



Dr Chris Ellis

Cardiologist, Auckland City Hospital

CT Cardiac Workstations - Concurrent Workshop Session Repeated

Saturday, 11 June 2011

Start 2:00pm

Duration: 55mins

Monet

Start 3:05pm

Duration: 55mins

Monet



General Practice Conference & Medical Exhibition



09-12 June 2011 | Energy Events Centre | Rotorua

CT Cardiac Angiography: Clinical Use

Dr Chris Ellis

Cardiologist

Greenlane CVS Services

Auckland City Hospital

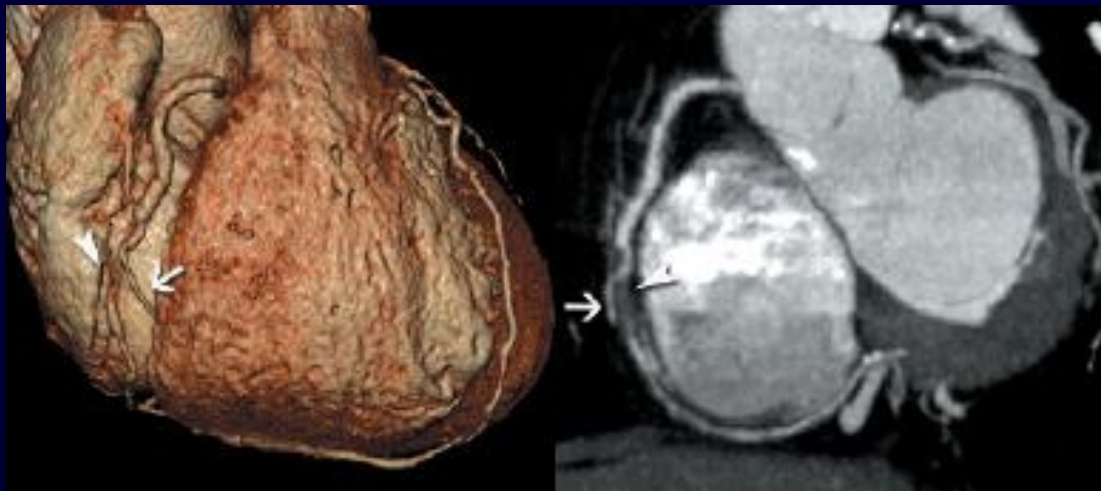
& Auckland Heart Group:

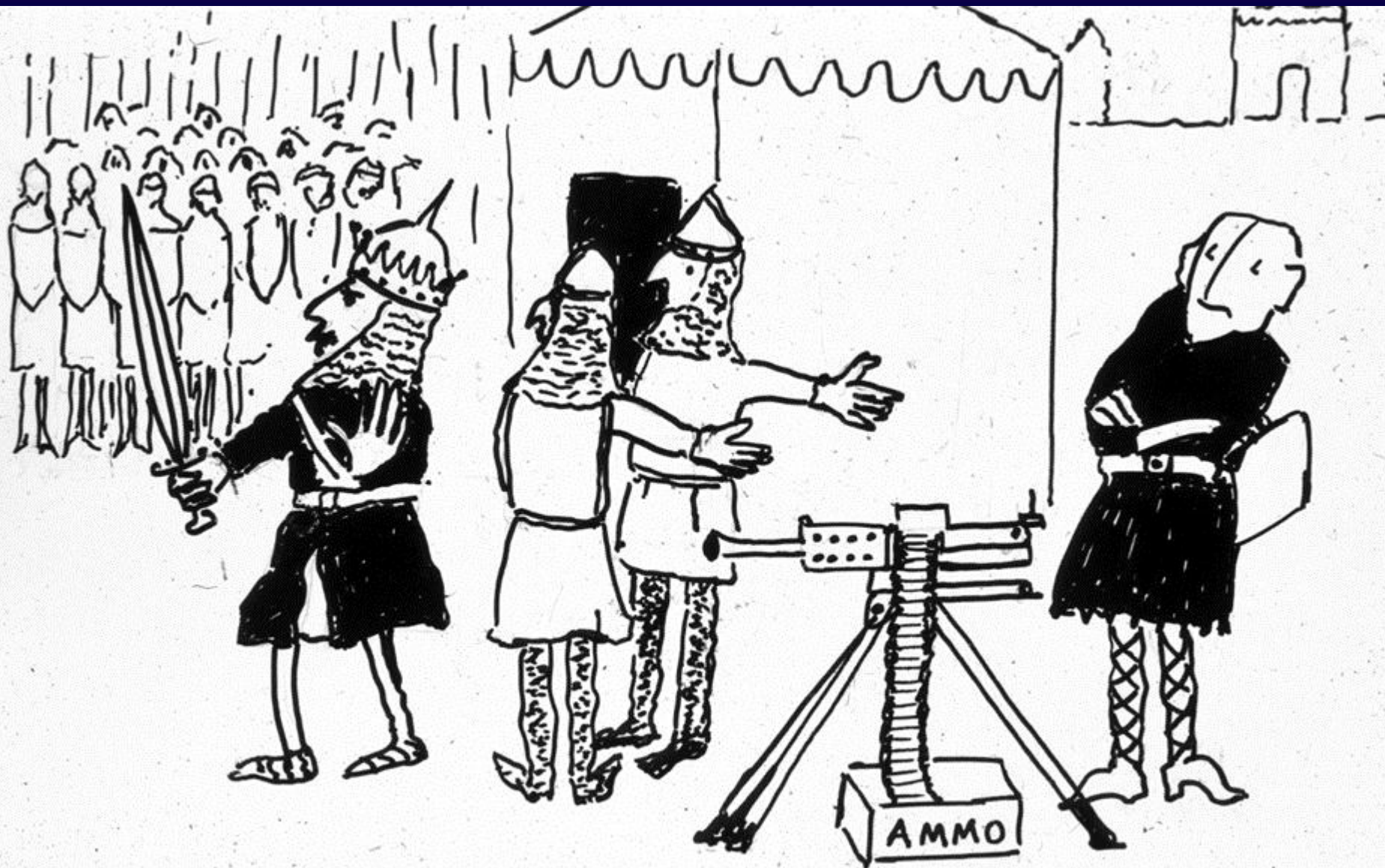
Mercy Hospital



NZMA GP CME Conference, Rotorua 9-12 June 2011

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





"Tell him we haven't got time for any of his bright ideas- we've got a battle on our hands."

CT Cardiac Angiography: Development Challenges

Coronary arteries:

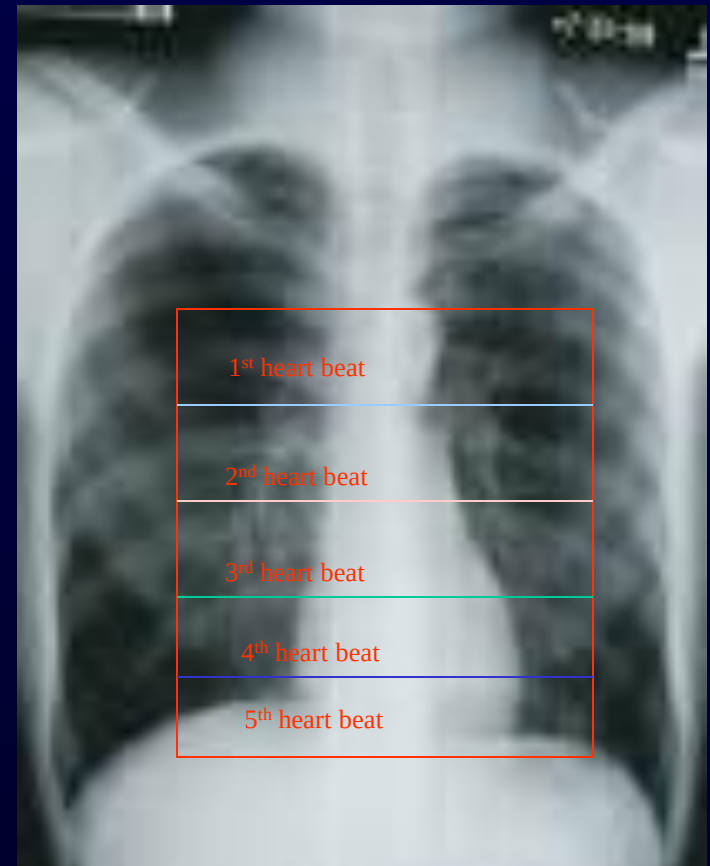
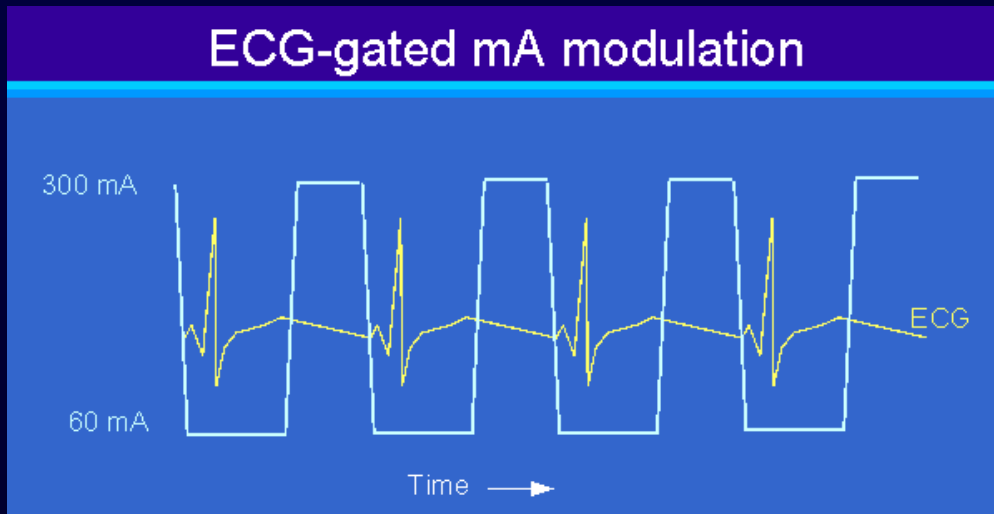
- small and tortuous (2-4mm).
- Subjected to complex respiratory and cardiac motion.
- RCA moves at up to 120 km/hour



120 km/h

Multi-Slice CT (64 slice)

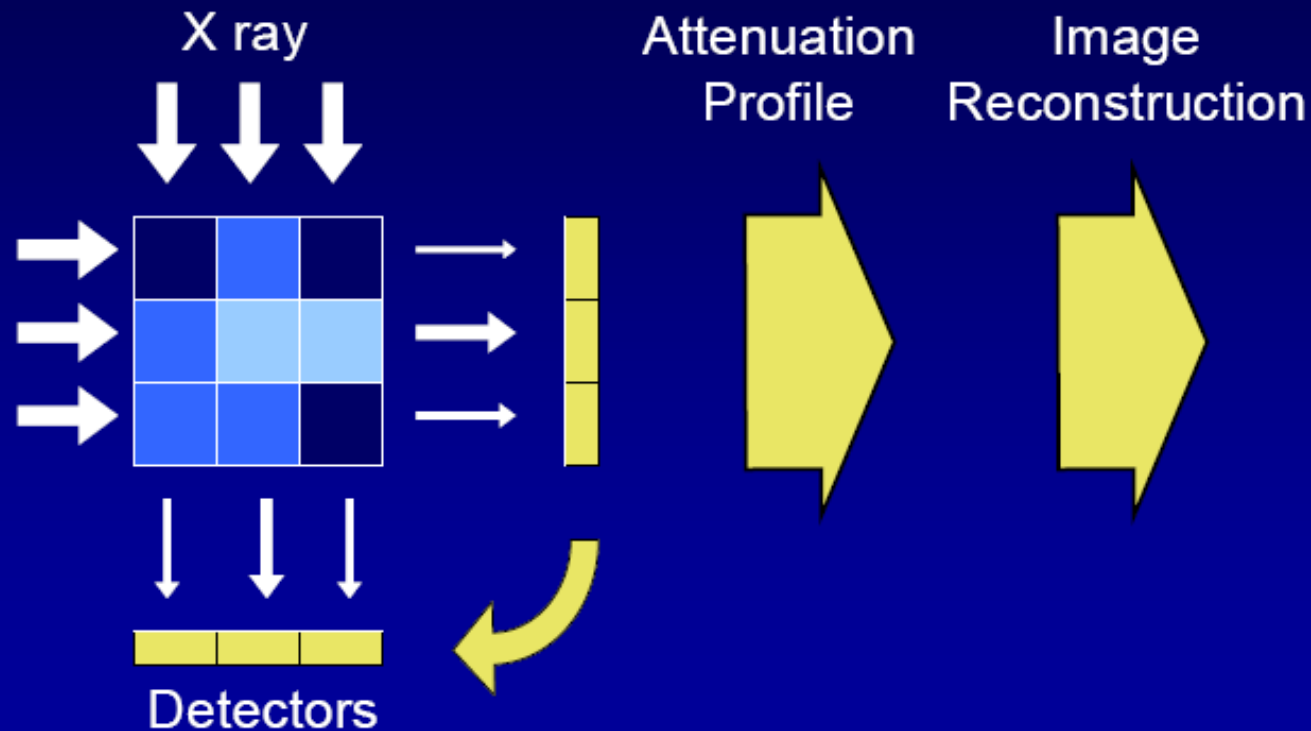
- ECG is 'gated'; requires slow and steady HR (50-70 bpm).
- Acquires a 3D data set of the whole heart, in 6-10 seconds



64-Slice CT Cardiac Angiography: CT Scanner



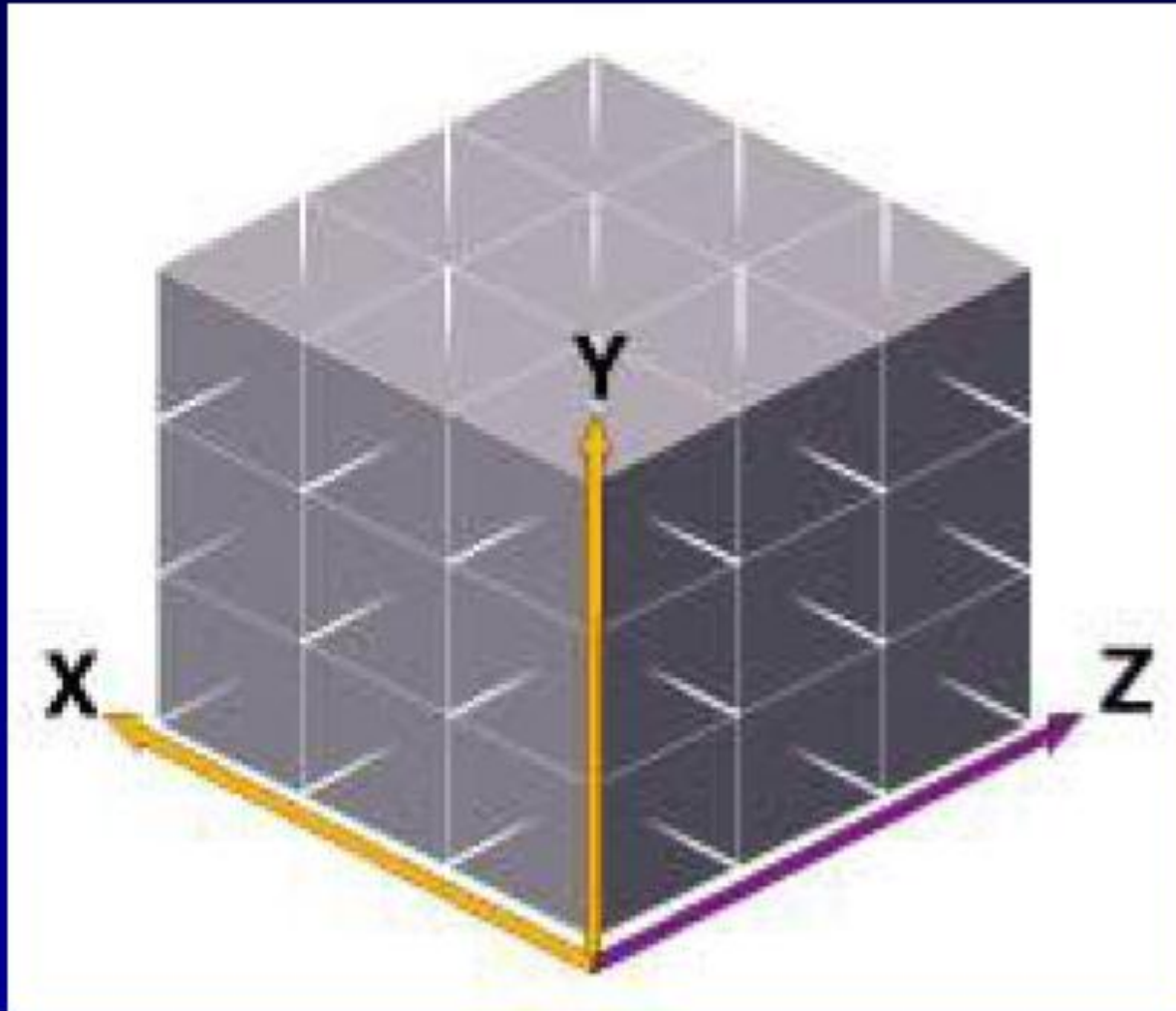
Data Acquisition



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

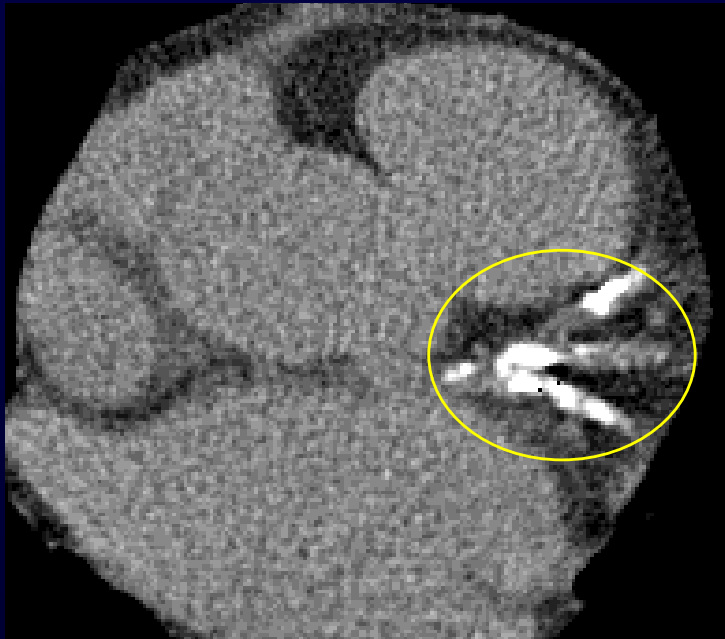
Voxel Size

Spatial resolution 0.4mm x 0.4mm x 0.625mm

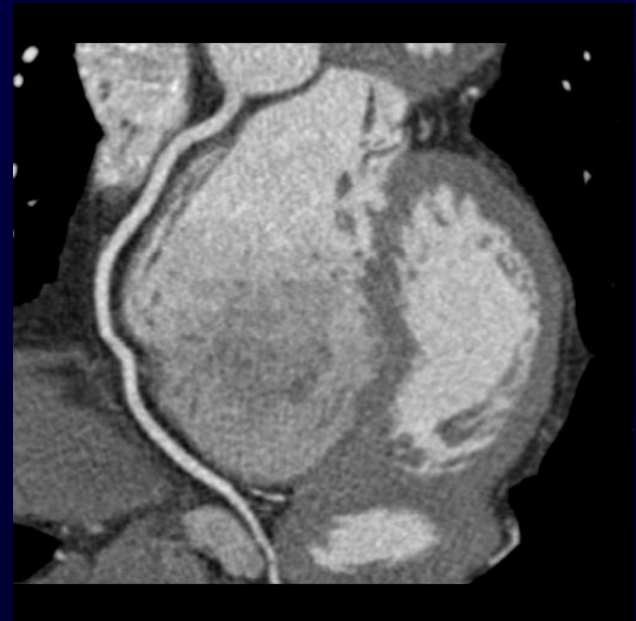


Voxel = “3-dimensional Pixel”

CTA Patients have 2 'scans'



1. Calcium Score



2. Main Scan

Coronary Calcium
Score (Agatston
Units)



Coronary Calcium Score:

Agatston Method Agatston et al JACC 1990;15:827-832.

- 30-40 contiguous slices obtained at 3mm intervals down the heart to include the entire coronary tree (ECG 'gated')
- Exposure time 100ms/tomographic slice
- 'Effective' radiation dose of approx 1mSv/Scan (Mammography approx 1mSv)
- 'Agatston score': Algorithm using density of calcium (Hounsfield Units) and the extent of calcified area

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 14
SN I132.50 Ax
DFOV 25.0cm
STND

A 183

TS1
M46Y
AW148002216.937.1305529664
Mar 08 2010
02:40:46 PM
SEGM 512 X 512

Mag = 1.00
FL:
ROT:



No calcium
in LAD

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN 1100.00 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

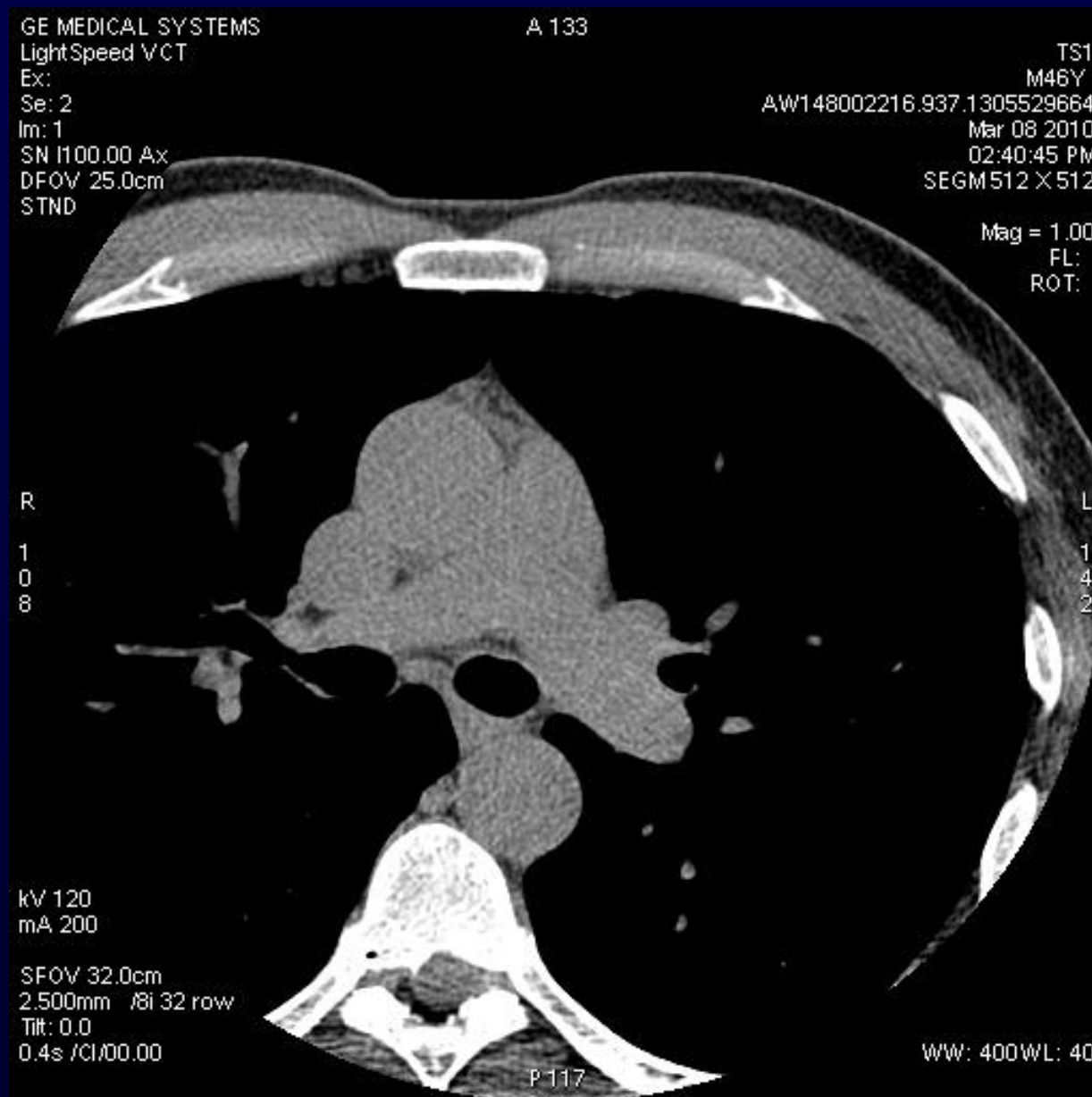
L
1
4
2

kV 120
mA 200

SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00

W/W: 400WL: 40

P 117

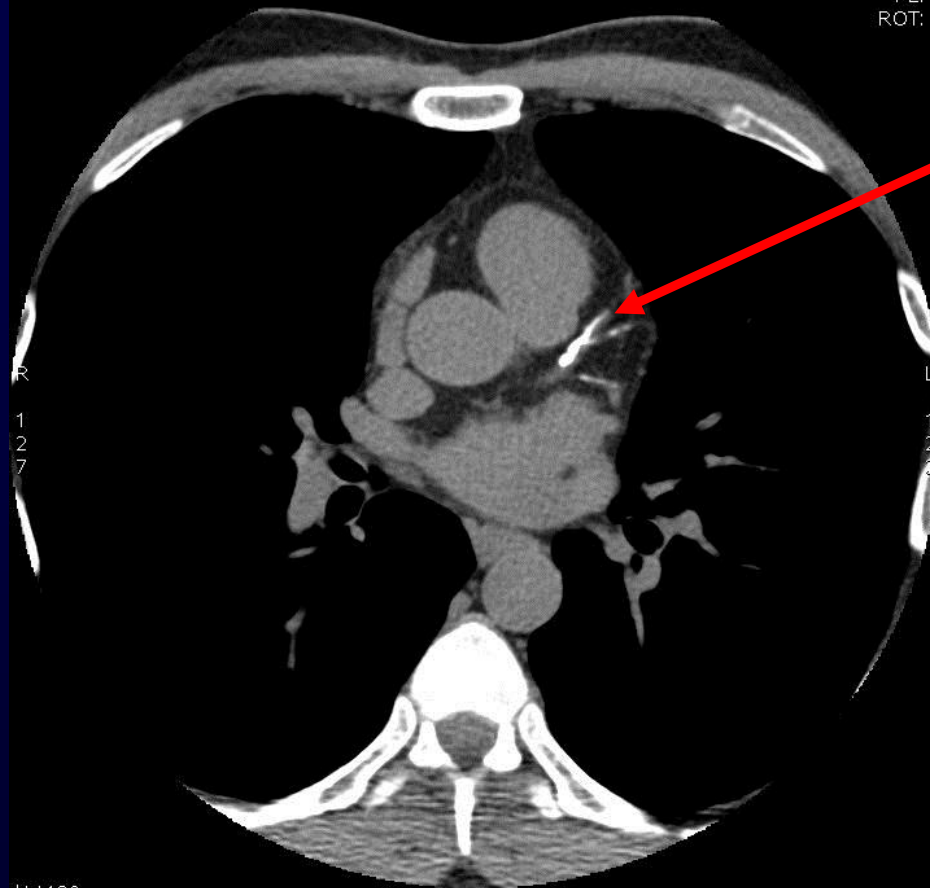


GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 13
SN I84.75 Ax
DFOV 25.0cm
STND

A 175

VS
M48Y
AW1700651958.994.1305536230
Mar 07 2011
02:56:34 PM
SEGM 512 X 512

Mag = 1.00
FL:
ROT:



Calcified
LAD

kV 120
mA 550

SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00

P 175

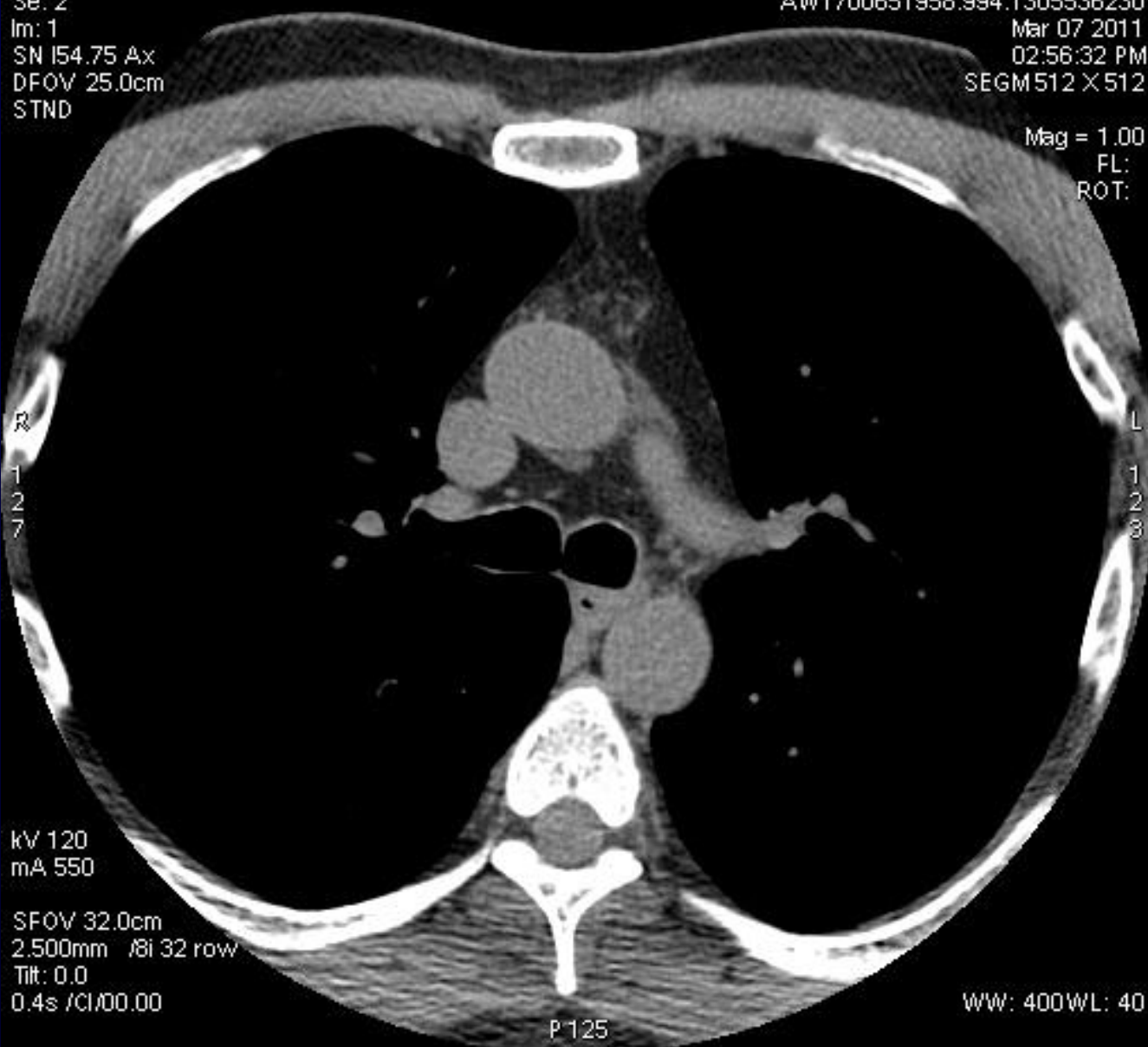
WW: 400WL: 40

GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN 154.75 Ax
DFOV 25.0cm
STND

A 125

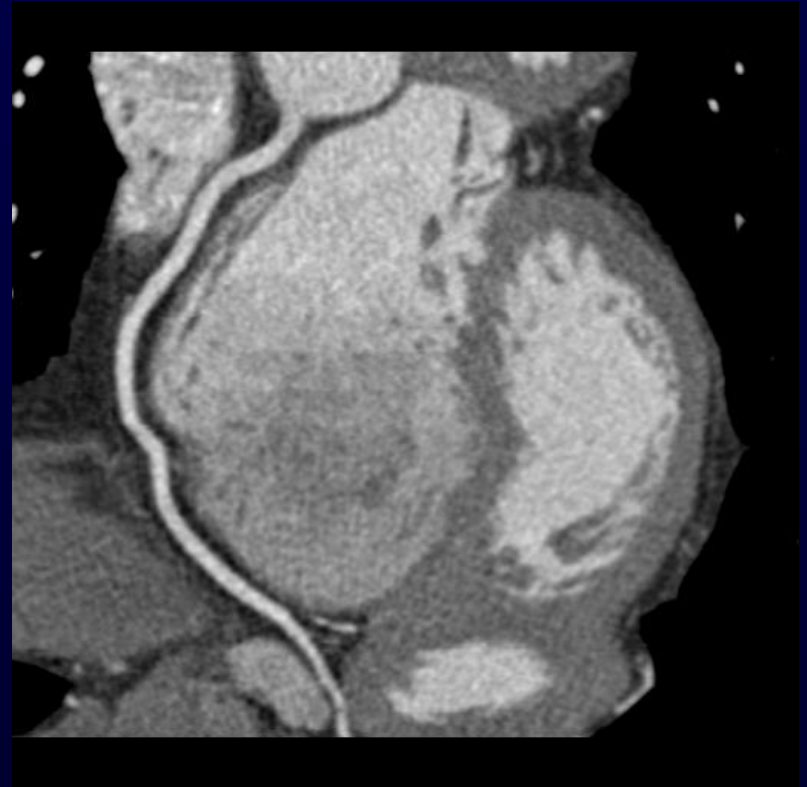
VS
M48Y
AW1700651958.994.1305536230
Mar 07 2011
02:56:32 PM
SEGM512 X512

Mag = 1.00
FL:
ROT:



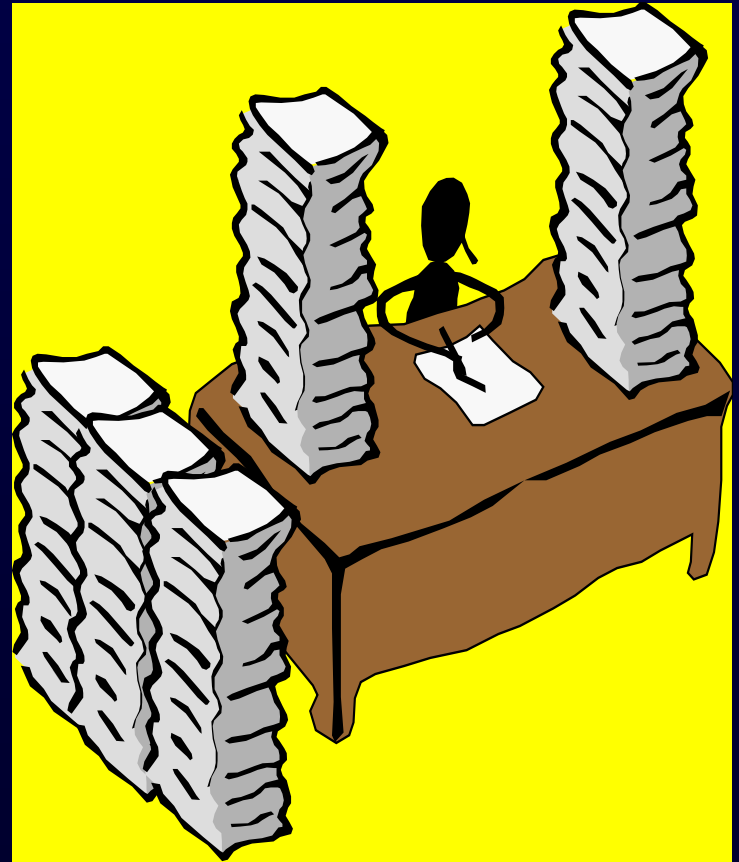
Main Scan

[iv Contrast]



CT Angiography Use

1. Assessment of coronary lumen and stenoses
2. Assessment of Cardiac structures
3. Additional tool for CVS risk assessment



Reformat 2

A 125

TS

Ex:

M 46 AW891998700.532.1304654424

Se: 133 +c

DoB:

I: 107.0

Ex: Mar 08 2010

DFOV 20.0cm

STND/C2 Ph:75%

R

L

7

1

6

2

4

0.4/

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 = 1311 L = 198

P 75

Reformat 2

I 94

TS

Ex:

M 46 AW891998700.532.1304654424

Se: 133 +c

DoB:

A: 105.6 (coi)

Ex: Mar 08 2010

DFOV 20.0cm

STND/C2 Ph:75%

R
A

L
P

0.4/

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 = 1311 L = 198

I 294

3D
Ex:
Se: 133 +c
Volume Rendering - No cut

195

TS
M 46 AW891998700.532.1304654424
DoB:
Ex: Mar 08 2010

DFOV 15.0cm
STND/C2 Ph:75% (No Fill)

0 L 0 LA 0 0 CRA

R
4
5

L
1
0
5

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

1245



Surface 2
Ex:
Se: 133 +c
Volume Rendering No cut

177

TS
M 46 AW891998700.532.1304654424
DoB:
Ex: Mar 08 2010

DFOV 20.0cm
STND/C2 Ph:75% (No Filt.)

