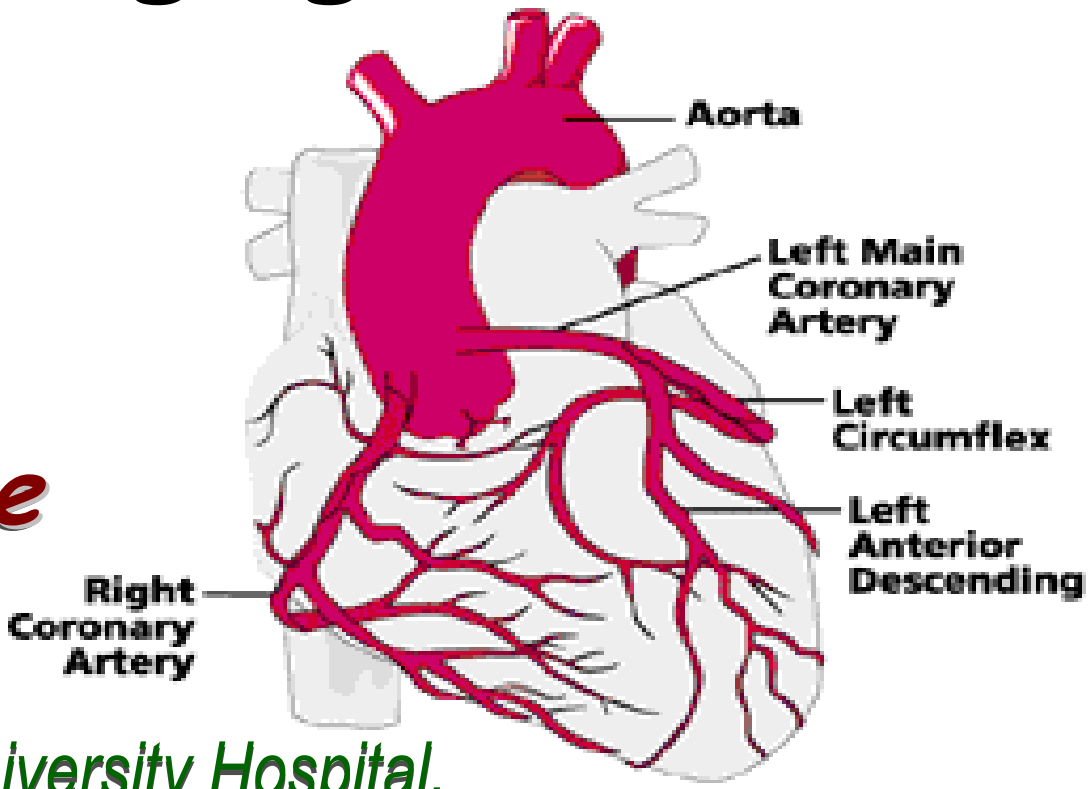
Interpretation of Coronary Angiogram



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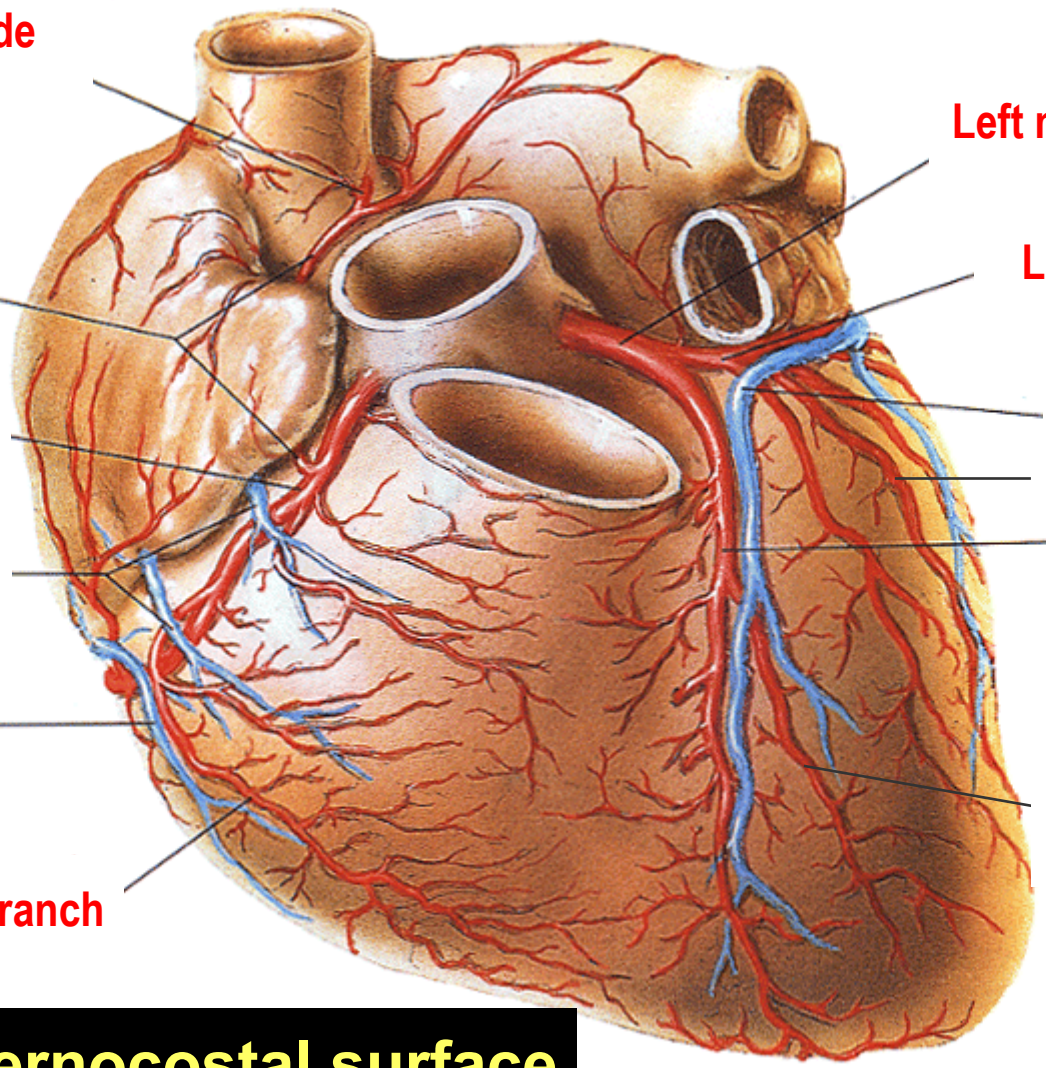
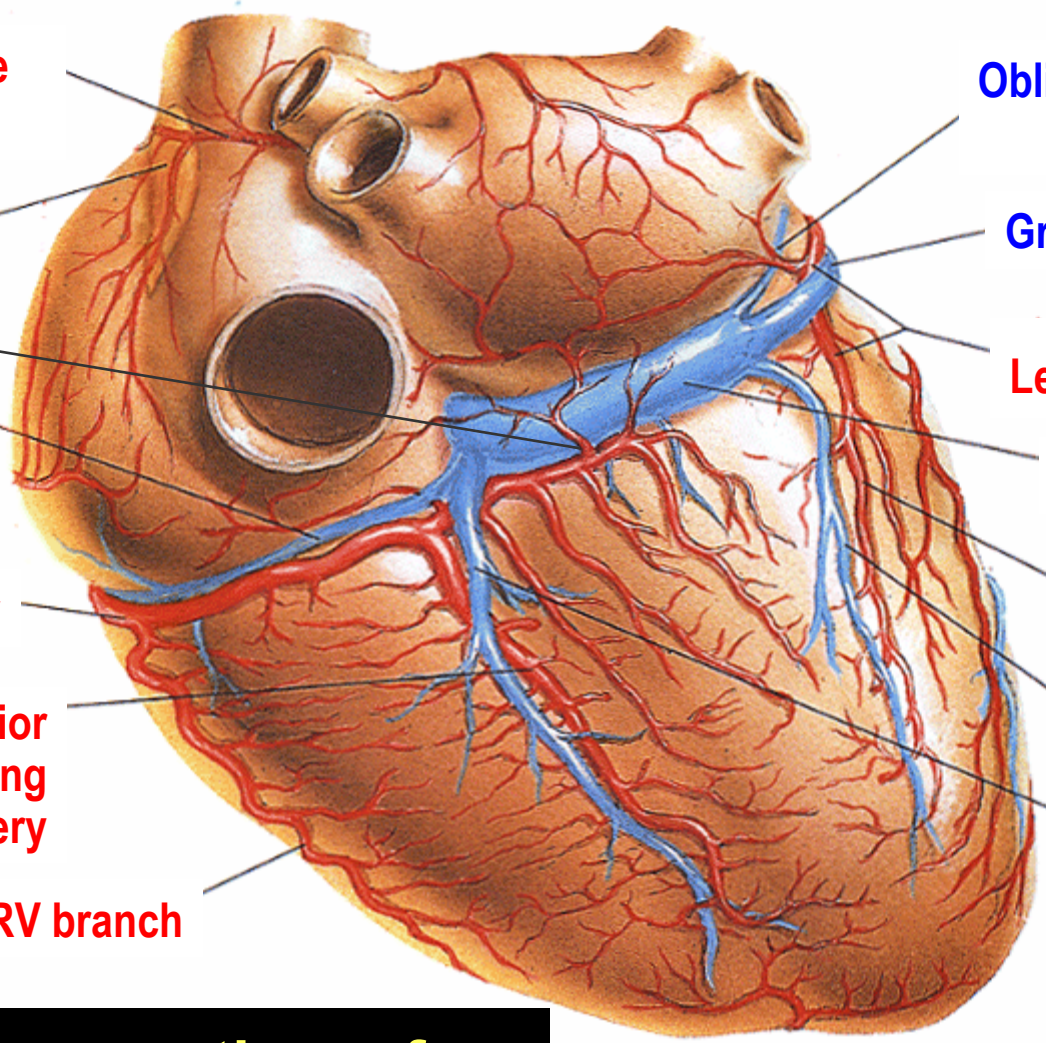
Coronary Anatomy



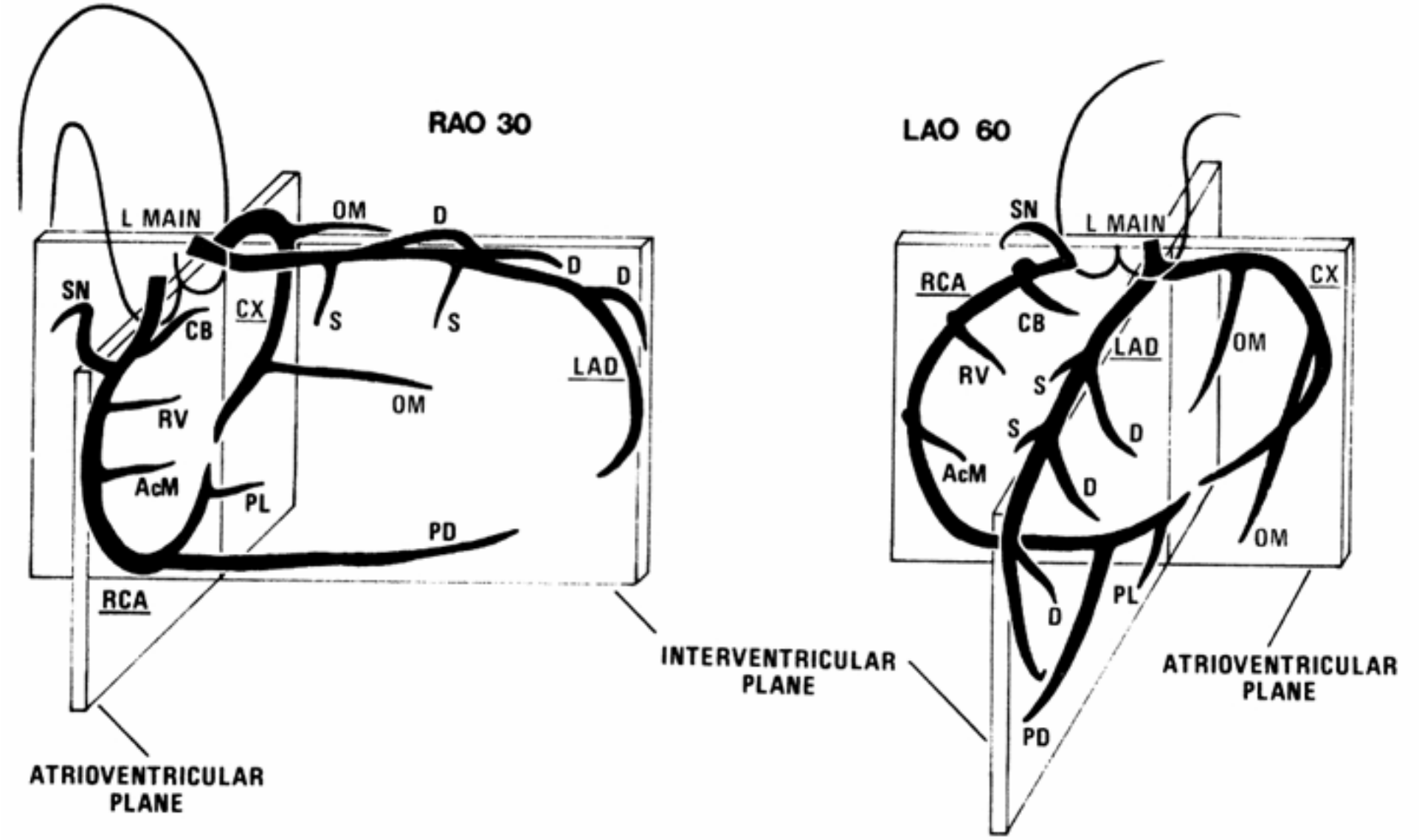
Sternocostal surface

Coronary Anatomy

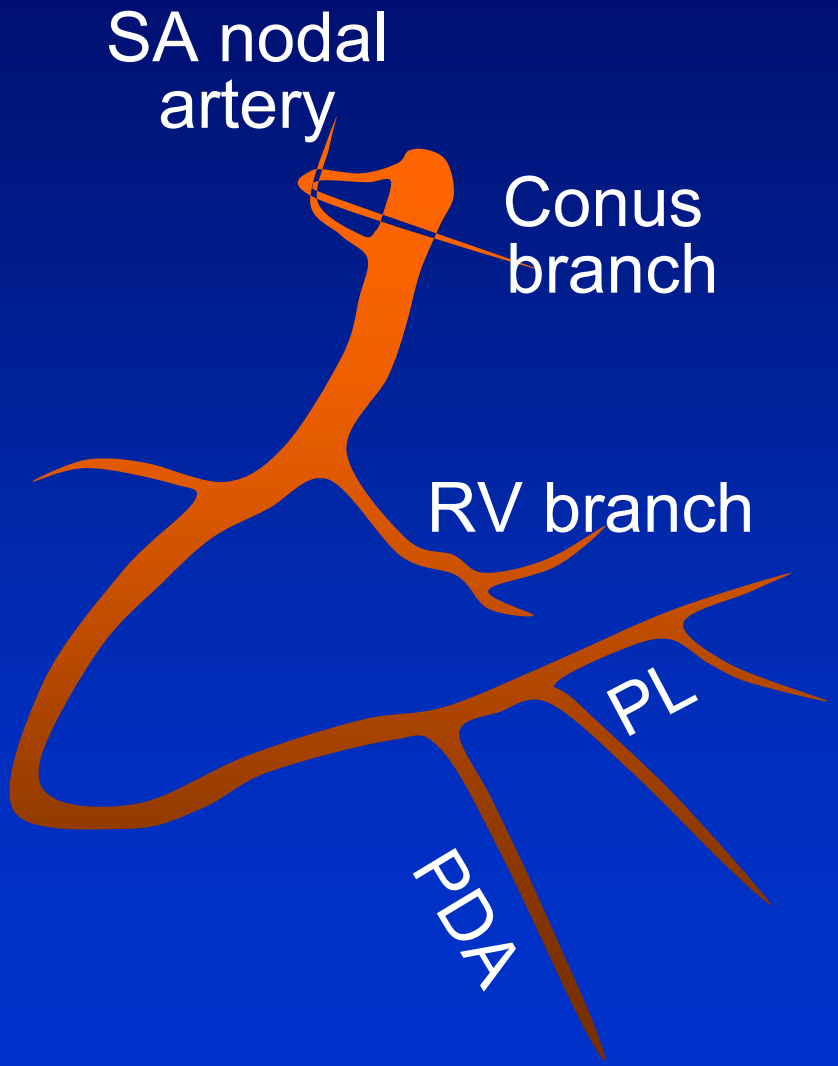


Diaphragmatic surface

Atrioventricular and Interventricular Planes



Right Coronary Artery



Right Coronary Artery

Basic Anatomy

- ***Origin***

  - Right aortic sinus (lower origin than LCA)

- ***Course***

  - Right-dominant system (85%)

    Down right AV groove toward crux of the heart, gives off PDA from which septals arise, continues in left AV groove giving off PL branches.

- ***Supplies to LV***

  - 25-35% of LV

Right Coronary Artery

Other Branches

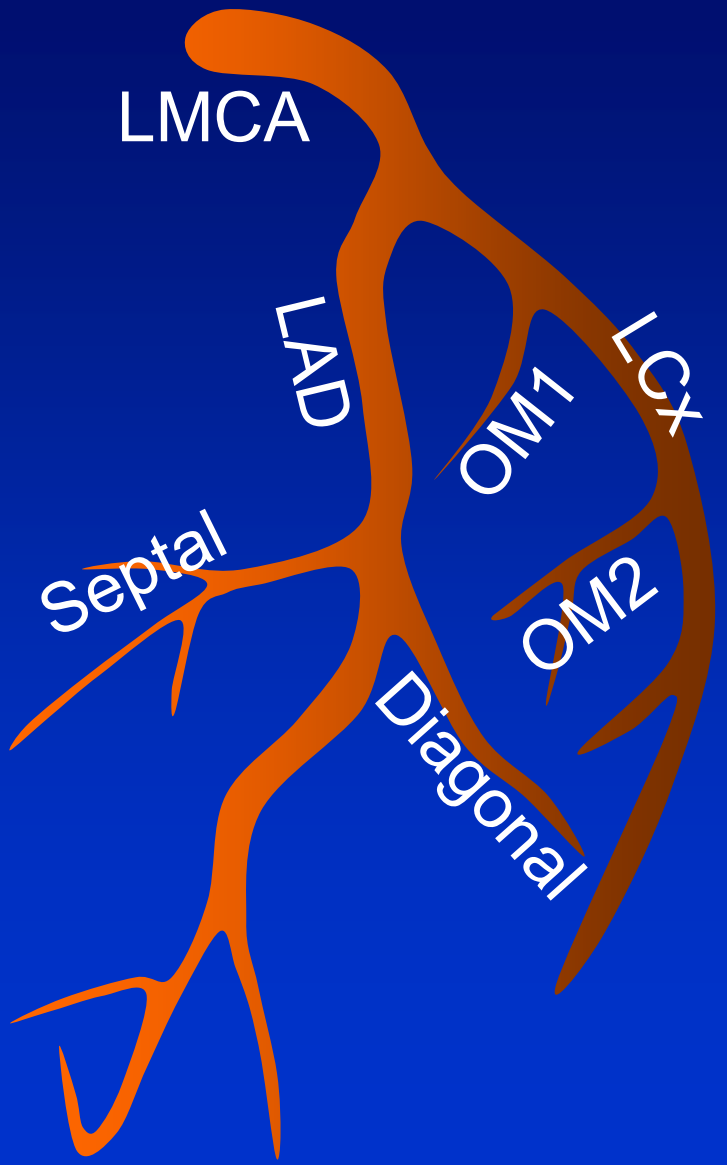
- ***Conus Artery***
  - Usually very proximal
  - ~50% have a separate origin
  - Courses anteriorly and upward over the RVOT
  - May be an important source of collaterals
- ***SA Nodal Artery***
  - Usually 2nd branch of RCA
  - Courses obliquely backward through upper portion of atrial septum and anteromedial wall of the RA
  - Supplies SA node, RA and sometimes LA

Right Coronary Artery

Other Branches

- ***Right Ventricular (Acute Marginal Branches)***
  - Arise from mid RCA; Supply anterior RV
  - May be a collateral source
- ***AV Nodal Artery***
  - Arises at or near crux; Supplies AV node
- ***Posterior Descending Artery (PDA)***
  - Supplies inferior wall, ventricular septum, posteromedial papillary muscle
- ***Posterolateral Artery (PL)***
  - From crux to left AV groove → Meet LCx artery

Left Coronary Artery



Left Coronary Artery

Left Main Coronary Artery

- ***Origin***
  - Upper portion of the left aortic sinus just below the sinotubular ridge.
  - Typically about 10 mm in length
- ***Optimal Views***
  - Caudal views might be the best to evaluate LMCA and both LAD and LCx ostia
  - Shallow LAO cranial view for ostial evaluation
  - Sometimes, RAO cranial will be helpful for ostial LAD evaluation

Left Coronary Artery

LAD Artery

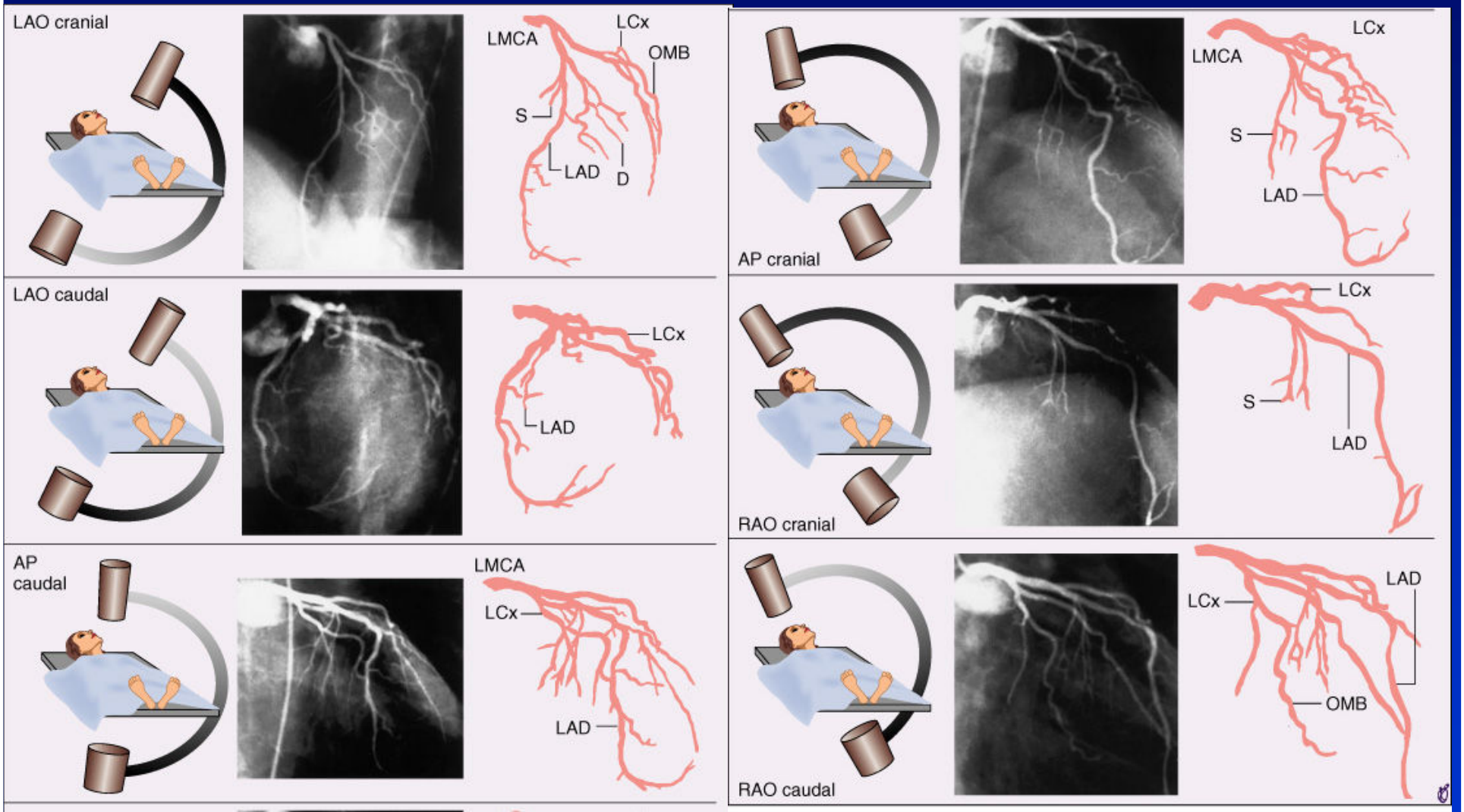
- ***Course***
  - Down the anterior interventricular groove
  - Usually reaches apex; 22% does not reach apex
  - Some have twin LADs (one for entire septal and the other for surface LAD)
- ***Branches***
  - Septals; root-like, intramyocardial, less movement
  - Diagonals; supply lateral LV, anterolateral papillary m.
  - 1/3 have ramus intermedius (RI)
- ***LV Supplies***
  - 45~55% of LV; anterolateral, apex, and septum

Left Coronary Artery

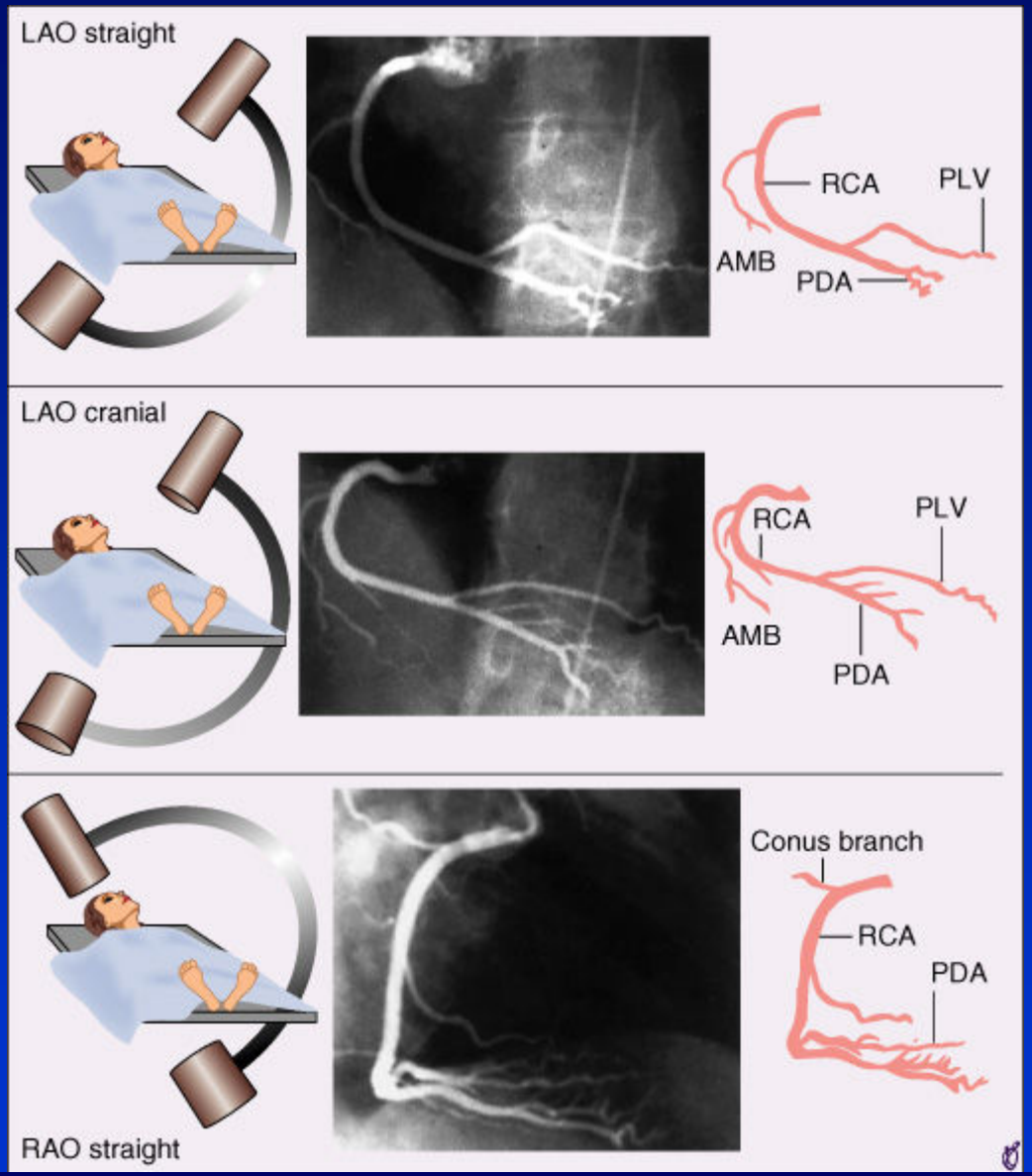
LCx Artery

- ***Course***
  - Down distal left AV groove
  - Left-dominant system (8%)
    → supply PL, PDA and AV nodal arteries
  - Balanced system (7%)
    → PDA from RCA, PL from LCx
- ***Branches***
  - Obtuse marginal; lateral free wall of LV
- ***LV Supplies***
  - 15~25% of LV
  - 40~50% in dominant LCx system

