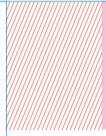




# Un peu d'ordre dans les indices

## *Physiologie Coronaire Epicardique Invasive*



PHYSIODAY 2024

BRAHIM HARBAOUI MD, PHD  
INSTITUT DE CARDIOLOGIE  
PLATEAU TECHNIQUE INTERVENTIONNEL

**HCL**

**HOSPICES CIVILS  
DE LYON**

# Conflits d'intérêts

*Abbott, AMGEN, Astra Zeneca, BMS, Boston, Edwards, Medtronic, Philips, Servier*

# Relation pression-flux

---

## Hémodynamique de base



Ratio Flux  $\approx$  ratio Pression/ Resistance

*si Resistance stable et basse*

Ratio Flux  $\approx$  ratio Pression

# Physio coronaire épicaudique invasive

---

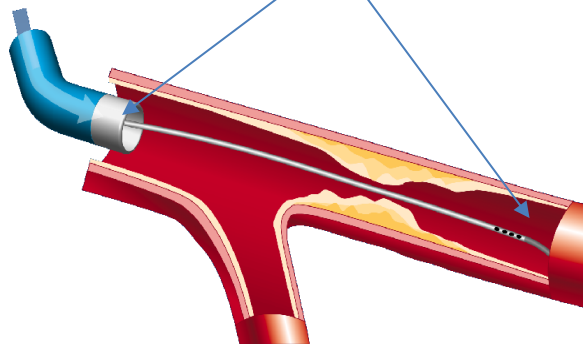
## Mesures de pressions intra-coronaires en pratique

Pd = pression moyenne distale

Pa = pression moyenne aortique

**Sténose  
intermédiaire**

Pd/Pa



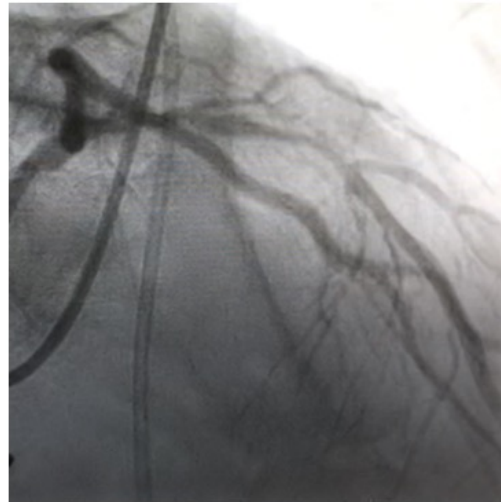
# Determinants Physio pressure drop

---

**Coronary stenosis characteristics correlates of functional significance**

**Area at risk**  
**Myocardial territory supplied**  
LAD  
Proximal location

**Lesion complexity\***  
Bifurcation  
Calcifications



**Angiography**  
Caliber reduction  
Lesion length

**Imaging**  
Plaque burden  
Low Attenuation Plaque

**Increased pressure drop  
= increased ischemia**

\*ACCAHA

# Physio coronaire épicaudique invasive

---

## Mesures de pressions intra-coronaires

Pd = pression moyenne distale  
Pa = pression moyenne aortique



$Pd/Pa$

Hyperhémie

FFR

# Physio coronaire épicardique invasive

---

## Alternatives/dérivés de la FFR

Pd = pression moyenne distale  
Pa = pression moyenne aortique



Pd/Pa  
FFR  
cFFR  
iFFR  
dPR  
RFR  
DFR  
...

Hyperhémie / sans Hyperhémie

Cycle complet / Wave free period/diastole

Pullback / Coronary physiology Mapping...

Mesures post PCI

Global FFR, delta FFR...

# Physio coronaire épicardique invasive

---

## Validation clinique études Randomisées ?

Pd = pression moyenne distale  
Pa = pression moyenne aortique



Pd/Pa  
FFR  
iFFR  
dFFR  
RFR  
DFR  
...



# Physio coronaire épicardique invasive

## Validation clinique études Randomisées ?

FFR

=

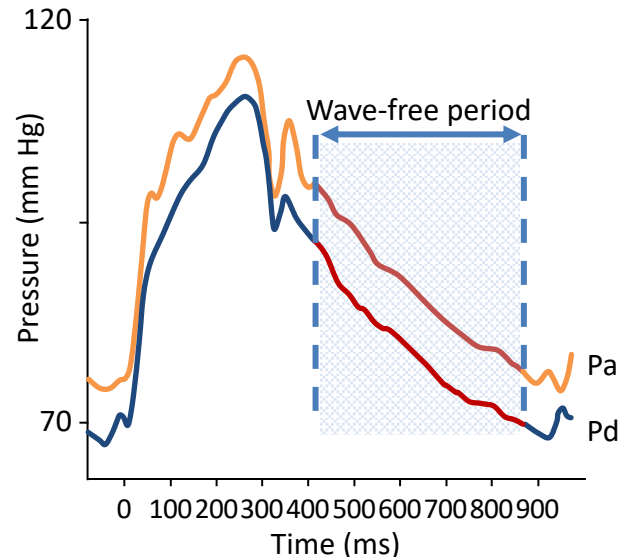
Ratio de pression Pd/Pa en hyperhémie pharmacologique

