



## Kam se ubírá koronární fyziologie

Tomáš Kovárník





# Le car Dijon



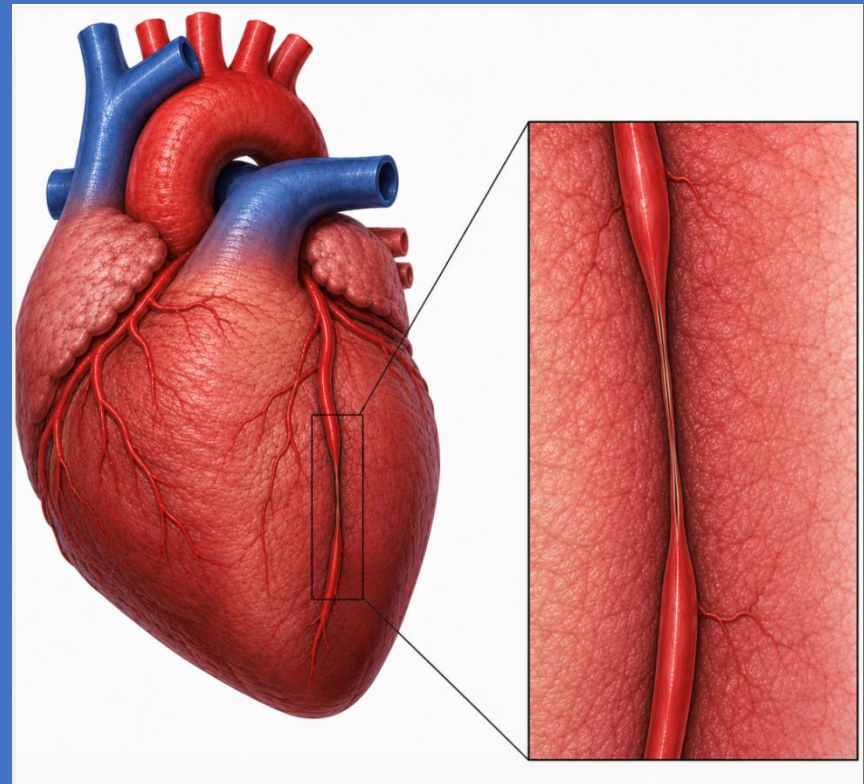
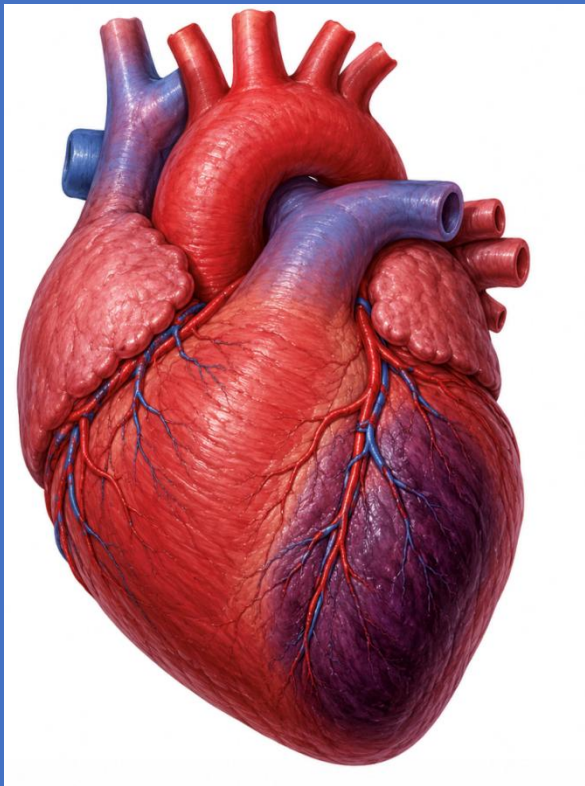
| Kam se ubírá koronární fyziologie

# Kam se ubírá koronární fyziologie

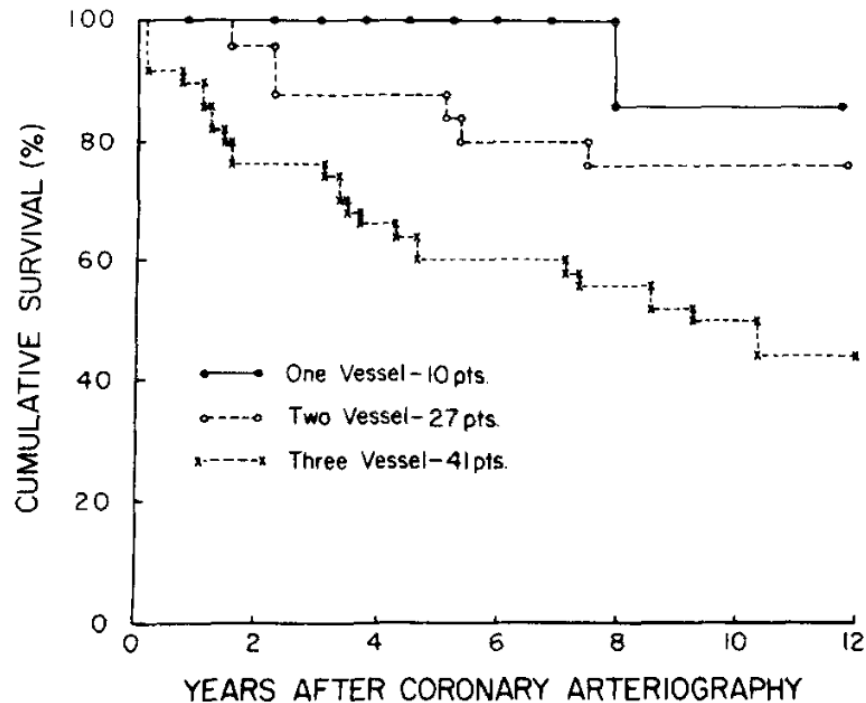


# Kam se ubírá koronární fyziologie

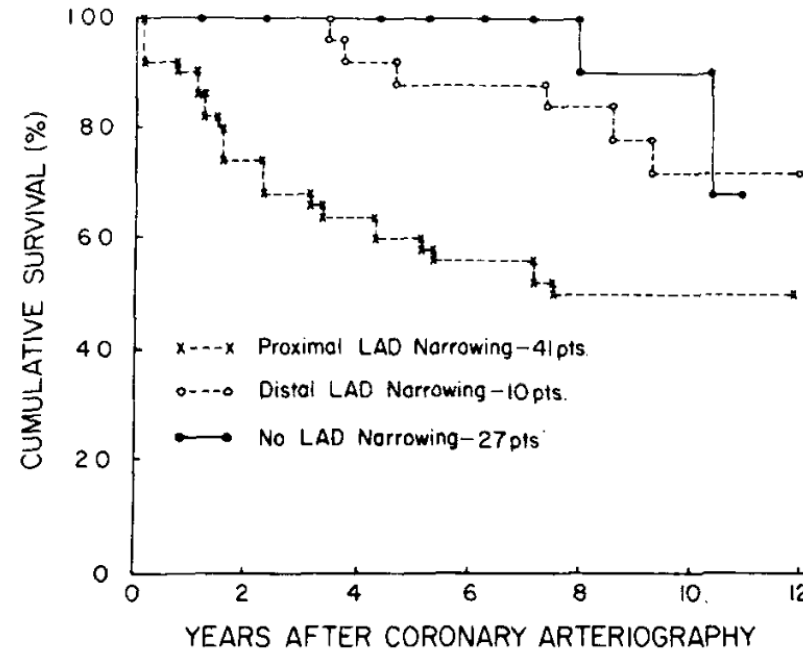
- Detekce lézí prokazatelně způsobujících ischemii myokardu
- Renesance hodnocení koronární mikrocirkulace a koronárních spasmů



# Clinical and Arteriographic Variables Predictive of Survival in Coronary Artery Disease



**FIGURE 3.** Influence of extent of coronary disease on expected cumulative survival. Extent of disease is defined as one, two or three major arteries narrowed by 50 percent or more. pts. = patients.



**FIGURE 4.** Cumulative survival of patients with 70 percent or greater narrowing proximal to the first left anterior descending (LAD) septal branch (41 patients), 70 percent or greater narrowing in a coronary segment distal to the first anterior descending septal branch (27 patients), and those patients without 70 percent or greater narrowing in either the anterior descending or left main coronary arteries (10 patients).

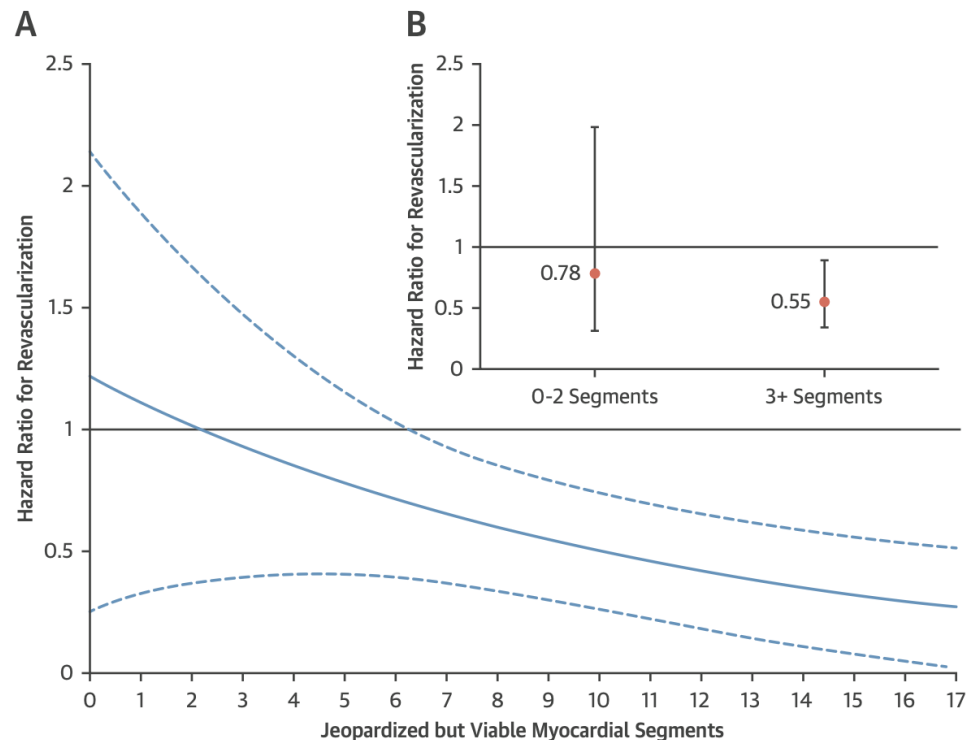
ORIGINAL RESEARCH

# Patient-Specific Registration of Segmental Jeopardy and Viability

## Novel Method to Guide Revascularization in Ischemic Cardiomyopathy

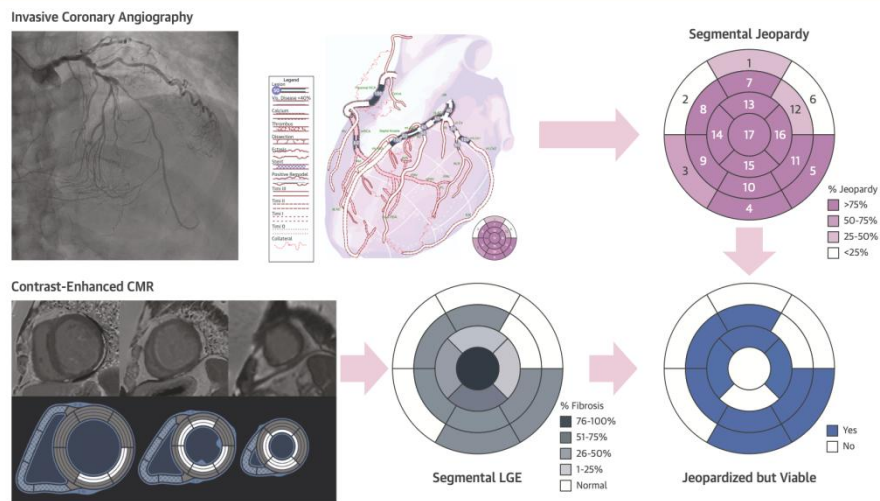
Jacob Abdaem, MD,<sup>a,b,\*</sup> Dina Labib, MD, PhD,<sup>a,b,c,\*</sup> Rhys Beaudry, PhD,<sup>a,b,c</sup> Augustine Amakiri, PhD,<sup>a,b</sup>

