



To Scan or Not to Scan: The Clinical Utility of Coronary Computed Tomography

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Patient KS

- **CC:** 52 yo female former smoker with hypercholesterolemia presents with chest pain
- **HPI:** While at the museum, patient had **acute onset of severe substernal pressure**. The pain radiated to the neck and was associated with **nausea and diaphoresis**. KS did not seek medical attention. She awoke later that evening with three episodes of similar pain that were less severe.



Patient KS

- **HPI cont'd:** KS has a history of **atypical chest pain** that usually occurs at rest. The pain lasts a few minutes, then spontaneously resolves. The pain is not associated with nausea, vomiting, shortness of breath, or diaphoresis. She is sure that this pain is distinct from her usual GERD symptoms.

Courtesy of Adeel Sabir, MD



Patient KS

- **PMH**
 - GERD
 - **Hypercholesterolemia**
 - Irritable Bowel Syndrome
- **Meds:** none
- **Family Hx:** HTN, DM; no CAD
- **Social Hx:** **former smoker** (36 pack-years)



Patient KS

Cardiac Markers

- Lipid profile
 - Cholesterol – 183 mg/dL
 - Triglycerides – 48 mg/dL
 - HDL – 60 mg/dL
 - LDL – **113 mg/dL**
- Ruled out for MI by cardiac enzymes
- Negative EKG stress test

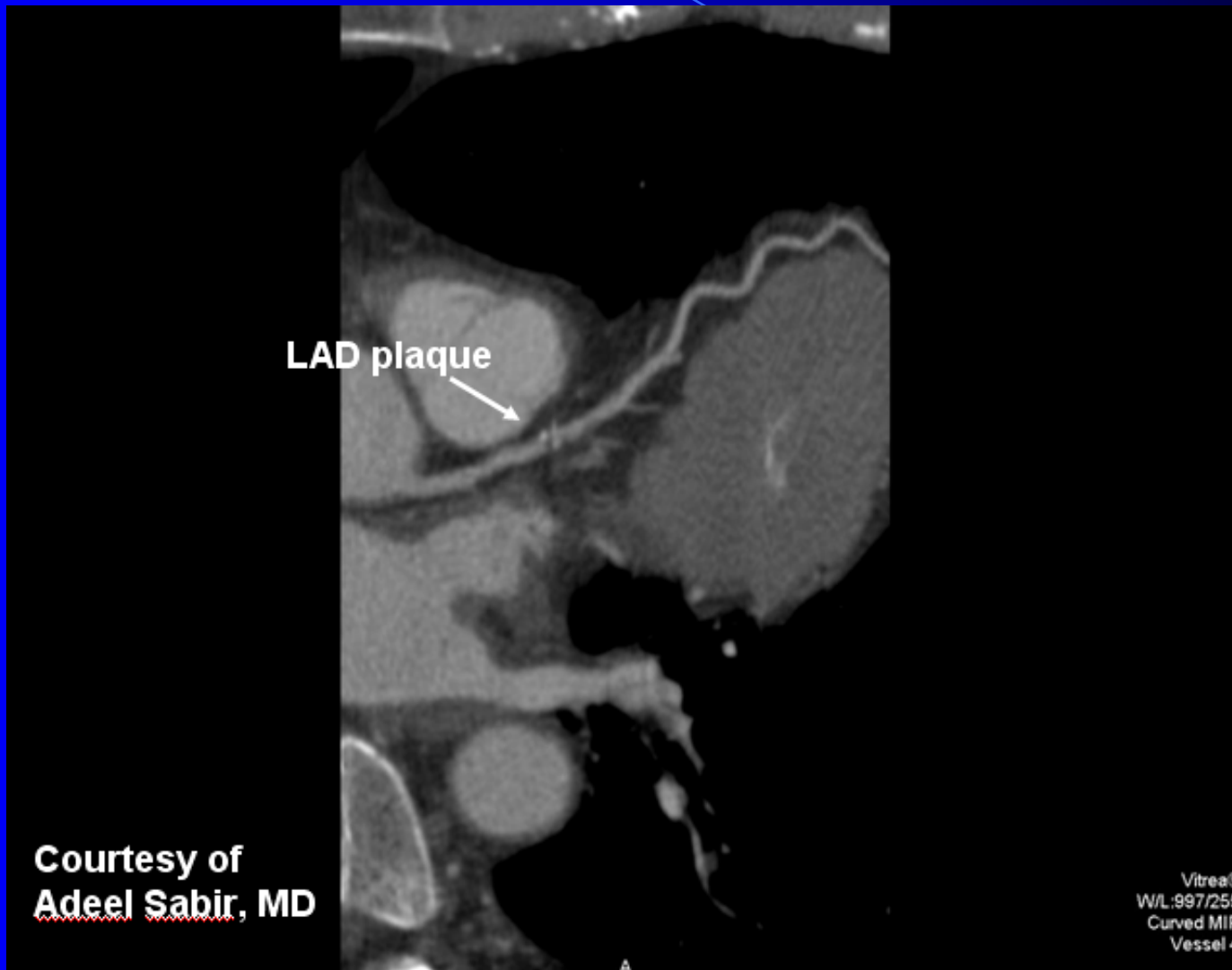


How can we further stratify the risk of CAD for patient KS?

- NCEP/ATIII guidelines have traditionally been used
- Electron beam computed tomography (EBCT) is a noninvasive method of actually visualizing the coronary arteries