IFR

=

Ratio de pression Pd/Pa pendant la wave-free period

Cut-off  $\leq 0,80$



Cut-off  $\leq 0,89$

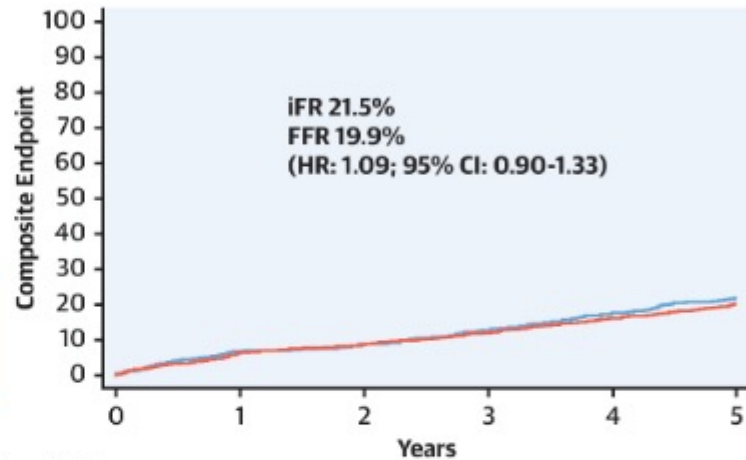
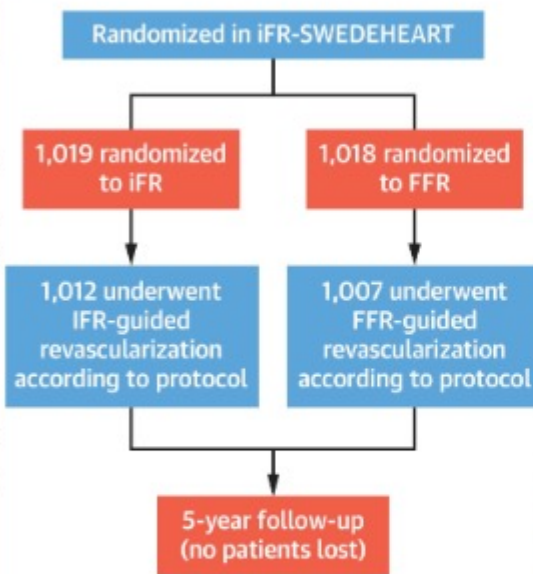
very good reproducibility and is easily usable in clinical daily practice

# Les études cliniques FFR et IFR

The Journal of the American College of Cardiology  
 © 2010 by the American College of Cardiology Foundation  
 Published by Elsevier Inc.

Vol. 55, No. 25, 2010  
 ISSN 0735-1097/\$36.00  
 doi:10.1016/j.jacc.2009.11.096

## CENTRAL ILLUSTRATION: Instantaneous Wave-Free Ratio vs Fractional Flow Reserve in Patients With Stable Angina Pectoris or Acute Coronary Syndrome: Study Enrollment and Outcome



No. at Risk		0	1	2	3	4	5
iFR	1,012	944	925	886	836	794	
FFR	1,007	946	920	889	845	807	

Composite outcome:  
 All-cause death, MI, unplanned revascularization

The iFR-SWEDEHEART trial demonstrated no difference in clinical outcome between iFR- and FFR-guided revascularization at 5-year follow-up

Götberg, M. et al. . 2022;79(10):965-974.

