

EUROPEAN HEART HOUSE

Coronary Physiology in the Catheterization Laboratory (8th Edition)

Thursday, April 24 – Saturday, April 26, 2014

Course Directors:

B. De Bruyne (BE), W.F. Fearon (US), N.H.J. Pijls (NL)

Faculty:

E. Barbato (BE), N. Curzen (UK), D. Duncker (NL), J. Escaned (SP), F. Hernández (SP), A. Jeremias (US), N. Johnson (US), J. Legutko (PL), B. Norgaard (DK), K.G. Oldroyd (UK), Z. Piroth (HU), C. Rogers (US), P.A.L. Tonino (NL), G. Toth (BE), W. Wijns (BE)



Clinical case in perspective

Cases from Poland

Assoc. Prof. Jacek Legutko, MD, PhD

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Fractional Flow Reserve (FFR)

ESC Guidelines Recommendations

Guidelines on myocardial revascularization

FFR-guided PCI is recommended for detection of ischaemia-related lesion(s) when objective evidence of vessel-related ischaemia is not available.

I

A

Wijns W, et al. Eur Heart J 2010; 31:2501–2555

ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

In lesions whose severity is difficult to assess, intravascular ultrasound or fractional flow reserve (FFR) measurements carried out 5 days after the index event are useful in order to decide on the treatment strategy

Hamm CW, et al. Eur Heart J 2011; 32:2999–3054

2013 ESC guidelines on the management of stable coronary artery disease

FFR is recommended to identify hemodynamically relevant coronary lesion(s) when evidence of ischaemia is not available.

I

A

Revascularization of an angiographically intermediate stenosis without related ischaemia or without FFR <0.80 is not recommended.

III

B

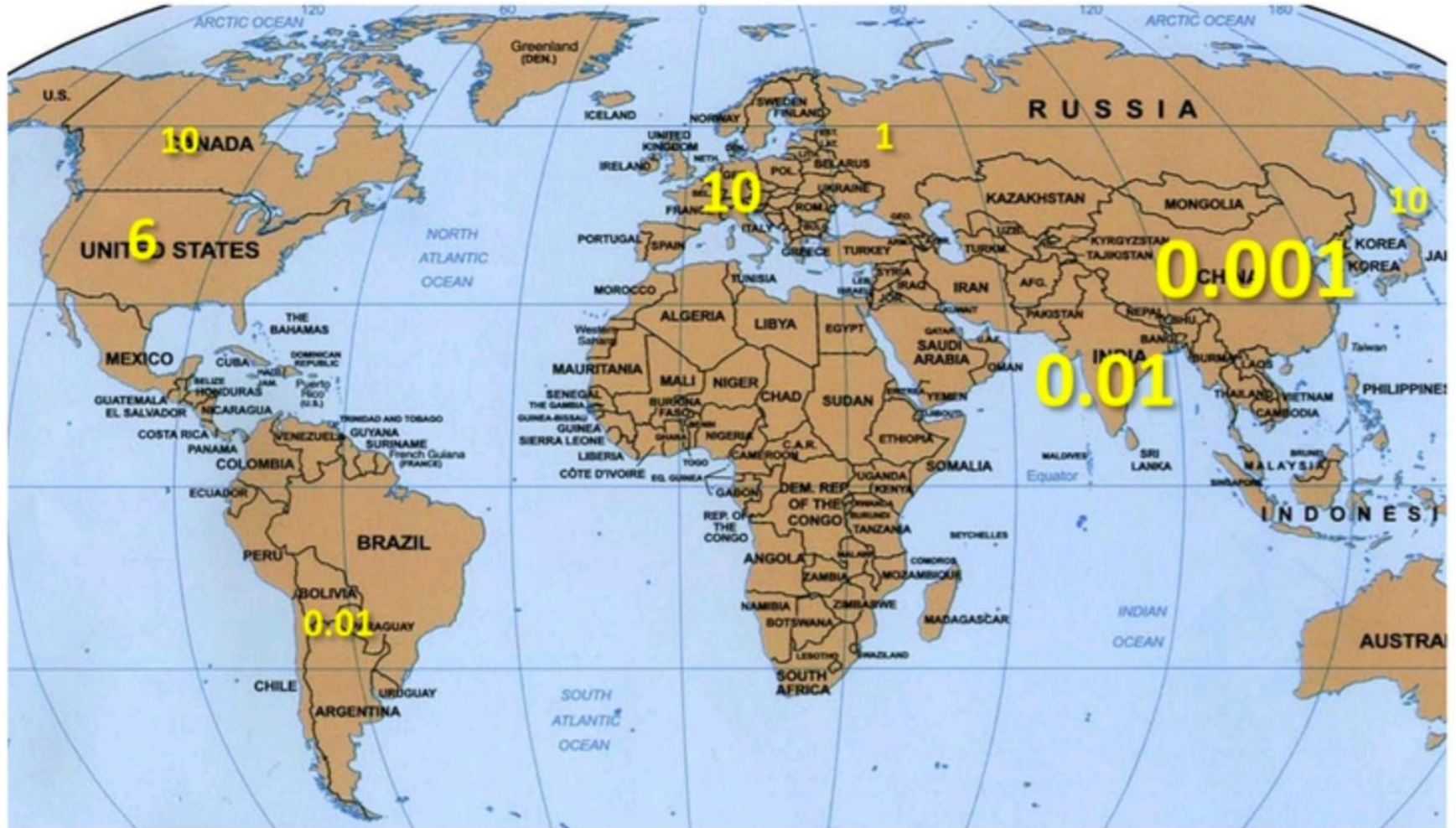
Revascularization of stenoses with FFR <0.80 is recommended in patients with angina symptoms or a positive stress test.

I

B

Montalescot G, et al. Eur Heart J 2013;4,2949–3003

Global adoption of FFR



Rough estimate of FFR adoption in different regions of the world. Figures show % of FFR adoption in clinical practice (not p values!)

Case presentation

Demography:

Age: 60 y.

Sex: female

Past Medical History:

Post MI: No

Post CABG: No

Post PCI: No

Risk Factors:

Diabetes: Yes (insulin)

Hypertension: Yes

Dyslipidemia: Yes

Smoking: Yes

Family history of CAD: No

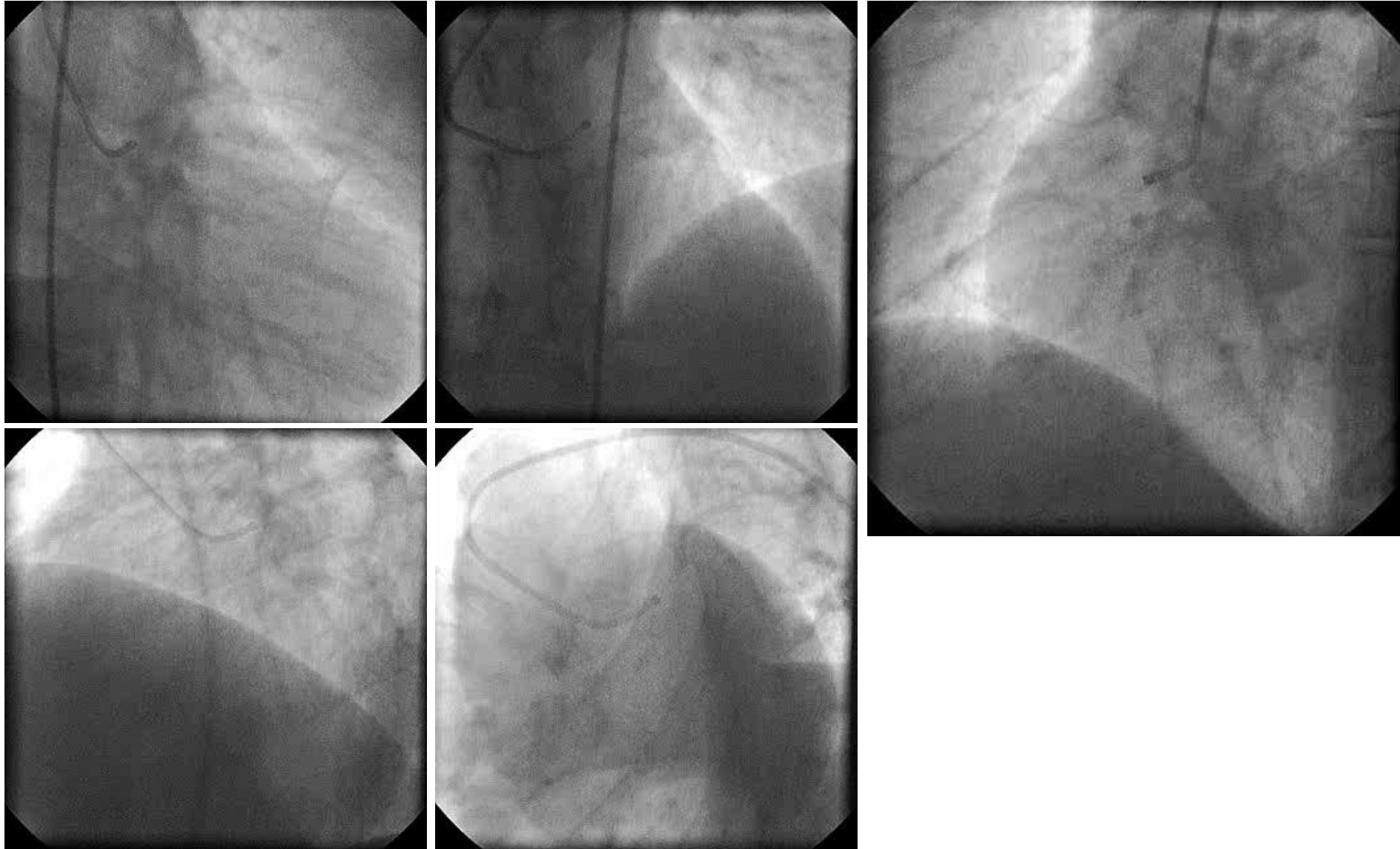
Clinical presentation (20.10.2009):

