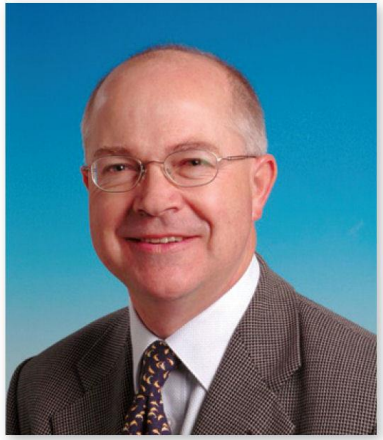


Dr Chris Ellis

Consultant Cardiologist
Auckland City Hospital
Auckland

Saturday, June 10, 2017

(Room 5)

16:30 - 17:25 WS #170: Everything You Need to Know About CT Cardiac Angiography & Calcium Scoring

17:35 - 18:30 WS #182: Everything You Need to Know About CT Cardiac Angiography & Calcium Scoring (Repeated)

Everything you need to know about CT Cardiac Angiography & Calcium Scoring

Dr Chris Ellis

Cardiologist

Greenlane CVS Services,

Auckland City Hospital

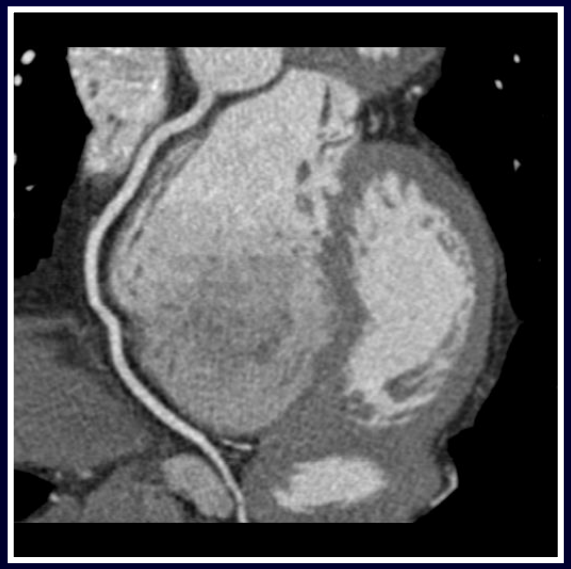
& Auckland Heart Group

NZMA Rotorua 2017 CME

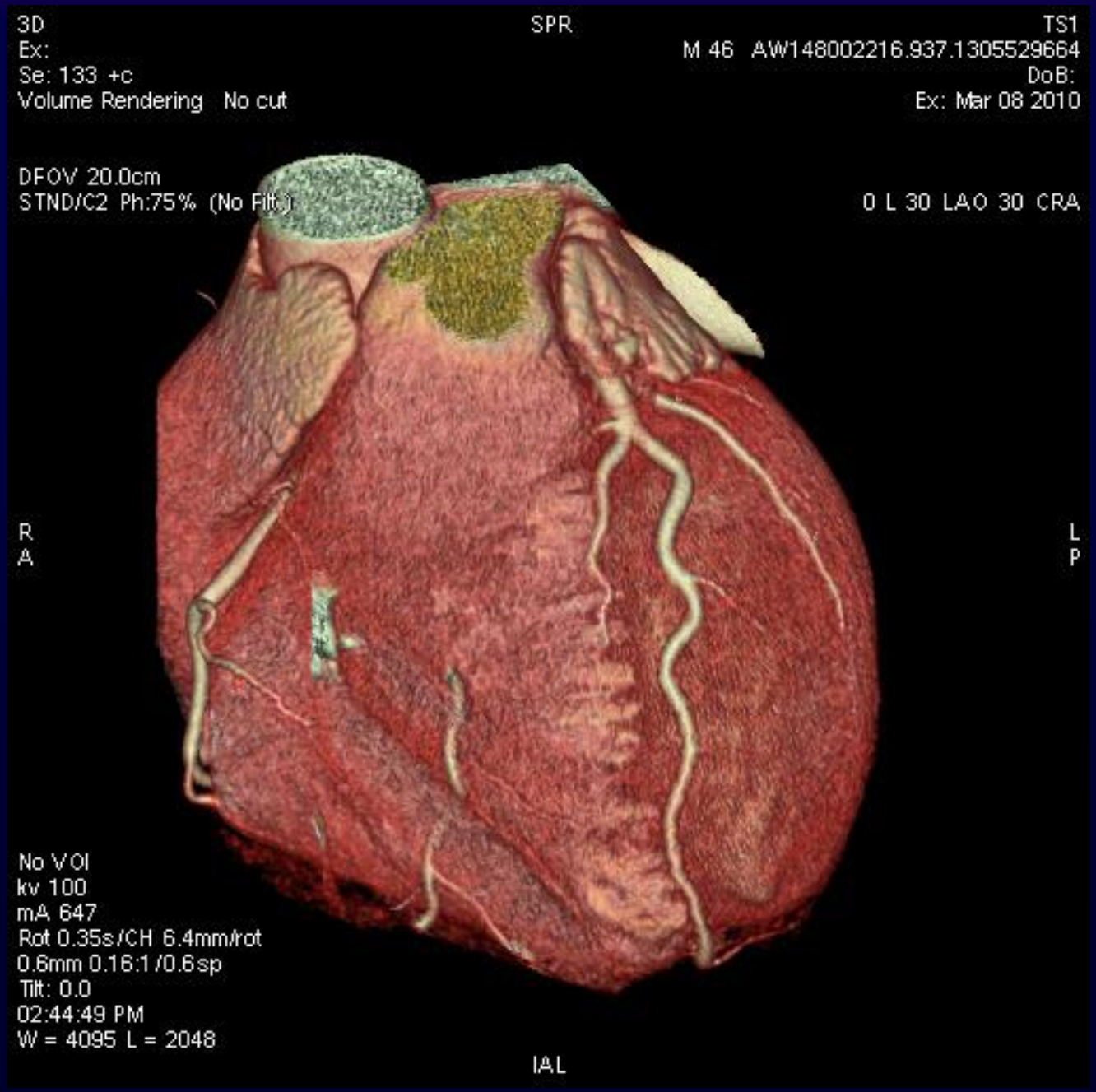
10 June 2017: 16.30

AUCKLAND HEART GROUP

Everything you need to Know about a Full CT Cardiac Angiogram (CTCA)



CT Cardiac Angiography 2017:
What is it? How Does it Work?


3D
Ex:
Se: 133 +c
Volume Rendering No cut
SPR
TS1
M 46 AW148002216.937.1305529664
DoB:
Ex: Mar 08 2010
DFOV 20.0cm
STND/C2 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 100
mA 647
Rot 0.35s/CH 6.4mm/rot
0.6mm 0.16:1/0.6sp
Tilt: 0.0
02:44:49 PM
W = 4095 L = 2048
IAL

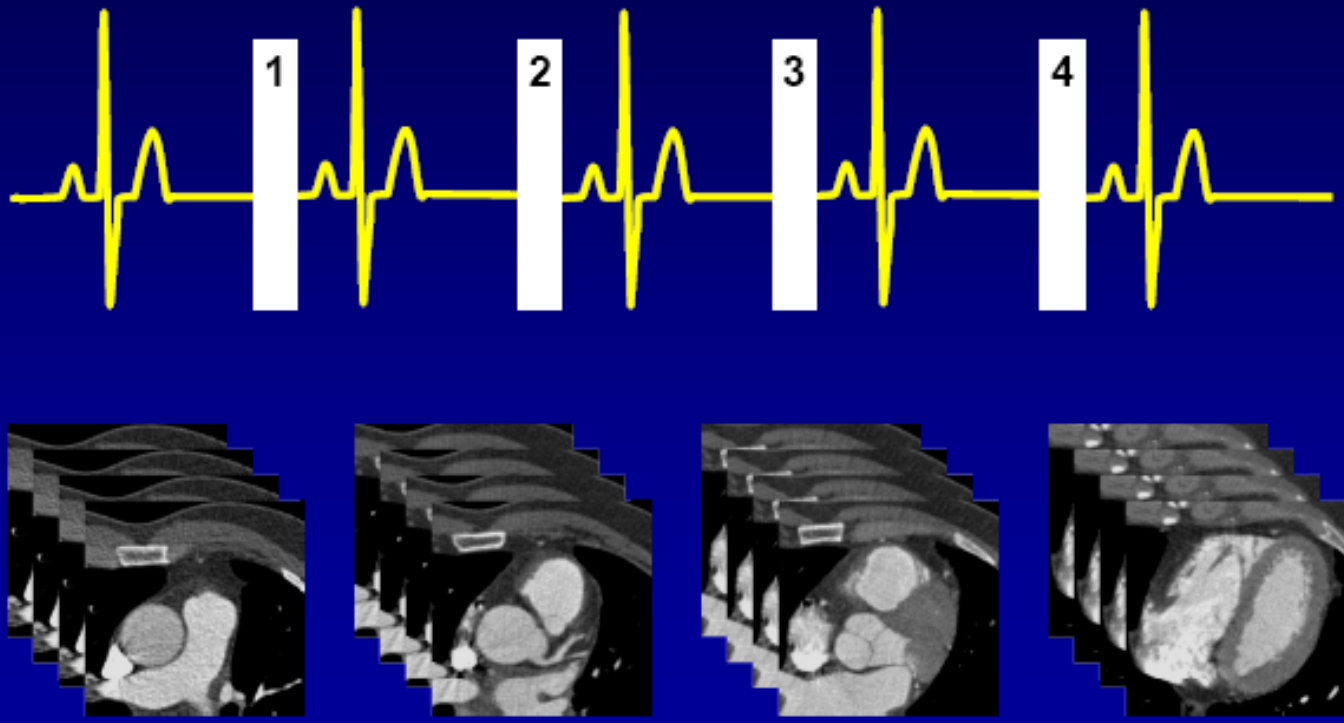
CT Cardiac Angiography 2017: Development Challenges

Coronary arteries:

- small and tortuous (2-4mm).
- Subjected to complex respiratory and cardiac motion.
- RCA moves at up to 120 km/hour

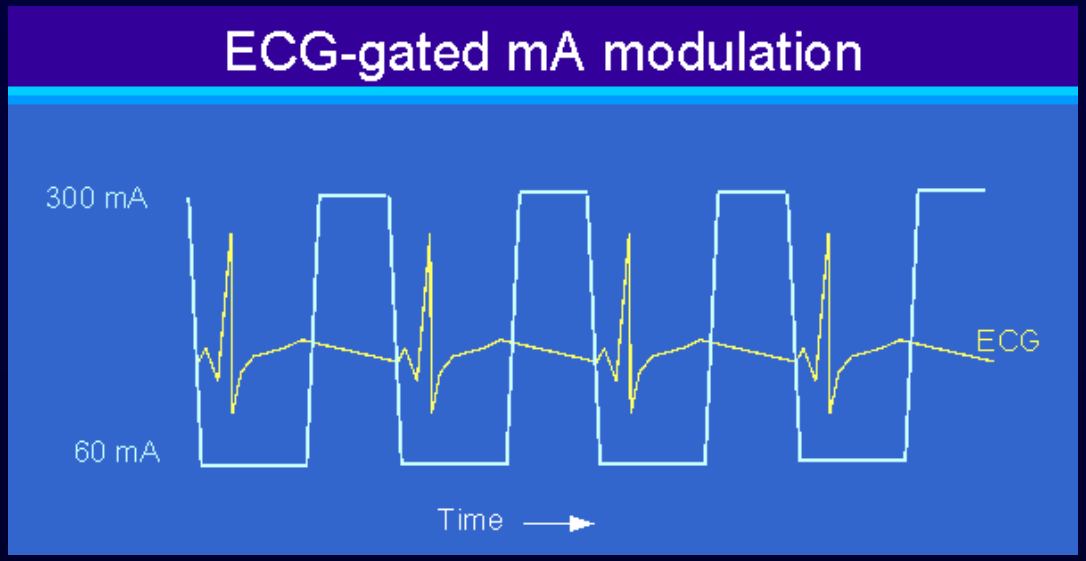
CTCA 2017: the Speed of the Right Coronary Artery

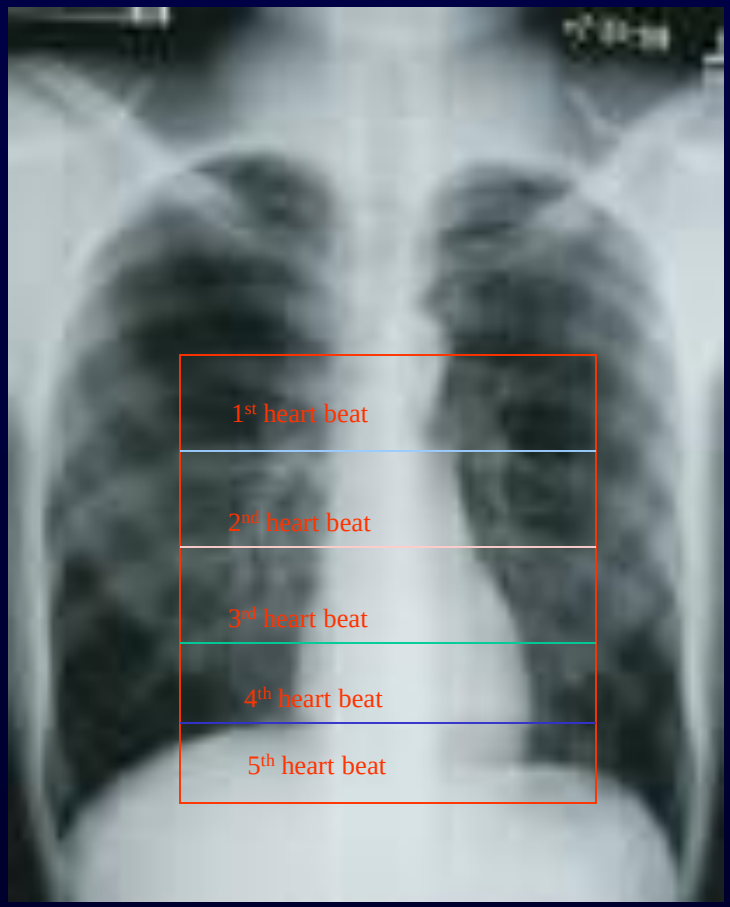
Synchronization With Cardiac Cycle



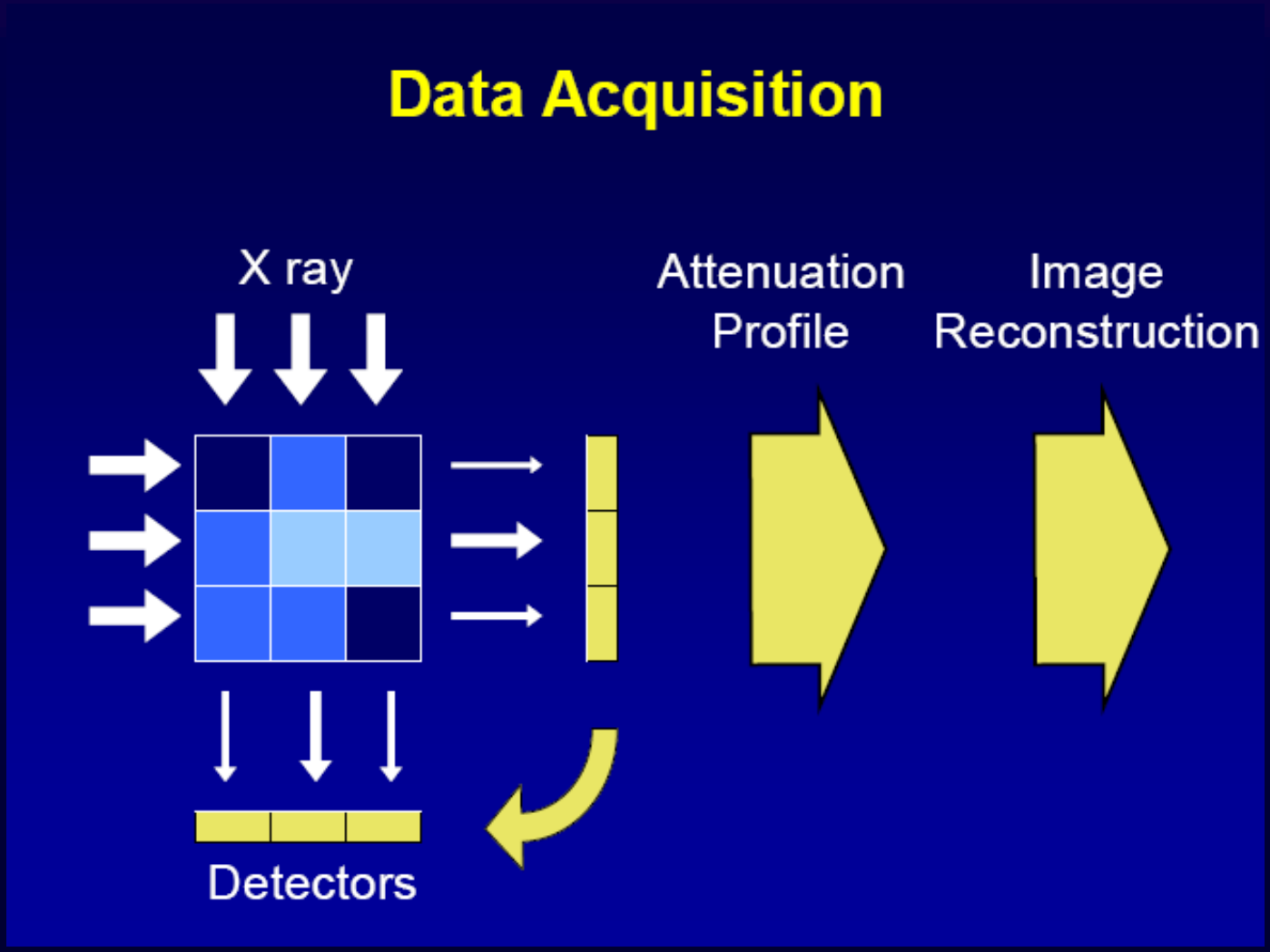
Multi-Slice CTCA

- ECG is ‘gated’; requires slow and steady HR (50-65 bpm).
- Acquires a 3D data set of the whole heart, in 6-10 seconds
- Scans in Diastole, static coronaries





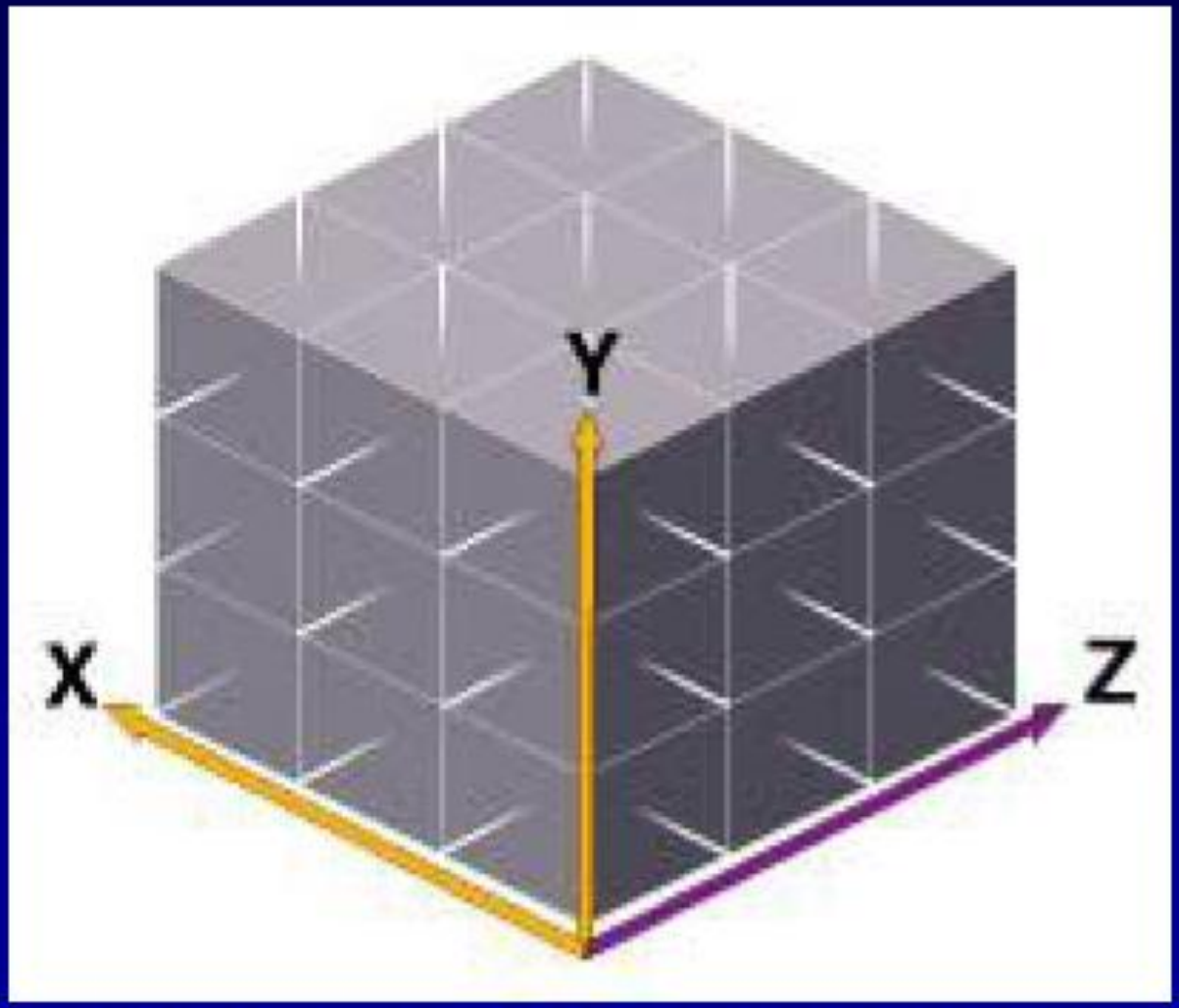
Data Acquisition



X-rays are collected by detectors which record and digitise into ‘voxels’ (3D ‘pixels’)

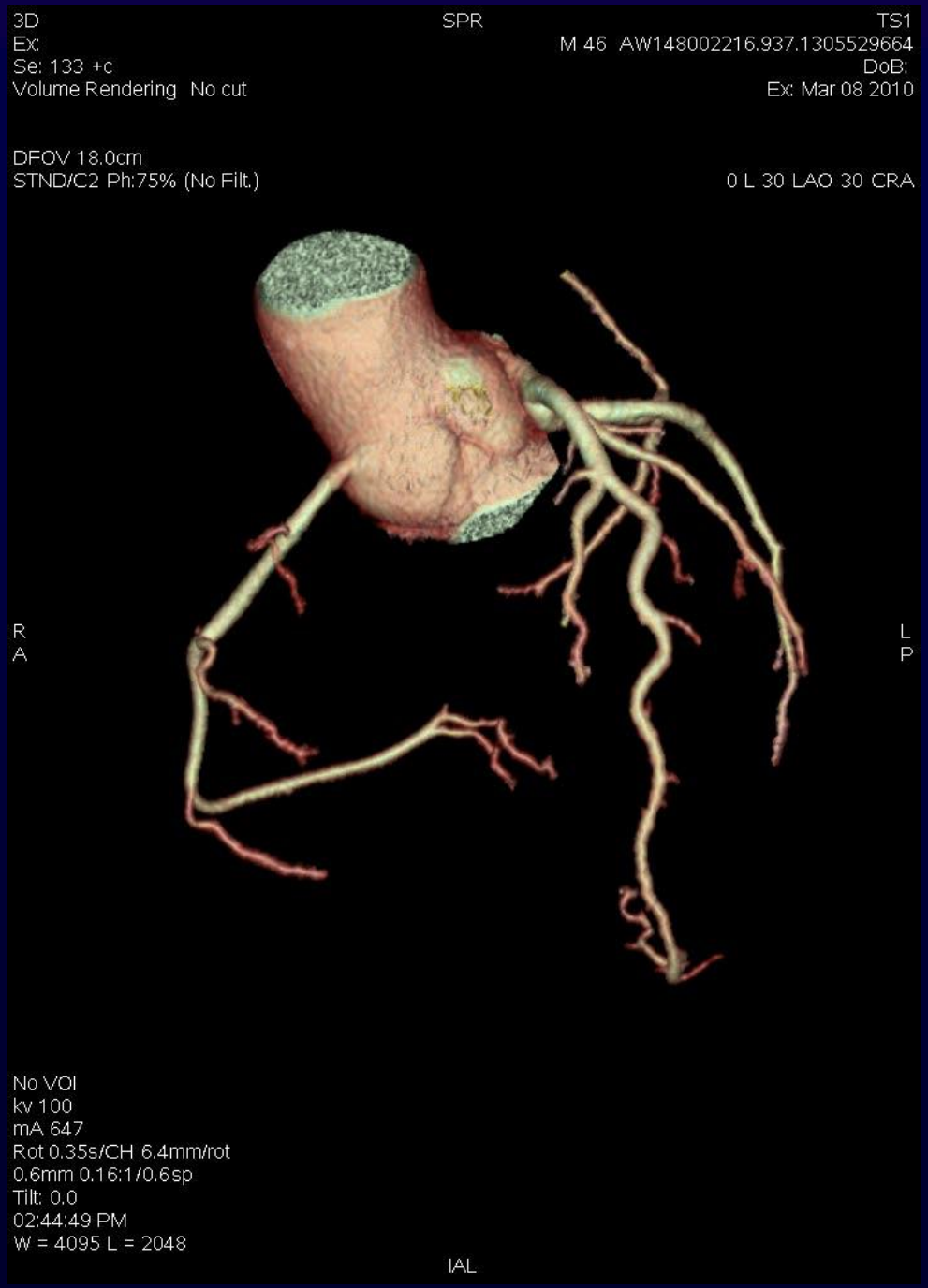
Voxel Size

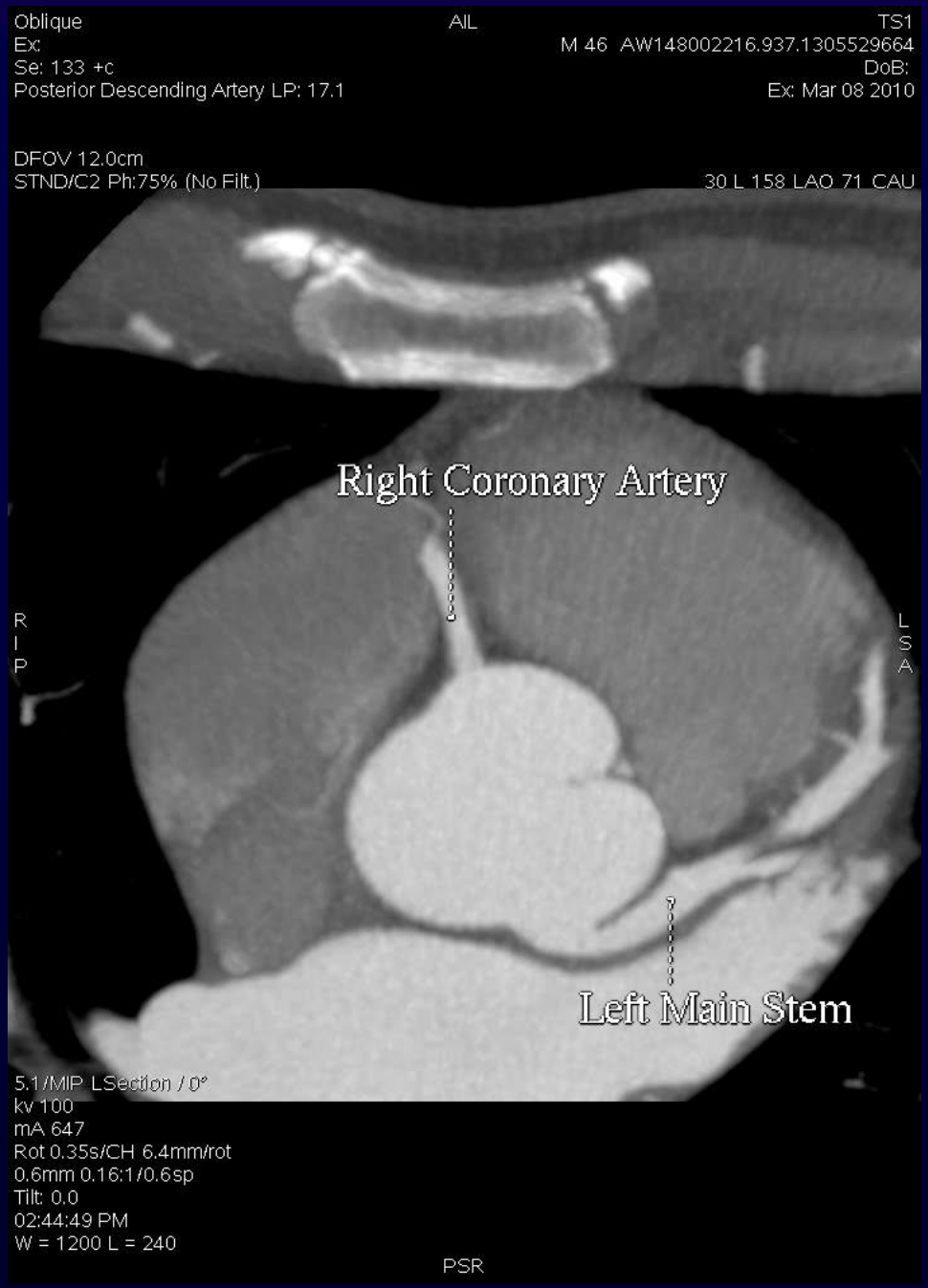
Spatial resolution 0.4mm x 0.4mm x 0.625mm

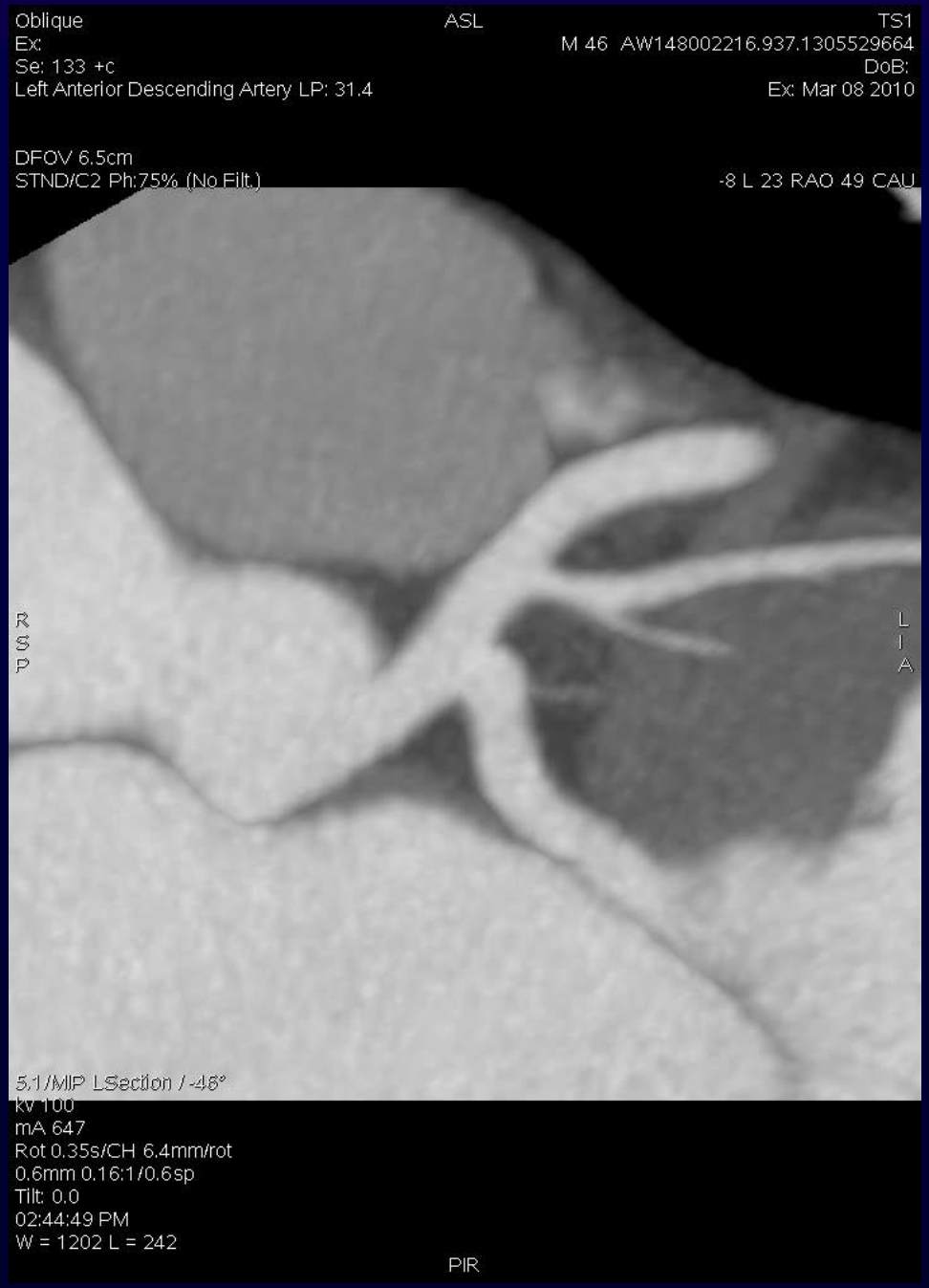


Voxel = “3-dimensional Pixel”


