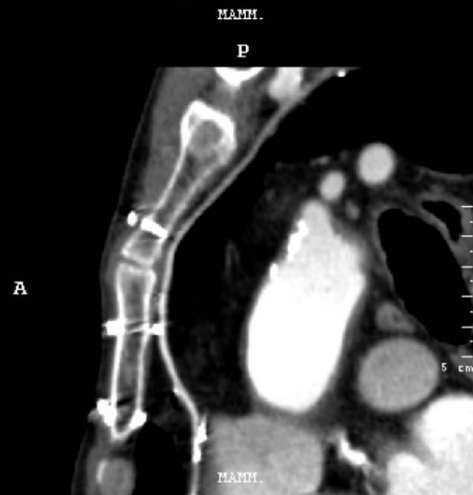
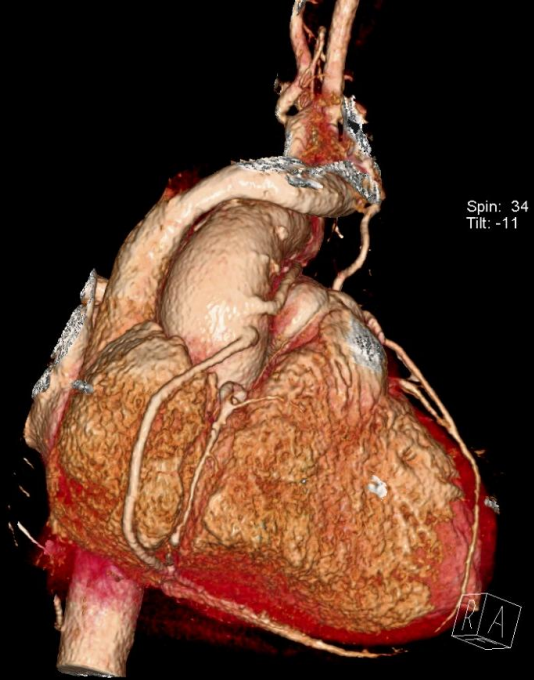


By Pass Lima- Iva



By pass aorto coronarici

- **Nel caso di reintervento di By pass:**
 - **Valutazione decorso LIMA**
 - **Rapporti con strutture circostanti (sterno)**



Valutazione anomalie coronariche

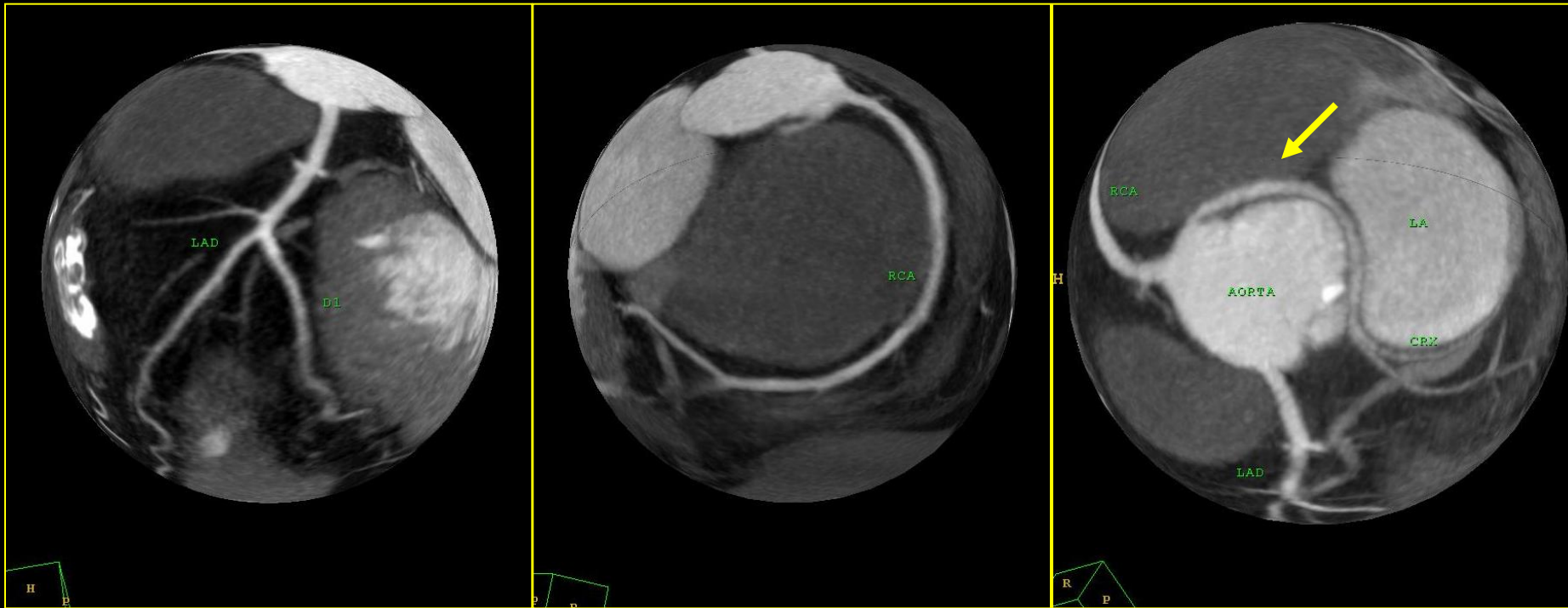
Tc

- Radiazioni
- Mezzo di contrasto

Alta risoluzione sia spaziale che temporale (che permette l'analisi anche di piccoli dettagli) rende ragionevole l'uso della Tc come modalità di imaging di **prima scelta** nella valutazione di eventuali anomalie coronariche

Rate Responsive CVCT™

Anomalous origin of Cx from right coronary sinus. (Courtesy of Carmel Medical Center, Haifa, Israel)



Calcium scoring

- **Agastone score: punteggio in base alla quantità totale di calcio presente nelle coronarie**
- **Tc multislice - Volume score: volume di calcio in mm³**
 - **Calcium mass: assoluta massa di calcio coronarico in mg.**
- **Nessuna indicazione per ripetuti calcium score per la stratificazione del rischio di eventi coronarici avversi.**
- **Contributo alla stratificazione del rischio in pz. con rischio intermedio di eventi coronarici (10 aa PROCAM score o Framingham risk)**

Placca non calcifica

- **Valutazione della parete: rimodellamento**
- **Quantificazione del volume: non soddisfacente**
Tc sottostima la piccola placca non calcifica non stenotica nei segmenti distali
- **Composizione della placca**
 - Tc ipodensa
 - intermedia
 - calcifica

Placca vulnerabile: porzione centrale lipidica con cappuccio fibroso

Difficoltà nel differenziare la componente lipidica dalla fibrosa

Placca non calcifica

Attualmente nessuna metodica di imaging è capace di identificare e caratterizzare in modo inequivocabile la placca coronarica vulnerabile

