



# Roles of MSCT in diagnosing variants and congenital anomalies of coronary arteries

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*Thấu hiểu nỗi đau - niềm tin của bạn*



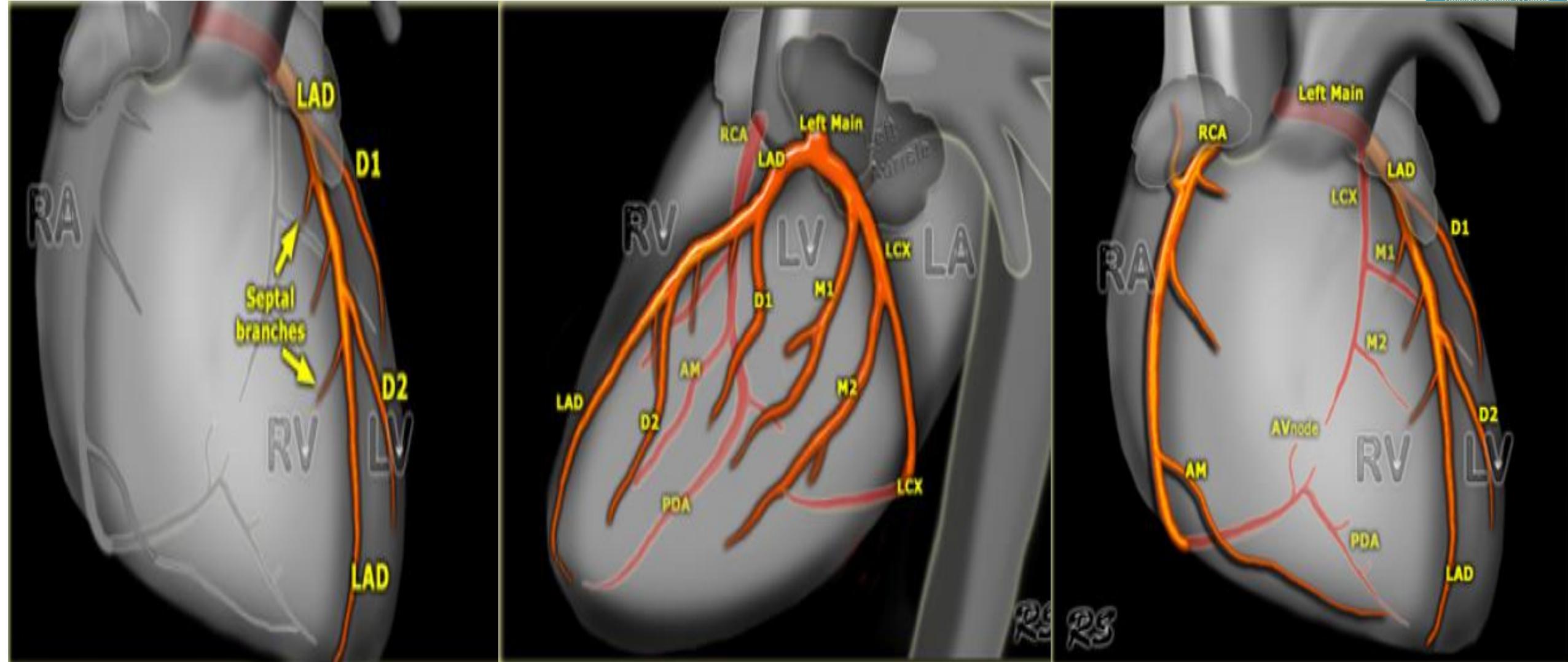
# Outline

1. Introduction
2. Classification
3. Case reports

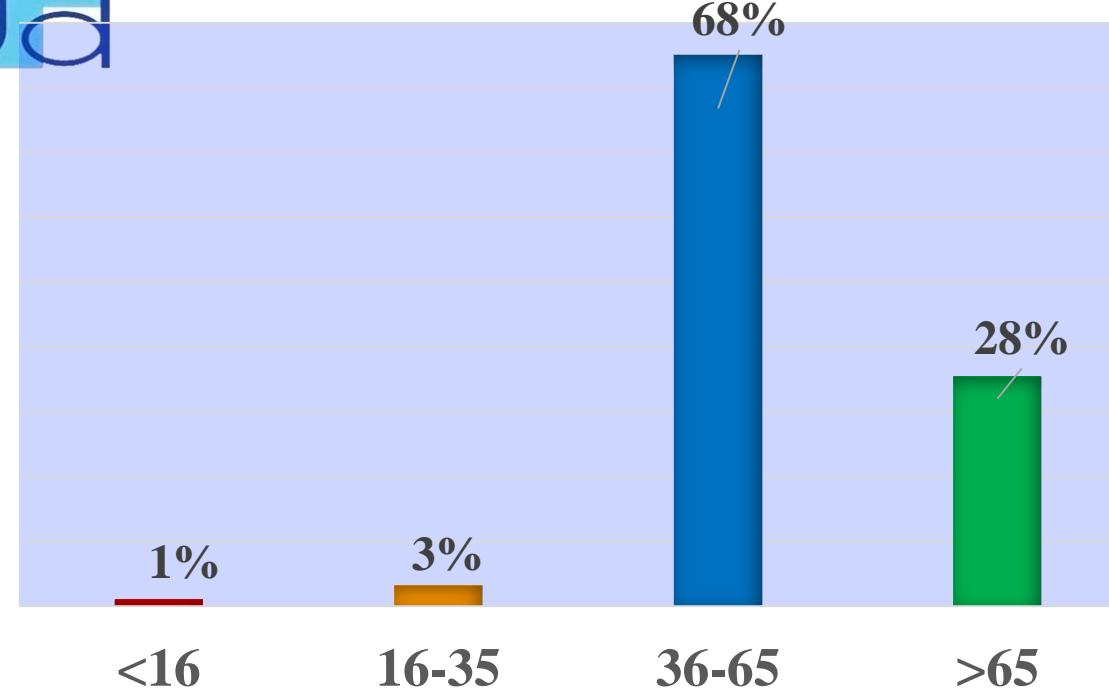
# Introduction

- Coronary Anomalies: 0.78-1.3 % invasive angiography
- 0.99-5.8% coronary CT angiography
- the second most common cause of sudden cardiac death