Oblique phase 70%
Ex: 1917
Se: 533
I: 192.6 (coi)
AI
MERCY RADIOLOGY
M 59 IGC793Z
Mar 12 2007
DFOV 21.3cm
STND Ph:70% (No Filt.)
15 L 180 LAO 52 CAU
R
L
9
1
1
2
2
0.4/
kv 120
mA Mod.
Rot 0.35s/CH 7.2mm/rot
0.6mm 0.18:1/0.6sp
Tilt: 0.0
03:30:55 PM
W = 800 L = 100
A
R
L
P
P
S


3D
SPR
TS1
Ex:
M 46 AW148002216.937.1305529664
Se: 133 +c
DoB:
Volume Rendering No cut
Ex: Mar 08 2010
DFOV 18.0cm
STND/C2 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 100
mA 647
Rot 0.35s/CH 6.4mm/rot
0.6mm 0.16:1/0.6sp
Tilt: 0.0
02:44:49 PM
W = 4095 L = 2048
IAL

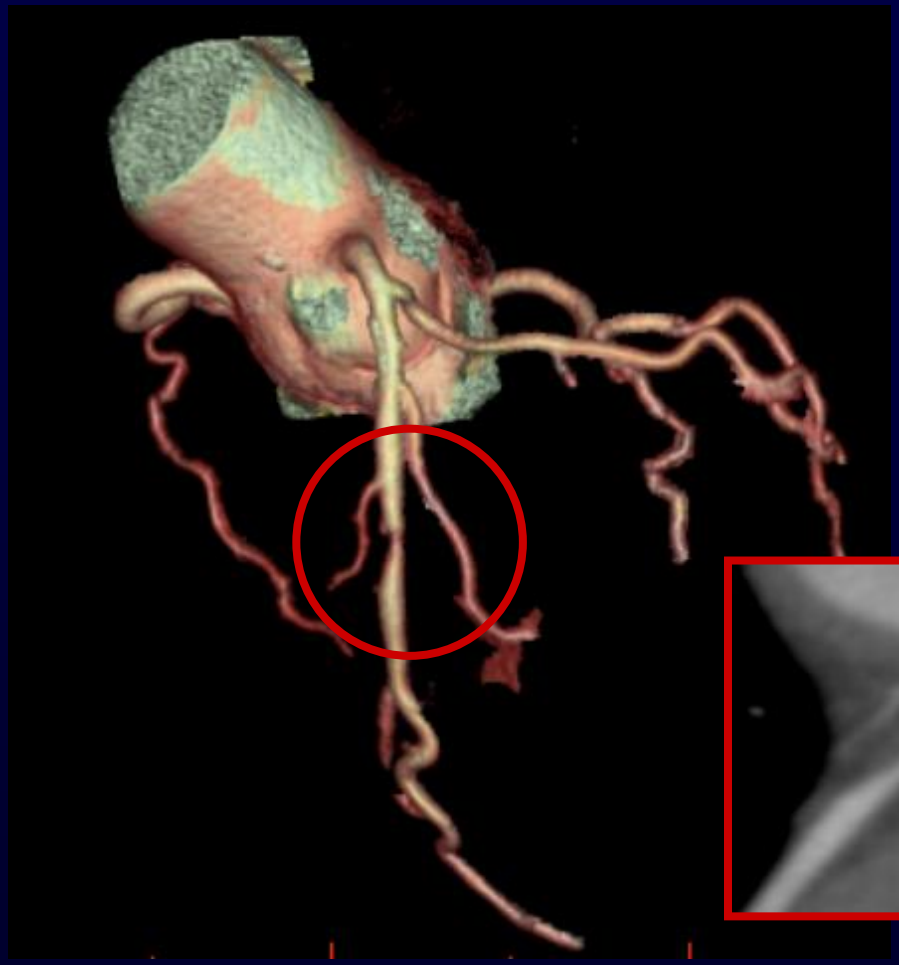

Oblique
AIL
TS1
Ex:
M 46 AW148002216.937.1305529664
Se: 133 +c
DoB:
Posterior Descending Artery LP: 17.1
Ex: Mar 08 2010
DFOV 12.0cm
STND/C2 Ph:75% (No Filt.)
30 L 158 LAO 71 CAU
Right Coronary Artery
R
I
P
L
S
A
Left Main Stem
5.1/MIP LSection / 0°
kv 100
mA 647
Rot 0.35s/CH 6.4mm/rot
0.6mm 0.16:1/0.6sp
Tilt: 0.0
02:44:49 PM
W = 1200 L = 240
PSR

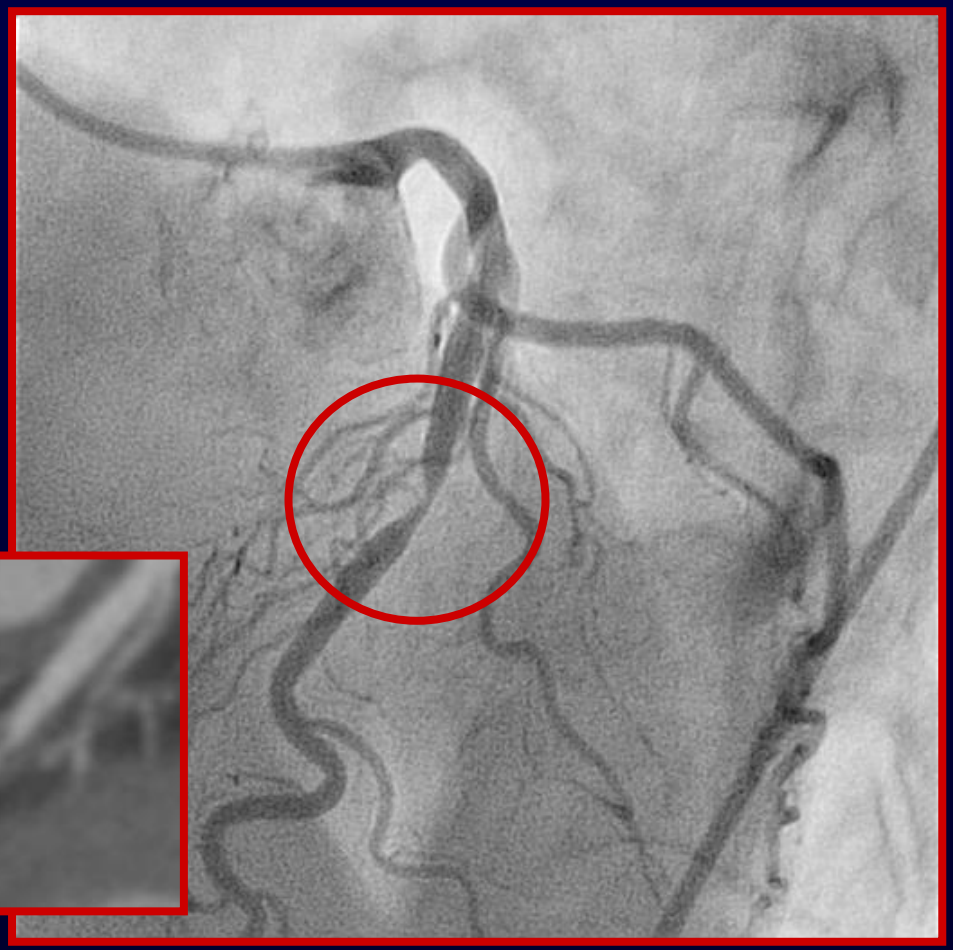

Oblique
ASL
TS1
Ex:
M 46 AW148002216.937.1305529664
Se: 133 +c
DoB:
Left Anterior Descending Artery LP: 31.4
Ex: Mar 08 2010
DFOV 6.5cm
STND/C2 Ph:75% (No Filt.)
-8 L 23 RAO 49 CAU
R
S
P
L
I
A
5.1/MIP LSection / -46°
kv 100
mA 647
Rot 0.35s/CH 6.4mm/rot
0.6mm 0.16:1/0.6sp
Tilt: 0.0
02:44:49 PM
W = 1202 L = 242
PIR

MPR: Curved Multiplanar Reformated Image, Single Frame

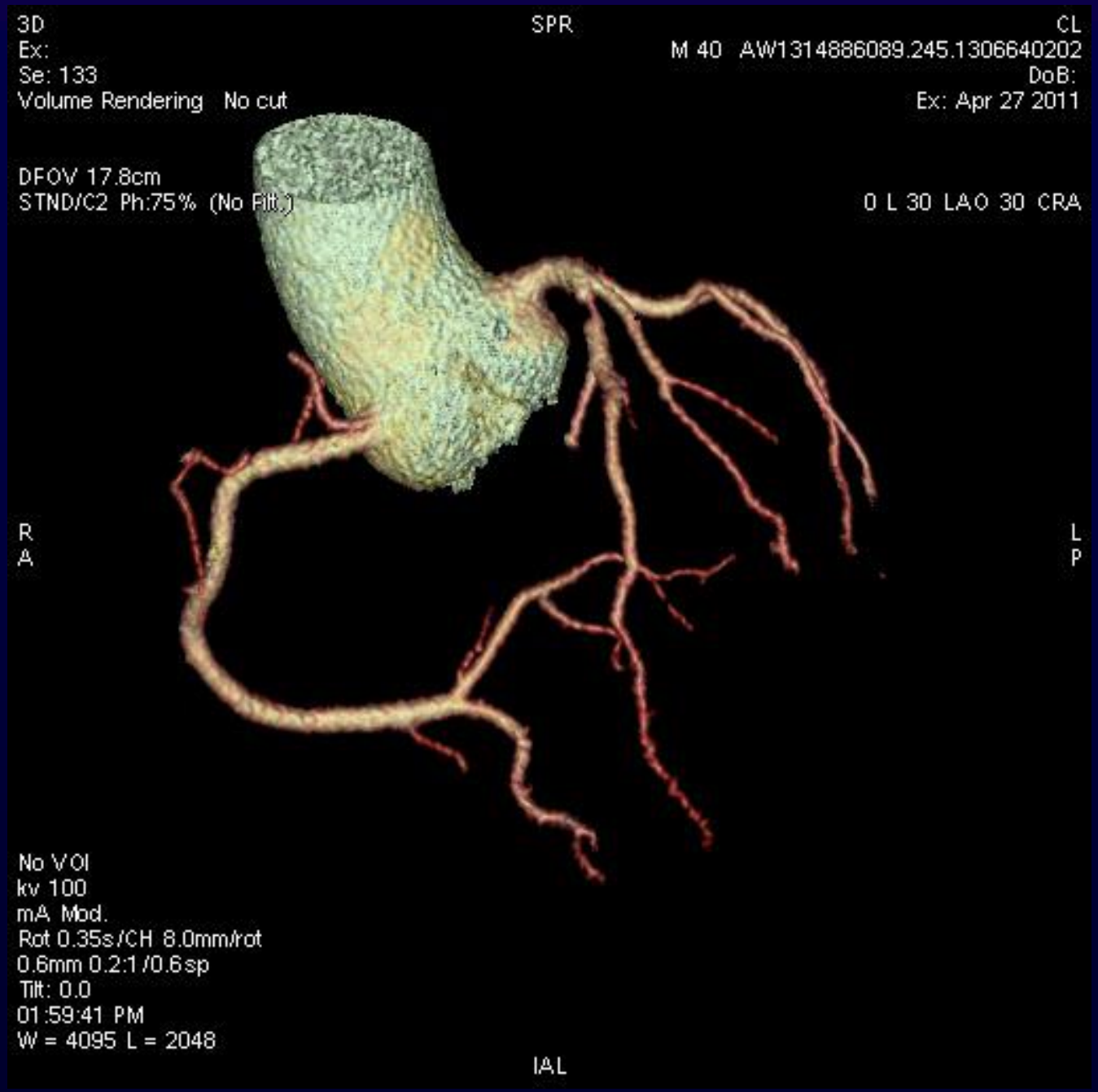
CT Angiography: Vessel Assessment

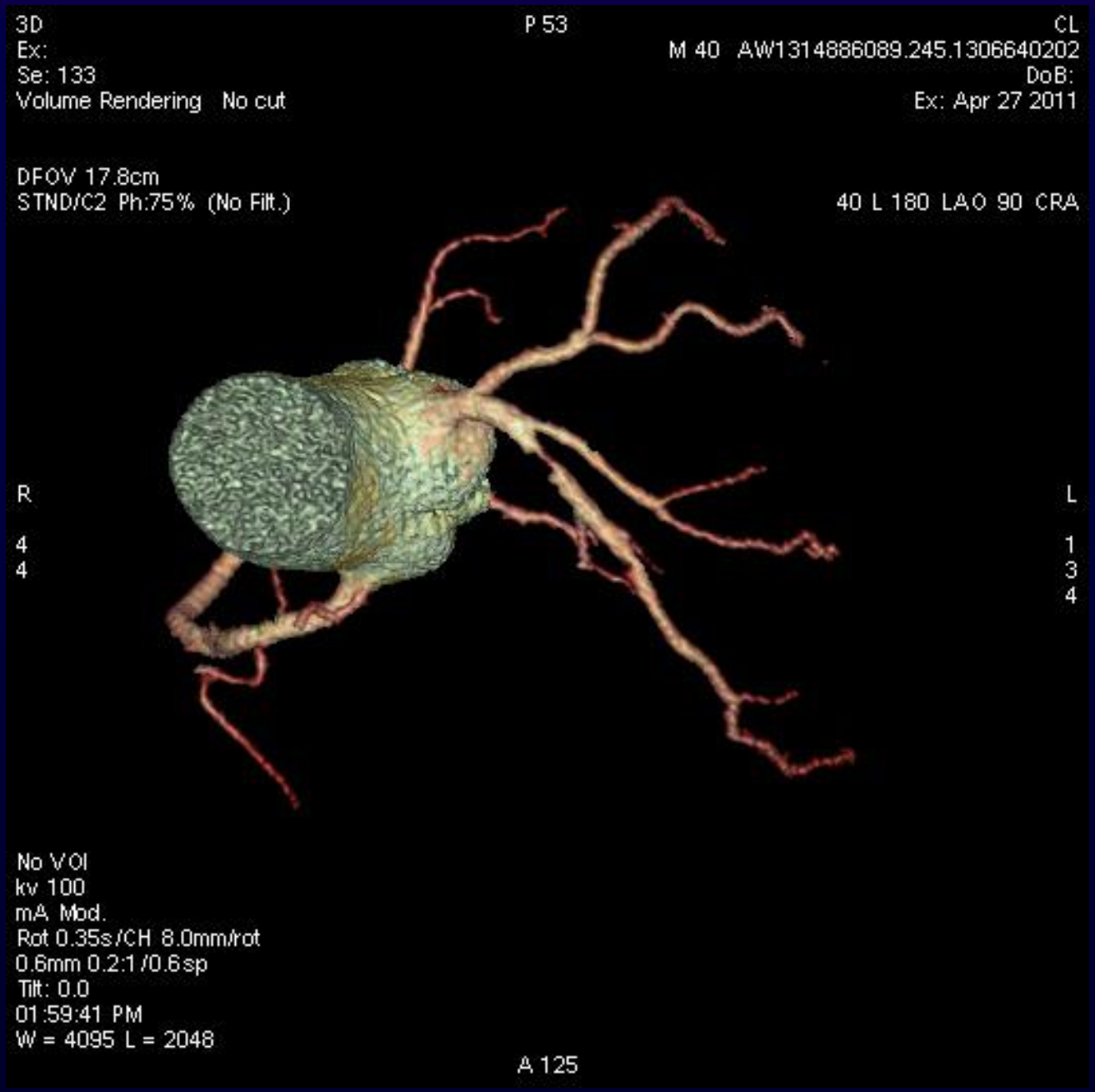
Case 1: Excellent correlation between CT Angiography and Conventional Angiography. Mid LAD stenosis. PCI

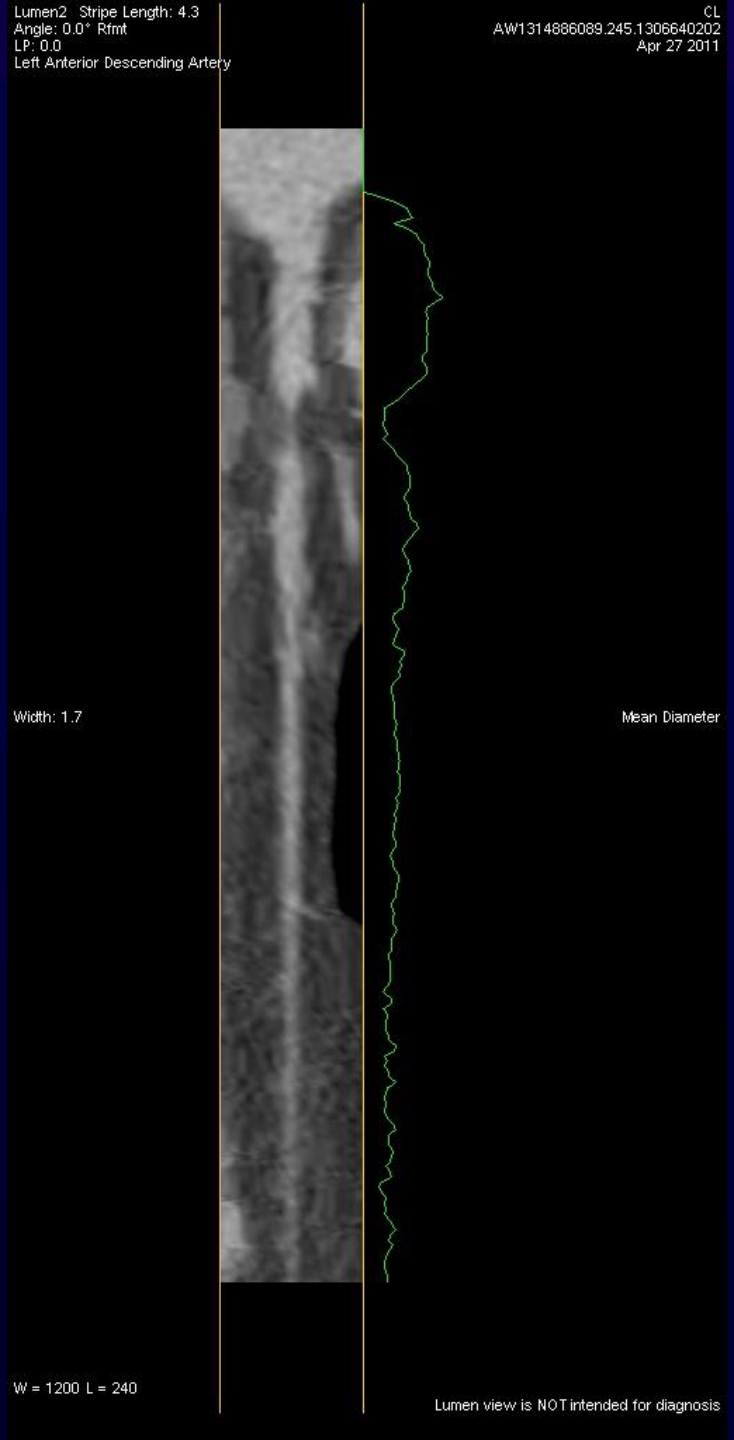


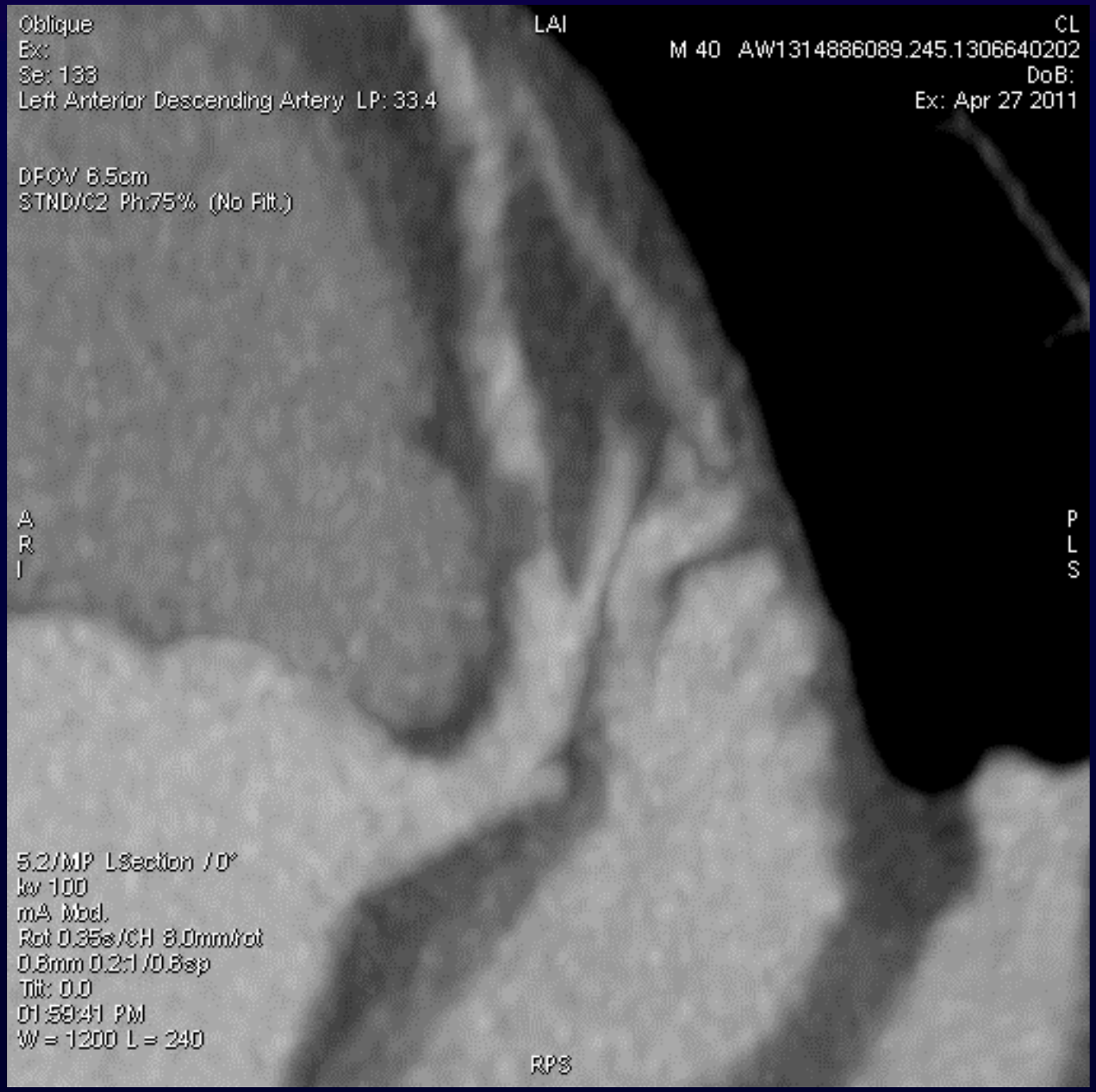


CTCA Case A: Male of 40 Years Presentation with Atypical Chest Pain


3D
SPR
CL
Ex:
M 40 AW1314886089.245.1306640202
Se: 133
DoB:
Volume Rendering No cut
Ex: Apr 27 2011
DFOV 17.8cm
STND/C2 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
01:59:41 PM
W = 4095 L = 2048
IAL


3D
P 53
CL
Ex:
M 40 AW1314886089.245.1306640202
Se: 133
DoB:
Volume Rendering No cut
Ex: Apr 27 2011
DFOV 17.8cm
STND/C2 Ph:75% (No Filt.)
40 L 180 LAO 90 CRA
R
L
4
4
1
3
4
No VOI
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
01:59:41 PM
W = 4095 L = 2048
A 125


Lumen2 Stripe Length: 4.3
Angle: 0.0° Rfmt
LP: 0.0
Left Anterior Descending Artery
CL
AW1314886089.245.1306640202
Apr 27 2011
Width: 1.7
Mean Diameter
W = 1200 L = 240
Lumen view is NOT intended for diagnosis


Oblique
Ex:
Se: 133
Left Anterior Descending Artery LP: 33.4
LAI
CL
M 40 AW1314886089.245.1306640202
DoB:
Ex: Apr 27 2011
DFOV 6.5cm
STND/C2 Ph:75% (No Filt.)
A
R
I
P
L
S
5.2/MP Lsection /0°
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.8mm 0.2:1 /0.8sp
Tilt: 0.0
01:59:41 PM
W = 1200 L = 240
RPS

CTCA Challenges 2017: Patient Selection

Heart rate inversely proportional to image quality: Need to lower HR to <60 bpm

- Oral & iv metoprolol tartrate before scan
- Significant asthma is a relative contra-indication

Calcification obscures lumen views

- Old patients (> 70 years) may not be suitable
- Prior CABG or PCI patients are not suitable

CTCA Challenges: Patient Selection 2

Obese patients: images are worse

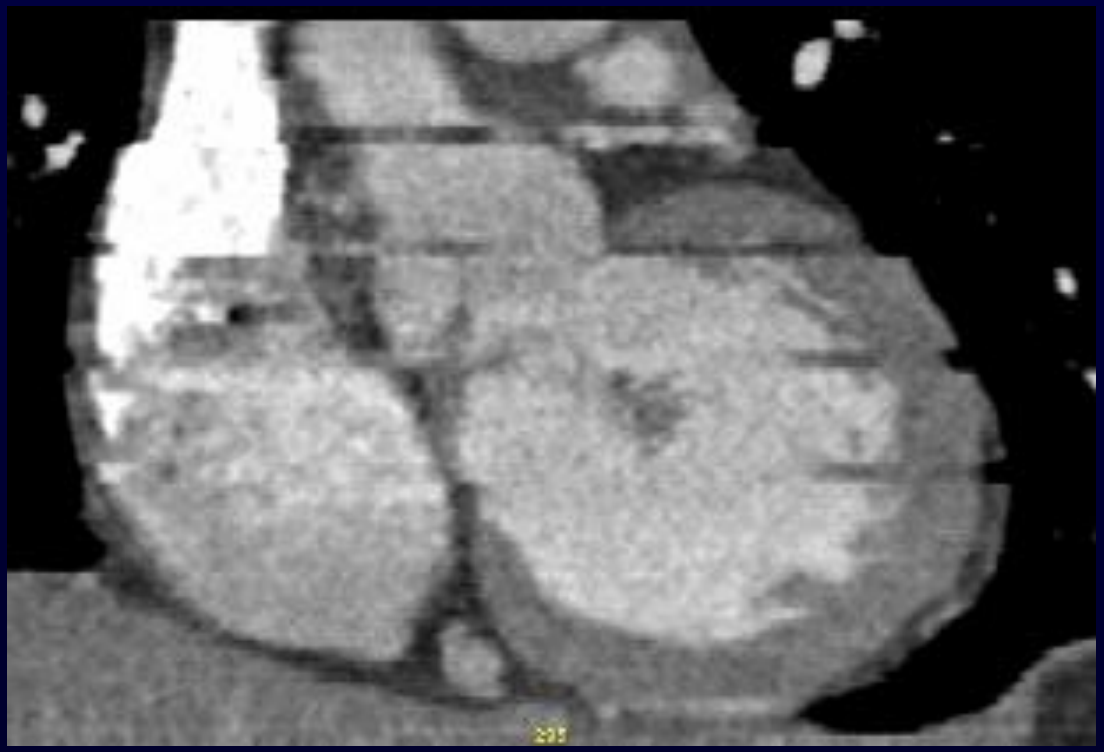
- Slender patients give better (more accurate) images

Irregular heart beats: limit accuracy

- Avoid patients with multiple atrial/ventricular ectopy
- Atrial fibrillation patients not usually suitable

CTCA Challenges 2017: Irregular Heart Beat

- Irregular rhythm results in a ‘artefact’
  - ‘Steps’ in the cardiac image
  - e.g. Atrial fibrillation, frequent ectopy



ACCURACY Trial.

Budoff et al. JACC 2008;52:1724-32

- To evaluate diagnostic accuracy of 64-slice CTA vs Invasive coronary angiography (ICA)
  - 16 USA Centres: All ‘Lightspeed’ GE Scanners
- 230 pts referred for a conventional ‘invasive coronary angiogram (ICA)
  - 59% male, mean age 57 ± 10 years
- Ability to detect ≥ 50% and ≥ 70% stenoses
- All pts and all segments assessed, no exclusions for poor images

ACCURACY Trial: Results

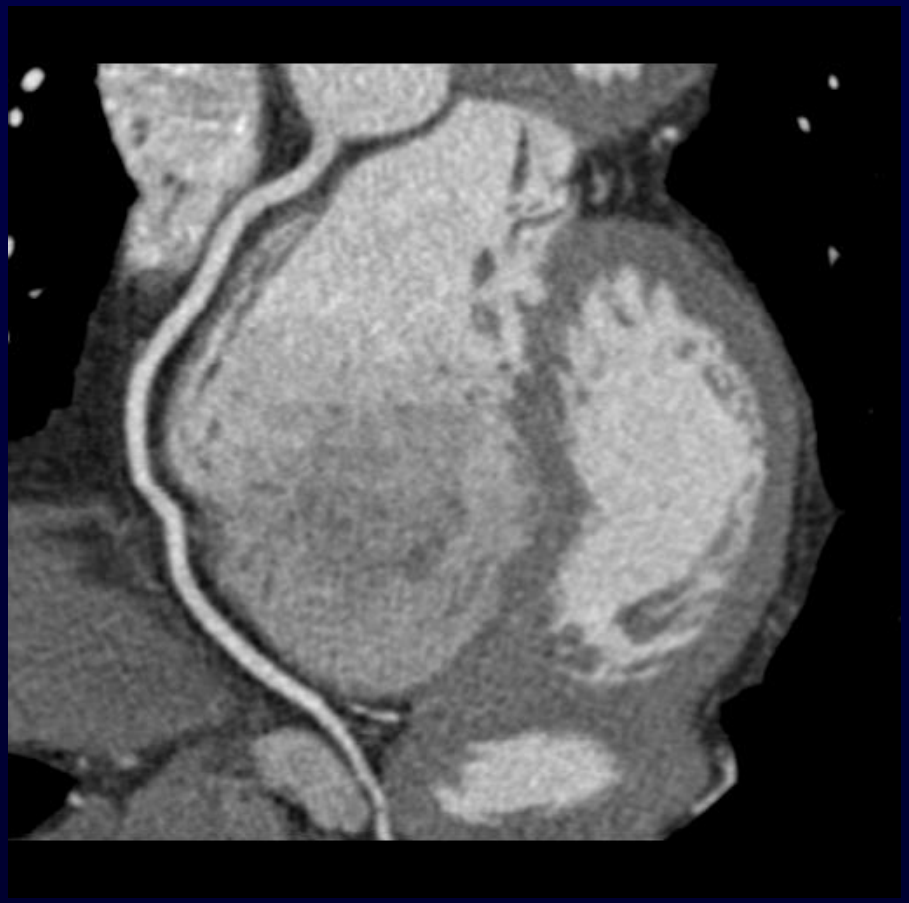
Table 2 Patient-Based Analysis

	Estimate, %	95% CI, %	Subjects in Group, n	Subjects Correct by CCTA, n
≥50% stenosis				
Sensitivity	95	85–99	55	52
Specificity	83	76–88	172	142
PPV	64	53–75	81	52
NPV	99	96–100	143	142
≥70% stenosis				
Sensitivity	94	79–99	31	29
Specificity	83	77–88	196	162
PPV	48	35–62	60	29
NPV	99	96–100	164	162

CCTA = coronary computed tomographic angiography; CI = confidence interval; NPV = negative predictive value; PPV = positive predictive value.

