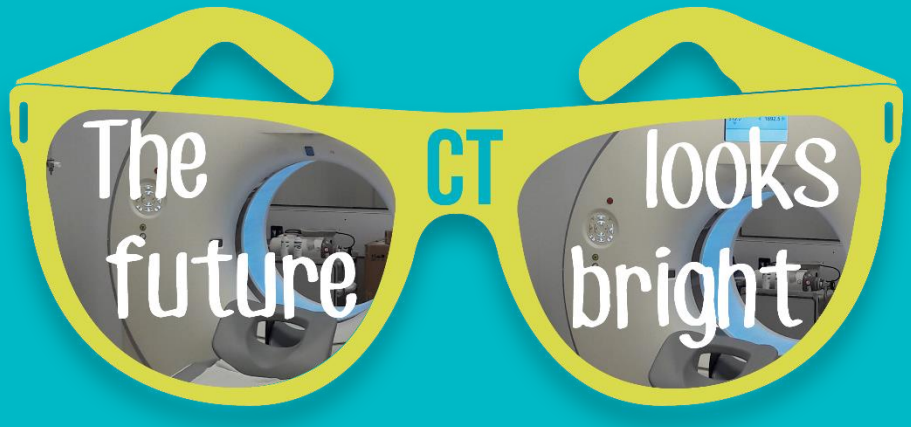
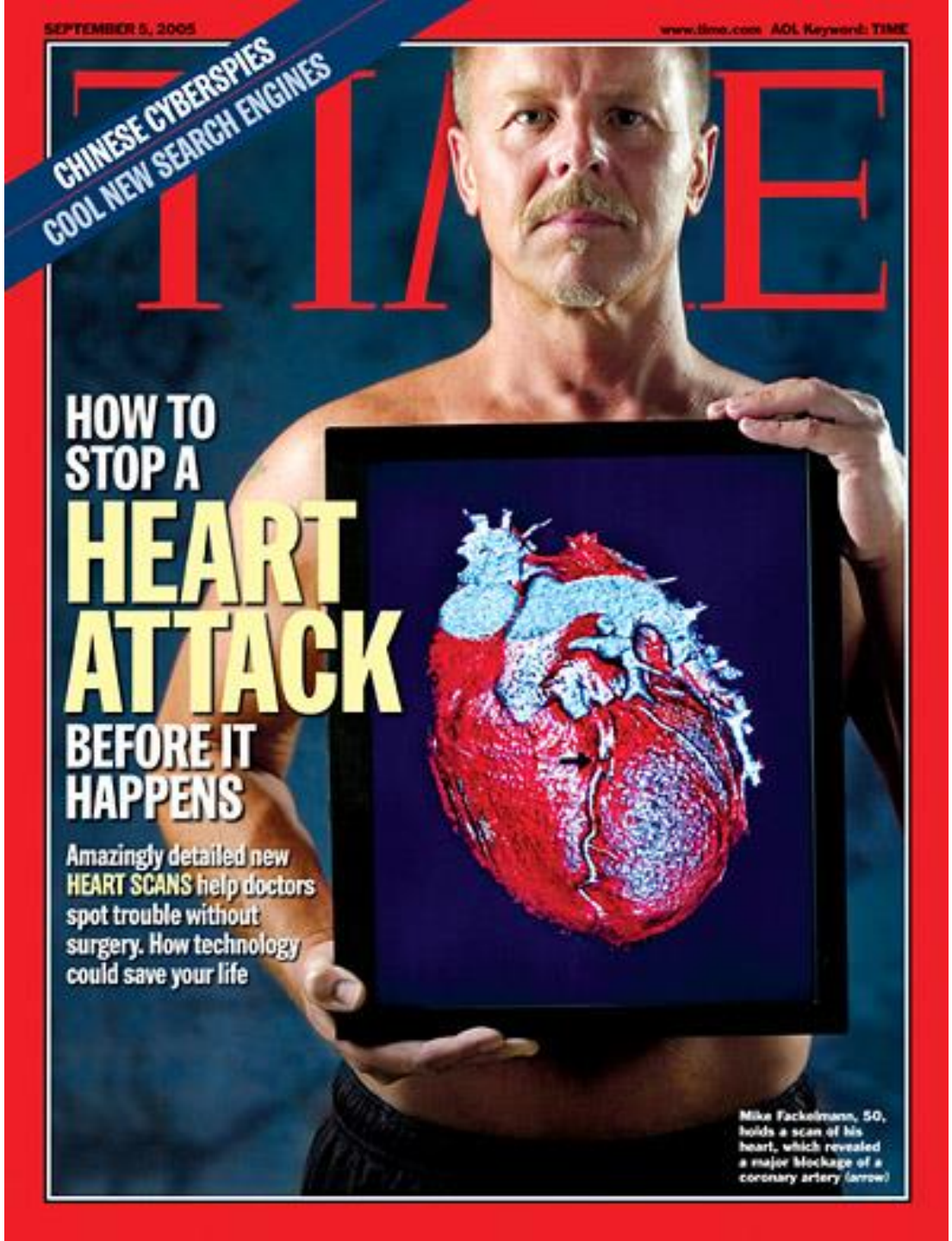


De diagnostische kracht van CT:

resolutie en snelheid voor cardio CT

Dr. Pieter Marchal

Medische Beeldvorming ZOL



The future CT looks bright

Ziekenhuis Oost-Limburg

Cardiovascular disease

- Leading cause of worldwide morbidity & mortality
  - 1 of 5 deaths related to cardiac disease
  - More than 12 million US citizens have history of CAD
  - Each year 1.1 million US citizens have heart attack
  - >40% does not survive cardiac event

- Angiography of the coronary arteries
  - Reference standard for evaluation of the coronary arteries
  - Possibility for balloon dilatation & stenting
  - 40% does not detect significant coronary artery disease

Ziekenhuis Oost-Limburg

What do we want?

- Avoid (nearly) negative coronary angiography
  - 'invasive' examination
  - higher threshold for patient and cardiologist
  - puncture- and procedure-related complications

- Exclude significant coronary artery disease
  - non-invasive, safe examination
  - low threshold for patient
  - high negative predictive value >> positive predictive value

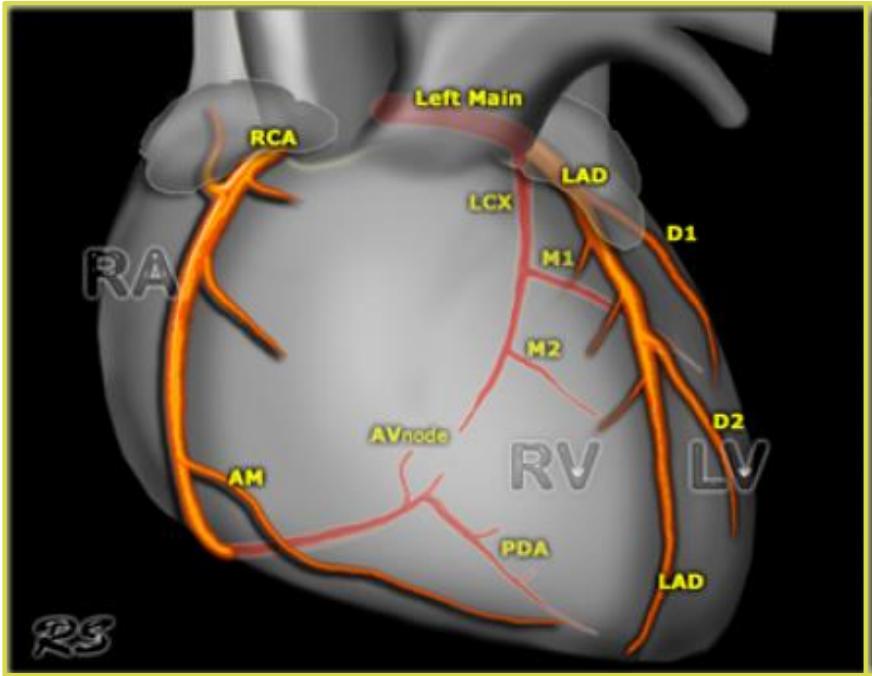
Ziekenhuis Oost-Limburg

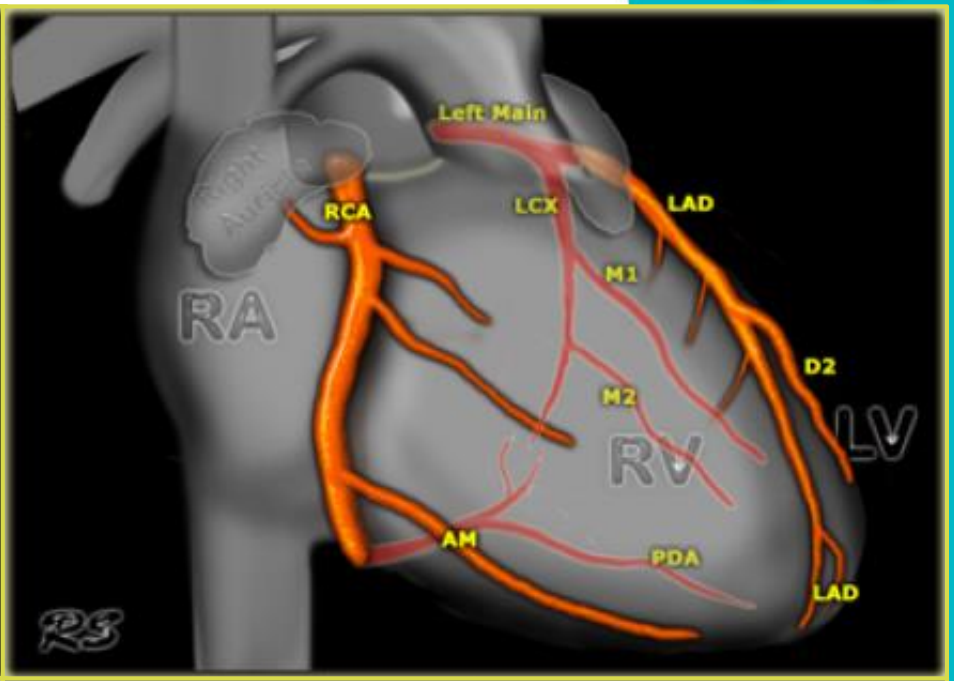
Cardiac CT

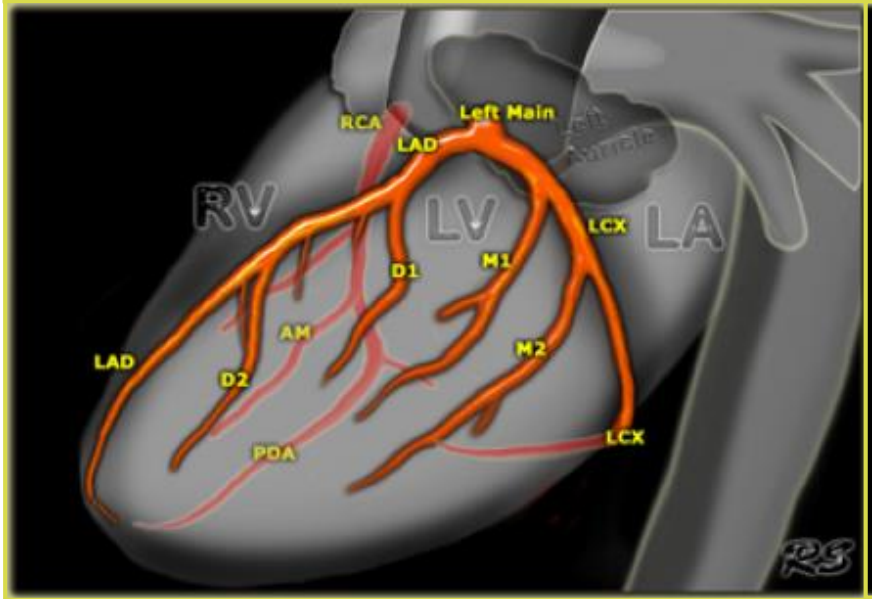
- Anatomy
- Calcium score
- Angiography
- Evolution through the years
- Bunch of great looking pictures

