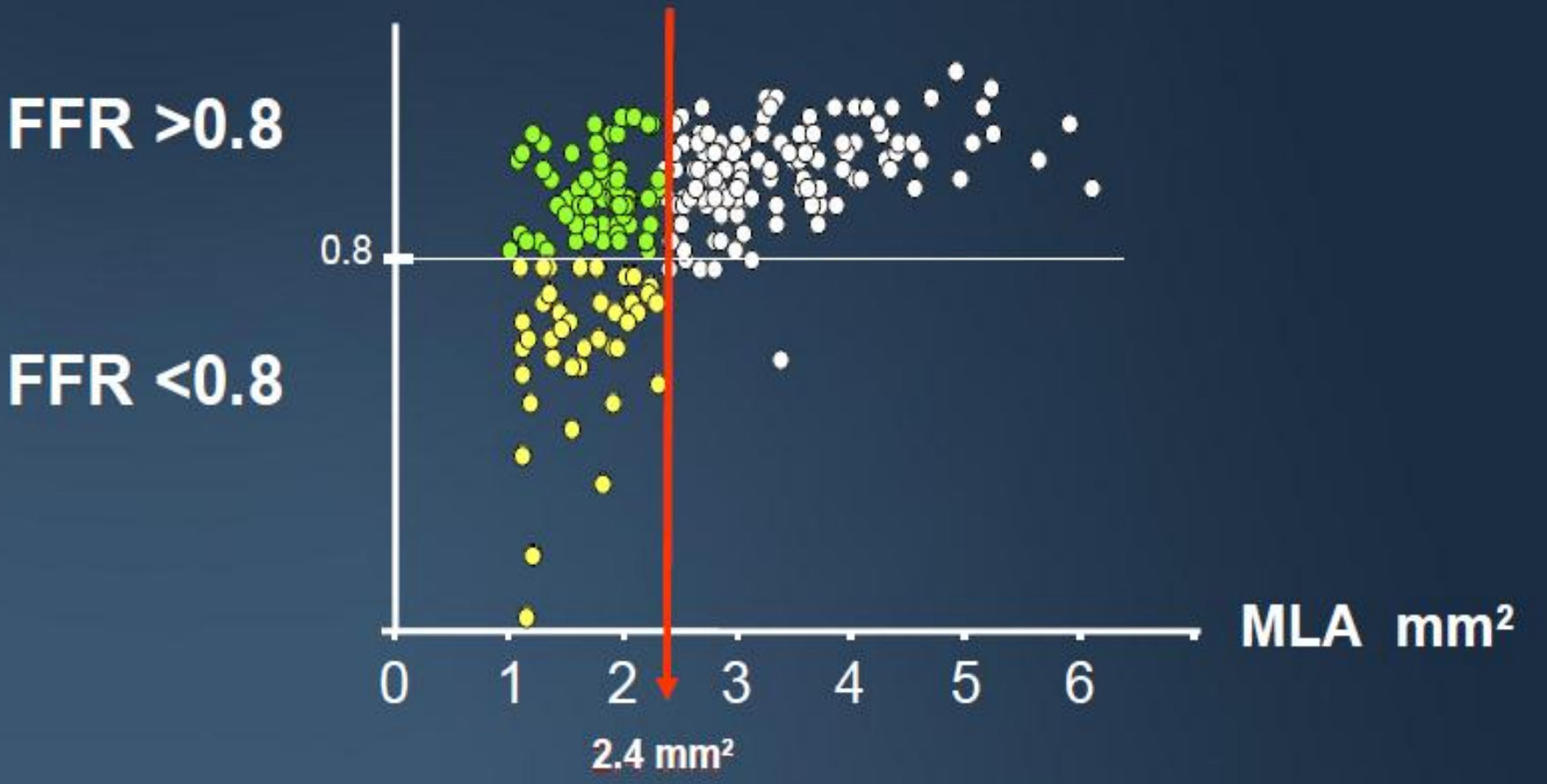
When and How to use OCT in daily practice