**FIGURE 4** Relationship Between Jeopardized but Viable Myocardial Segments and Early Revascularization



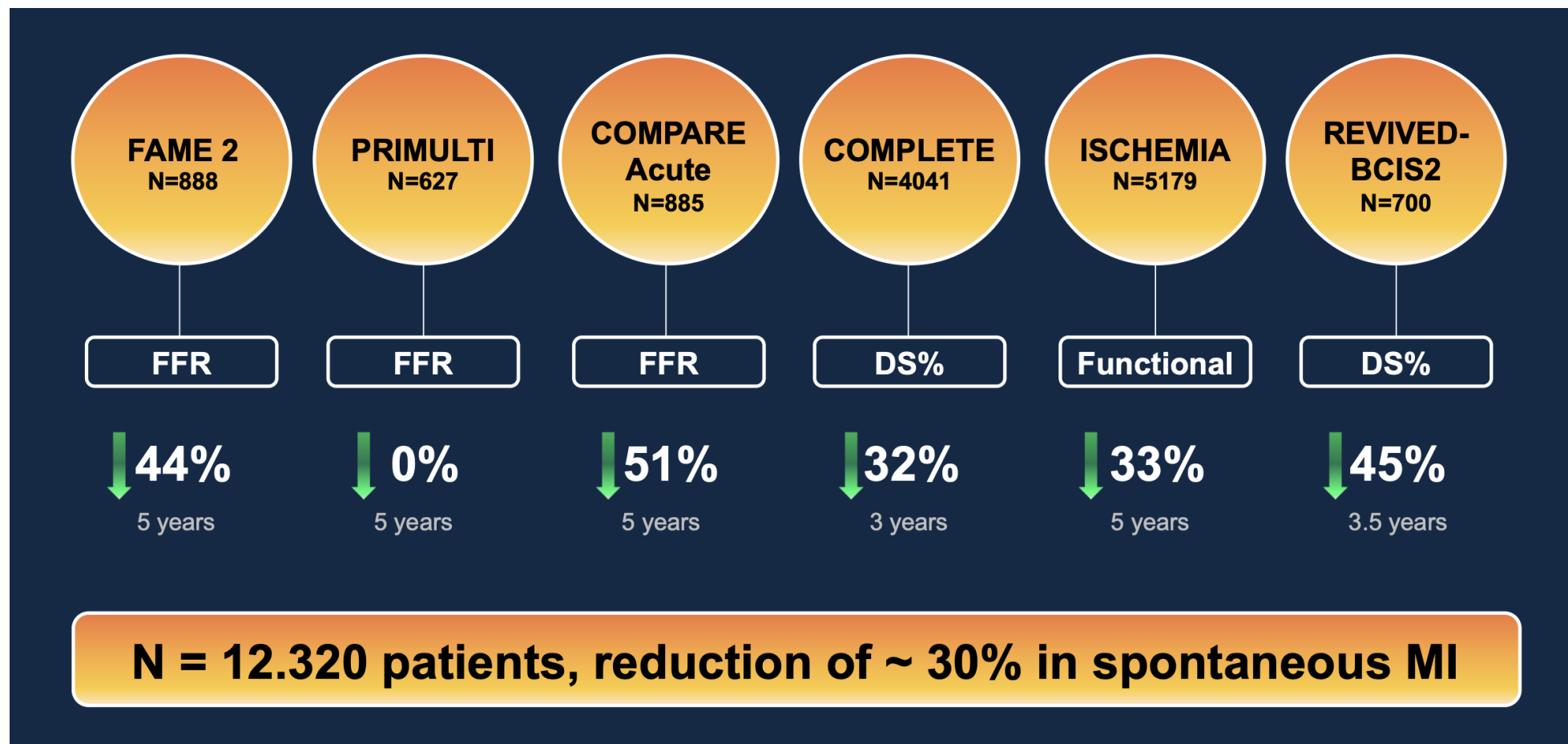
(A) HR for all-cause mortality with revascularization according to the number of jeopardized but viable myocardial segments. (B) Comparison of HRs for revascularization in patients with 0 to 2 vs 3+ jeopardized but viable myocardial segments.

**FIGURE 1** Case Example



A 70-year-old woman with multivessel coronary artery disease and a left ventricular ejection fraction of 34%. (Top left) Invasive coronary angiography image shows

# PCI vede k redukcii vzniku infarktu myokardu

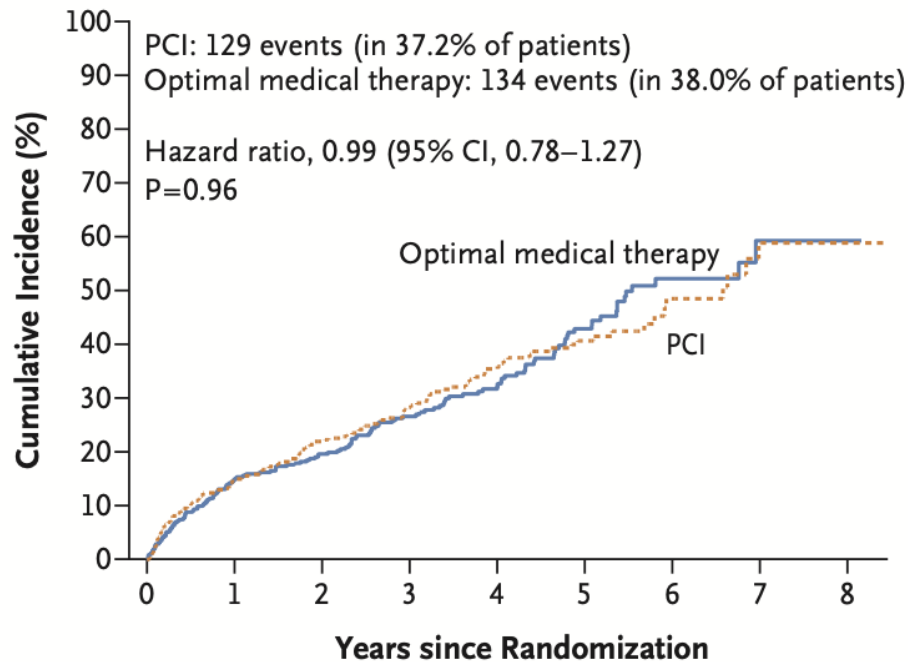


ORIGINAL ARTICLE

REVIVED-BCIS2

## Percutaneous Revascularization for Ischemic Left Ventricular Dysfunction

Divaka Perera, M.D., Tim Clayton, M.Sc., Peter D. O’Kane, M.D.,



Celk. mortalita  
a/nebo  
rehospitalizace pro  
srdeční selhání

### PCI vs srovnání s OMT vede k:

- 12% snížení kardiovaskulární mortality
- 44% redukcii výskytu spontánního infarktu myokardu
- 58% redukcii adekvátní terapií z implantovaného defibrilátoru
- zlepšení kvality života

Severe Left Ventricular Systolic Dysfunction  
+ Extensive Coronary Disease + Myocardial Viability  
N=700

# 2024 ESC Guidelines for the management of chronic coronary syndromes

Revascularization to improve outcomes		
In chronic coronary syndrome patients with left ventricular ejection fraction >35%		
In CCS patients with LVEF >35%, myocardial revascularization is recommended, in addition to guideline-directed medical therapy, for patients with functionally significant left main stem stenosis to improve survival. <sup>718,719,859,860</sup>	I	A
In CCS patients with LVEF >35%, myocardial revascularization is recommended, in addition to guideline-directed medical therapy, for patients with functionally significant three-vessel disease to improve long-term survival and to reduce long-term cardiovascular mortality and the risk of spontaneous myocardial infarction. <sup>55,56,317,732–734</sup>	I	A
In CCS patients with LVEF >35%, myocardial revascularization is recommended, in addition to guideline-directed medical therapy, for patients with functionally significant single- or two-vessel disease involving the proximal LAD, to reduce long-term cardiovascular mortality and the risk of spontaneous myocardial infarction. <sup>55,56,317,719,732–734</sup>	I	B
In chronic coronary syndrome patients with left ventricular ejection fraction ≤35%		
In CCS patients with LVEF ≤35%, it is recommended to choose between revascularization or medical therapy alone, after careful evaluation, preferably by the Heart Team, of coronary anatomy, correlation between coronary artery disease and LV dysfunction, comorbidities, life expectancy, individual risk-to-benefit ratio, and patient perspectives.	I	C
In surgically eligible CCS patients with multivessel CAD and LVEF ≤35%, myocardial revascularization with CABG is recommended over medical therapy alone to improve long-term survival. <sup>53,54,749,861</sup>	I	B
In selected CCS patients with functionally significant MVD and LVEF ≤35% who are at high surgical risk or not operable, PCI may be considered as an alternative to CABG. <sup>526,729</sup>	IIb	B
Revascularization to improve symptoms		
In CCS patients with persistent angina or anginal equivalent, despite guideline-directed medical treatment, myocardial revascularization of functionally significant obstructive CAD is recommended to improve symptoms. <sup>50,321,402,732,734,757</sup>	I	A

## 2024 ESC Guidelines for the management of chronic coronary syndromes

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
During ICA, selective assessment of functional severity of intermediate <sup>c</sup> diameter stenoses is recommended to guide the decision to revascularize, using the following techniques:		
• FFR/iFR (significant $\leq 0.8$ or $\leq 0.89$ , respectively); <sup>49,308,310,311,313,321–323,332,373</sup>	I	A
• QFR (significant $\leq 0.8$ ). <sup>325,355,374,375</sup>	I	B
In addition:		
• CFR/HSR/CFC should be considered as a complementary investigation; <sup>359,360,366–368,376</sup>	IIa	B
• resting invasive measurement of Pd/Pa, dPR, RFR, or angiography-derived vessel FFR may be considered as alternative parameters. <sup>353,377</sup>	IIb	C
Systematic and routine wire-based coronary pressure assessment of all coronary vessels is not recommended. <sup>346,347</sup>	III	A

# Koncept frakční průtokové rezervy

- 1) Poměr maximální průtoku ve stenotické tepně a normální průtoku při teoretické absenci stenózy:

$$FFR = \frac{Q_s}{Q_n}$$

- 2) Průtok je rovinu podílu tlakového rozdílu a myokardiální rezistence:

$$Q = \frac{\Delta P}{R}$$

- 3) Při maximální hyperemii je rezistence minimální:

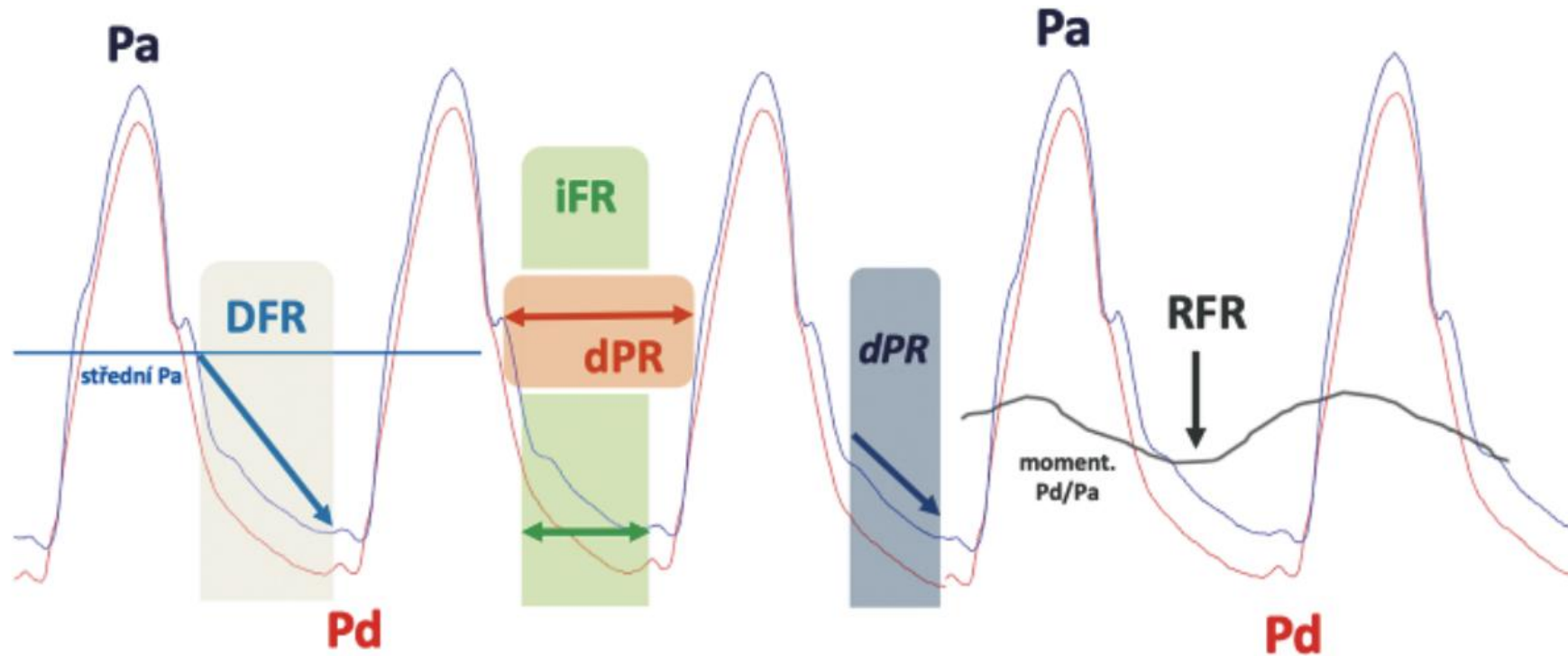
$$FFR = \frac{P_d - P_v}{P_a - P_v}$$

- 4) Vliv centrálního žilního tlaku je ve většině případů zanedbatelný:

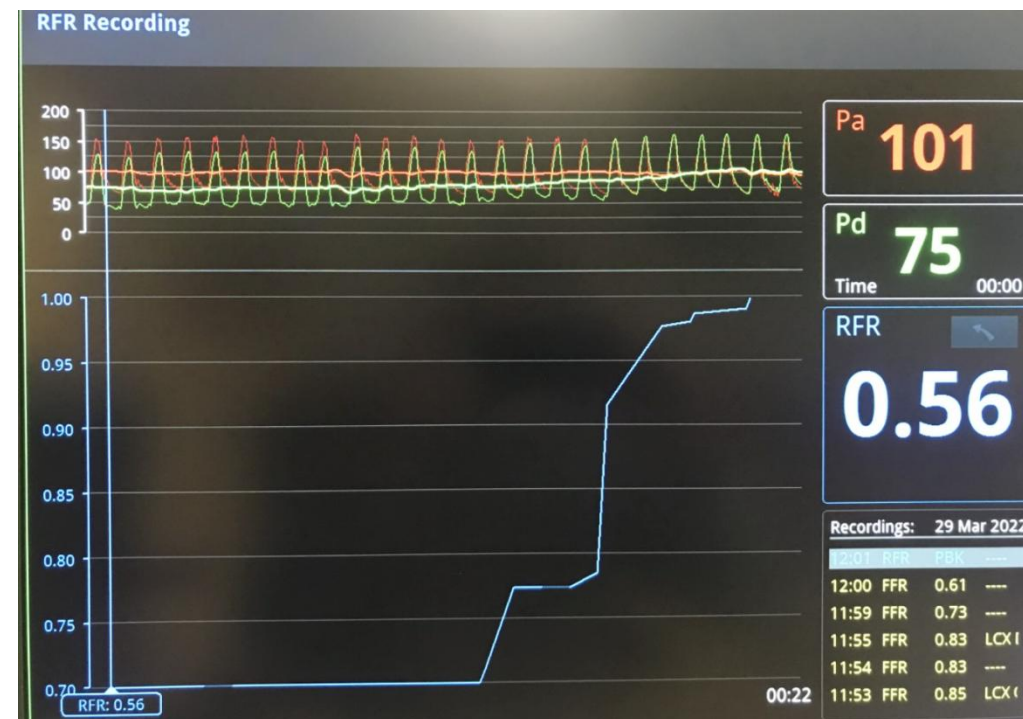
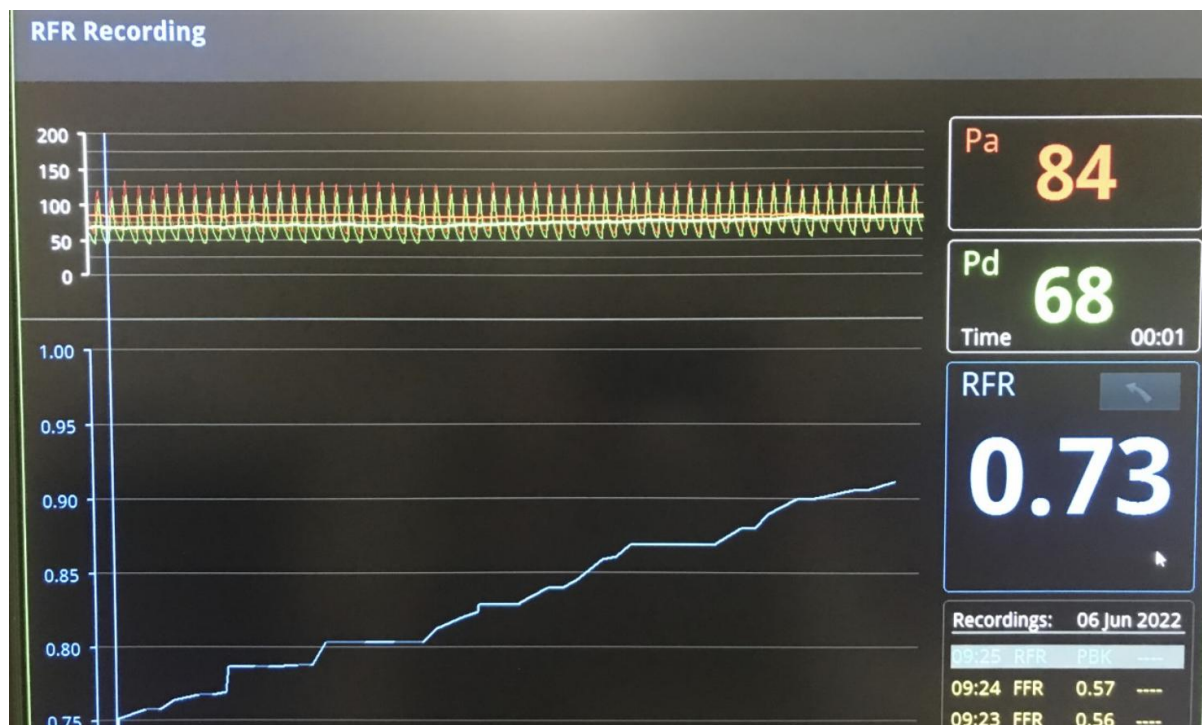
$$FFR = \frac{P_d}{P_a}$$

$$\Delta P = \underbrace{f_1(1/A_s^2, l, \dot{Q})}_{\text{VISCOUS}} + \underbrace{f_2(1/A_s^2, 1/A_n^2, \dot{Q}^2)}_{\text{SEPARATION}}$$

# Non-hyperemic indices



# Pullback za použití klidových indexů



# Measurement of Hyperemic Pullback Pressure Gradients to Characterize Patterns of Coronary Atherosclerosis



Carlos Collet, MD,<sup>a,\*</sup> Jeroen Sonck, MD,<sup>a,b,\*</sup> Bert Vandeloo, MD,<sup>c</sup> Takuya Mizukami, MD, PhD,<sup>a,d</sup>

PPG index =

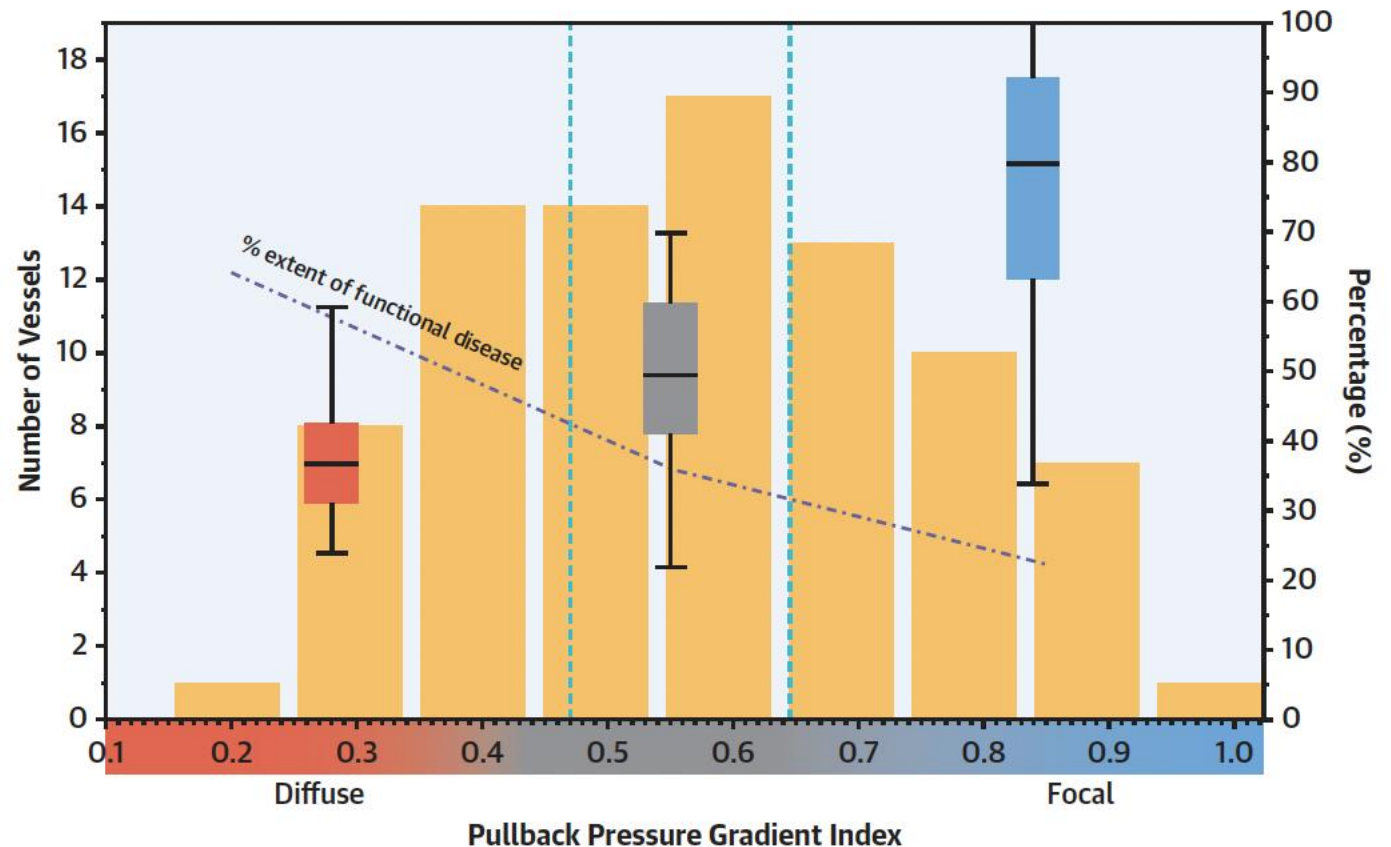
$$\frac{\left\{ \frac{MaxPPG_{20mm}}{\Delta FFR_{vessel}} + \left( 1 - \frac{Length\ with\ functional\ disease\ (mm)}{Total\ vessel\ length\ (mm)} \right) \right\}}{2}$$