Ziekenhuis Oost-Limburg

Anatomy


Left Main
RCA
LAD
LCX
D1
M1
M2
RA
AVnode
RV
LV
D2
AM
PDA
LAD


Left Main
RCA
LCX
LAD
M1
RA
D2
M2
LV
RV
AM
PDA
LAD


RCA
Left Main
LAD
RV
LV
LCX
LA
D1
M1
AM
LAD
M2
D2
LCX
PDA

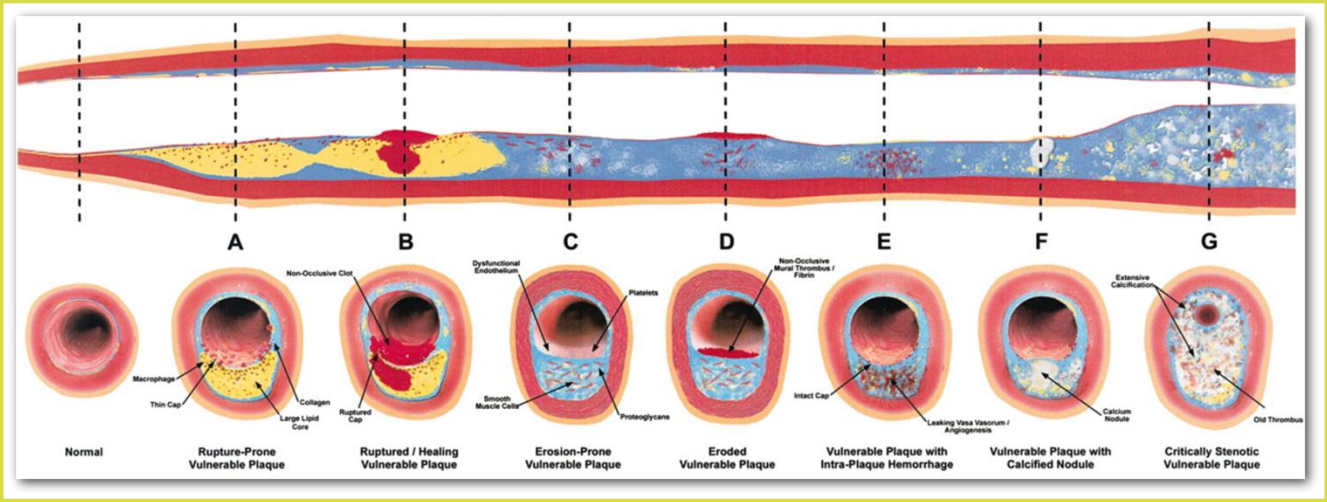
R
N
L
LA

Calcium score

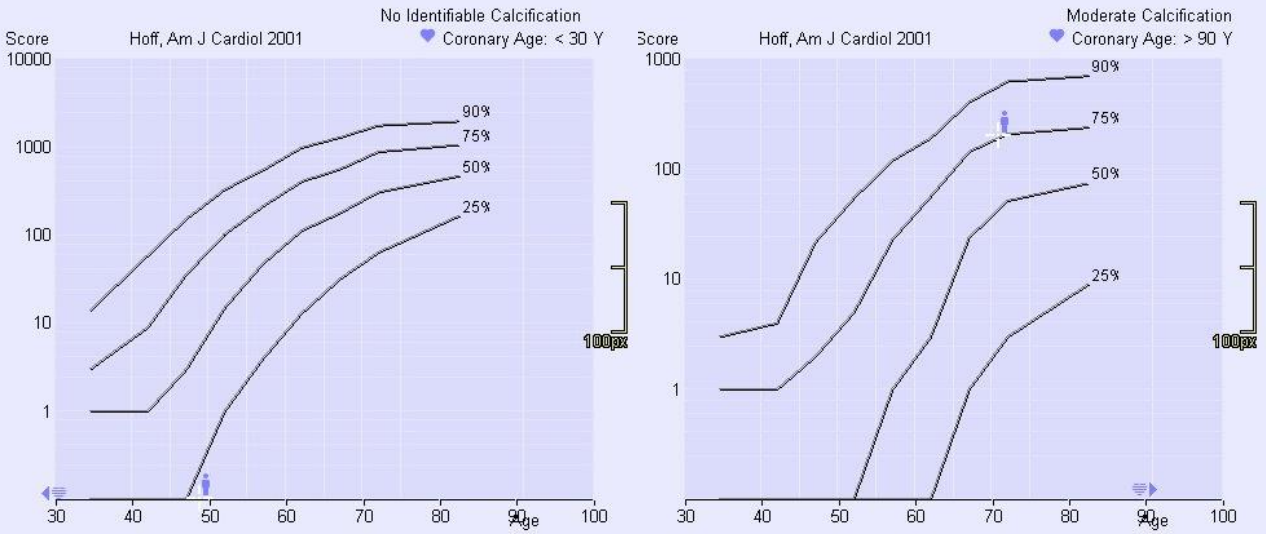
Calcium is a marker for a diseased artery

- Absolute score
- Percentile for that person's age, sex, and ethnicity

Anything above the 75th percentile for age, sex, and ethnicity or an absolute score of 300 (Agatston units) is abnormal



Calcium score



Artery	Lesions	Volume / mm³	Equiv. Mass / mg	Score
LM	0	0,0	0,00	0,0
LAD	6	103,4	18,54	119,1
CX	1	8,5	1,26	6,1
RCA	6	75,0	13,08	74,0
Total	**13**	**186,9**	**32,89**	**199,1**
U1	0	0,0	0,00	0,0
U2	0	0,0	0,00	0,0

100px

Settings
Score Type: Agatston equivalent, Threshold: 130 HU (95,6 mg/cm³ Ca
Mass calibration factor: 0,7

Calcium score

- The presence of coronary artery calcium (CAC) is highly sensitive for the presence of ≥50 percent angiographic stenosis.
- The absence of CAC, particularly in an asymptomatic patient, is highly predictive of the absence of significant coronary artery stenosis and implies a favorable prognosis.
- CAC screening, especially for intermediate risk patients, can enhance the prediction of risk in asymptomatic individuals and increase the predictive value of the Framingham Risk Score.

Ziekenhuis Oost-Limburg

Calcium score

However

- Ca-score underestimates atherosclerosis
- non-calcified plaques ?
- Ca-score only useful when combined with other tests

Ziekenhuis Oost-Limburg

Coronary computed tomography angiography (CCTA)

CCTA is a noninvasive method to image the coronary arteries.

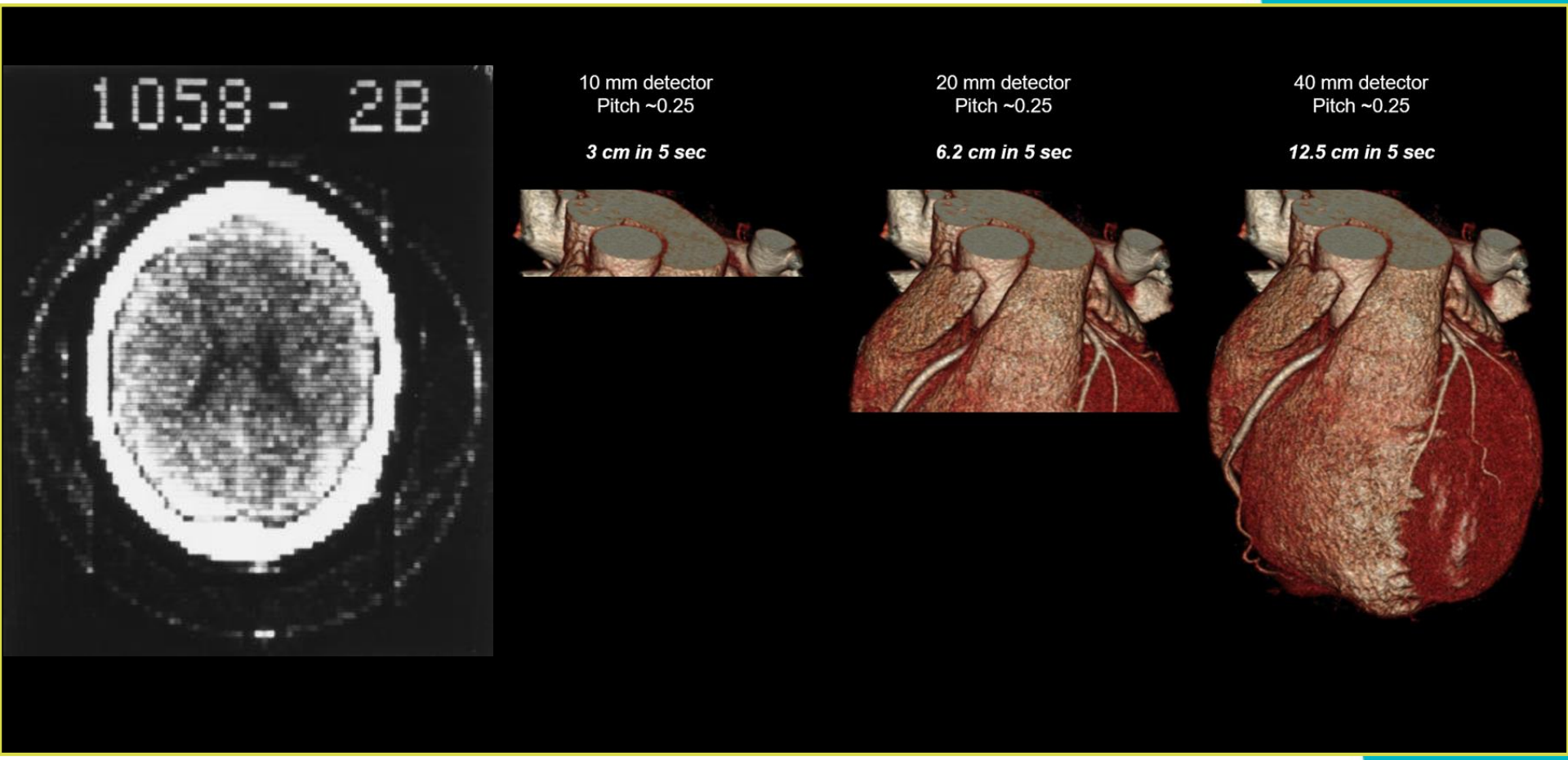
Applications include the following:

- Diagnosis of coronary artery disease (CAD) for symptomatic patients who are at **intermediate risk for CAD after initial risk stratification**, including patients with ECG uninterpretable for ischemic changes (baseline ST segment abnormalities, LBBB), patients who are unable to exercise, and patients with equivocal stress test results.
- Identifying suspected coronary artery anomalies
- Diagnosis of in-stent restenosis
- Evaluation of coronary bypass graft patency