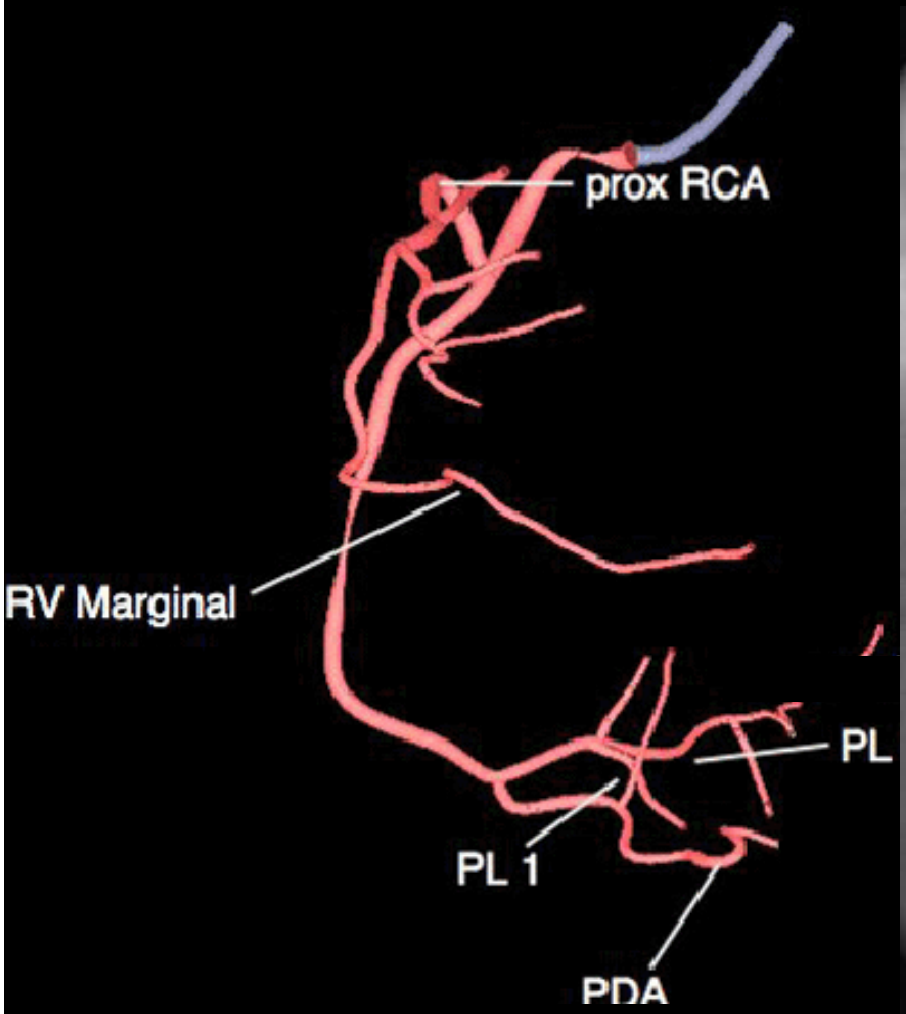
Left Coronary Angiogram



Right Coronary Angiogram

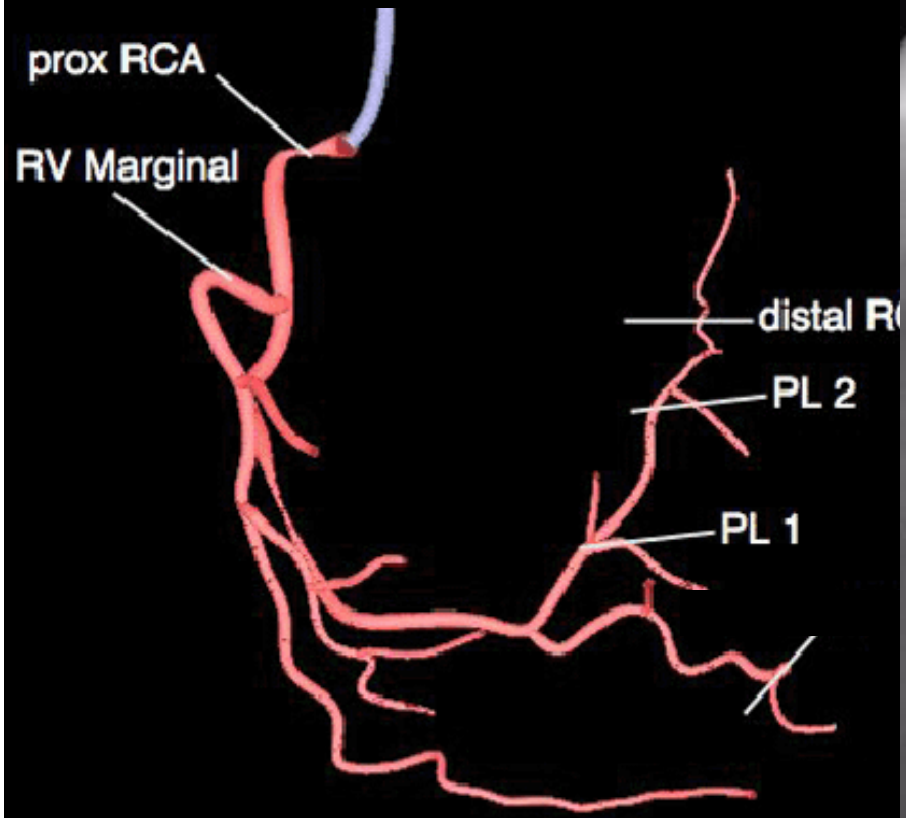


Right Coronary Angiogram



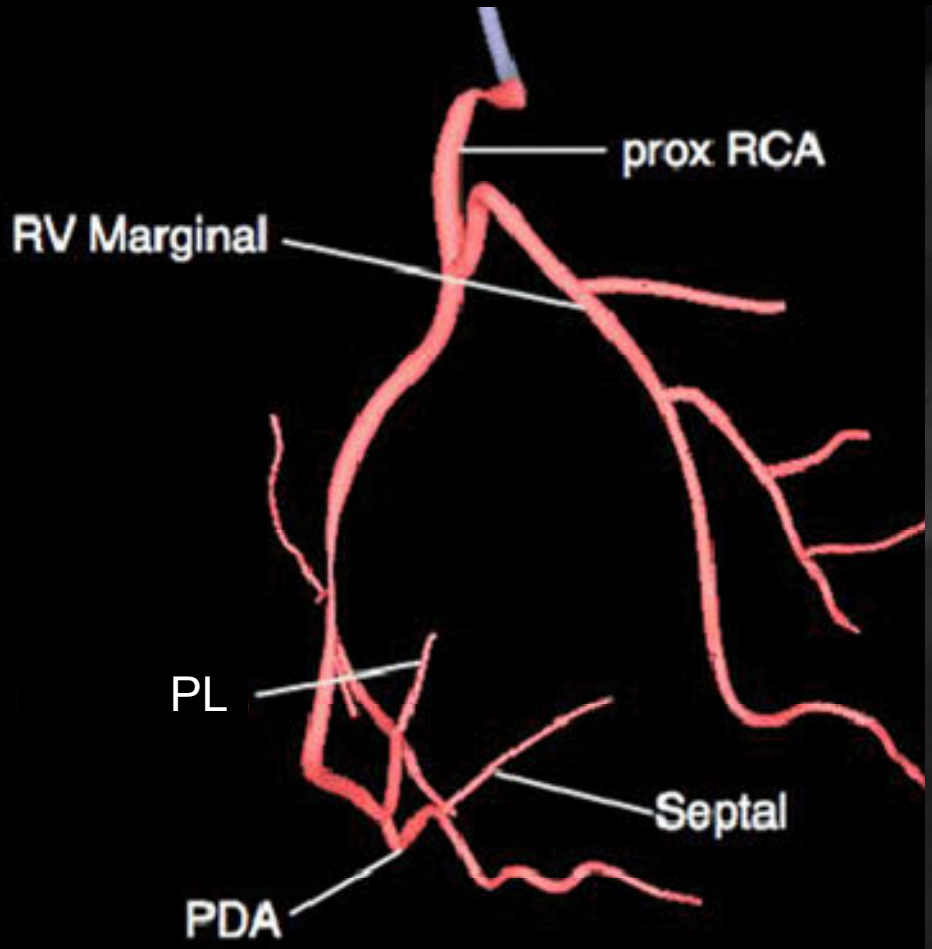
LAO view

Right Coronary Angiogram



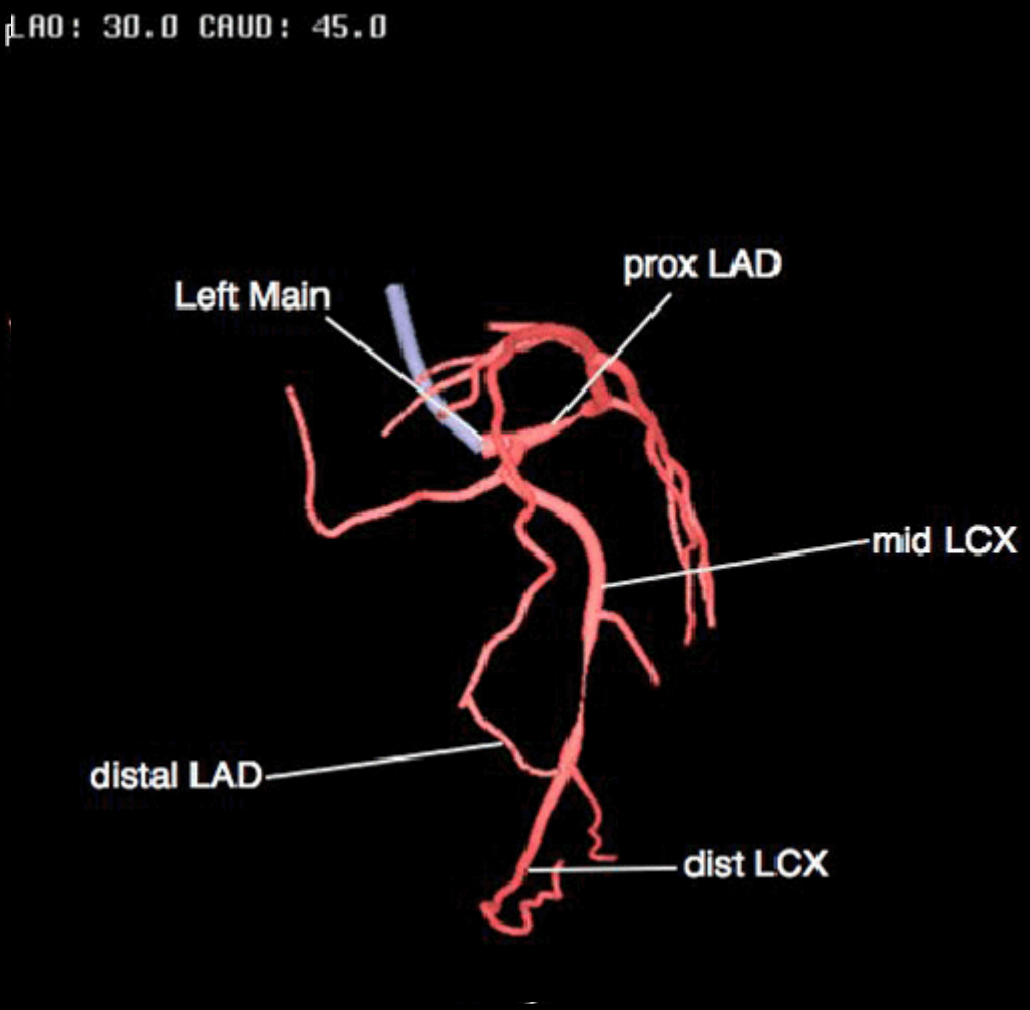
AP or LAO cranial view

Right Coronary Angiogram



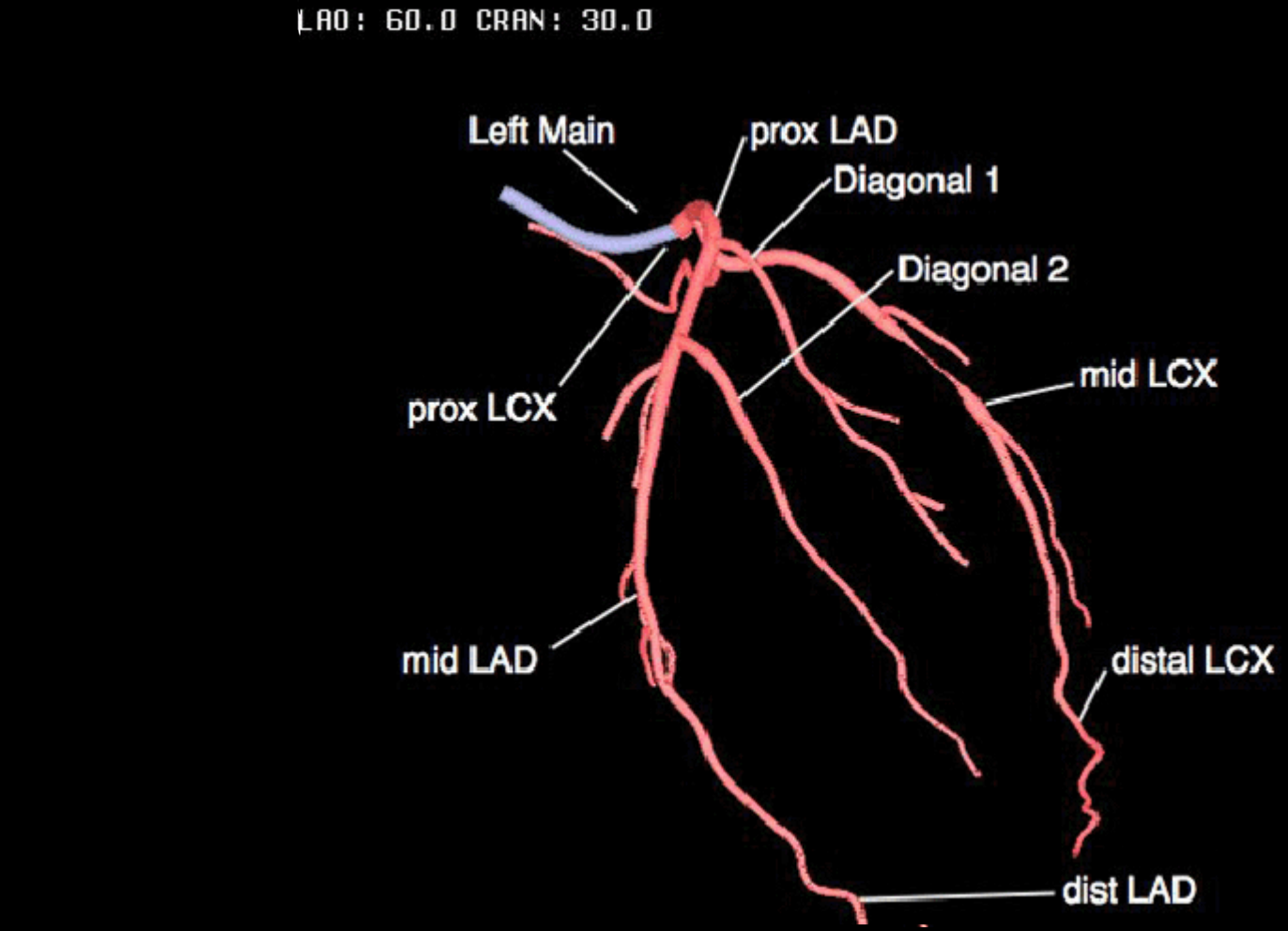
RAO view

Left Coronary Angiogram



Caudal View

Left Coronary Angiogram

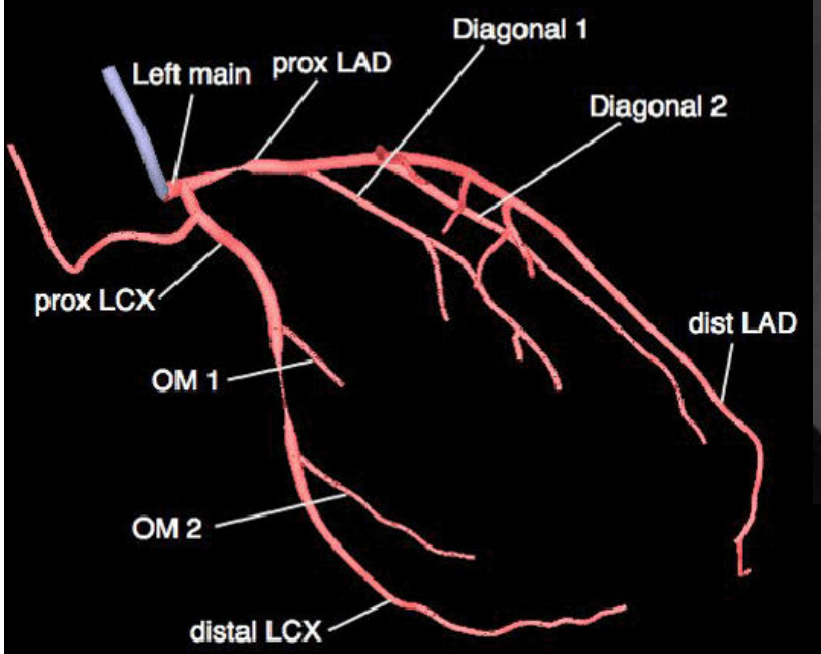


Cranial View

LAD vs. LCx ?

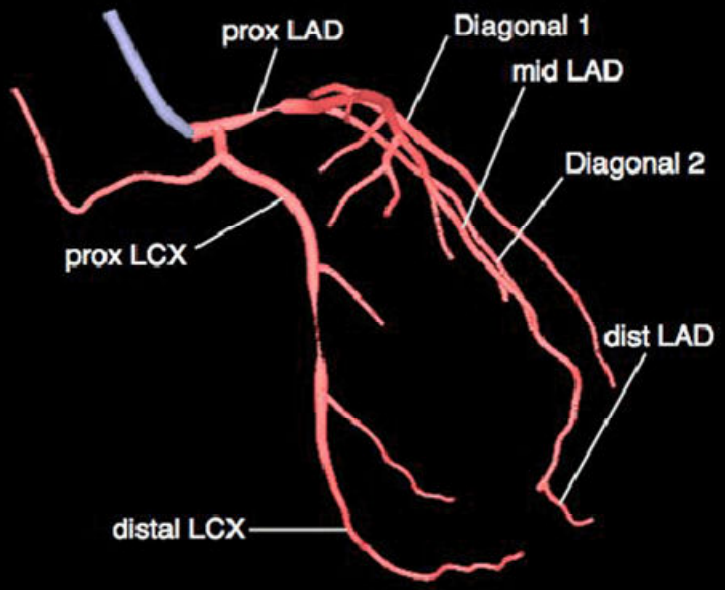
RAO Caudal


PHILIPS
RAO: 30.0 CAUD: 30.0

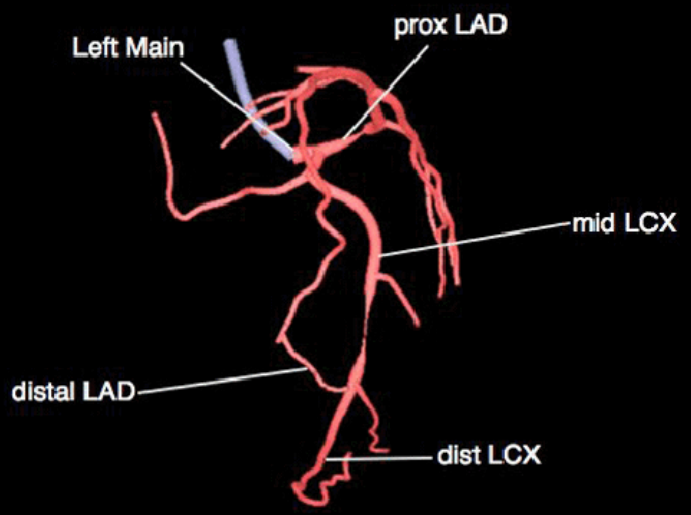

Diagonal 1
Left main
prox LAD
Diagonal 2
prox LCX
dist LAD
OM 1
OM 2
distal LCX

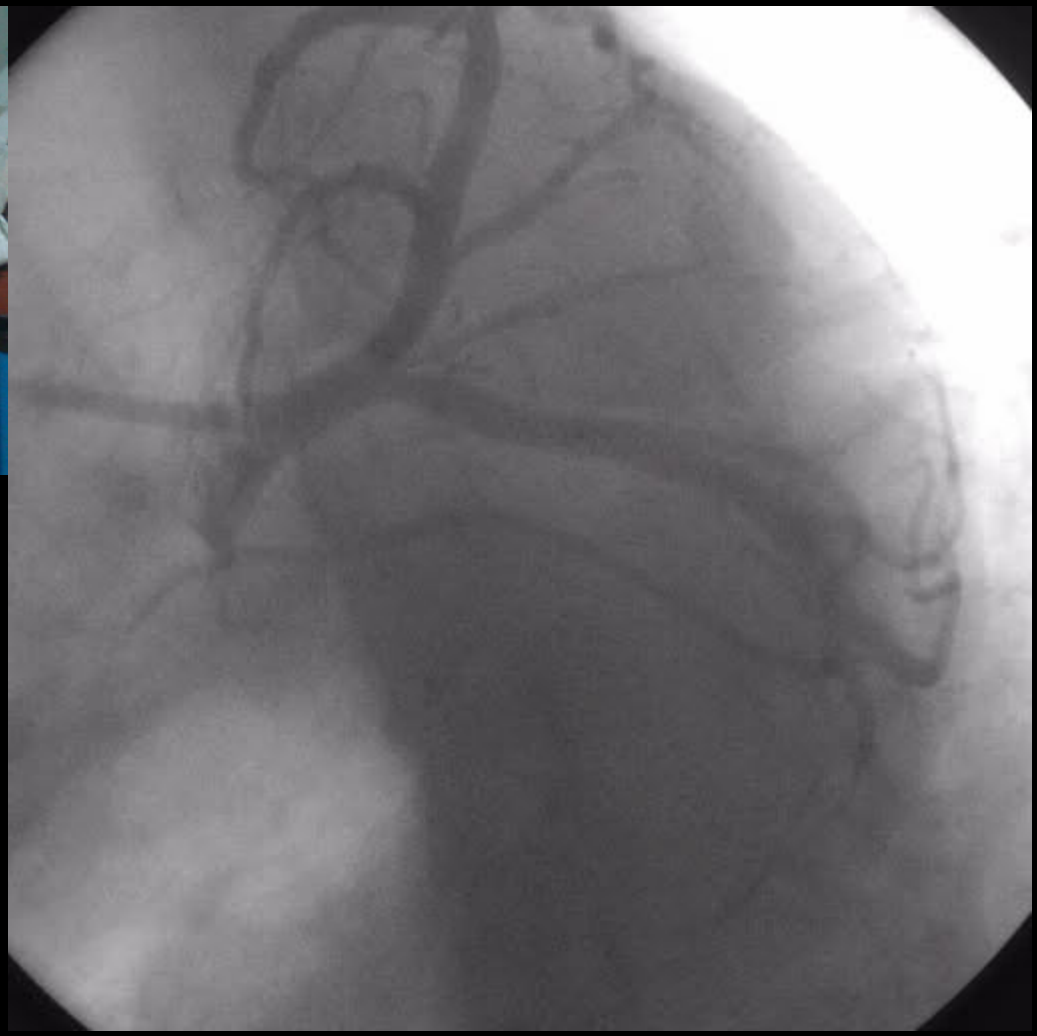
AP Caudal

RAO: 0.0 CAUD: 30.0



LAO Caudal (Spider)



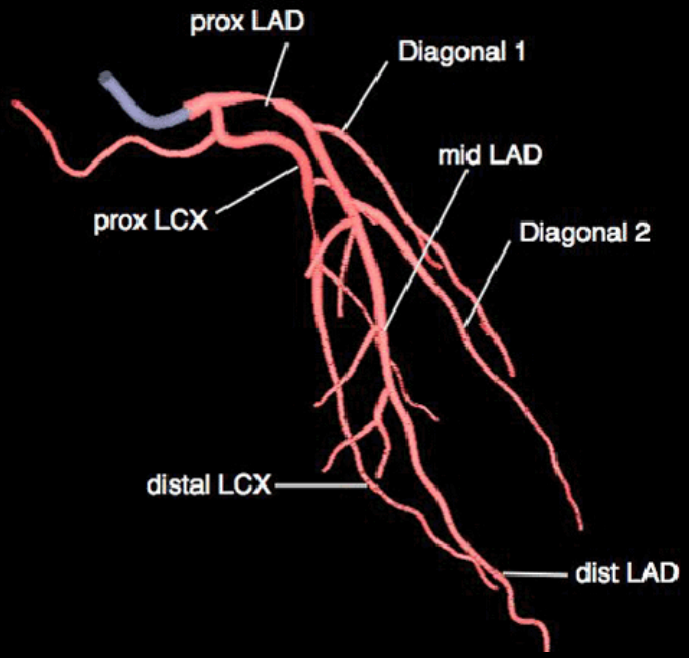


RAO Cranial


RAO: 30.0 CRAN: 30.0
prox LAD
Diagonal 1
prox LCX
OM 1
OM 2
dist LAD
distal LCX

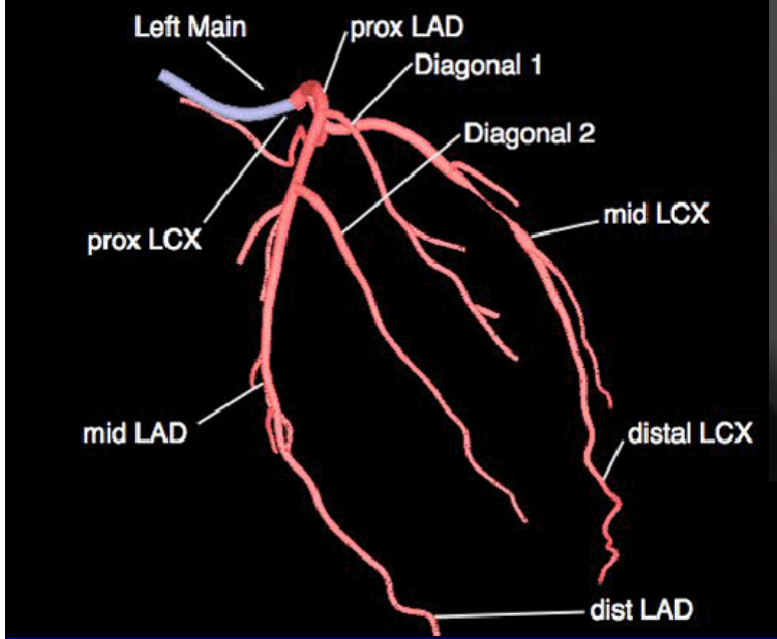
AP Cranial


RAO: 0.0 CRAN: 30.0


prox LAD
Diagonal 1
mid LAD
prox LCX
Diagonal 2
distal LCX
dist LAD

LAO Cranial

LAO: 60.0 CRAN: 30.0



Lesion Description

Lesion Description

Number of vessels diseased

- **>50% DS in Five major vessels >2mm diameter**
  - LAD → LAD, Dx, Septal, RI
  - LCx → LCx, OM
  - RCA → RCA, RV, PDA, PL
  - LMCA
  - Graft → LIMA, SVG, GEA, RA

Ex) LAD + OM → 2 VD
LMCA disease → 2 VD
LMCA + mRCA → 3 VD
LAD + Small PCA (Ø=1.0mm) → 1 VD

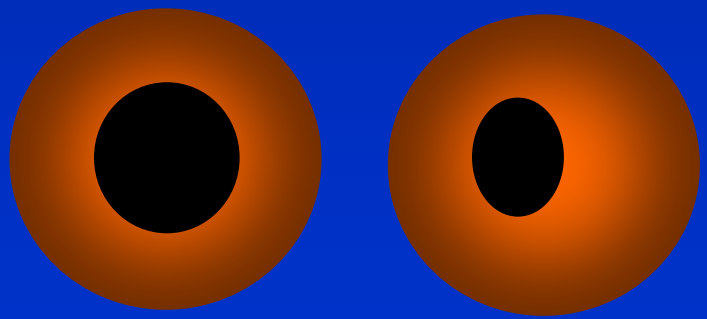
Lesion Description

Lesion length

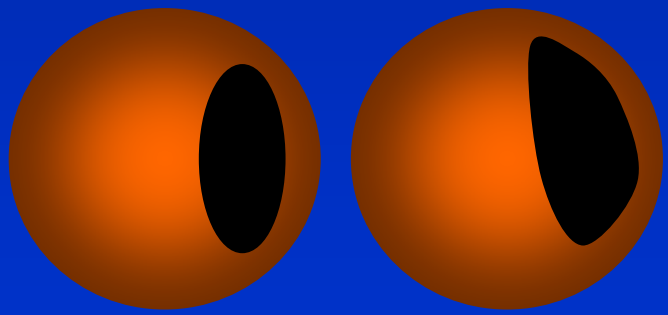
- Discrete: <10 mm in length
- Tubular: 10~20 mm in length
- Diffuse: >20 mm in length

Eccentricity

- Concentric; 병변의 축이 중간 **50%** 이내에 있는 경우
- Eccentric; 병변의 축이 양쪽 side의 **25%** 밖에 있는 경우



Concentric



Eccentric

Lesion Description

Arrangement of the lesions

- Tandem; two lesions located within one balloon length
- Sequential; two lesions located at a distance longer than the balloon

Contour

- Smooth vs. Irregular
- Ulceration; lesions with a small crater consisting of a discrete luminal widening in the area of stenosis

Lesion Description

Proximal vessel tortuosity (accessibility)

- **Number of >75º bends to reach the lesion**
  - None
  - Mild; one bends
  - Moderate; two bends
  - Severe; ≥ three bends

Lesion angulation

- None/Mild; lesion located on a straight segment or a bend <45º
- Moderate; 45º~90º bend
- Severe; bend >90º

Lesion Description

Calcification

- None
- Mild; densities noted only after contrast injection
- Moderate; densities noted only with cardiac motion prior to contrast injection
- Severe; radiopacities noted without cardiac motion prior to contrast injection

Thrombus

- Discrete, intraluminal filling defect is noted with defined borders and is largely separated from the adjacent wall
- Contrast staining may or may not be present

Lesion Description

Ostial lesion

- **Origin of the lesion ≤ 3mm of the vessel origin**

  - Aorto-ostial; aortic junction과 경계부위 (LMCA, pRCA)

  - Branch-ostial; aorta와 경계 부위가 아니면서 major epicardial artery의 분지부

    LAD & LCx os

    Dx os

    OM os

    PDA and PL os

Lesion Description

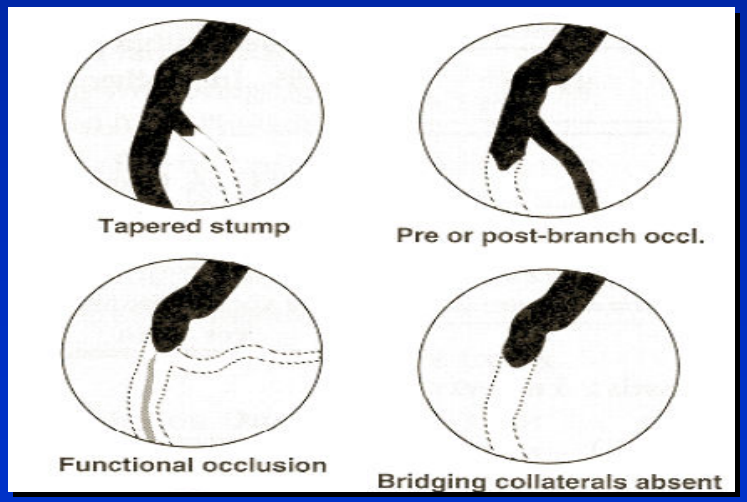
Chronic total occlusion (CTO)

- **TIMI 0 or 1**

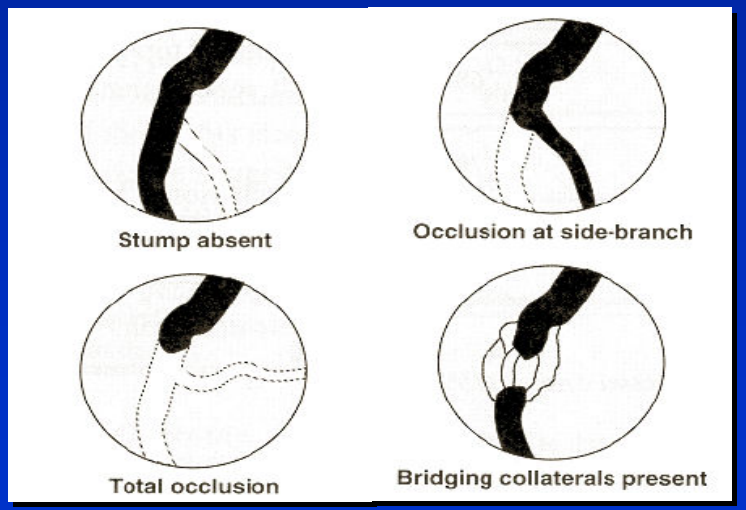
  - Duration; usually more than 3 months

    ; defined by clinical history (Sx onset, MI, …)