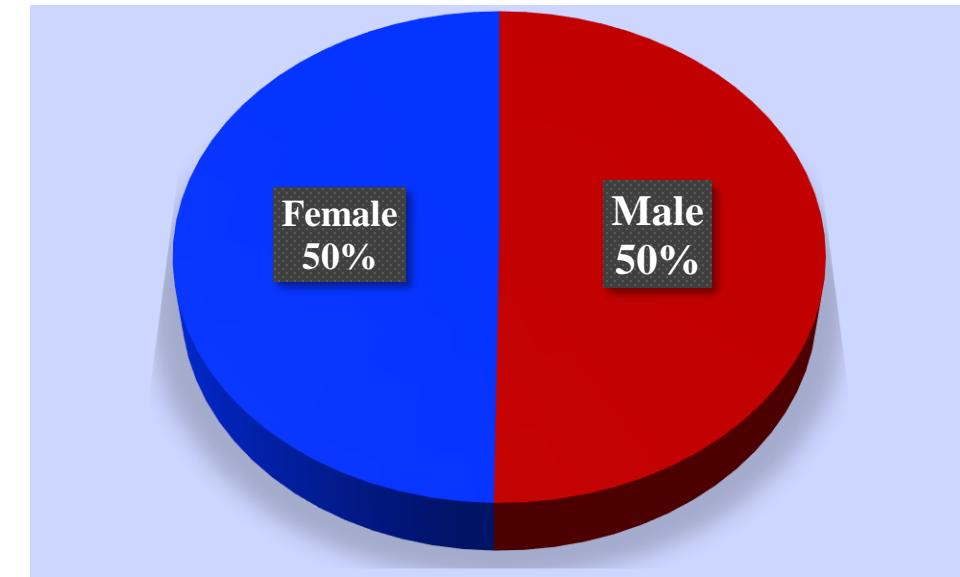
# Coronary anatomy



## Age groups



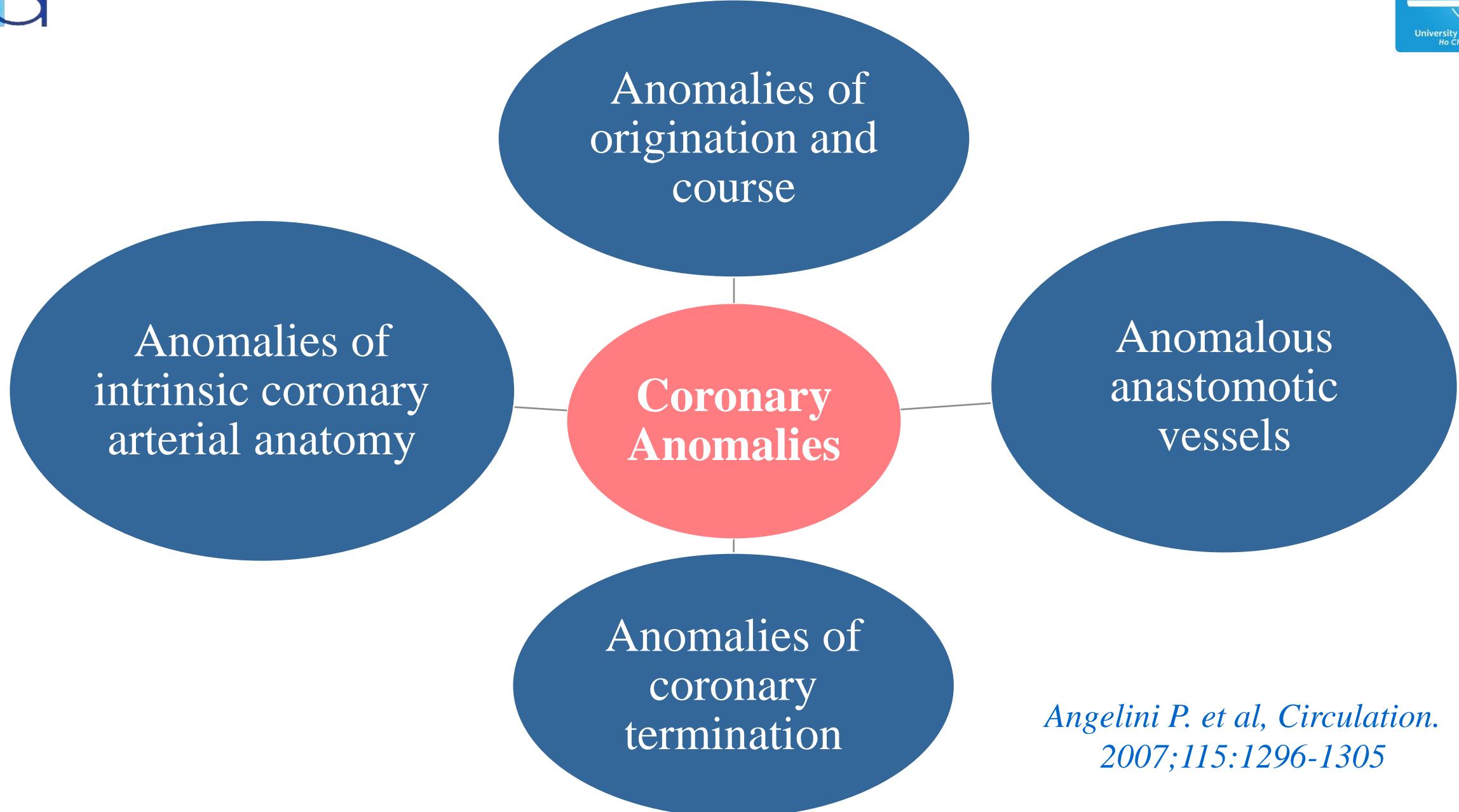
## Gender



**10/2018-10/2019:  
653 CCTA cases in UMC**

|              |           |                         |             |
|--------------|-----------|-------------------------|-------------|
| High takeoff | 2,5% (16) | Incomplete MB           | 18,8% (123) |
| ALCAPA       | 0,3% (2)  | Deep MB                 | 5,1% (33)   |
| Double LAD   | 0,8% (5)  | Coronary artery fistula | 0,45% (3)   |

# Classification of Coronary Anomalies in Human Hearts



*Angelini P. et al, Circulation.*  
2007;115:1296-1305

## A. Anomalies of origination and course

1. Absent left main trunk
2. Anomalous location of coronary ostium within aortic root (high, low, commissural)
3. Anomalous location of coronary ostium outside normal “coronary” aortic sinuses: noncoronary sinus, **pulmonary artery**, ascending aorta, aortic arch, left ventricle, right ventricle,...
4. Anomalous location of coronary ostium at improper sinus:
  - **RCA that arises from left anterior sinus, with anomalous course**
  - **LAD that arises from right anterior sinus, with anomalous course**
  - Cx that arises from right anterior sinus, with anomalous course
  - LCA that arises from right anterior sinus, with anomalous course
5. Single coronary artery

# Anomalies of origin and course

## ***Anomalous Origin of the Coronary Artery from the Pulmonary Artery***

- Common form: LCA arises from the pulmonary artery (**ALCAPA** or Bland-White- Garland syndrome)
  - RCA from the pulmonary artery (ARCAPA)

### **ALCAPA:**

- one of the most serious congenital coronary artery anomalies
- one in 300,000 live births
- 90% of untreated infants die in the 1st year of life
- Coronary angiography: confirm, collateral circulation, a coronary "steal" phenomenon into the pulmonary artery



## CT-SCAN:

- Origin and course of the anomalous coronary artery from the pulmonary artery
- Dilatation and tortuosity
- Collateral vessels

Image size: 1070 x 1070

View size: 1248 x 1248

WL: 127 WW: 255

N19-0009138 ( 36 y , 36 y ) Image size: 577 x 512

Vascular 06\_Thorax\_Abd\_Angio\_Pre\_Intervantion\_Ecg (Adult)

06\_Thorax\_ABD\_Angio\_PRE\_Intervantion\_ECG

1674



Zoom: 117% Angle: 0

Im: 1/17

Uncompressed

Position: FFS



1/18/19, 10:53:18  
Made In Horos

Zoom: 244% Angle: 0

Im: 1/1

Uncompressed

Thickness: 11.80 mm Location: -164.53 mm

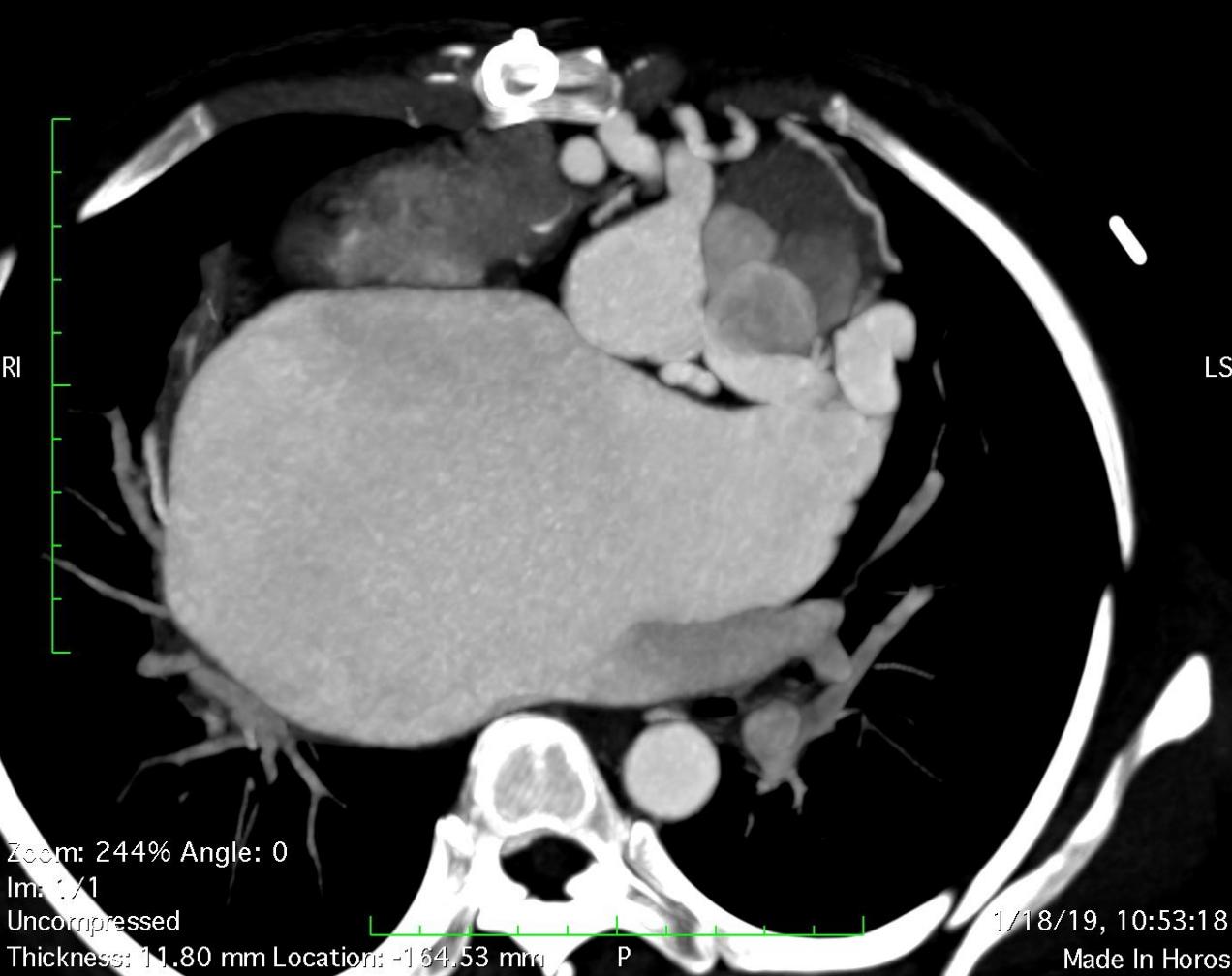
A

N19-0009138 ( 36 y , 36 y )

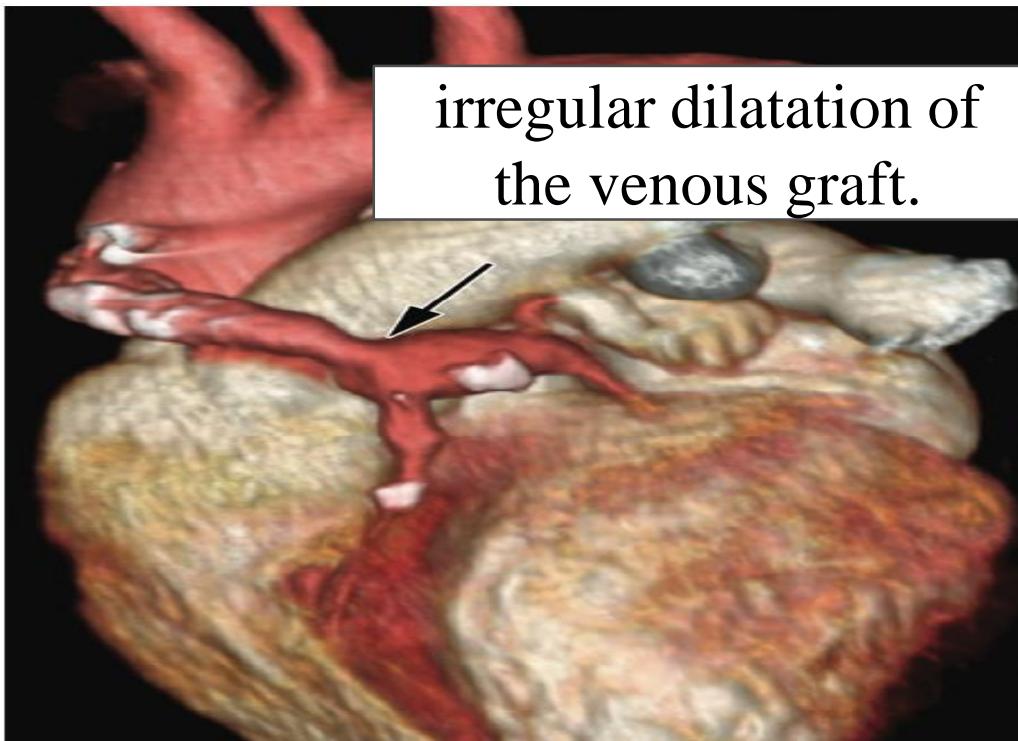
Vascular 06\_Thorax\_Abd\_Angio\_Pre\_Intervantion\_Ecg (Adult)