UpToDate 30/08/2017

Ziekenhuis Oost-Limburg

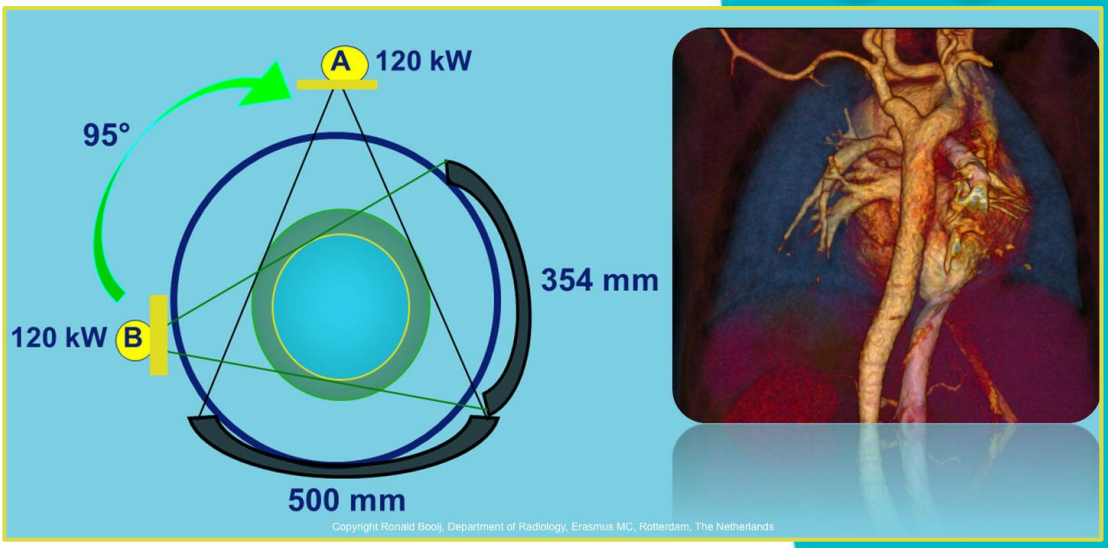
Evolution through the years



Dual source CT force: Pitch=3.2, 12-16 cm **in 0.2 sec**

Evolution through the years

- Temporal resolution
- Spatial resolution
- Reconstruction techniques
- Artifact reduction
- Dose reduction
- Contrast agent reduction



Dose

Diagnostic modality	Typical effective radiation dose (mSv)	Equivalent number of chest X-rays	Approximate equivalent period of natural background radiation
Chest (single PA film)[1-9]	0.02	1	3 days
Echocardiography[2]	0	0	0
Electron-beam CT[4,5]	1.5–2	75–100	7–9 months
Multi-slice CT[4-7]			
Calcium score	1.5–2.7	75–135	7–14 months
CTCA (16 slices)	6.5–10.7	325–535	2.7–4.4 years
CTCA s/p CABG (16 slices)	12.9	645	5.3 years
CTCA (64 slices)	10.5	400	3 years
Magnetic resonance imaging[1-3]	0	0	0
Catheterisation laboratory			
Diagnostic coronary study (Coronary angiography and ventriculography)[1,8,9,11]	2.1–7	105–350	0.9–2.9 years
Angiography s/p CABG[8]	6.3	315	2.6 years
Aortography[8]	4	200	1.6 years
Coronary angioplasty[1,3,8,9,11]	7.5–57	375–2,850	3–23 years
Carotid stenting[8,11]	10	500	4.1 years
Nuclear cardiology[1-3]			
^{201}Thallium-Cl (2 mCi)	17	850	7 years
^{99m}Technetium tetrofosmin (30 mCi)	8.5	425	3.5 years
^{99m}Technetium sestamibi (30 mCi)	8.9	445	3.7 years
Non-cardiology imaging			
X-ray[1]			
Mammogram	0.13	6	18 days
Barium enema			
(10 images, 137 second fluoroscopy)	7.0	350	2.9 years
CT head	2.0	100	9 months
CT abdomen	10	500	3 years
Nuclear medicine[1-3]			
Bone (^{99m}Tc MDP [20 mCi])	4.4	220	1.8 years
Lung perfusion/ventilation (^{99m}Tc MAA and ^{133}Xe [5 & 10 mCi])	1.5	75	6 months
Kidney (^{99m}Tc DTPA [20 mCi])	3.1	155	1 year
Tumour (^{67}Ga [3 mCi])	12.2	610	5 years
PET CT (^{18}F FDG [10 mCi])	5–25	250–1,250	2.3–11.5 years

Key: CA = coronary angiography; CABG = coronary artery bypass graft; CT = computed tomography; DTPA = diethylenetriamine-pentaacetic acid; FDG = fluorodeoxyglucose; MAA = macroaggregated albumin; mCi = millicurie (radiopharmaceutical, nuclear isotope activity); MDP = methylene diphosphate; PA = posterior-anterior; PET = positron emission tomography; s/p = status post

Dual source CT flash:

< 1mSv

Ziekenhuis Oost-Limburg

Siemens Definition

4208 exams (between 11/08/2008 and 14/03/2017)

- Total median effective dose (CaSc + CTA + topogram + monitoring): 14,618 mSv
- Median effective dose CaSc: 4,626 mSv
- Median effective dose CTA: 10,531 mSv

Siemens Force

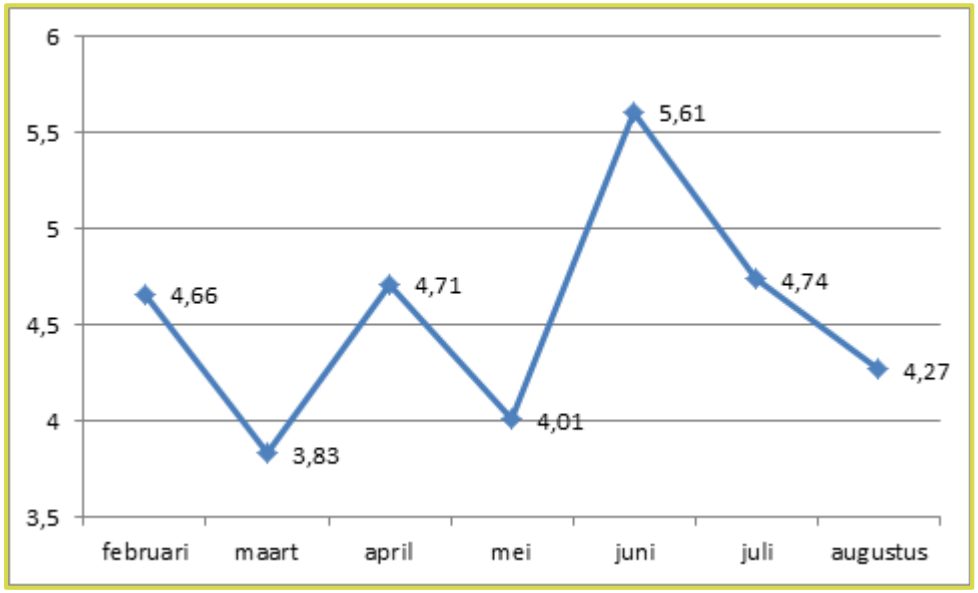
361 exams (between 21/02/2017 and 01/09/2017)

- Total median effective dose (CaSc + CTA + topogram + monitoring): 4,458 mSv
- Median effective dose CaSc: 1,009
- Median effective dose CTA: 3,156

→ Dose reduction of 69,5 %

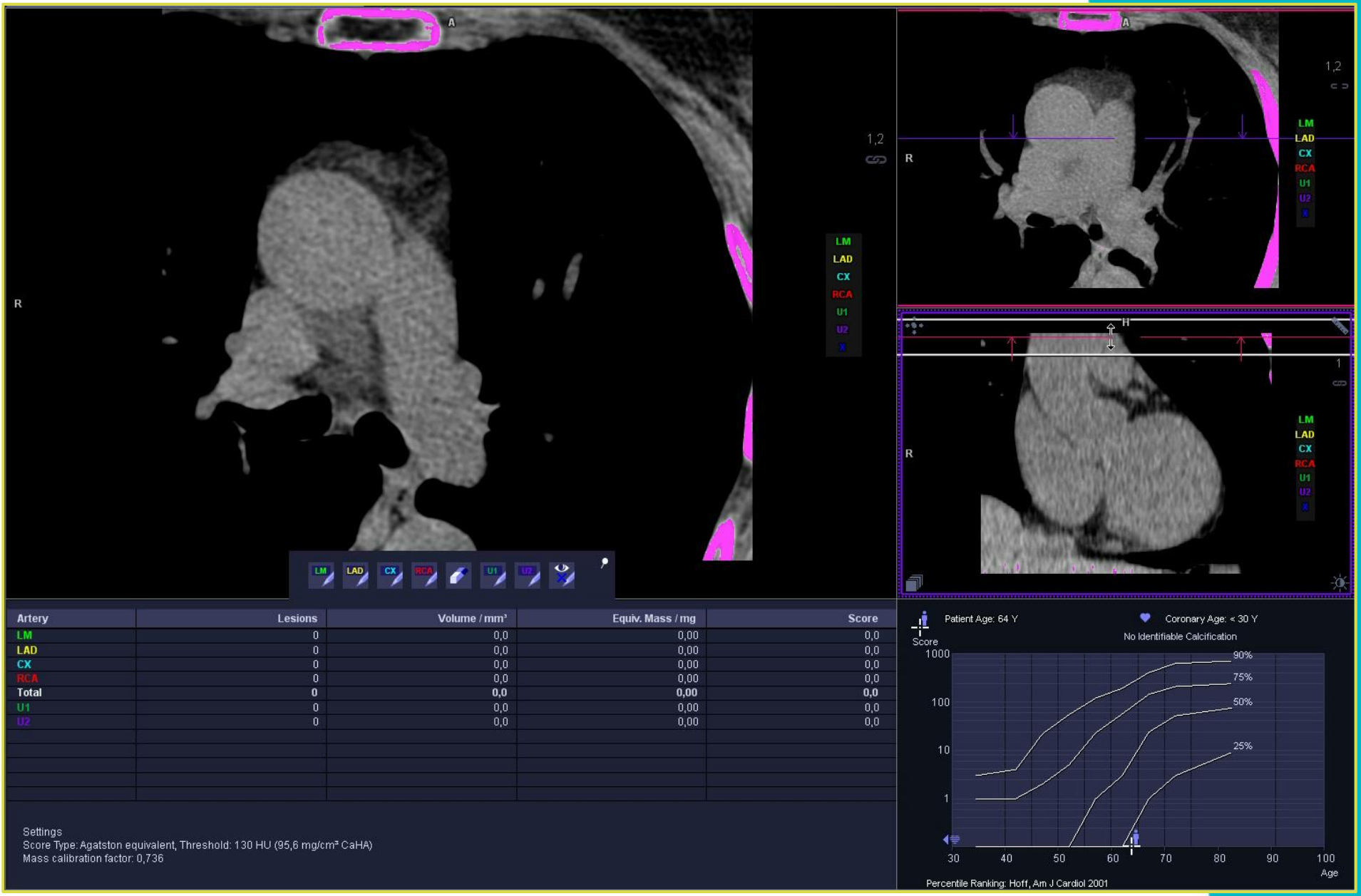
Siemens Force

- 221/361 patients scanned in flash mode (average HR 61 bpm, average BMI 25,8)
- 140/361 patients scanned in different scan modes



Dual source angio flash scan: total average dose (CaSc + CTA + topogram + monitoring) of 1,527 mSv (in patients with normal BMI)

