



---

# **Imaging vs functional assessment of left main intermediate lesion. A time for the final statement ?**

Tomasz Pawłowski, MD, PhD, FESC  
Klinika Kardiologii Inwazyjnej CSK MSWiA  
Warsaw, Poland



---

***I have no conflict of interest related to this presentation***

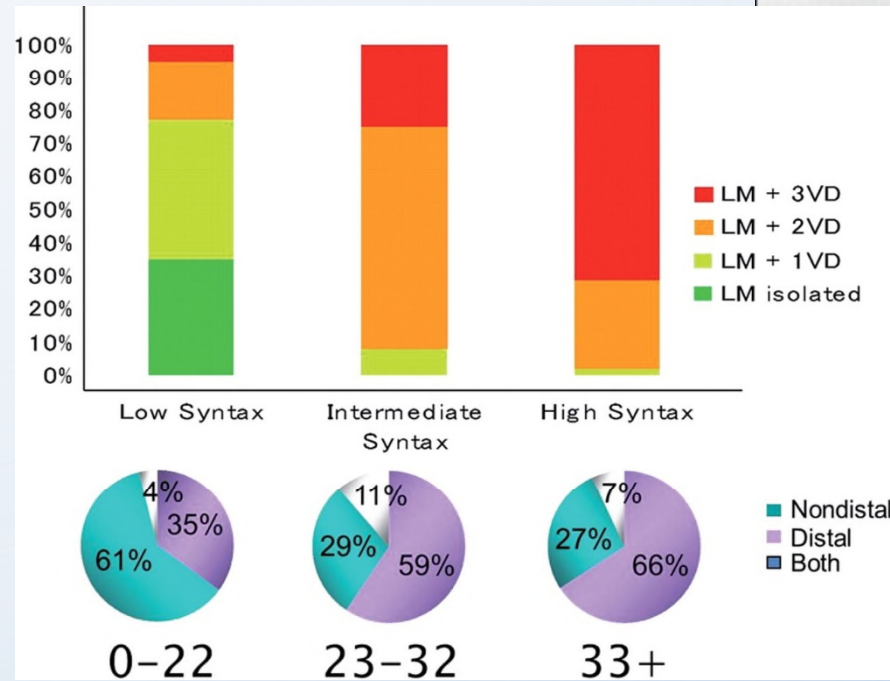
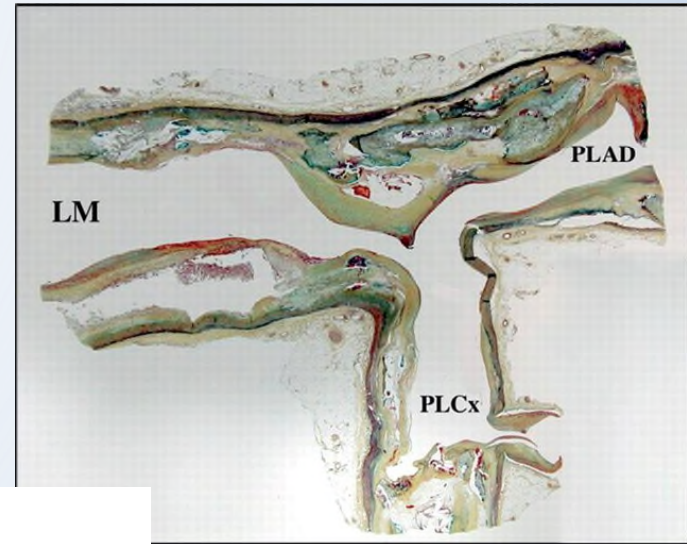


# Left main stenosis

## Current management of left main coronary artery disease

Jean Fajadet<sup>1\*</sup> and Alaide Chieffo<sup>2</sup>

- LM disease  
5-7 % of all angios
- Mortality within 3 years – 50 % with medical treatment





---

**How to assess intermediate left main ?**



The question.....

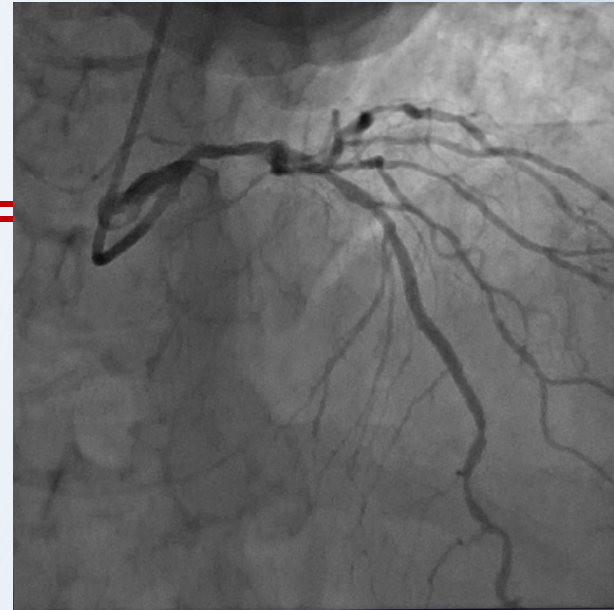
## LM Disease: When to Use FFR, IVUS, or Both

Gary S. Mintz, MD

Cardiovascular Research Foundation

## Left Main Disease: When to Use FFR vs. IVUS

William F. Fearon, M.D.  
Professor of Medicine  
Director, Interventional Cardiology  
Stanford University



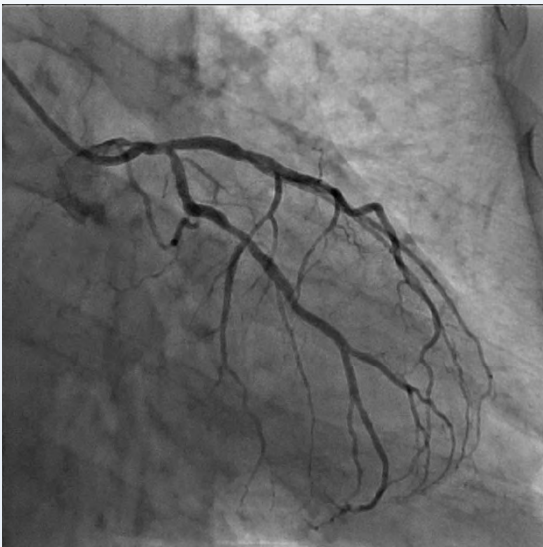
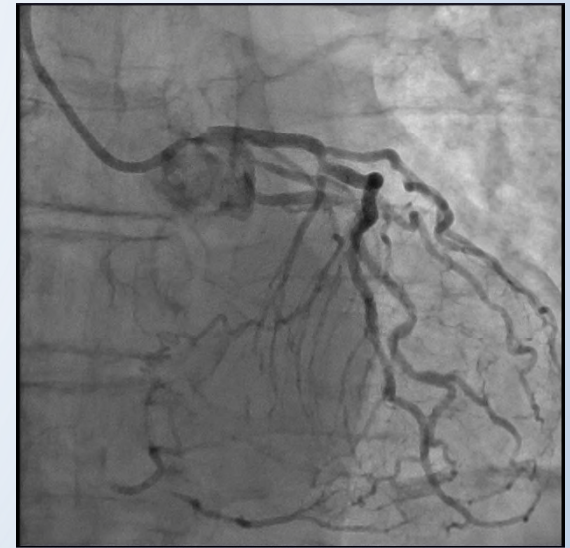
### Limitations of angiography:

- Overlap of the catheter and LAD/Cx
- Spillover of contrast medium
- Mixing of blood & contrast media
- No reference segment
- Small LM – diffuse disease
- Bifurcation
- Calcification
- Continuity of the plaque into LAD/Cx



## Contrast imaging of intermediate & ambiguous lesion

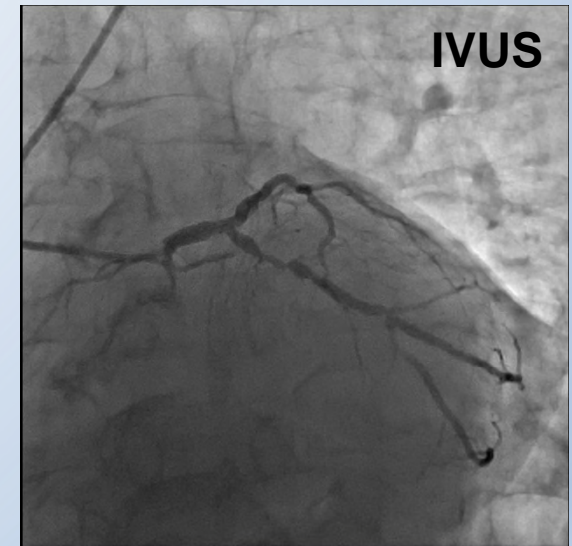
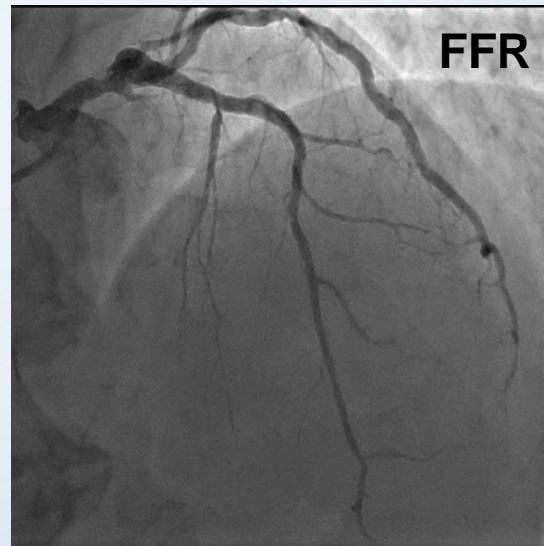
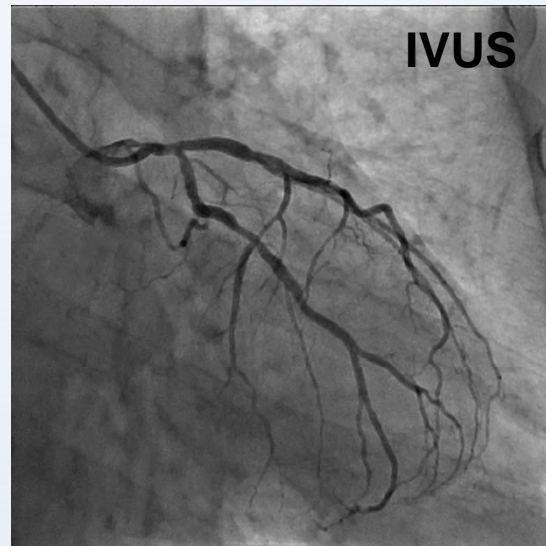
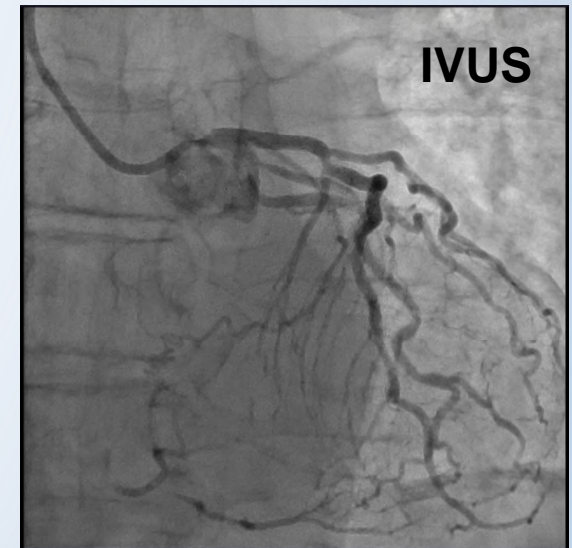
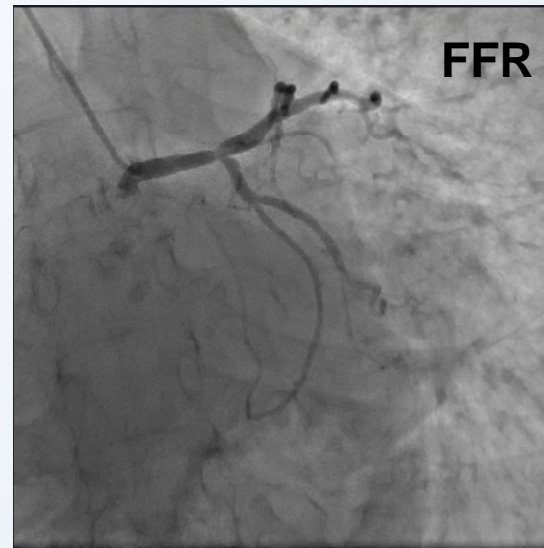
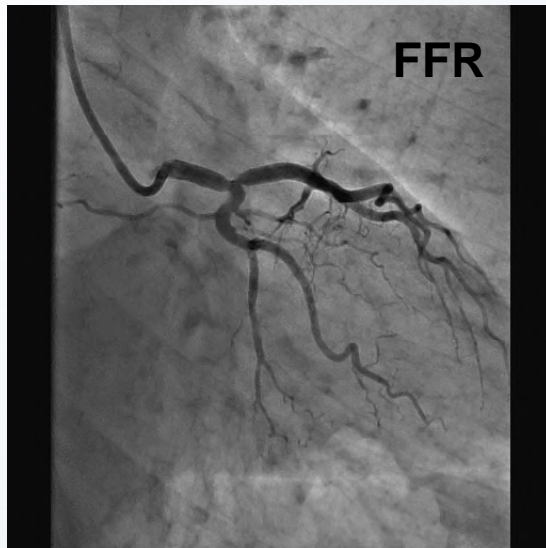
---