EBCT of Patient KS





EBCT of Patient KS



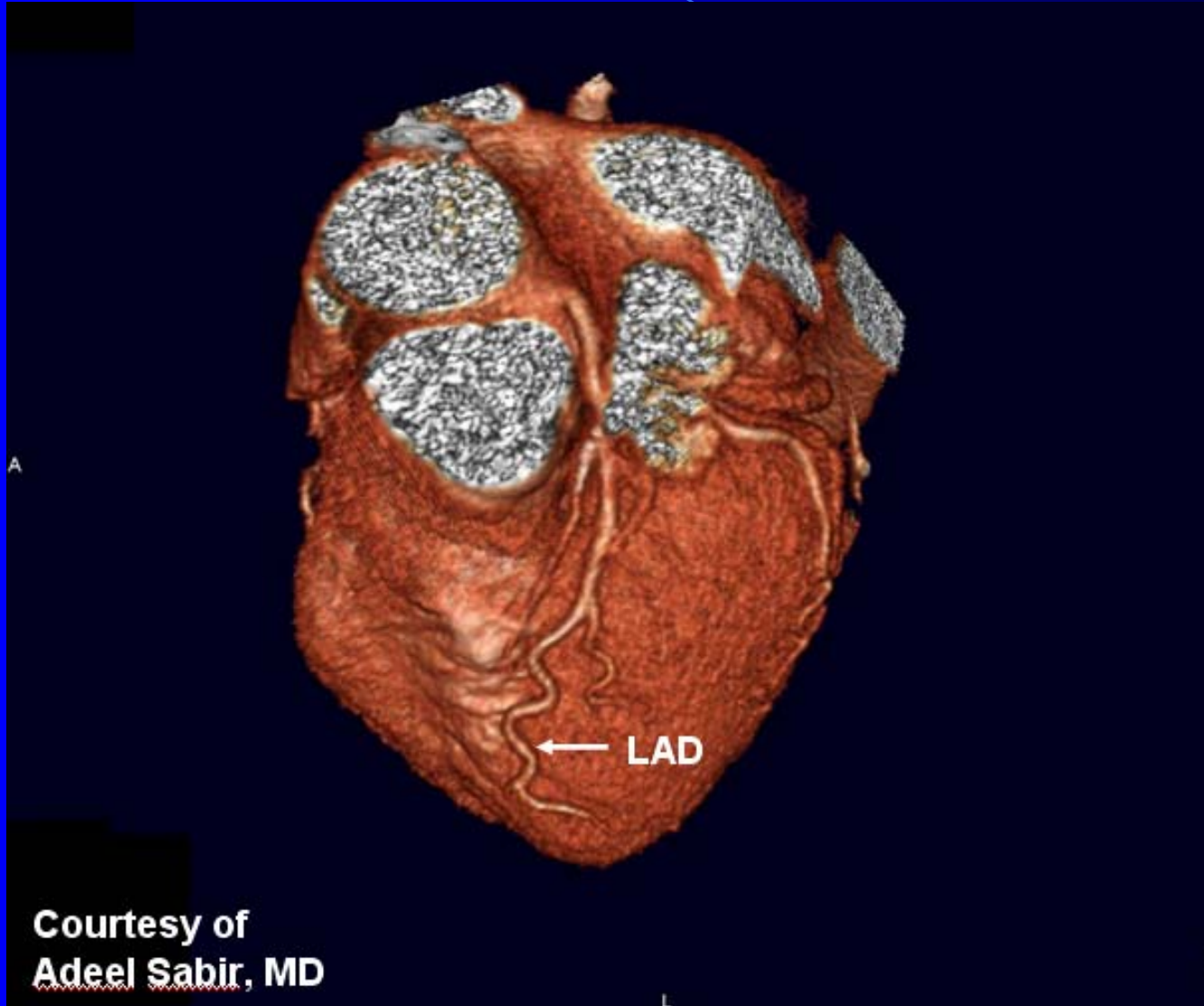
Courtesy of
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Vitrea©
WL:996/259
Curved MIP
Vessel 4