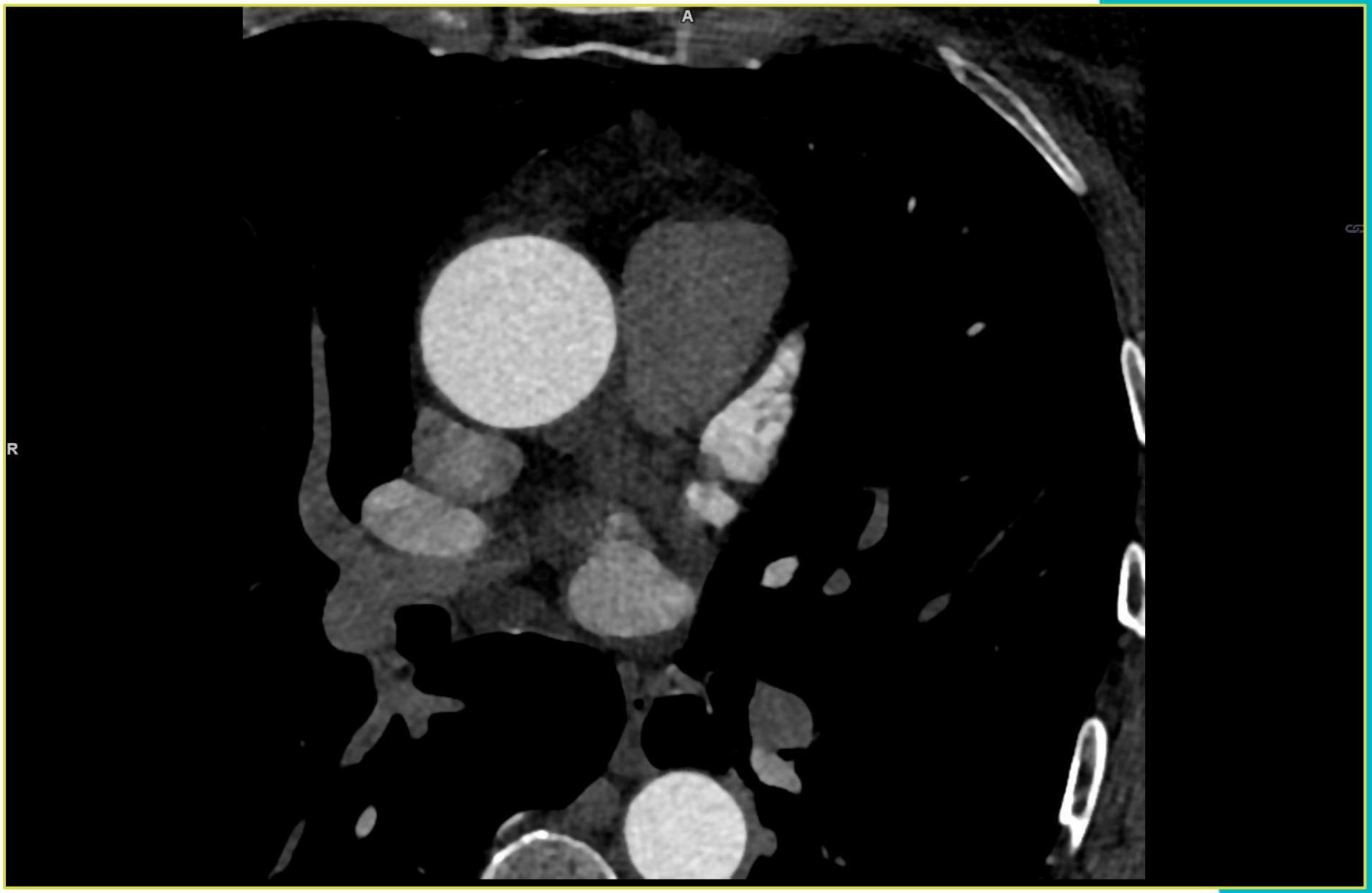
Diagnosis of coronary artery disease (CAD)

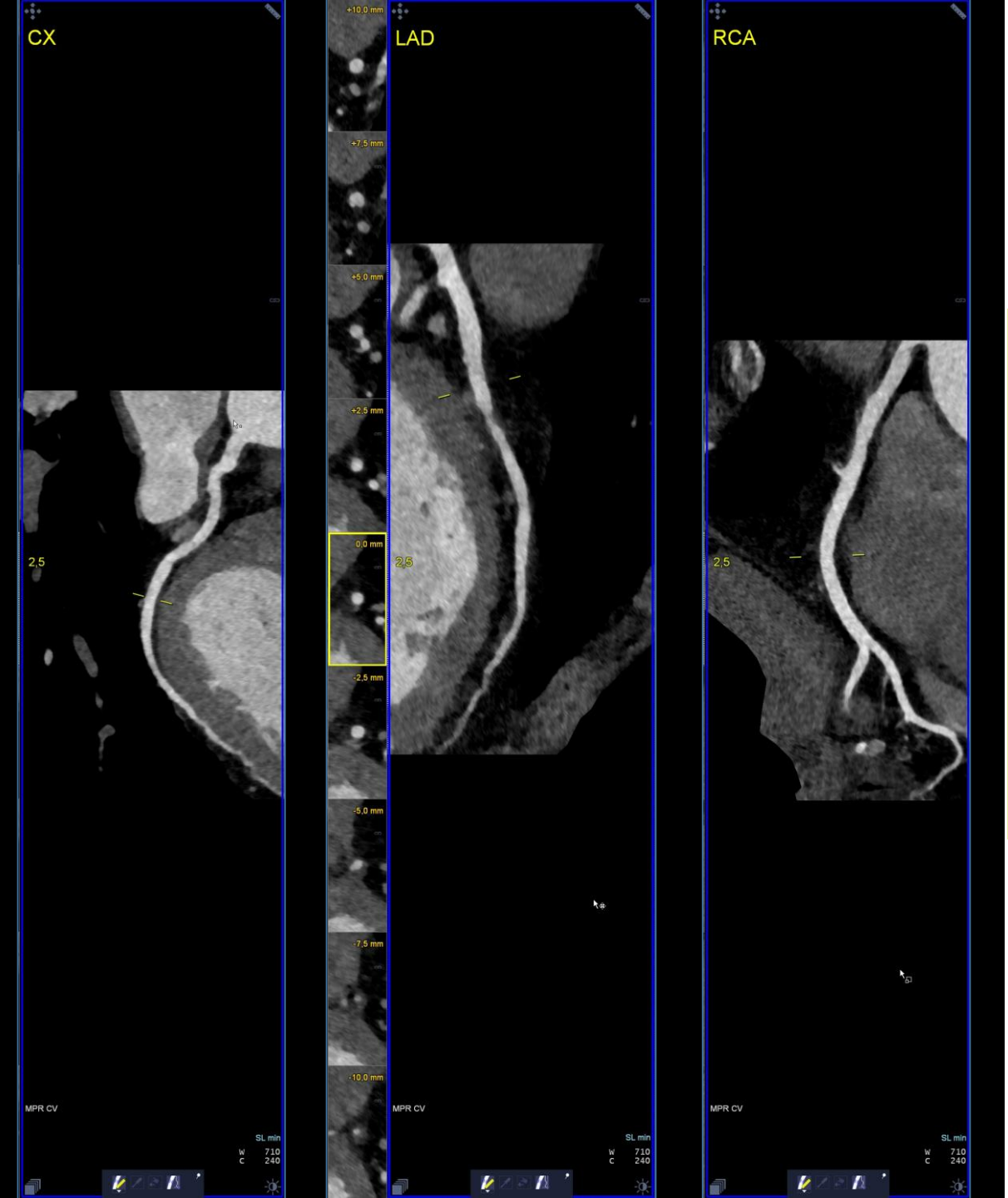


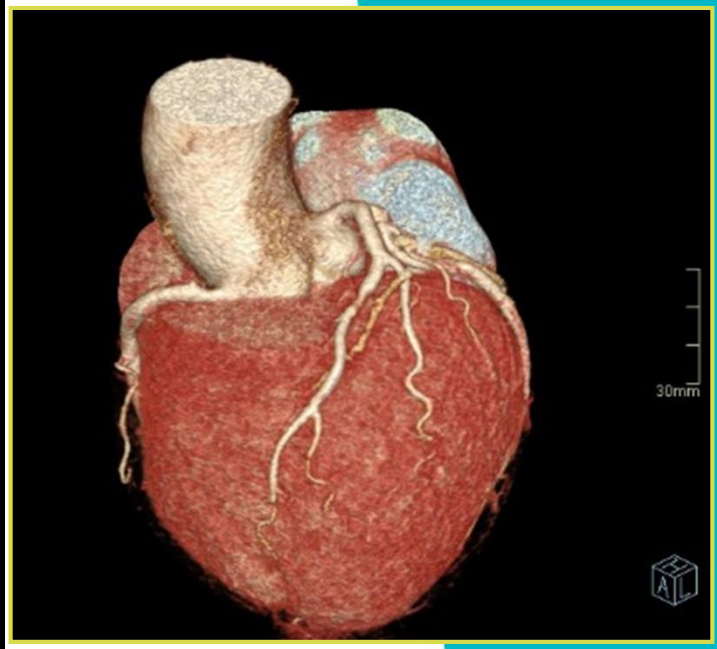
Artery	Lesions	Volume / mm³	Equiv. Mass / mg	Score
LM	0	0,0	0,00	0,0
LAD	0	0,0	0,00	0,0
CX	0	0,0	0,00	0,0
RCA	0	0,0	0,00	0,0
Total	**0**	**0,0**	**0,00**	**0,0**
U1	0	0,0	0,00	0,0
U2	0	0,0	0,00	0,0

Settings
Score Type: Agatston equivalent, Threshold: 130 HU (95,6 mg/cm³ CaHA)
Mass calibration factor: 0,736

Diagnosis of coronary artery disease (CAD)