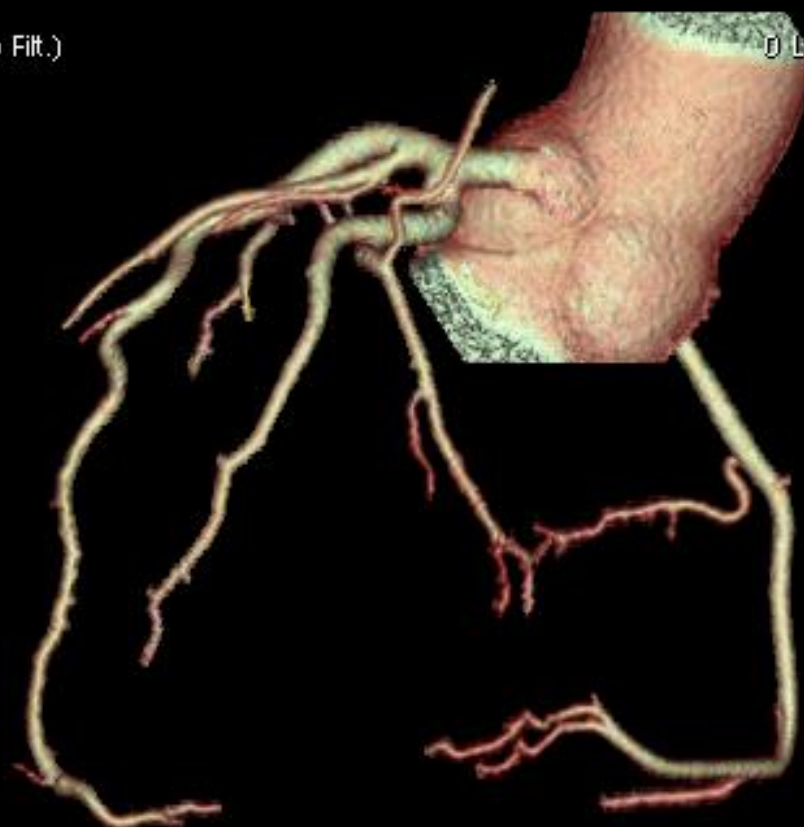
0 L 180 LAO 0 CRA

L
1
3
8

R
6
2

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

1277



Surface 2
Ex:
Se: 133 +c
Volume Rendering No cut

A 126

TS
M 46 AW891998700.532.1304654424
DoB:
Ex: Mar 08 2010

DFOV 20.0cm
STND/C2 Ph:75% (No Filt.)

40 L 180 LAO 90 CAU



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

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



3D
Ex:
Se: 133 +c
MP No cut Grayscale

SRP

TS1
M 46 AW148002216.937.1305529664
DoB:
Ex: Mar 08 2010

DFOV 20.0cm
STND/C2 Ph:75% (No Filt.)

-2 L 55 LAO 51 CRA

A
R
S

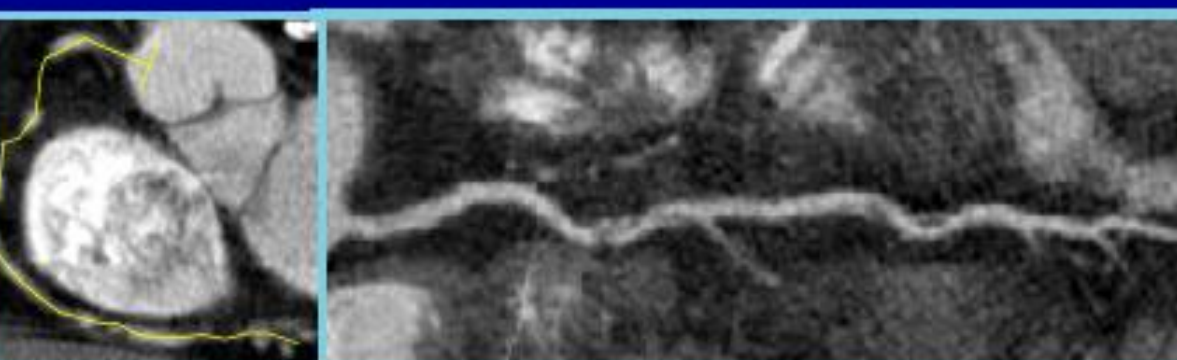
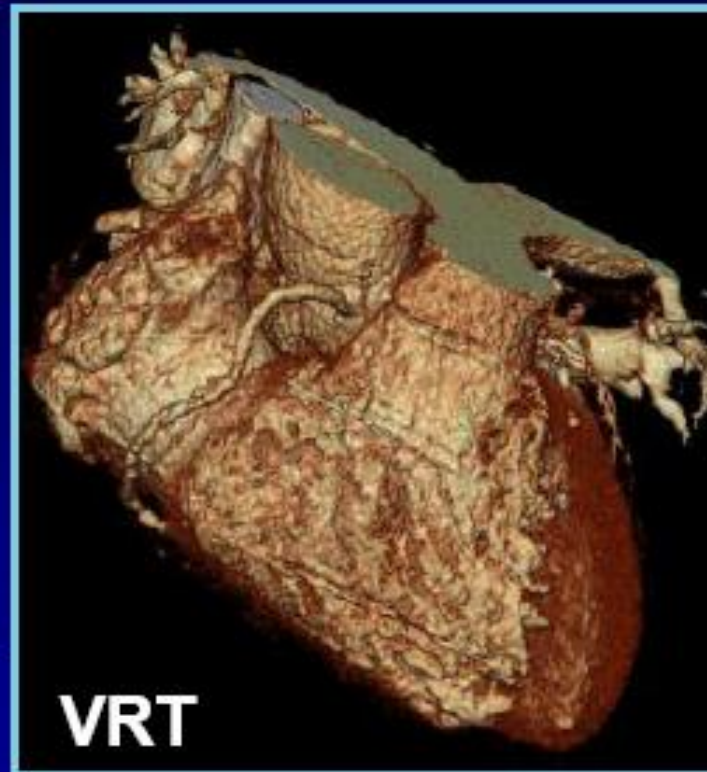
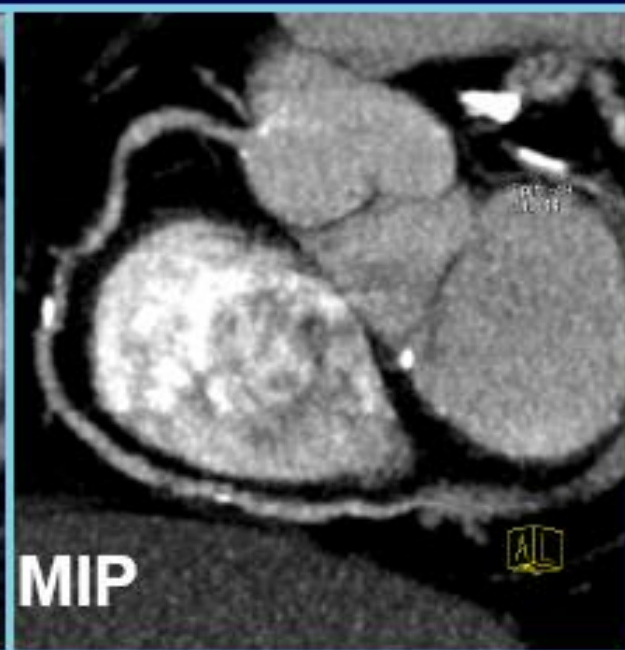
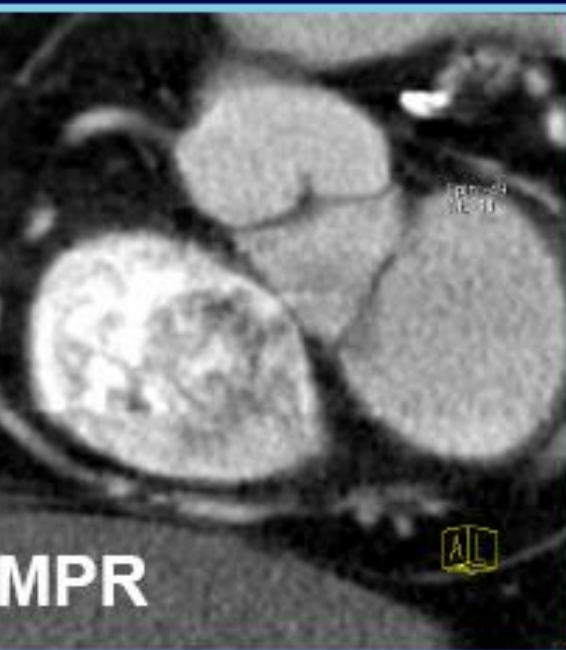
P
L
I

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 = 1409 L = 541

ILA



Image Processing



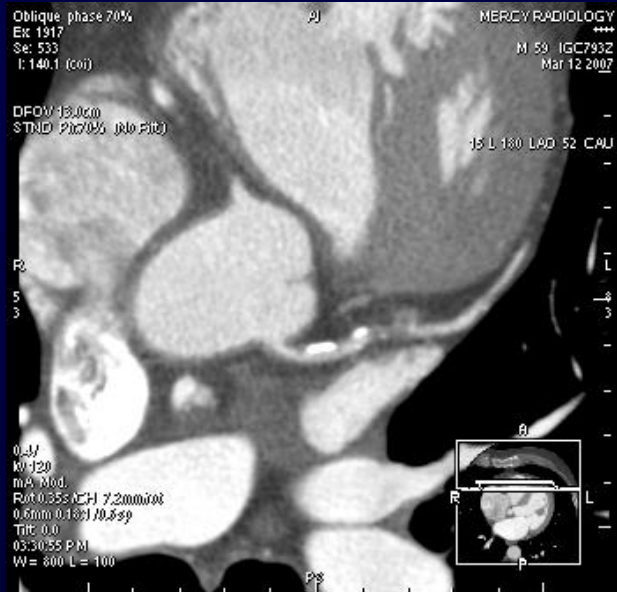
MPR: multiplanar reconstructions

MIP: maximum intensity projections

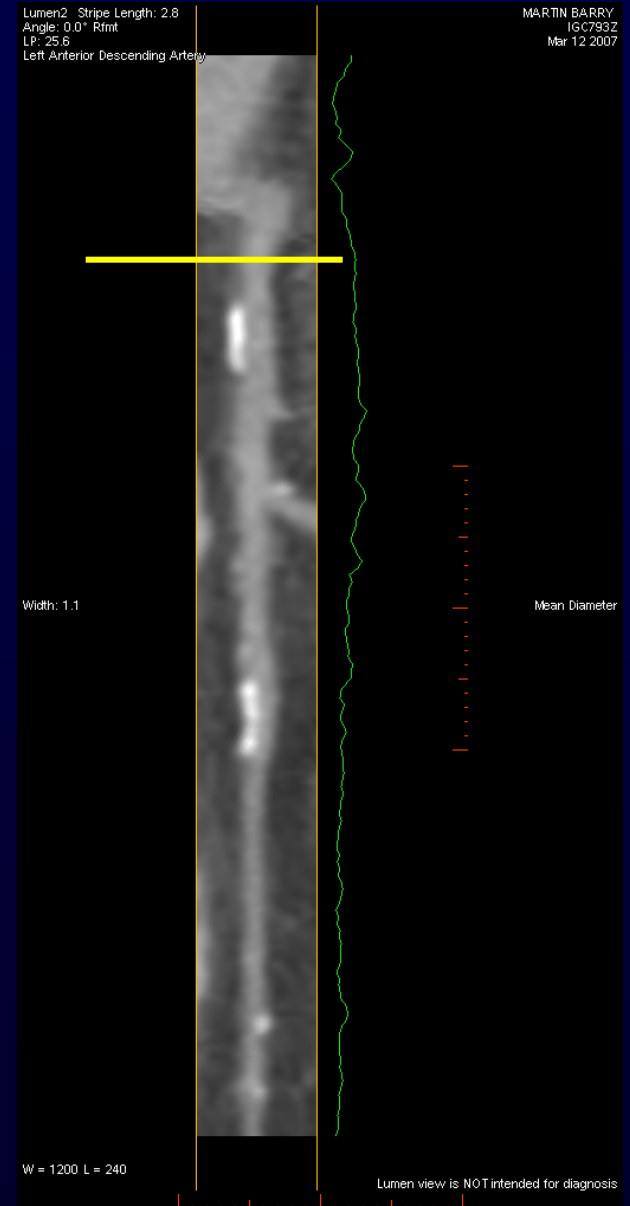
VRT: volume rendering techniques

Multiplanar Reconstruction (MPR): Luminal/Straight

Long Axis



Short Axis



Oblique

AIR

TS

Ex:

M 46 AW891998700.532.1304654424

Se: 133 +c

DoB:

Left Anterior Descending Artery I: 131.3 (col)

Ex: Mar 08 2010

DFOV 8.5cm

STD/C2 Ph75% (No Fil.)

R
S
P

L
I
A

5:1 / MIP No Lock

kv 100

mA 847

Rot 0.35s/CH 3.4mm/rot

0.3mm 0.18s / 0.3ap

Tilt: 0.0

02:43:48 PM

W = 1200 L = 240

PSL

Curved
Ex:
Se: 133 +c
Left Anterior Descending Artery Angle: 0.0

TS1
M 48 AWH48002218.037.1305529884
DOB:
Ex: Mar 08 2010

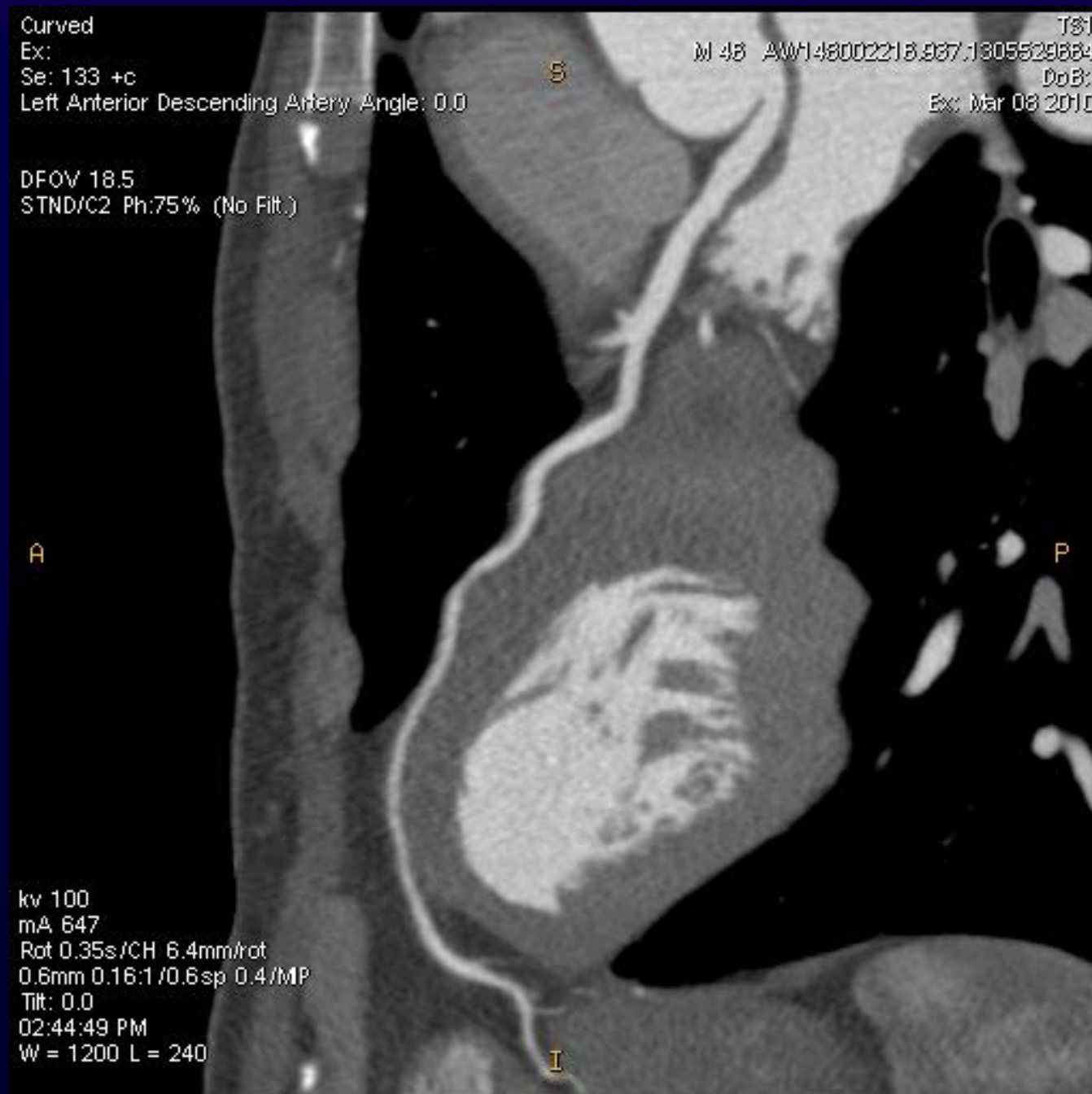
DFOV 18.5
STND/C2 Ph:75% (No Filt.)

A

P

kv 100
mA 647
Rot 0.35s/CH 6.4mm/rot
0.6mm 0.16:1/0.6sp 0.4/MP
Tilt: 0.0
02:44:49 PM
W = 1200 L = 240

I



Curved
Ex:
Se: 133 +c
Left Marginal Branch Angle: 350.0

T31
M 48 AW148002218.937.1305529684
DoB:
Ex: Mar 08 2010

DFOV 12.1
STND/C2 Ph:75% (No Filt.)

kv 100
mA 847
Rot 0.35s/CH 8.4mm/rot
0.8mm 0.18s/0.8s 0.4/0.4
Tilt: 0.0
02:44:48 PM
W = 1200 L = 240



CTA Report Given to Patient

- Outstanding Impact on the patient
- Better understanding of medical issue
- Better understanding of their own situation
- VERY motivating for a patient with advanced atheroma
- “Give me the pills!”



3D
Ex:
Se: 133 +c
Volume Rendering No cut

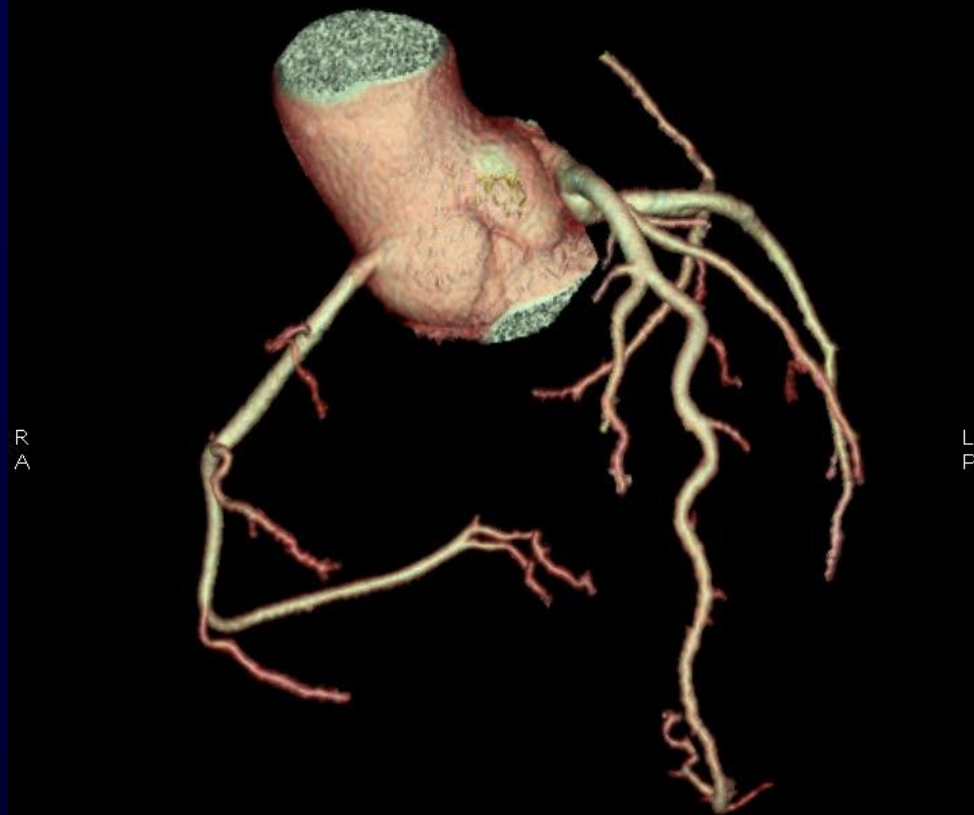
SPR

TS1
M 46 AW148002216.937.1305529664

DoB:
Ex: Mar 08 2010

DFOV 18.0cm
STND/C2 Ph:75% (No Filt.)

0 L 30 LAO 30 CRA



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

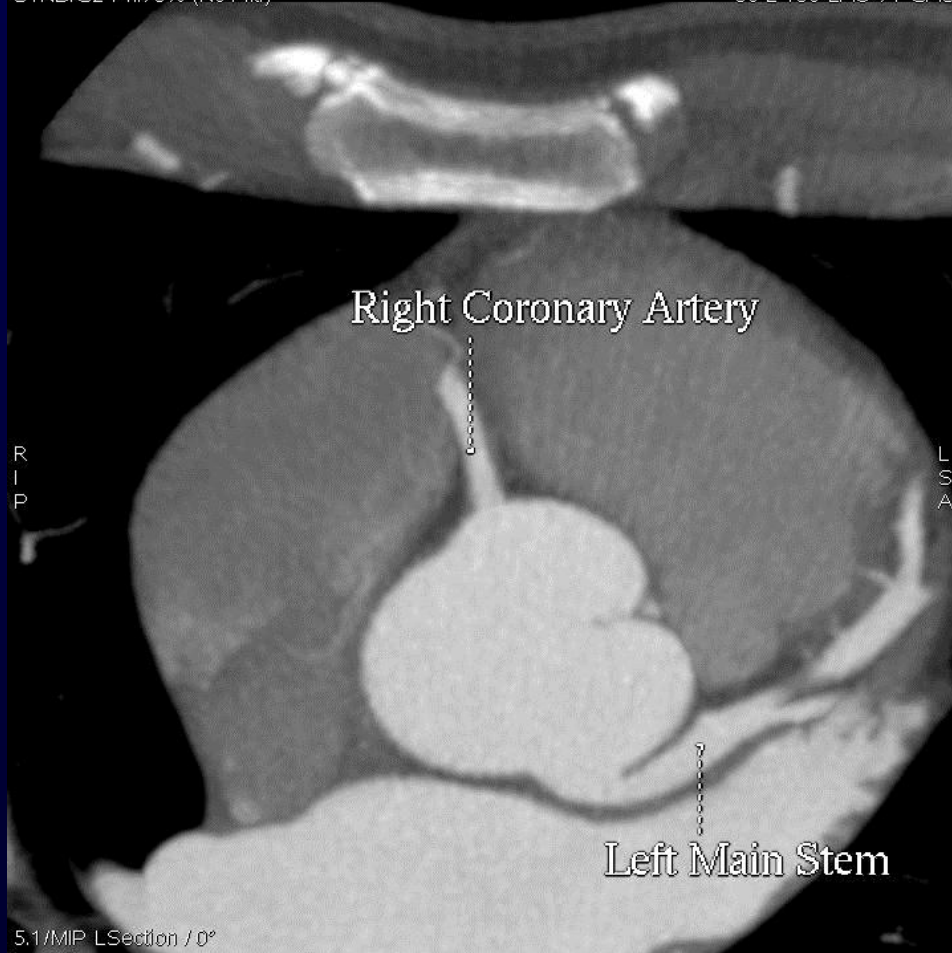
Oblique
Ex:
Se: 133 +c
Posterior Descending Artery LP: 17.1

AIL

TS1
M 46 AW148002216.937.1305529664
DoB:
Ex: Mar 08 2010

DFOV 12.0cm
STND/C2 Ph:75% (No Filt.)

30 L 158 LAO 71 CAU



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
Ex:
Se: 133 +c
Left Anterior Descending Artery LP: 31.4

ASL

TS1
M 46 AW148002216.937.1305529664
DoB:
Ex: Mar 08 2010

DFOV 6.5cm
STND/C2 Ph:75% (No Filt.)

-8 L 23 RAO 49 CAU



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 Reformatted Image, Single Frame



MIP: Maximal Intensity Projection



CTA Case History 1



CTA Case History 1

- 40 year old man, 2 month history of chest heaviness, radiating to the throat and arms
- Walking up a hill, cutting grass
- Hospital admission, Negative troponin, referred for out-pt treadmill test
- Exercised to 12 minutes, minor ST changes, but pain provoked and very SOB
- Clinical Diagnosis 'Angina', referred for CT Cardiac Angiography (CTA)

3D
Ex:
Se: 133
Volume Rendering No cut

P 59

CL
M 40 AW1314886089.245.1306640202
DoB:
Ex: Apr 27 2011

DFOV 17.8cm
STND/C2 Ph:75% (No Filt.)

40 L 180 LAO 90 CRA

R
5
6

L
1
2
2

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 119



3D
Ex:
Se: 133
Volume Rendering No cut

SPR

CL
M 40 AW1314886089.245.1306640202
DoB:
Ex: Apr 27 2011

DFOV 17.8cm
STND/C2 Ph:75% (No Filter)

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
Ex:
Se: 133
Volume Rendering No cut

P 53

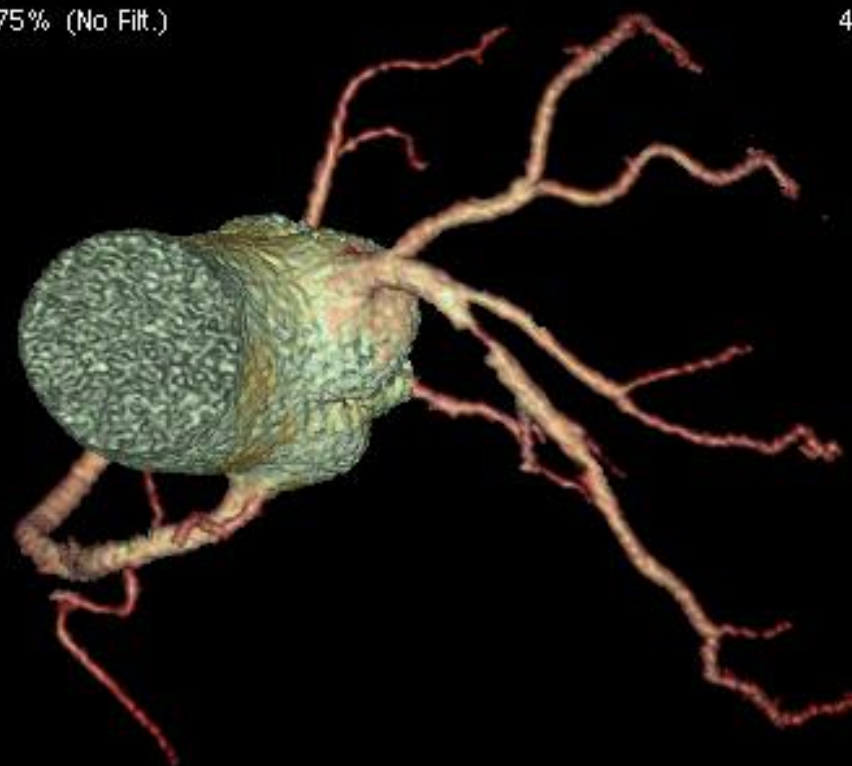
CL
M 40 AW1314886089.245.1306640202
DoB:
Ex: Apr 27 2011

DFOV 17.8cm
STND/C2 Ph:75% (No Filt.)