06\_Thorax\_ABD\_Angio\_PRE\_Intervantion\_ECG

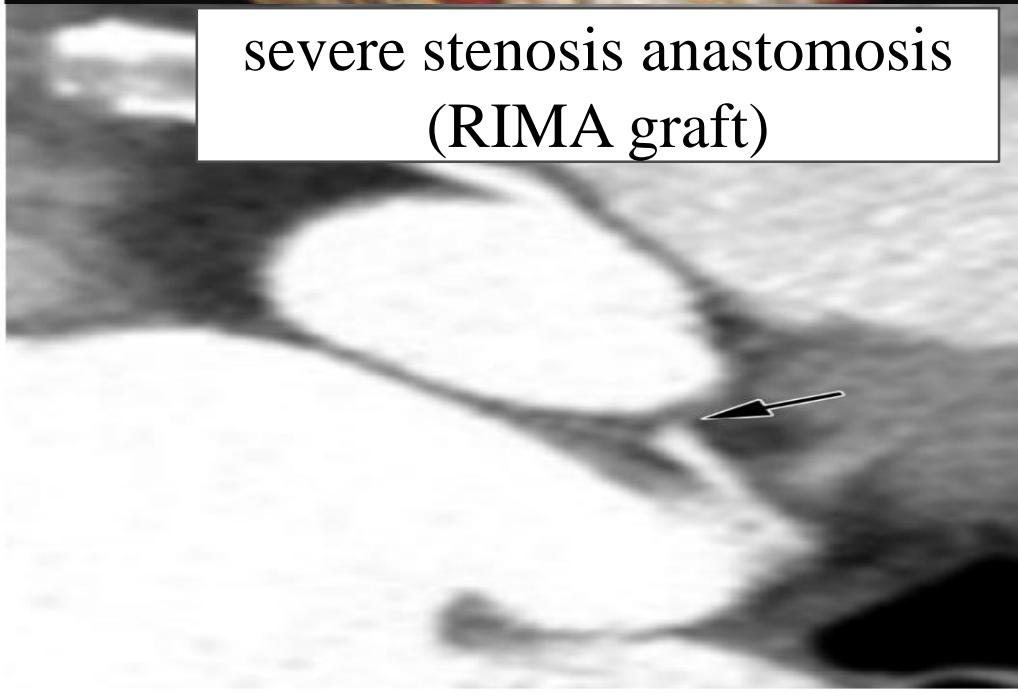
1684



A 36-year-old female with shortness of breath, no history of chest pain → **CCTA: ALCAPA**



irregular dilatation of the venous graft.



severe stenosis anastomosis  
(RIMA graft)

## CT-SCAN:

- Origin and course of the anomalous coronary artery from the pulmonary artery
- Dilatation and tortuosity
- Collateral vessels

## *Follow-up imagings:*

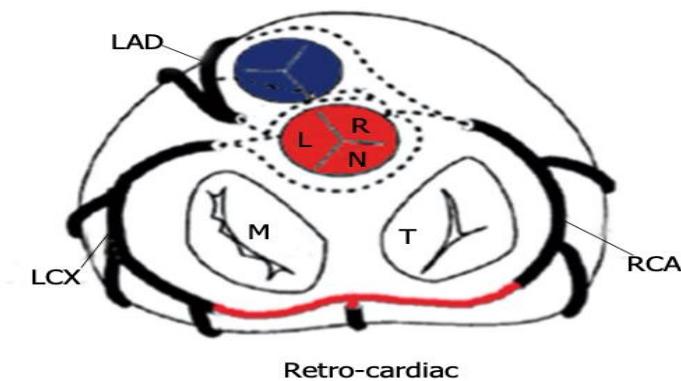
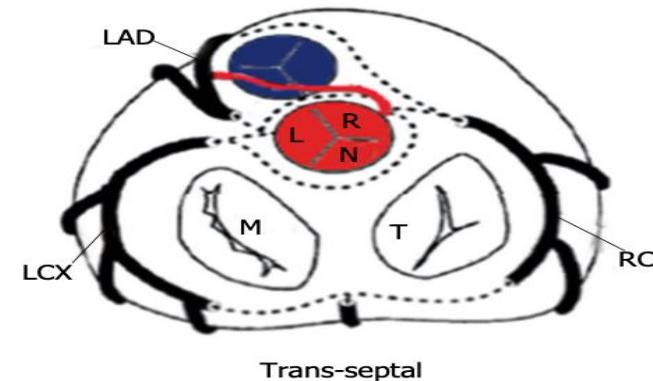
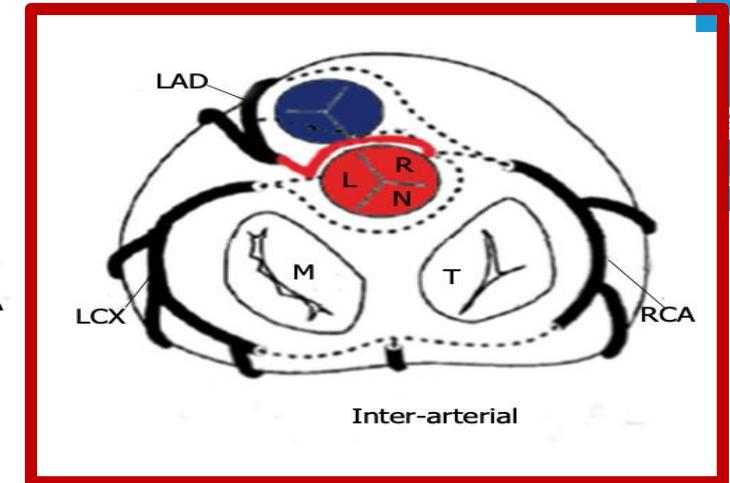
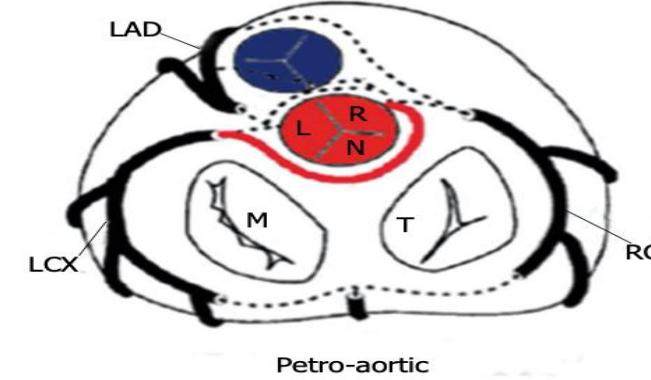
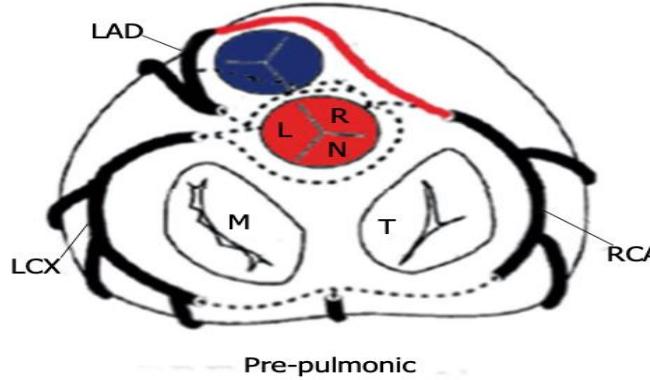
- Bleeding and kinking at the anastomotic site
- Stent or baffle leak/stenosis
- Saphenous vein graft aneurysms

# Anomalies of origin and course

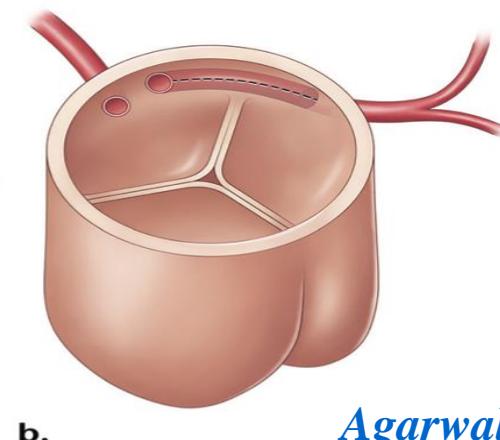
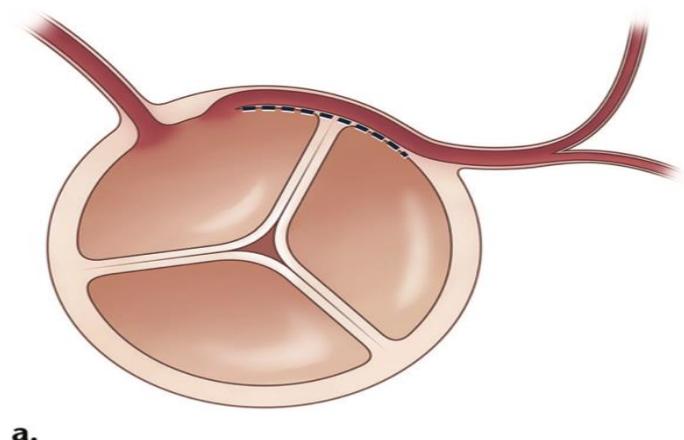
## *Anomalous Origin of Coronary Artery from Opposite Sinus with Anomalous Course*

0.15% to 0.39% cath, 0.35%– 2.1% CT

- Asymptomatic, chest pain, syncope, or breathlessness
  - (a) interarterial (between the aorta and the pulmonary artery), (b) retroaortic, (c) prepulmonic, (d) septal (subpulmonic)
- The most common course: interarterial → sudden cardiac death in 30% of patients