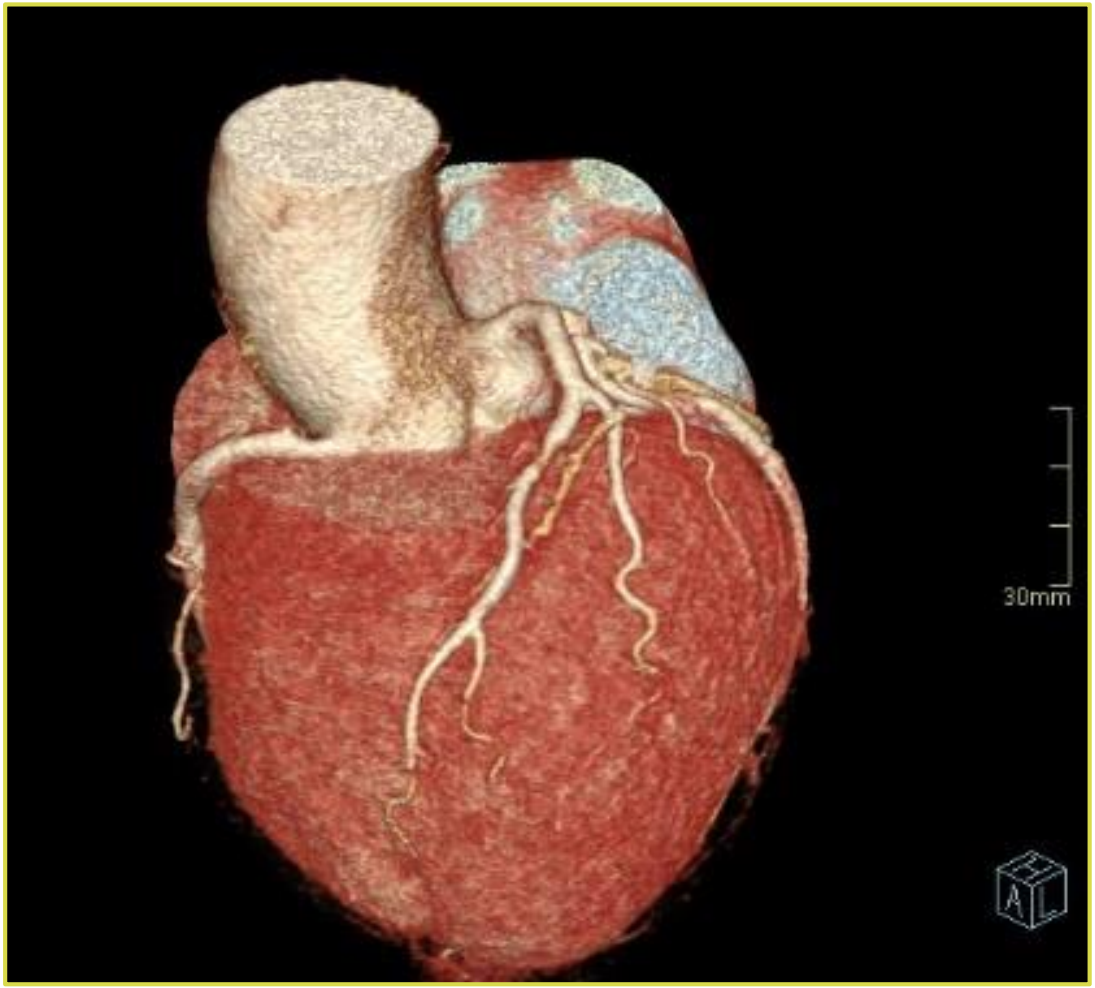




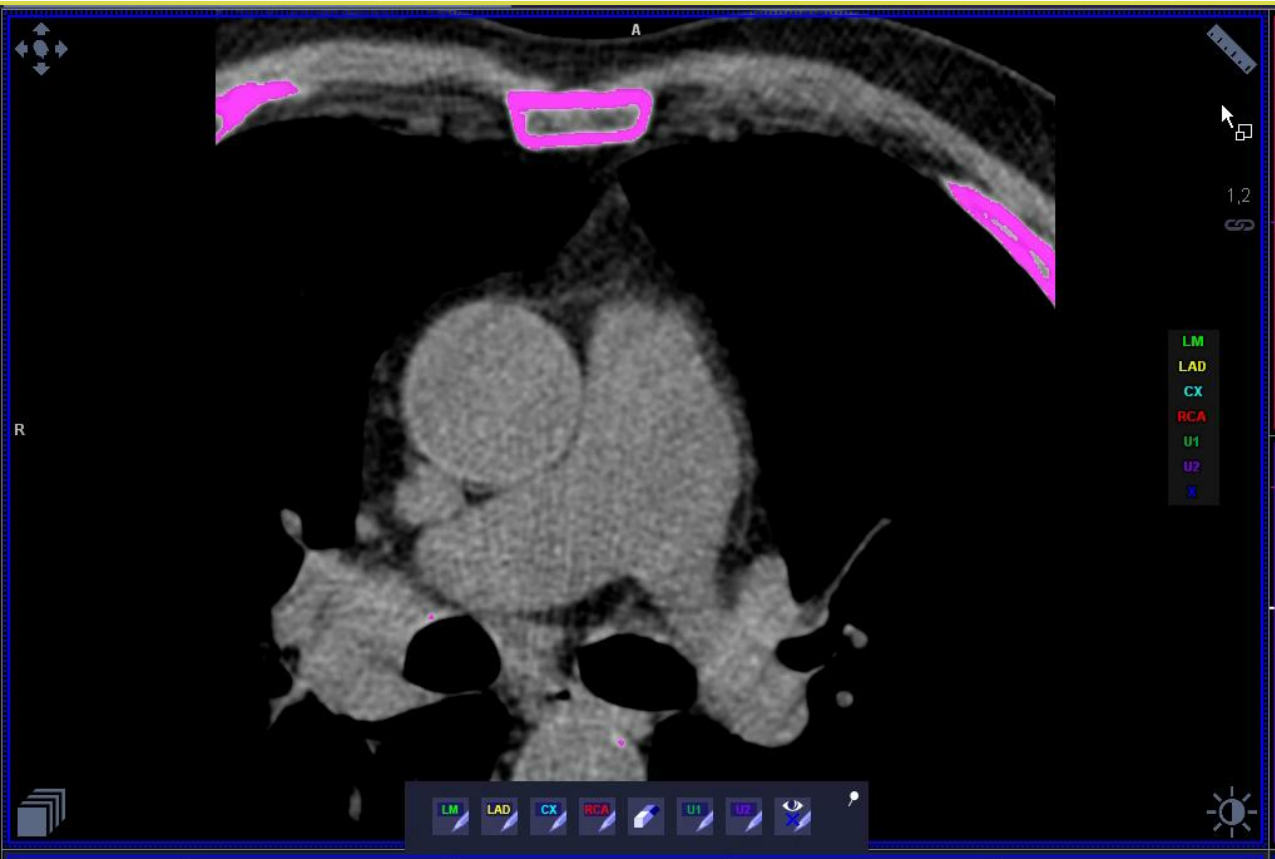


The future CT looks bright

Ziekenhuis Oost-Limburg


30mm
A
L

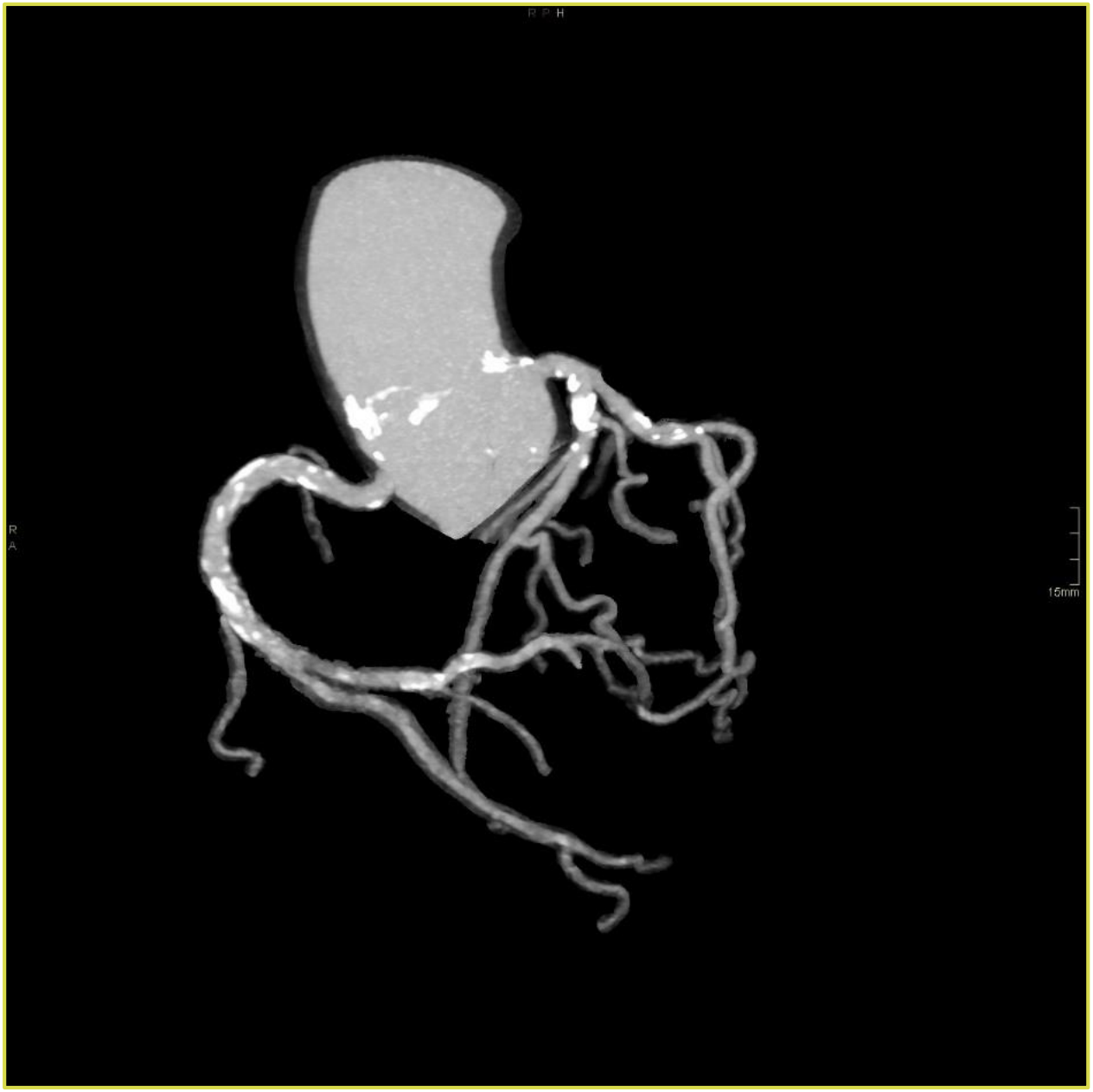
Diagnosis of coronary artery disease (CAD)



Artery	Lesions	Volume / mm³	Equiv. Mass / mg	Score
LM	1	9,0	1,36	7,3
LAD	4	310,6	66,04	378,9
CX	5	50,4	9,11	47,0
RCA	13	566,3	95,84	569,6
Total	**23**	**936,2**	**172,35**	**1002,7**
U1	0	0,0	0,00	0,0
U2	0	0,0	0,00	0,0

Settings
Score Type: Agatston equivalent, Threshold: 130 HU (95,6 mg/cm³ CaHA)
Mass calibration factor: 0,736