Directly transferred to the cathlab by an ambulance

STEMI inf.; ST \uparrow - II, III, aVF; ST \downarrow - I, aVL, V1-V3

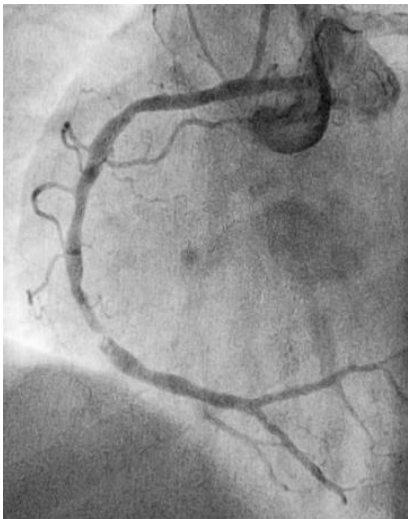
Coronary angiography – 20.10.2009

STEMI inf.

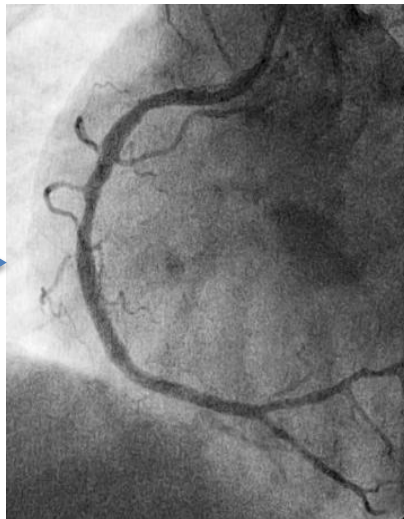


Primary PCI: RCA – 20.10.2009

- Direct stenting, BMS 3,5 x 19 mm, 14 atm
- TIMI-3



BMS



How to treat this patient?

1. Optimal Medical Therapy (OMT) ?
2. Elective PCI: CX at second stage + OMT ?
3. Invasive assessment (IVUS, FFR) of the left main ?
4. CABG ?

How to treat this patient?

1. Optimal Medical Therapy (OMT) ?

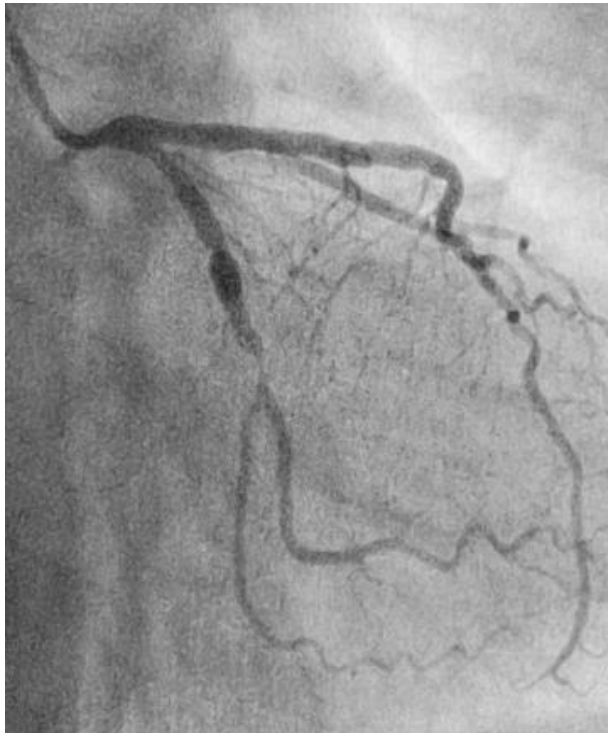
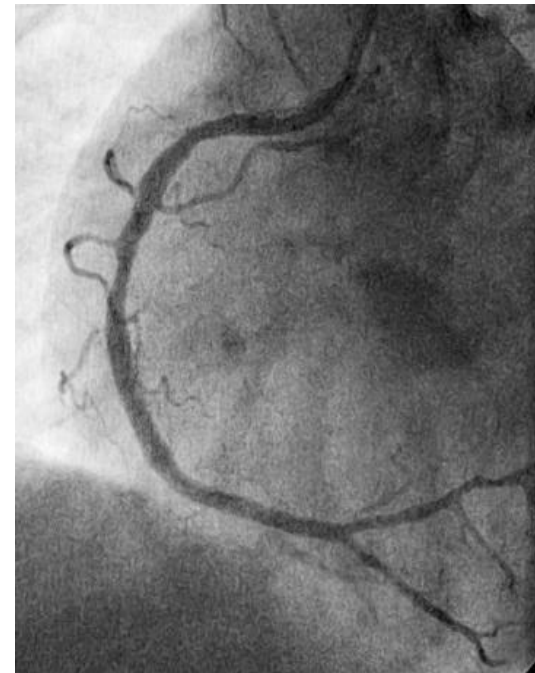
2. Elective PCI: CX at second stage + OMT ?

3. Invasive assessment (IVUS, FFR) of the left main ?

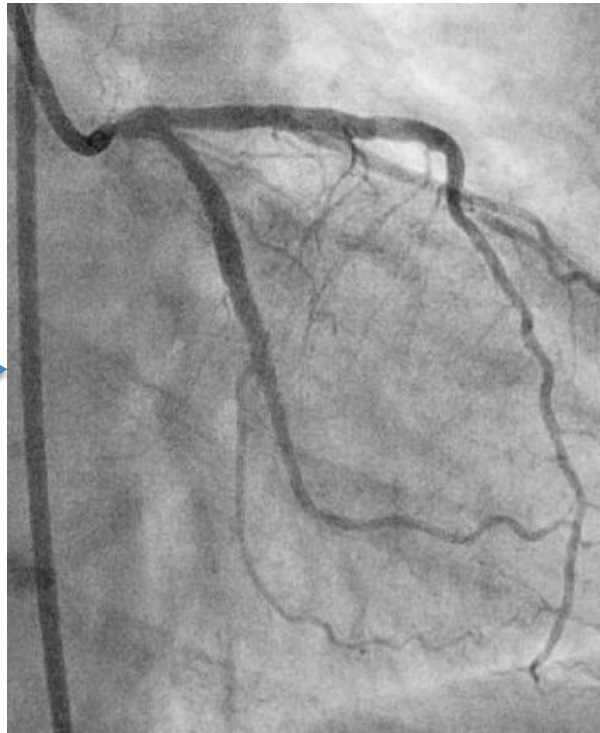
4. CABG ?

PCI: CX – 9.11.2009

- Stable angina CCS II, EF=50%
- Optimal result of pPCI: RCA
- DES 3,0 x 28 mm, 14 atm



DES

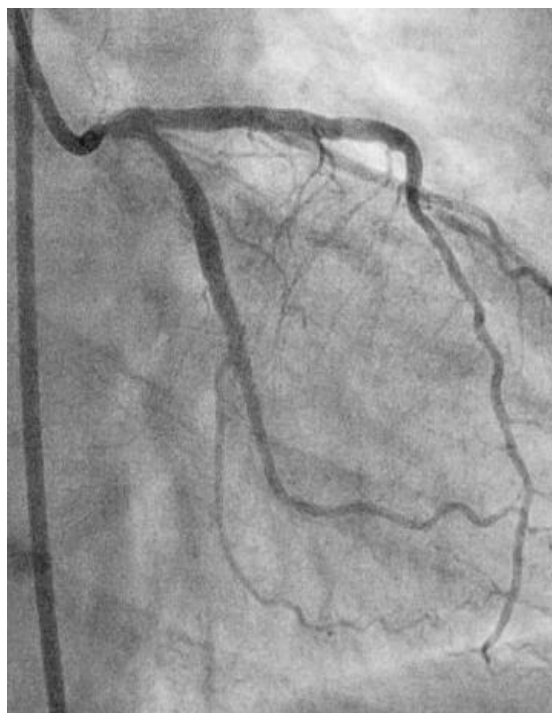
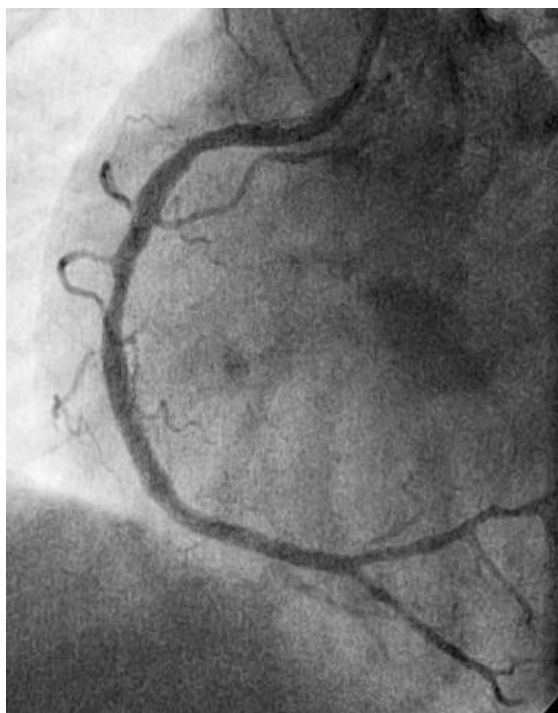


Optimal Medical Therapy

- Aspirin 75 mg
- Clopidogrel 75 mg
- Bisoprolol 10 mg
- Perindopril 10 mg
- Atorvastatin 80 mg
- Pantoprazol 20 mg
- Insulin

Repeat hospitalization – 24.06.2010

- Stable angina CCS II/III, EF=50%
- Optimal Medical Therapy
- **Optimal result of pPCI: RCA and CX**
- **No disease progression by angiography**



How to treat this patient?