## Intramural segment



# Anomalies of origin and course

## *Anomalous Origin of Coronary Artery from Opposite Sinus with Anomalous Course*

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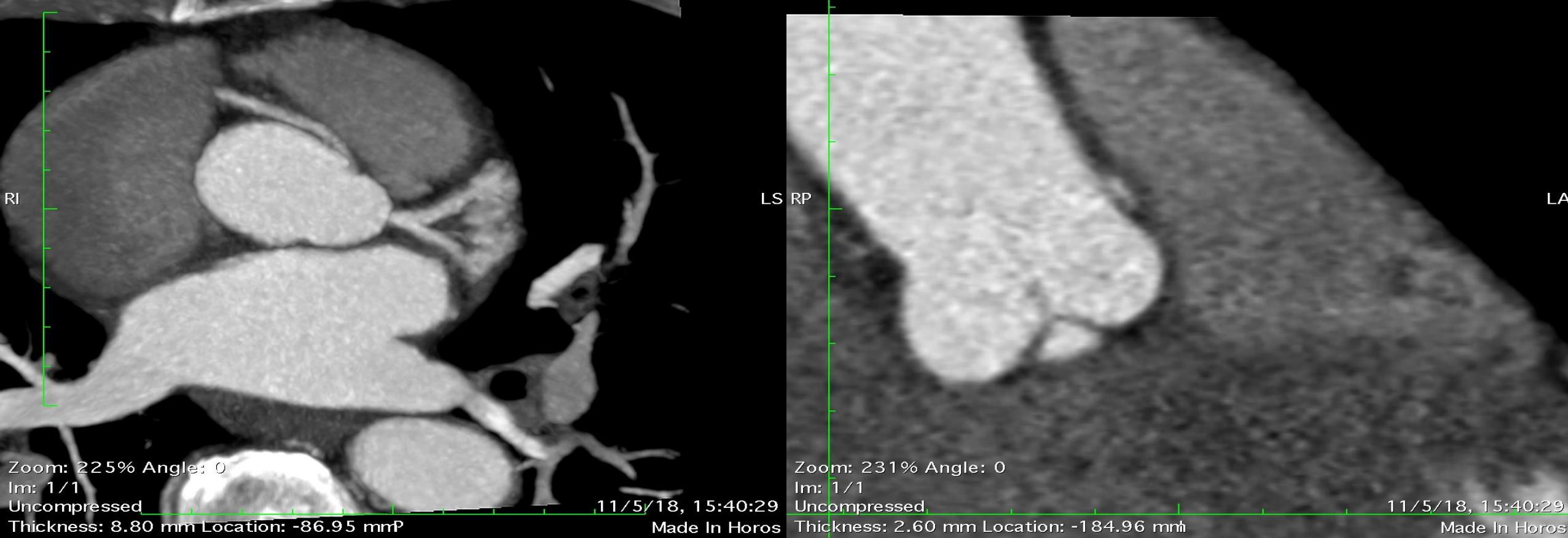
The RCA arises from the left sinus of Valsalva:

- Right ACAOS > left ACAOS (3 times).

Image size: 512 x 552  
View size: 1153 x 1243  
WL: 343 WW: 894

A N18-0378509 ( 65 y , 64 y ) Image size: 512 x 538  
Cardiac 2\_Cas\_Coronarycta\_Spiral (Adult) View size: 1183 x 1243  
2\_CaS\_CoronaryCTA\_Spiral WL: 303 WW: 782  
1327

S N18-0378509 ( 65 y , 64 y )  
Cardiac 2\_Cas\_Coronarycta\_Spiral (Adult)  
2\_CaS\_CoronaryCTA\_Spiral  
1331



**CCTA:** slitlike orifice, acute angle of origin, intramural segment.

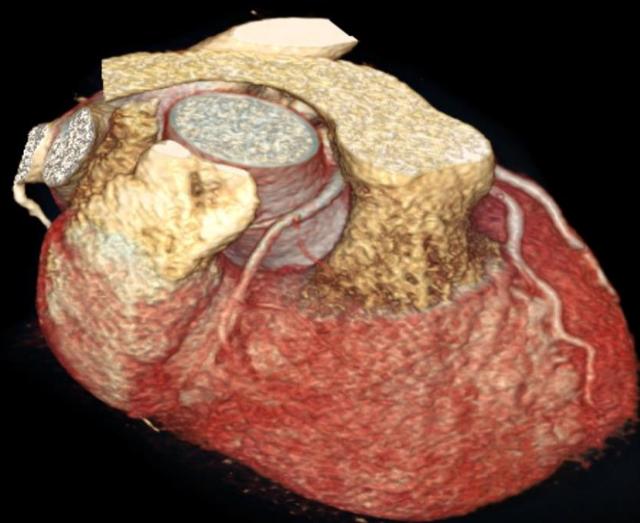
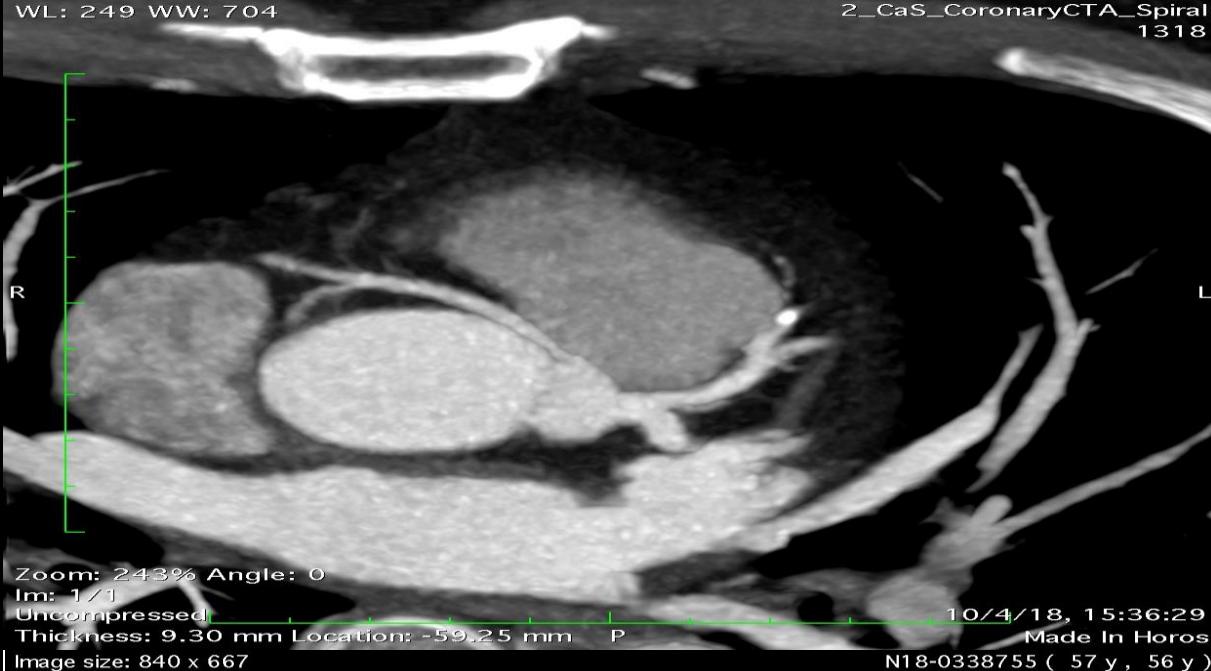
intramural segment: elliptical cross section of the artery with height-to-width ratio > 1.3

Image size: 1220 x 1220  
View size: 1188 x 1188  
WL: 127 WW: 255

N18-0338755 ( 57 y , 56 y )  
Cardiac 2\_Cas\_Coronarycta\_Spiral (Adult)  
2\_CaS\_CoronaryCTA\_Spiral  
1215

Image size: 512 x 512  
View size: 1244 x 1242  
WL: 249 WW: 704

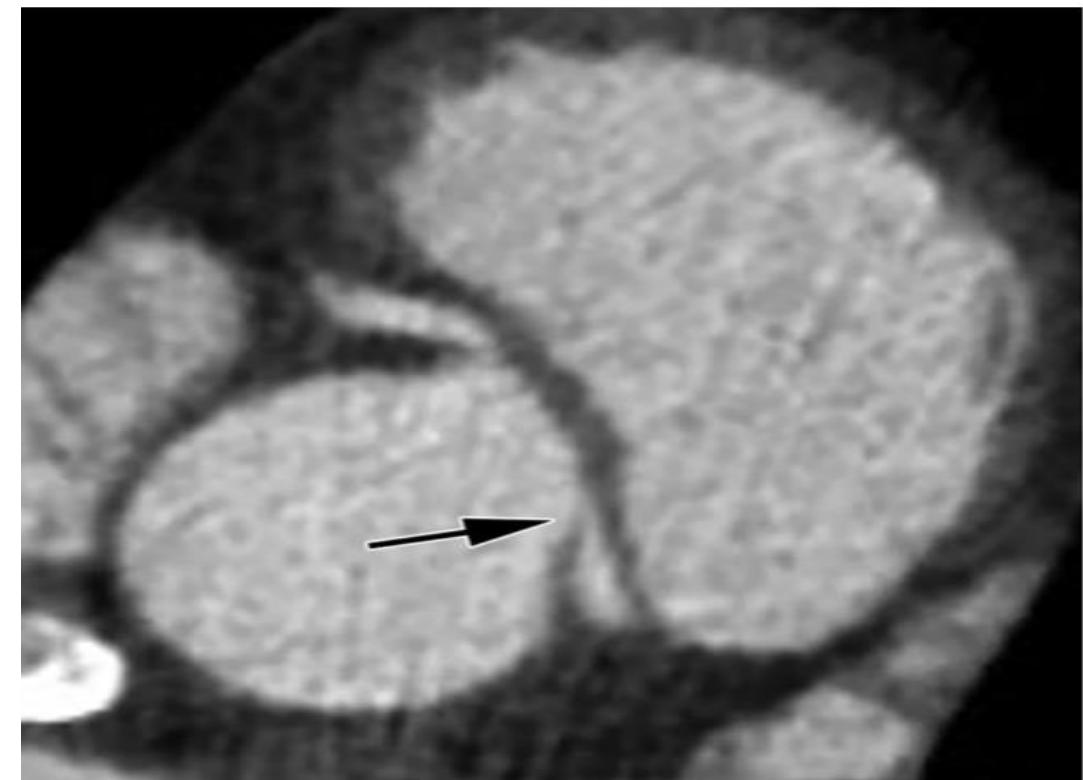
A  
N18-0338755 ( 57 y , 56 y )  
Cardiac 2\_Cas\_Coronarycta\_Spiral (Adult)  
2\_CaS\_CoronaryCTA\_Spiral  
1318



A 58 year-old male with unstable angina

## The LCA arises from the right sinus of Valsalva:

- Interarterial course: 75% of patients - acute angle of the ostium, intramural segment, compression between the commissure of the right and left coronary cusps
- Association with SCD