"The high NPV (99%) firmly establishes CTA as an effective non-invasive method to rule out obstructive coronary artery stenosis."

CTA: High Negative Predictive Value for Non-obstructive Coronary Disease

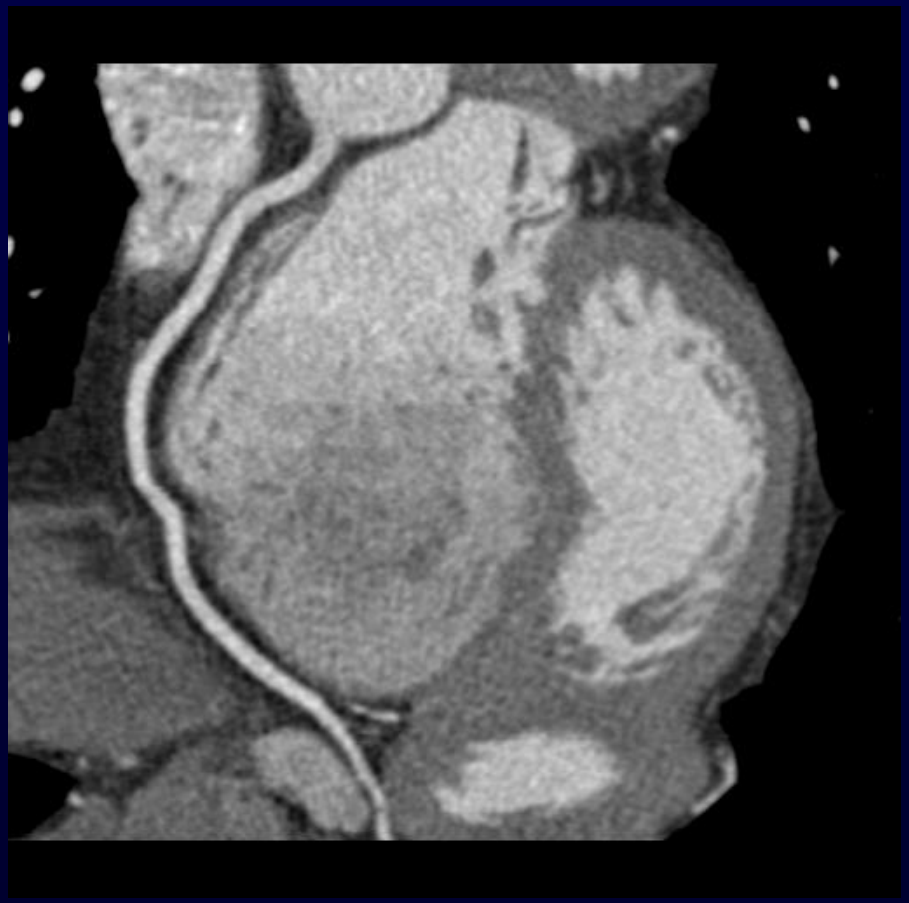


As long as the images obtained are of good quality

Case 1 (MM): Recurrent Atypical Symptoms

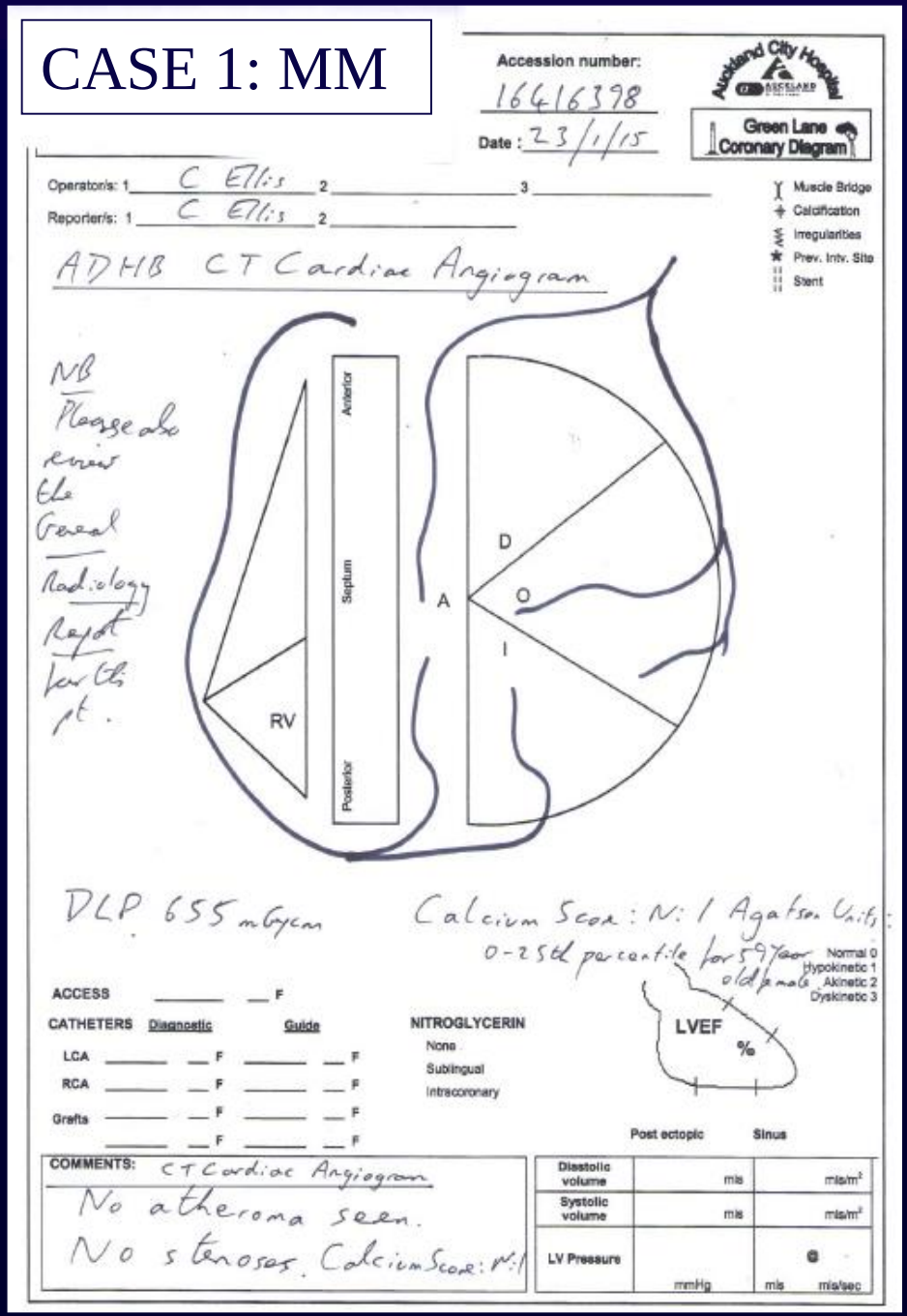
- 59 year old female, ‘vice-like’ chest pains
  - ACH admission: Xmas holidays
  - ECG/Troponins normal
  - SOB at 7 mins ETT, No ECG changes
- FH of hypertension; T Chol. 6.0 mmol/l
- Options:
  - Nil else, stress echo, Cath, CTA, Other?

CTA: High Negative Predictive Value for Non-obstructive Coronary Disease



As long as the images obtained are of good quality

CASE 1: MM



Accession number: 16416398

Date: 23/1/15

Auckland City Hospital

Green Lane Coronary Diagram

Operator/s: 1 C Ellis 2 3

Reporter/s: 1 C Ellis 2

Muscle Bridge
Calcification
Irregularities
Prev. Intv. Site
Stent

ADHB CT Cardiac Angiogram

NB Please also review the formal Radiology Report for this pt.

Anterior
Septum
Posterior
RV
A
D
O
I

DLP 655 mGycm

Calcium Score: N: 1 Agatston Units: 0-25th percentile for 5-9 year old females

Normal 0
Hypokinetic 1
Akinetic 2
Dyskinetic 3

LVEF %

ACCESS ___ F

CATHETERS Diagnostic Guide

	Diagnostic		Guide	
LCA	___	F	___	F
RCA	___	F	___	F
Grafts	___	F	___	F
	___	F	___	F

NITROGLYCERIN
None
Sublingual
Intracoronary

Post ectopic Sinus

COMMENTS: CT Cardiac Angiogram

No atheroma seen.

No stenoses. Calcium Score: N:1

Diastolic volume	mls	mls/m²
Systolic volume	mls	mls/m²
LV Pressure	mmHg	mls mls/sec

Case 1 (MM) Atypical Symptoms: Summary

- CT Angiogram excluded flow limiting stenoses
  - Ca score optimally assessed CVS risk
- Gastroscopy, GORD, Omeprazole
  - Patient happy
  - Drs confident of diagnoses
  - Management clear

CASE 2 (BA): Inconclusive ETT Results

- 70 year old male, usually fit & well
  - 2 month history of exertional chest pain & SOBOE
  - COPC ETT to 12 mins
  - No chest pain or ST segment changes
- FH IHD (F < 60 years), hypertension, on statin
- Options:
  - Nil else, stress echo, Cath, CTA, Other?

The Problem with HIGH Calcium load

CASE 2: BA

Accession number: 16417069

Date: 23/1/15

Auckland City Hospital

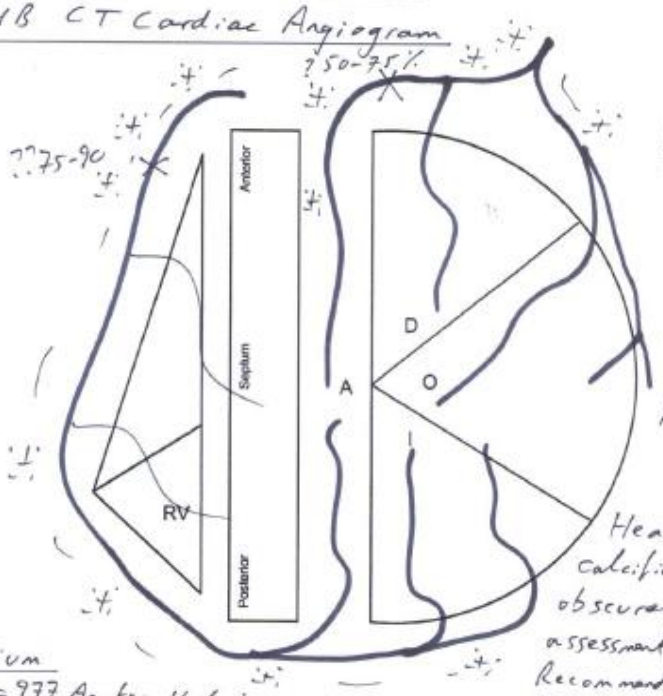
Green Lane Coronary Diagram

Operator/s: 1 C Ellis 2 3

Reporter/s: 1 C Ellis 2

Muscle Bridge
Calcification
Irregularities
Prev. Intv. Site
Stent

ADHB CT Cardiac Angiogram



NB Please Also review the General Radiology Report for this pt

Heavy calcification obscures good assessment of Lumen. Recommend Invasive Coronary angiogram.

Calcium Score = 977 Agatston Units: 75 to 90th percentile for a 70 year old male.

DLP 818 mGycm

Normal 0
Hypokinetic 1
Akinetic 2
Dyskinetic 3

LVEF %

ACCESS ____ F

CATHETERS Diagnostic Guide

LCA	F	F
RCA	F	F
Grafts	F	F
	F	F

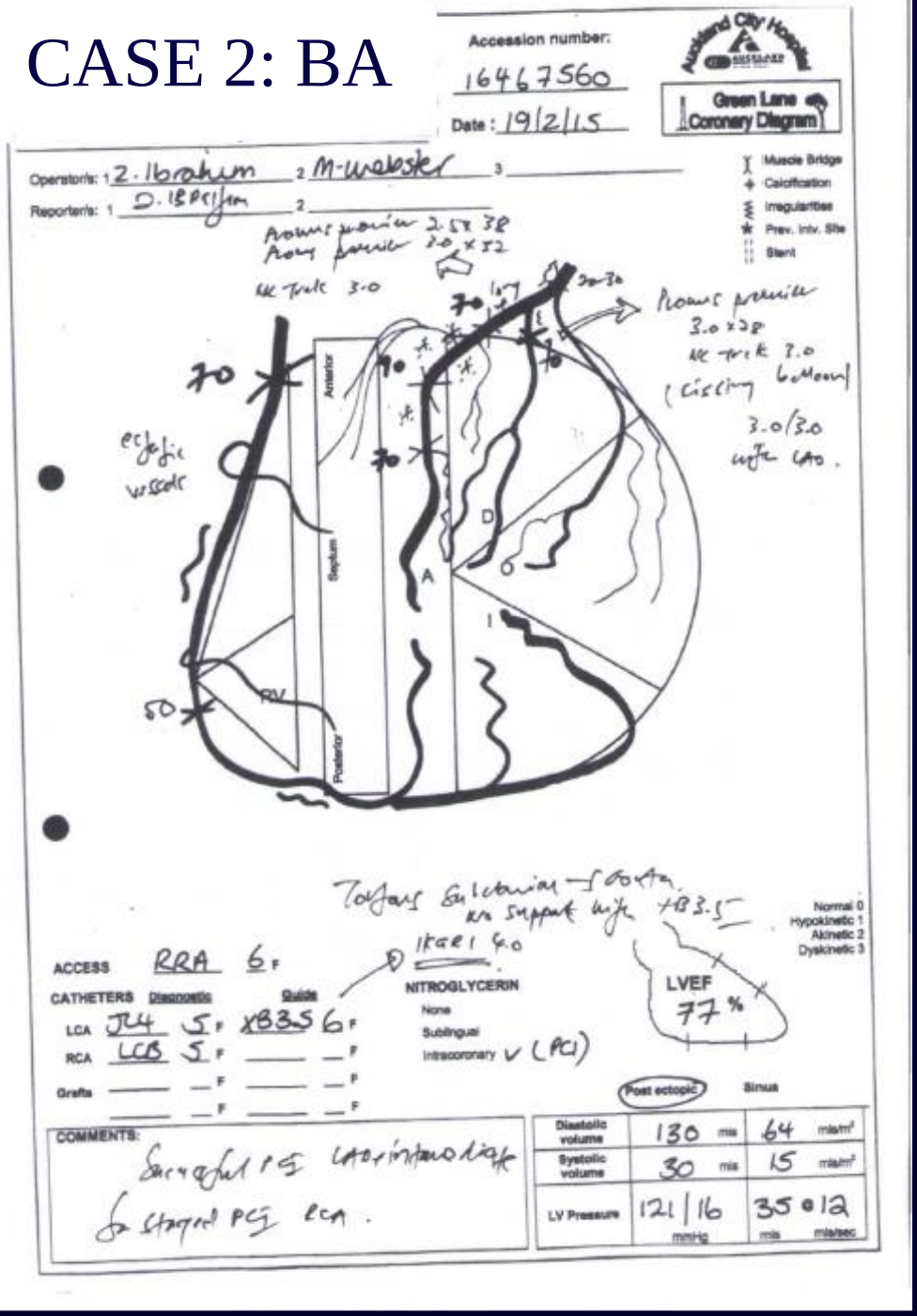
NITROGLYCERIN
None
Sublingual
Intracoronary

Post ectopic Sinus

COMMENTS:
Ca Score: 977 (75-90%)
Calcium obscures Lumen.
Possible Stenoses. Recommend Invasive Angiogram.

Diastolic volume	mls	mls/m²
Systolic volume	mls	mls/m²
LV Pressure	mmHg	☺ mls mls/sec

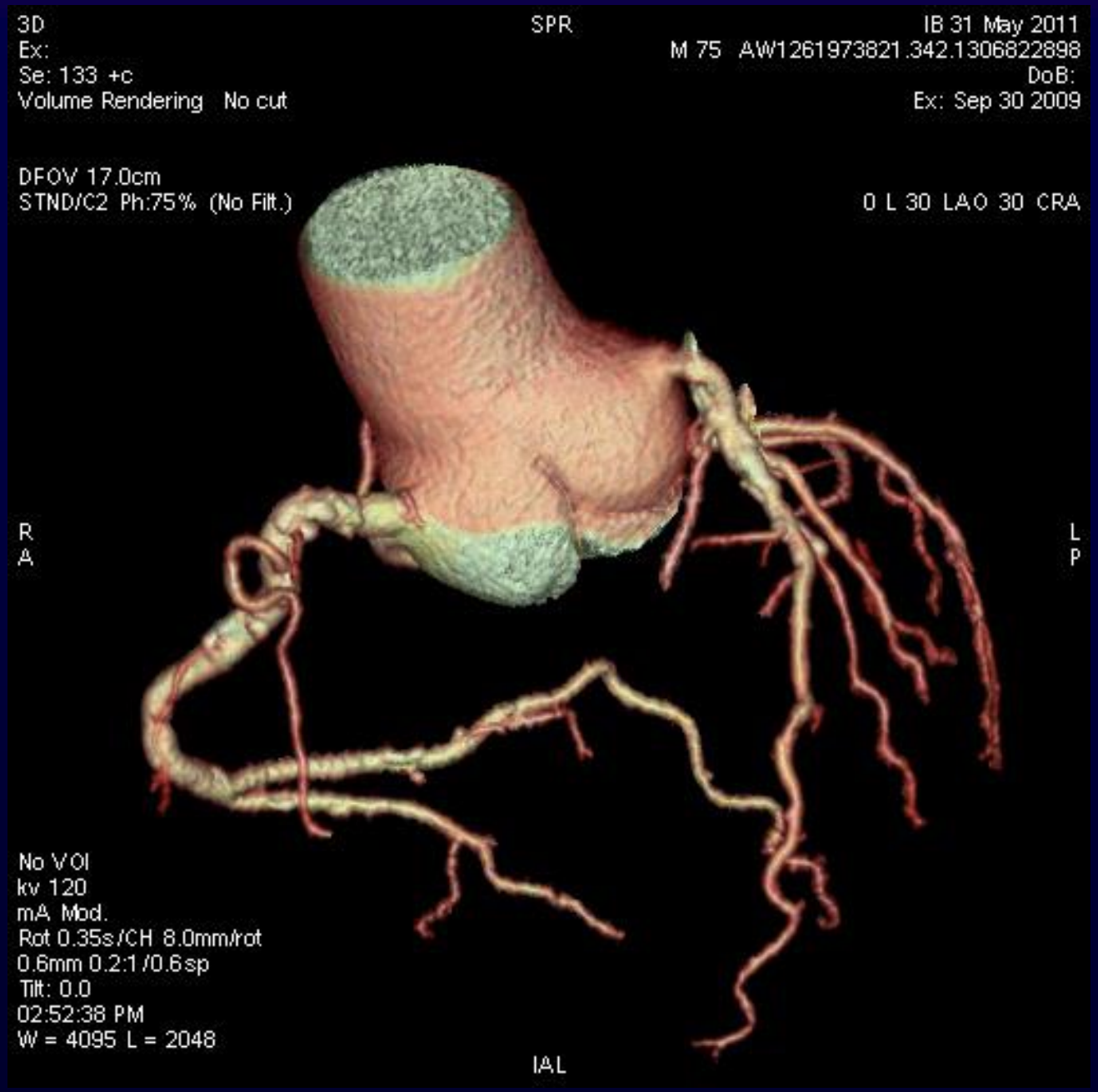
CASE 2: BA

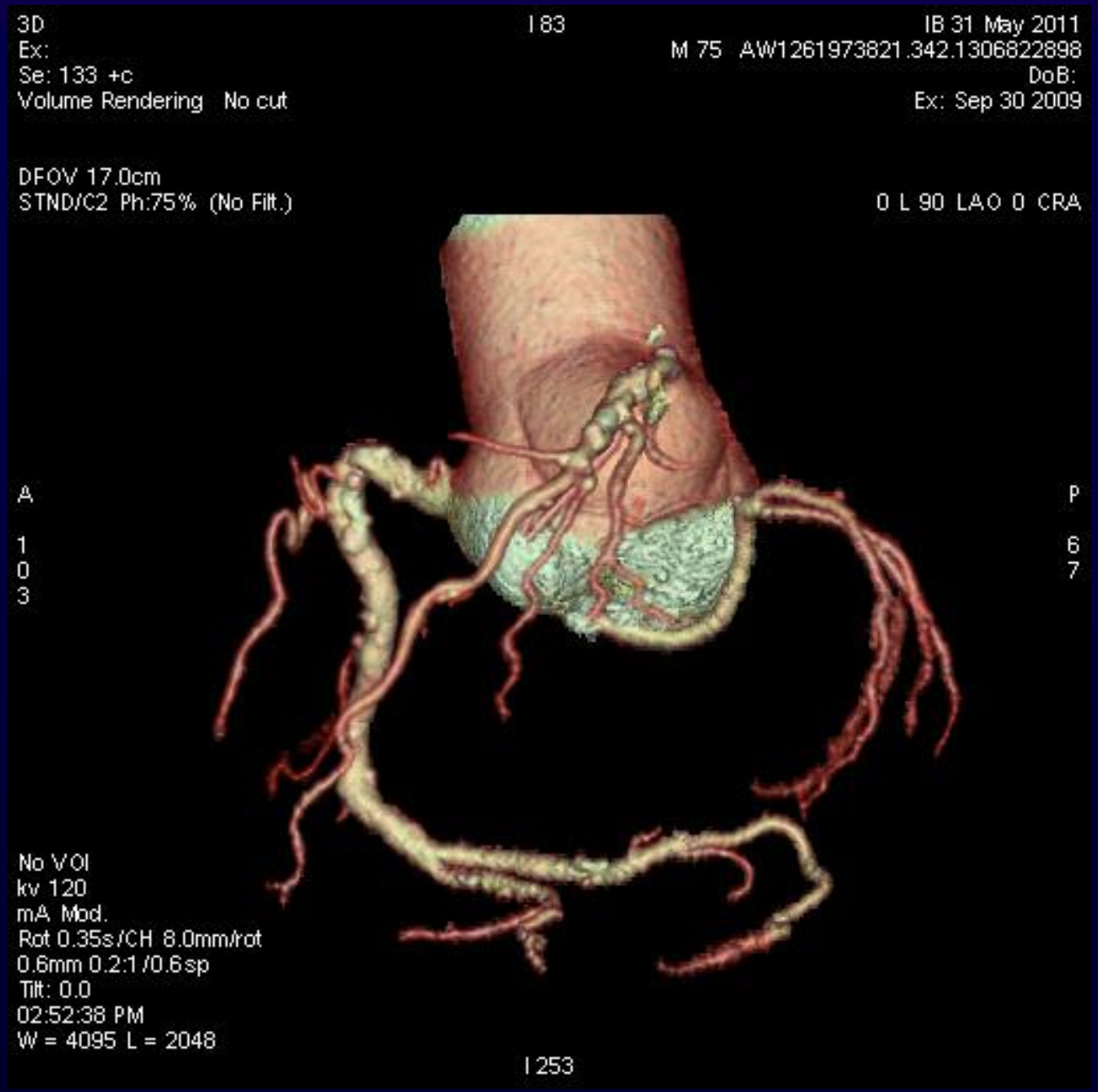

Accession number:
16467560
Date: 19/2/15
Auckland City Hospital
Green Lane Coronary Diagram
Operators: 1 Z. Ibrahim 2 M-Webster 3
Reporters: 1 D. Ispiljan 2
Muscle Bridge
Calcification
Irregularities
Prev. Intv. Site
Stent
Anterior
Septum
Posterior
RV
70
70
70
70
50
ectopic vessel
Normal 0
Hypokinetic 1
Akinetic 2
Dyskinetic 3
LVEF
77 %
ACCESS RRA 6 F
CATHETERS Diagnostic Guide
LCA JL4 5 F XB3.5 6 F
RCA LCB 5 F
Grafts
NITROGLYCERIN
None
Sublingual
Intracoronary
Post ectopic
Sinus
COMMENTS:
Diastolic volume 130 mls 64 mls/m²
Systolic volume 30 mls 15 mls/m²
LV Pressure 121 / 16 mmHg 35 • 12 mls mls/sec

Case 2 (BA) Inconclusive ETT: Summary

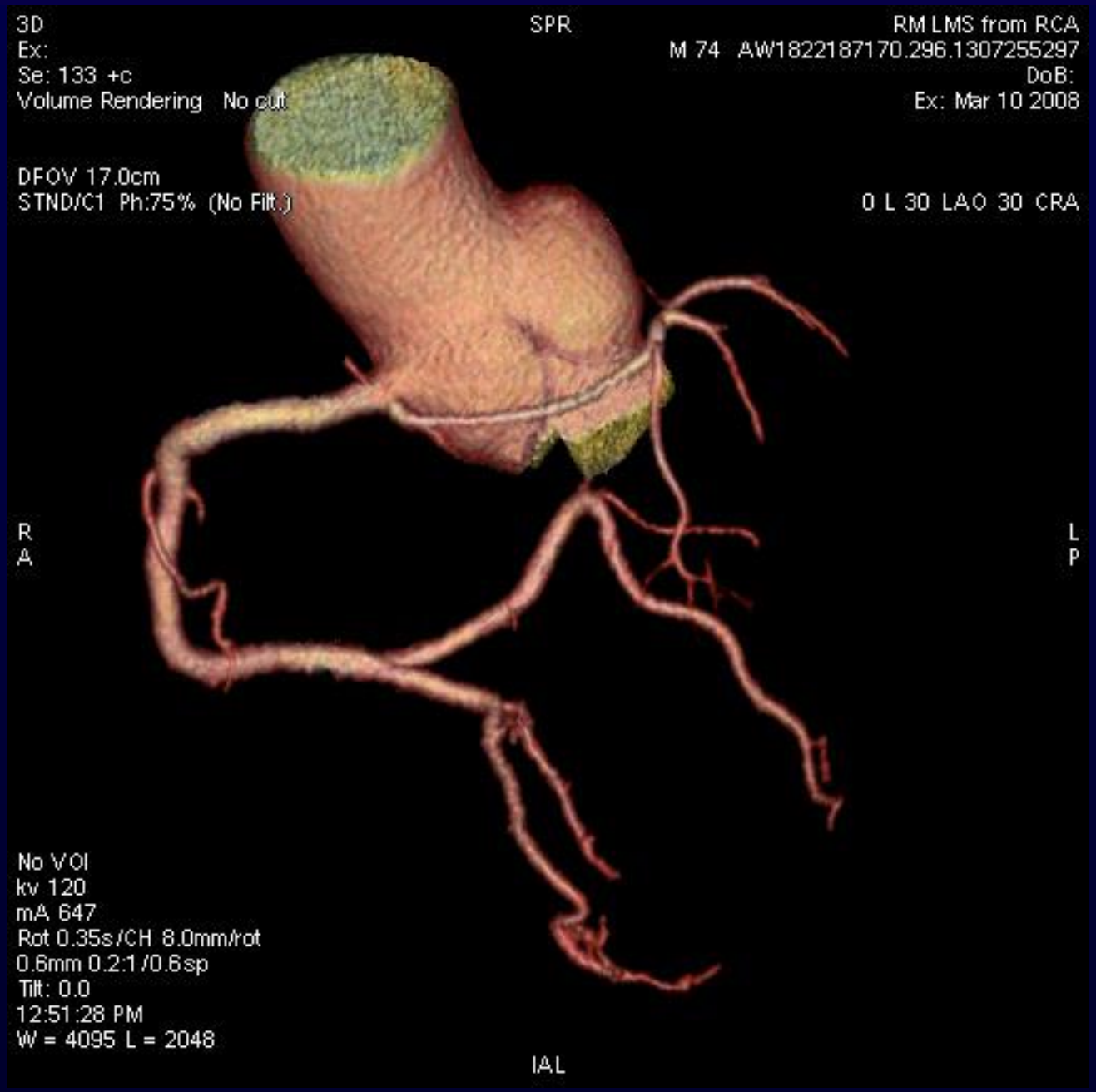
- CT Calcium score: 75-90th percentile
  - CT Angiogram incomplete, but probable flow limiting stenoses
  - Conventional angiogram required, then PCI
- Reasonable use of CTA (Could have gone straight to Cath)
  - Drs confident of diagnoses
  - Management clear (PCI & prevention medication)
  - Patient properly diagnosed and treated

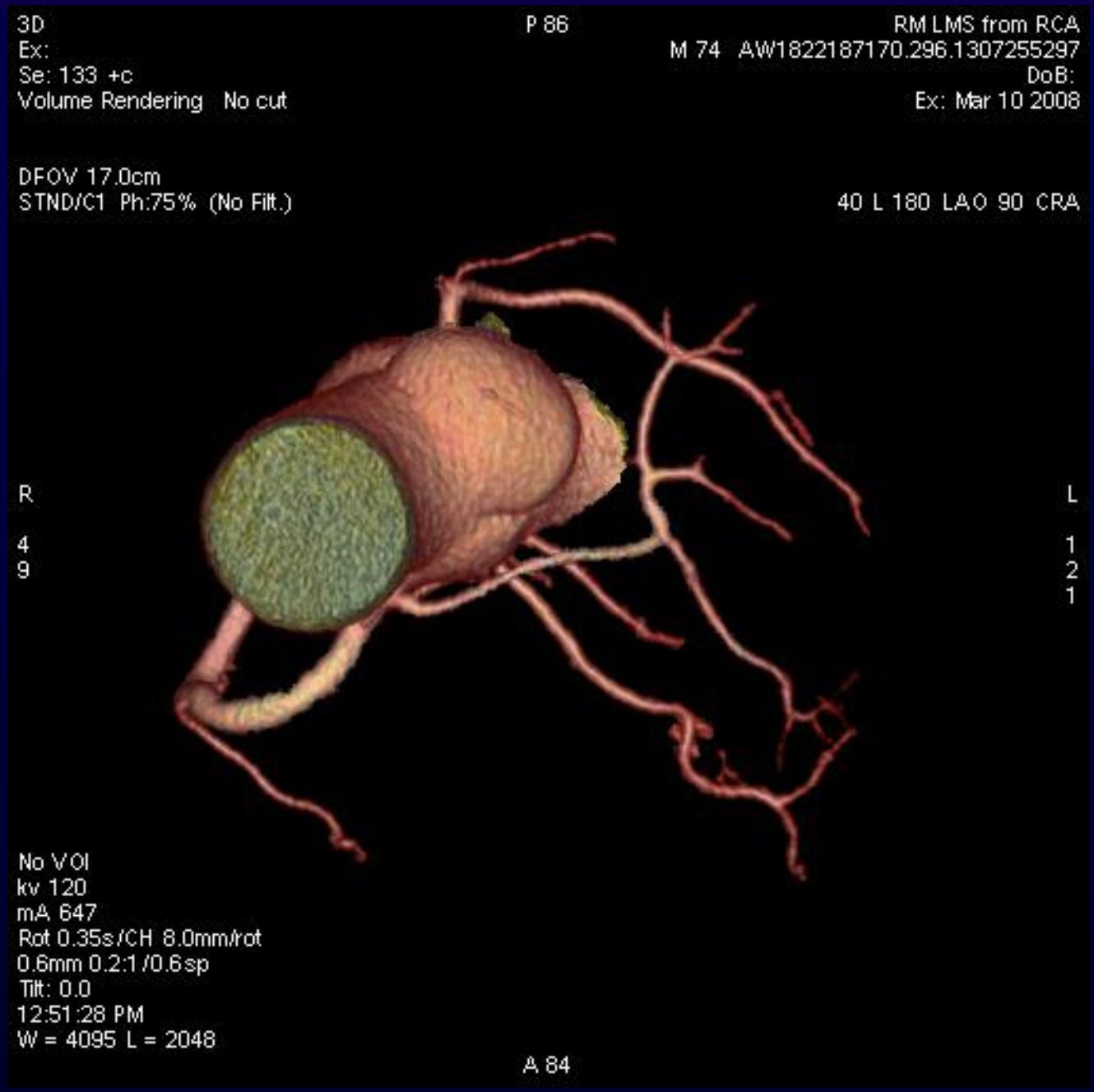
CTCA 2017: Imaging Aberrant Coronary Arteries 1