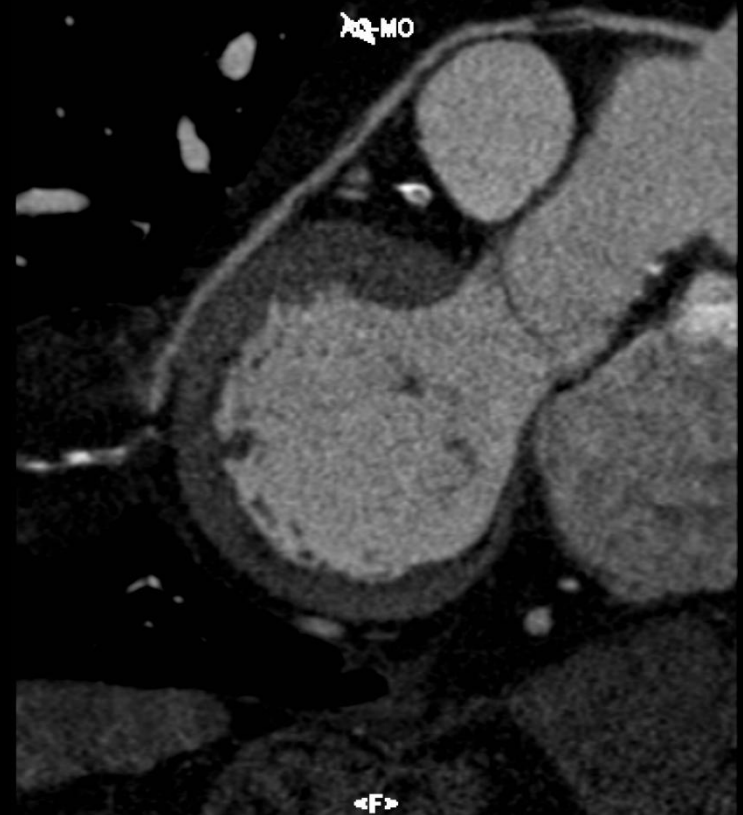
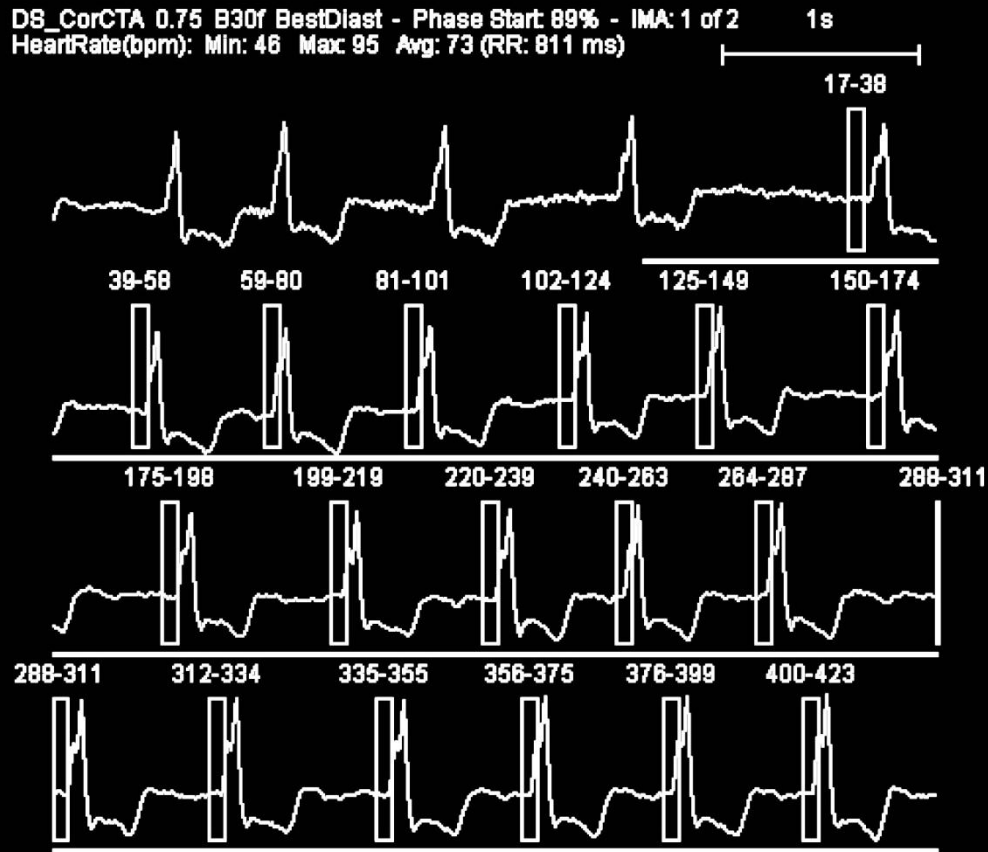
Controindicazioni

- **Allergia nota al m.d.c.**
- **Insufficienza renale grave**
- **Gravidanza**

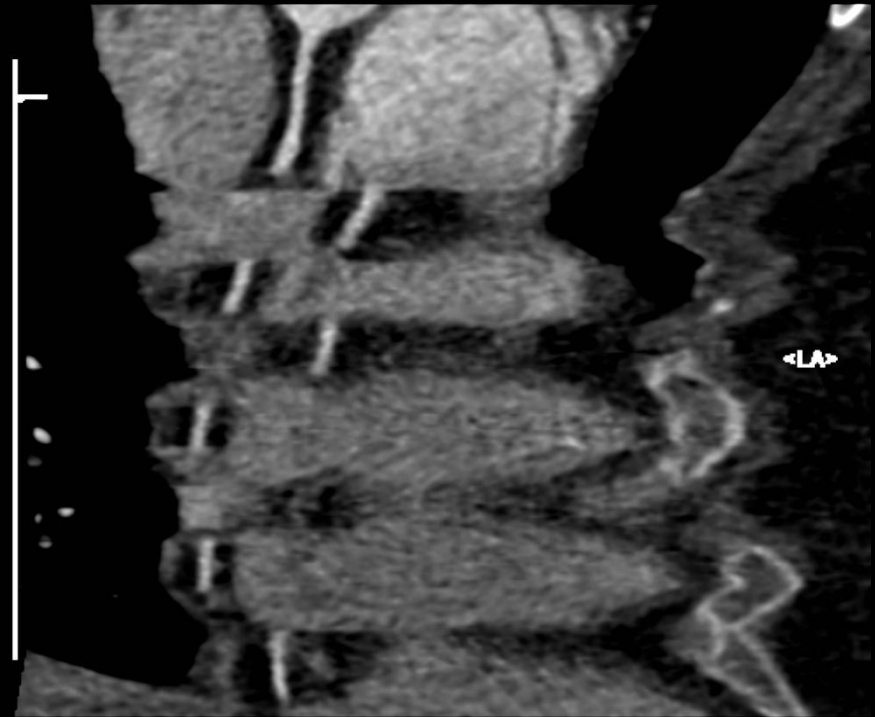
Limitazioni

- Irregolare Aritmia (fibrillazione atriale)
- Extrasistoli frequenti (utilizzo di lidocana a basse dosi)
- TC a 64 detettori Fc < 65 b/min. (UTILIZZO DI FARMACI Beta bloccanti)
- **Calcificazioni coronariche**
- Dose di esposizione

