Integrated Use of FFR and IMR in Daily Practice

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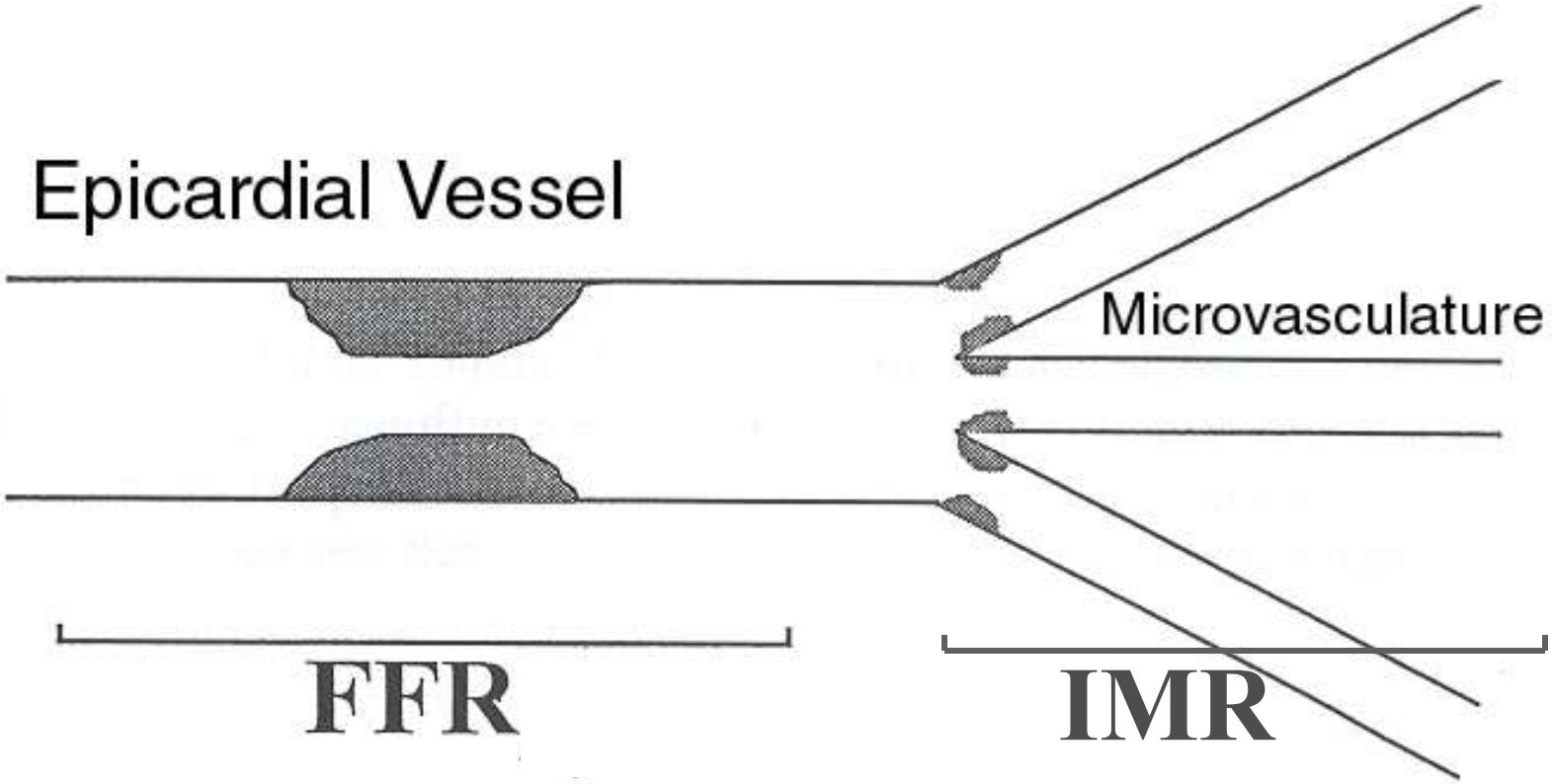
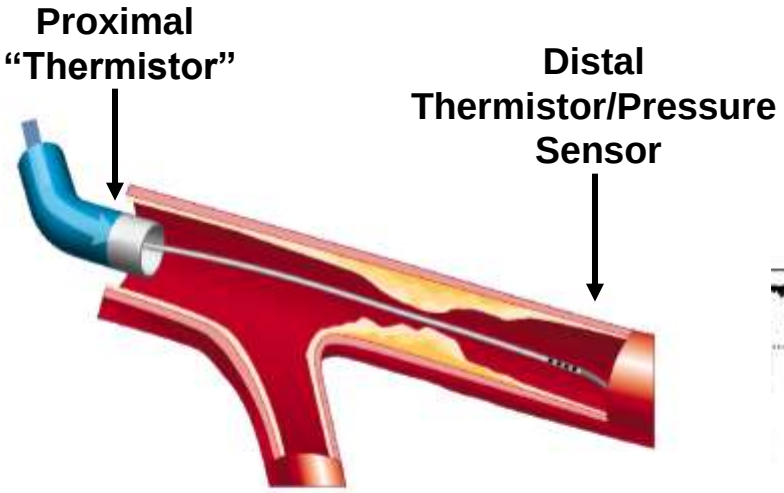
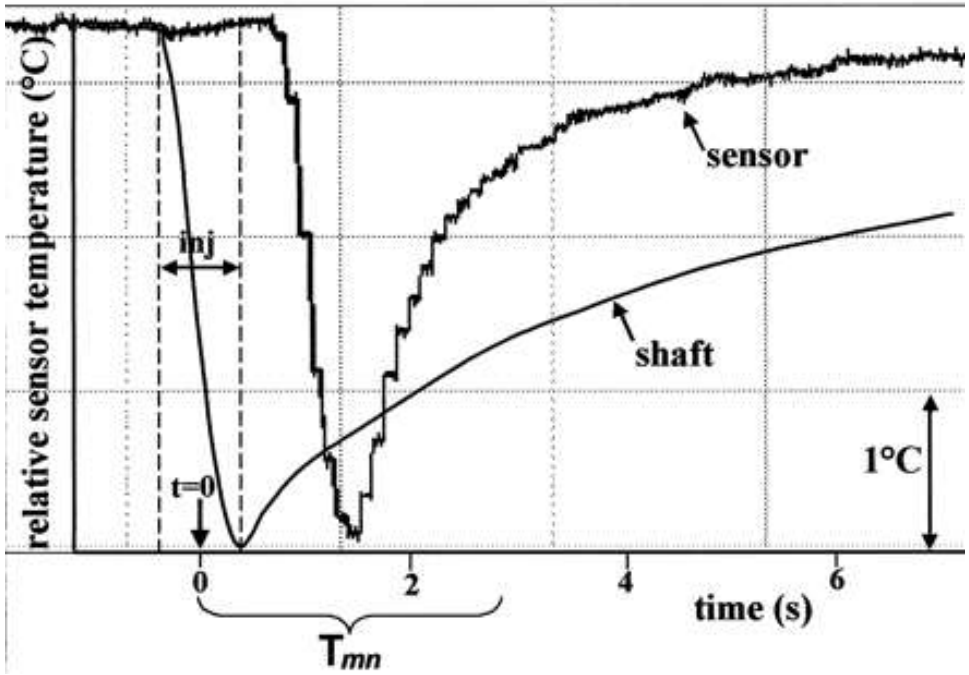
Fractional Flow Reserve and the Index of Microcirculatory Resistance:



Estimation of Coronary Flow



Calculation of mean transit time



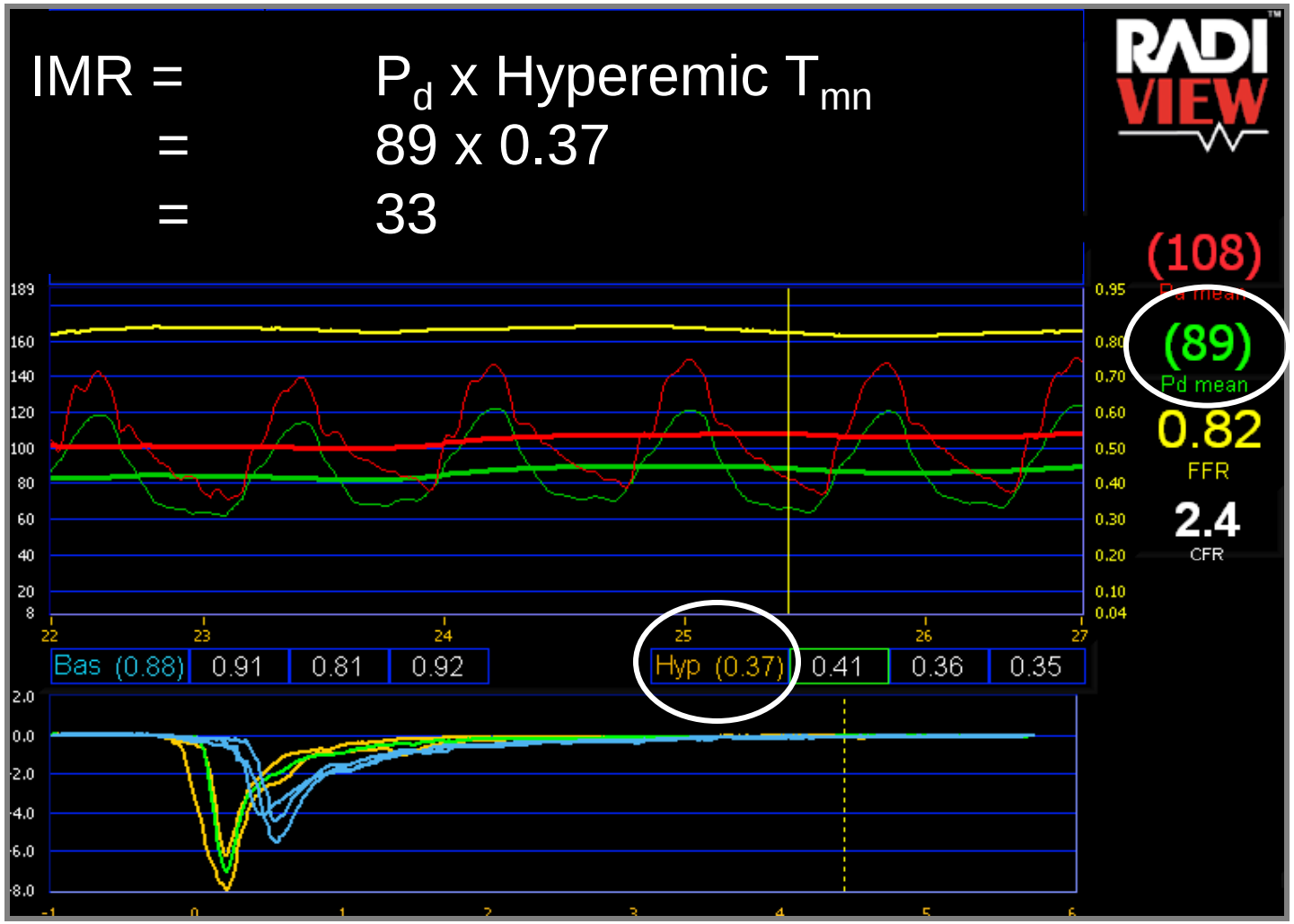
De Bruyne, et al. Circulation 2002;104:2003

Derivation of IMR:

- Resistance = Δ Pressure / Flow
- Δ Pressure = P_d-P_v Flow $\cong$ 1 / T_{mn}
- IMR = P_d-P_v / (1 / T_{mn})
- IMR = P_d x T_{mn} ***at maximal hyperemia…***

Circulation 2003;107:3129-3132.