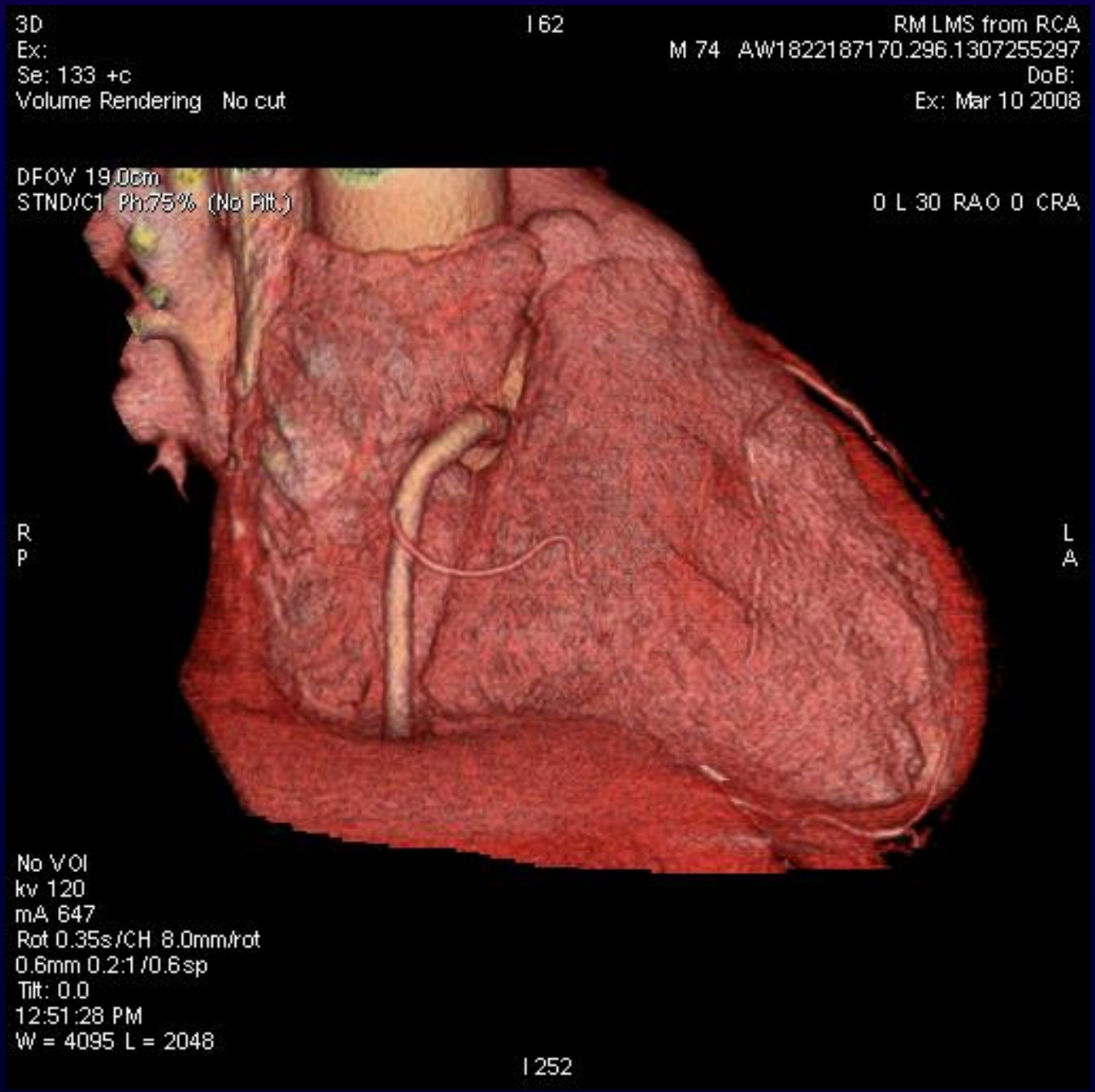

3D
Ex:
Se: 133 +c
Volume Rendering No cut
SPR
IB 31 May 2011
M 75 AW1261973821.342.1306822898
DoB:
Ex: Sep 30 2009
DFOV 17.0cm
STND/C2 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 120
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:52:38 PM
W = 4095 L = 2048
IAL

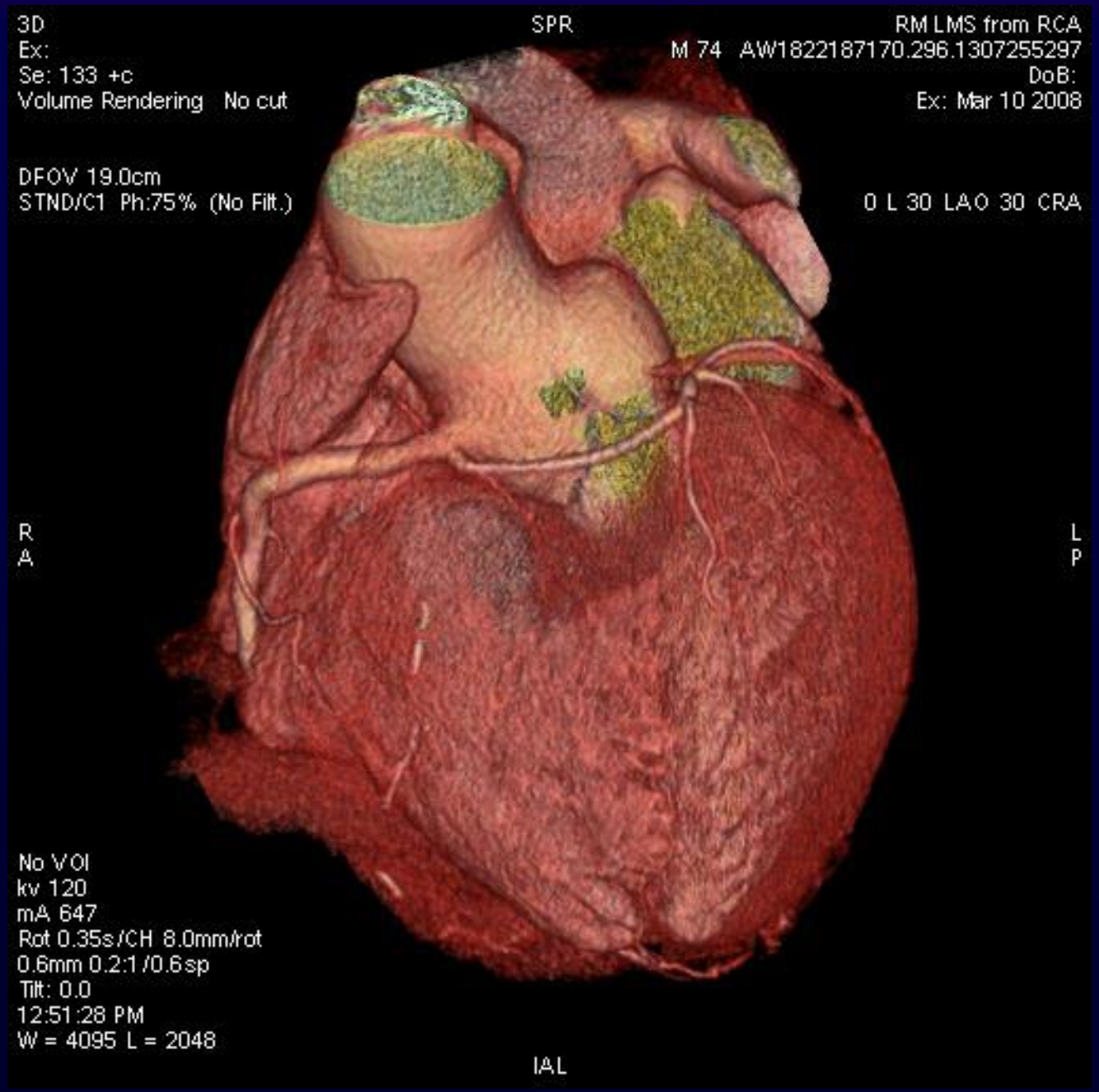

3D
Ex:
Se: 133 +c
Volume Rendering No cut
I 83
IB 31 May 2011
M 75 AW1261973821.342.1306822898
DoB:
Ex: Sep 30 2009
DFOV 17.0cm
STND/C2 Ph:75% (No Filt.)
0 L 90 LAO 0 CRA
A
P
1
0
3
6
7
No VOI
kv 120
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:52:38 PM
W = 4095 L = 2048
I 253

CTCA 2017: Imaging Aberrant Coronary Arteries 2

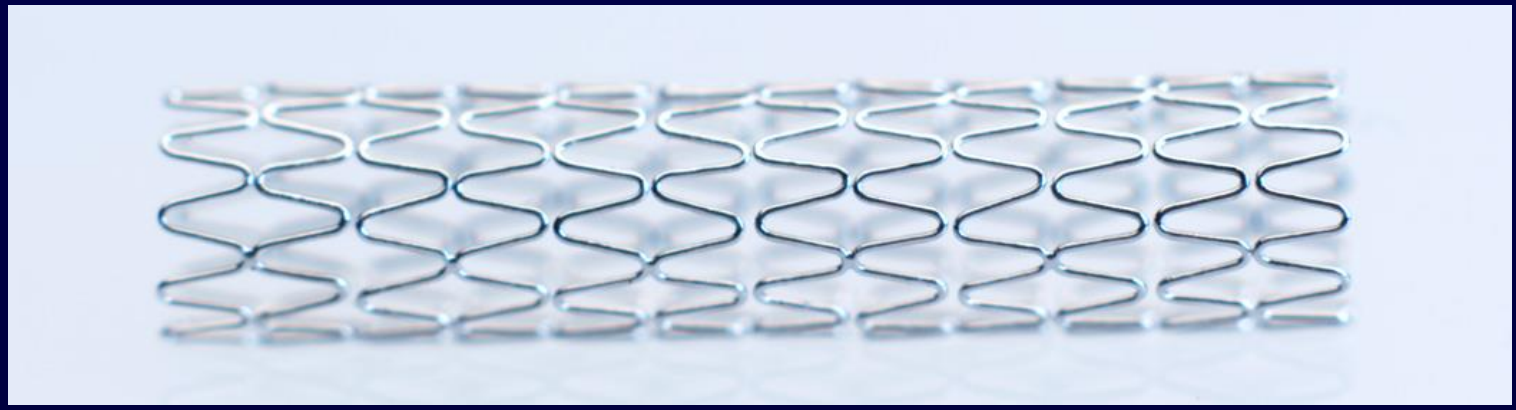

3D
Ex:
Se: 133 +c
Volume Rendering No cut
SPR
RM LMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008
DFOV 17.0cm
STND/C1 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 120
mA 647
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:51:28 PM
W = 4095 L = 2048
IAL


3D
Ex:
Se: 133 +c
Volume Rendering No cut
P 86
RM LMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008
DFOV 17.0cm
STND/C1 Ph:75% (No Filt.)
40 L 180 LAO 90 CRA
R
L
4
9
1
2
1
No VOI
kv 120
mA 647
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:51:28 PM
W = 4095 L = 2048
A 84

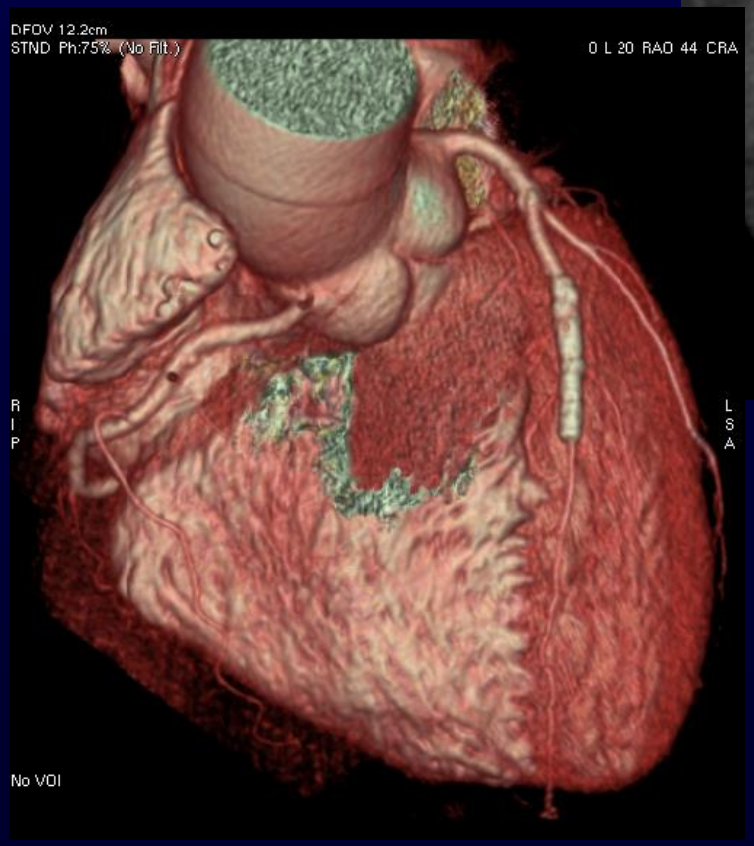

3D
Ex:
Se: 133 +c
Volume Rendering No cut
I 62
RM LMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008
DFOV 19.0cm
STND/C1 Ph:75% (No Filt.)
0 L 30 RAO 0 CRA
R
P
L
A
No VOI
kv 120
mA 647
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:51:28 PM
W = 4095 L = 2048
I 252

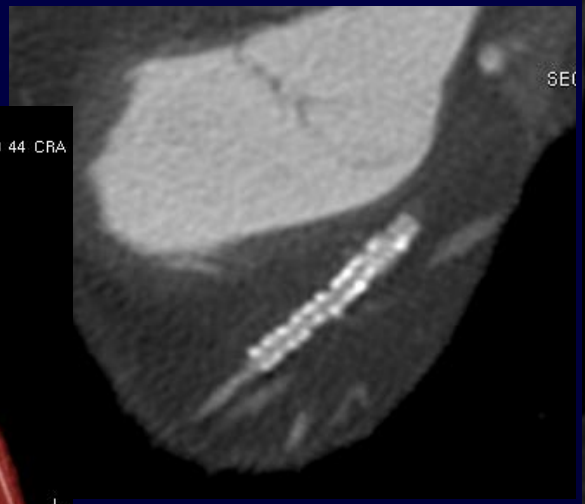

3D
Ex:
Se: 133 +c
Volume Rendering No cut
DFOV 19.0cm
STND/C1 Ph:75% (No Filt.)
SPR
RM LMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 120
mA 647
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:51:28 PM
W = 4095 L = 2048
IAL

