FFR-Guided Stenting for Diffuse Coronary Lesions

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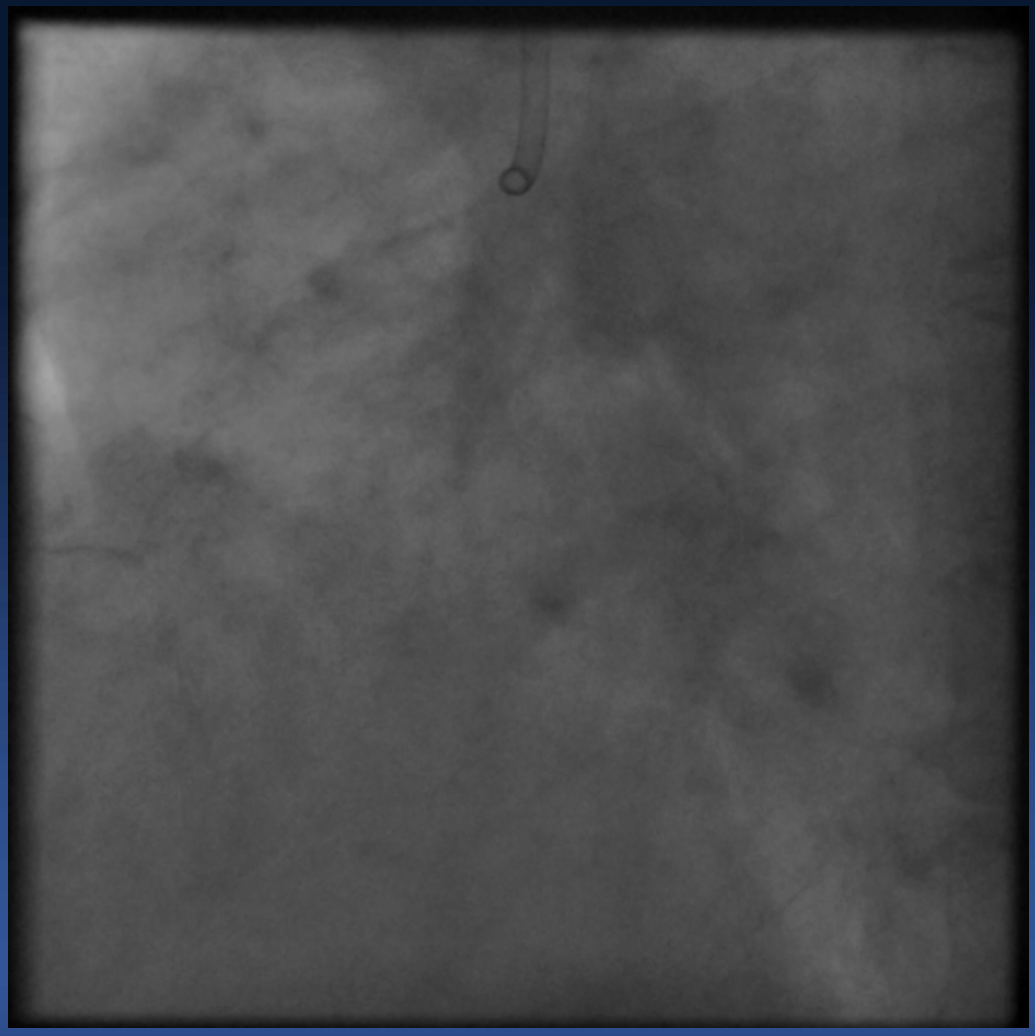
Diffuse Coronary Lesion

- More diabetic
- Low ejection fraction
- Older
- Small vessel involvement
- Multivessel disease
- Bifurcation involvement

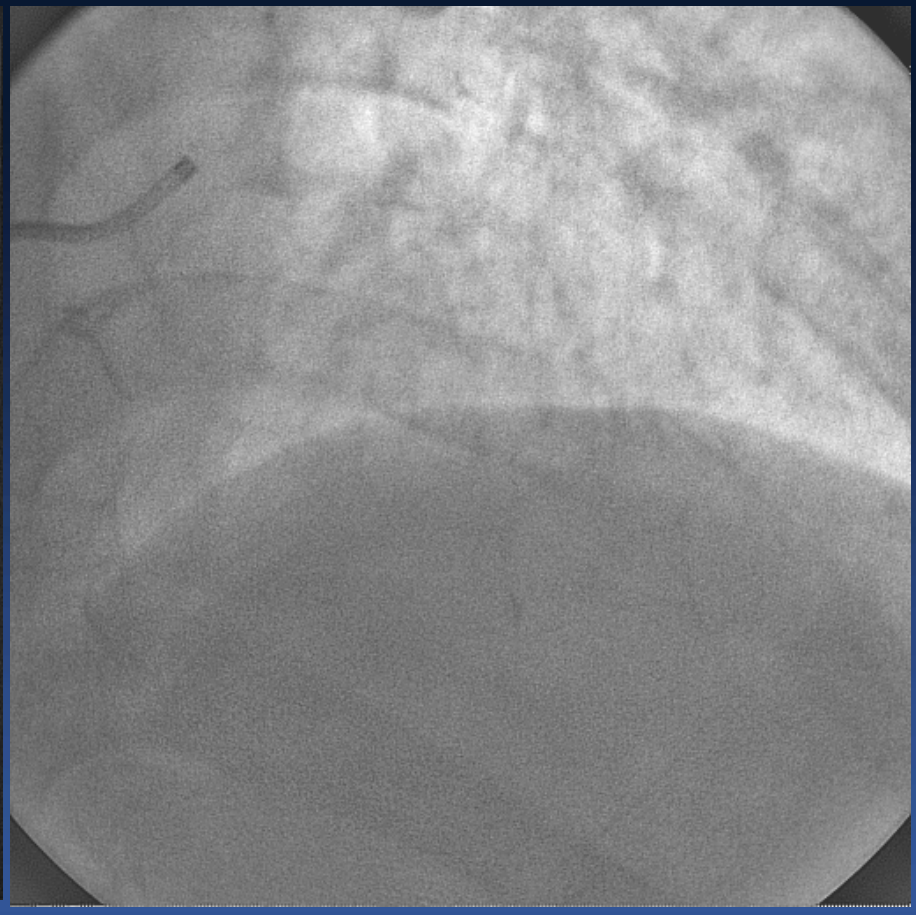
Case 1: Recent Chest Pain

- F / 80
- Chest pain and dyspnea for 1 month
- Multiple stenosis including LM by coronary CT in another hospital
- Normal EKG
- Normal echocardiography with 65% of LV EF
- Good exercise performance before symptom
- No coronary risk factor

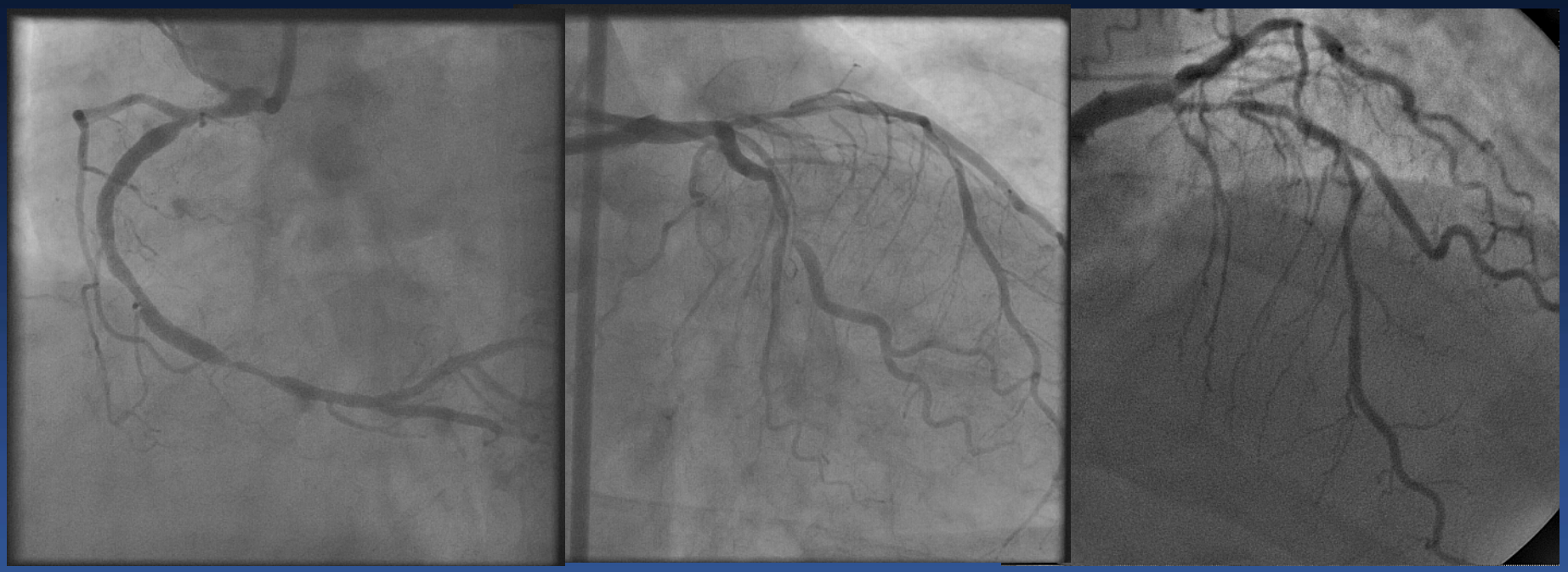
Coronary Angiogram



Coronary Angiogram



Coronary Angiogram
SYNTAX Calculation



How to do ?

- Medical vs. revascularization
- PCI vs. CABG
- Techniques of PCI
  - Ad hoc vs. staged procedure
  - Angiography-guided vs. function-guided
  - FFR vs. SPECT vs. other perfusion studies

ESC 2011 Update
Indications of Revascularization

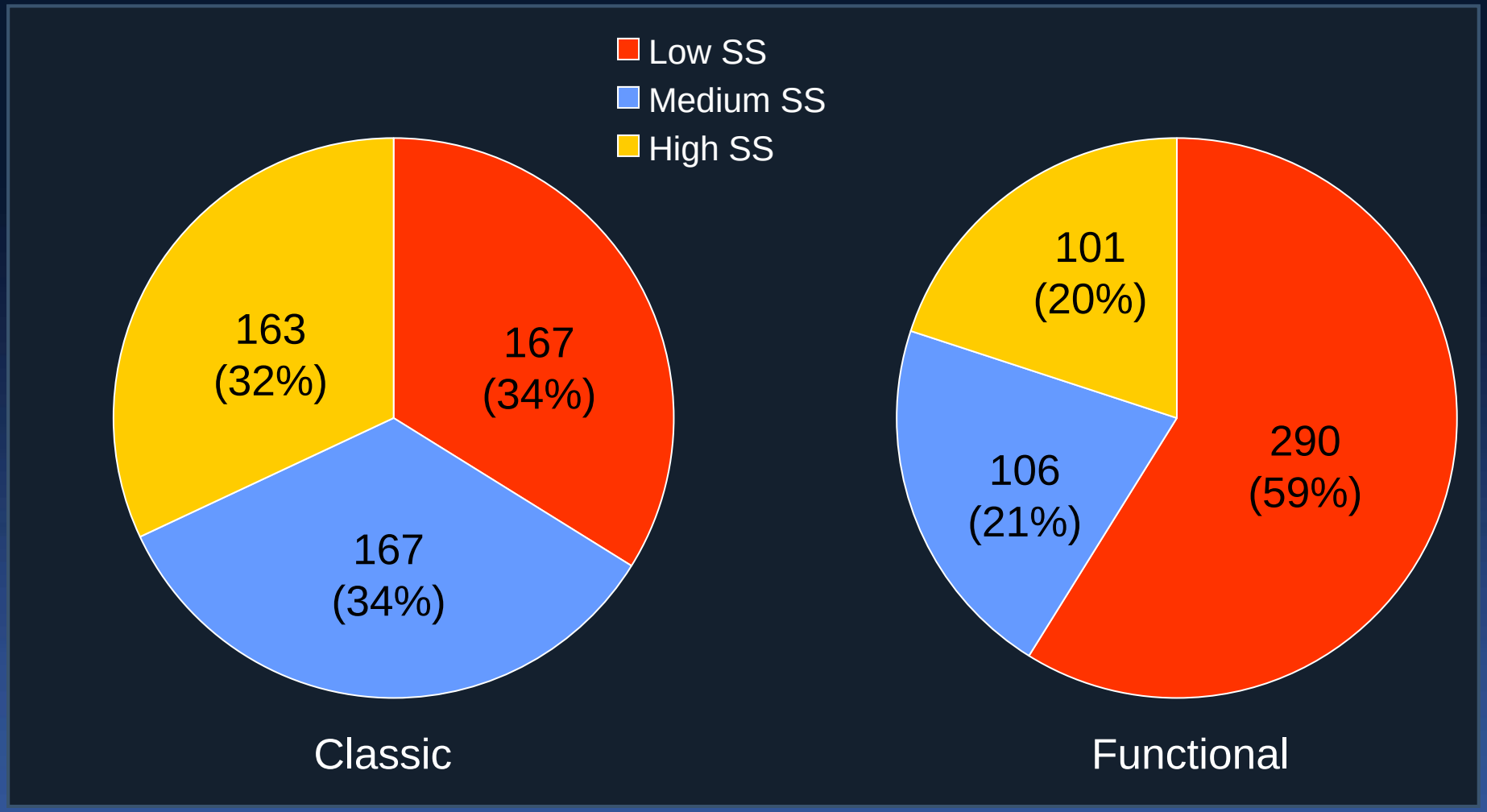
	Subset of CAD by anatomy	Class	Level
For prognosis	Left main >50% *	I	A
	Any proximal LAD >50% *	I	A
	2VD or 3VD with impaired LV function *	I	B
	Proven large area of ischemia (> 10%LV)	I	B
	Single remaining patent vessel >50% stenosis *	I	C
	1VD without proximal LAD and without>10% ischemia	III	A
For symptoms	Any stenosis>50% with limiting angina or angina equivalent, unresponsive to OMT	I	A
	Dyspnea/CHF and>10%LV ischemia/viability supplied by >50% stenotic artery	IIa	B
	No limiting symptoms with OMT	III	C