Practical Measurement of IMR



Accessing IMR

System

↓

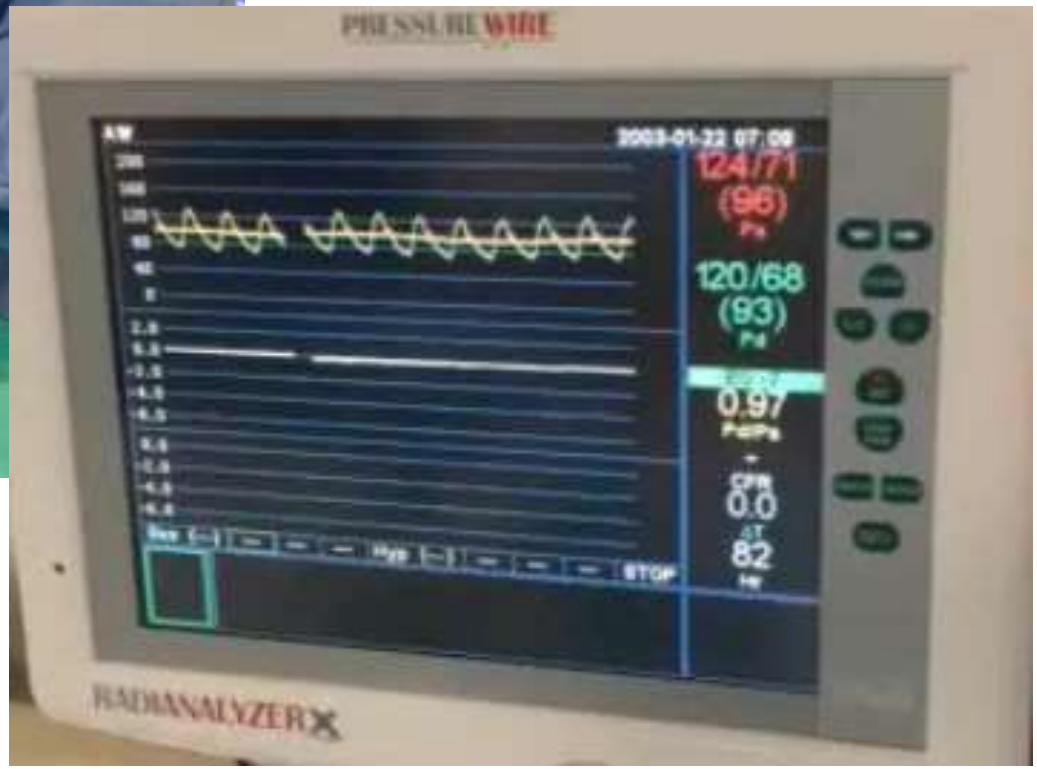
Options

↓

CFR

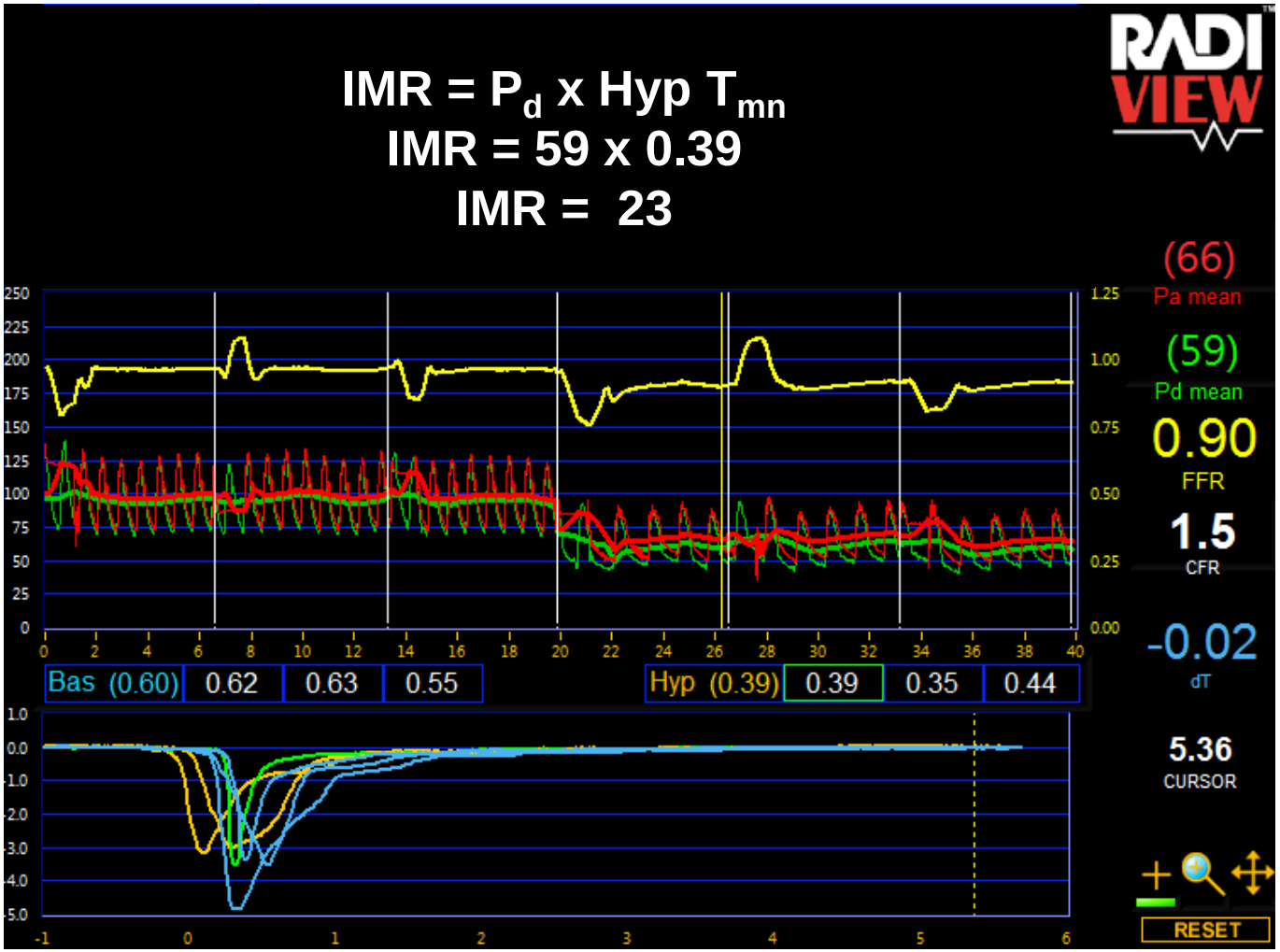
Flushing the System

Resting T_{mn} Measurements



Hyperemic T_{mn} Measurements

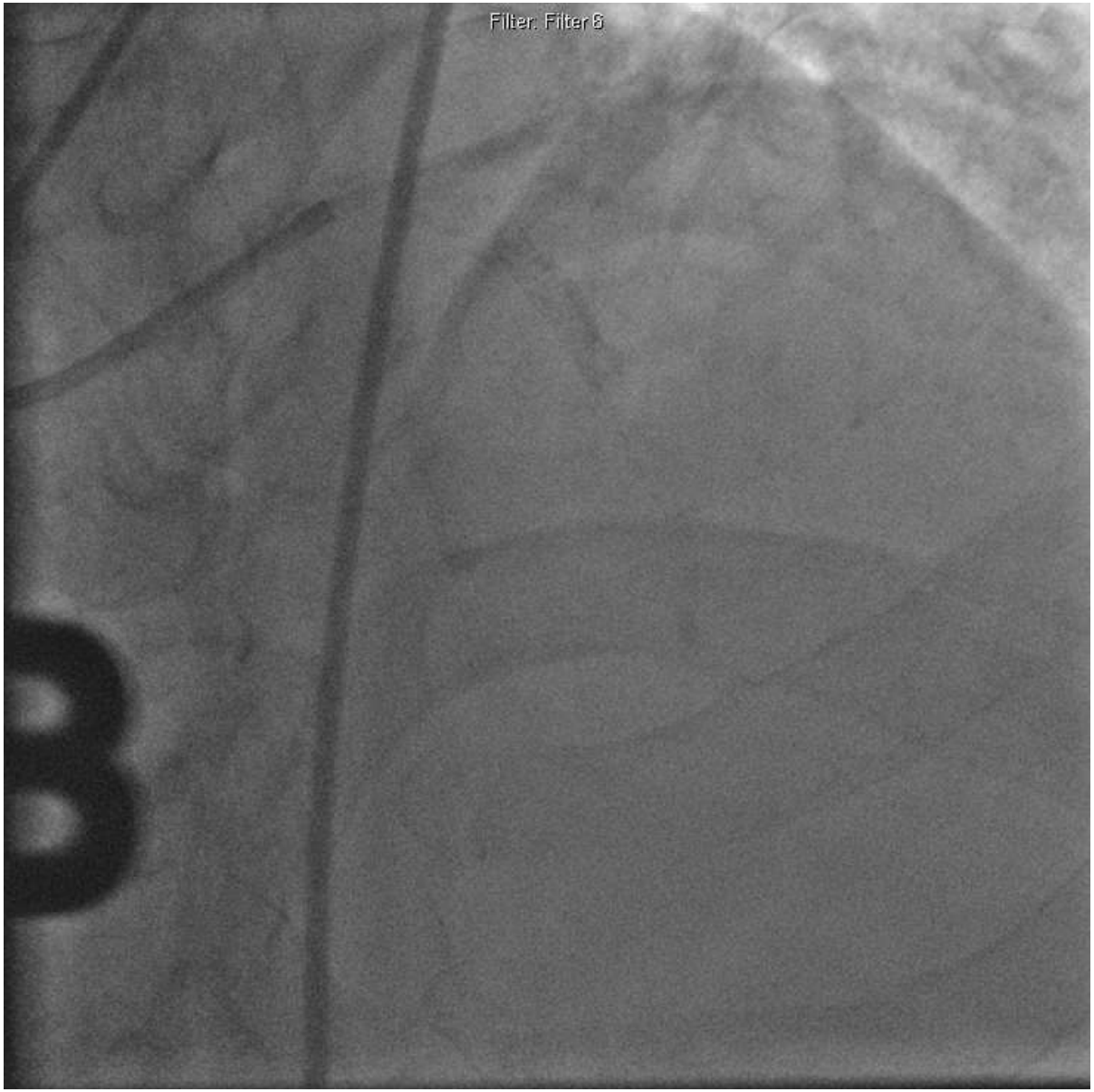
Calculating IMR

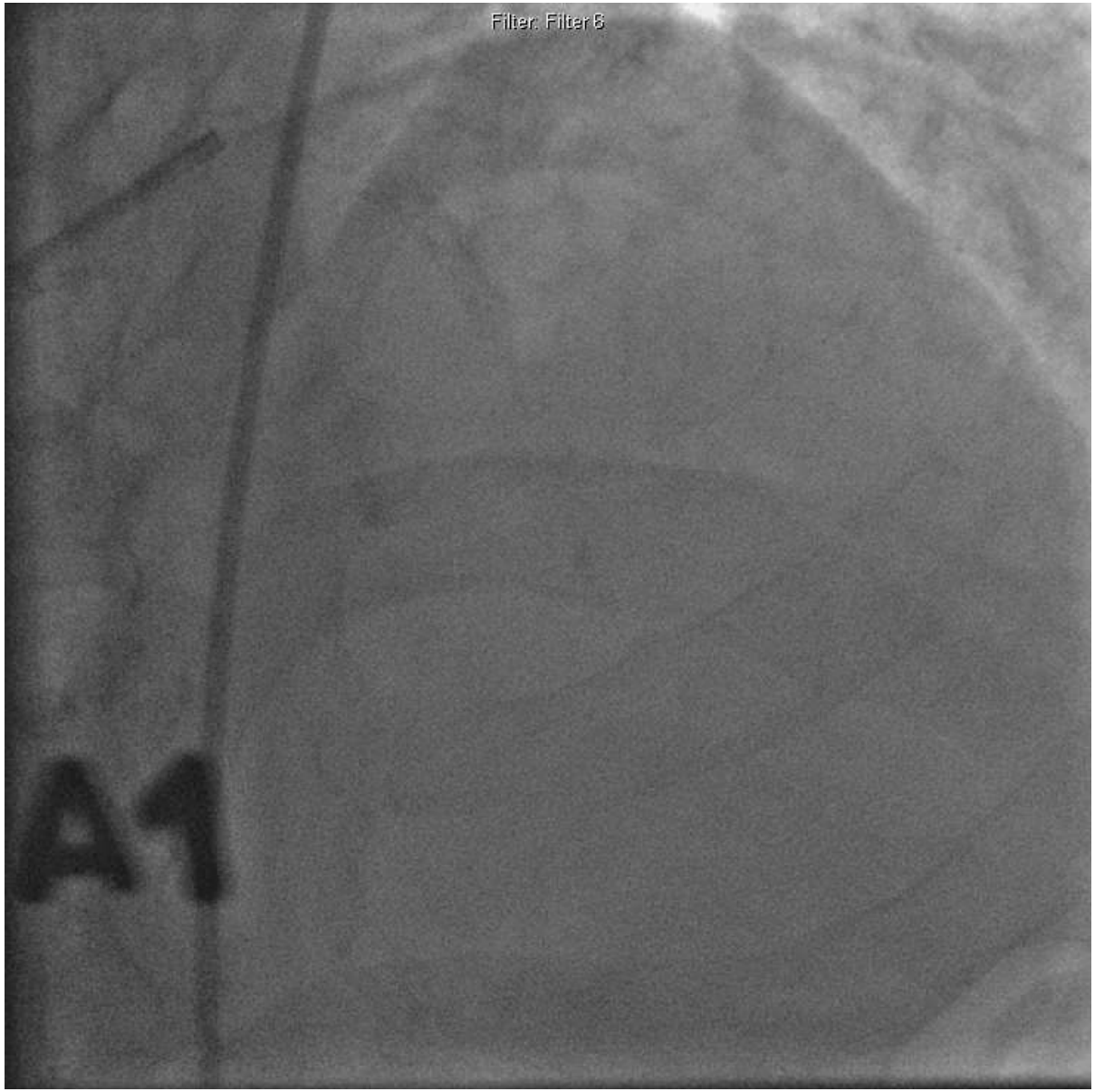


Case Example (April 13,2015):