- **Angiographic predictor of PCI success/failure**



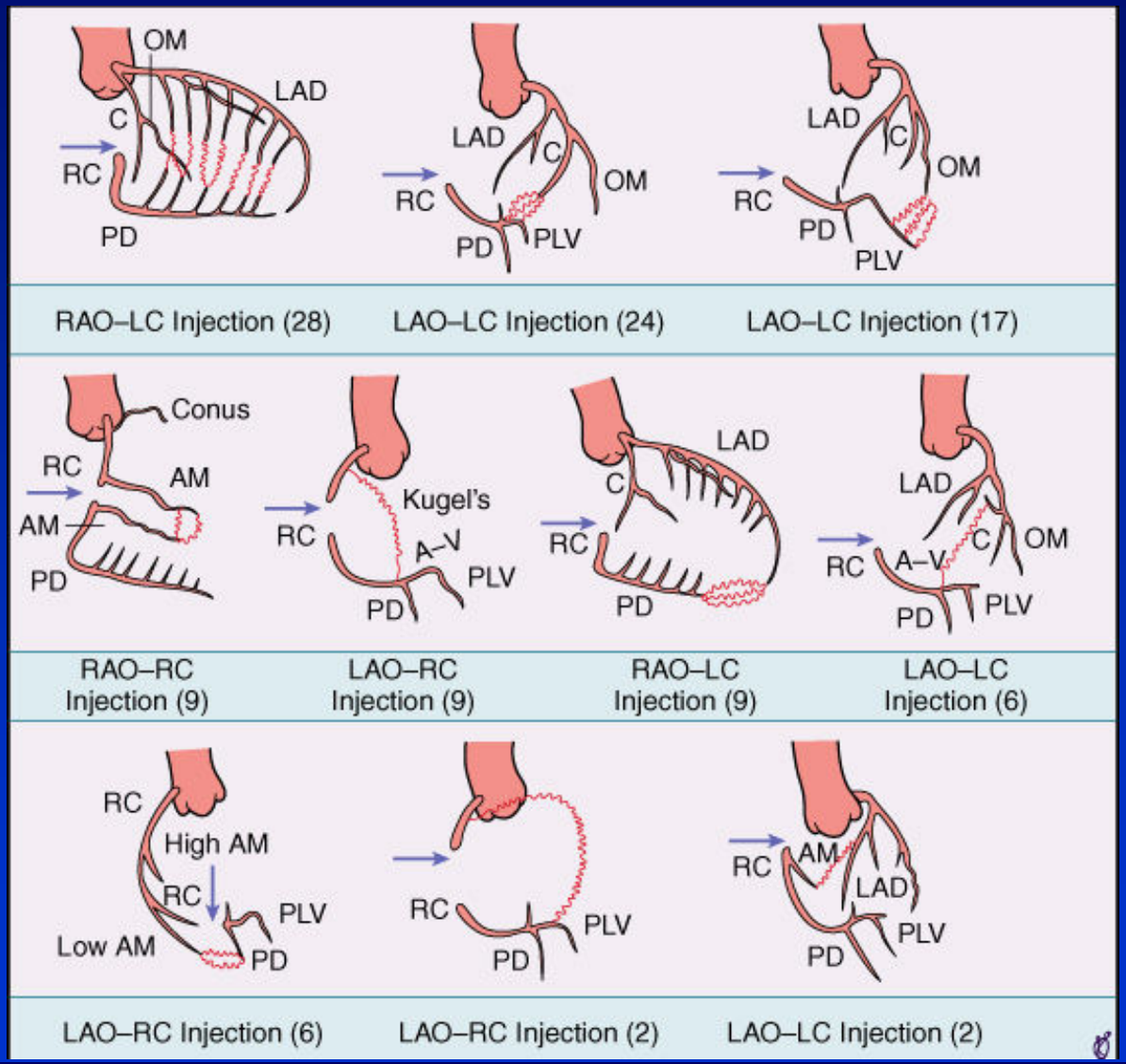
Favorable



Unfavorable

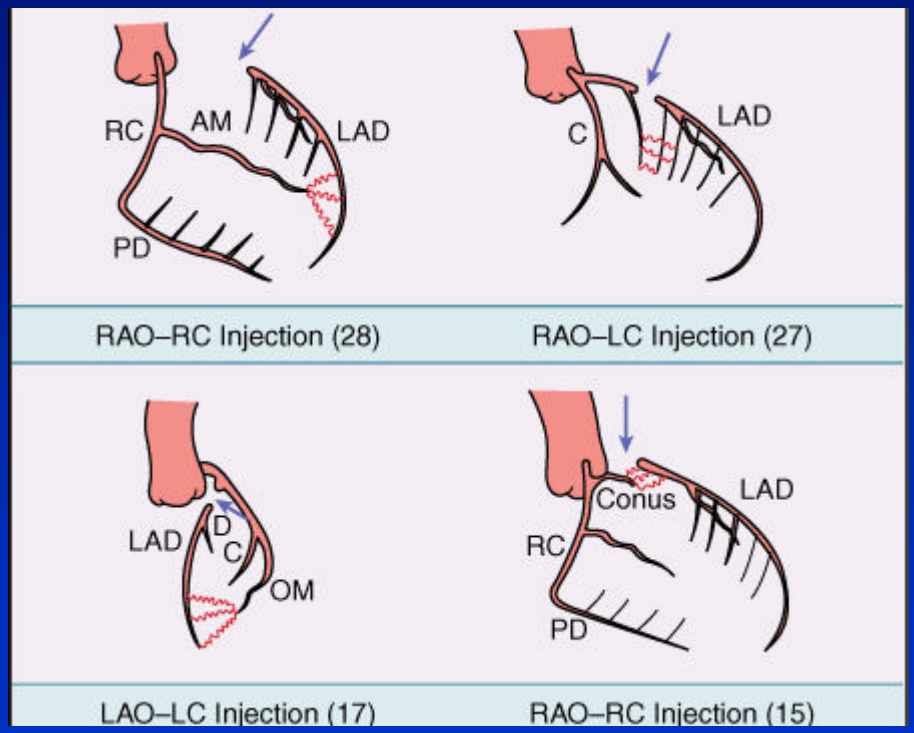
Lesion Description

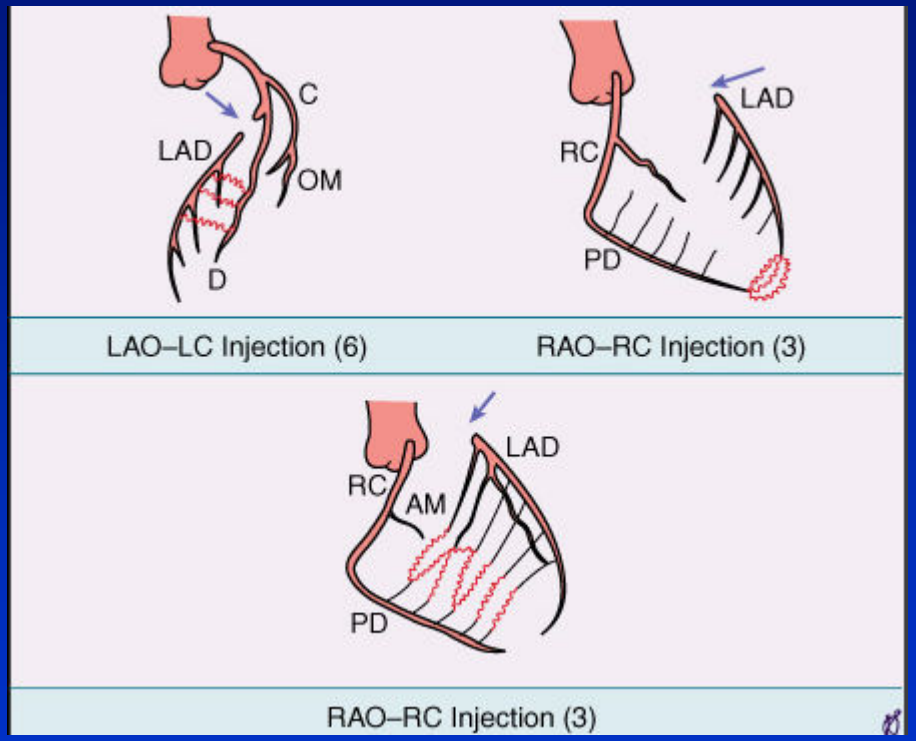
Collateral channels in RCA occlusion



Lesion Description

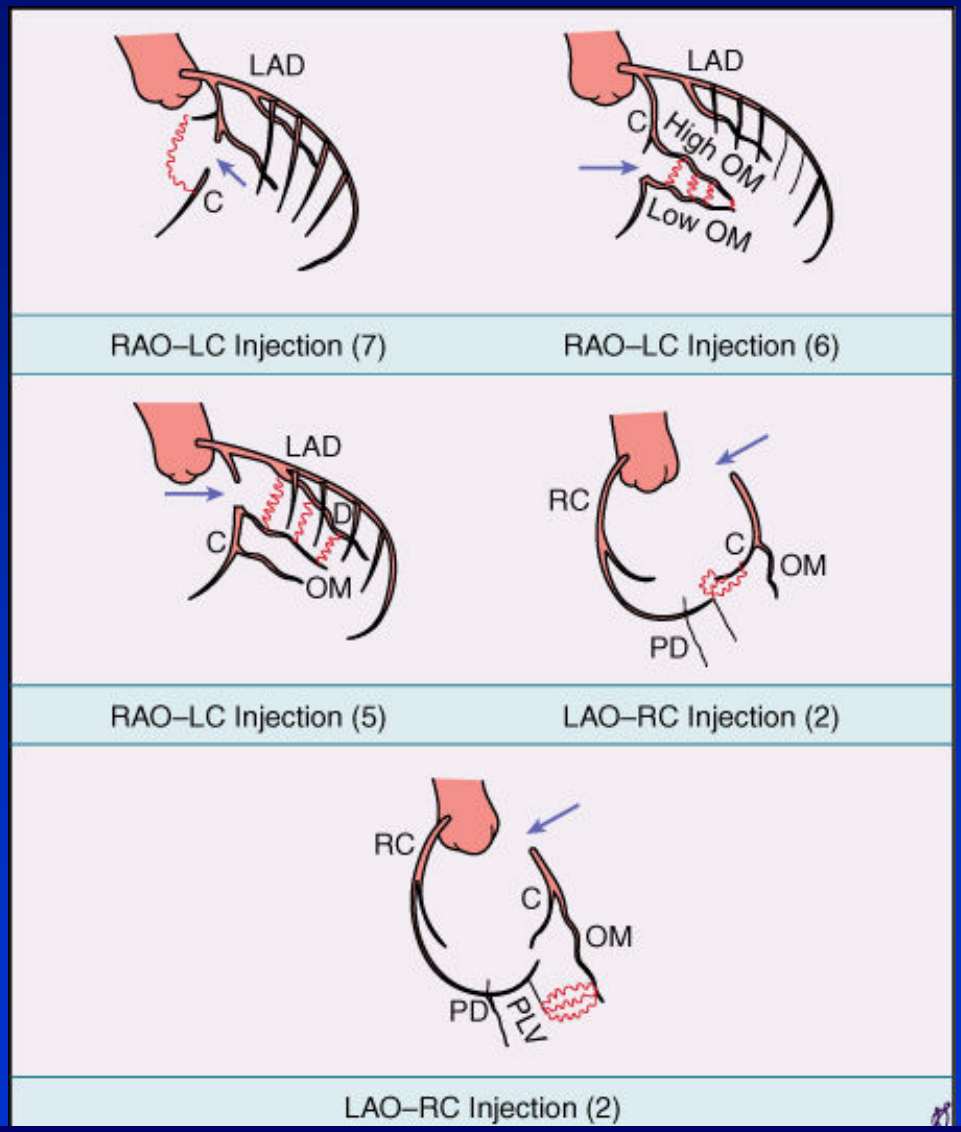
Collateral channels in LAD occlusion





Lesion Description

Collateral channels in LCx occlusion



Lesion Description

Bifurcation lesion

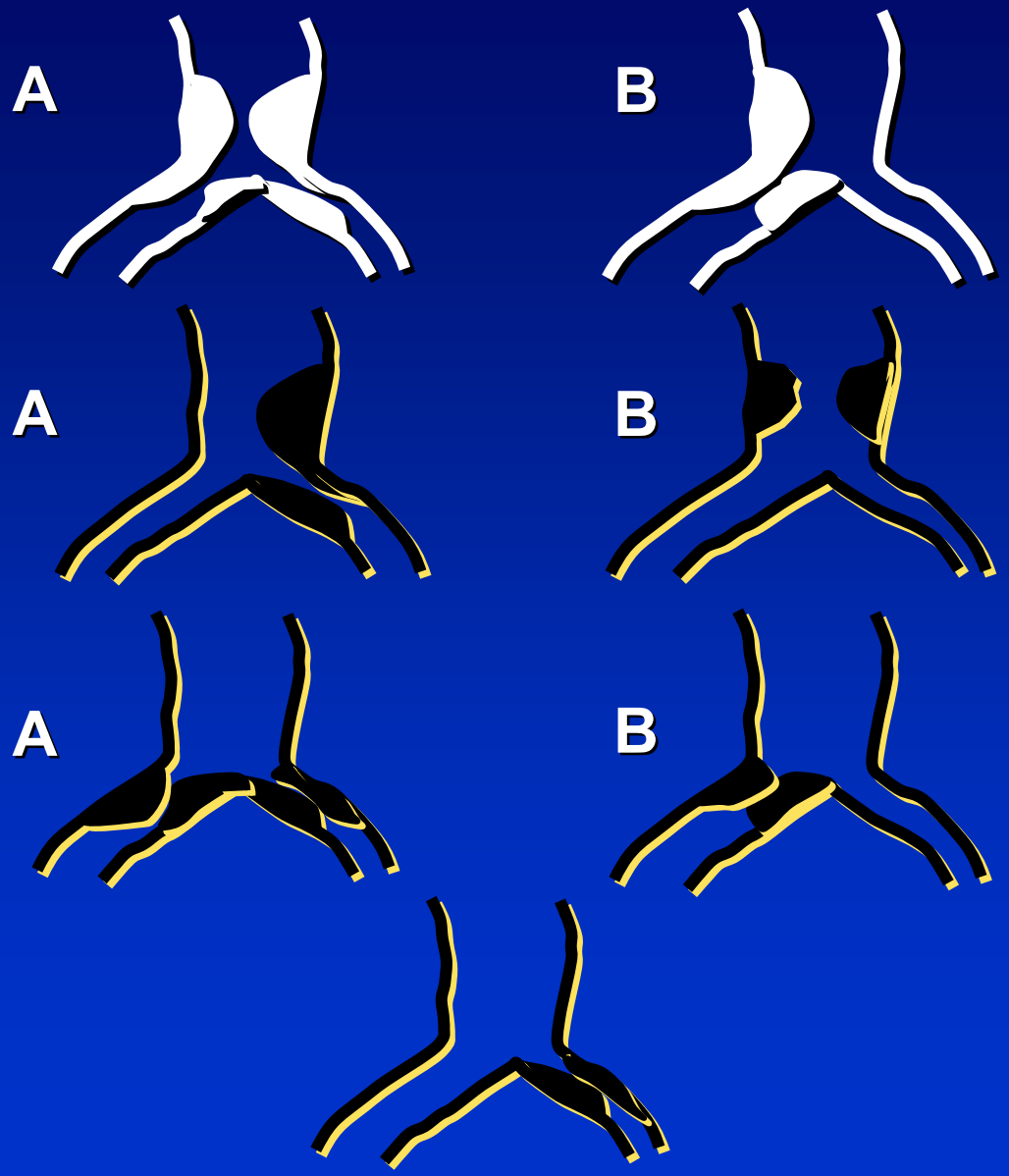
Safian Classification

Type I
Parent vessel stenosis proximal and distal to bifurcation

Type II
Parent vessel stenosis proximal to bifurcation

Type III
Parent vessel stenosis distal to bifurcation

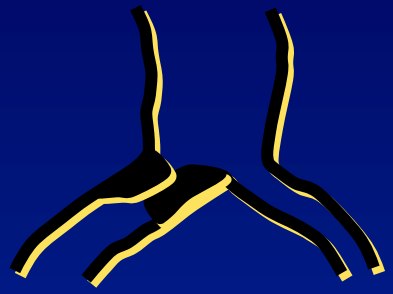
Type IV
Parent vessel normal, ostial side branch stenosis



Duke Classification

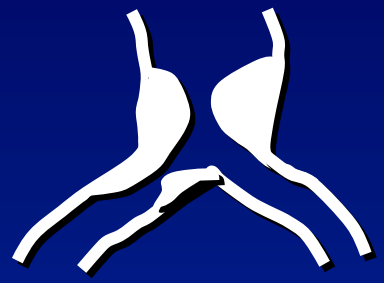
Type A

Prebranch stenosis not involving the ostium of the side branch



Type B

Postbranch stenosis of the parent vessel not involving the ostium of the side branch

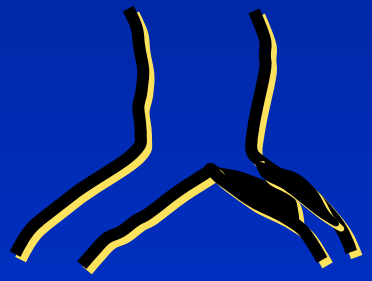


Type C

Stenosis of the parent vessel not involving the ostium of the side branch

Type D

Stenosis involving the parent vessel and the ostium of the side branch



Type E

Stenosis involving the ostium of the side branch only

Type F

Stenosis discretely involving the parent vessel and ostium of the side branch

Lefevre (ICPS) Classification

Type 1

Lesions located in the main branch, proximal and distal, and the ostium of side branch

Type 2

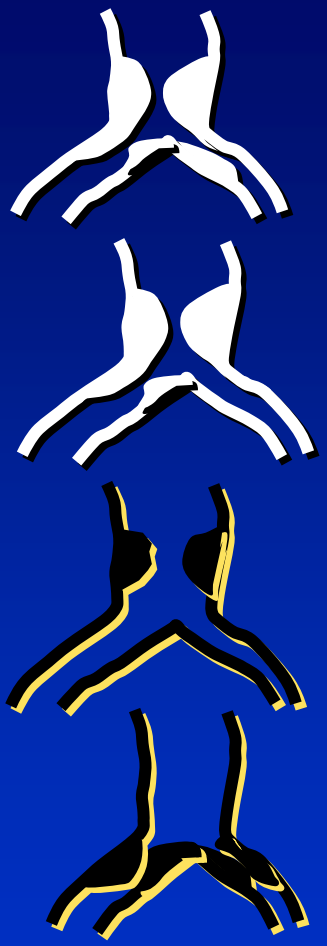
Lesions located only in the main branch, proximal and distal, and not the ostium of side branch

Type 3

Lesions located in the main branch proximal to the bifurcation

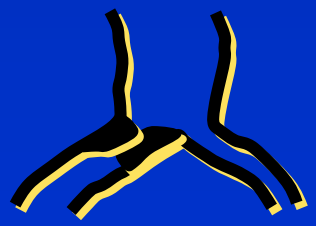
Type 4

Only the ostium of each branch of the bifurcation involved with no proximal disease



Type 4a

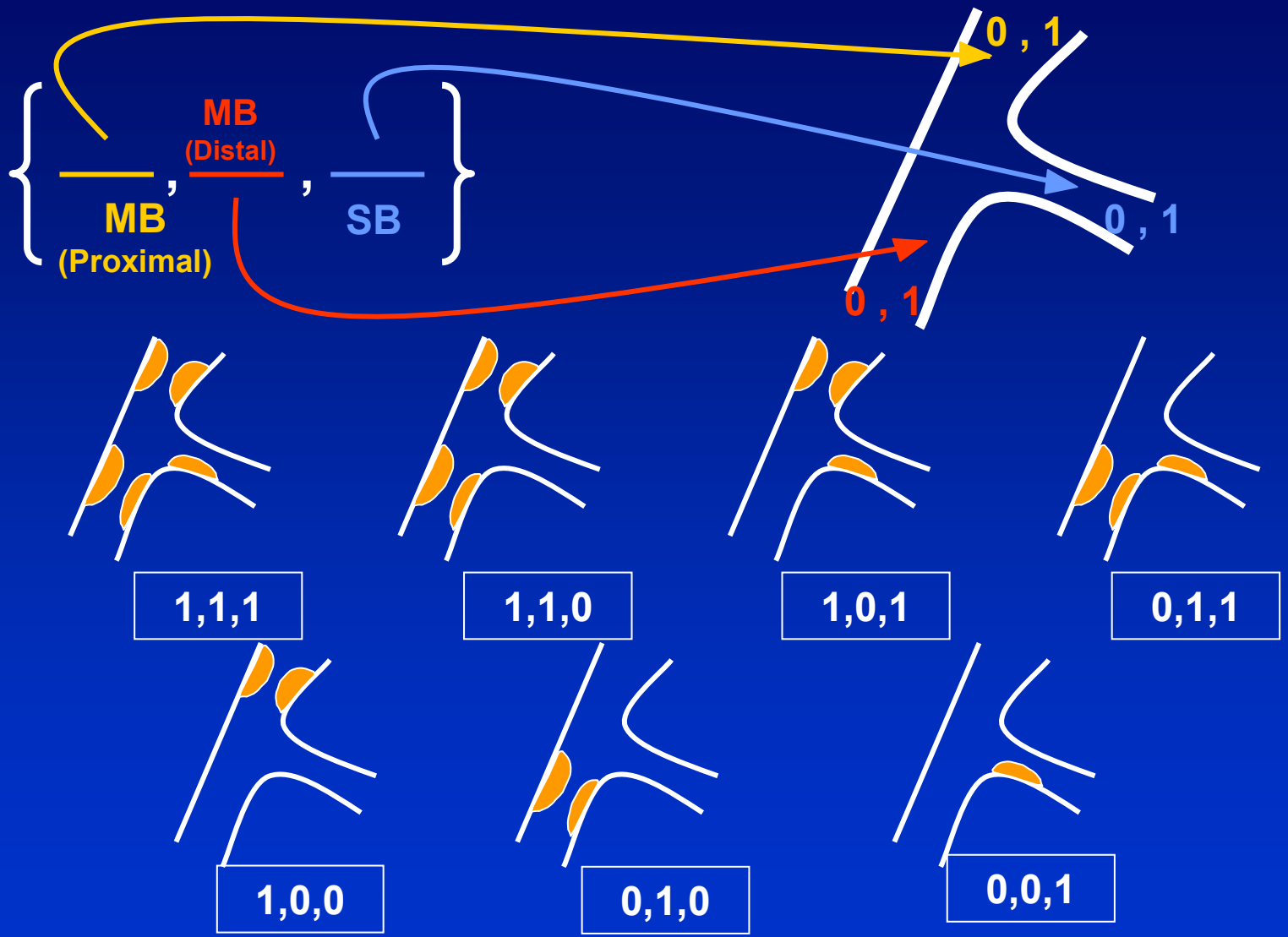
Lesion located only in the ostium of main branch



Type 4b

Lesion located only in the ostium of side branch

Medina Classification



Lesion Description

Low Risk	Moderate Risk	High Risk
Discrete	Tubular	Diffuse
Concentric	Eccentric	Excessive tortuosity of proximal segment
Readily accessible	Moderate tortuosity of prox. seg.	Extremely angulated >90º
Nonangulated (<45º)	Moderately angulated (45~90º)	CTO >3 months old &/or bridging collaterals
Smooth contour	Irregular contour	Inability to protect major side branches
Little or no calcification	Moderate or heavy calcification	Degenerated SVG with friable lesions
Less than totally occ.	Total occlusions < 3 months old	
Not ostial in location	Ostial in location	
No major side branch	Bifurcation requiring double GW	
Absence of thrombus	Some thrombus present	

Lesion Description

Lesion Type (AHA/ACC)

- **Type A**

  - lesion with only low risk

- **Type B1**

  - lesion with only one moderate risk

- **Type B2**

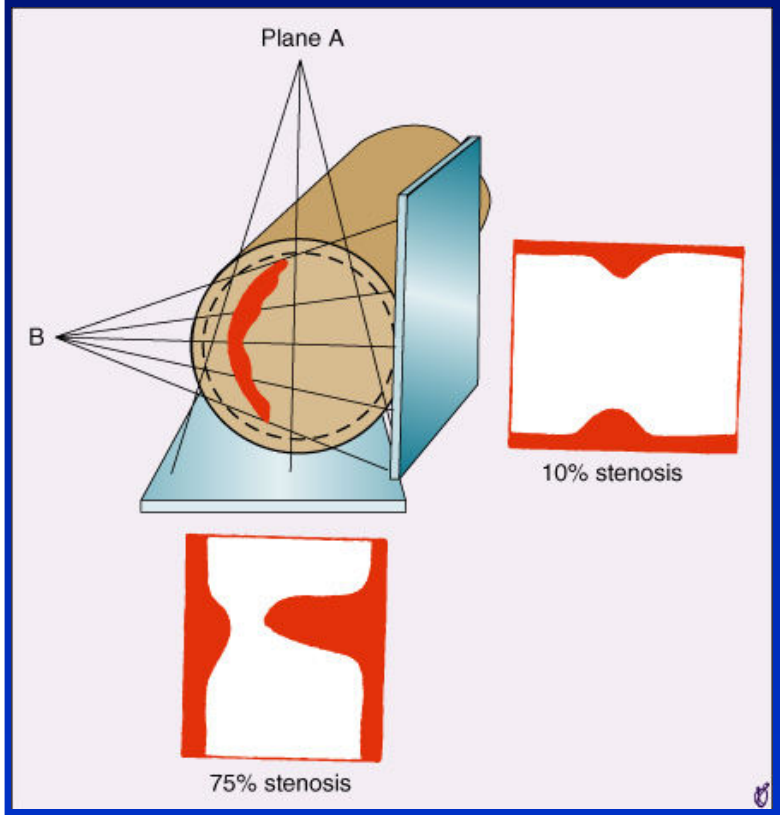
  - lesion with two or more moderate risk

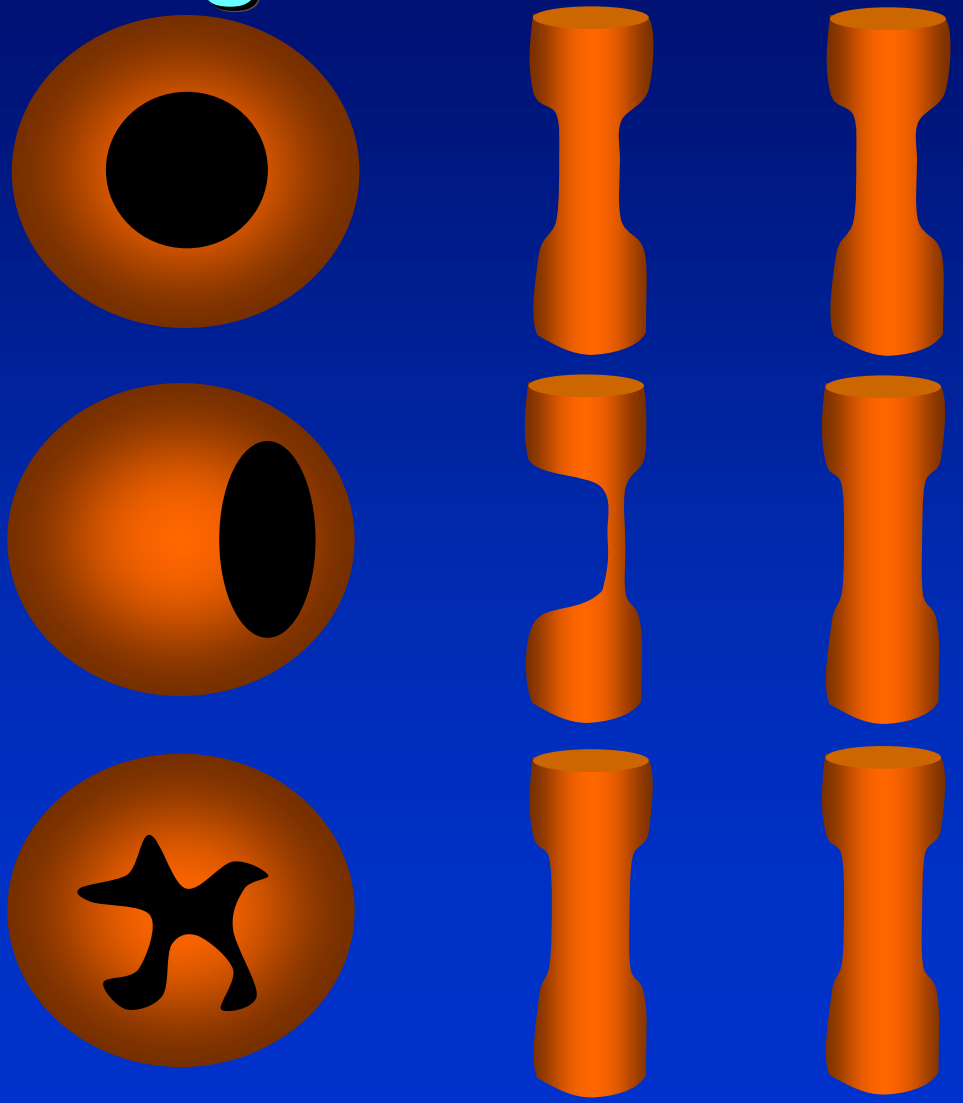
- **Type C**

  - lesion with at least one high risk

Pitfalls of Coronary Angiography

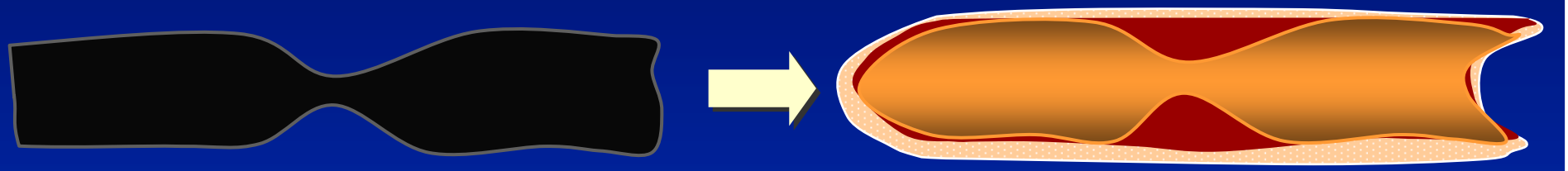
Lumen-o-gram



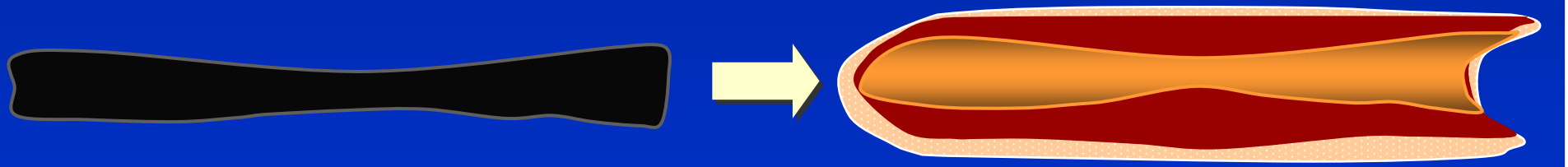


Pitfalls of Coronary Angiography

Lumen-o-gram



Focal narrowing



Diffuse narrowing

Pitfalls of Coronary Angiography

Lumen-o-gram

How to solve it ?

- Multiple projection with different angle
- Have a sense of normal caliber of major coronaries

LMCA	4.5±0.5 mm
LAD	3.7±0.4 mm
LCx	3.4±0.5 mm for nondominant
	4.2±0.6 mm for dominant
RCA	2.8±0.5 mm for nondominant
	3.9±0.6 mm for dominant

- IVUS examination
- Functional study; CFR, FFR

Mistakes in Interpretation

- Inadequate number of projections
- Inadequate injection of contrast materials
- Superselective injection
- Catheter-induced coronary spasm
- Congenital variants of coronary origin and distribution
- Myocardial bridges
- Total occlusions at the ostium
- Wire induced spasm (Accordion effect)

Case Study

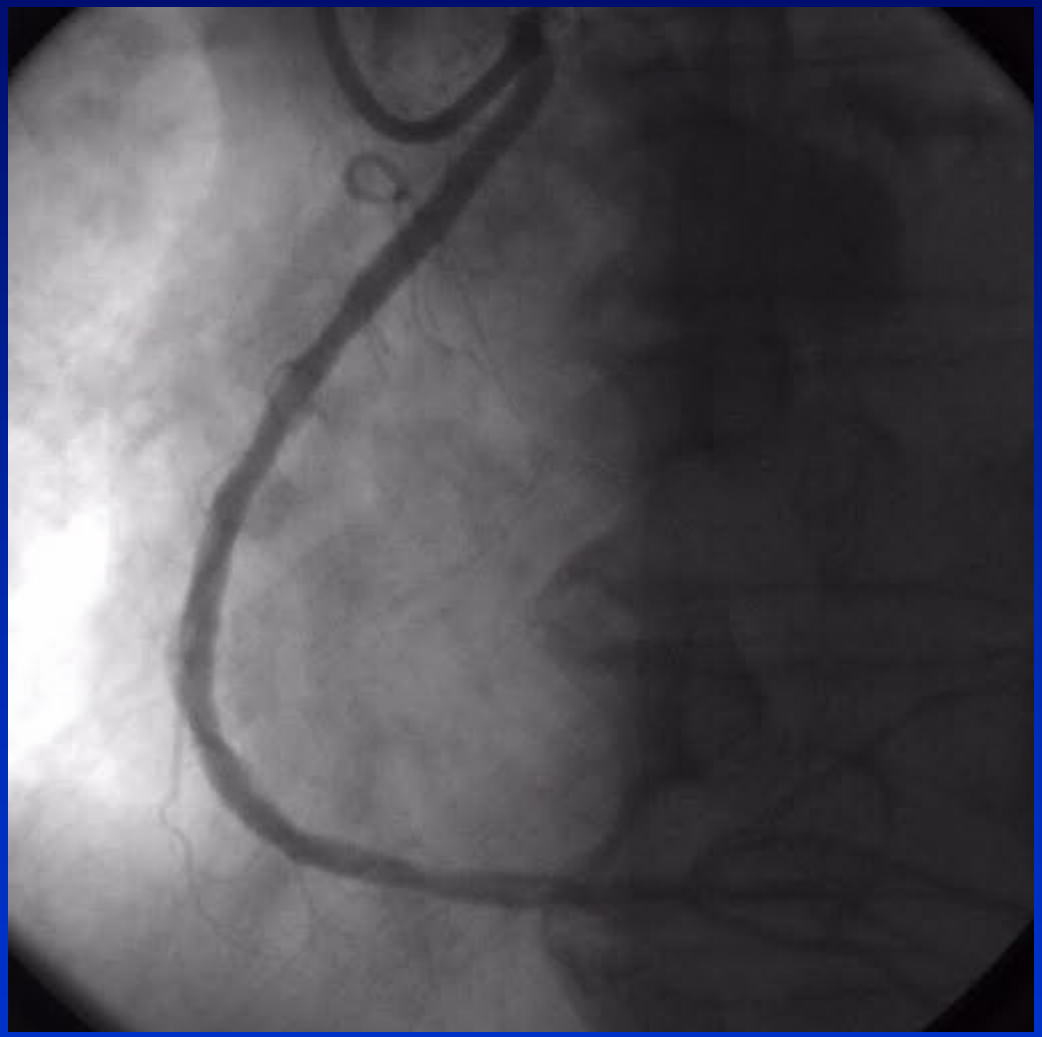
Anatomic Variants

- **Anomalies of origin**
  - High take-off
  - Multiple ostia
  - Single coronary artery
  - Anomalous origin from pulmonary artery
  - Origin from systemic vessels
- **Anomalies of origin & course**
  - Origin of coronary artery from opposite sinus (ACAOS)
  - Course between great vessels
- **Anomalies of course**
  - Myocardial bridge
  - Duplication of arteries
- **Anomalies of termination**
  - Coronary artery fistula
  - Coronary arcade
  - Extracardiac termination

56/M, LCx STEMI

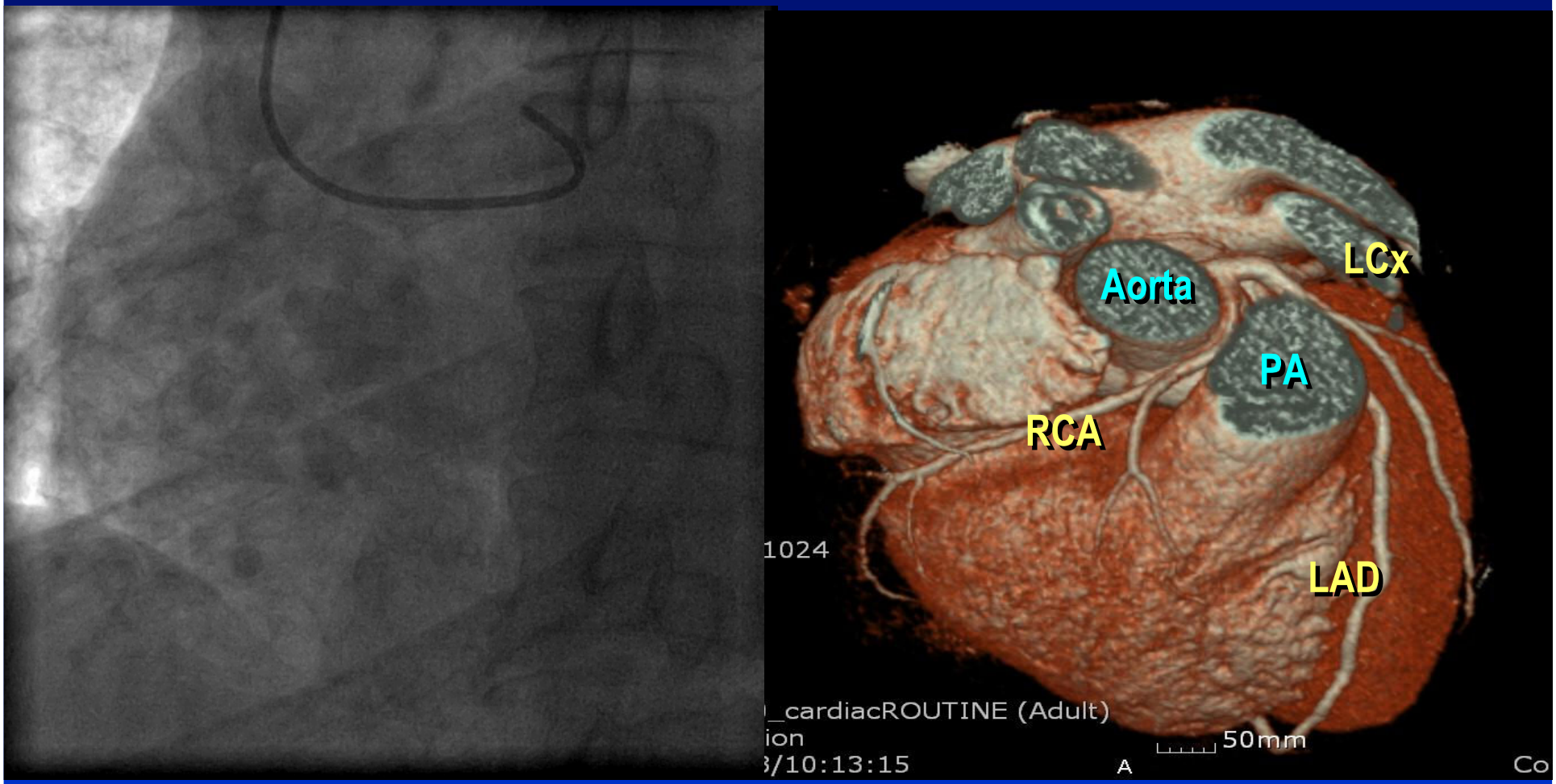
AL engagement

Anomalous origin of Coronary Artery from Opposite Sinus (ACAOS)