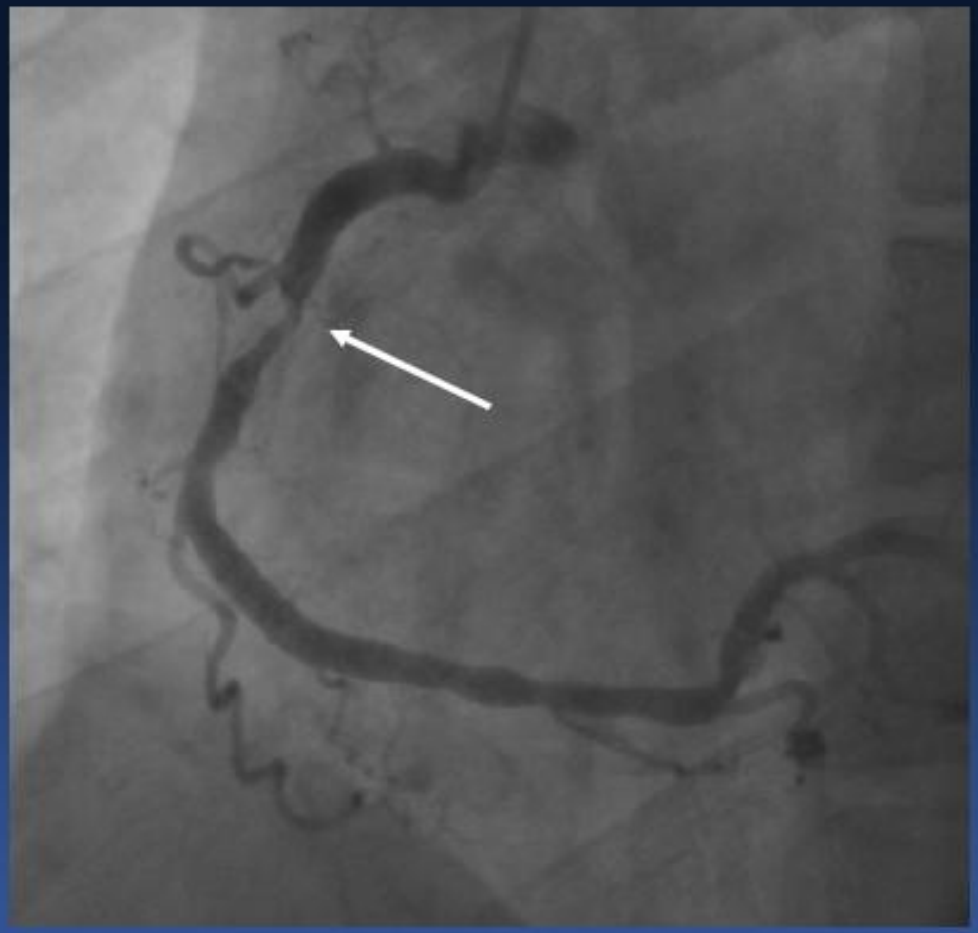
Novas Fronteiras em Cardiologia
Ericeira, February 2014

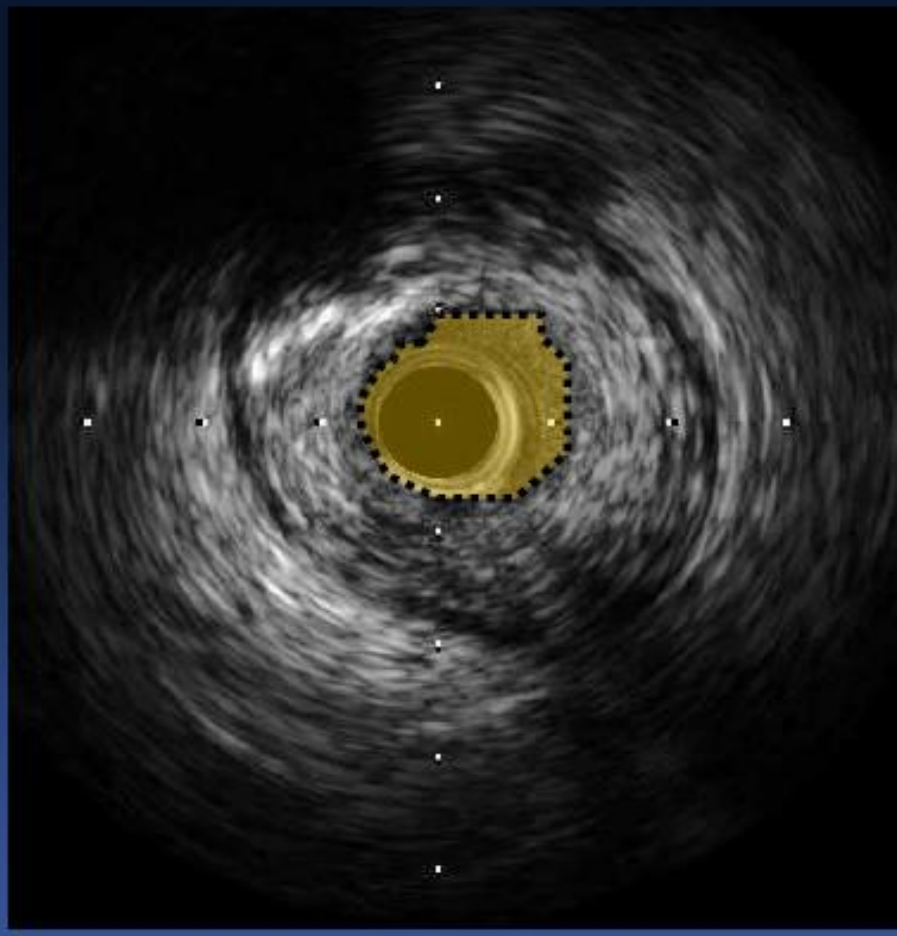
Francesco Prati
San Giovanni Hospital, Rome
Rome Heart Research