40 L 180 LAO 90 CRA

R
4
4

L
1
3
4



No VOl
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

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 Ph75% (No Fil.)

A
R
I

P
L
S

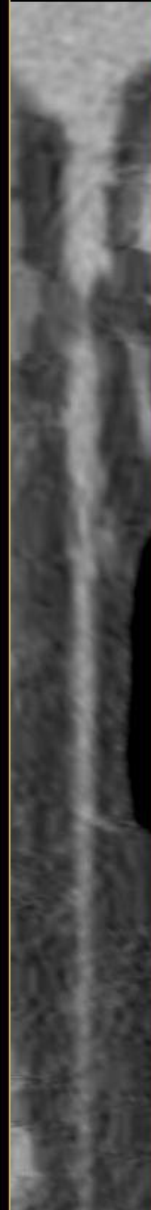
5.2/MP LSection / 0°
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.8mm 0.2:1 / 0.8ap
Tilt: 0.0
01:58:41 PM
W = 1200 L = 240

RPS

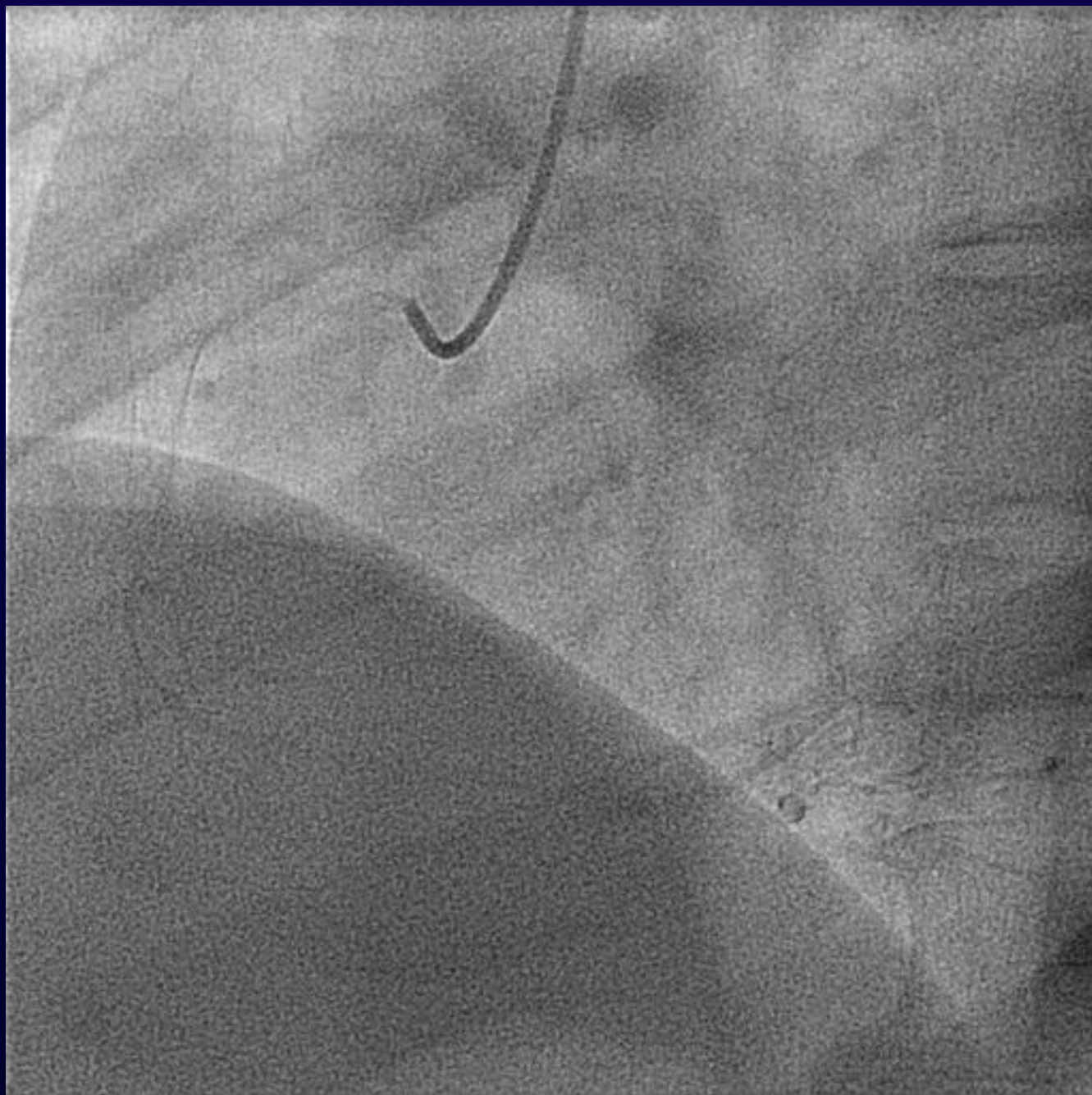
Lumen2 Stripe Length: 4.3
Angle: 0.0° Rmt
LP: 0.0
Left Anterior Descending Artery

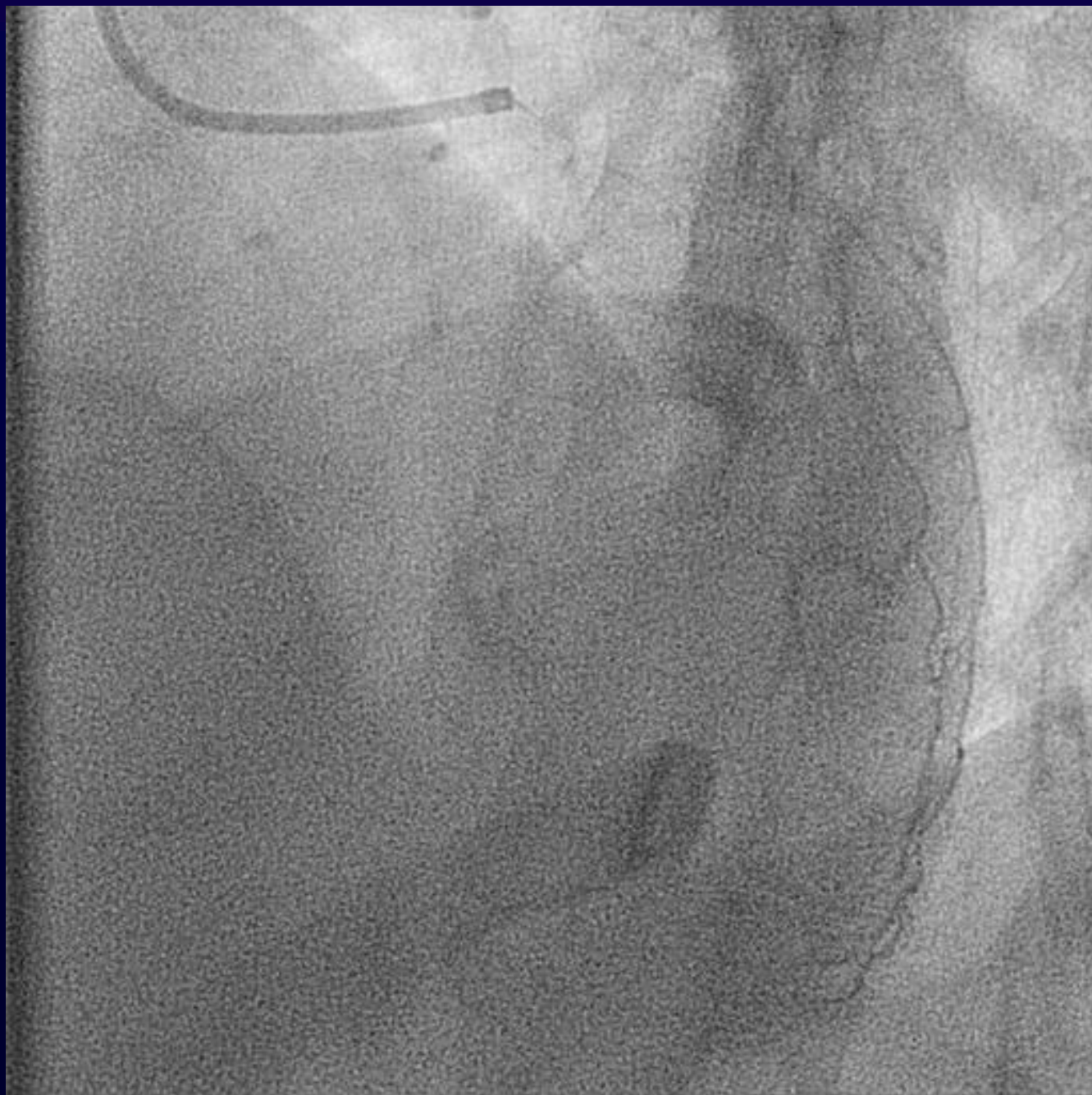
CL
AW1314886089.245.1306640202
Apr 27 2011

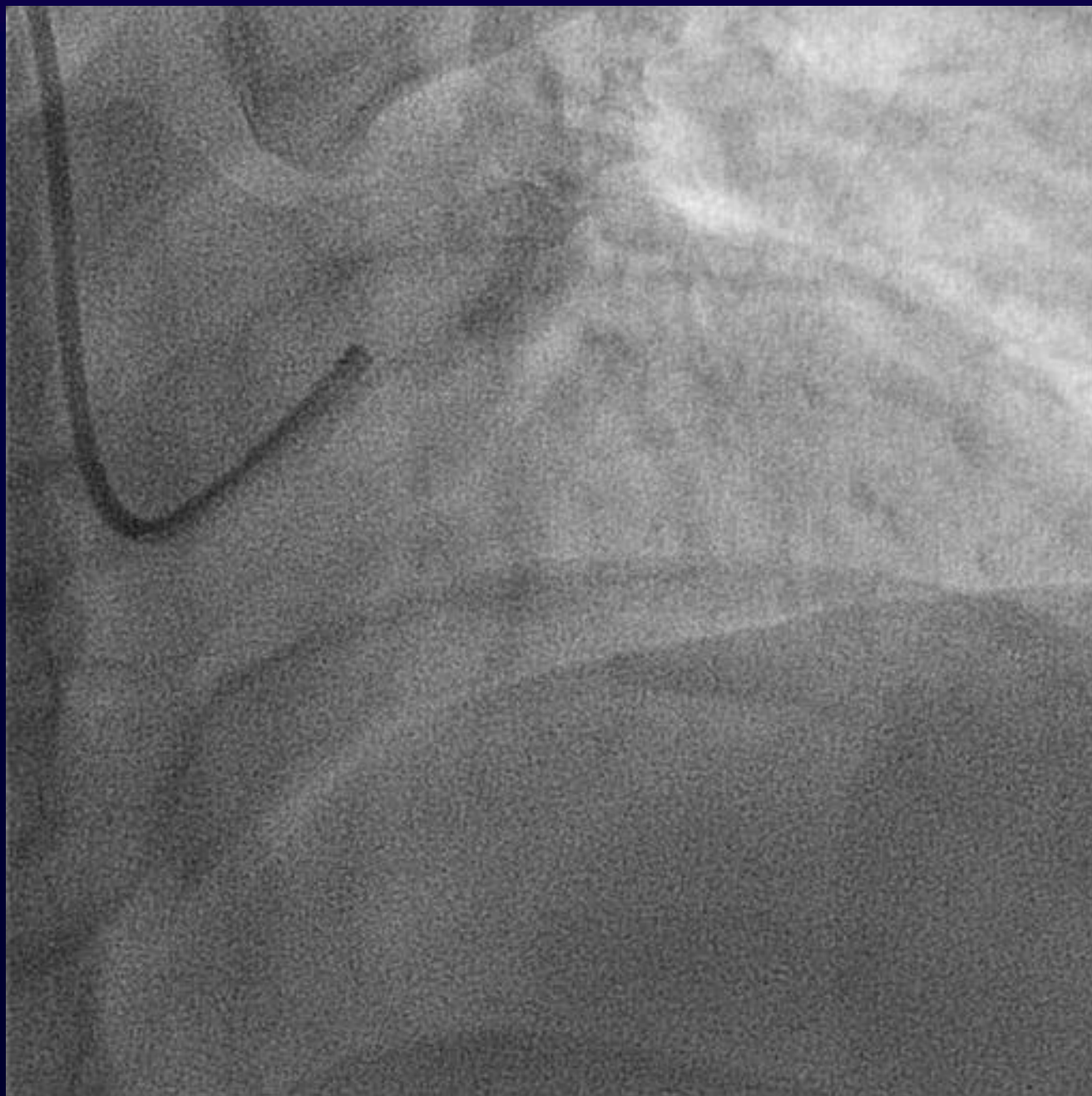
Width: 1.7

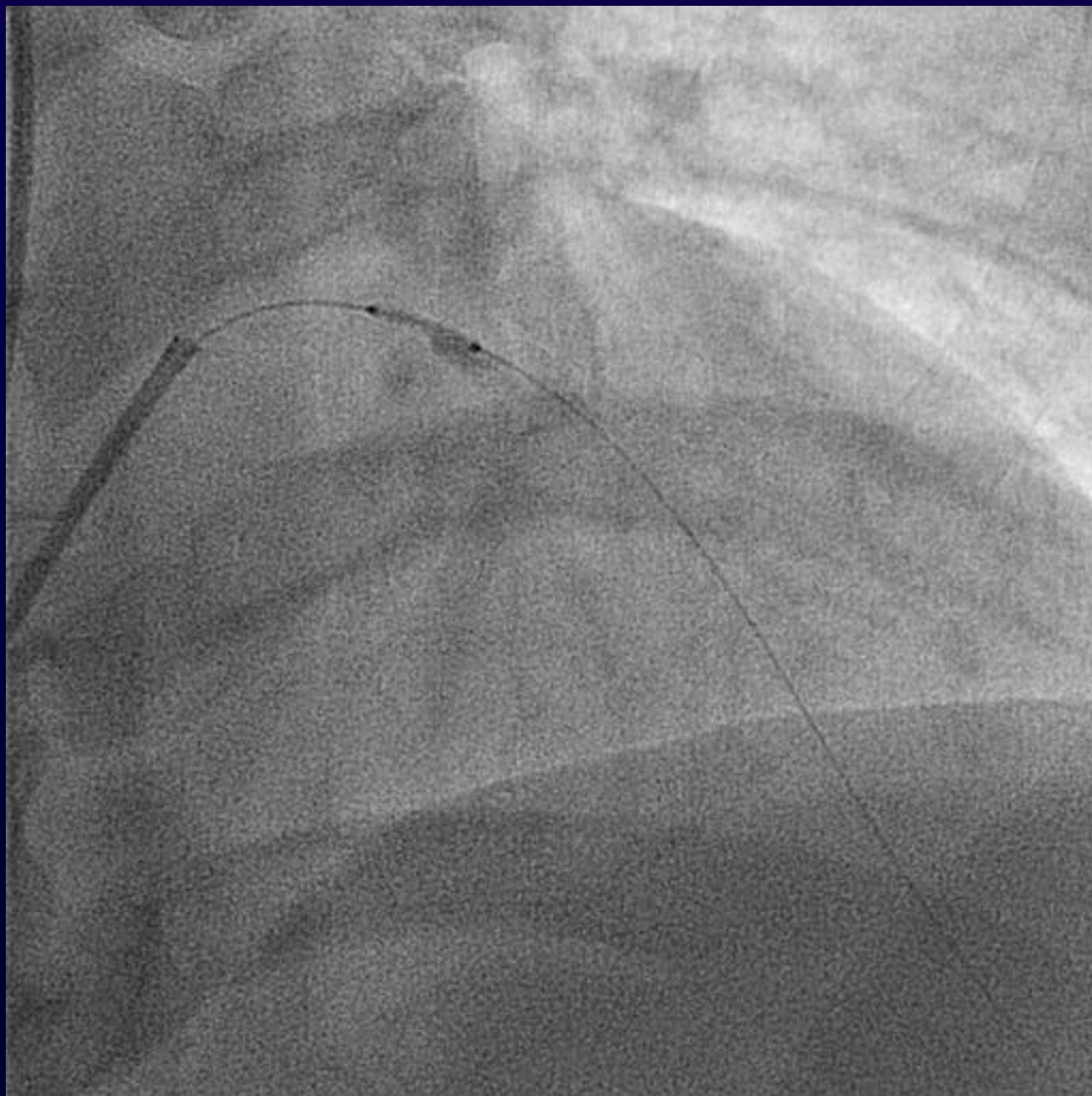


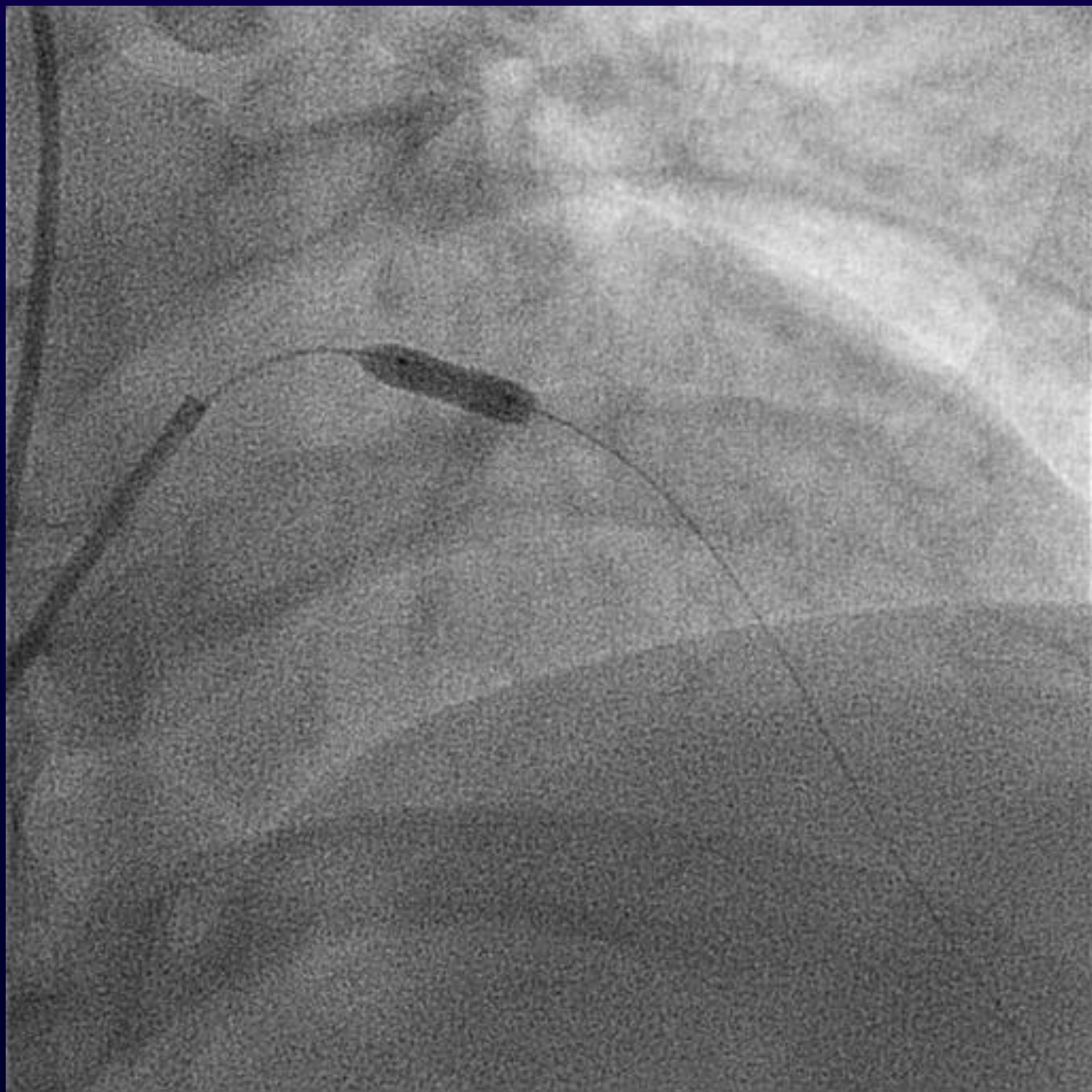
Mean Diameter

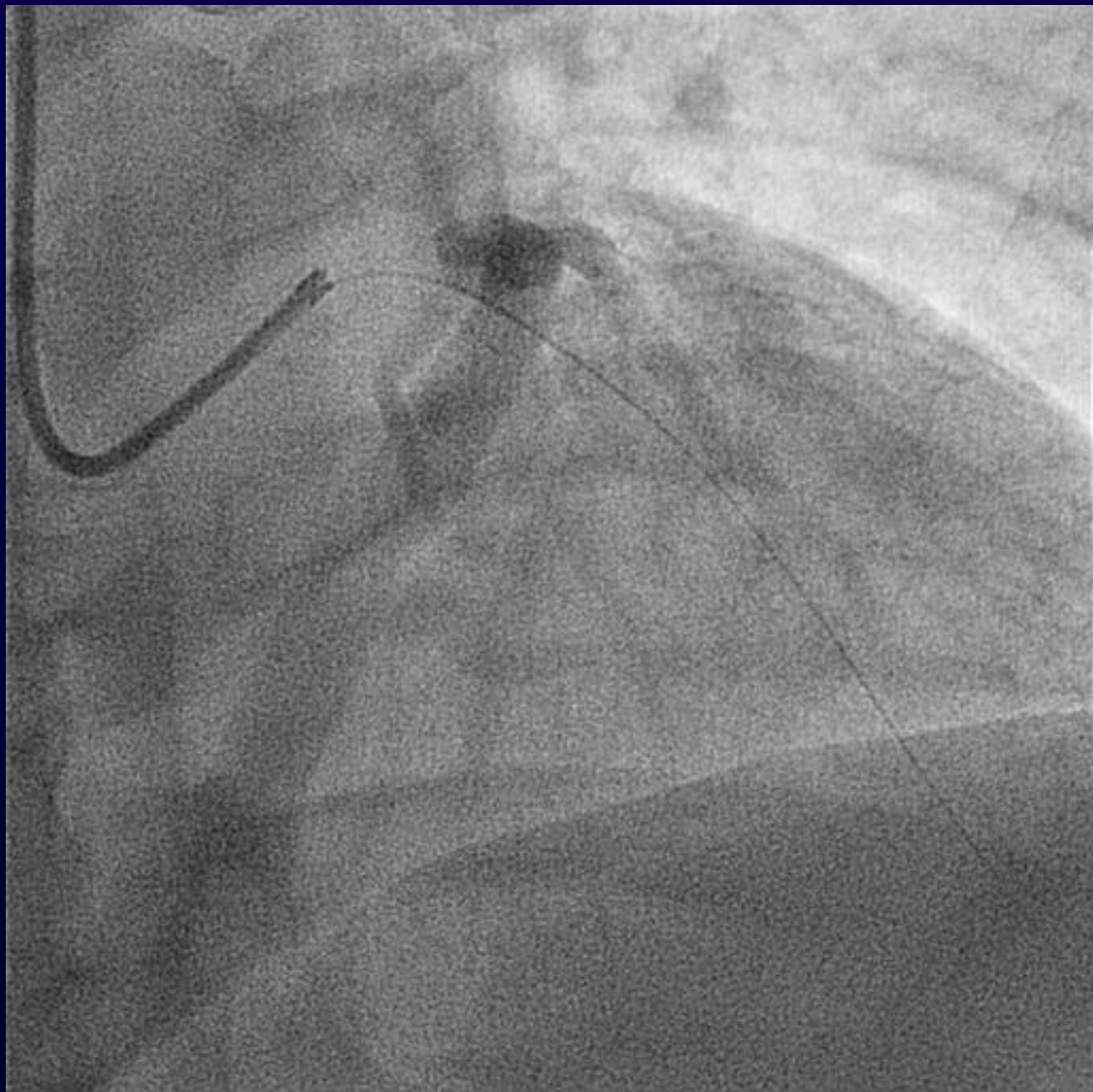


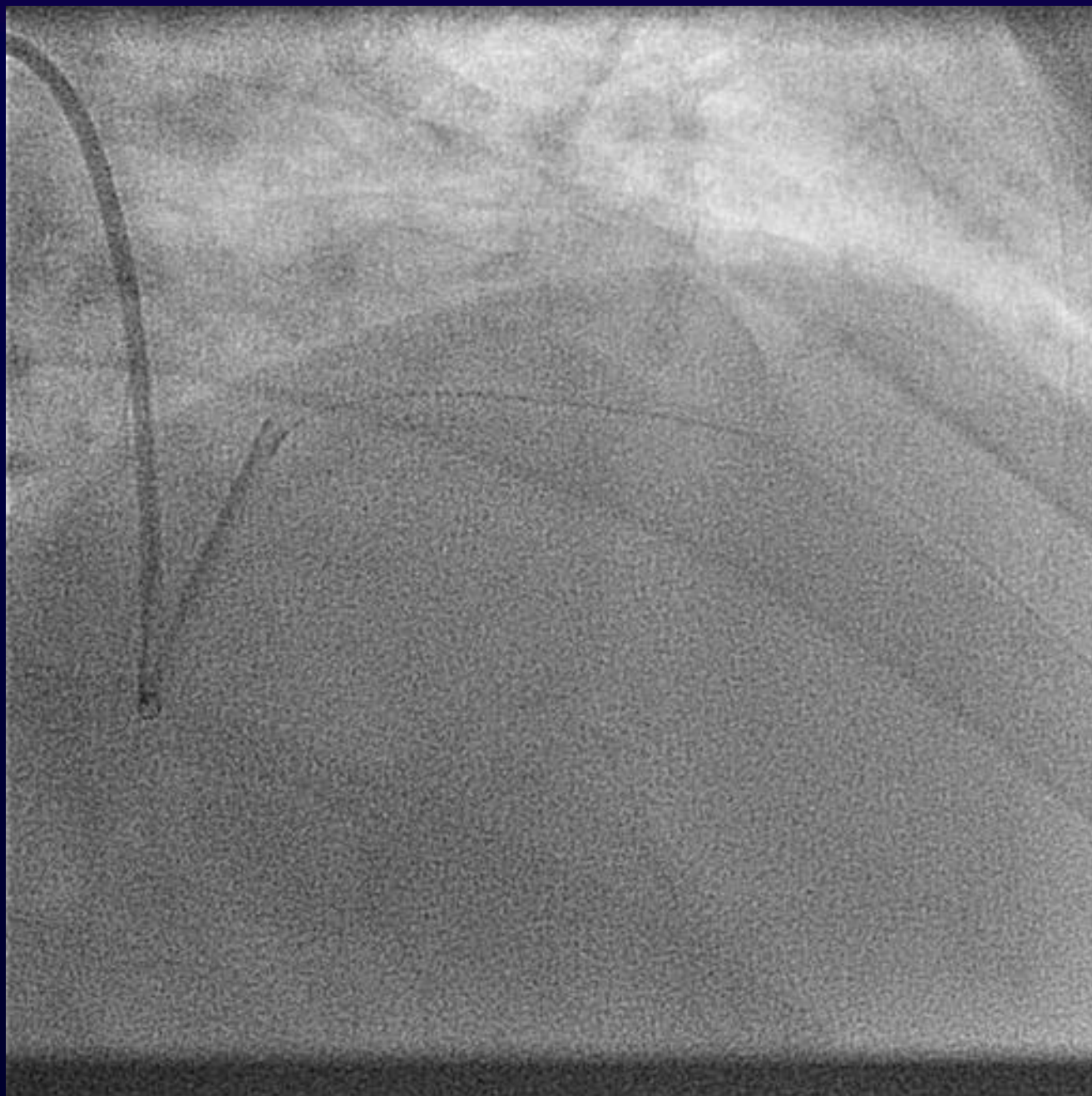










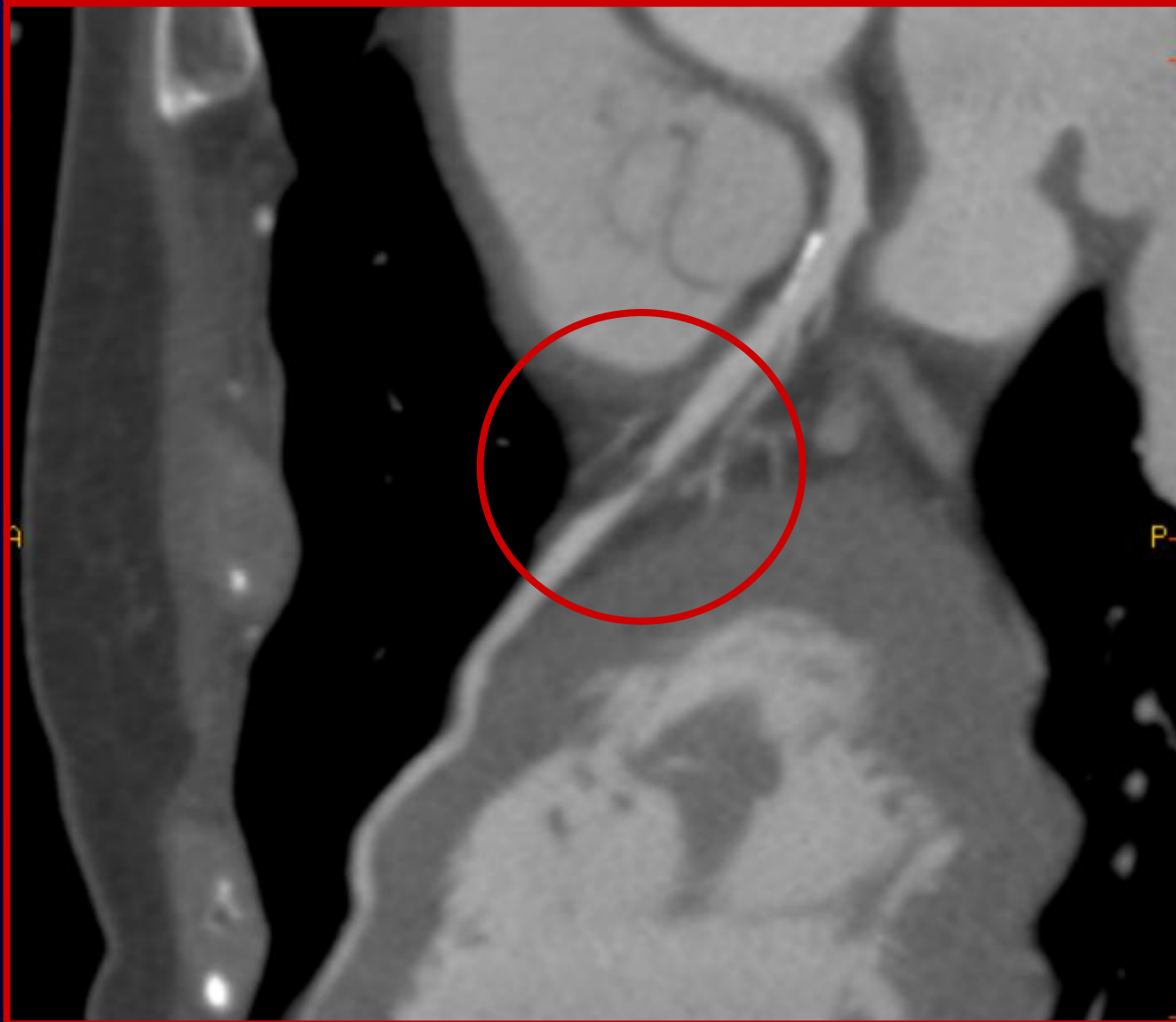


CTA Case History 1: Comment

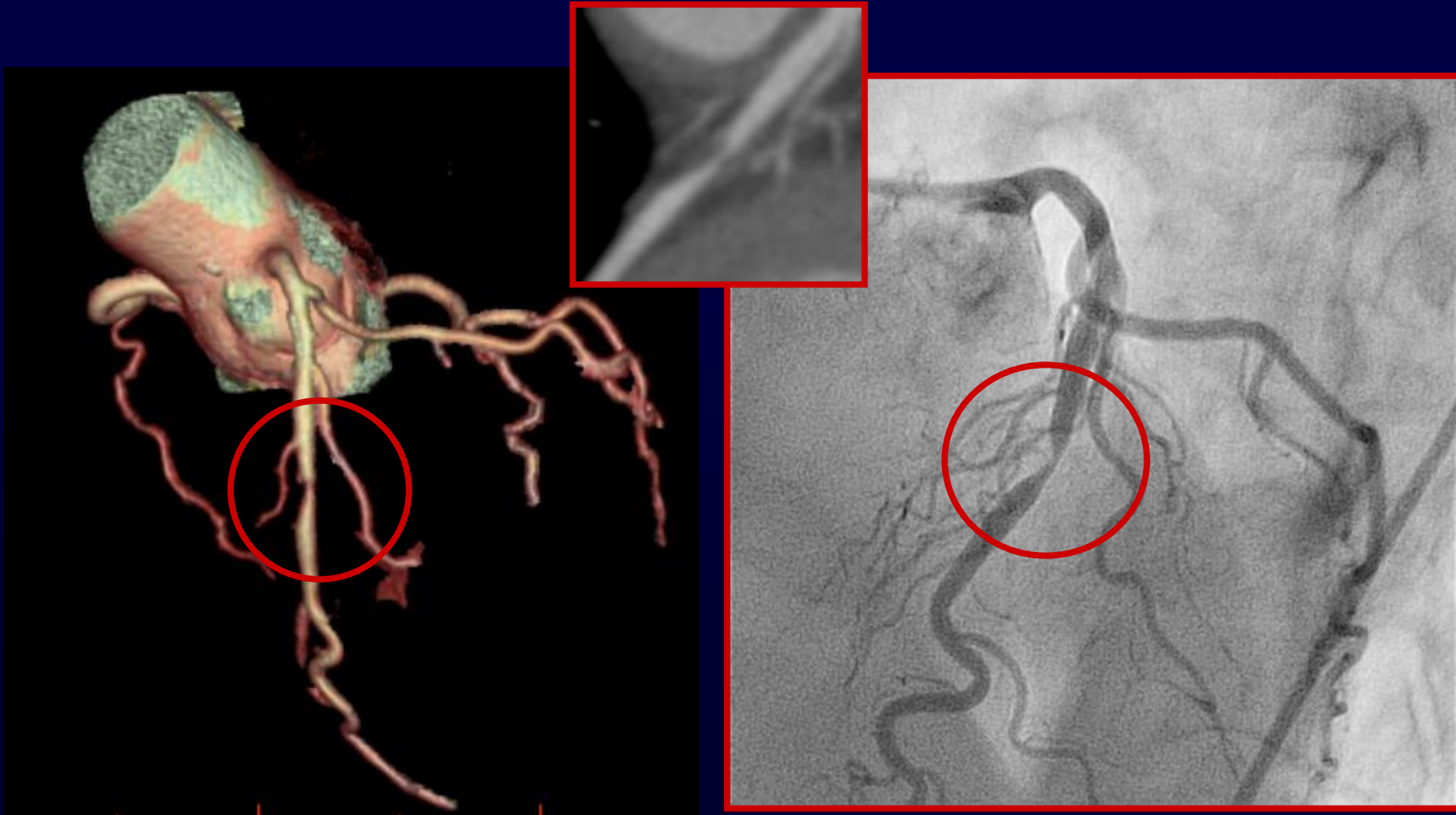
- The CT Cardiac Angiogram is most appropriate to 'rule out' severe coronary stenoses
- IF the Doctor thinks the pain is NOT angina ["Equivocal symptoms +/- equivocal signs], but wants to be exclude severe coronary stenoses, use CTA
- IF the Doctor thinks the pain is angina, use conventional (invasive) angiography