S

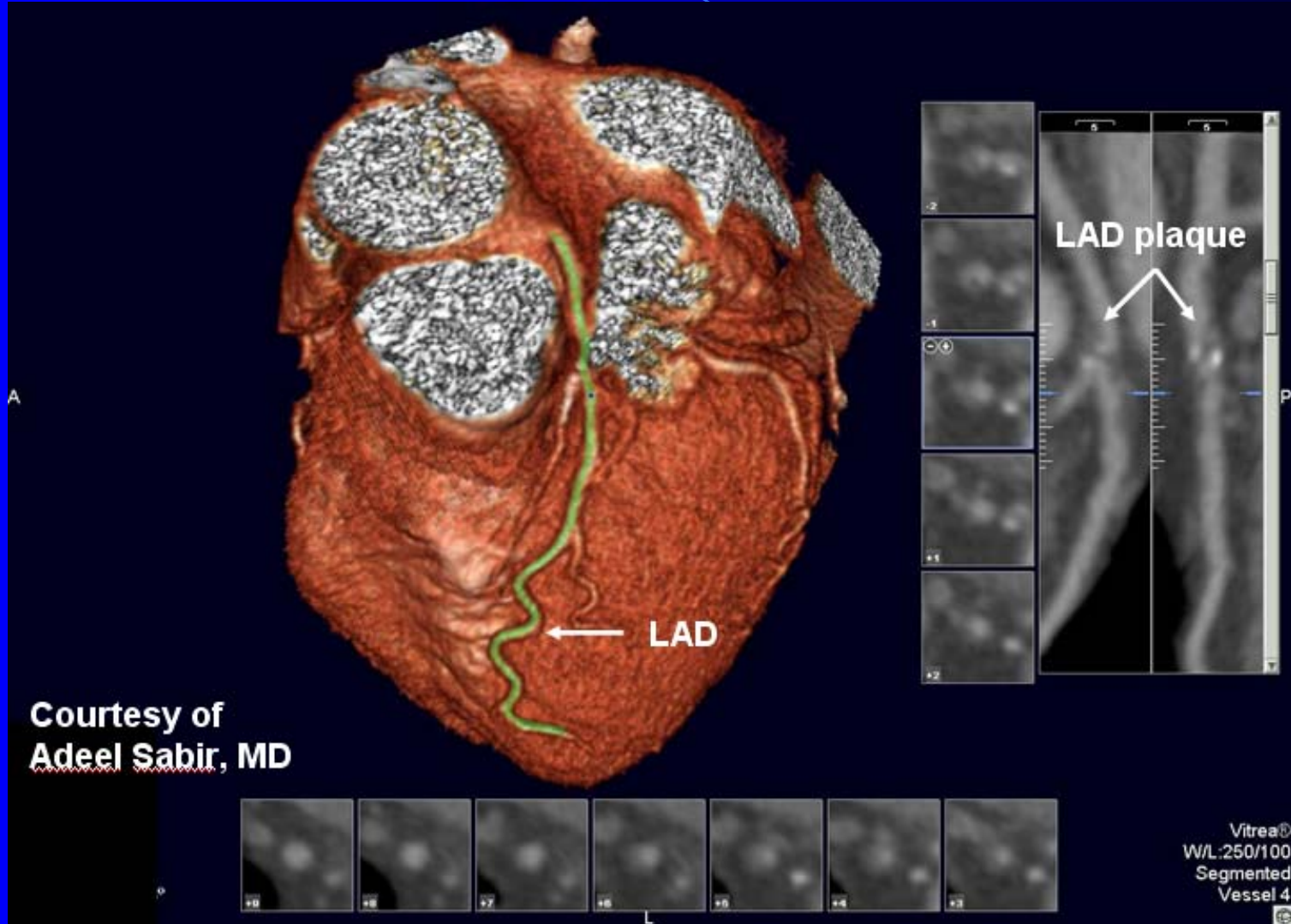


EBCT of Patient KS





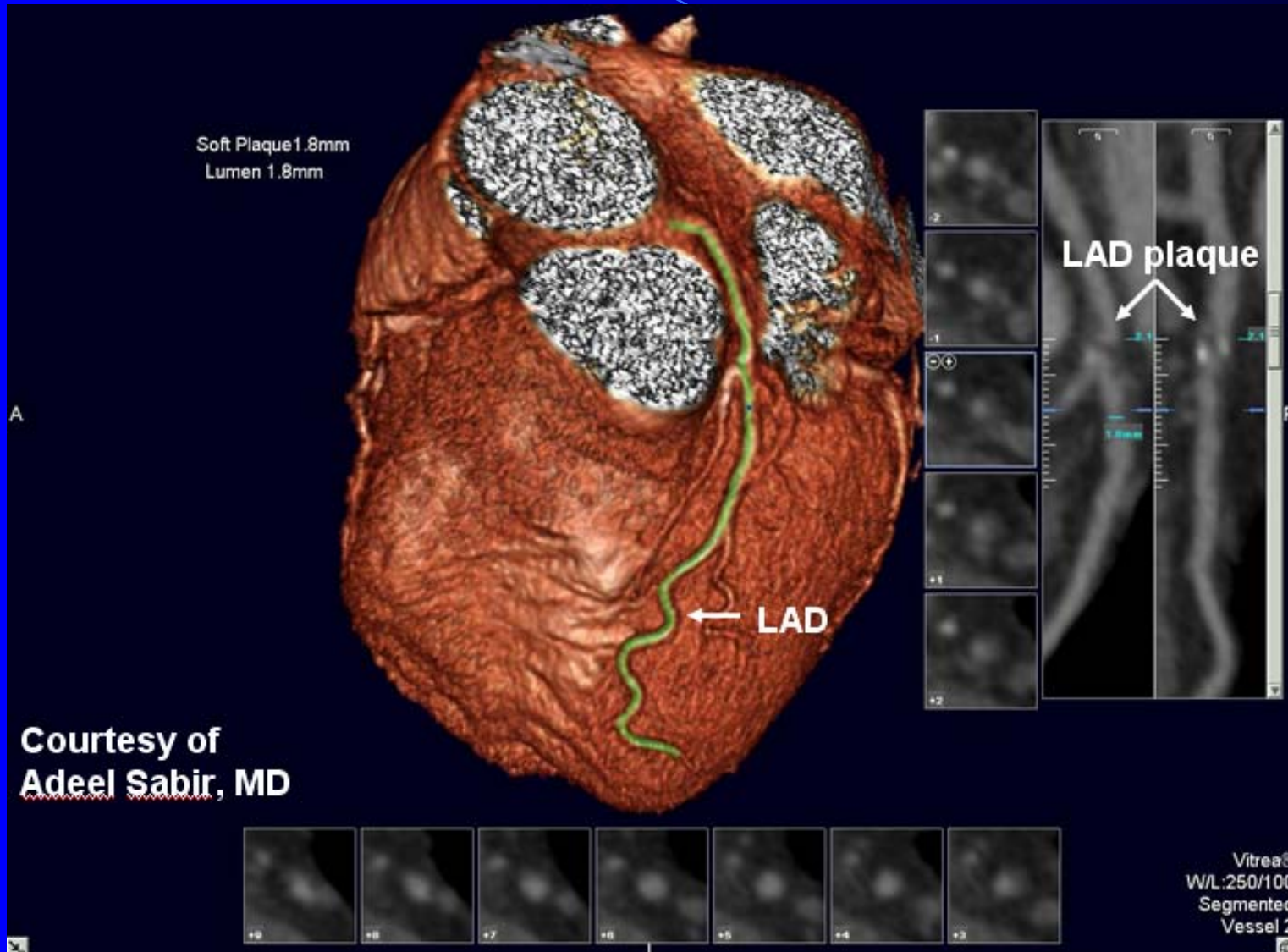
EBCT of Patient KS



Courtesy of
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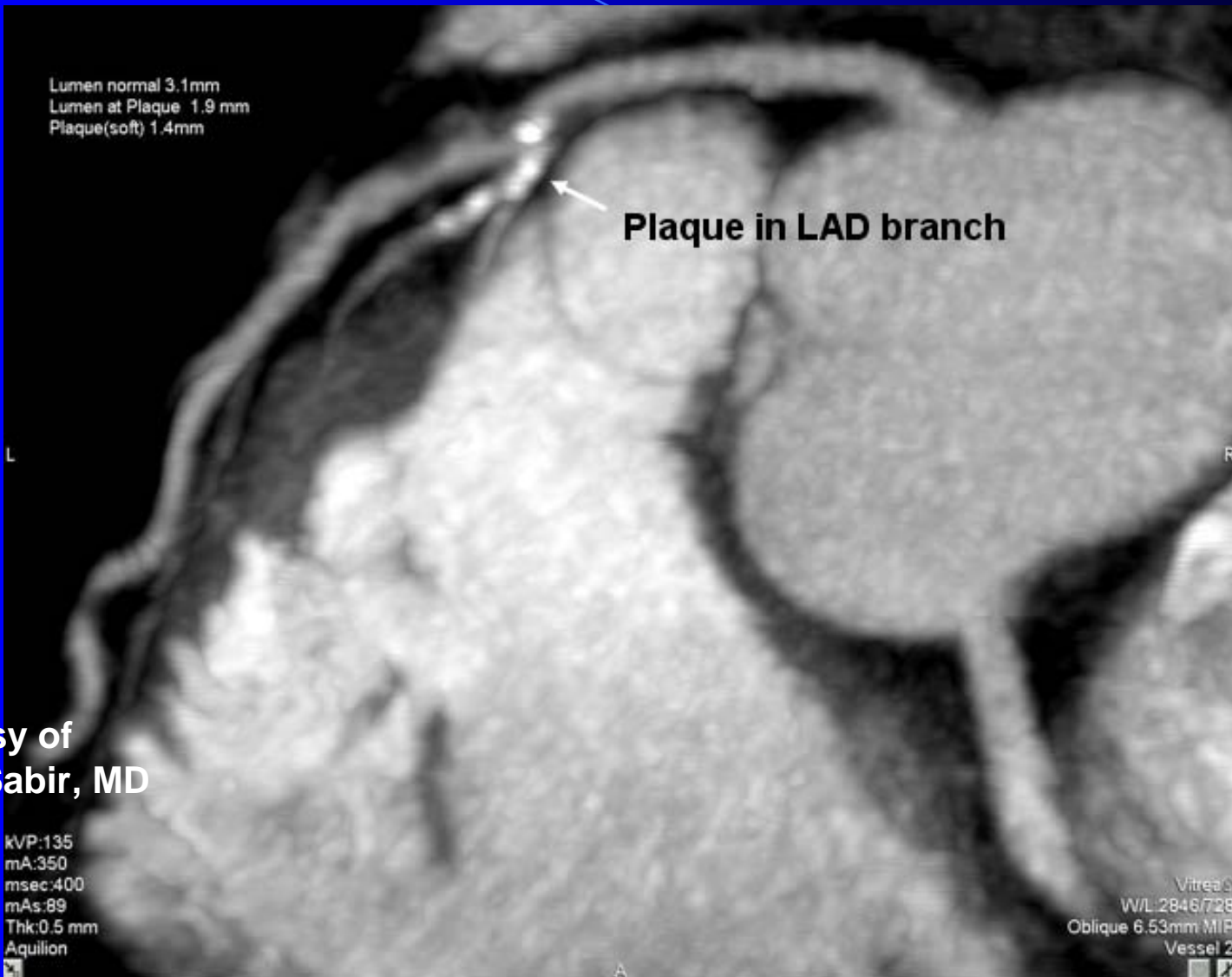
EBCT of Patient KS



