Bifurcation PCI with Physiologic Index:

FFR, Contrast FFR, Pd/Pa, and iFR – When, How, and What?

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What are these?

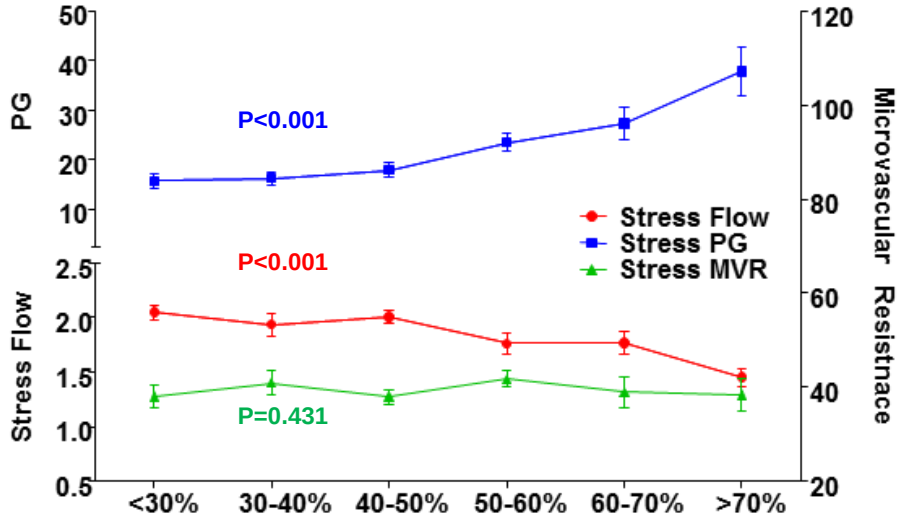
- Fractional flow reserve (**FFR**) - 0.80
- Instantaneous wave-free ratio (**iFR**) – 0.89
- Contrast FFR (**cFFR**) – 0.83
- Whole cycle resting **Pd/Pa** – 0.91
- Diastolic pressure ratio (**dPR**) – 0.89 (?)
- Resting full-cycle ratio (**RFR**) – 0.89 (?)
- ……

Coronary Circulatory Response to Epicardial Stenosis

Resting

*MV, microvascular; PG, pressure gradient

Hyperemia



As stenosis severity (epicardial resistance) increases

- Minimal and stable MV resistance
- Hyperemic flow ▼
- **Hyperemic pressure gradient ▲**

Lee JM, Koo BK, et al. Circulation 2017

Experimental Basis of Determining Maximum Coronary, Myocardial, and Collateral Blood Flow by Pressure Measurements for Assessing Functional Stenosis Severity Before and After Percutaneous Transluminal Coronary Angioplasty

Nico H.J. Pijls, MD; Jacques A.M. van Son, MD; Richard L. Kirkeeide, PhD; Bernard De Bruyne, MD; and K. Lance Gould, MD

Coronary Flow Reserve Calculated From Pressure Measurements in Humans

Validation With Positron Emission Tomography

Bernard De Bruyne, MD; Thierry Baudhuin, MD†; Jacques A. Melin, MD, PhD; Nico H.J. Pijls, MD, PhD; Stanislas U. Sys, MD, PhD; Anne Bol, PhD; Walter J. Paulus, MD; Guy R. Heyndrickx, MD, PhD; William Wijns, MD, PhD

FFR and Hyperemia

$$FFR = \frac{Q^{S}_{max}}{Q^{N}_{max}} = \frac{(Pd-Pv)/R}{(Pa-Pv)/R} = \frac{P_d}{P_a}$$

At constant Pa, determinants of Pd

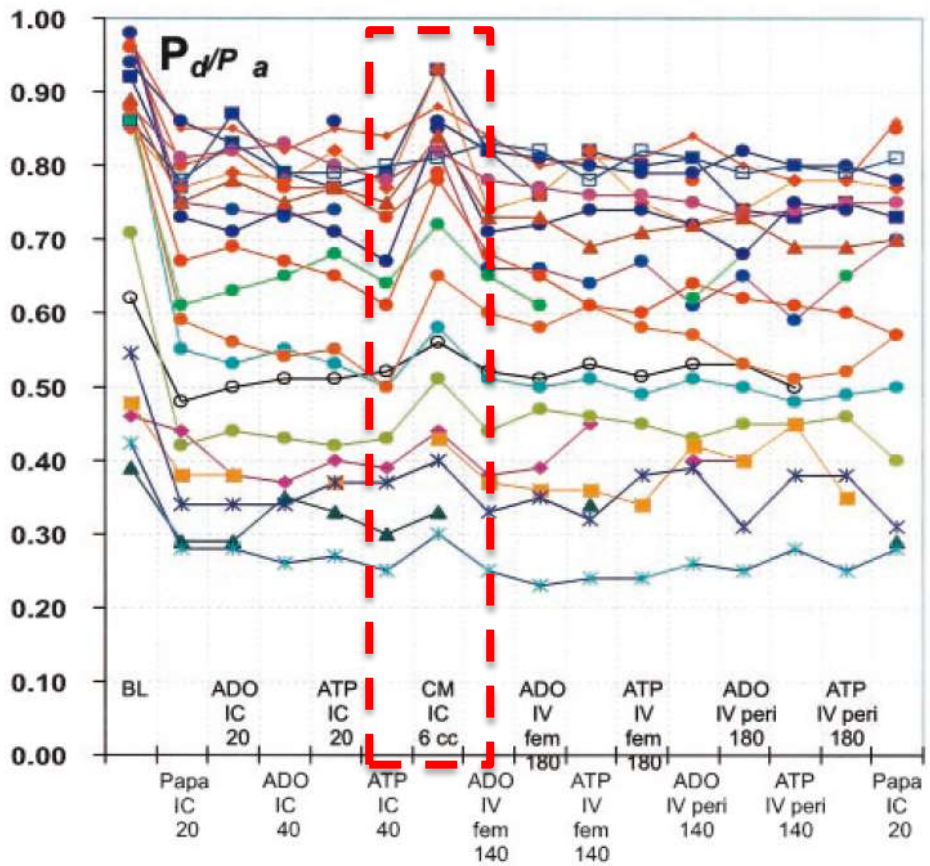
- Epicardial stenosis
- Myocardial resistance

Contrast FFR (cFFR)

Intracoronary and Intravenous Adenosine 5′-Triphosphate, Adenosine, Papaverine, and Contrast Medium to Assess Fractional Flow Reserve in Humans

Bernard De Bruyne, MD, PhD; Nico H.J. Pijls, MD, PhD; Emanuele Barbato, MD; Jozef Bartunek, MD, PhD; Jan-Willem Bech, MD; William Wijns, MD, PhD; Guy R. Heyndrickx, MD, PhD