EBU or JL engagement

RCA origin from LMCA



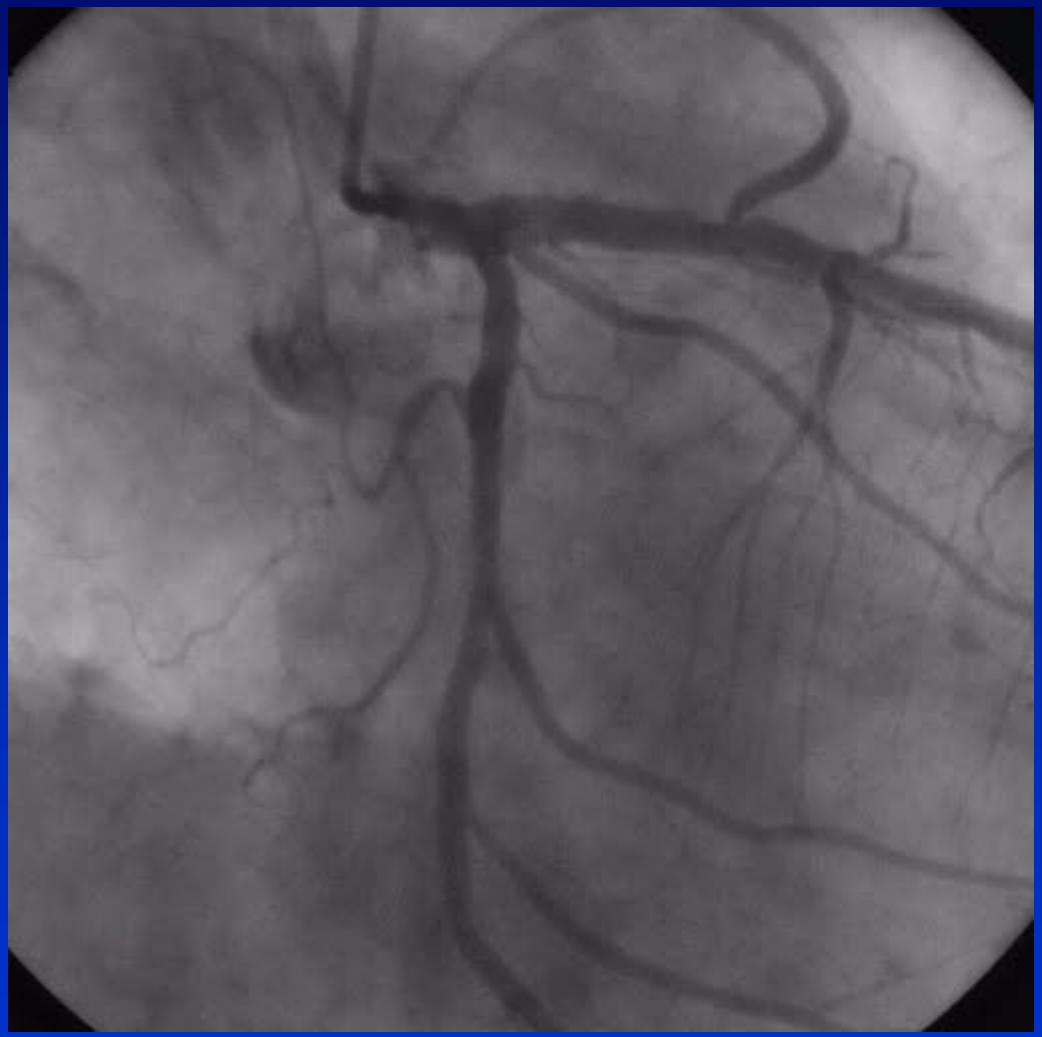
56/M, Atypical chest pain

RCA origin from LAD

67/M, Stable angina

LMCA-pLAD cross over

RCA origin from LAD

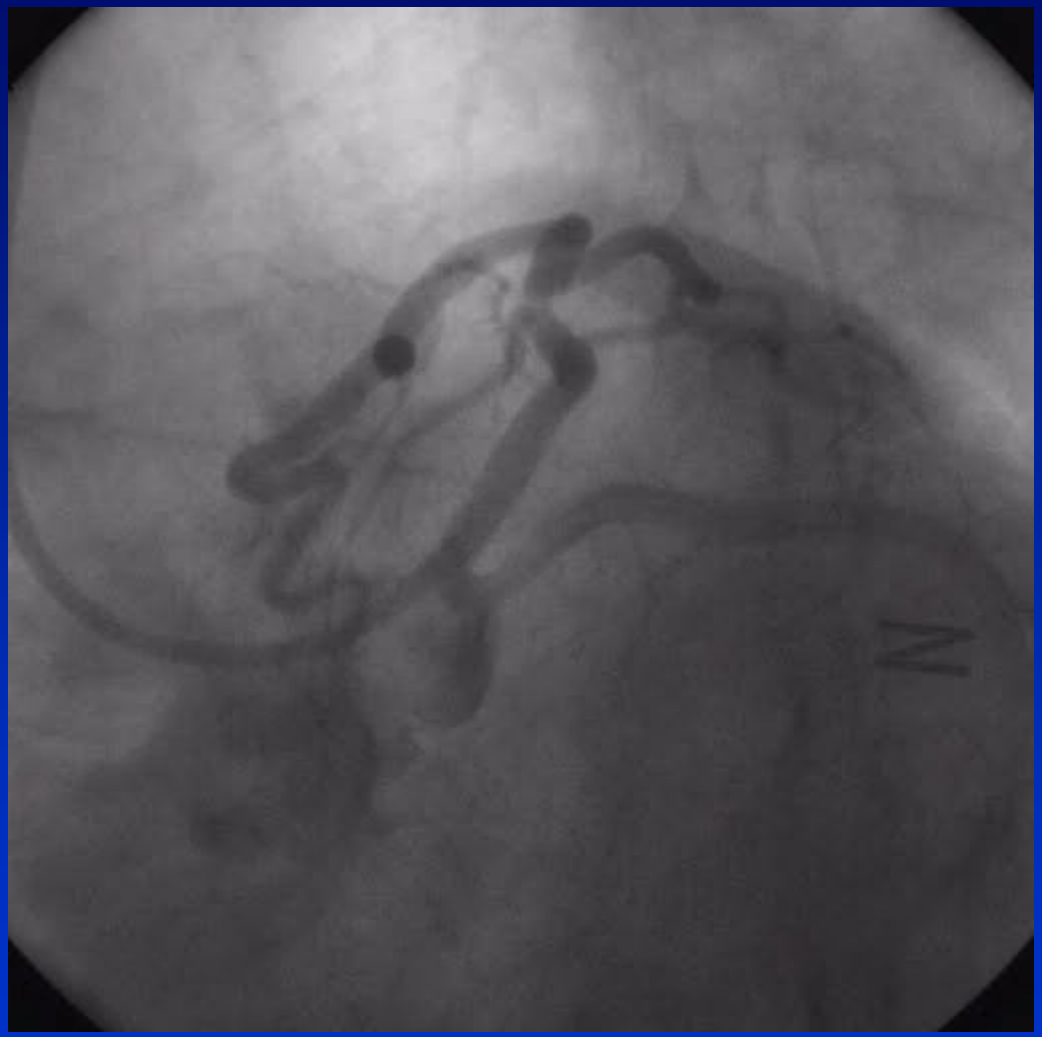


FU angiogram

Separated LMCA origin

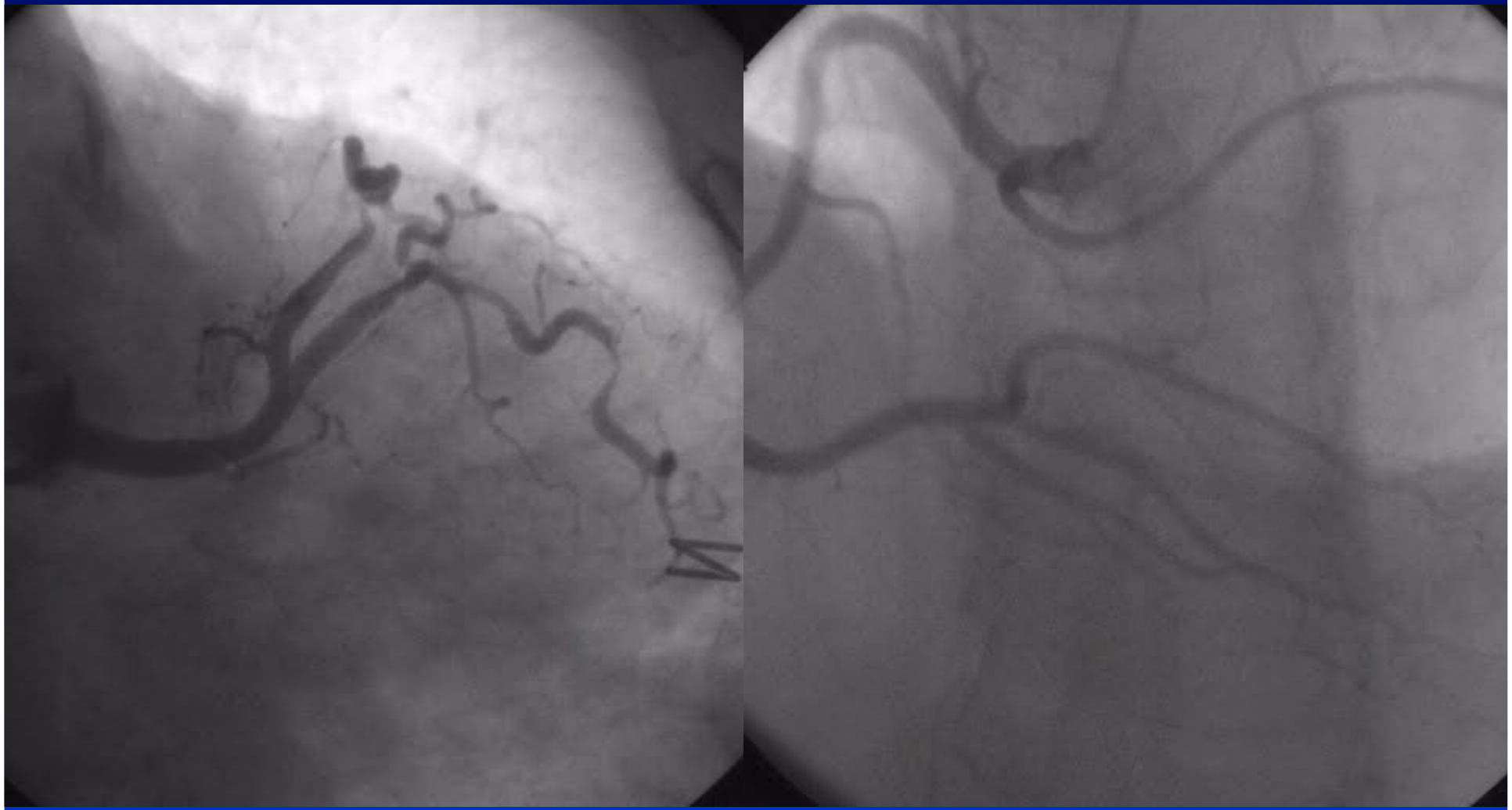
60/M, Unstable angina

Separated LMCA origin



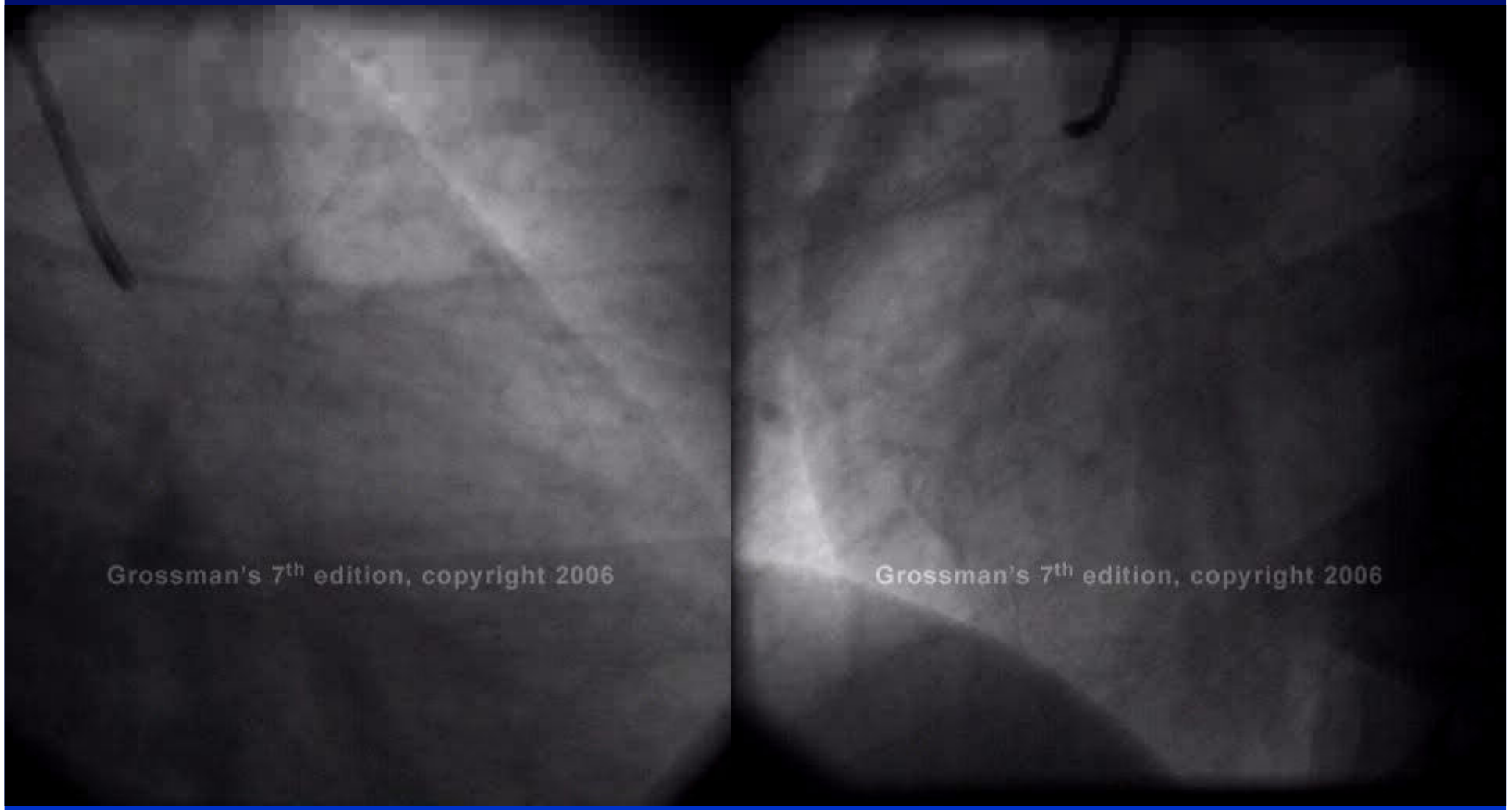
60/M, Unstable angina

LCx origin from RCA



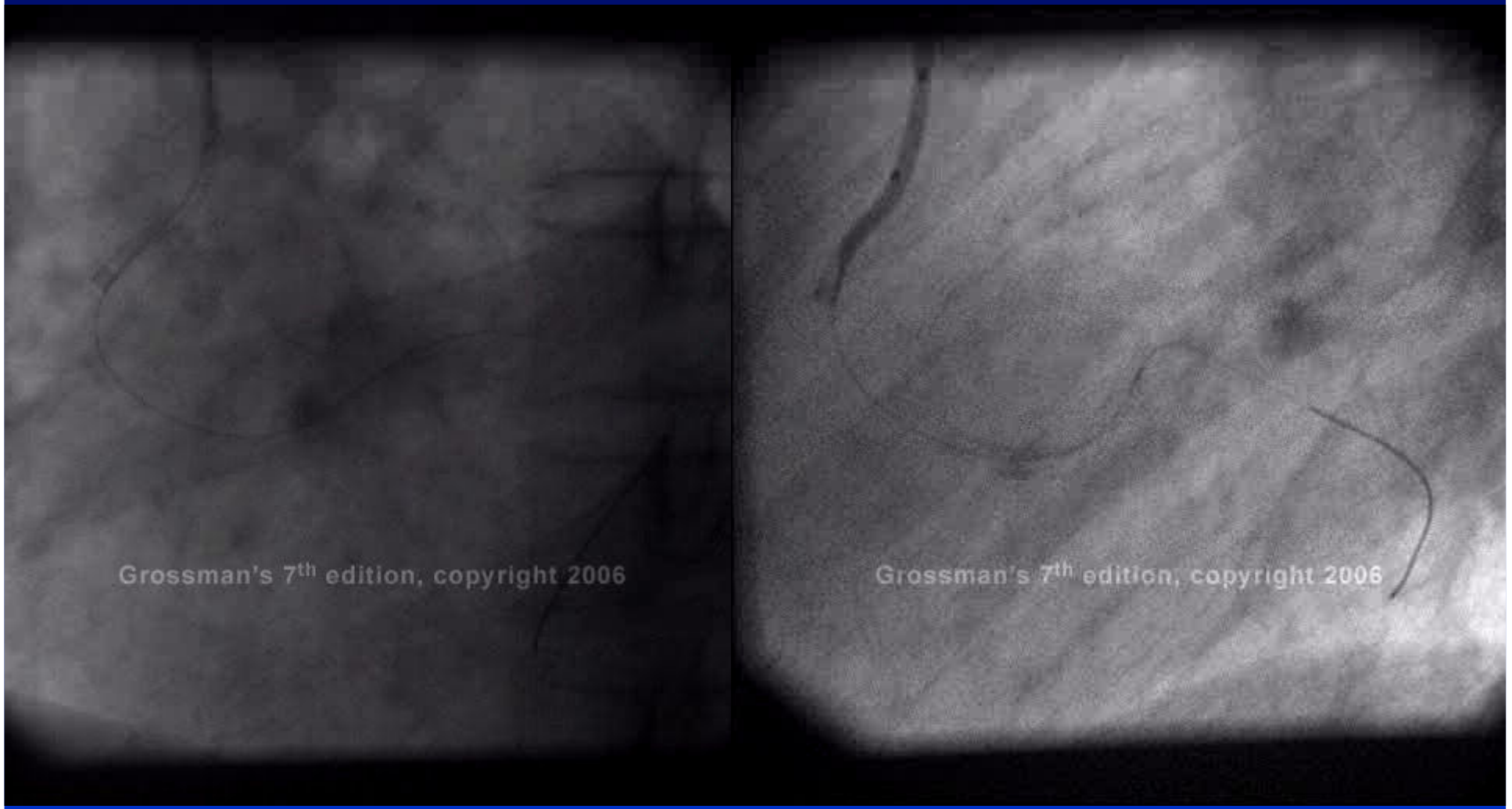
70/M, Unstable angina

45/F, Effort angina



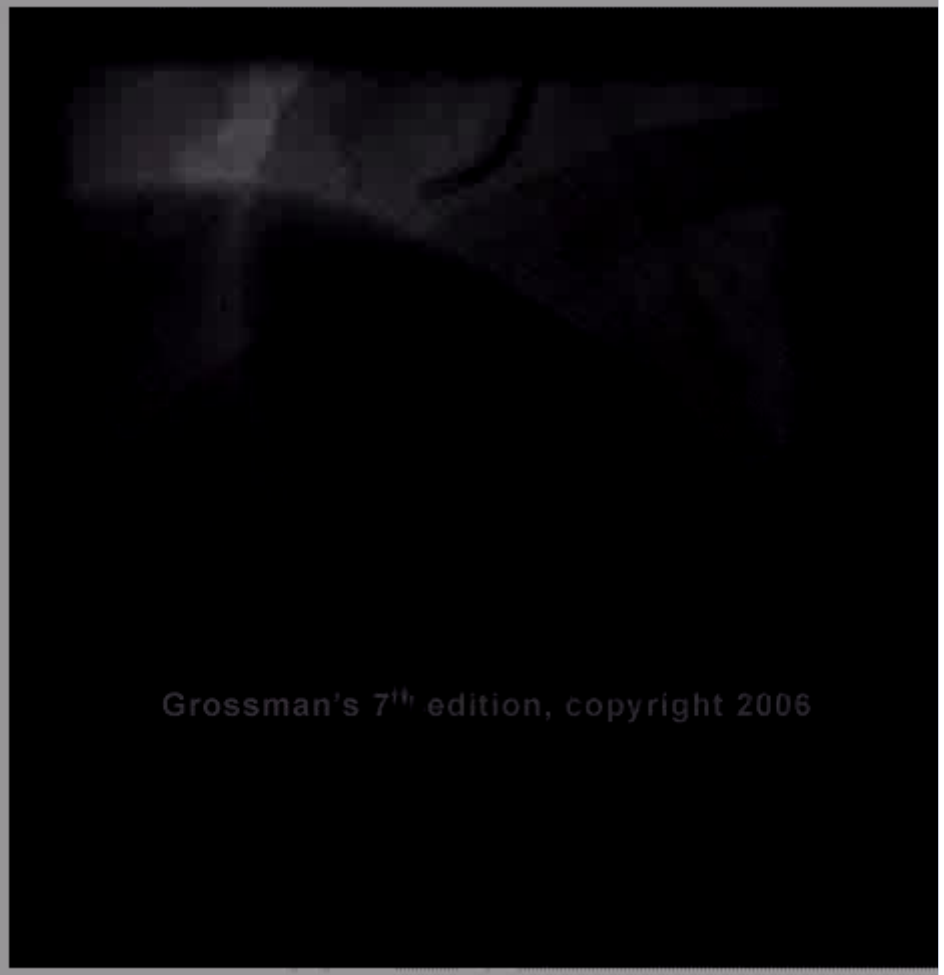
Lateral perfusion defect on SPECT

45/F, Effort angina



Lateral perfusion defect on SPECT

Where is LCx origin ?



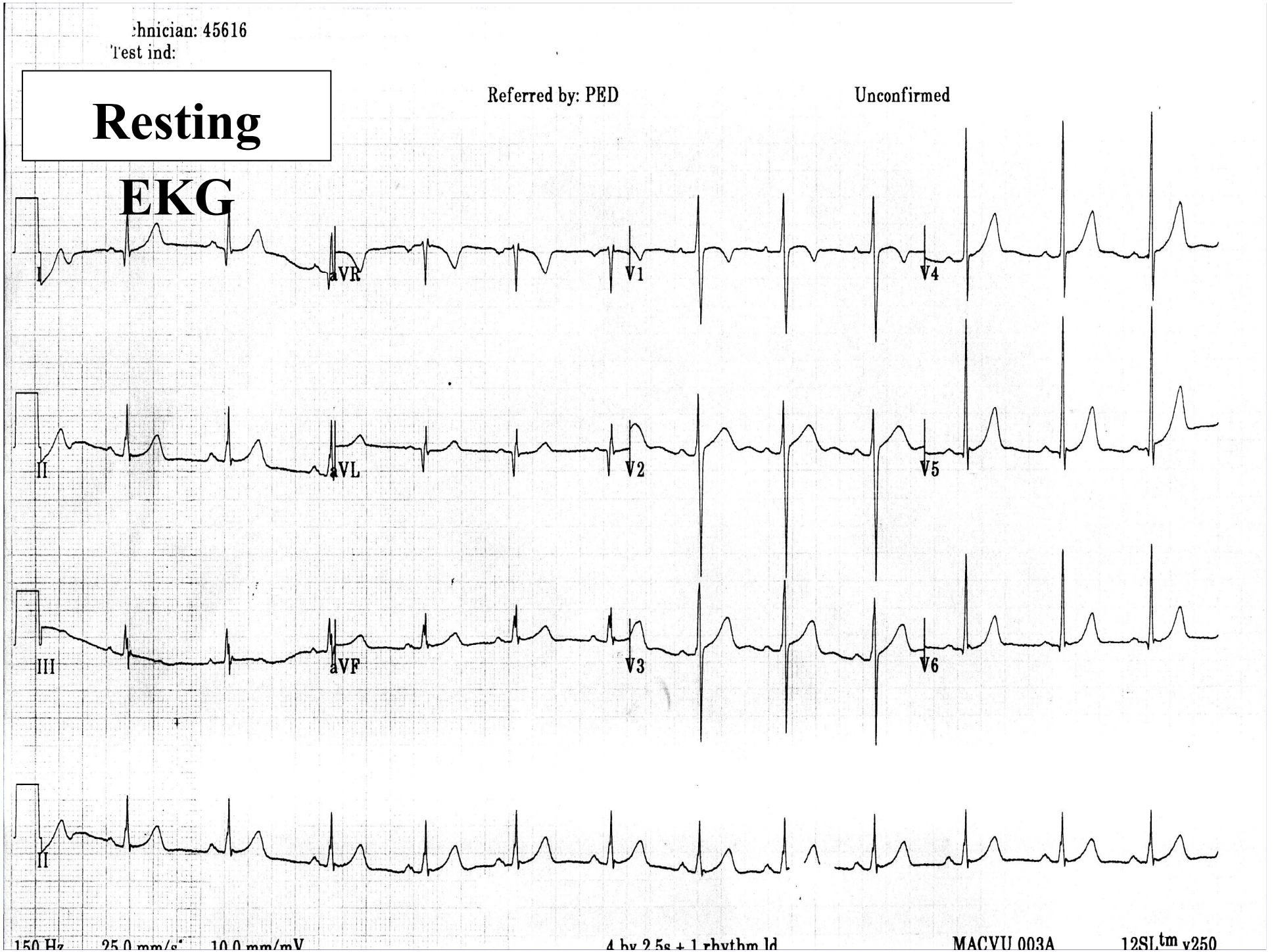
Superdominant RCA

12-years-old boy

Exertional chest pain with syncope for 3 yrs

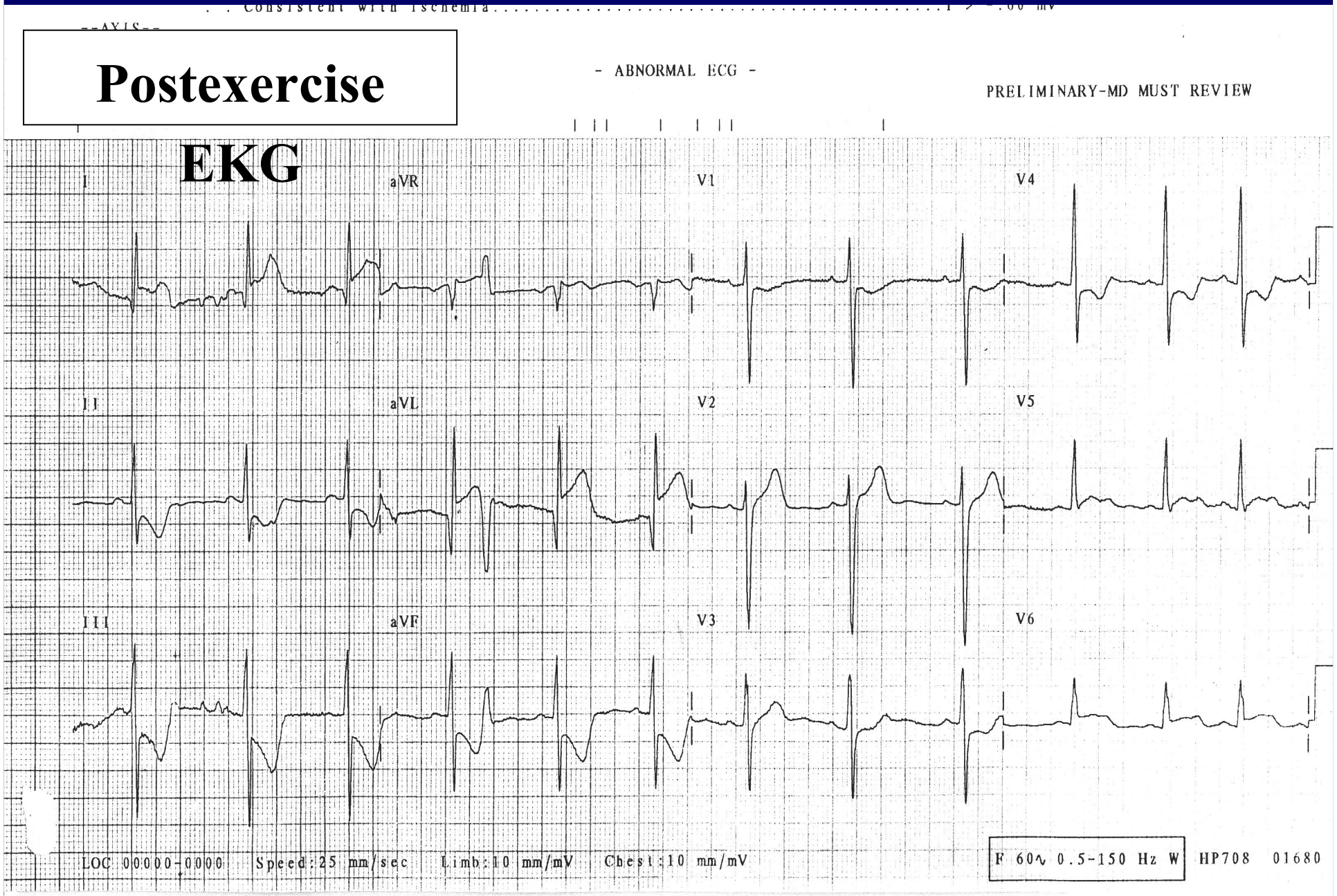
Chest pain and shock during treadmill test

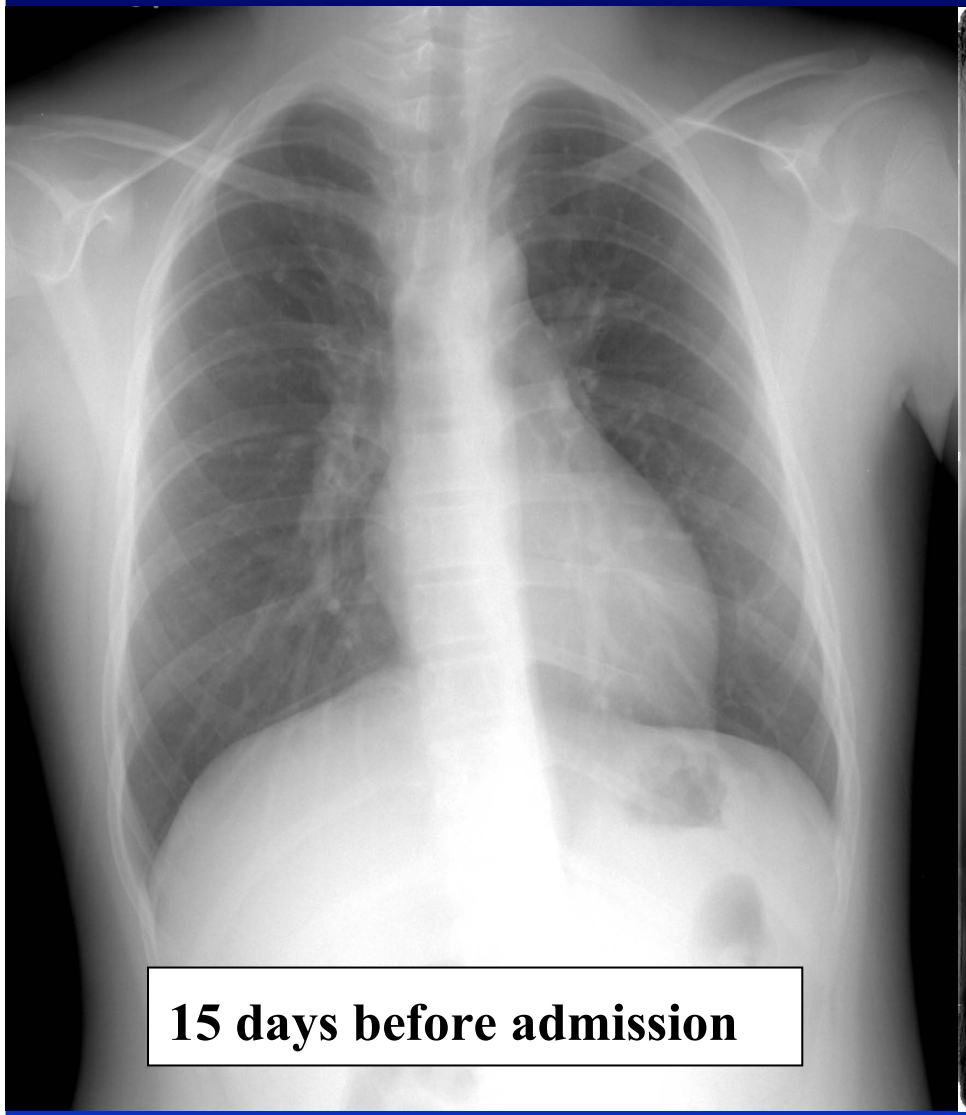
Peak CK / CK-MB = 893 / 23.4 IU/L


:hnician: 45616
Test ind:
Resting
EKG
Referred by: PED
Unconfirmed
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
150 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 1 rhythm ld
MACVU 003A
12SL tm v250