- **Coronary lesion assessment with OCT**


FFR >0.8
FFR <0.8
0.8
0
1
2
3
4
5
6
MLA mm²
2.4 mm²

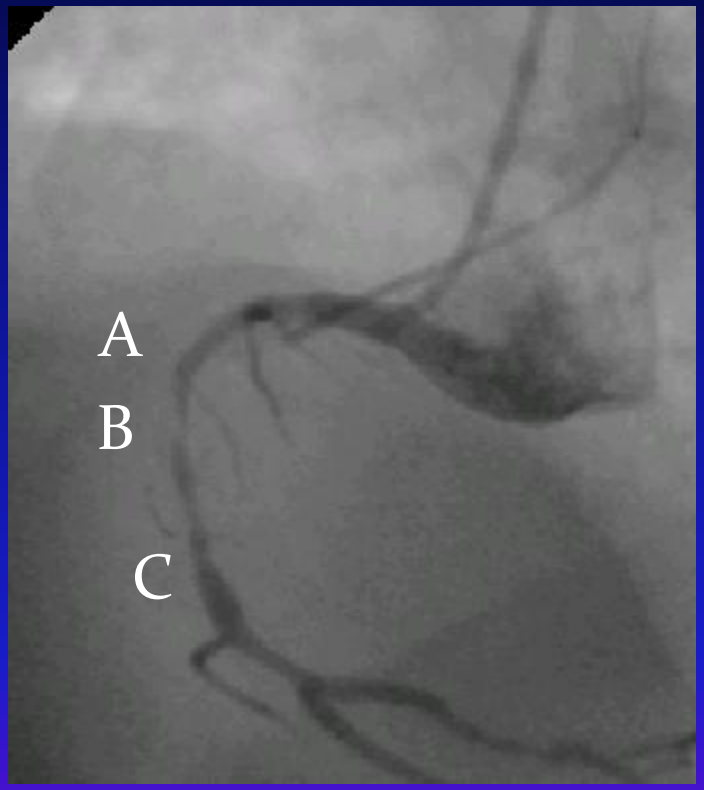
IVUS

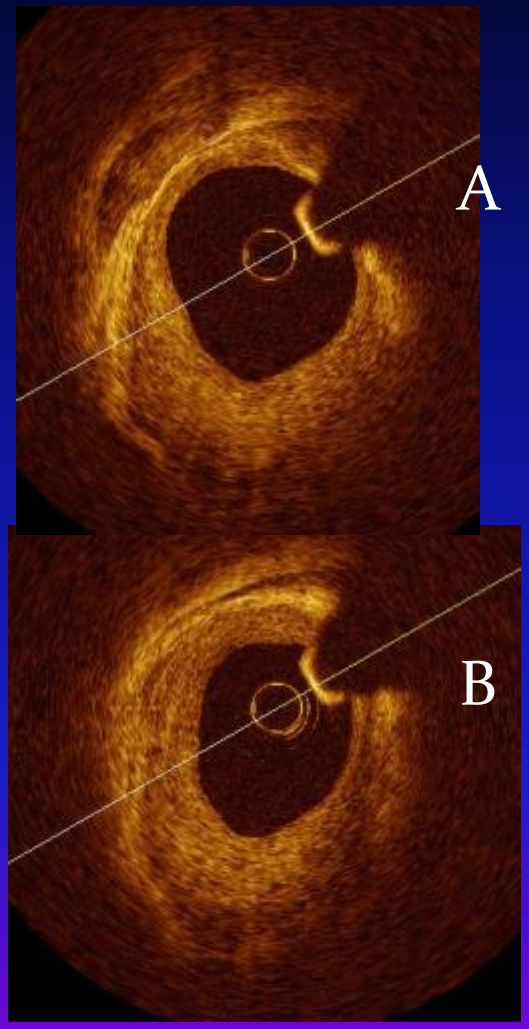




MLA 2.8 mm²

70 Y female with stable angina



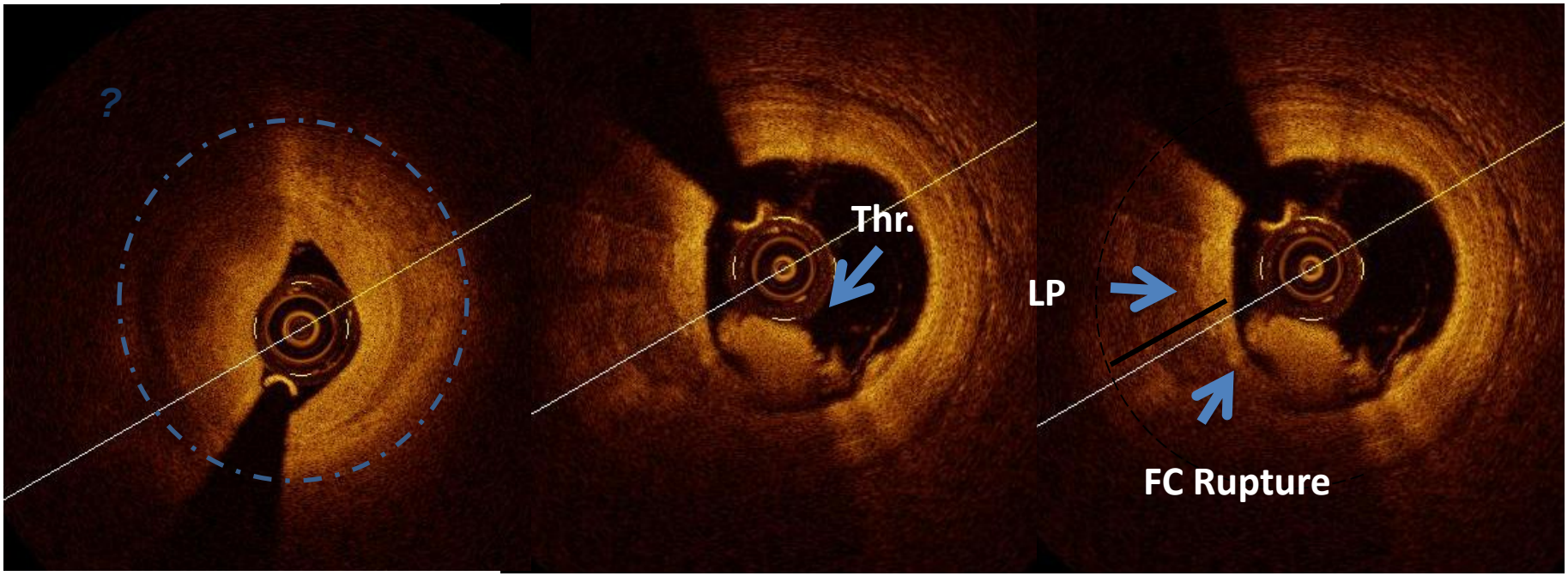


Target Lesion