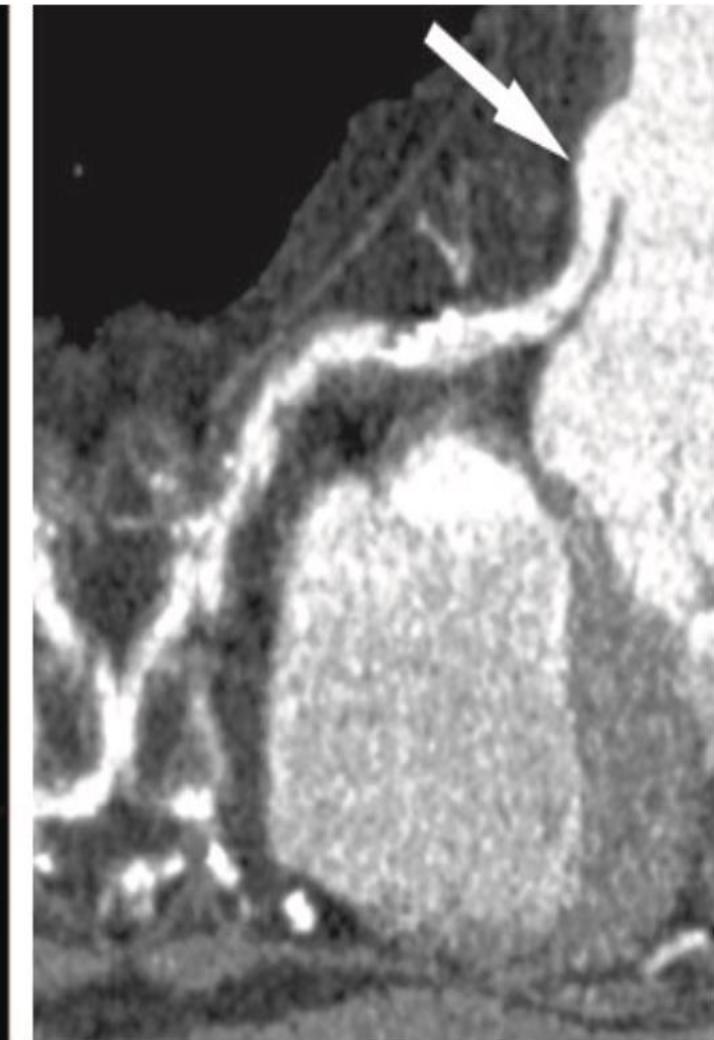


Agarwal et al, RadioGraphics 2017; 37:740–757

# Anomalies of origin and course

## *High takeoff:*

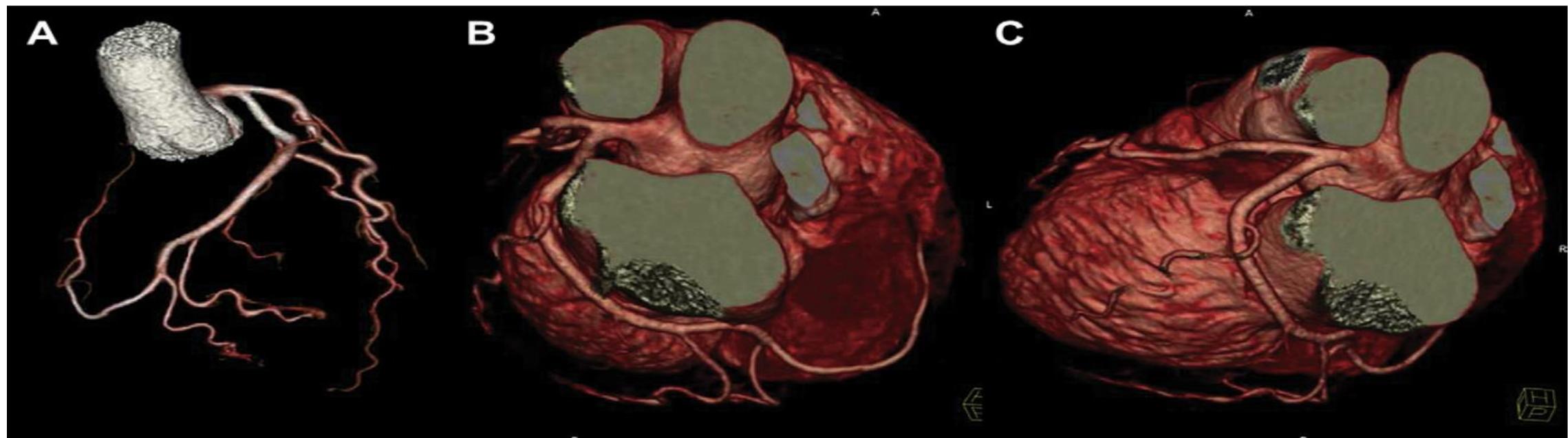
- Sinotubular junction
- 6% of adult hearts
- No major clinical problems
- Difficulty in cannulating the vessels/coronary arteriography



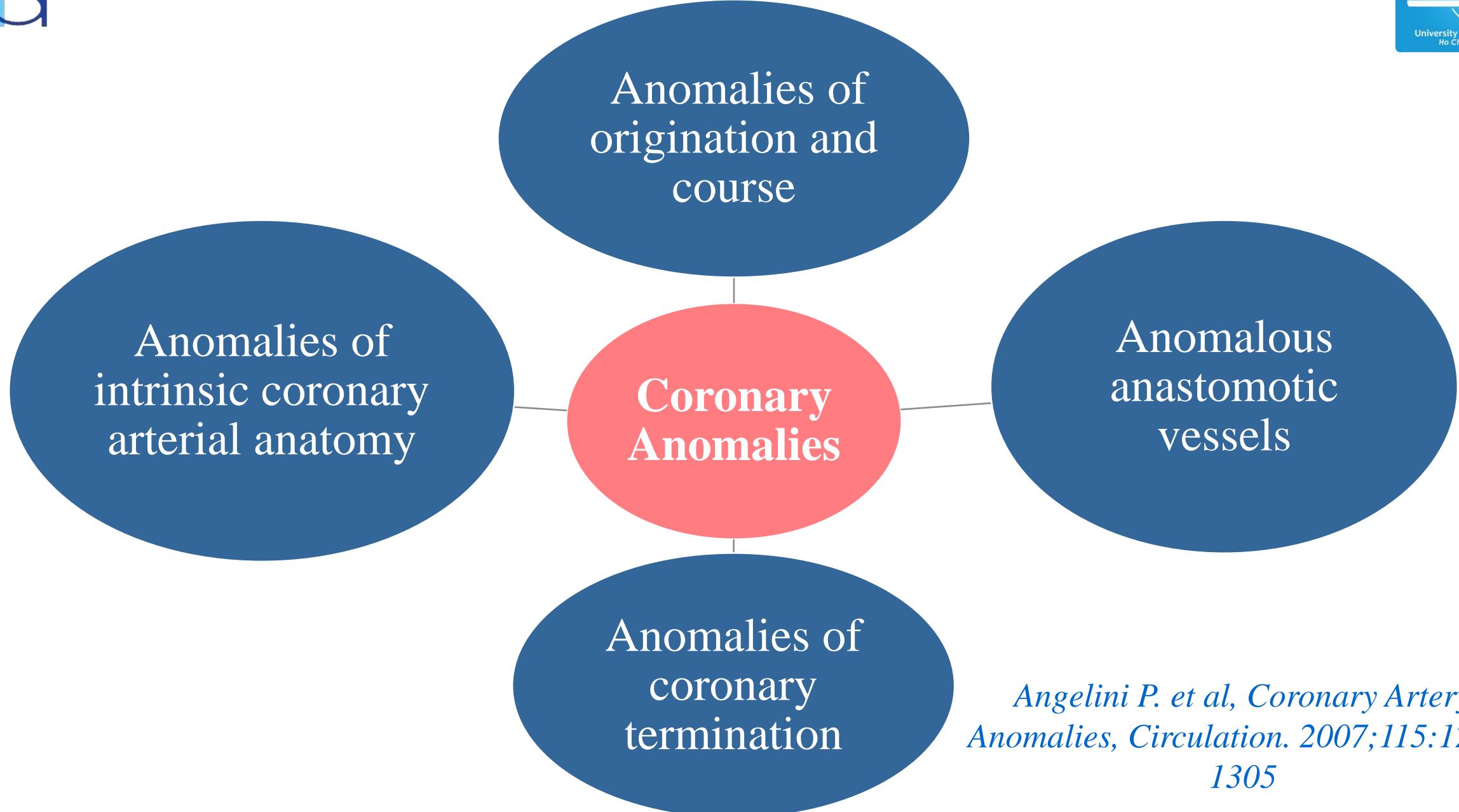
# Anomalies of origin and course

## *Single coronary artery:*

- 0.0024%– 0.044% of the population
- Follow the pattern of a normal RCA or LCA.
- Normal life expectancy
- Risk for sudden death if a major coronary branch crosses between the pulmonary artery and the aorta



# Classification of Coronary Anomalies in Human Hearts



*Angelini P. et al, Coronary Artery Anomalies, Circulation. 2007;115:1296-1305*

## B. Anomalies of intrinsic coronary arterial anatomy

1. Congenital ostial stenosis or atresia (LCA, LAD, RCA, Cx)
2. Coronary ostial dimple
3. Coronary ectasia or aneurysm
4. Absent coronary artery
5. Coronary hypoplasia
- 6. *Intramural coronary artery (muscular bridge)***
7. Subendocardial coronary course
8. Coronary crossing

## B. Anomalies of intrinsic coronary arterial anatomy

9. Anomalous origination of PDA from the anterior descending branch or a septal penetrating branch
10. Split RCA: proximal & distal PDA from RCA, PDA from RCA and LAD, parallel PDAs
11. Split LAD: **Double LAD**, LAD + first septal branch
12. Ectopic origination of first septal branch: RCA, right sinus...

# Anomalies of intrinsic coronary anatomy

## *Myocardial Bridge:*

- Middle segment of the LAD
- Angiography (0.5%–2.5%), autopsy (15%– 85%)
- CT coronary angiography (CTCA): 4% to 58%
- Asymtomatic, angina pectoris, myocardial infarction, life-threatening arrhythmias, or death,
- Hypertrophic cardiomyopathy.

