FFR/iFR: my tips and tricks

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Che cosa ci aspettiamo dalla FFR?
Cosa può offrici la FFR?

FFR = Fractional Flow Reserve

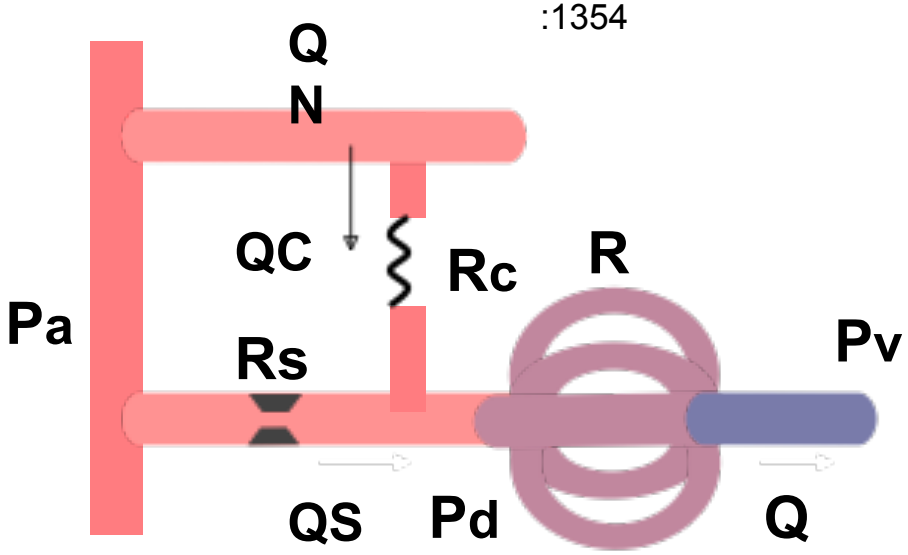
But….do we measure Flow with FFR?

PRESSURE

Pressure-derived Fractional Flow Reserve (FFR)

FFR is a ratio of two flows

Pijls NH et Al. Circulation 1993 ; 86 :1354



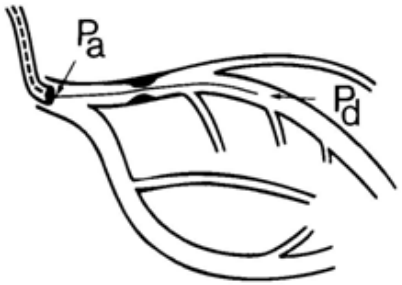
$$Q_{myo} = Q_s + Q_c$$

$$Q \text{ h } Norm = \frac{Pa - Pv}{R}$$

$$Q \text{ h } Stenosis = \frac{Pd - Pv}{R}$$

at Venous pressure equal to 0 ...

$$FFR_{myo} = \frac{Q \text{ h } Stenosis}{Q \text{ h } Norm} = \frac{(Pd - Pv)/R}{(Pa - Pv)/R} = \frac{Pd - Pv}{Pa - Pv} = \frac{Pd}{Pa}$$

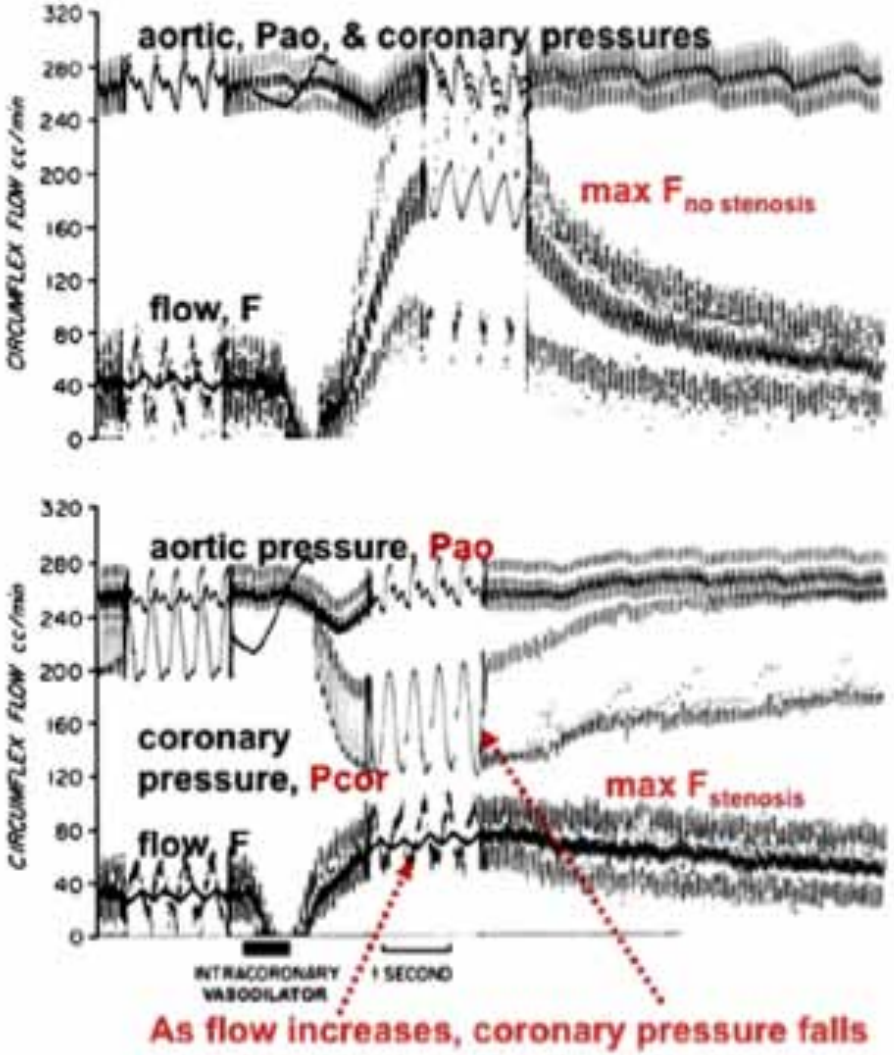


During maximal coronary hyperemia

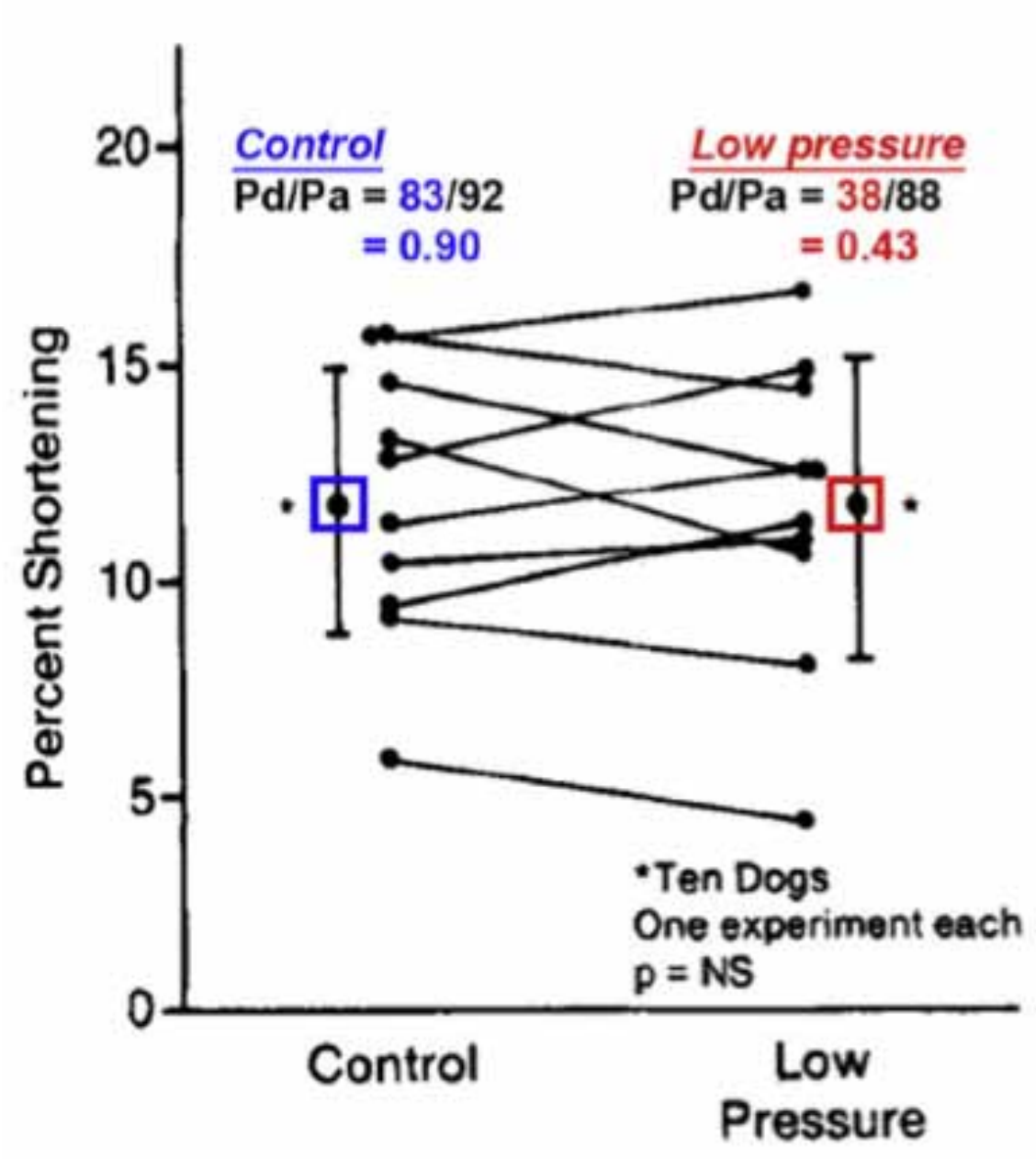
Are Pressure and Flow interchangal

NO STENOSIS

STENOSIS

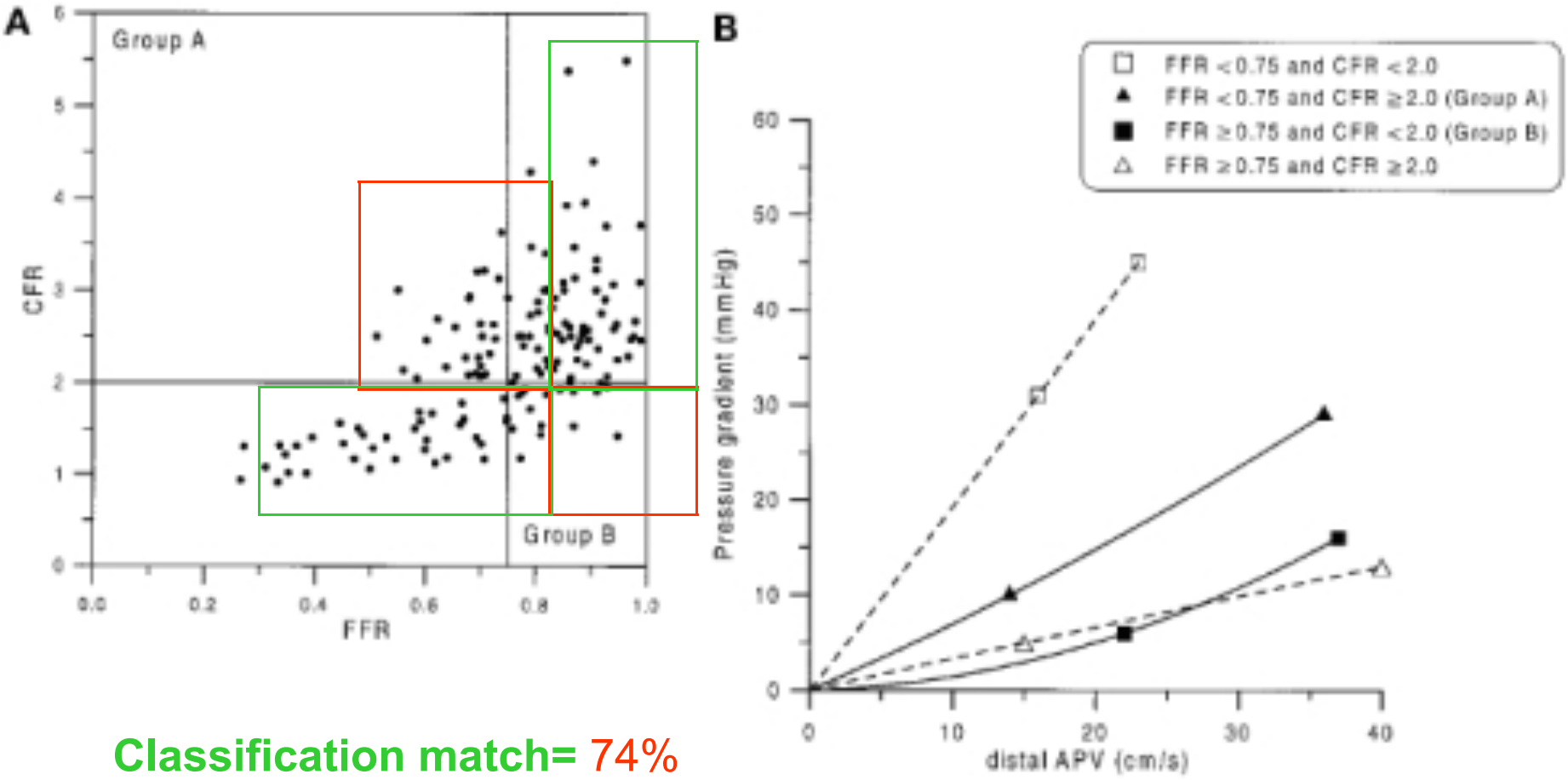


Generally speaking YES but…



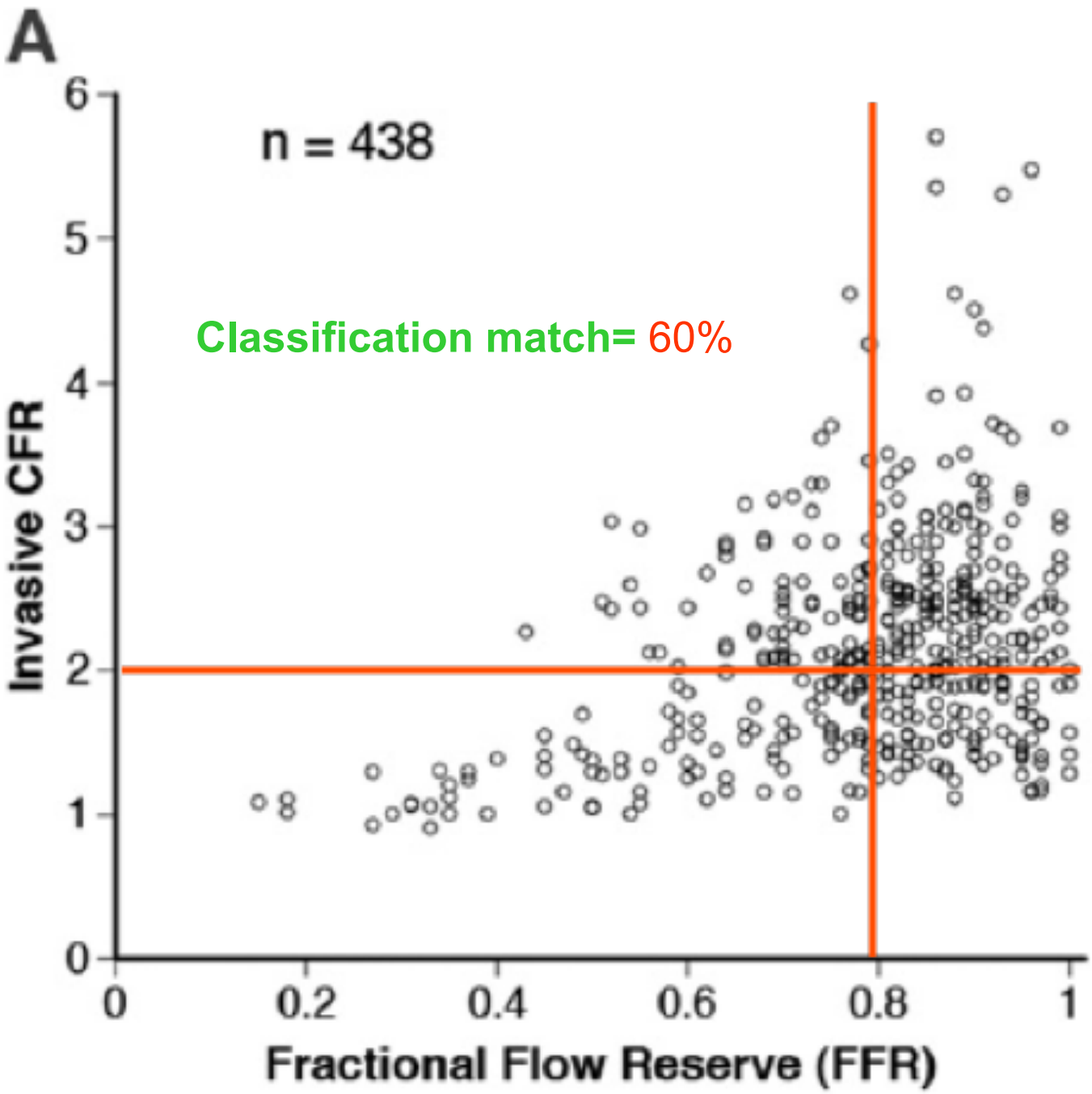
Significative changes in FFR with **constant flow** and mantained ~~contraction~~

From the practical point of view……



Classification match= 74%

Meuwissen Z Cardiol 91 (Suppl3):III/108, 2002



Johnson N, JACC CVI 5(2); 193-202.