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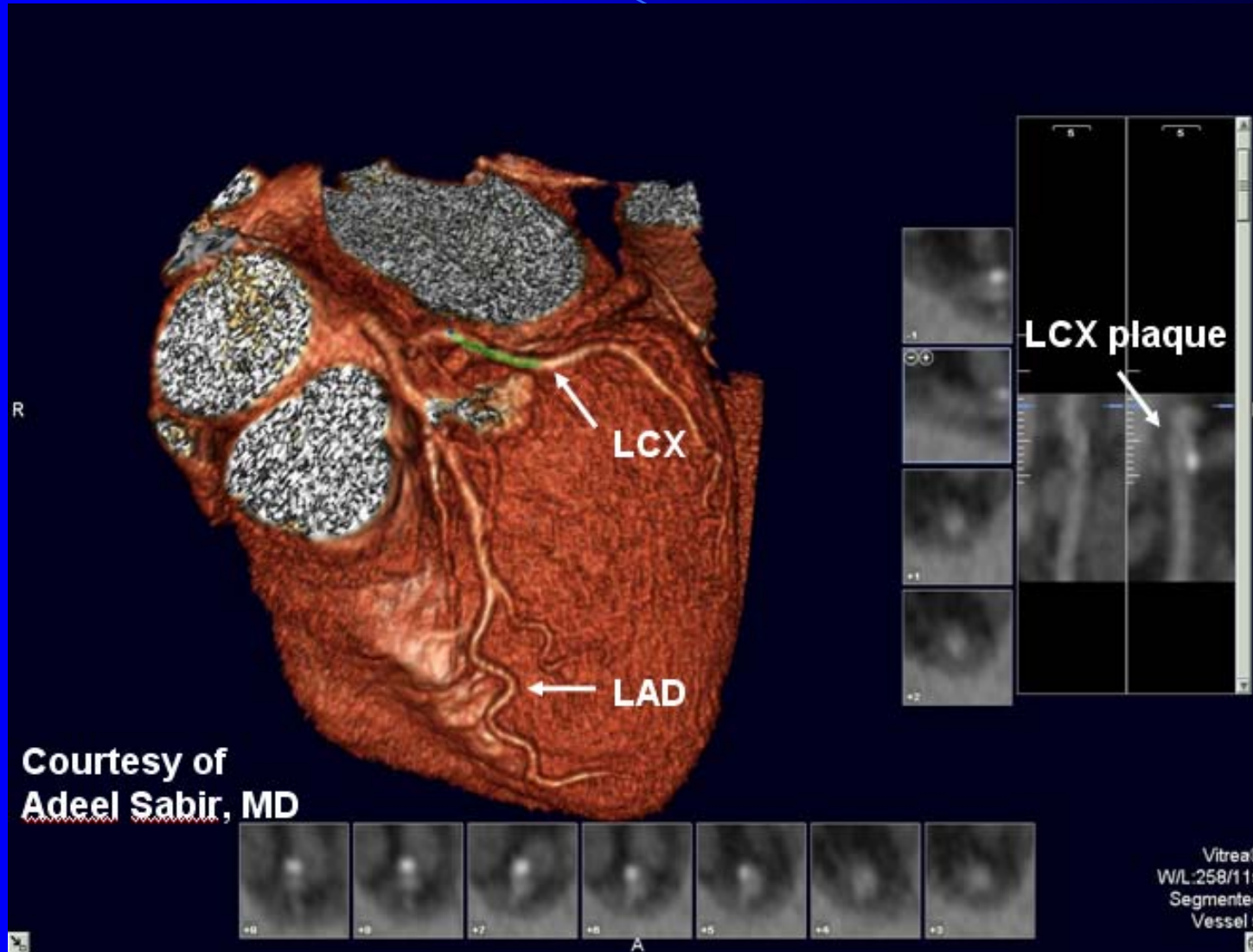
EBCT of Patient KS



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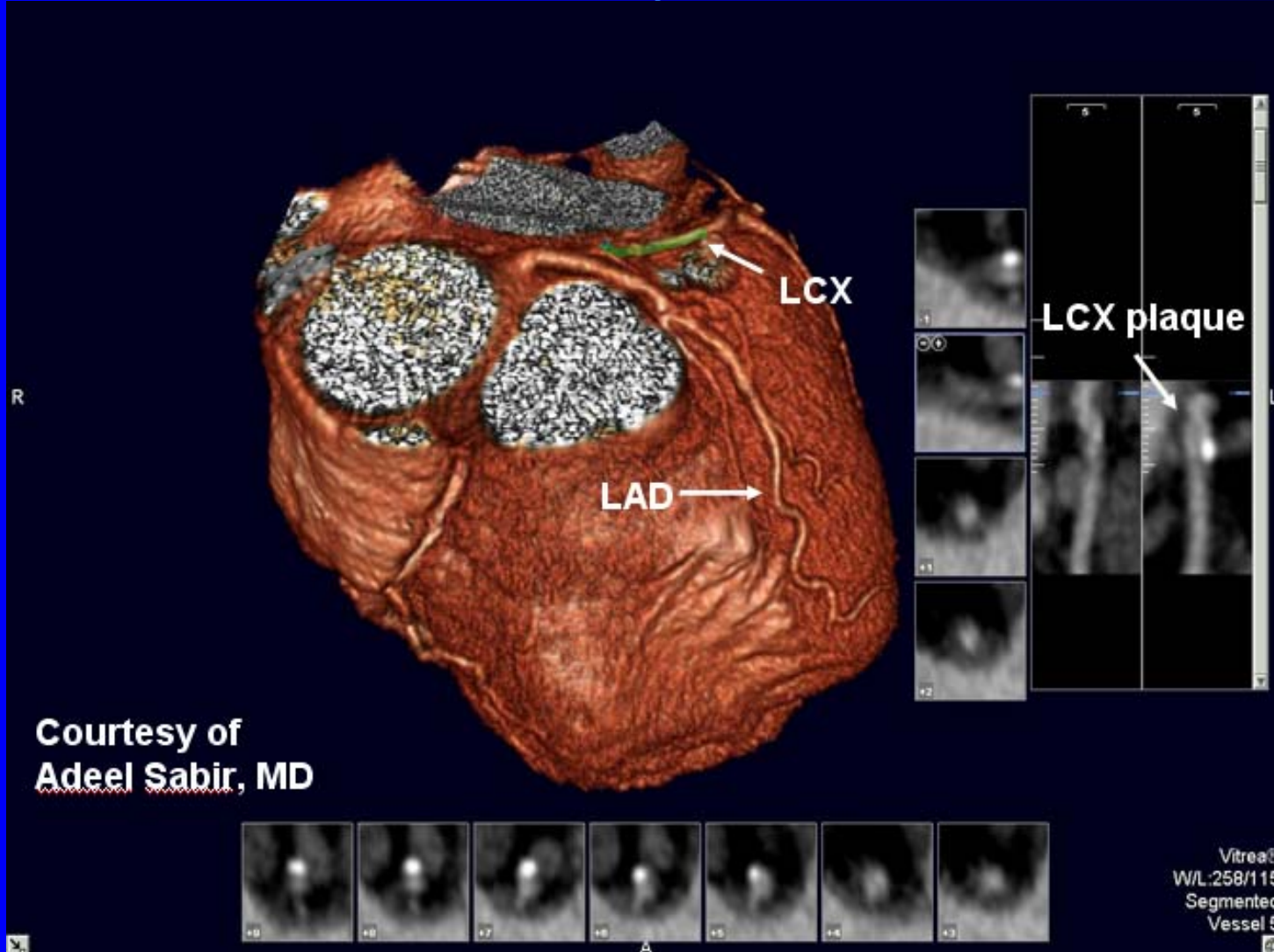
EBCT of Patient KS



Courtesy of
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EBCT of Patient KS