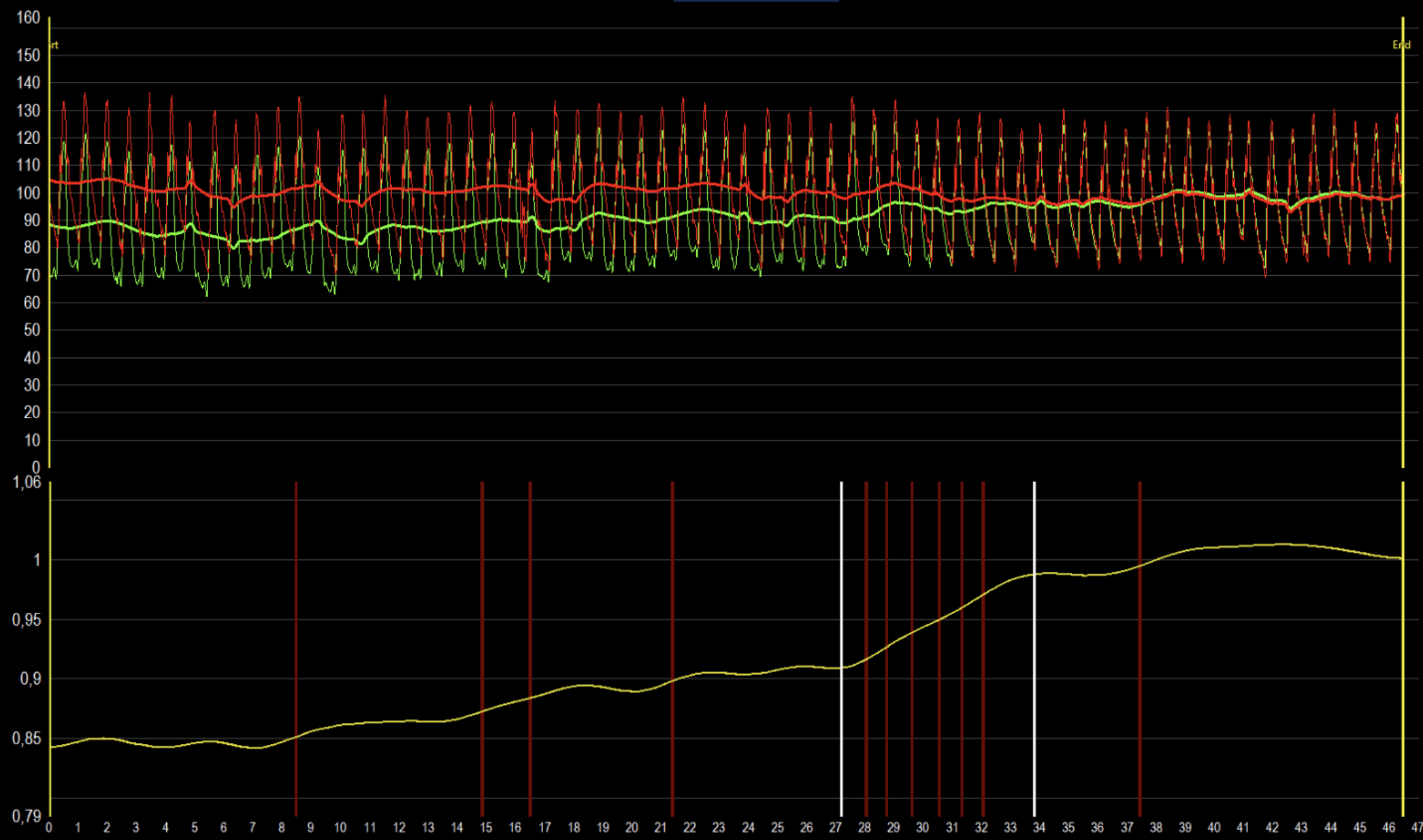
PPG = 1

- fokální postižení

PPG = 0

- difúzní postižení

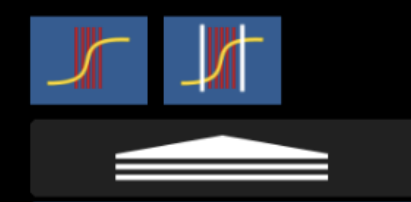





Start  
**0,85** 89 Pd  
105 Pa

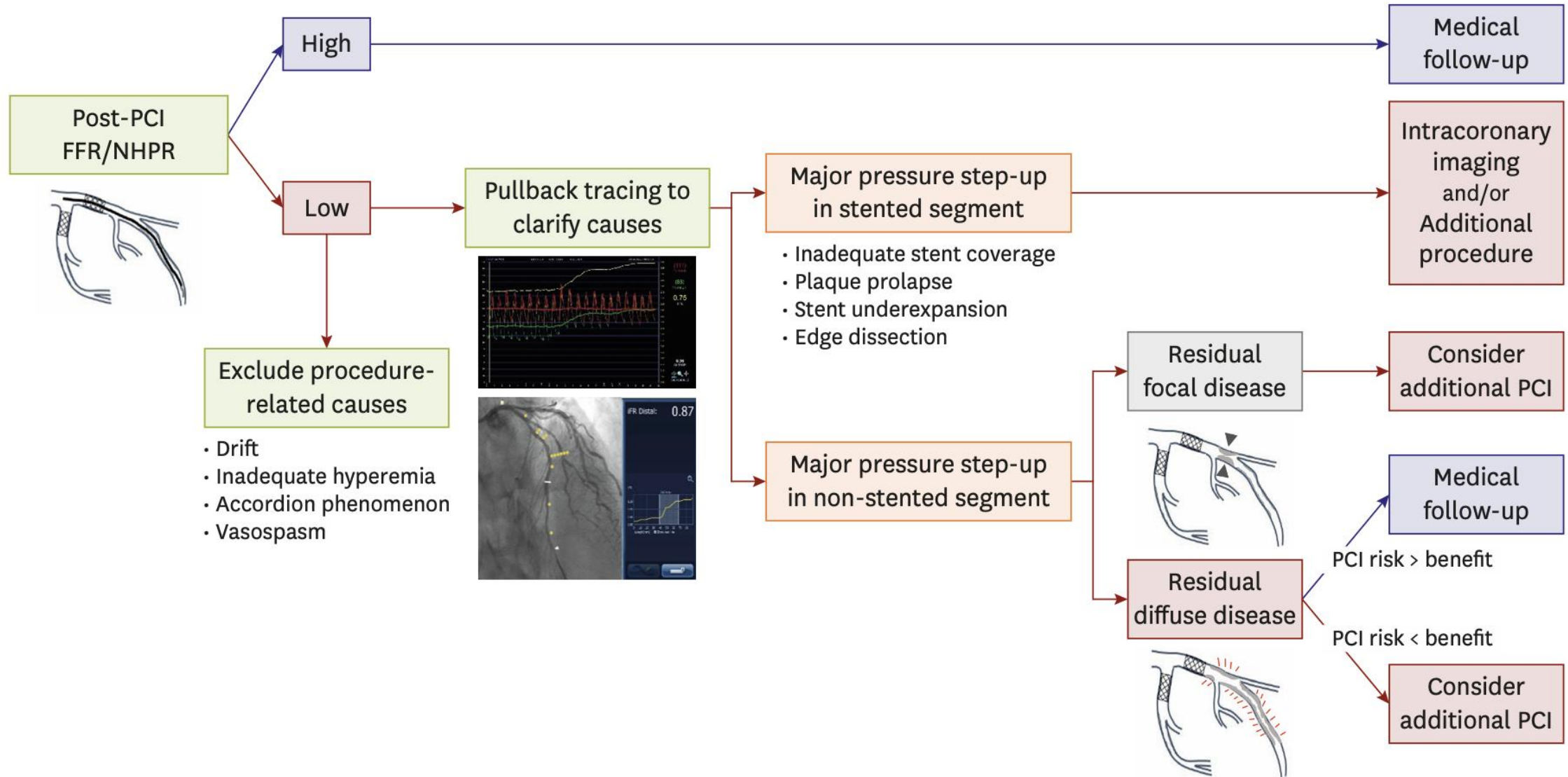
End  
**1,00** 99 Pd  
99 Pa

PPG  
**0,53**  $\Delta$  0,08  
% 50



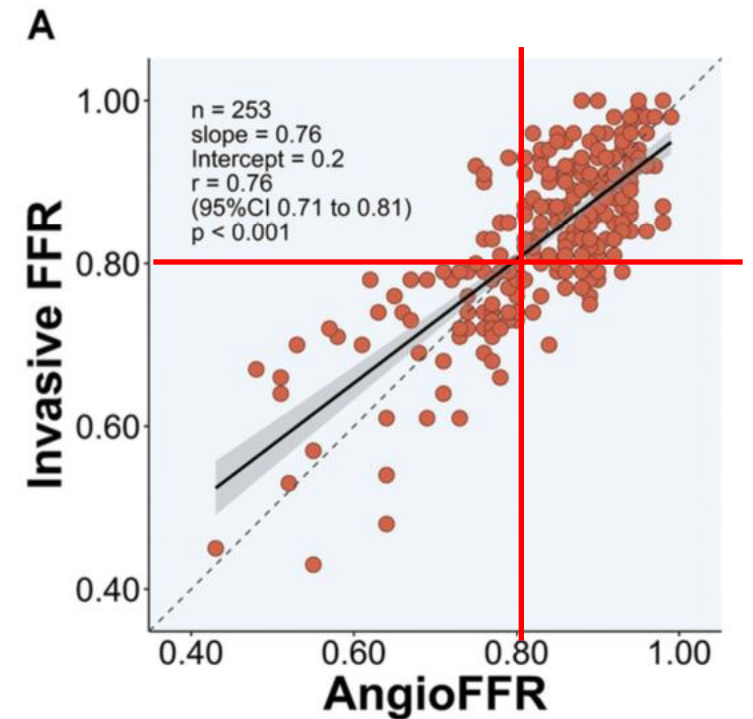
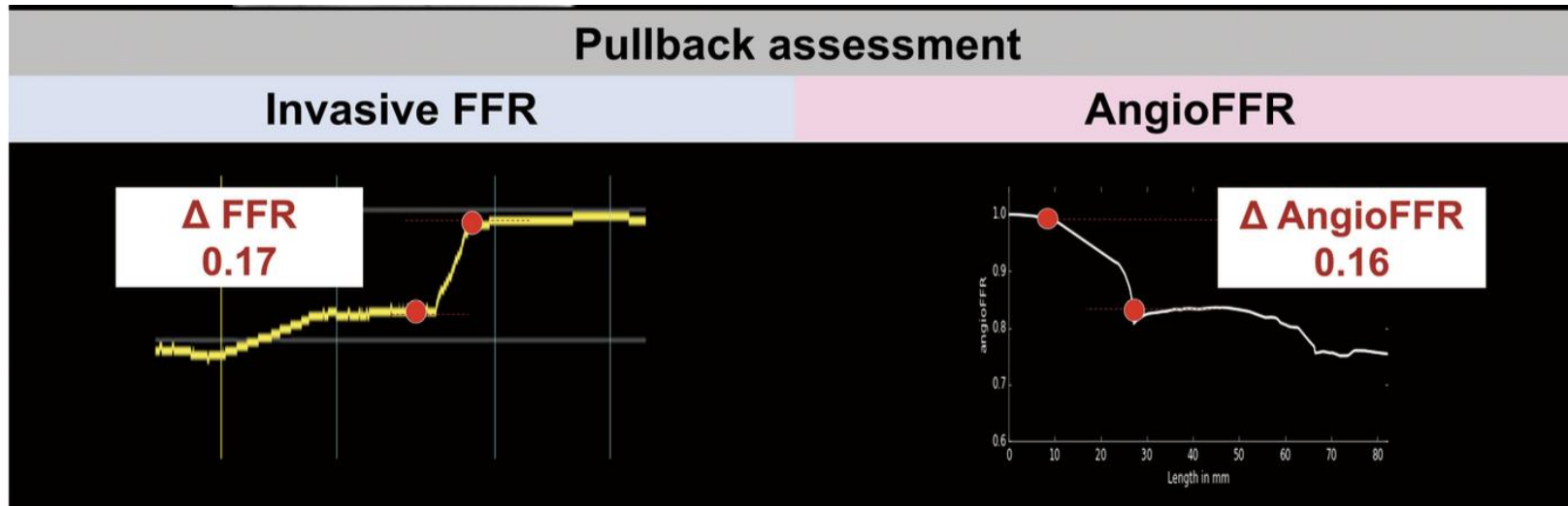
  