FFR is an estimation of coronary flow reduction obtained using pressure gradients.
FFR has a classification match with CFR that ranges between 60 to 75%.

Additional limitations of FFR:

) From the physiological point of view, true intermediate lesions (40-60%) tend to have FFR results that cluster around the cut-off.

:) When FFR is tested vs non-invasive imaging techniques (and not vice-versa), the diagnostic accuracy is moderate (Sens: 75% [69-82] Spec: 76% [71-81]).

3) The technology has been widely tested on populations that are different to that which it is most often used (true intermediate lesions vs FAME lesions)

HRCT in lung cancer diagnosis: Sens : 95% e Spec: 100%.

FFR limitations

FFR is an estimation of coronary flow reduction obtained using pressure gradients.
FFR has a classification match with CFR that ranges between 60 to 75%.

Additional limitations of FFR:

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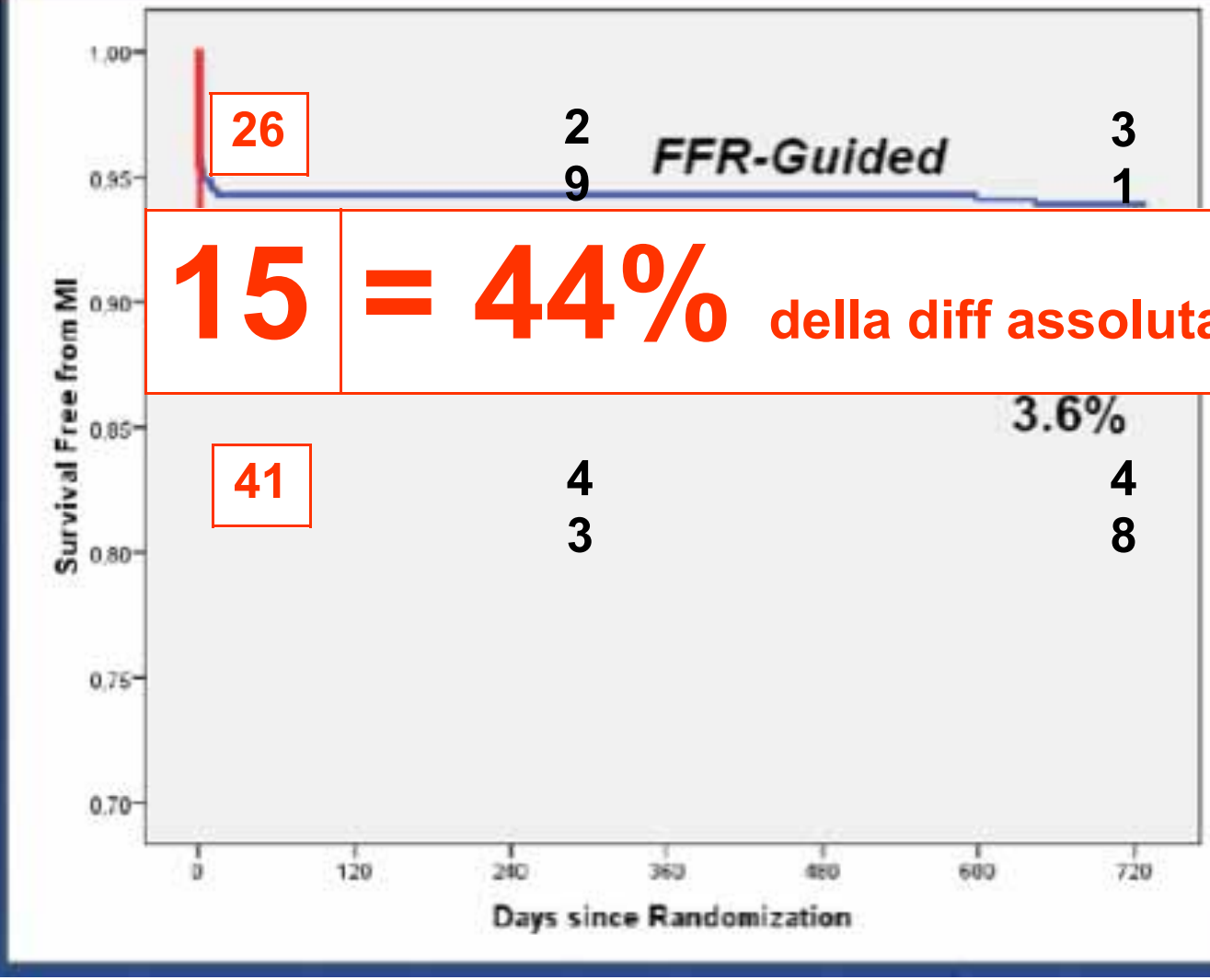
2) When FFR is tested vs non-invasive imaging techniques (and not vice-versa), the diagnostic accuracy is moderate.
3) The technology has been widely tested on populations that are different to that which it is most often used (true intermediate lesions vs FAME lesions)

Clinical advantage (reduction of hard end-points incidence) of FFR-guided PCI is not proven, when FFR is the only criterion on which to base the decision

Adverse Events at 2 Years

	Angio-Guided n = 496	FFR-Guided n = 509	P Value
Total no. of MACE	139	105	
Individual Endpoints			
Death	19 (3.8)	13 (2.6)	0.25
Myocardial Infarction	48 (9.7)	31 (6.1)	0.03
CABG or repeat PCI	61 (12.3)	53 (10.4)	0.35
Composite Endpoints			
Death or Myocardial Infarction	63 (12.7)	43 (8.4)	0.03
Death, MI, CABG, or re-PCI	110 (22.2)	90 (17.7)	0.07

2 Year Survival Free of MI



15 = 44% della diff assoluta di eventi

Table 3. End Points at 12 Months in the Per-Protocol Population.

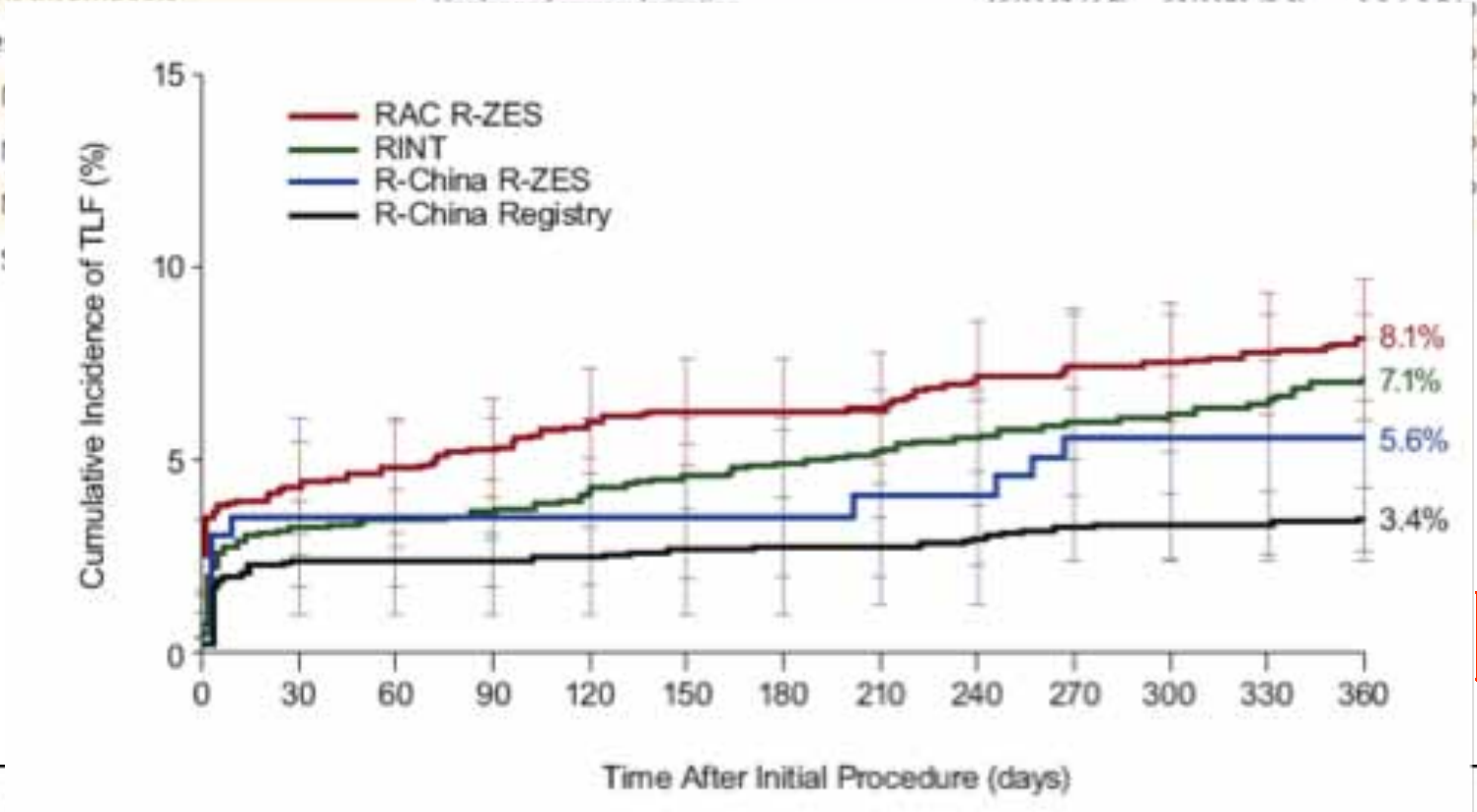
End Point	iFR Group (N=1012)	FFR Group (N=1007)	Hazard Ratio (95% CI)	P Value
	no. (%)			
Primary end point: death from any cause, nonfatal myocardial infarction, or unplanned revascularization	68 (6.7)	61 (6.1)	1.12 (0.79–1.58)	0.53

Swedeheart

Table 3. Outcomes for Difference in Risk at 1 Year.*

Outcome	iFR Group	FFR Group	Difference in Risk		P Value
	no./total no. (%)		*percentage points (95% CI)*	*percentage points (99% CI)*	
Primary end point: death from any cause, nonfatal myocardial infarction, or unplanned revascularization	78/1148 (6.8)	83/1182 (7.0)	−0.2 (−2.3 to 1.8)†	−0.2 (−2.9 to 2.5)	0.83
Death from any cause					
Nonfatal myocardial infarction					
Unplanned revascularization					
Target-lesion revascularization					
Restenosis					
Stent thrombosis*					
Che			0.4)	−1.3 (−3.1 to 1.9)	0.13
			1.6)	0.3 (−1.4 to 2.0)	0.62
			0.8)	0.3 (−0.5 to 1.0)	0.34
			1.4)	0.5 (−0.5 to 1.6)	0.19
			1.8)	0.8 (−0.5 to 2.1)	0.11

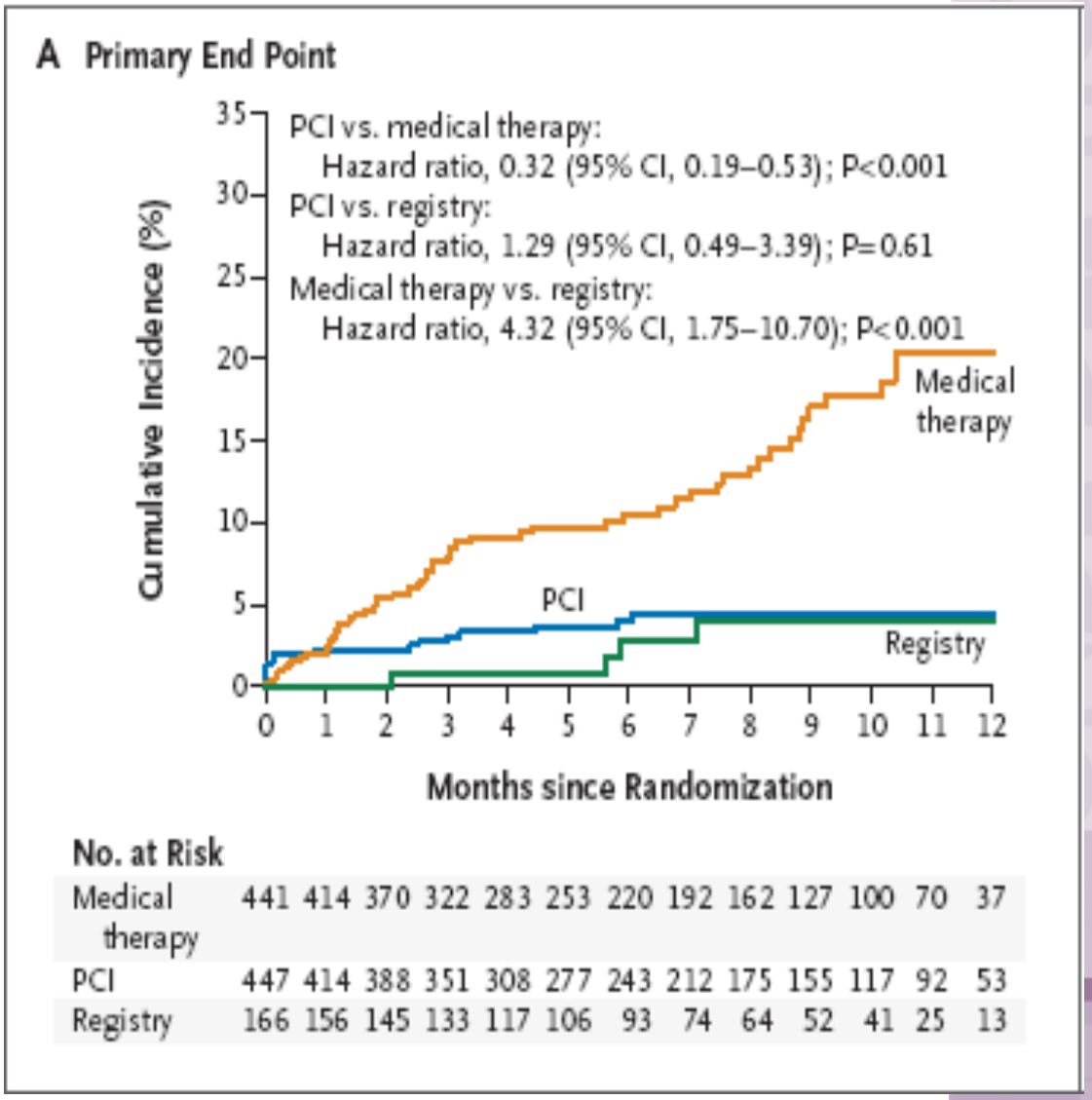
Define-Flair



Res AC/Inter/China

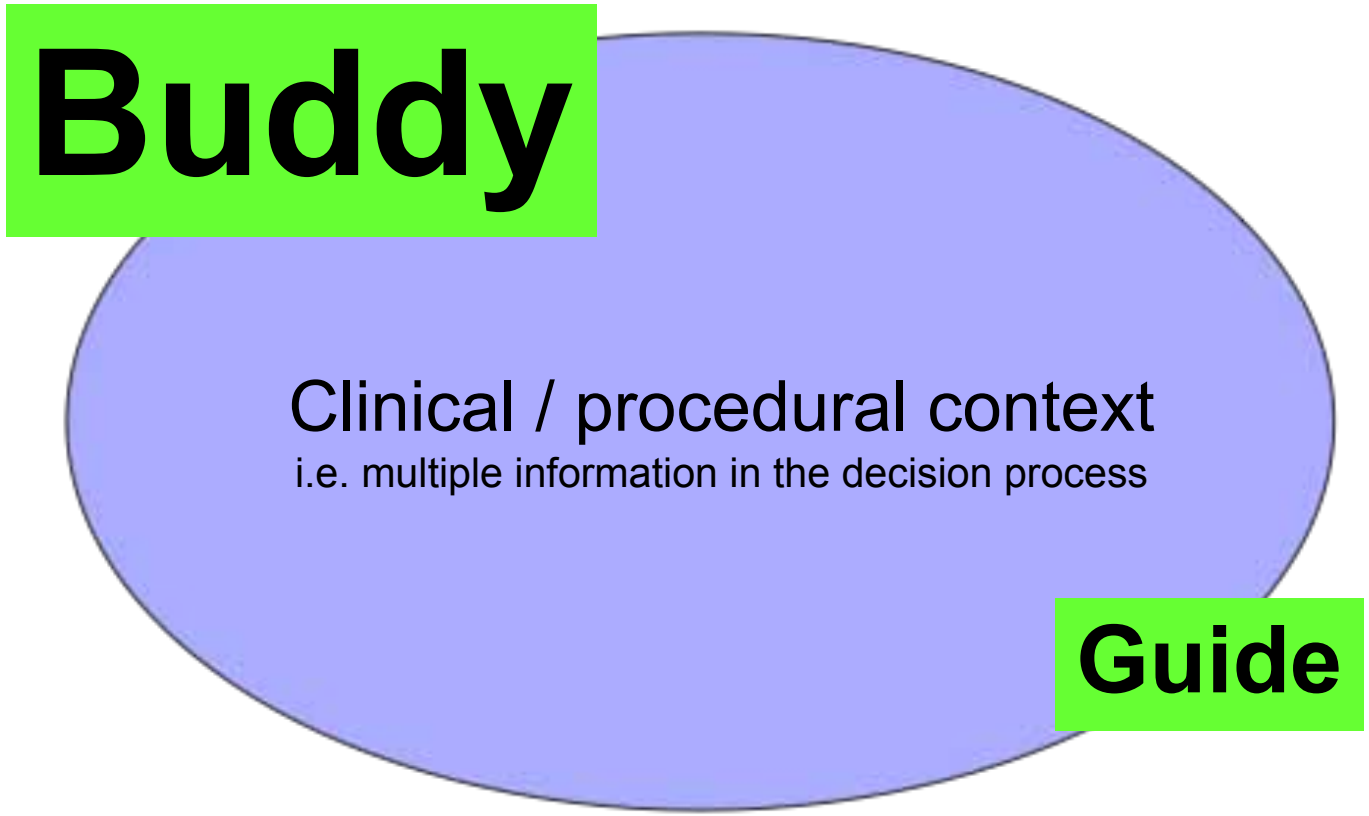
PATIENTS

Patients in stable condition who were appropriate candidates for PCI and who had angiographically assessed one-, two-, or three-vessel coronary artery disease suitable for PCI were included in the trial. Details of the inclusion and exclusion criteria are provided in the Supplementary Appendix. The investigator first indicated which stenoses were thought to require stenting on the basis of the clinical and angiographic data. FFR was then measured with a coronary guidewire (PressureWire Certus or PressureWire Aeris, St. Jude Medical) during adenosine-induced hyperemia to assess the hemodynamic severity of each indicated stenosis. Patients who had at least one stenosis in a major coronary artery with an FFR of 0.80 or less were randomly assigned, by means of an interactive voice-response system, to FFR-guided PCI plus the best available medical therapy (hereinafter called the PCI group) or to the best available medical therapy alone (hereinafter called the medical-therapy group). The randomization schedule was