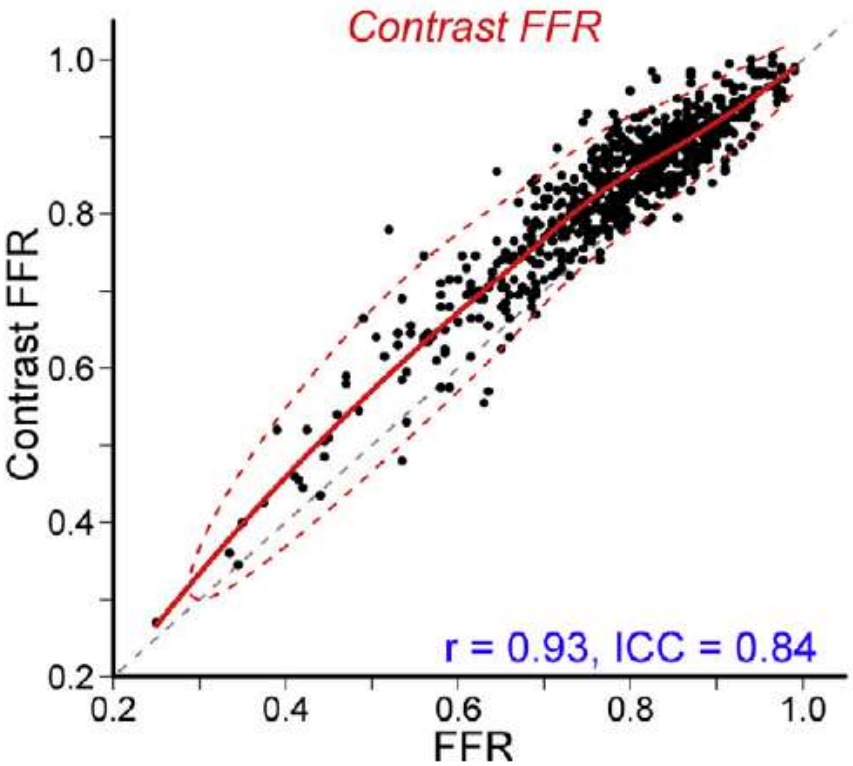
Background—Inducing both maximal and steady-state coronary hyperemia is of clinical importance to take full advantage



2003 Circulation

Continuum of Vasodilator Stress From Rest to Contrast Medium to Adenosine Hyperemia for Fractional Flow Reserve Assessment

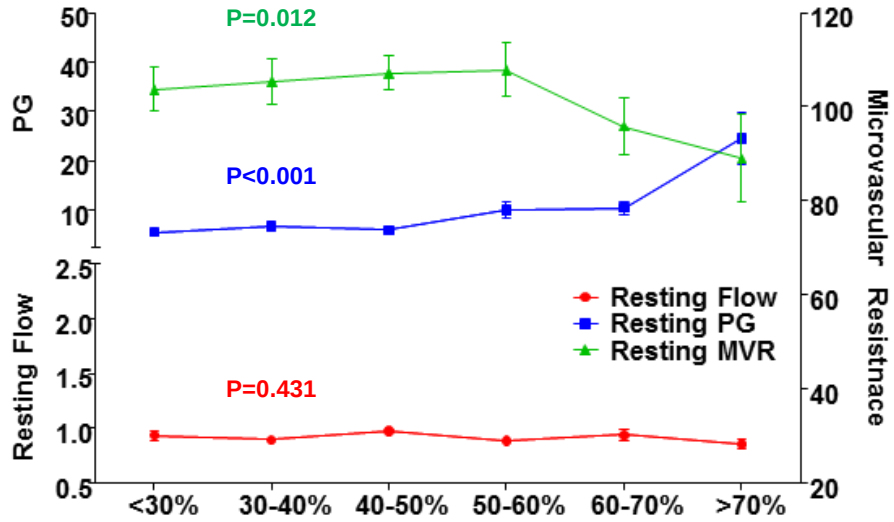
Nils P. Johnson, MD, MS,[a] Allen Jeremias, MD, MSc,[b,c] Frederik M. Zimmermann, MD,[d] Julien Adjedj, MD,[e] Nils Witt, MD, PhD,[f] Barry Hennigan, MB BCh BAO, BMedSci,[g,h] Bon-Kwon Koo, MD, PhD,[i] Akiko Maehara, MD,[j,k] Mitsuaki Matsumura, BS,[l] Emanuele Barbato, MD, PhD,[d,e] Giovanni Esposito, MD, PhD,[b] Bruno Trimarco, MD,[b] Gilles Rioufol, MD, PhD,[f] Seung-Jung Park, MD, PhD,[m] Hyoung-Mo Yang, MD, PhD,[n,o] Sérgio B. Baptista, MD,[p] George S. Chrysant, MD,[q] Antonio M. Leone, MD, PhD,[r] Colin Berry, MBChB, PhD,[g,h] Bernard De Bruyne, MD, PhD,[e] K. Lance Gould, MD,[s] Richard L. Kirkeeide, PhD,[s] Keith G. Oldroyd, MBChB, MD,[g] Nico H.J. Pijls, MD, PhD,[d,t] William F. Fearon, MD[u]