1. Optimal Medical Therapy (OMT) ?
2. Invasive assessment (FFR, IVUS) of the left main ?
3. PCI: LMCA + OMT ?
4. CABG ?

How to treat this patient?

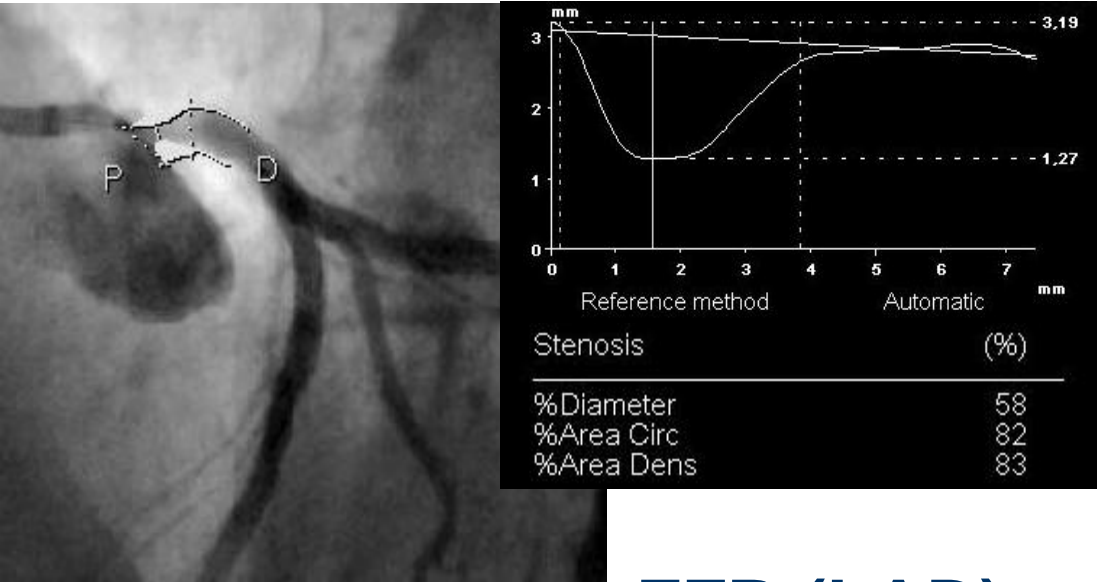
1. Optimal Medical Therapy (OMT) ?

2. Invasive assessment (FFR, IVUS) of the left main

3. PCI: LMCA + OMT ?

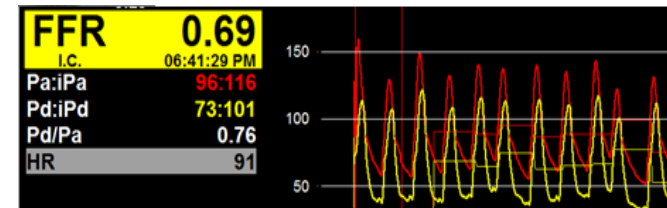
4. CABG ?

FFR and IVUS: LMCA



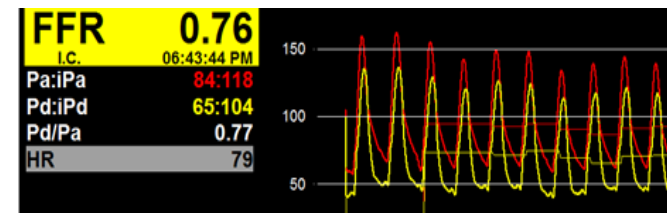
FFR (LAD) = 0,69

Adenosine i.v. infusion,
(180 µg/kg/min.)

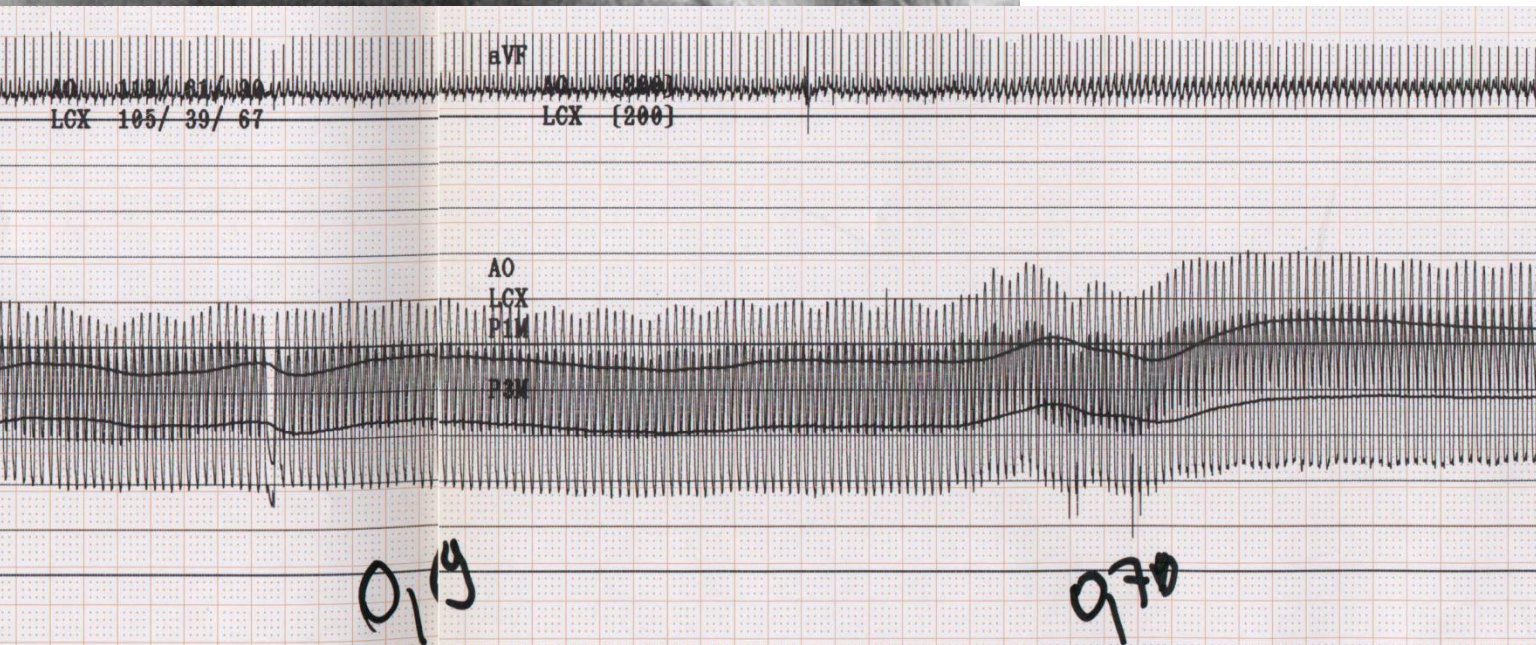


FFR (LCX) = 0,76

Adenosine i.v. infusion,
(180 µg/kg/min.)