Coronary Artery Disease

ation

American

CINE

Ratio versus  
 o Guide PCI

L. Sandhall, M. Danielewicz,  
 E. Omerovic, F. Calais,  
 S.K. James, A. Käregren,  
 rlsson, G. Panayi, D. Erlinge,

and O. Fröbert, for the iFR-SWEDEHEART Investigators\*

J.E. Davie  
 S.J. Le  
 M. Laine  
 G. Niccol  
 H. Vin

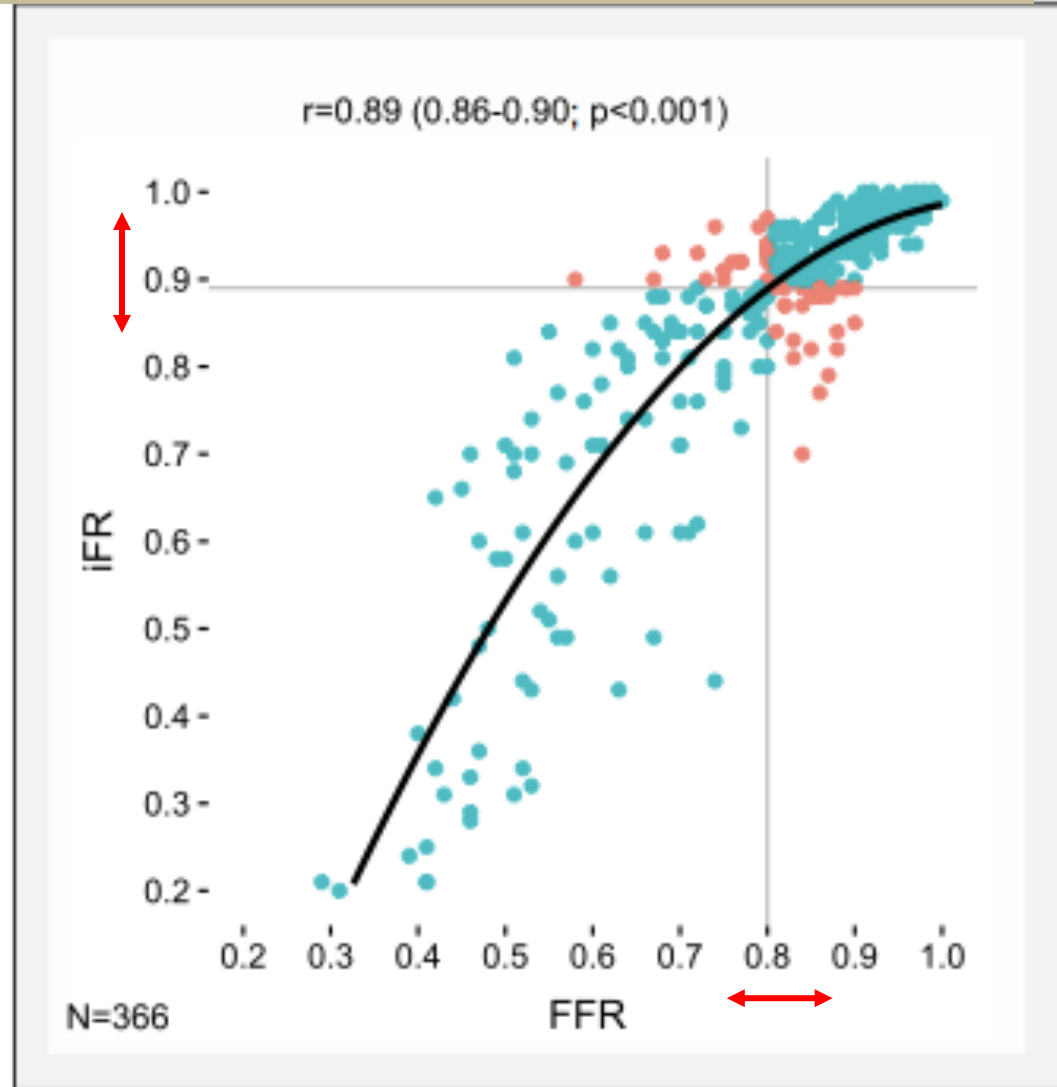
C.-W. Nam, E.-S. Shin, J.-H. Doh, S. Brugaletta, E. Alegria-Barrero, M. Meuwissen,  
 J.J. Piek, N. van Royen, M. Sezer, C. Di Mario, R.T. Gerber, I.S. Malik,  
 A.S.P. Sharp, S. Talwar, K. Tang, H. Samady, J. Altman, A.H. Seto, J. Singh,  
 A. Jeremias, H. Matsuo, R.K. Kharbanda, M.R. Patel, P. Serruys, and J. Escaned