2016 JACC Intv

Coronary Circulatory Responses to Epicardial Stenosis

Resting



As stenosis severity (epicardial resistance) increases

- No change in resting flow
- MV resistance ▼
- **Resting pressure gradient ▲**

*MV, microvascular; PG, pressure gradient

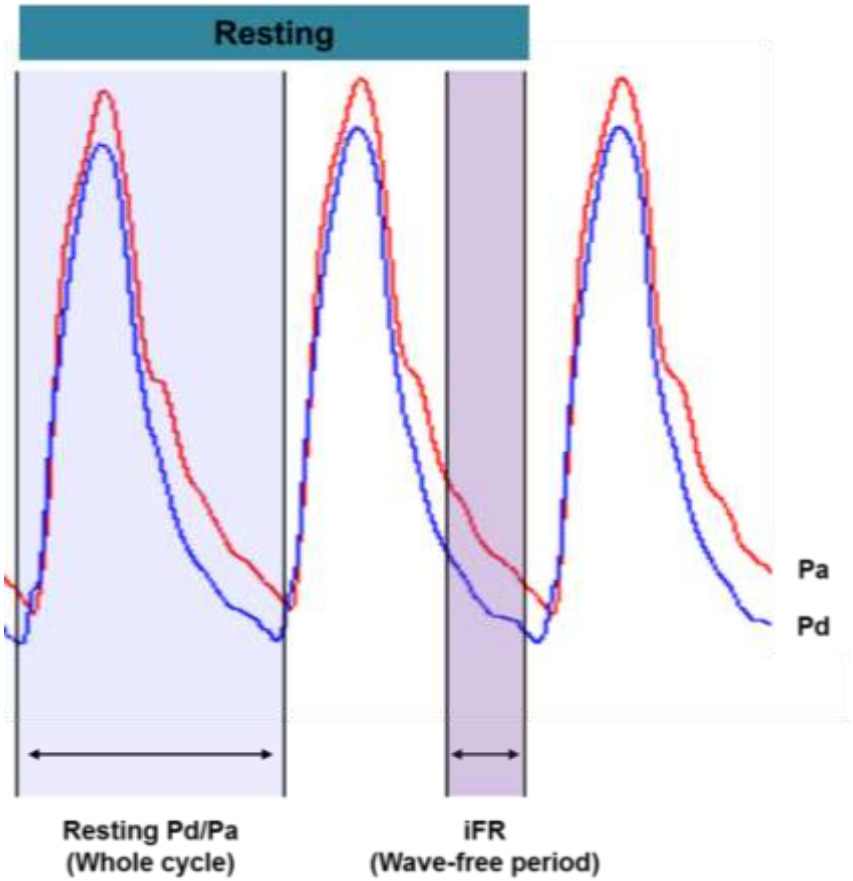
Hyperemia

As stenosis severity (epicardial resistance) increases

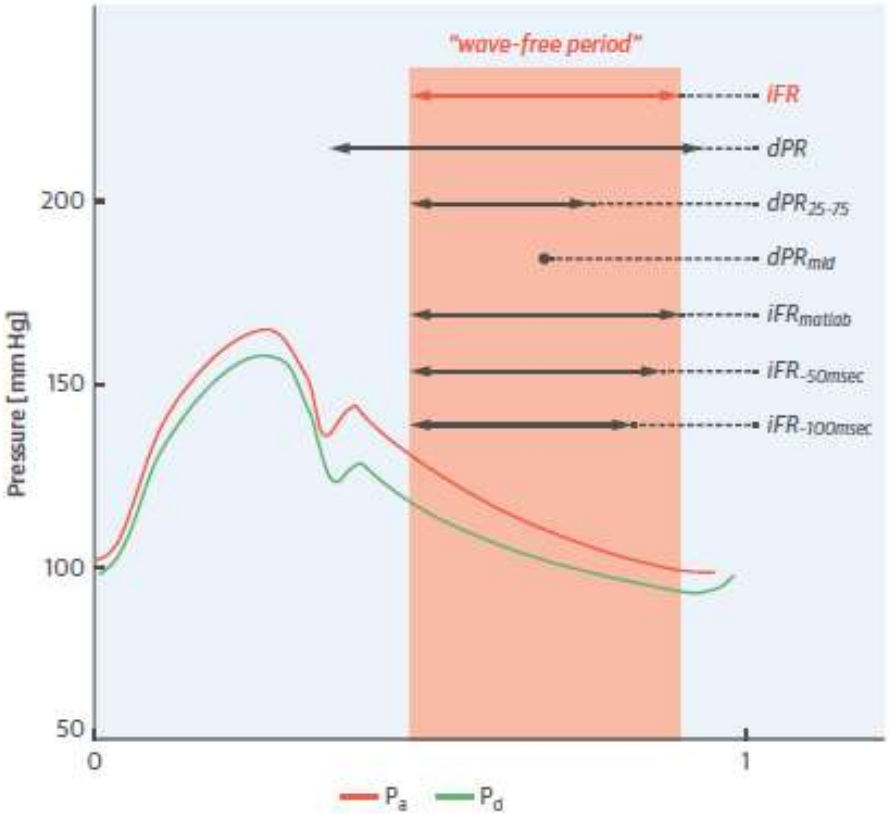
- Minimal and stable MV resistance
- Hyperemic flow ▼
- Hyperemic pressure gradien ▲

Lee JM, Koo BK, et al. Circulation 2017

Resting Pressure Indexes: Resting Pd/Pa, iFR, dPR, RFR……

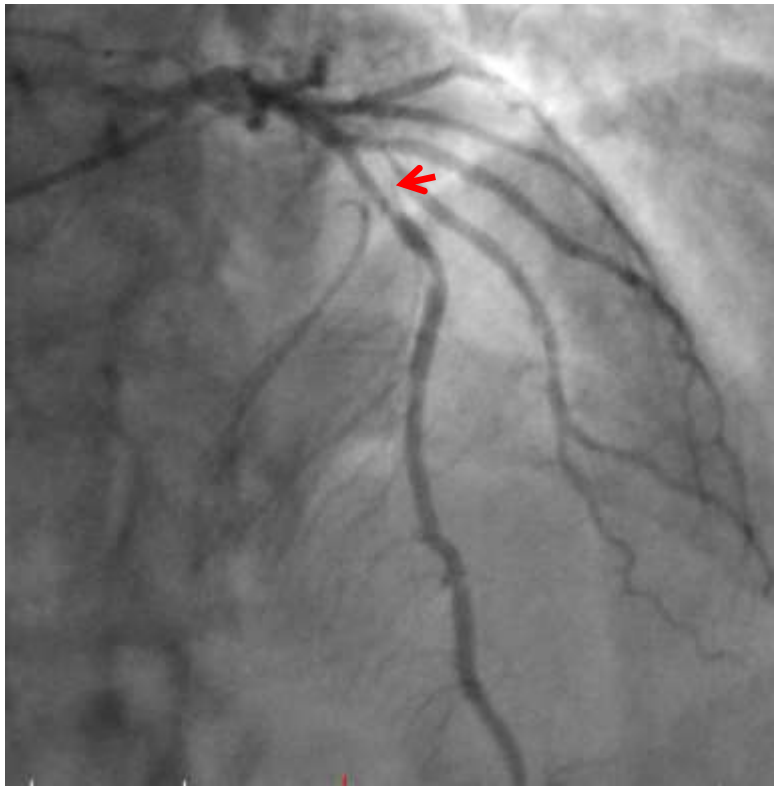


Lee JM, ……, Koo BK, J Am Coll Cardiol 2017

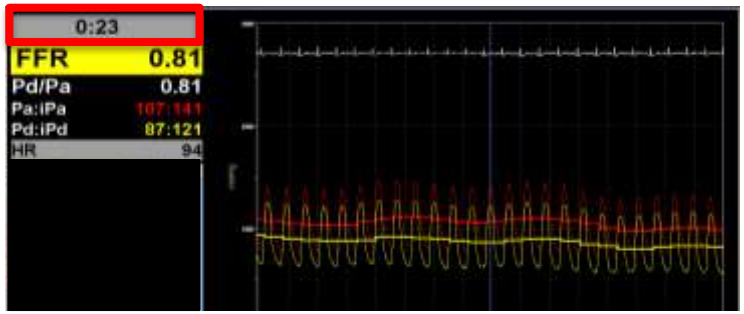


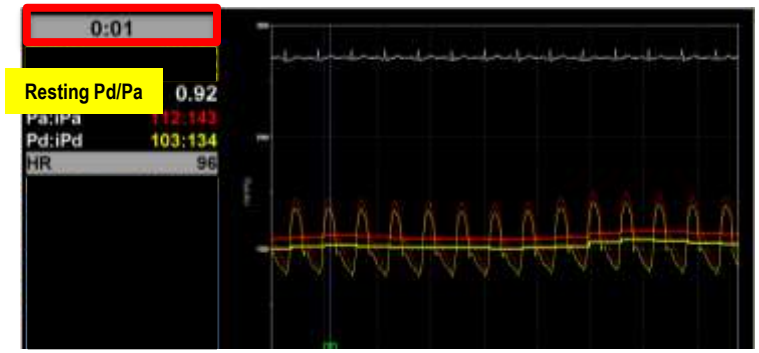
van't Veer, M. et al. J Am Coll Cardiol 2017