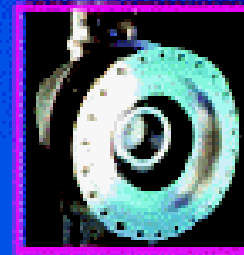
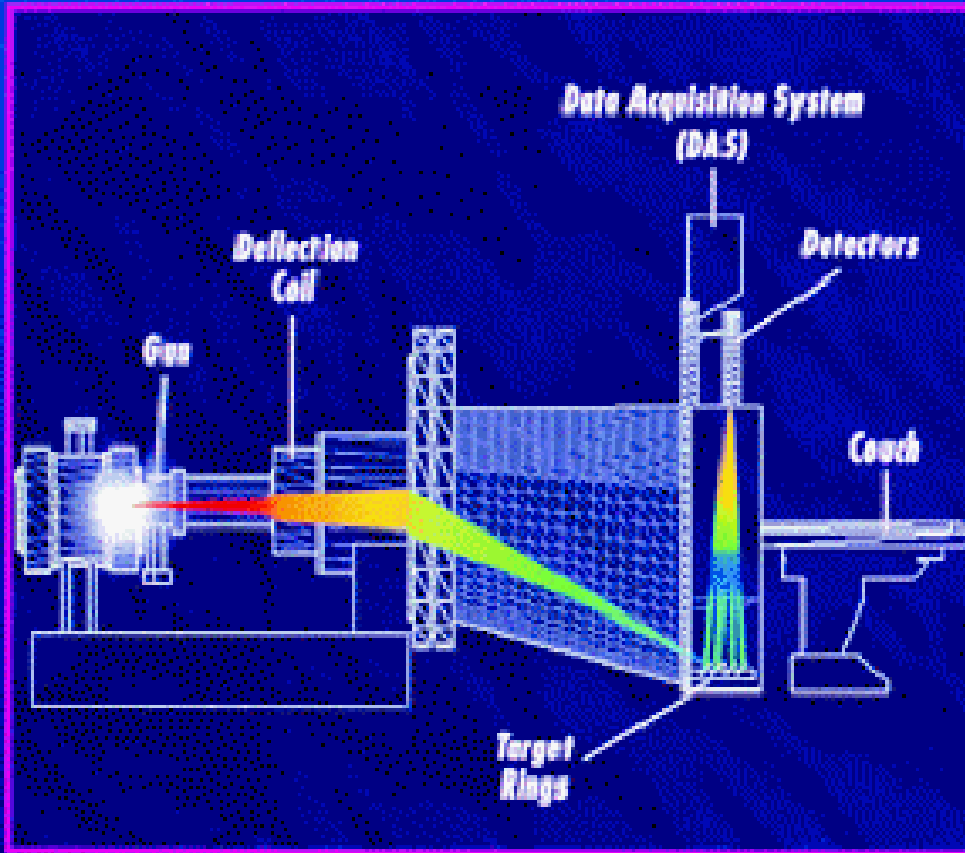


Electron Beam Computed Tomography (EBCT)

- An electron beam is directed toward tungsten target rings
- The beam generates a rotating fan of X-rays that pass through the patient to detectors
- The elimination of a moving X-ray source allows for image acquisition in milliseconds, effectively “freezing” the heart in time