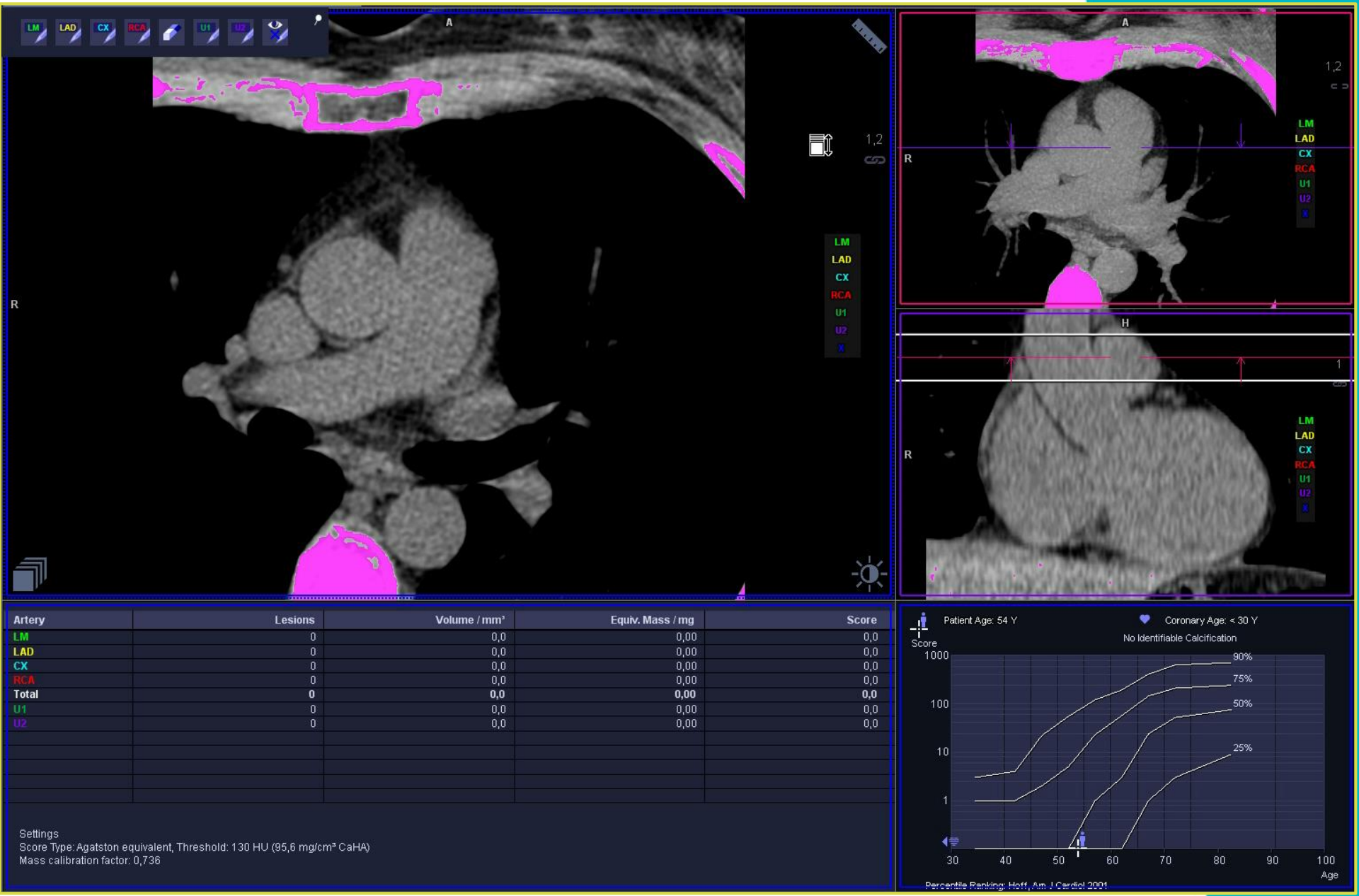
Ziekenhuis Oost-Limburg

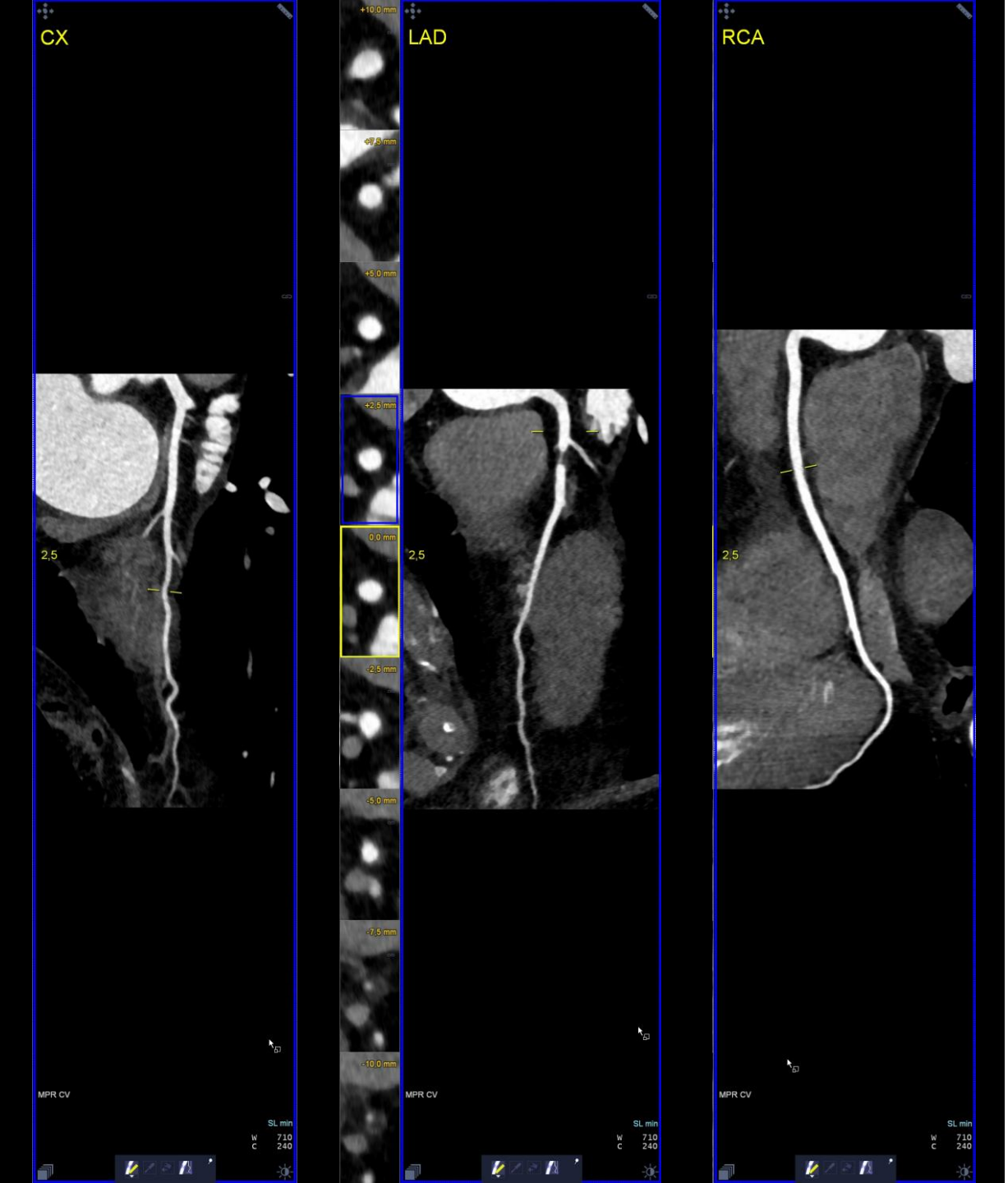


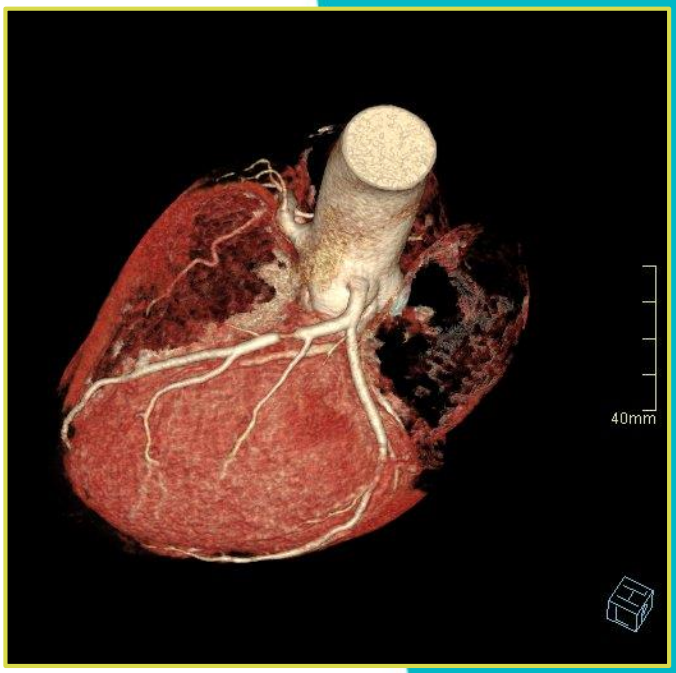
The future CT looks bright

Ziekenhuis Oost-Limburg

Diagnosis of coronary artery disease (CAD)



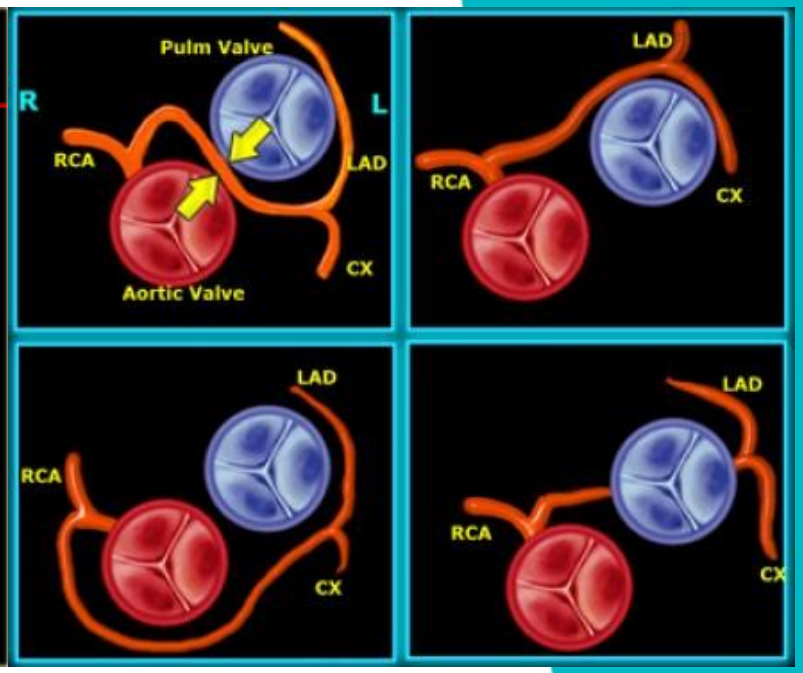

CX
LAD
RCA
+10.0 mm
+7.5 mm
+5.0 mm
+2.5 mm
0.0 mm
-2.5 mm
-5.0 mm
-7.5 mm
-10.0 mm
2,5
2,5
2,5
MPR CV
MPR CV
MPR CV
SL min
W 710
C 240
SL min
W 710
C 240
SL min
W 710
C 240


40mm

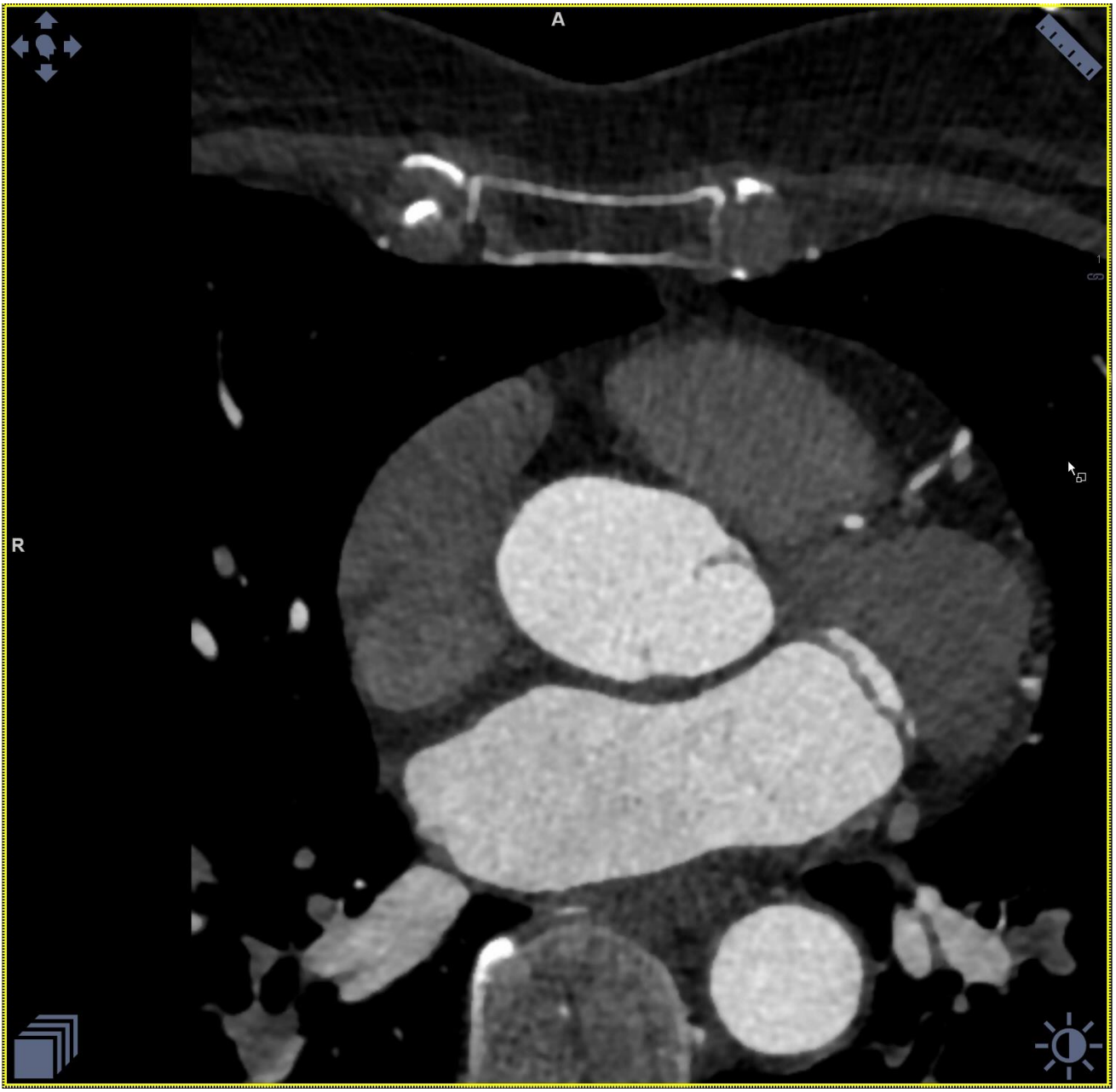
Identifying suspected coronary artery anomalies