*** With documented ischemia or FFR < 0.8**

ESC 2011 and ACC 2011 Update
PCI vs. CABG

	<< CABG		<< PCI	
Subset of CAD by anatomy	**ESC**	**ACC**	**ESC**	**ACC**
1VD or 2VD – non-proximal LAD	**IIbC**	**IIa B**	**IC**	**IIb B**
1VD or 2VD – proximal LAD	**IA**	**IA**	**IIa B**	**IIa B**
3VD simple lesions, full functional revascularization achievable with PCI,SYNTAX score>22	**IA**	**IB**	**IIa B**	**IIb B**
3VD complex lesions, incomplete revascularization achievable with PCI,SYNTAX score>22	**IA**	**-**	**III A**	**-**
Left main (isolated or 1VD, ostium/shaft)	**IA**	**IB**	**IIa B**	**IIa B**
Left main (isolated or 1VD, distal bifurcation)	**IA**	**IB**	**IIb B**	**IIb B**
Left main + 2VD or 3VD, SYNTAX score≤32	**IA**	**IB**	**IIb B**	**IIb B**
Left main + 2VD or 3VD, SYNTAX score≥33	**IA**	**IB**	**III B**	**III B**

Functional SYNTAX Score in FAME



Nam et al, JACC 2011;58:1211-18

How to do ?

- Medical vs. **revascularization**
- **PCI** vs. CABG
- Techniques of PCI
  - Ad hoc vs. staged procedure
  - Angiography-guided vs. function-guided
  - FFR vs. SPECT vs. other perfusion studies

Ad hoc PCI

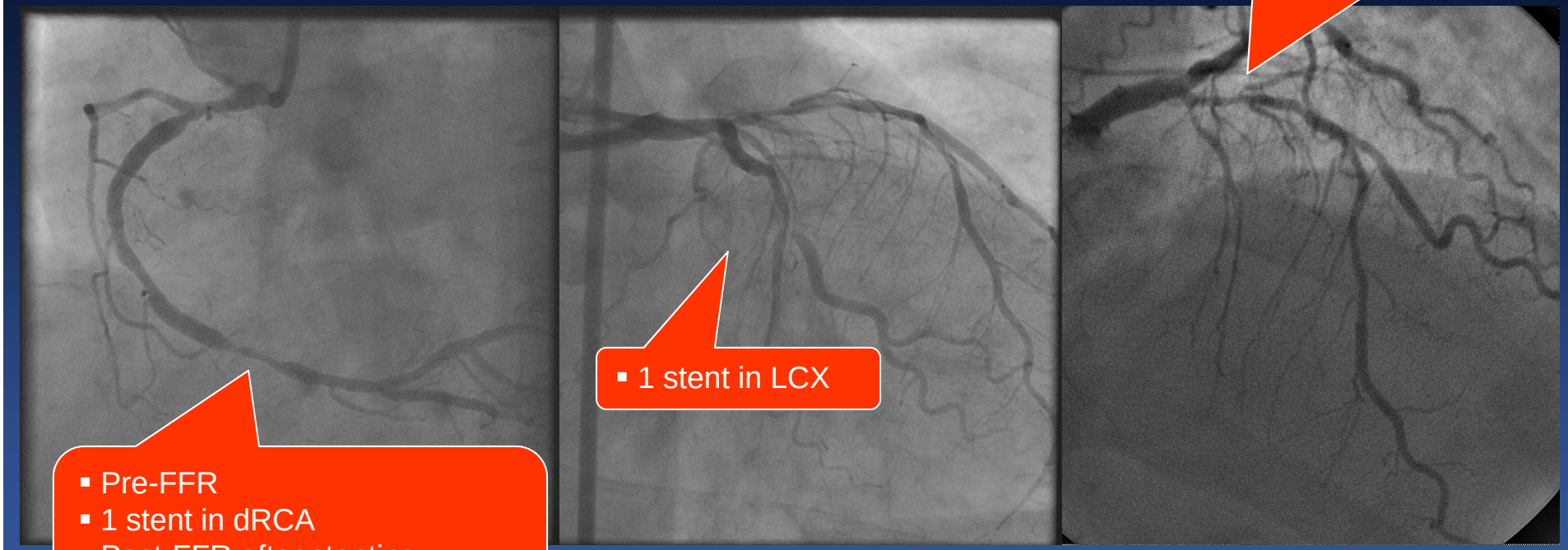
Not recommended in ESC/ACC 2011 !

Ad hoc PCI
Haemodynamically unstable patients (including cardiogenic shock).
Culprit lesion in STEMI and NSTE-ACS.
Stable low-risk patients with 1- or 2- vessel disease (pLAD excluded) and favourable morphology (RCA, non-ostial LCx, mid or distal LAD).
Non-recurrent restenotic lesions.
Revascularization at an interval
Lesions with high-risk morphology.
Chronic heart failure.
Renal failure (eGFR <60 mL/min), if total contrast volume required >4 mL/kg.
Stable patients with MVD including LAD involvement.
Stable patients with ostial or complex pLAD lesion.
Any clinical or angiographic evidence of higher periprocedural risk with ad hoc PCI.

How to do ?

- Ad hoc PCI with FFR
- Staged procedure with SPECT
- Staged procedure with other functional test
- Staged procedure without functional test
- Staged procedure with FFR
- CABG
- Medication

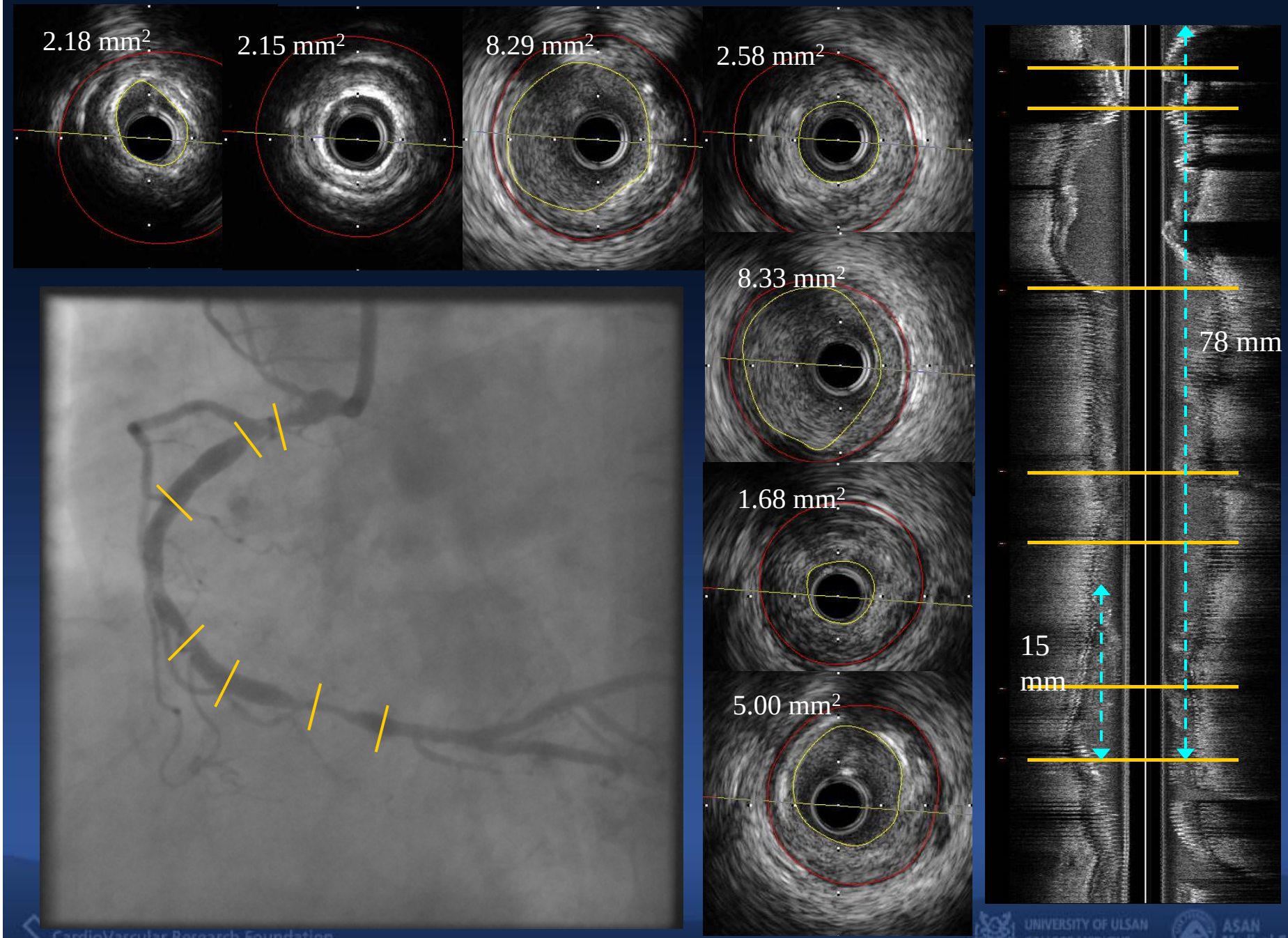
Planning



- Pre-FFR
- 1 stent in pLAD
- Post-FFR after stenting
- 1 stent in other LAD if p-FFR ≤ 7.5

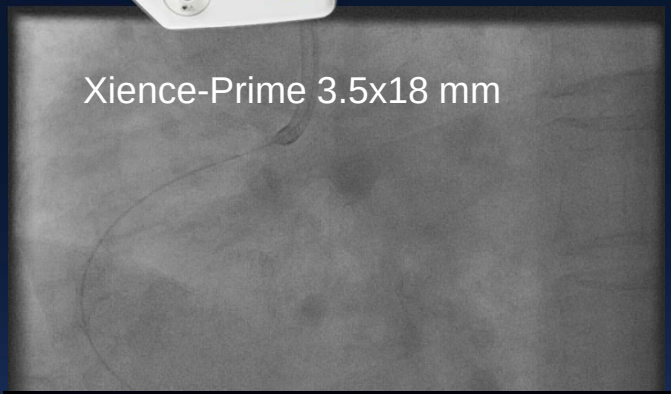
- 1 stent in LCX

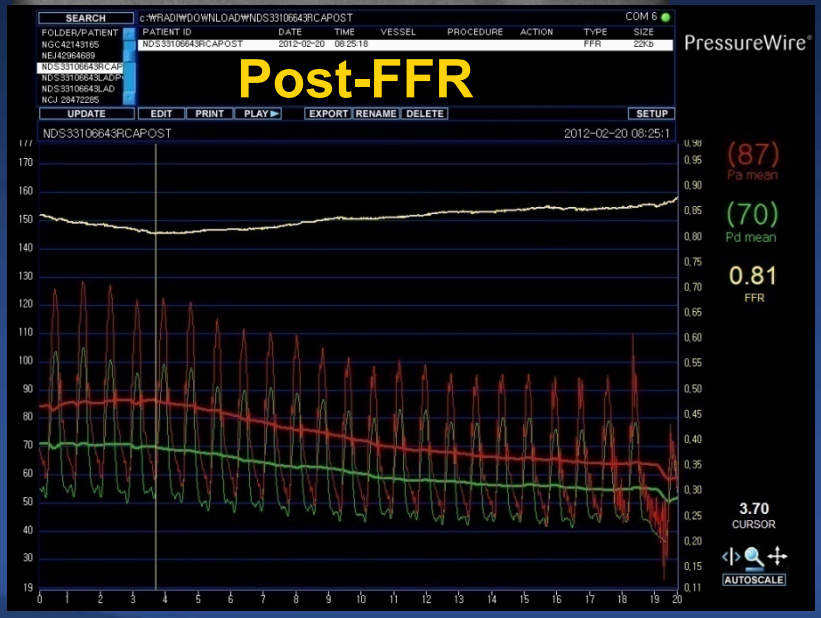
- Pre-FFR
- 1 stent in dRCA
- Post-FFR after stenting
- 1 stent in pRCA if p-FFR ≤ 7.5