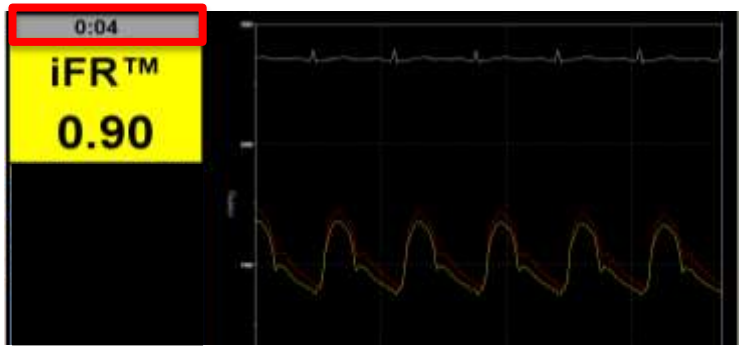
Resting indexes doesn't need hyperemia and measurement is instantaneous.



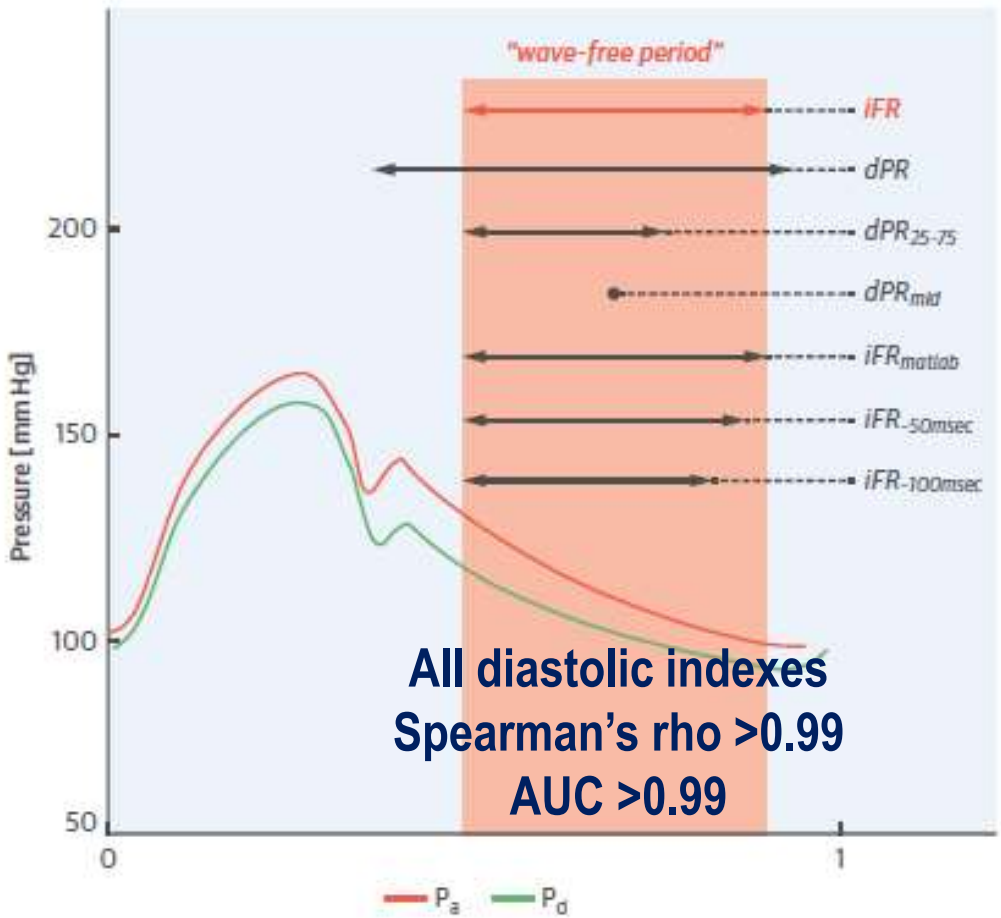
20 sec with adenosine, chest discomfort…..



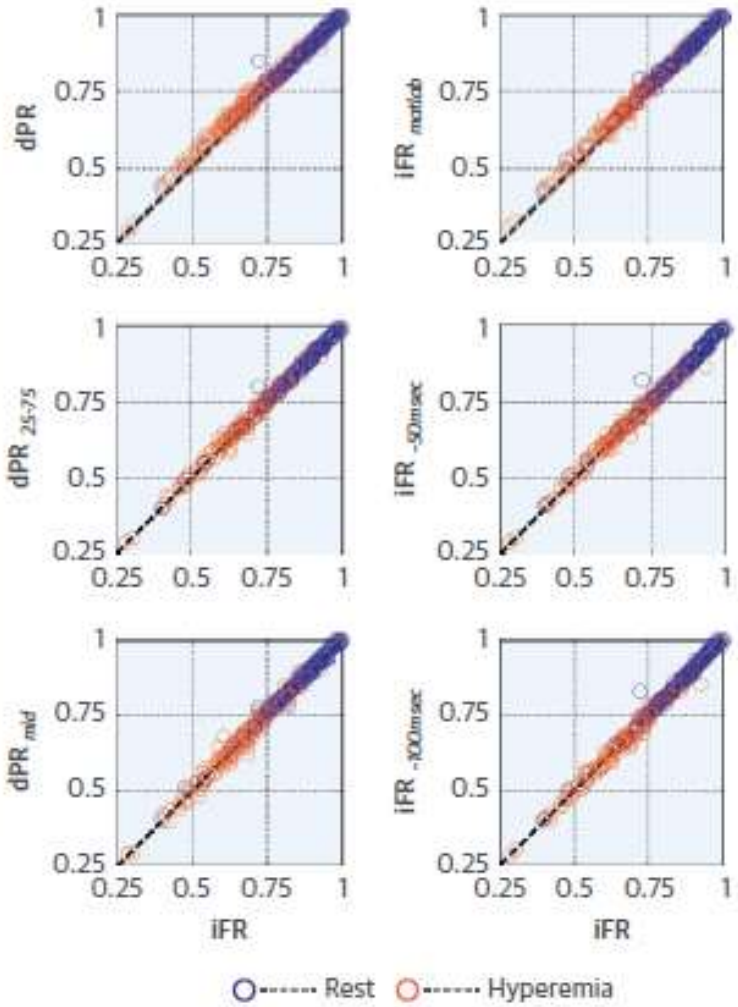




Good news #1: All diastolic indexes are (almost) the same!