Fibrillazione Atriale

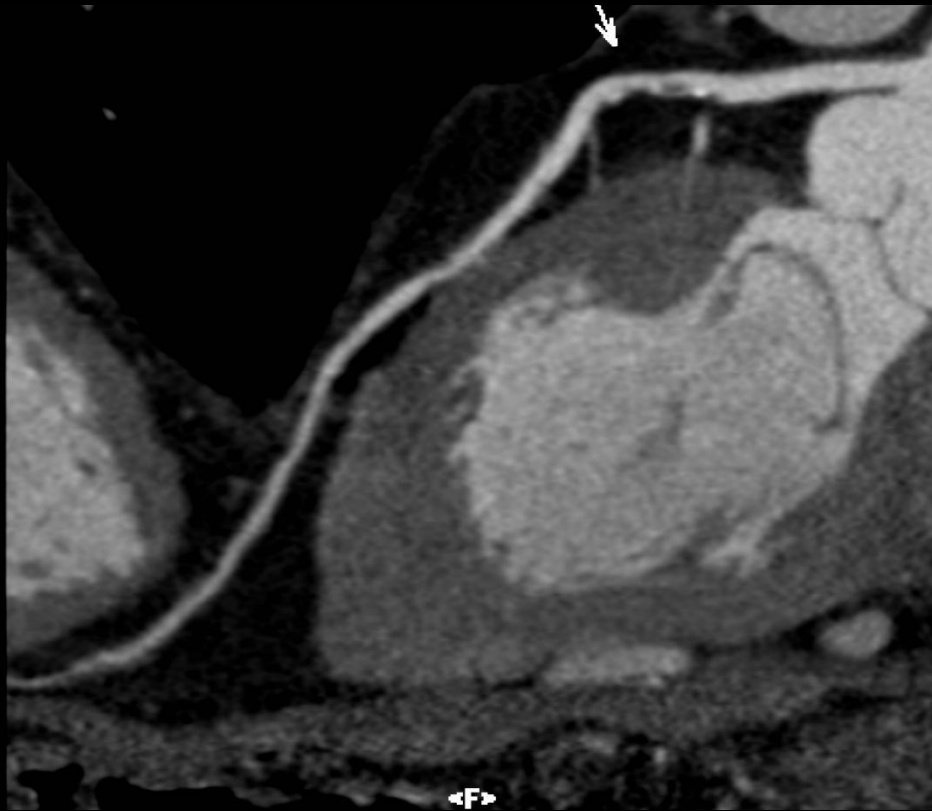


Ritmo Bigemino



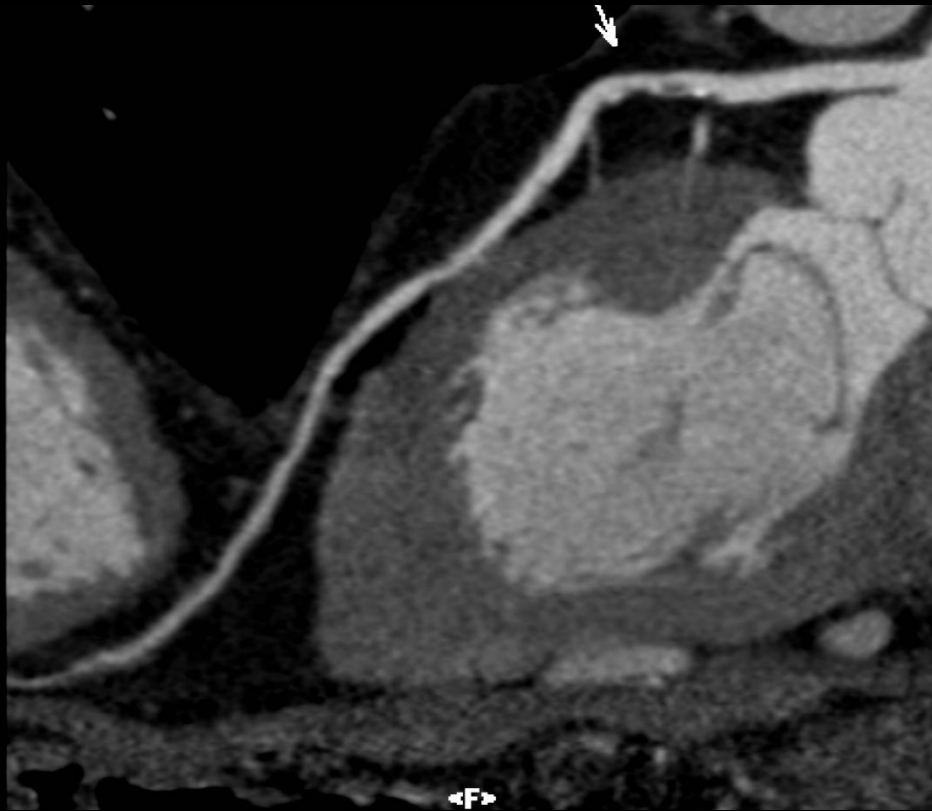


TC Dual Source



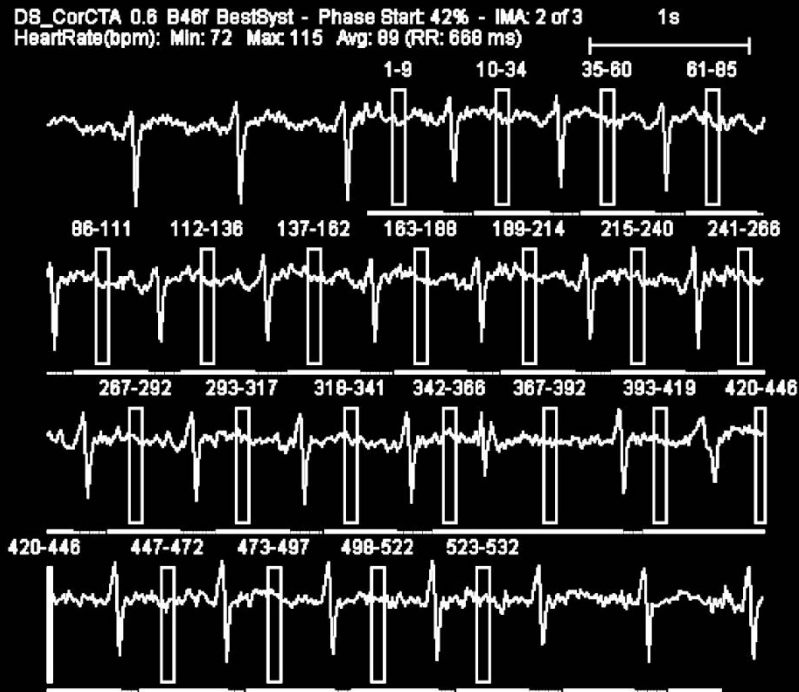
70 -75 b.p.m.

TC Dual Source

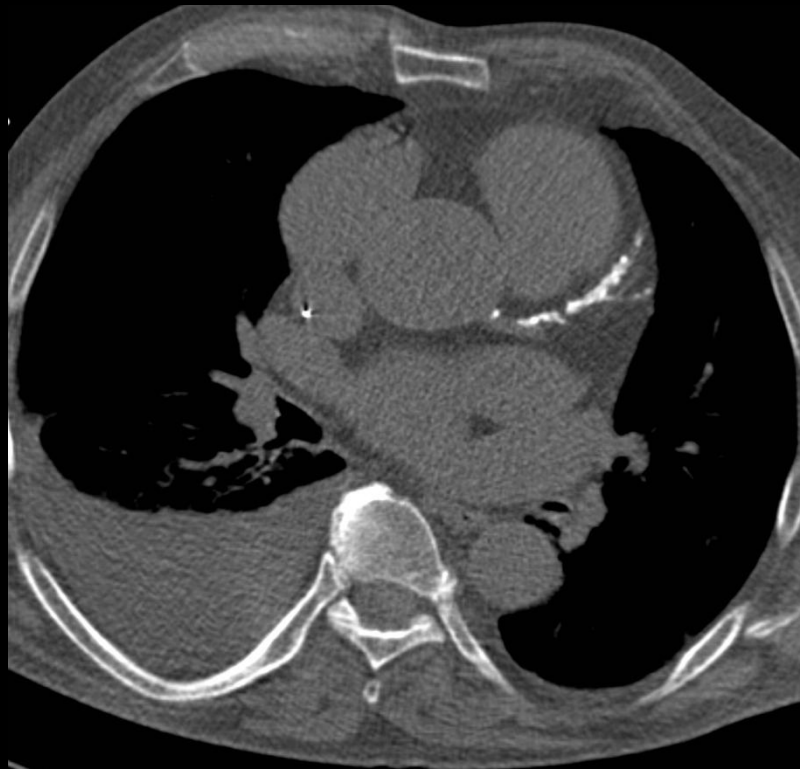


70 -75 b.p.m.

TC Dual Source:



Calcificazioni

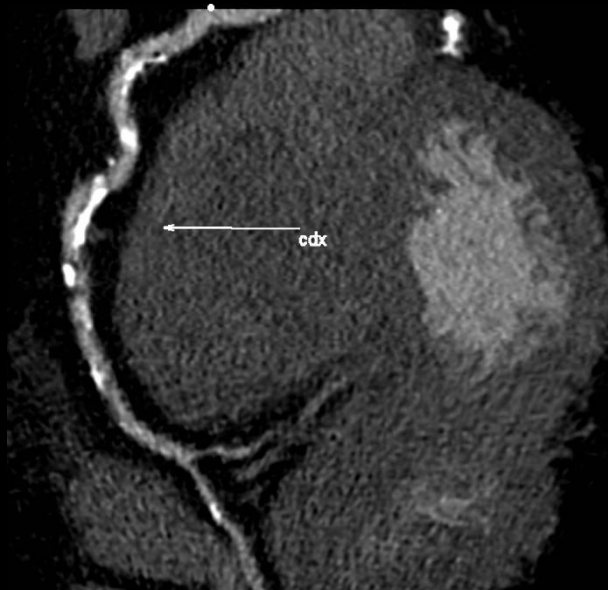
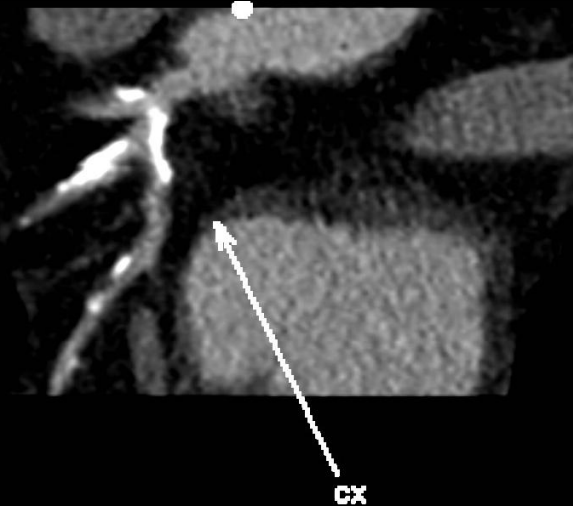
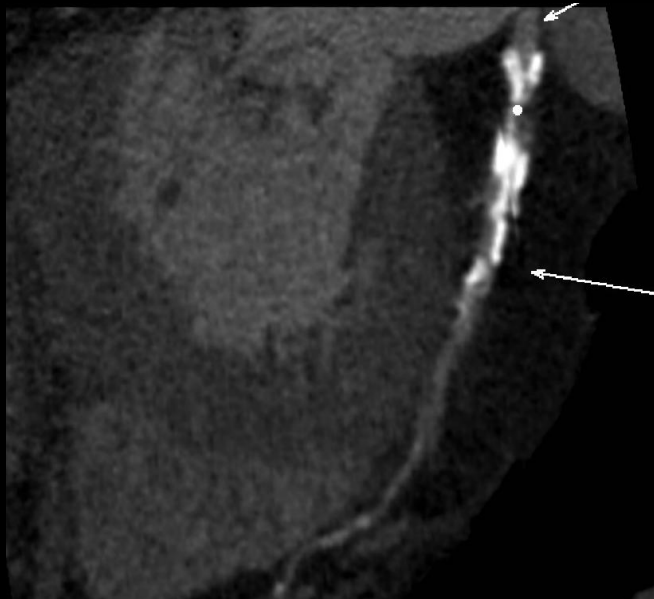


Threshold = 130 HU
(103.2 mg/cm³ CaHA)