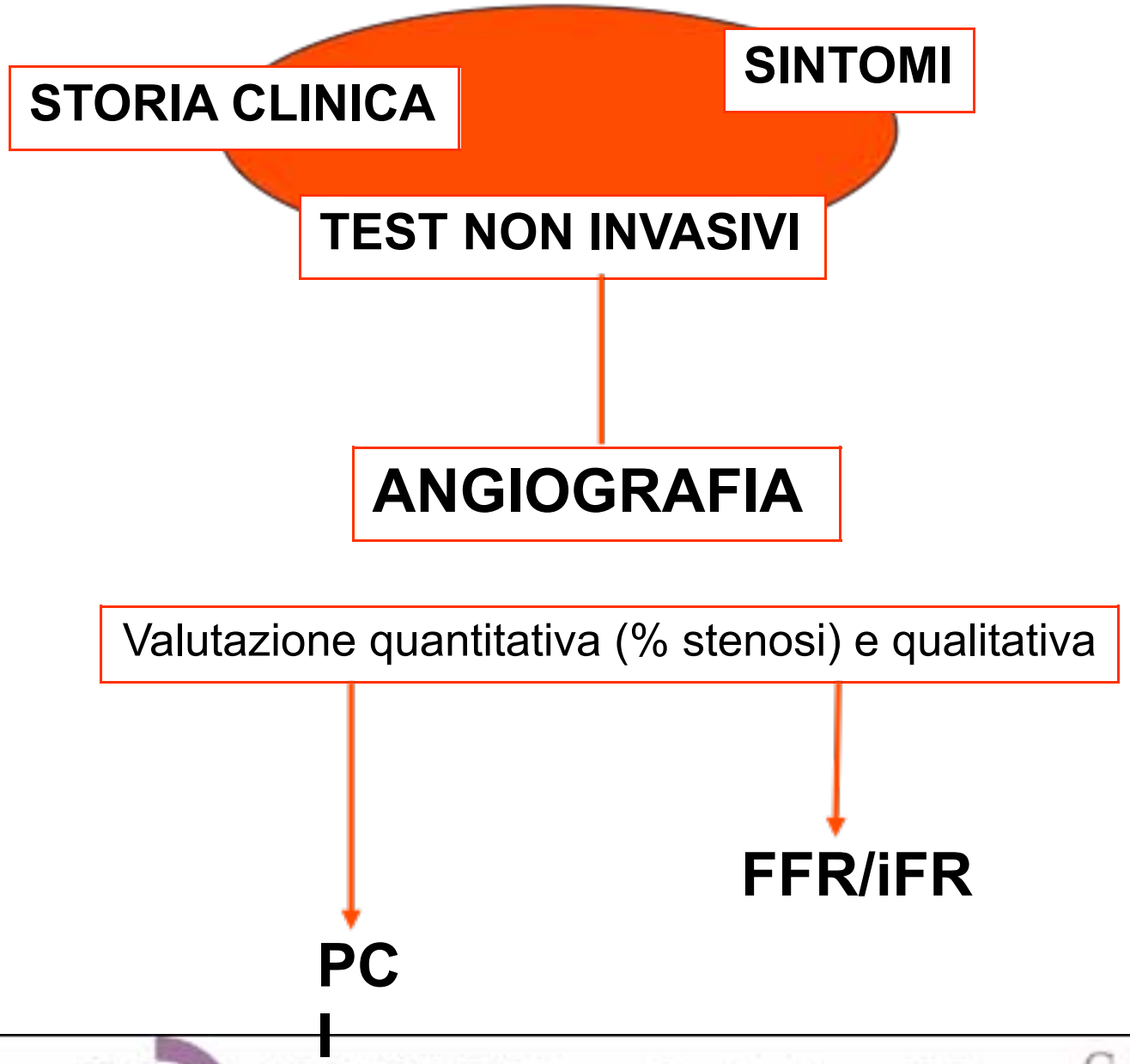


Source: FAME 2 trial

Che cosa ci aspettiamo dalla FFR?
Cosa può offrirci la FFR?



1- SELEZIONE DEL PAZIENTE

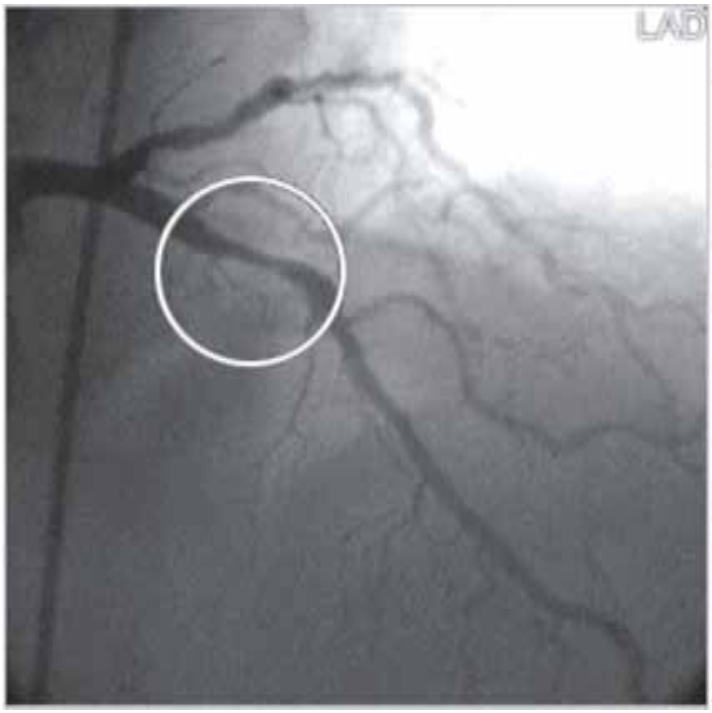


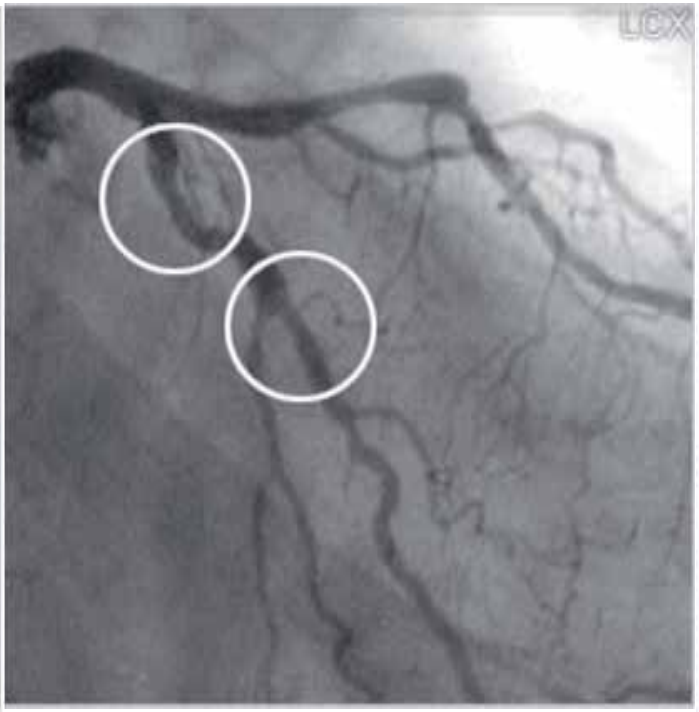
LESIONI INTERMEDIE

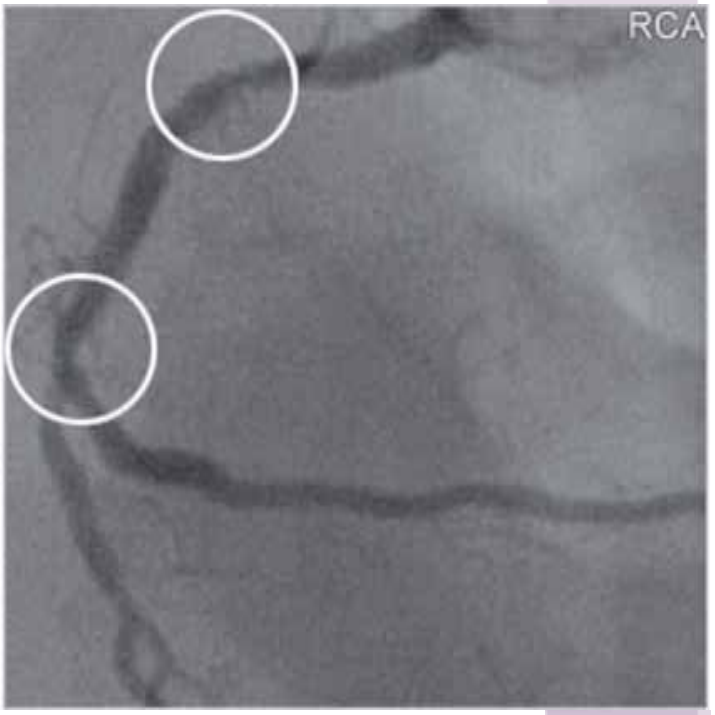
QUALSIASI PAZIENTE NEL QUALE MANCA UNA EVIDENZA OGGETTIVA DI ISCHEMIA E CHE NECESSITA DI UN CORRETTO INQUADRAMENTO TERAPEUTICO:

- PCI SI vs NO
- PCI MONO vs MULTI LESIONE/VASALE
- PCI vs CABG

1- SELEZIONE DEL PAZIENTE







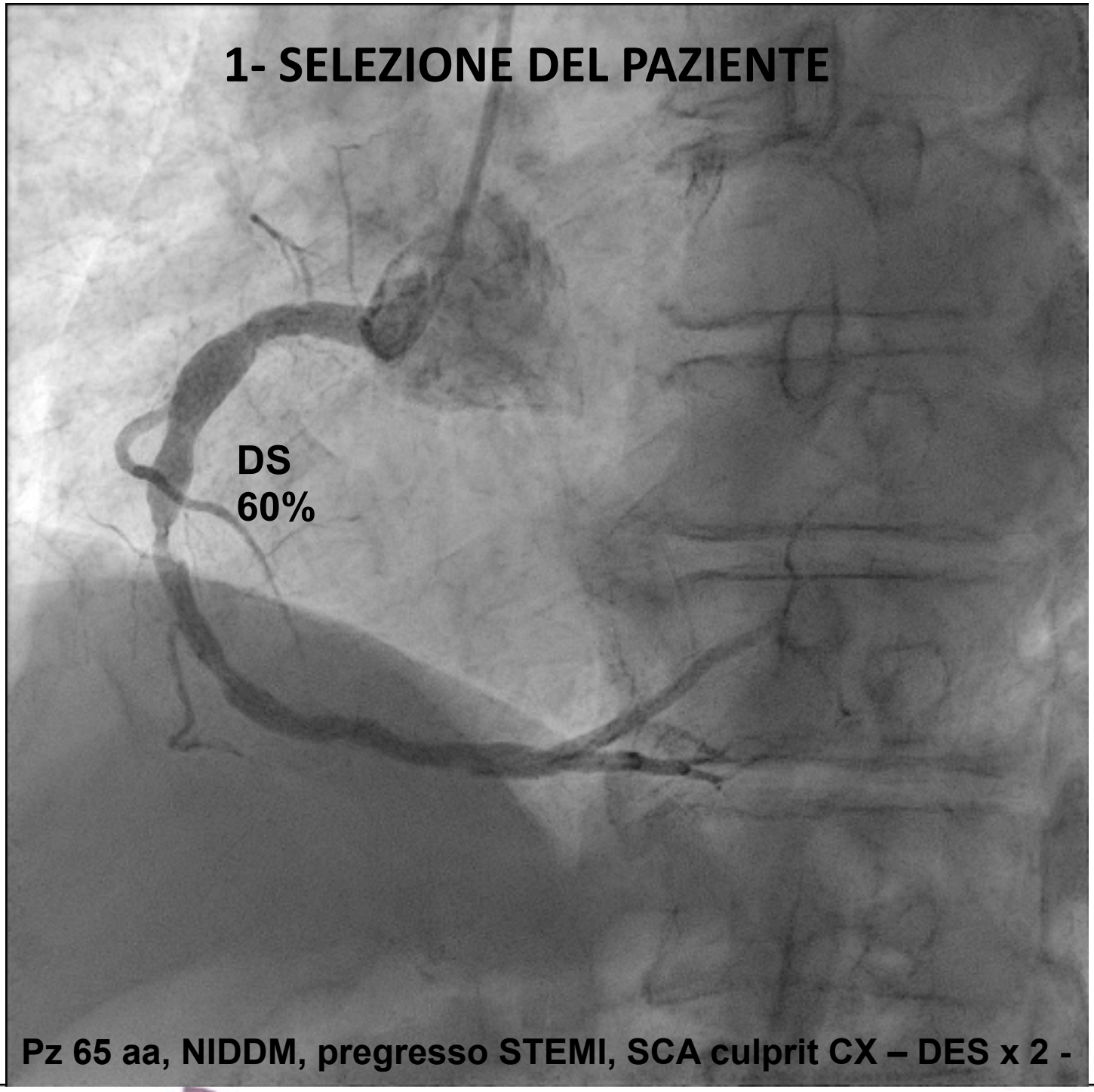
FFR 0.85

FFR 0.71

FFR 0.66

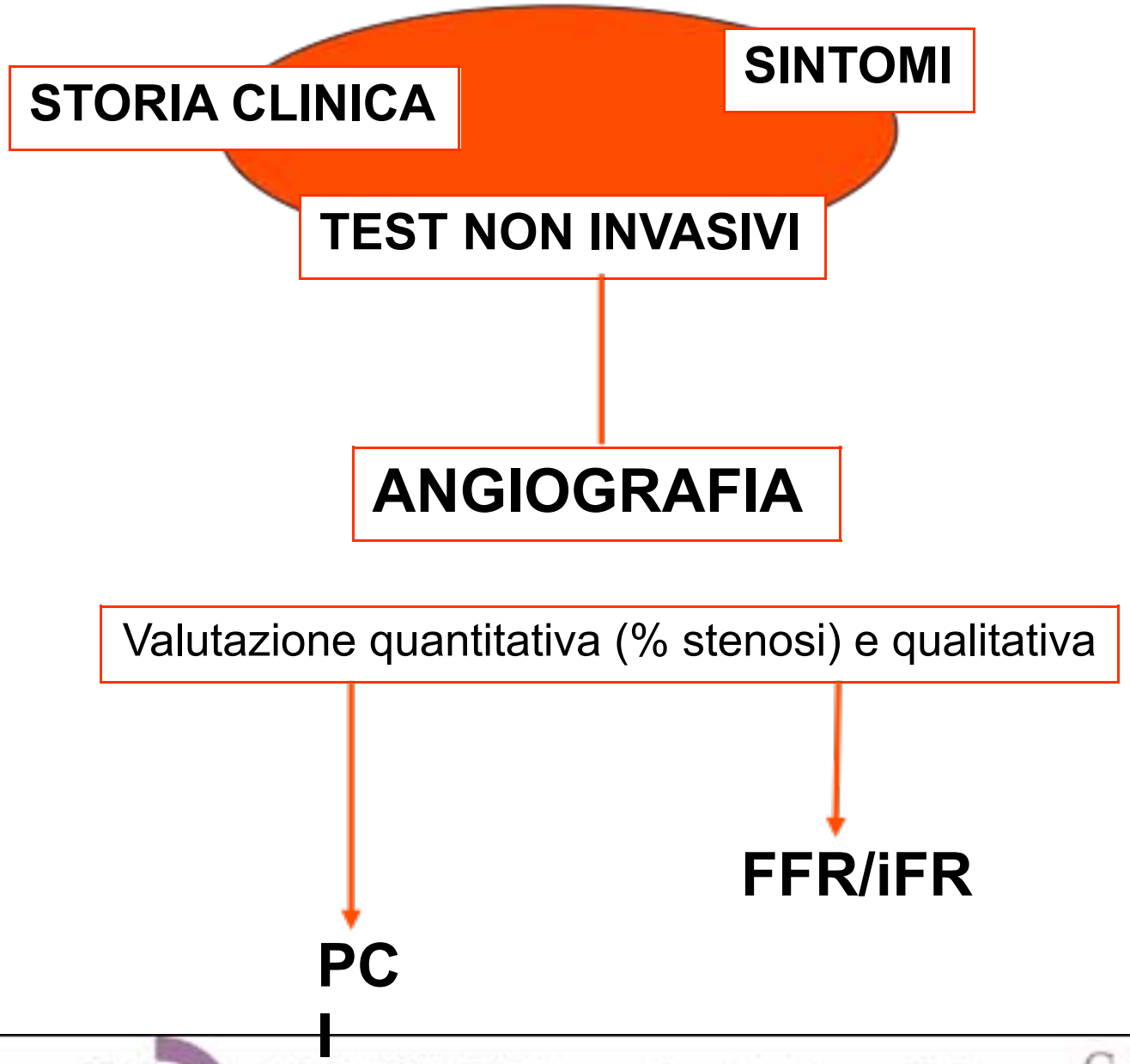
Paziente senza pregressi CV, no test d'ischemia. Cirrosi end-stage. CORO per inserimento lista TX