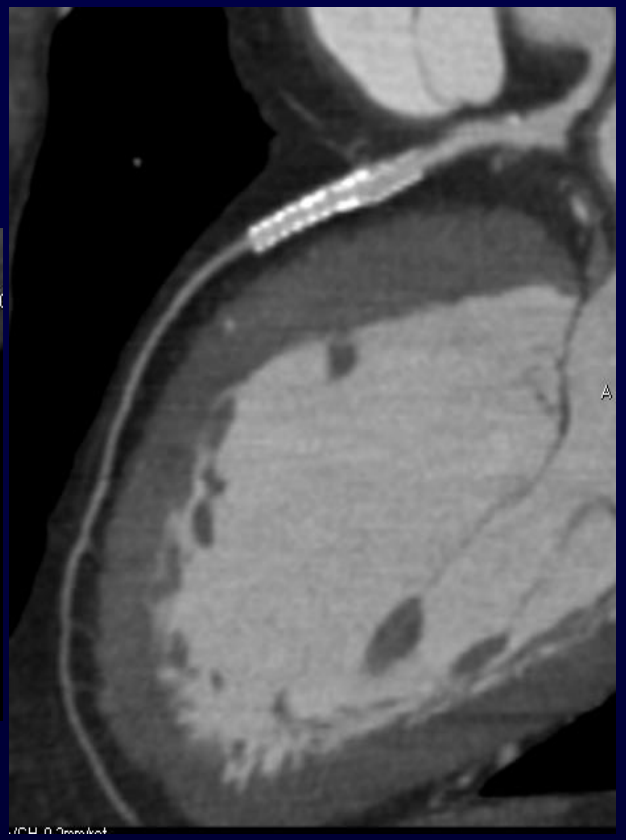
PCI: Coronary Stents

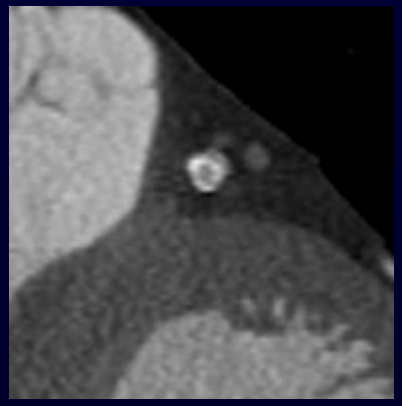


Coronary Stent

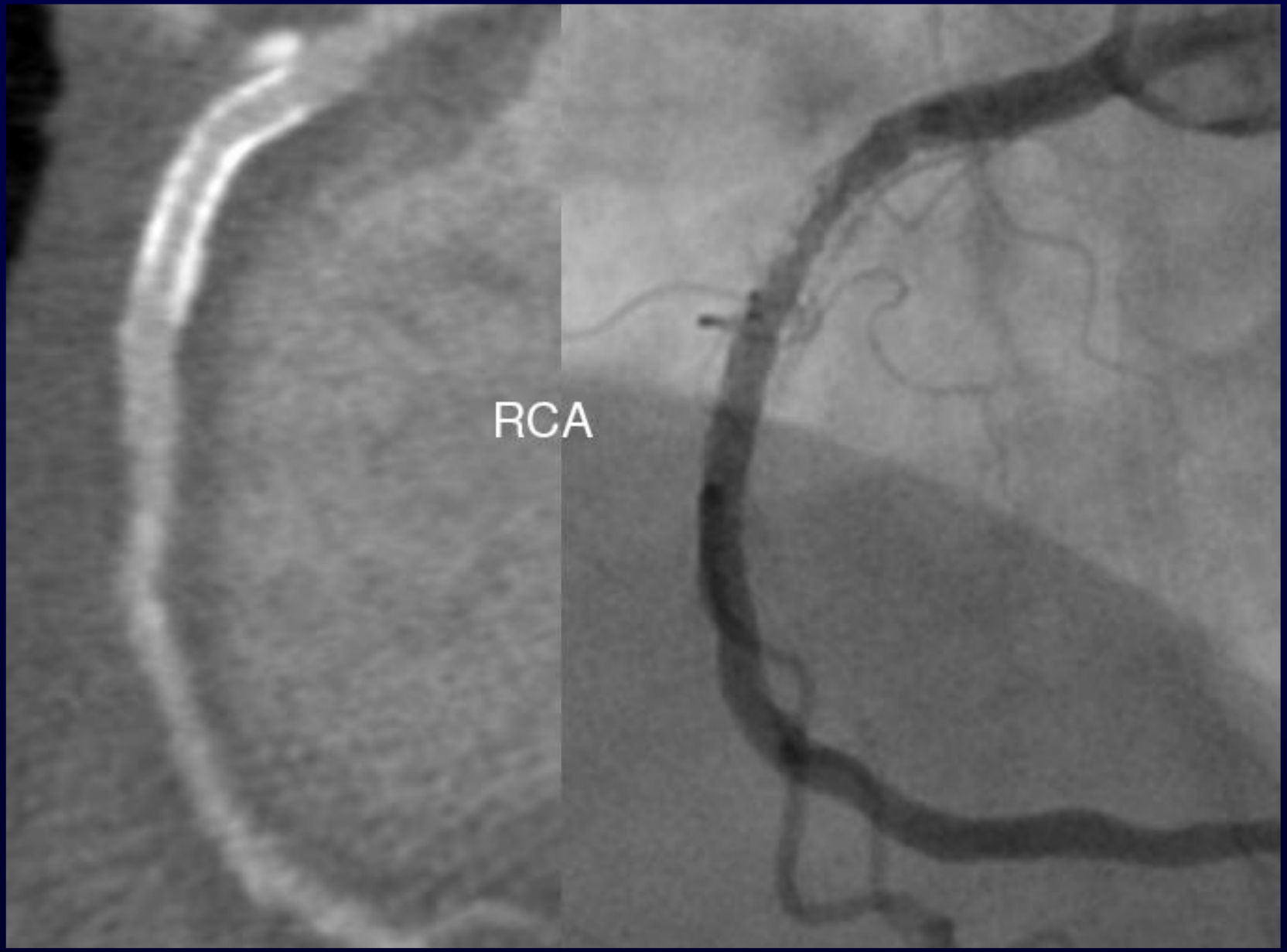




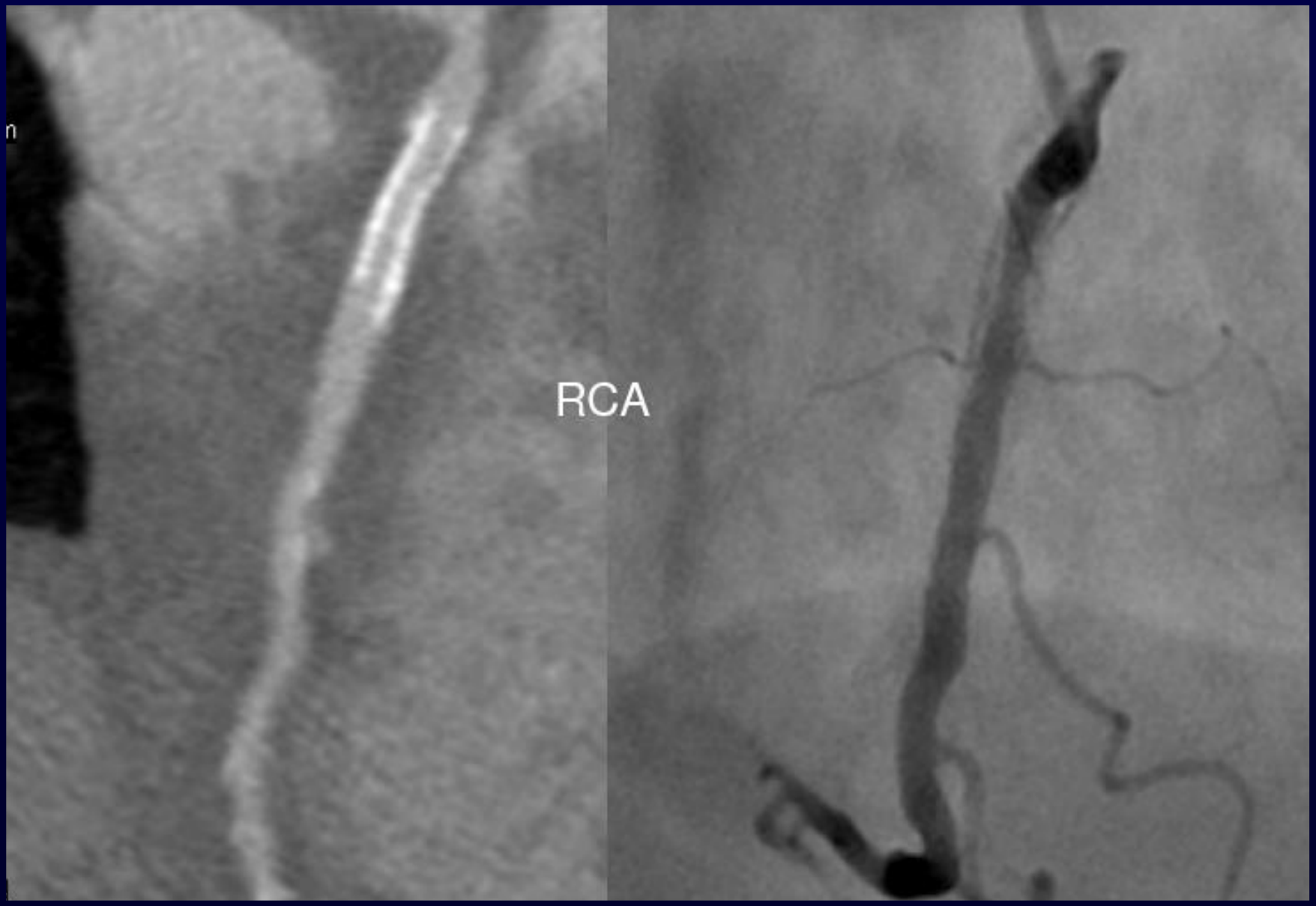




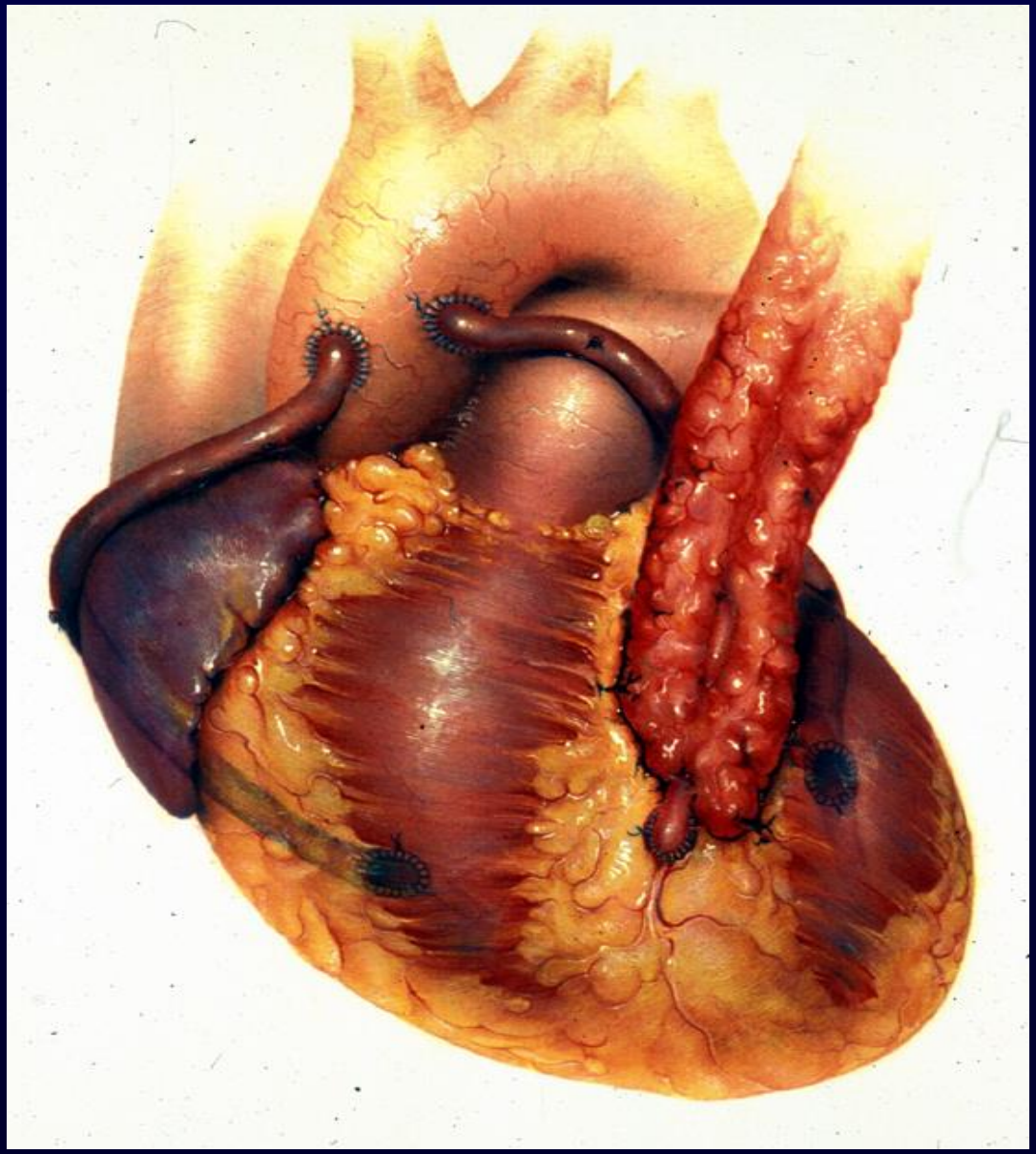
Coronary Stent



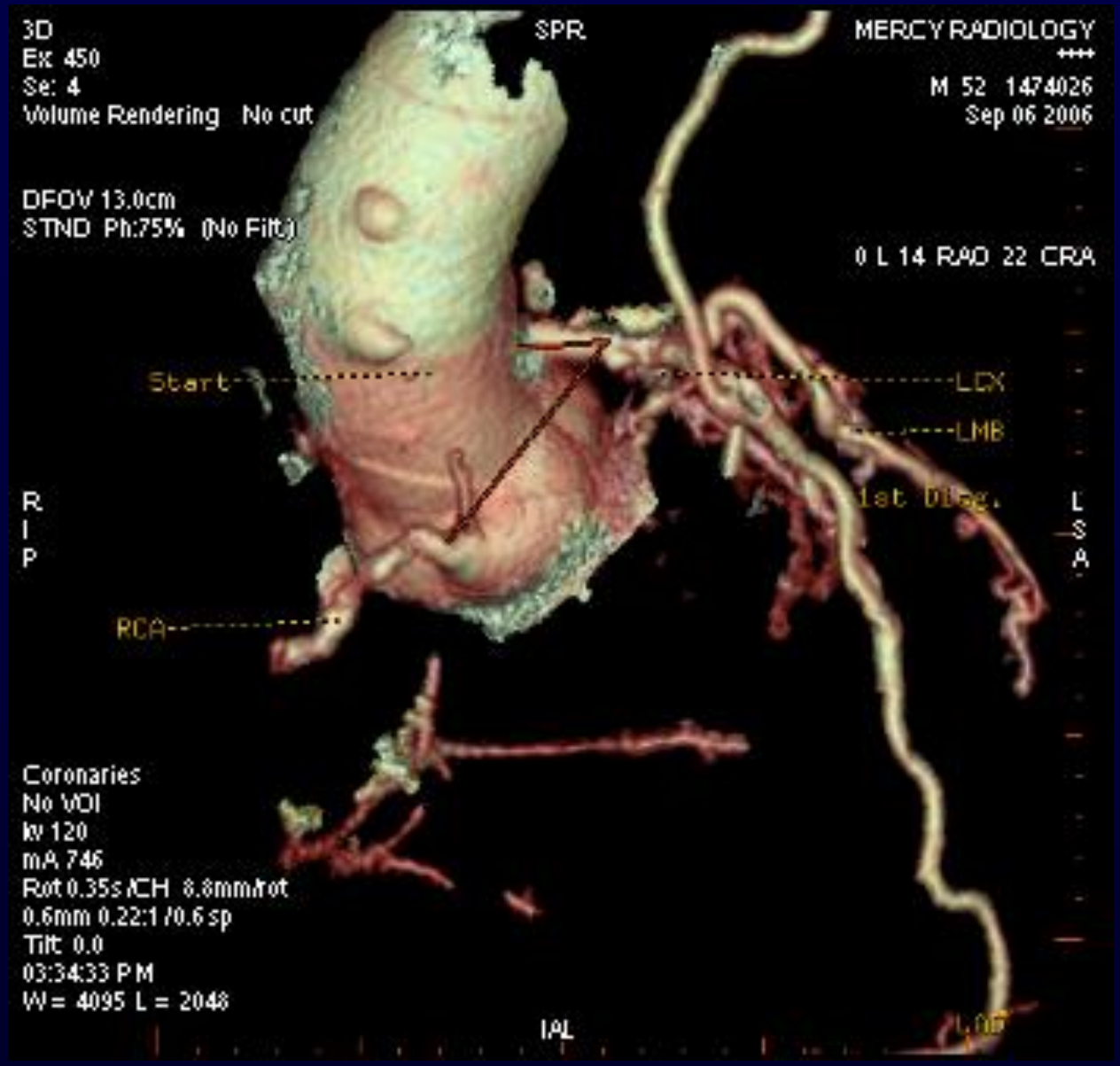
Coronary Stent



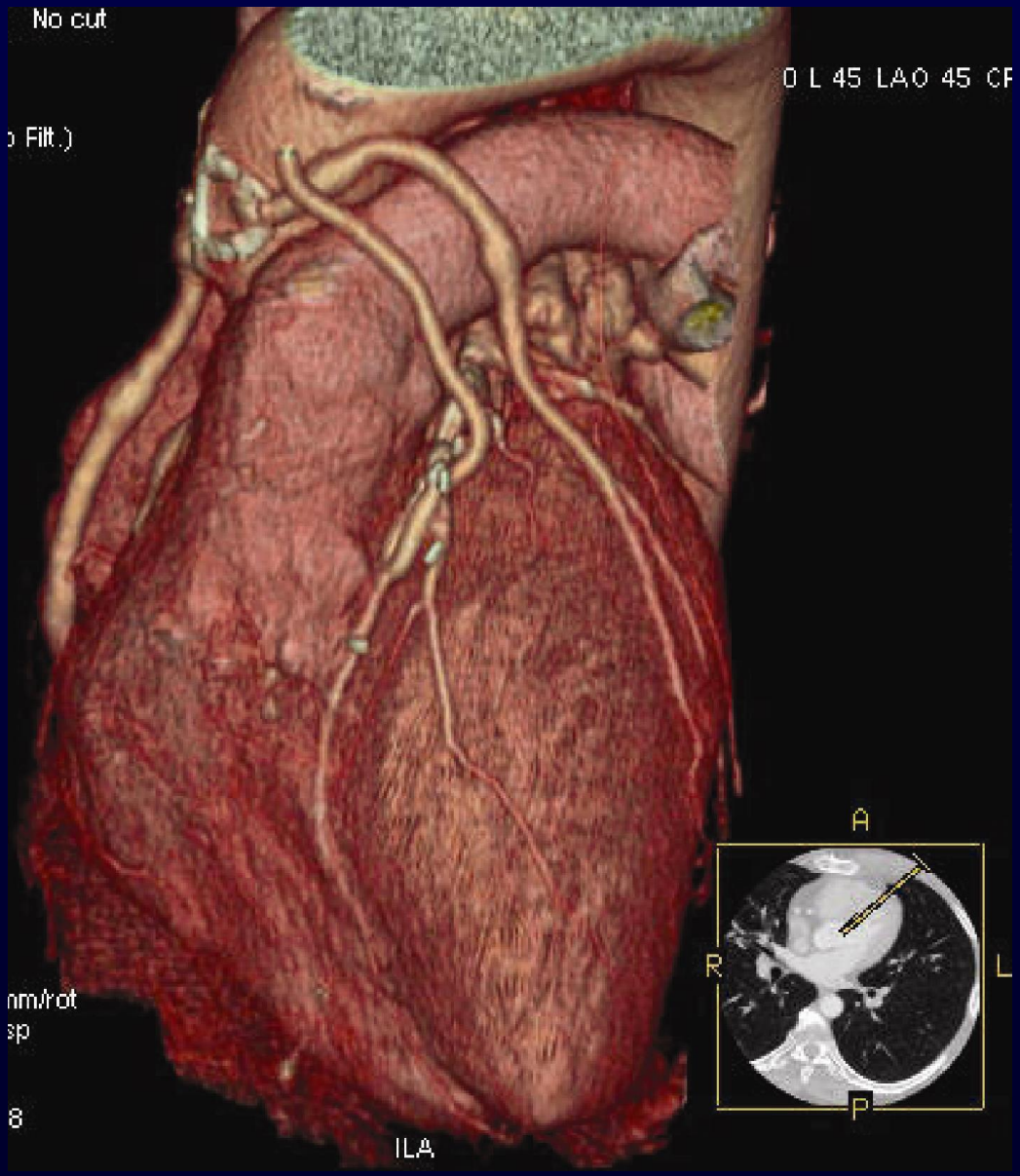
CABG Surgery

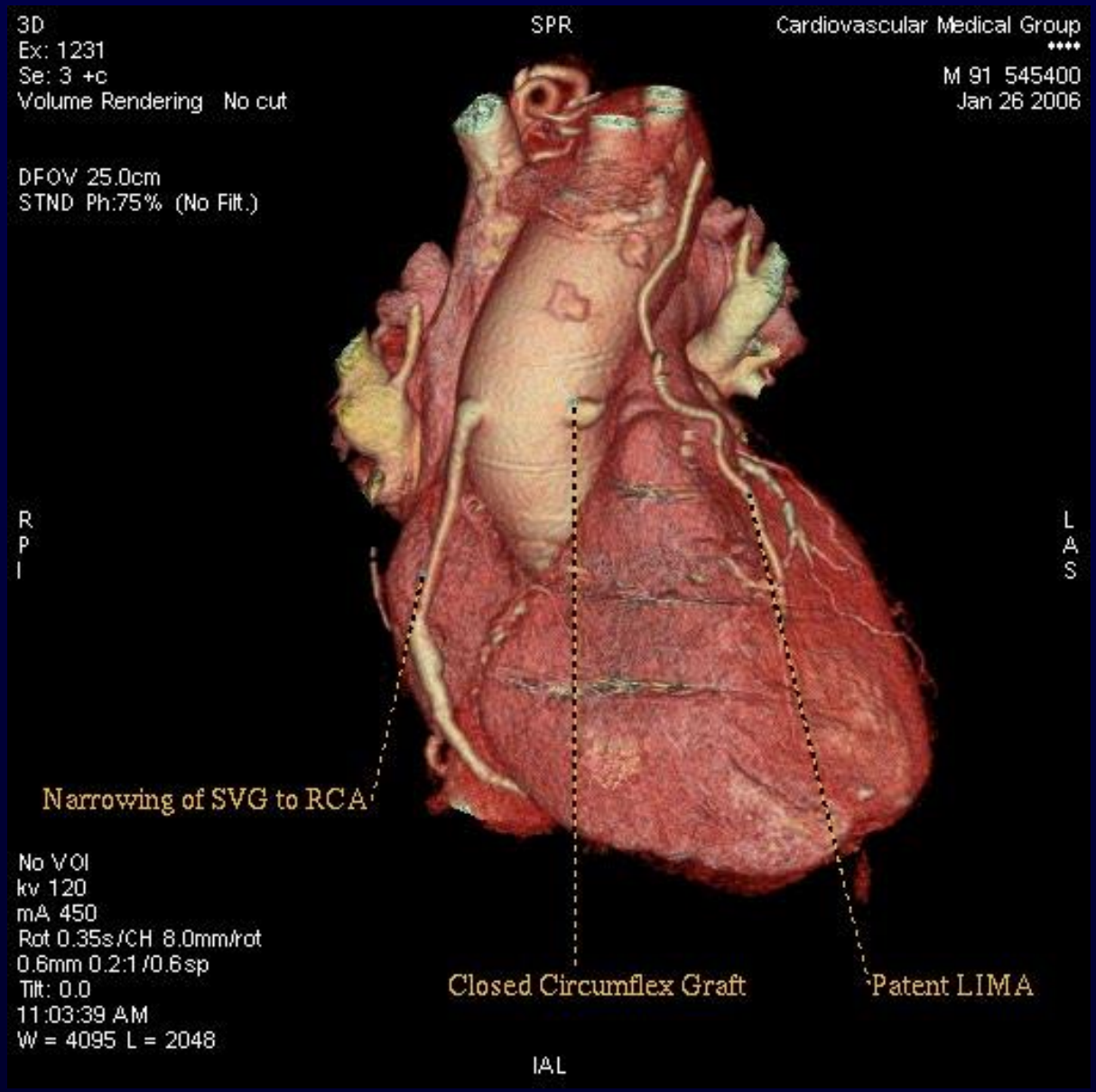


CT Angiography: Previous Bypass Grafts

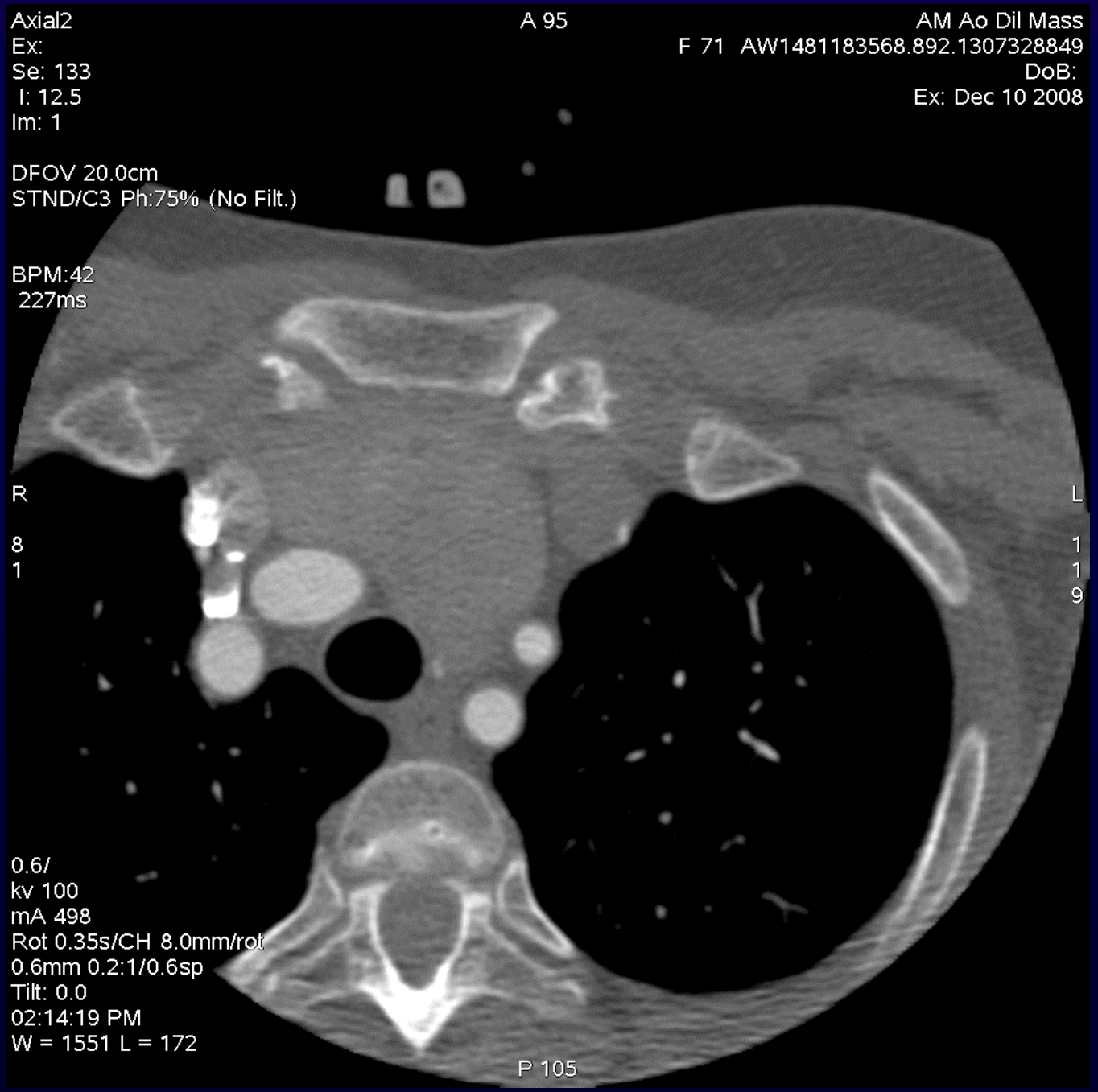


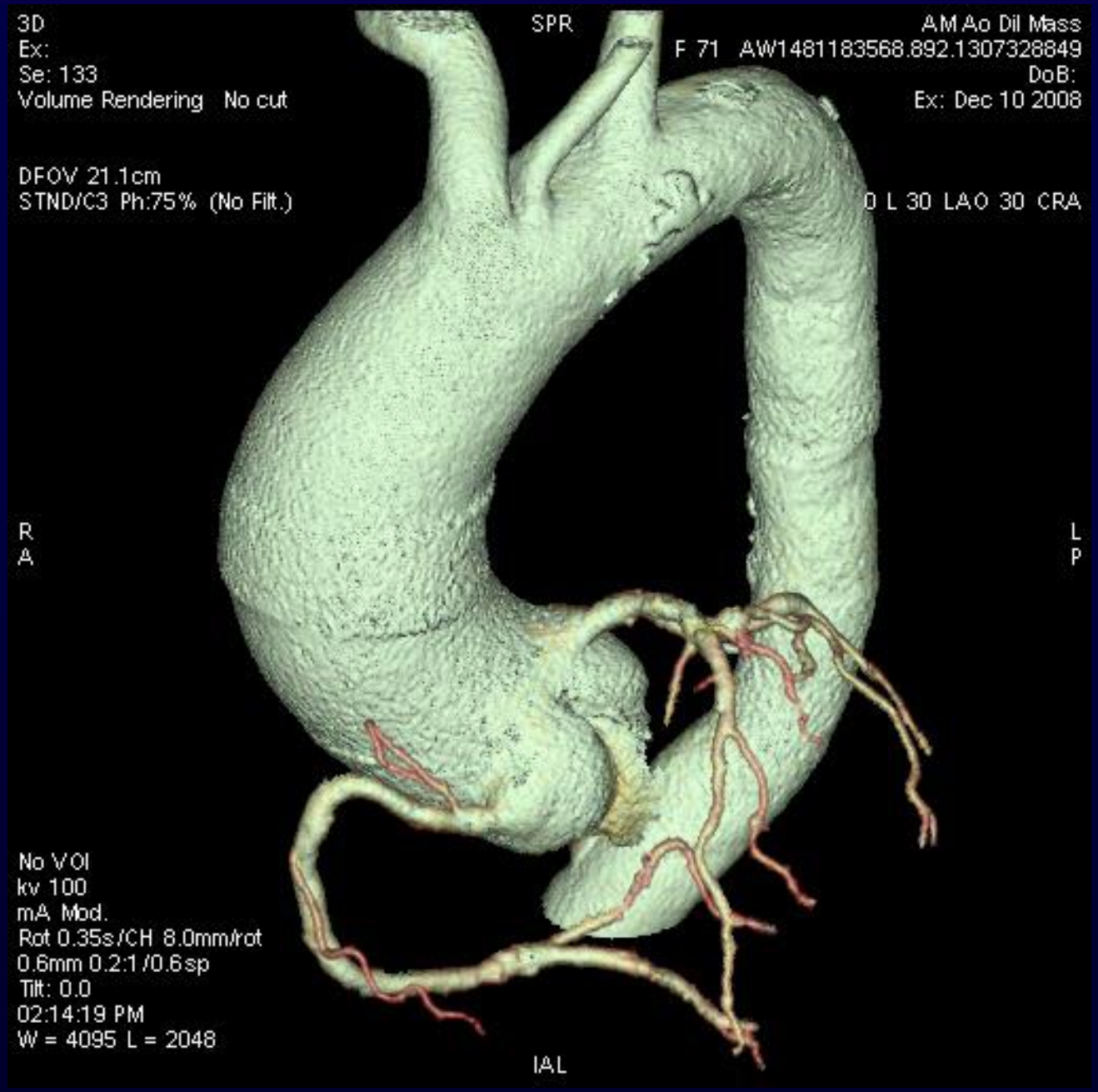
SV x 3 Bypass Grafts




3D
Ex: 1231
Se: 3 +c
Volume Rendering No cut
DFOV 25.0cm
STND Ph:75% (No Filt.)
SPR
Cardiovascular Medical Group
M 91 545400
Jan 26 2006
R
P
I
L
A
S
Narrowing of SVG to RCA
Closed Circumflex Graft
Patent LIMA
No VOI
kv 120
mA 450
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
11:03:39 AM
W = 4095 L = 2048
IAL

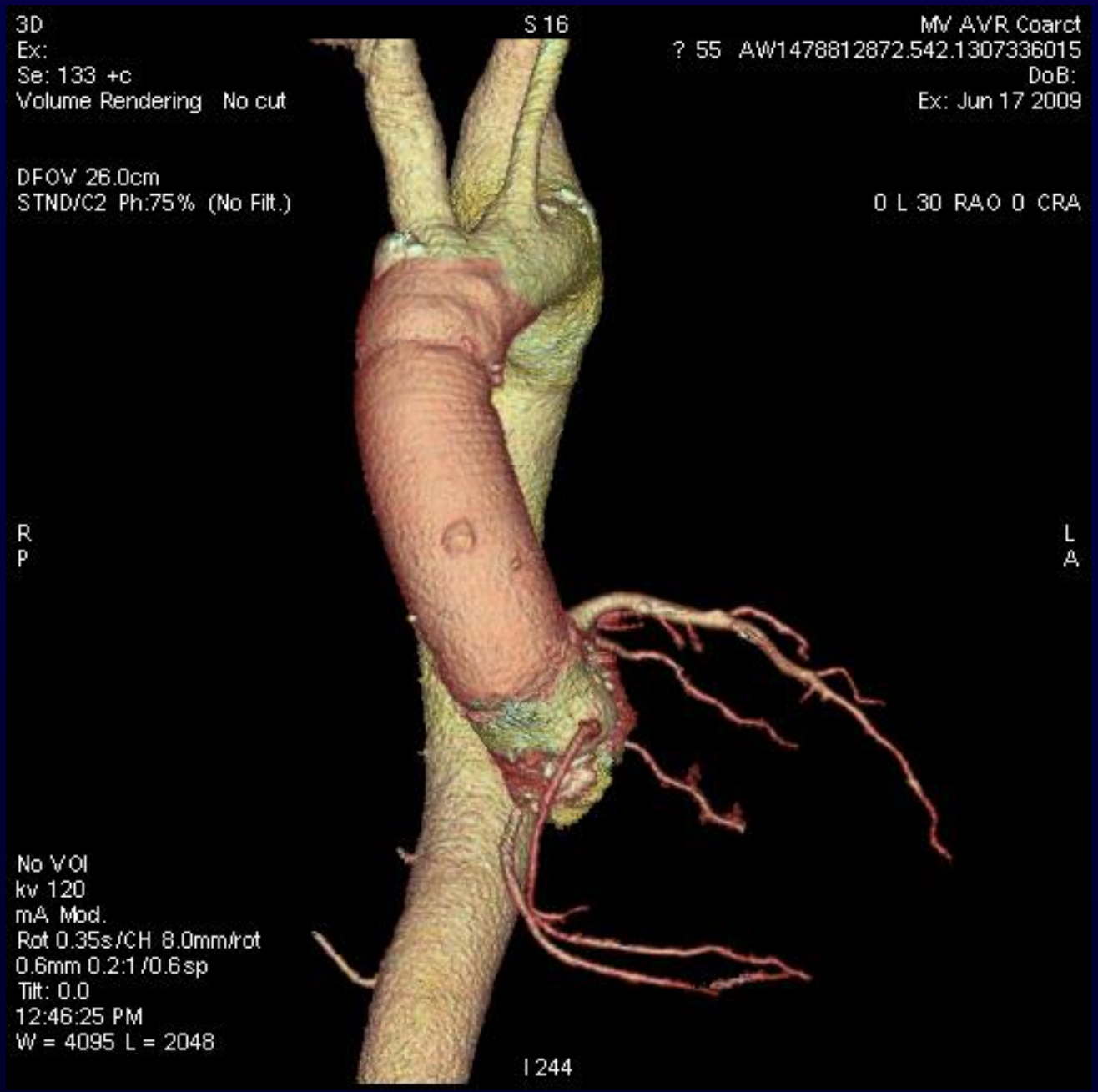
CTCA 2017: Imaging Thoracic Aorta 1


Axial2
Ex:
Se: 133
I: 12.5
Im: 1
DFOV 20.0cm
STND/C3 Ph:75% (No Filt.)
BPM:42
227ms
A 95
AM Ao Dil Mass
F 71 AW1481183568.892.1307328849
DoB:
Ex: Dec 10 2008
R
L
8
1
1
1
9
0.6/
kv 100
mA 498
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:14:19 PM
W = 1551 L = 172
P 105

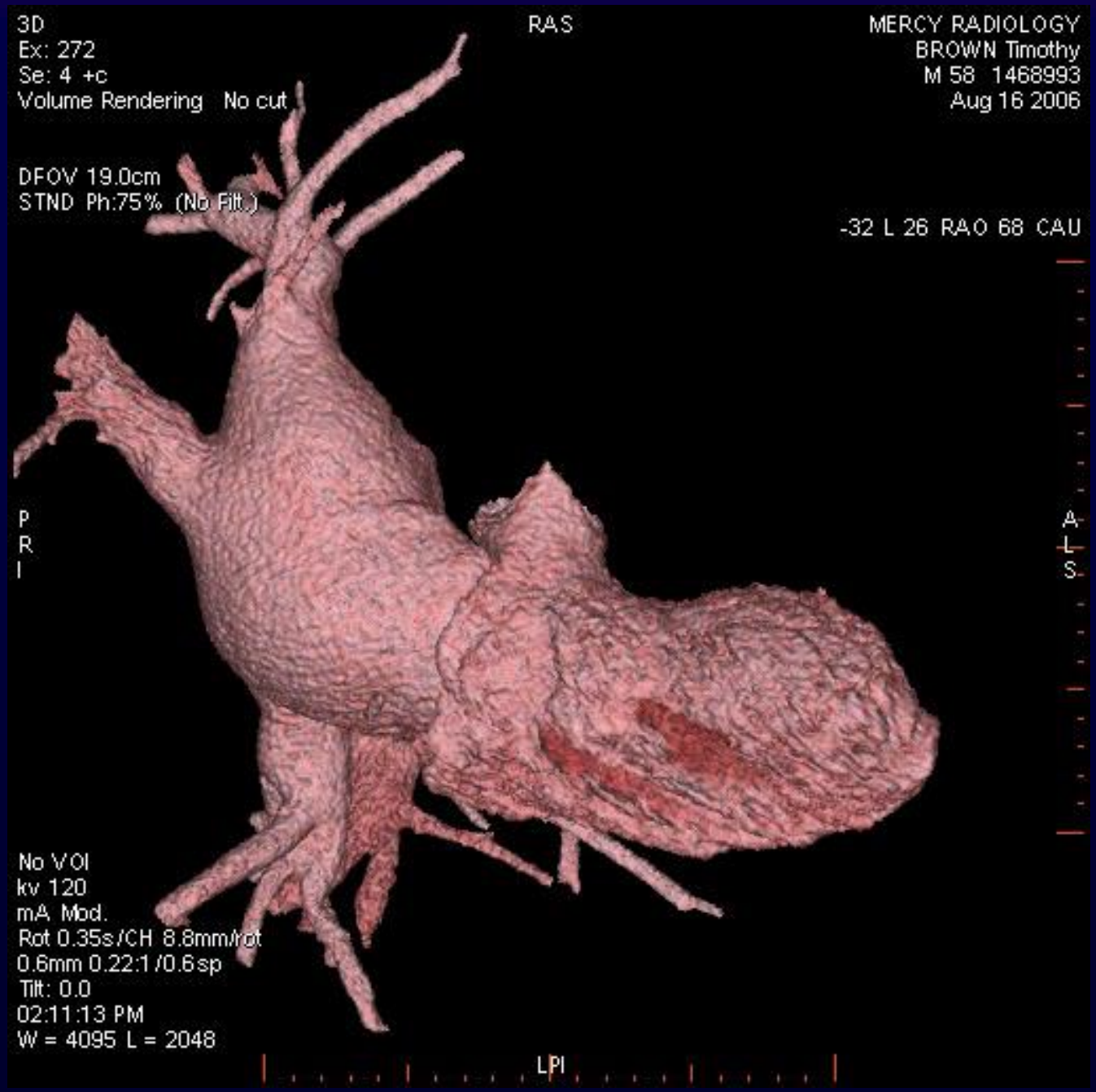

3D
Ex:
Se: 133
Volume Rendering No cut
SPR
AM Ao Dil Mass
F 71 AW1481183568.892.1307328849
DoB:
Ex: Dec 10 2008
DFOV 21.1cm
STND/C3 Ph:75% (No Filt.)
0 L 30 LAO 30 CRA
R
A
L
P
No VOI
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:14:19 PM
W = 4095 L = 2048
IAL

CTCA 2017: Imaging Thoracic Aorta 2

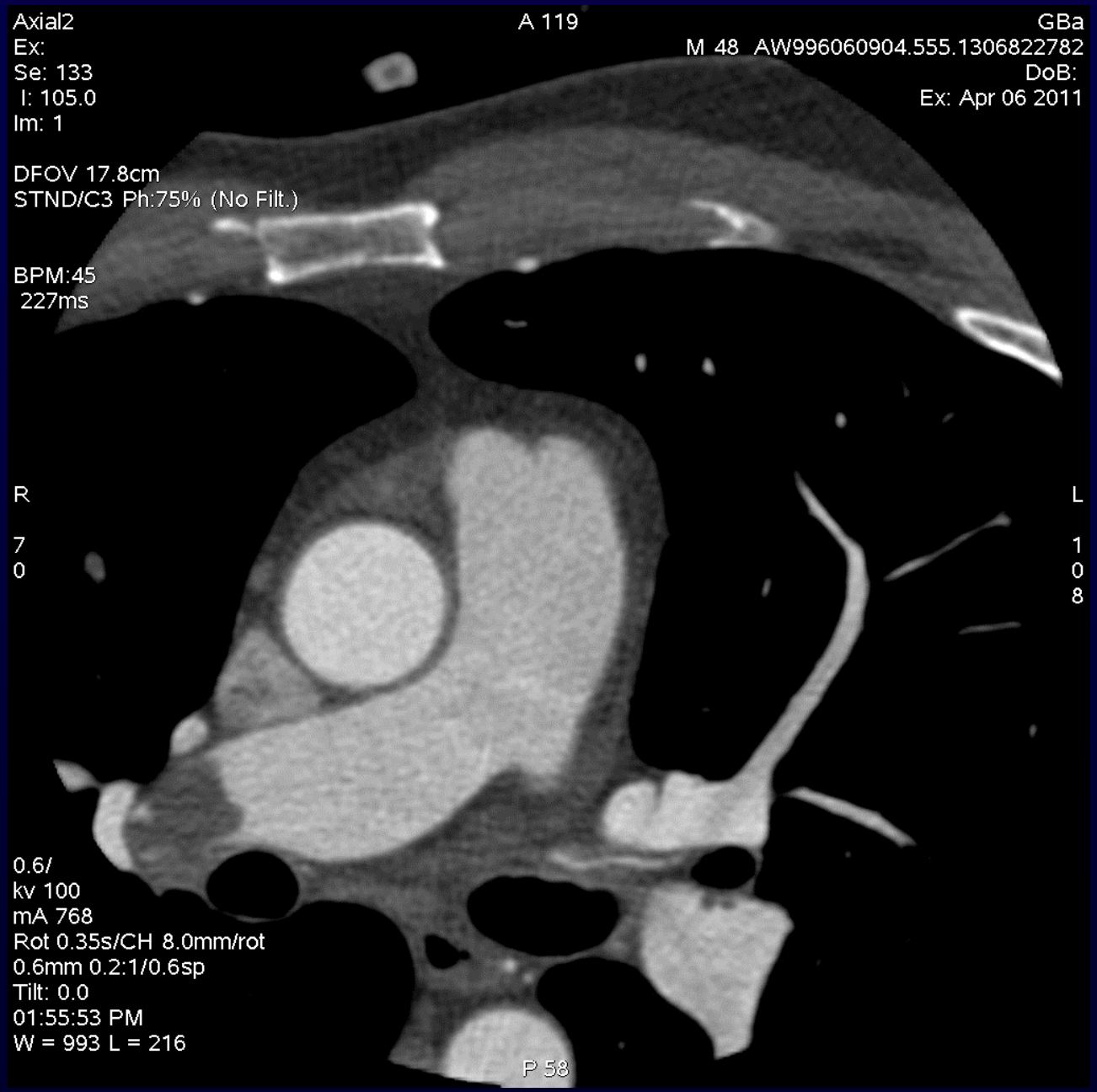

Axial2
Ex:
Se: 133 +c
S: 8.8
Im: 1
A 113
MV AVR Coarct
? 55 AW1478812872.542.1307336015
DoB:
Ex: Jun 17 2009
DFOV 21.6cm
STND/C2 Ph:75% (No Filt.)
BPM:48
227ms
R
L
7
8
1
3
7
0.6/
kv 120
mA 697
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:46:25 PM
W = 800 L = 100
P 103

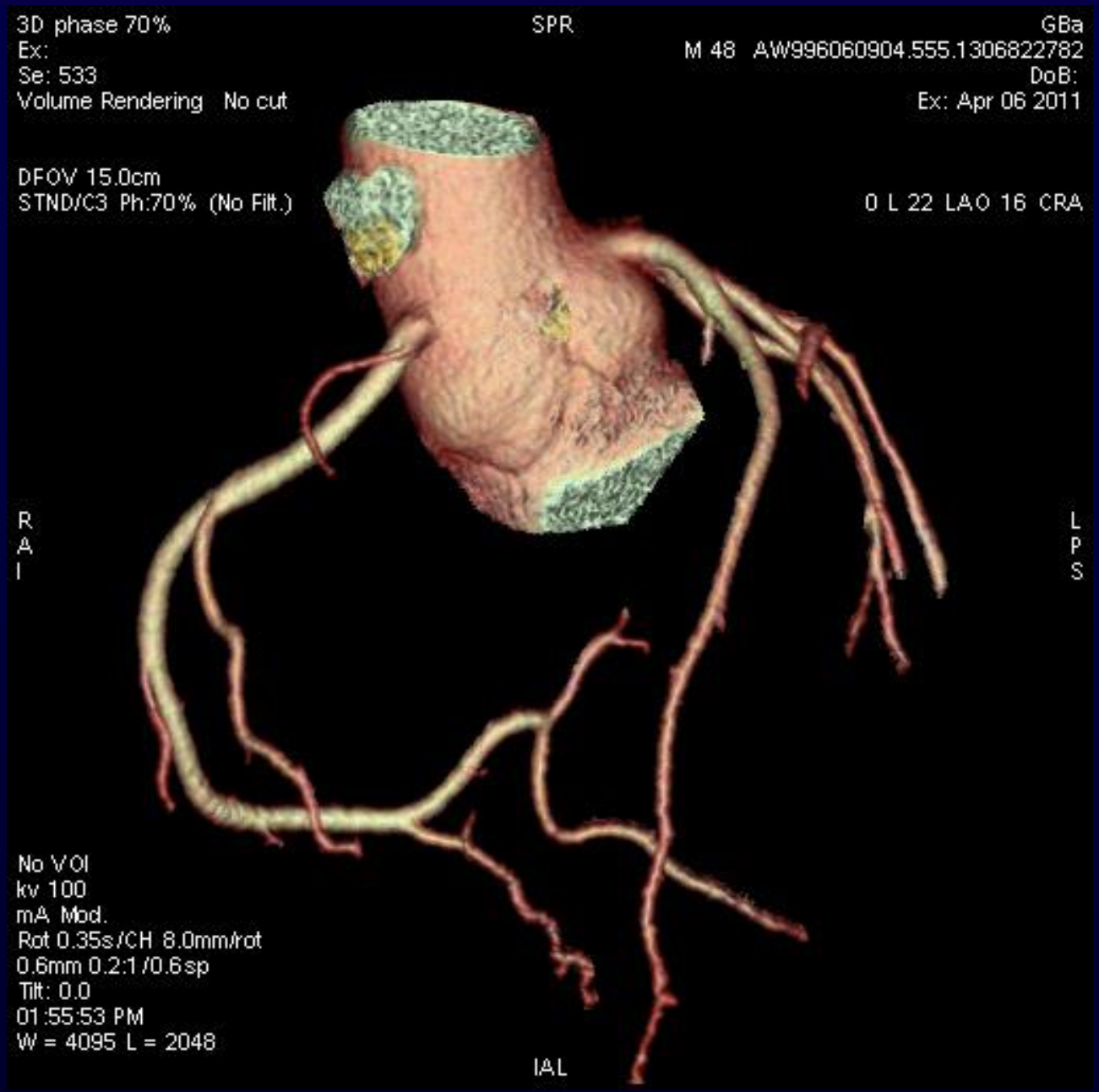

3D
Ex:
Se: 133 +c
Volume Rendering No cut
S 16
MV AVR Coarct
? 55 AW1478812872.542.1307336015
DoB:
Ex: Jun 17 2009
DFOV 26.0cm
STND/C2 Ph:75% (No Filt.)
0 L 30 RAO 0 CRA
R
P
L
A
No VOI
kv 120
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
12:46:25 PM
W = 4095 L = 2048
I 244