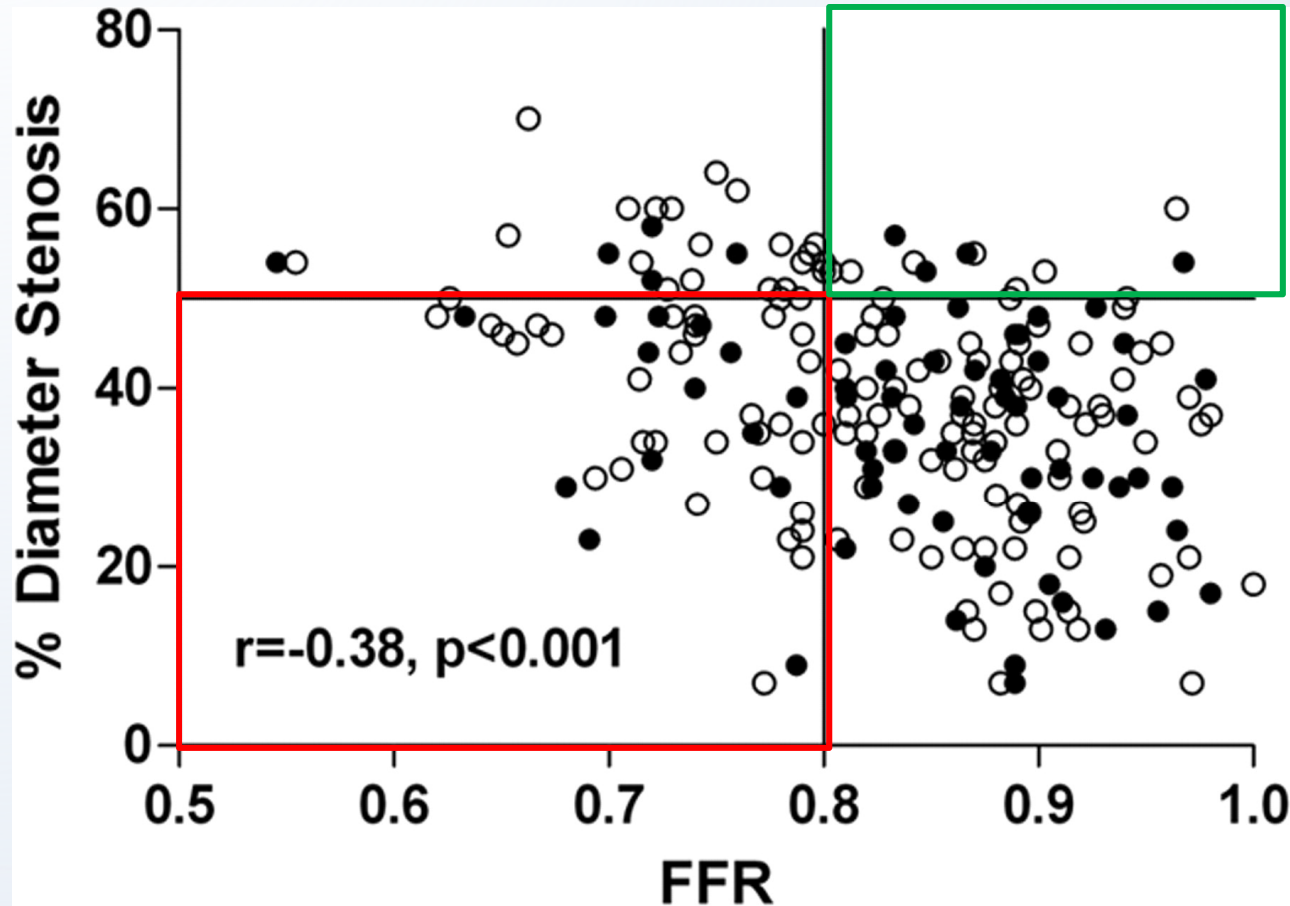
## Contrast imaging of intermediate & ambiguous lesion

*IVUS vs FFR – a selection bias ???*





## Contrast imaging of intermediate & ambiguous lesion



*Misclassification by angio:*

62/213pts = 29 %

18/72 pts = 25 % (isolated LM)

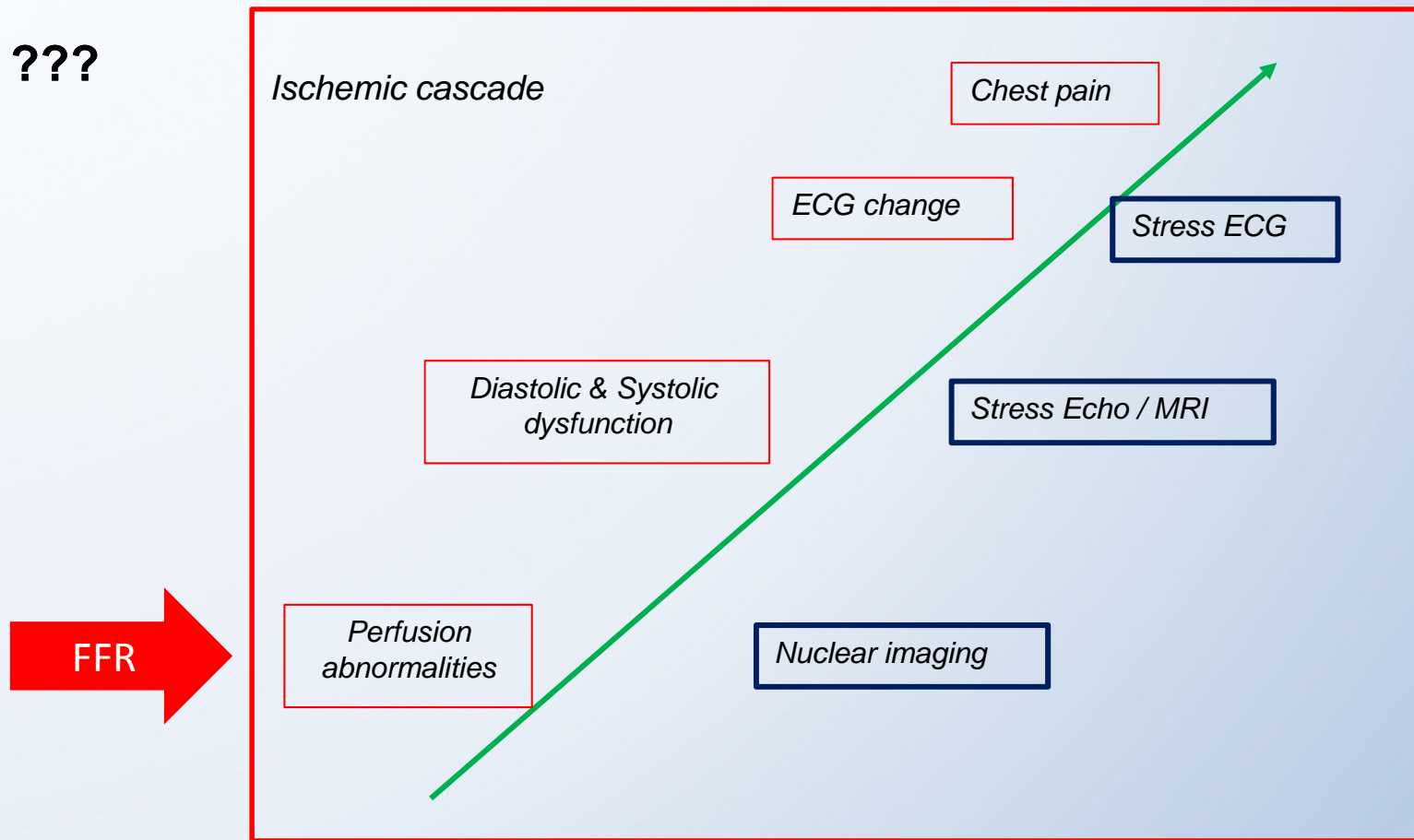
The dots represent patients with isolated LMCA stenosis.





## Non-invasive assessment of left main significance

IVUS ???