1- SELEZIONE DEL PAZIENTE



Pz 65 aa, NIDDM, pregresso STEMI, SCA culprit CX – DES x 2 -

1- SELEZIONE DEL PAZIENTE

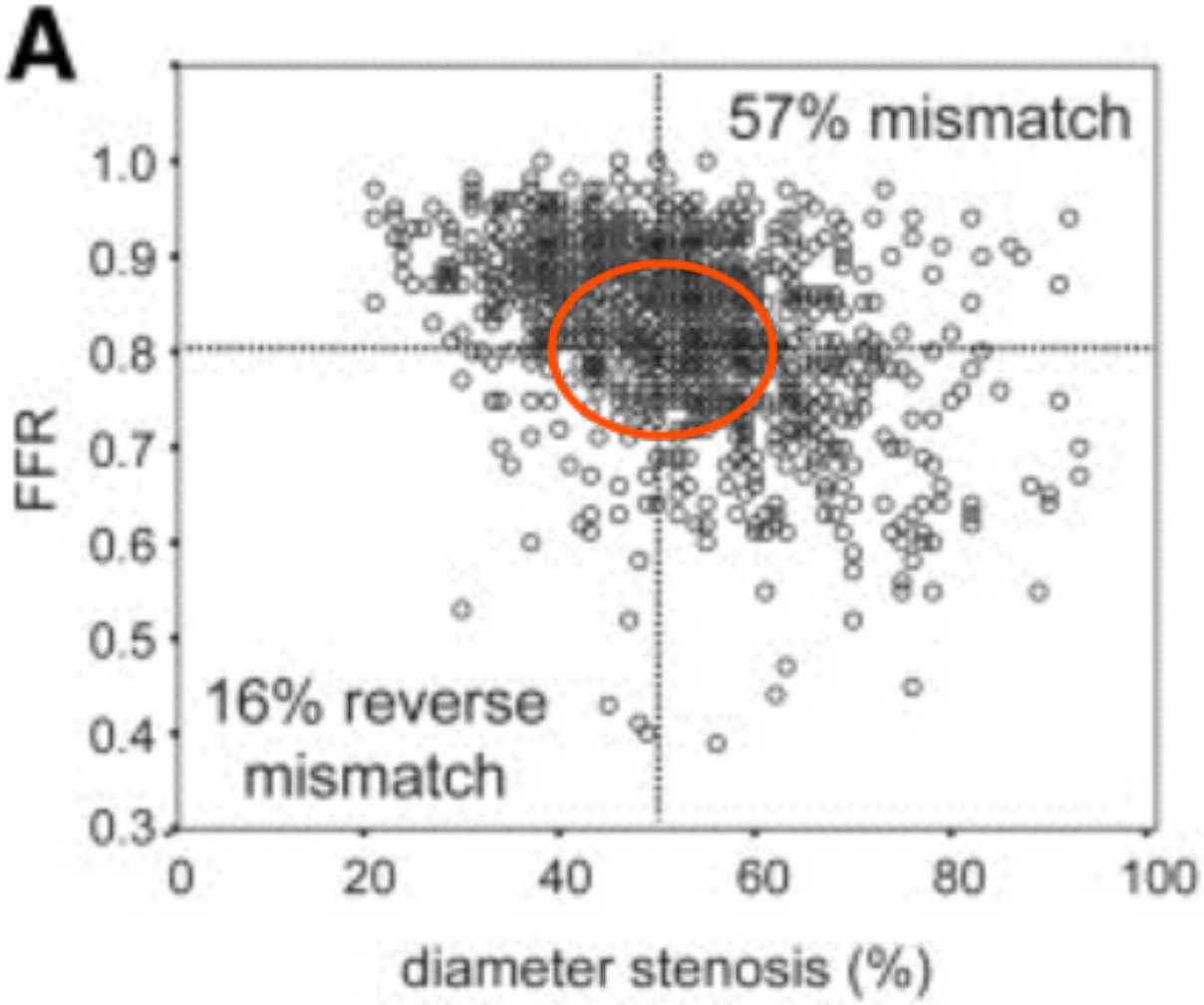


2- CUT OFF VALUE

0.75

2- CUT OFF VALUE

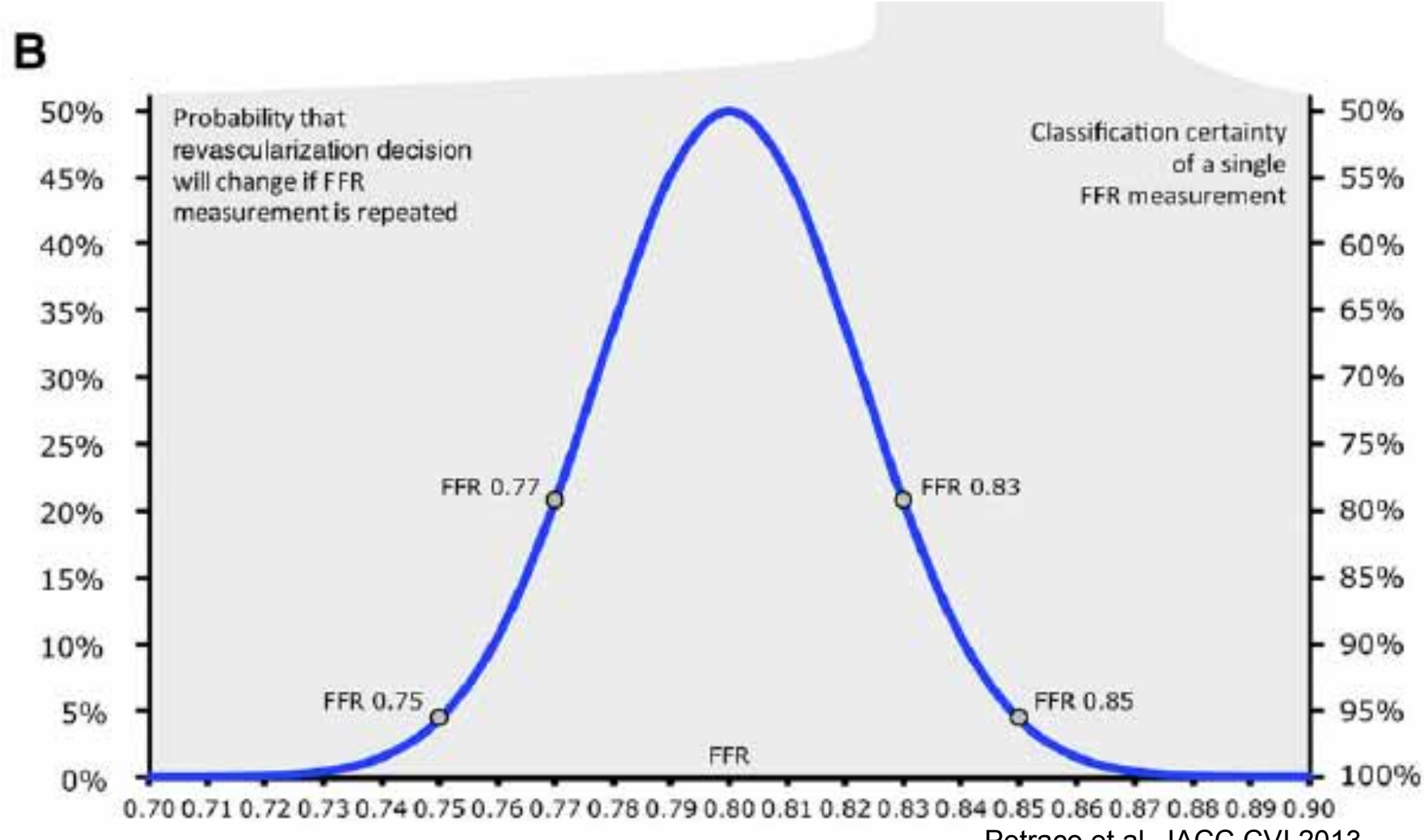
From the physiological point of view, true intermediate lesions (40-60%) tend to have FFR results that cluster around the cut-off.



Park SJ, JACC CVI 2012;5(10):1029-1036

2- CUT OFF VALUE

Having a cut-off point on a continuous variable decreses the accuracy of the test when interpreted as a binary yes/no outcome.



Petraco et al, JACC CVI 2013

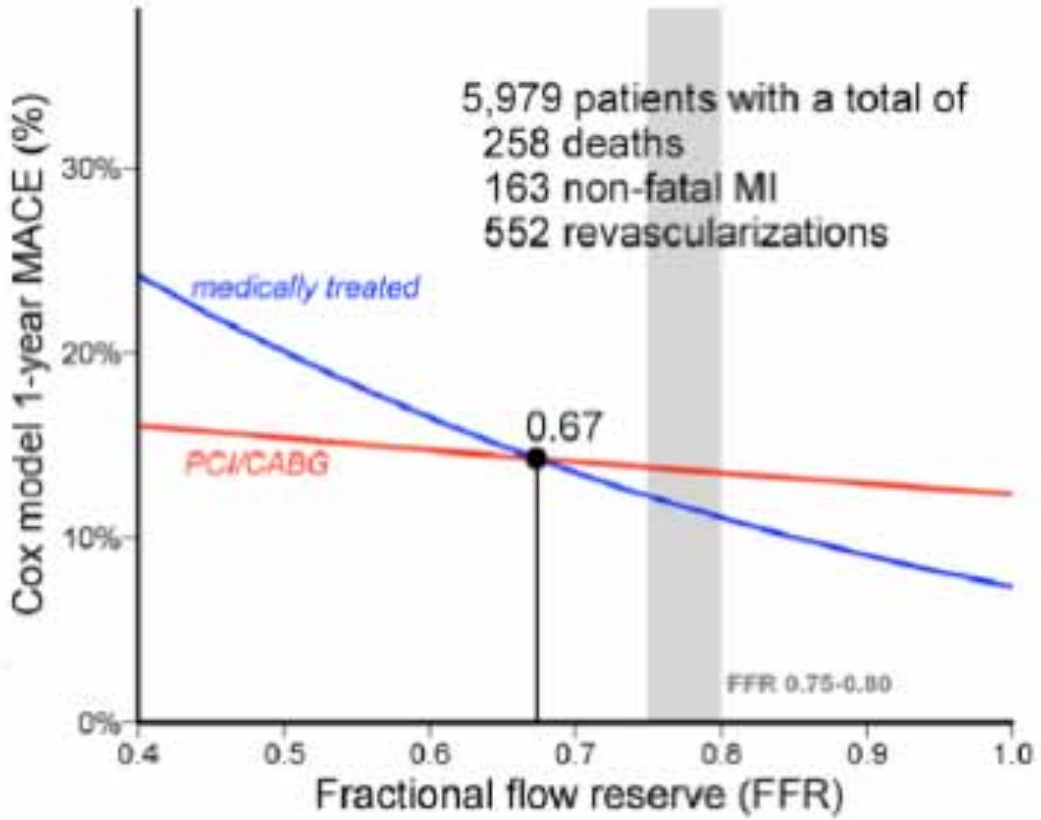
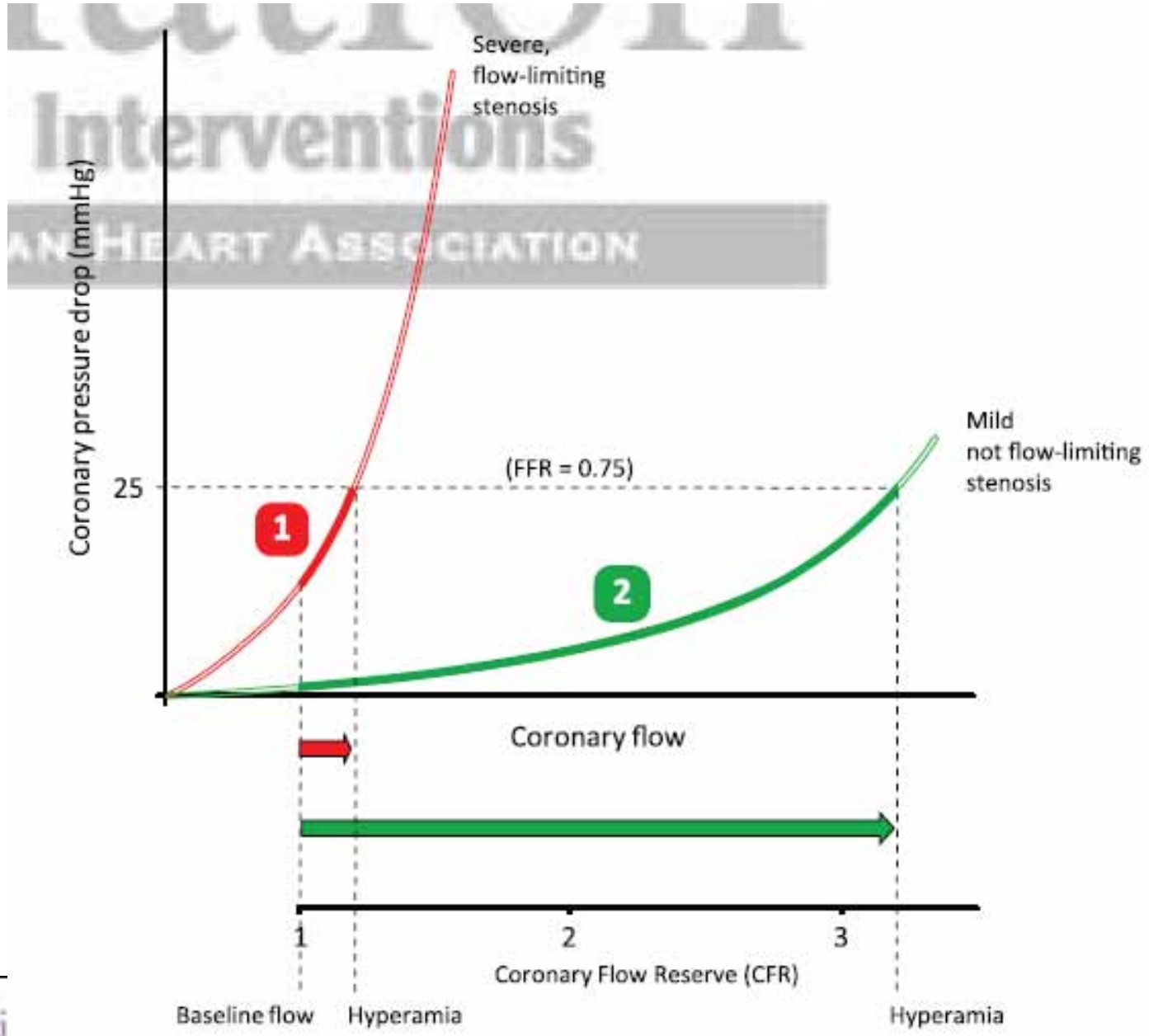


Figure 1. Patient-level meta-analysis of a broad outcomes literature through February 2014 on the relation of fractional flow reserve (FFR) to adverse events. FFR has a continuous relation to events that differs between medical therapy and revascularization.[12] The crossover point of these curves marked by the black dot indicates where potential risk associated with the procedure is greater than the potential benefit of eliminating the stenosis. Potentially low FFR threshold for intervention would be expected to show the greatest benefit from revascularization because of the highest event rates potentially reduced by the procedure. A high FRR threshold would be expected to incur greater risk because of the procedure than from such mild disease. MACE indicates major adverse coronary events; and MI, myocardial infarction. Adapted from Johnson et al[12] with permission of the publisher. Copyright © 2014, the American College of Cardiology.