Gonzalo et al JACC 2012. The new OCT cut-off is 1,8 mm ^{2}

- **Identification of culprit lesions in patients with ACS**

OCT details plaque morphology with high accuracy



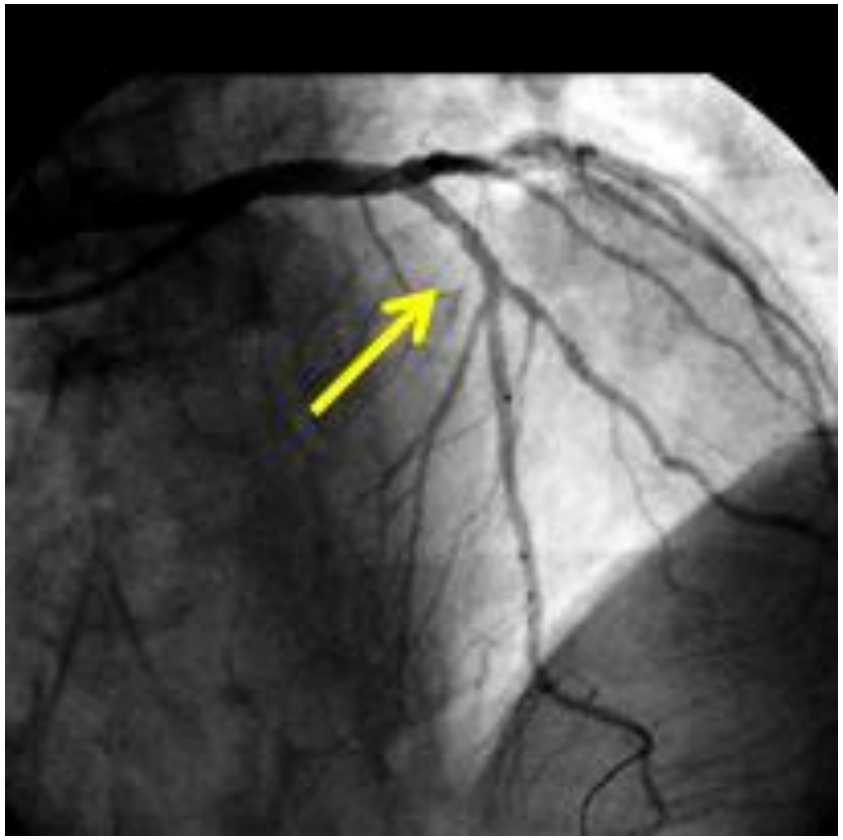
Example of plaque rupture with thrombus in a pt with STEMI

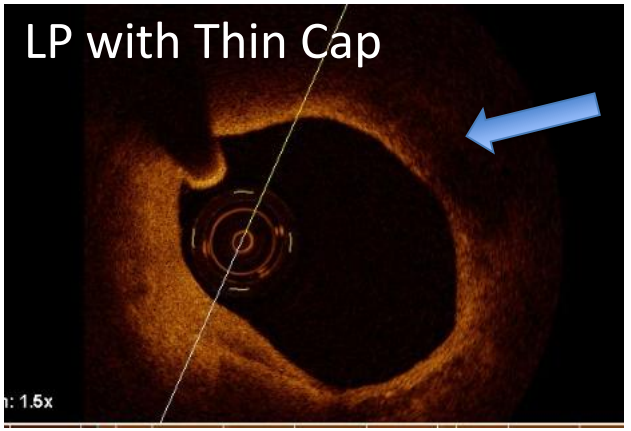
Exp Rev. Doc. on OCT for assessment of atherosclerosis. Eur H J 2010.
Cons. DOC on OCT JACC 2011

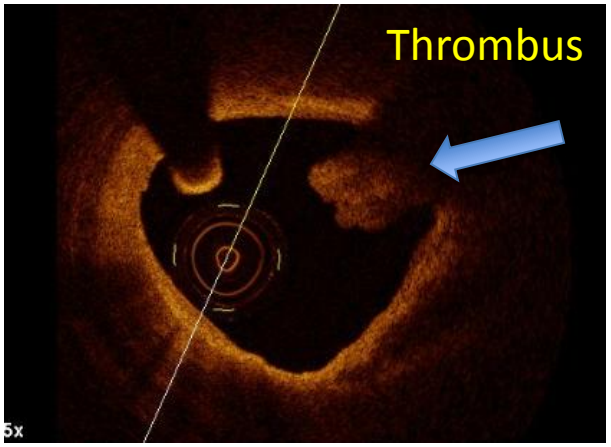
- 61 years old male without a previous history of CAD
- RF: Smoke
- Unstable angina with a single rest episode.
- The ECG showed a transient ST elevation in the anterior leads lasting 5-10 minutes.