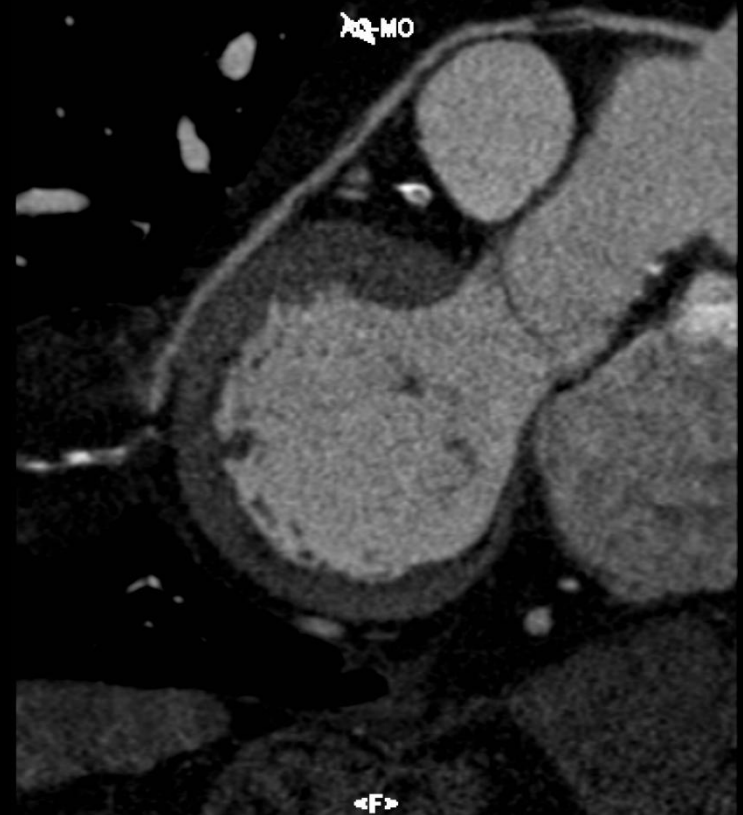
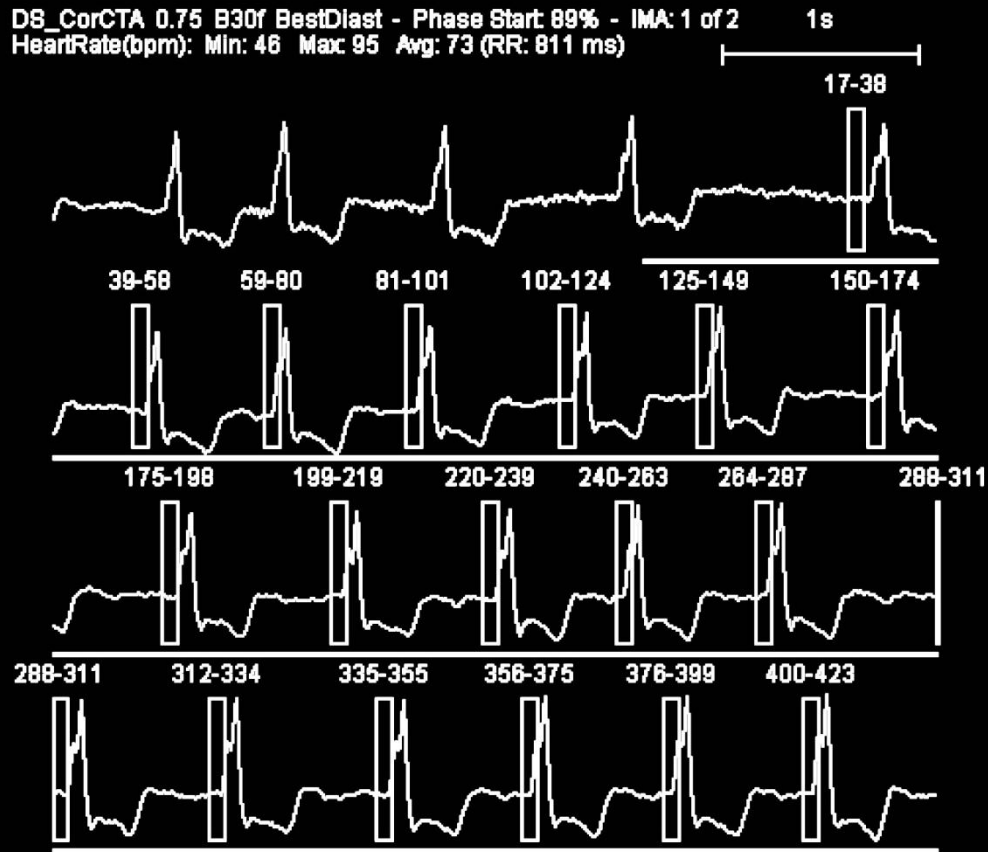
Artery	Number of Lesions (1)	Volume [mm ³] (3)	Equiv. Mass [mg CaHA] (4)	Calcium Score (2)
LM	1	32.2	8.20	37.6
LAD	5	1254.4	384.20	1642.5
CX	6	693.2	185.84	867.0
RCA	1	532.2	116.05	689.6
Total	13	2511.9	656.29	3236.8

(1) Lesion is volume based
(2) Agatston score
(3) Isotropic Interpolated volume
(4) Calibration Factor: 0.794

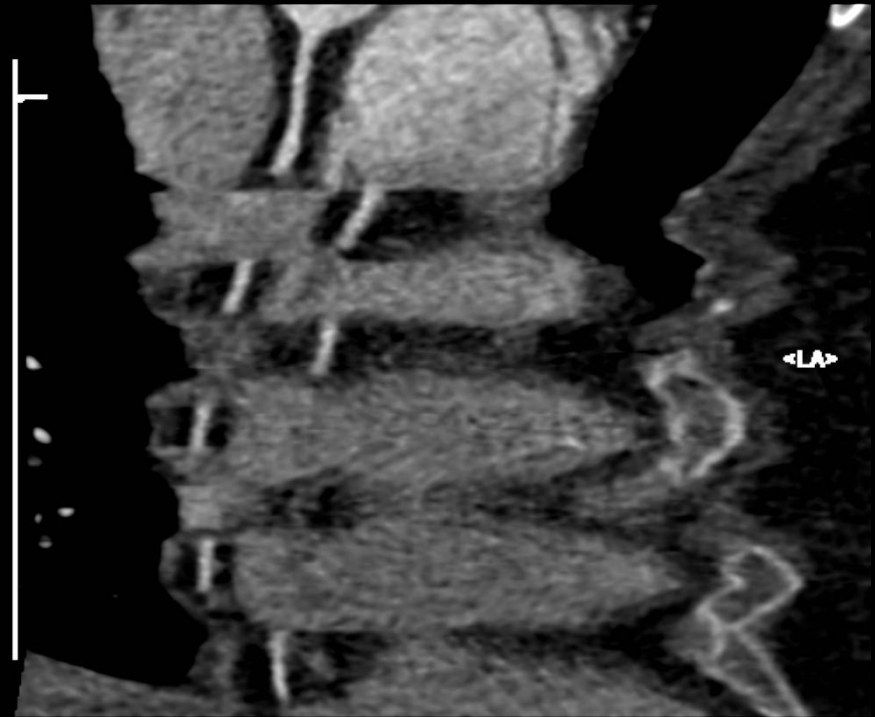
Calcificazioni



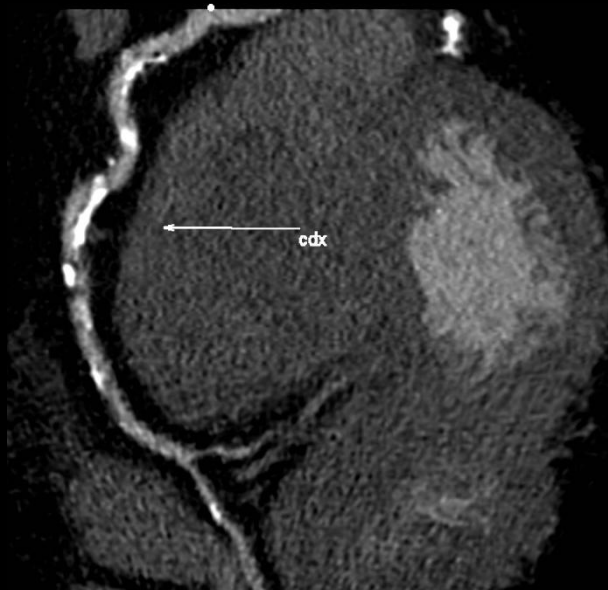
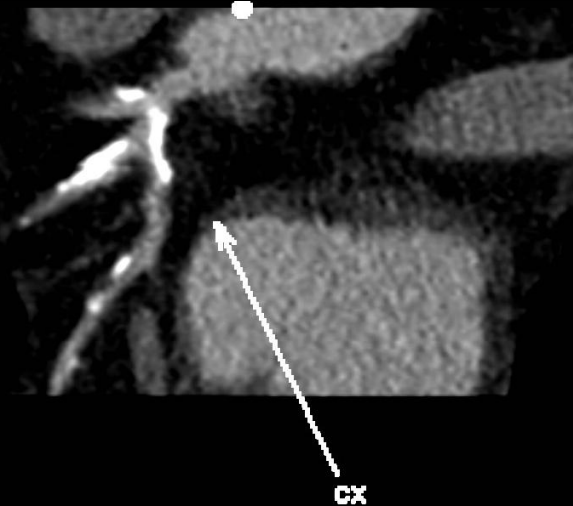
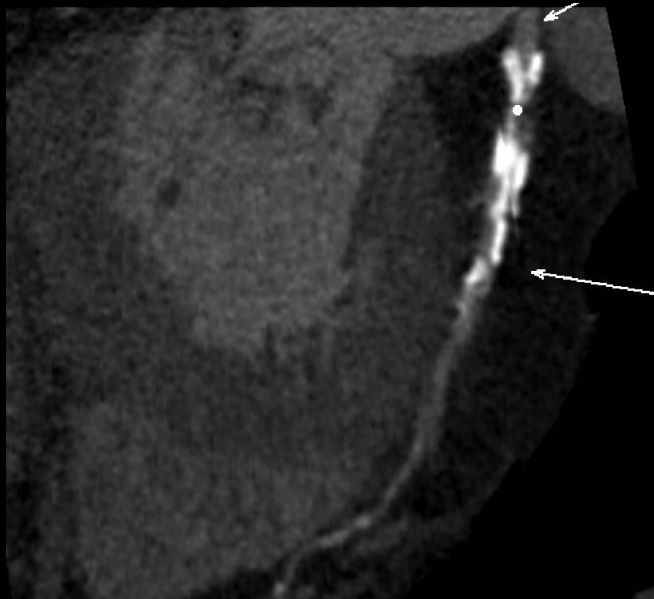
Fibrillazione Atriale