2- CUT OFF VALUE



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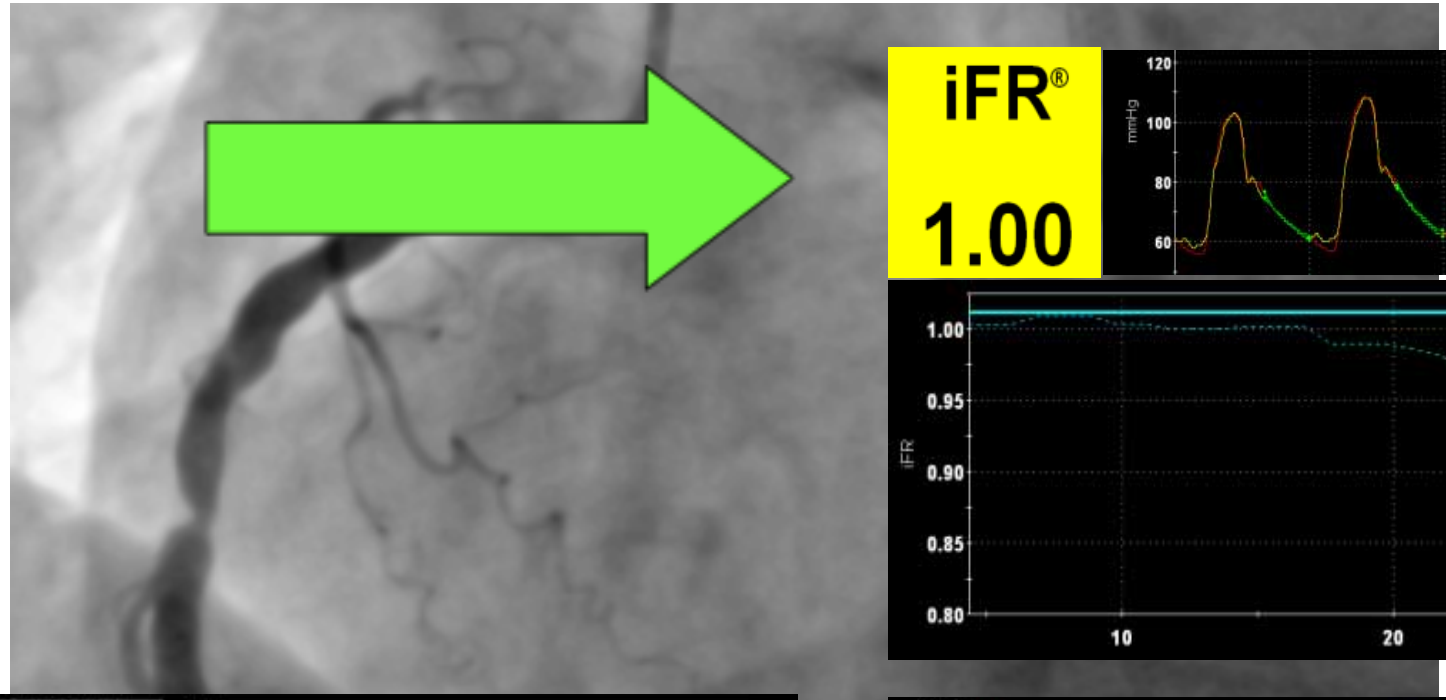
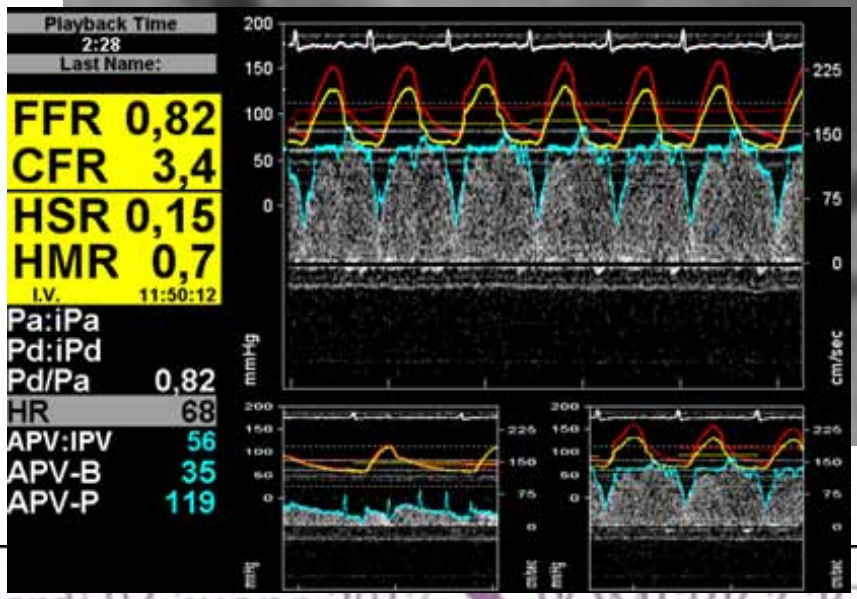
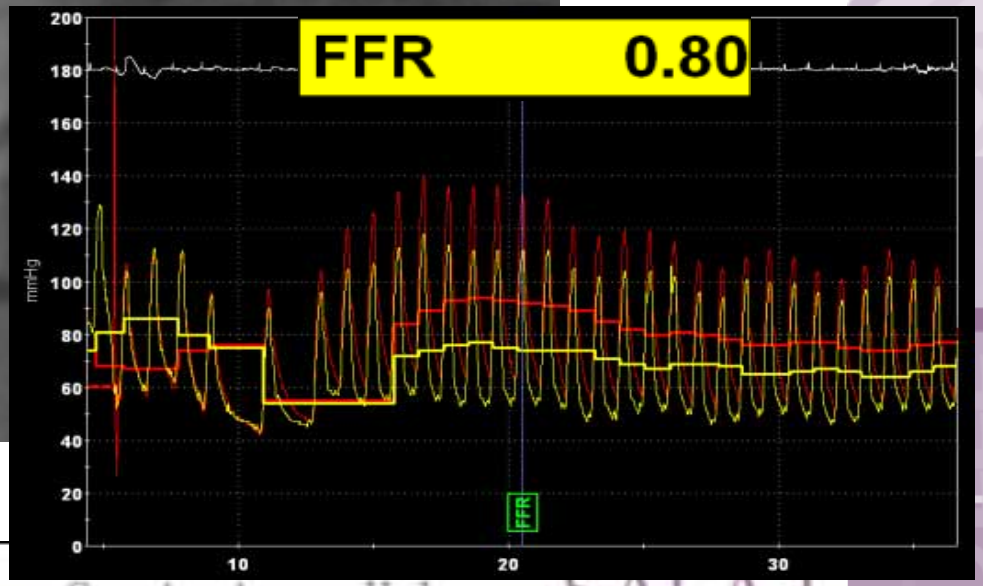
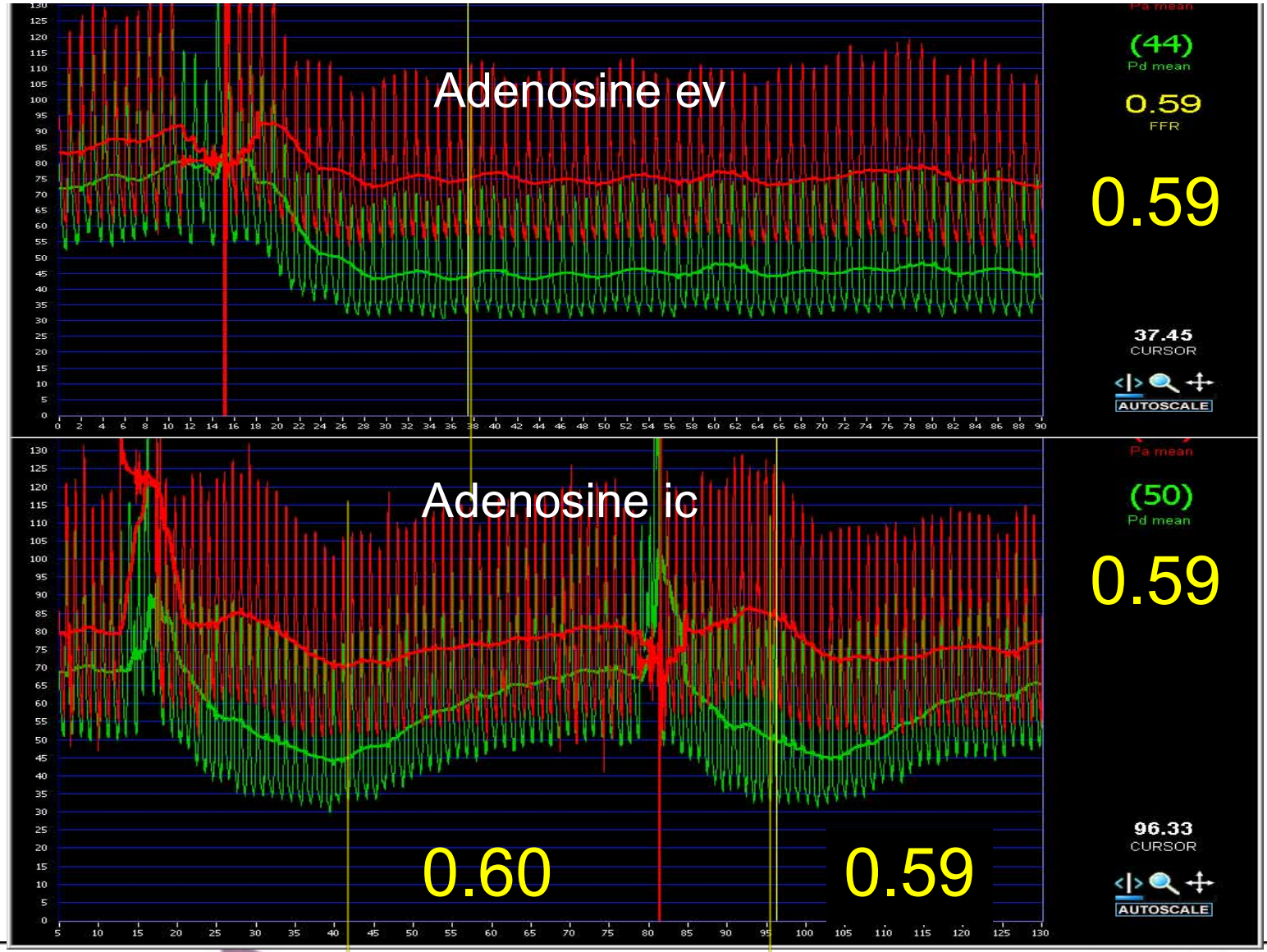






3- IPEREMIA I.C. vs I.V. vs NO IPEREMIA

Maximal Hyperemia



4- DOSE DEL FARMACO E TEMPO DI SOMMINISTRAZIONE

Maximal Hyperemia

EPICARDIAL dilatation	
Isosorbide dinitrate:	**200** µg ic bolus Min 30 sec prior to measurement FFR
MICROVASCULAR dilatation	
Adenosine	**140**µg/kg/min e.v
Adenosine	**80** to **300** µg ic bolus
Papaverine ic	**12-16** mg RCA, 16-20 mg LCA ic bolus
Nitroprusside ic	**0.6** µg/kg ic bolus
Regadenoson	**400** mg bolus e.v.

4- DOSE DEL FARMACO E TEMPO DI SOMMINISTRAZIONE

ADENOSINA

i.c.

Dose: 4-500 microg **RCA ; 6-800** microg **LAD-CFX**

Tempo: fino a raggiungimento plateau

ADENOSINA i.v.

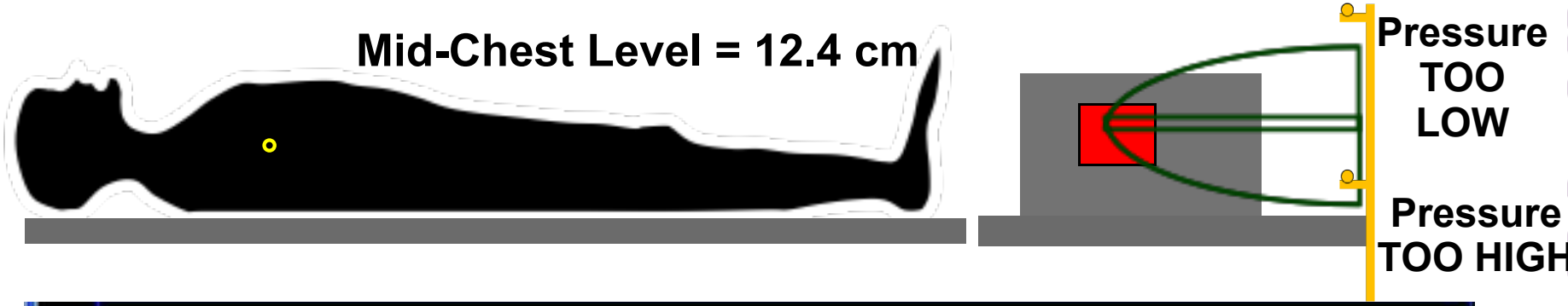
Dose: 140 microg **/Kg/min**

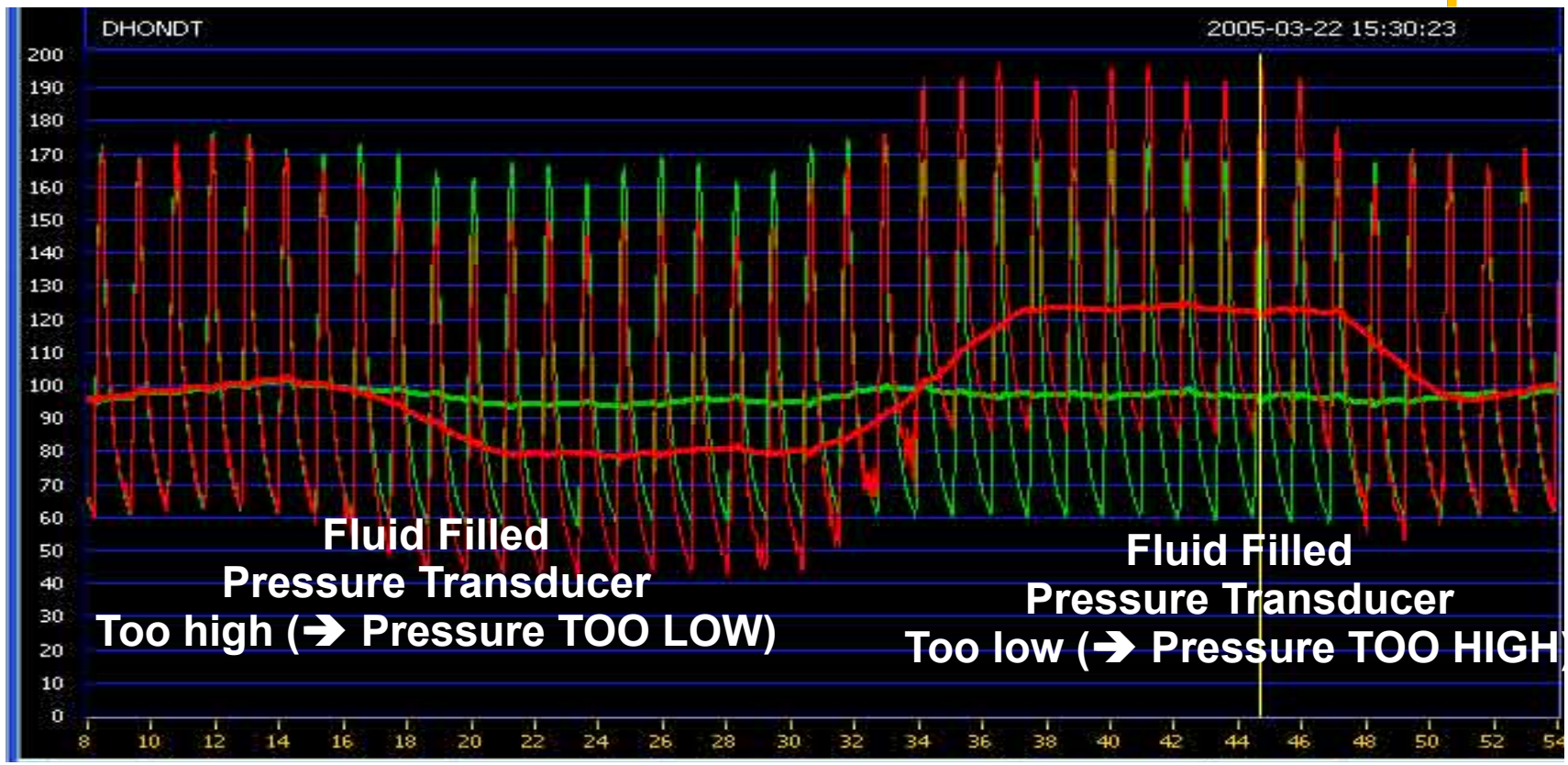
ma...