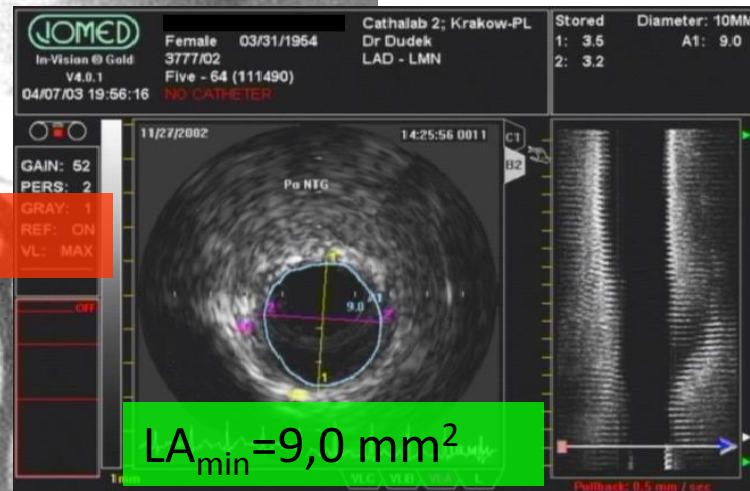


Ostial left main stenosis – FFR vs. IVUS

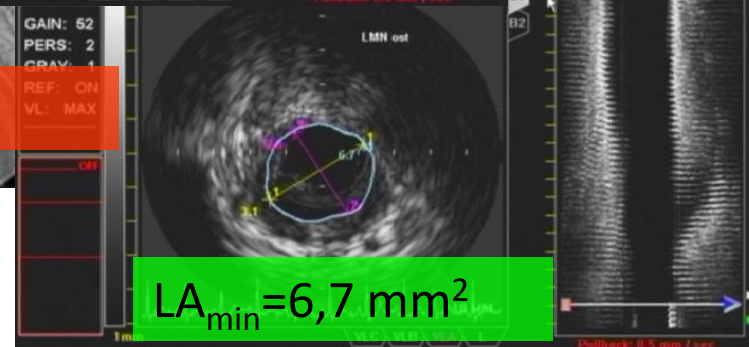


Ostial left main stenosis – FFR vs. IVUS

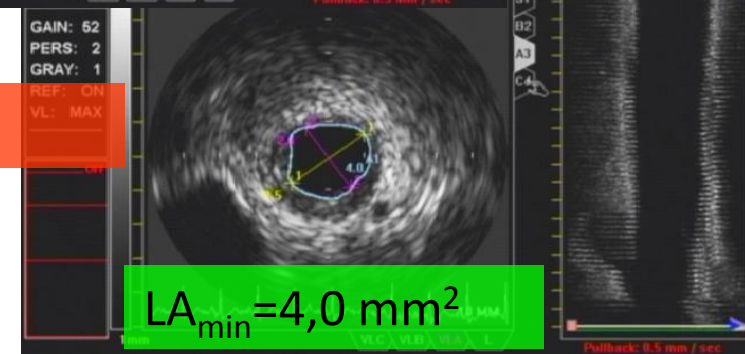
NTG i.c. bolus of 1000 μg



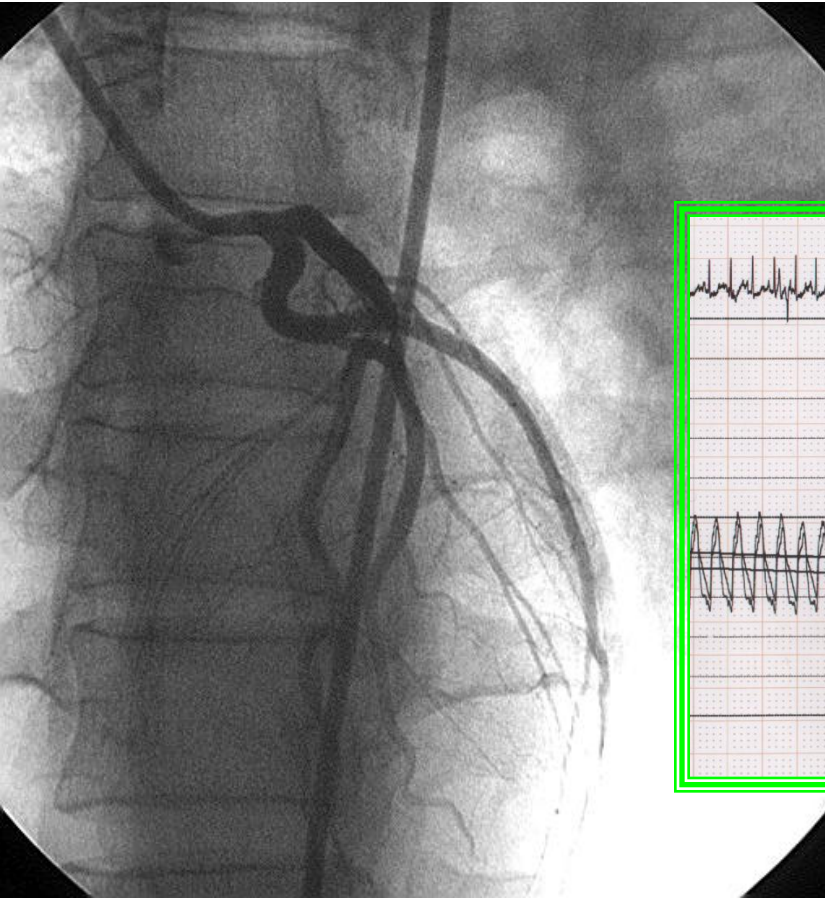
NTG i.c. bolus of 500 μg



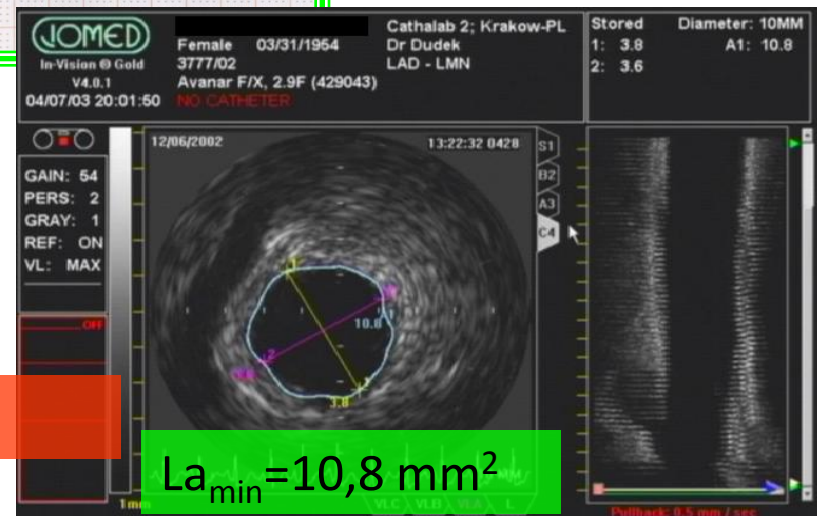
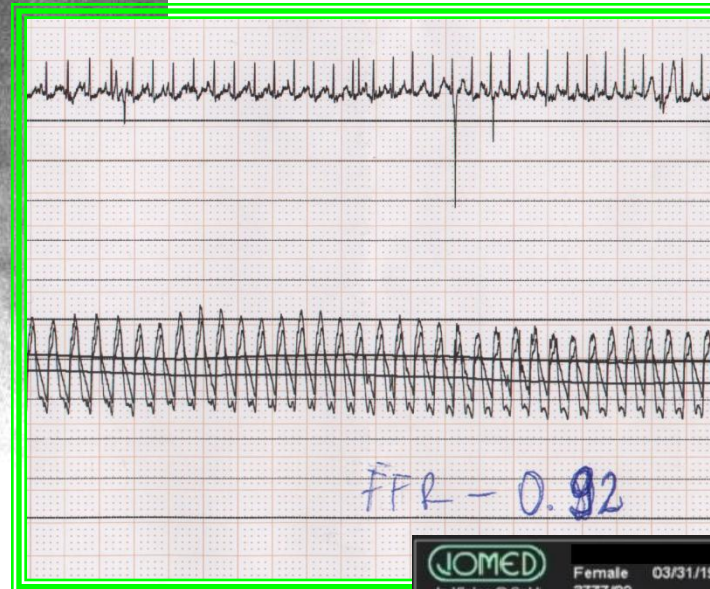
NTG i.c. bolus of 250 μg