- 72 year old retired naval officer
- HTN and dyslipidemia
- PCI of proximal LAD in 2006
- Some relief of angina
- Recent worsening angina
- Multiple stress tests (mild apical ischemia) and coronary angiograms


Filter: Filter6


Filter: Filter 8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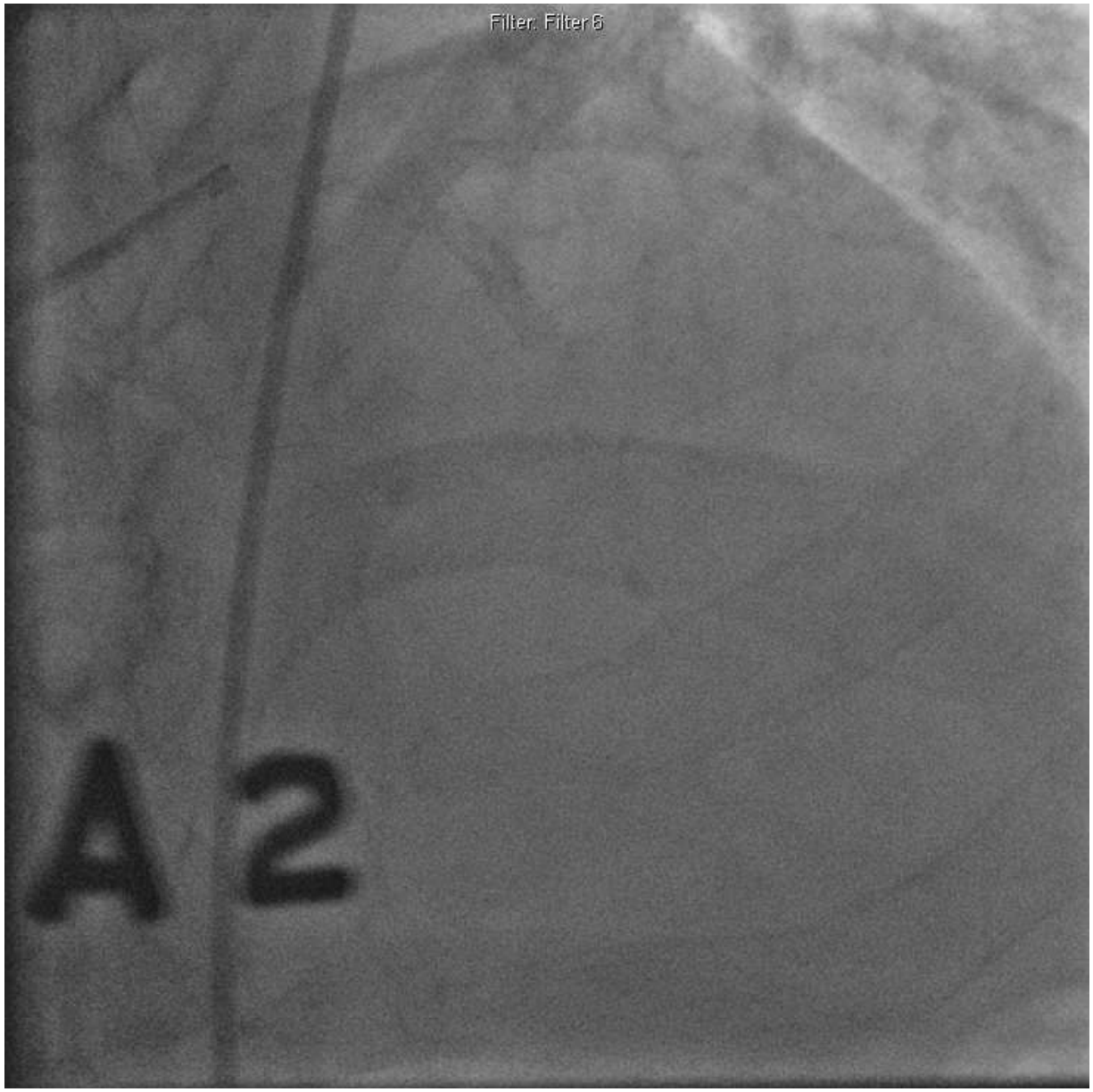
A1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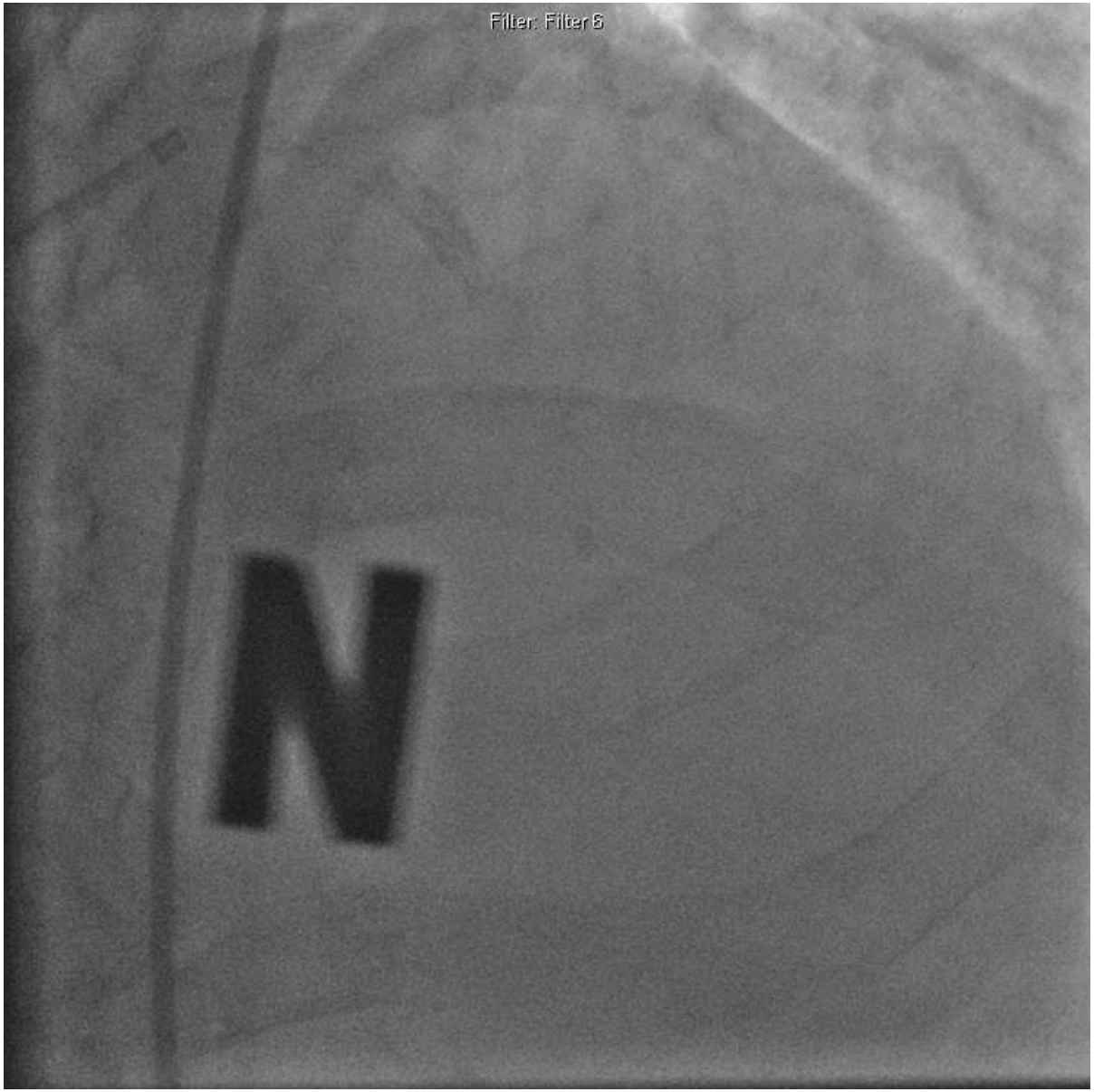
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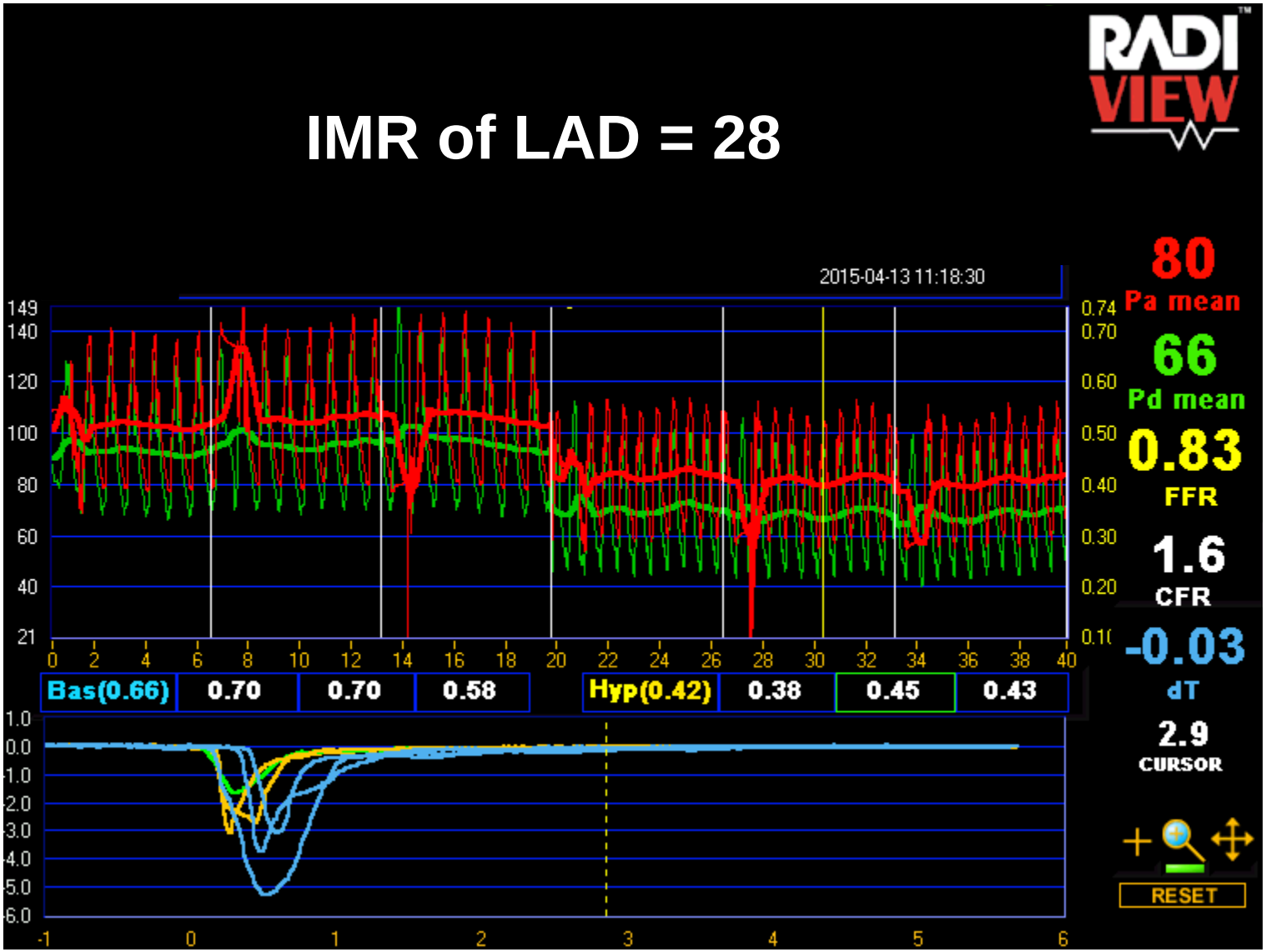
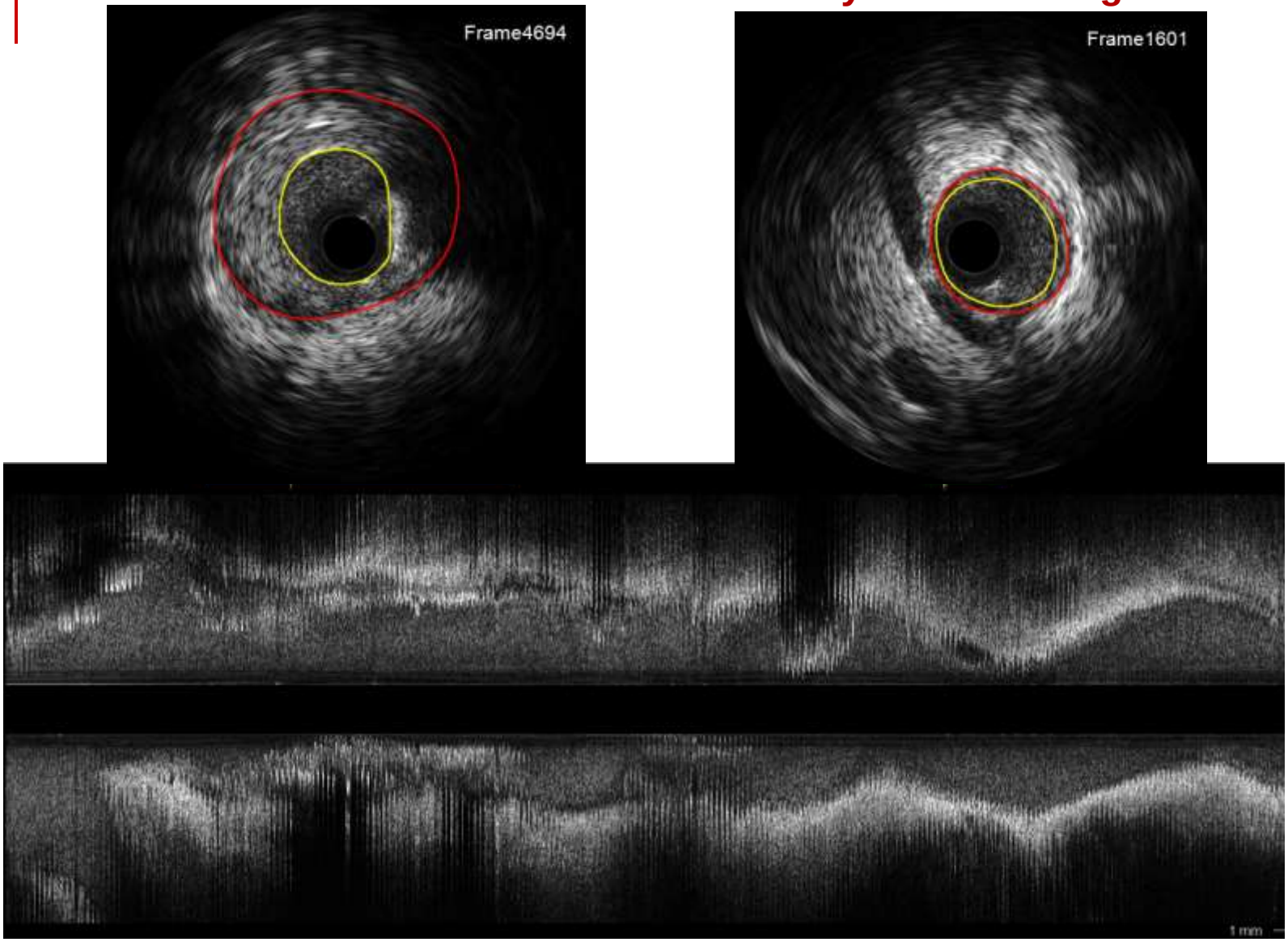
Filter: Filter 6