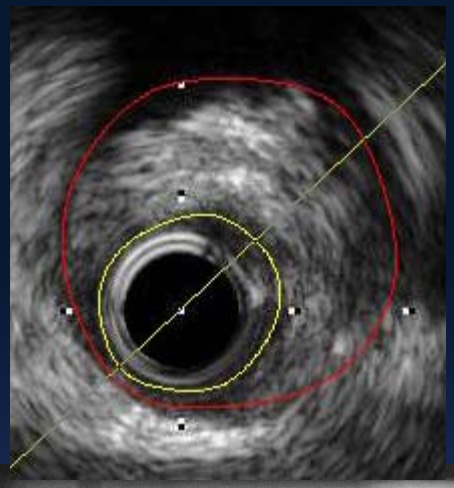
RCA Intervention

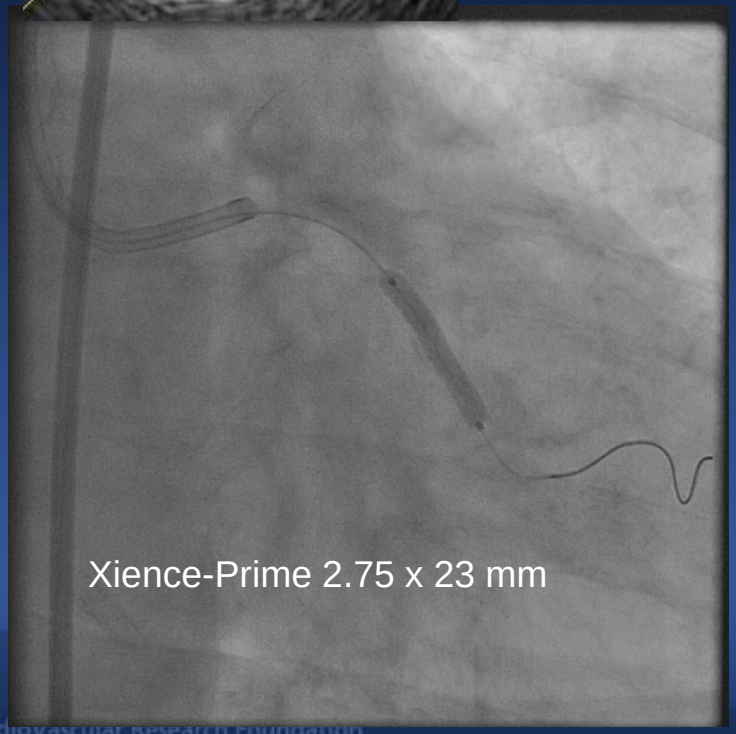
Pre-FFR 0.72 in dRCA

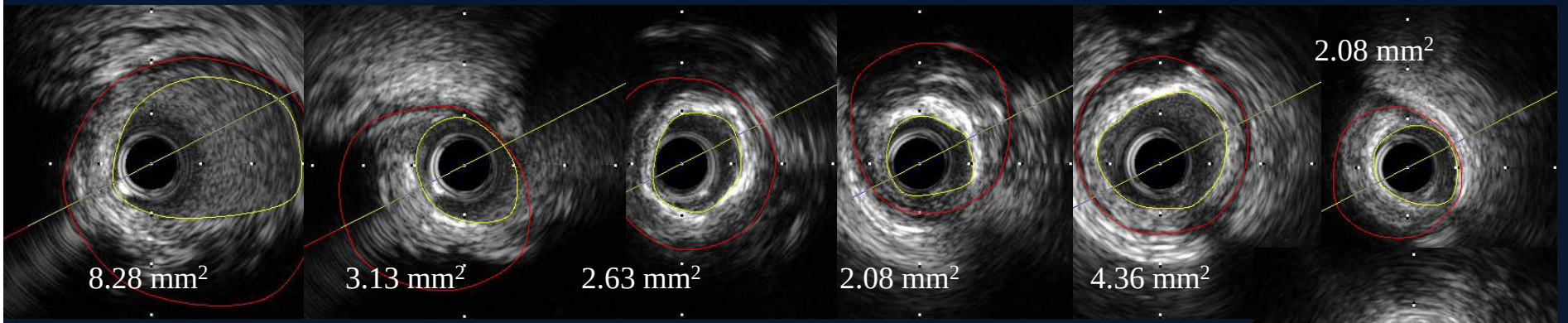


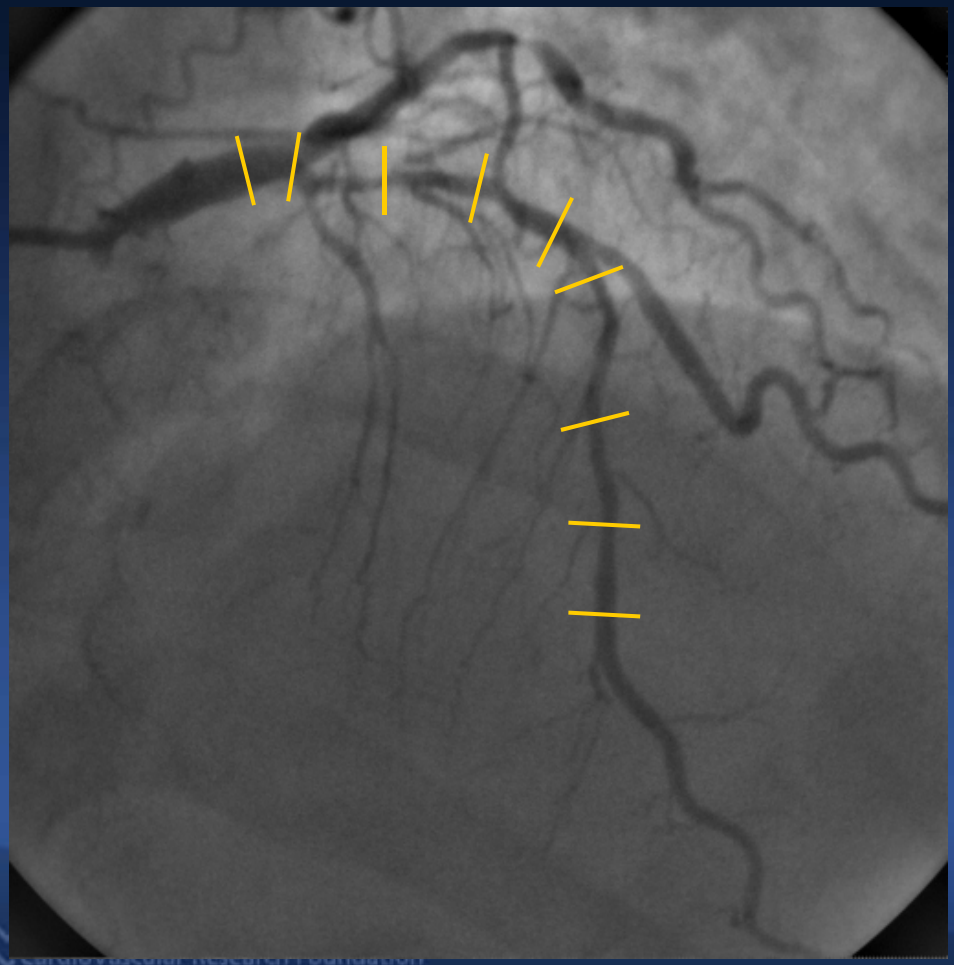


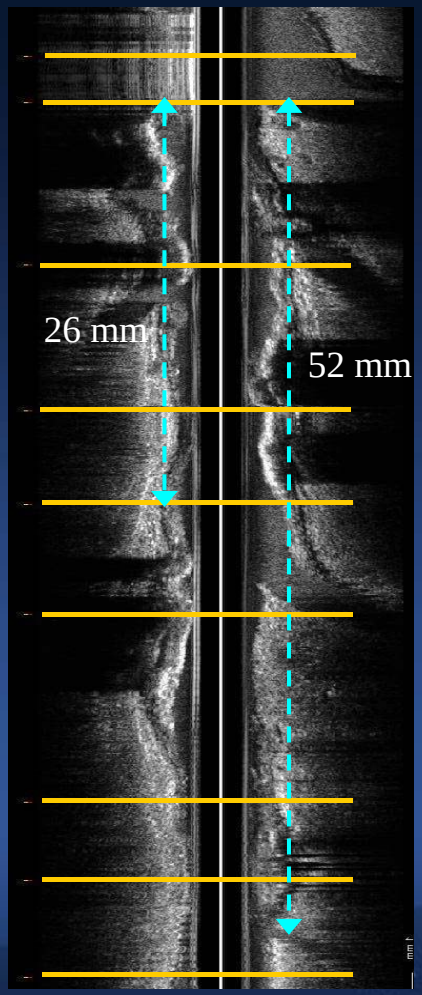
IVUS and LCX Stenting without FFR

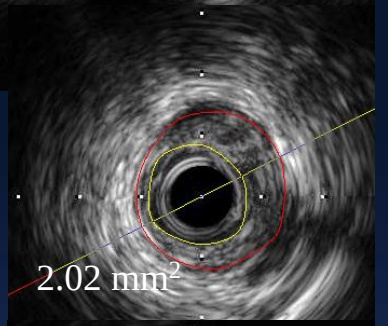


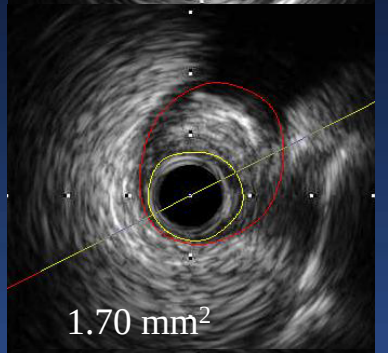


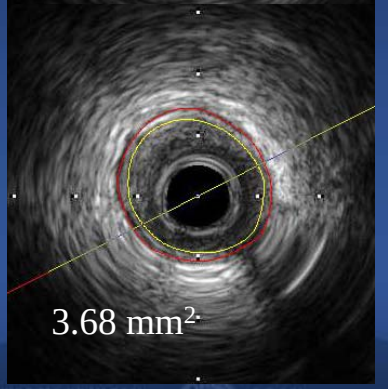




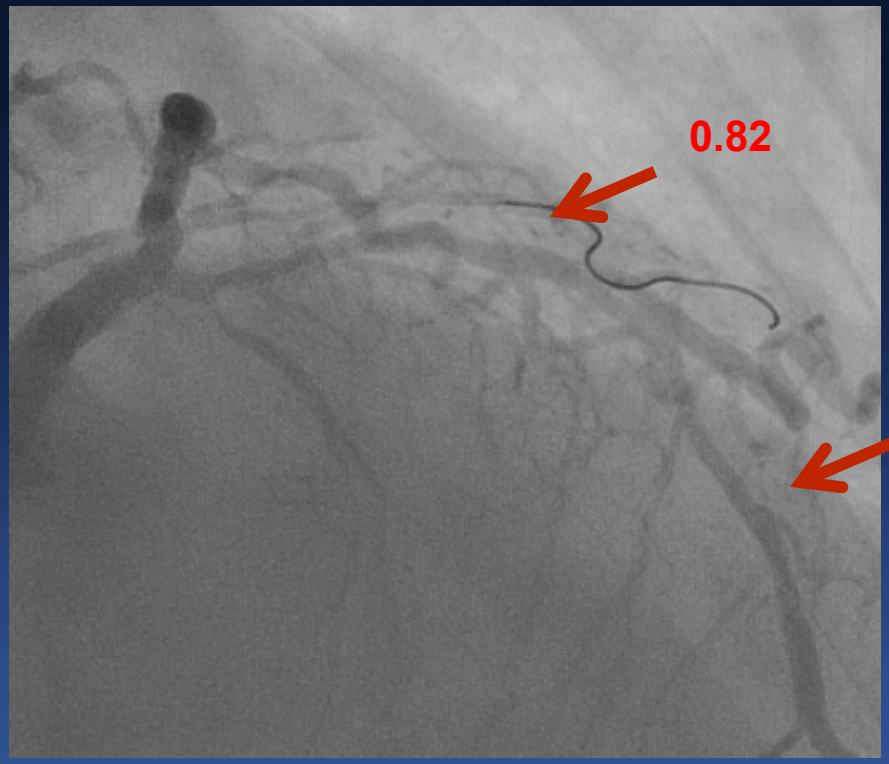




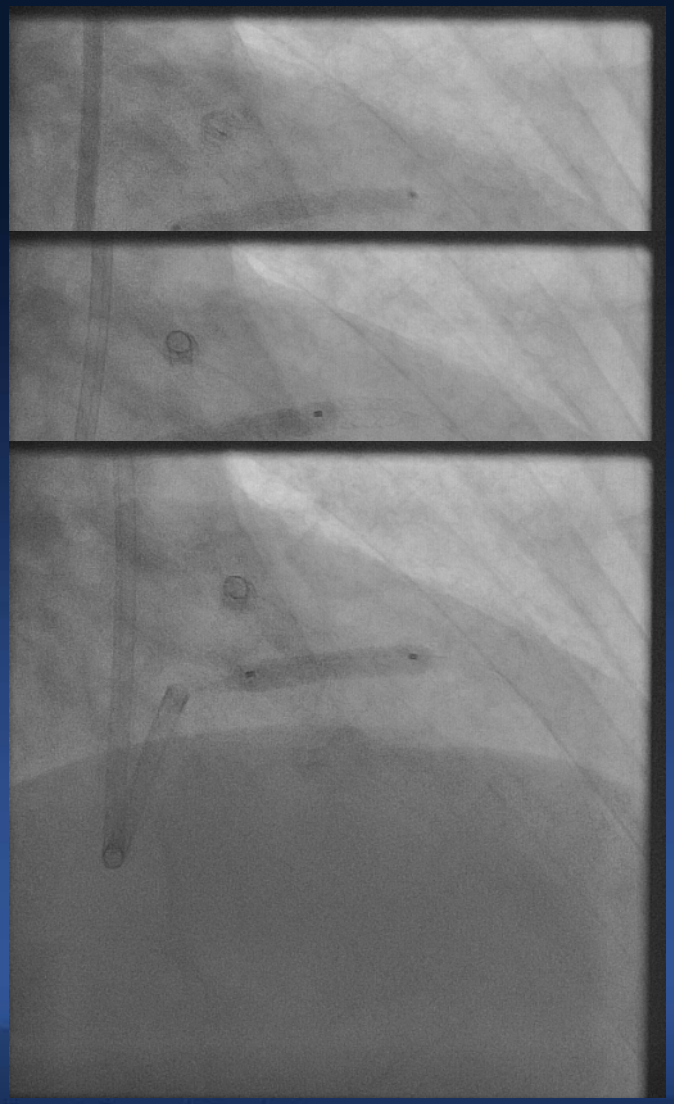




LAD Intervention with FFR



Stenting followed by NC

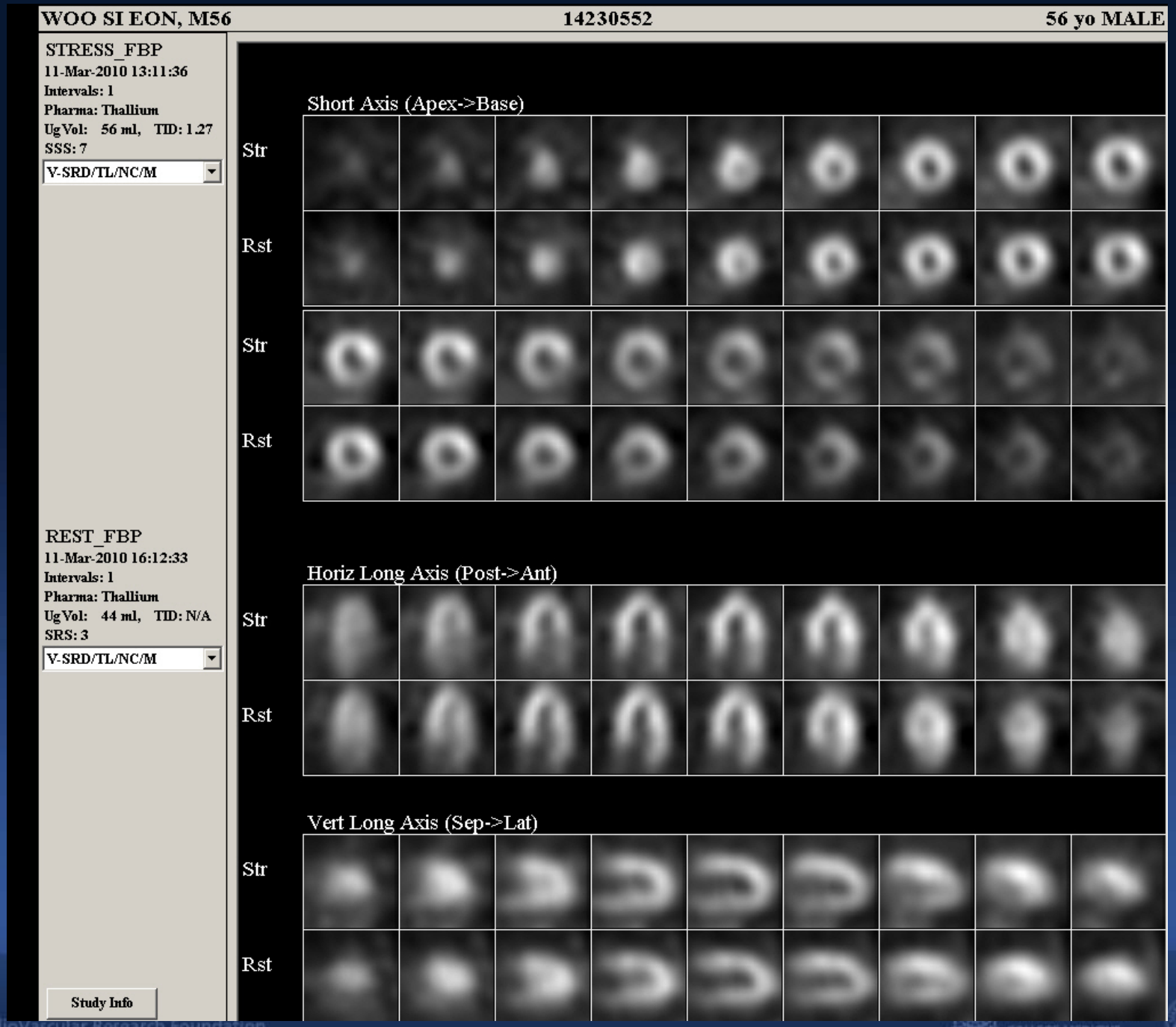


Post-FFR

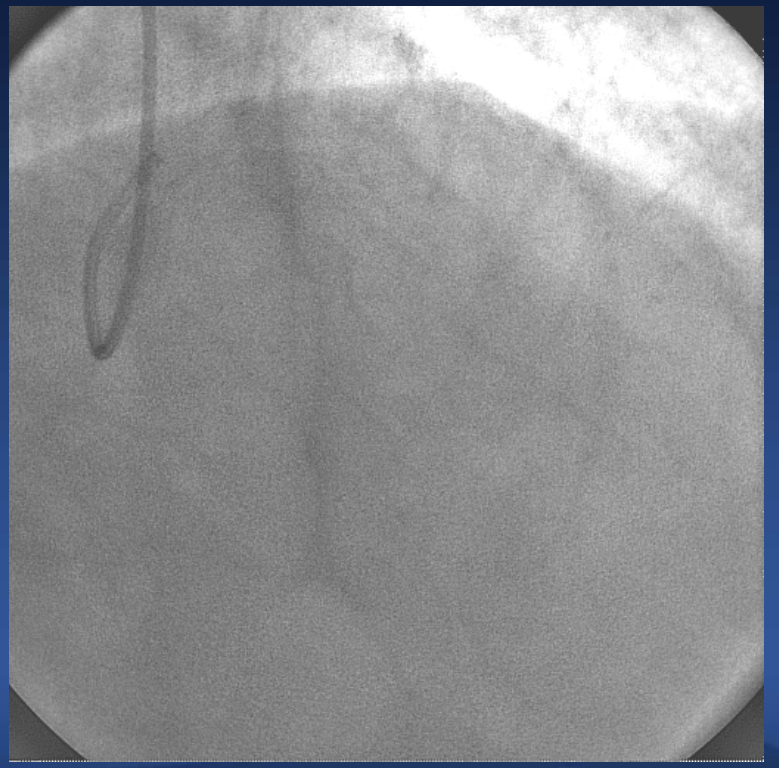

NDS33106643LADPOST
2012-02-20 08:56:0
(66)
Pa mean
(59)
Pd mean
0.89
FFR
11.85
CURSOR
AUTOSCALE