MSCT + ECG-gated reconstruction: clearly, comparison of systolic phase vs diastolic phase → luminal narrowing during the systolic phase

## Myocardial bridge

Incomplete (partially)  
myocardial bridge

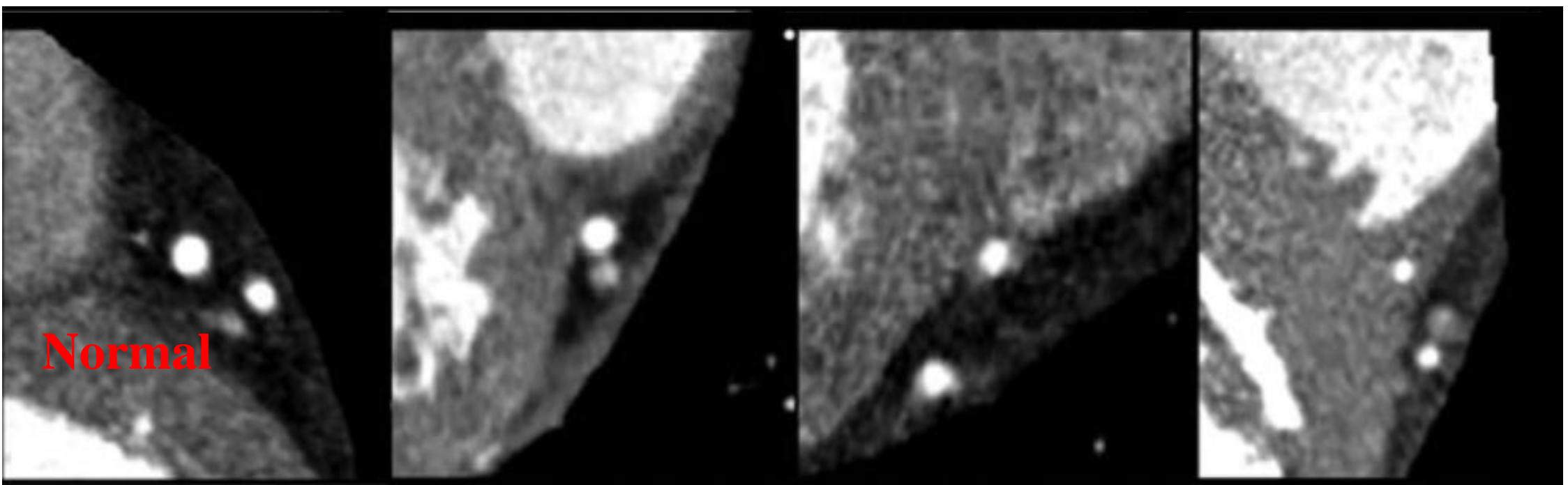
thin layer of connective tissue,  
nerves, and fatty tissue (<0,7mm)

Superficial(complete)  
myocardial bridge

1 or 2 mm

Deep myocardial  
bridge

> 2mm



**Index terms:**

Myocardial bridging

Computed tomography (CT)

Dual-source CT

CT coronary angiography

Conventional angiography

Coronary arteries

DOI:10.3348/kjr.2010.11.5.514

**Korean J Radiol 2010;11:514-521**

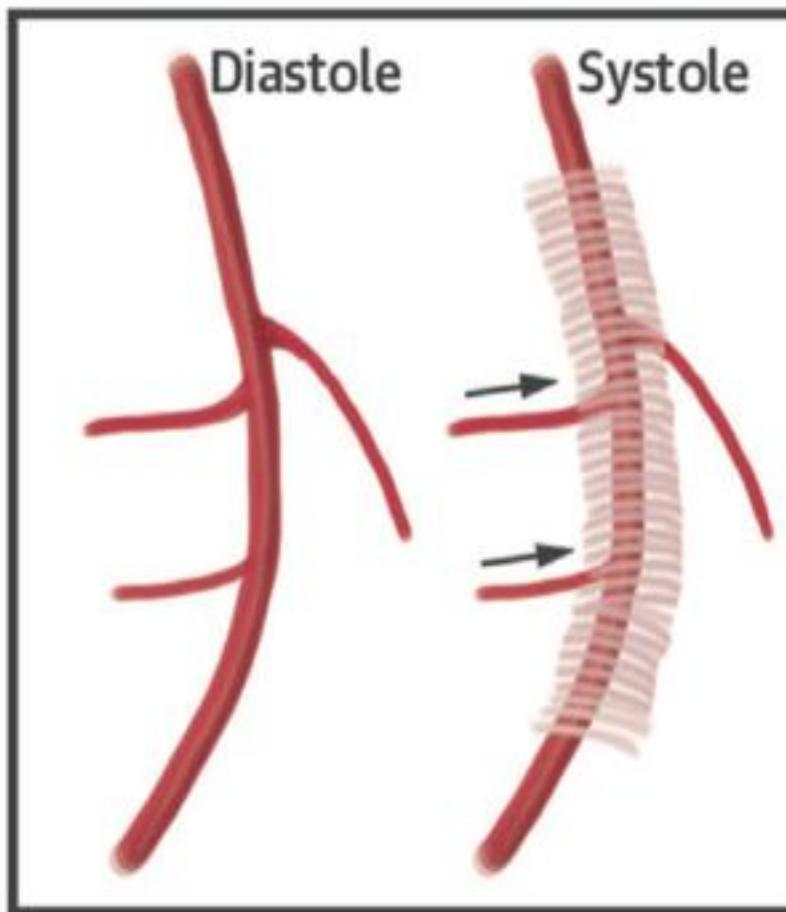
Received April 2, 2010; accepted  
after revision May 26, 2010.

**Results:** Of the 1,275 patients included in this study, 557 cases of MB were found from 536 patients (42%). Superficial MB was observed in 368 of 557 (66%) cases, and deep MB was seen in 189 of 557 (34%) cases. Superficial MB showed 2 types: complete (128 of 368, 35%) and incomplete (240 of 368, 65%). The mean length of a tunneled segment for superficial MB was  $16.4 \pm 8.6$  mm. The mean length and depth of a tunneled segment for deep MB were  $27.6 \pm 12.8$  mm and  $3.0 \pm 1.4$  mm, respectively. The incidence of atherosclerotic plaques in a 2-cm-long segment proximal to MB was 16%.

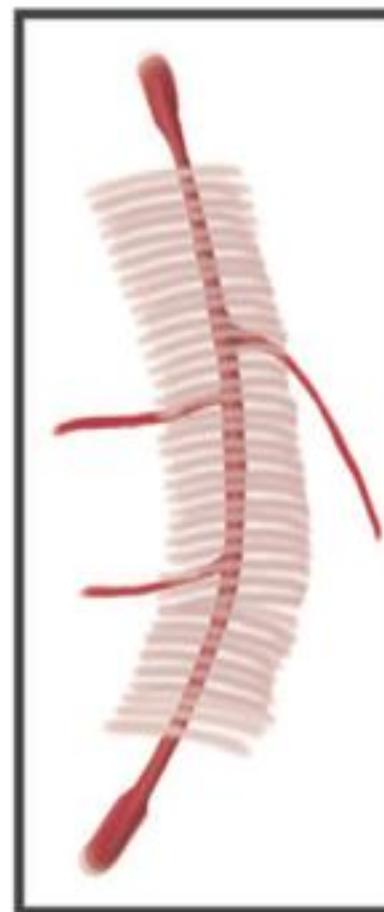
**Conclusion:** The depiction rate of LAD-MB using DSCT in a large series of patients was 42%, with two-thirds of MB segments being the superficial type.