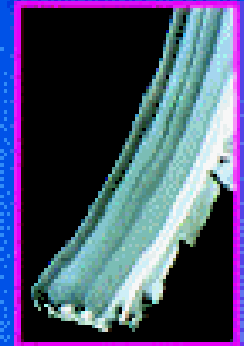


EBT Scanner Configuration

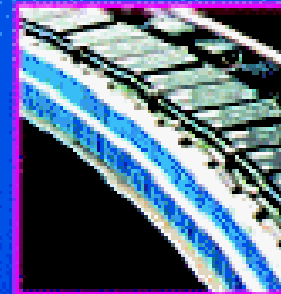


Electron gun

4 target rings

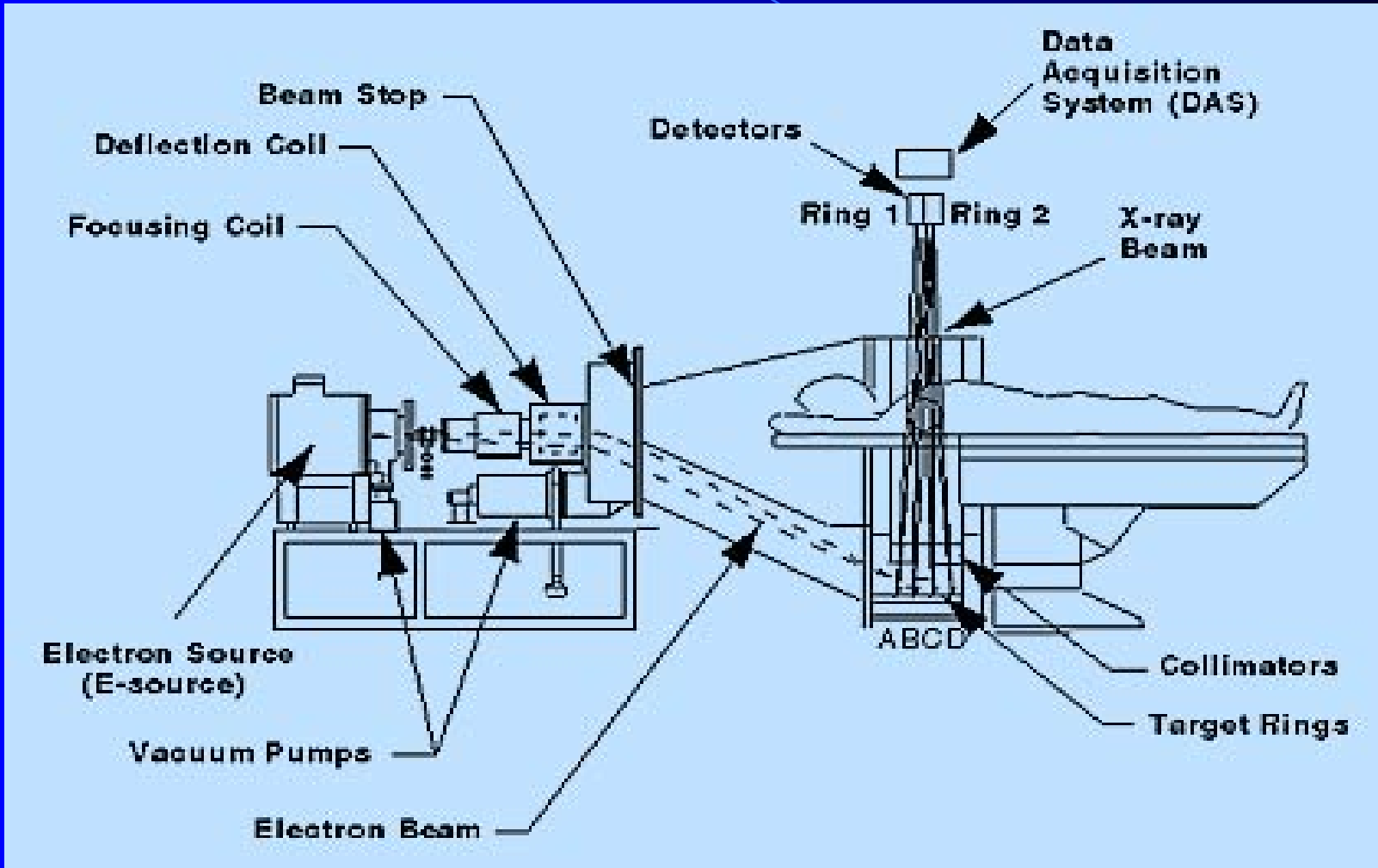


2 detector rings





EBCT Configuration





EBCT

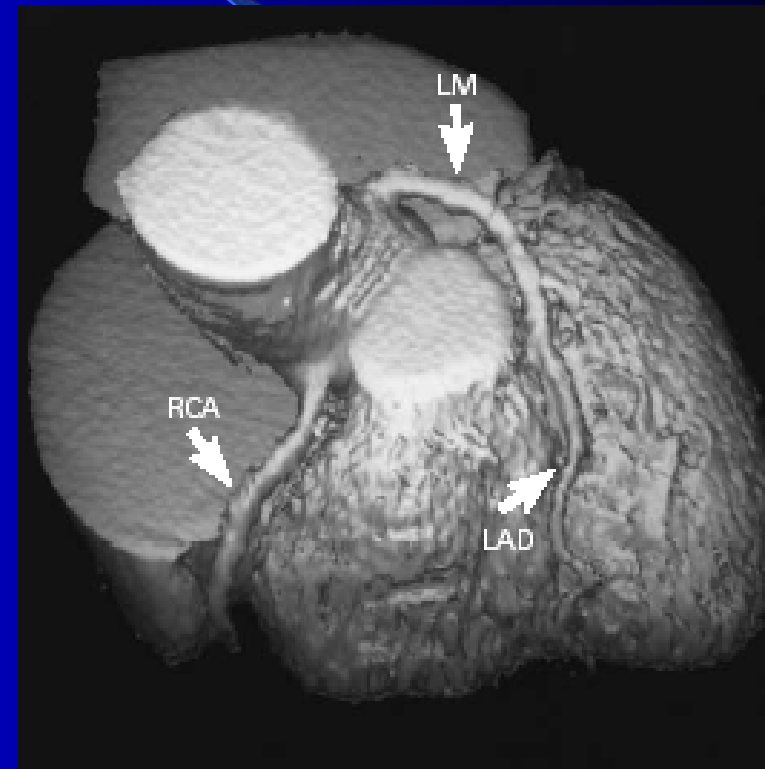
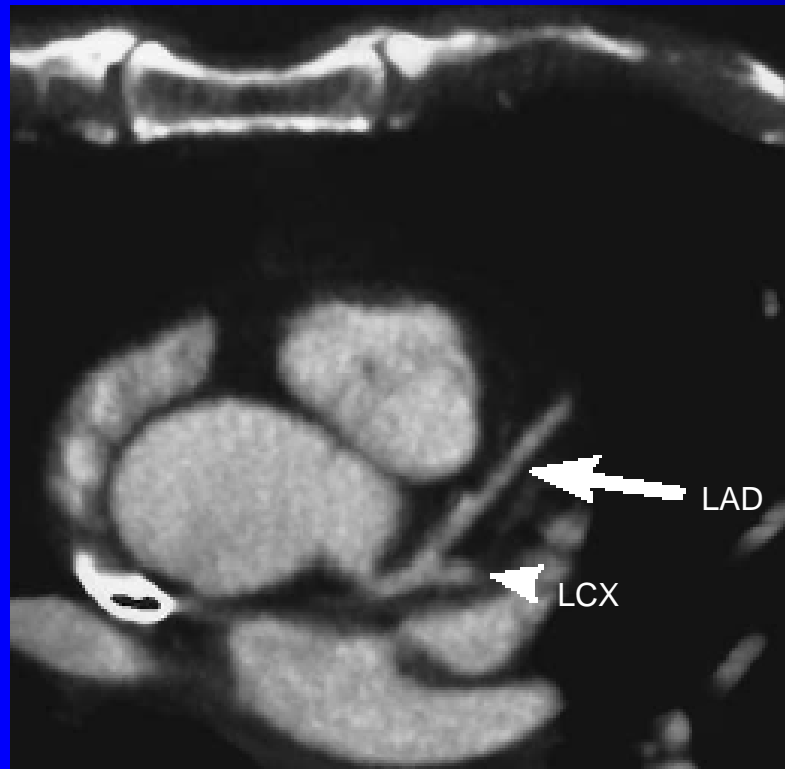
Data Acquisition

- Scanning is gated to the EKG, with images timed to be taken in diastole at 60-80% of the R-R interval
- 30-40 axial images of the heart are obtained
- Coronary artery calcium is measured as areas with density >130 Hounsfield units
- Images can be taken with IV contrast to assess coronary artery lumen size, but NOT to assess coronary artery calcium