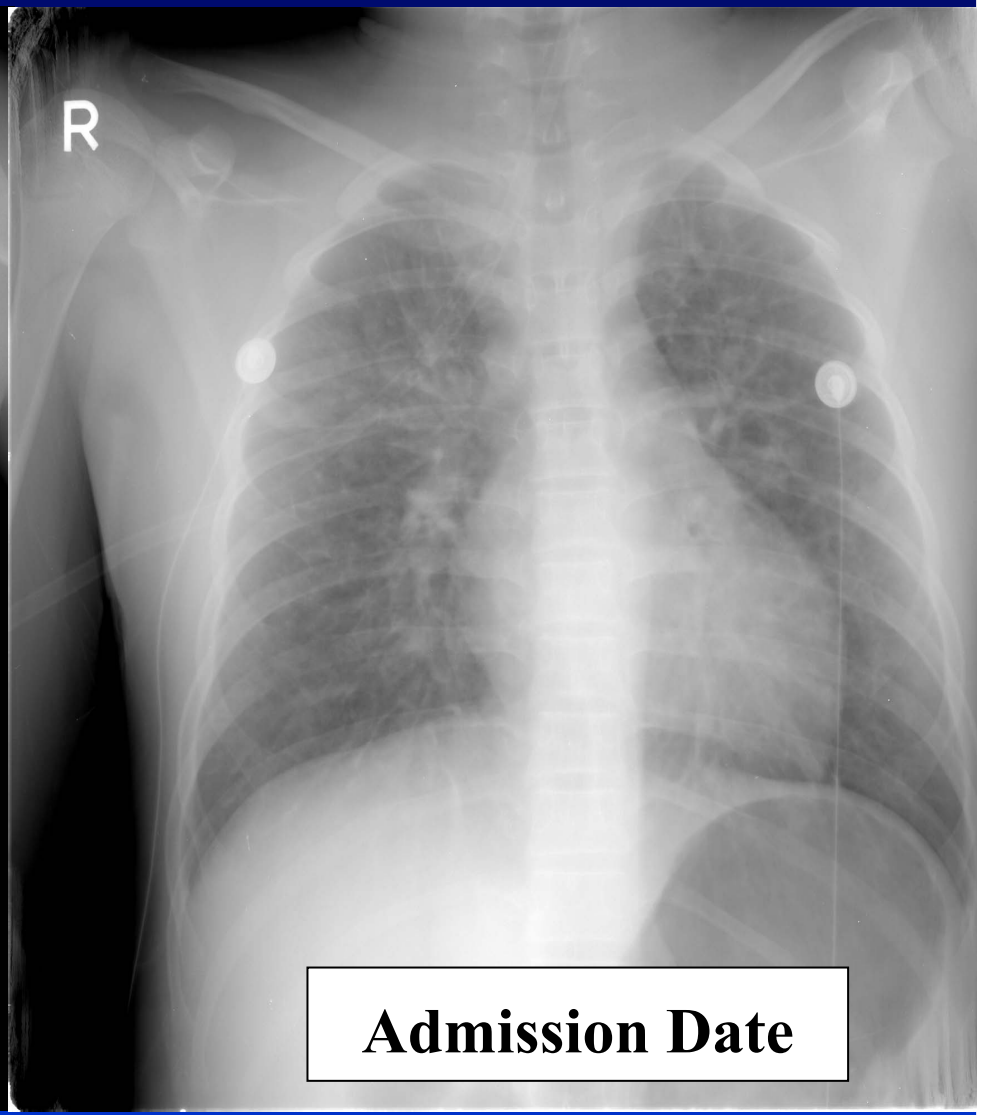
Postexercise EKG

Postexercise EKG

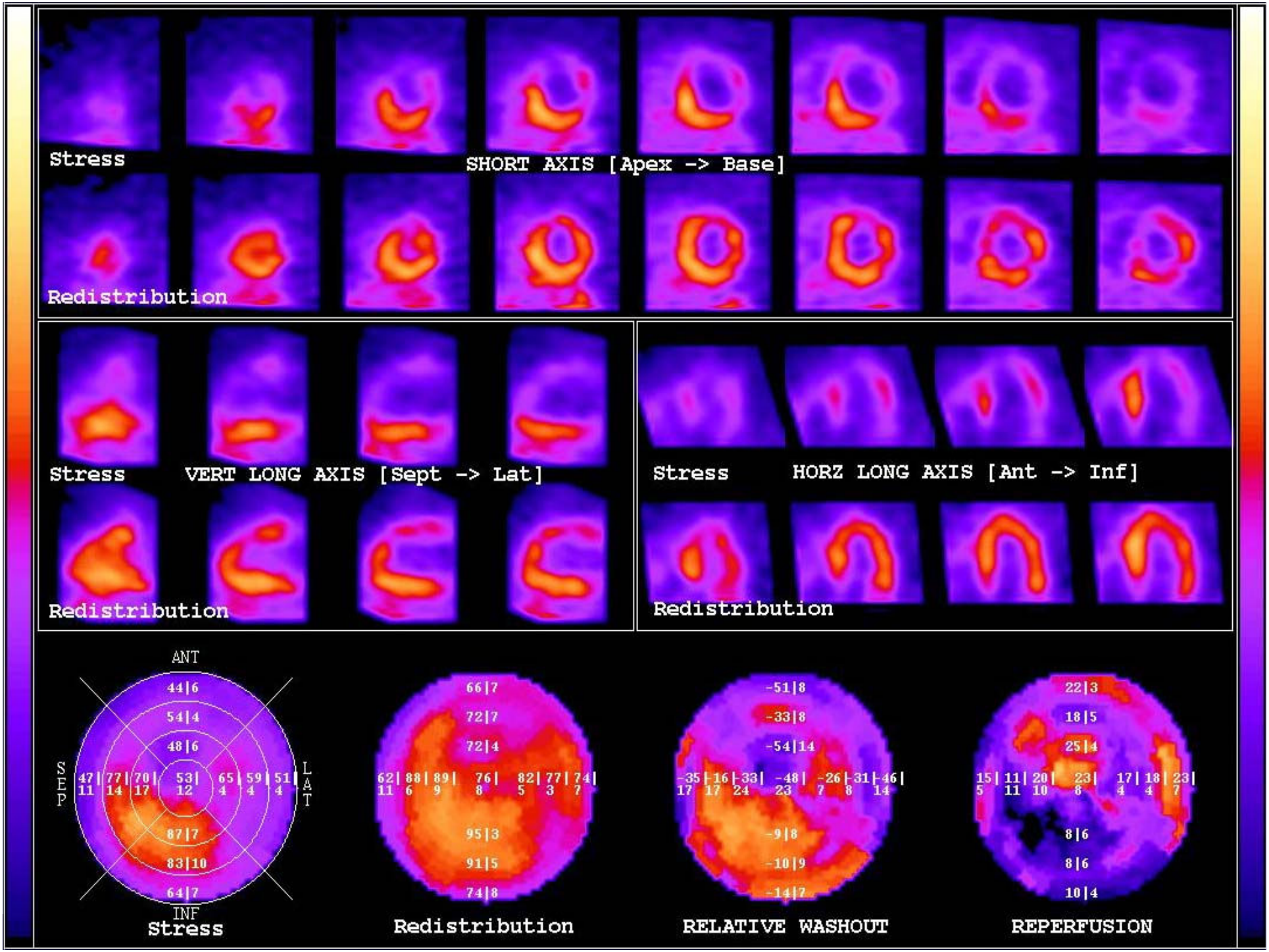


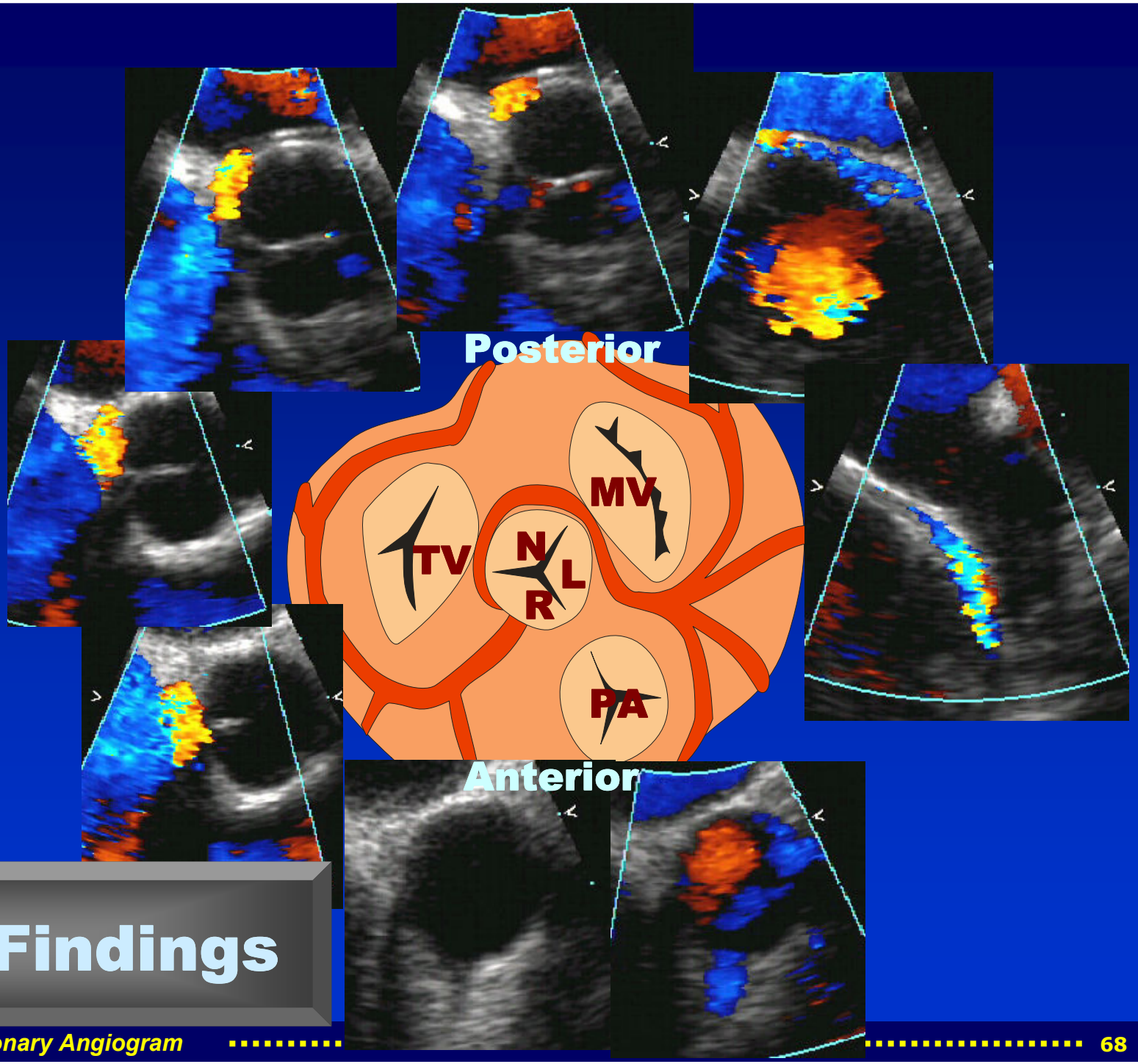


15 days before admission



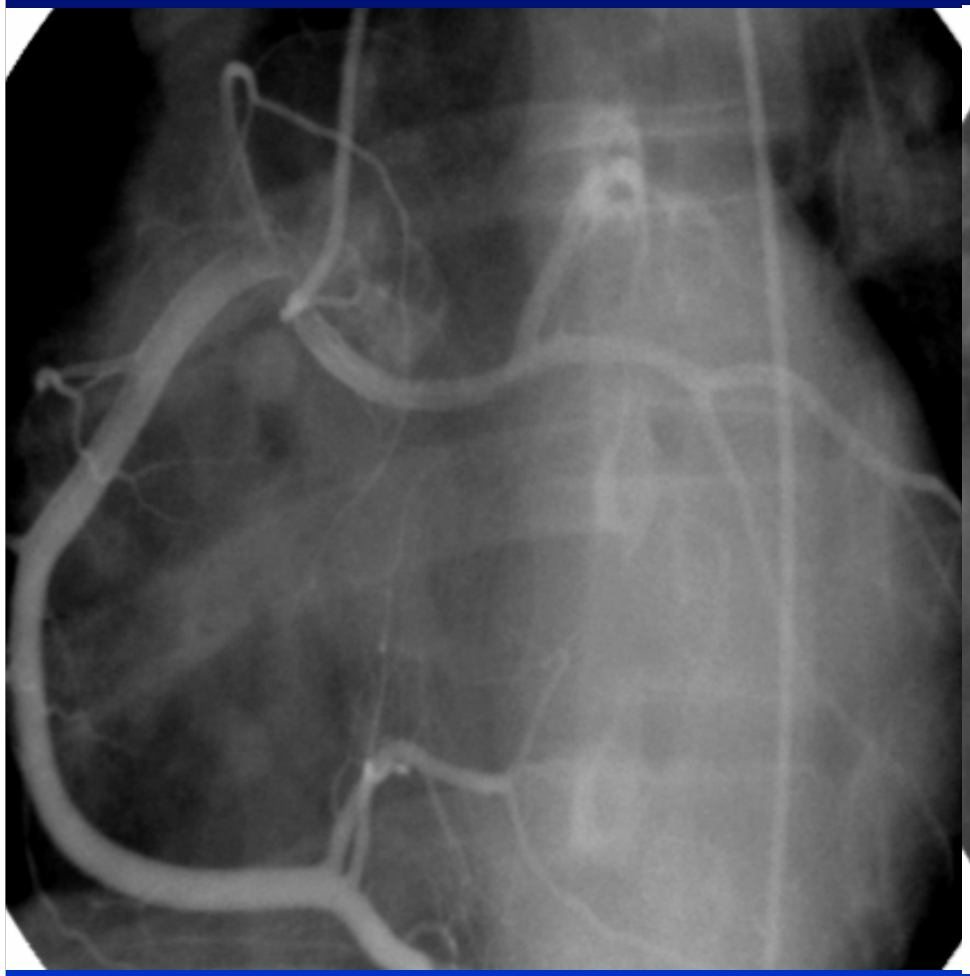
Admission Date

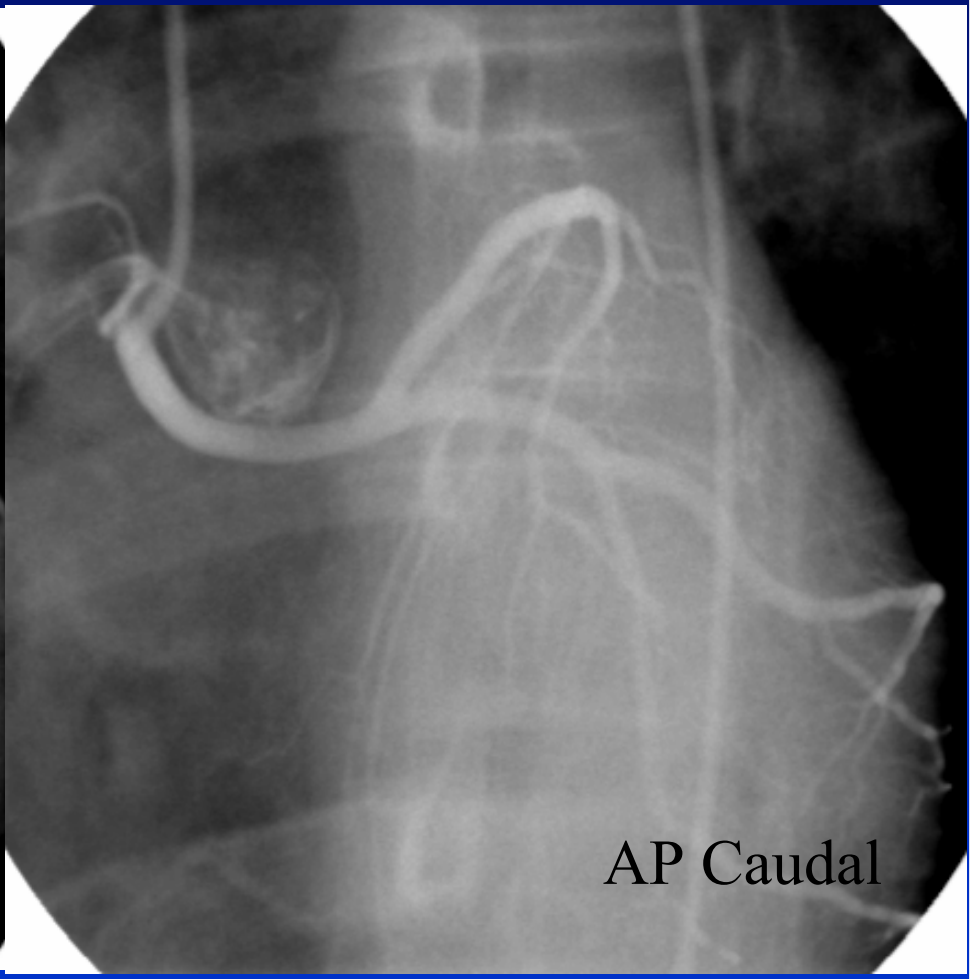

Stress
SHORT AXIS [Apex -> Base]
Redistribution
Stress
VERT LONG AXIS [Sept -> Lat]
Redistribution
Stress
HORZ LONG AXIS [Ant -> Inf]
Redistribution
ANT
SEP
LAT
INF
44|6
54|4
48|6
47|11
77|14
70|17
53|12
65|4
59|4
51|4
87|7
83|10
64|7
Stress
66|7
72|7
72|4
62|11
88|6
89|9
76|8
82|5
77|3
74|7
95|3
91|5
74|8
Redistribution
-51|8
-33|8
-54|14
-35|17
-16|17
-33|24
-48|23
-26|7
-31|8
-46|14
-9|8
-10|9
-14|7
RELATIVE WASHOUT
22|3
18|5
25|4
15|5
11|11
20|10
23|8
17|4
18|4
23|7
8|6
8|6
10|4
REPERFUSION