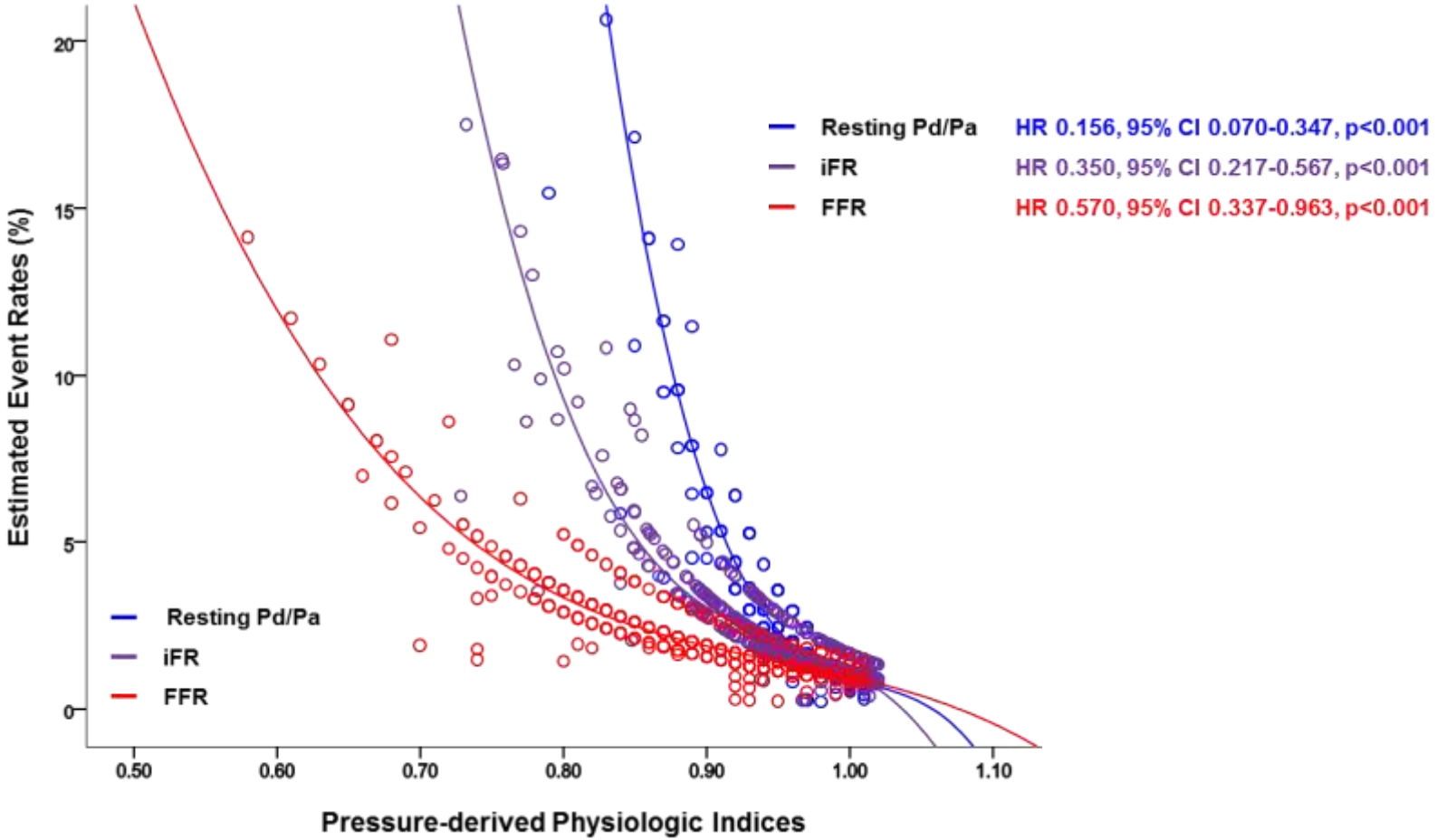


All diastolic indexes
Spearman's rho >0.99
AUC >0.99



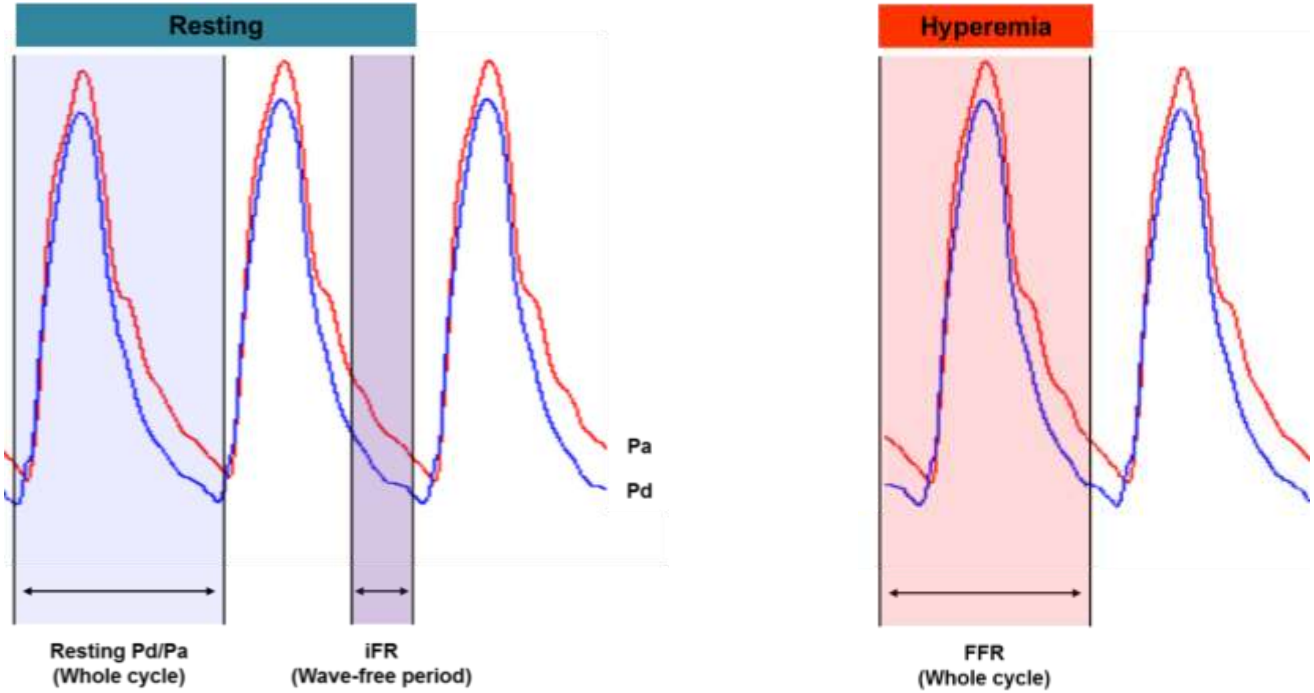
Van't Veer, M. et al. JACC 2017

Good news #2: All hemodynamic indexes have prognostic implications!