Ostial left main stenosis – FFR vs. IVUS



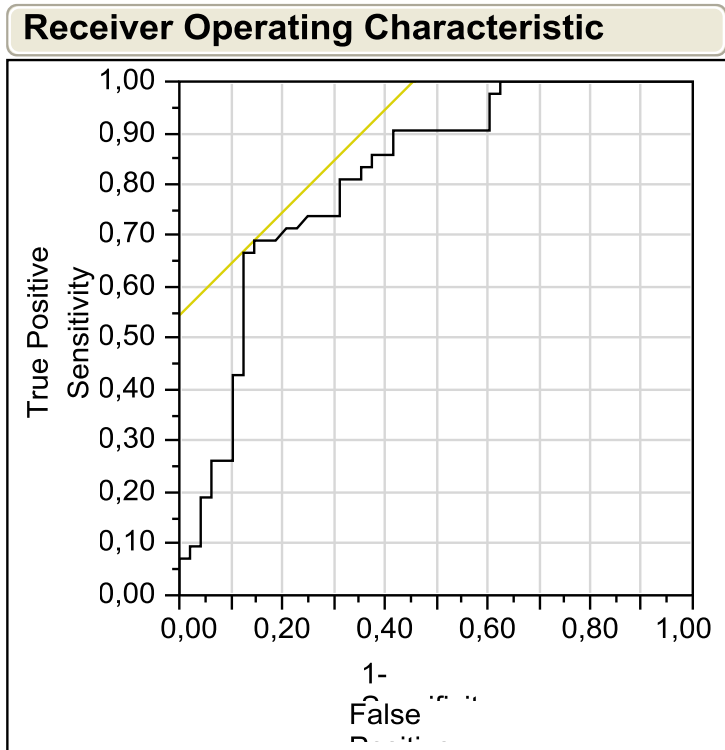
1 year follow-up



NTG ic bolus of 250 μg

Borderline Left Main Stenosis

Comparison of FFR and IVUS



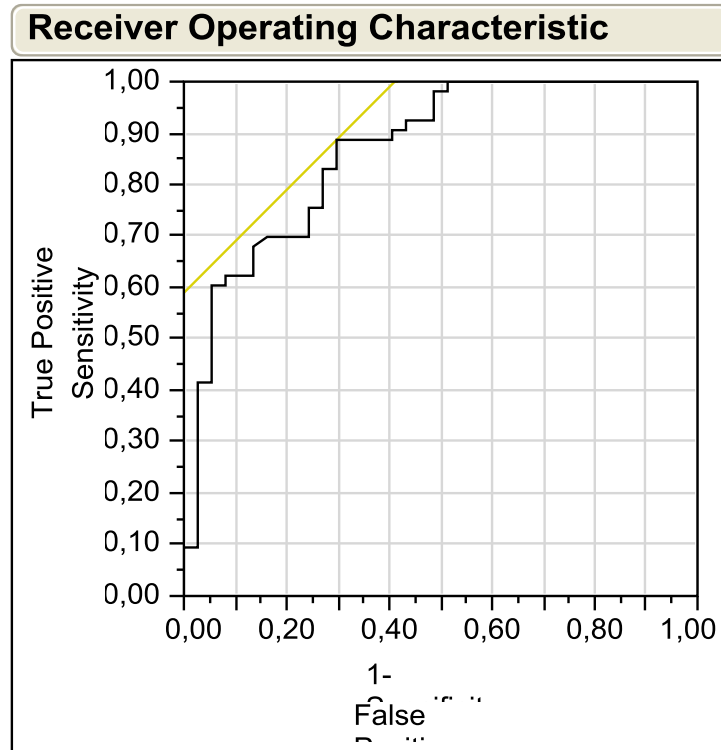
FFR ≤ 0,75 – MLA ≤ 5,9 mm²

Area Under Curve = 0,81250

Sensitivity = 0,6905

Specificity = 0,8542

P < 0,001



FFR ≤ 0,80 – MLA ≤ 7,5 mm²

Area Under Curve = 0,86512

Sensitivity = 0,8868

Specificity = 0,7027

P < 0,001

Prospective Application of Pre-Defined Intravascular Ultrasound Criteria for Assessment of Intermediate Left Main Coronary Artery Lesions

Results From the Multicenter LITRO Study

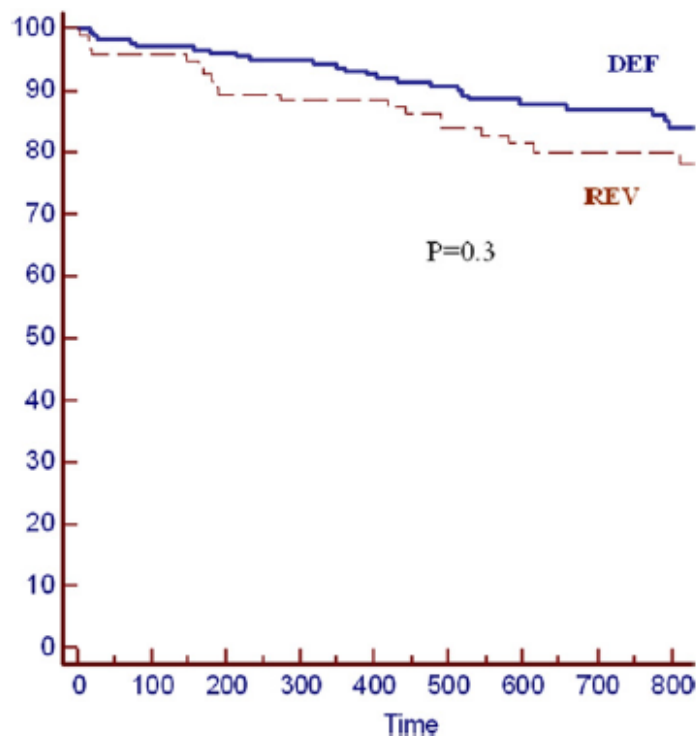


Figure 5

Survival Free of Cardiac Death, Myocardial Infarction, and Any Revascularization in Both Groups

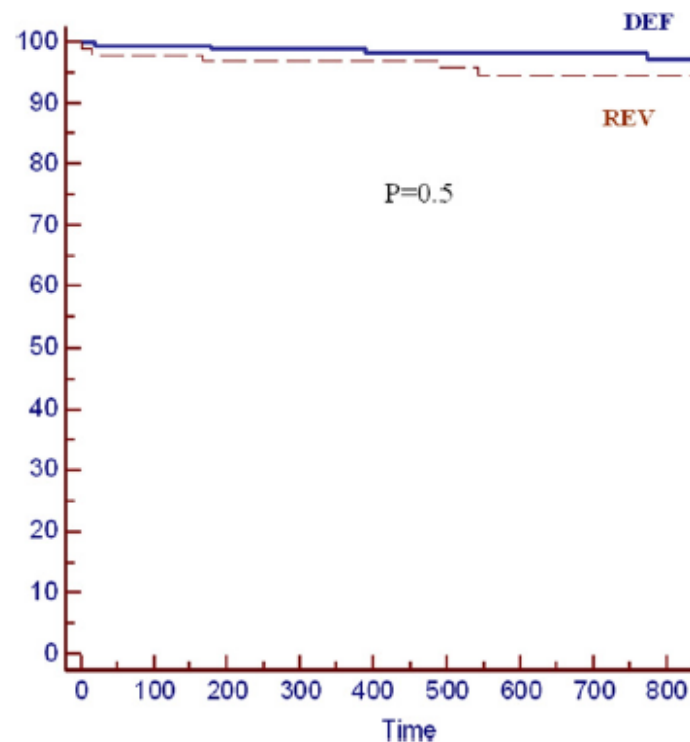
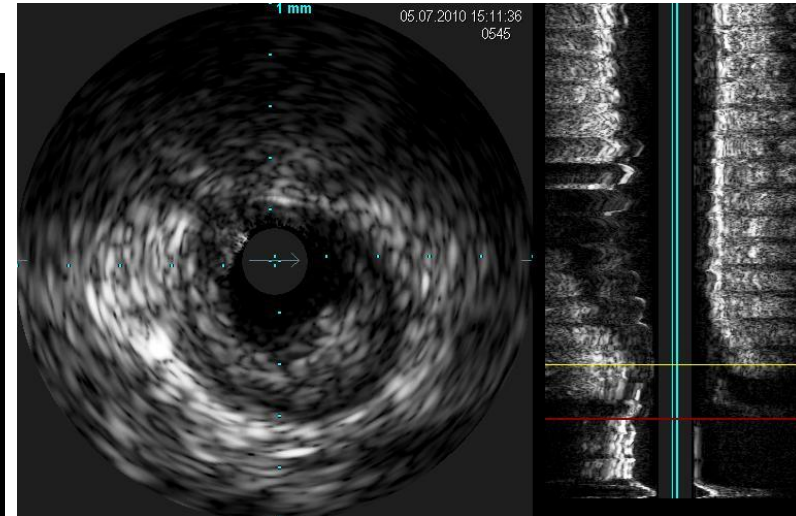
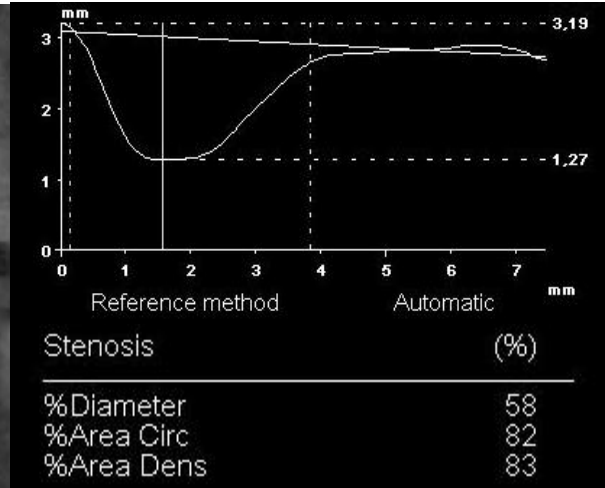
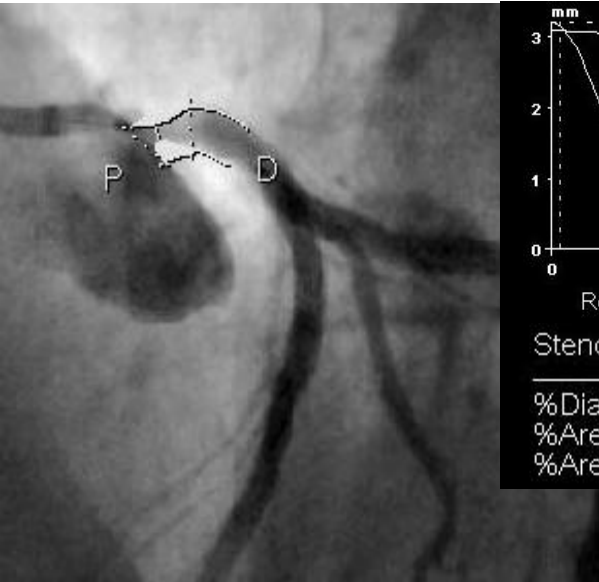


Figure 4

Survival Free of Cardiac Death in Both Groups

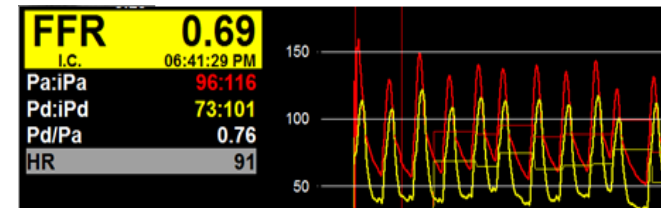
FFR and IVUS: LMCA



L_{Amin} = 4,1 mm²

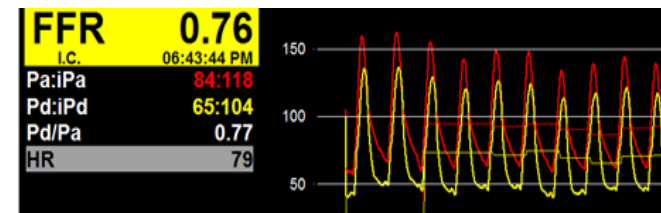
FFR (LAD) = 0,69

Adenosine i.v. infusion,
(180 µg/kg/min.)