EBCT Images of the Heart

Normal Coronary Arteries

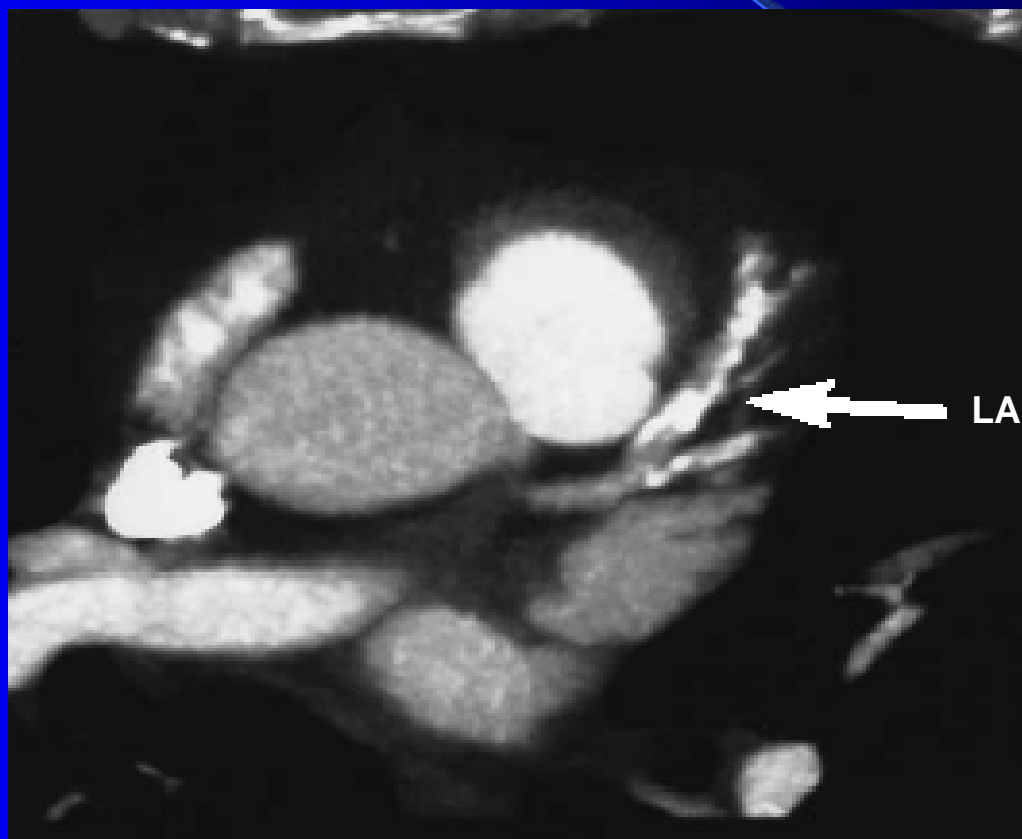


Achenbach et al. *NEJM*. 1998; 339:1964-71



EBCT Images of the Heart

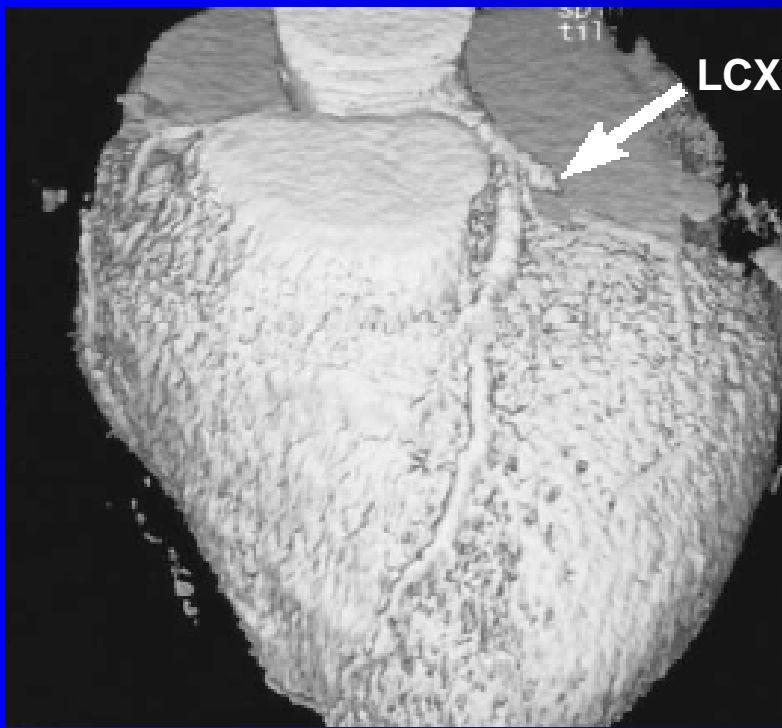
Coronary Artery Calcifications



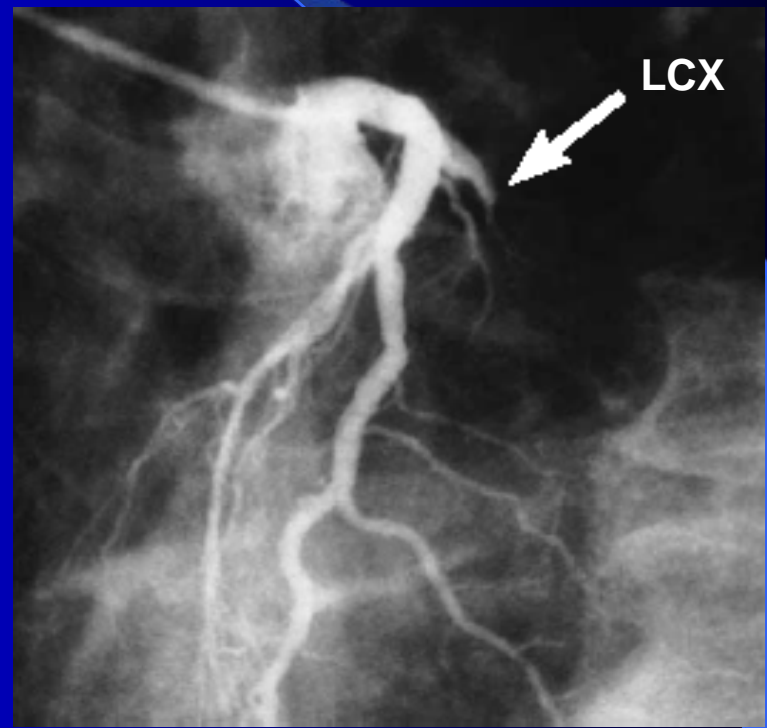
Achenbach et al. *NEJM*. 1998; 339:1964-71



EBCT Images of the Heart Coronary Artery Occlusion



EBCT



Coronary Angiography

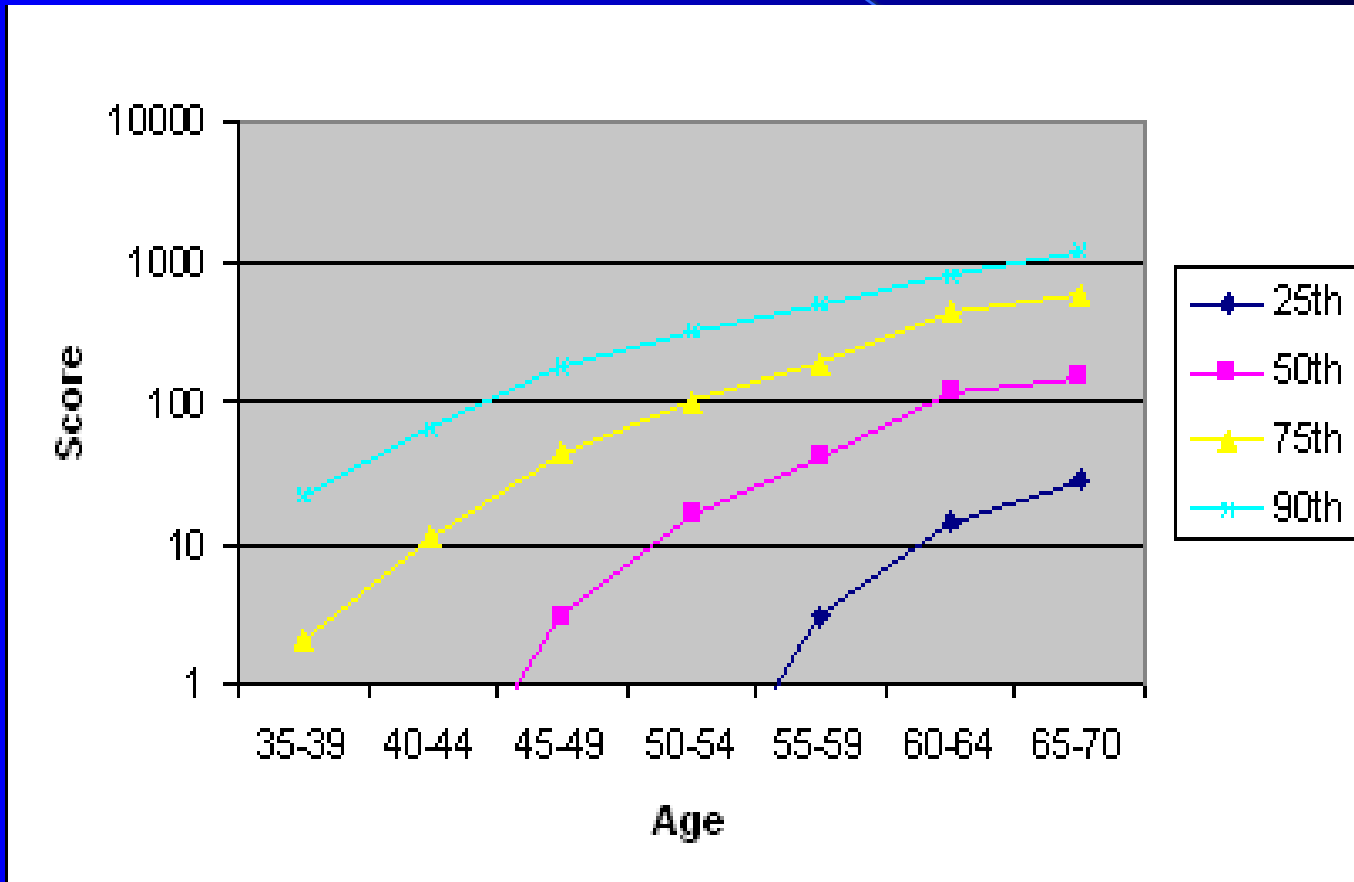


Agatston Score

- The presence of *any* calcium in the coronary arteries is diagnostic of coronary atherosclerosis, and the amount of calcium is strongly correlated with the extent of CAD
- Coronary calcium score also directly correlates with the risk of cardiac events
 - **Scores <11** considered a negative test
 - **Scores between 11 and 400** associated with >2% per year risk of future cardiac events
 - **Scores >400** associated with >4.8% risk of future cardiac events, and high likelihood of at least one vessel with >70 % stenosis