Insert references here

FD-OCT: Ruptured plaque with mild thrombus







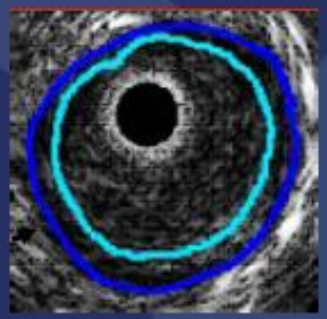
PTCA done

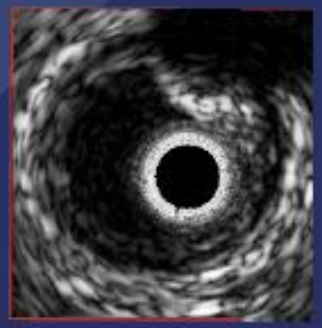
Exp Rev. Doc. on OCT for assessment of atherosclerosis. Eur H J 2010.
Exp Rev. Doc. on OCT for coronary intervention. Eur H J 2010.

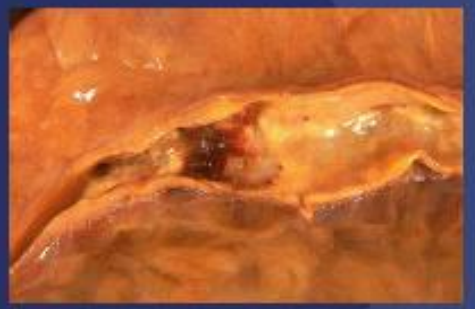
- **Pre-stenting assessment**

Acute coronary syndromes

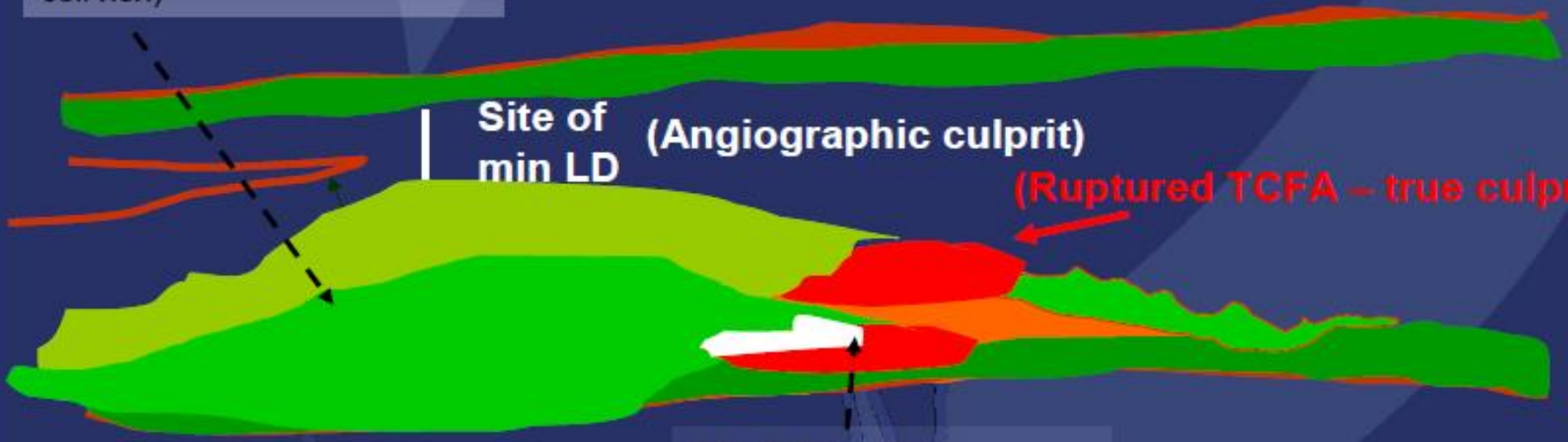
Rupture of an Eccentric ID TCFA and the Thrombotic Tails







Fall Out of the problem Layers of distal Thrombotic Tail (Red cell rich)



Site of the problem
Plaque rupture and layers of healed plaque ruptures

R Virmani, CVPath and
P Margolis, Volcano Corp.