FFR (LCX) = 0,76

Adenosine i.v. infusion,
(180 µg/kg/min.)



HEART TEAM APPROACH



**Clinical Cardiologist
(non-interventional)**

**Interventional
cardiologist**

Cardiologist Y

Cardiac Surgeon

Anesthesiologist

Cardiac Surgeon

Radiologist

**Vascular
surgeon**

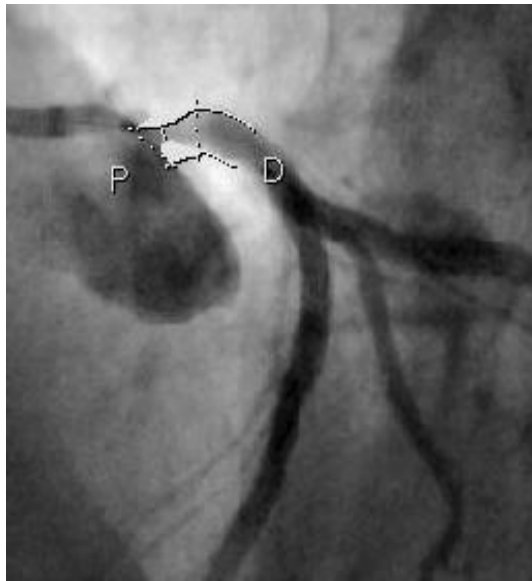
PATIENT

**Interventional
Cardiologist**

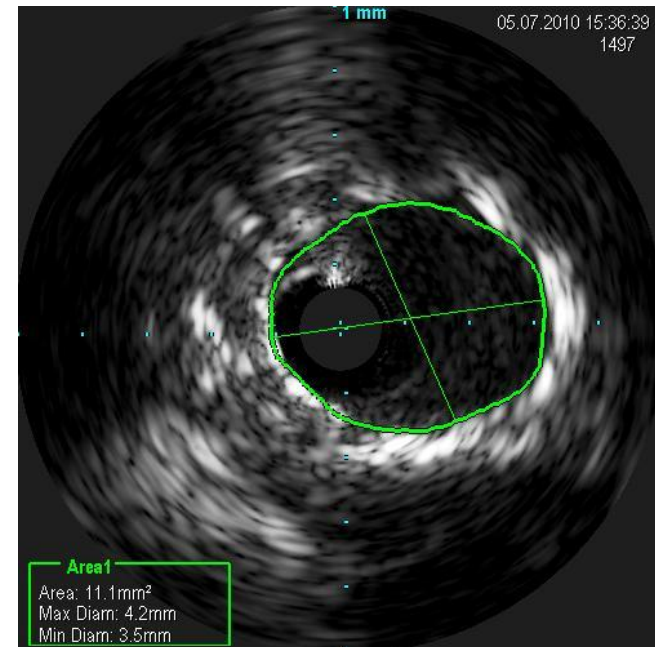
Cardiac Surgeon

PCI: LMCA – 5.07.2010

- Direct stenting
- DES 3,5 x 18 mm, 14 atm
- Balloon postdilatation 4,0 x 10 mm, 14 atm



→
DES



L_{Amin} = 11,1 mm²

Case summary

ANGIO-guided revascularization



FFR-guided revascularization



Case summary

ANGIO-guided revascularization



ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

Subset of CAD by anatomy	Favours CABG	Favours PCI
IVD or 2VD - non-proximal LAD	IIb C	I C

Subset of CAD by anatomy	Favours CABG	Favours PCI	Ref.
IVD or 2VD - non-proximal LAD	IIb C	I C	—
IVD or 2VD - proximal LAD	IA	IIa B	30, 31, 50, 51
3VD simple lesions, full functional revascularization achievable with PCI, SYNTAX score ≤ 22	IA	IIa B	4, 30-37, 53
3VD complex lesions, incomplete revascularization achievable with PCI, SYNTAX score > 22	IA	III A	4, 30-37, 53
Left main (isolated or IVD, ostium/shaft)	IA	IIa B	4, 54
Left main (isolated or IVD, distal bifurcation)	IA	IIb B	4, 54
Left main + 2VD or 3VD, SYNTAX score ≤ 32	IA	IIb B	4, 54
Left main + 2VD or 3VD, SYNTAX score ≥ 33	IA	III B	4, 54

The revascularization strategy (ad-hoc culprit lesion PCI/multivessel PCI/CABG) should be based on the clinical status as well as the disease severity, i.e. distribution and angiographic lesion characteristics (e.g. SYNTAX score), according to the local 'Heart Team' protocol.

Left main + 2VD or 3VD, SYNTAX score ≤ 32	IA	IIb B	4, 54
Left main + 2VD or 3VD, SYNTAX score ≥ 33	IA	III B	4, 54

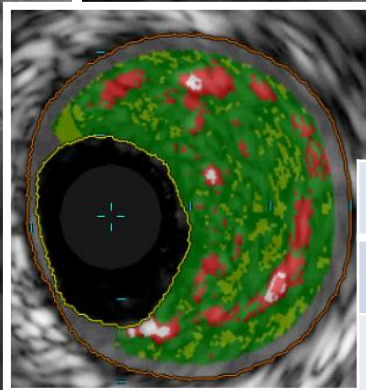
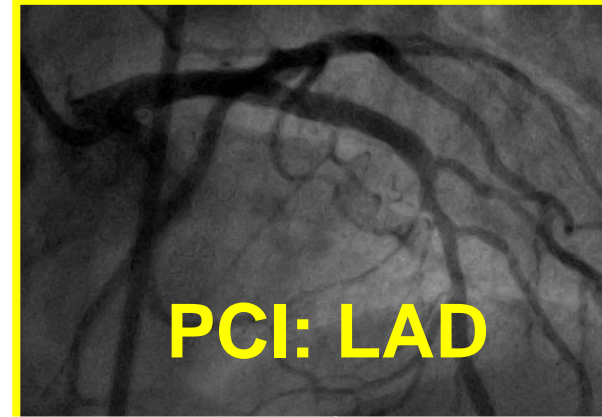
European Heart Journal dot10.1093/eurheartj/ehq277

ESC/EACTS GUIDELINES

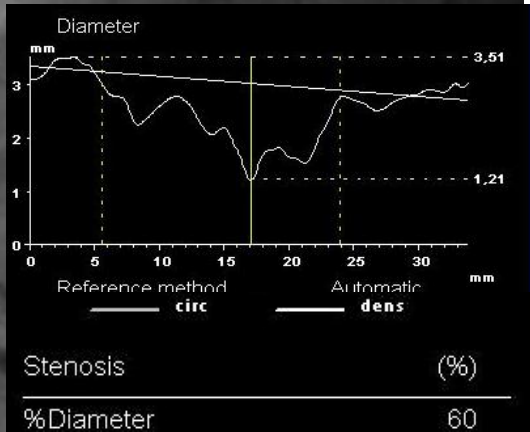
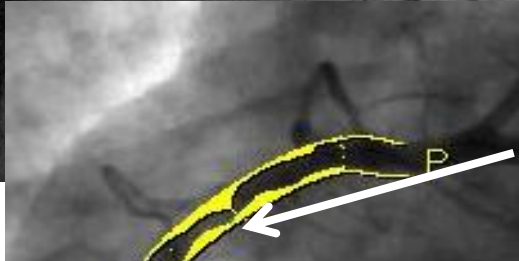
Guidelines on myocardial revascularization

FFR vs. IVUS

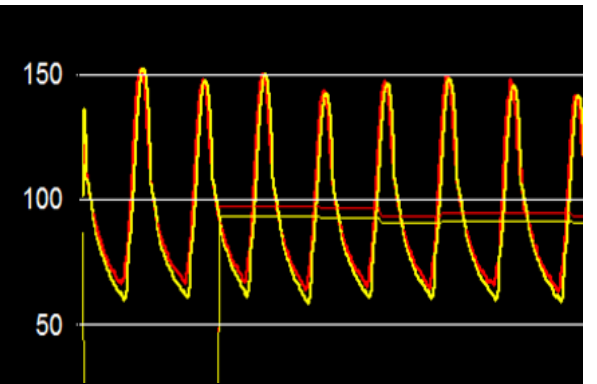
in non Left Main Lesion Assessment



Minimum Lumen Area (MLA)	2.50 mm ²
Percent Plaque Burden	75 %
Plaque type	PIT



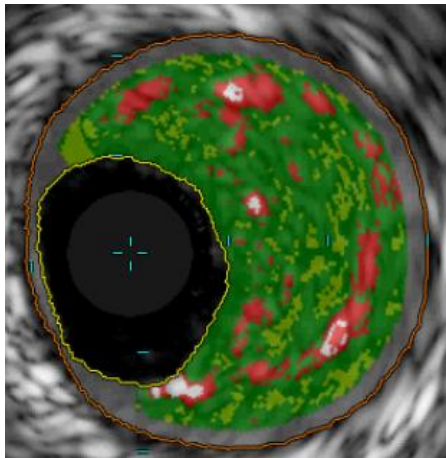
FFR 0.96
 I.C. 10:20:46 AM
 Pa:iPa 93:118
 Pd:iPd 90:102
 Pd/Pa 0.97
 HR 64



Adenosine i. v. infusion 140 µg/kg/min.