IMR of LAD = 28

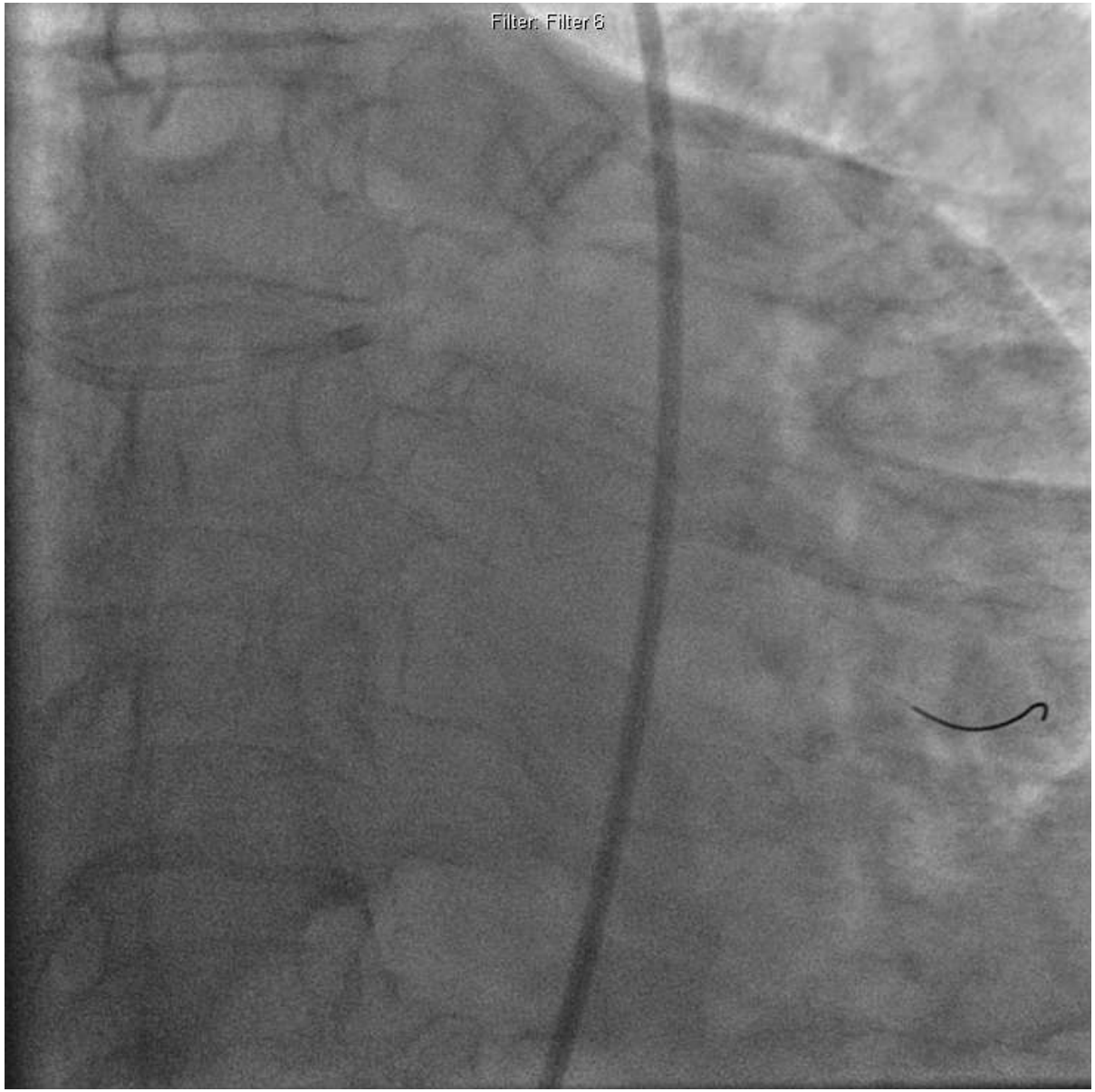

RADI VIEW
2015-04-13 11:18:30
80
Pa mean
66
Pd mean
0.83
FFR
1.6
CFR
-0.03
dT
2.9
CURSOR
RESET
Bas(0.66) 0.70 0.70 0.58
Hyp(0.42) 0.38 0.45 0.43

MSA = 4.3 mm2

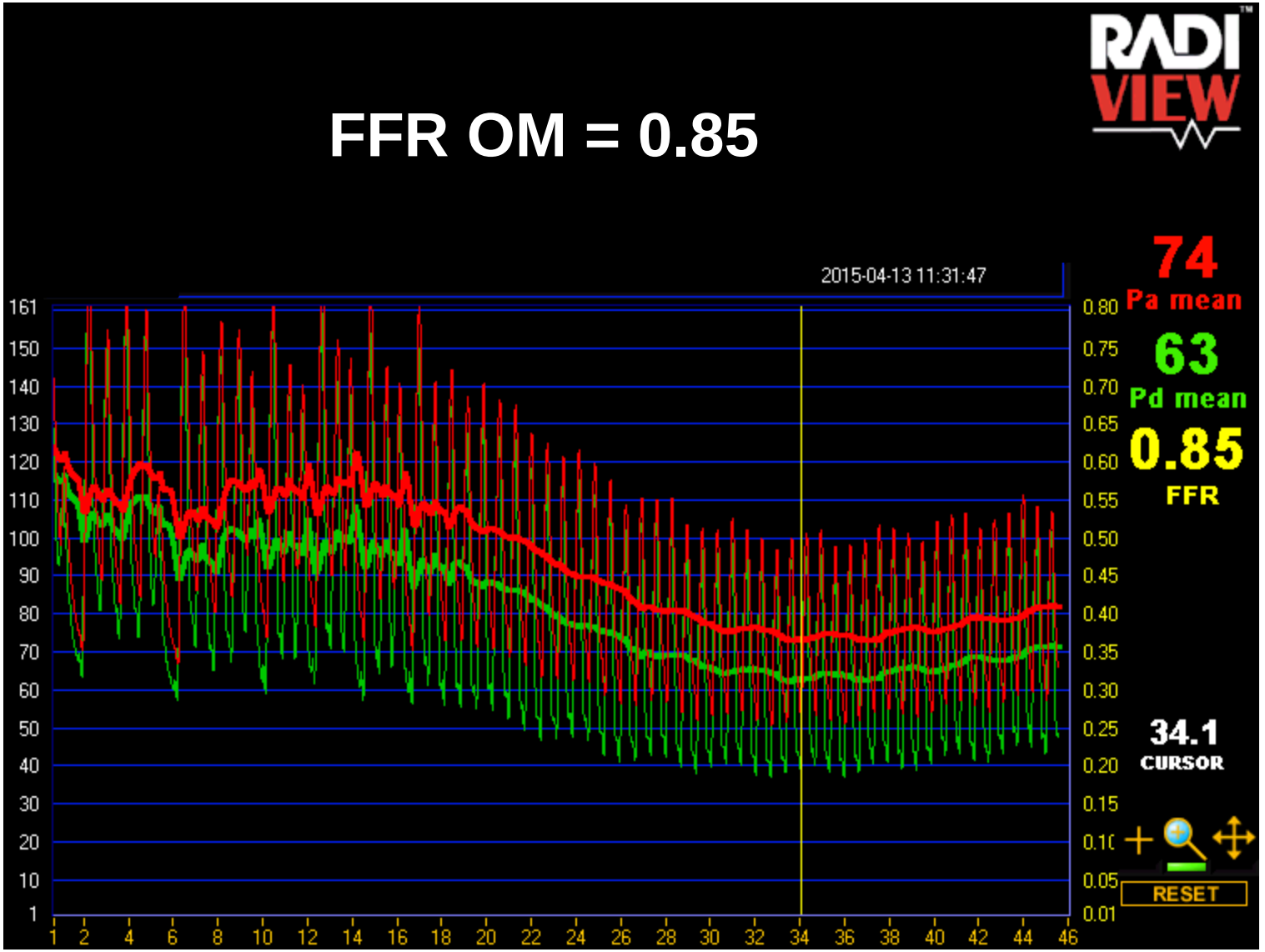
Myocardial Bridge



IVUS of LAD


Filter: Filter 6

FFR OM = 0.85


RADI VIEW
2015-04-13 11:31:47
74
Pa mean
63
Pd mean
0.85
FFR
34.1
CURSOR
RESET
161 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 1
0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 0.20 0.15 0.10 0.05 0.01
1 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46

Case Summary:

- No significant endothelial dysfunction/spasm
- Moderate restenosis of the LAD stent with mild diffuse epicardial atherosclerosis, which is not functionally significant
- Short mild bridging which is not significant
- Evidence for microvascular dysfunction
- Moderate OM disease which is not functionally significant

Case Summary (cont.):

- Treatment plan:
  - Reassure patient no need for stent based on FFR results.
  - Notify patient that we have a diagnosis for chest pain: microvascular dysfunction in conjunction with epicardial CAD.
  - Augment medical therapy (statin, ACE I, carvedilol, calcium blocker, nitrate)

Chest Pain and “Normal Coronaries”

- 139 patients referred for coronary angiography because of symptoms and/or abnormal stress test and found to have “normal” appearing coronaries

- FFR, IMR, CFR, IVUS and acetylcholine challenge were performed down the LAD

Lee BK, et al. Circulation 2015;131:1054-60.