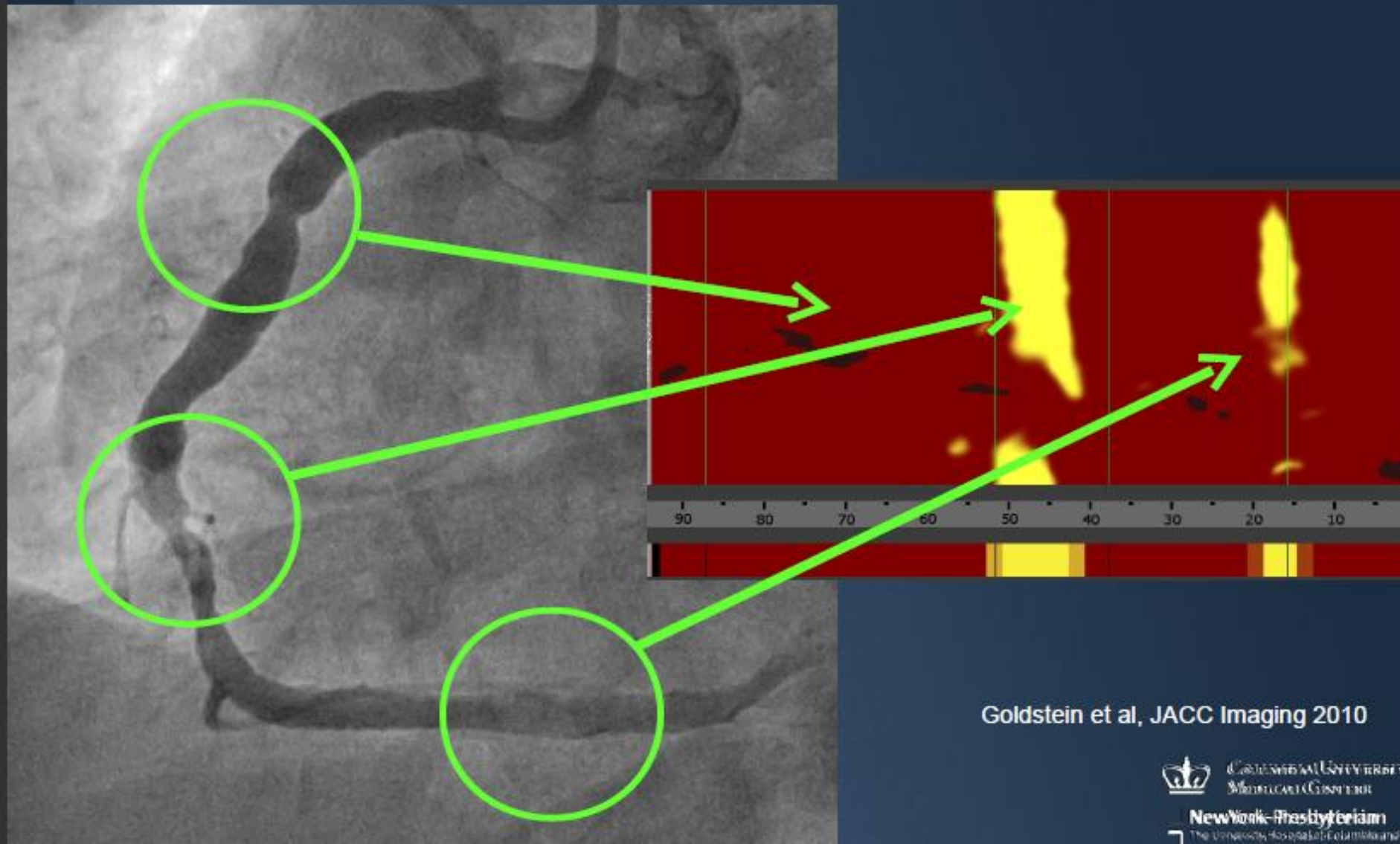
Association Between Proximal Stent Edge Positioning on Atherosclerotic Plaques Containing Lipid Pools and Postprocedural Myocardial Infarction (from the CLI-POOL Study)

Fabrizio Imola, MD[a], Michele Occhipinti, MD[b], Giuseppe Biondi-Zoccai, MD[b,c], Luca Di Vito, MD[a], Vito Ramazzotti, MD[a], Alessandro Manzoli, MD[a], Alessandro Pappalardo, MD[a], Alberto Cremonesi, MD[d], Mario Albertucci, MD[b], and Francesco Prati, MD[a,b,*]

…….. landing of proximal stent edges on lipid pools was significantly more frequent in patients with post procedural MI than in controls (10 [66%] vs 2 [13%], p [0.009)