Lee JM, Koo BK, et al. Circulation 2017
Lee JM, Koo BK, et al. JACC 2017

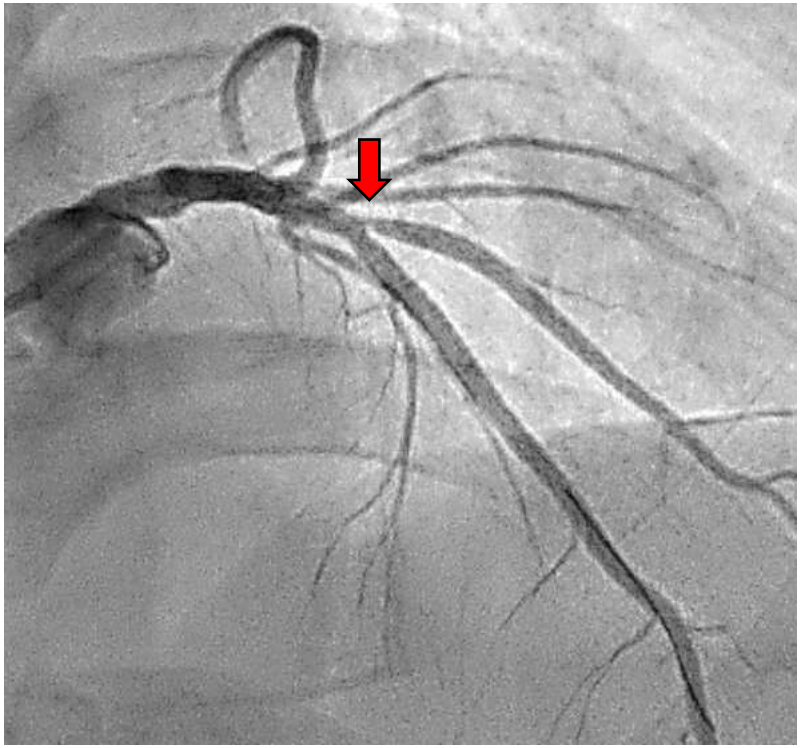
Resting and Hyperemic indexes: What's what?



Response to anatomical or hemodynamic stenosis severity	Resting Pd/Pa	<	iFR	<	FFR
Diagnostic accuracy for ISCHEMIA, Vulnerability Association with MACE	Resting Pd/Pa	=?	iFR	=?	FFR
Vulnerability to measurement variability	Resting Pd/Pa	>	iFR	>	FFR

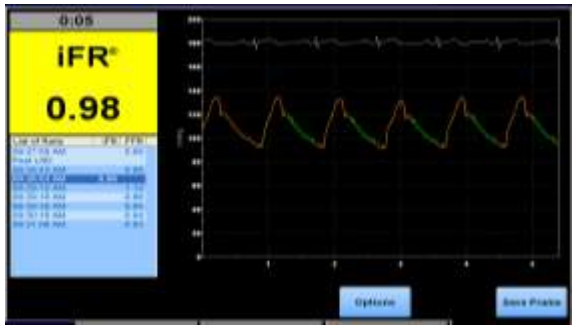
Lee JM, Koo BK, et al. Circulation 2017
Lee JM, Koo BK, et al. JACC 2017

When and How?

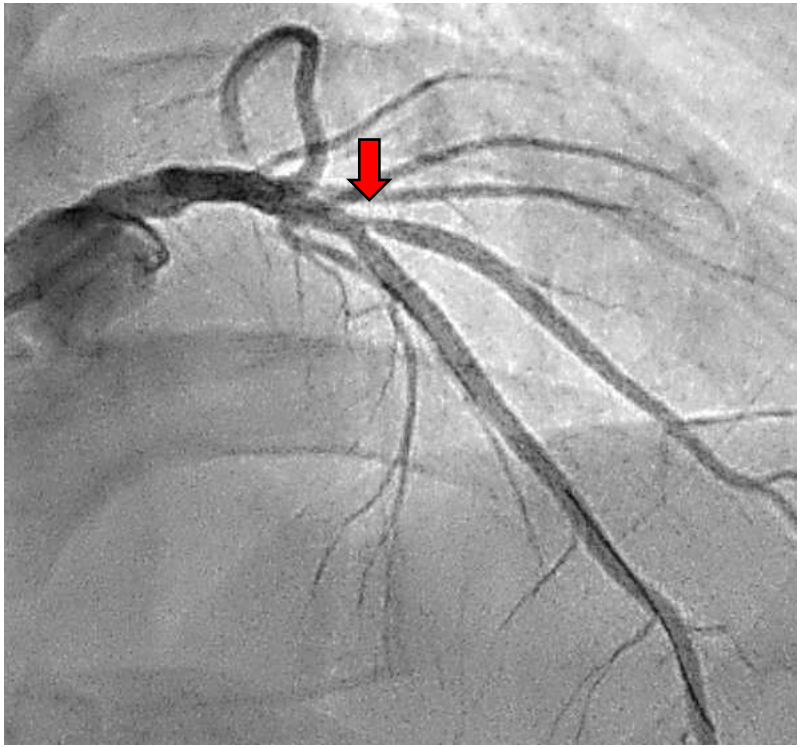


Advance the wire, then

Click the iFR button

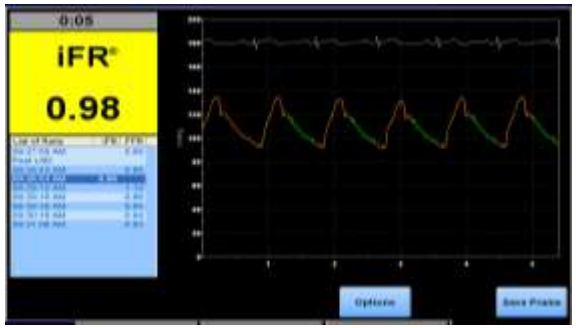


When and How?