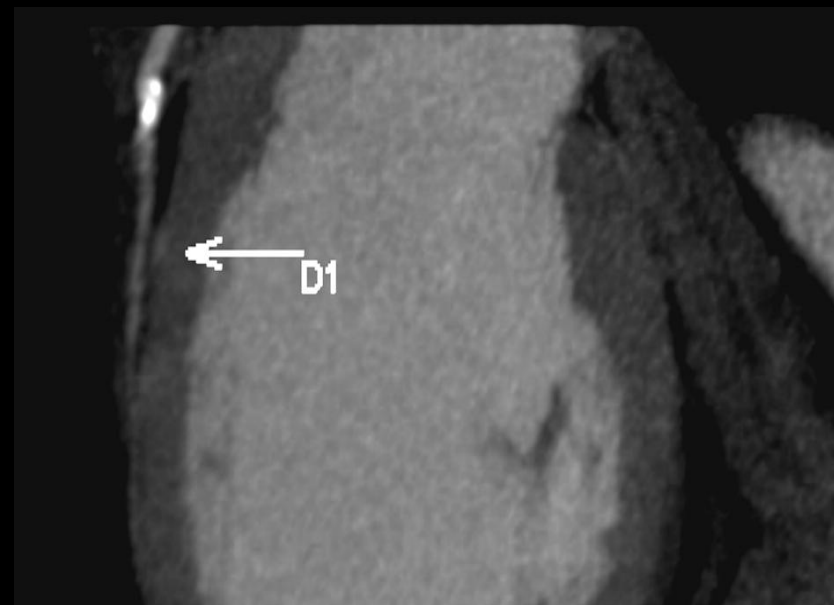
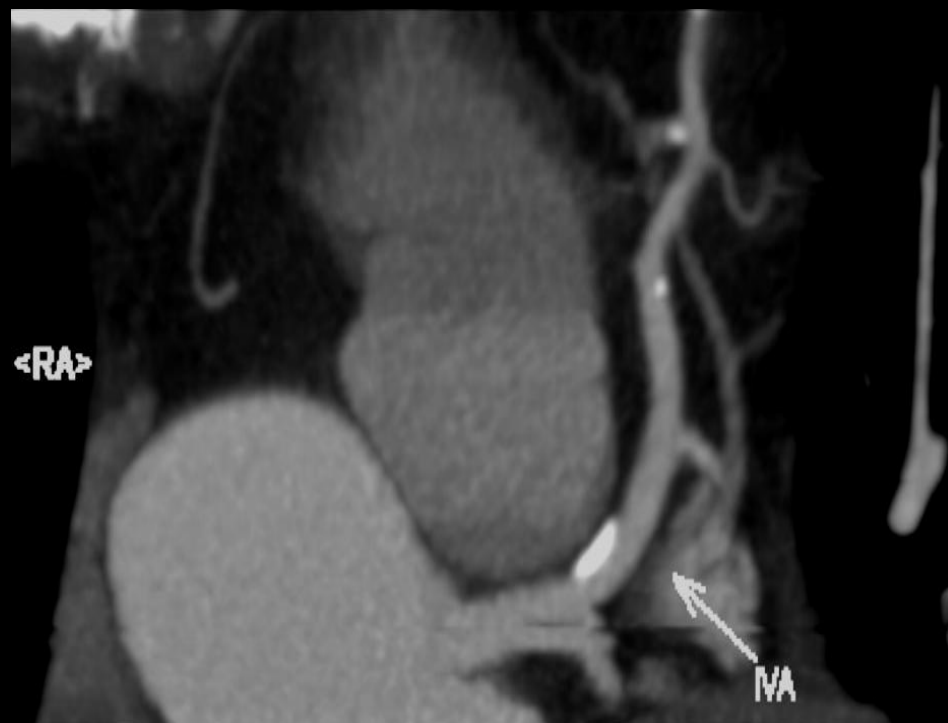
Ritmo Bigemino



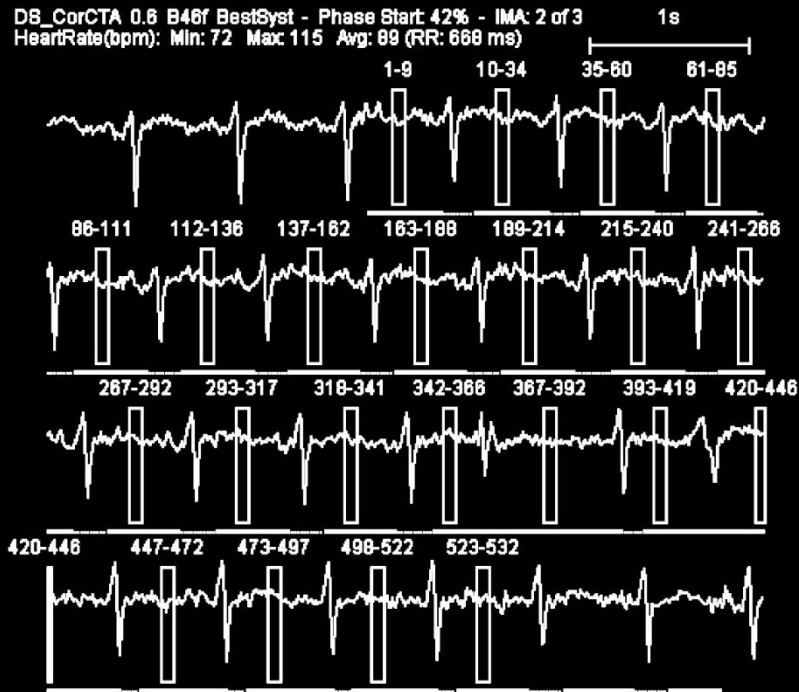
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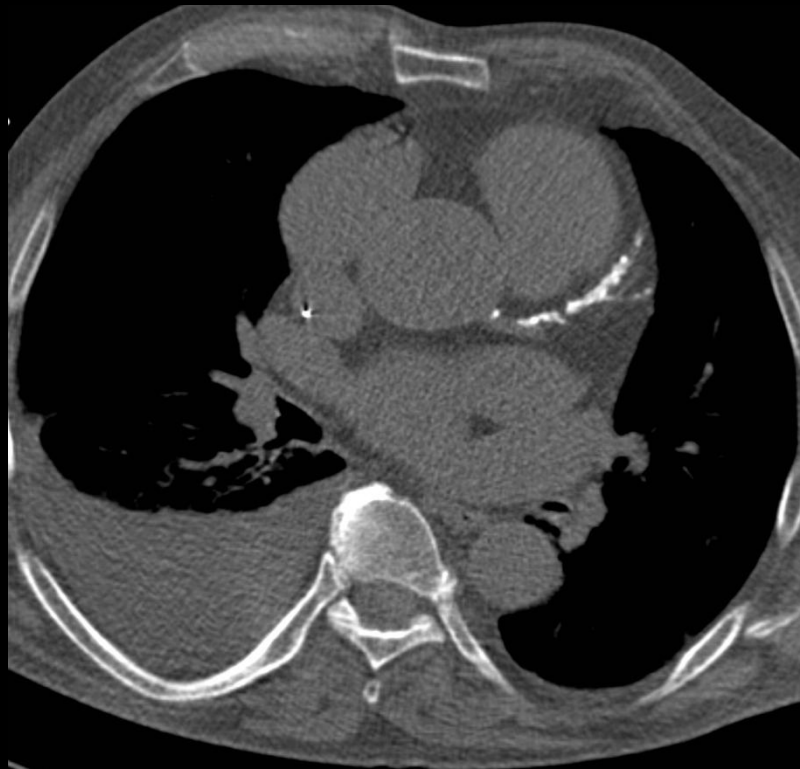
Calcificazioni