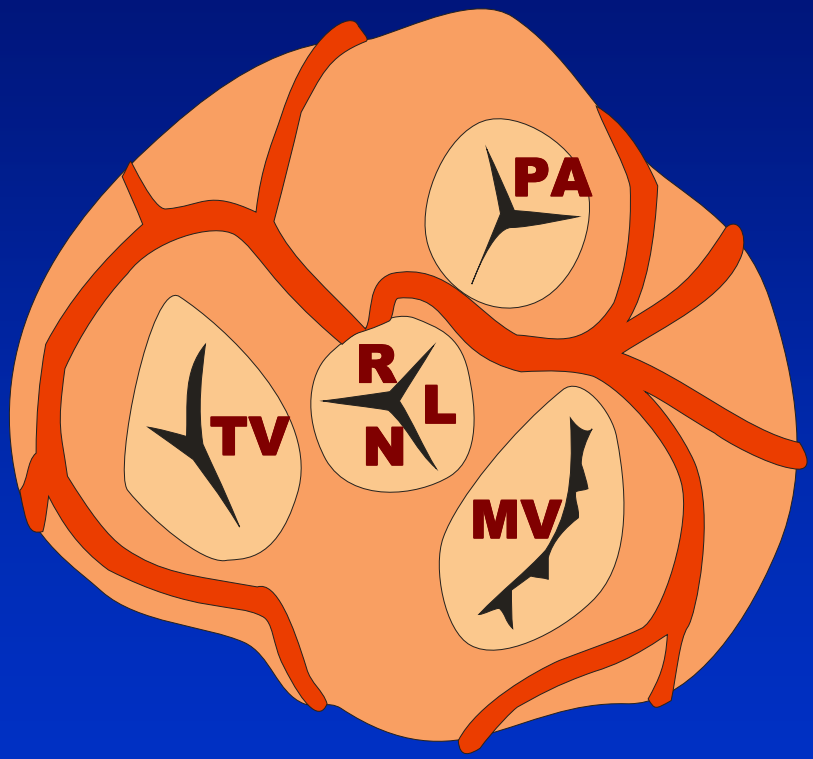


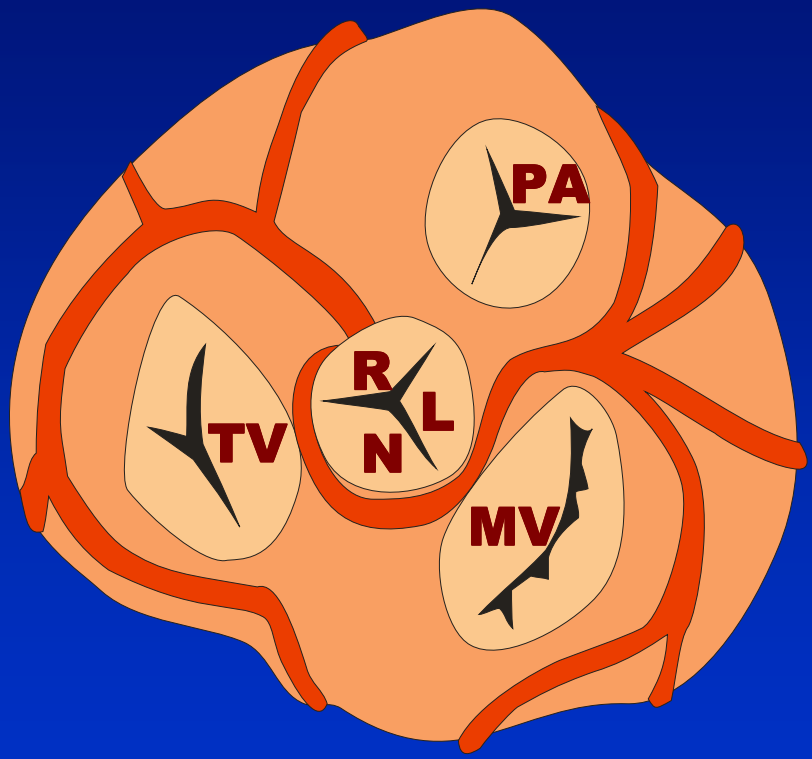
TEE Findings

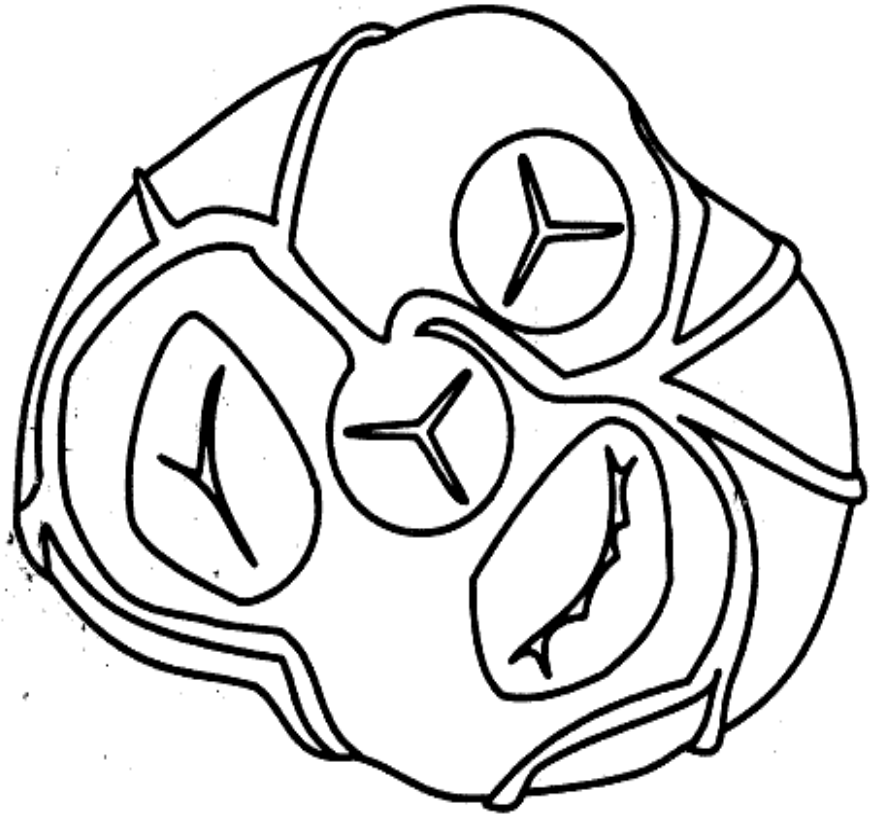
Coronary Angiogram Findings



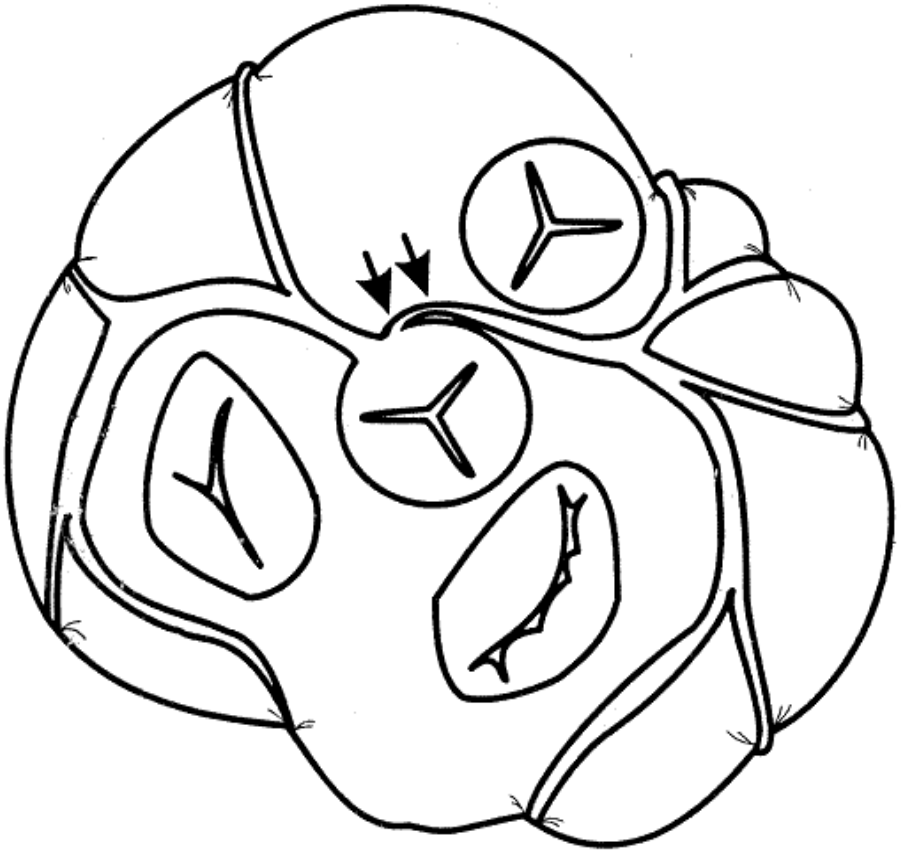



PA
TV
R
L
N
MV


PA
TV
R
L
N
MV

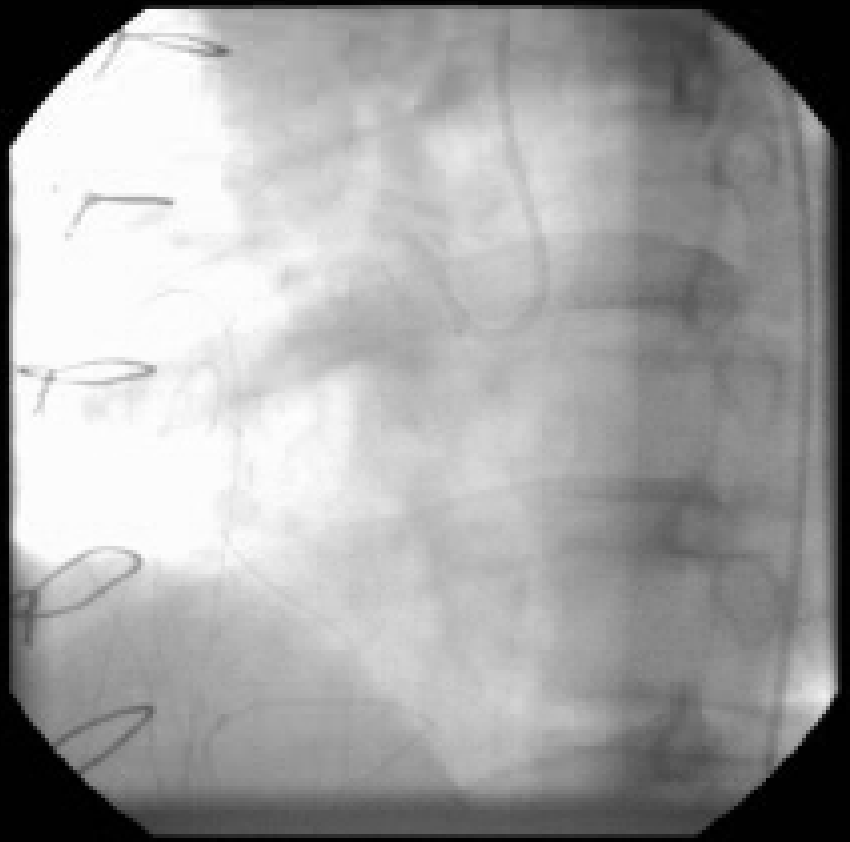


Rest

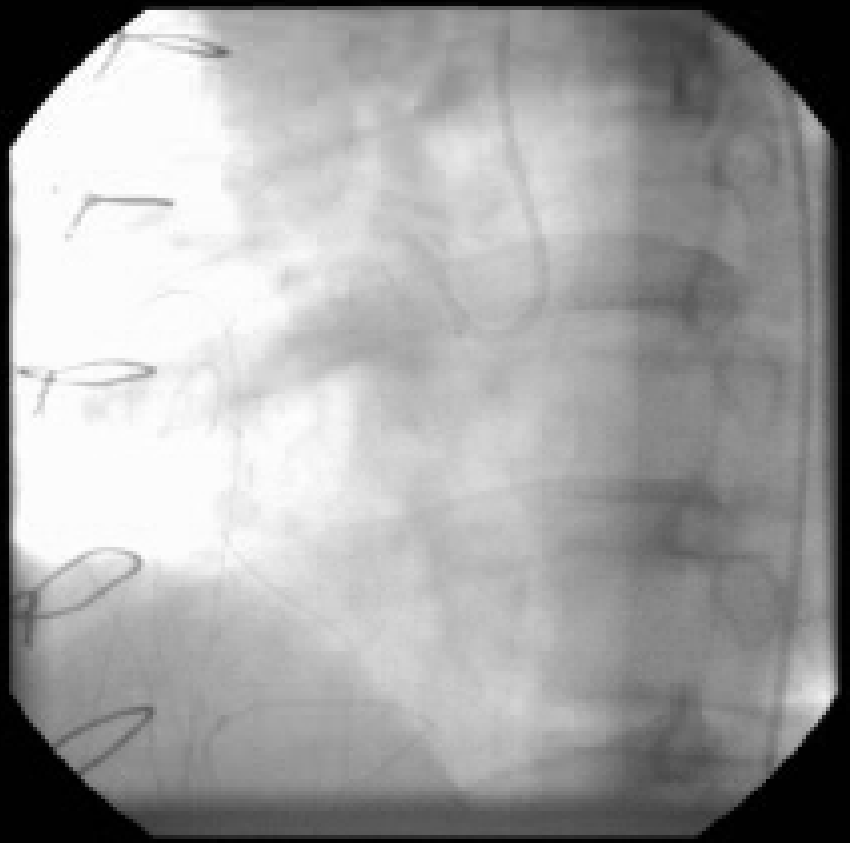


Exercise

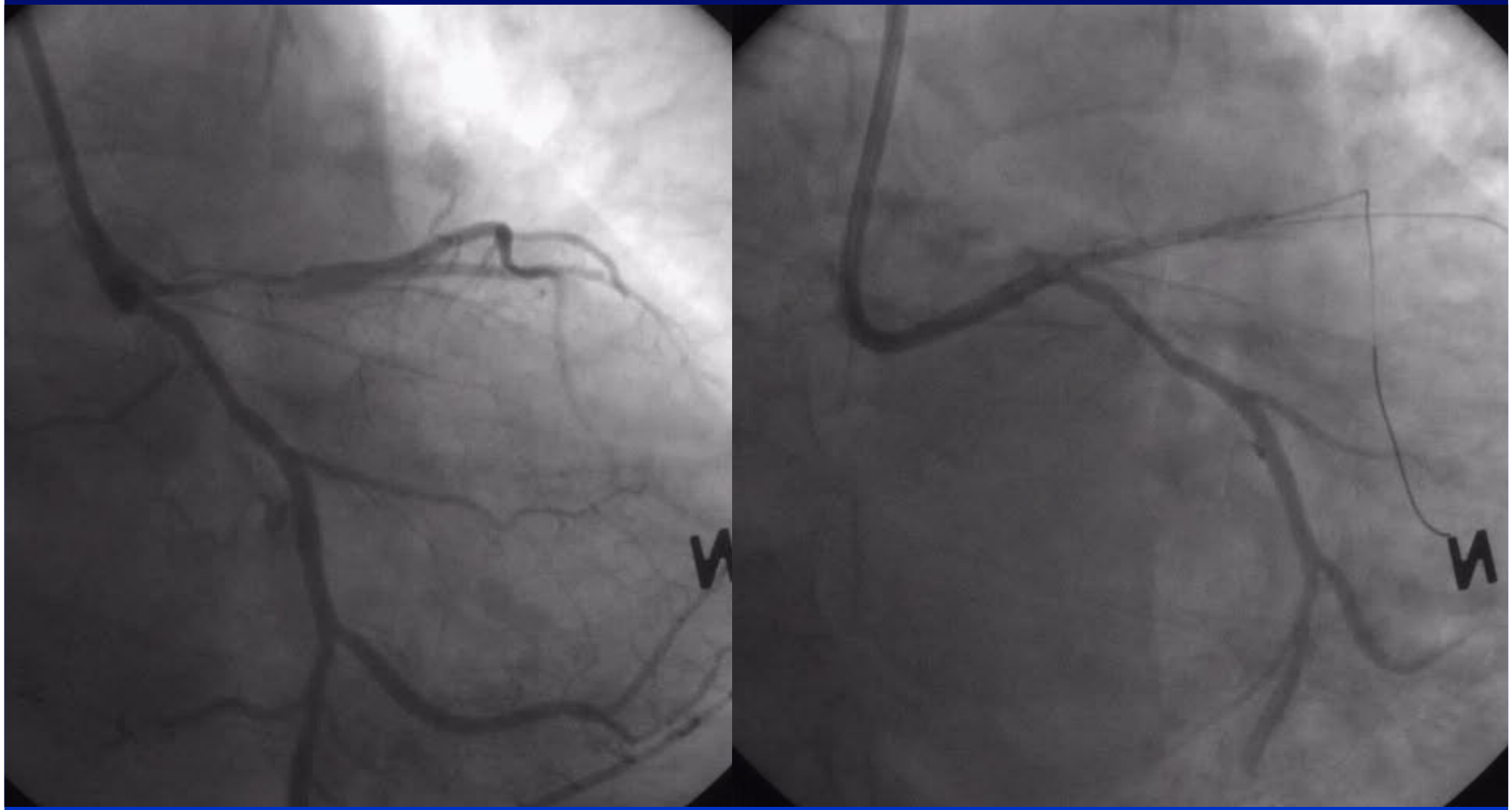
Immediate Postoperative Angiogram



Postoperative 6-month Follow-up Angiogram

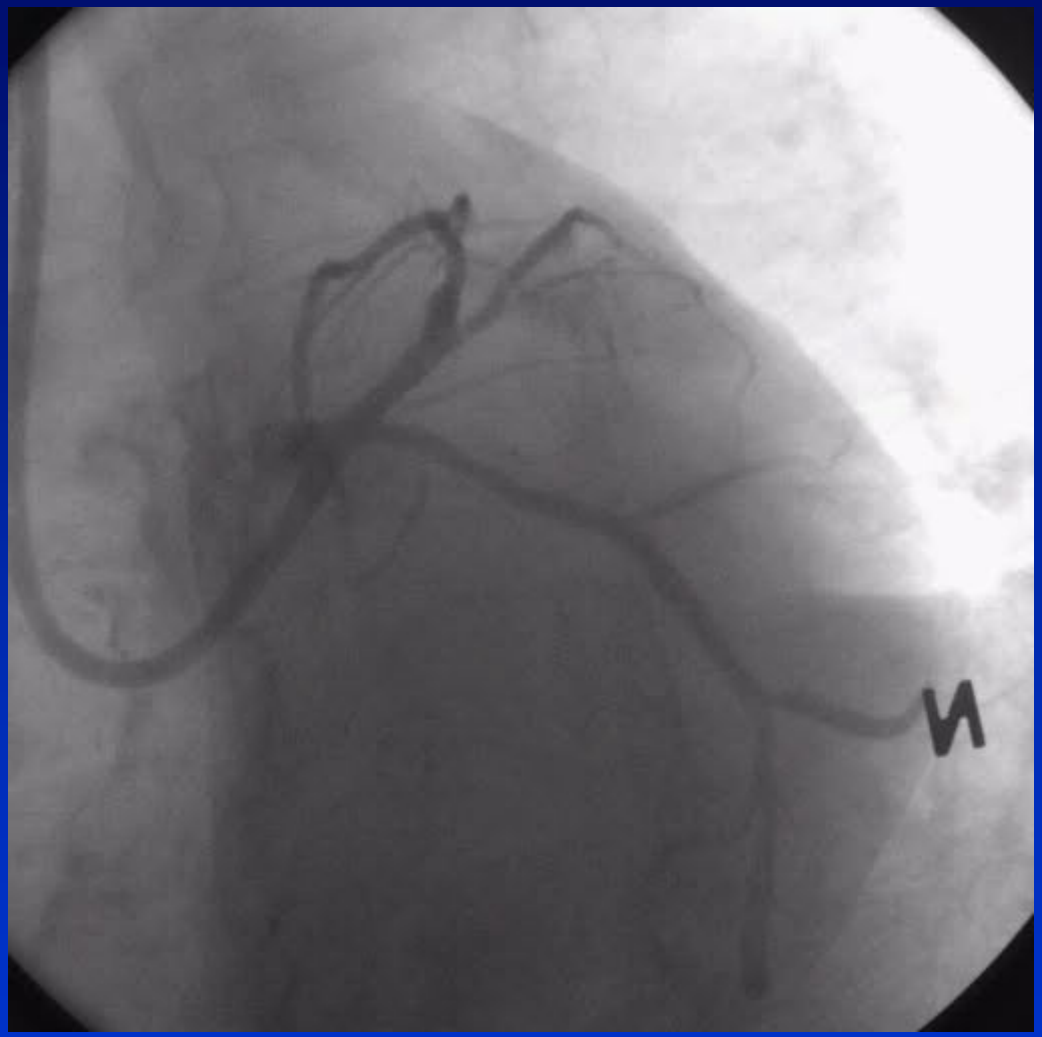


LMCA or LAD ostial stenting



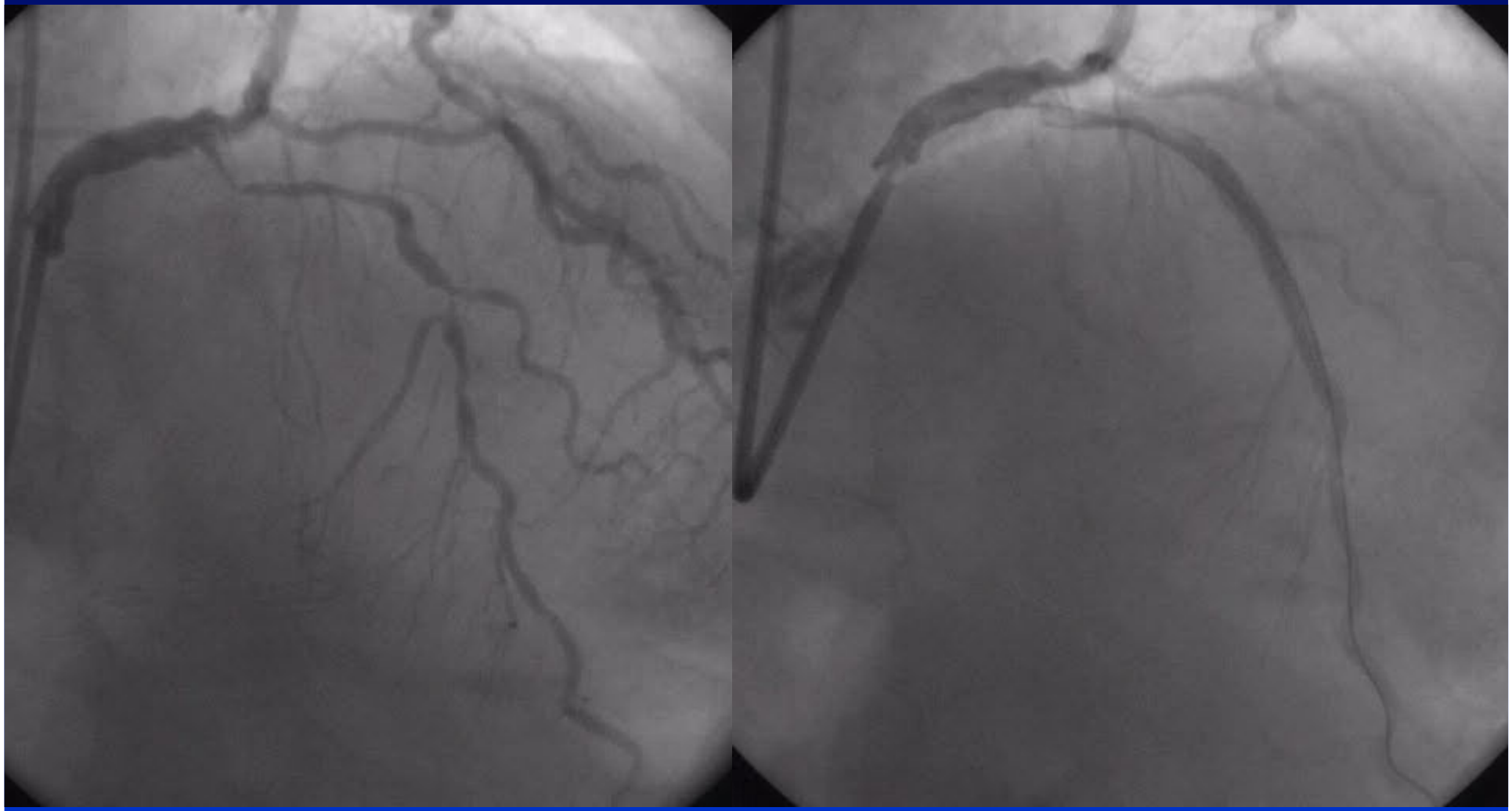
AP or RAO caudal projection is the best

LMCA or LAD ostial stenting



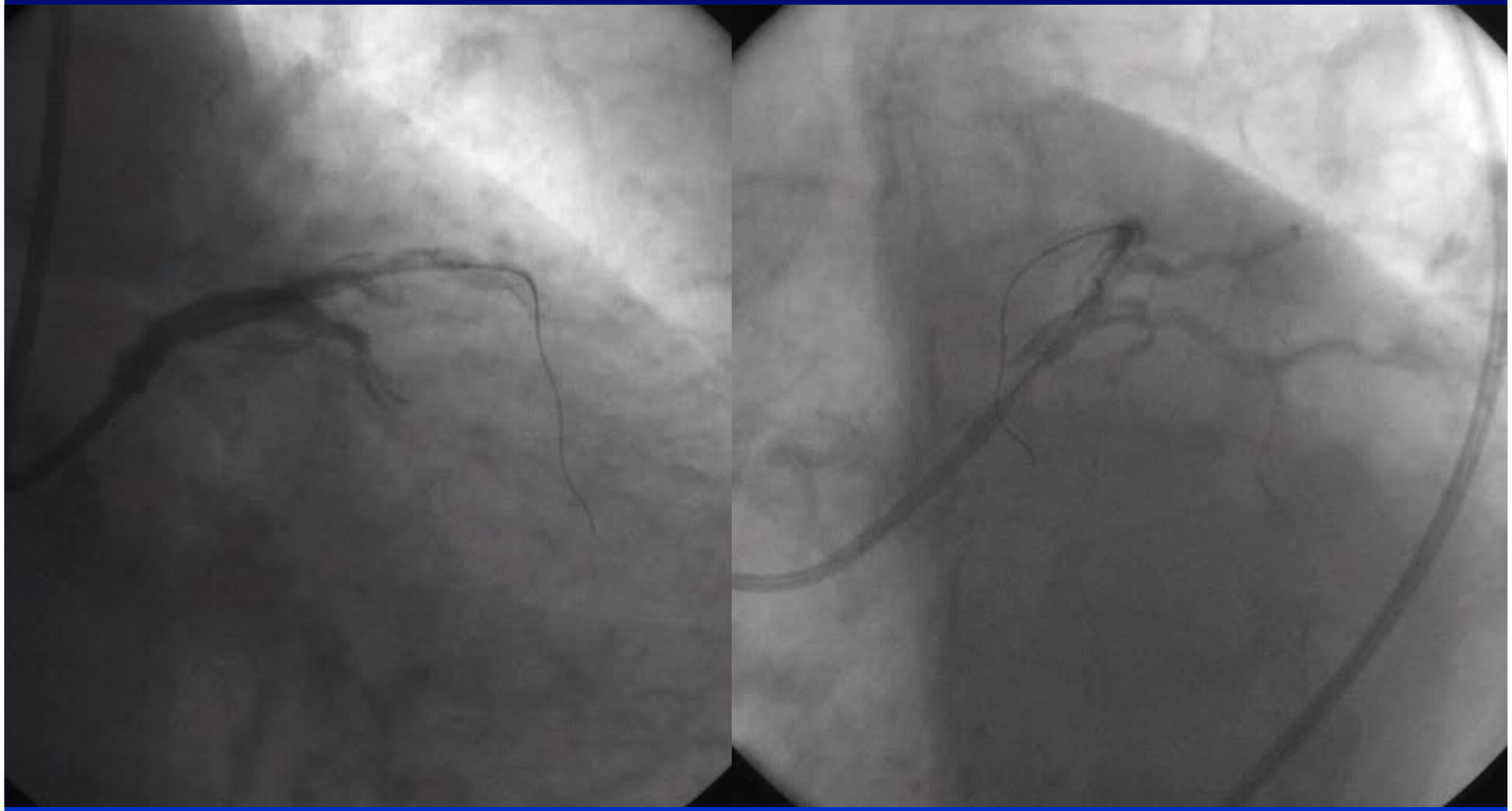
AP or RAO caudal projection is the best

LMCA or LAD ostial stenting



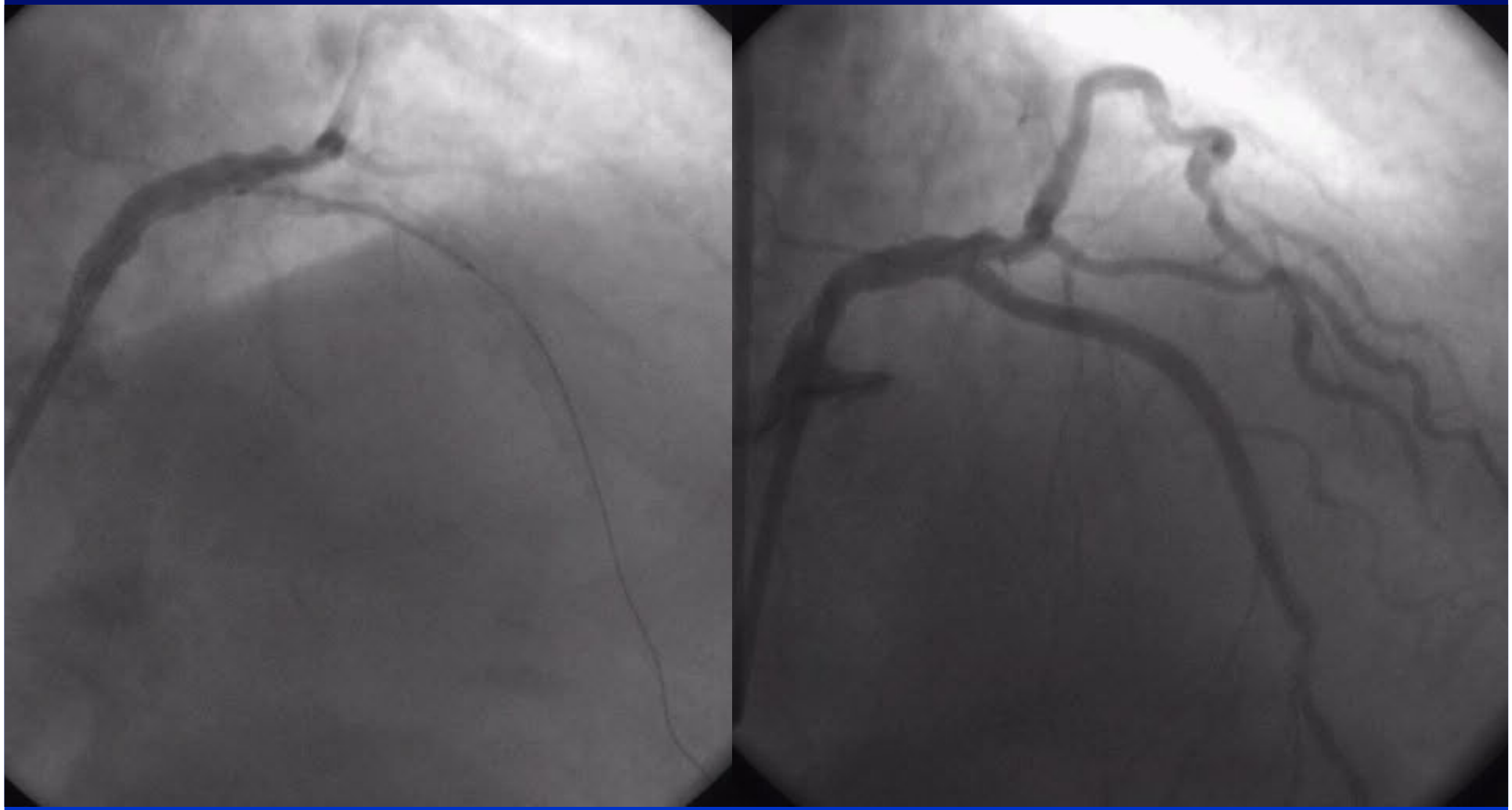
Caudal projection will be the best – Always ?

LMCA or LAD ostial stenting



Caudal projection will be the best – Always ?

LMCA or LAD ostial stenting



RAO cranial – Sometimes helpful

LMCA or LAD ostial stenting

RAO cranial – Sometimes helpful

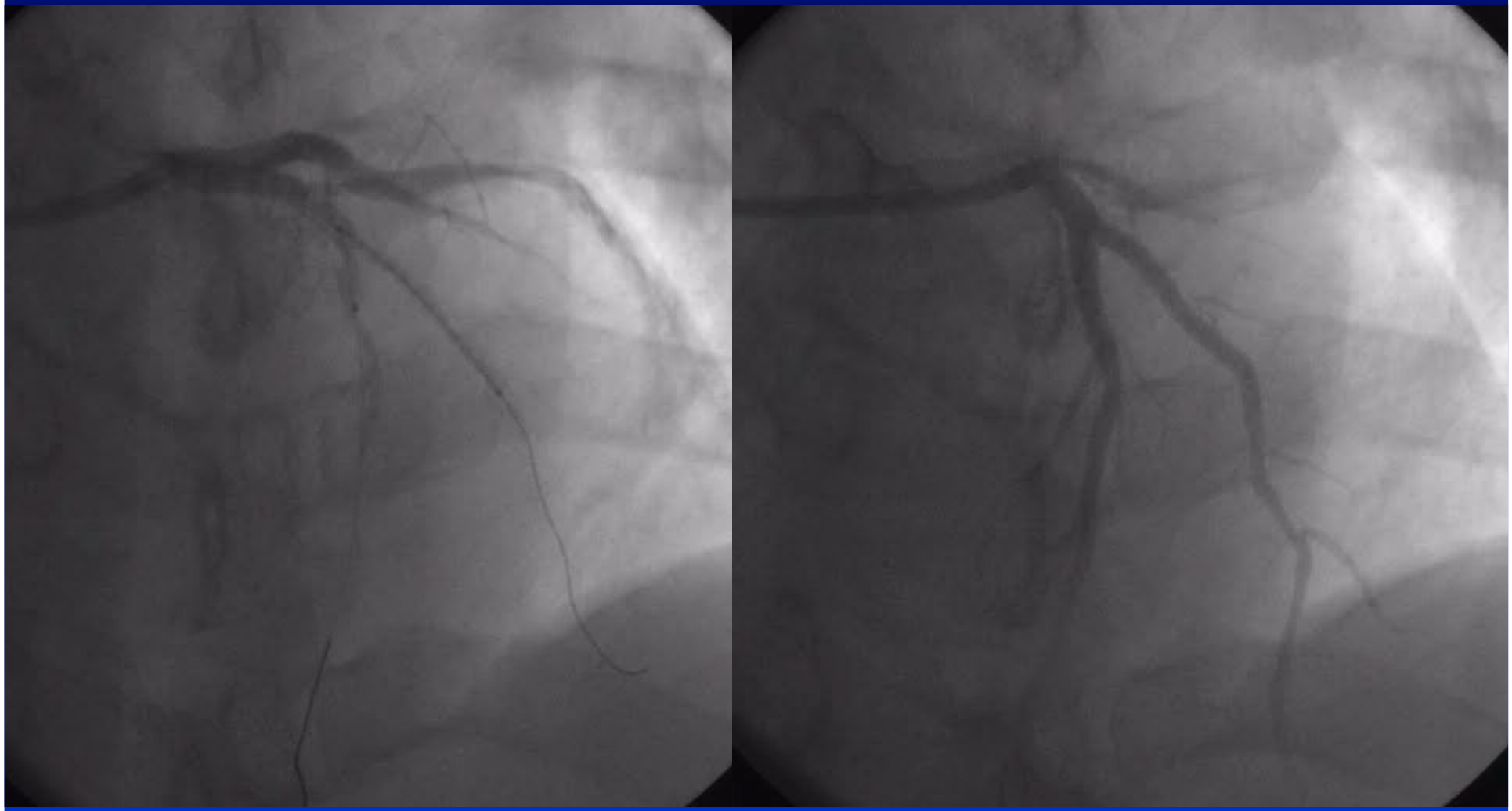
Who is the culprit ?

60/M, NSTEMI, Apical hypokinesia

Who is the culprit ?

60/M, NSTEMI, Apical hypokinesia

Who is the culprit ?

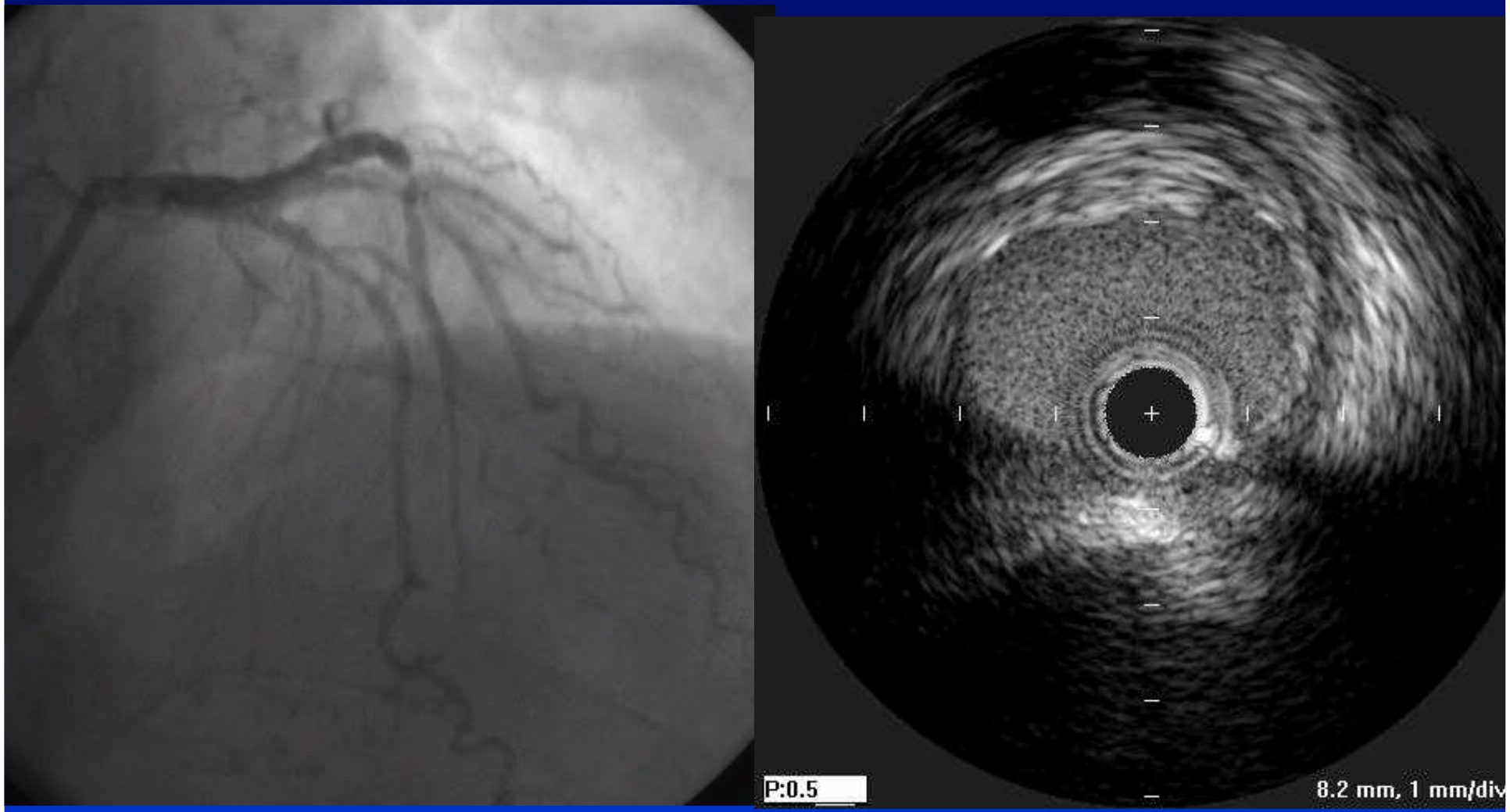


60/M, NSTEMI, Apical hypokinesia

Who is the culprit ?

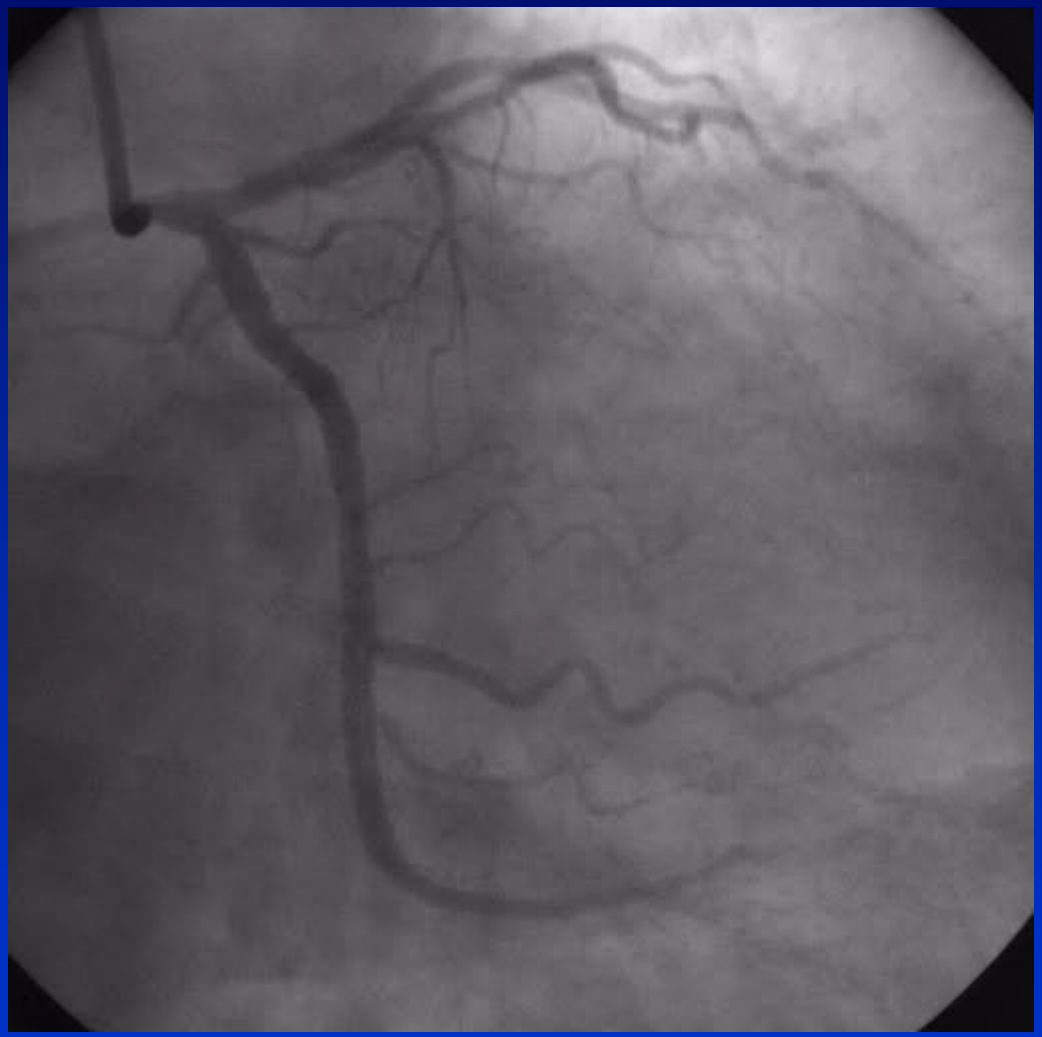
71/F, Unstable angina

Who is the culprit ?



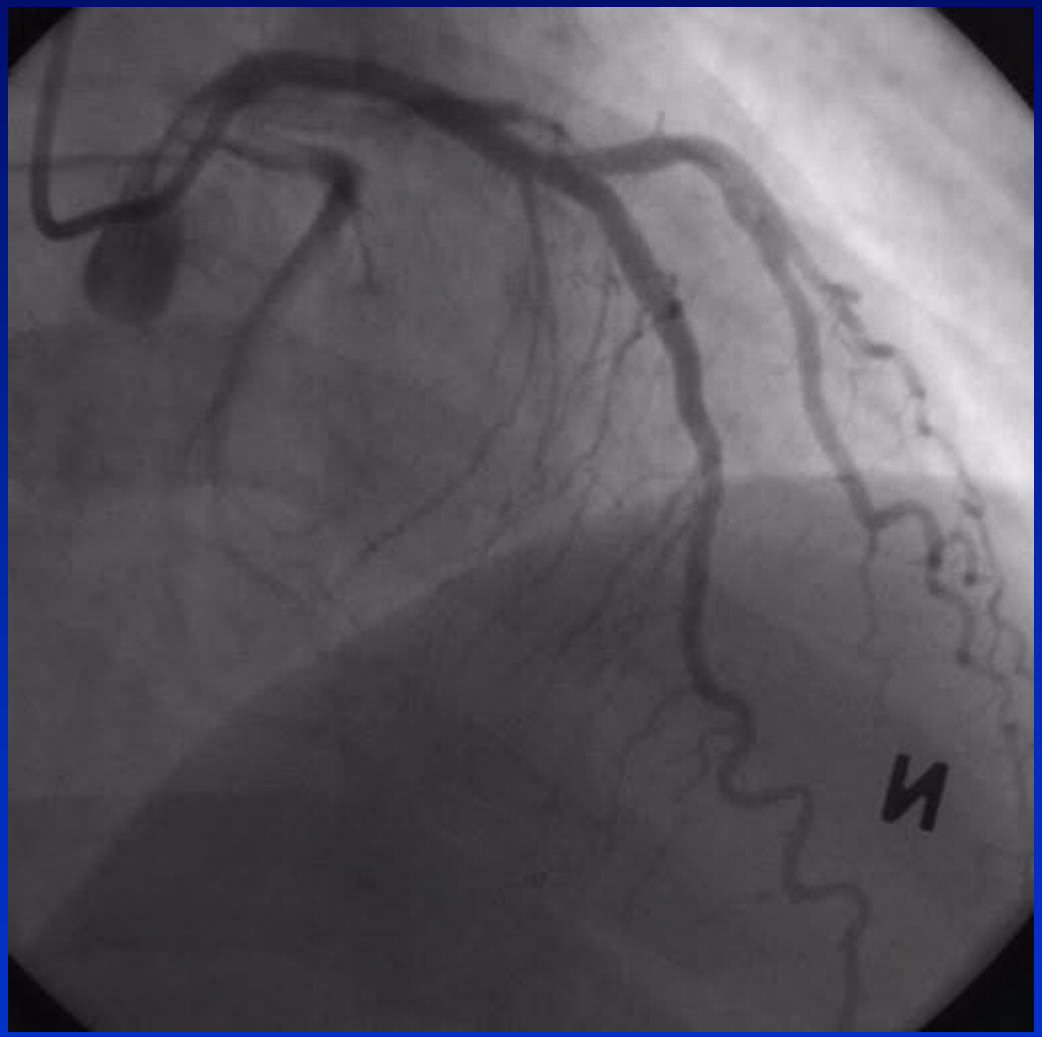
71/F, Unstable angina

Who is the culprit ?