Case 1: Excellent correlation between CT Angiography and Coronary Angiography. Mid LAD lesion proceeded from Coronary Angiography to PCI

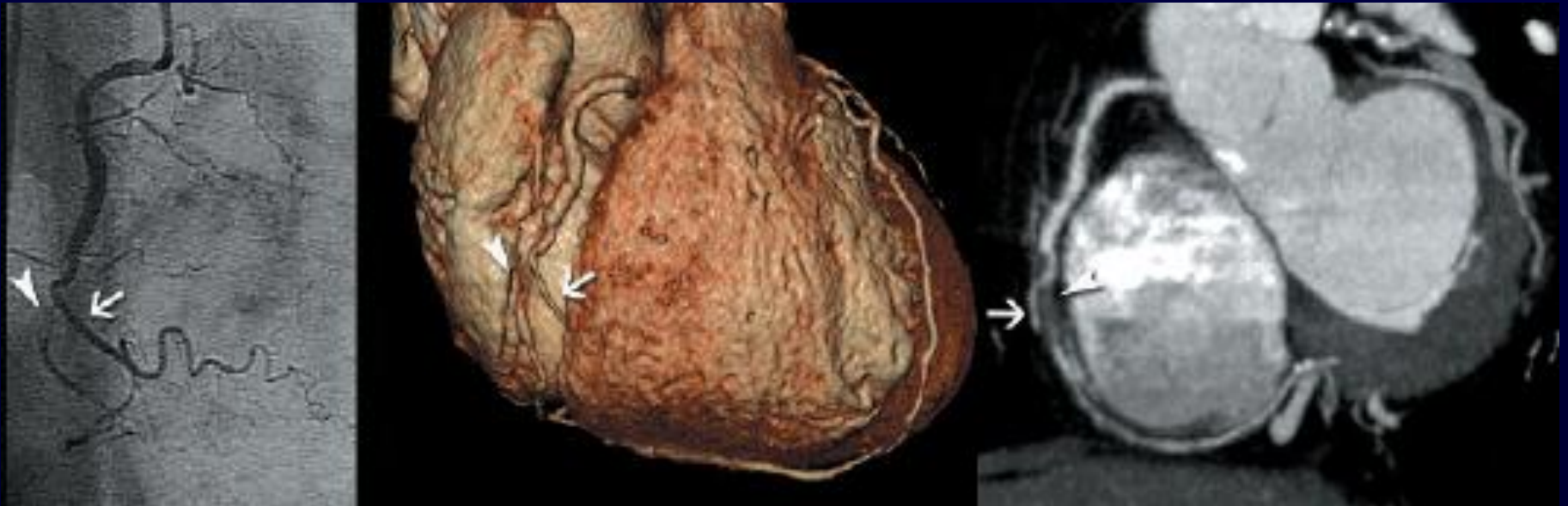


Case 1: Excellent correlation between CT Angiography and Coronary Angiography. Mid LAD lesion proceeded from Coronary Angiography to PCI



CT vs Conventional (Invasive) Angiography: Assessment of coronary lumen and stenoses

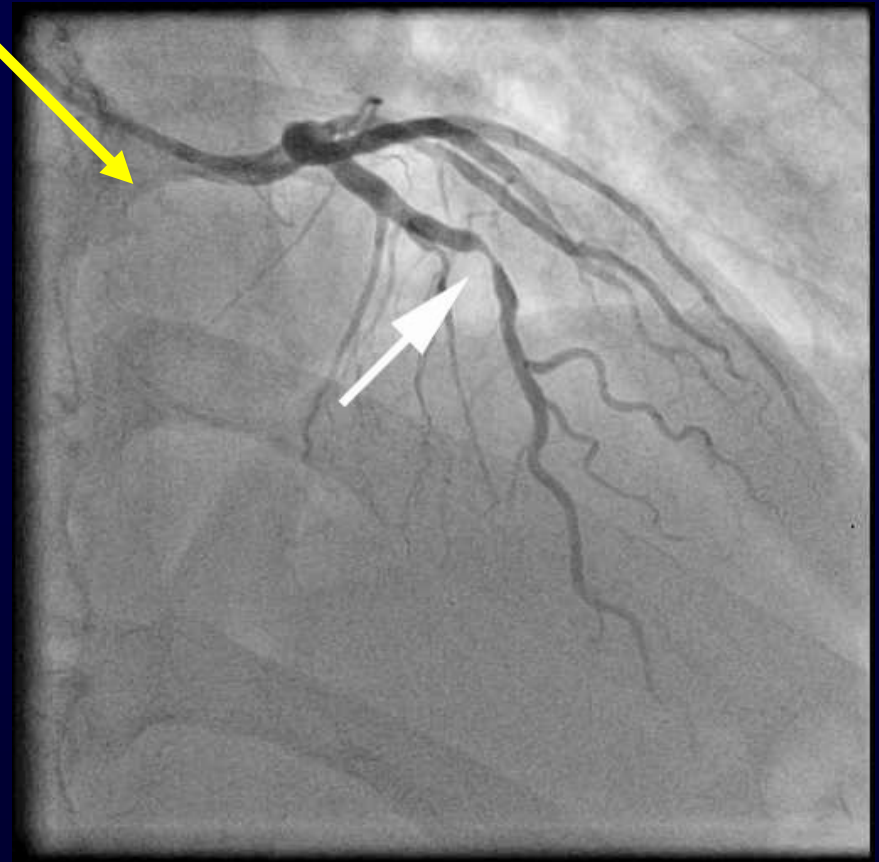
Which is better?



Invasive Angiography is the 'Gold Standard' for assessing the coronary lumen & stenoses



64-slice CT angiogram



Invasive angiogram

CTA Case History 2



"I'd say it's your gallbladder, but if you insist on a second opinion, I'll say kidneys."

CTA Case History 2

- 70 year old man, hospital admission with severe mid-scapular back pain with ‘radiation’ as a ‘band’ around chest
 - 15 mins, sweaty, SOB
- CT Chest ruled out dissection
 - Neg. troponin, ECG no acute changes
 - S/b Rheumatologist, diagnosed acute compression fracture T4-T5 [X-Ray: ‘osteophytes’]
 - No ExTT
- Referred for clinic assessment, SOBOE
 - FH: Father died of unheralded MI at 70 years
 - SOB at ExTT at 7 mins, minor ST ‘sag’

3D
Ex:
Se: 133
Volume Rendering No cut

SPR

TB 29 May 2011
M 70 AW166265282.59.1306645756
DoB:
Ex: Jan 24 2011

DFOV 15.0cm
STND/C2 Ph:75% (No Filt.)

0 L 25 RAO 18 CRA

R
I
P

L
S
A

No VOI
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1 /0.6sp
Tilt: 0.0
12:58:10 PM
W = 4095 L = 2048

IAL



Oblique
Ex:
Ser: 133
Left Anterior Descending Artery LP: 40.0

AIR

TB 29 May 2011
M 70 AW166265282.59.1306645756
DoB:
Ex: Jan 24 2011

DFOV 8.5cm
STD/C2 Ph75% (No Fill.)

R
S
P

L
I
A

5.1/MP LSection /-105°
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1 /0.8ap
Tilt: 0.0
12:58:10 PM
W = 1200 L = 240

PSL

Lumen2 Stripe Length: 4.3
Angle: 43.0° Rfnt
LP: 48.2
Left Anterior Descending Artery

TB 29 May 2011
AW166265282.59.1306645756
Jan 24 2011

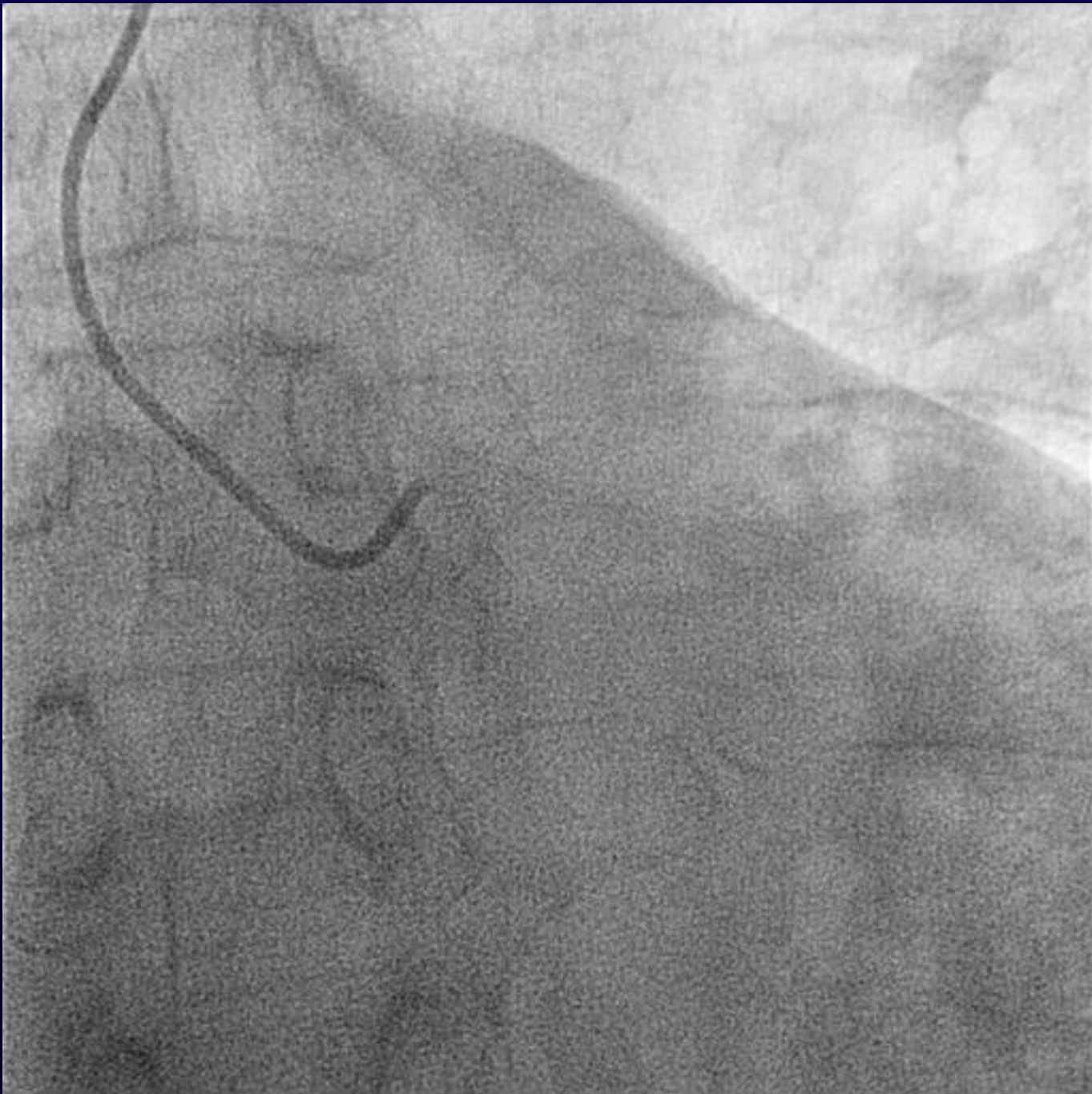
Width: 1.7

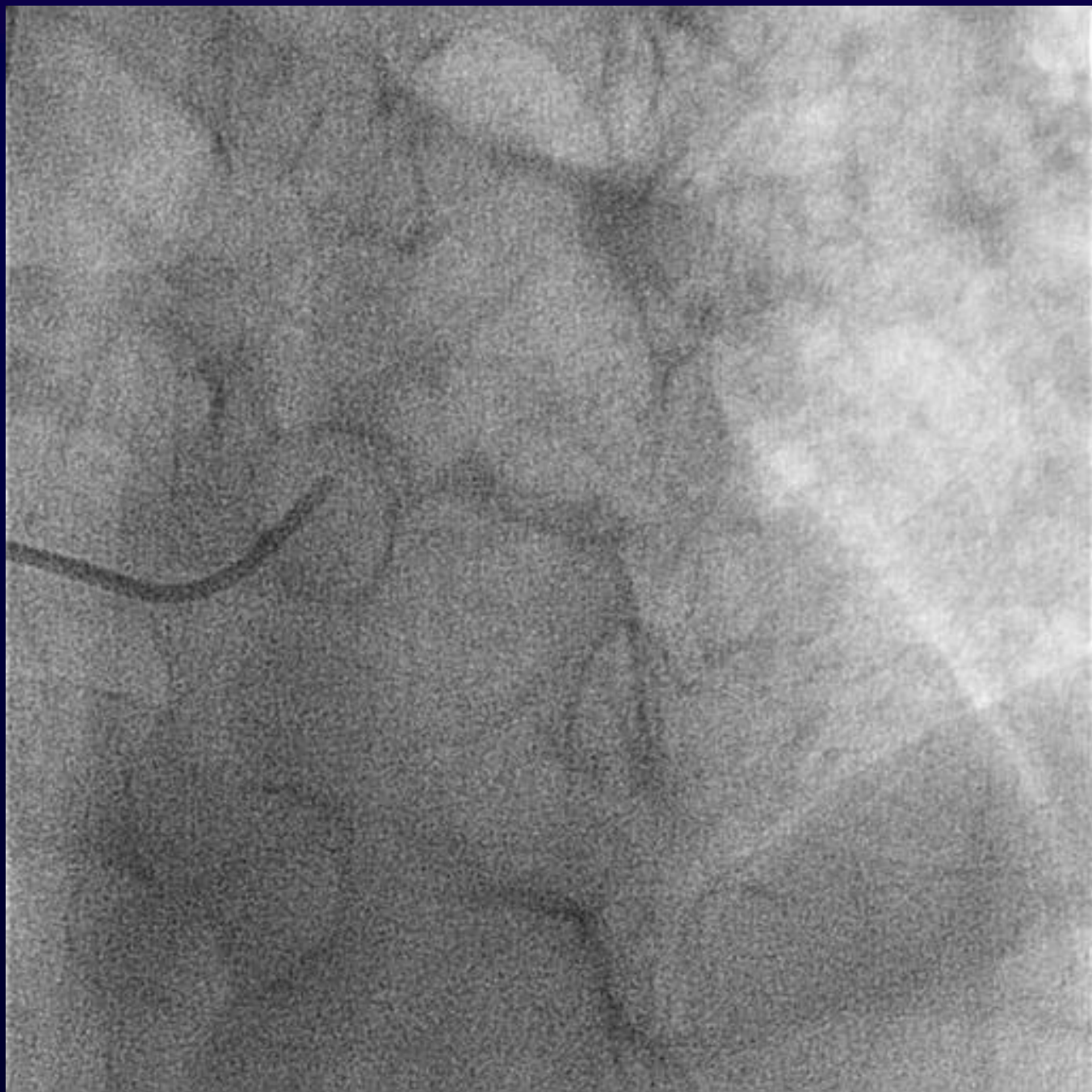
Mean Diameter

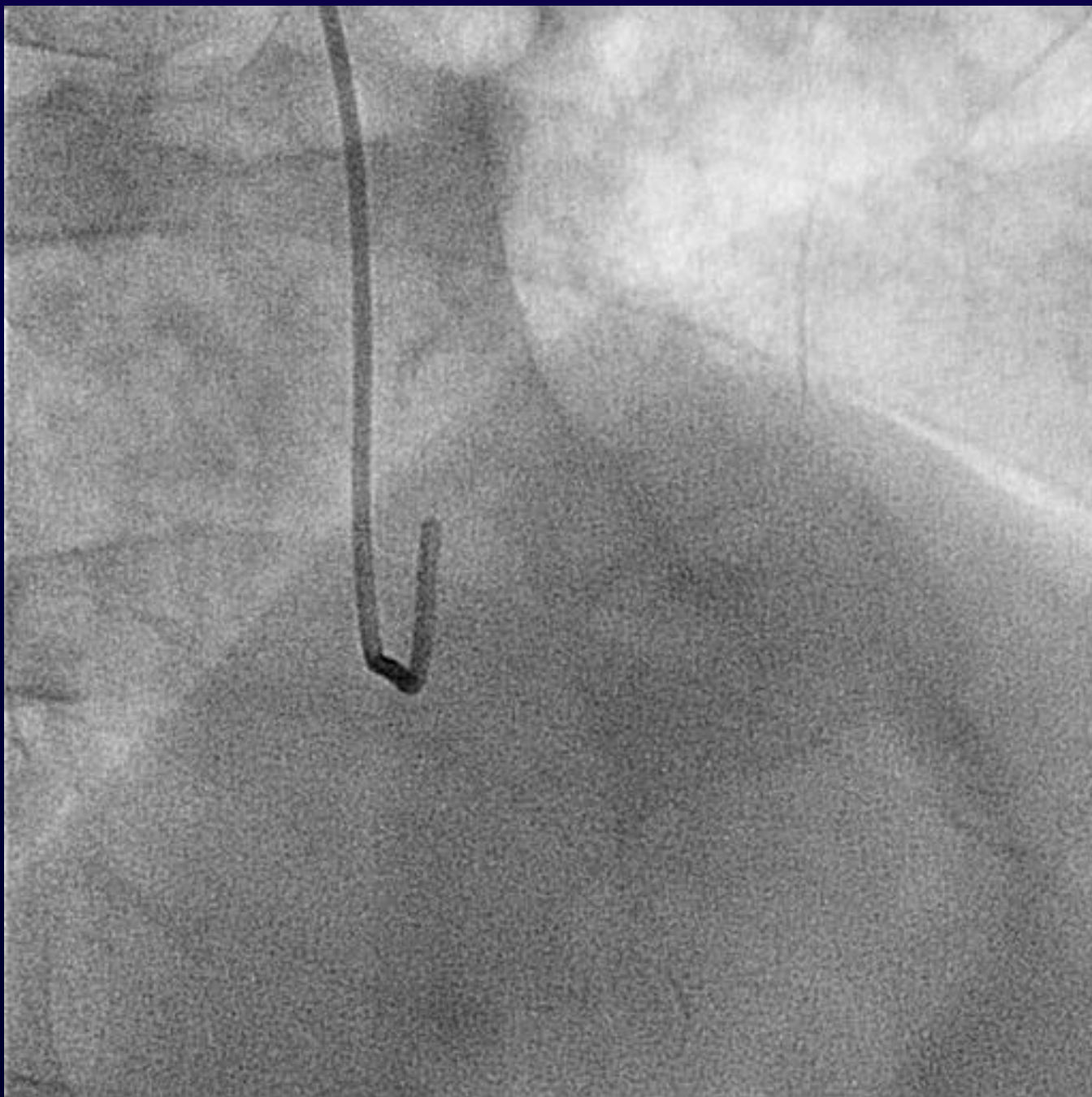
W = 1200 L = 240

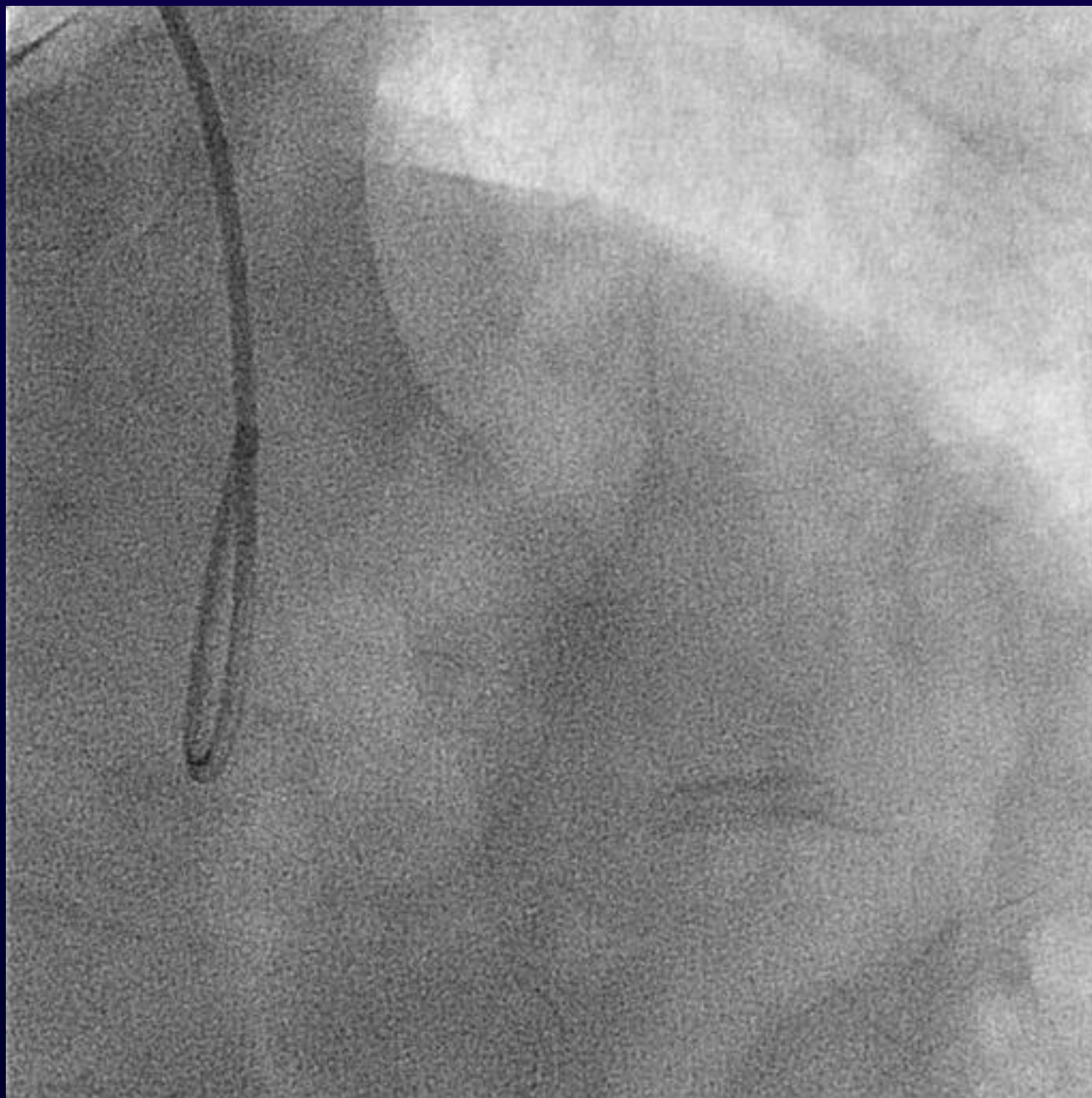
Lumen view is NOT intended for diagnosis