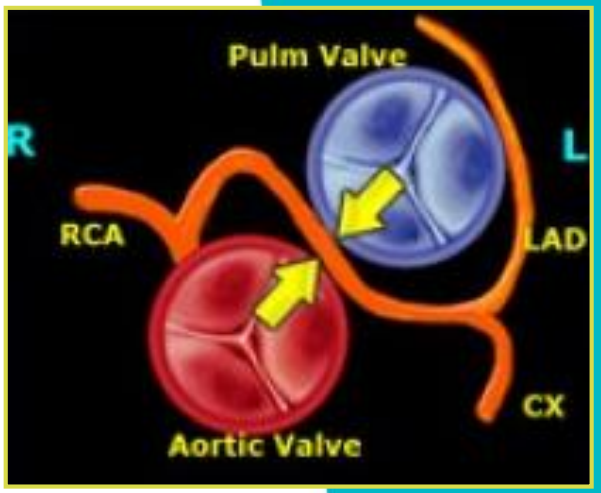
Coronary anomalies

- **Anomalies of the origin**
  - Anomalous origin of coronary artery from pulmonary artery
  - Single coronary artery
  - Origin from 'non-coronary cusp'
- **Anomalies of the course**
  - Myocardial bridging
  - Duplication
- **Anomalies of termination**
  - Coronary artery fistula
  - Extracardiac termination