# Case presentation

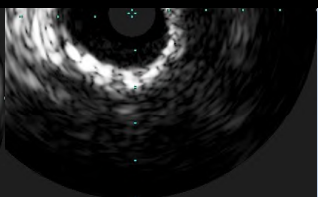
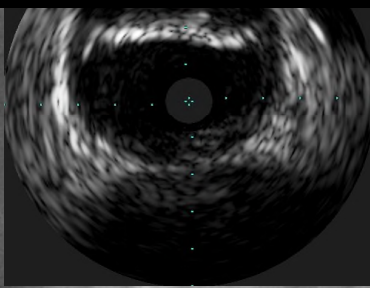
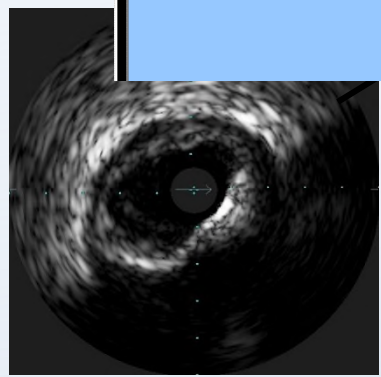
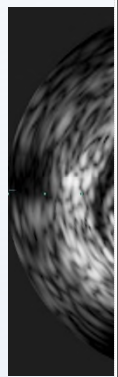
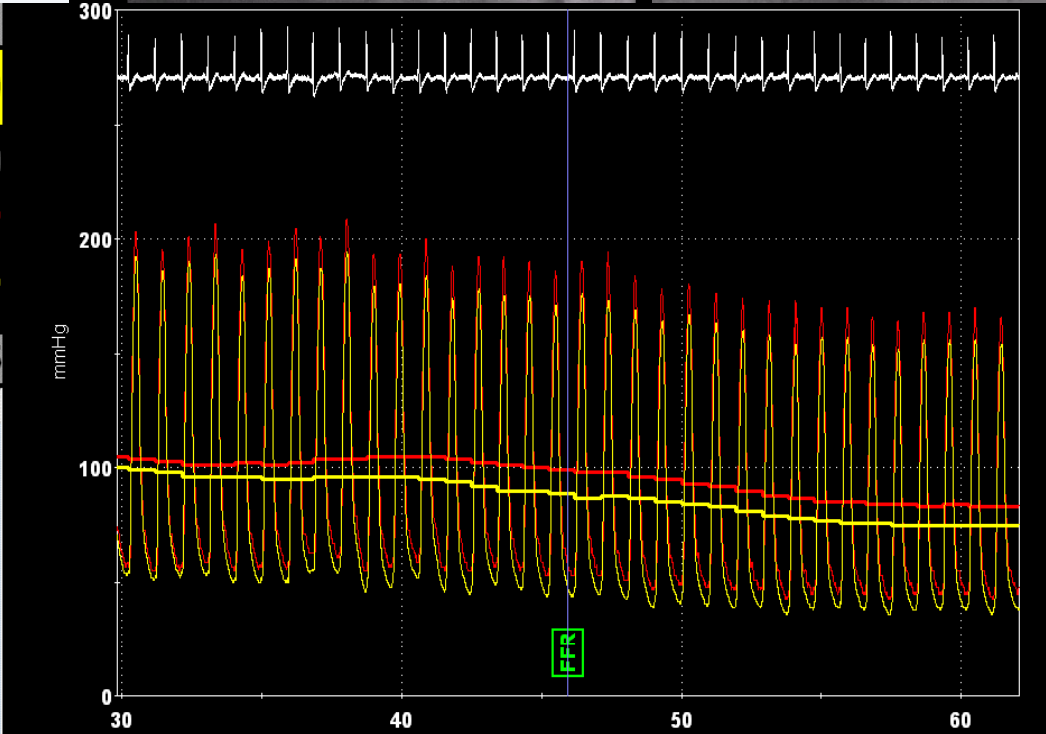
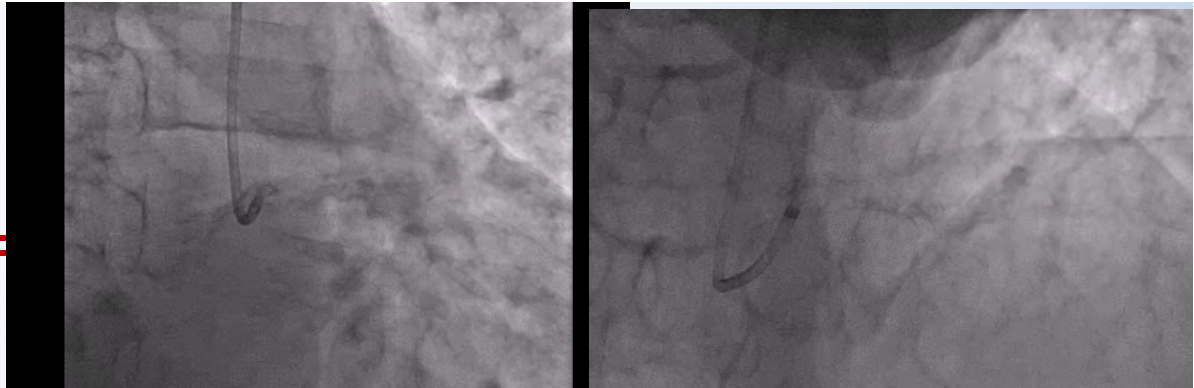
- 78 years old man
- Hypertension history
- Dyslipidemia
- Referred for

assessment

**FFR 0.90**  
**Pd/Pa 0.90**  
**Pa:iPa 99: 57**  
**Pd:iPd 89: 47**

HR 65

Lista etapów	iFR	FFR
08:44:01 PM		0.90





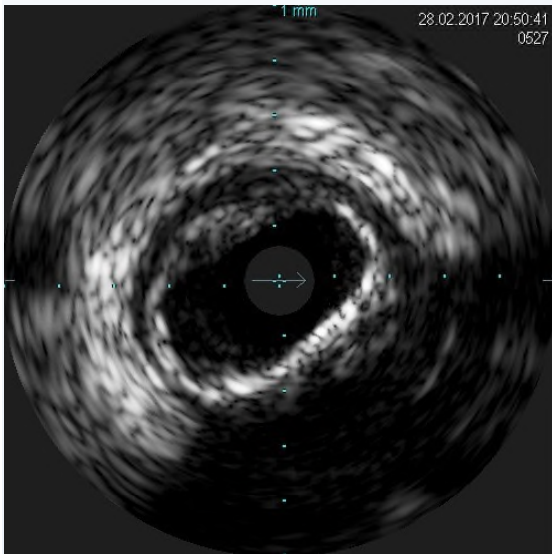
---

**How to assess intermediate left main ?**



## Intravascular ultrasound (IVUS)

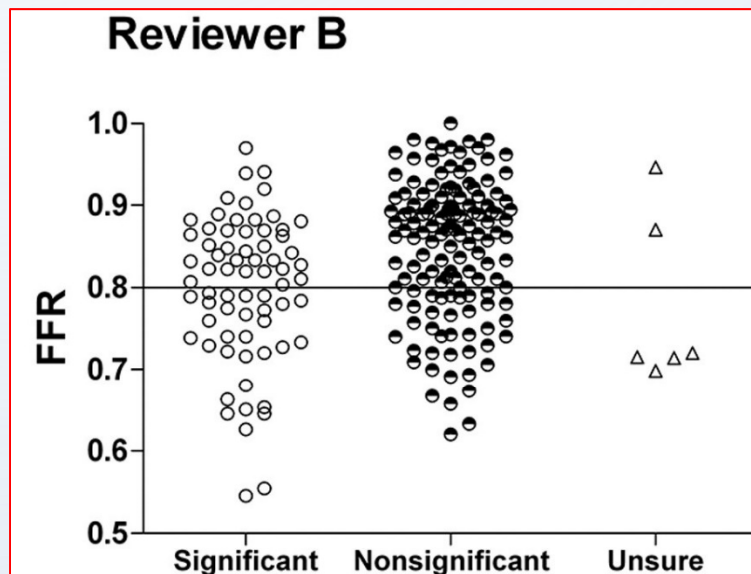
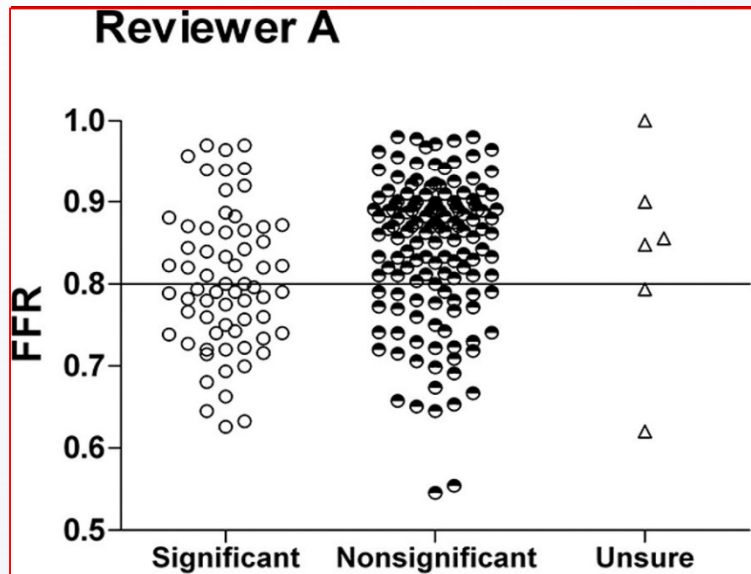
---



- *Tomographic view of left main as well as proximal parts of LAD & Cx*
- *Plaque burden & composition, vessel size & remodelling*
- *Proved clinical value for LM PCI optimisation*
  
- *Variability in sizes & lengths & plaque distribution*
- *Variability in amount of supplied myocardium*
- *Two separate pullbacks are needed*



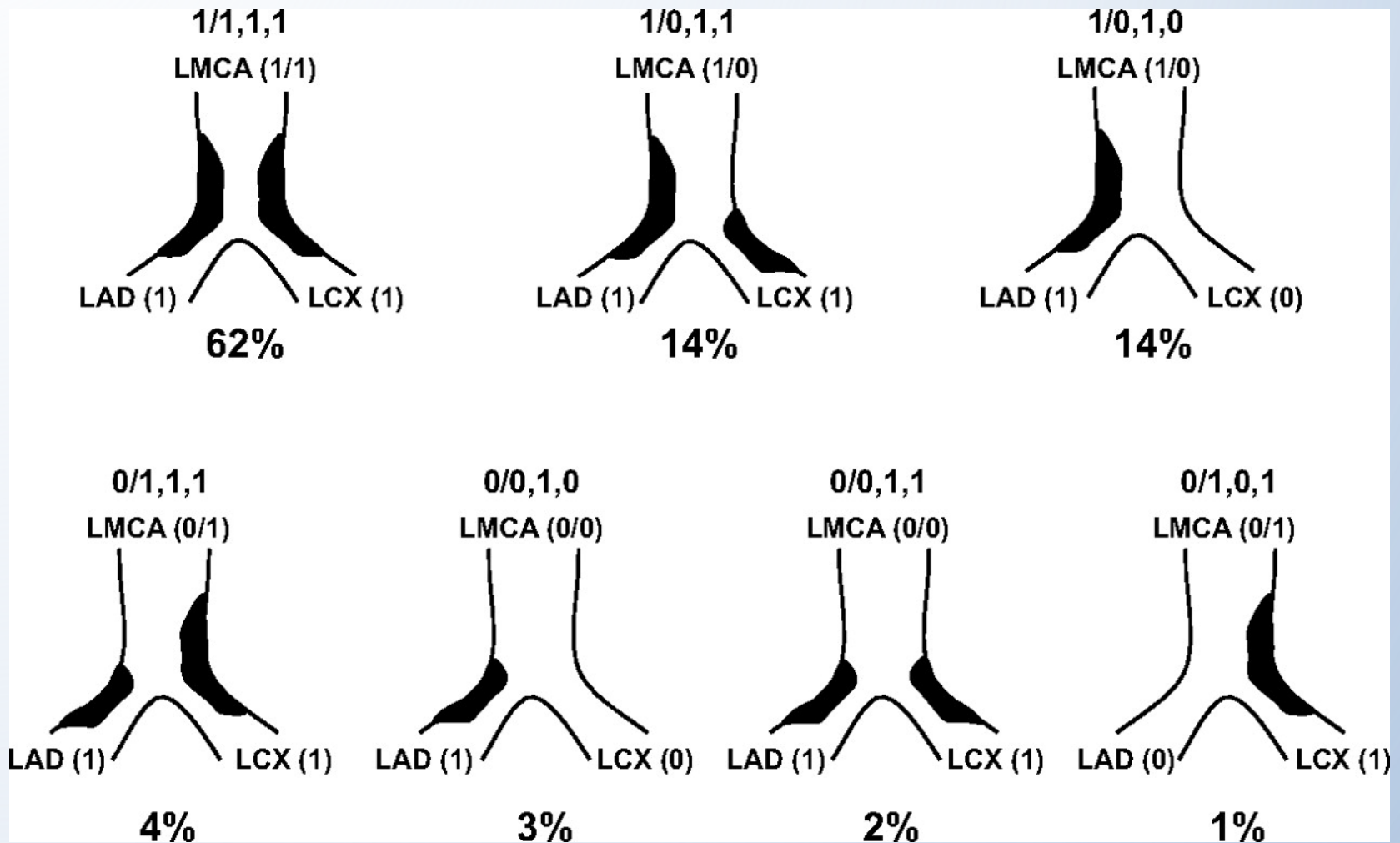
## Visual estimation of LM stenosis by different reviewers



- 26 % of cases, Reviewers disagreed that LM was significant, non-significant or unsure
- In 74 % they agreed,
- In 23 % cases were misclassified that means  
In 23 cases DS.>50 % - FFR was >0.80 and  
In 25 cases DS.<50 % - FFR was <0.80
- General – in 49 % of cases there was either disagreement or misclassification