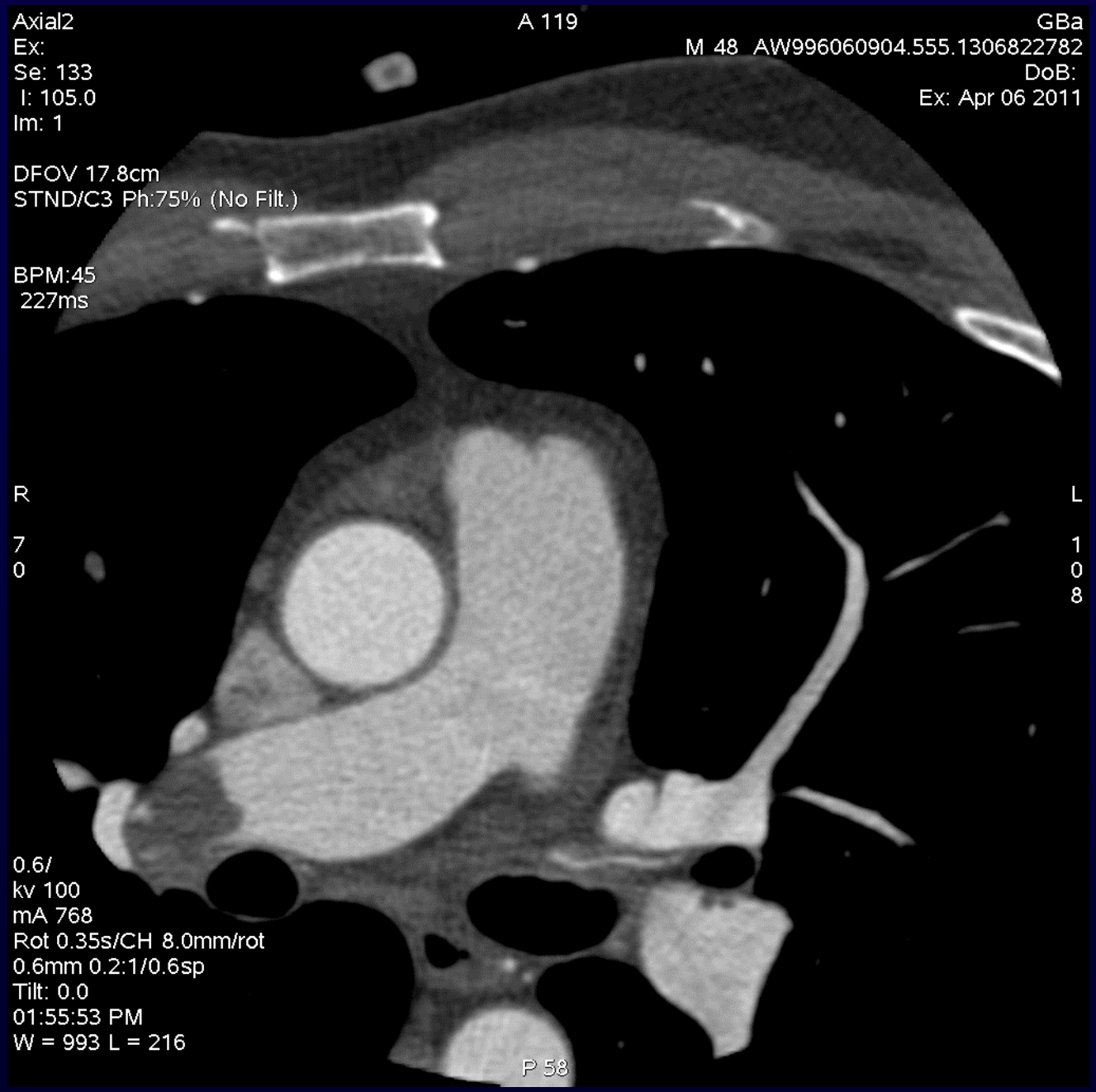
CTCA 2017: Imaging Left Atrium pre EP Af Ablation

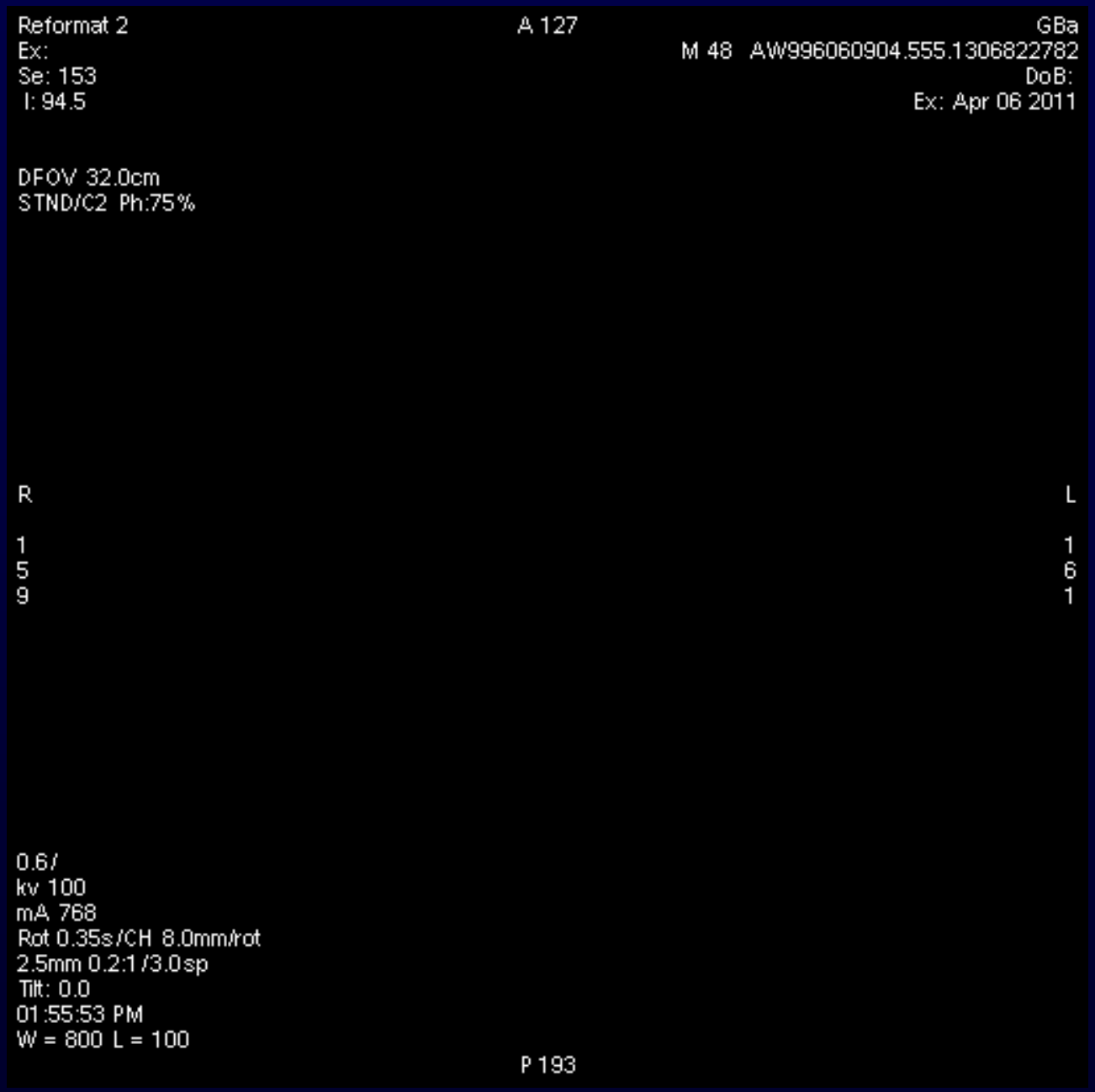

3D
Ex: 272
Se: 4 +c
Volume Rendering No cut
DFOV 19.0cm
STND Ph:75% (No Filt.)
RAS
MERCY RADIOLOGY
BROWN Timothy
M 58 1468993
Aug 16 2006
-32 L 26 RAO 68 CAU
P
R
I
A
L
S
No VOI
kv 120
mA Mod.
Rot 0.35s/CH 8.8mm/rot
0.6mm 0.22:1/0.6sp
Tilt: 0.0
02:11:13 PM
W = 4095 L = 2048
LPI

CTCA 2017: Other Causes of Shortness Of Breath 1

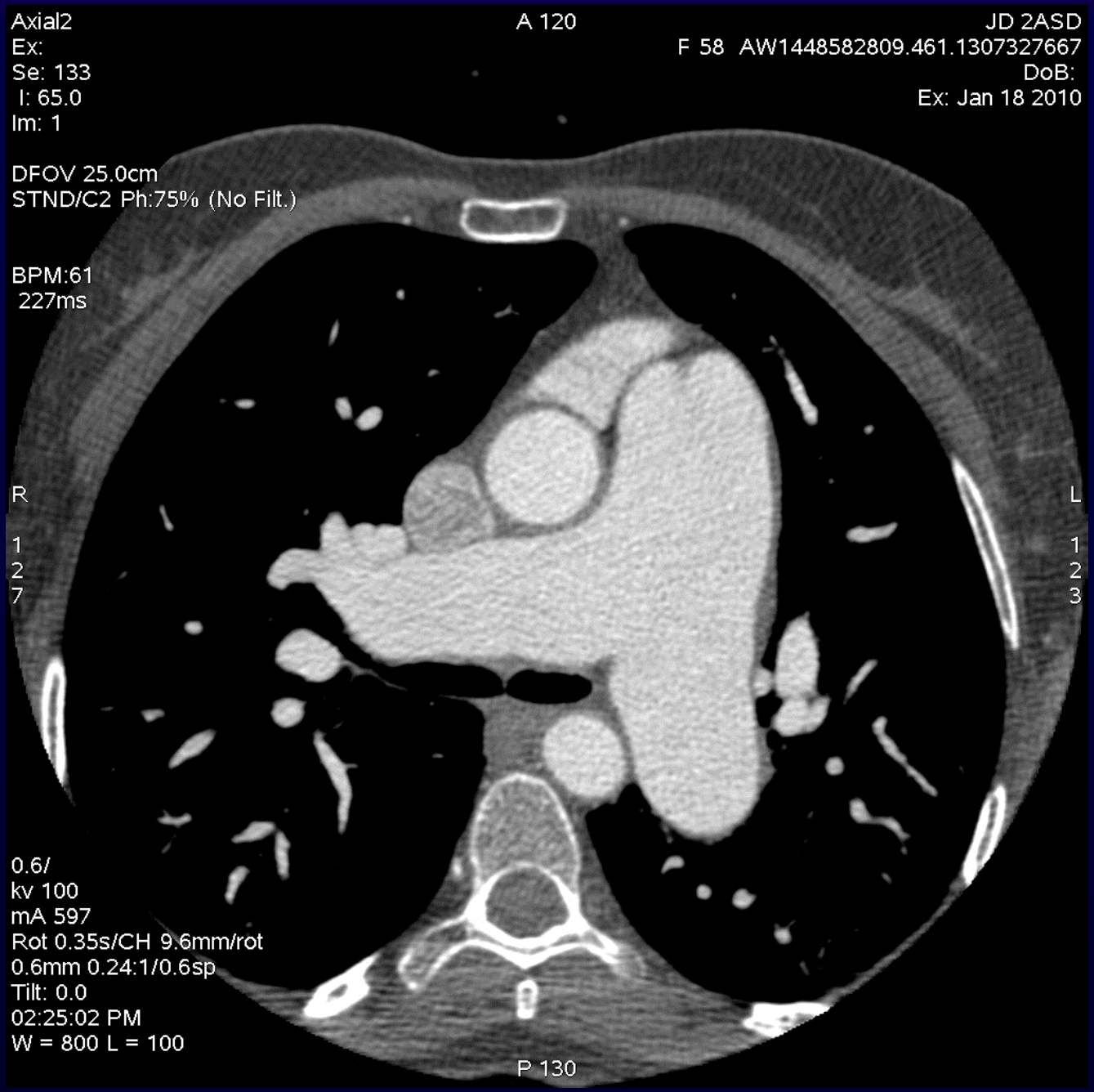

Axial2
Ex:
Se: 133
I: 105.0
Im: 1
DFOV 17.8cm
STND/C3 Ph:75% (No Filt.)
BPM:45
227ms
A 119
GBa
M 48 AW996060904.555.1306822782
DoB:
Ex: Apr 06 2011
R
L
7
0
1
0
8
0.6/
kv 100
mA 768
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
01:55:53 PM
W = 993 L = 216
P 58


3D phase 70%
SPR
GBa
Ex:
M 48 AW996060904.555.1306822782
Se: 533
DoB:
Volume Rendering No cut
Ex: Apr 06 2011
DFOV 15.0cm
STND/C3 Ph:70% (No Filt.)
0 L 22 LAO 16 CRA
R
A
I
L
P
S
No VOI
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
01:55:53 PM
W = 4095 L = 2048
IAL


Axial2
Ex:
Se: 133
I: 105.0
Im: 1
DFOV 17.8cm
STND/C3 Ph:75% (No Filt.)
BPM:45
227ms
A 119
GBa
M 48 AW996060904.555.1306822782
DoB:
Ex: Apr 06 2011
R
L
7
0
1
0
8
0.6/
kv 100
mA 768
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
01:55:53 PM
W = 993 L = 216
P 58


Reformat 2
A 127
GBa
Ex:
M 48 AW996060904.555.1306822782
Se: 153
DoB:
I: 94.5
Ex: Apr 06 2011
DFOV 32.0cm
STND/C2 Ph:75%
R
L
1
5
9
1
6
1
0.6/
kv 100
mA 768
Rot 0.35s/CH 8.0mm/rot
2.5mm 0.2:1/3.0sp
Tilt: 0.0
01:55:53 PM
W = 800 L = 100
P 193

CTCA 2017: Other Causes of Shortness Of Breath 2


Axial2
Ex:
Se: 133
I: 65.0
Im: 1
A 120
JD 2ASD
F 58 AW1448582809.461.1307327667
DoB:
Ex: Jan 18 2010
DFOV 25.0cm
STND/C2 Ph:75% (No Filt.)
BPM:61
227ms
R
L
1
2
7
1
2
3
0.6/
kv 100
mA 597
Rot 0.35s/CH 9.6mm/rot
0.6mm 0.24:1/0.6sp
Tilt: 0.0
02:25:02 PM
W = 800 L = 100
P 130

Everything you need to Know about a CT Calcium Score Test

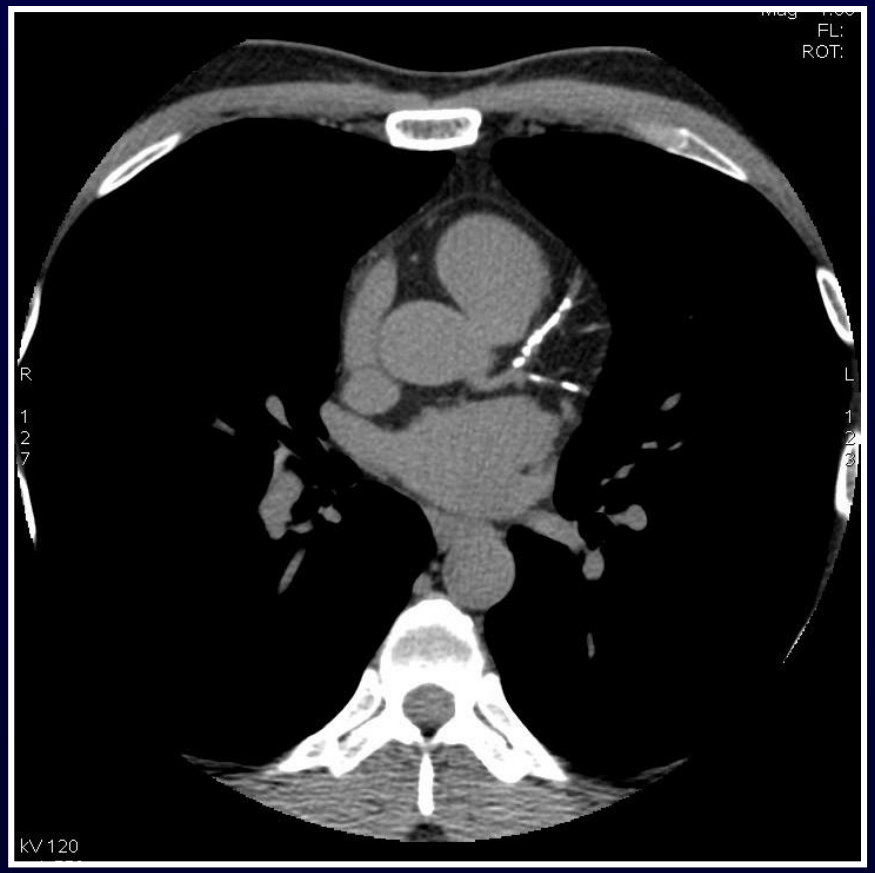


Image-Based Assessment of CVS Risk : CT Calcium Score Test

X-Ray ‘slices’ of the heart

3mm Intervals

About 50 cardiac slices per scan

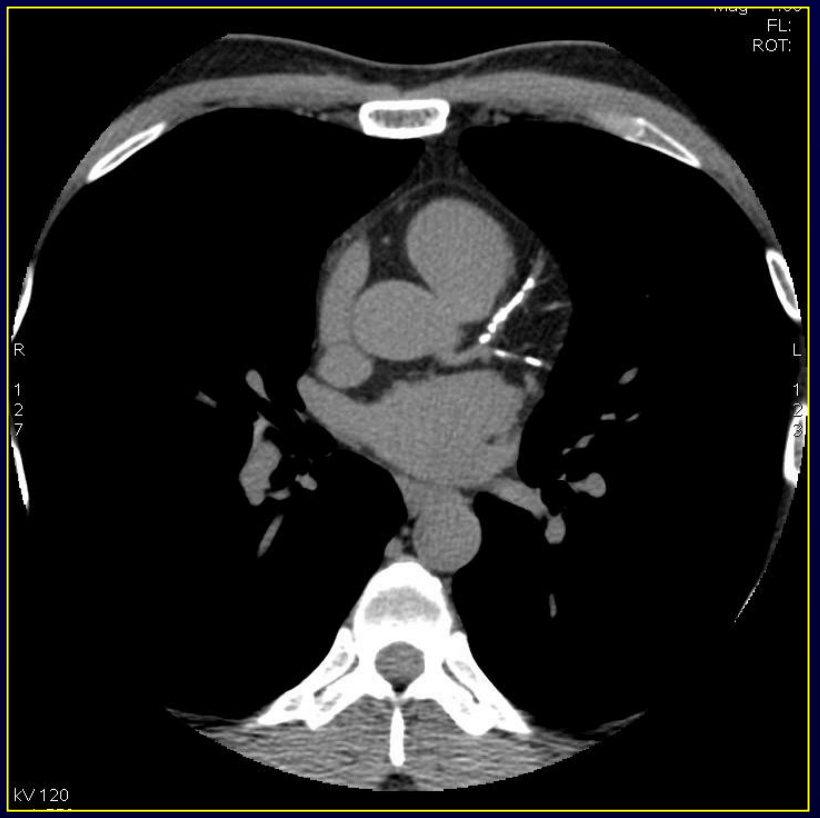
Score relates to volume and density of calcium in the coronary arteries

“Agatston” Units

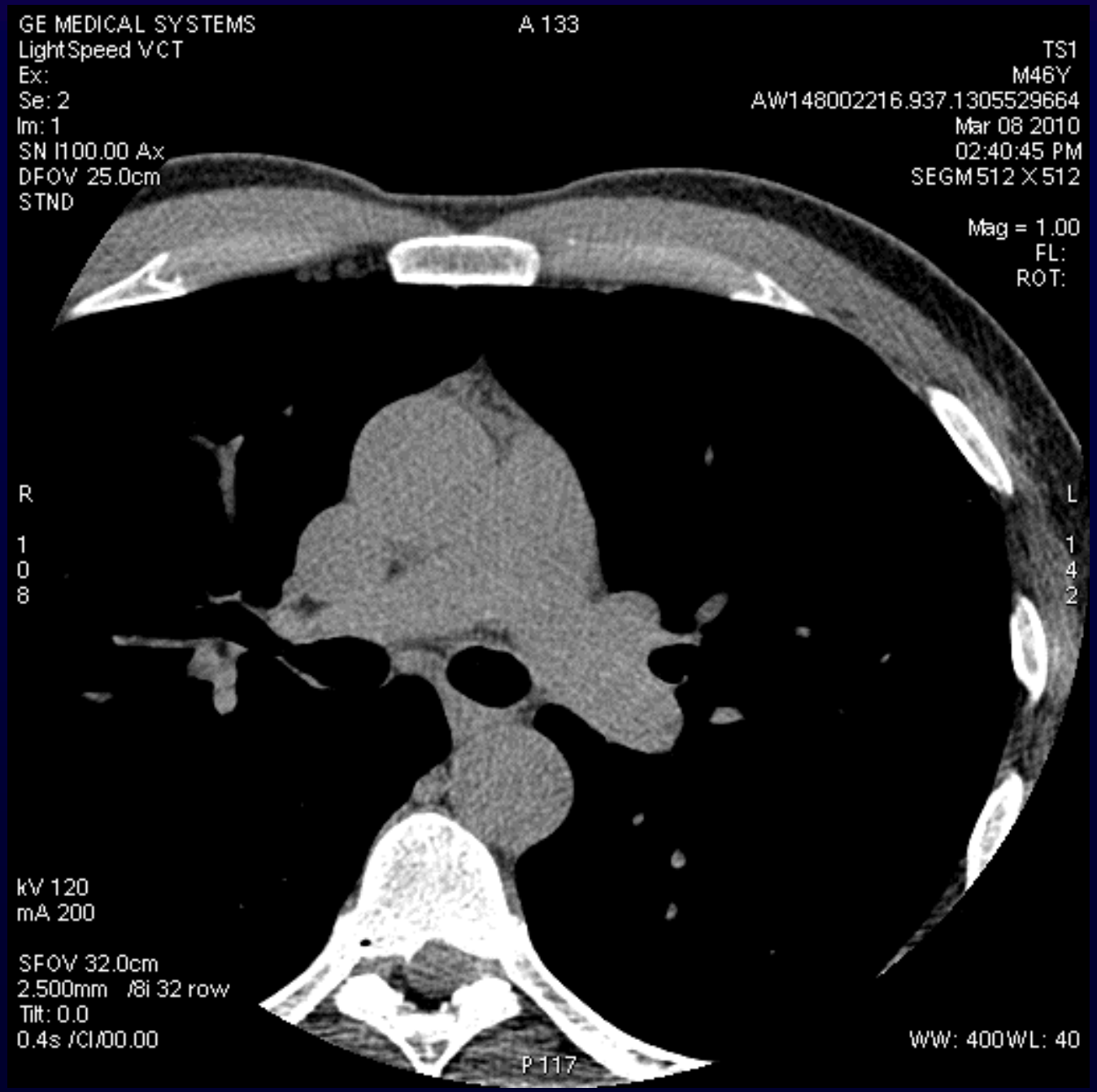
Use for *asymptomatic* People

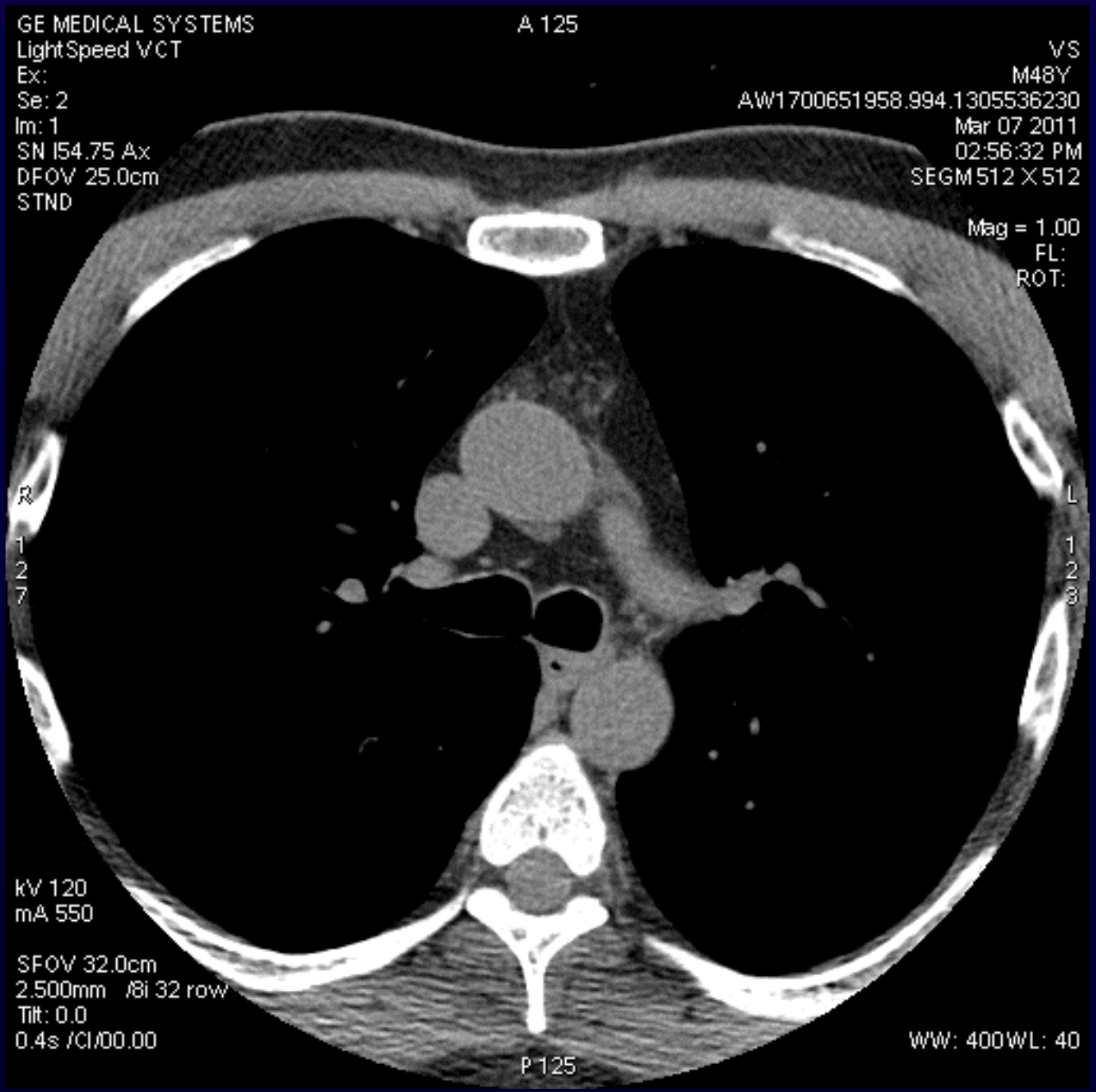
Images from a CT Calcium Score Test

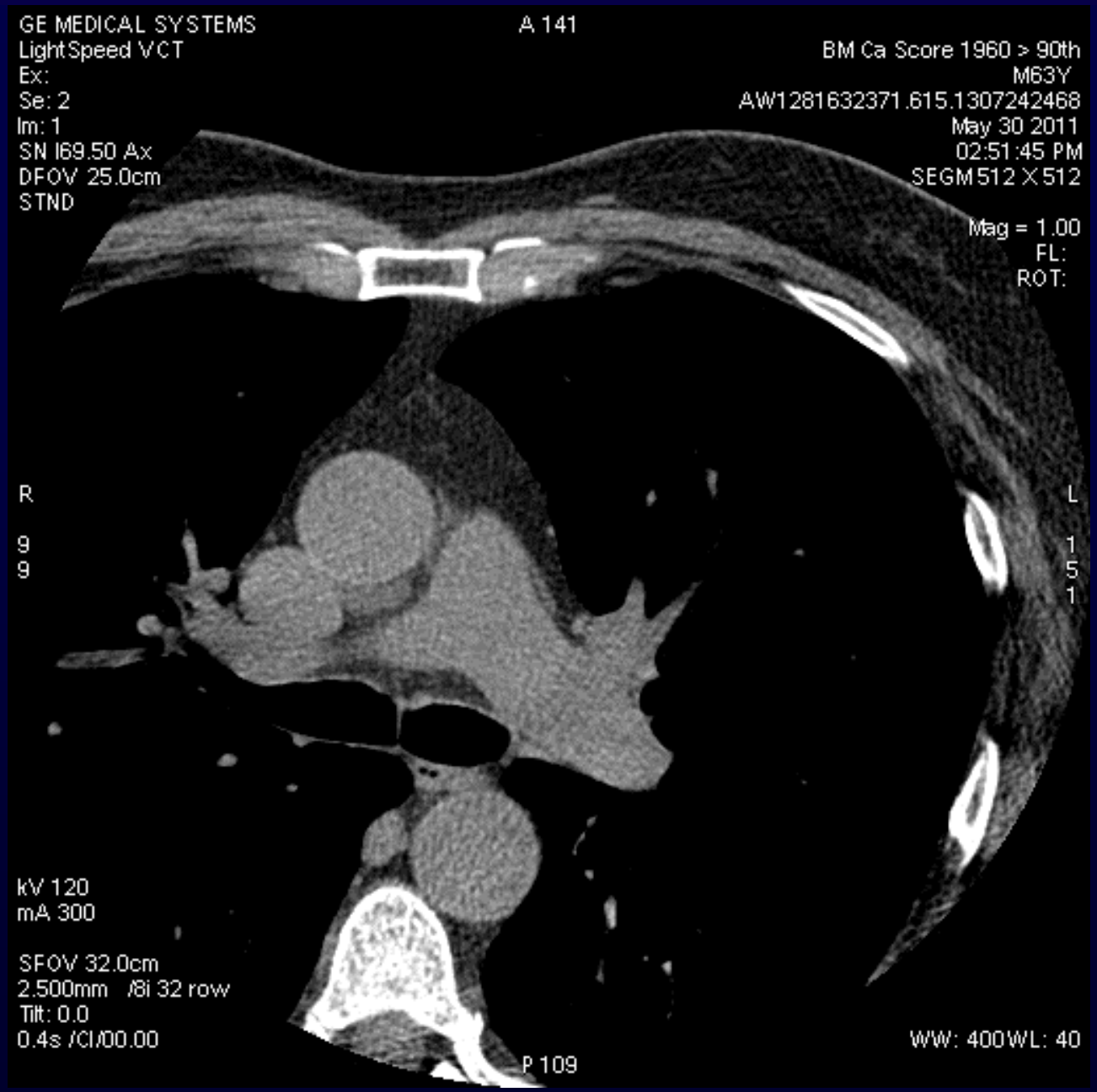
No calcium

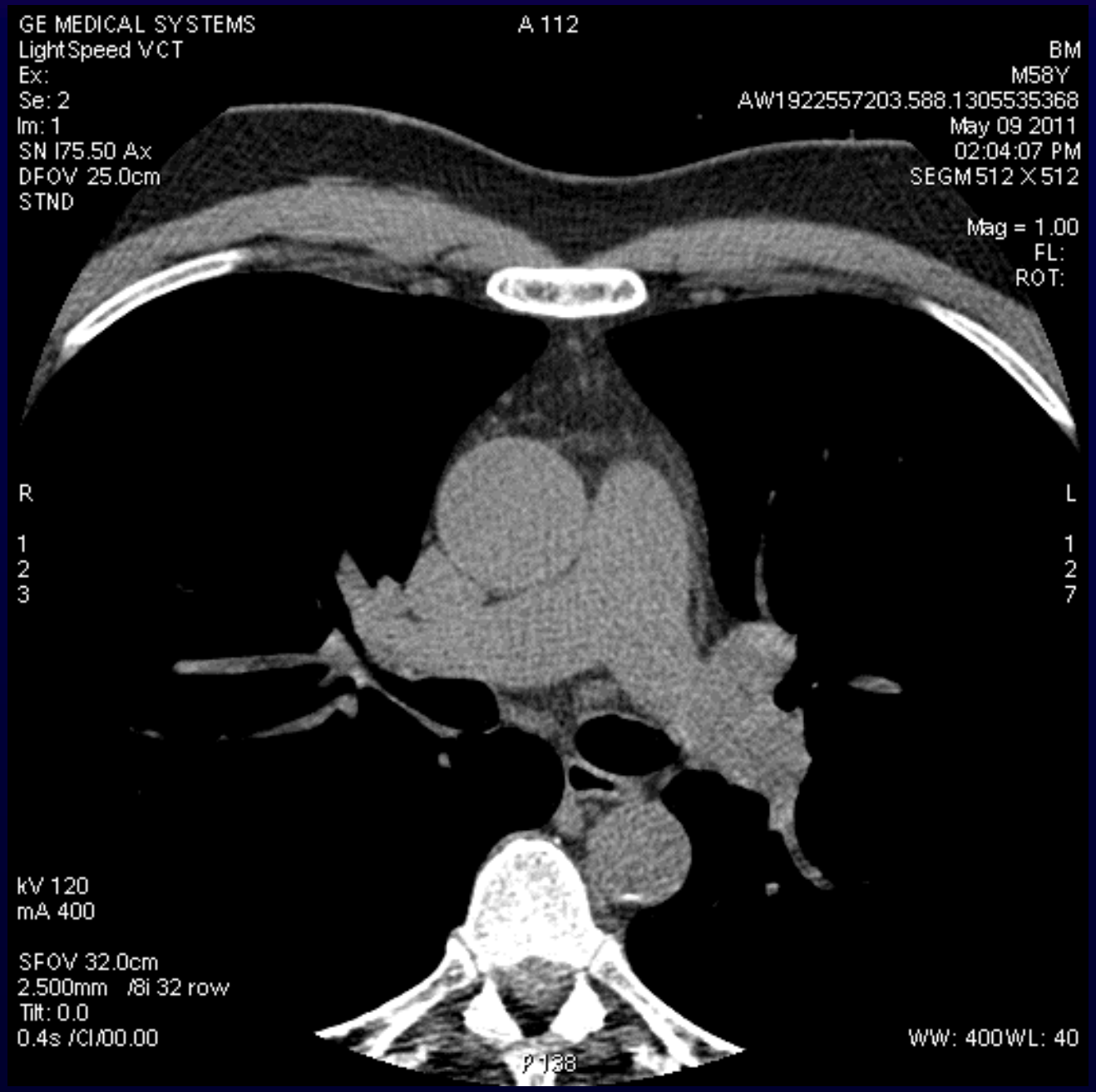


Heavy calcium

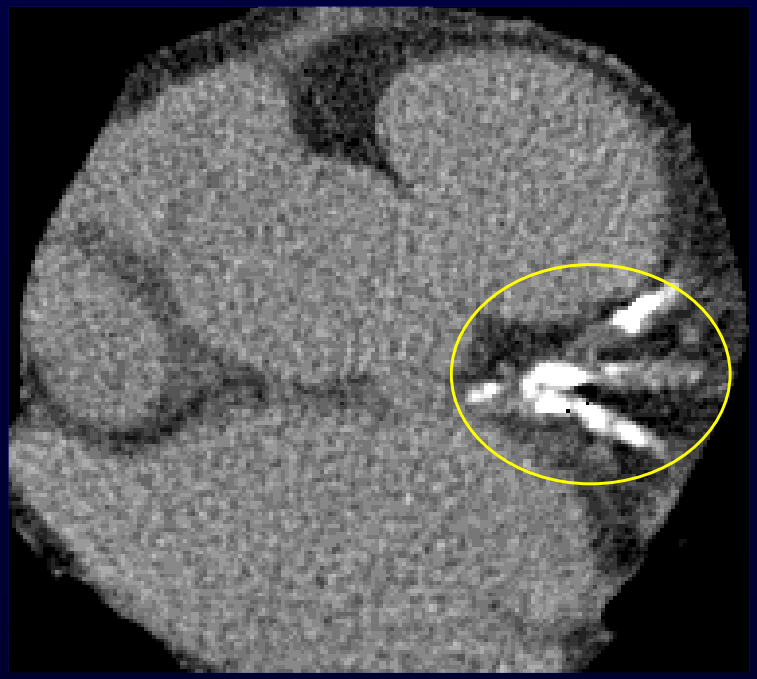

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN I100.00 Ax
DFOV 25.0cm
STND
A 133
TS1
M46Y
AW148002216.937.1305529664
Mar 08 2010
02:40:45 PM
SEGM512 X 512
Mag = 1.00
FL:
ROT:
R
1
0
8
L
1
4
2
kV 120
mA 200
SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00
P 117
WW: 400WL: 40