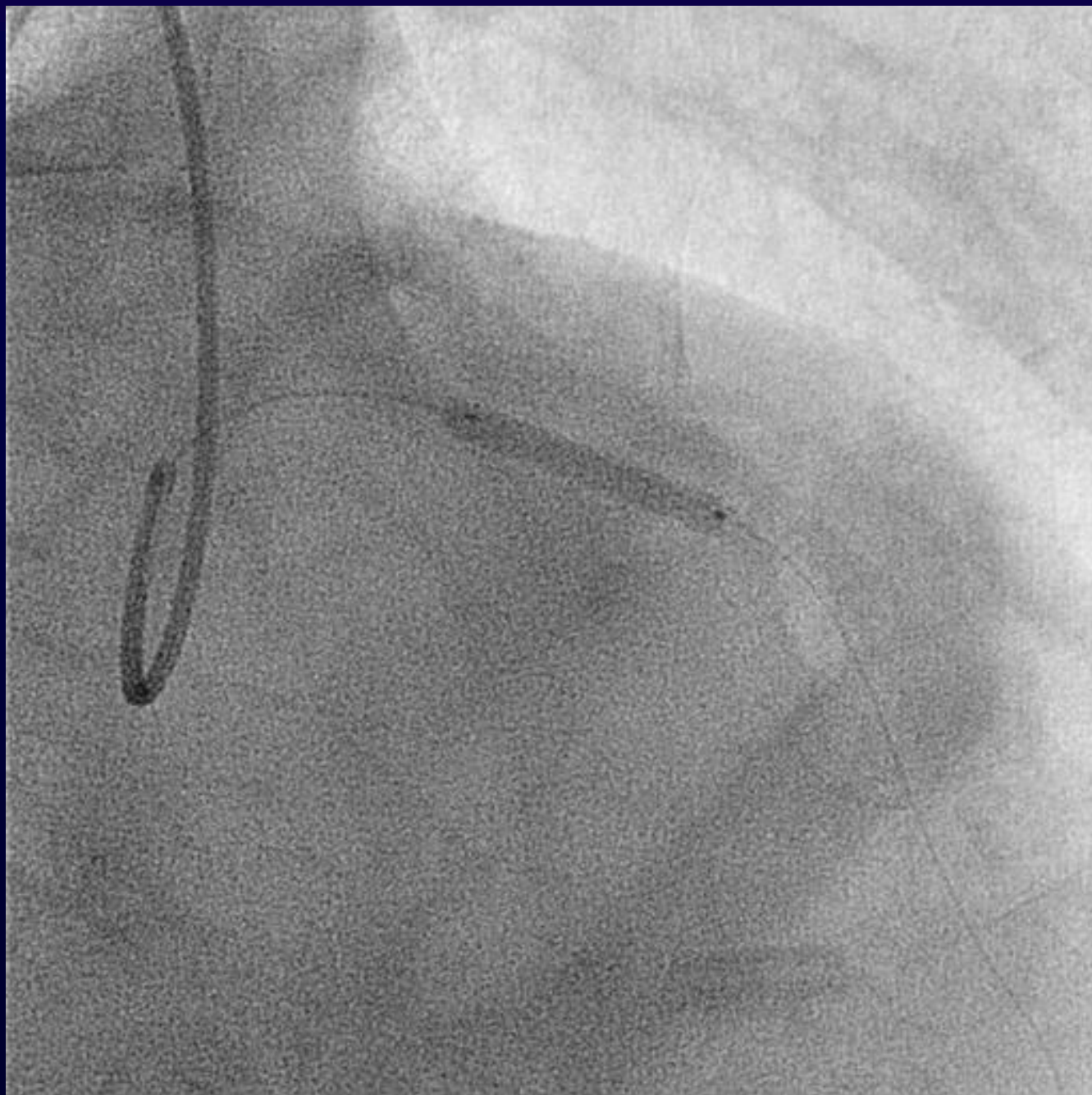


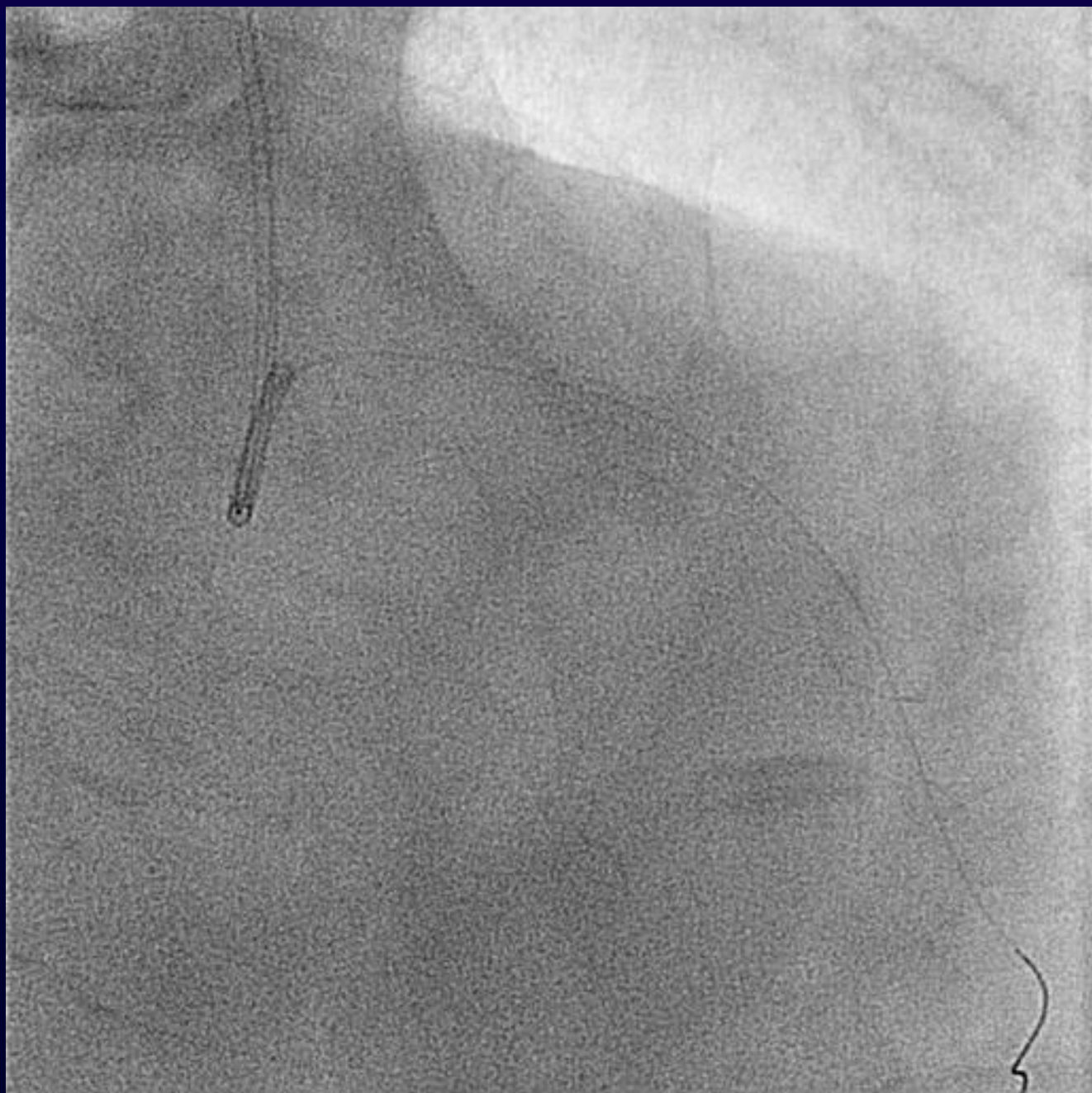


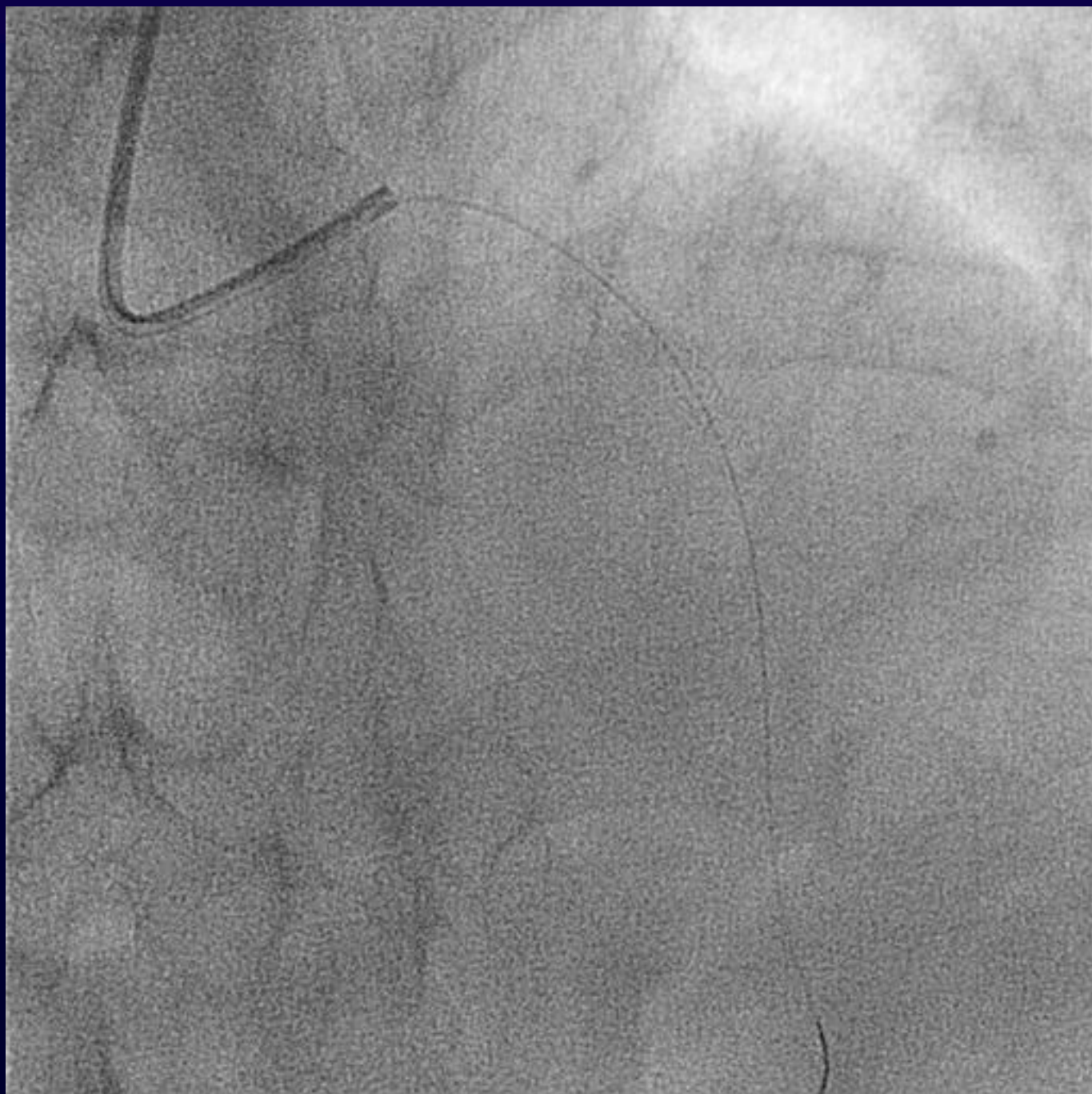
Flow Wire & FLAME Study

Tonino et al. NEJM 2009;360:213-224

- Intra coronary ‘flow wire’ after adenosine injection creates ‘hyperaemia’ i.e. ‘exercise’
- Fractional flow reserve (FFR) = the ratio of maximal blood flow in a stenosed artery compared to a normal blood flow
- FFR of ≤ 0.80 guided PCI vs angiographic guidance
 - Results: FFR an advantage over angiography only in vascular endpoints [early ‘procedural MI’ and late revascularisation [re-stenosis]
 - angina outcome the same in each group







CTA Case History 2: Comment

- Initial hospital assessment was inadequate
- CTA performed as ‘equivocal symptoms and signs’
- Subsequent conventional angiogram showed area of recent ruptured plaque with ‘positive’ remodelling in the wall of the artery
- Subsequent FFR of 0.79 led to successful PCI and resolution of symptoms of SOBOE
 - Subsequent comfortable ExTT to 9 mins

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 $\geq 50\%$ and $\geq 70\%$ stenoses
- All pts and all segments assessed, no exclusions for poor images

ACCURACY Trial: Results

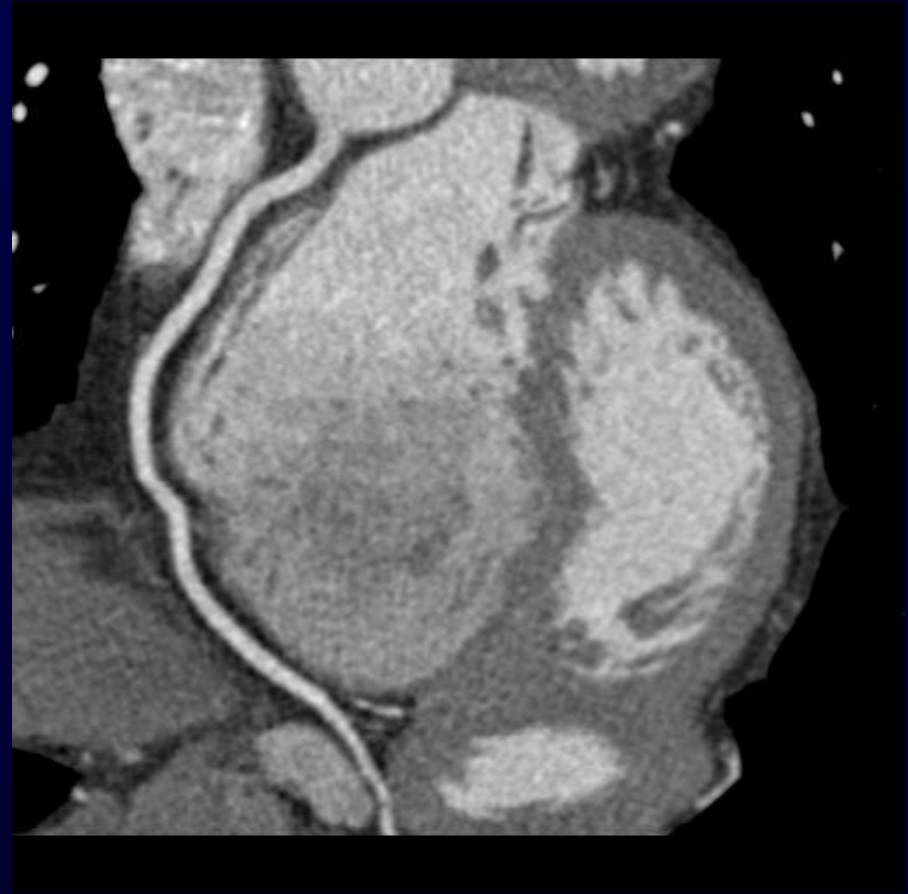
Table 2 Patient-Based Analysis

	Estimate, %	95% CI, %	Subjects In Group, n	Subjects Correct by CCTA, n
<u>≥50% stenosis</u>				
Sensitivity	95	85-99	55	52
Specificity	83	76-88	172	142
PPV	64	53-75	81	52
NPV	99	96-100	143	142
<u>≥70% stenosis</u>				
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.”

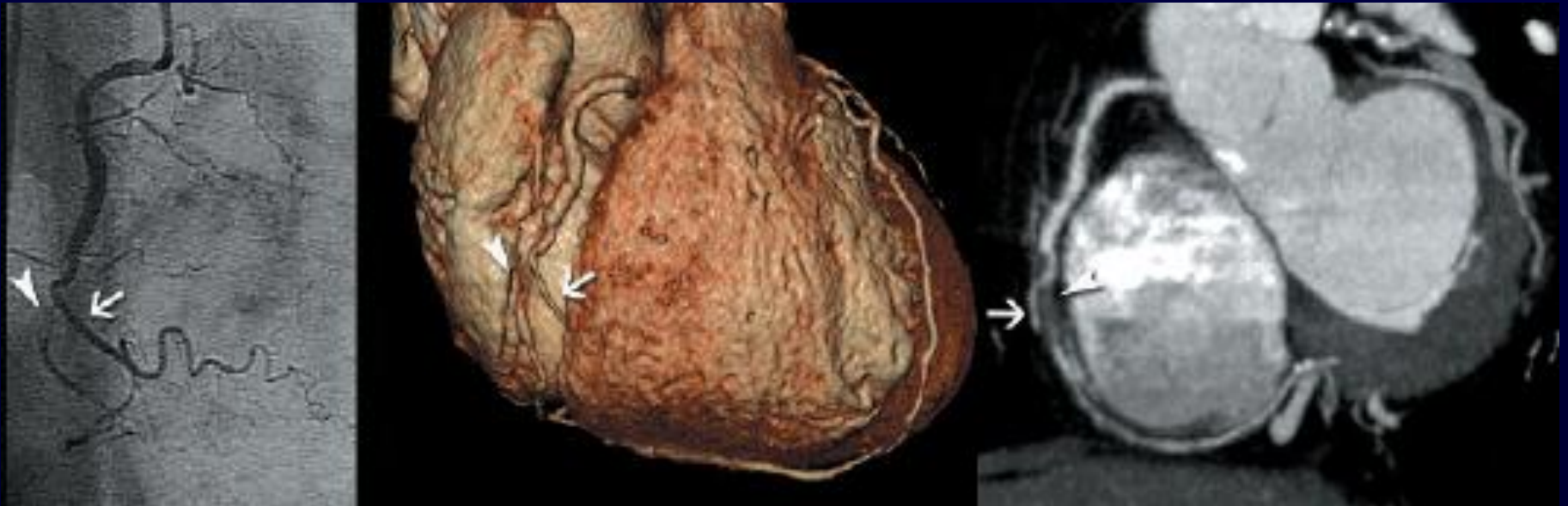
CTA: High Negative Predictive Value for Non-obstructive Coronary Disease



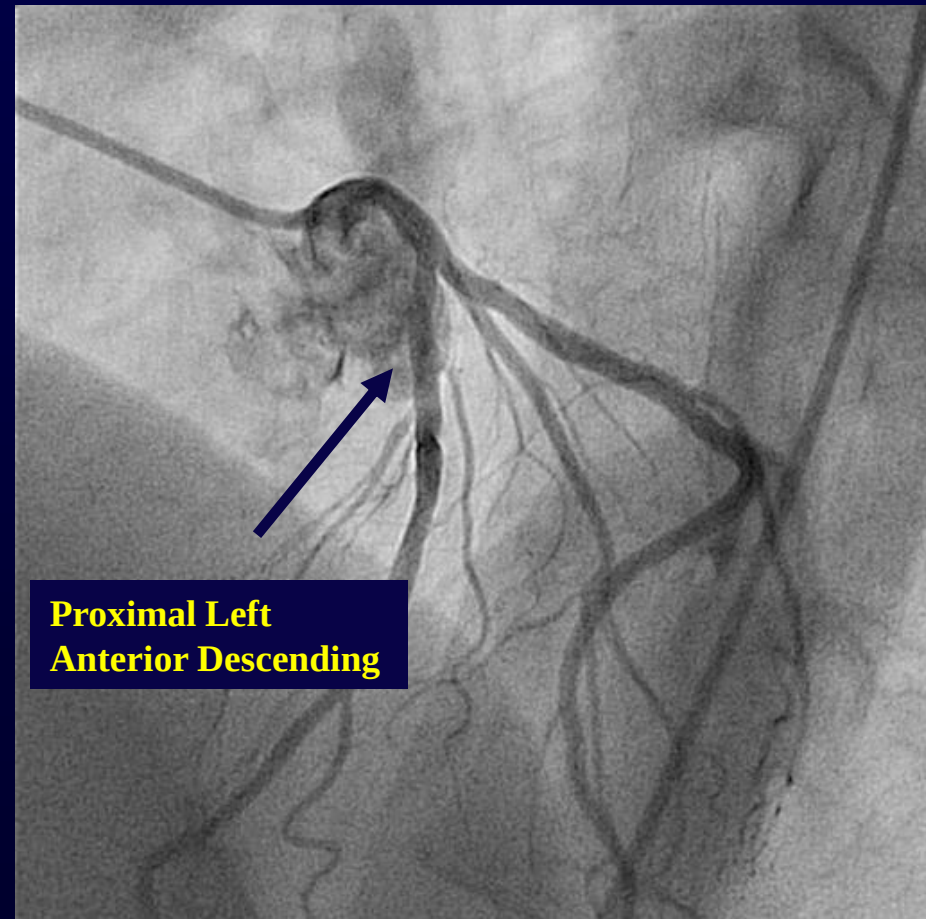
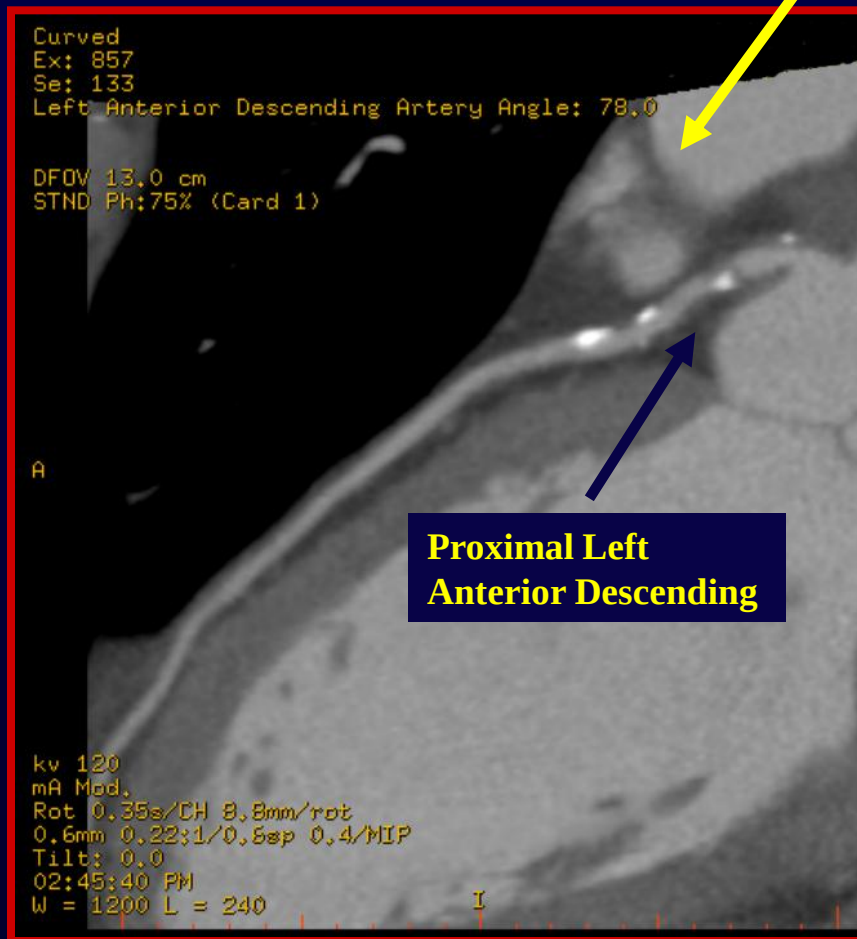
As long as the images obtained are of good quality

CT vs Conventional (Invasive) Angiography: Assessment of coronary artery wall

Which is better?

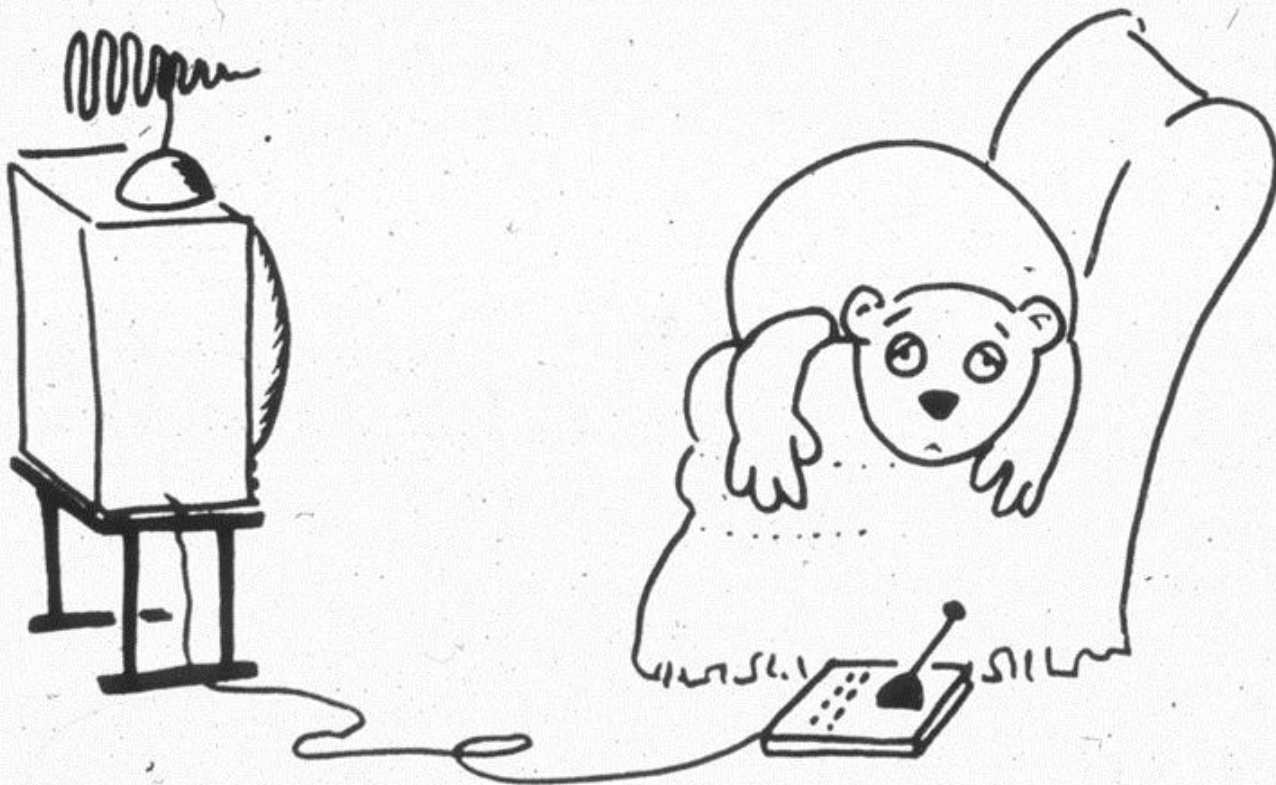


CT Angiography is the 'Gold Standard' for assessing the coronary artery wall



CTA Case History 3: GB

... FRANKLY I FIND
FOOTBALL TOO
STRENUOUS ...



CTA Case History 3: GB

- 59 year old man, Cholesterol 8.5mmol/l
- GP treated with lipitor 20mg 4 years before
- CK 10,000, marked myalgia
- 4 months to settle symptoms.....

CTA Case History 3: GB 2

- Clinic review
- FH father died from MI at 68 years
- Overweight: BMI 33, mild asthma
- ExTT negative at 7 mins but *Very* SOB
- Clinical suspicion of significant stenoses, but conventional angiogram seemed a big step, especially in this patient

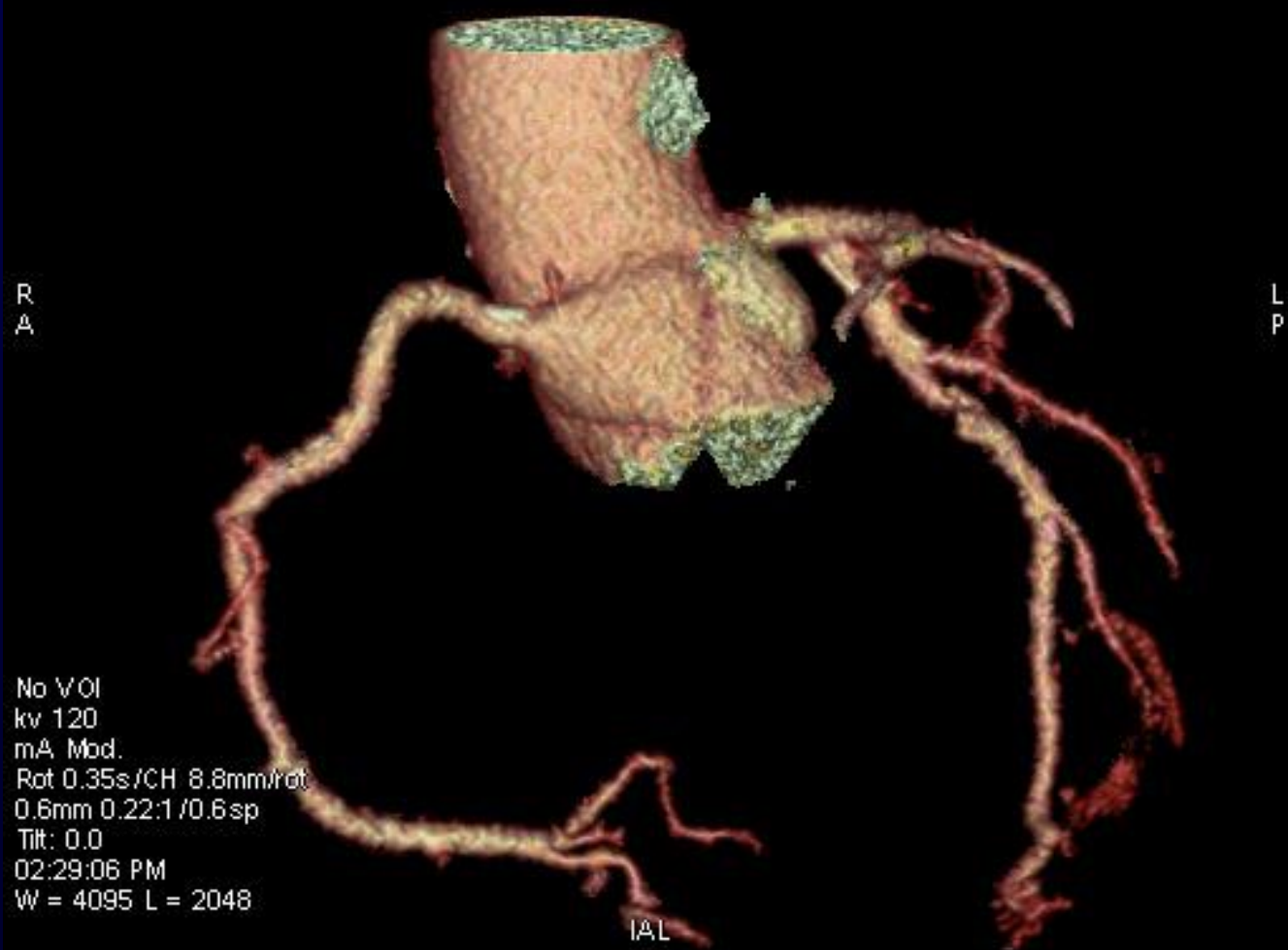
3D phase 70%
Ex:
Se: 533 +c
Volume Rendering No cut

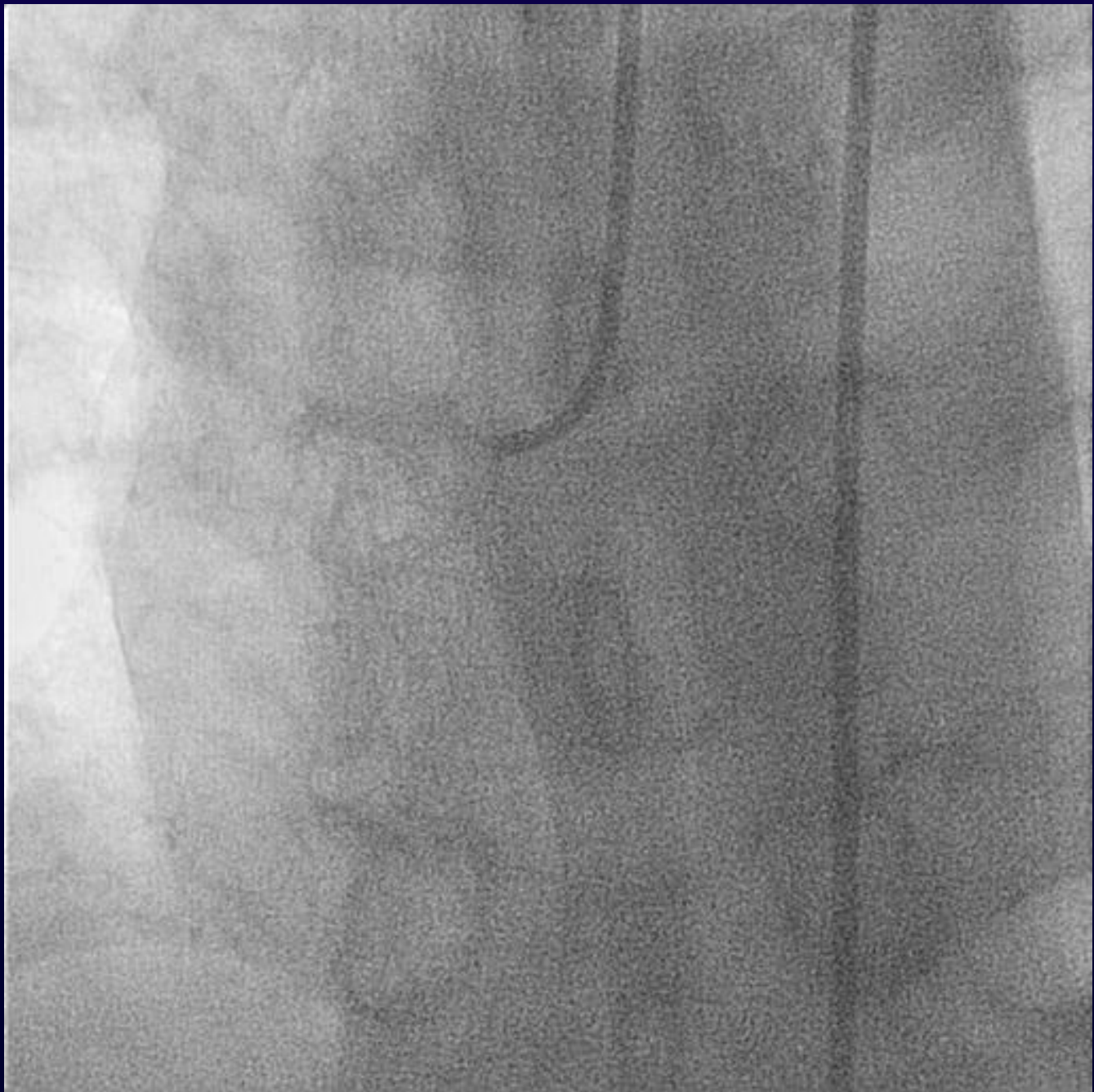
SPR

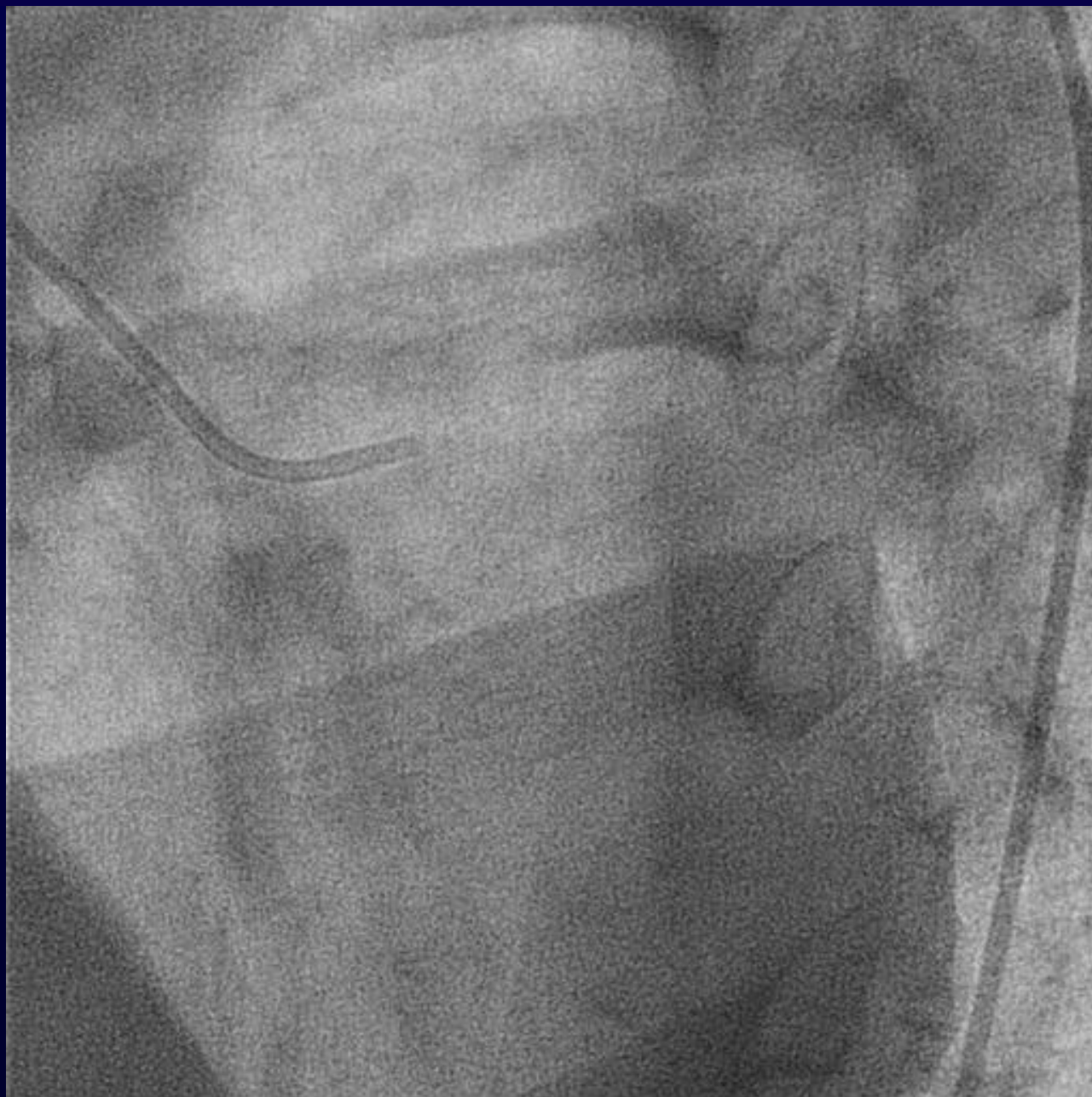
GB 31 May 2011
M 53 AW566427552.887.1306822684
DoB:
Ex: May 25 2009

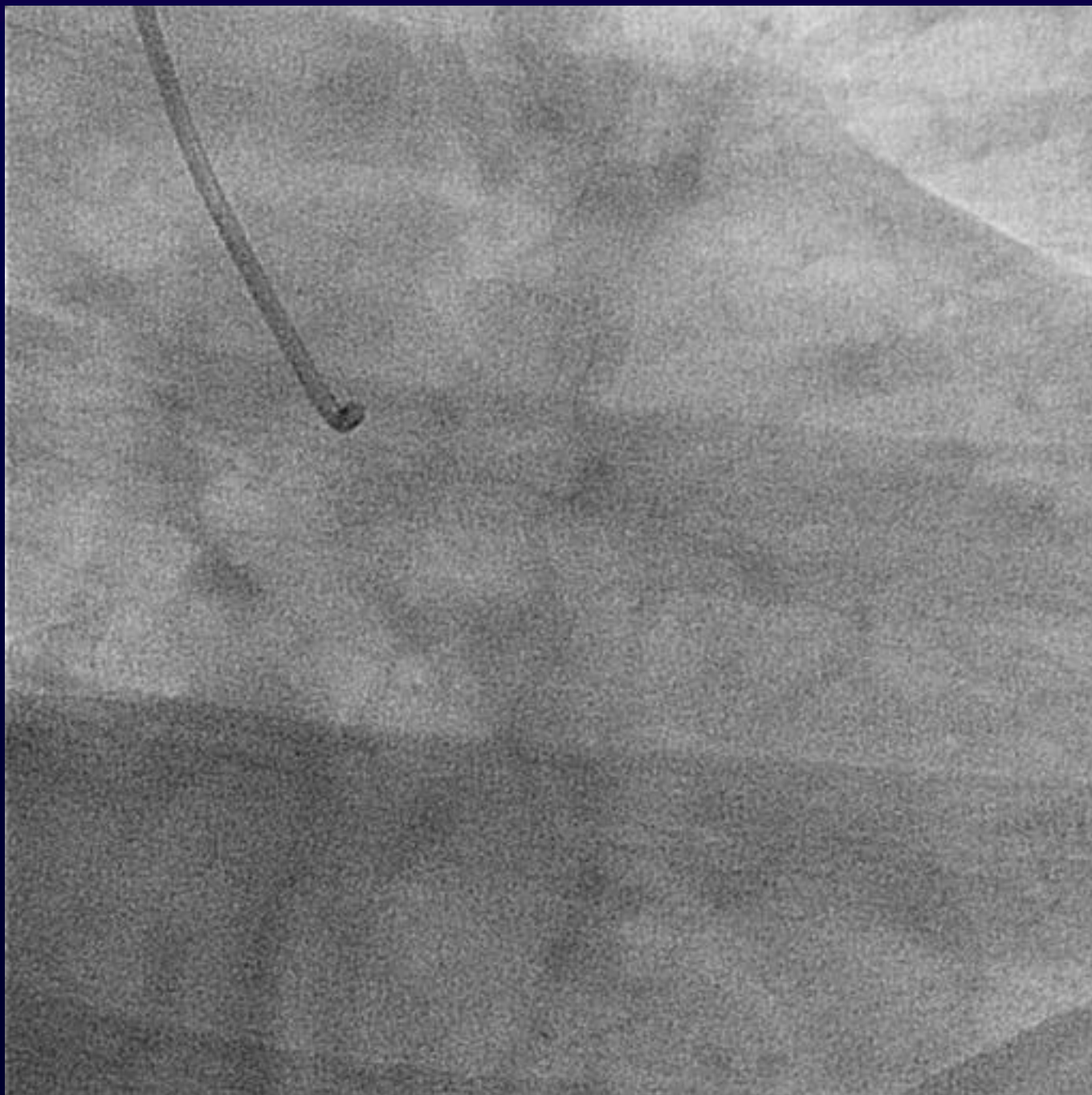
DFOV 15.0cm
STND/C2 Ph:70% (No Filt.)