# Potentially Symptomatic

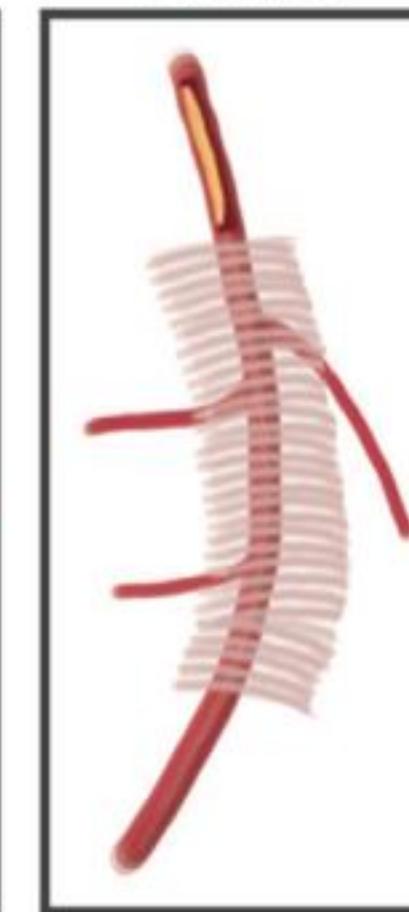
Myocardial Steal



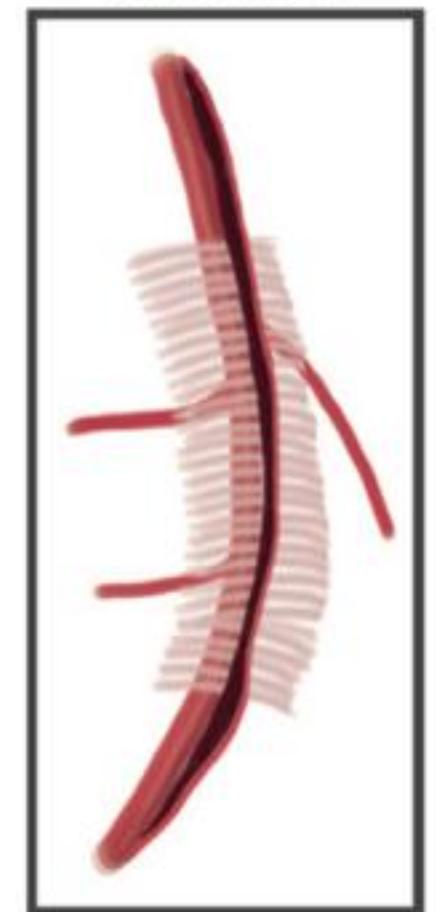
Coronary Spasm

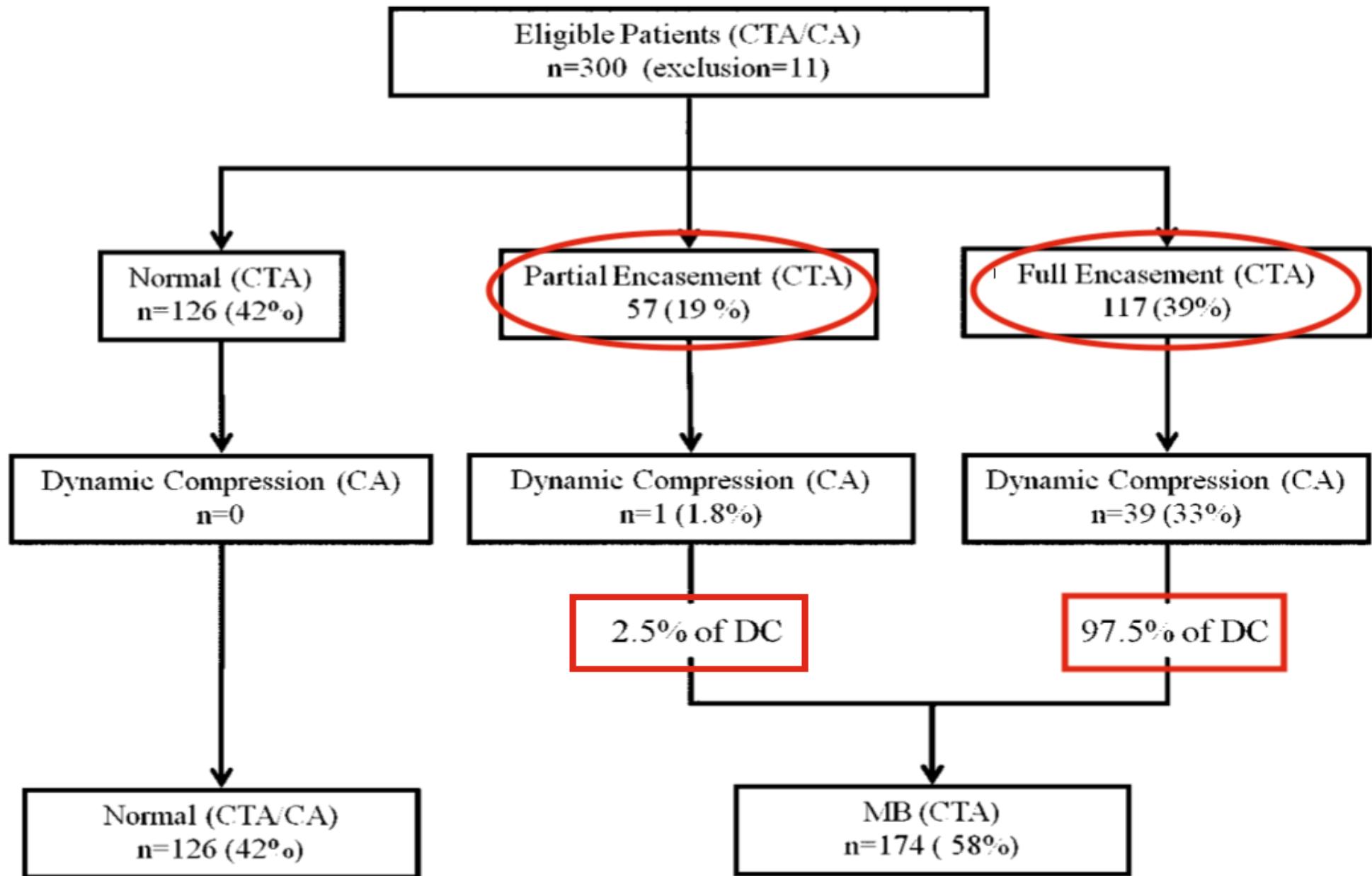


Coronary Artery Disease



Coronary Dissection

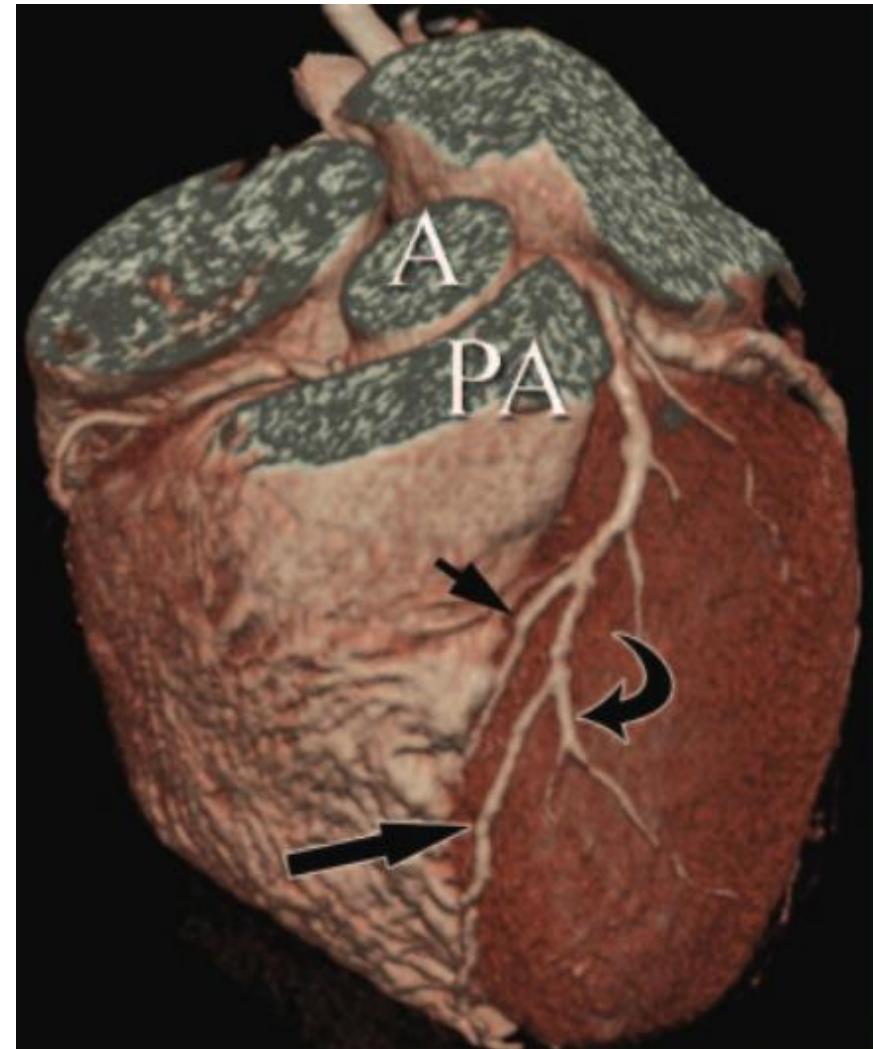




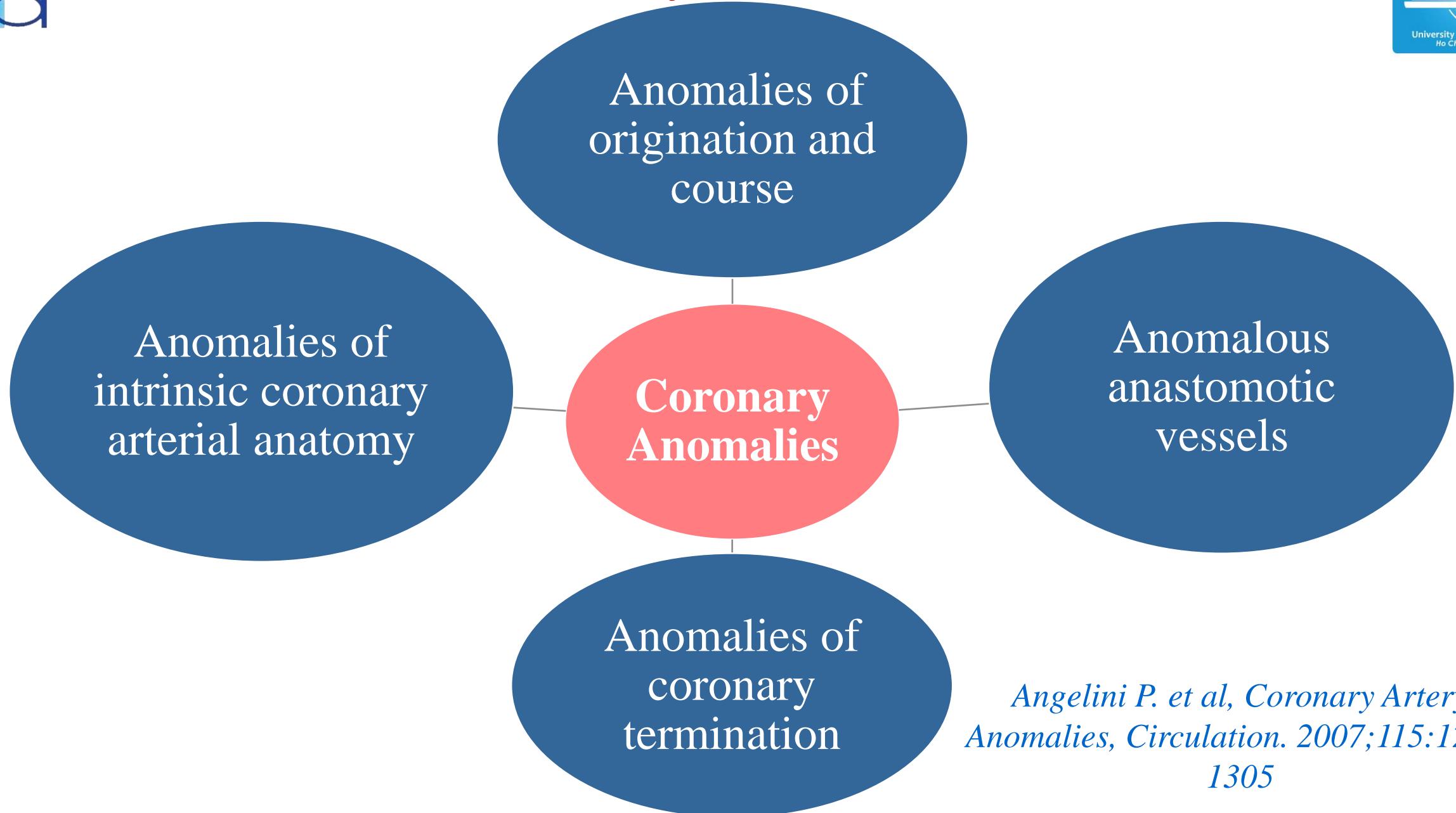
# Anomalies of intrinsic coronary anatomy

## *Duplication of LAD:*

- 0.13%–1% of the general population
- Short LAD: in the anterior interventricular sulcus without reaching the apex
- Long LAD: originates from LAD or RCA, enters the distal anterior interventricular sulcus and courses to the apex
- Bypass graft surgery: forewarn the cardiac surgeon
  - ≠ Diagonal branch running parallel: not reenter the anterior interventricular sulcus.



# Classification of Coronary Anomalies in Human Hearts



*Angelini P. et al, Coronary Artery Anomalies, Circulation. 2007;115:1296-1305*

## C. Anomalies of coronary termination

1. Inadequate arteriolar/capillary ramifications
2. *Fistulas from RCA, LCA, or infundibular artery*

## Coronary Artery Fistula:

### Classification of CAFs

|                   |  |
|-------------------|--|
| Vessel of origin  | LCA (LAD, ramus intermedius, LCX)<br>RCA<br>Anomalous coronary artery  |
| Segment of origin | Sakakibara type A: originating from proximal native vessel, distal artery normal<br>Sakakibara type B: entire coronary artery is dilated and terminates in right heart |
| Termination site  | Coronary arteriovenous fistulas (eg, coronary sinus, vena cavae, pulmonary artery, bronchial veins)<br>Coronary cameral fistulas (RA, RV, LA, LV)                      |
| Termination mode  | Macrofistulas: discrete fistulous vessel<br>Microfistulas: contrast blush without discrete vessel  |
| Morphology        | Simple (single origin, single vessel, single termination)<br>Complex   |
| Number            | Single<br>Multiple   |

Source.—Reference 27.