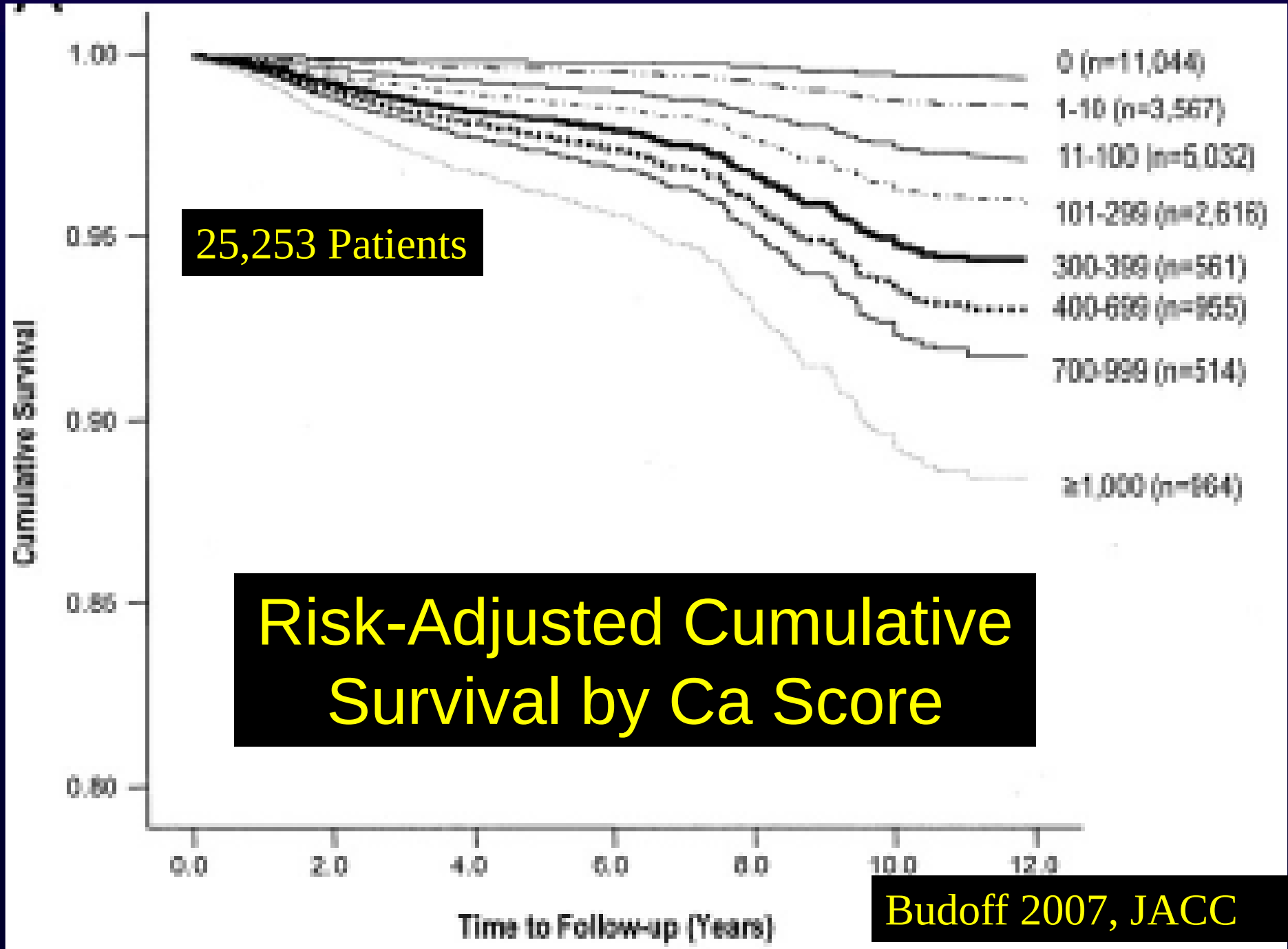

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN I54.75 Ax
DFOV 25.0cm
STND
A 125
VS
M48Y
AW1700651958.994.1305536230
Mar 07 2011
02:56:32 PM
SEGM 512 X 512
Mag = 1.00
FL:
ROT:
R
127
L
123
kV 120
mA 550
SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00
WW: 400 WL: 40
P 125


GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN I69.50 Ax
DFOV 25.0cm
STND
A 141
BM Ca Score 1960 > 90th
M63Y
AW1281632371.615.1307242468
May 30 2011
02:51:45 PM
SEGM 512 X 512
Mag = 1.00
FL:
ROT:
R
L
9
9
1
5
1
kV 120
mA 300
SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00
P 109
WW: 400 WL: 40

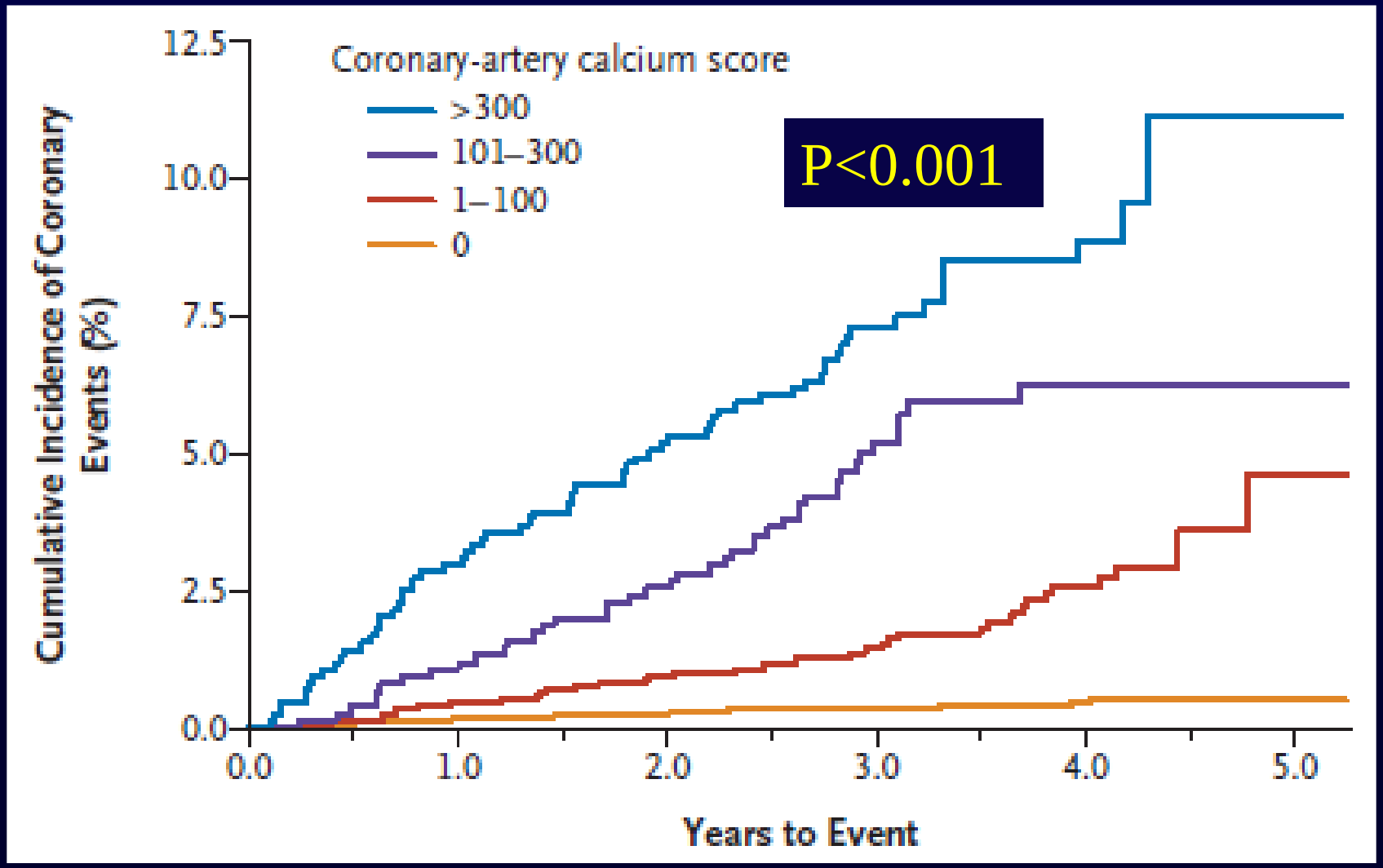

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN I75.50 Ax
DFOV 25.0cm
STND
A 112
BM
M58Y
AW1922557203.588.1305535368
May 09 2011
02:04:07 PM
SEGM 512 X 512
Mag = 1.00
FL:
ROT:
R
L
1
2
3
1
2
7
kV 120
mA 400
SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00
WW: 400 WL: 40
P138

What is the Science to show that Calcium Scores Predict CVS Risk?



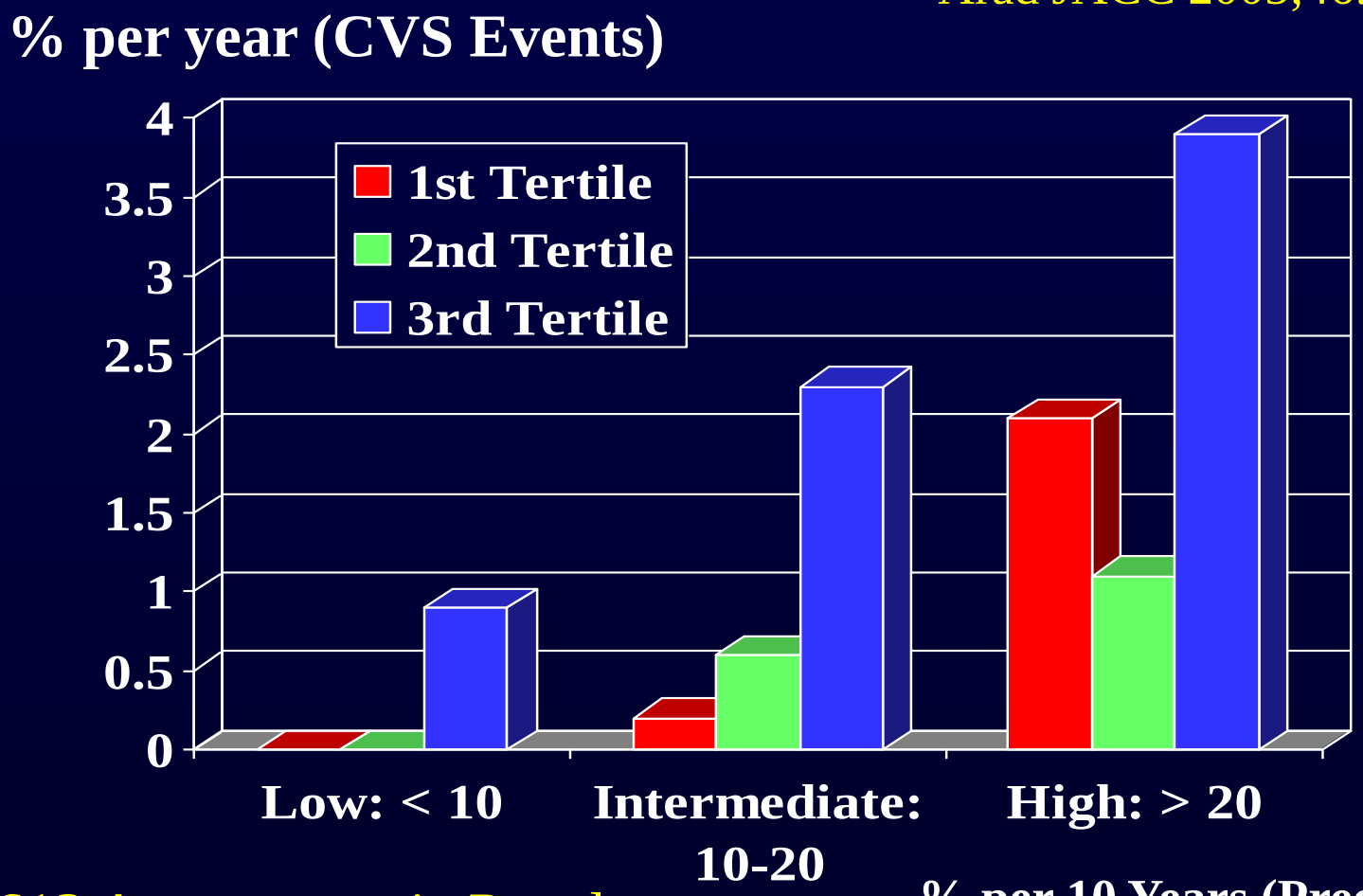

25,253 Patients
Risk-Adjusted Cumulative Survival by Ca Score
Budoff 2007, JACC
Cumulative Survival
1.00
0.95
0.90
0.85
0.80
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Time to Follow-up (Years)
0 (n=11,044)
1-10 (n=3,567)
11-100 (n=5,032)
101-299 (n=2,616)
300-399 (n=561)
400-699 (n=955)
700-999 (n=514)
≥1,000 (n=664)

Calcium Score & Any Coronary Events: MESA Study NEJM 2008;358:1336-45



St Francis Heart Study: Coronary Event Rates as a function of Calcium Score within Framingham Risk Groups

Arad JACC 2005;46:158-65



4613 Asymptomatic People

St Francis Heart Study [of 4,613 Asymptomatic People]

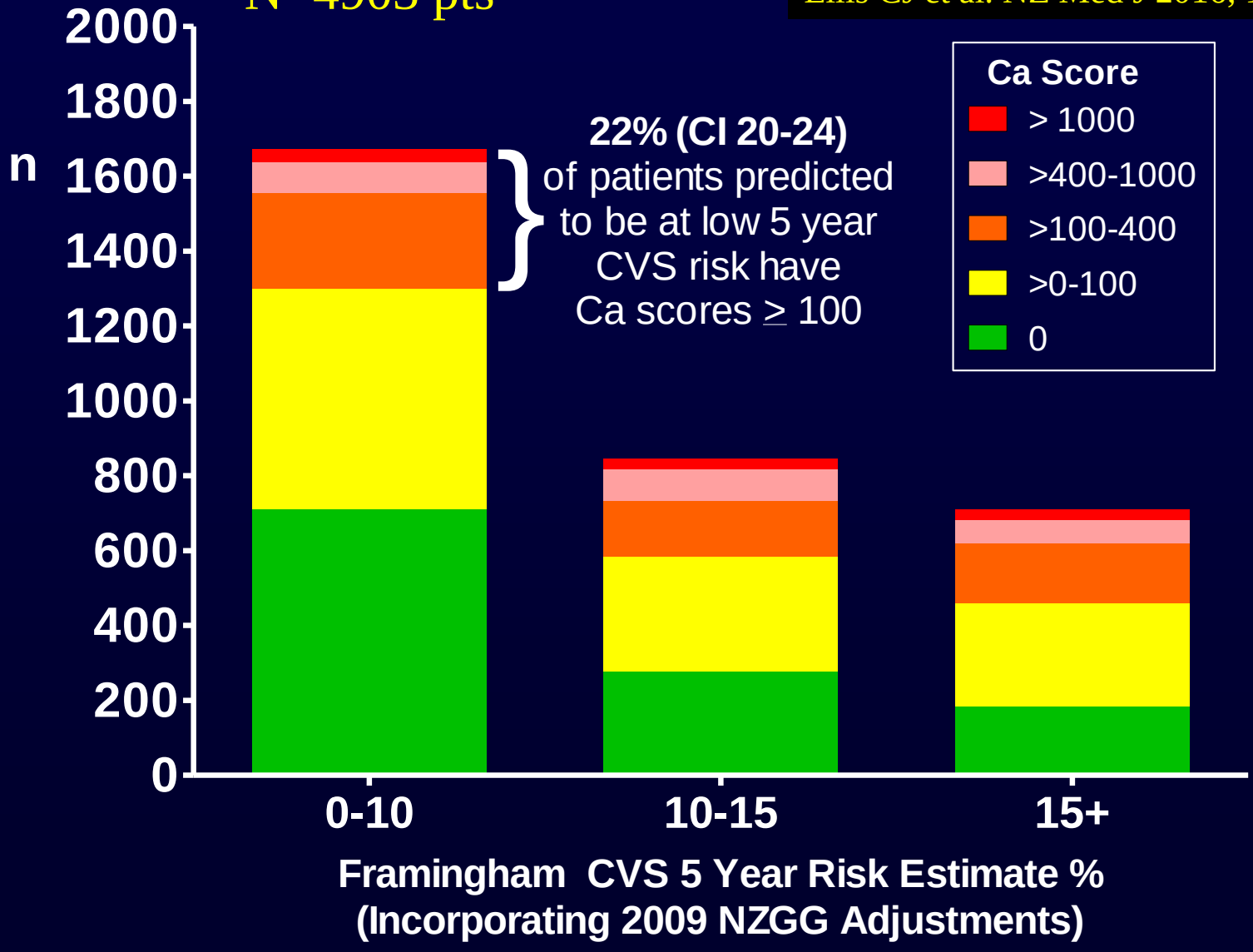
Arad et al. JACC 2005;46: 158-65, 166-72.

- A Coronary Calcium Score of $\geq$ 100 Agatston units
  - Resulted in x 10 times increase risk of a CVS events
- The Coronary Calcium Score
  - Was superior to the Framingham Risk Equation (Receiver-operator curve 0.79 $\pm$ 0.03 vs 0.69 $\pm$ 0.03, p=0.0006)
  - Enhanced stratification of Framingham Risk categories, low, intermediate, high risk ($p<0.0001$)

Agatston Calcium Score by Band of 5-Year CVS Risk Estimated by the NZ Guidelines Group 2009 'Adjusted' (Anderson) Framingham Equation

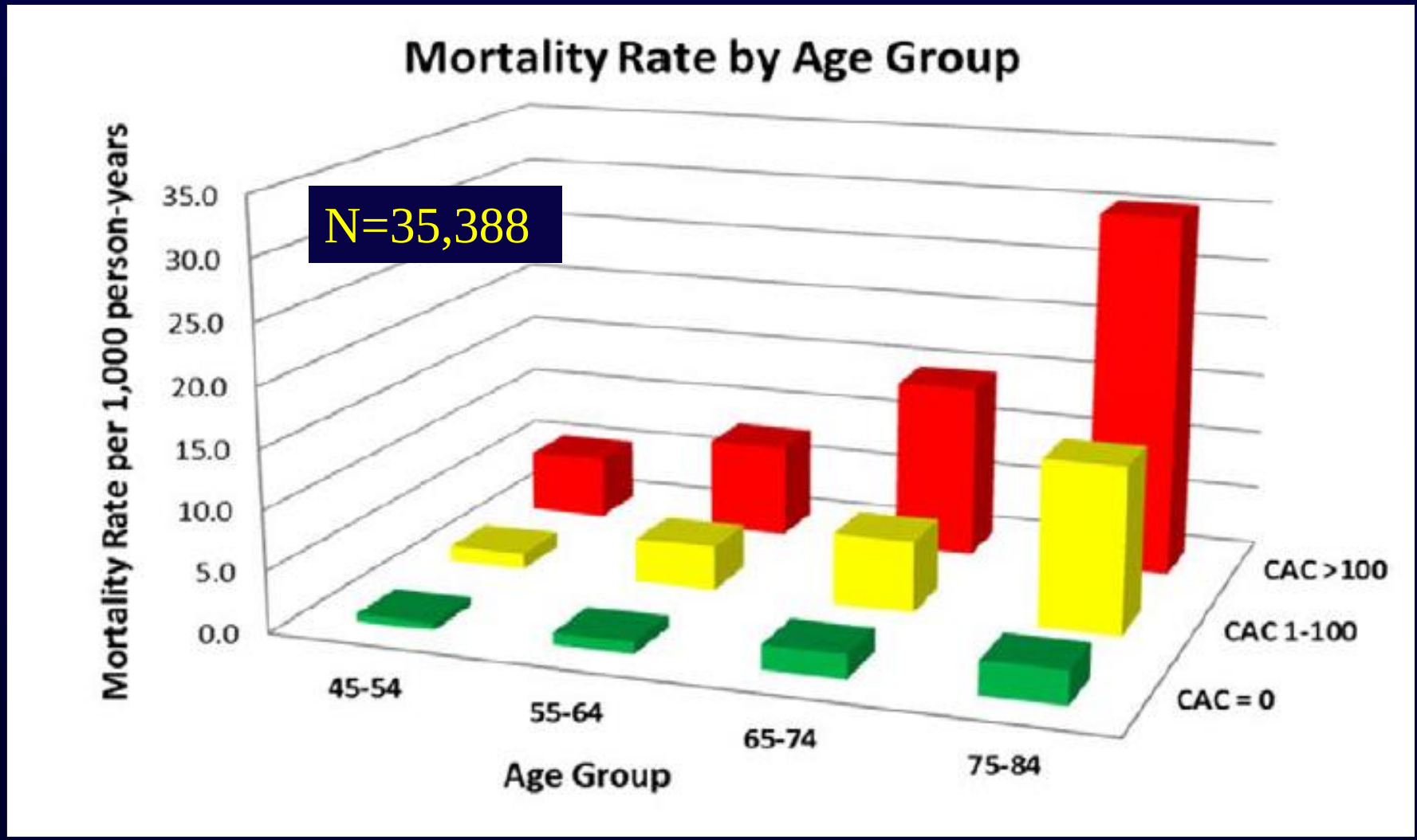
N=4903 pts

Ellis CJ et al. NZ Med J 2016; 124: 1335.



Calcium Score Level Predicts CVS Events More Than Age

Blaha MJ et al. Circ CVS Imaging 2014;7: 398-408.

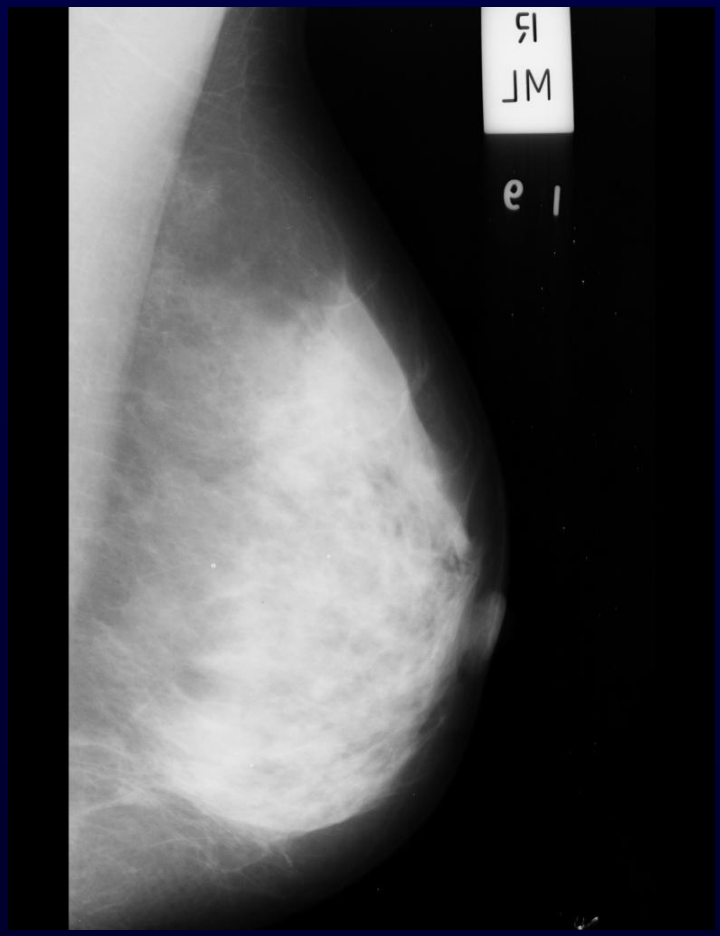


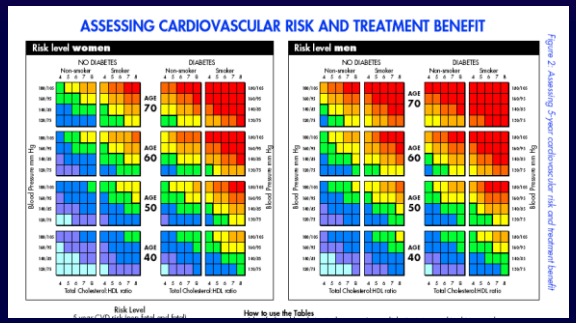
The Radiation Dose of a CT Calcium

Calcium Score (Alone)

~ 1 mSv: ~ Same
as a Mammogram

Background Radiation
dose in NZ is 3 mSv/year

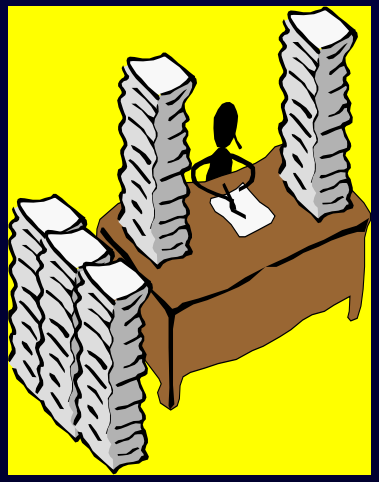




Framingham-Based:
5 or 10-Year Risk &
"Lifetime-Risk"

Family History

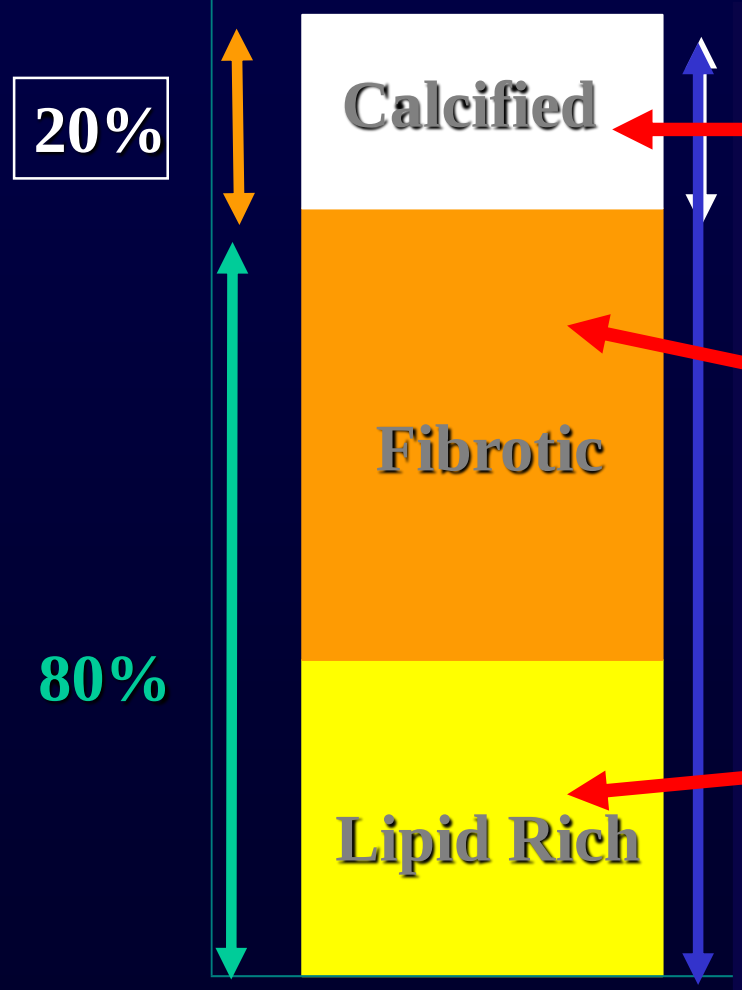
CVS Risk Assessment



"Modern Risk Factors"