Case 2: Stable Angina

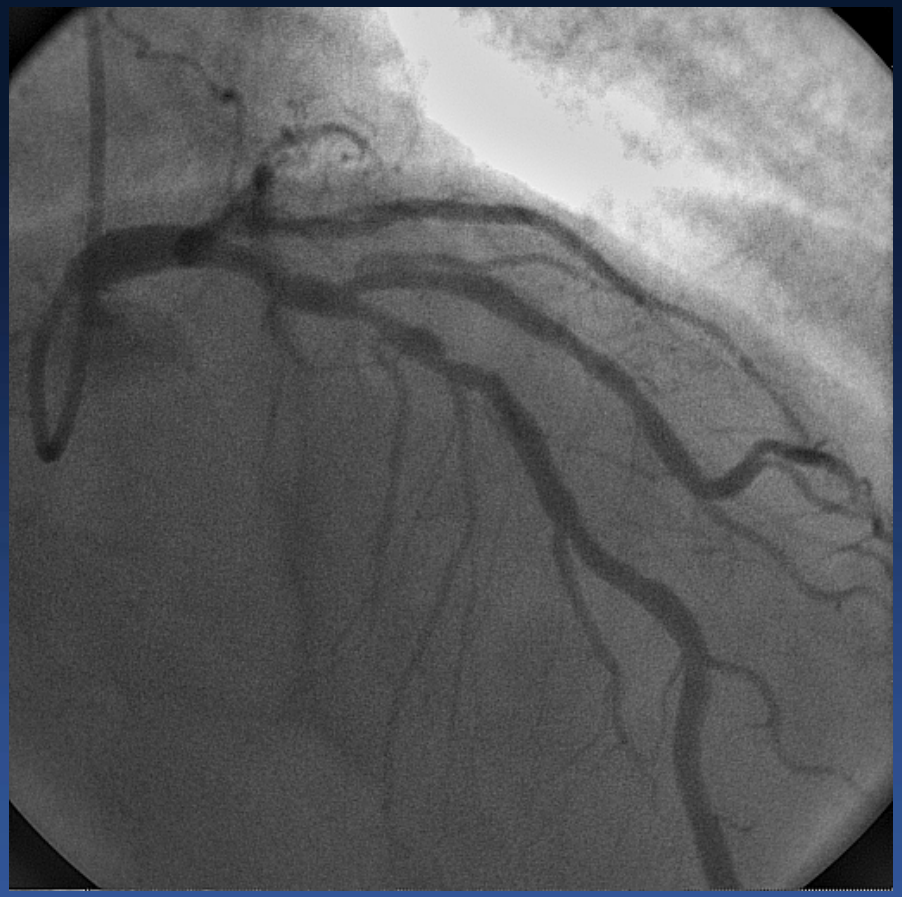
- M / 58
- Effort chest pain for 9 months
- Hypertension
- Normal EKG
- Treadmill test: stage 3 +
- Normal echo with 64% of LV EF
- Thallium SPECT: medium-seized reversible inferolateral wall


WOO SI EON, M56
14230552
56 yo MALE
STRESS_FBP
11-Mar-2010 13:11:36
Intervals: 1
Pharma: Thallium
UgVol: 56 ml, TID: 1.27
SSS: 7
V-SRD/TL/NC/M
REST_FBP
11-Mar-2010 16:12:33
Intervals: 1
Pharma: Thallium
UgVol: 44 ml, TID: N/A
SRS: 3
V-SRD/TL/NC/M
Study Info
Short Axis (Apex->Base)
Str
Rst
Str
Rst
Horiz Long Axis (Post->Ant)
Str
Rst
Vert Long Axis (Sep->Lat)
Str
Rst

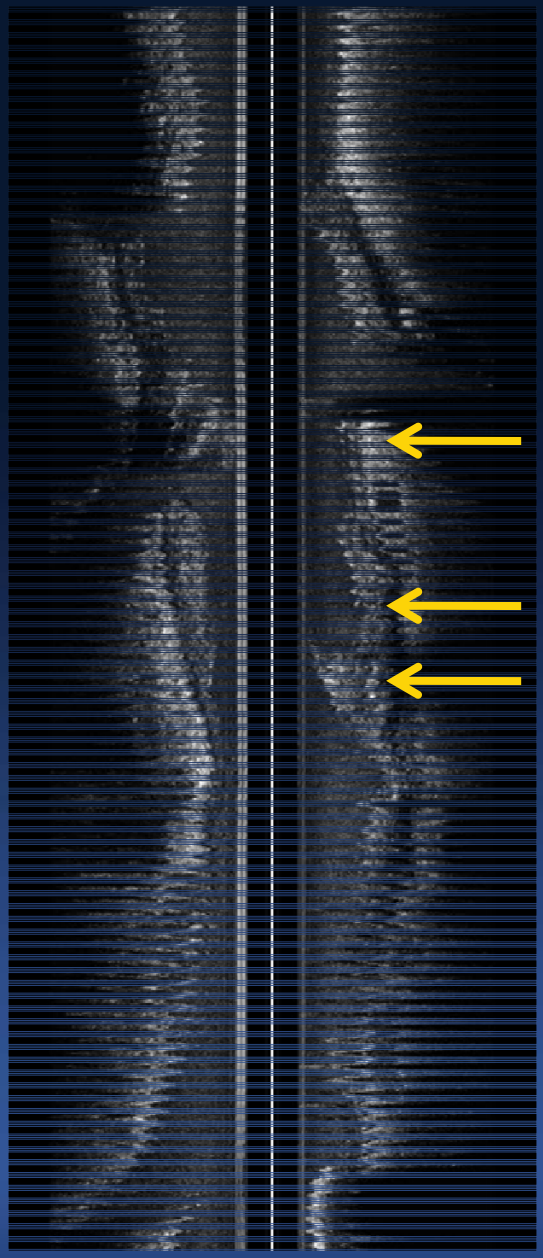
- Intermediate RCA
- LCX CTO with collateral from RCA
- Diffuse intermediate LAD