# Discordance IFR/FFR

N=567 artères 301 patients

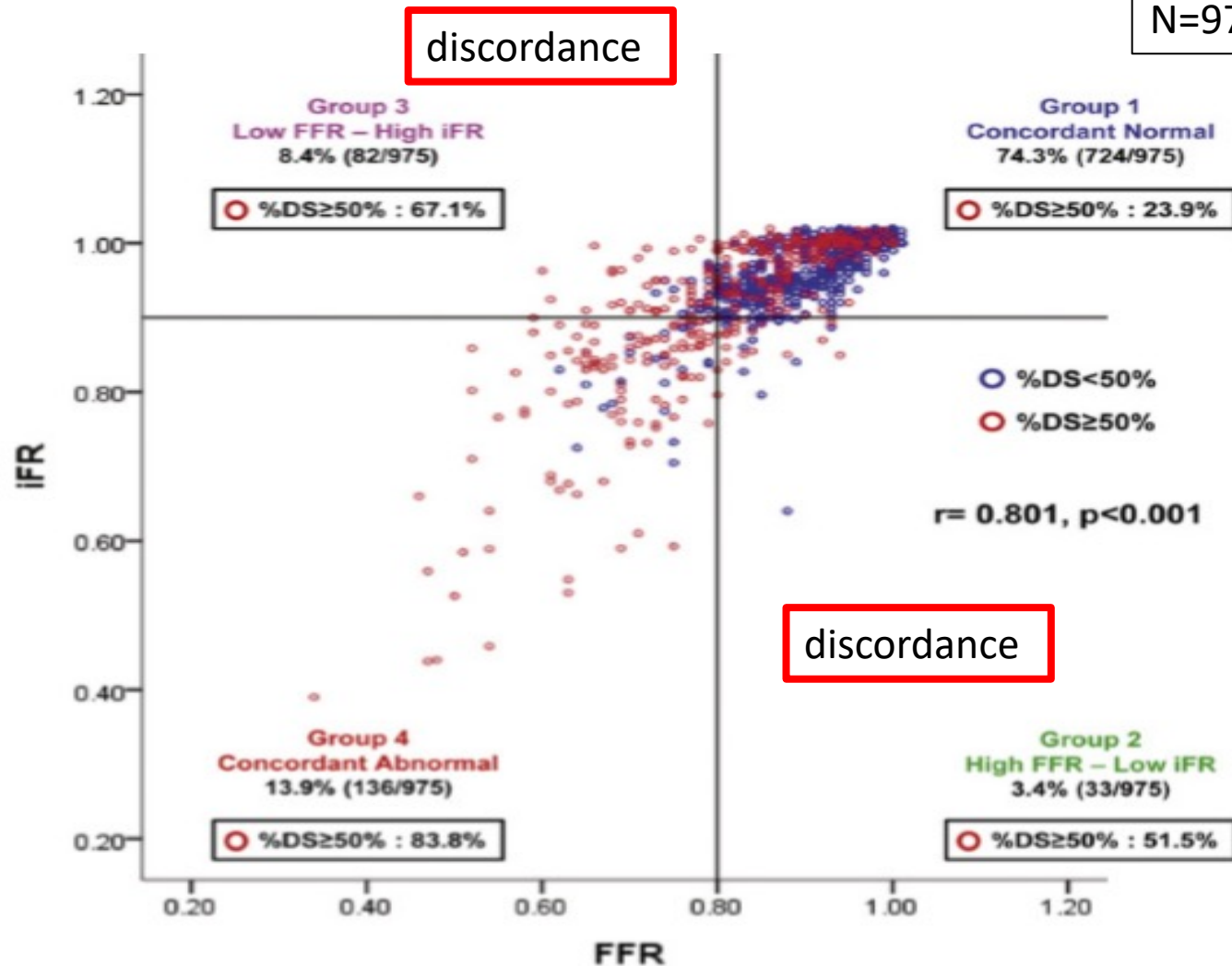
= 20% des cas

Zones grises



# Discordance IFR/FFR

N=975 artères 393 patients

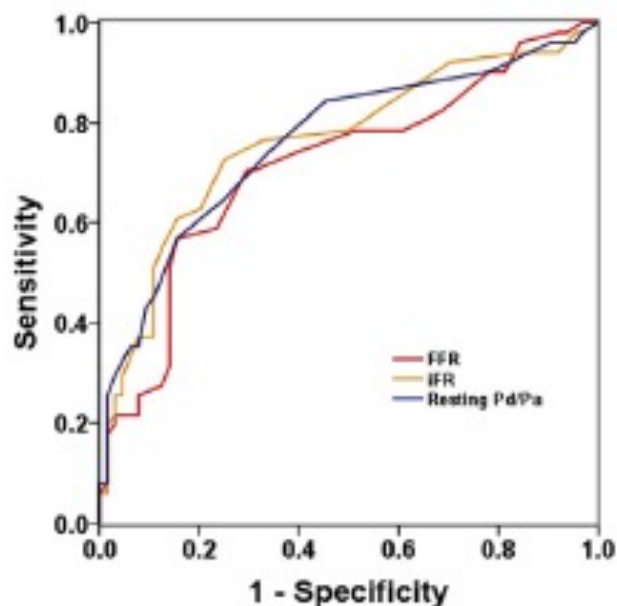


Femme  
Diabète  
Petits vaisseaux  
Sténose angio serrée

# Gold standard de l'ischémie?

## FFR et IFR vs CFR PET scanner (n=115 IVA)

PET-derived CFR<2.0 as a reference standard



	AUC	95% CI	p value
FFR	0.716	0.619-0.813	<0.001
IFR	0.762	0.671-0.854	<0.001
Resting Pd/Pa	0.761	0.670-0.852	<0.001

Reference	Testing	Difference between areas	p value
IFR	FFR	0.046	0.133
Resting Pd/Pa	FFR	0.045	0.183
IFR	Resting Pd/Pa	0.001	0.932

# iFR et autres indices diastoliques

---

“iFR-like” diastolic index

correlation correcte iFR

Absence d'étude Clinique studies, “offline calculations”

# Les recommandations



## Indications for revascularization in patients with stable angina or silent ischaemia (2)



Extent of CAD (anatomical and/or functional)		Class	Level
For prognosis	Left main disease with stenosis >50%. <sup>a</sup>	I	A
	Proximal LAD stenosis >50%. <sup>a</sup>	I	A
	Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%). <sup>a</sup>	I	A

<sup>a</sup> With documented ischaemia or haemodynamically relevant lesion defined by FFR ≤ 0.80 or iwFR ≤ 0.89 or > 90% stenosis in a major coronary vessel.

<sup>b</sup> Based on FFR < 0.75 indicating a prognostically relevant lesion

[www.escardio.org/guidelines](http://www.escardio.org/guidelines)

2018 ESC/EACTS Guidelines on myocardial revascularisation

ESC 2018

Recommendations for the Use of Coronary Physiology to Guide Revascularization With PCI		
Referenced studies that support the recommendations are summarized in Online Data Supplement 5.		
COR	LOE	Recommendations
1	A	1. In patients with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenoses, the use of fractional flow reserve (FFR) or instantaneous wave-free ratio (iFR) is recommended to guide the decision to proceed with PCI. <sup>1-6</sup>