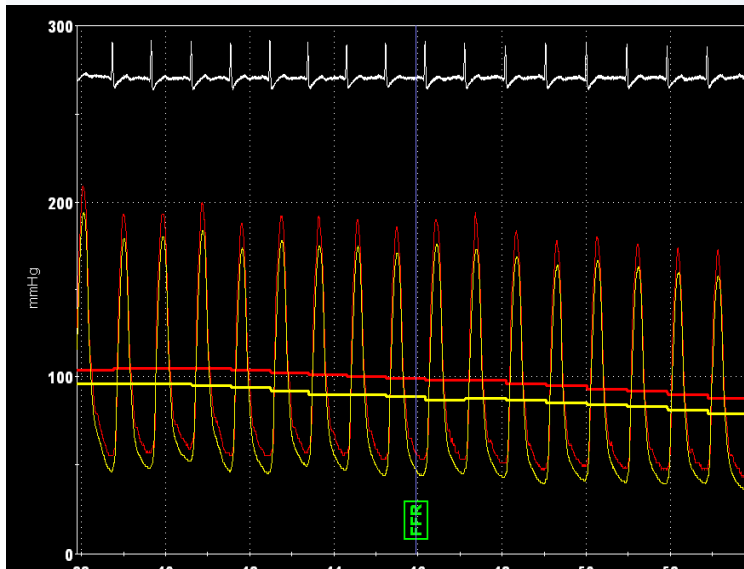


## Plaque distribution in LM & proximal LAD & Cx





## Fractional flow reserve (FFR)



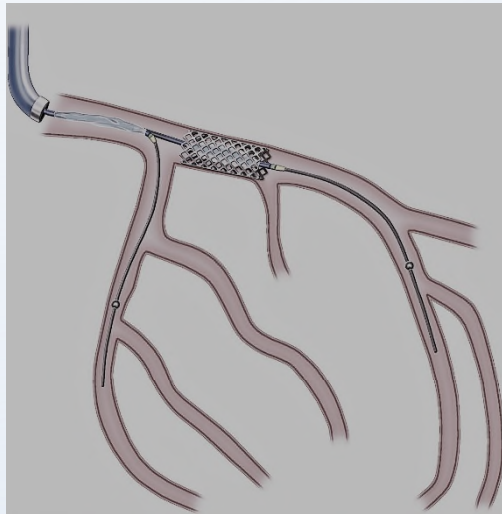
- *Easy and accurate procedure protocol*
- *Proved clinical cut-off value for lesion deferral*
- *Proximal LAD & Cx disease affects FFR results in LM*
- *Adenosine infusion needed*



## Disadvantages in FFR

### The Impact of Downstream Coronary Stenosis on Fractional Flow Reserve Assessment of Intermediate Left Main Coronary Artery Disease

Human Validation



## Comparison of Efficacy and Safety of Intracoronary Sodium Nitroprusside and Intravenous Adenosine for Assessing Fractional Flow Reserve

Wojciech Rudzinski,\* MD, PhD, Alfonso H. Waller, MD, Arthur Rusovici, MD, Abed Dehnee, MD, Ali Nasur, MD, Michael Benz, MD, Salvador Sanchez, CVT, Marc Klapholz, MD, and Edo Kaluski, MD

### Side effects of Adenosine infusion (53 pts):

26 % shortness of breath

19 % flushing

19 % headache

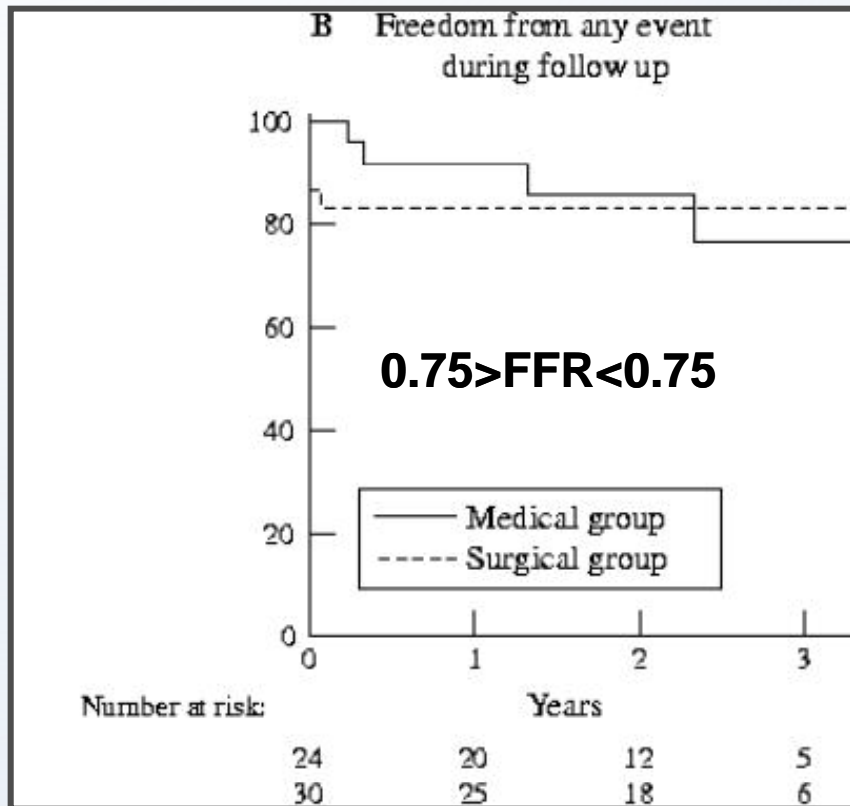
6 % AV block II degree

**COSTS !!!!**

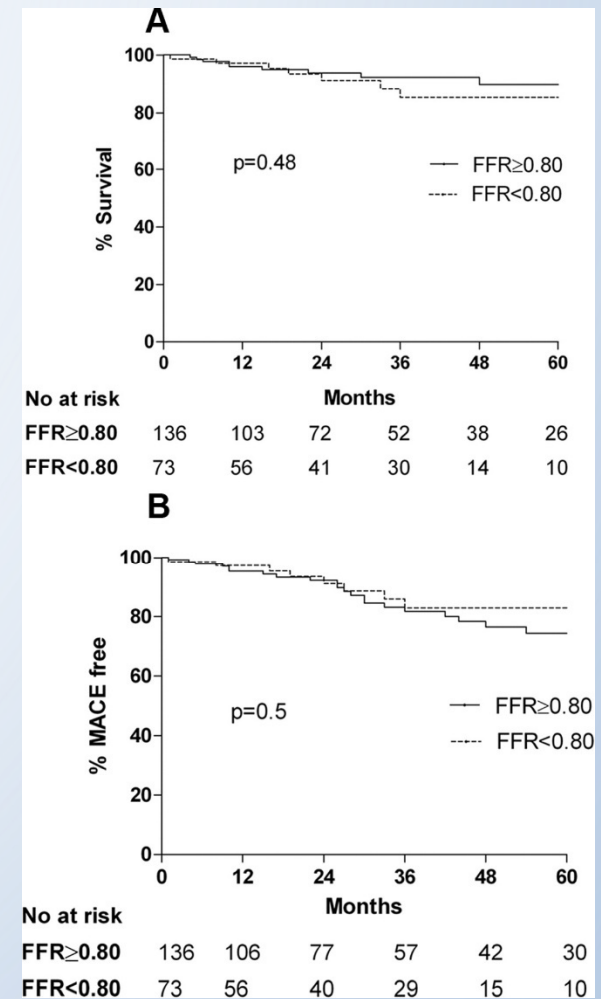




## Safety of LM revascularisation defferal (IVUS & FFR) (01)



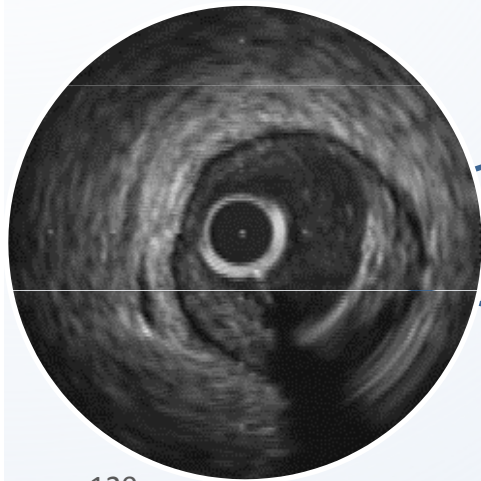
*Bech et al. Heart 2001*



*Hamilos et al. Circulation 2009*



## Safety of LM revascularisation deferral (IVUS & FFR) (02)



> 6  
mm<sup>2</sup>

186 pts – 96,2 % LM revasc not done

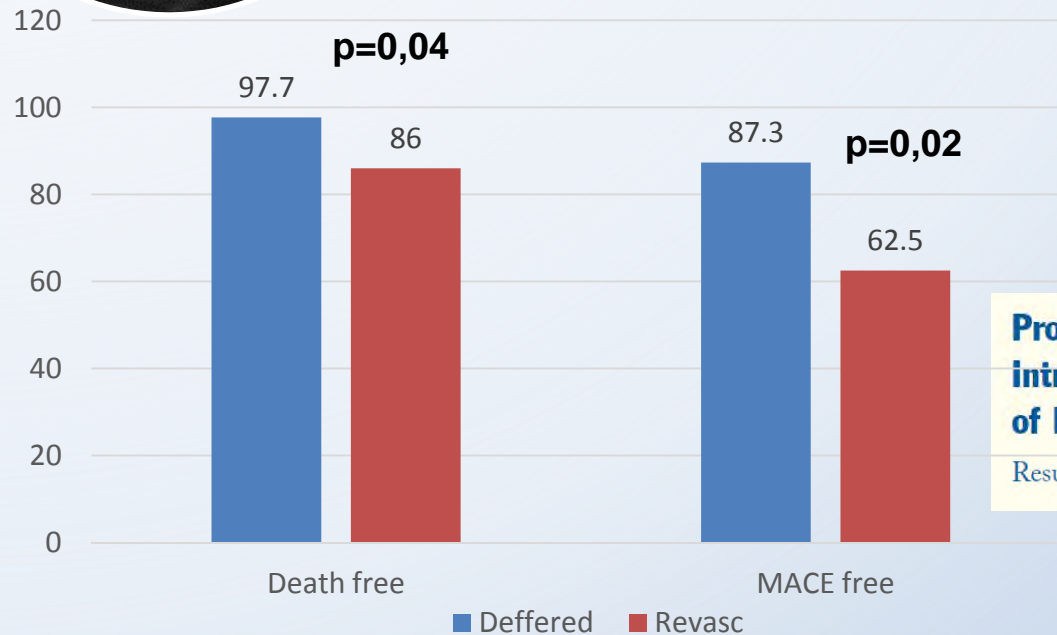
< 6  
mm<sup>2</sup>

168 pts – 90,5 % LM revasc done

55,2 % - CABG

17,2 % - PCI LM

27,6 % - PCI LM+other PCI

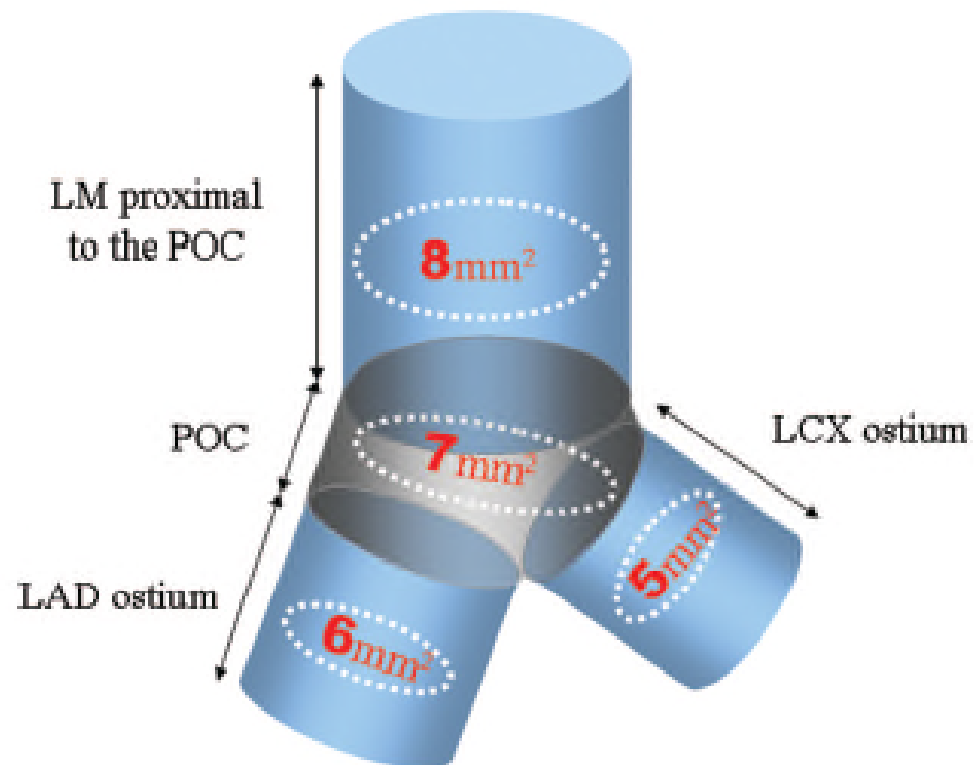


**Prospective Application of Pre-Defined intravascular Ultrasound Criteria for Assessment of Intermediate Left Main Coronary Artery Lesions**