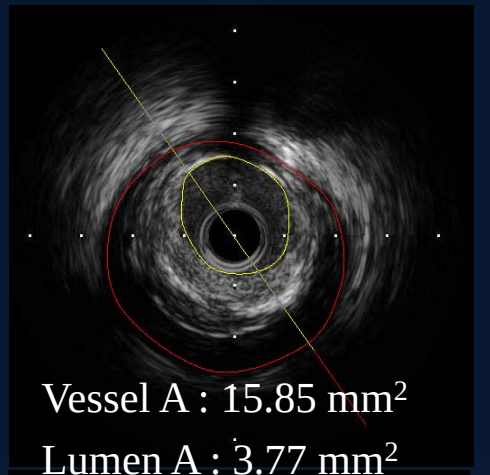


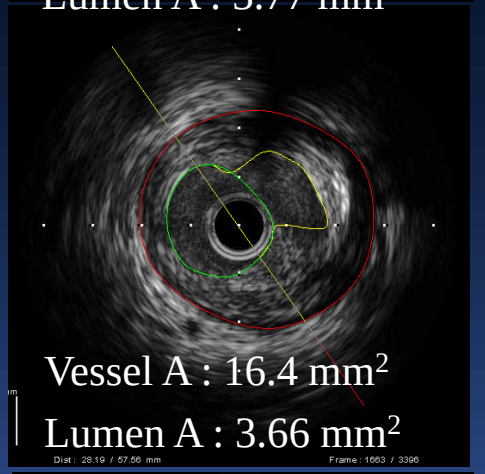
Medical Treatment in RCA and LCX
How to Treat LAD ?

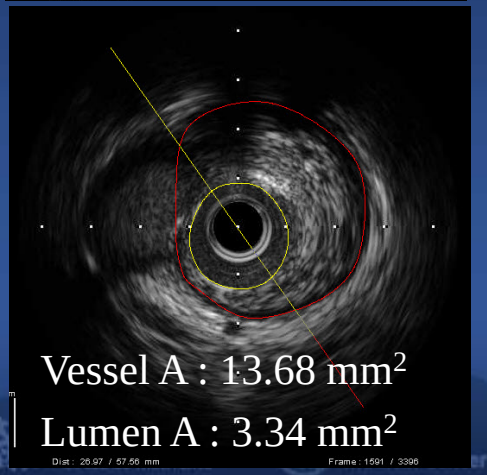


- Total occlusion in another left-side artery
- Negative thallium
- Unstable morphology
- Diffuse disease
- Bifurcation involvement
- Ostial involvement