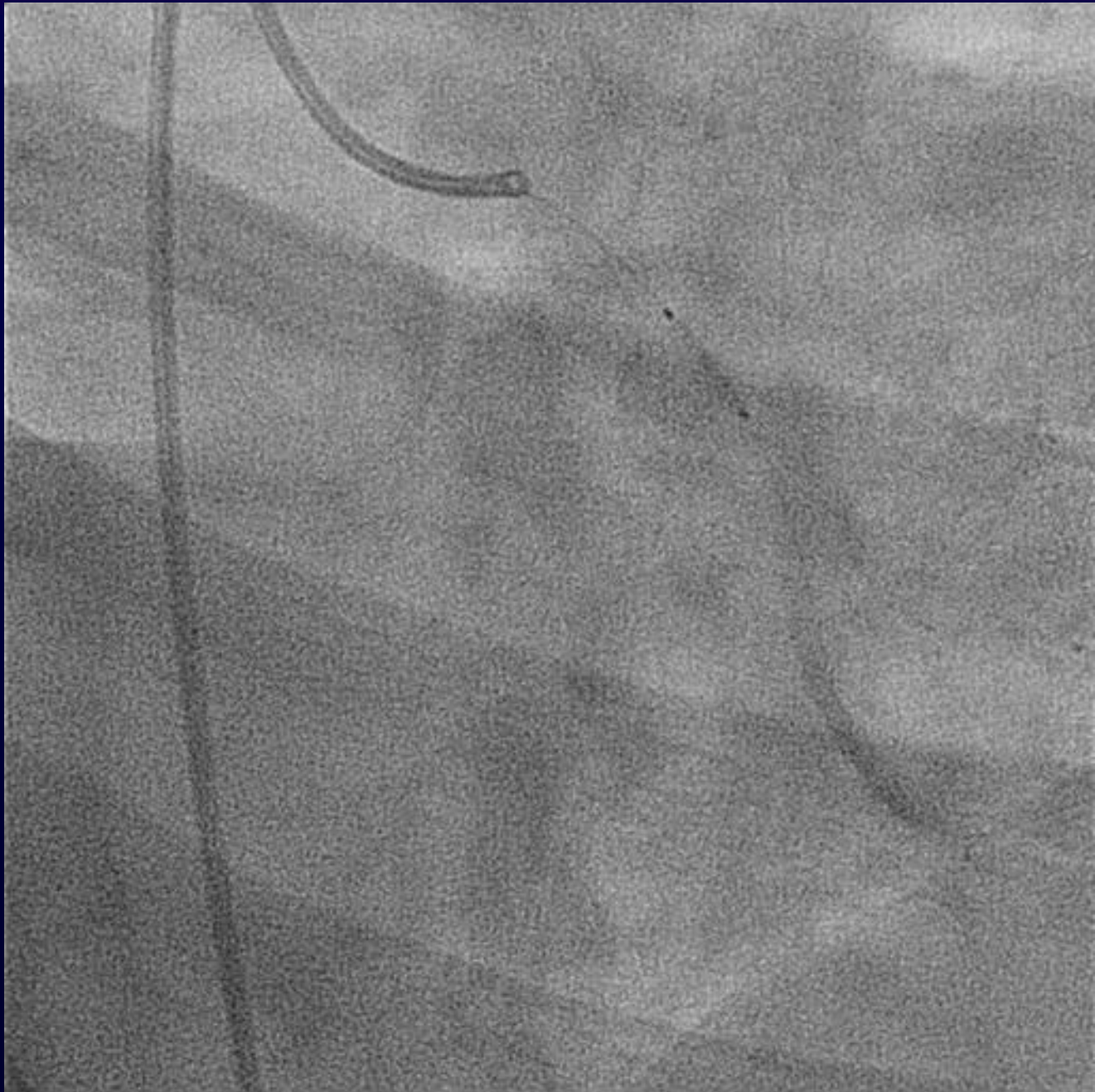
0 L 30 LAO 9 CRA

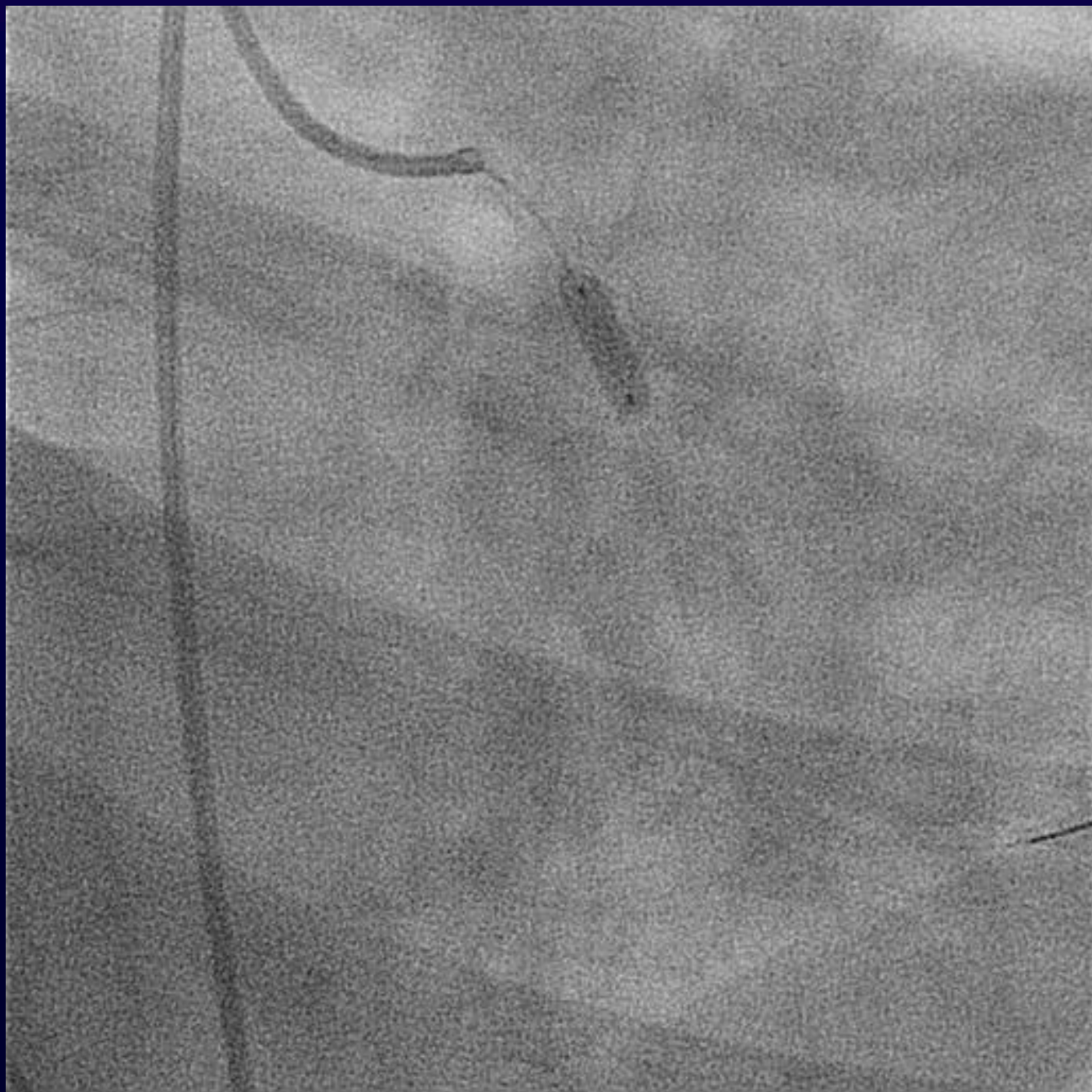


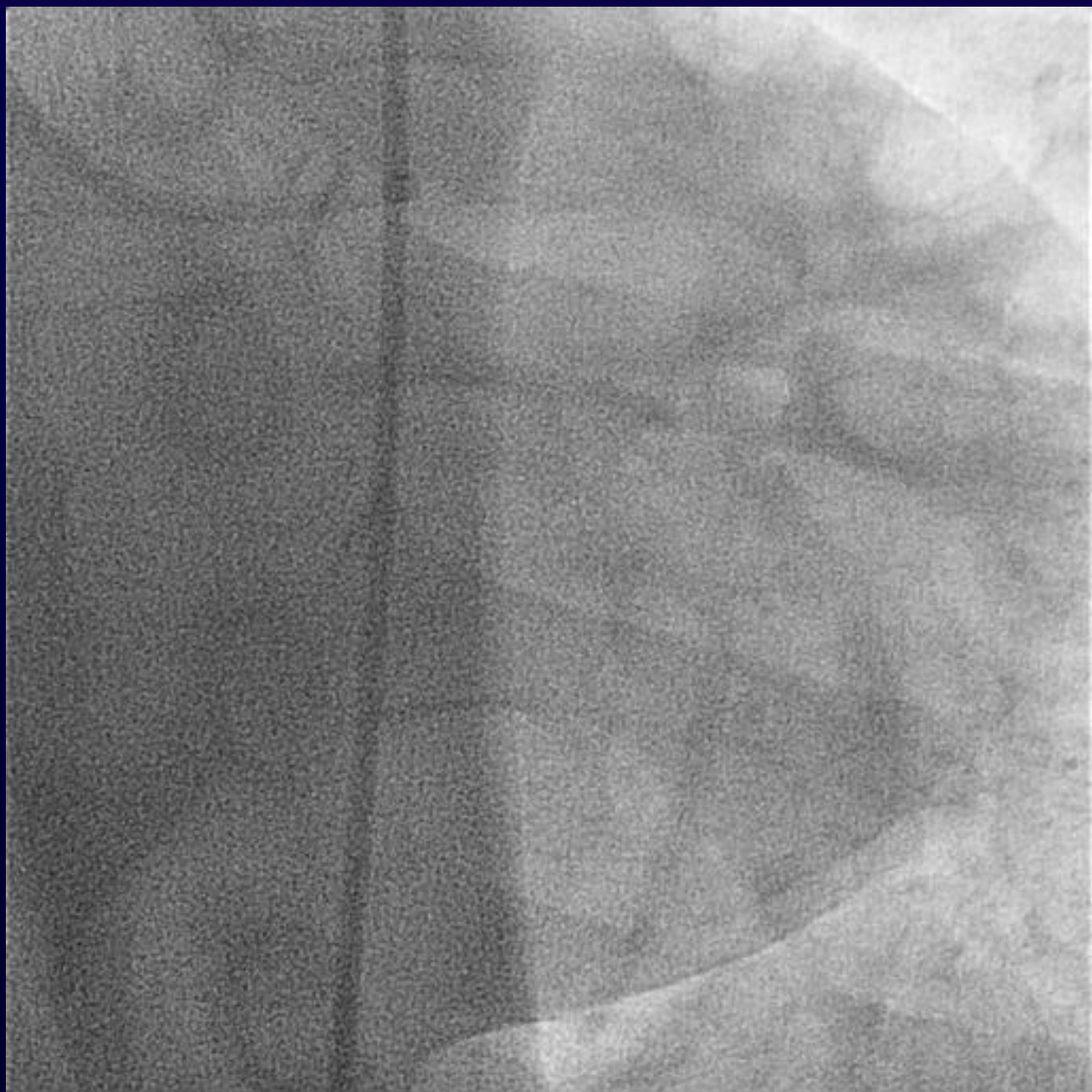












CTA Case History 3: Comment

- Less clear CTA images are seen if the patient is overweight, or > 75 years [Calcium ++]
- The heart rate is too fast, often due to inability to use beta-blockade [moderate asthma]
- Atrial fibrillation/markedly irregular rhythm
- Hence patient selection is important for CTA
- BUT for this patient, a highly useful test

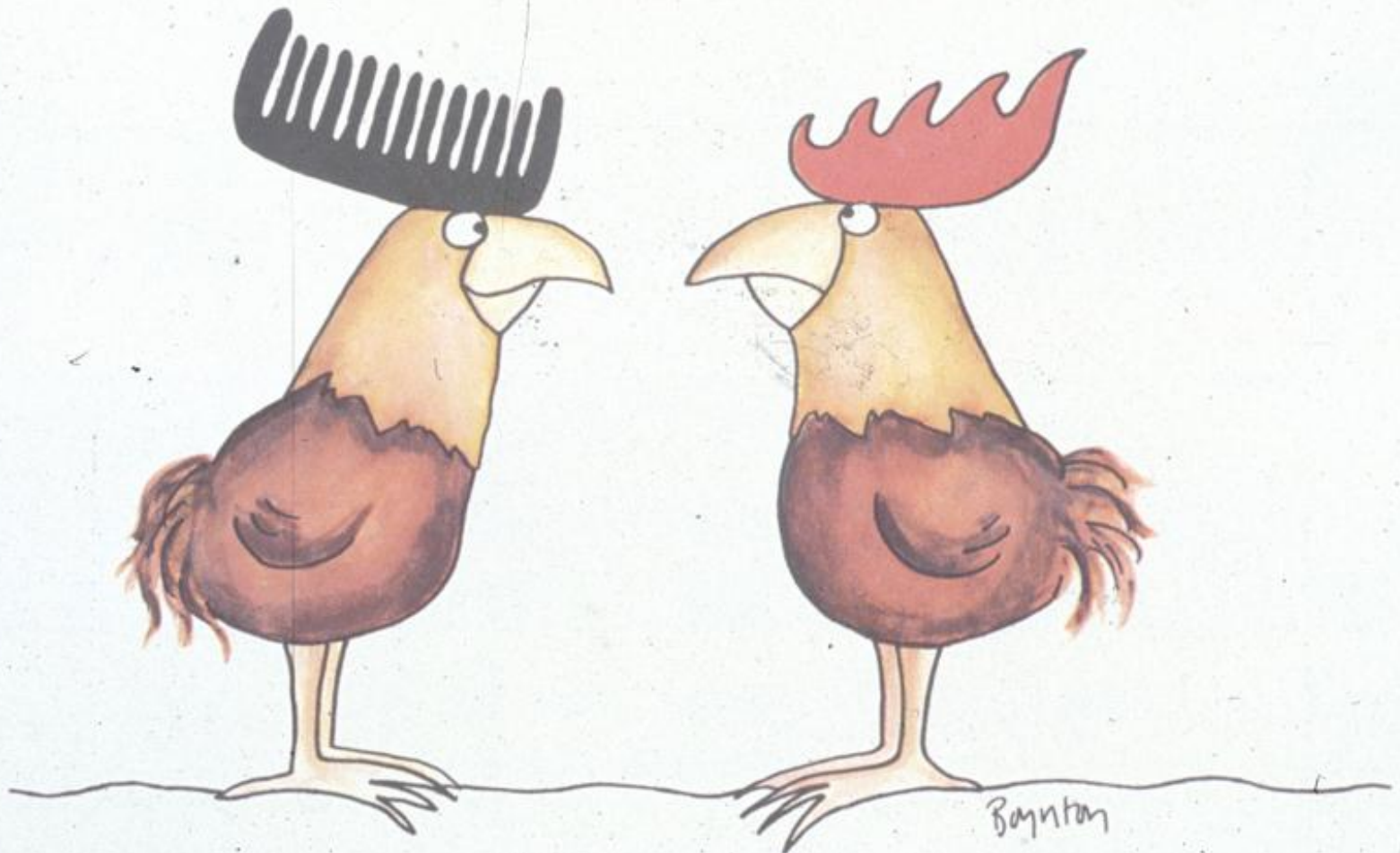
The Problem with HIGH Calcium scores



CTA Ca Score Case History 4

Strategies For Success - #12

Dare to be different.



CTA Ca Score Case History 4

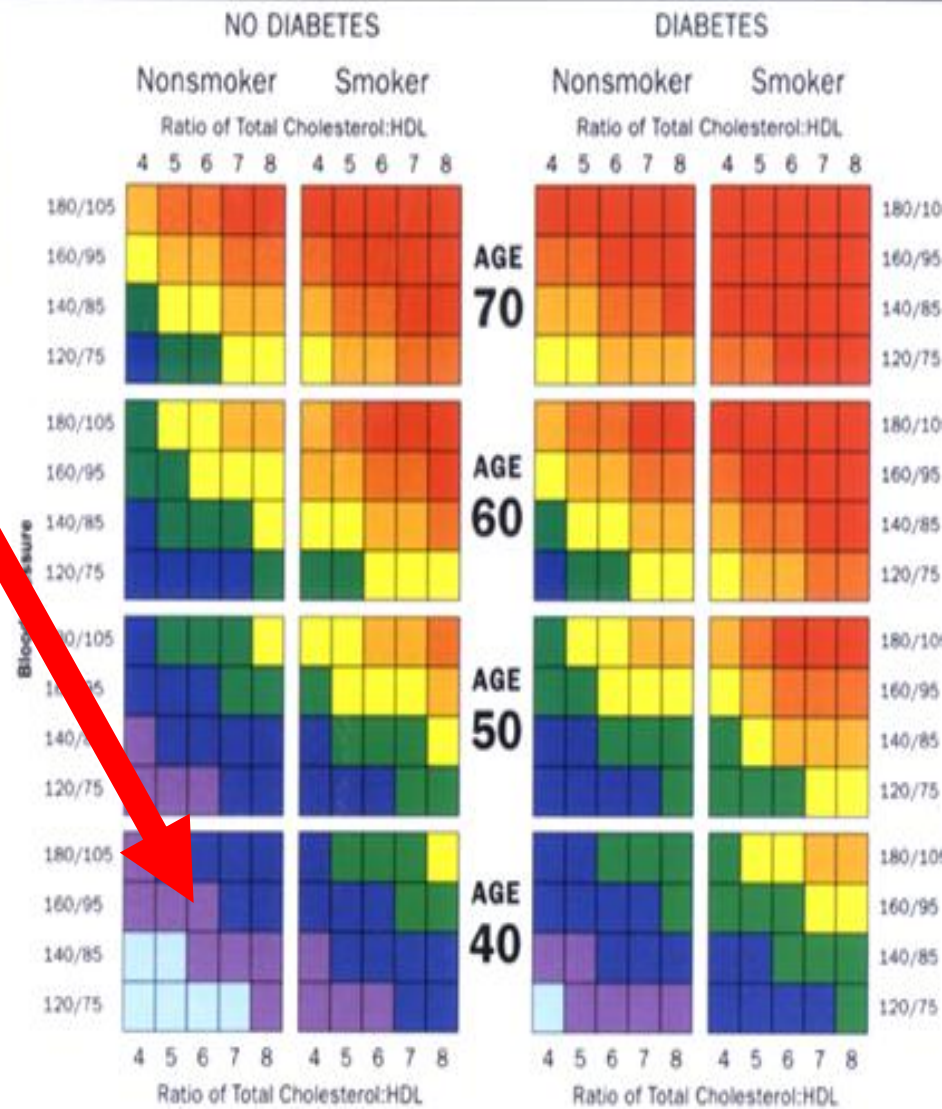
- 48 year old Indian Accountant
- Mother CABG at 63 years
- Mild BP from 40 years: Cilazapril
- Cholesterol 6.0mmol/l at 40 years: Lipex
- Reluctant and intermittent pill taker
- Returned at 48 years, no medicines for 3 years

Framingham 5-year CVS Risk 2.5 to 5%

	RISK LEVEL 5 year CVD risk (non fatal and fatal)	BENEFIT (1) CVD events prevented per 100 treated for 5 years #	BENEFIT (2) Number needed to treat for 5 years to prevent 1 event #
Very High	>30%	>10 per 100	<10
	25-30%	9 per 100	11
	20-25%	7.5 per 100	13
High	15-20%	6 per 100	16
Moderate	10-15%	4 per 100	25
	5-10%	2.5 per 100	40
Mid	2.5-5%	1.25 per 100	80
	<2.5%	<0.8 per 100	>120

Based on a 20% reduction in total cholesterol or a reduction in blood pressure of 10-15 mmHg systolic or 5-8 mmHg diastolic, which reduces risk of cardiovascular disease by about one-third over five years.

Risk level men



GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN IS4.75 Ax
DFOV 25.0cm
STND

A 125

VS
M48Y
AW1700651958.994.1305536230
Mar 07 2011
02:56:32 PM
SEGM512 X 512

Mag = 1.00
FL:
ROT:

R
1
2
7

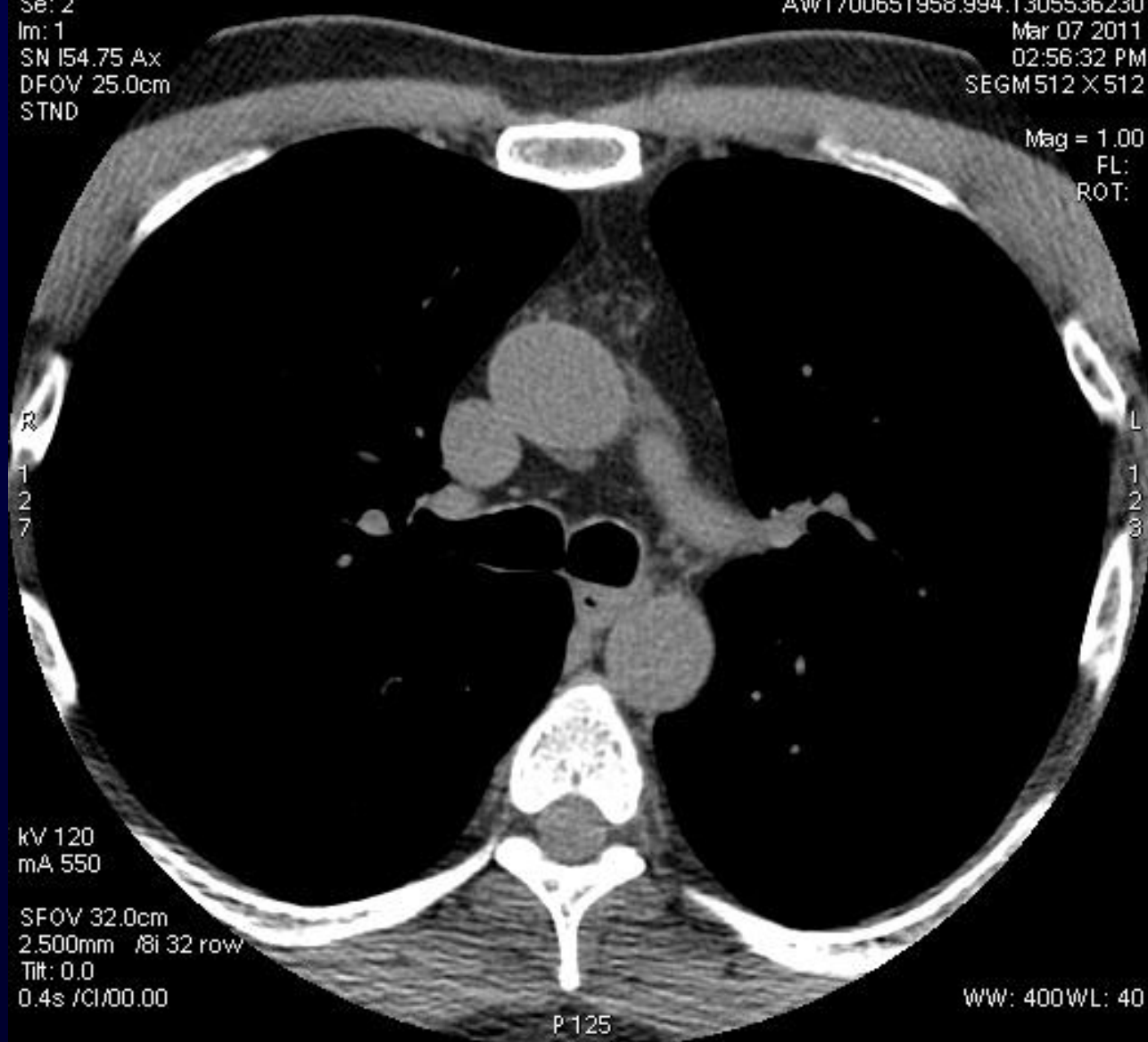
L
1
2
3

kV 120
mA 550

SFOV 32.0cm
2.500mm /81 32 row
Tilt: 0.0
0.4s /CI/00.00

P 125

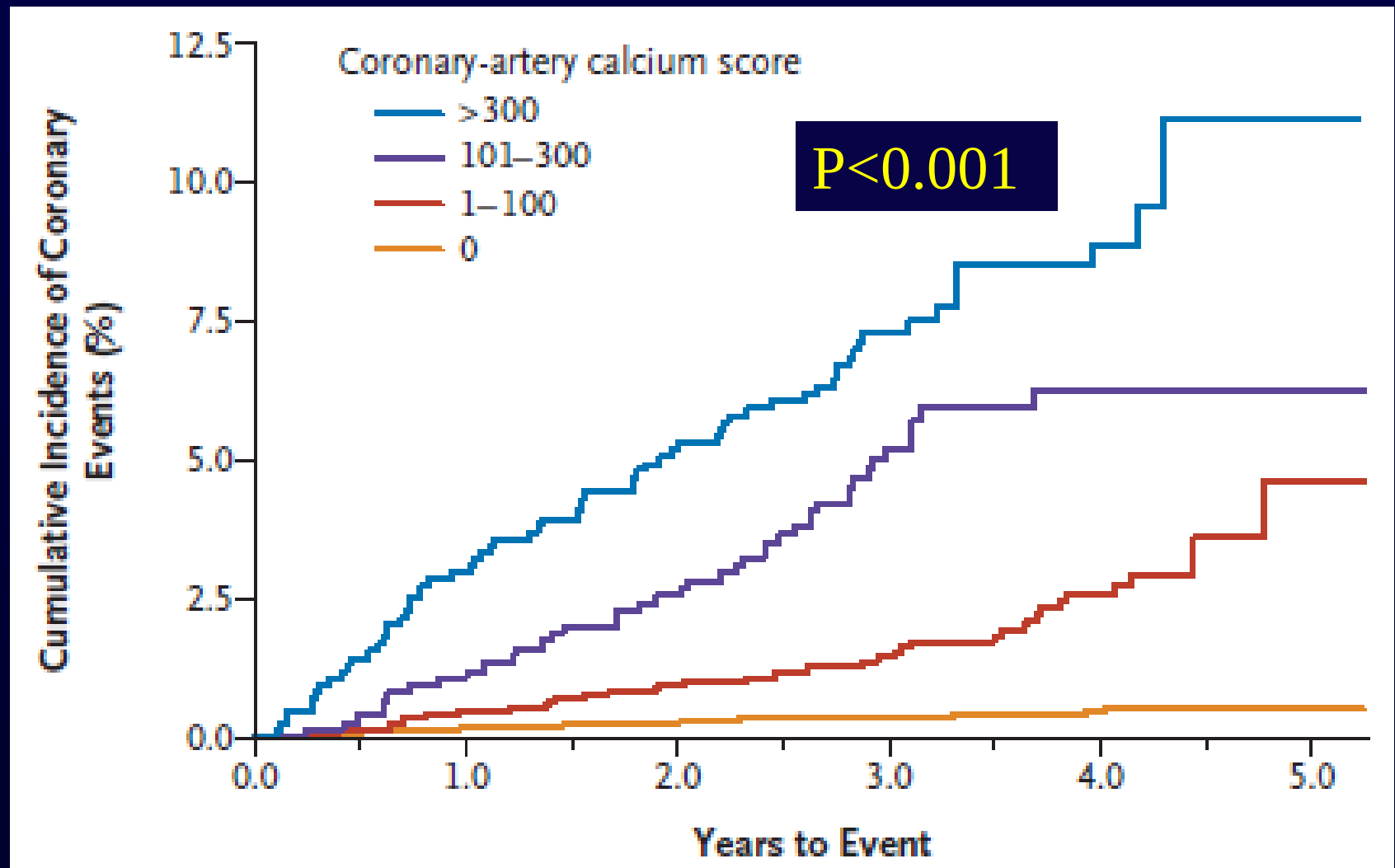
WW: 400WL: 40



CTA Ca Score Case History 4: Comment

- 48 year old Indian Accountant
- Calcium score 1304 Agatston units: > 90th percentile for age/gender-matched 'Normal' population
- Now highly motivated, can see calcium in arteries
- Lipitor 80mg, ezetimibe 10mg, cilazapril,
- Lifestyle ++
- VERY useful Calcium score test

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



THE NEW ZEALAND MEDICAL JOURNAL

Journal of the New Zealand Medical Association



High calcium scores in patients with a low Framingham risk of cardiovascular (CVS) disease: implications for more accurate CVS risk assessment in New Zealand

Chris J Ellis, Malcolm E Legget, Colin Edwards, Niels Van Pelt, John A Ormiston,
Jonathan Christiansen, Helen Winch, Mark Osborne, Greg Gamble

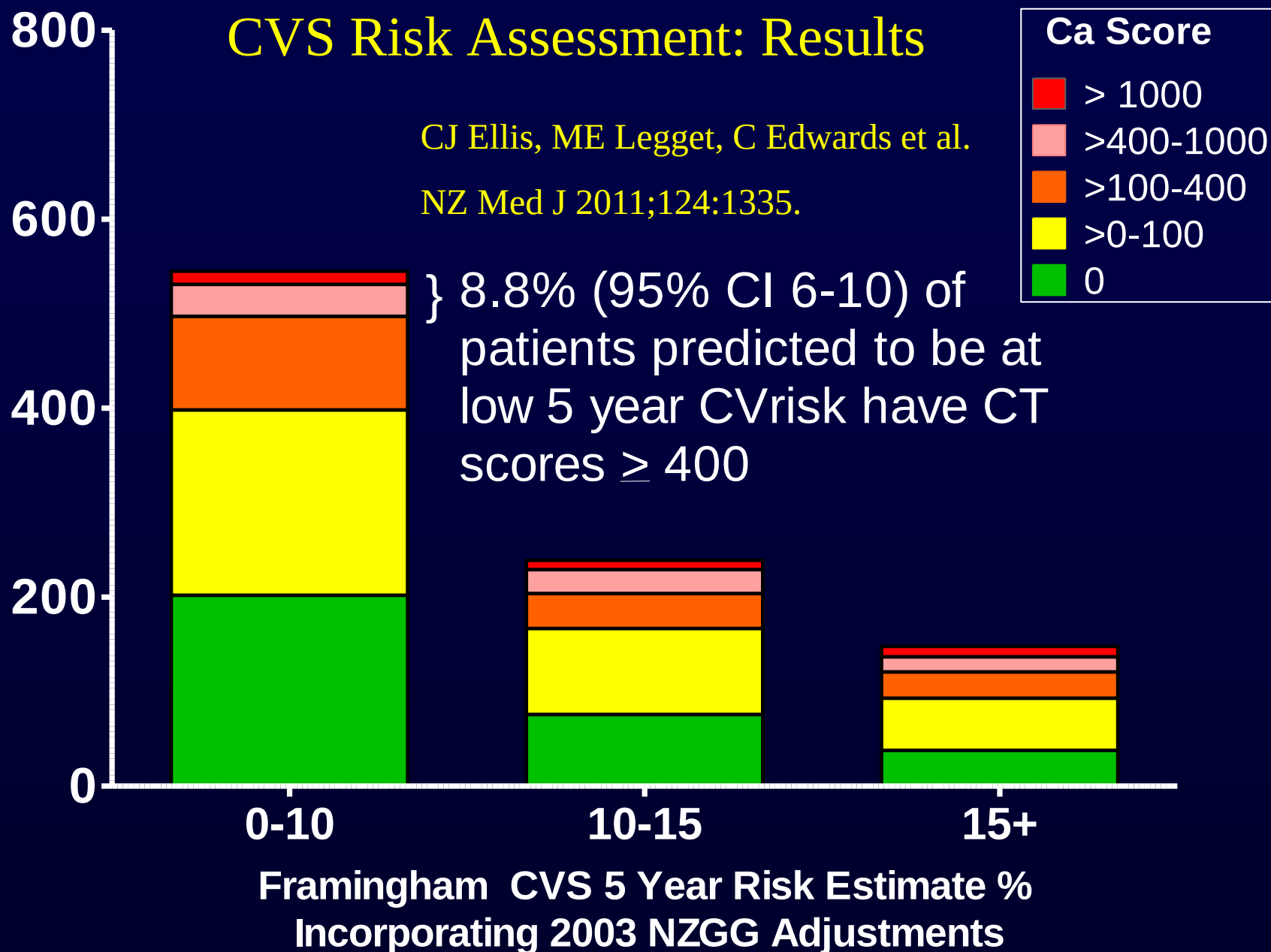
NZMJ 27 May 2011, Vol 124 No 1335; ISSN 1175 8716

URL: <http://www.nzma.org.nz/journal/124-1335/4676/>

Calcium Score & More Accurate CVS Risk Assessment: Results

CJ Ellis, ME Legget, C Edwards et al.