**Live >**

# Hodnocení FFR/NHI po provedené PCI



# Diagnostic Accuracy of Artificial Intelligence-Based Angiography-Derived Fractional Flow Reserve Using Pressure Wire-Based Fractional Flow Reserve as a Reference

Hiroyuki Omori, MD; Yoshiaki Kawase, MD; Takuya Mizukami, MD, PhD;



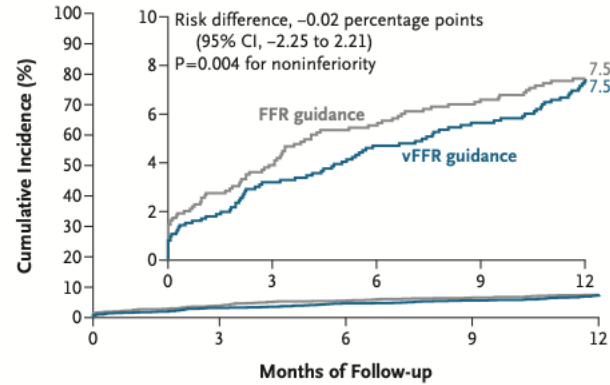
ORIGINAL ARTICLE

# Angiography-Based Physiology to Guide Coronary Revascularization

FAST III Investigators\*

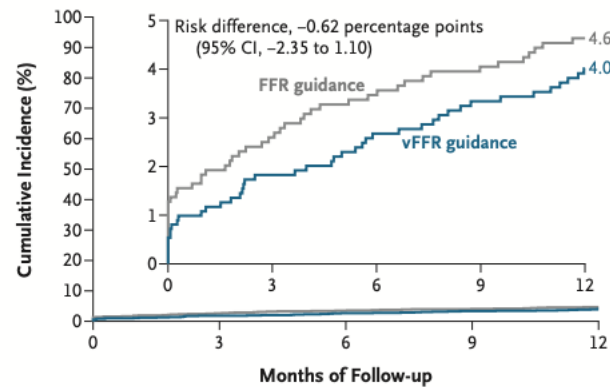
Joost Daemen, M.D., Ph.D.,<sup>1</sup> Jari A. van der Eijk, M.Sc.,<sup>1</sup> Marco Barbierato, M.D.,<sup>2</sup>

### A Death, Myocardial Infarction, or Revascularization



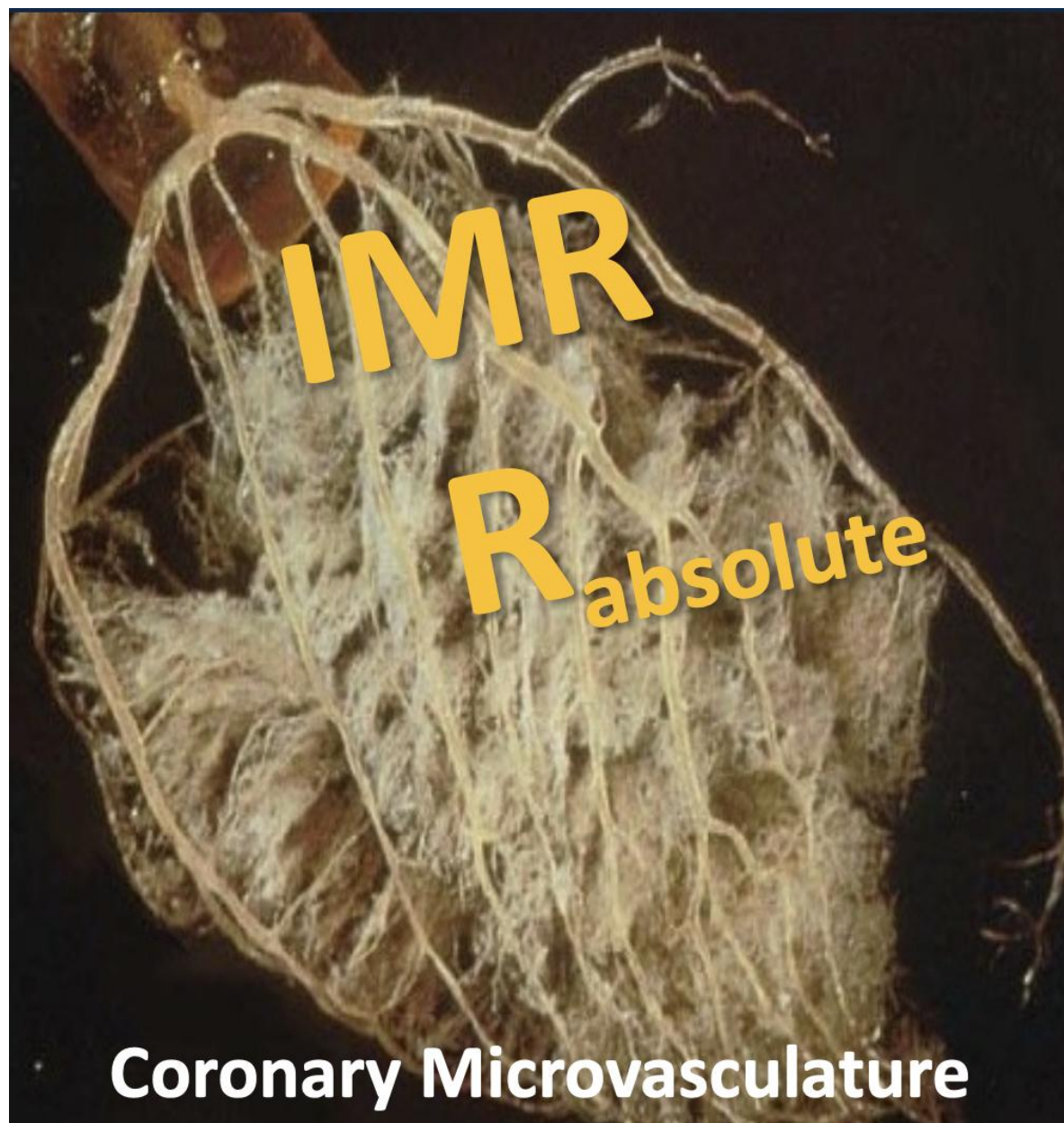
No. at Risk	0	3	6	9	12
FFR guidance	1095	999	981	969	953
vFFR guidance	1116	1033	1012	999	972

### B Study-Vessel Failure

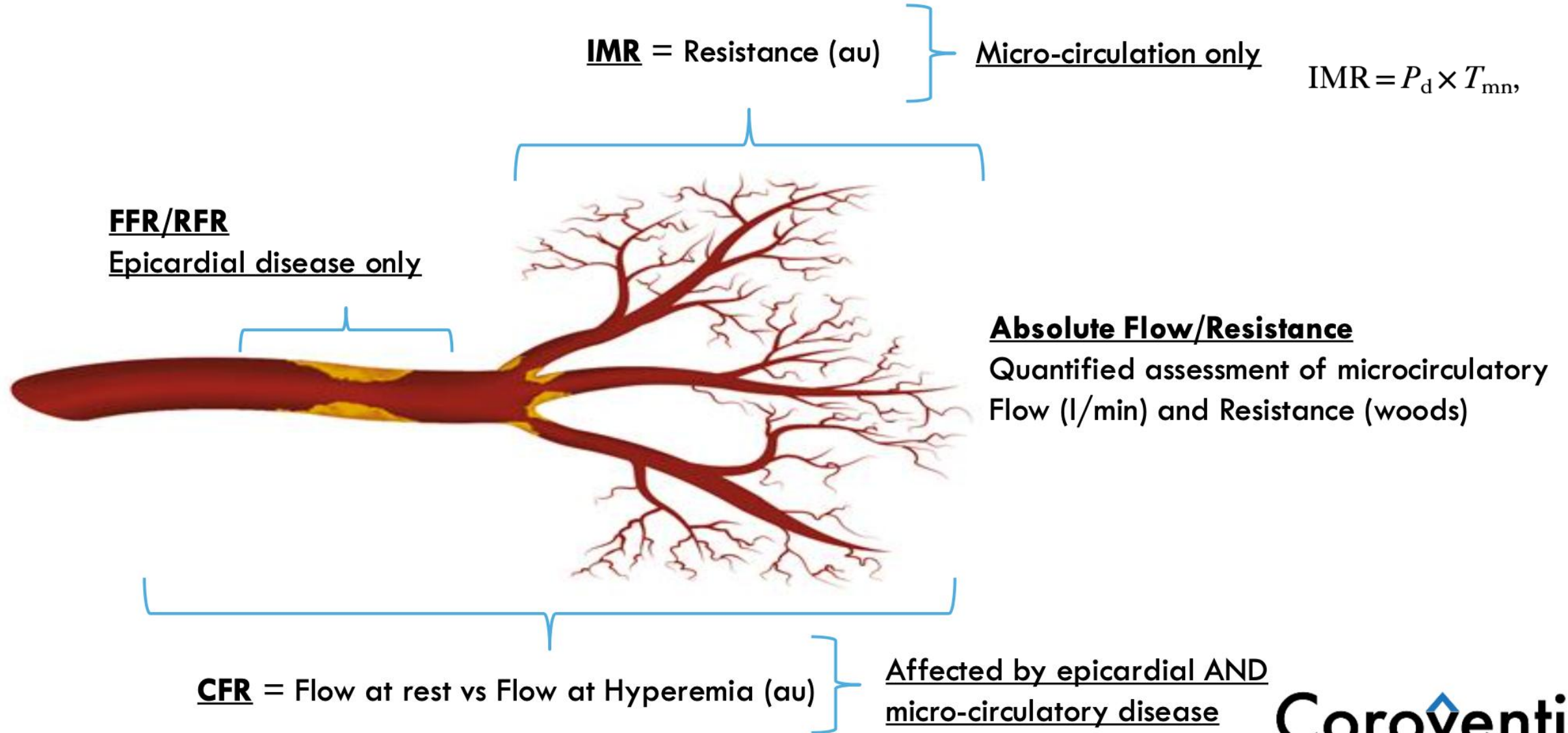


No. at Risk	0	3	6	9	12
FFR guidance	1095	1011	996	989	973
vFFR guidance	1116	1045	1029	1017	997