3: No benefit	B-R	2. In stable patients with angiographically intermediate stenoses and FFR >0.80 or iFR >0.89, PCI should not be performed. <sup>7-10</sup>

### Multivessel disease in haemodynamically stable STEMI patients undergoing PPCI

Complete revascularization is recommended either during the index PCI procedure or within 45 days. <sup>508-511,531</sup>	I	A
It is recommended that PCI of the non-IRA is based on angiographic severity. <sup>511,524</sup>	I	B
Invasive epicardial functional assessment of non-culprit segments of the IRA is not recommended during the index procedure.	III	C

### Multivessel disease in haemodynamically stable NSTEMI-ACS patients undergoing PCI

In patients presenting with NSTEMI-ACS and MVD, complete revascularization should be considered, preferably during the index procedure. <sup>513,514</sup>	IIa	C
Functional invasive evaluation of non-IRA severity during the index procedure may be considered. <sup>518,527,528,532</sup>	IIb	B

© ESC 2023

ESC 2023

ACC, AHA, SCAI 2021

# FFR, iFR et stratégie thérapeutique

---

## • Concepts fondamentaux

### ● DEFERRAL

- Bon pronostic sous OMT si FFR > 0.80

### ● RECLASSIFICATION

- A l'échelle des vaisseaux monotronculaire, bitronculaire...
- A l'échelle du patient OMT, PCI, CABG

***Faut-il implanter un stent?***

***Décider de la revascularisation ou non***

Nam JACC 2011  
Van Belle Circulation 2014  
Van Belle JACC CV Int 2018



# FFR, outil de planification et optimisation PCI

---

- **Nouveaux concepts, moins invasifs**

- **Cartographie coronaire**
  - Coronary physiology mapping
- **Virtual PCI**
- **FFR post PCI/Mapping post PCI**

*Faut-il implanter un stent ?*

*Où et quel(s) stent(s) implanter ?*

*Faut-il optimiser l'angioplastie ?*

# Conclusion

---

- IFR et FFR explorent le réseau épicaordique
  - Indices de pression facilement accessibles
  - Mieux que l'angiographie seule
  - Niveau de preuve élevé
  - ESC Guidelines IA pour FFR et iFR
- Autres indices diastoliques, pas d'étude cliniques
- Information incomplète sur l'ischémie (microcirculation)