FFR vs. IVUS in non Left Main Lesion Assessment

IVUS-guided PCI
of the RCA?



Minimum Lumen Area (MLA)

2.50 mm²

↓
YES!

FFR-guided
PCI of the RCA?



FFR = 0,97

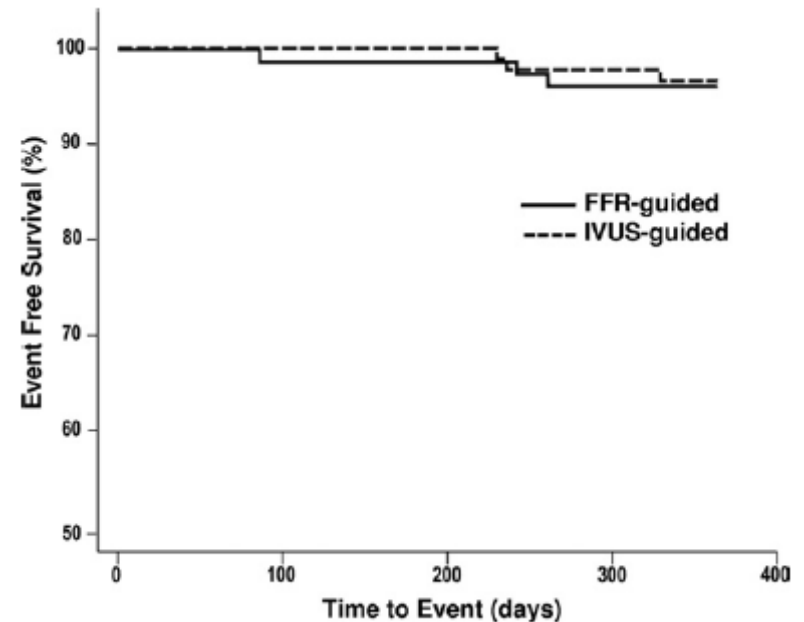
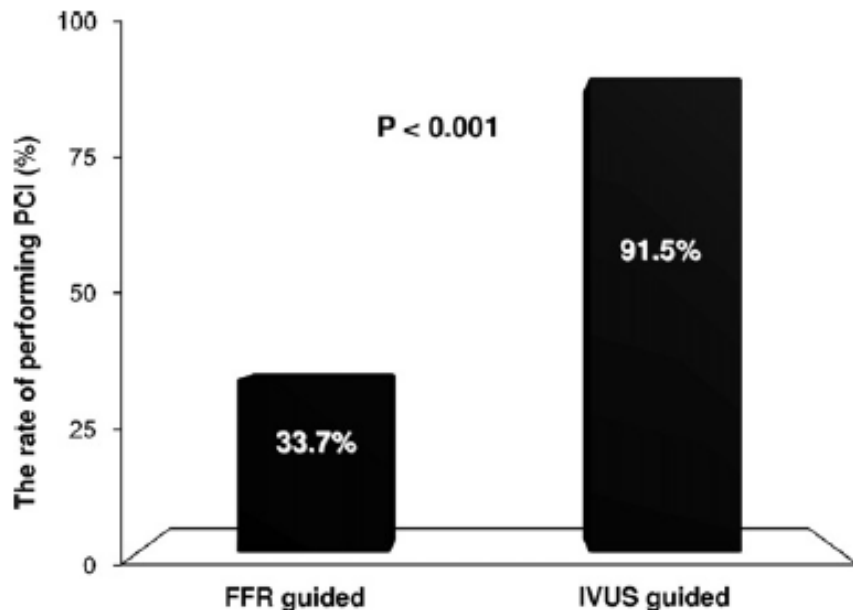
Adenosine i.v. infusion,
(180 µg/kg/min.)

↓
NO!

Outcomes of Percutaneous Coronary Intervention in Intermediate Coronary Artery Disease

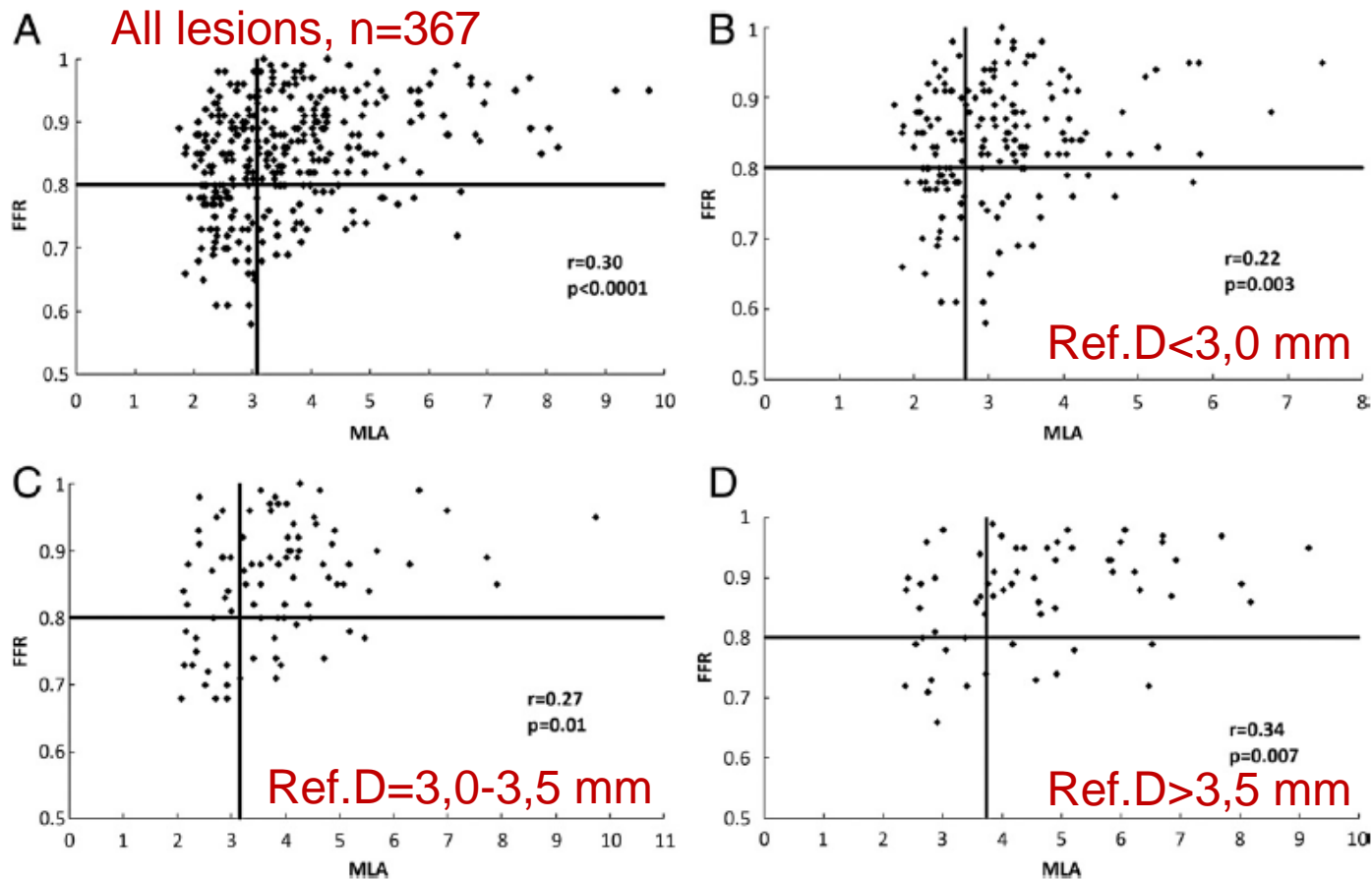
Fractional Flow Reserve–Guided Versus Intravascular Ultrasound–Guided

167 consecutive patients, with intermediate coronary lesions evaluated by FFR or IVUS (FFR-guided, 83 lesions vs. IVUS-guided, 94 lesions). Cutoff value of FFR in FFR-guided PCI was 0.80, whereas that for minimal lumen cross sectional area in IVUS-guided PCI was 4.0 mm². MACE: death, MI, ischemia-driven TVR at 1 year.