Results From the Multicenter LITRO Study

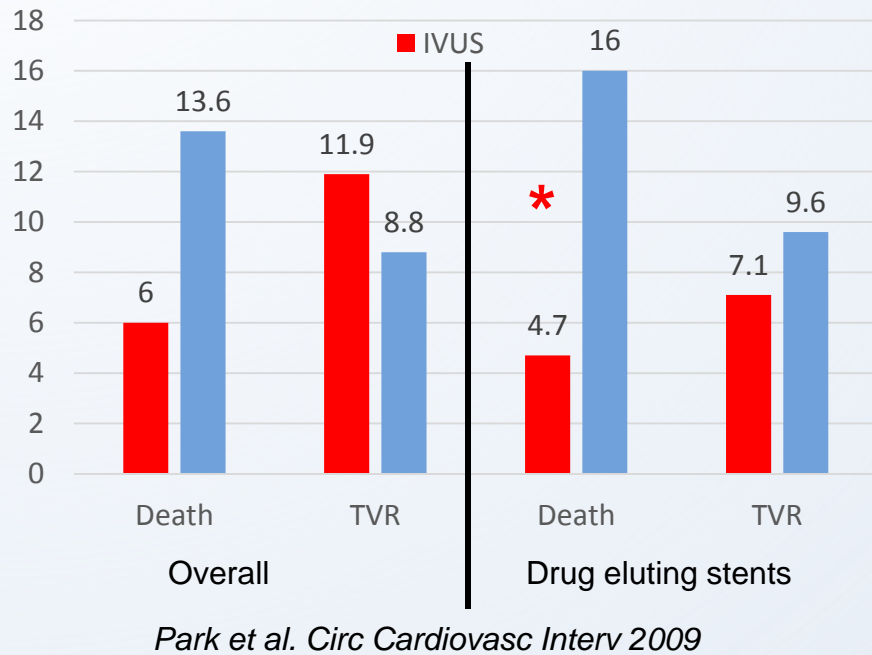


## IVUS in LM revascularisation



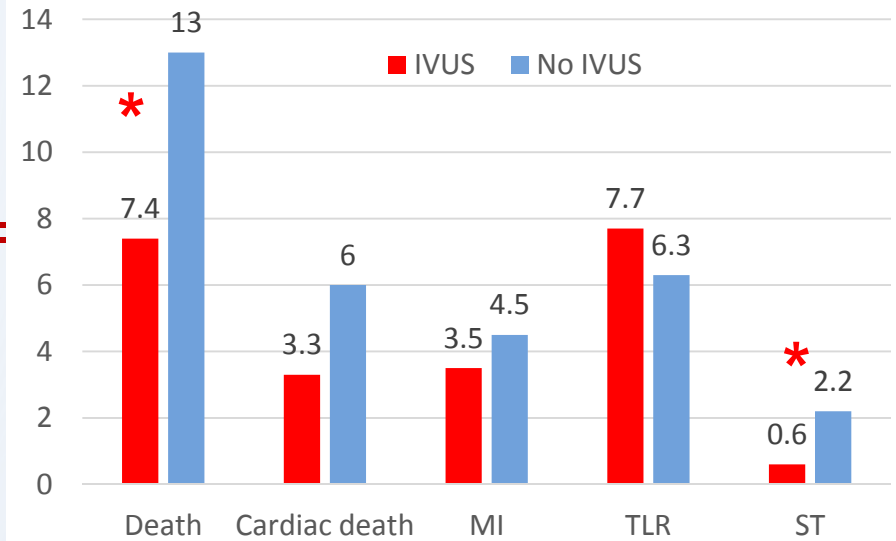


**Impact of Intravascular Ultrasound Guidance on Long-Term Mortality in Stenting for Unprotected Left Main Coronary Artery Stenosis**



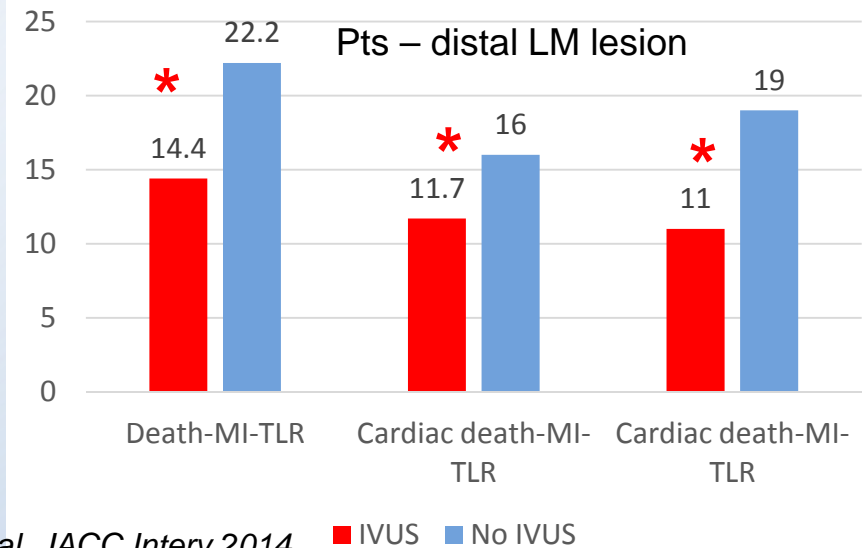
**\*p<0.05**

*Hernandez et al. JACC Interv 2014*



**Clinical Impact of Intravascular Ultrasound Guidance in Drug-Eluting Stent Implantation for Unprotected Left Main Coronary Disease**

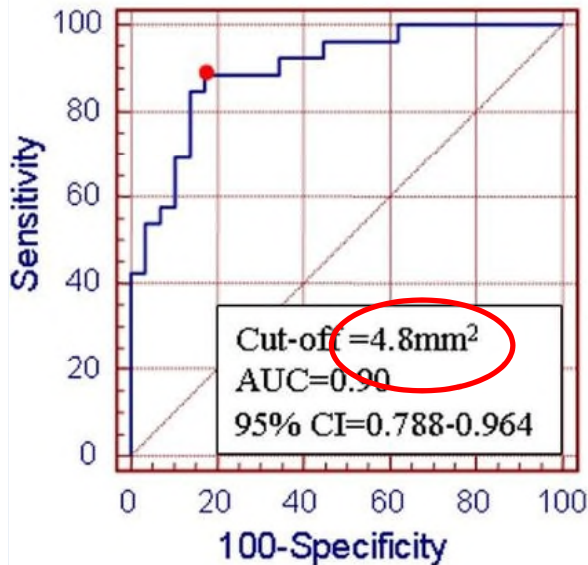
*Pooled Analysis at the Patient-Level of 4 Registries*





## IVUS & FFR in LM – substitute or surrogate ?

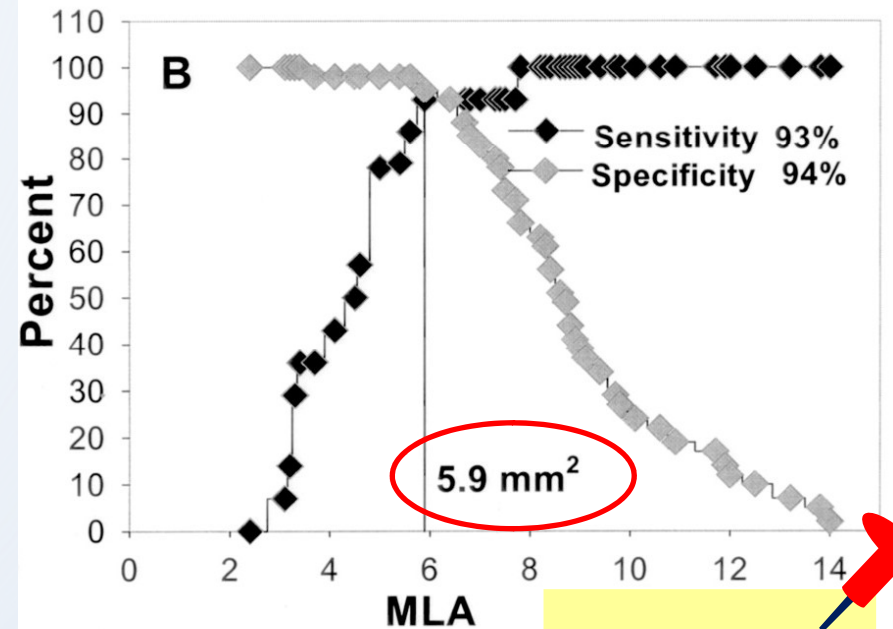
**A. MLA predicting FFR<0.80**



Sensitivity 89%  
Specificity 83%  
PPV 82%  
NPV 89%  
Accuracy 86%

55 pts with 30-80% DS. of LM

*Kang et al.*  
*JACC Interv 2011*

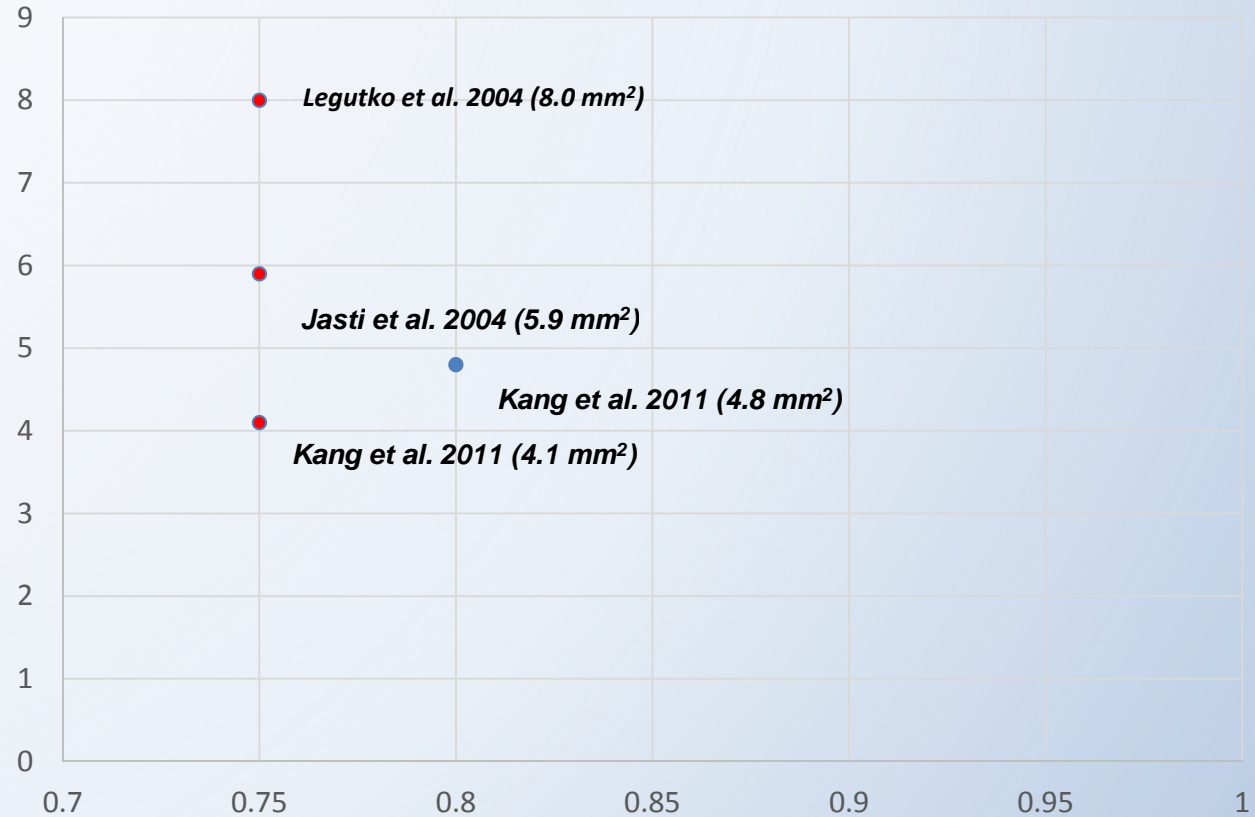
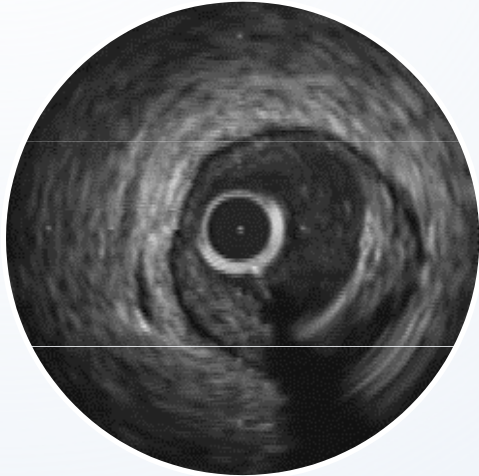