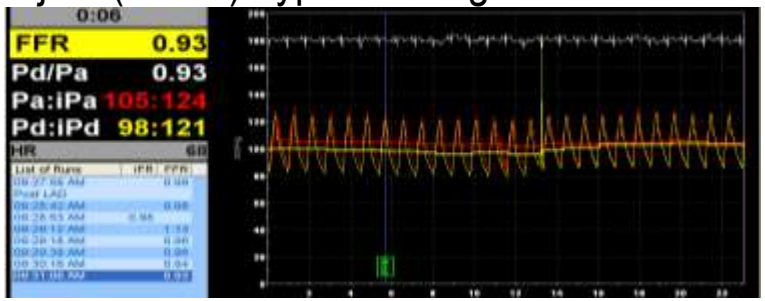


Advance the wire, then

Click the iFR button



Inject (infuse) hyperemic agent

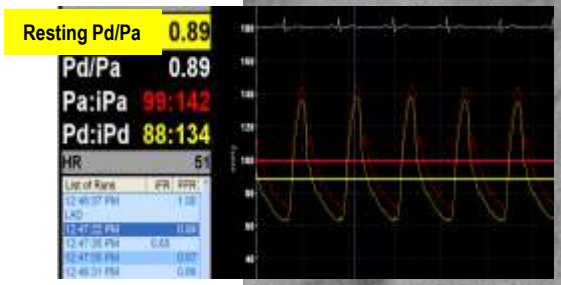


Inject the contrast

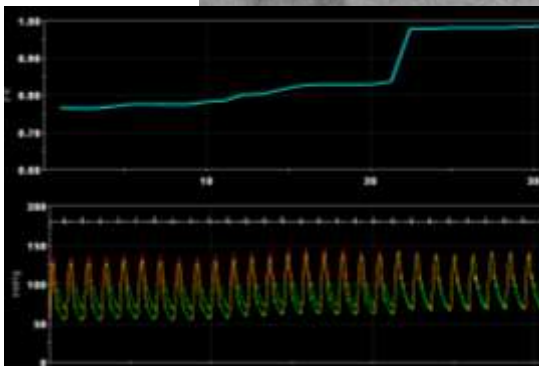
Numbers, numbers, numbers….

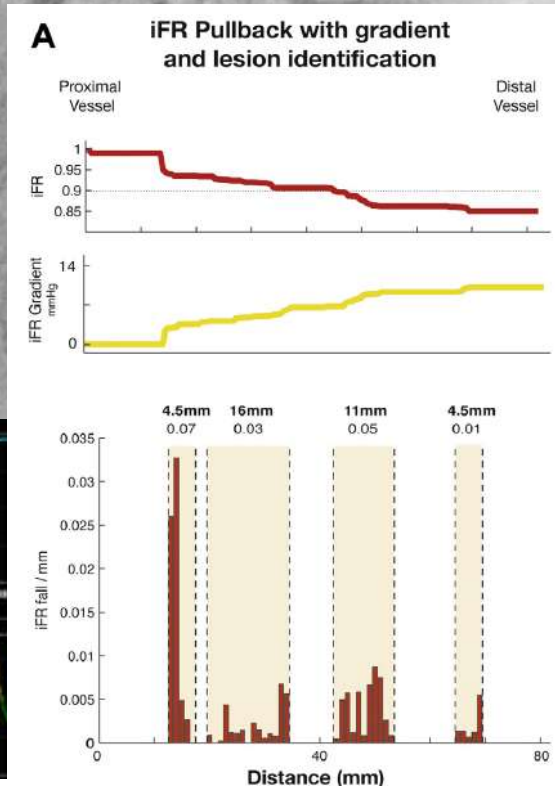
0.90, 0.80, 0.85, 0.76, 0.89, 0.74, 0.77, 0.66

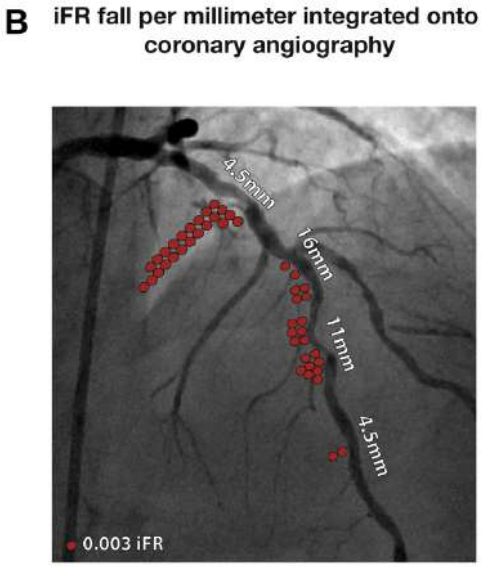
Numbers, numbers, numbers….