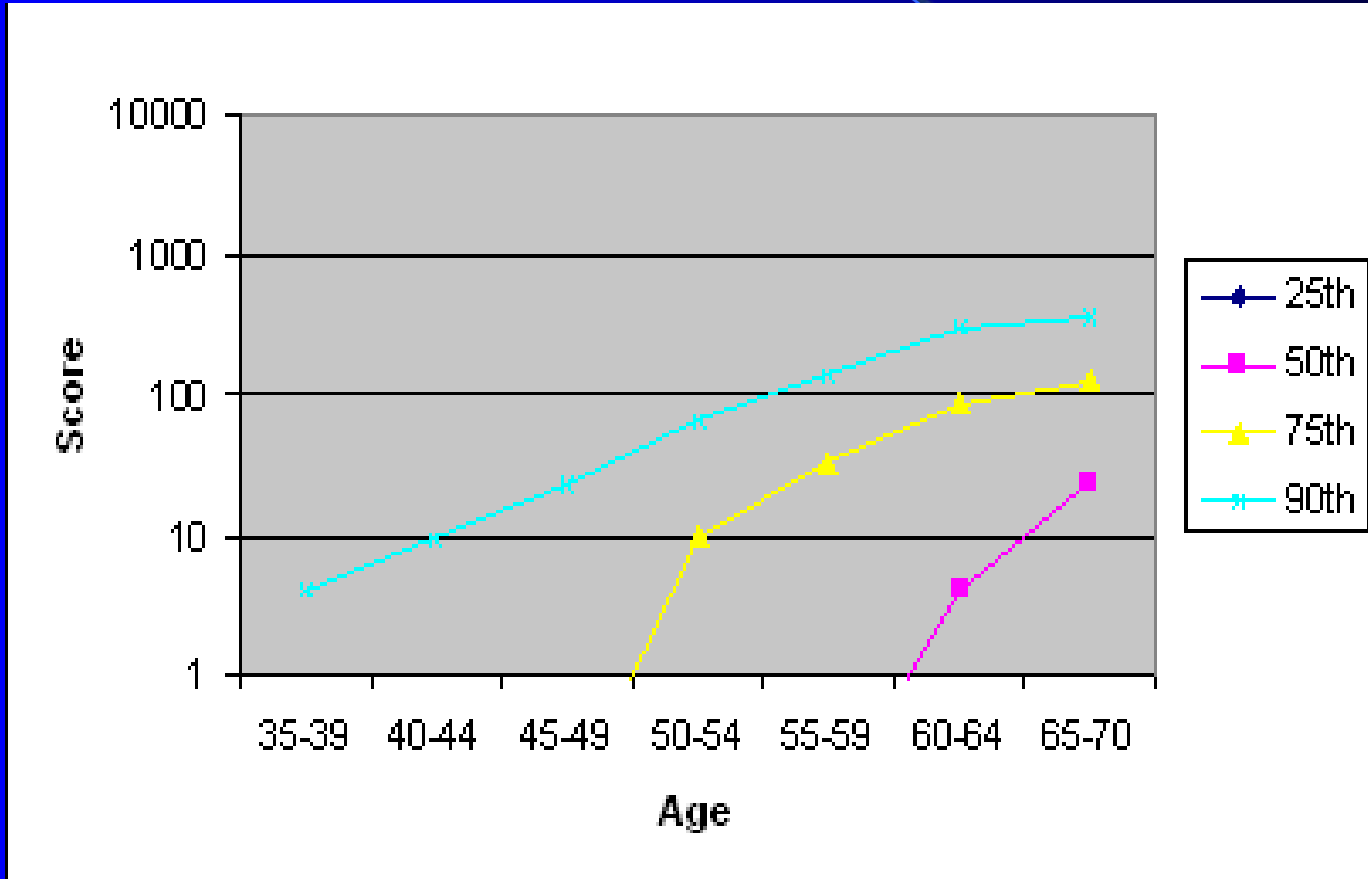


Distribution of Calcium Scores in Men





Distribution of Calcium Scores in Women





Clinical Utility of EBCT

- Sensitivity ranges between 80-92%
- Specificity ranges between 40-51%
- Advantages
 - Fast image acquisition
 - Noninvasive
 - Motivational tool for patients
 - Can be used to monitor plaque burden and response to lipid-lowering treatments



Clinical Utility of EBCT (cont'd)

- Disadvantages

- Not effective for detection of soft plaques
- Low specificity
- Calcium score does not accurately indicate location or degree of luminal obstruction
- High prevalence of noncardiac incidental findings
- Out of pocket expense to patients



To Scan or Not To Scan: Is EBCT an Effective Screening Tool for CAD?

- In patients considered **low risk** for a CAD event, a positive EBCT will not justify implementing aggressive intervention
- In patients considered **high risk** for a CAD event, a negative result will not justify withholding aggressive intervention

Greenland and Gaziano. *NEJM*. 2003; 349(5): 465-73



To Scan or Not To Scan: Is EBCT an Effective Screening Tool for CAD? (cont'd)

- For patients with intermediate risk, the additional information gained from EBCT may influence treatment decisions

Greenland and Gaziano. *NEJM*. 2003; 349(5): 465-73



Probability of a Coronary Event within 10 Years Calculated on the Basis of the Results of EBCT

Pretest Probability of a Coronary Event within 10 Yr	Probability within 10 Yr According to Results of Electron-Beam CT	
	Calcium Score ≥ 80	Calcium Score < 80
	<i>percent</i>	
1.0	3.0	0.2
2.0	6.5	0.4
3.0	9.5	0.6
4.0	12.5	0.9
5.0	15.0	1.0
6.0	18.0	1.2
7.0	20.0	1.4
10.0	27.0	2.2
15.0	38.0	3.4
20.0	46.0	4.8

Stratifying patients based on their coronary calcium score can help give a more accurate prediction of their 10 year risk of a coronary event

Adapted from Greenland and Gaziano. *NEJM*. 2003; 349(5): 465-73



Multi-slice Detector CT

- Comparable to EBCT for coronary artery calcium screening, except for Agatston scores <11
- May be effective in detecting noncalcified atherosclerotic plaques
- Image quality degraded by severe calcifications and high heart rate



Conclusions

- EBCT is an effective and accurate method of detecting coronary calcification
- Ongoing trials seek to establish coronary CT as an effective screening tool for asymptomatic patients with intermediate risk for future coronary events
- Multi-slice detector CT appears to be the future of coronary imaging



Acknowledgements

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