Calcium Scoring & CT Angiography

Coronary Calcium Score & Coronary Artery Plaque :Risk Assessment



PROVEN

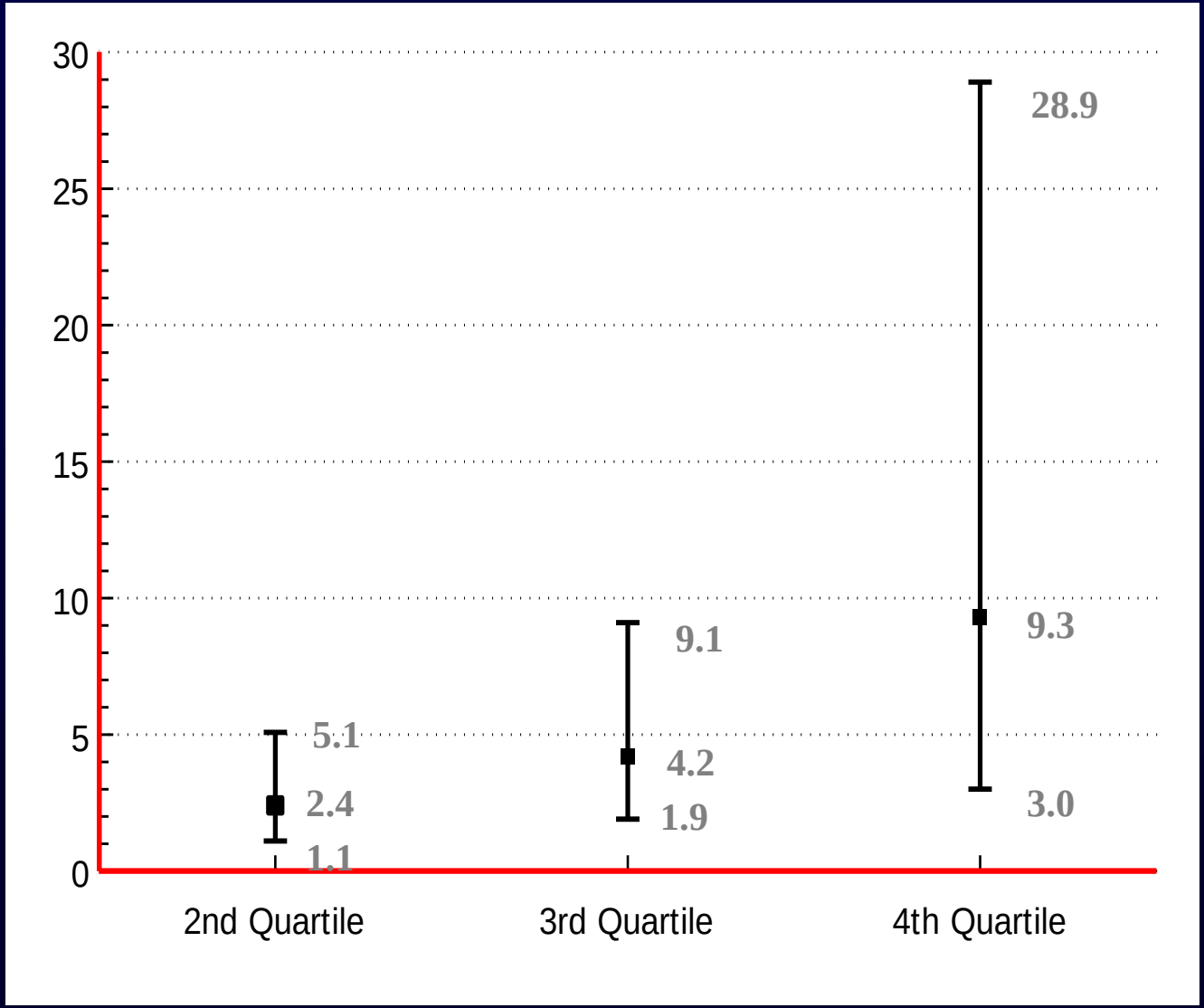
Plaque Detectable by IVUS, CTAngio, Pathology

20%

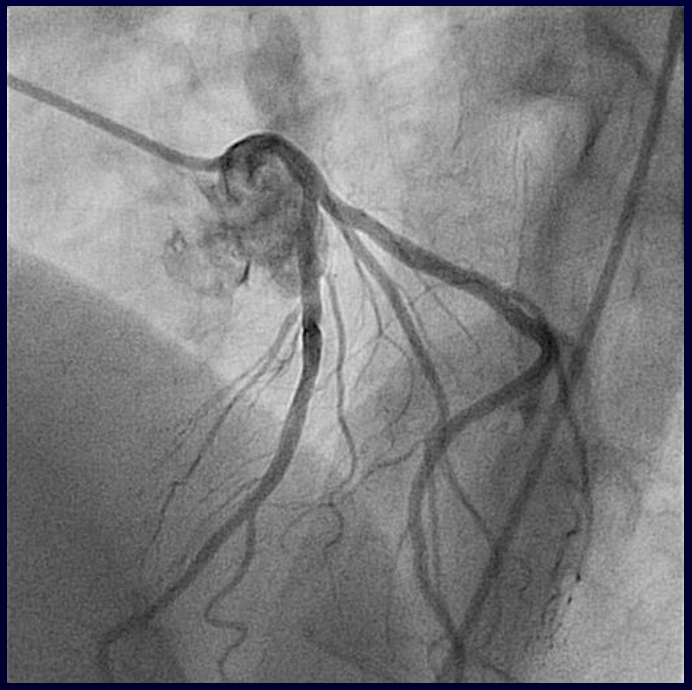
80%

UNPROVEN (to date)

Odds Ratio of maintaining statin therapy with various levels of baseline CAC (3.6 yr f/u) – Kalia et al. 2006



Personal Risk: No longer abstract!
Very motivating: Lifestyle & Medication

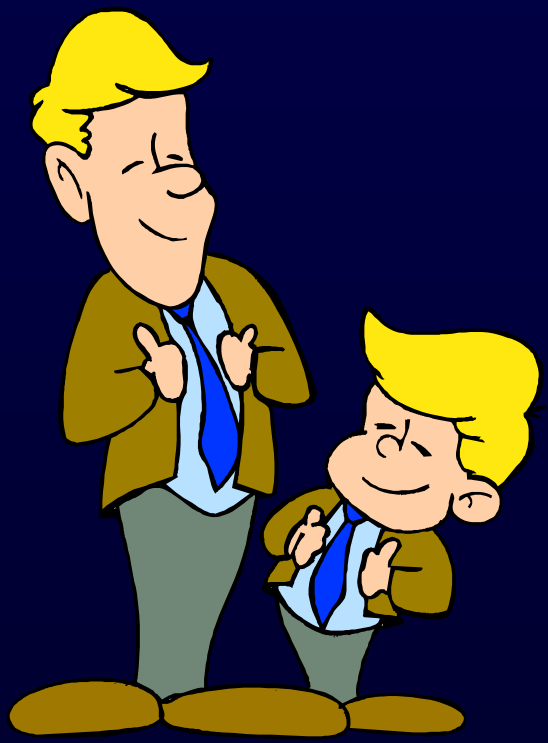


Assessing CVS Risk

Who is at High Risk?

Atherosclerosis: Is Poorly Understood

A Highly Complex Ageing of the Arteries

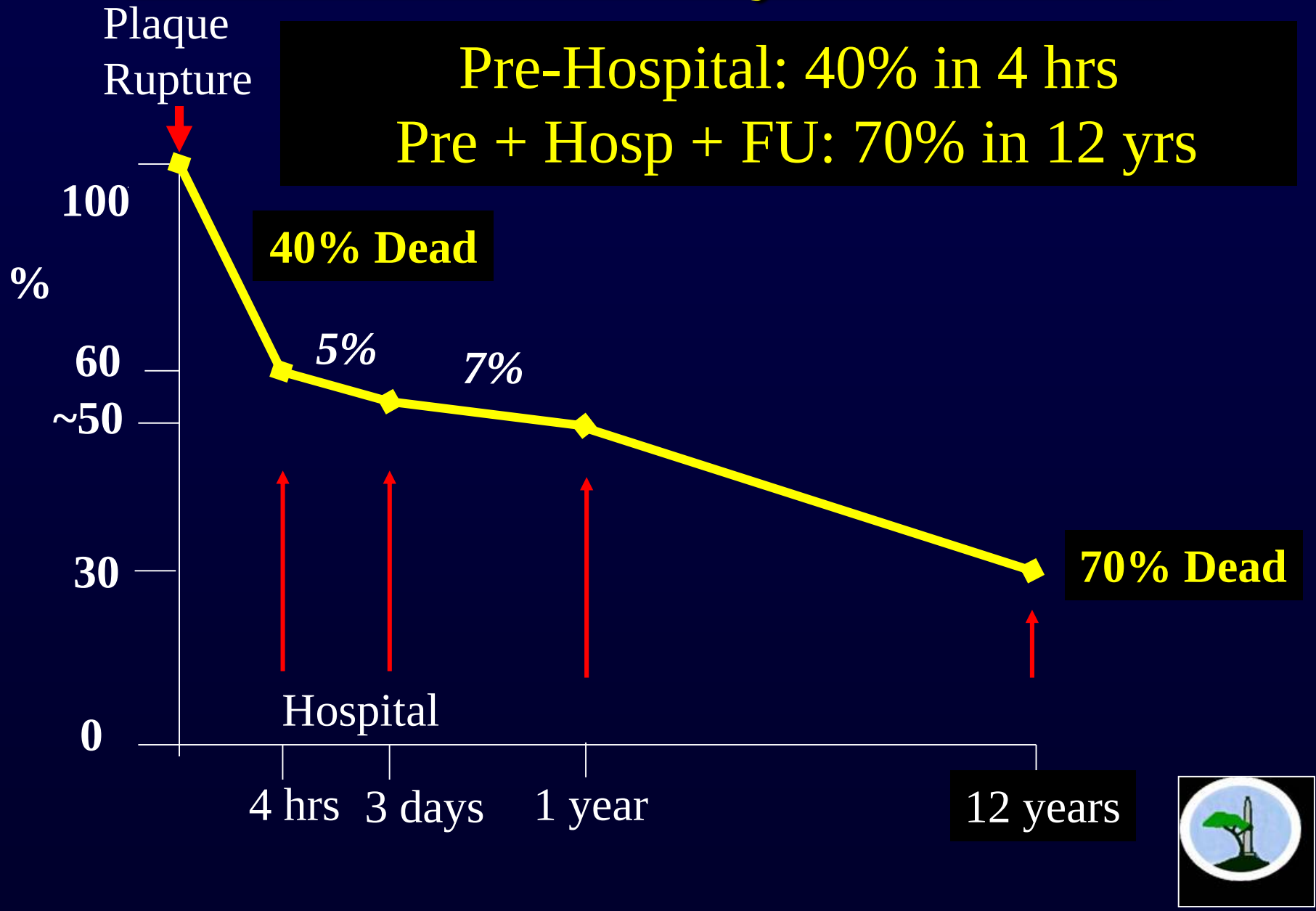


It is driven by *Lifestyle* and *Genetic* factors

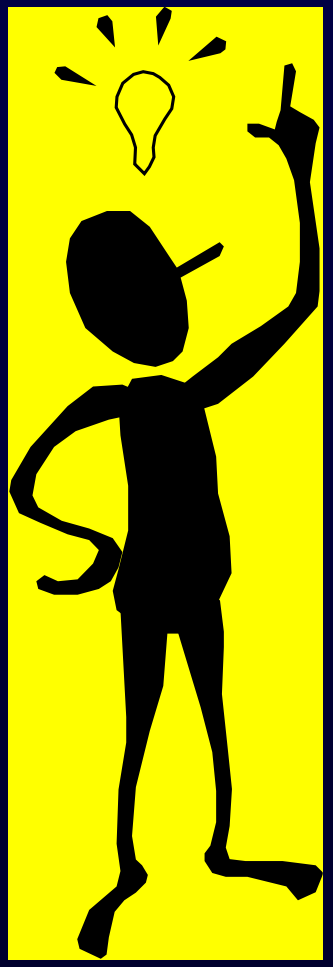
Plaque Rupture/Erosion Causing Acute Arterial Thrombus: Well Understood Mechanism of Harm

- Coronary artery
  - STEMI/NSTEMI/UAP
- Carotid or Cerebral artery
  - Stroke/TIA

What is the Mortality After a MI?



A Ruptured Plaque in a Coronary Artery is Very Serious



Atherosclerosis: A Complex Ageing/Disease Process: How *Have* we Assessed CVS Risk in New Zealand?

Patient Risk Assessment: Methods

- Epidemiology Based
  - Risk Factors
  - Complex Equation

VS

- Imaging Based
  - Look for Atheroma

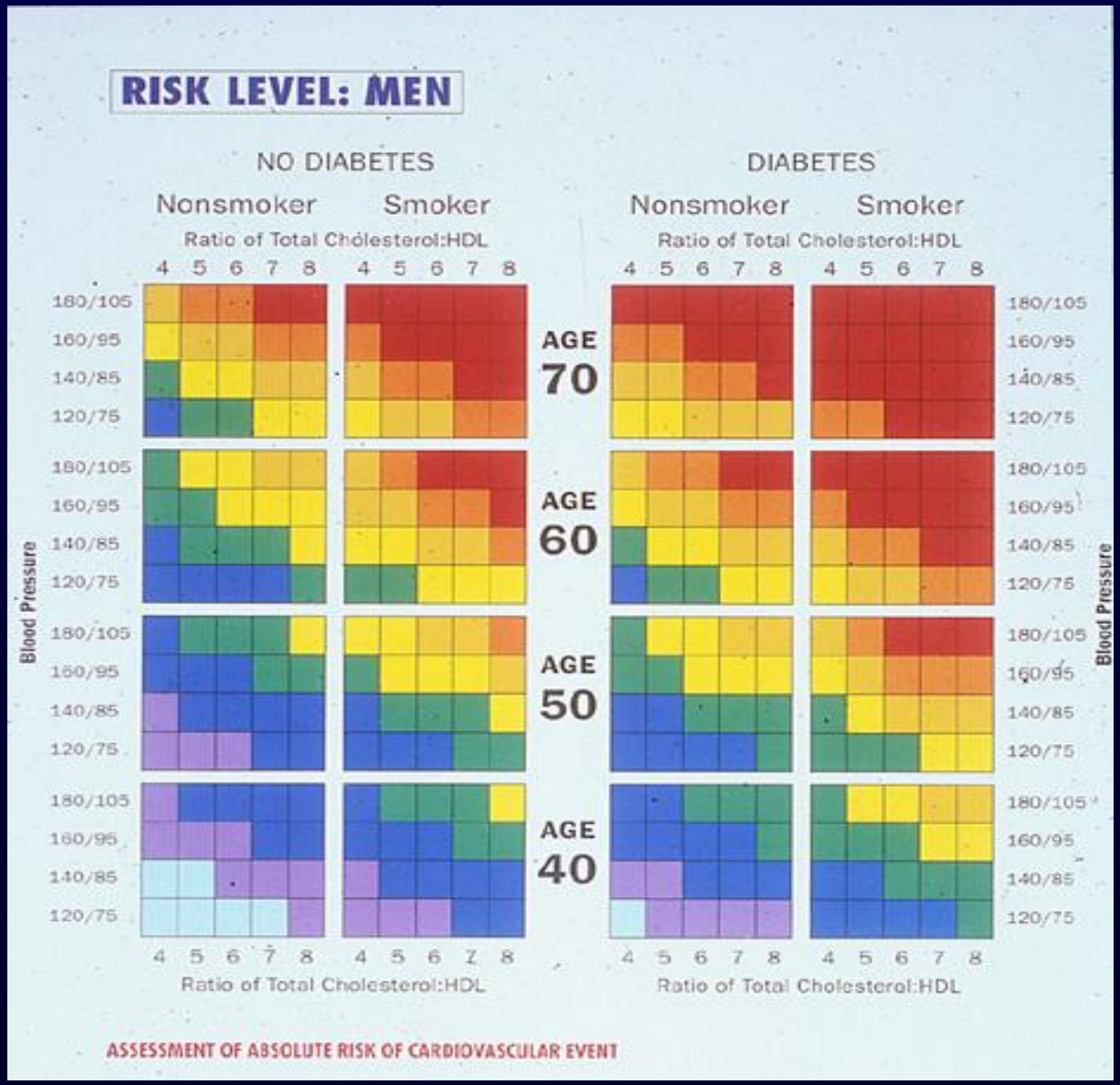
Patient Risk Assessment: Methods

- Epidemiology Based
  - Risk Factors
  - Complex Equation

VS

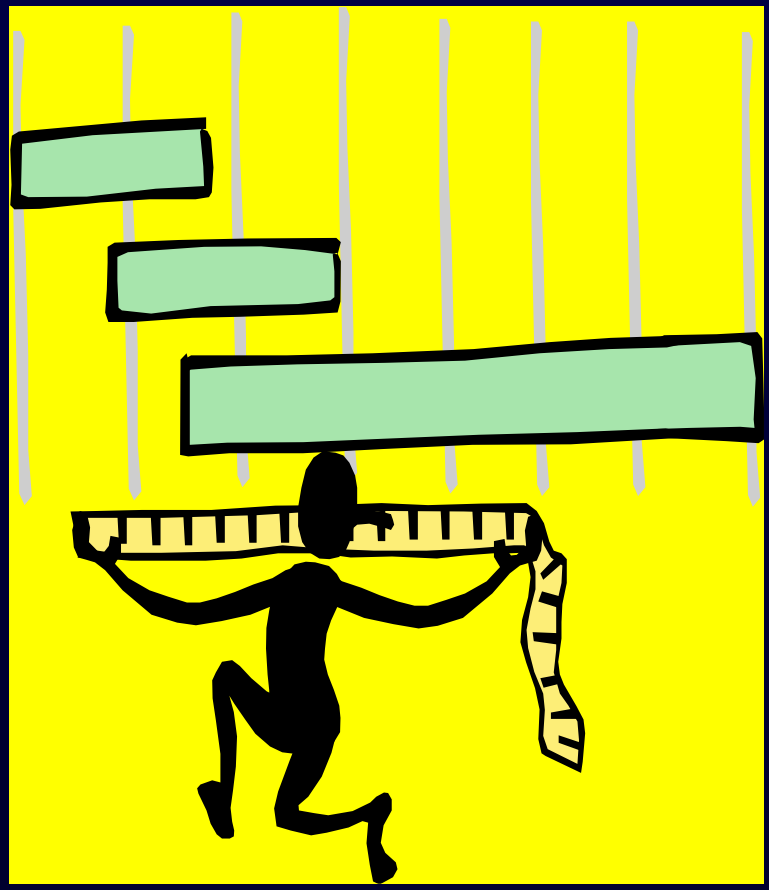
- Imaging Based
  - Look for Atheroma

Framingham-Based Risk Tables



Framingham-Based CVS Risk Tables: Risk Factors Used in NZ

- Age (decades)
- Gender
- Diabetes Status (Y/N)
- Hypertension
- Smoker (Y/N)
- Total Cholesterol/HDL Ratio



Additional 5% CVS Risk Factors (2003/2009 NZ Guidelines)

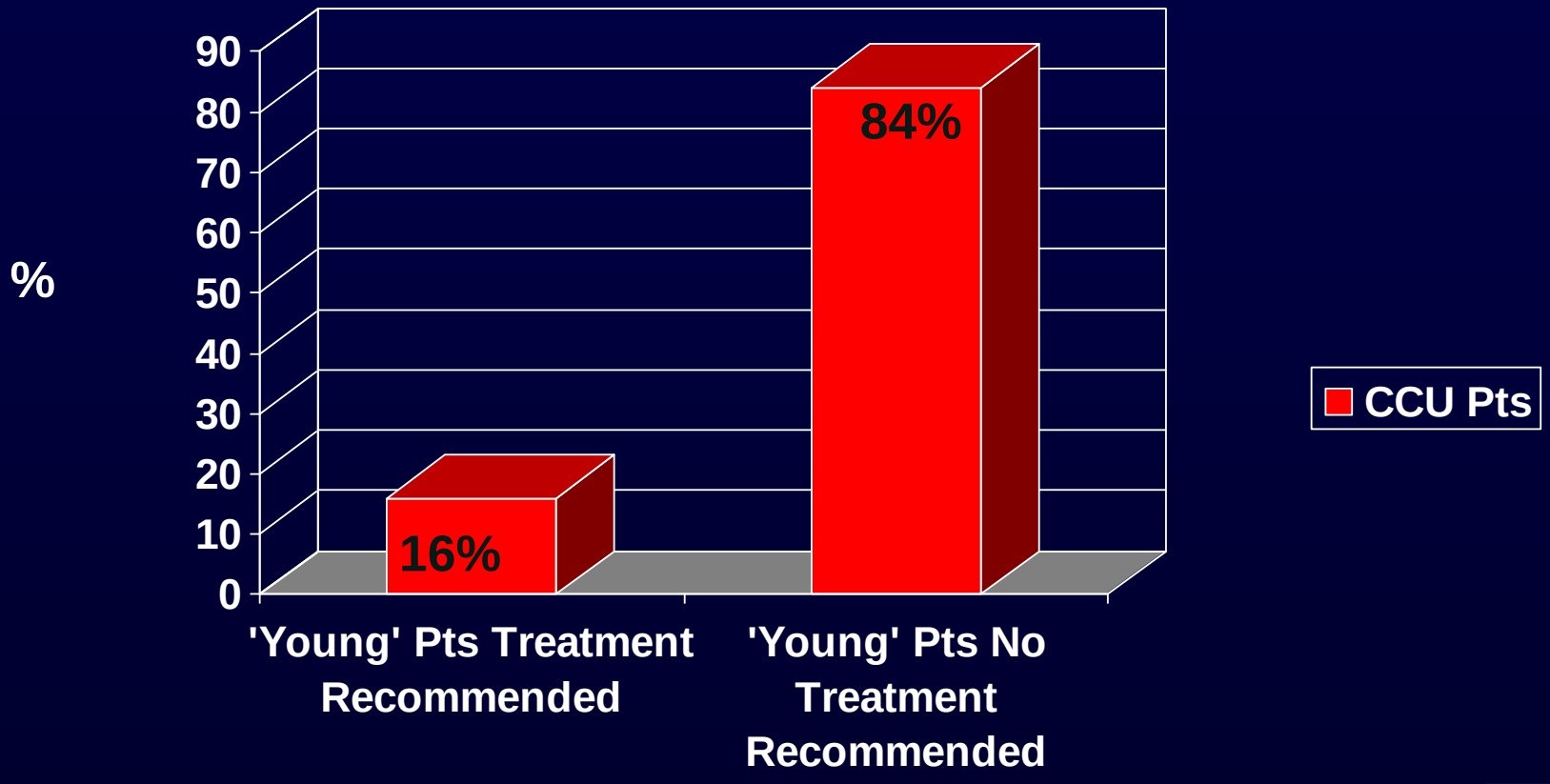
Family history of premature CHD or ischaemic stroke: • In a first-degree male relative before the age of 55 years *or* • In a first-degree female relative before the age of 65 years
Maori
Pacific peoples or people from the Indian subcontinent
People with both diabetes *and* microalbuminuria
People who have had type 2 diabetes mellitus: • For more than 10 years *or* • Who have an HbA1c consistently greater than 8%
(People with the metabolic syndrome) *GONE 2009*
IF Total Cholesterol ≥ 8 then risk ≥ 15%
if Total Cholesterol/ HDL ≥ 8 then risk≥ 15%
if BP consistently ≥ 170/100 then risk ≥ 15%

Can the USA Framingham Tables Really Predict CVS Risk: in Acute Coronary Syndrome Patients in NZ?

Auckland City Hosp CCU Pts 1 June 06 to 30 June 07

J Looi, CJ Ellis et al CSANZ 2008

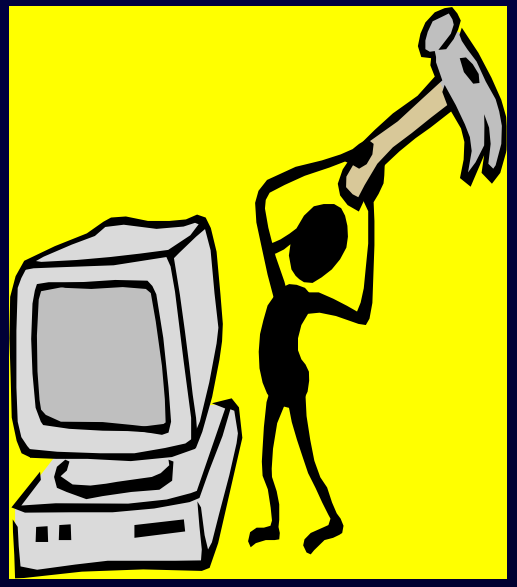
Pts with NZ Framingham CVS Risk > 15% over 5 Years



229 pts: 'Young' (male<55, female<65 years), no prior CVS disease

Gradual Realisation over time……..

- Even the best Epidemiological models of CVS risk assessment are inaccurate
- NZ Model is changing (again)
  - Epidemiological focus (most Guidelines)
- Certainly a reasonable way to start:
  - Focus on risk factors, can be addressed
  - Smoking, obesity, diabetes
  - High BP, high cholesterol
- BUT is it really good enough….?



Patient Risk Assessment: Methods

- Epidemiology Based
  - Risk Factors
  - Complex Equation

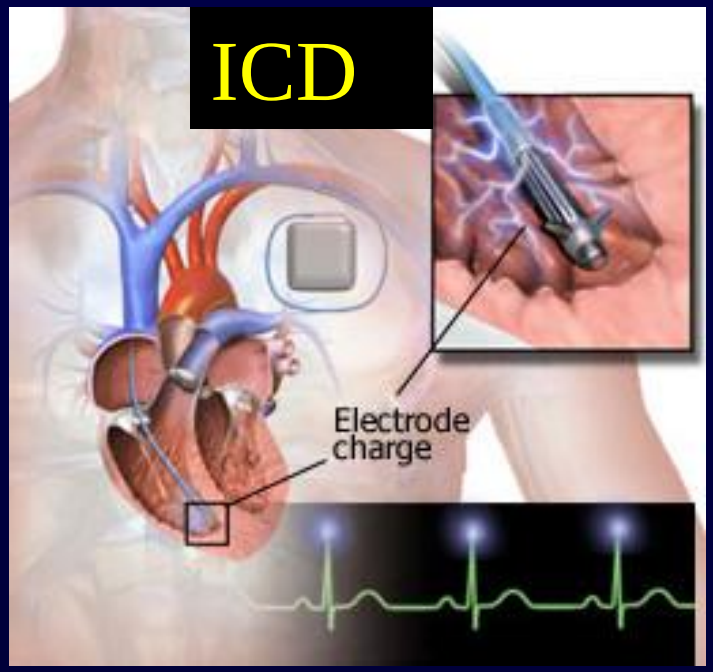
VS

- Imaging Based
  - Look for Atheroma

Calcified Coronary Arteries

- Intuitive for CVS Risk
  - *Look for disease*
  - Concept used elsewhere
  - Mammography, Colonoscopy
- Calcified Atherosclerosis
  - The ‘End Product’ of all CVS risk factors [known or unknown]
  - The *extent* of coronary atherosclerosis is the strongest predictor of CVS events

Secondary Care: Expensive with Invasive Treatments



Prevention is Better than Cure

Primary Prevention is Better than Cure
(We Have to do Better than This)

Collapsed January 2016 Sunday Star Times: 1 May 2016

"There was no pain, no numbness, no warning. I was running for a pass, and then the light changed - a bit like an eclipse.

Geoff Brogan, above, with wife Tara.

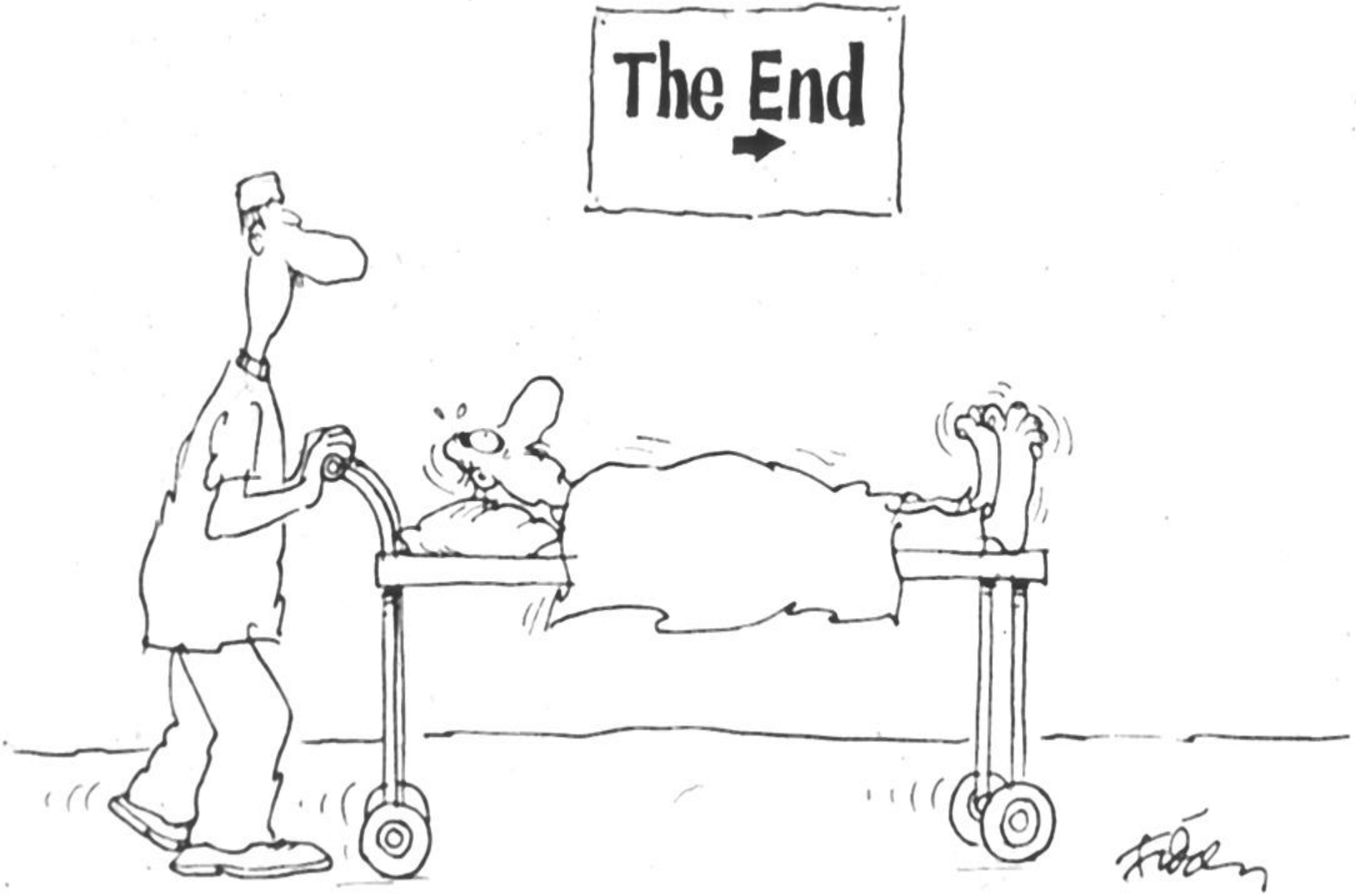
- Age 54 years
- Physical activity
- Cardiac arrest
- Club's AED
- FH IHD
- High Cholesterol
- No Treatment….

Summary: *Combine* Strategies to Investigate those at High Risk

- Epidemiology Based
  - Risk Factors
  - Complex Equation
- Additional Imaging Based
  - Strategies are now available
  - Look for Atheroma

CT Heart Scanning 2017: Summary

- Ca Score alone: CVS Risk
- Ca Score & CT Angiography
  - Atypical symptoms
  - Equivocal ETT
- CT Angiography alone
  - Aorta, Pericardium imaging
  - TAVI assessment
  - EP (Pre-Af ablation assessment)


The End