Tempo: risposta iperemica da 30s a 5 minuti

5- ASPETTI TECNICI PRE-VALUTAZIONE

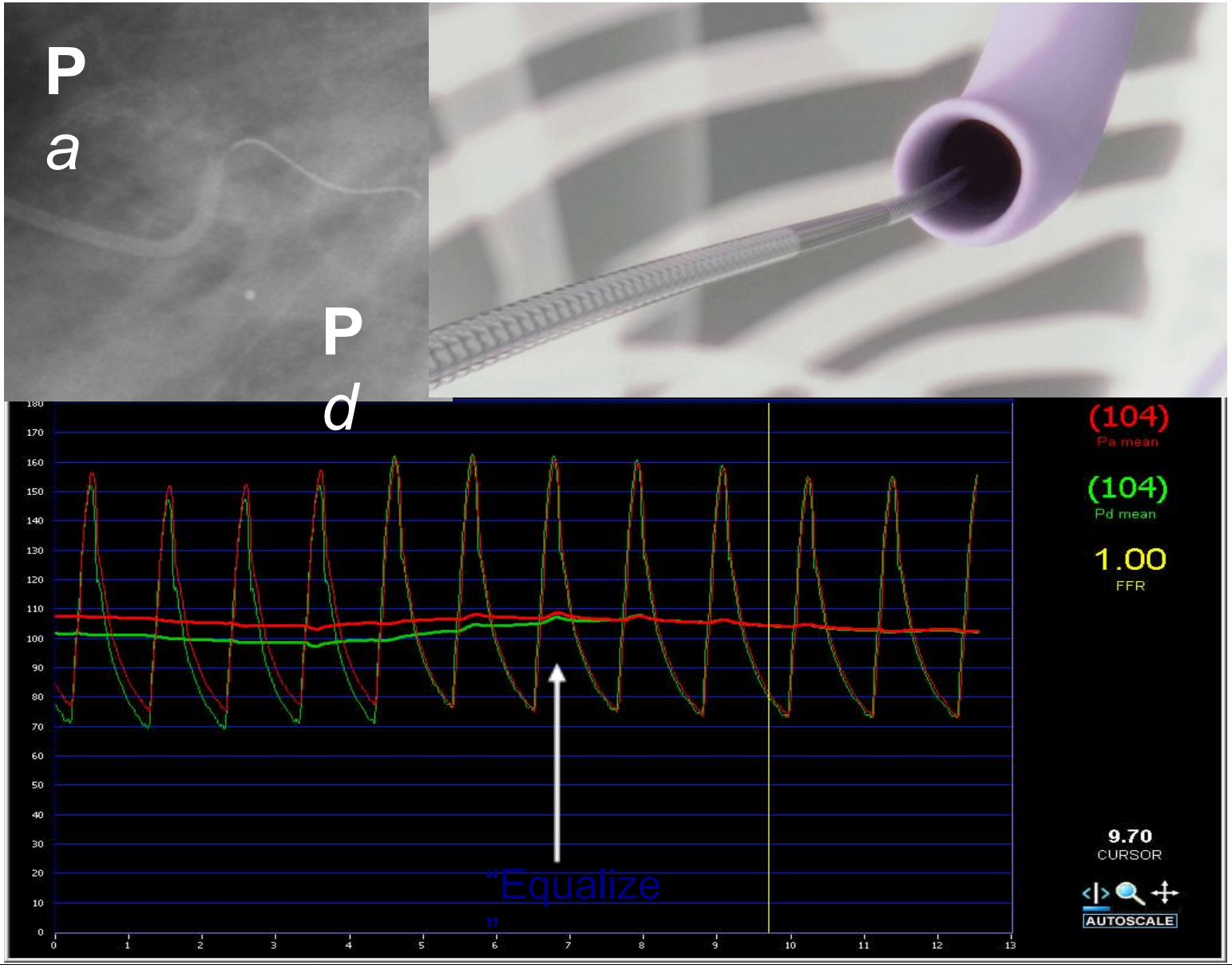
Accurate “zero-level” and equalization



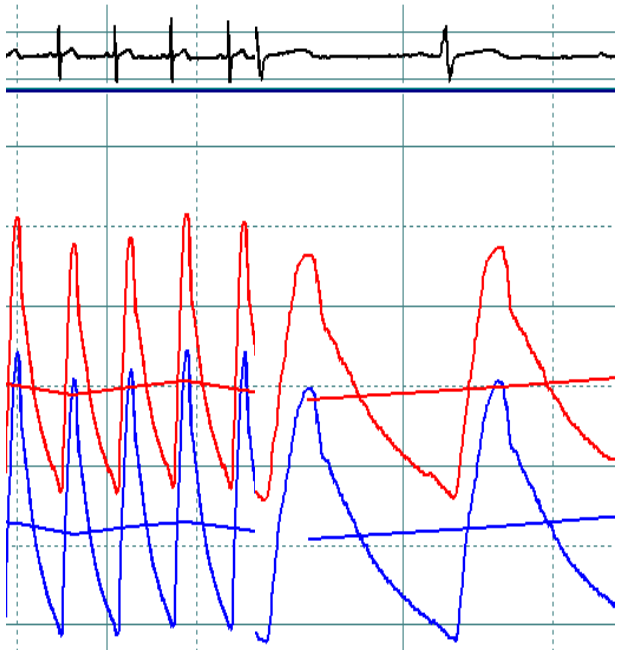


5- ASPETTI TECNICI PRE-VALUTAZIONE

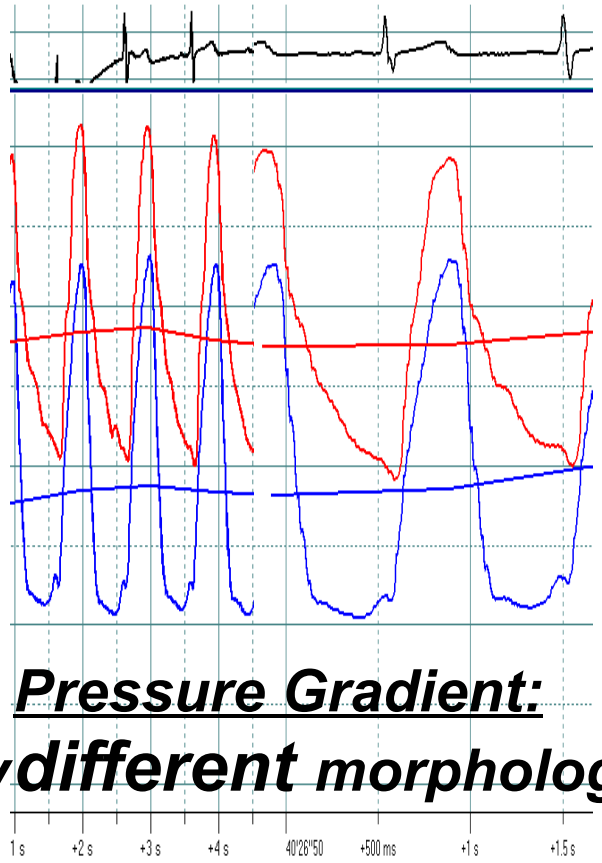
Rimuovere contrasto, NO, Equalization



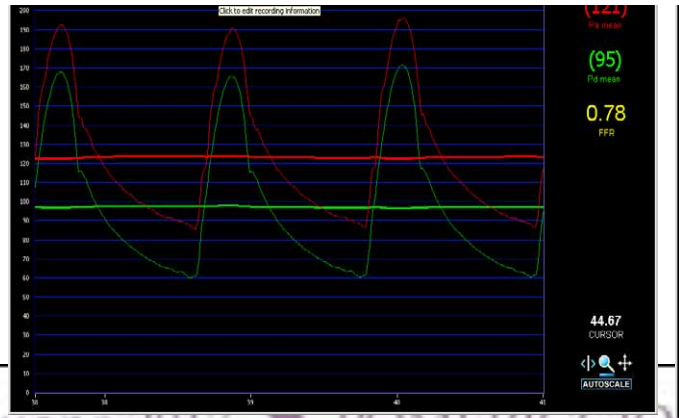
5- ASPETTI TECNICI PRE-VALUTAZIONE

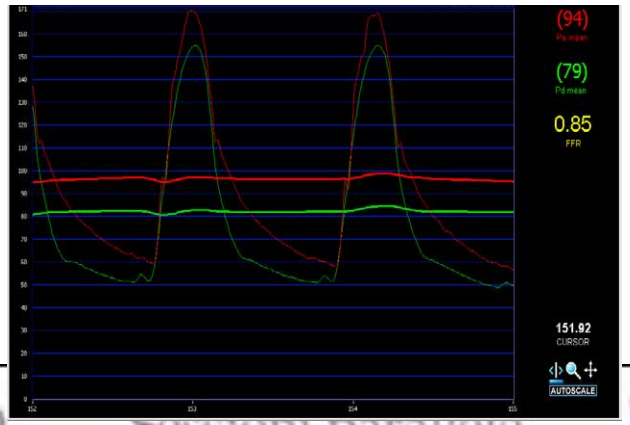


Pressure Drift:
identical morphology



Pressure Gradient:
different morphology





Subsets specifici nei quali la FFR/iFR svolge un ruolo importante:

6- VALUTAZIONE LESIONI IN SERIE

7- VALUTAZIONE MALATTIA DIFFUSA

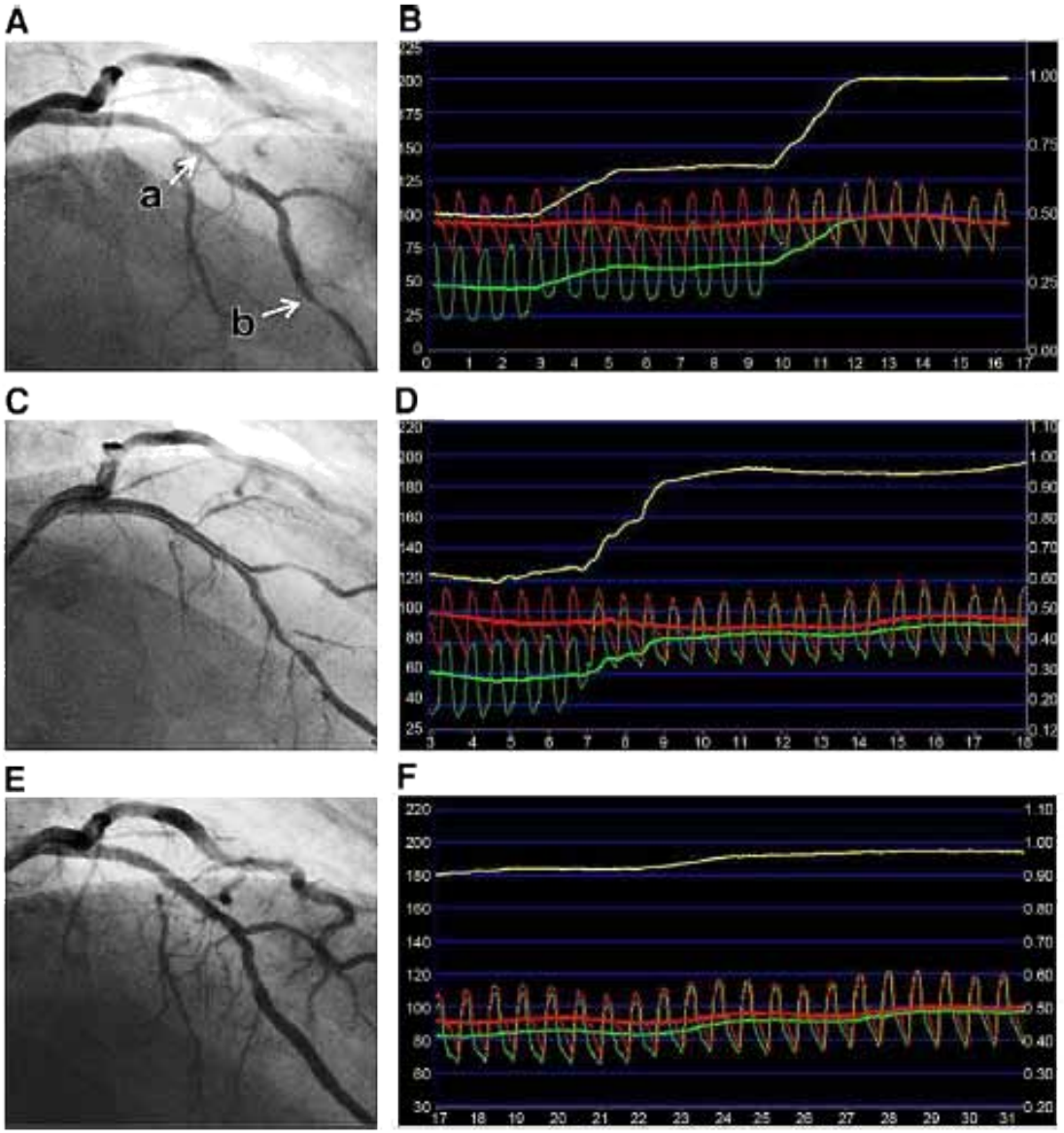
8- VALUTAZIONE ISR

9- VALUTAZIONE IN PZ con SAO

10 – ESTENSIONE DELL'AREA DI PERFUSIONE

FFR

6- VALUTAZIONE LESIONI IN SERIE



FFR Pullback
Requires IV adenosine
Cross talk between serial stenoses

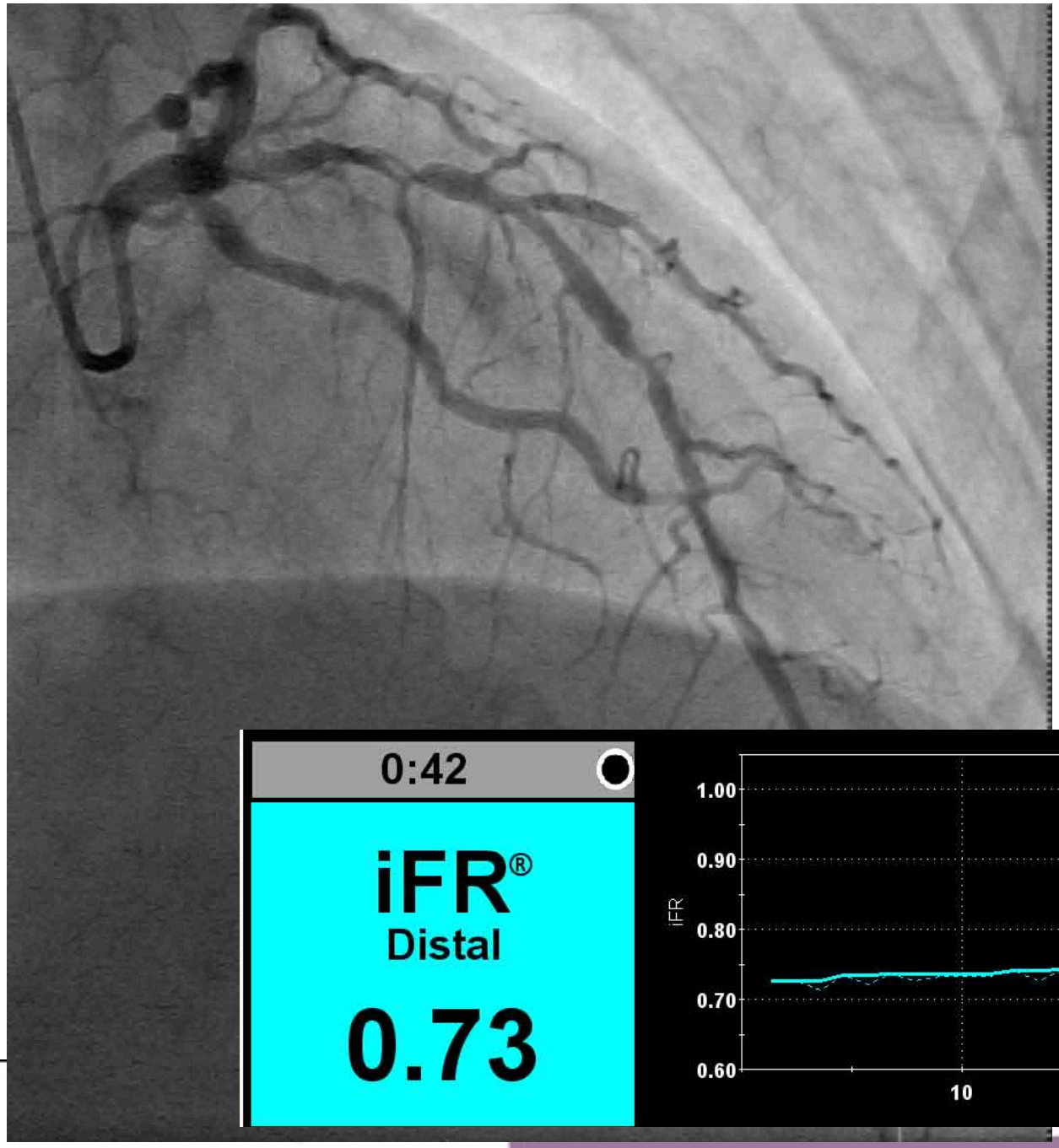
In case of serial lesions:

FFR Pullback should be repeated after each PCI to check the final result

A non significant lesion might become significant after PCI

Case example*:
Lesion A shows a larger pressure gradient;
After PCI of Lesion A, the pressure gradient increas in lesion B

6- VALUTAZIONE LESIONI IN SERIE



iFR SCOUT

History

85yr Male

Acute ACS presentation

Trop +ve

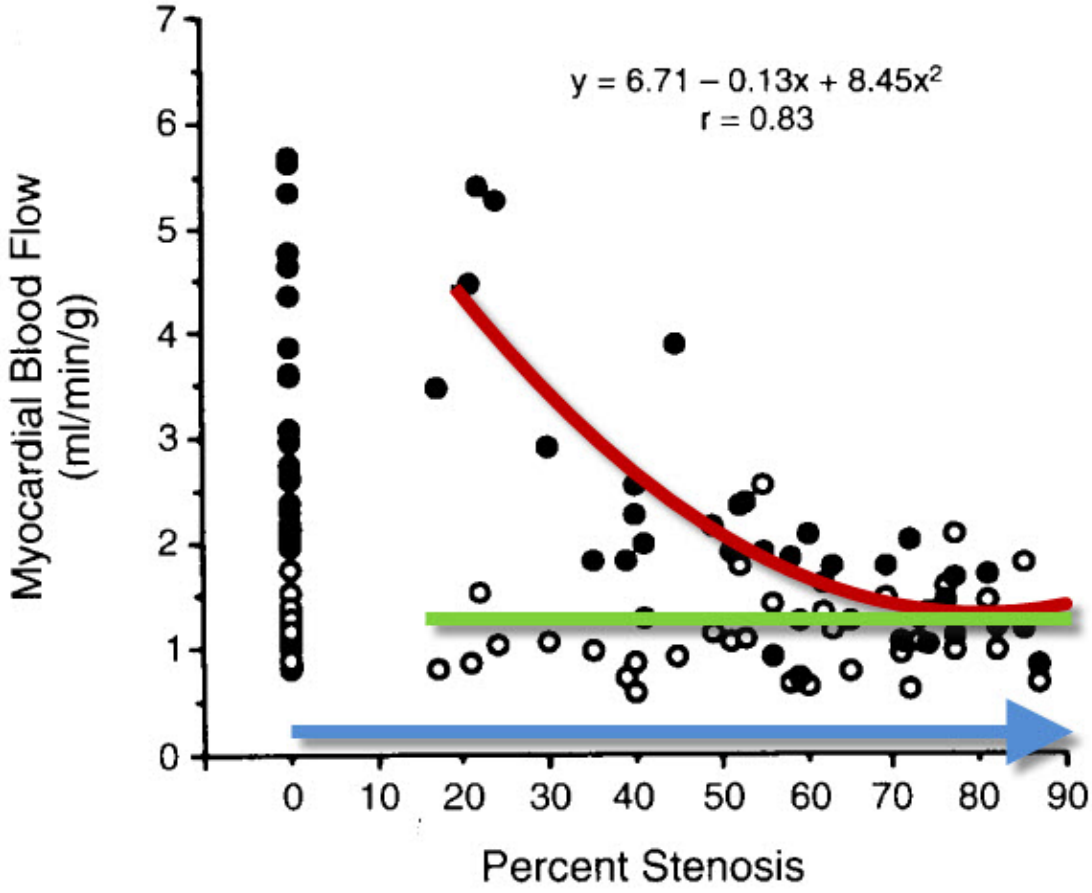
Imaging

Diffusely ectatic LAD

Serial lesions

6- VALUTAZIONE LESIONI IN SERIE

Hyperemic Versus Baseline Blood Flow



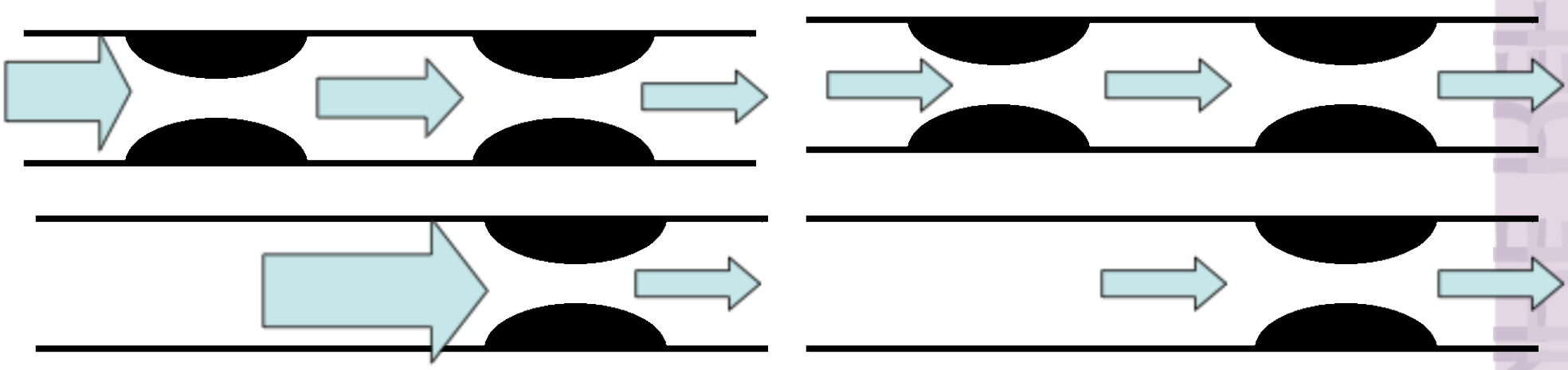
As percent stenosis increases from 10 to 90 Hyperemic blood flow decreases substantially While base line blood flow does not decrease

Uren N, De Bruyne et al. Relation between myocardial blood flow and the severity of coronary artery stenosis. The New England Journal of Medicine 1994; 330: 1782-1788

Hyperemic Versus Baseline Blood Flow

Hyperemic Flow (FFR)

- Baseline Flow (iFR)



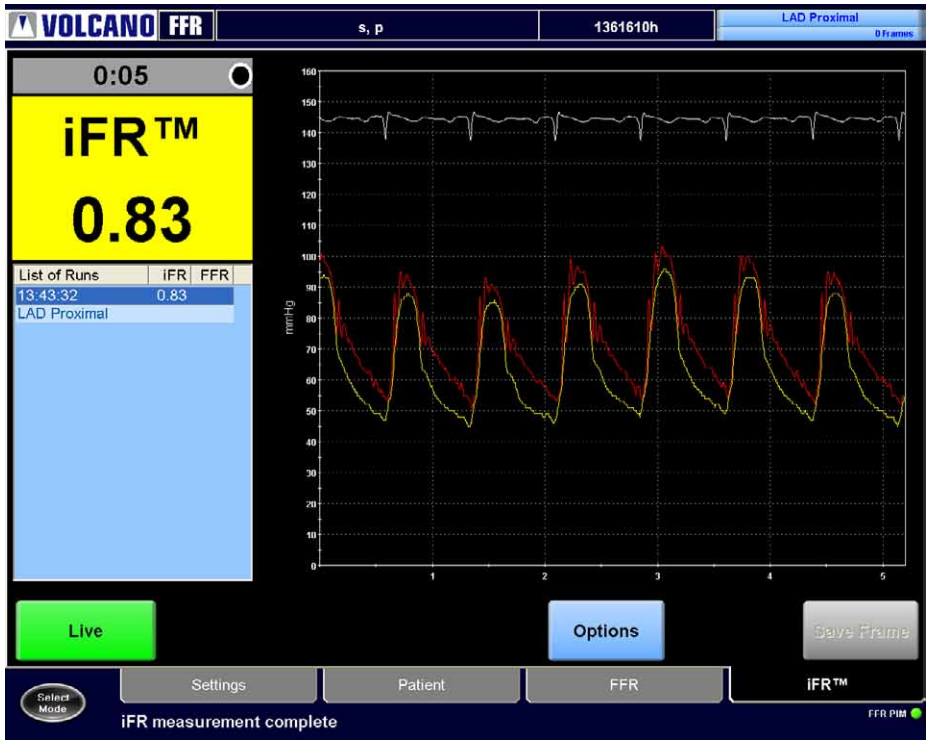
- The proximal lesion limits the maximum blood flow into the distal lesion, while the distal lesion limits the maximum blood flow across the proximal lesion
- When one lesion is removed, the FFR value of the remaining lesion is changed

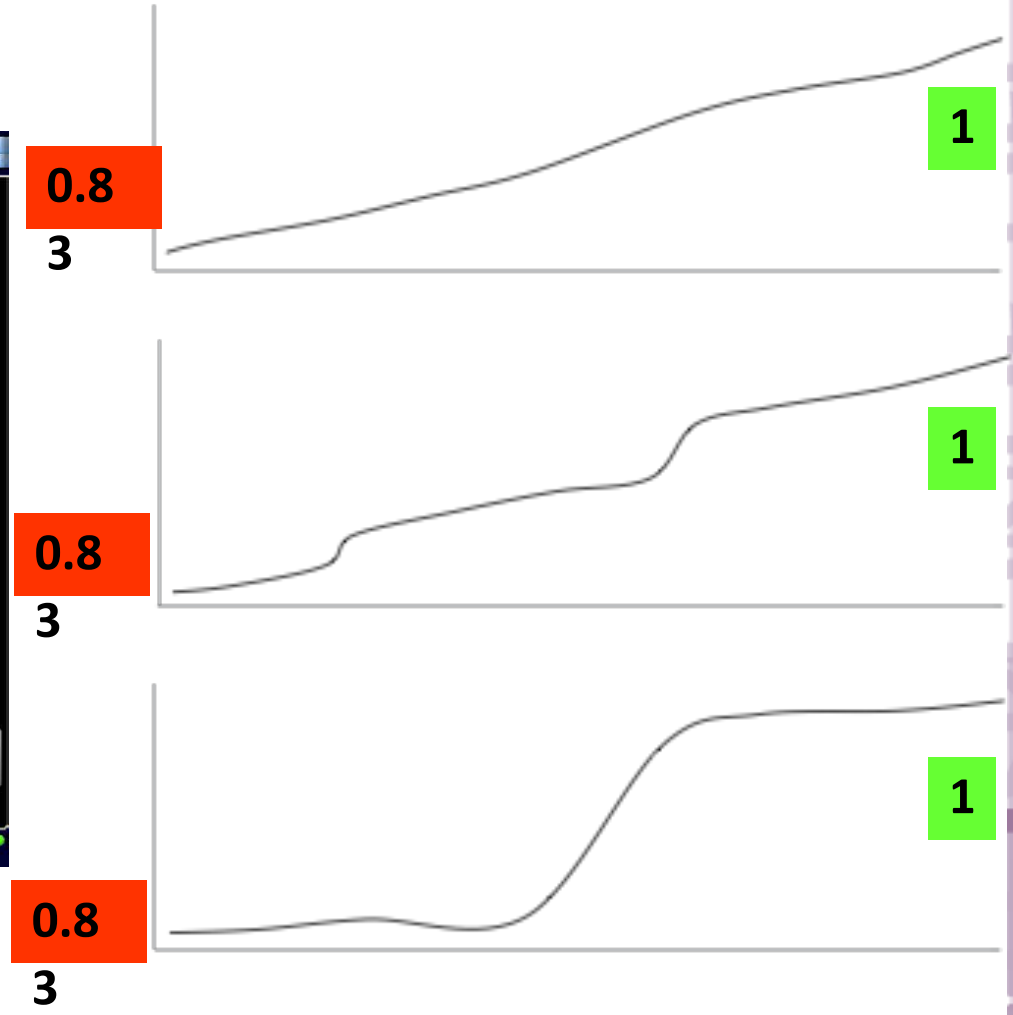
- The microvasculature maintains the baseline distal flow (autoregulation)
- When a lesion is removed, flow does not change substantially
- The iFR value of the remaining lesion remains constant

Nijjer S, et al. "Pre-Angioplasty Instantaneous Wave-Free Ratio (iFR) Pullback Provides Virtual Intervention and Predicts Hemodynamic Outcome for Serial Lesions and Diffuse Coronary Artery Disease. JACC: Cardiovascular Interventions 2014; 12: 1386-1396.