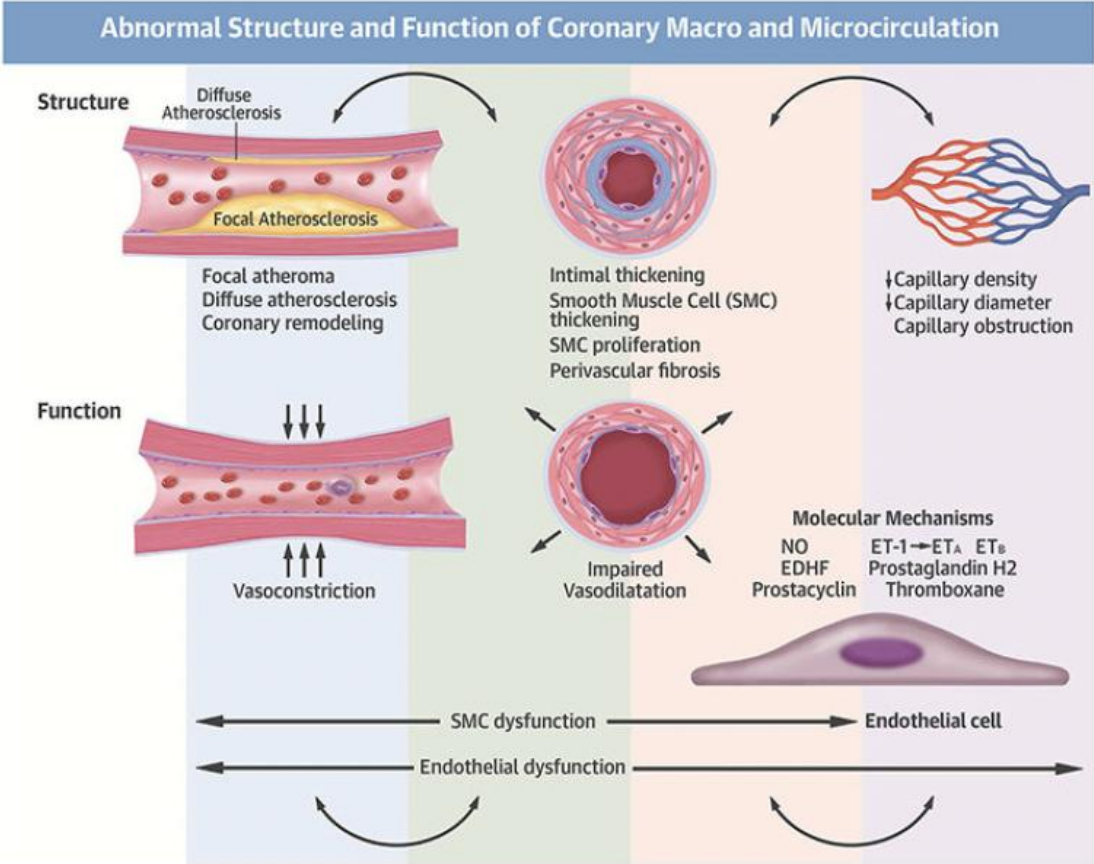
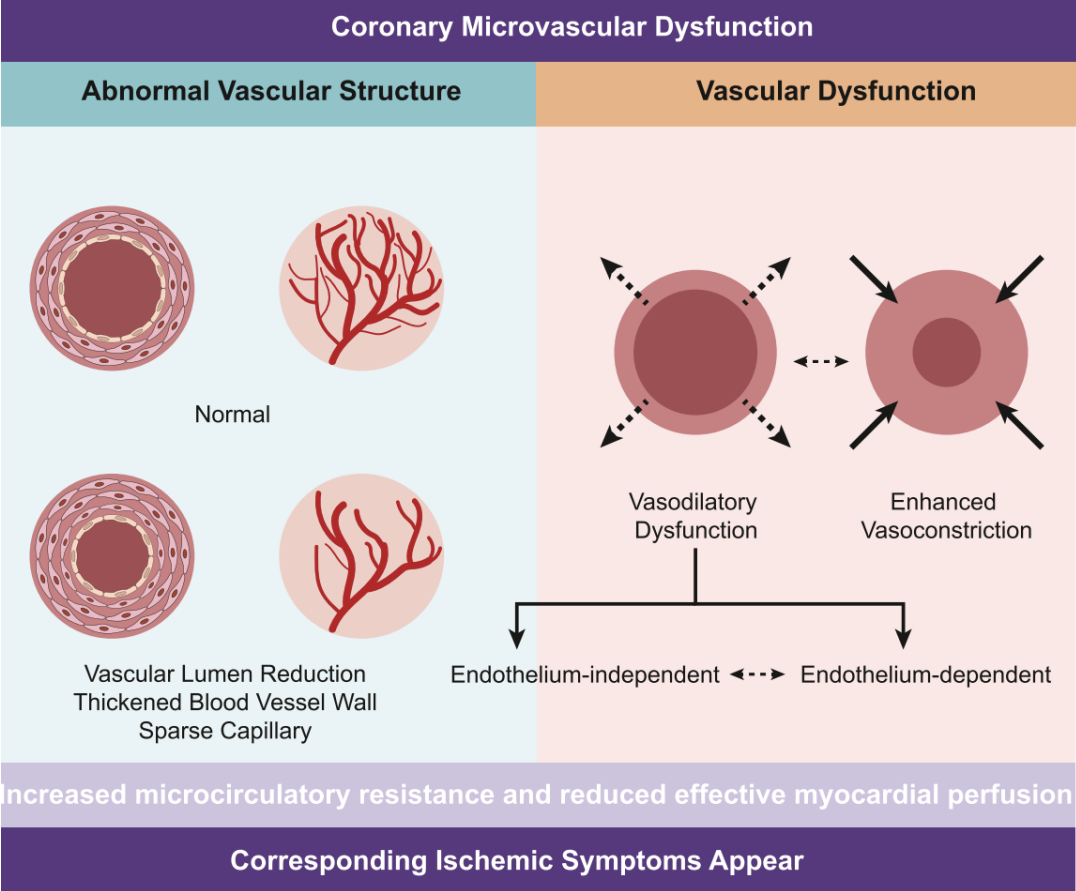
Mikrovaskulární  
postižení



# COMPLETE CARDIAC CHARACTERIZATION

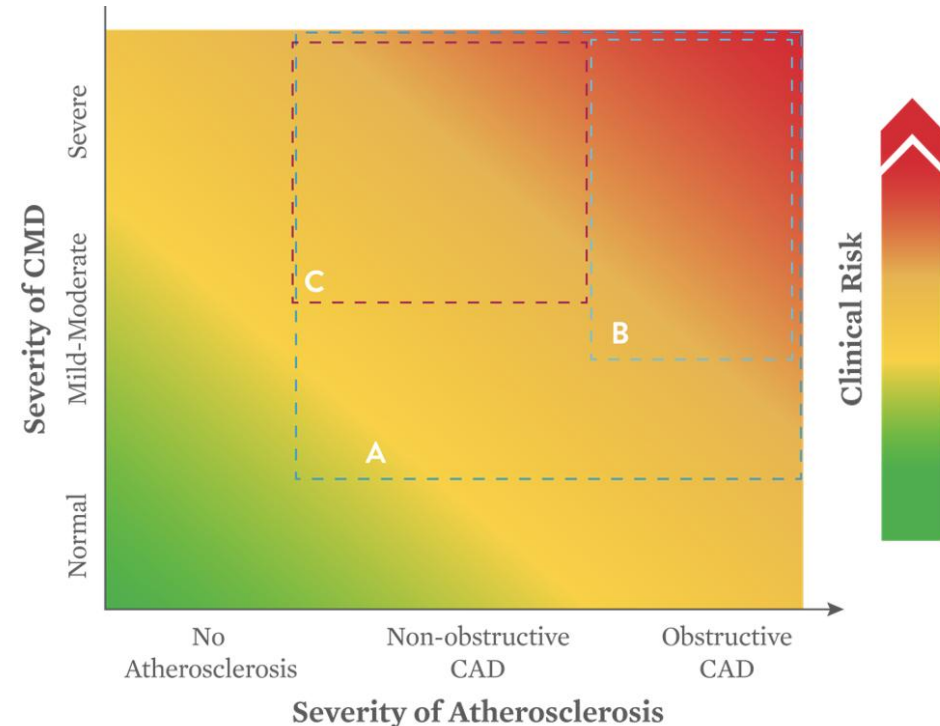
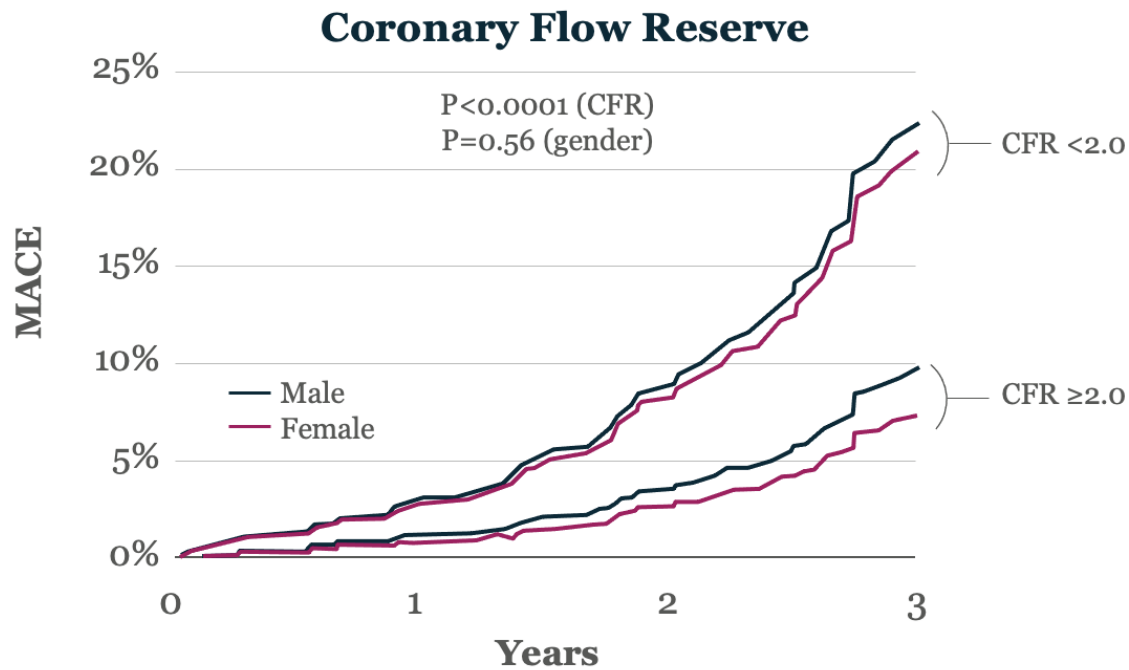


# Mikrovaskulární dysfunkce (CMD)



# Coronary microvascular dysfunction (CMD)

- INOCA – ischemia caused by non-obstructive coronary artery disease



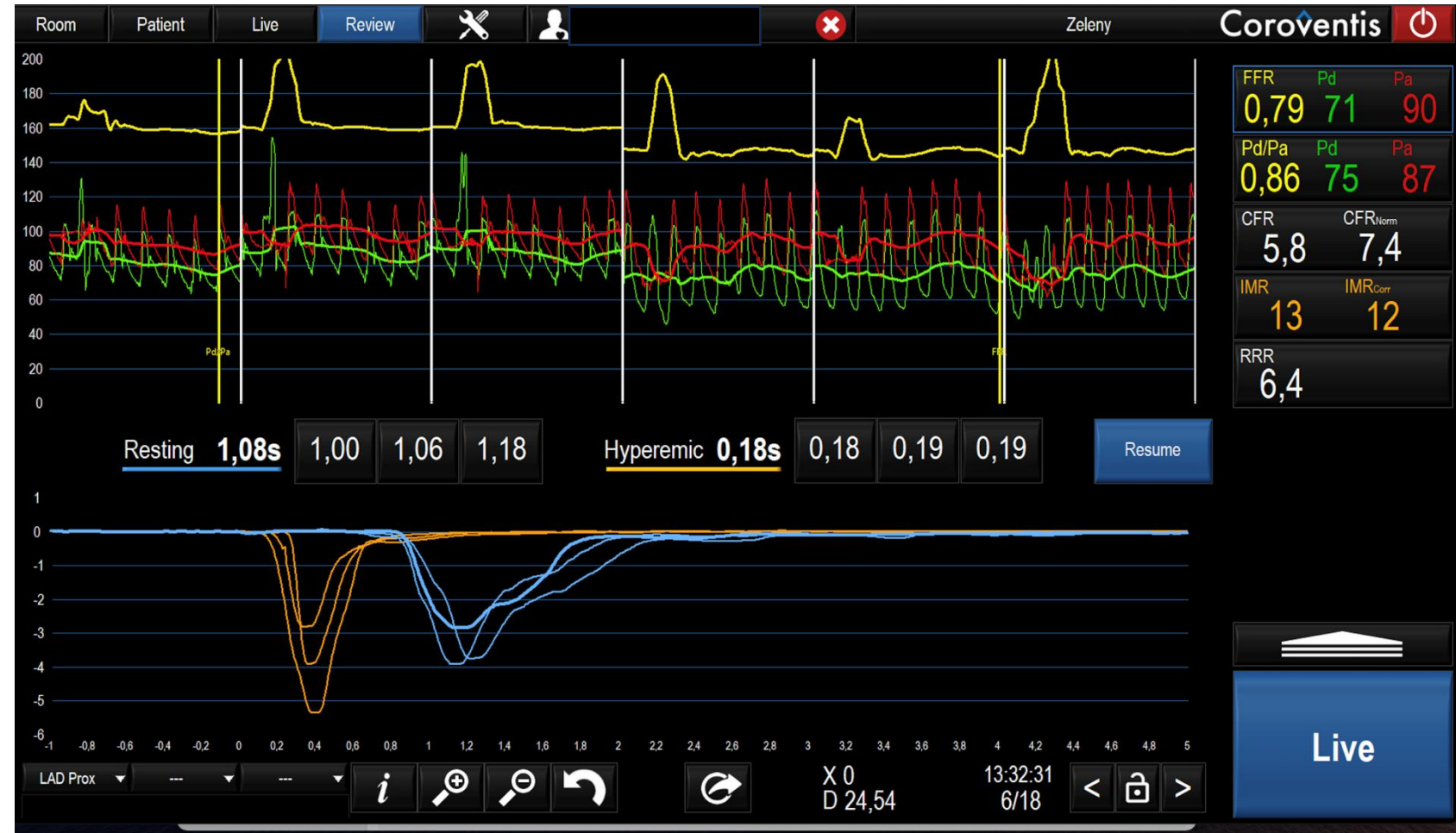
CFR/HSR/CFC should be considered as a complementary investigation; [359,360,366–368,376](#)