55 pts with ambiguous LM

*Jasti et al.*  
*Circulation 2004*



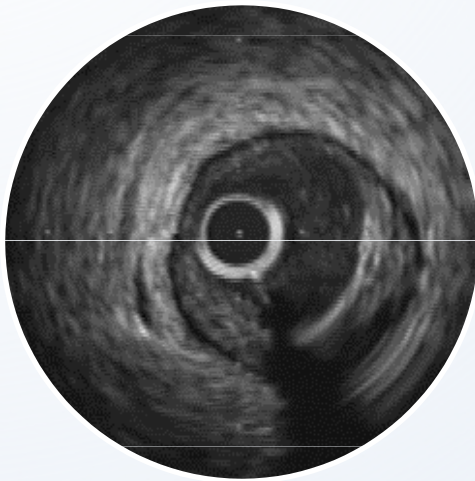
## Variability of IVUS LM cut-off values



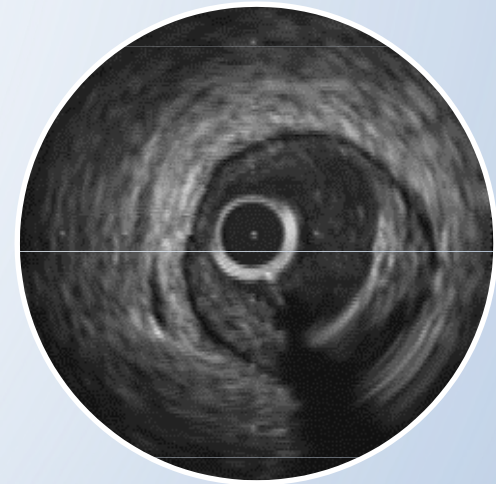
**General recommendation is to use 6 mm<sup>2</sup> to defer revascularisation**



## Variability of IVUS LM cut-off values

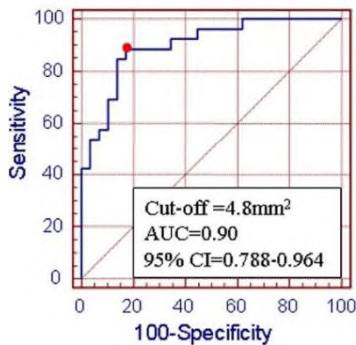


6 mm<sup>2</sup> is enough ?  
FFR=0.85

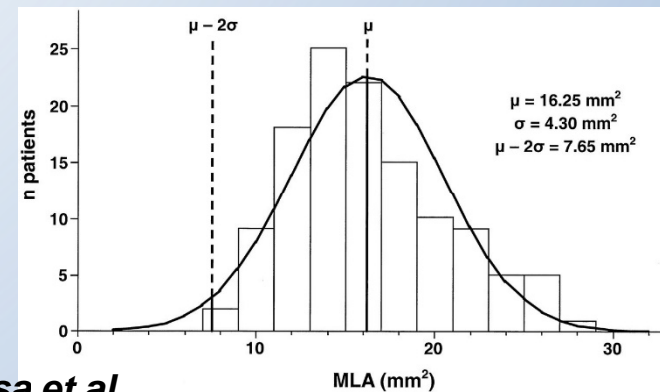


6 mm<sup>2</sup> is too small ?  
FFR=0.72

### A. MLA predicting FFR<0.80



*Kang et al.*

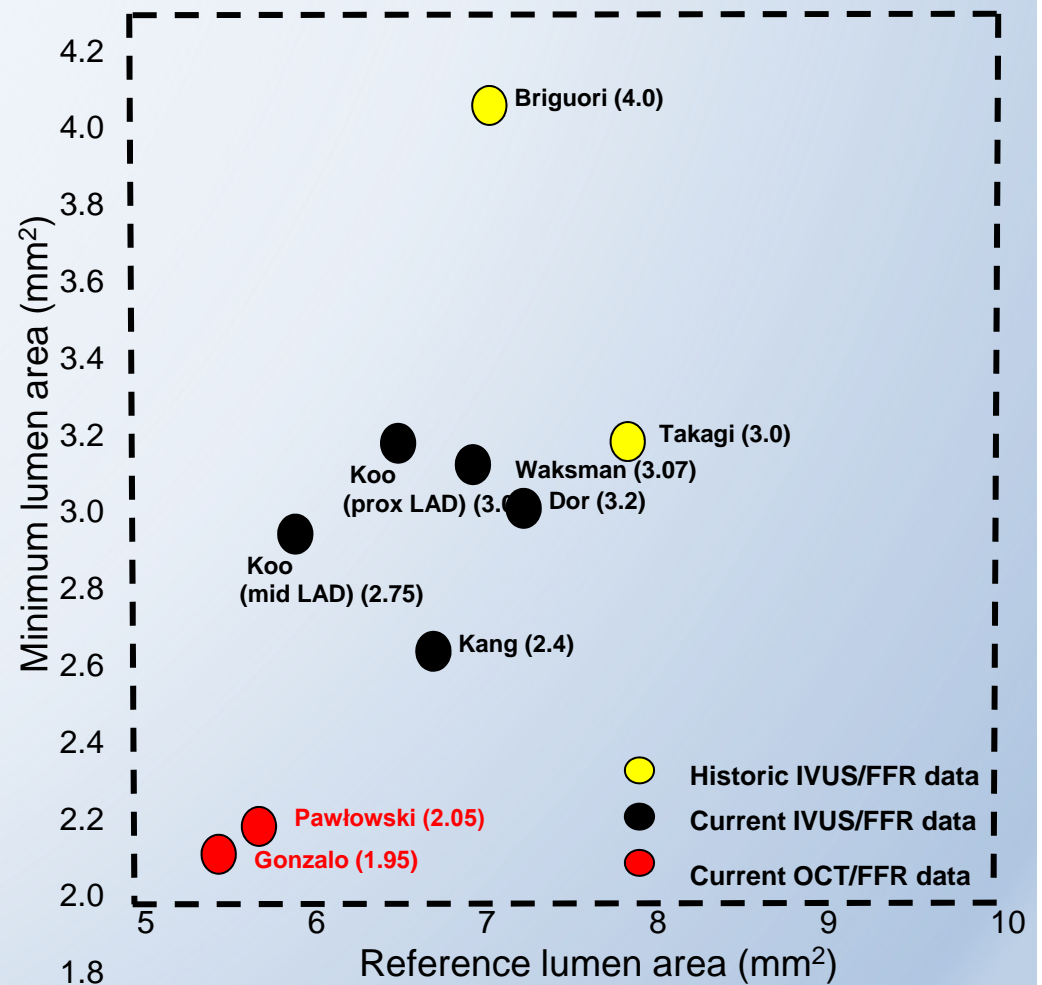
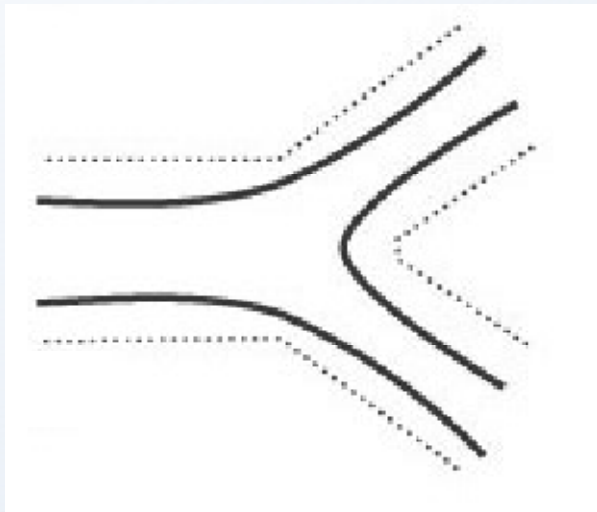


*Fassa et al.*



## Variability of IVUS LM cut-off values

Murray law for LM = 5-6 mm<sup>2</sup>



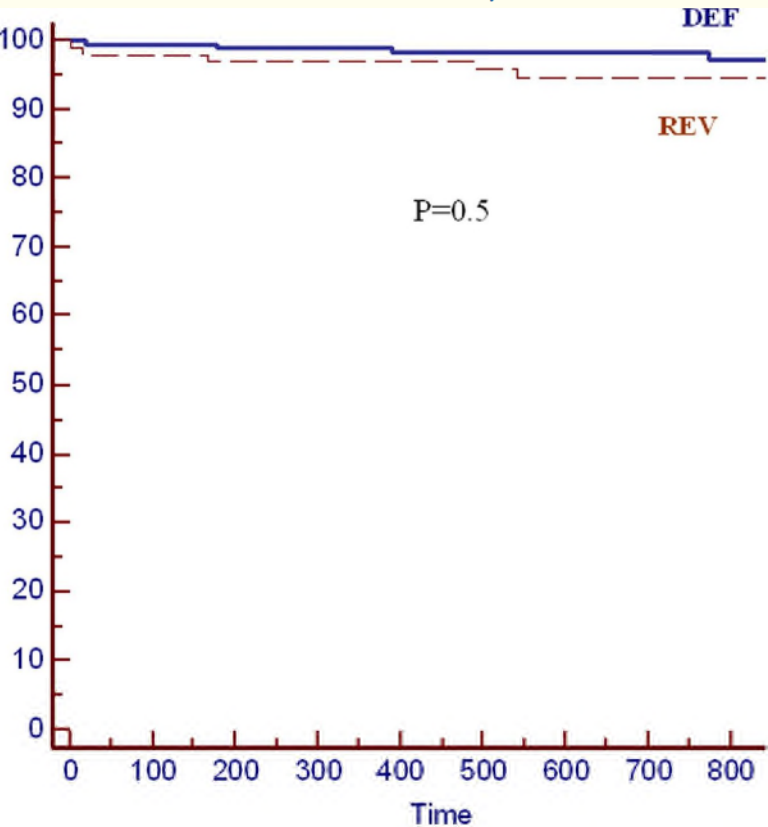




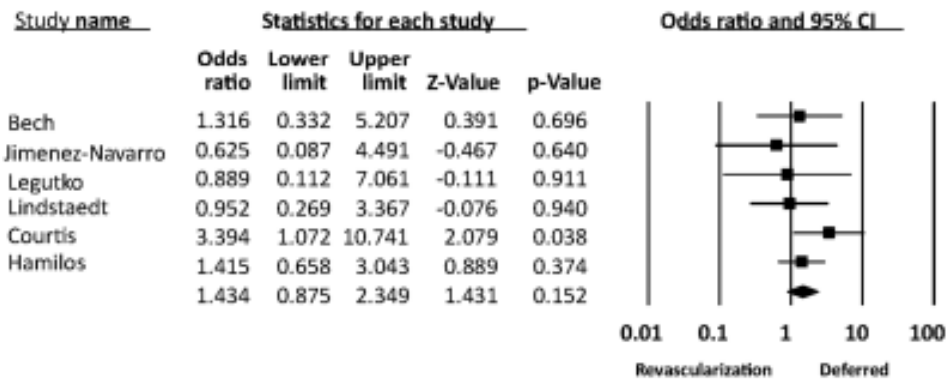
## FFR vs IVUS in intermediate LM

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

Results From the Multicenter LITRO Study



### Long-Term Outcomes Following Fractional Flow Reserve-Guided Treatment of Angiographically Ambiguous Left Main Coronary Artery Disease: A Meta-analysis of Prospective Cohort Studies