NZ Med J 2011;124:1335.



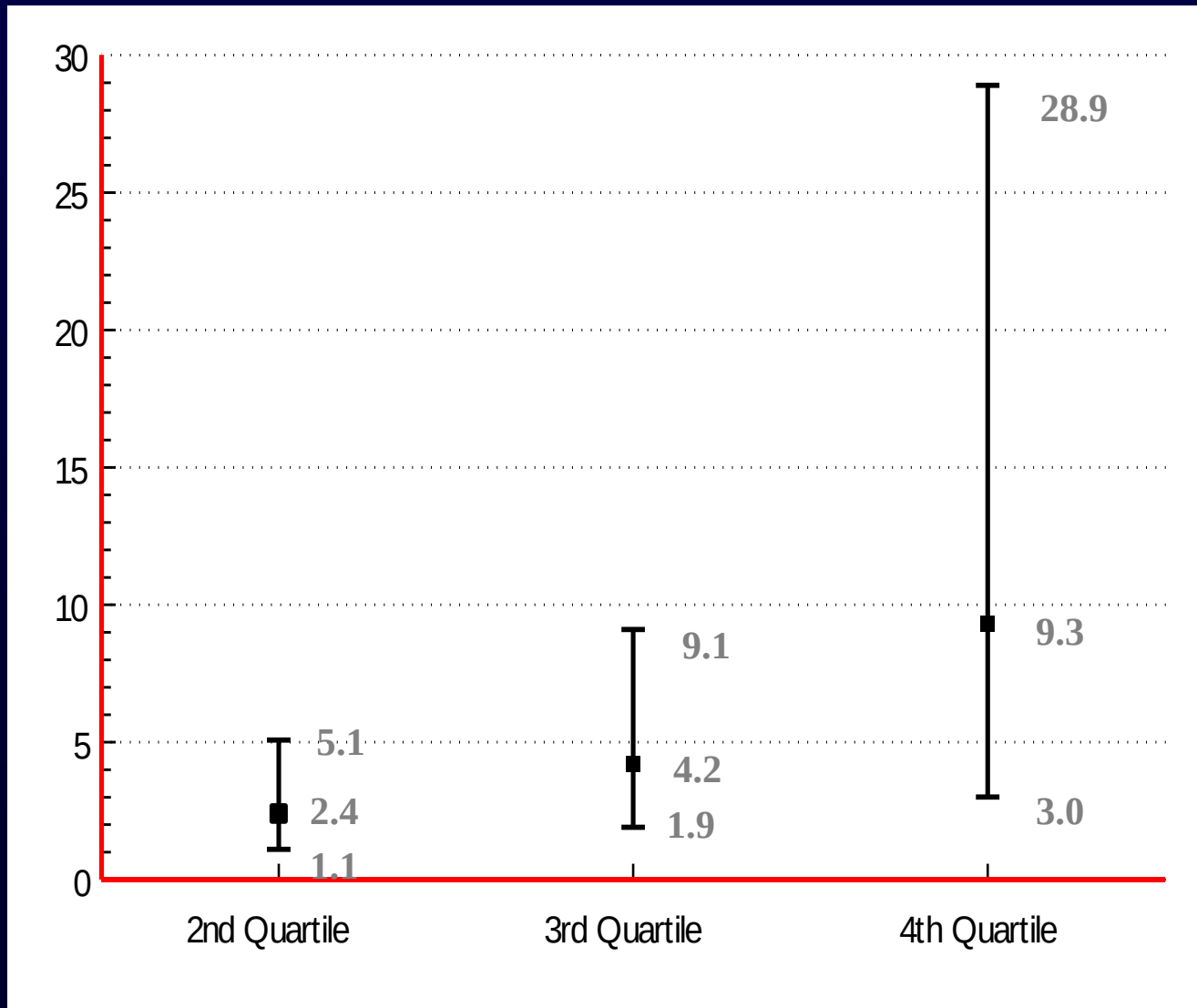
64-slice CT Cardiac Angiography

The opportunity to 'Personalise' CVS risk

Coronary Calcium Score and Compliance with Medical Therapy

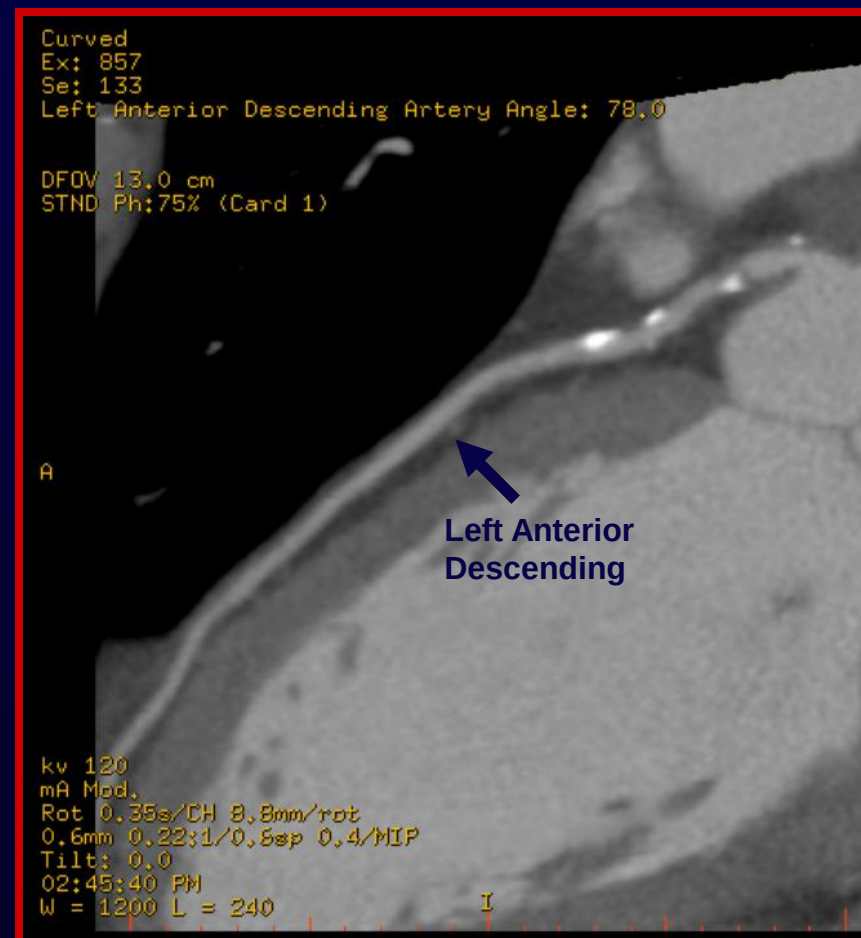
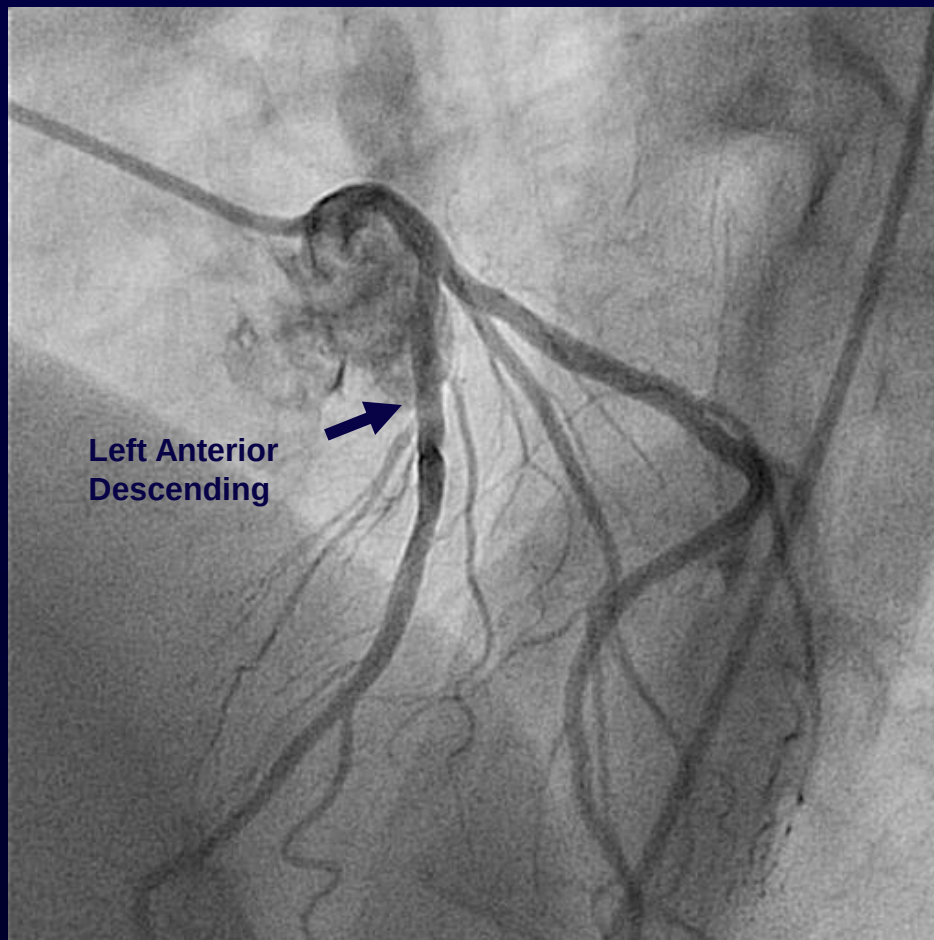


Odds Ratio of maintaining statin therapy with various levels of baseline CAC (3.6 yr f/u) – Kalia et al. 2006

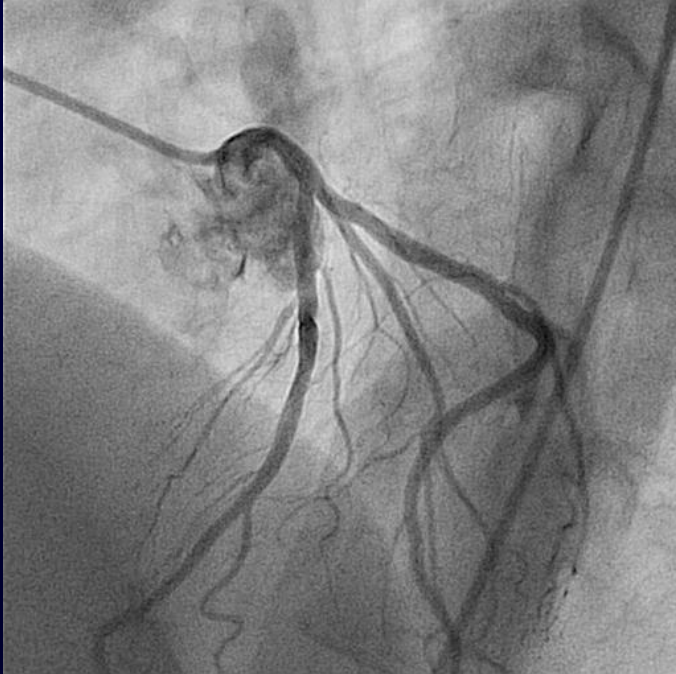


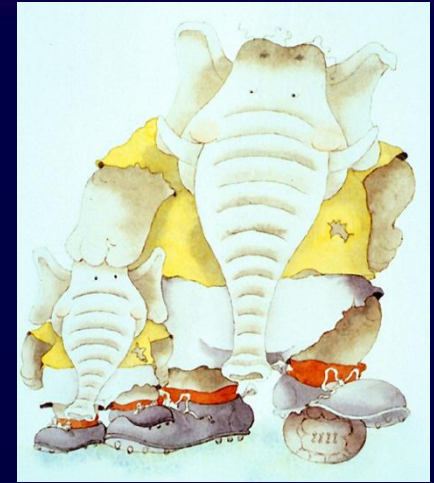
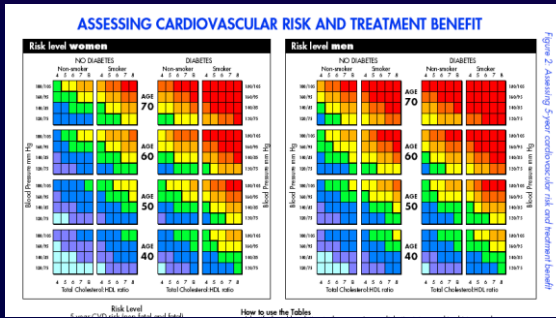
Mild, calcified CAD seen on CT Angiography

Confirmed at Coronary Angiography



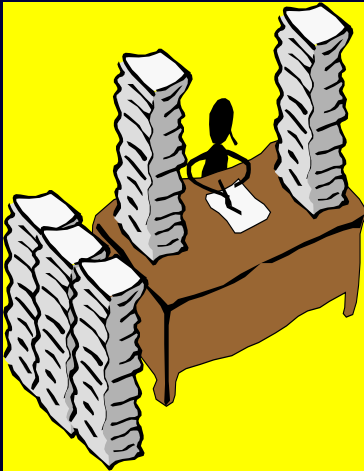
Personal Risk: No
longer abstract!
Very motivating:
Lifestyle &
Medication





Framingham-Based: 5 or 10-Year Risk & “Lifetime-Risk”

CVS Risk Assessment



CTA & Ca score Cases: 'Quick-Fire'



"This shouldn't take too long!"

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.)

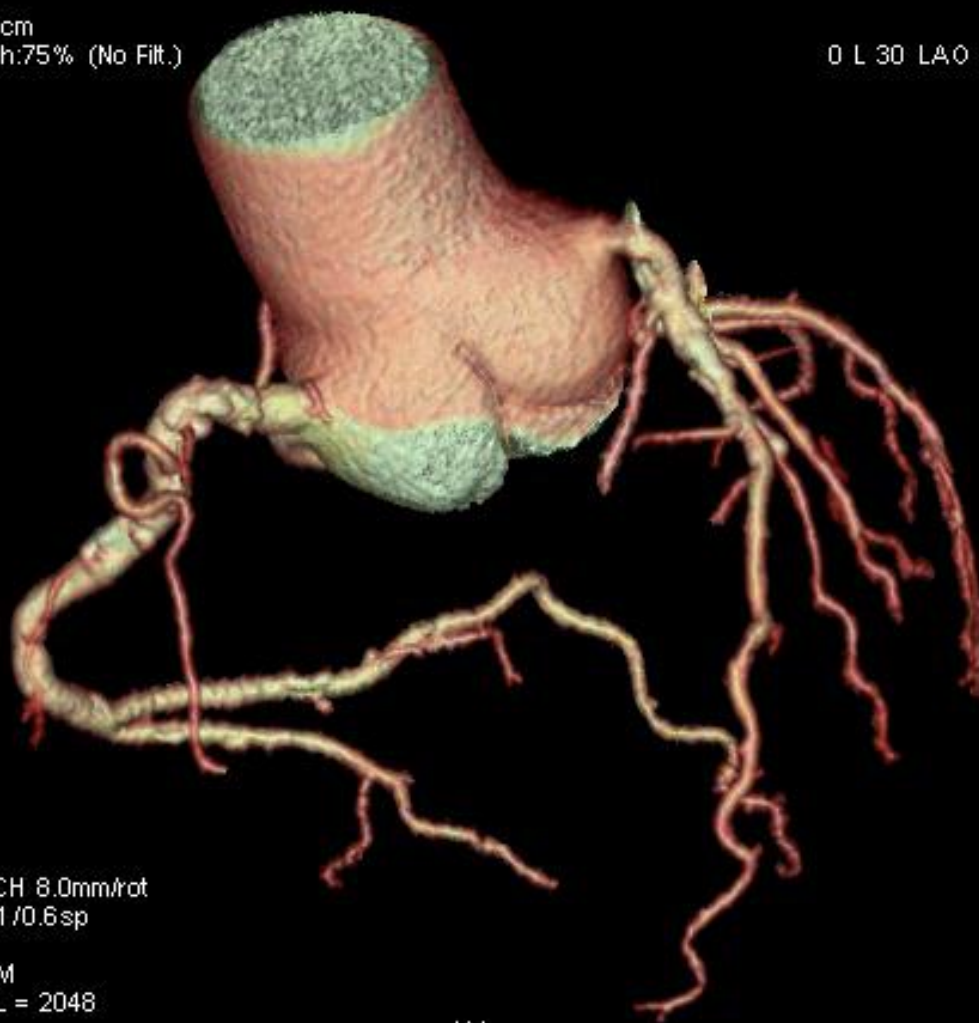
0 L 30 LAO 30 CRA

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

183

IB 31 May 2011
M 75 AW1261973821.342.1306822898
DoB:
Ex: Sep 30 2009

DFOV 17.0cm
STND/C2 Ph:75% (No Filt.)

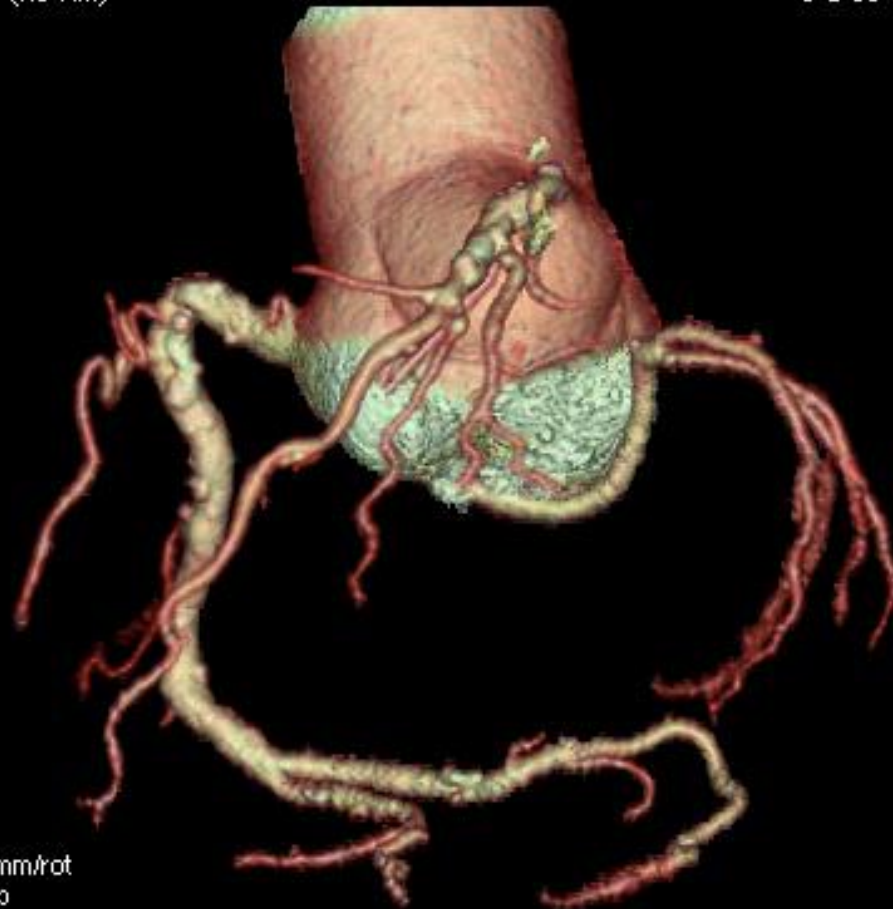
0 L 90 LA 0 0 CRA

A
1
0
3

P
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



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 19.0cm
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



Curved

Ex:

Se: 133 +c

Left Anterior Descending Artery Angle: 0.0

IB 31 May 2011

M 75 AW1261973821.342.1306822898

DoB:

Ex: Sep 30 2009

DFOV 14.7

STND/C2 Ph:75% (No Filt.)

A

P

kv 120

mA Mod.

Rot 0.35s/CH 8.0mm/rot

0.6mm 0.2:1 /0.6sp 0.4/MP

Tilt: 0.0

02:52:38 PM

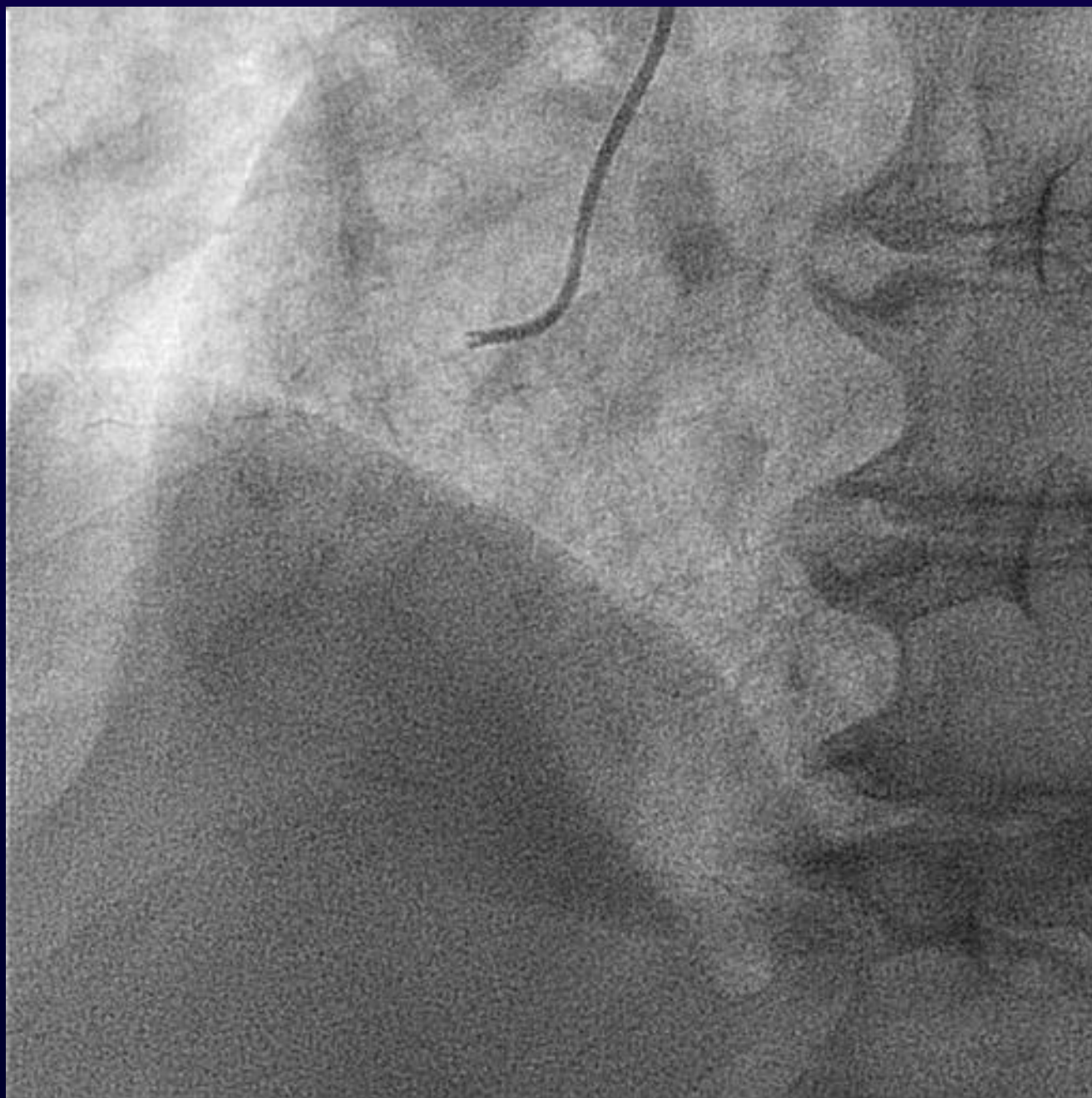
W = 1200 L = 240

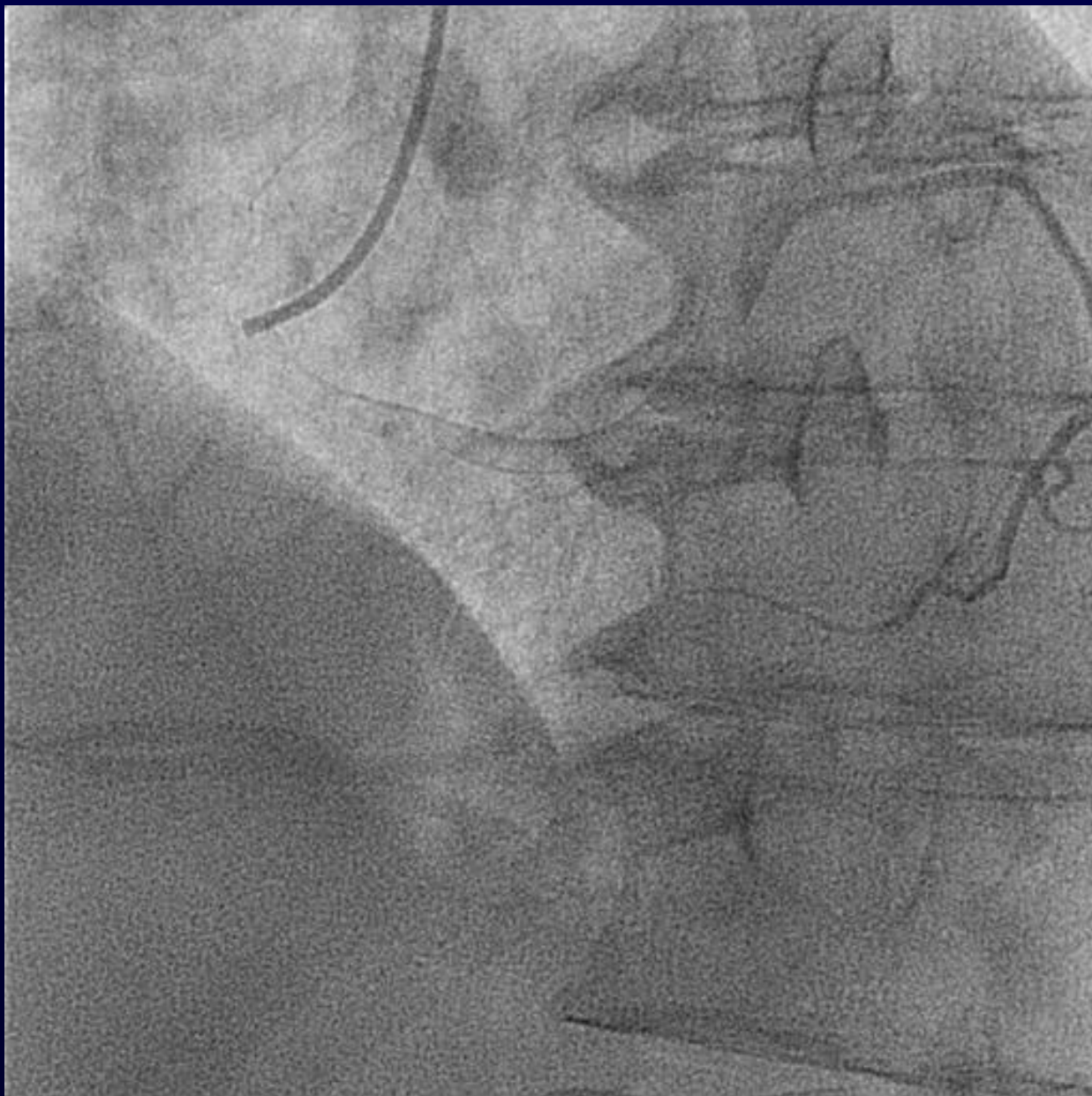
I













CTA Case History 5: Comment

- Aberrant Circumflex from RCA
- Non-Malignant course [not between 2 great arteries]
- Mild/moderate calcified coronary wall atheroma
- Medical management



Axial2

A 93

RM LMS from RCA

Ex:

M 74 AW1822187170.296.1307255297

Se: 133 +c

DoB:

I: 90.0

Ex: Mar 10 2008

Im: 1

DFOV 20.0cm

STND/C1 Ph:75% (No Filt.)

BPM:49

227ms

R

7

4

L

1

2

6

0.6/

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 = 817 L = 90

P 107

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 LA 0 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

175

RMLMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008

DFOV 17.0cm
STND/C1 Ph:75% (No Filt.)

0 L 30 RA 0 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

1245



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 Ph75% (No Filt.)

0 L 30 RAO 0 CRA



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

SPR

RM LMS from RCA
M 74 AW1822187170.296.1307255297
DoB:
Ex: Mar 10 2008

DFOV 19.0cm
STND/C1 Ph:75% (No Filt.)