TC Dual Source:



Calcificazioni

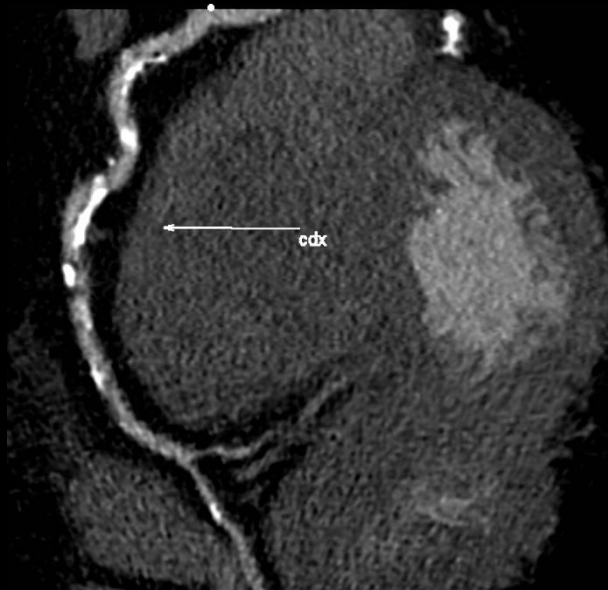
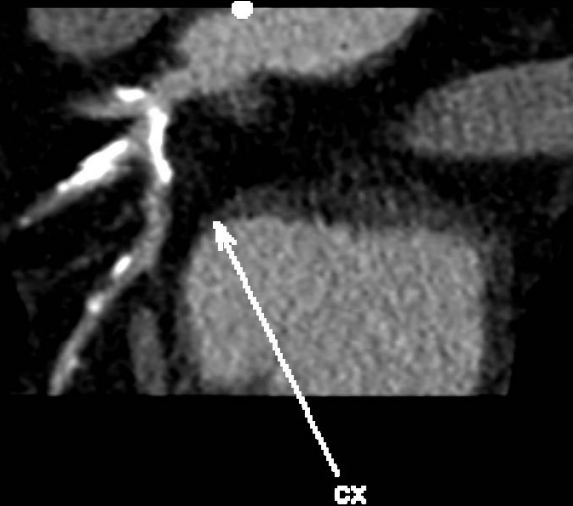
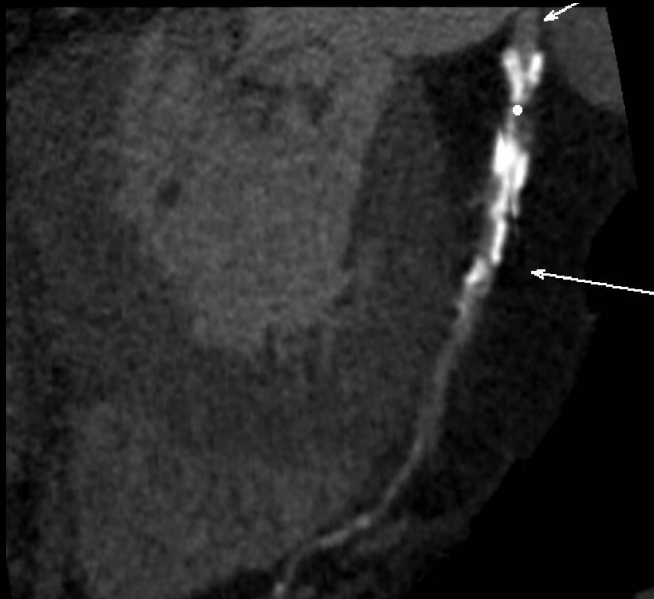


Threshold = 130 HU
(103.2 mg/cm³ CaHA)

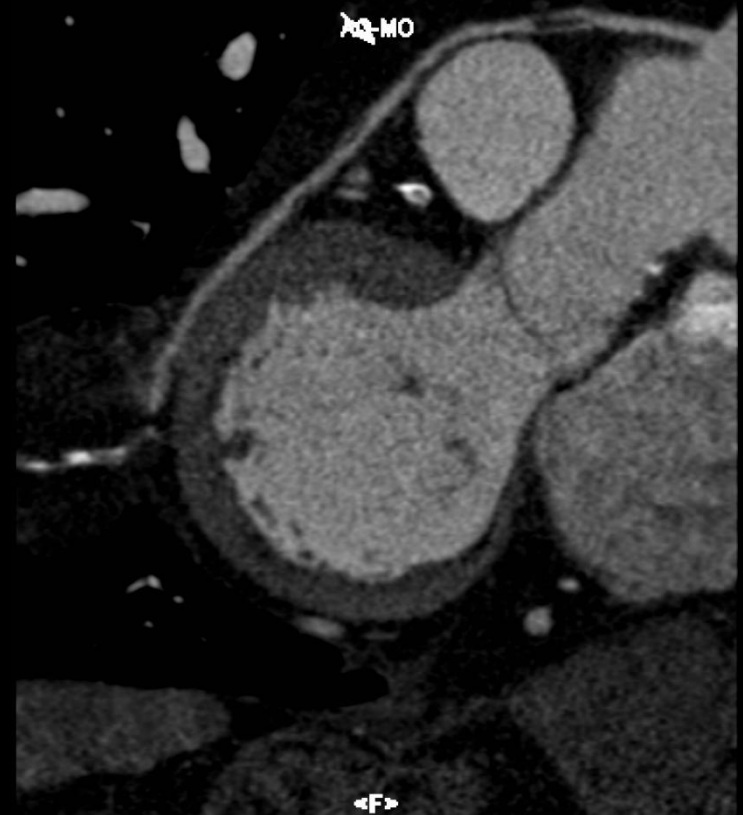
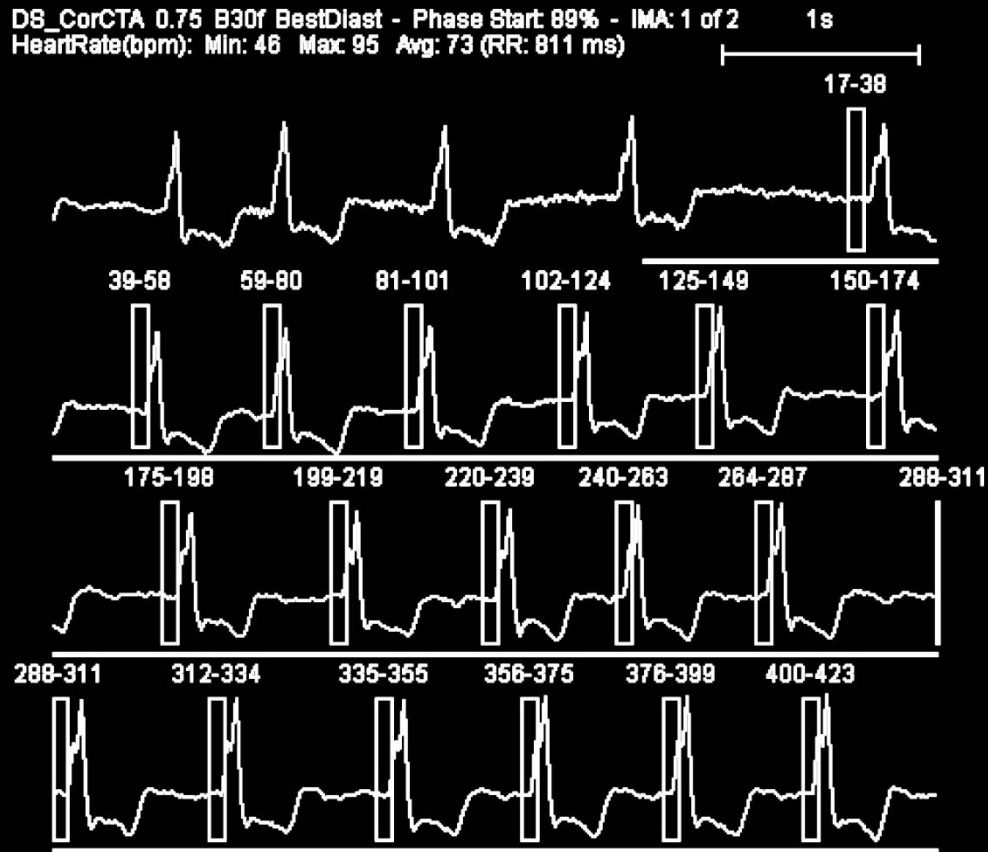
Artery	Number of Lesions (1)	Volume [mm ³] (3)	Equiv. Mass [mg CaHA] (4)	Calcium Score (2)
LM	1	32.2	8.20	37.6
LAD	5	1254.4	384.20	1642.5
CX	6	693.2	185.84	867.0
RCA	1	532.2	116.05	689.6
Total	13	2511.9	656.29	3236.8