FIRST: Fractional Flow Reserve and Intravascular Ultrasound Relationship Study

Ron Waksman, MD,* Jacek Legutko, MD,† Jasvinder Singh, MD,‡ Quentin Orlando, DO,§ Steven Marso, MD,|| Timothy Schloss, MD,¶ John Tugaoen, MD,# James DeVries, MD,** Nicholas Palmer, MD,†† Michael Haude, MD,‡‡ Stacy Swymelar, BS,* Rebecca Torguson, MPH* Washington, DC; Krakow, Poland; St. Louis, Kansas City, Washington, Missouri; Erie, Pennsylvania; Columbus, Ohio; Lebanon, New Hampshire; Liverpool, United Kingdom; and Neuss, Germany



FIRST: Fractional Flow Reserve and Intravascular Ultrasound Relationship Study

Ron Waksman, MD,* Jacek Legutko, MD,† Jasvinder Singh, MD,‡ Quentin Orlando, DO,§ Steven Marso, MD,|| Timothy Schloss, MD,¶ John Tugaoen, MD,# James DeVries, MD,** Nicholas Palmer, MD,†† Michael Haude, MD,‡‡ Stacy Swymelar, BS,* Rebecca Torguson, MPH* Washington, DC; Krakow, Poland; St. Louis, Kansas City, Washington, Missouri; Erie, Pennsylvania; Columbus, Ohio; Lebanon, New Hampshire; Liverpool, United Kingdom; and Neuss, Germany

Table 4

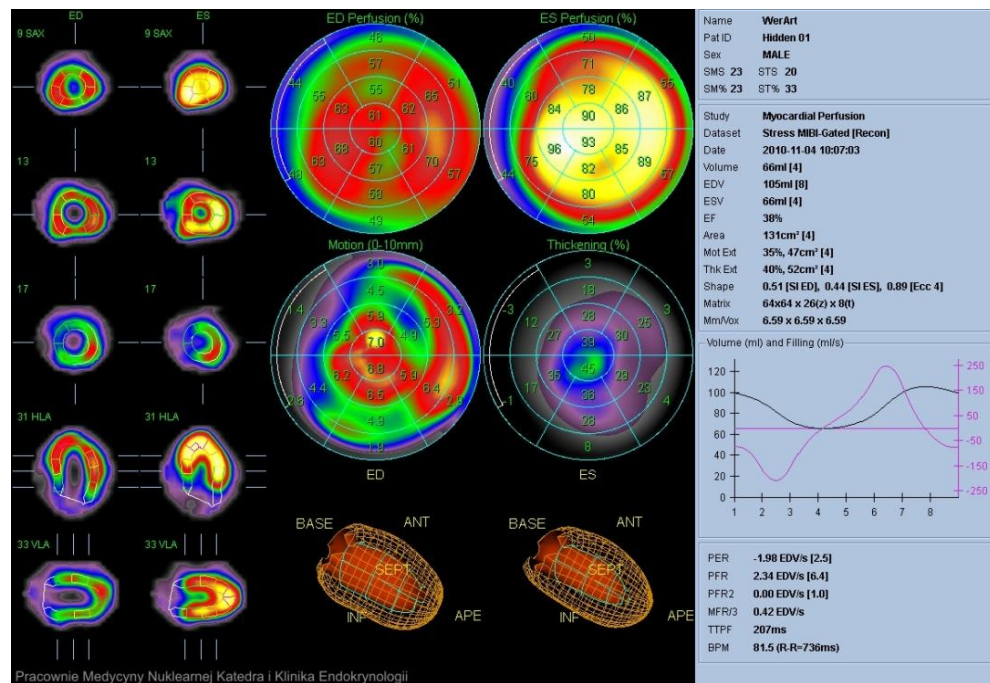
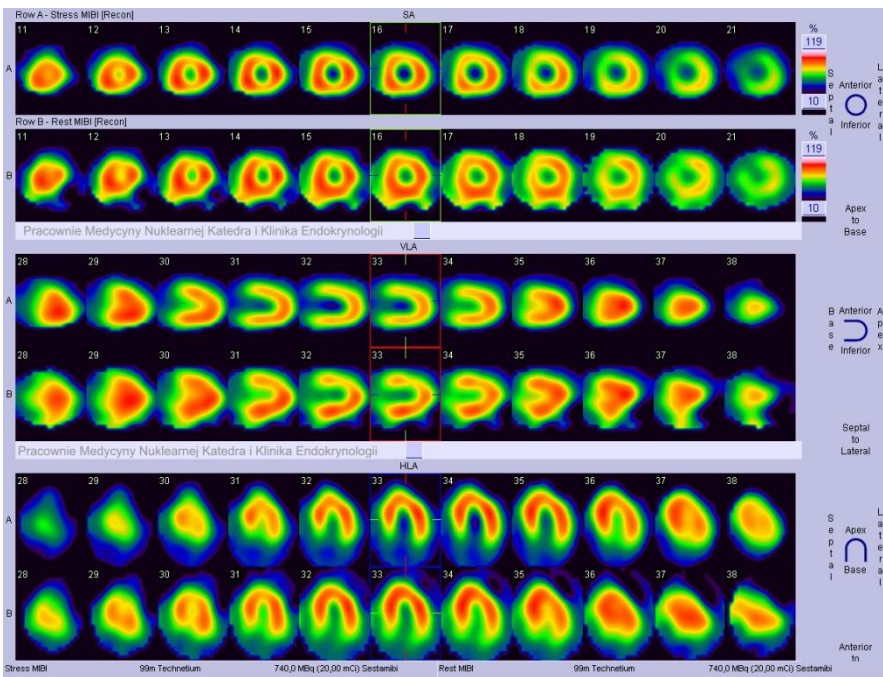
Correlates of Fractional Flow Reserve <0.8: Multivariable Logistic Regression

Variable	Odds Ratio	95% Confidence Interval	p Value
IVUS MLA, mm ²	0.72	0.52–0.98	0.039
Plaque burden, %	1.03	0.99–1.06	0.110
Diameter stenosis, %	1.05	1.01–1.09	0.028
Left anterior descending lesions (vs. RCA)	3.19	1.44–7.05	0.004
Left circumflex lesions (vs. RCA)	0.37	0.11–1.31	0.124

Conclusions: Anatomic measurements by IVUS show a moderate correlation with the FFR values. The optimal cutoff for an MLA to FFR 0.8 is vessel dependent. Plaque morphology characteristics do not correlate with FFR. The utility of IVUS MLA as an alternative to FFR to guide intervention in intermediate lesions may be limited in accuracy and should be tested clinically.

30 days follow-up

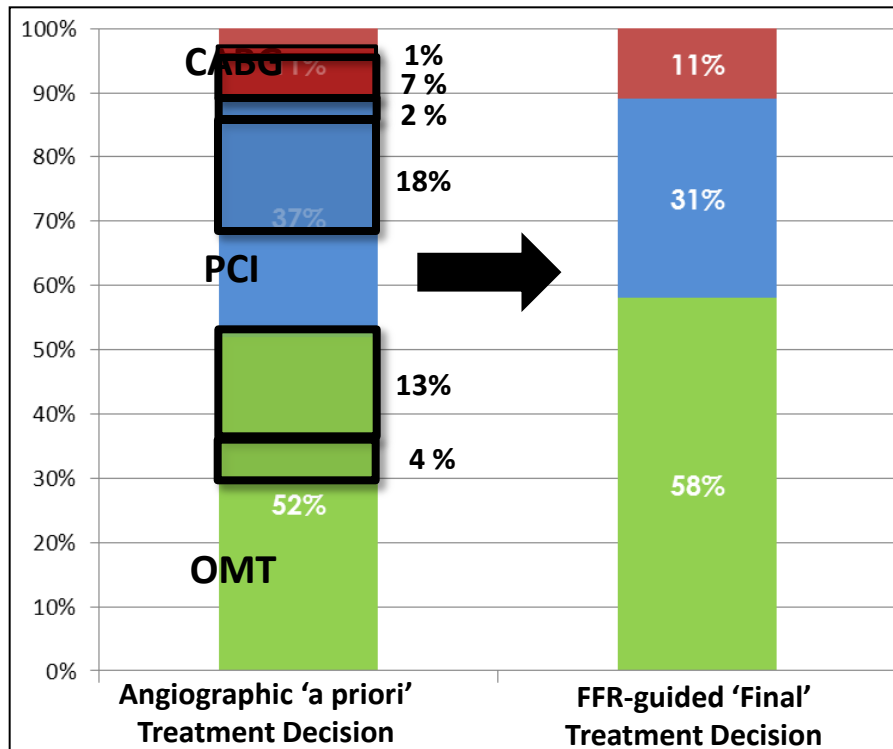
SPECT - 1 month after PCI: LAD 13 METs, no symptoms



Fractional Flow Reserve (FFR)

Everyday Clinical Practice in the Cathlab

Is FFR impacting the treatment strategy?
(example of the R3F registry)



45% of patients
changed therapy
with FFR
guidance

- 945 patients evaluated with angio, then FFR for final treatment decision
- FFR guidance reduced PCIs by 6%, but **changed the treatment for 45% of patients**

Thank you for your attention!

2nd Department of Cardiology, Institute of Cardiology, Jagiellonian University Medical College



*2nd Department of Cardiology and Cardiovascular Interventions, University Hospital in Krakow
Poland*