**IIa**

**B**

Taqueti. JACC 2018

# Měření CFR a IMR



$T_{mn}$ : mean transit time

CFR/HSR/CFC should be considered as a complementary investigation,<sup>359,360,366–368,376</sup>

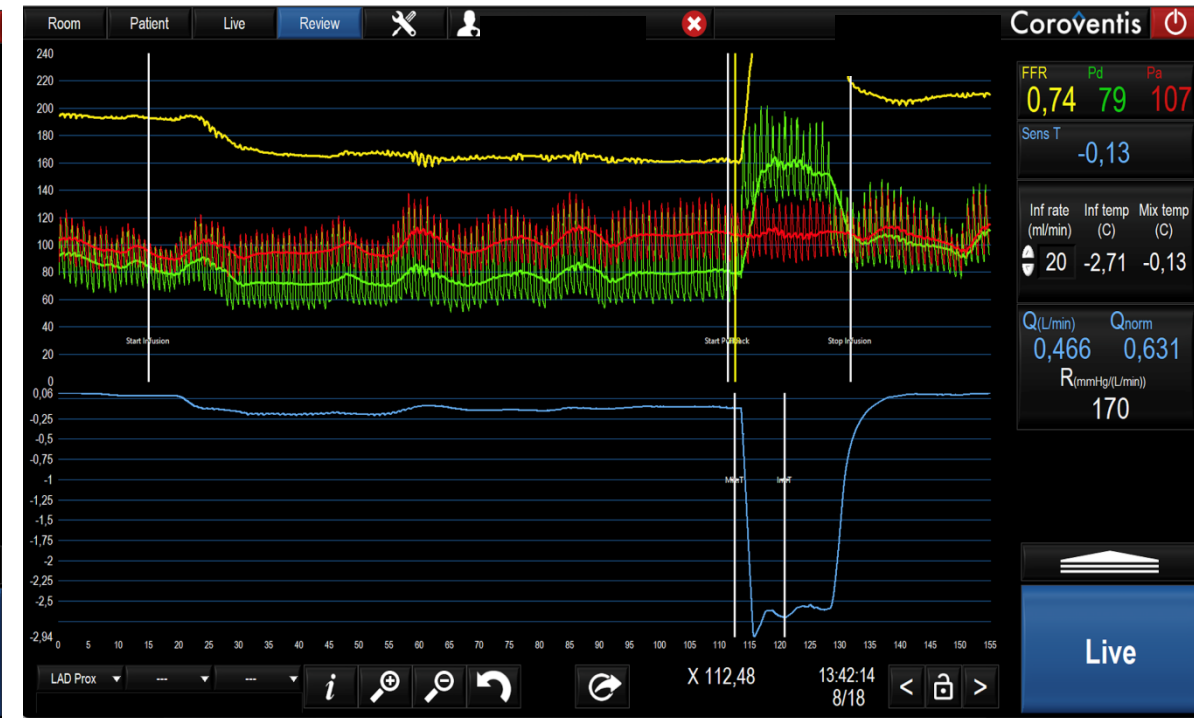
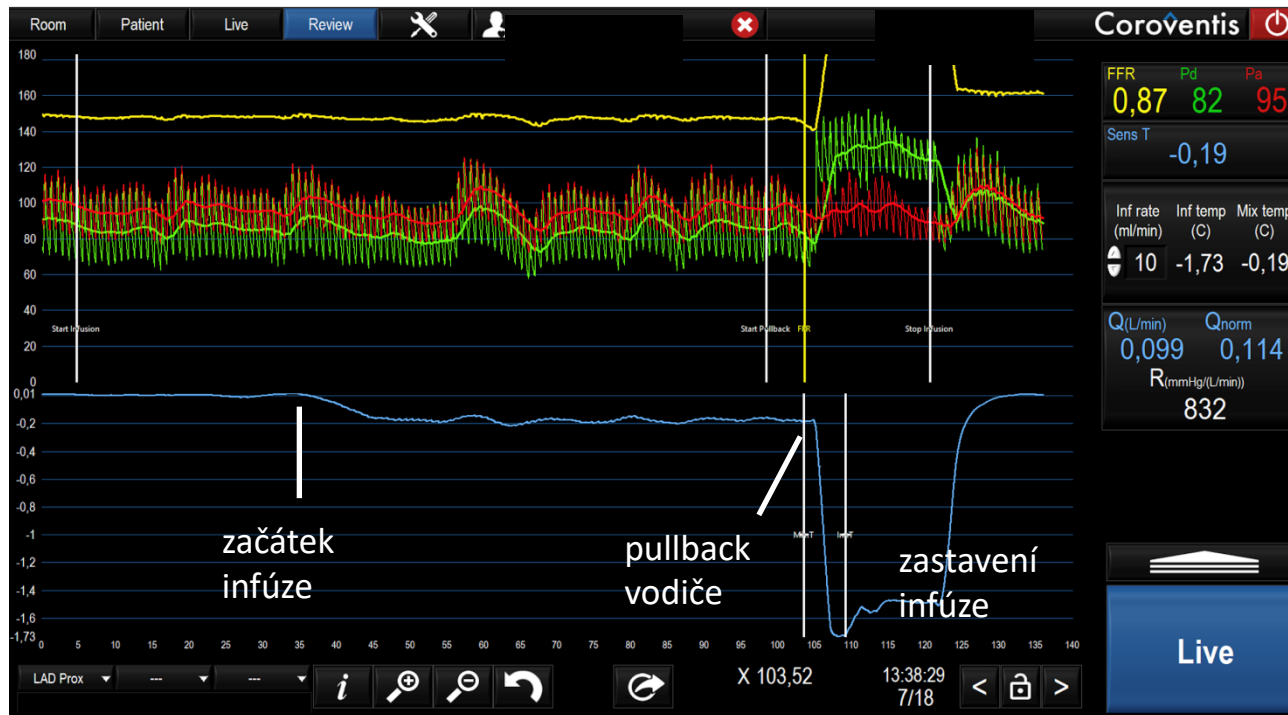
**Ila**

**B**

Kovárník T. Vnitř Lék 2020; 66(3): 152–159

# Měření absolutního průtoku

- bez adenosinu, kontinuální infuze FR do koronární tepny



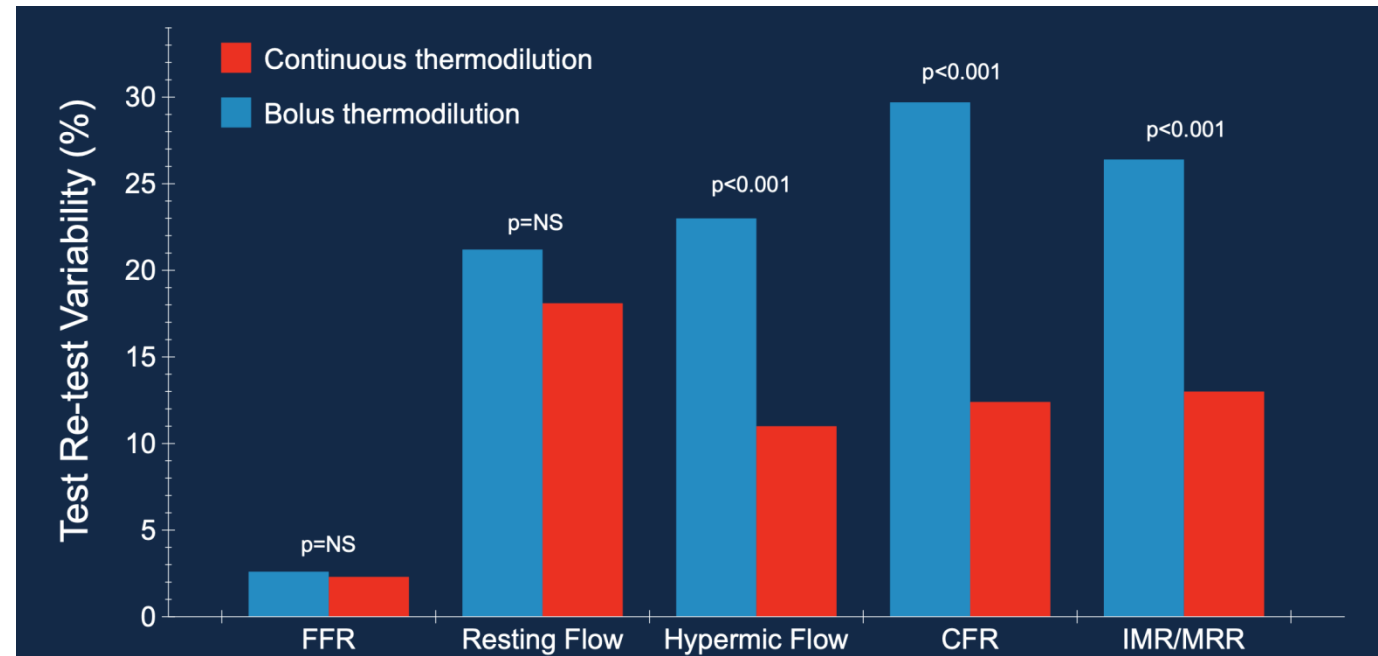
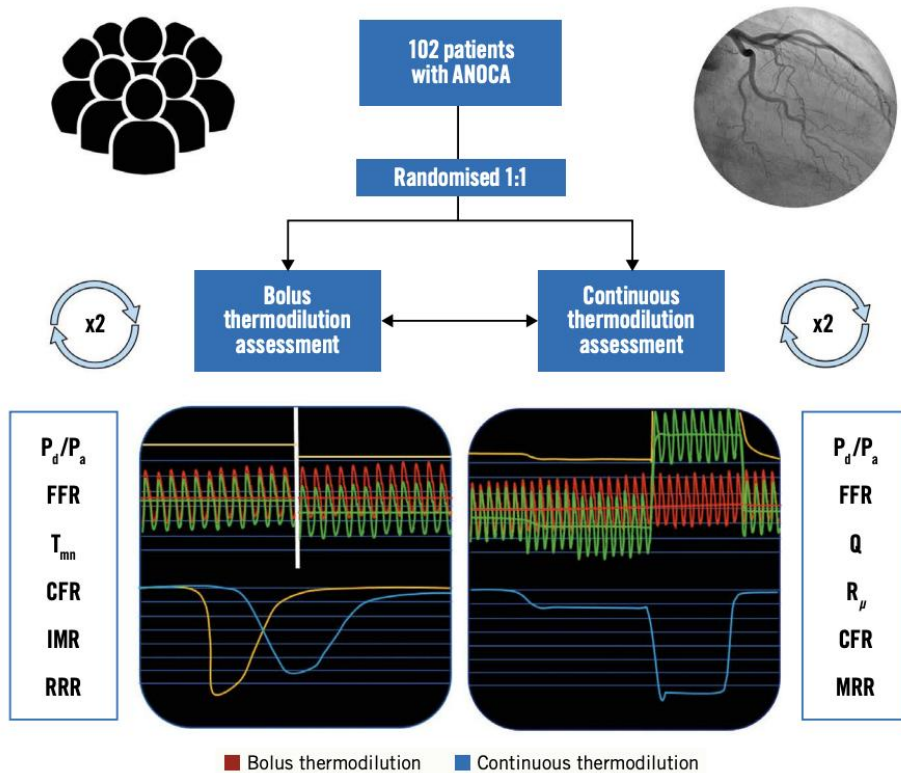
$$CFR = Q_{max} / Q_{rest}$$

$$MRR = \frac{Q_{max}}{Q_{rest}} \cdot \frac{P_{a,hyp}}{P_{d,hyp}} \cdot \frac{P_{d,rest}}{P_{a,rest}}$$