(1) Lesion is volume based
(2) Agatston score
(3) Isotropic Interpolated volume
(4) Calibration Factor: 0.794

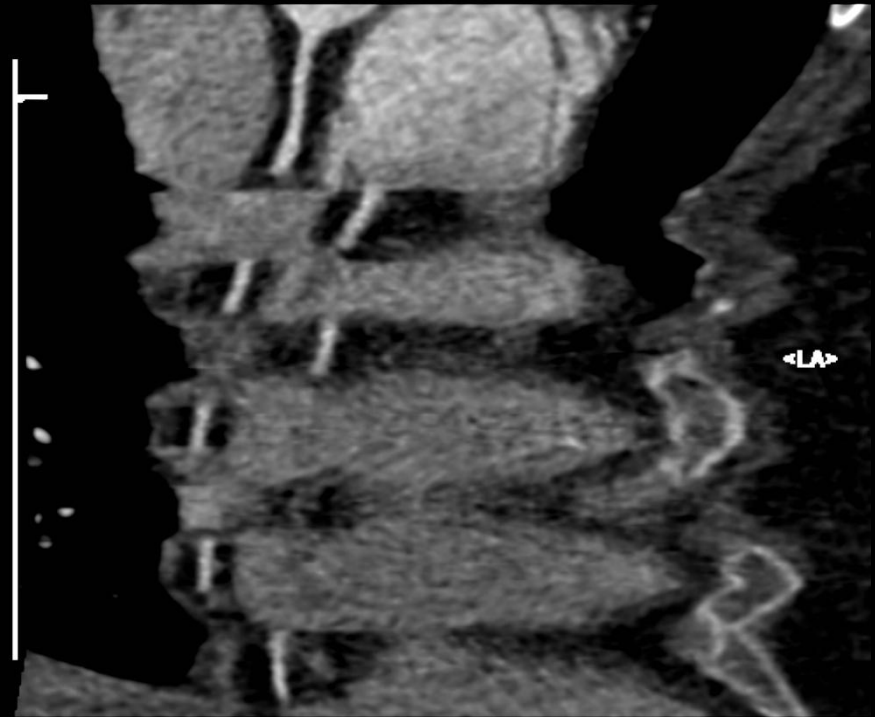
Calcificazioni



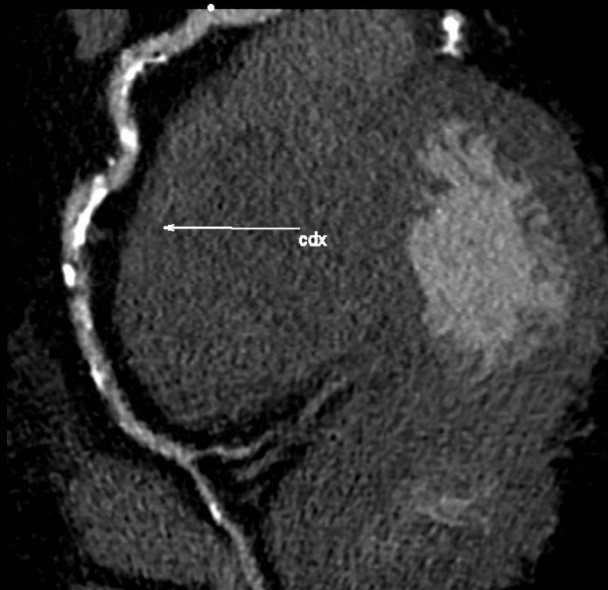
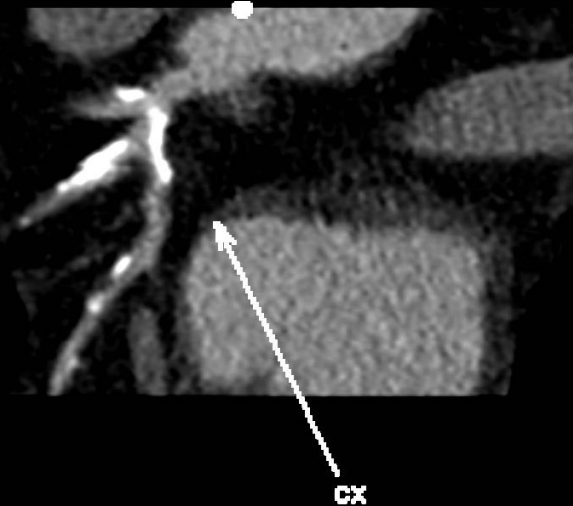
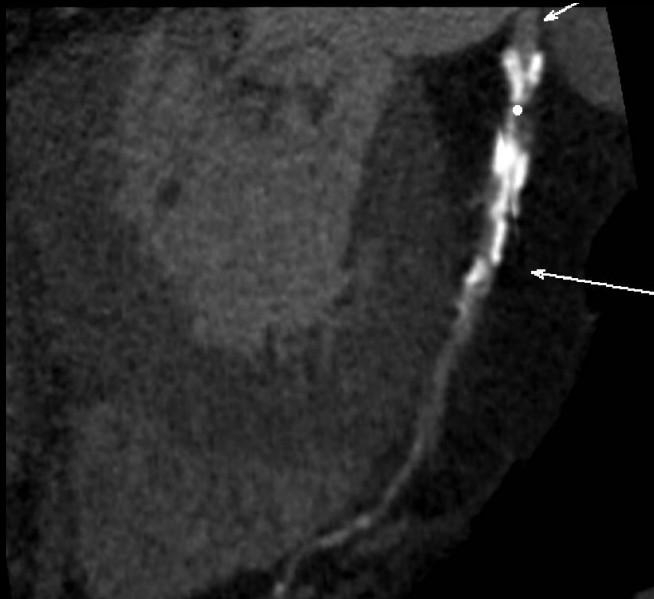
Fibrillazione Atriale



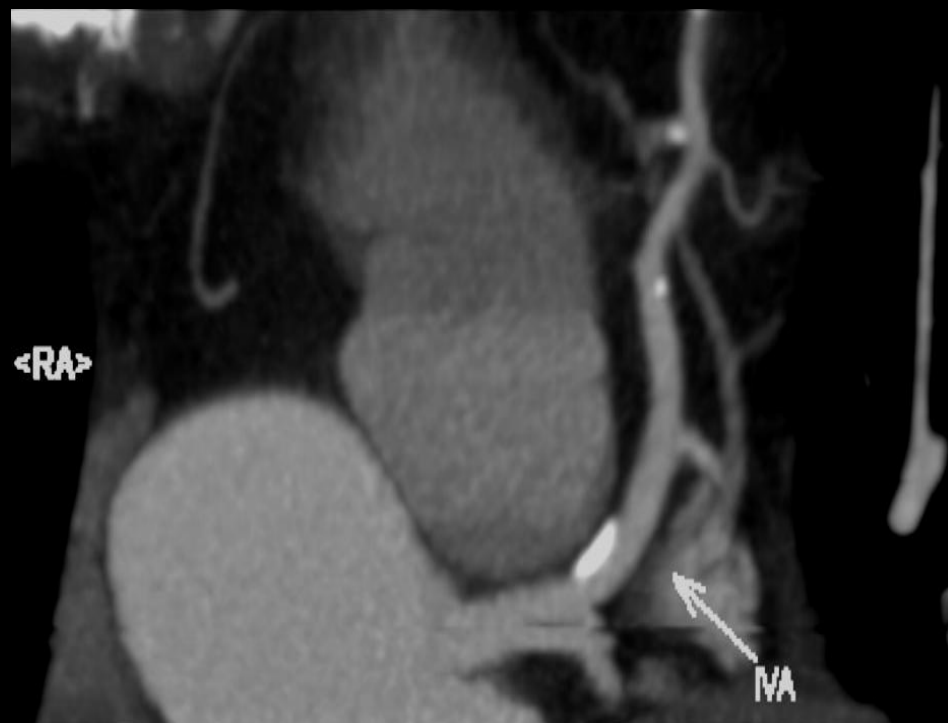
Ritmo Bigemino



Calcificazioni



Calcificazioni



Dose di Esposizione

- Radiazione di fondo annua USA 3 – 3.6 mSv
- Scintigrafia Tecnezio: 8 – 12 mSv
Tallio: 27 mSv
- Coronarografia: 5.6 – 5.8 mSv
- Tc coronarica: 5 – 20 mSv

Dose di Esposizione

- **Protocollo di acquisizione (gating retrospettivo)**
 - **Volume di studio**
 - **Pitch variabile**
 - **Modulazione di dose (ECG pulsing)**
 - **Uso di 100 kV vs. 120 kV (BMI)**
- **Step and Shoot (prospective gating): 2-5 mSv**

Imaging non coronarico

- **Valutazione anatomica delle vene polmonari e dell'atrio sin. prima di intervento di termocoagulazione con RF in pz. con FA**
- **Mappaggio del sistema venoso coronarico (posizionamento pace maker biventricolare)**