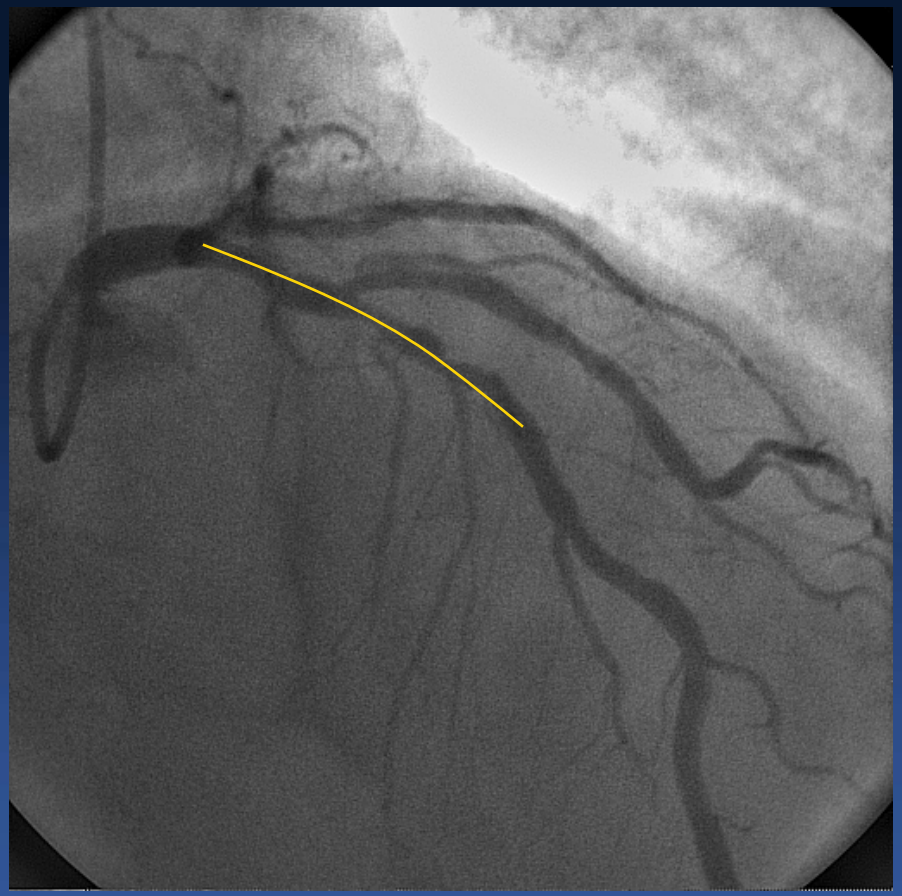



Vessel A : 15.85 mm²
Lumen A : 3.77 mm²


Vessel A : 16.4 mm²
Lumen A : 3.66 mm²

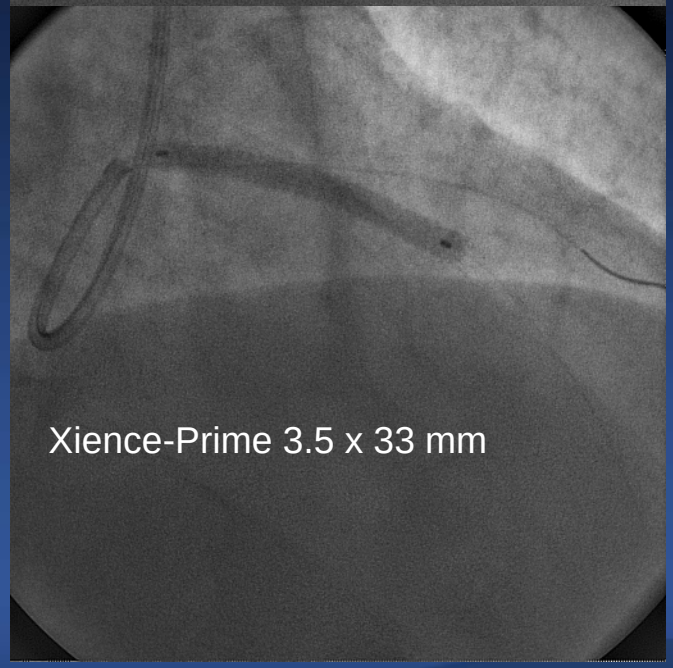

Vessel A : 13.68 mm²
Lumen A : 3.34 mm²

Plan for Diffuse & Bifurcation LAD

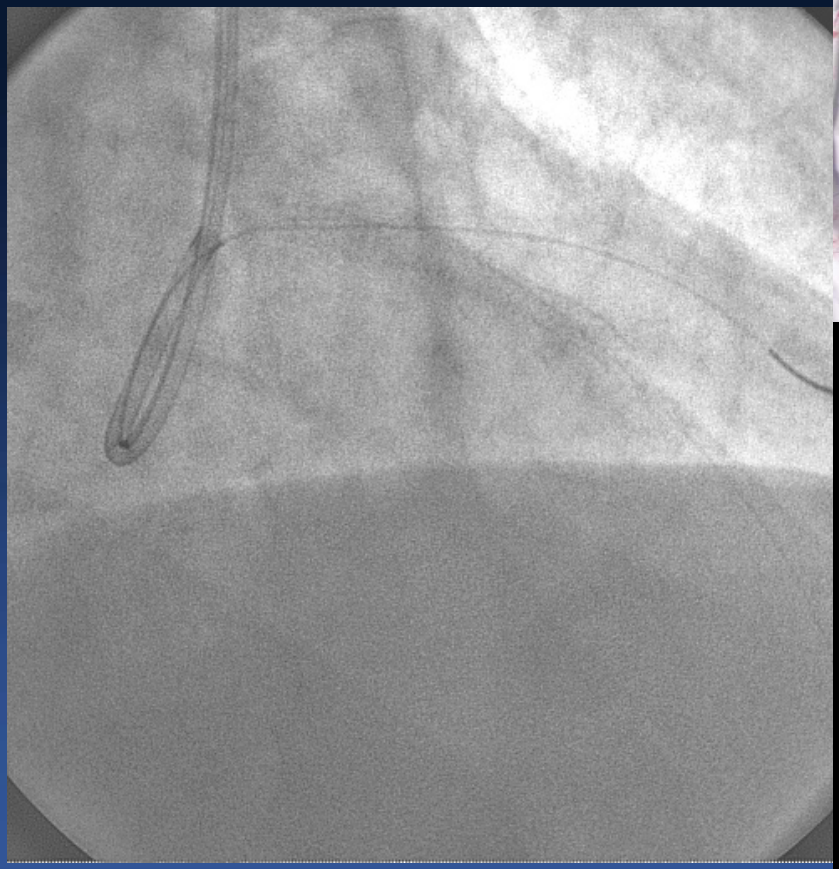


- Single-stent technique in LAD if FFR < 0.8
- FFR in D1 if compromised

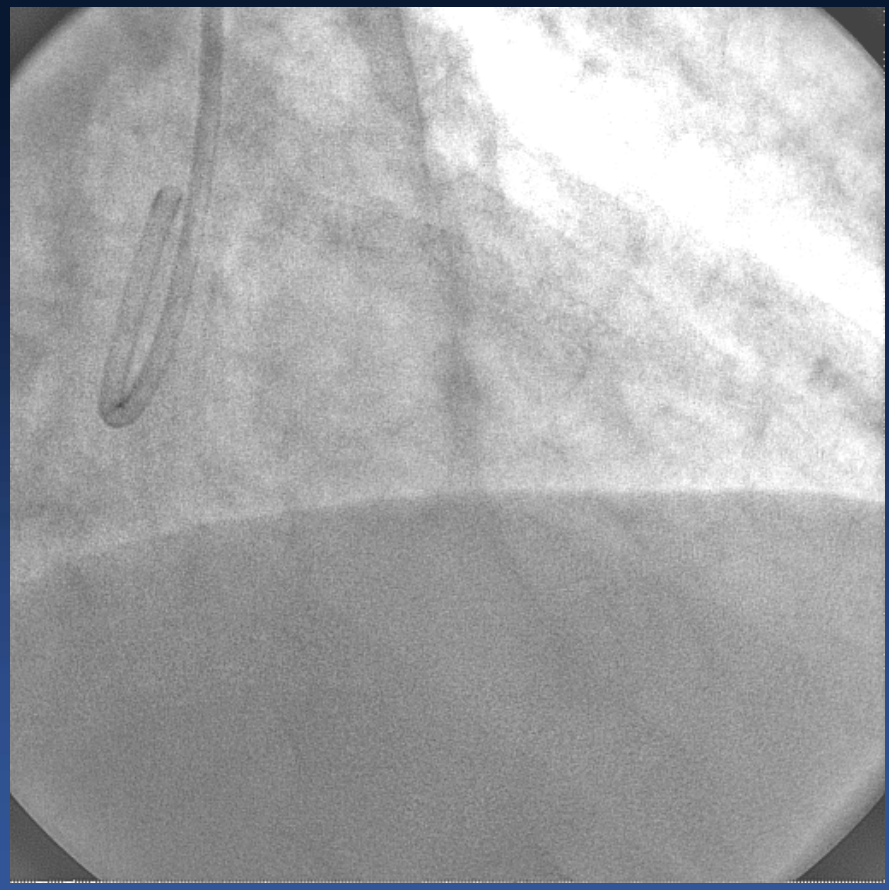
Stenting through FFR wire in LAD



FFR wire in D1



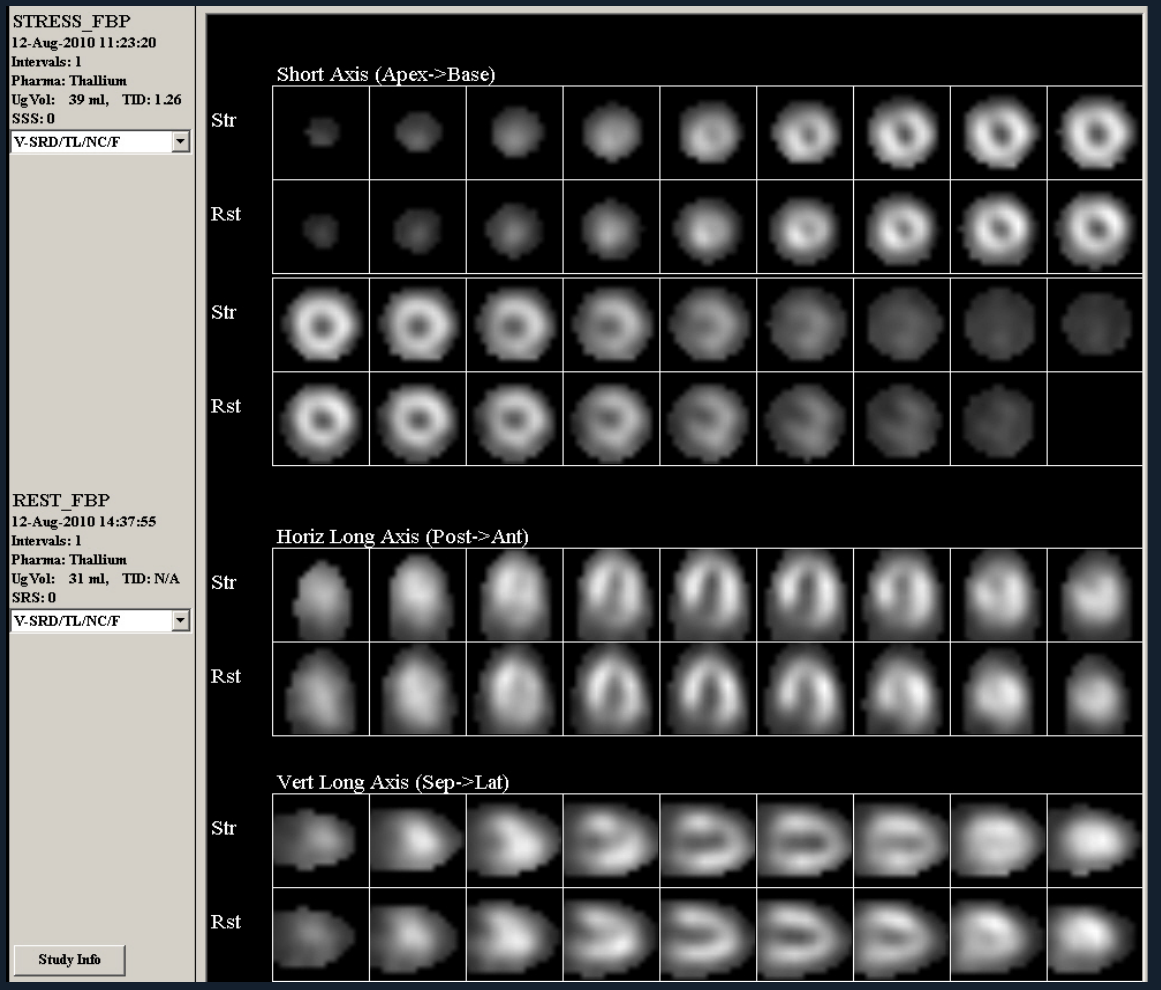
Final



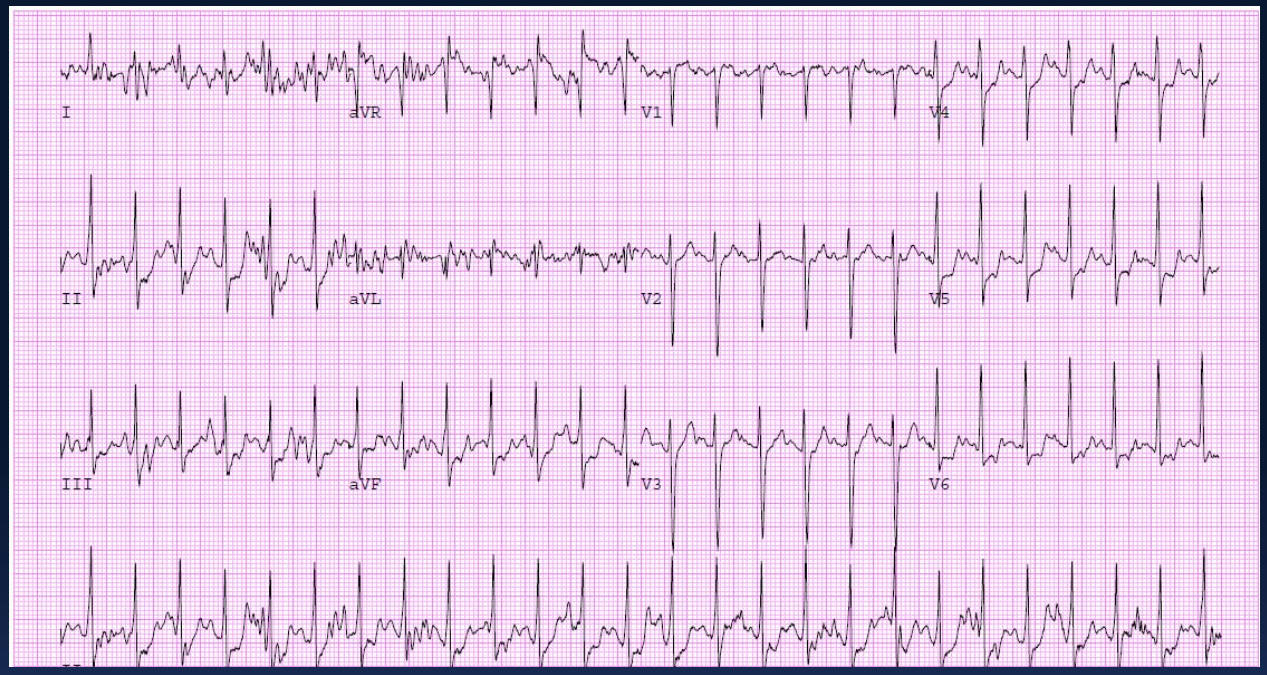
Case 3: Stable Angina

- 64 / F
- Hypertension, DM ,Hyperlipidemia
- Normal EKG
- Normal echo
- Abnormal thallium

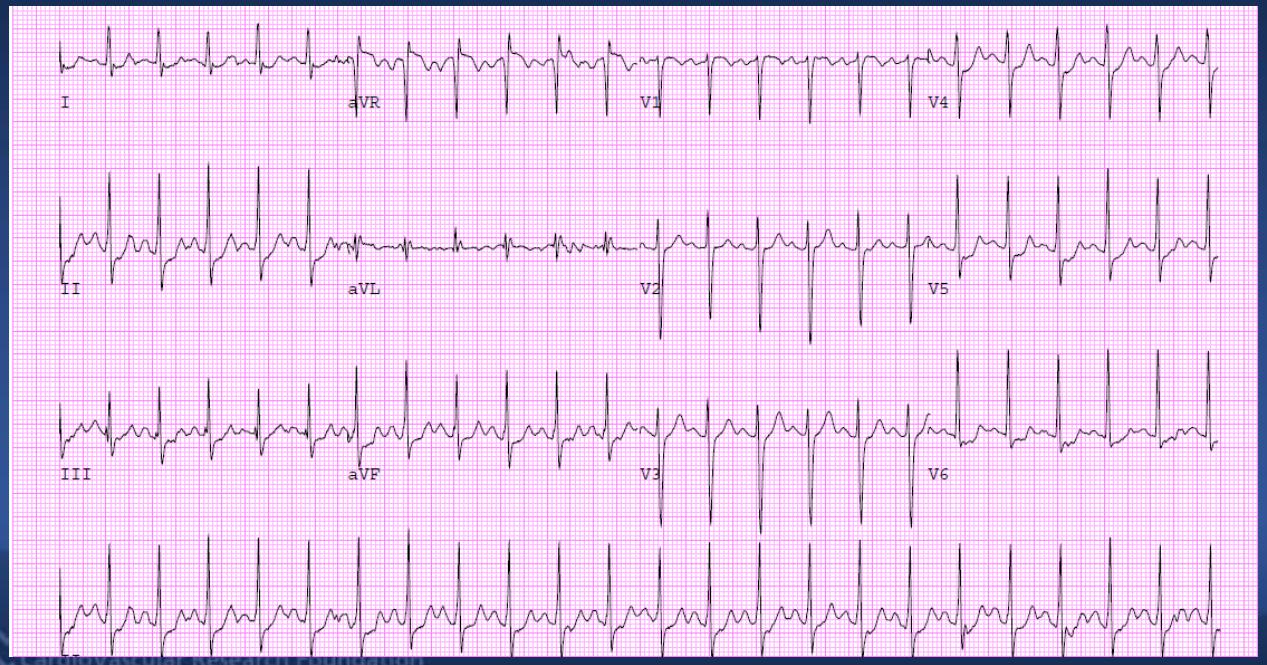
Thallium SPECT



Reversible medium sized mild-to-moderately decreased perfusion in apical-mid anterior wall