MRR > 2.7-3.0 – normální mikrocirkulace

MRR < 2.1- 2.3 – mikrovaskulární dysfunkce

# Bolusová vs kontinuální termodiluce



## 🫀 Effect of Acetylcholine on Coronary Perfusion

### Dual (Paradoxical) Effect Depending on Endothelial Function

#### ✅ Normal Endothelium

- Acetylcholine stimulates M3 receptors on endothelium
- → Release of nitric oxide (NO)
- → Vasodilation of coronary arteries
- → ↑ Coronary blood flow (perfusion)

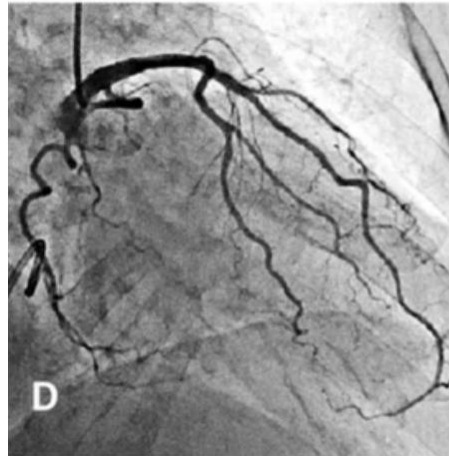
👉 Result: Improved myocardial perfusion

#### ⚠️ Endothelial Dysfunction

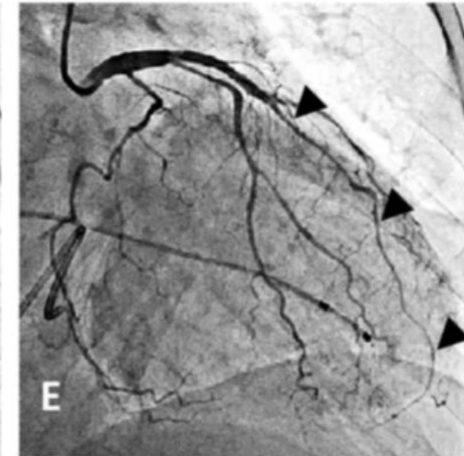
- Impaired NO production
- Acetylcholine acts directly on vascular smooth muscle
- → Vasoconstriction / coronary spasm
- → ↓ Coronary perfusion

👉 Result: Myocardial ischemia (e.g., vasospastic angina)

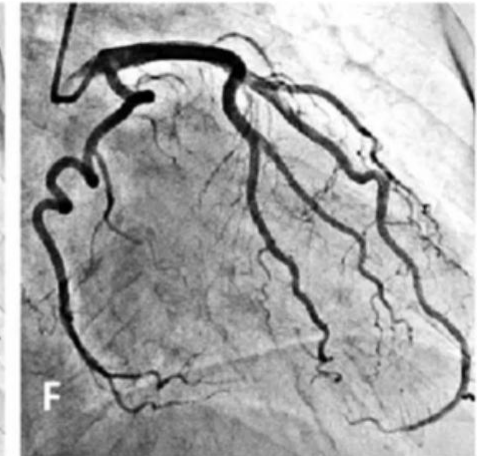
#### Diffuse spasm pattern



Control CAG



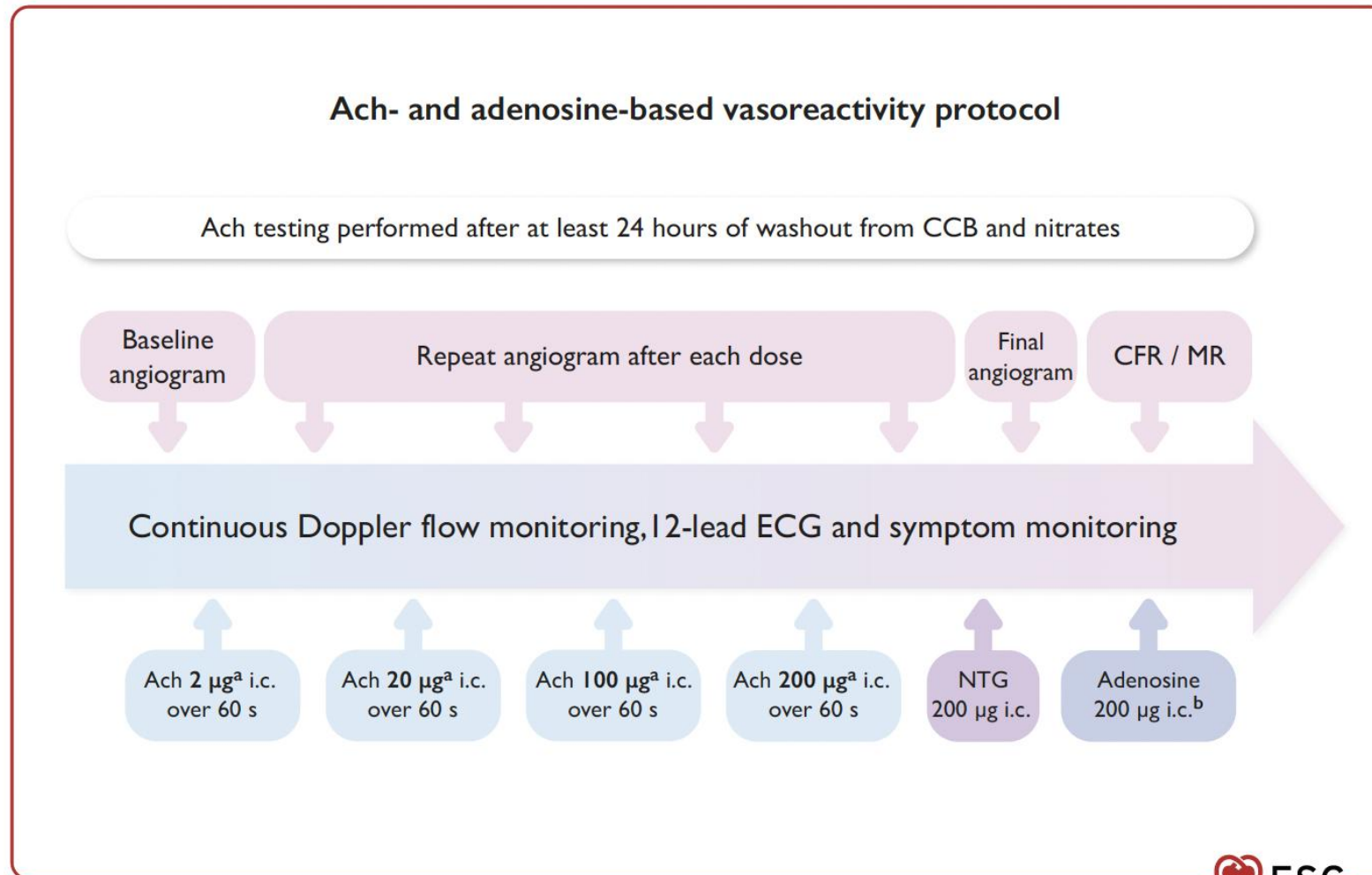
Acetylcholine 100µg



Nitroglycerin

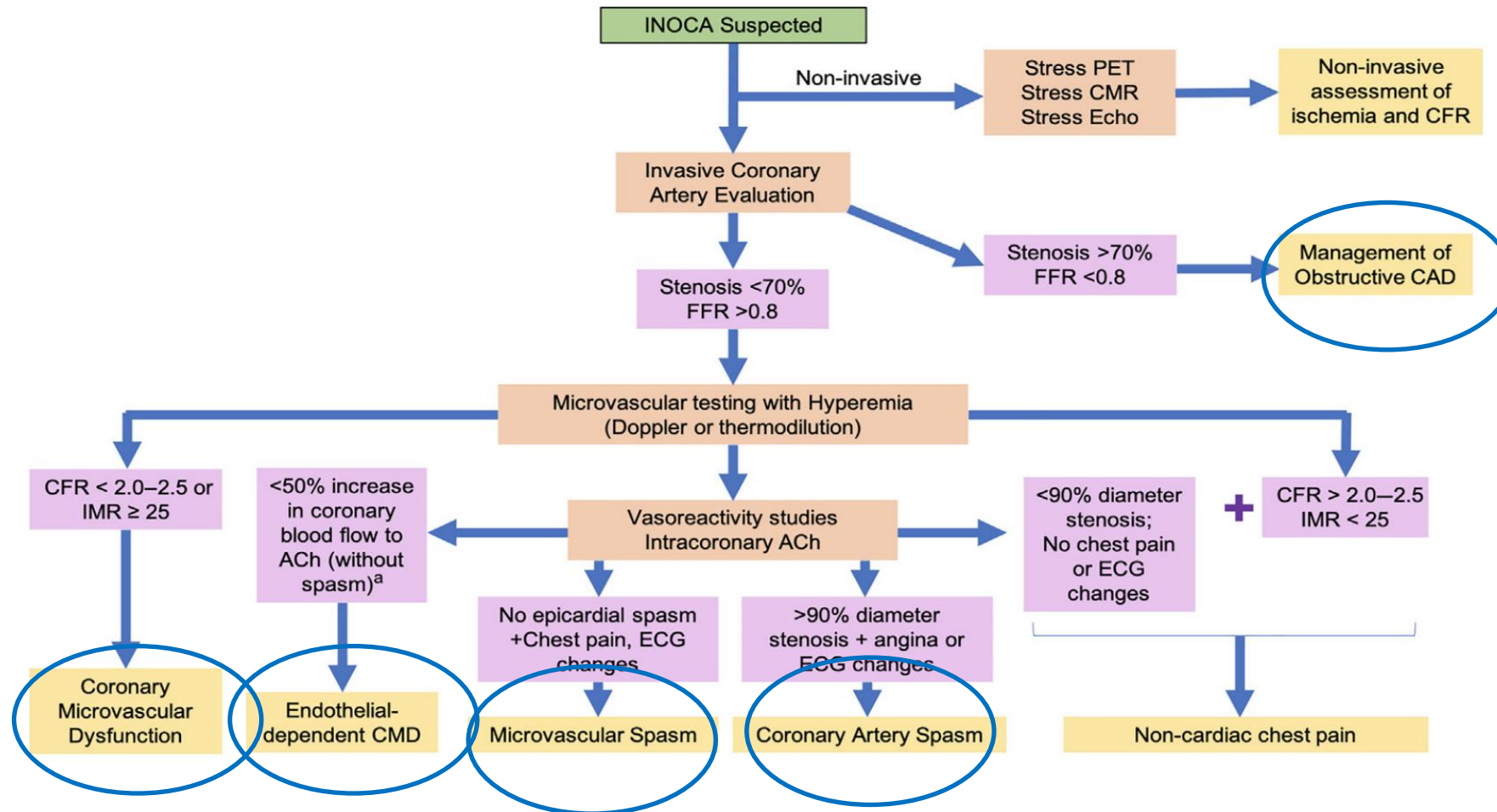
Sato K. JAHA 2013;e000227

# Testování koronární vasoreaktivity za použití intrakoronární aplikace acetylcholinu



# Beyond Coronary Artery Disease

## Assessing the Microcirculation



# Závěr

Invazivní funkční vyšetření má v aktuálních ESC doporučení třídu doporučení IA

Komplexní vyšetření zahrnující vyšetření koronární mikrocirkulace má úroveň doporučení IIA

Je patrna renesance testování koronární vasoreaktivity za použití intrakoronární aplikace acetylcholinu

Zásadním problémem zůstává terapeutický přístup u pacientů s prokázanou mikrovaskulární dysfunkcí





ČESKÁ ASOCIACE INTERVENČNÍ KARDIOLOGIE

# 16. ročník WORKSHOP OCT, IVUS, NIRS, FFR/iFR, RFR

Akce konaná pod záštitou České asociace intervenční kardiologie

Dne **11. 2. 2027, 9.00 – 16.00 hodin**

Kardiocentrum CINRE, Nemocnica Bory, Ul. Ivana Kadlečíka 6851/2, 841 03 Bratislava IV, SK