iFR®
Distal
0.77





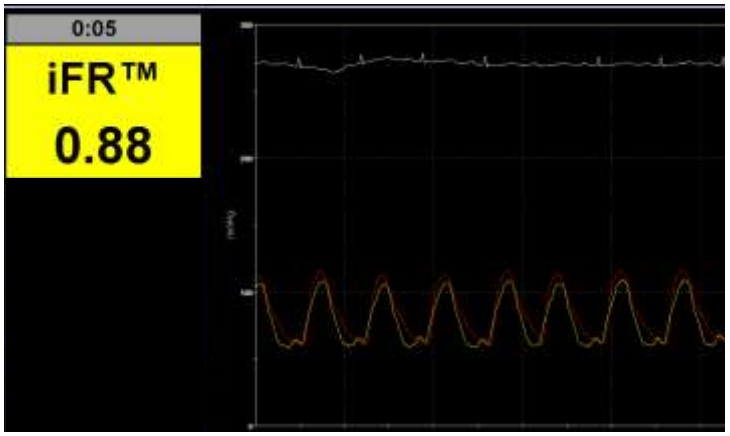


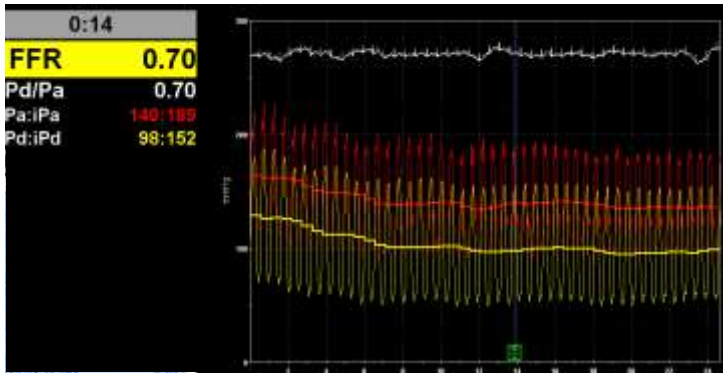
Co-registration and Treatment planning

Nijjer S, Davies J, et al. JACC intv 2014

Integration of physiology in daily practice

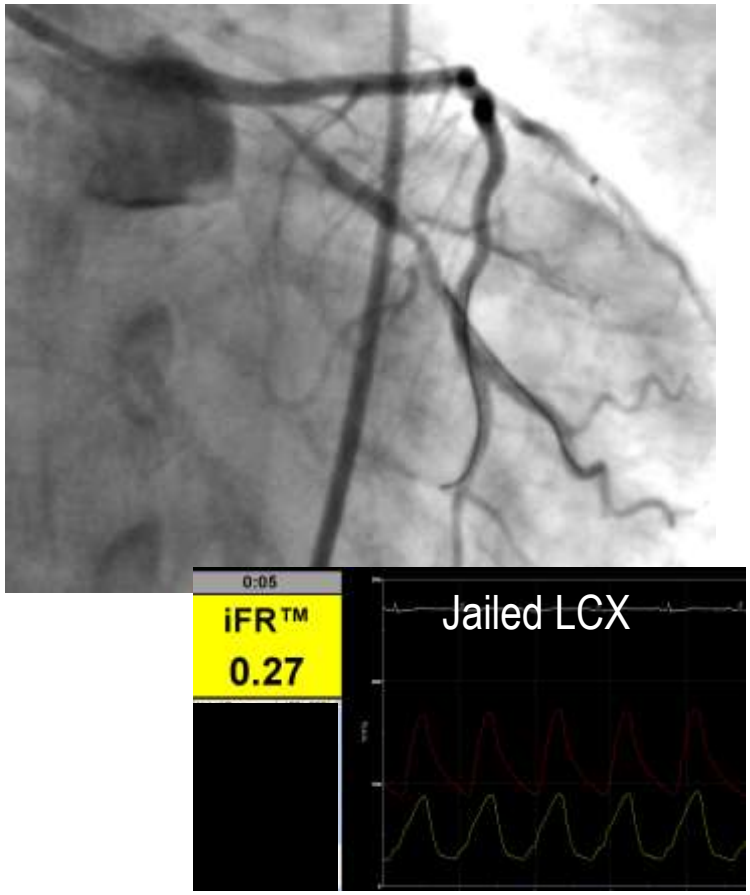
F/57, crescendo angina
CAG: distal LM, pLAD, mLAD, pLCX disease

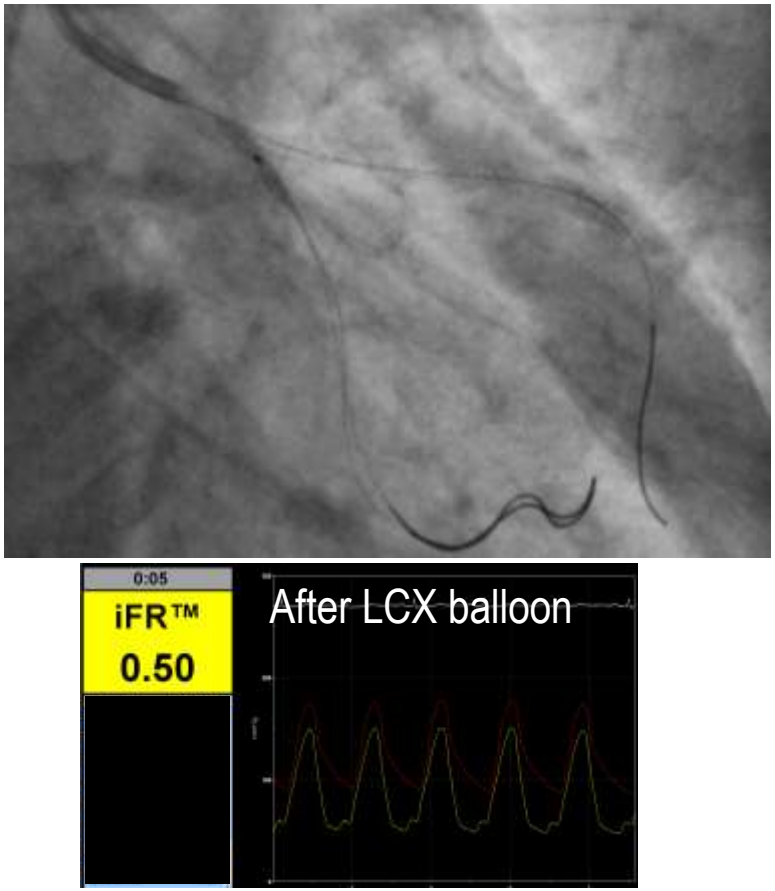




Integration of physiology in daily practice

F/57, crescendo angina
CAG: distal LM, pLAD, mLAD, pLCX disease



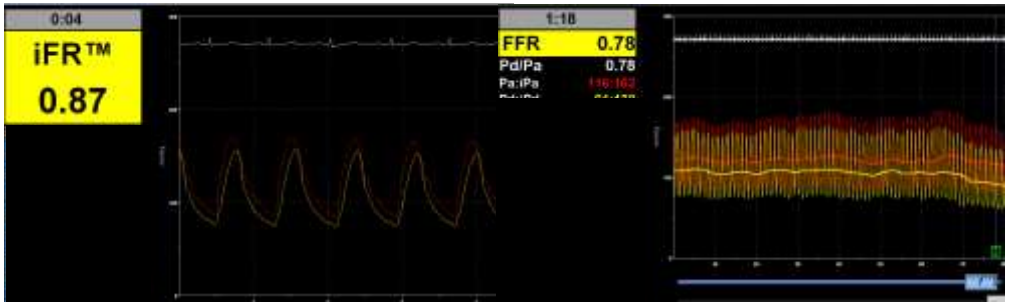


Integration of physiology in daily practice

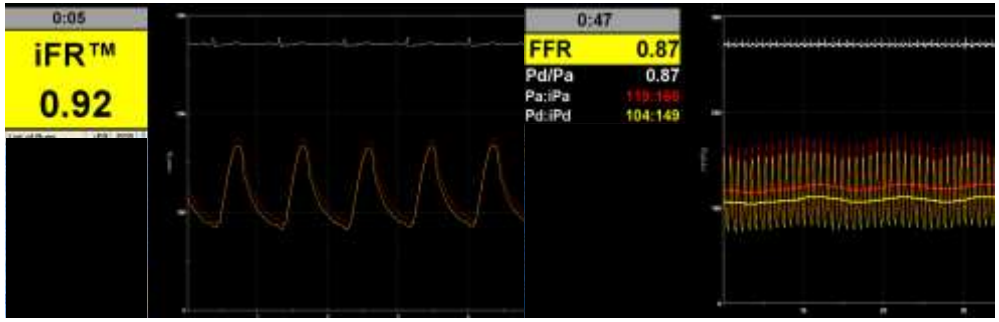
F/57, crescendo angina
CAG: distal LM, pLAD, mLAD, pLCX disease

- LM-LAD/LCX: Culotte stenting (LM to LAD BES 3x36mm, LM to LCX BES 3x24)
- MidLAD : BES 2.75x24mm

LAD



LCX



FFR, Contrast FFR, Pd/Pa, and iFR – When, How, and What?

- **Coronary bifurcation physiology itself is**

  hemodynamic assessment is not comple

  - You can choose whatever you want fron

    (resting Pd/Pa, iFR, dPR, RFR, FFR…..

  - You can use any of them whenever you

Aortic stenosis

* Measurement	
AV area (2D)	1.02 cm^2
LVOT diameter	21 mm
LVOT peak velocity	1.1 m/s
AV peak velocity	3.5 m/s
LVOT TVI	29 cm
AV TVI	90 cm
LVOT Mean PG	2.9 mmHg
AV mean PG	29 mmHg
LV ejection fraction	68%

- **Coronary hemodynamic assessment should be integrated in your daily practice.**