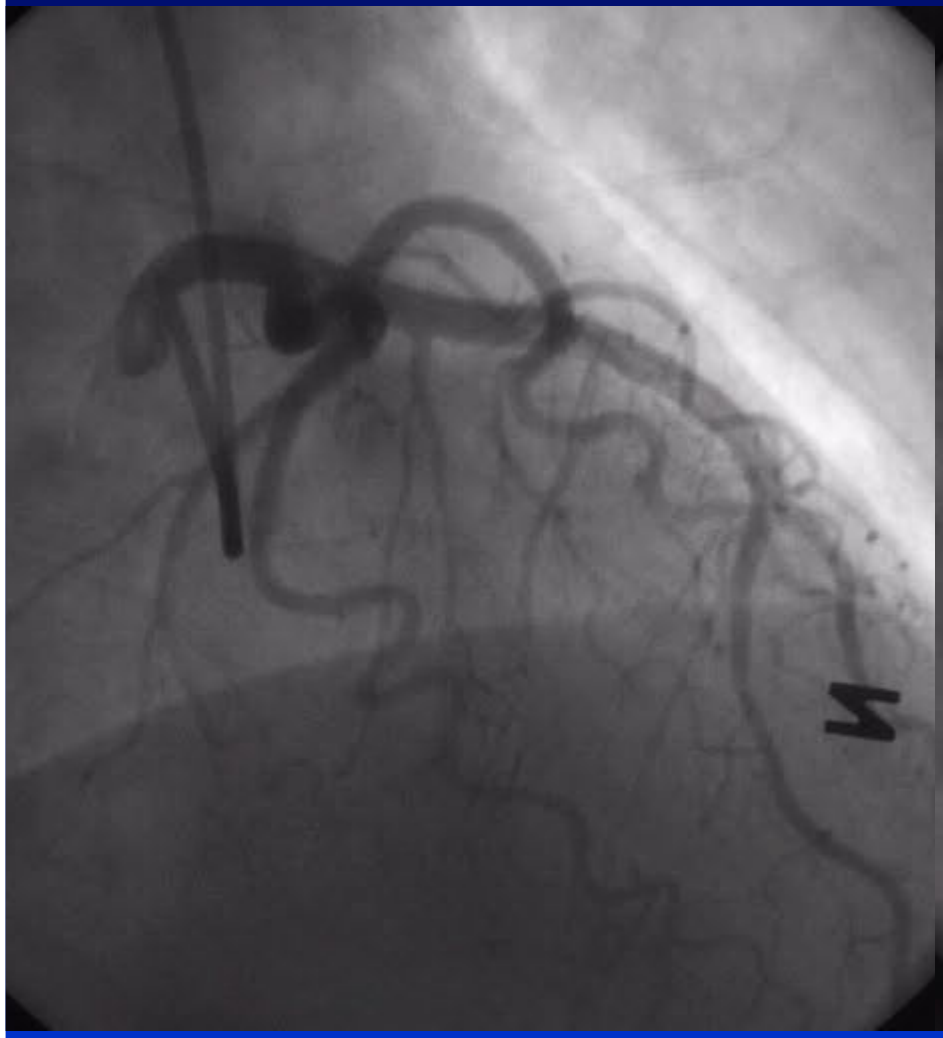
71/F, Unstable angina

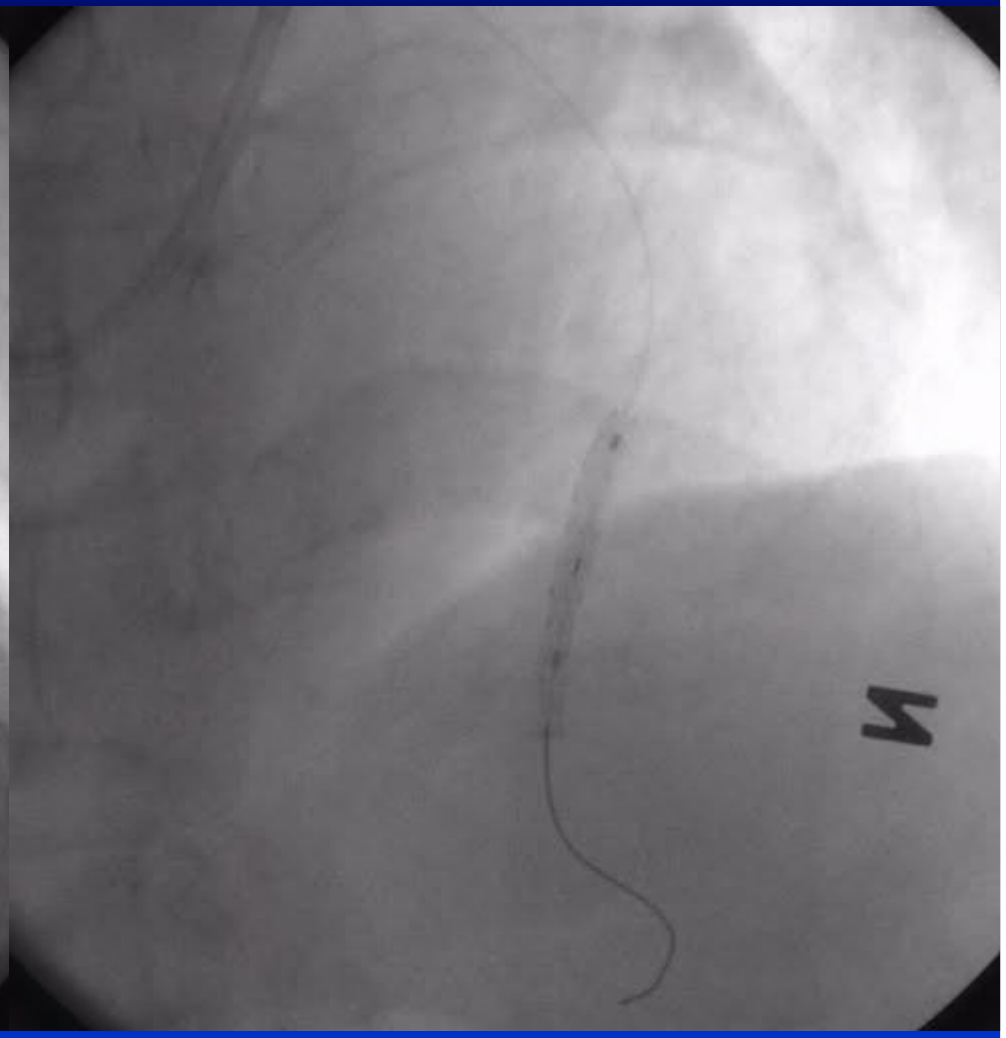
Myocardial Bridging



54/F, Atypical chest pain

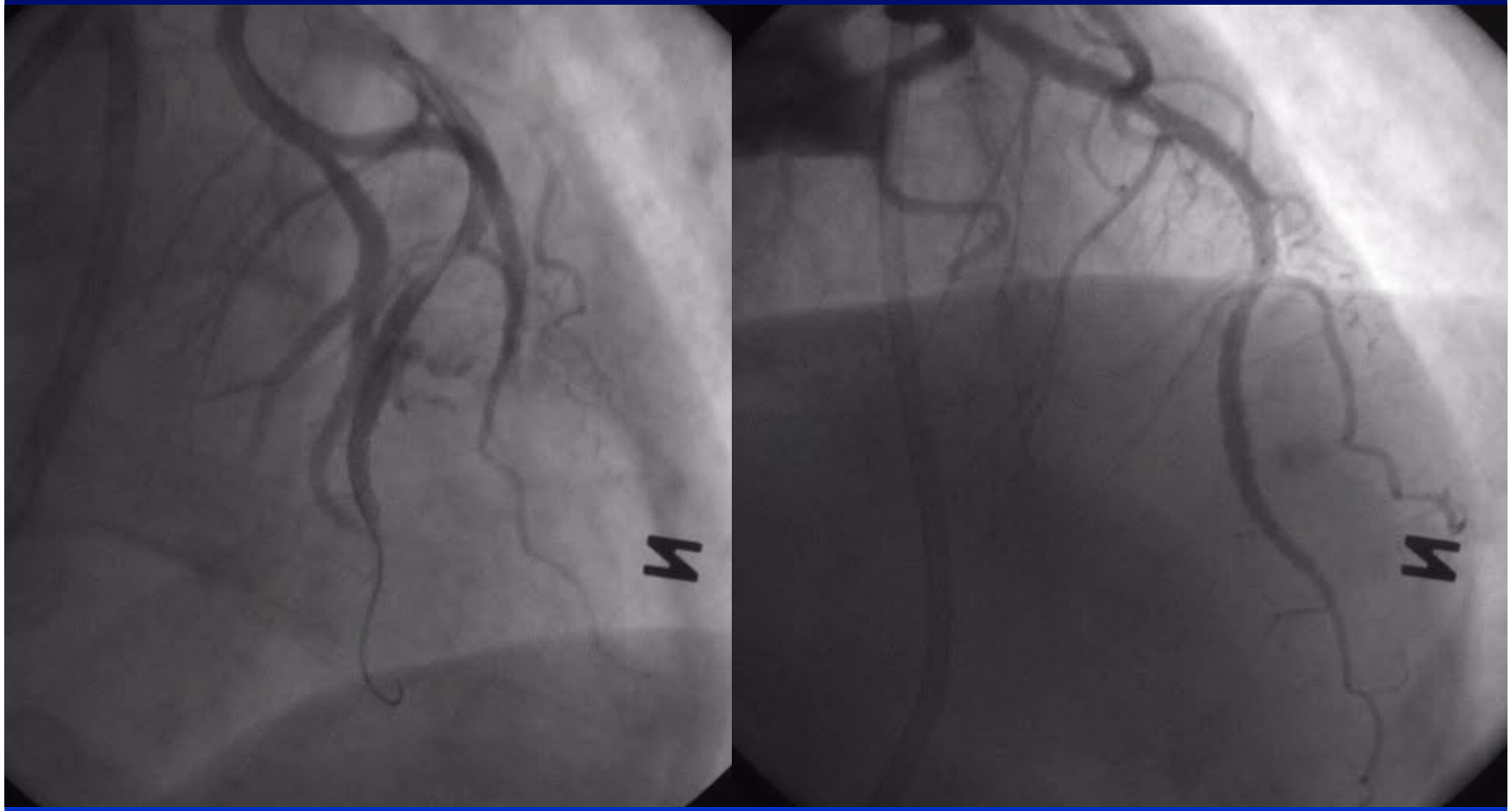
Myocardial Bridging





65/F, Resting chest pain **Stenting and HP dilatation**

Myocardial Bridging



65/F, Resting chest pain

STEMI with heavy thrombus

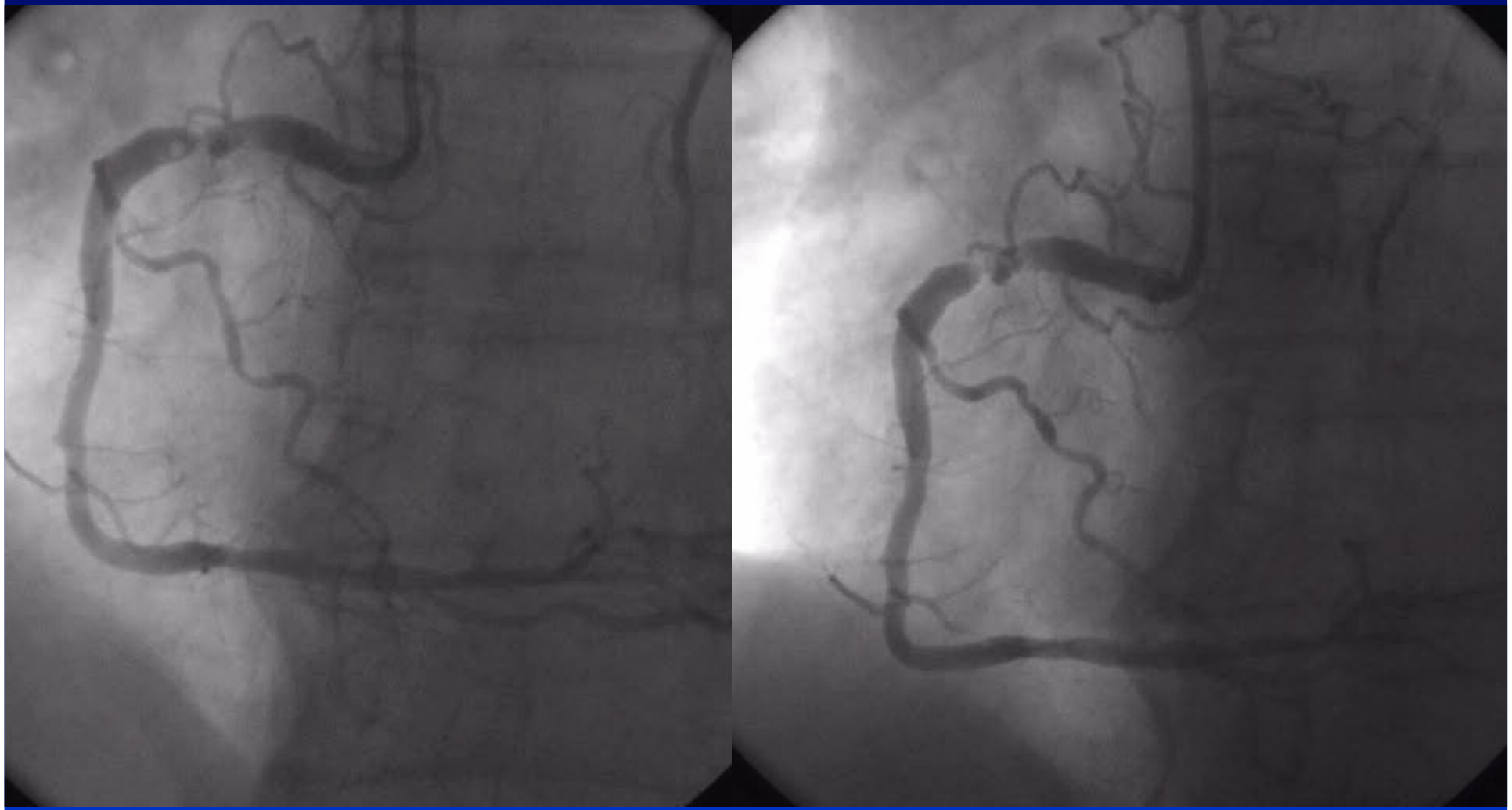
M/25, STEMI 3 hours

Thrombi suction only

STEMI with heavy thrombus

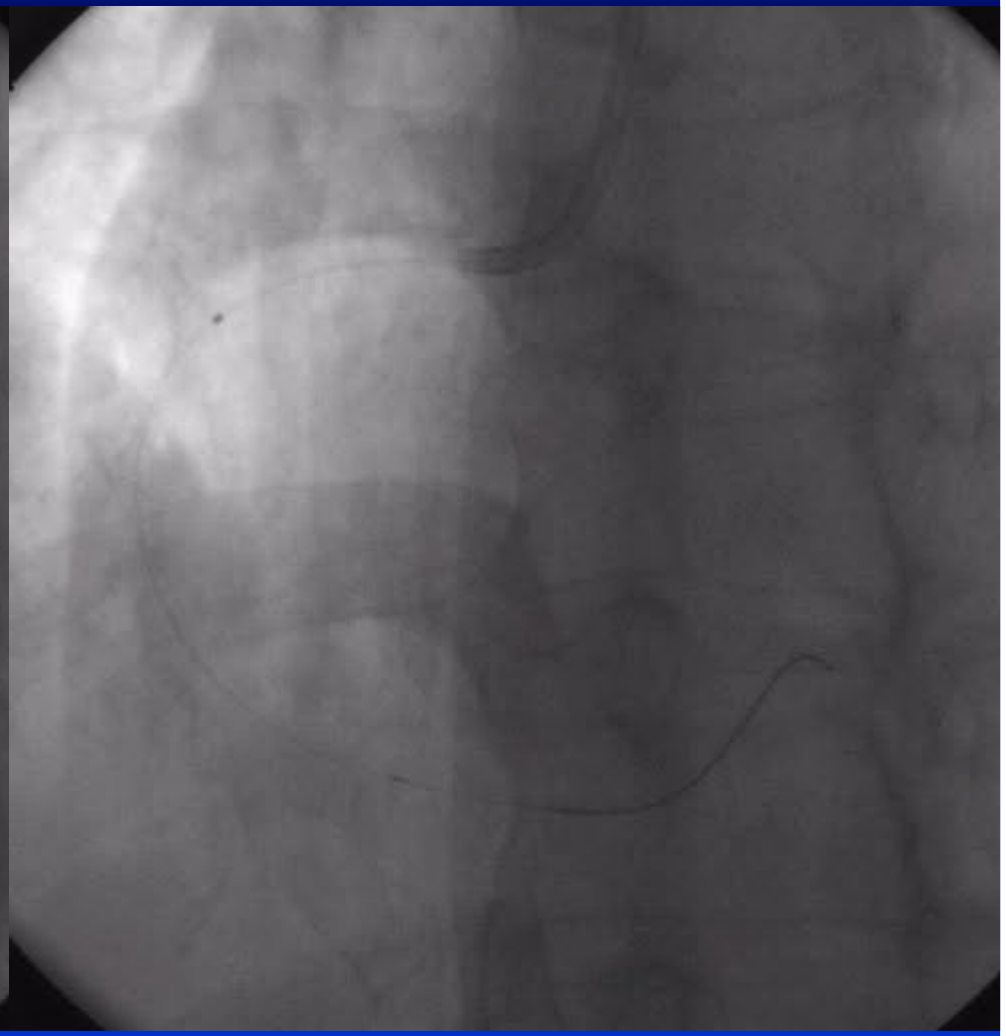
Heparin + Reopro, 5 days later

NSTEMI with visible thrombus



Heparin + Reopro, 3 days

STEMI with heavy thrombus



F/66, STEMI 5 hours

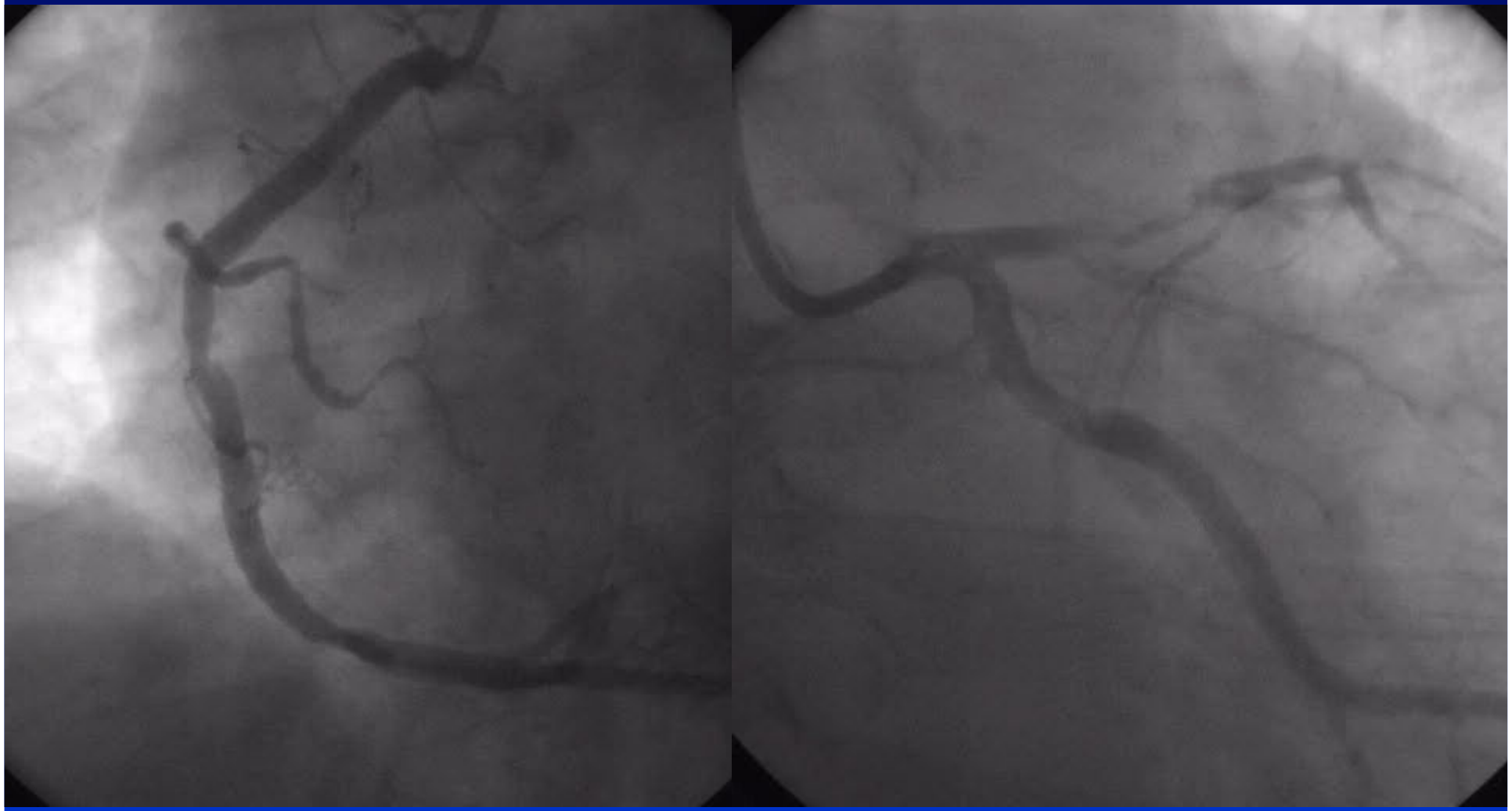
Thrombi suction

STEMI with heavy thrombus

Stenting with DPD

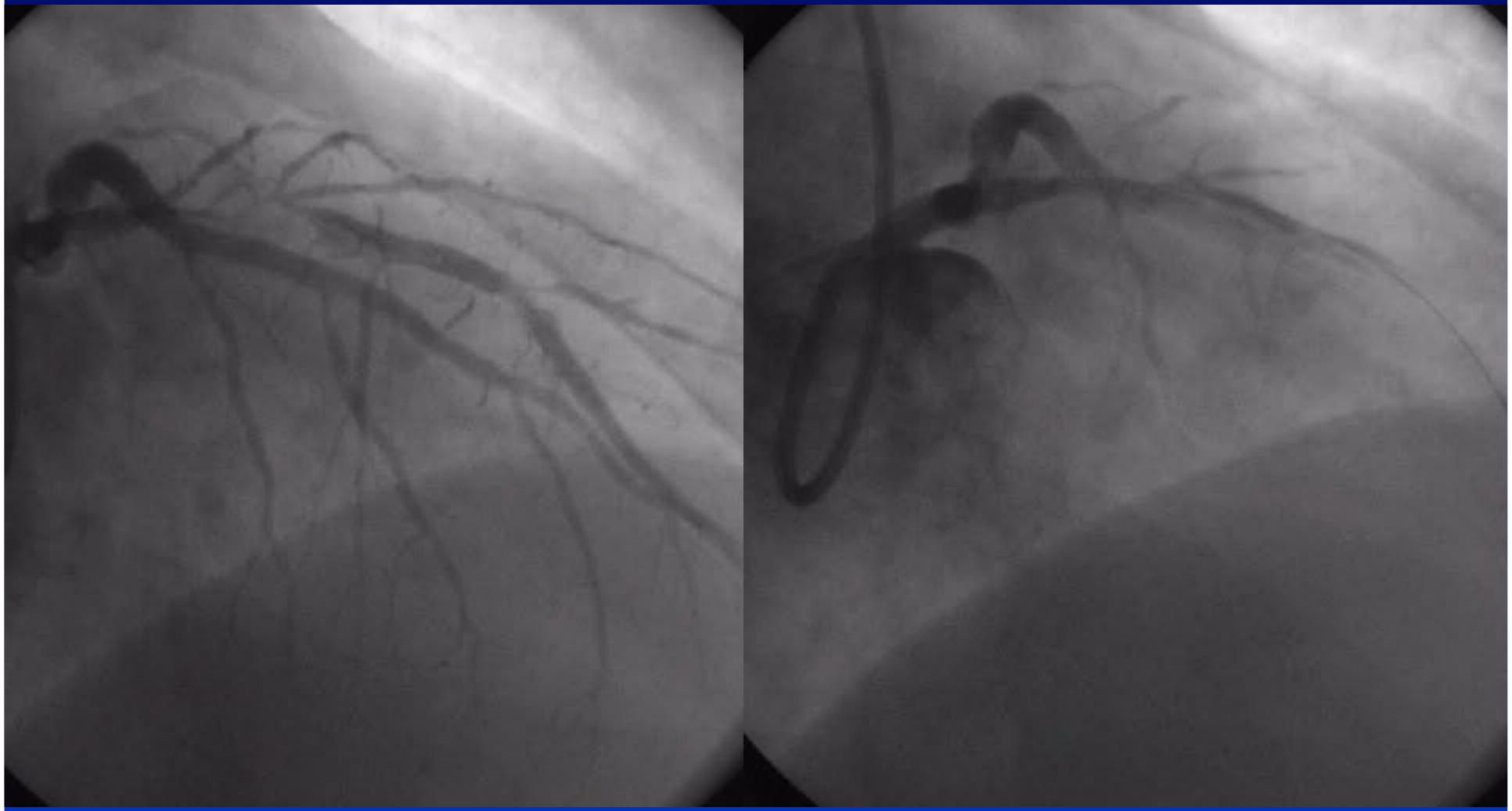
Final

NSTE-ACS with heavy thrombus



67/M, Unstable angina III_B

NSTE-ACS with heavy thrombus

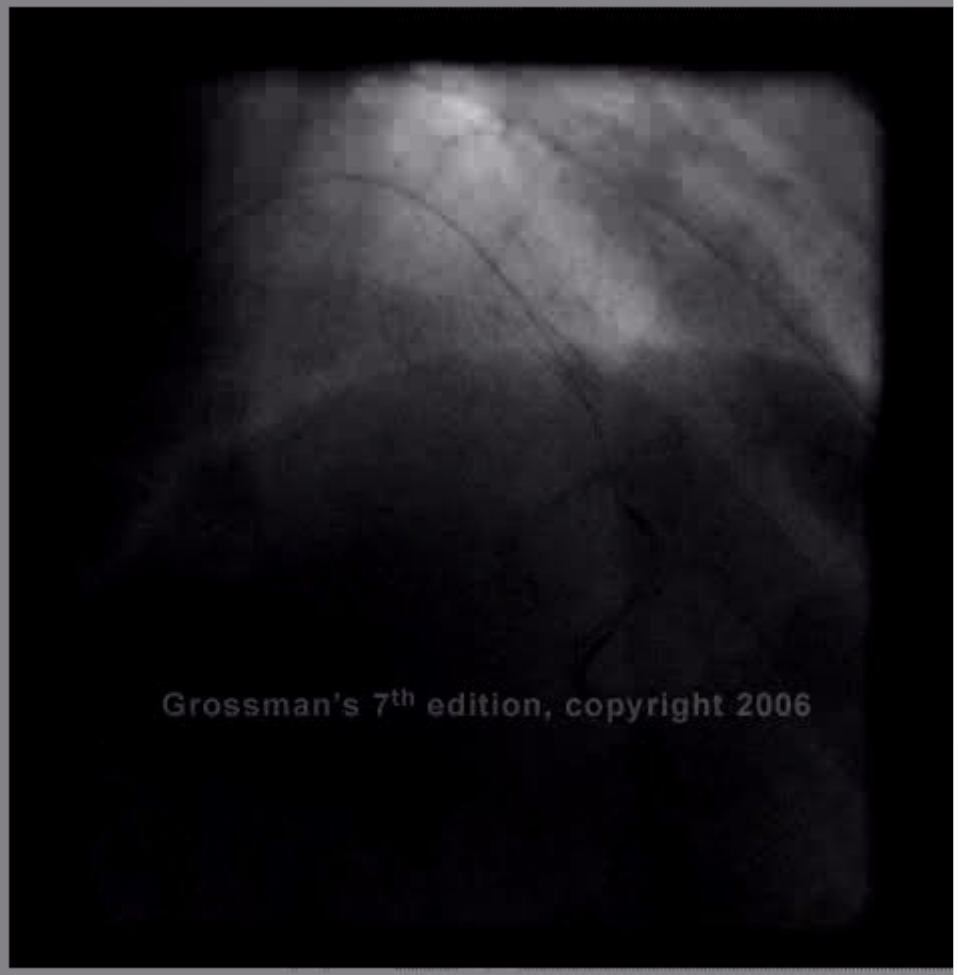


pLAD balloon

NSTE-ACS with heavy thrombus

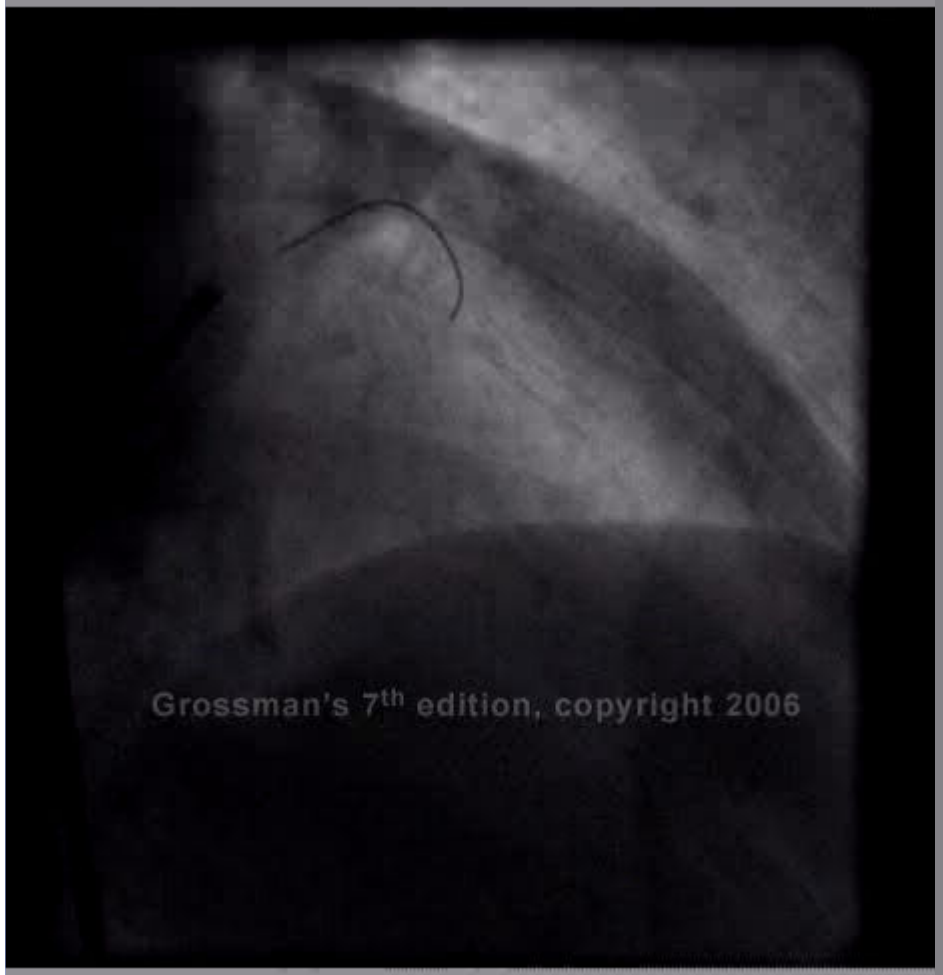
After stenting

After mLAD stenting

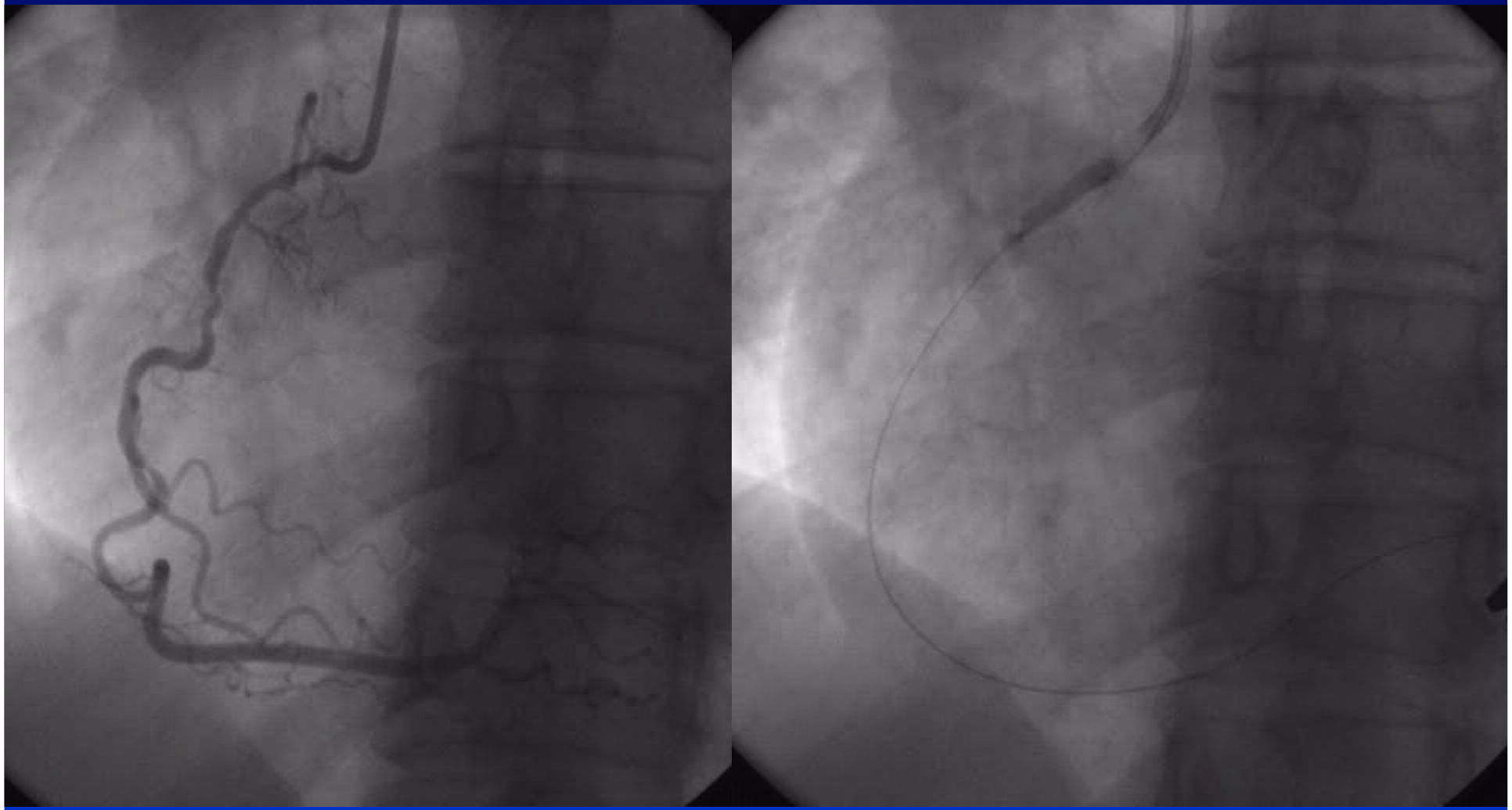


LAD ostial spasm vs. dissection ?