Chest Pain and “Normal Coronaries”

Patient Characteristic	n=139
Age (years)	54 ±11
Female	77%
Hypertension	53%
Diabetes	23%
Dyslipidemia	63%
Tobacco Use	8%

Lee BK, et al. Circulation 2015;131:1054-60.

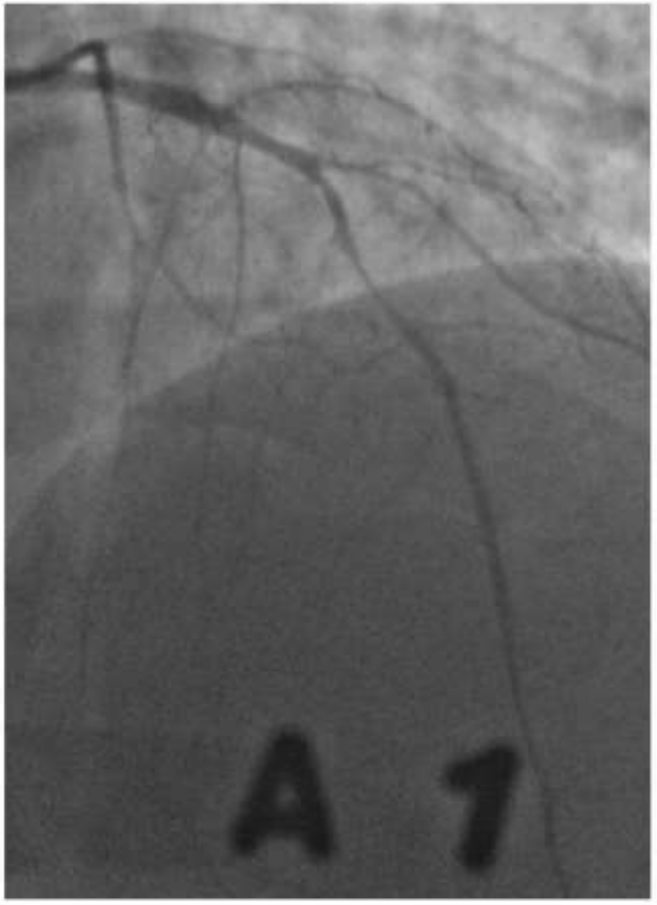
Chest Pain and "Normal Coronaries"

- The mean IMR was 19.6 ±9.1
- Microvascular dysfunction was present in 21% (defined as IMR ≥ 25)
- Patients with microvascular dysfunction were older and more often hypertensive and diabetic

Lee BK, et al. Circulation 2015;131:1054-60.

Endothelial Dysfunction:

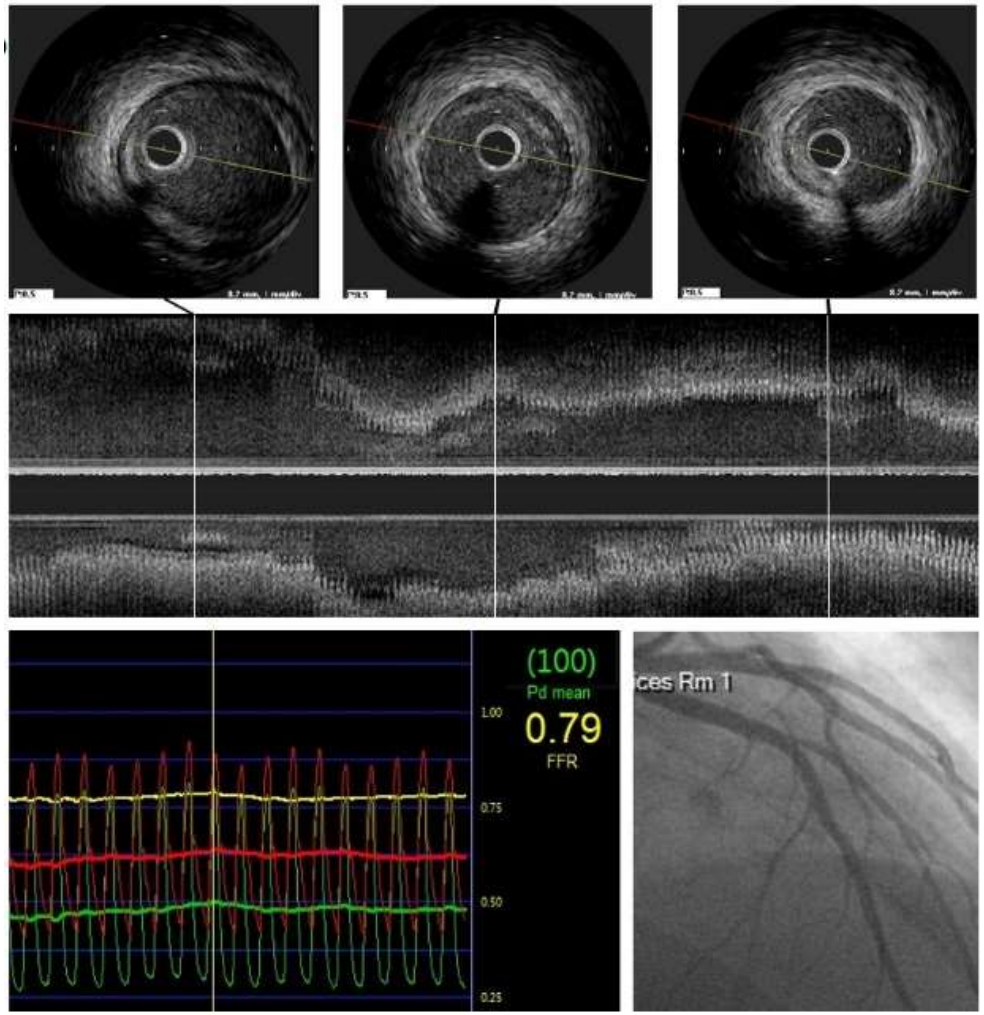
After Acetylcholine



After Nitroglycerin

Lee BK, et al. Circulation 2015;131:1054-60.

Diffuse Mild Epicardial Disease:



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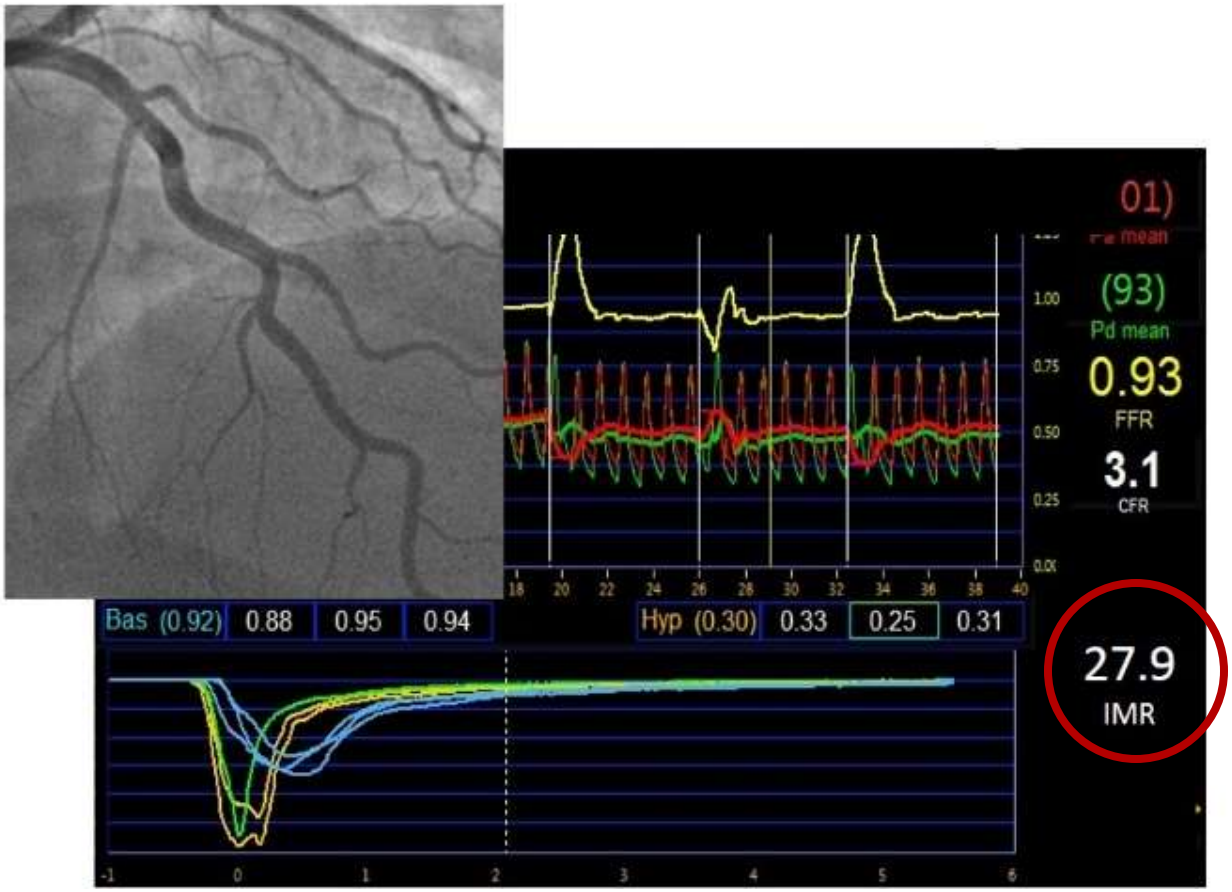
Microvascular Dysfunction:

Index of Microcirculatory Resistance ≥ 25



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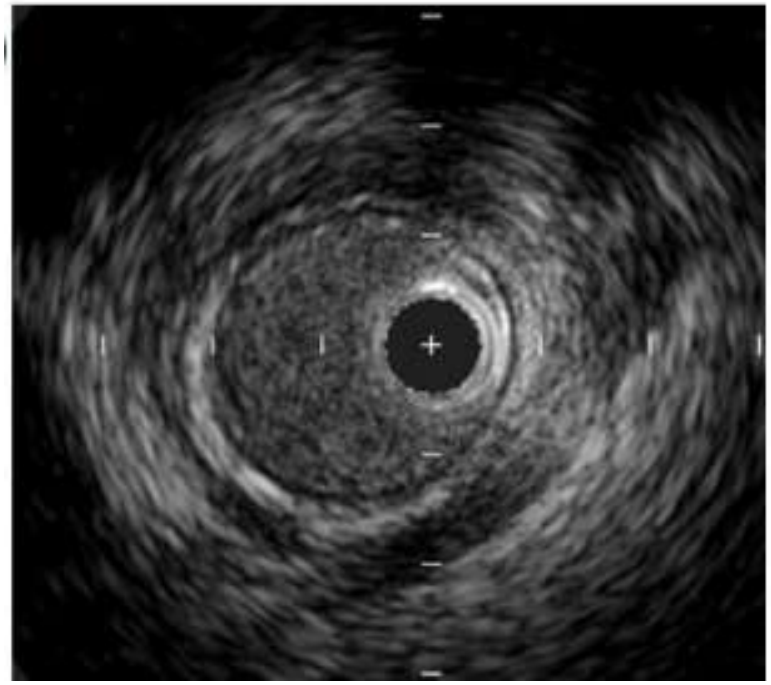
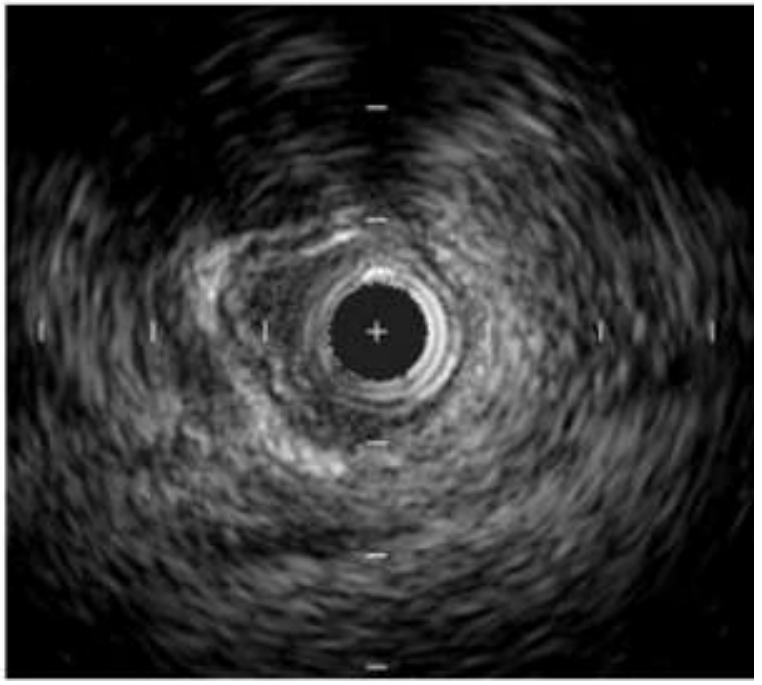
Myocardial Bridging:

Diastole ***Systole***





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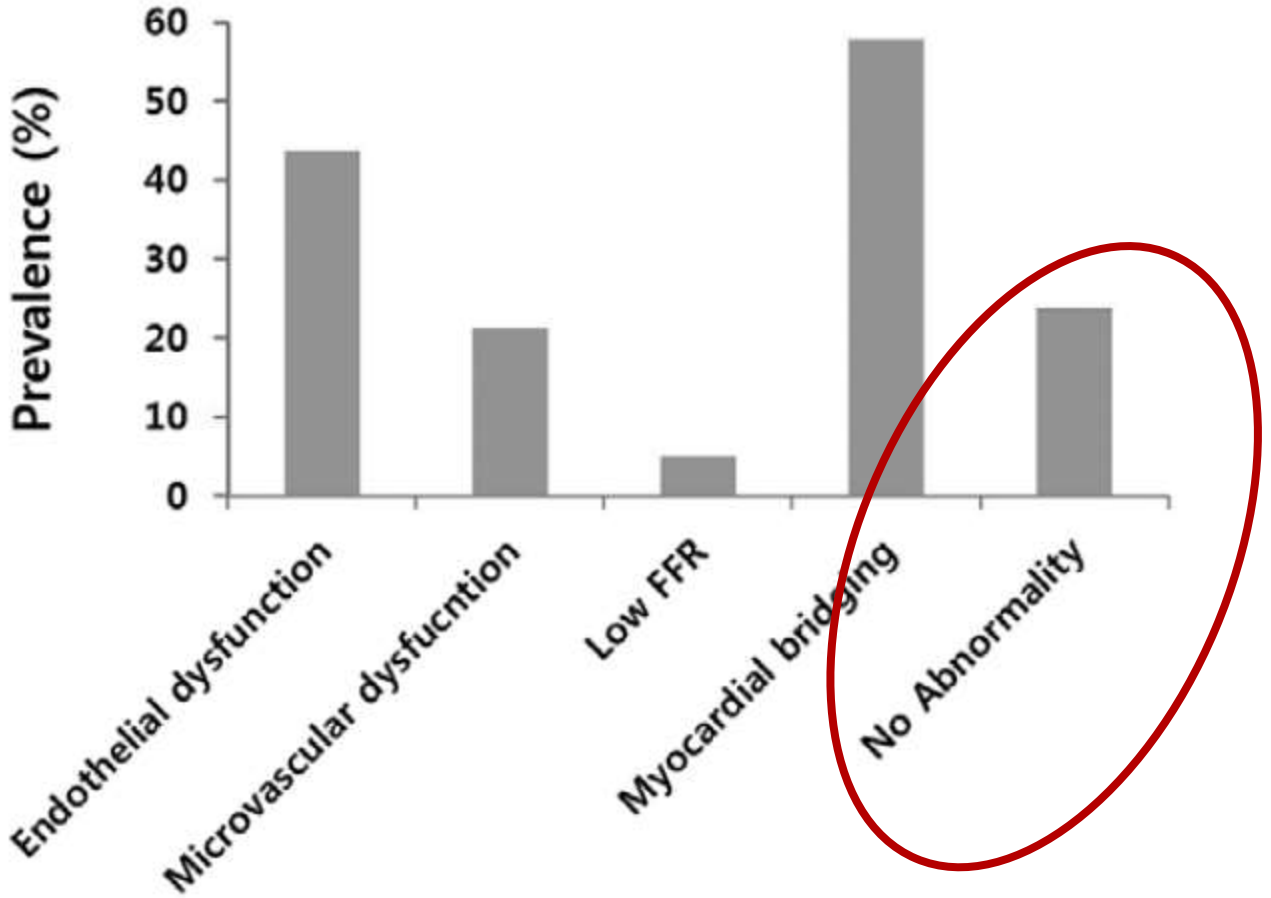
Chest Pain and “Normal Coronaries”

77% of patients had at least one occult coronary circulatory abnormality



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Conclusion:

- Measurement of FFR and IMR can help to diagnose the etiology of chest pain/abnormal stress test in patient with angiographically normal appearing coronaries.

- This information can reassure patients and prevent unnecessary testing and treatment.