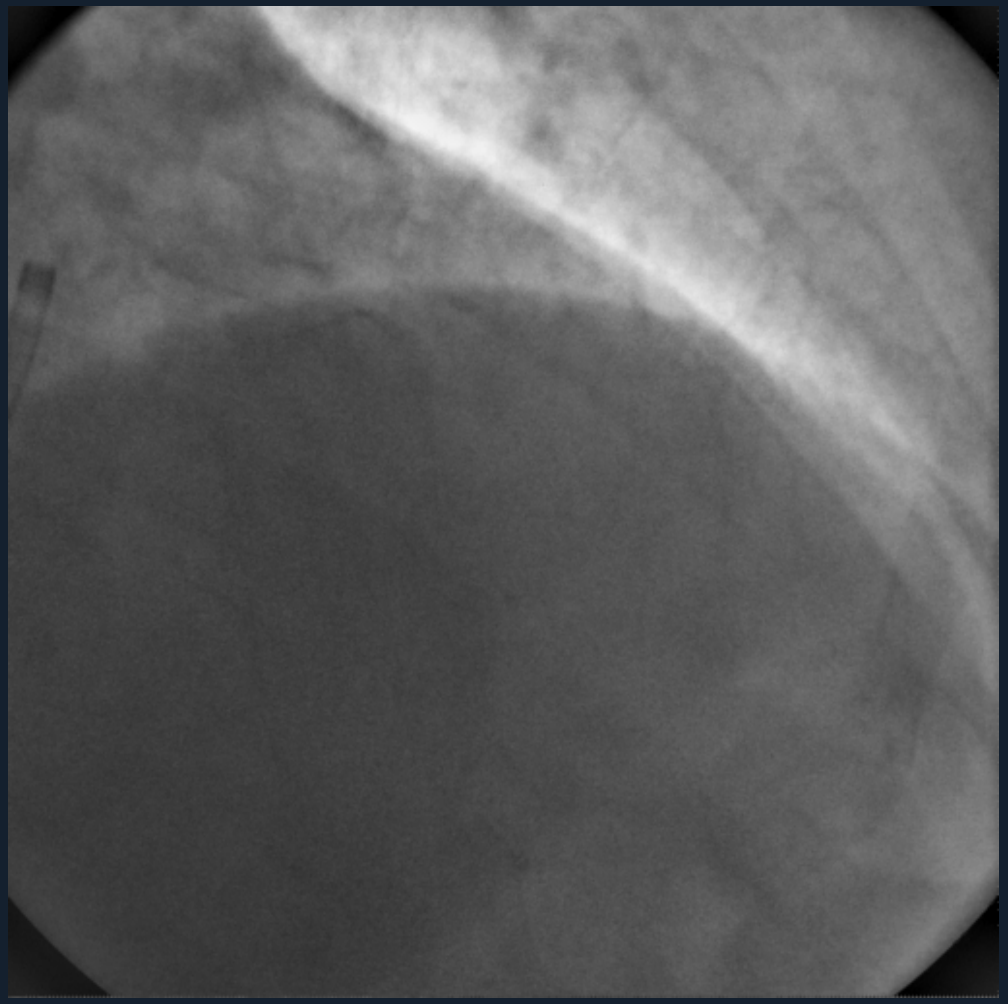


Stage 3

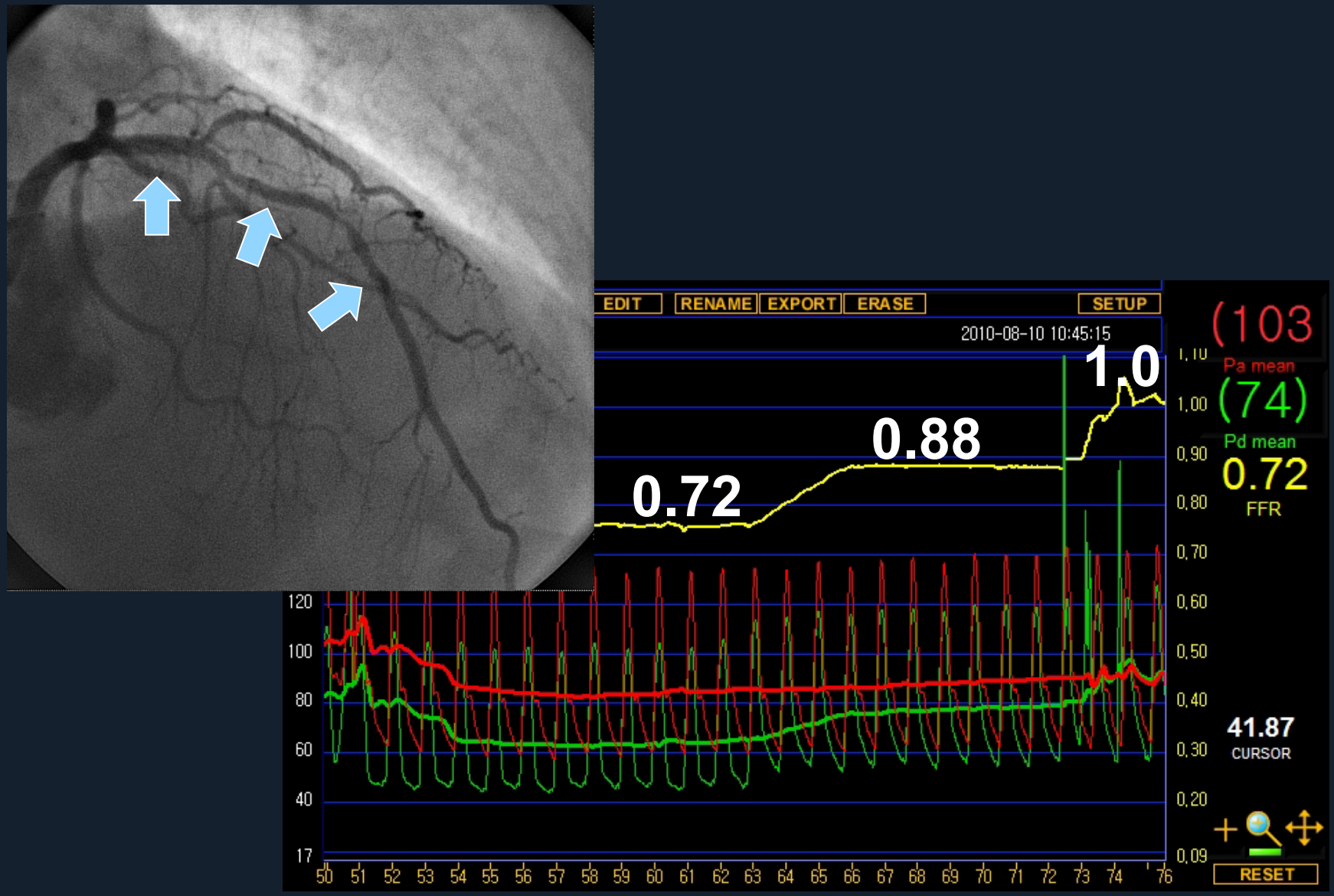


Stage 4

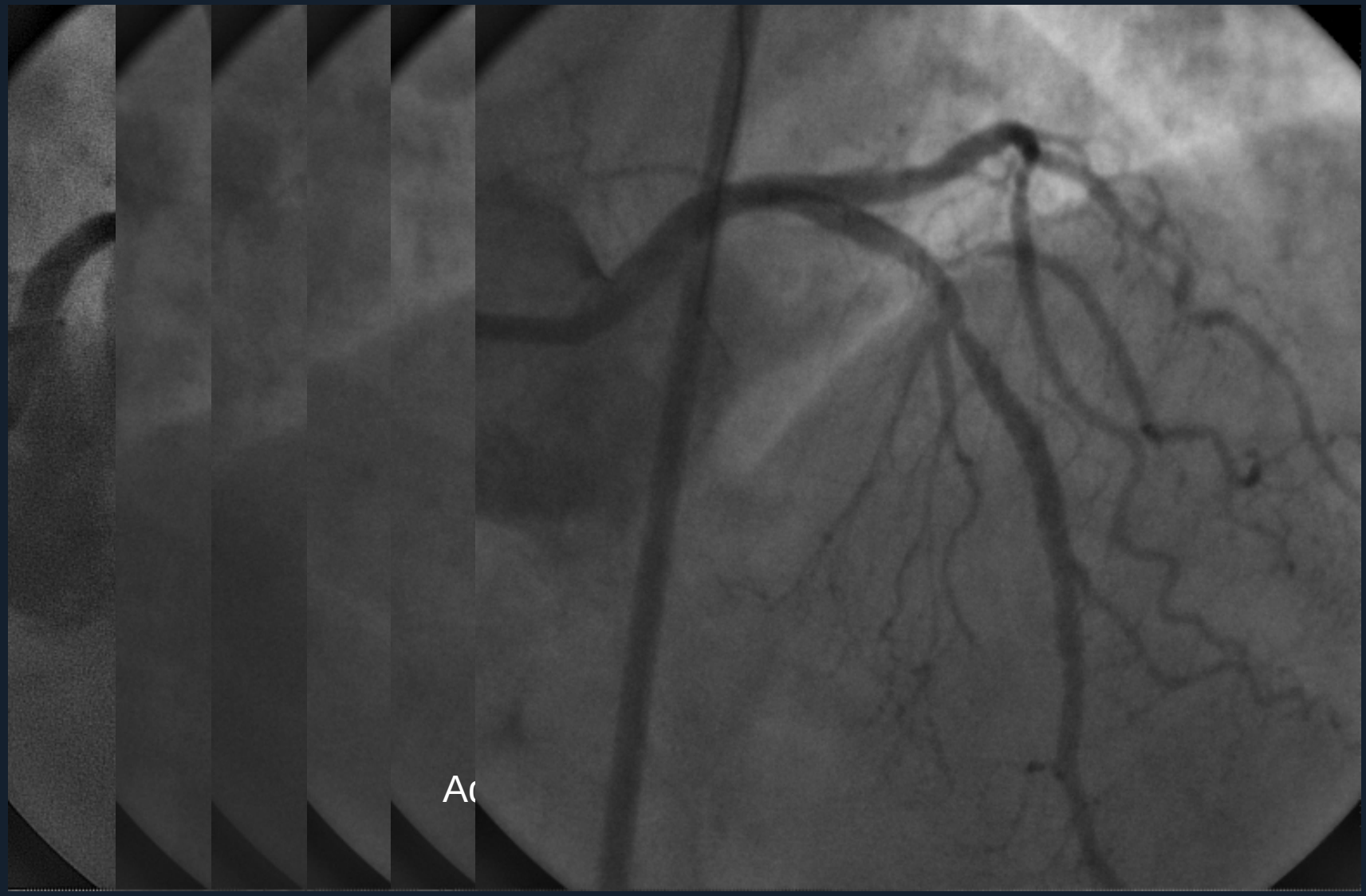
LCX and RCA are normal
Diseased LAD



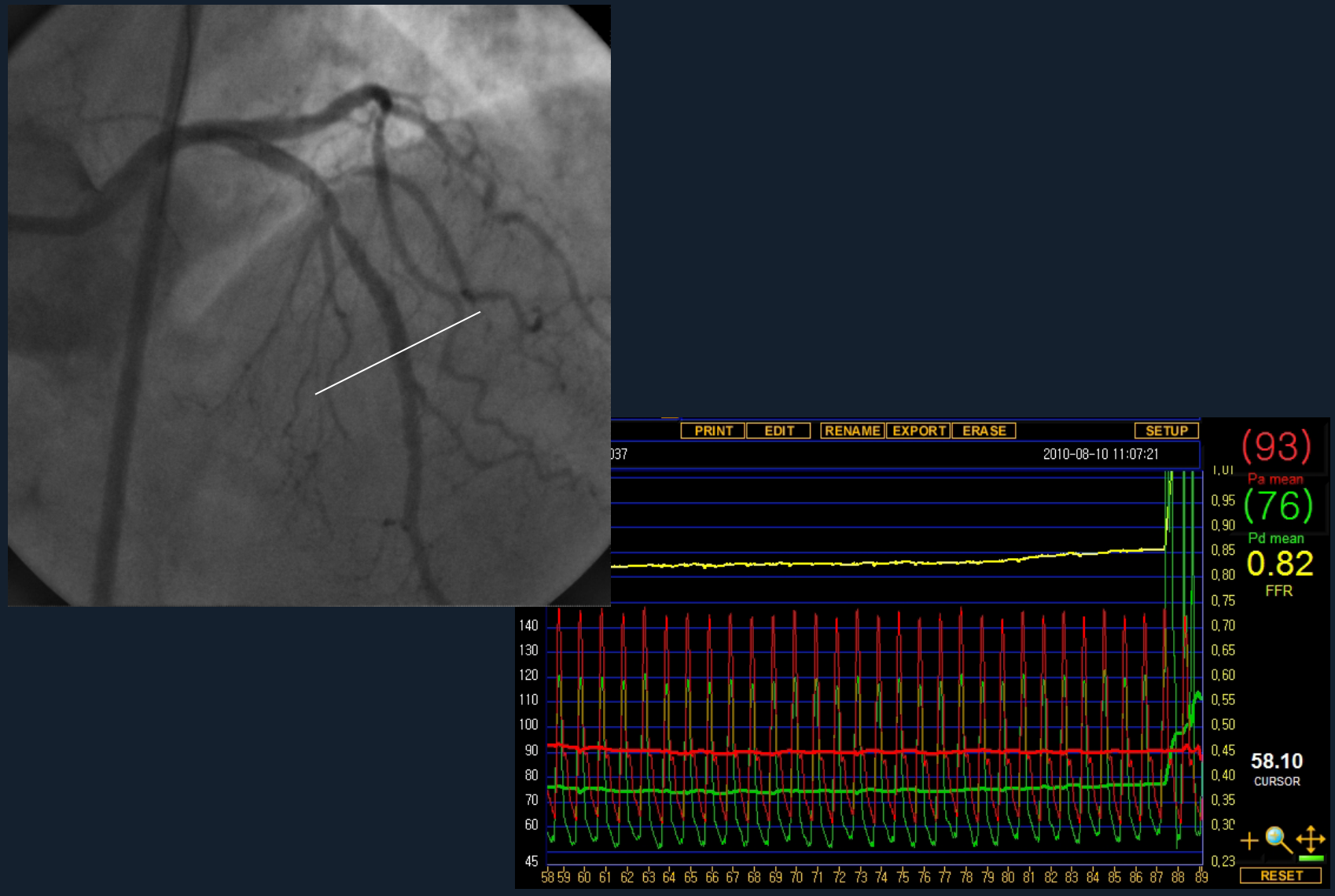
FFR measurement



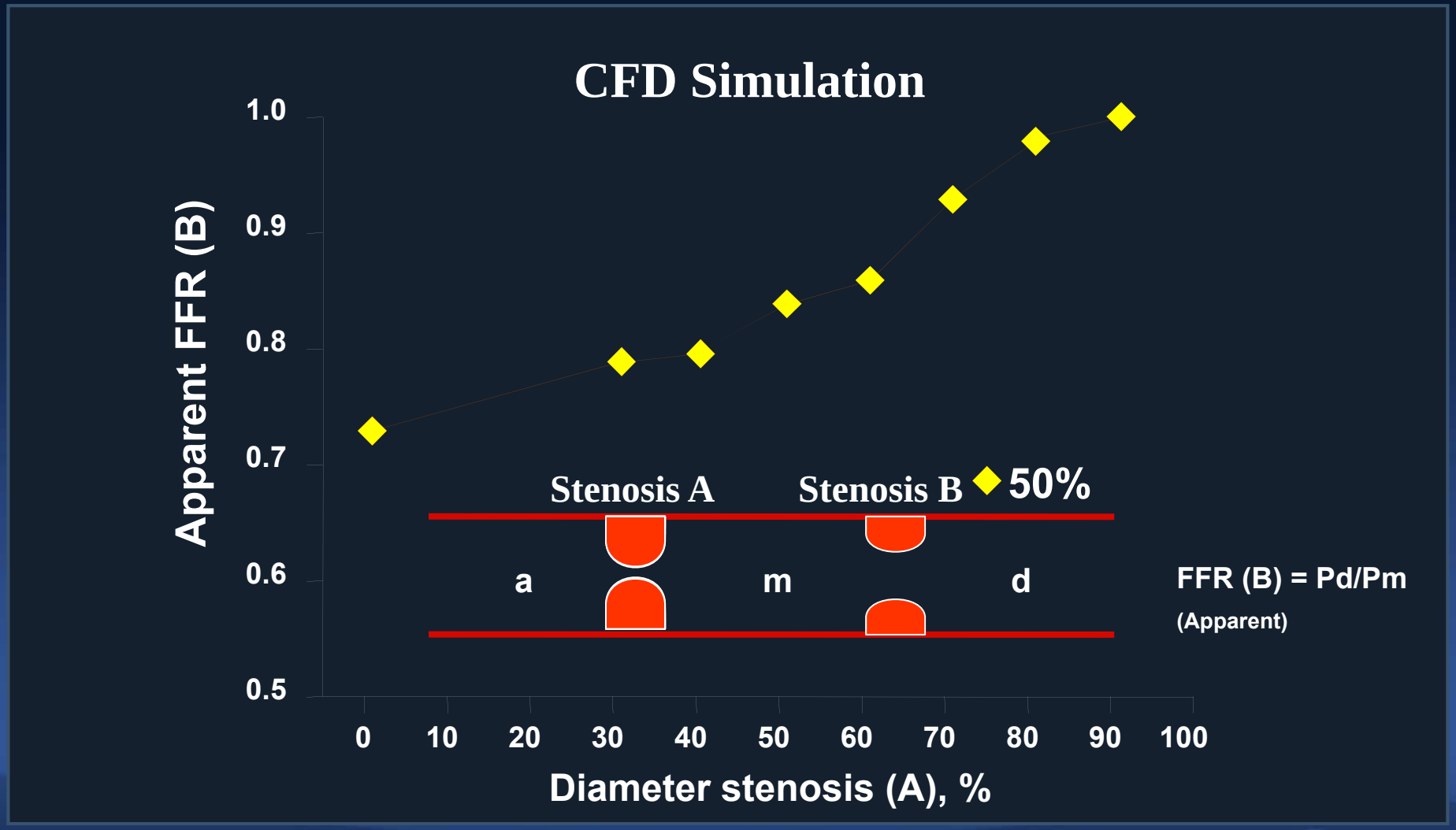
PCI



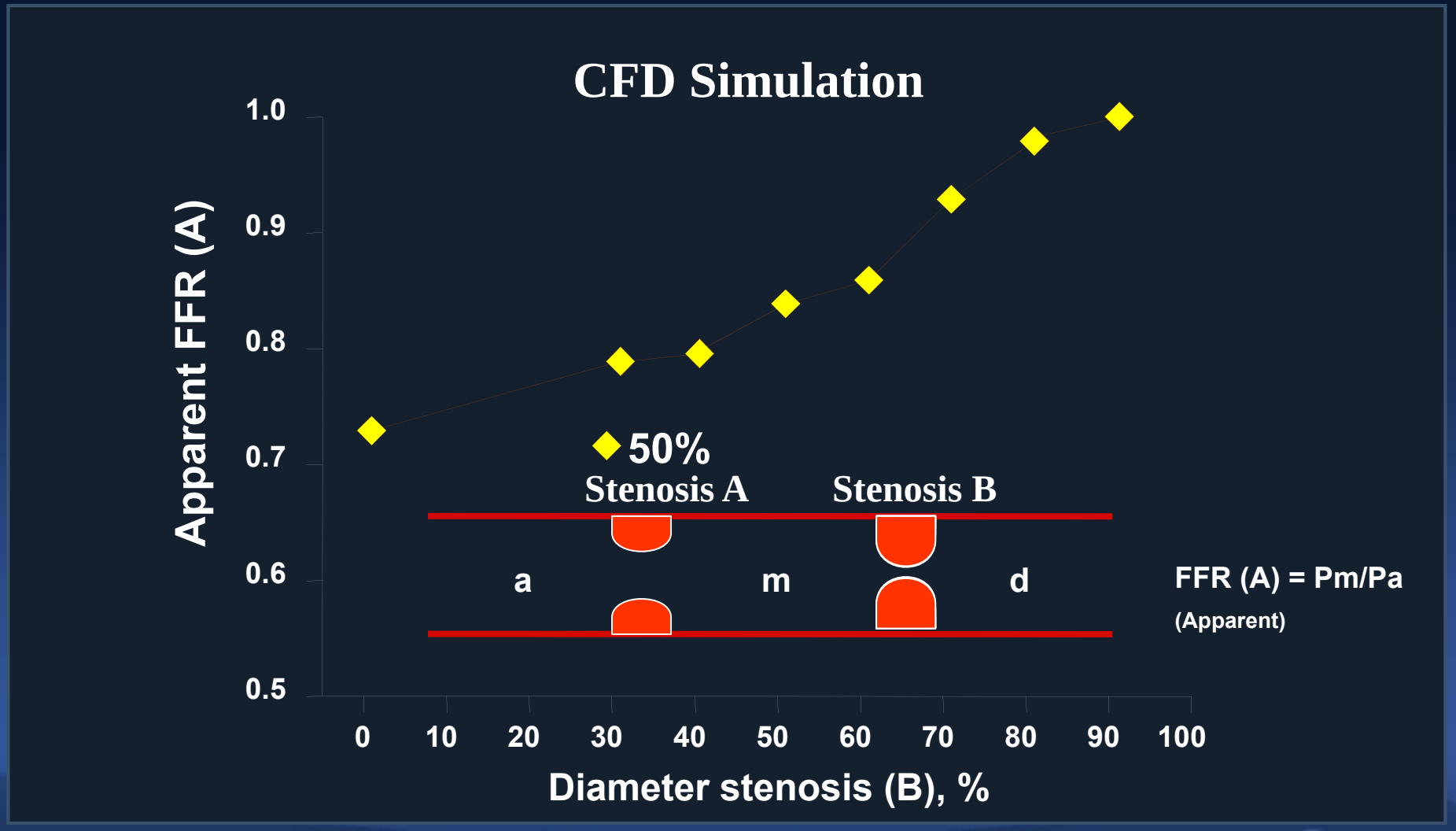
Repeated FFR Measurement



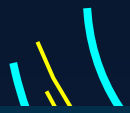
Hydromechanical Interaction Between Stenoses



Hydromechanical Interaction Between Stenoses



Rule of Big Delta



Stenosis (A)

Tighter
Stenosis (B)

Treat
Distal lesion First !

△FFR(A) < Big△FFR(B)

Courtesy of SJ Park

Rule of Big Delta

Treat
Proximal lesion First !

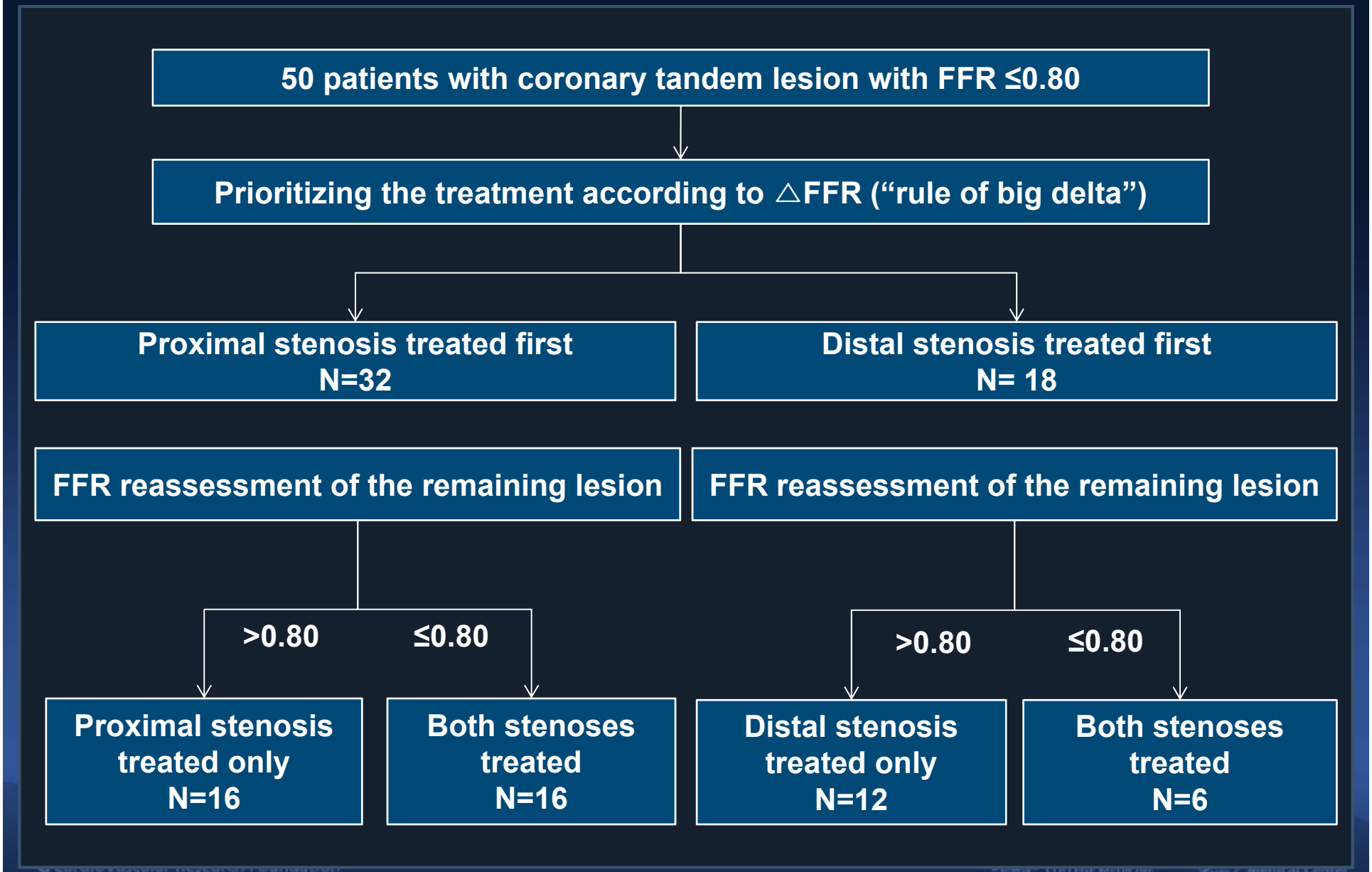
Big $\Delta FFR(A) > \Delta FFR(B)$

Courtesy of SJ Park

Clinical Characteristics (N=50)

Age (years)	62±9
Male	33 (66%)
Diabetes, N (%)	18 (36%)
Hypertension, N (%)	23 (46%)
Smoking, N (%)	10 (20%)
Hyperlipidemia, N (%)	17 (34%)
Previous PCI, N (%)	122 (12%)
Clinical manifestation	
Stable angina, N (%)	26 (52%)
Unstable angina, N (%)	21 (42%)
Non-ST elevation MI, N (%)	3 (6%)