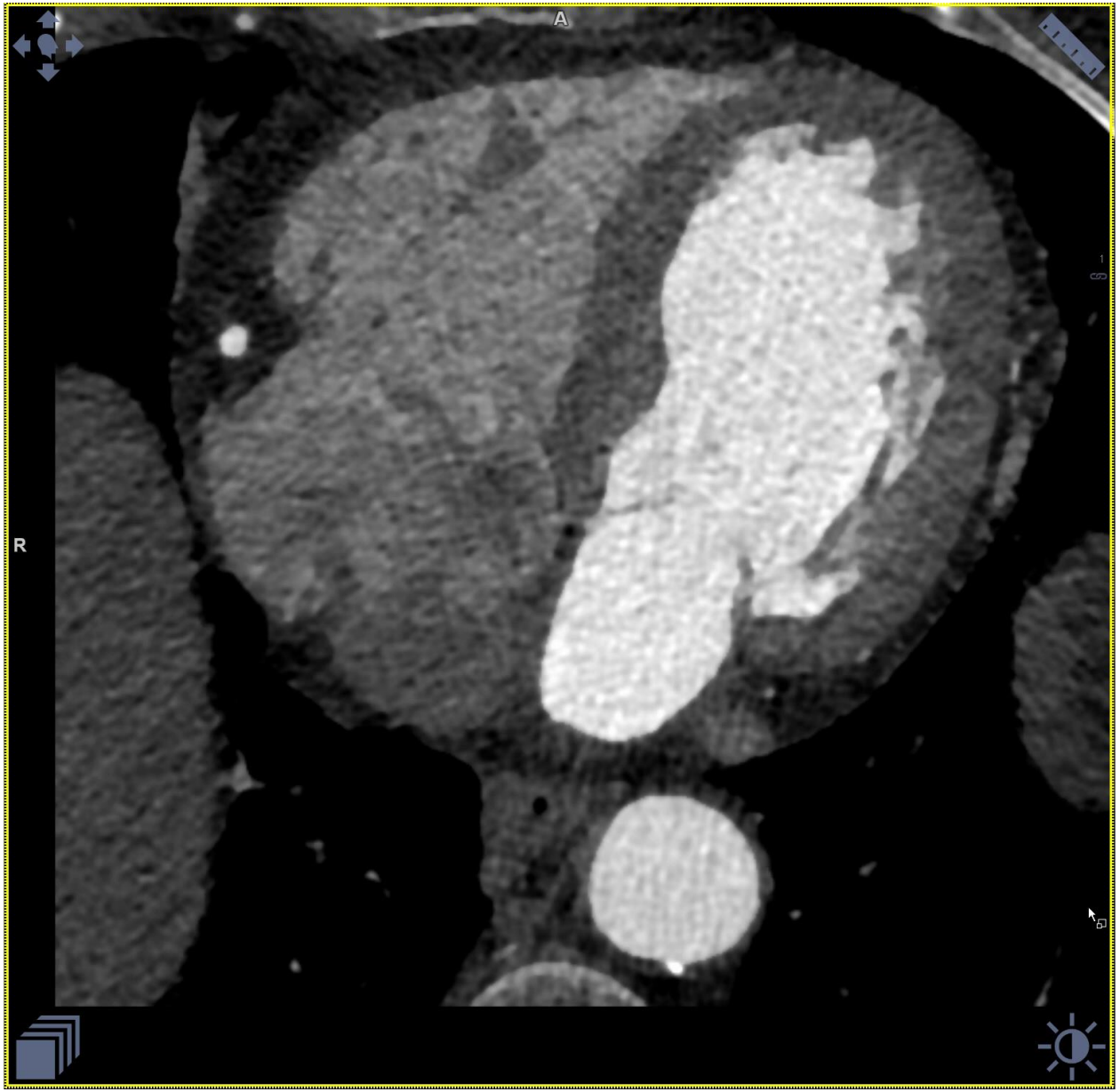


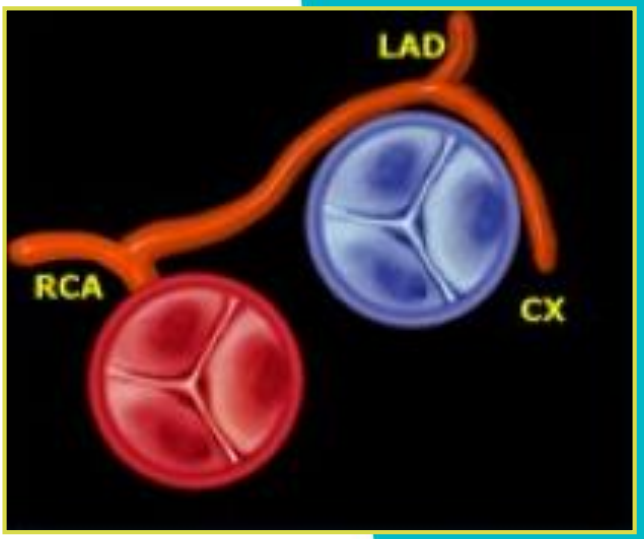
Malignant course = interarterial



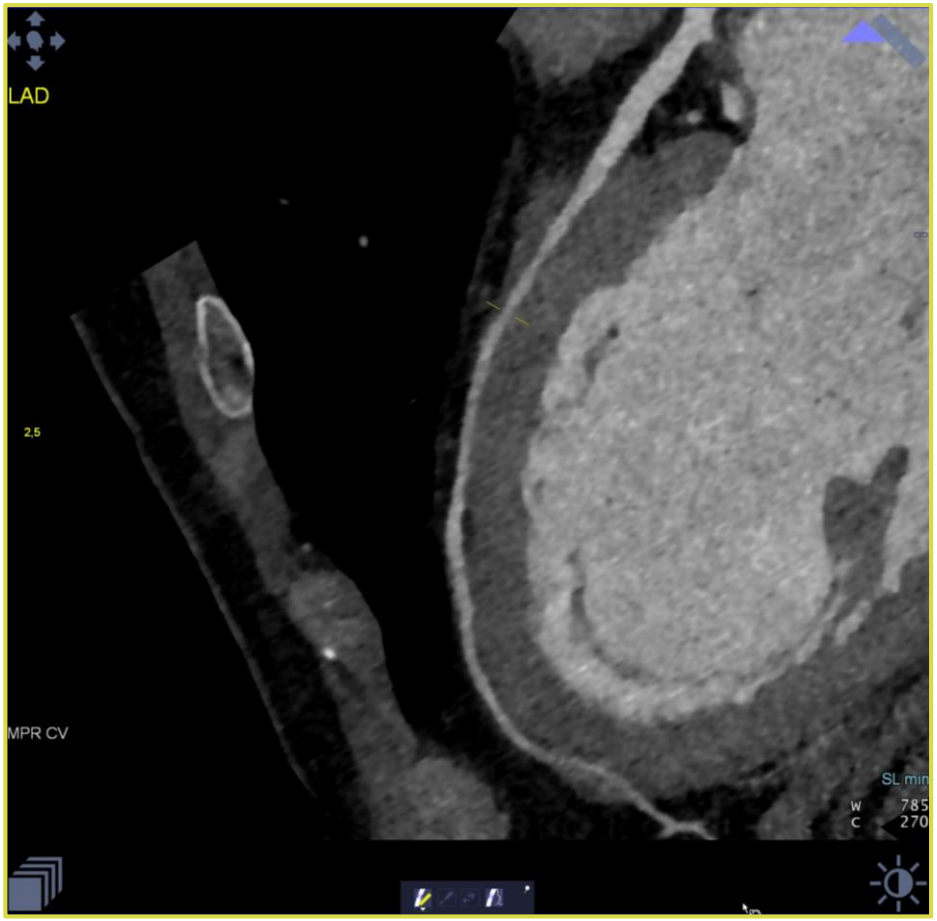


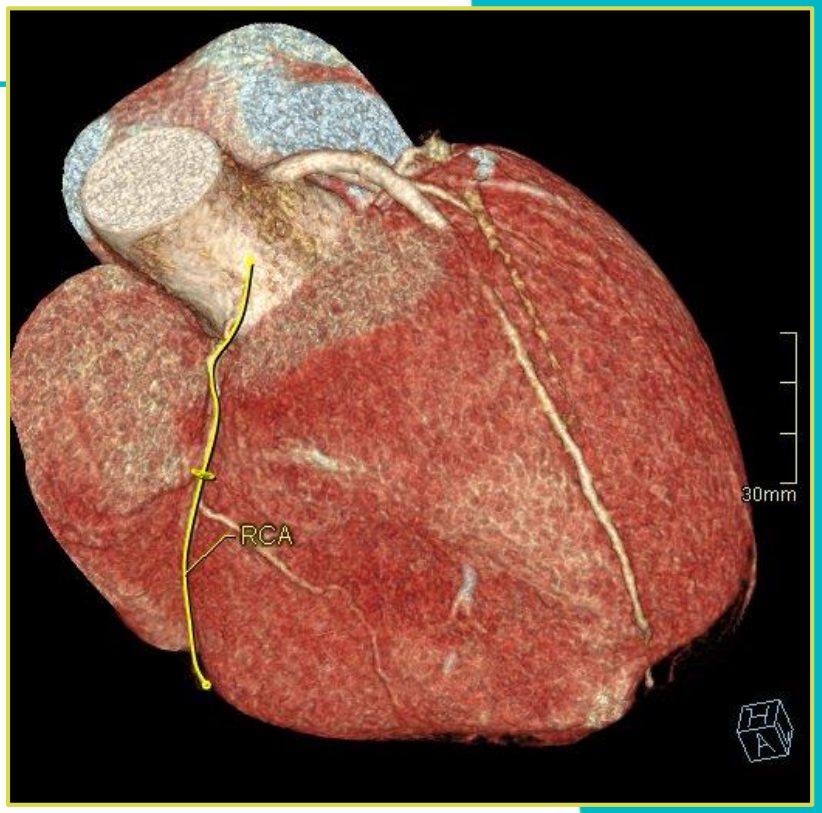
Benign course

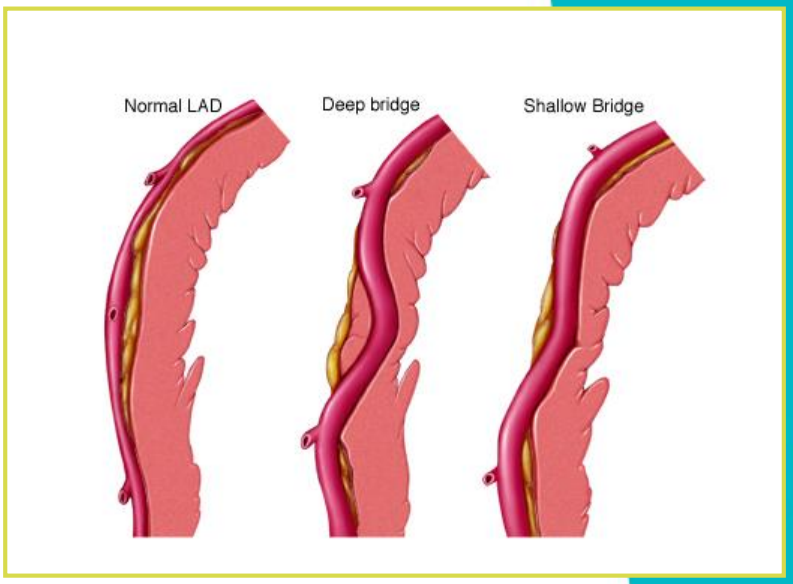




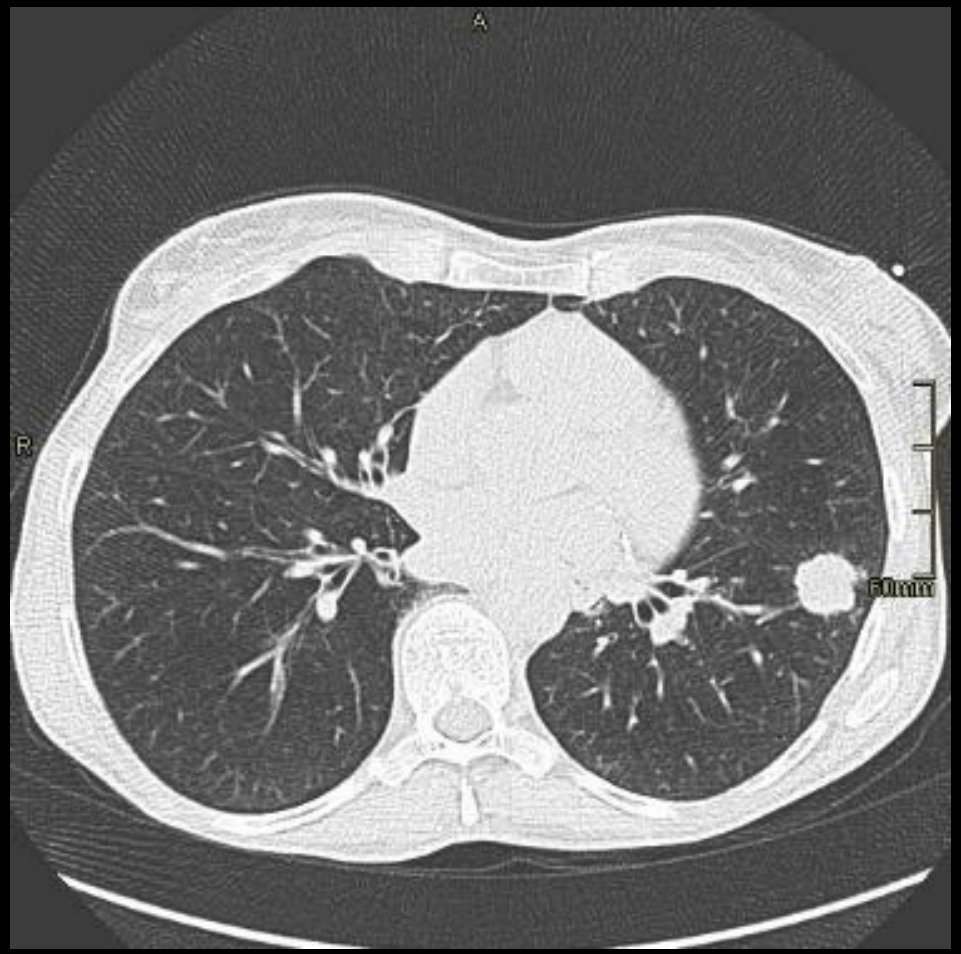
Myocardial bridging

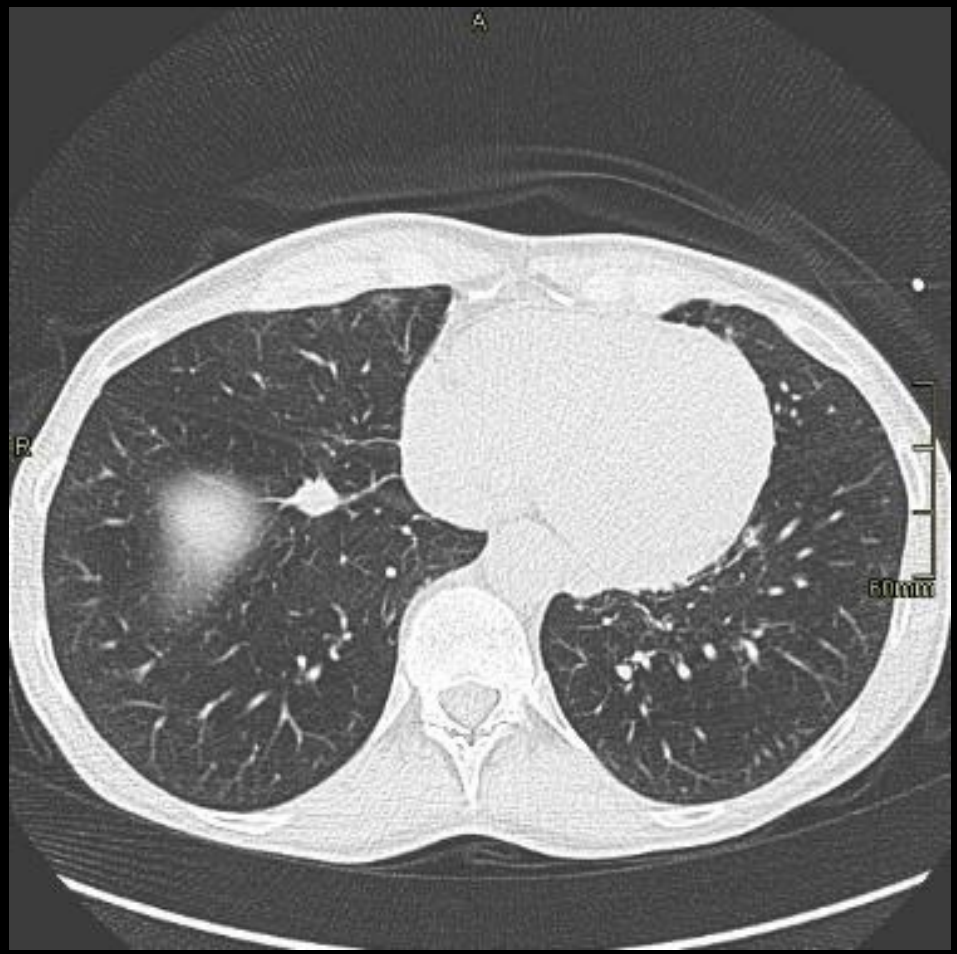




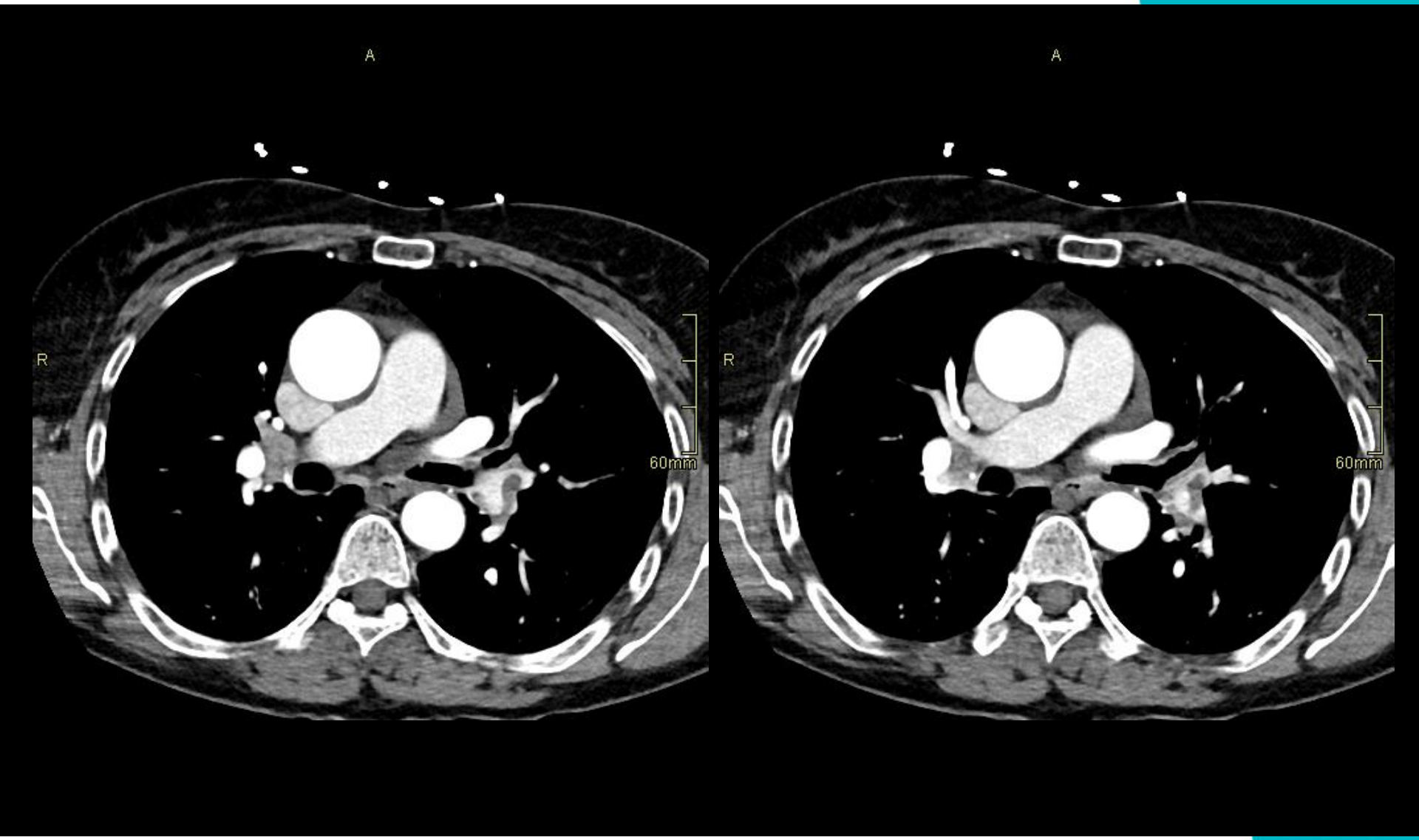


Additional findings





LE



Conclusion

- Cardiac CT is continuously evolving
- Todays state-of-the-art equipment will be second-best next year
- CT's main goal is to exclude coronary pathology
- Cardiac CT can only be successful when the patient benefits from the results

Ziekenhuis Oost-Limburg

Dank u voor uw aandacht