Imaging of the pulmonary veins by multi-detector row computed tomography

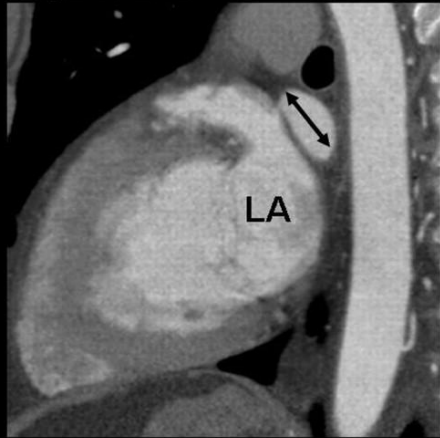
(A) Axial view



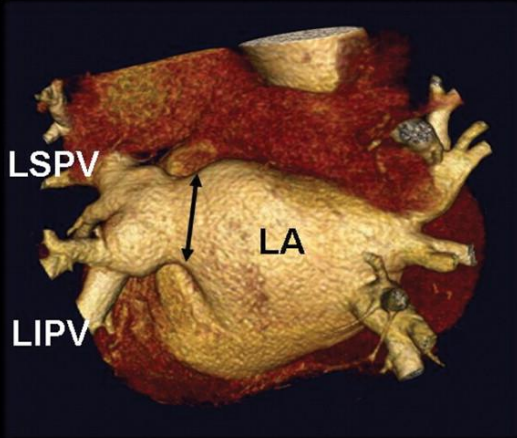
(B) Coronal view



(C) Sagittal view

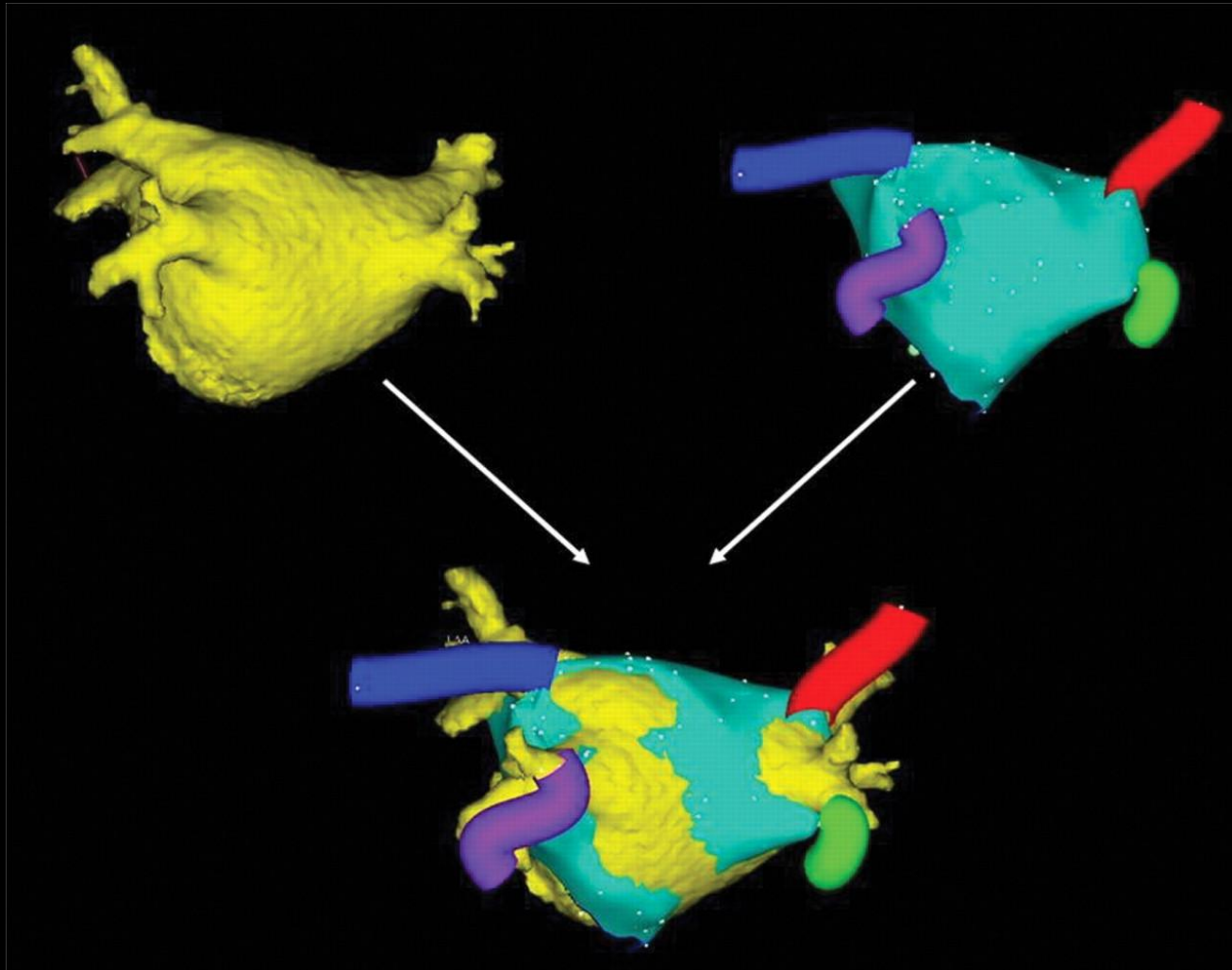


(D) Volume-rendered reconstruction



Schroeder, S. et al. Eur Heart J 2008 29:531-556;

Fusion imaging in electrophysiology using multi-detector row computed tomography and electro-anatomical mapping



Schroeder, S. et al. Eur Heart J 2008 29:531-556;

Valutazione sistema venoso

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Non-Invasive Visualization of the Cardiac Venous System in Coronary Artery Disease Patients Using 64-Slice Computed Tomography

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Leiden, the Netherlands; and Gent, Belgium

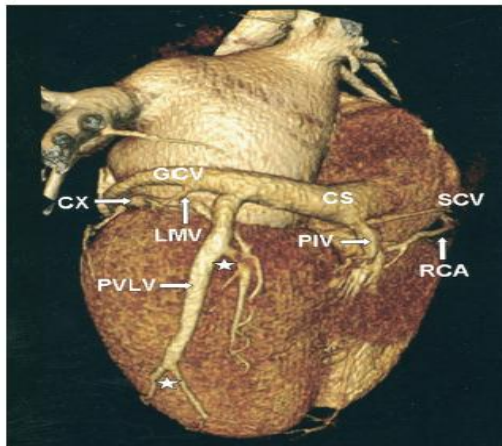


Figure 1. Volume-rendered reconstruction of the heart, posterolateral view. The first tributary of the coronary sinus (CS) is the posterior interventricular vein (PIV), running in the posterior interventricular groove. The second tributary of the CS is the posterior vein of the left ventricle (PVLV) with several side branches (asterisks). The next tributary is the left marginal vein (LMV). The great cardiac vein (GCV) will then continue as anterior cardiac vein in the anterior interventricular groove. Also note the circumflex coronary artery (CX) and right coronary artery (RCA).

1834 Van de Veire et al.
Cardiac Veins in CAD Patients Using Multi-Slice CT

JACC Vol. 48, No. 9, 2006
November 7, 2006:1832-8

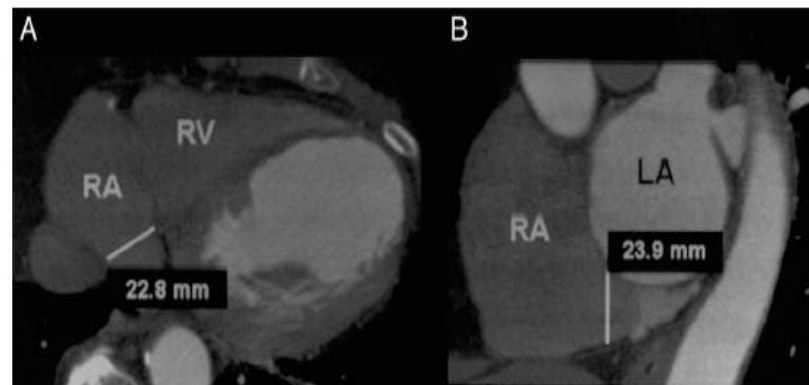


Figure 2. Measurement of the diameter of the coronary sinus (CS). The ostium of the CS was defined as the site where the CS makes an angle with the right atrium in the crux cordis area. This is best seen on the transverse plane. The diameter is first measured in the anteroposterior position (A). Multiplanar reformatting was then used to determine the size of the ostium in the supero-inferior direction on the coronal plane (B). LA = left atrium; RA = right atrium; RV = right ventricle.

Imaging non coronarico

- **Malattia Valvolare**
- **Masse cardiache**
- **Funzione ventricolare**
- **Malattie Congenite**
- **Vitalità e perfusione Miocardica**

**In caso di limitazioni nell'uso di ecocardiogramma,
MRI o TEE**