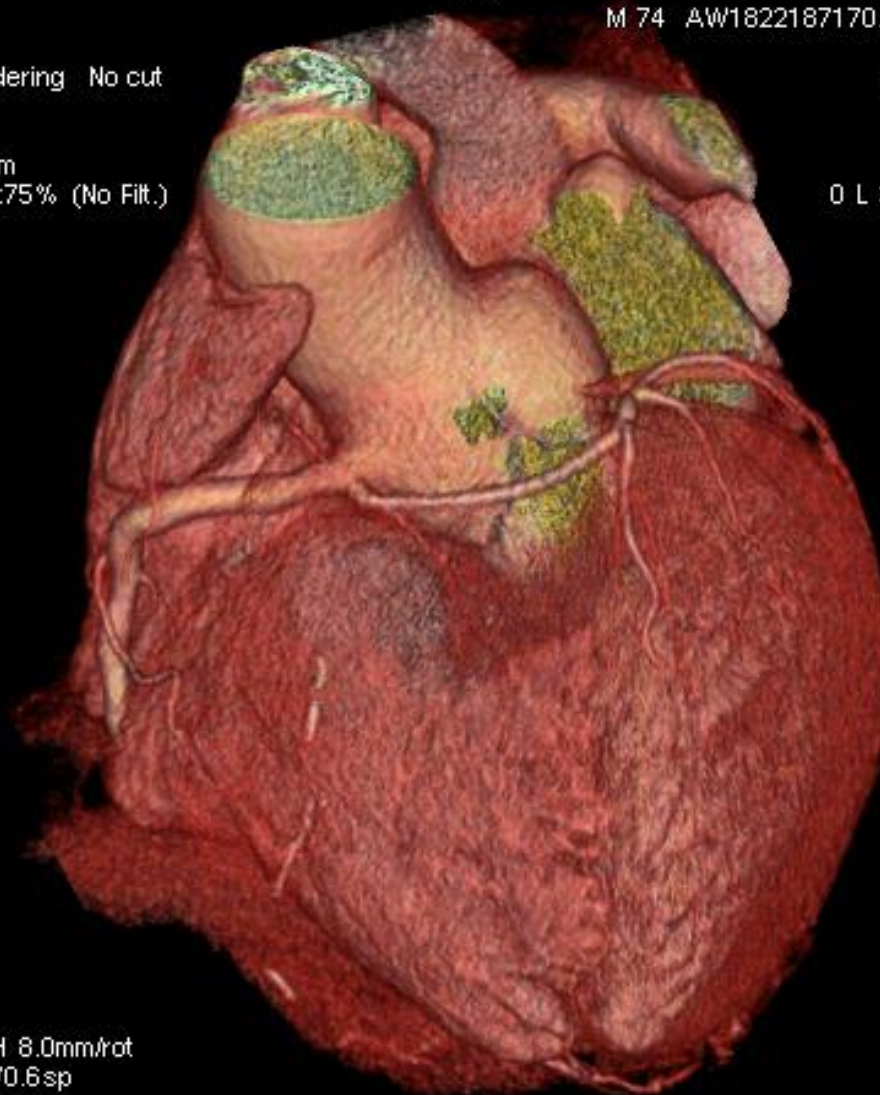
0 L 30 LAO 30 CRA

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



CTA Case History 6 : Comment

- Aberrant Left Main from RCA
- Malignant course [between 2 great arteries]
- Mild chest pains ? GORD
- No significant coronary wall atheroma, Age 76 years
- Negative stress scintiscan
- Medical management



Axial2
Ex:
Se: 133
I: 12.5
Im: 1

A 95

AM Ao Dil Mass
F 71 AW1481183568.892.1307328849
DoB:
Ex: Dec 10 2008

DFOV 20.0cm
STND/C3 Ph:75% (No Filt.)

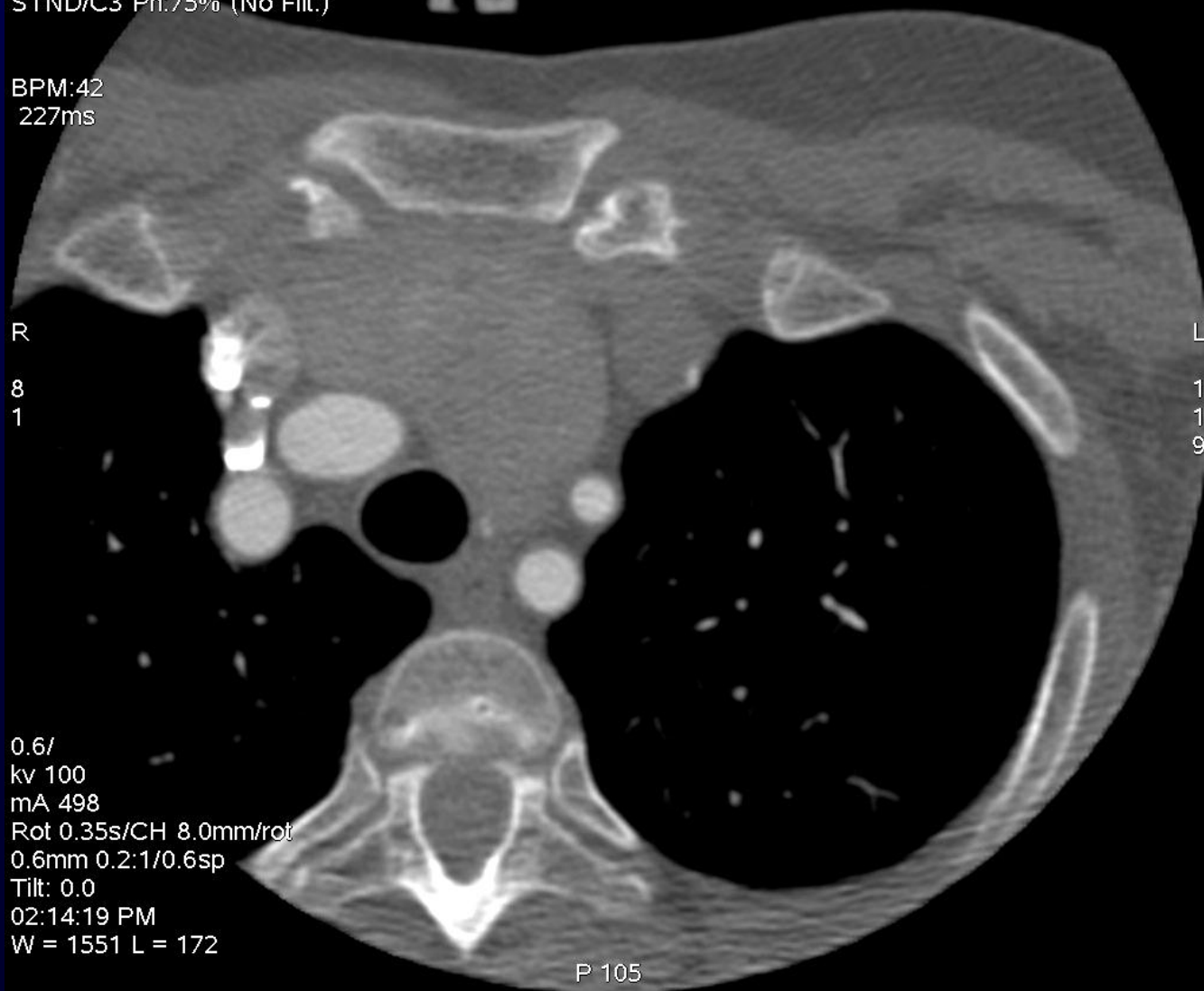
BPM:42
227ms

R
8
1

L
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

DFOV 21.1cm
STND/C3 Ph:75% (No Filt.)

SPR

AM Ao Dil Mass
F 71 AW1481183568.892.1307328849
DoB:
Ex: Dec 10 2008

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



3D
Ex:
Se: 133
Volume Rendering No cut

DFOV 21.1cm
STND/C3 Ph:75% (No Filt.)

AM Ao Dil Mass
F 71 AW1481183568.892.1307328849
DoB:
Ex: Dec 10 2008

0 L 30 RAO 0 CRA

R
P

L
A

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

I 221



CTA Case History 7 : Comment

- Anterior Chest 5cm mass: Thymoma
- Removed
- 5.8cm dilated aorta
- Repaired with gortex graft
- Coronaries mild atheroma



Axial2
Ex:
Se: 133
I: 105.0
Im: 1

A 119

GBa
M 48 AW996060904.555.1306822782
DoB:
Ex: Apr 06 2011

DFOV 17.8cm
STND/C3 Ph:75% (No Filt.)

BPM:45
227ms

R
7
0

L
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
Ex:
Se: 133
Volume Rendering No cut

SPR

GBa
M 48 AW996060904.555.1306822782
DoB:
Ex: Apr 06 2011

DFOV 17.0cm
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
01:55:53 PM
W = 4095 L = 2048

IAL



Axial2
Ex:
Se: 133
I: 105.0
Im: 1

A 119

GBa
M 48 AW996060904.555.1306822782
DoB:
Ex: Apr 06 2011

DFOV 17.8cm
STND/C3 Ph:75% (No Filt.)

BPM:45
227ms

R

7
0

L

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

SPR

GBa

Ex:

M 48 AW996060904.555.1306822782

Se: 133

DoB:

Volume Rendering No cut

Ex: Apr 06 2011

DFOV 17.8cm

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

01:55:53 PM

W = 4095 L = 2048

IAL

CTA Case History 8 : Comment

- Chest pain and SOB due to pulmonary emboli
- NOT coronary disease!



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.)

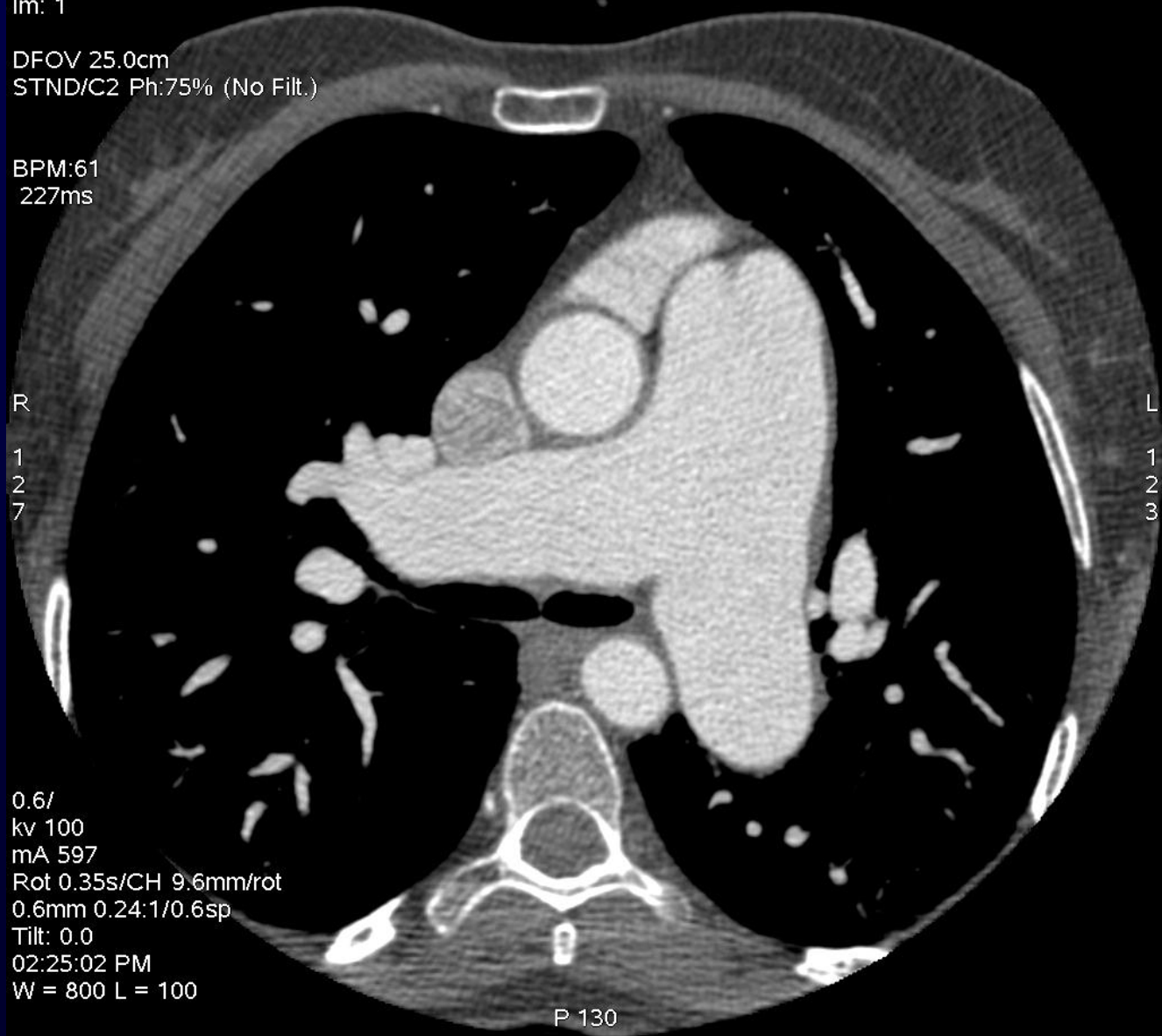
BPM:61
227ms

R
1
2
7

L
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



Coronal
Ex:
Se: 133
A: 96.1

14

JD 2ASD
F 58 AW1448582809.461.1307327667
DoB:
Ex: Jan 18 2010

DFOV 25.0cm
STND/C2 Ph:75% (No Filt.)

R

1
2
7

L

1
2
3

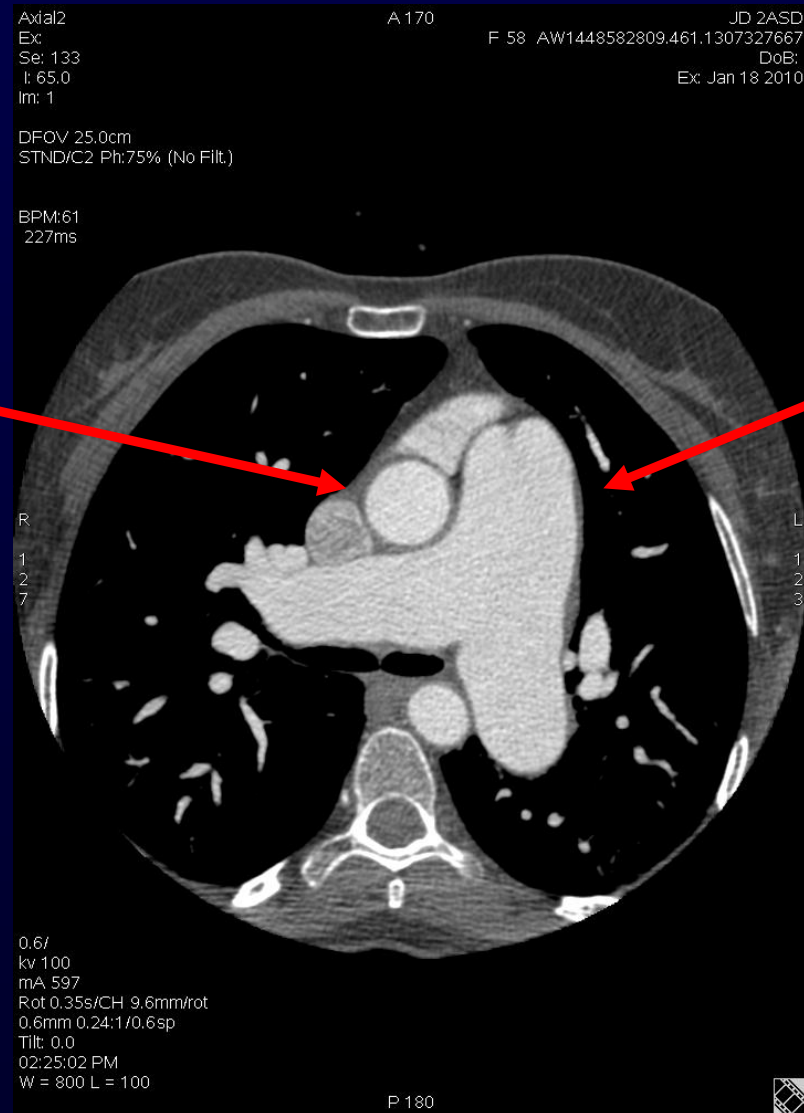
0.5/
kv 100
mA 597
Rot 0.35s/CH 9.6mm/rot
0.6mm 0.24:1 /0.6sp
Tilt: 0.0
02:25:02 PM
W = 800 L = 100

1254

CTA Case History 9: Marked PA Dilatation from Secundum ASD

Aorta

Pulmonary Artery



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



3D
Ex:
Se: 133 +c
Volume Rendering No cut

DFOV 26.0cm
STND/C2 Ph:75% (No Filt.)

SRP
MV AVR Coarct
? 55 AW1478812872.542.1307336015
DoB:
Ex: Jun 17 2009

0 L 60 LAO 30 CRA

A
R

P
L

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

ILA



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

1244



CTA Case History 10 : Comment

- Good surgical result from Bentall's procedure [AVR + aortic root graft] for bicuspid aortic valve
- No significant coronary disease
- Mild coarctation noted, has not been repaired



Axial2
Ex:
Se: 133 +c
I: 42.5
Im: 1

A 95

LG PHT
F 58 AW343456414.985.1307328242
DoB:
Ex: Jan 19 2009

DFOV 20.0cm
STND/C3 Ph:75% (No Filt.)

BPM:55
227ms

R
5
9

L
1
4
1

0.6/
kv 120
mA 697
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:52:40 PM
W = 1477 L = 127

P 105



Coronal
Ex:
Se: 133 +c
A: 86.0

I 21

LG PHT
F 58 AW343456414.985.1307328242
DoB:
Ex: Jan 19 2009

DFOV 20.0cm
STND/C3 Ph:75% (No Filt.)

R

5
9

L

1
4
1

0.4/
kv 120
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1/0.6sp
Tilt: 0.0
02:52:40 PM
W = 1477 L = 127

I 221

CTA Case History 11 : Comment

- Severe pulmonary hypertension
- No significant coronary disease
- SOBOE not coronary related



Husband & Wife Primary Prevention Assessment

- Both without symptoms
- Both with 'average' cholesterol
- Wife with modest FH of CVS Disease
- Husband: father died at 56 years from MI
- Both at low CVS Risk (NZ Guidelines)
- Both Negative ExTT



GE MEDICAL SYSTEMS
LightSpeed VCT
Ex:
Se: 2
Im: 1
SN 147.25 Ax
DFOV 25.0cm
STND

A 110

HM Ca Score 4 50-75th
F62Y
AW643760551.868.1307242788
May 30 2011
02:56:28 PM
SEGM512 X 512

Mag = 1.00
FL:
ROT:

R
1
0
6

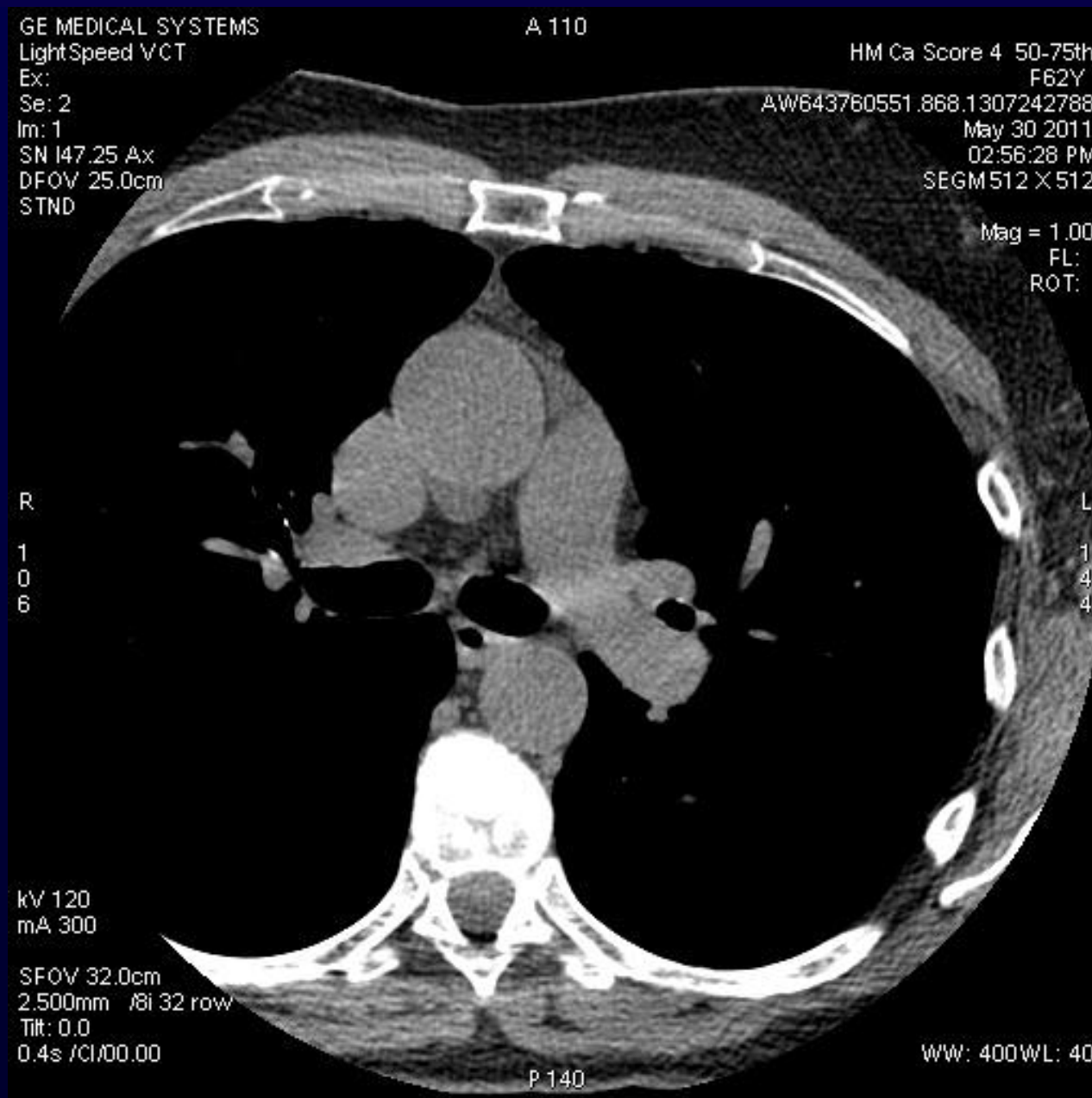
L
1
4
4

kV 120
mA 300

SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00

WW: 400WL: 40

P 140



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
SEGM512 X512

Mag = 1.00
FL:
ROT:

R
9
9

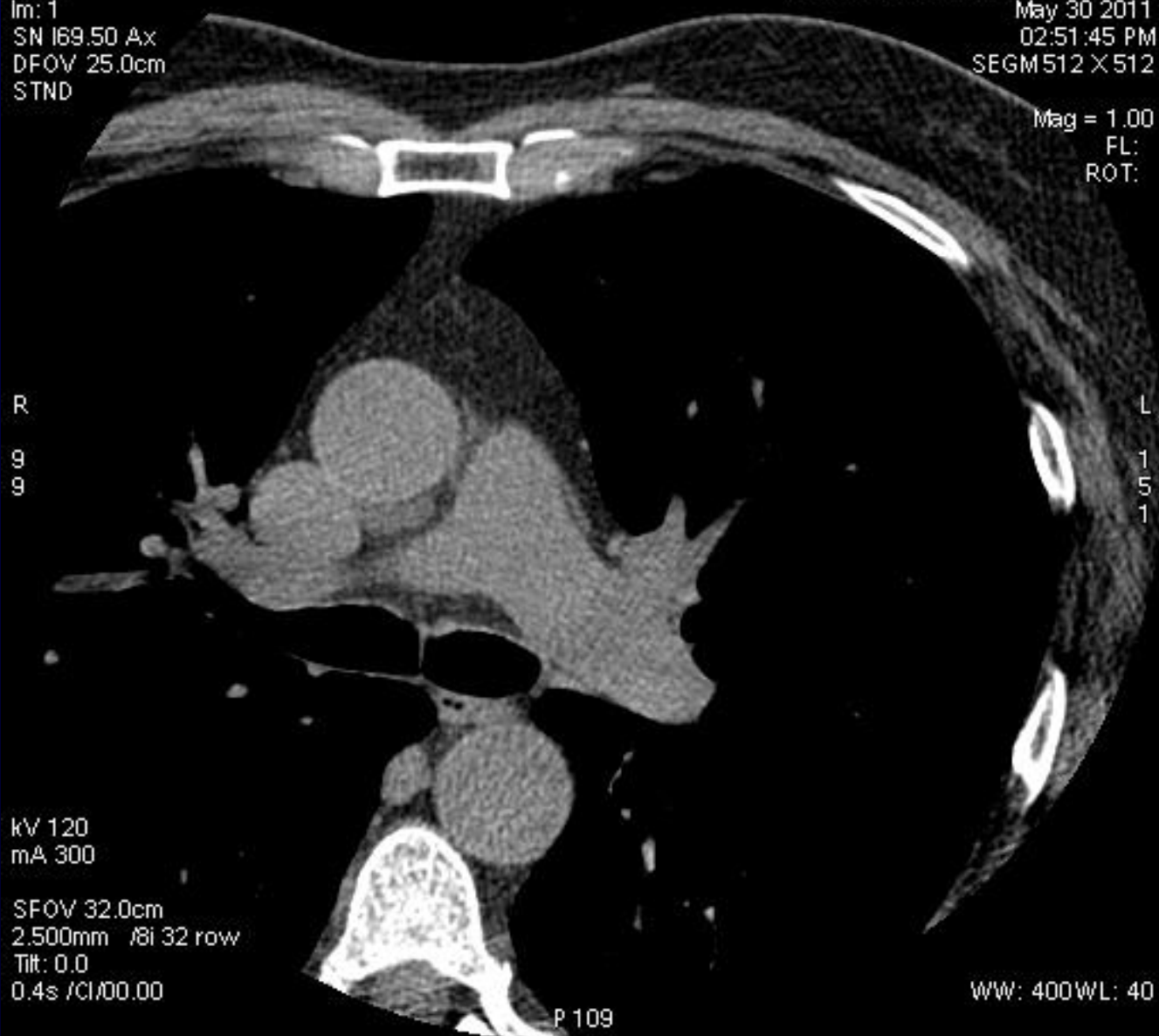
L
1
5
1

kV 120
mA 300

SFOV 32.0cm
2.500mm /8i 32 row
Tilt: 0.0
0.4s /CI/00.00

P 109

WW: 400WL: 40



CTA Case History 12 : Comment

- Wife: aged 60 years
- Calcium score 4 Agatston units: 50-75th percentile, age/sex normal population
- 50=3 units, 75=57 units
- Husband: aged 63 years
- Calcium score 1960 Agatston units: > 90th percentile
- 90+1299 units



64-slice CT Cardiac Angiography

Significant issues

‘Effective Radiation Dose’ (mSv) for Selected Procedures

Circ 2009;119:1056-65

<u>Test</u>	<u>Effective Dose (mSv)</u>	<u>Reported Range (mSv)</u>
CX-Ray PA + Left Lateral	0.1	
Lumbar spine X-Ray	2.4	
CT Head	2.0	
CT Chest	7	4-18
CT Abdomen	10	4-25
Barium Enema	15	
Screening Mammography	1	0.5-1.5
EBCT Calcium Score	1	1-1.5
64-Slice CTCA, Current Modulation	9 (7 @ AHG)	7-11
Invasive Coronary angiogram	7	4-12
PCI	12	7-57
Stress Scintigraphy (Sestamibi)	9	
Yearly Background Dose (NZ)	3	1-10

Effective Radiation Dose: In Perspective

- Yearly Background Radiation: 3mSv (1-10)
- Yearly Background Radiation in Cornwall and Aberdeen: 10mSv
- Occupational Exposure: 20mSv/year (NZ NRL)
 - Over 5 years, max 50 mSv/year
- Airline Crew: 3-6 mSv/year
 - Dose doubles every 1500m altitude
 - Dose varies with sunshine & latitude
 - No consistent finding of increased cancer risk except skin (recreational exposure!)

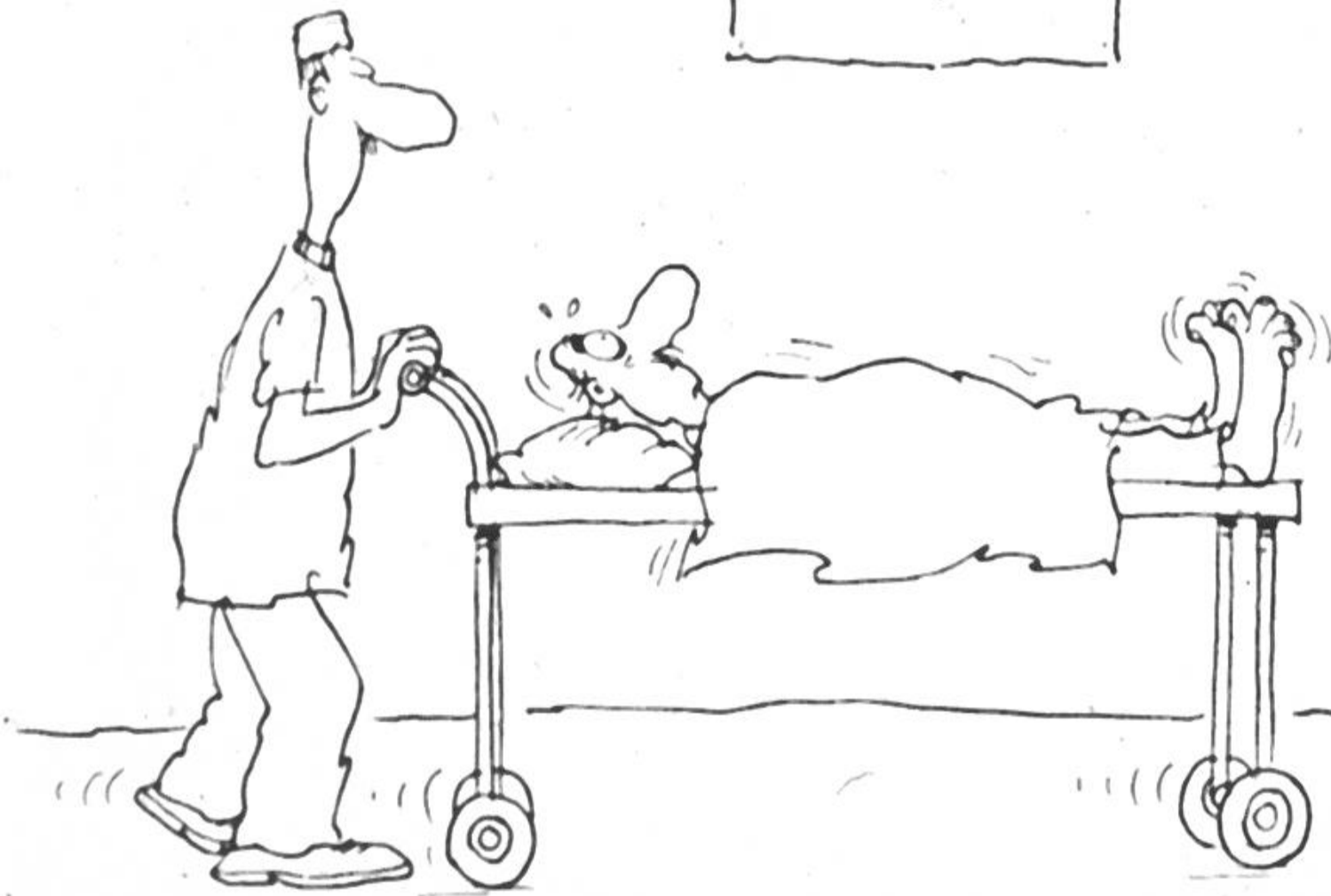
Summary: CT Cardiac Angiography



Potential Roles for CT Cardiac Angiography: Summary

- Impressive & accurate images of the heart
 - Potential to help in various clinical settings
 - Need to further lower X-Ray dose
- The negative predictive value for severe coronary stenosis has huge potential
- The calcium score has been proven to significantly improve CVS risk assessment above the traditional Framingham risk
 - Clear ability to ‘personalise’ risk with Ca score and atheromatous images
- Likely to develop within Cardiology as an occasional or frequent test for different clinical problems
- ‘Watch the CTA space’!

The End
➔



CT Cardiac Angiography Cardiologists at Auckland Heart Group & Mercy Radiology



Collaboration in Cardiac CT Angiography

Mercy Radiology

- CT Experience
- Infrastructure/machine!
- Non-Cardiac findings

Auckland Heart Group

- Cardiology expertise
- Coronary anatomy experience
- Patient management

Mercy Hospital