Note.—LA = left atrium, LCX = left circumflex coronary artery, LV = left ventricle, RA = right atrium, RV = right ventricle.

# **Coronary Artery Fistula**

## CT imaging features:

### \* Pretreatment Imaging:

- Dilated, tortuous coronary artery
- Abnormal communication with another cardiovascular structure
- Dilated left ventricle (left-to-left shunts)
- Biventricular and pulmonary arterial dilatation (left-to-right shunts)

### \* Posttreatment Complications:

- Aneurysmal dilatation, thrombosis of the CAF after coil embolization
- Coil or device migration or embolization

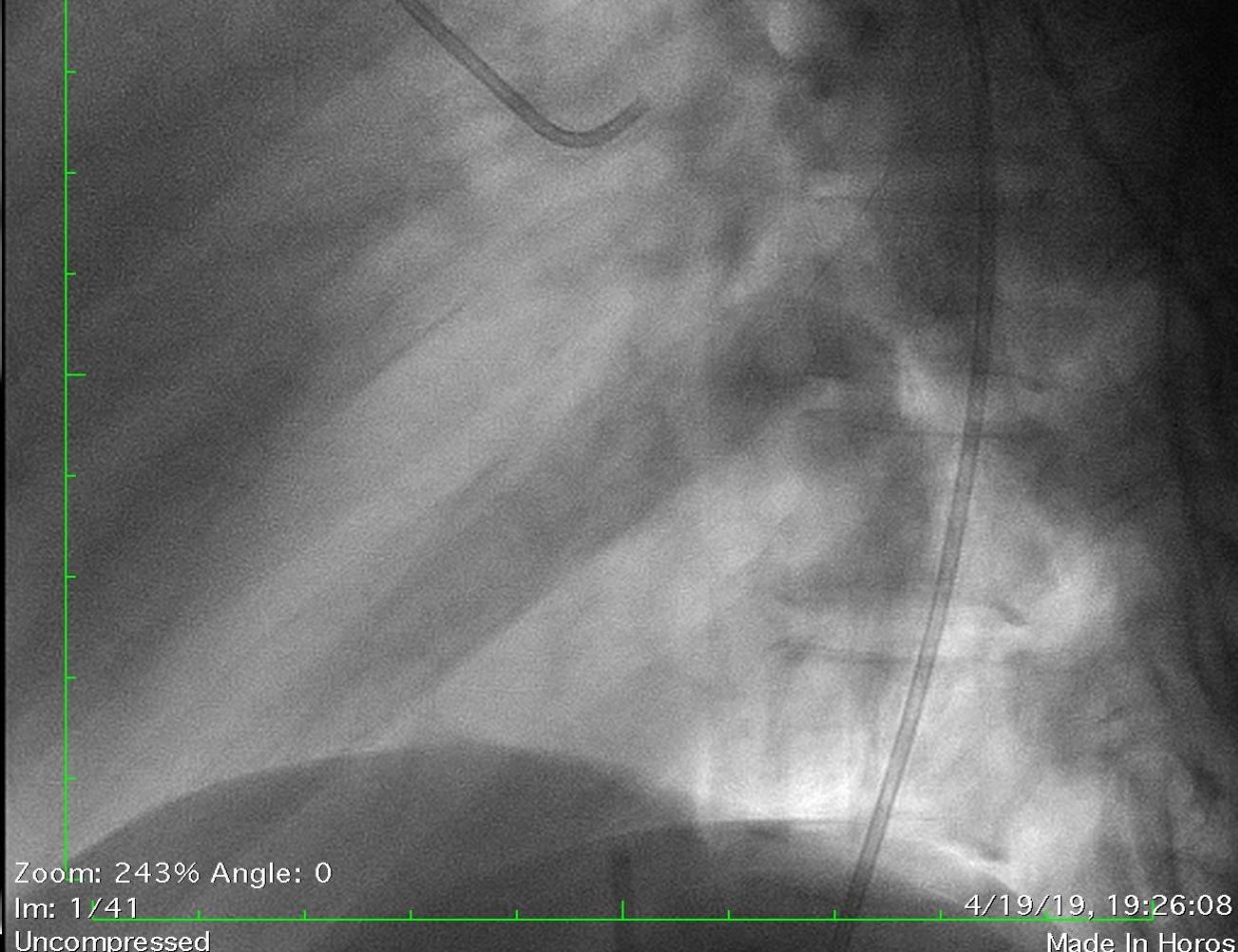
Image size: 1024 x 1024  
View size: 1246 x 1246  
WL: 127 WW: 255

N19-0106675 ( 19 y , 18 y )  
Cardiac 2\_Cas\_Coronarycta\_Spiral (Adult)  
2\_CaS\_CoronaryCTA\_Spiral  
1430



Image size: 512 x 512  
View size: 1242 x 1240  
WL: 66 WW: 130

N19-0106675 ( 19 y , 18 y )  
Cardiac  
Cardiac  
1011

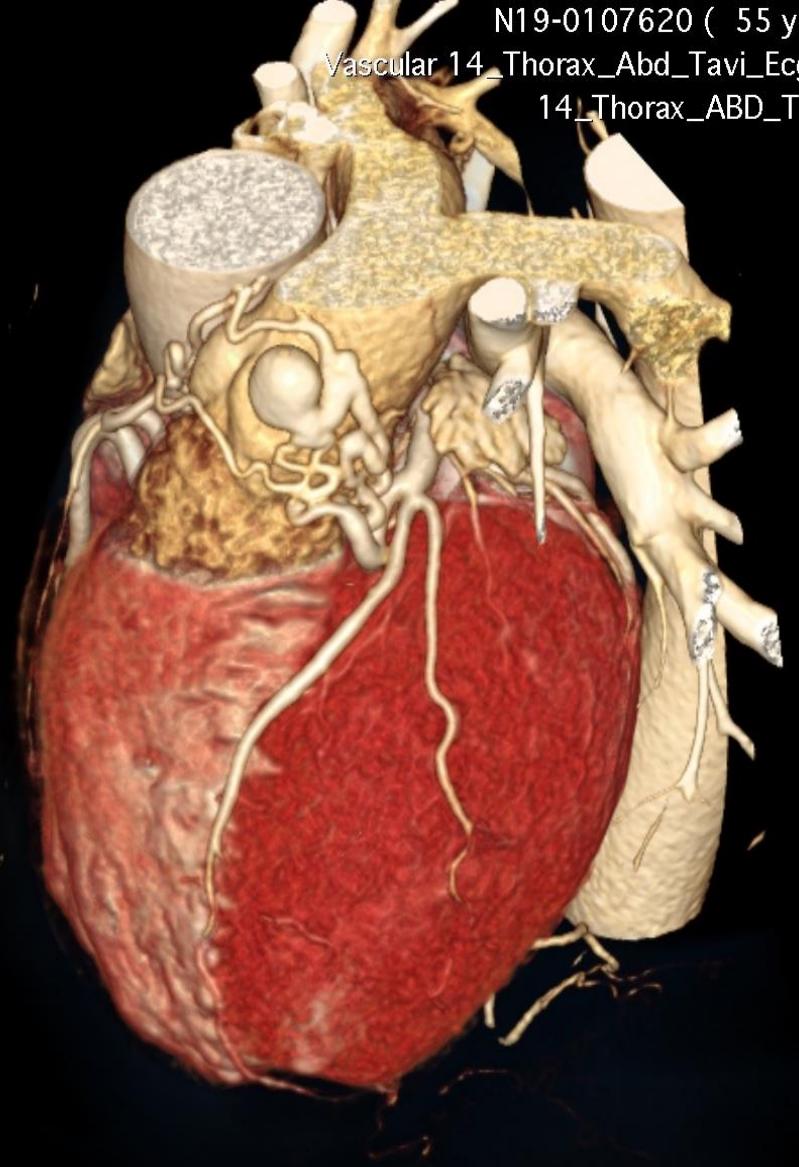


A 19 year-old female with unstable angina.  
*CTCA: LCX to right atrium fistula*

Image size: 717 x 700  
View size: 1278 x 1248  
WL: 127 WW: 255

N19-0107620 ( 55 y , 54 y ) Image size: 512 x 513  
Vascular 14\_Thorax\_Abd\_Tavi\_Ecg (Adult) View size: 1245 x 1247  
14\_Thorax\_ABD\_TAVI\_ECG WL: 242 WW: 694  
1528

A N19-0107620 ( 55 y , 54 y )  
Vascular 14\_Thorax\_Abd\_Tavi\_Ecg (Adult)  
14\_Thorax\_ABD\_TAVI\_ECG  
1524



A 55 year-old male with unstable angina.  
***CTCA: left coronary artery to PA fistula***

## Findings in Patients in whom a Coronary Artery Anomaly was Confirmed at Surgery

| Patient No./Age (y)/Sex | Diagnosis   | Coronary Artery Anomaly             |                |
|-------------------------|---|-------------------------------------|----------------|
|                         |   | ACA                                 | Course of ACA  |
| 1/3.1/F                 | Hypoplastic RV, pulmonary atresia, patient underwent Hemi-Fontan procedure  | LMT from the RCA                    | Anterior to PA |
| 2/2.0/F                 | TOF, patient underwent surgical repair                                      | LAD from the RCA                    | Anterior to PA |
| 3/4.6/M                 | TOF, patient underwent surgical repair                                      | Coronary artery branch from the LAD | Across RVOT    |
| 4/3.7/M                 | DORV, VSD, subvalvular PS, patient underwent creation of right modified BTS | LAD from the anterior aortic cusp   | Anterior to PA |

Note.—ACA = abnormal coronary artery, BTS = Blalock-Taussig shunt, DORV = double-outlet right ventricle, LAD = left anterior descending artery, LMT = left main trunk, PA = pulmonary artery, PS = pulmonary stenosis, RCA = right coronary artery, RV = right ventricle, RVOT = right ventricular outflow tract, TOF = tetralogy of Fallot, VSD = ventricular septal defect.

# Conclusion

- Anomalous origin of Coronary artery from opposite sinus with interarterial course (intramural segment), coronary artery origin from the pulmonary artery, coronary artery fistula: early diagnosis.
- Coronary CT angiography: excellent noninvasive imaging  
→ reduce radiation dose (dual source CT-Scanner).



# THANK YOU FOR LISTENING