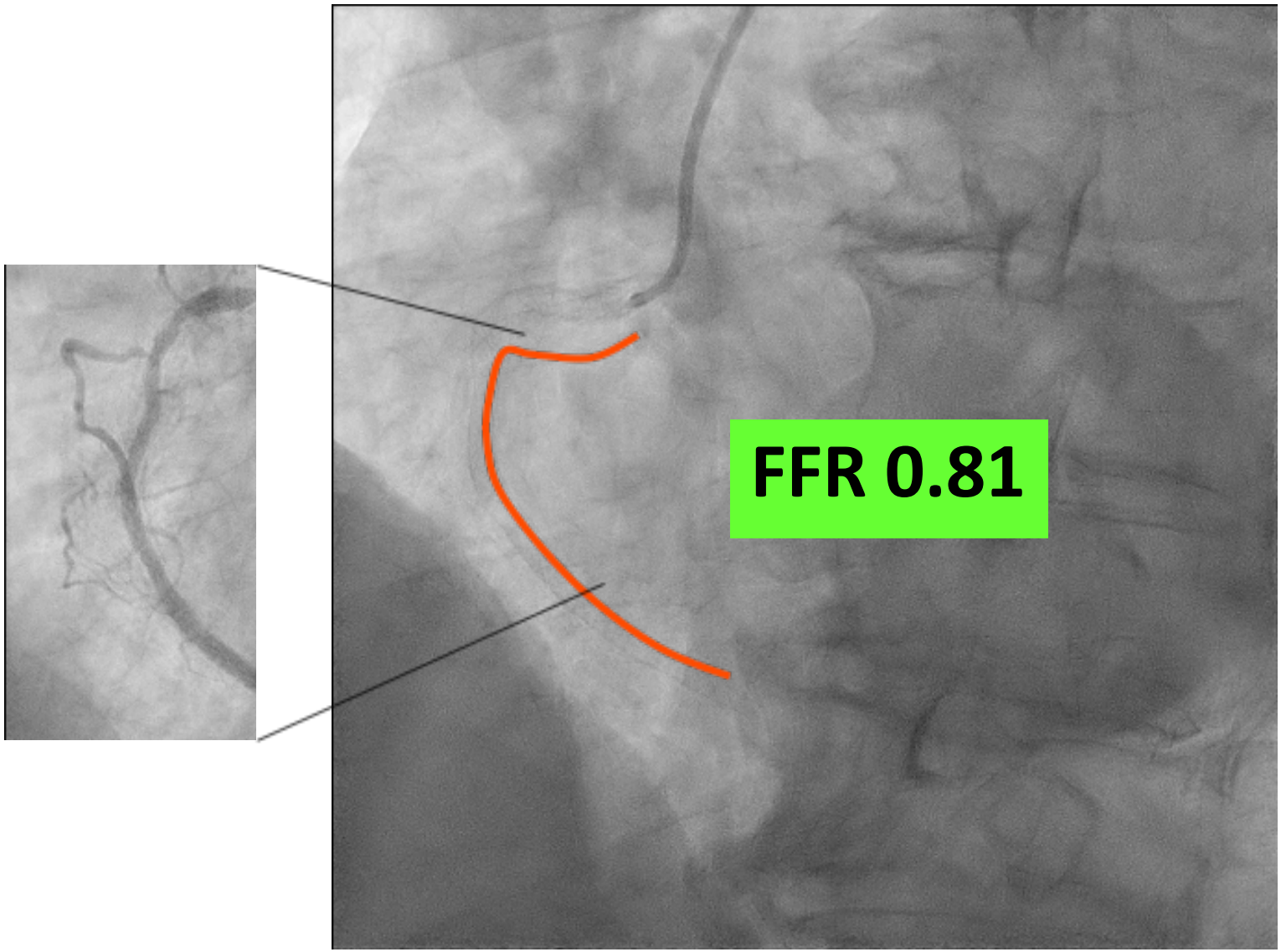
7- VALUTAZIONE MALATTIA DIFFUSA

Importanza del pull-back con **iFR SCOUT**





8- VALUTAZIONE ISR



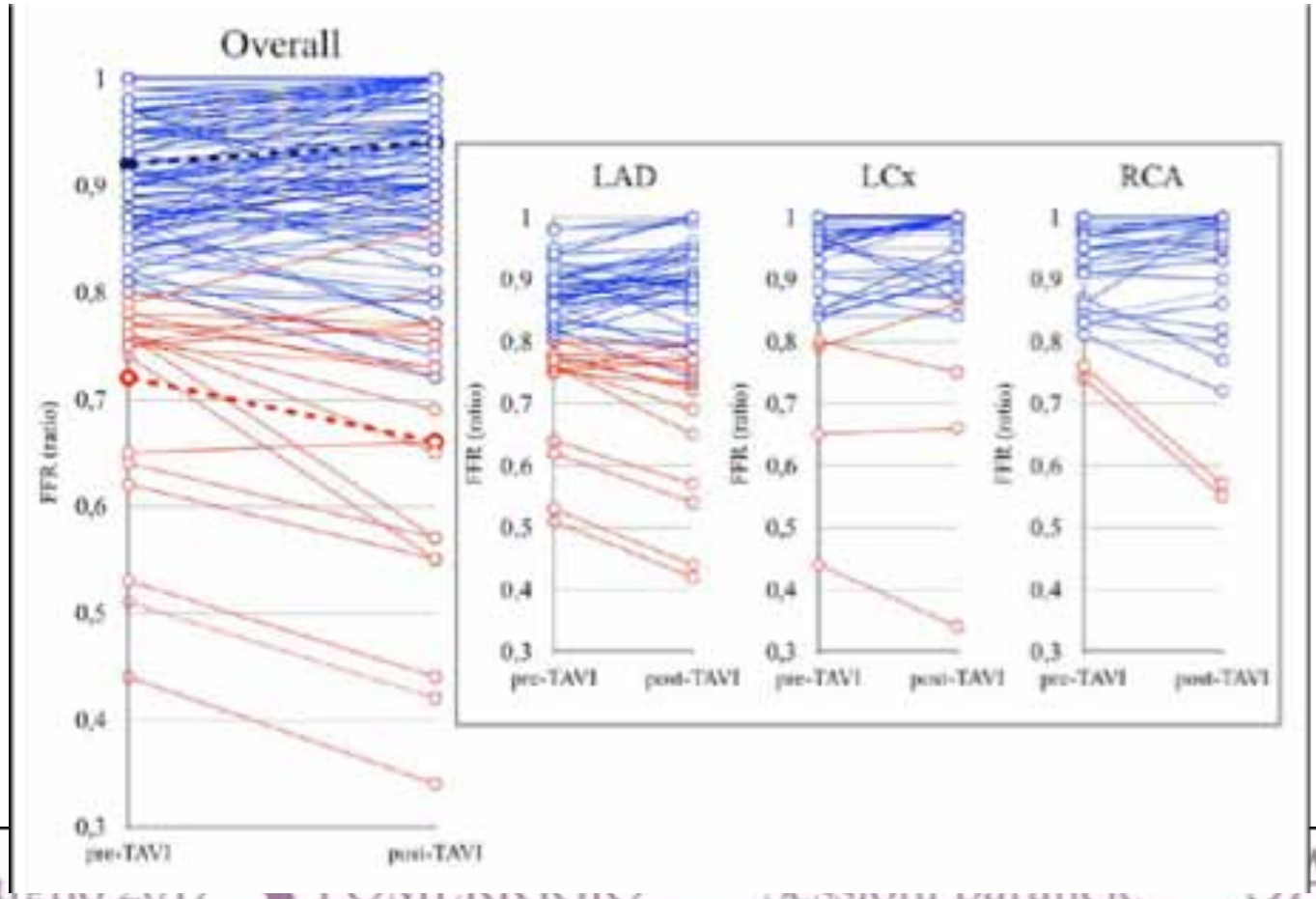
Take into consideration altered vasomotion due to diffuse stenting

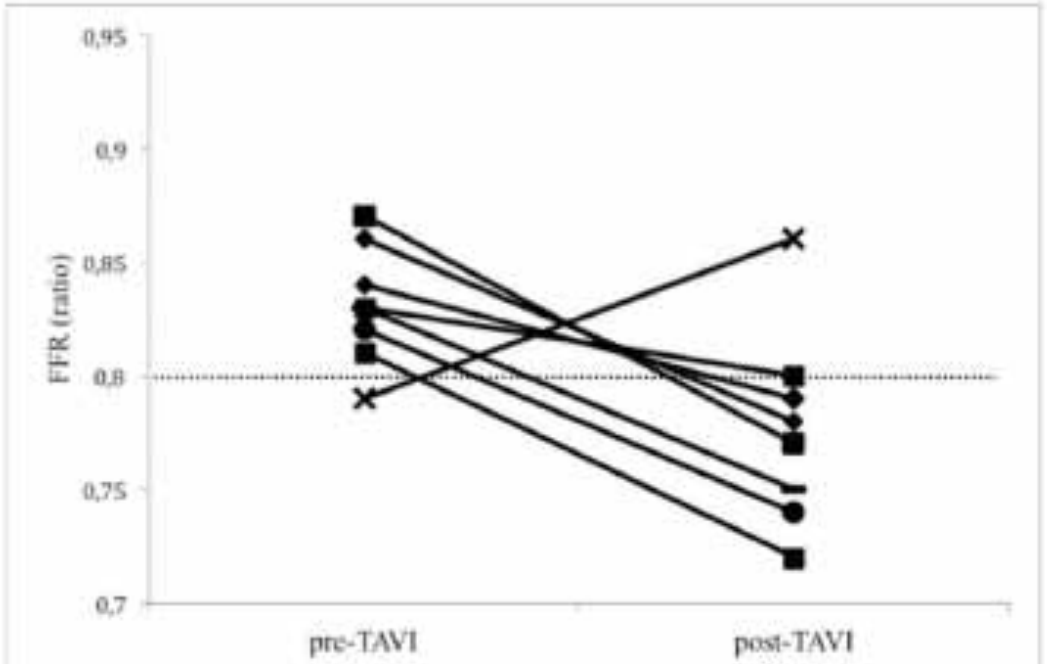
9- VALUTAZIONE IN PZ con SAO

Functional Assessment of Coronary Artery Disease in Patients Undergoing Transcatheter Aortic Valve Implantation

Influence of Pressure Overload on the Evaluation of Lesions Severity

Gabriele Pesarini, MD; Roberto Scarsini, MD; Carlo Zivelonghi, MD; Anna Piccoli, MD; Alessia Gambaro, MD; Leonardo Gottin, MD; Andrea Rossi, MD; Valeria Ferrero, MD; Corrado Vassanelli, MD; Flavio Ribichini, MD





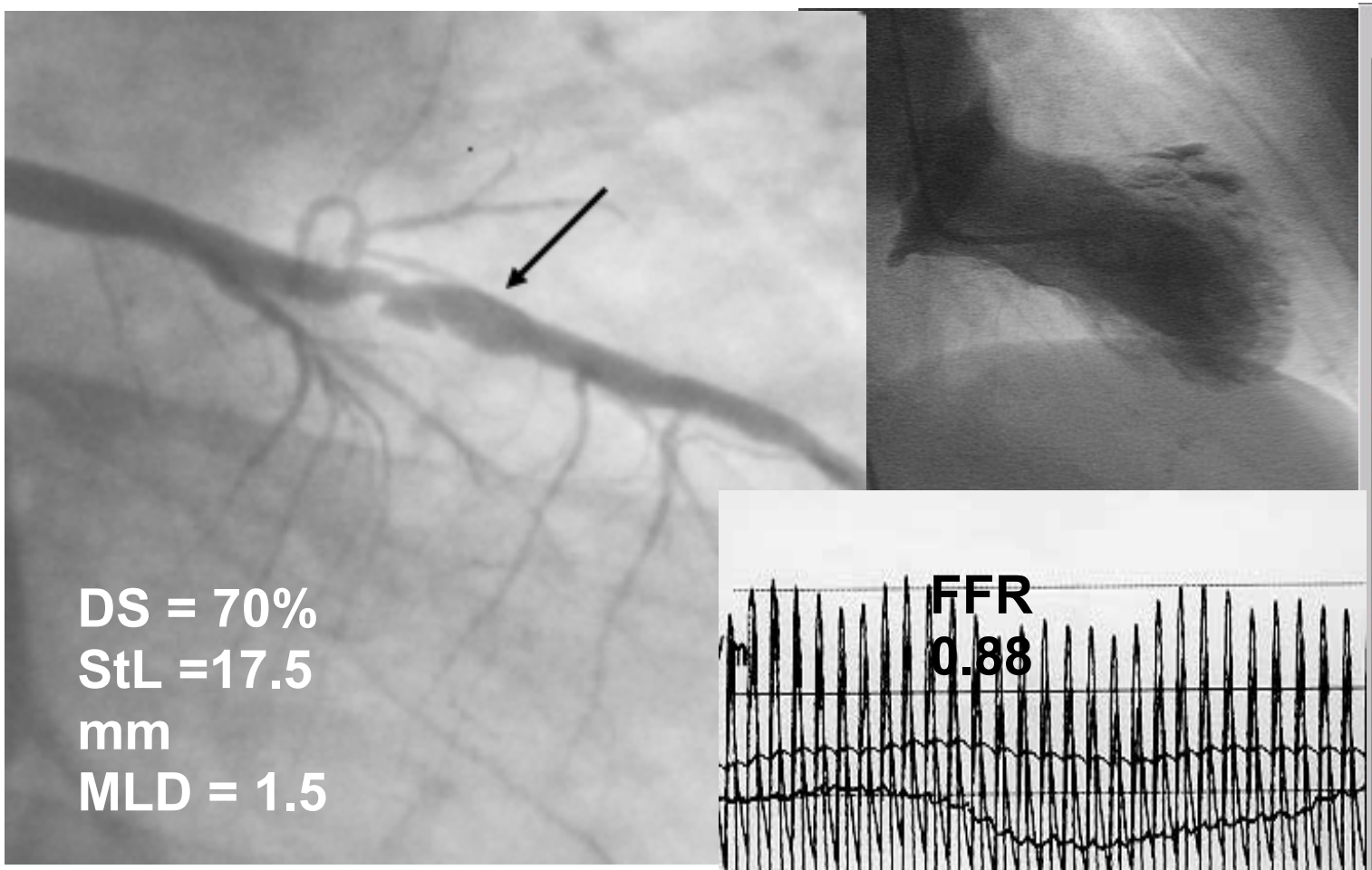
Coronary Lesion	Coronary segment	%DS at QCA	FFR pre-TAVI	FFR post-TAVI
•1	Proximal LAD	43	0,84	0,79
■2	Proximal RCA	47	0,87	0,77
•3	Proximal LAD	51	0,86	0,78
■4	Mid RCA	63	0,81	0,72
■5	Proximal RCA	53	0,83	0,8
•6	Mid LAD	59	0,82	0,74
×7	Proximal LCx	55	0,79	0,86
-8	Proximal LAD	54	0,83	0,75

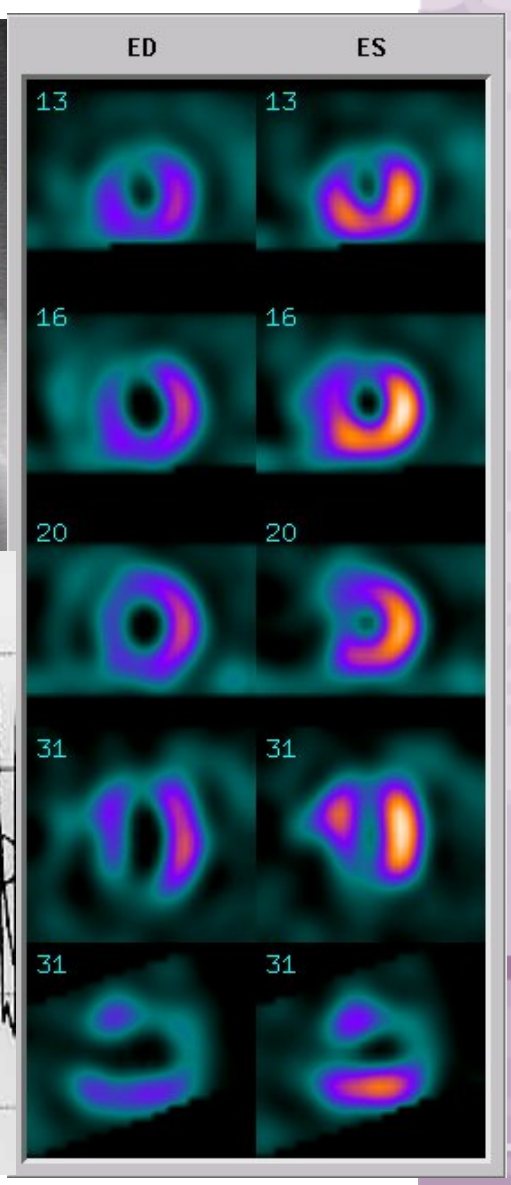
ATTENZIONE

\+ SAO associata a CFR ridotta cronicamente

10 – ESTENSIONE DELL'AREA DI PERFUSIONE

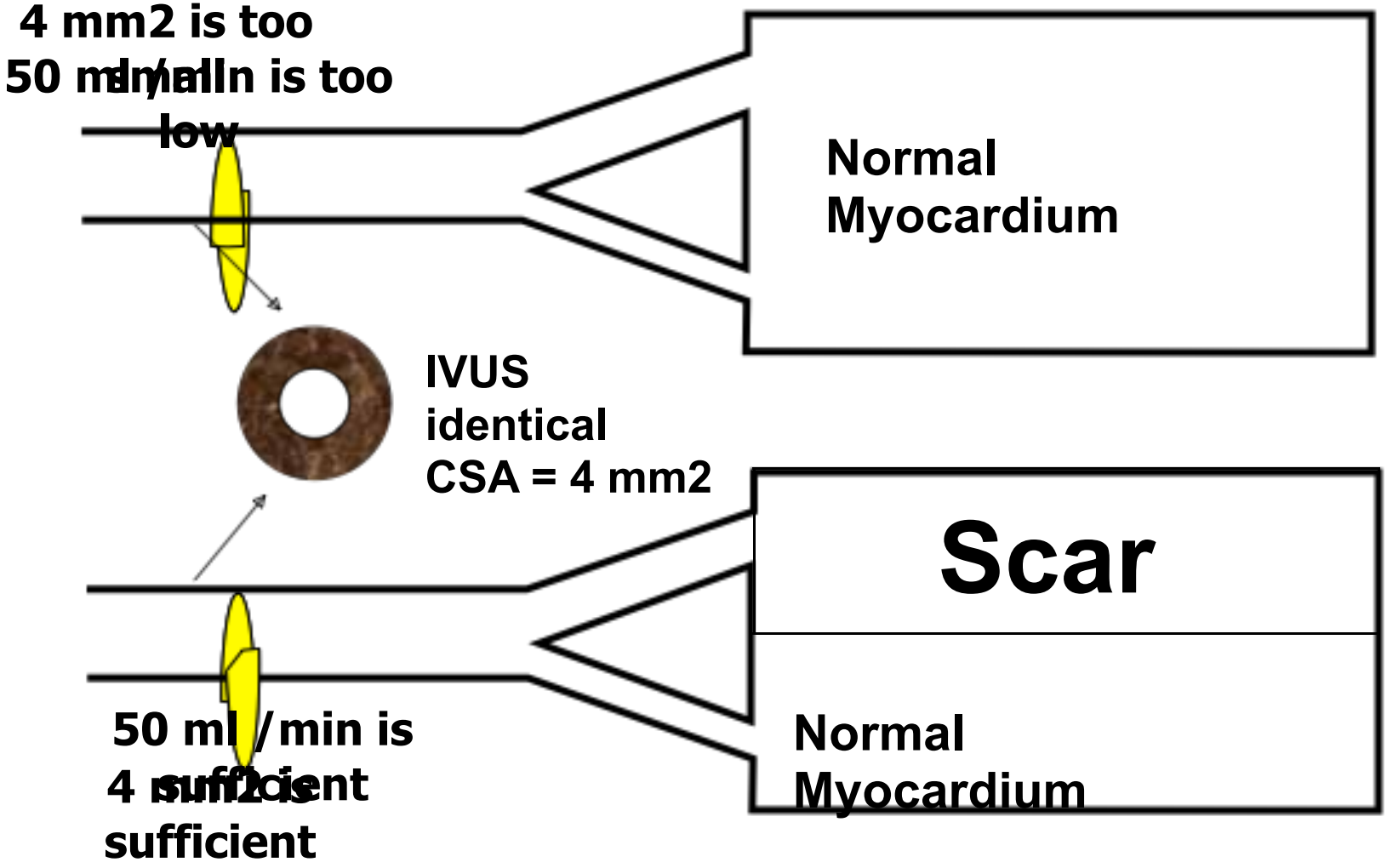
Degree of Stenosis and viable myocardium





10 - Degree of Stenosis and viable myocardium

similar stenosis but different extent of perfusion area



CONCLUSIONI

FFR/iFR è buon strumento diagnostico che, conoscendone le caratteristiche, può aggiungere informazioni importanti al processo decisionale e quindi aiutarci significativamente nell' ottimizzazione della procedura.

FFR/iFR non dovrebbe essere intesa come guida alla rivascolarizzazione (specialmente come approccio sistematico). Noi guidiamo la procedura integrando tutte le informazioni che abbiamo a disposizione, dove la FFR/iFR è una di queste.

Nell'ambito di una valutazione integrata, la FFR/iFR può avere un impatto positivo sugli outcomes clinici a distanza.

Condizioni fondamentali per il corretto utilizzo:

Selezione del paziente con l'individuazione di particolari sottogruppi o tipologie di lesioni che possono beneficiarne

Utilizzi di una corretta metodica di esecuzione dell'esame.