Mean diameter stenosis, %	57±10

Treatment Results



Treatment Results

Variables	Singe Lesion (56%, N=28)	Dual Lesion (44%, N=22)	P value
Number of Stented Lesion	28	44	
Total stent length, mm	26.6 ± 9.7	47.3 ± 17.3	<0.001
Total stent number per patient	1.1 ± 0.4	2.0 ± 0.7	<0.001

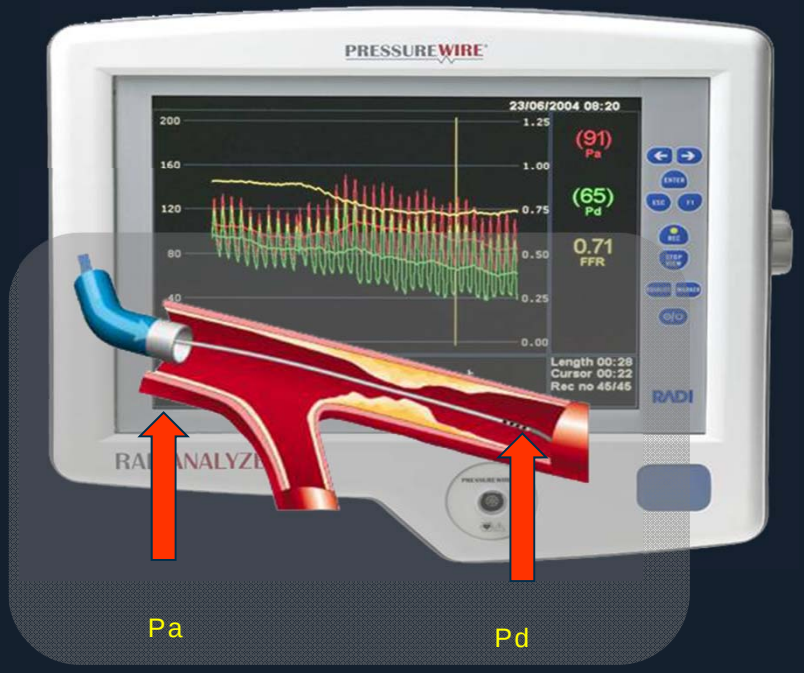
- In 56% of patients, single lesion was treated only and thus 28% of lesions were deferred

Conclusions

- For diffuse coronary lesions, FFR assessment before PCI has a novel activity to identify ischemia-producing segment.
- Moreover, FFR assessment during the procedure can determine whether the remaining unstented segment in a diffuse lesion requires additional stenting or not.
- Therefore, there is no doubt that FFR plays a crucial role to perform optimal stenting for diffuse coronary lesions.

Therefore, tailored stenting approach based on the separate functional assessment for the individual stenosis would be theoretically and clinically useful for PCI optimization and achieving better outcomes.

Fractional Flow Reserve



$$FFR = \frac{Q_S^{max}}{Q_N^{max}} = \frac{Pd}{Pa}$$