Cardiac deaths & survival



---

**Invasive assessment of intermediate left main stenosis  
by intravascular ultrasound & fractional flow reserve  
Long term clinical outcome of deferral & revascularisation**

***T. Pawłowski, S. Gołębiowski, J. Bil, P. Modzelewski, R.J. Gil***

Central Clinical Hospital of the Ministry of the Interior and Administration  
Warsaw, Poland



## Direct comparison- IVUS vs FFR

Total 120 pts with angio  
intermediate LM lesion assesed  
invasively in 2009-2014

Matched pairs according to demographics, risk factors, isolated LM stenosis

60 pts with assesed by FFR  
(140 ug/kg/min, Adenosine  
infution, FFR<0,80 for defferal)

60 pts with assesed by IVUS  
(cut-off value >6 mm<sup>2</sup> for  
revascularisation defferal)

2 year follow-up with MACE  
(Death, infarction, TVR)



## Direct comparison- IVUS vs FFR

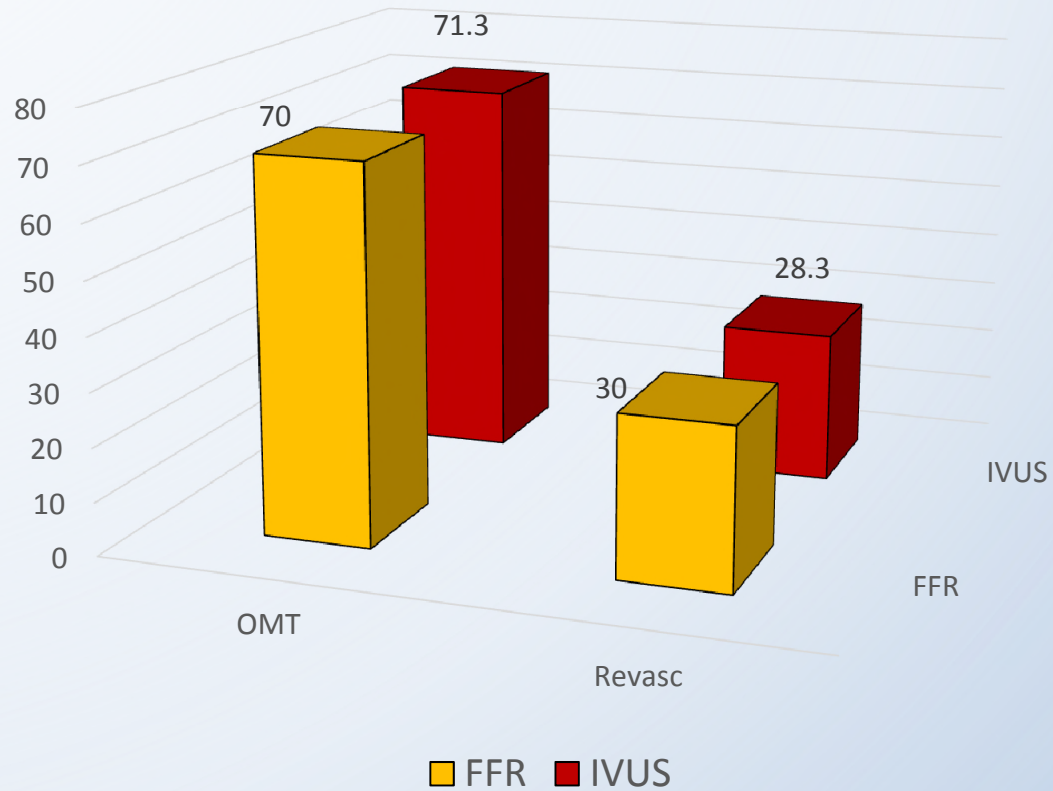
### Demographics

	Group 1 (FFR)	Group 2 (IVUS)	p
Age (years)	68.5±9.2	69.8±7.8	NS
Hypertension (%)	46.6	46.6	NS
Diabetes (%)	15.0	15.0	NS
Smoking (%)	35.0	35.0	NS
Distal LM lesion (%)	36.6	38.3	NS
Previous MI (%)	16.6	18.3	NS



## Direct comparison- IVUS vs FFR

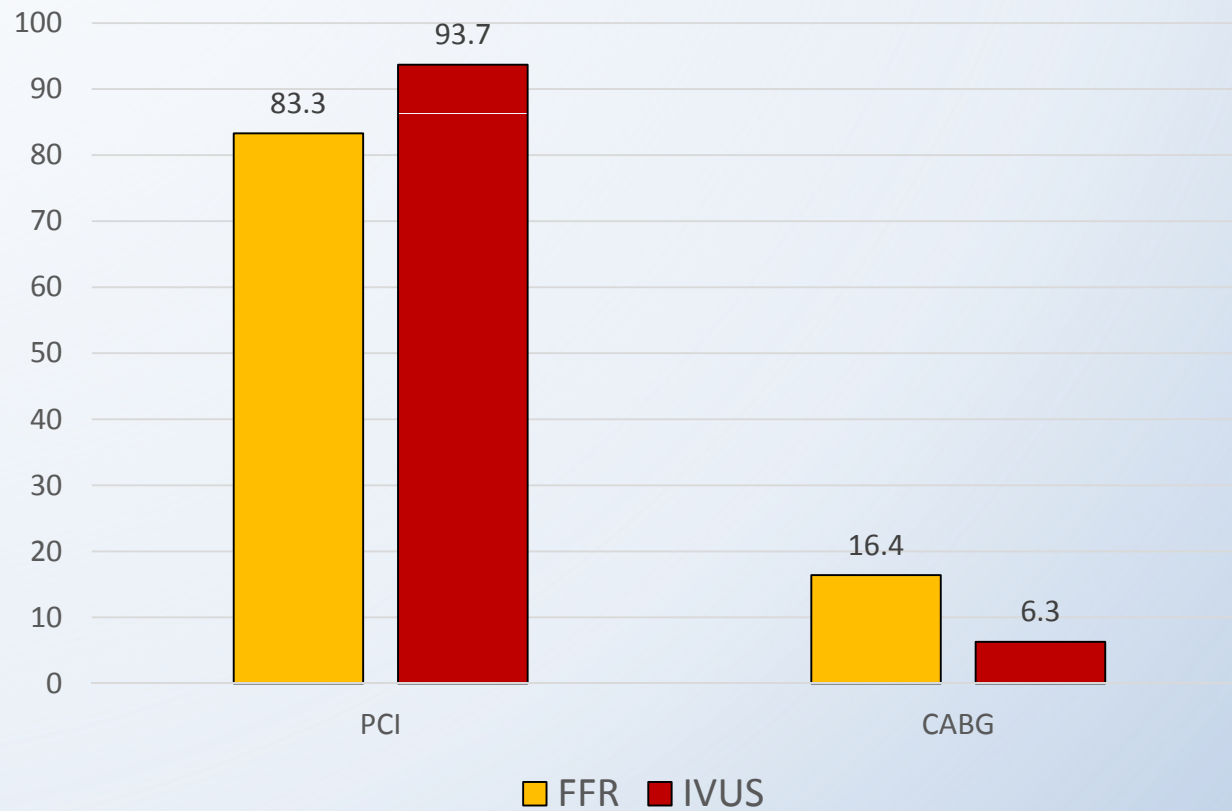
### Results of LM assessment





## Direct comparison- IVUS vs FFR

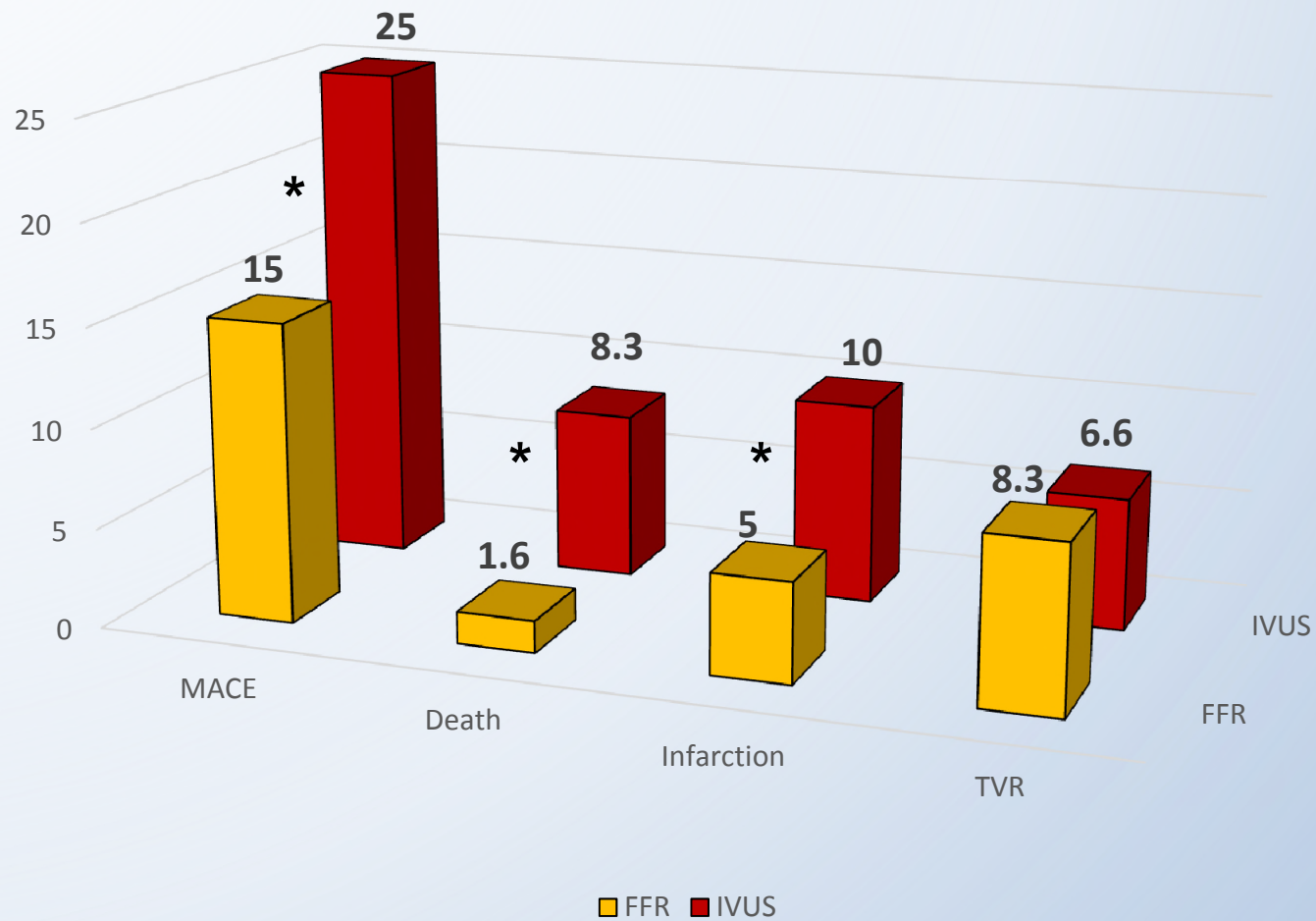
### Operator & heart team decisions Revascularisation