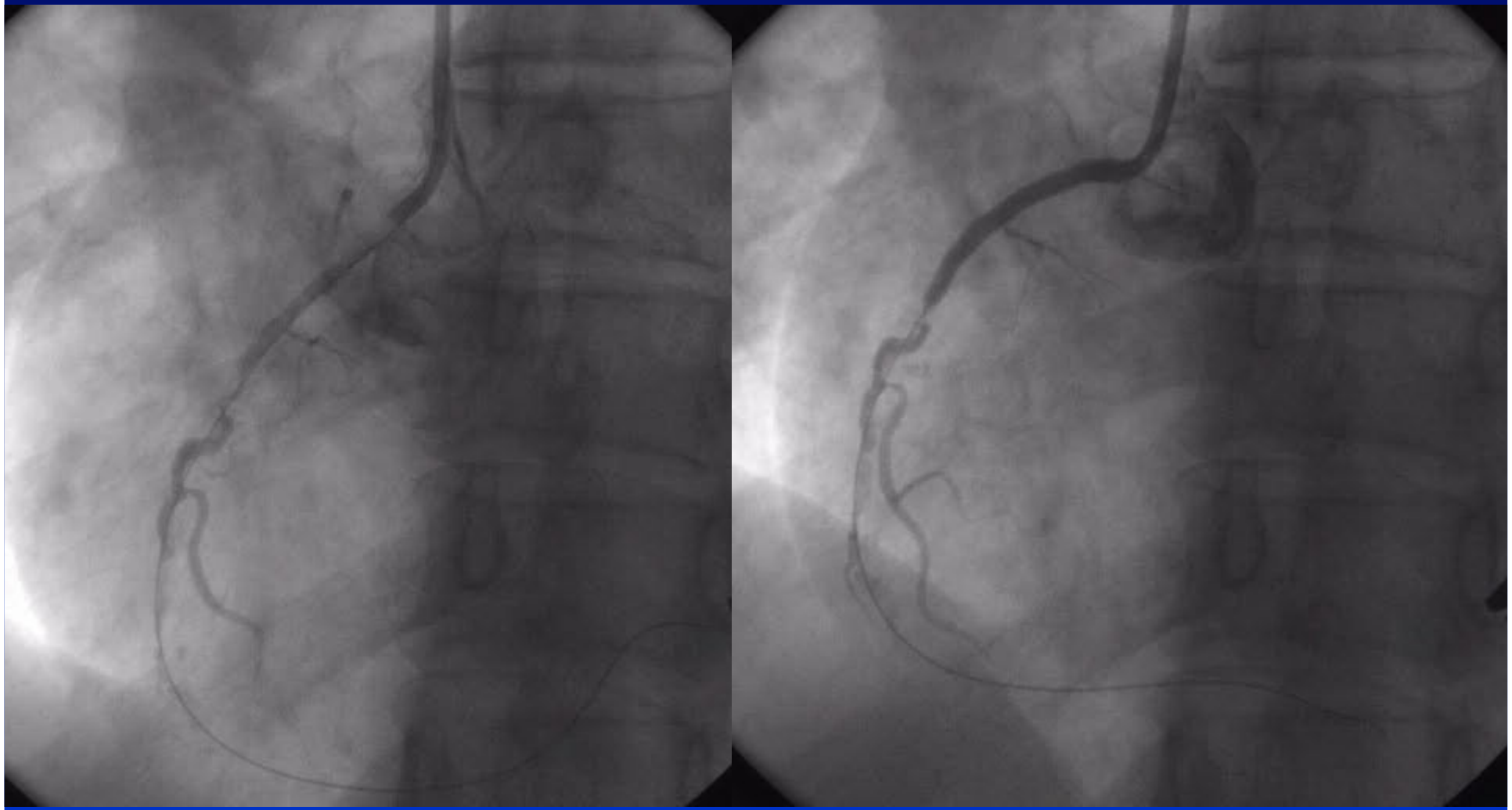
Pleating artifact (Accordion)



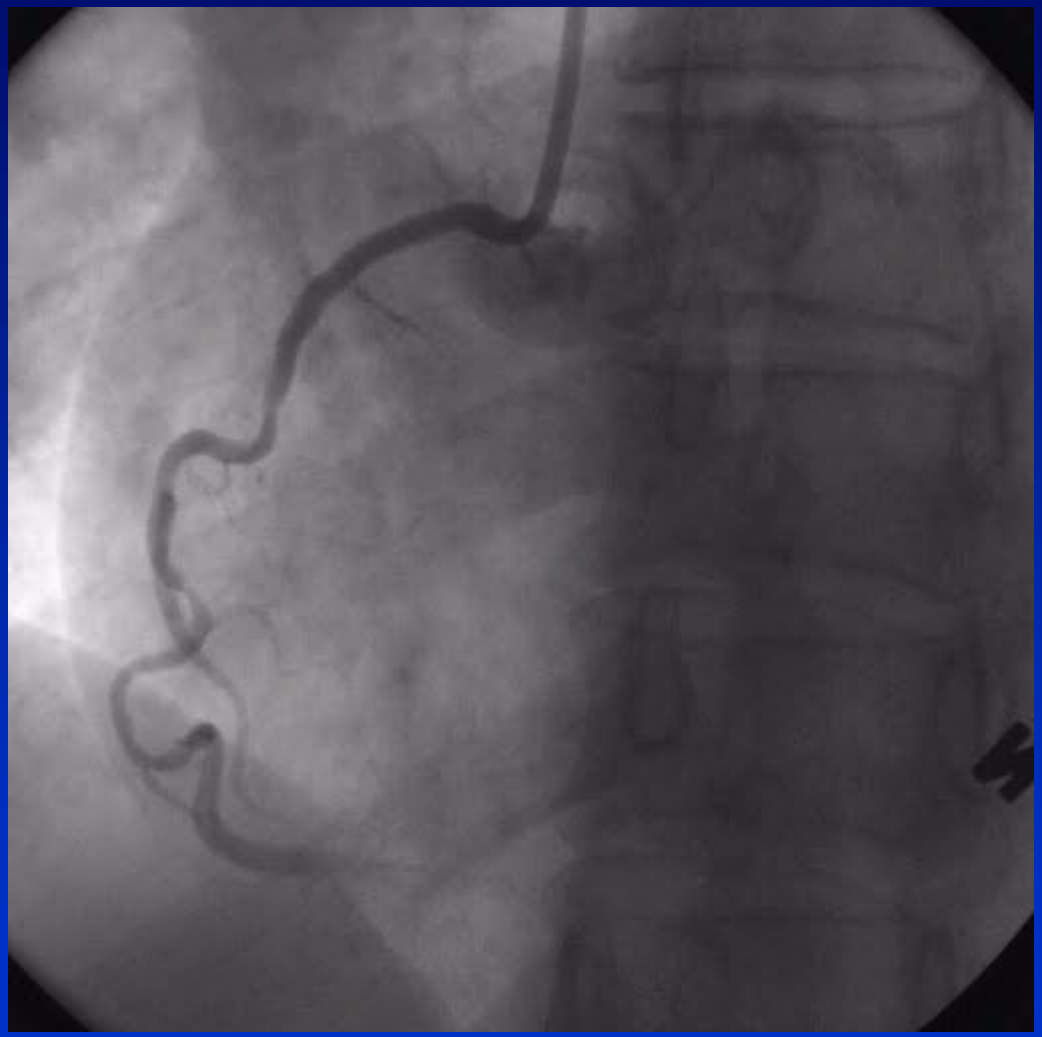
Pleating artifact (Accordion)



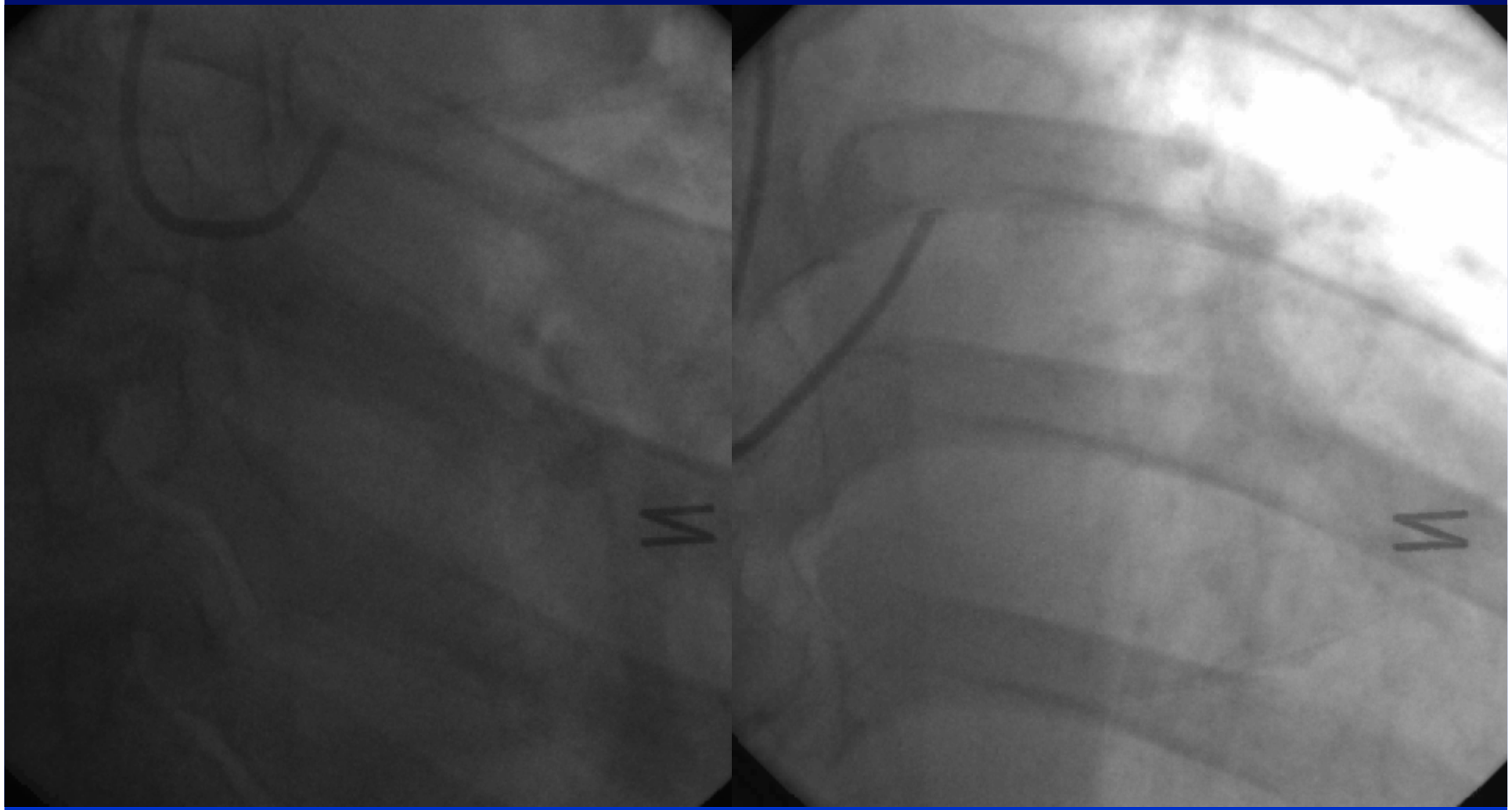
Pleating artifact (Accordion)



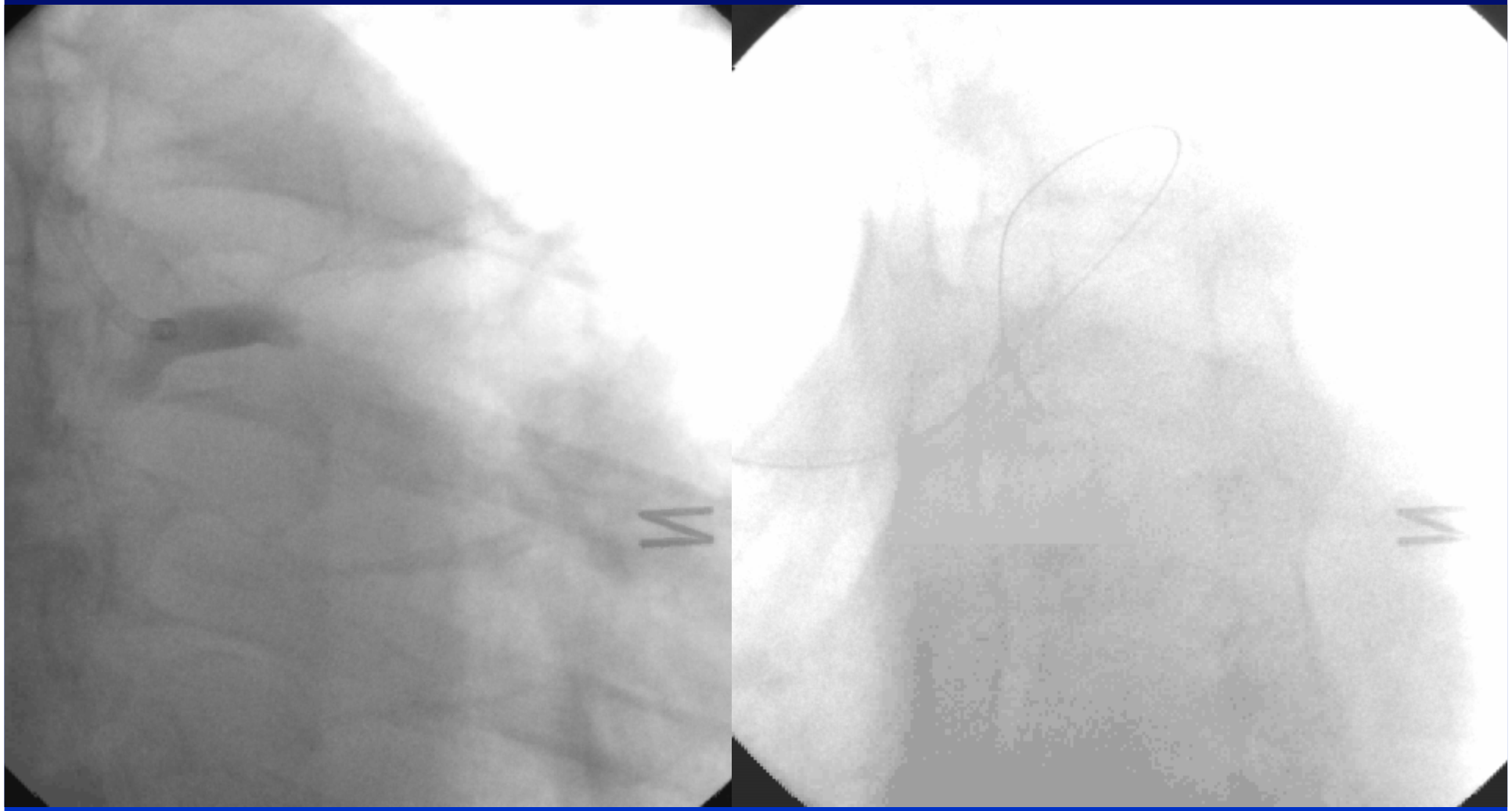
Pleating artifact (Accordion)



55/M, Stable angina

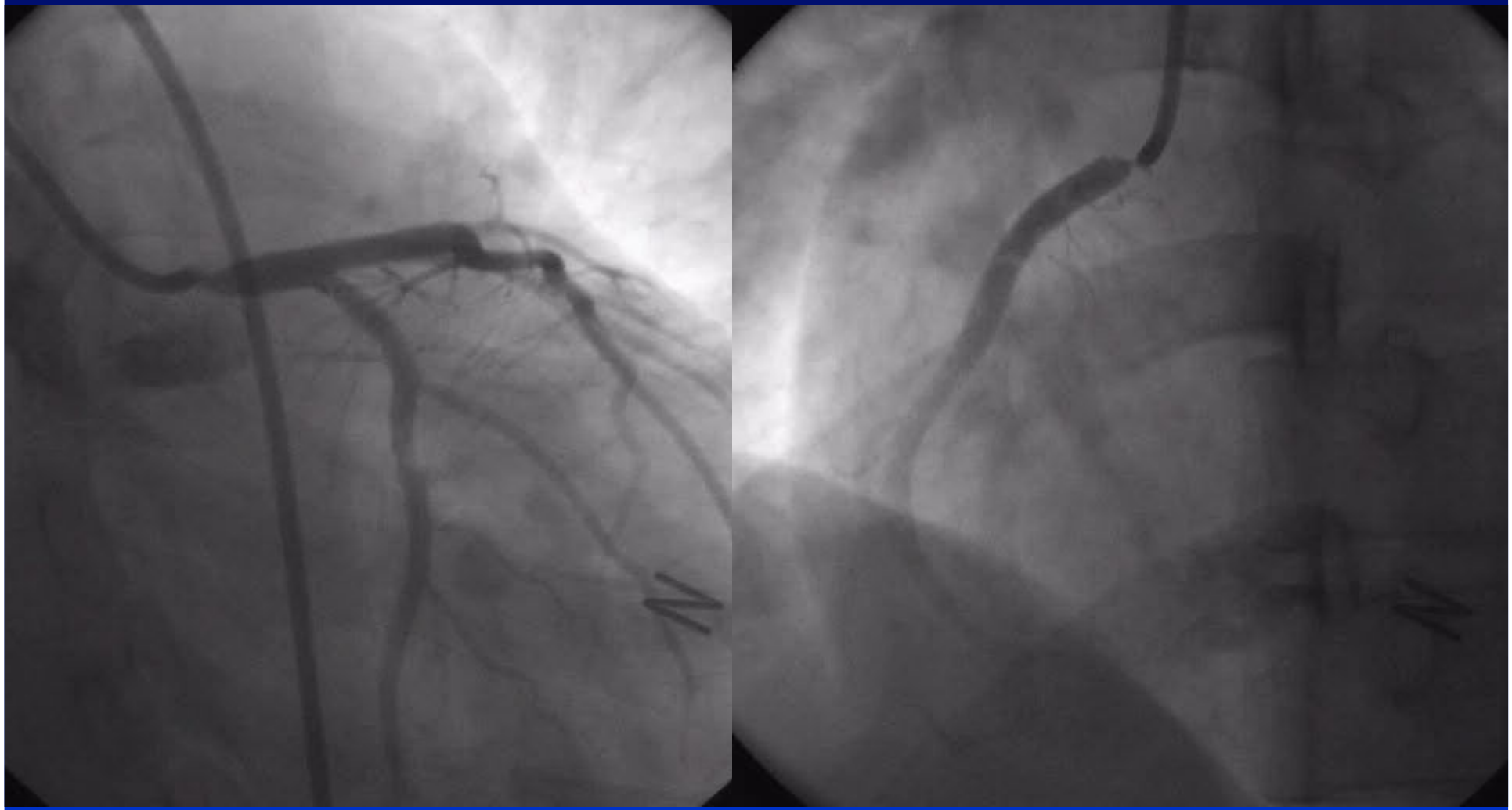


55/M, Stable angina



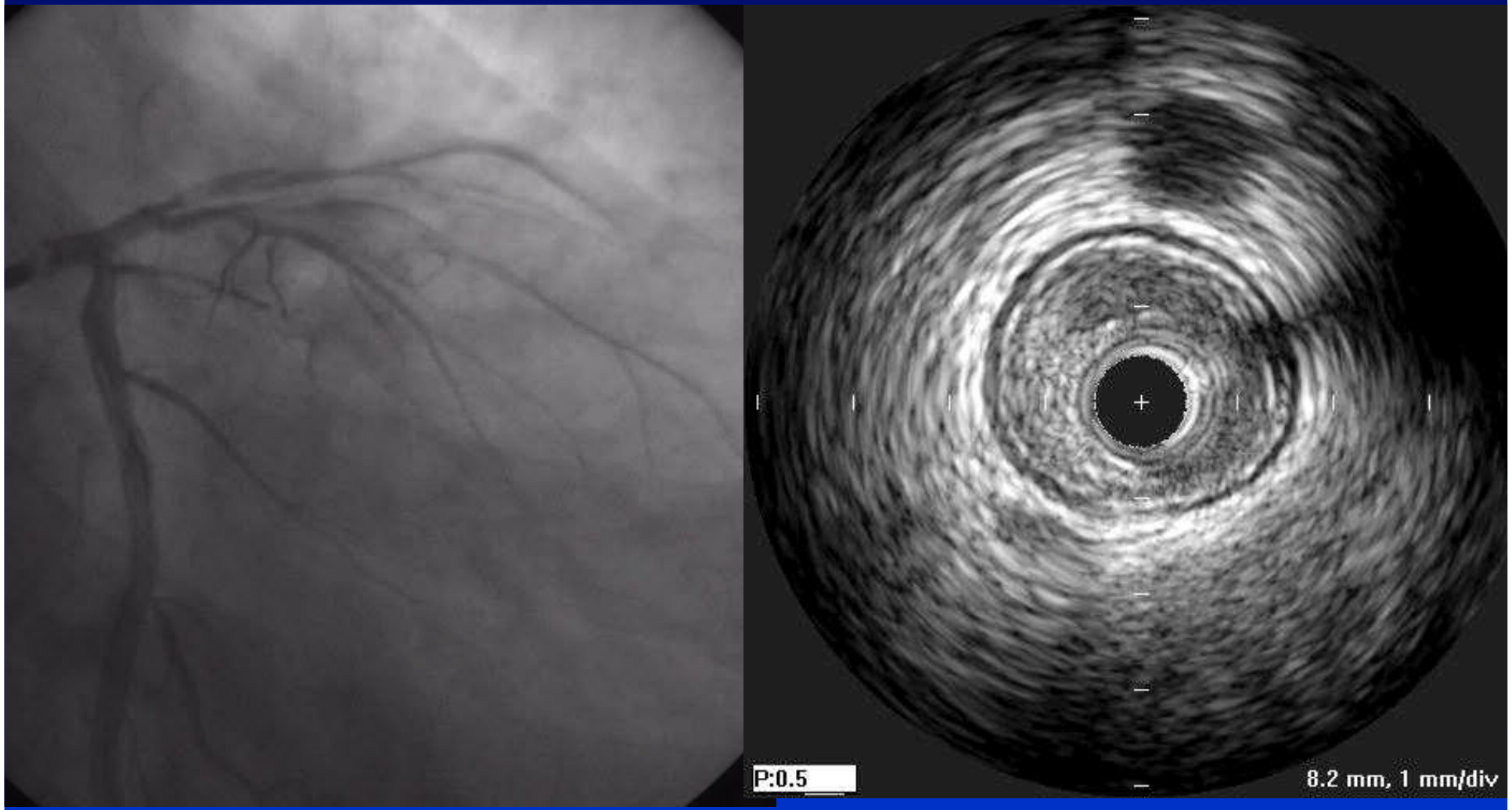

Thanks for your time.

Both aorto-ostial stenosis



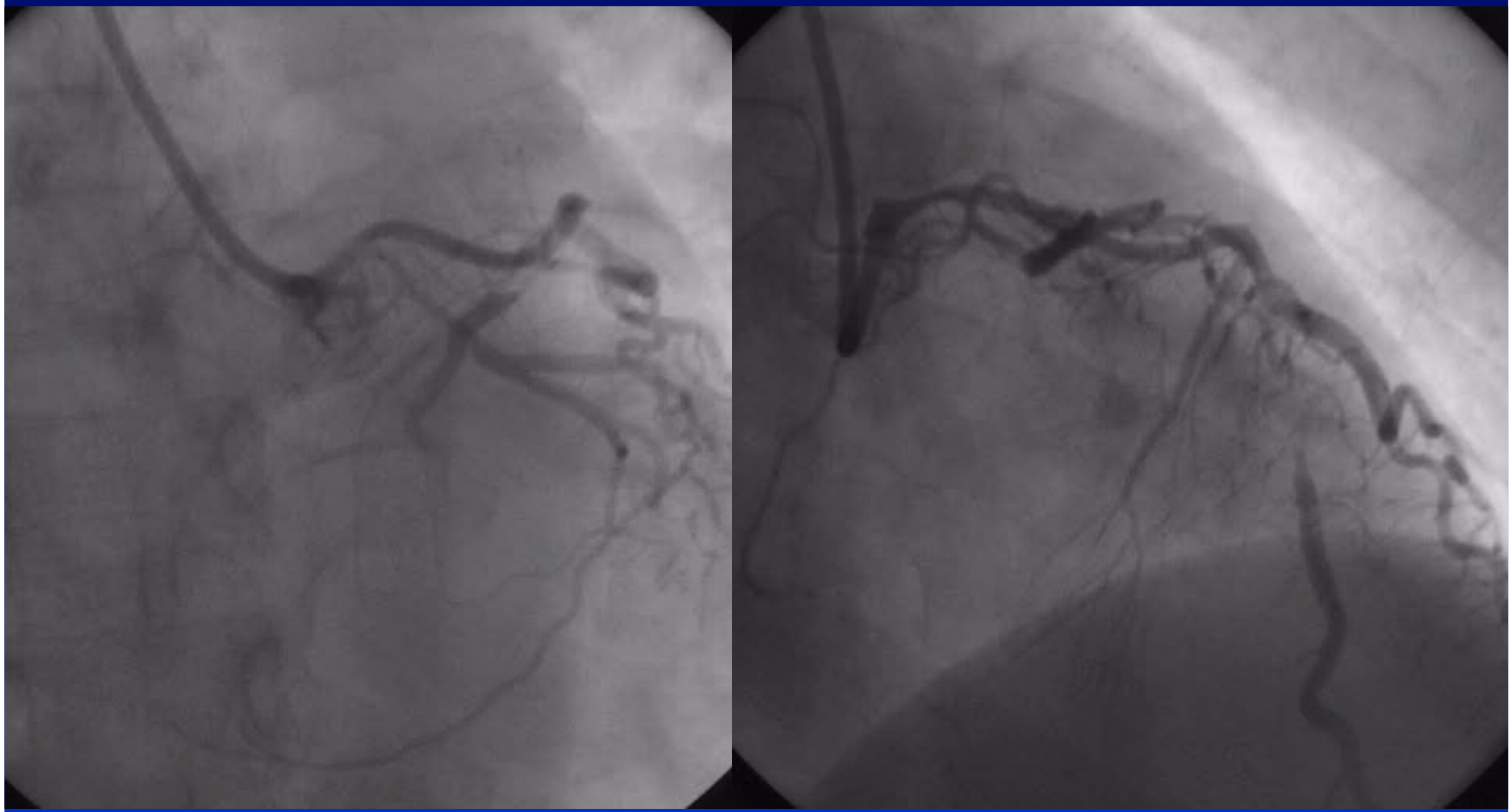
32/F, NSTEMI

Dissection?

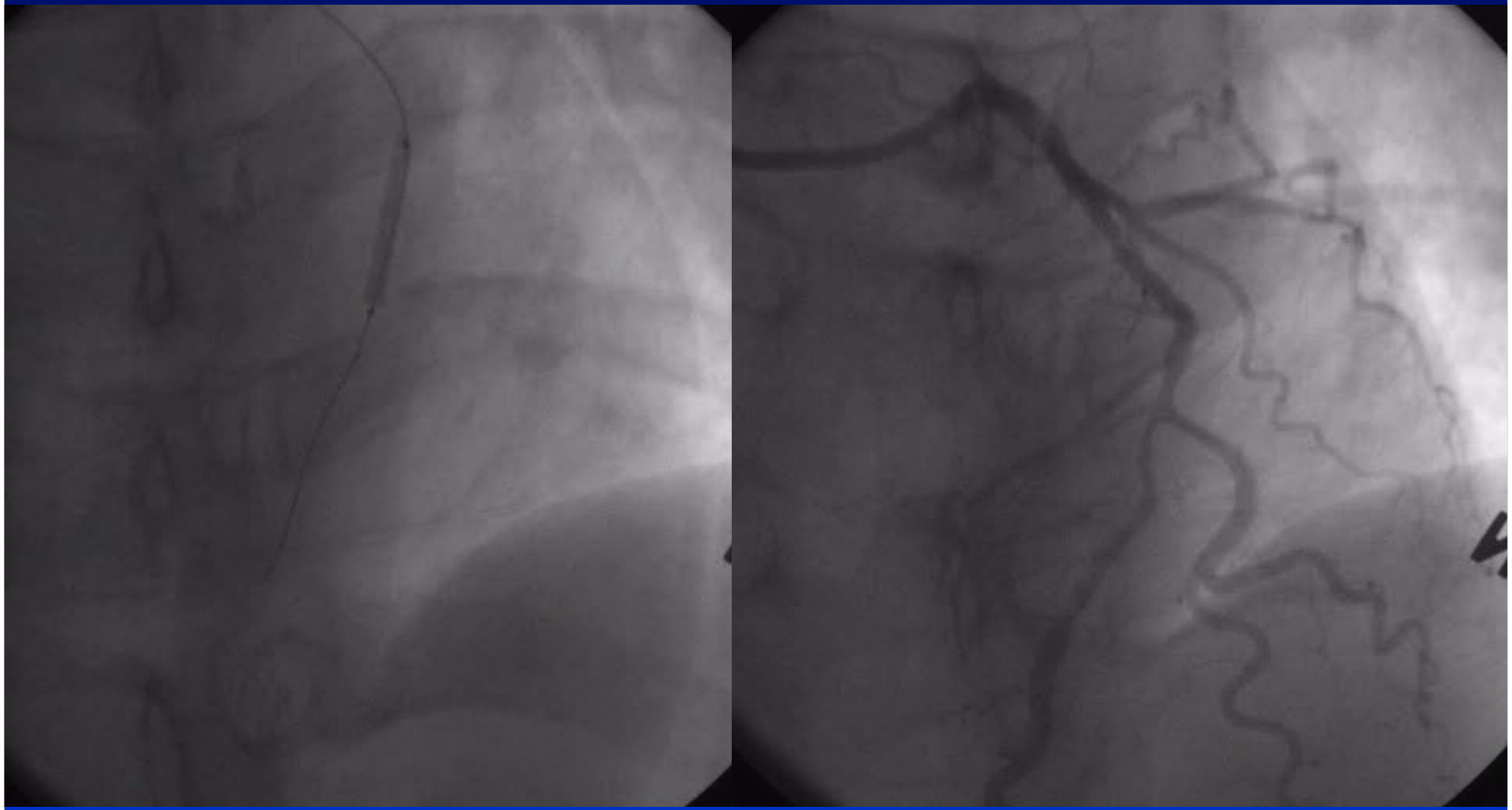


55/M, Unstable angina

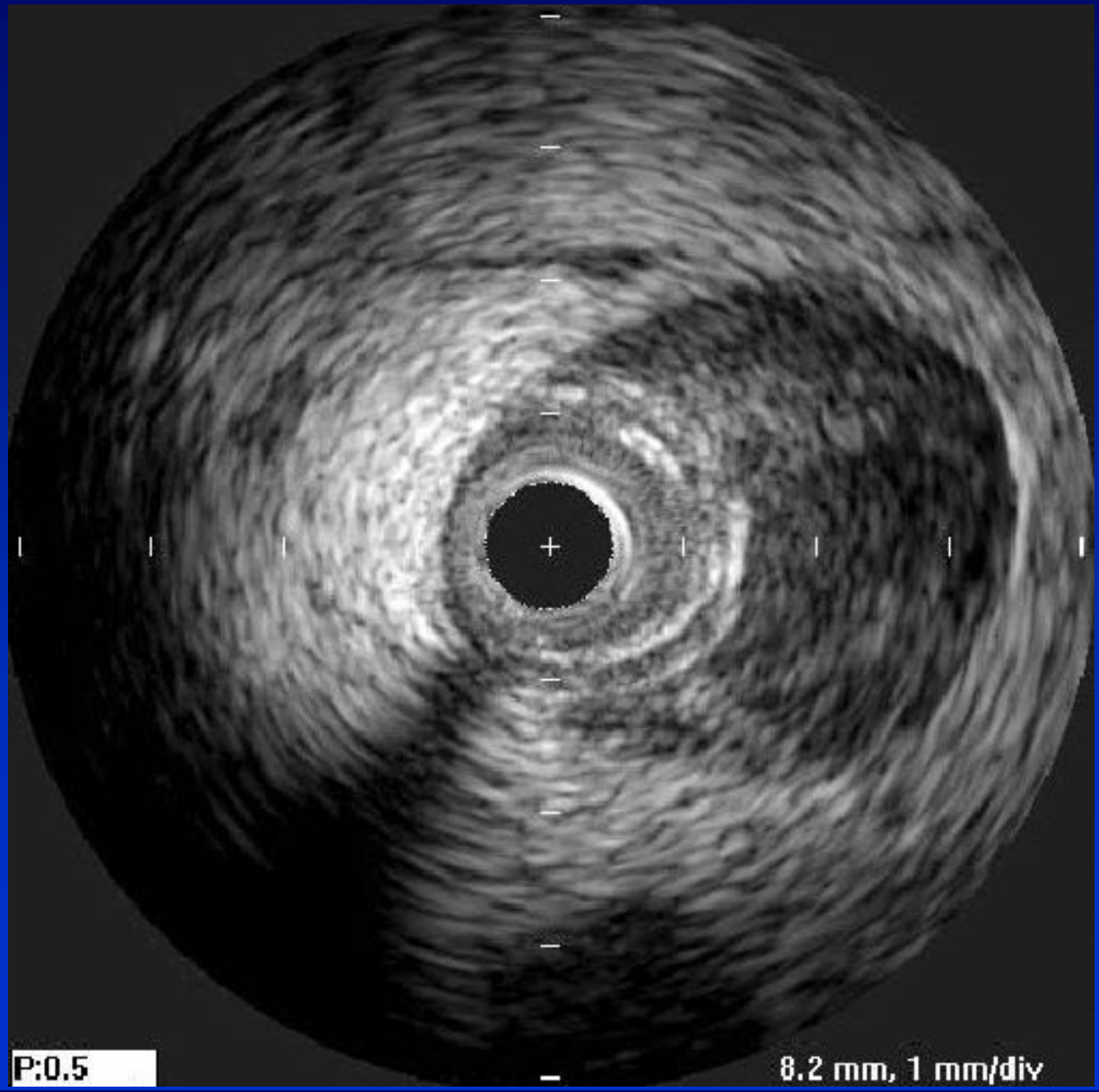
45/F, NSTEMI



45/F, NSTEMI



Spontaneous intramural hemorrhage



Spontaneous intramural hemorrhage

FU angiogram