## Direct comparison- IVUS vs FFR

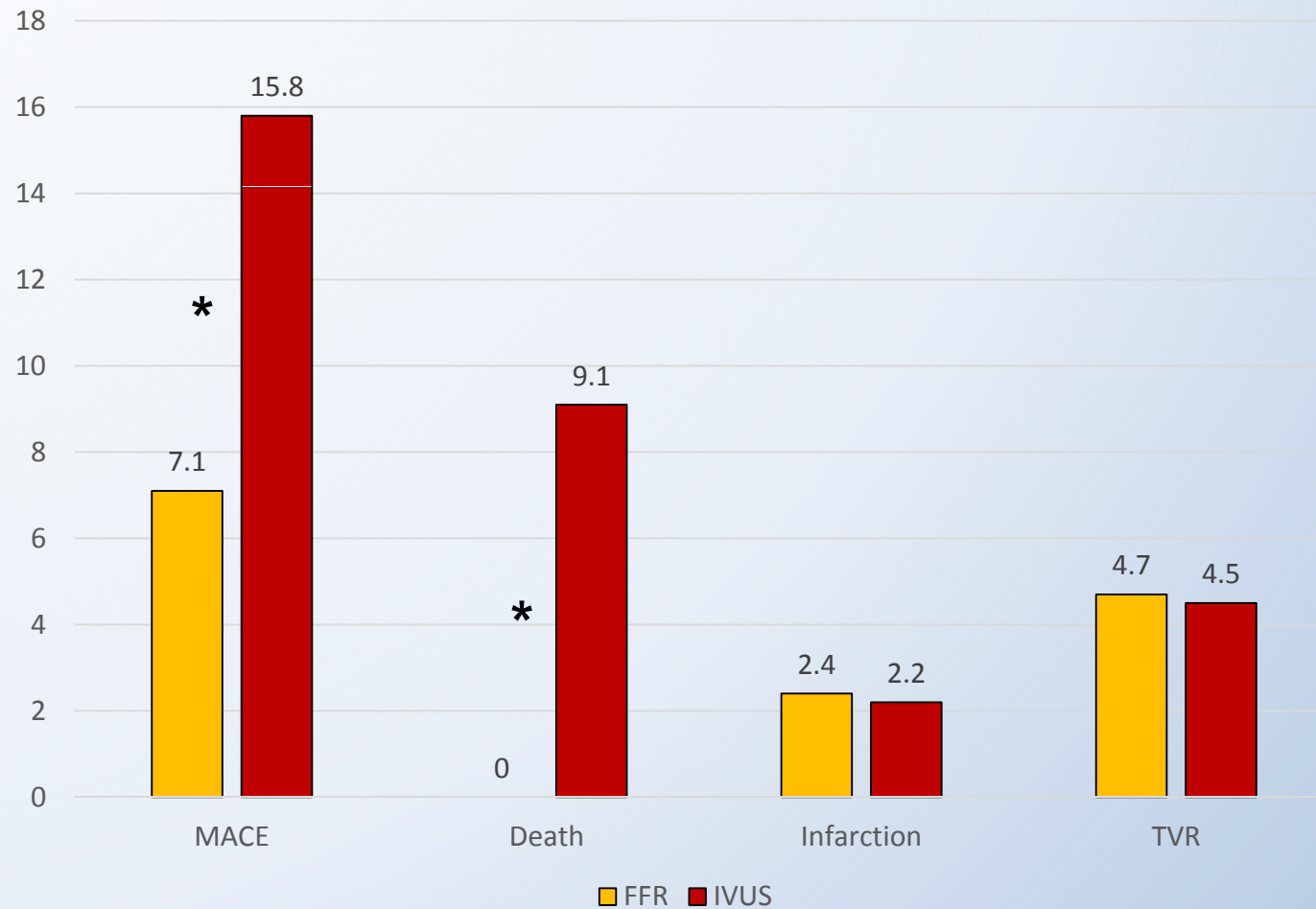
### 2 year follow-up – all patients





## Direct comparison- IVUS vs FFR

### 2 year follow-up – deffered pts

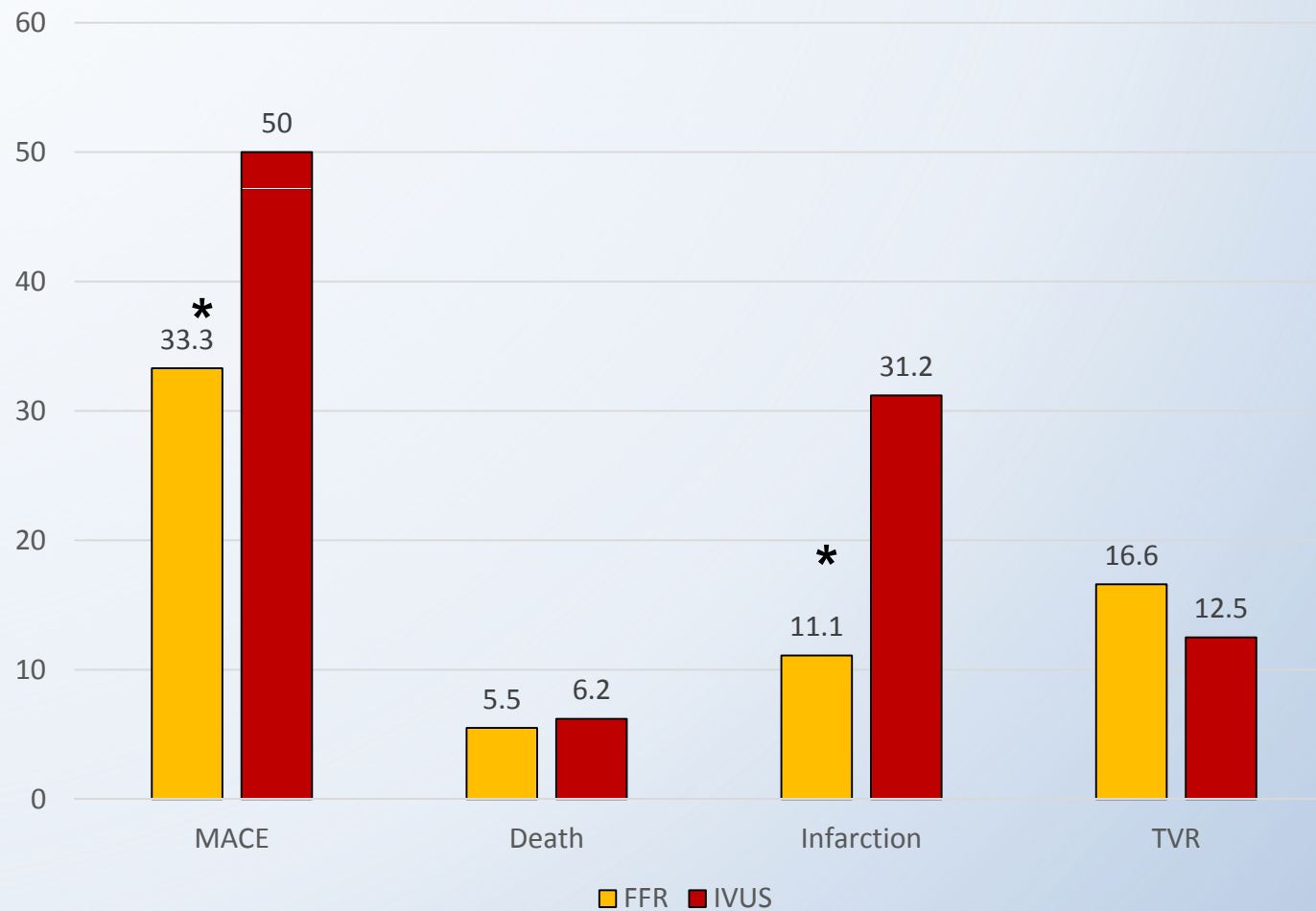






## Direct comparison- IVUS vs FFR

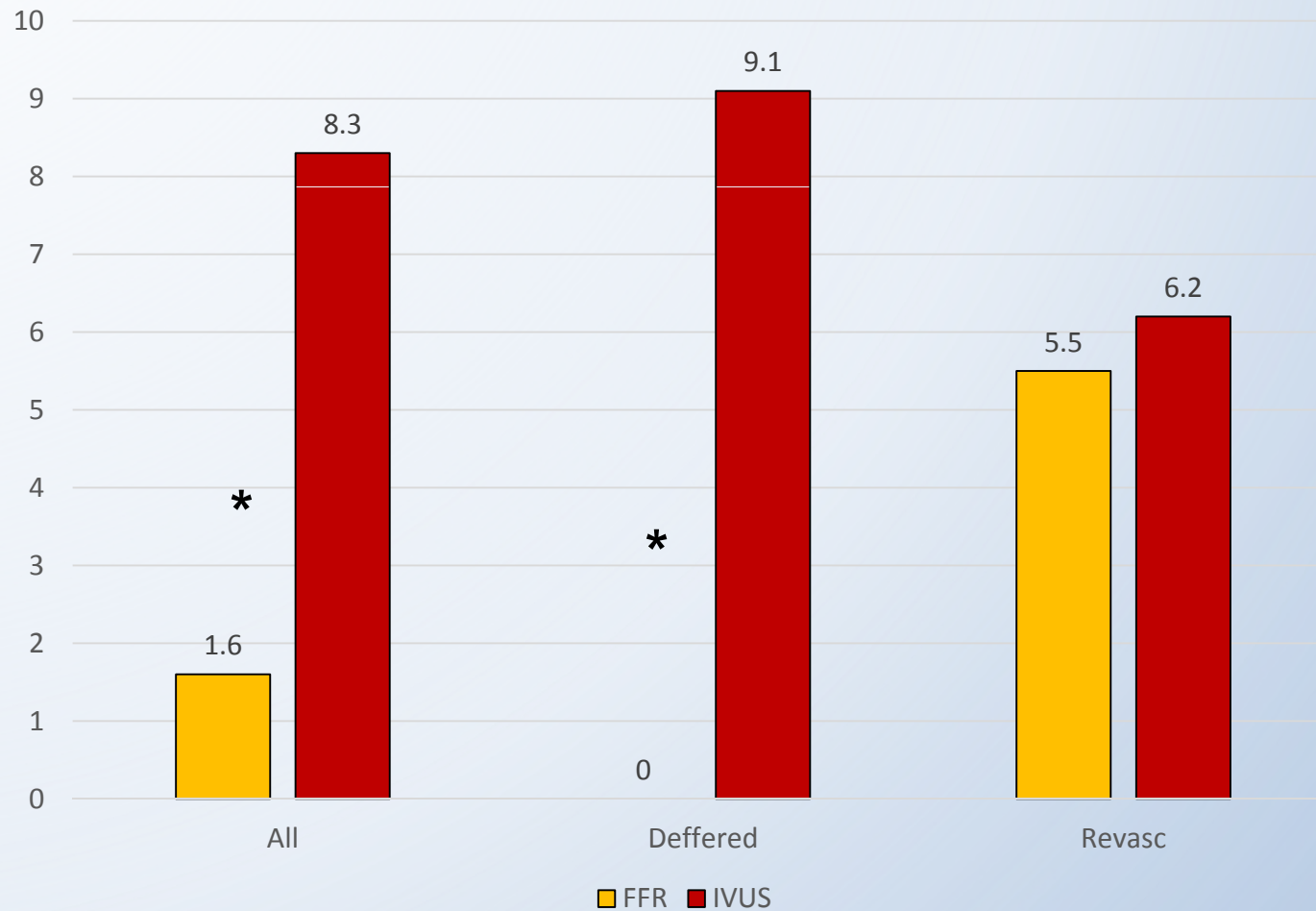
### 2 year follow-up – revascularized pts





## Direct comparison- IVUS vs FFR

### 2 year follow-up – mortality in subgroups





# Conclusions (01)

---

- FFR in comparison to IVUS provides a better long term clinical outcome, especially in terms of mortality in deferred from revascularisation pts
- There is a trend to higher number of infarction in IVUS revascularized subgroup
- The number of target vessel failure is lower in this subgroup that is probably related with IVUS optimisation technique
- Using IVUS when assessing intermediate LM lesion, provides a larger number of LM coronary angioplasty



## Conclusions (02)

---

- The general recommendation (cardiologist's feeling) was to use FFR or IVUS to defer revascularisation but with tendency for IVUS for subsequent optimisation of LM stenting
- Many data, similarly to native arteries, have showed that there is no single cut-off value for intermediate LM lesion deferring.  
Of note, huge variability in sizes & lengths of LM may play a role
- Fractional flow reserve provides a simple protocol, clear cut-off value & good clinical outcomes and very important – is not related to variability of LM sizes and myocardial area supplied