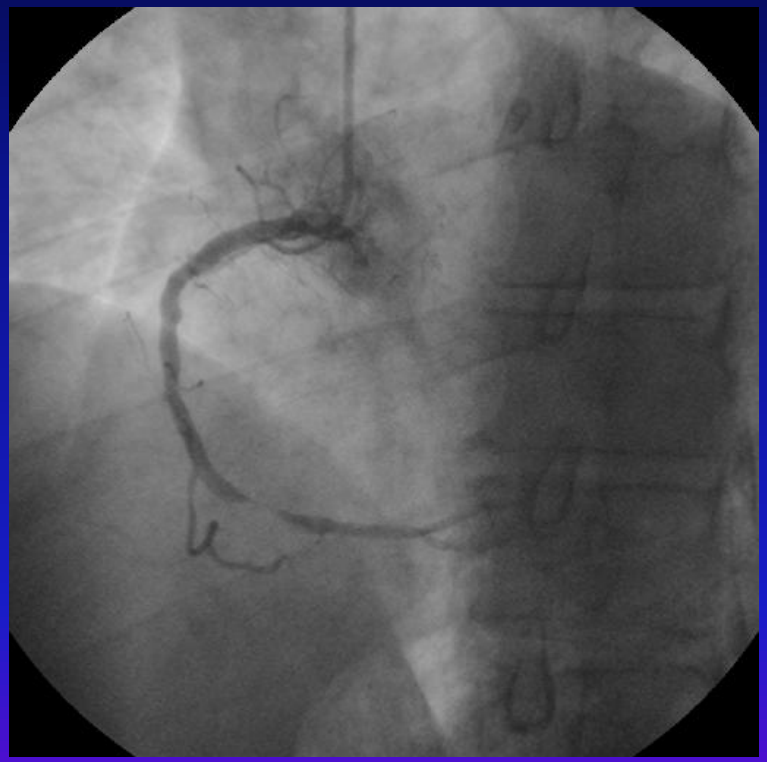
Imola et al- Am J Cardiol 2012

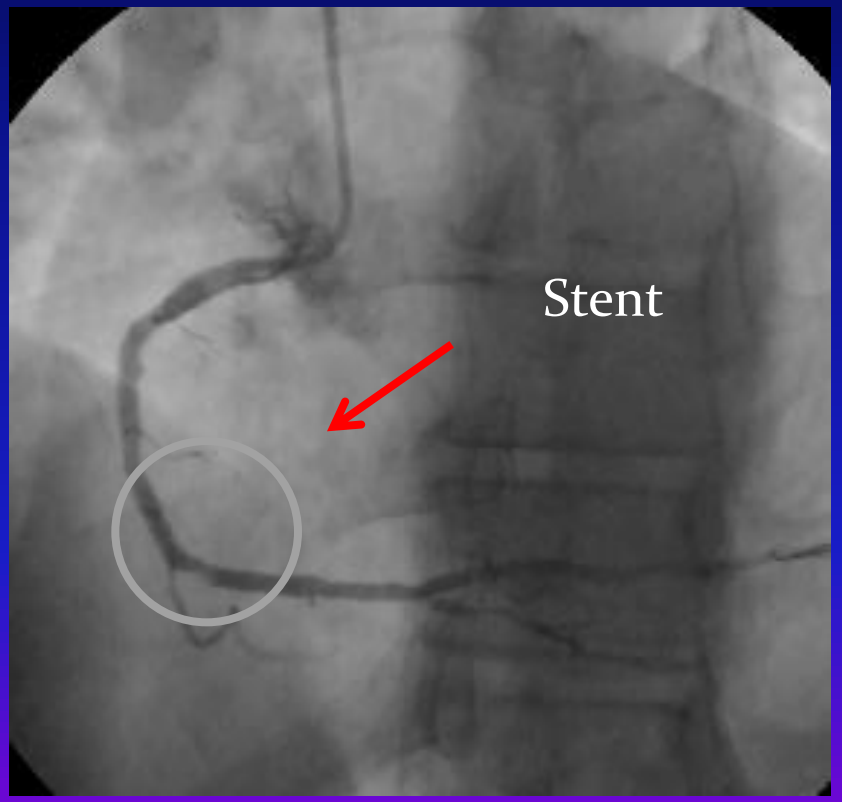
Prediction of No-Reflow



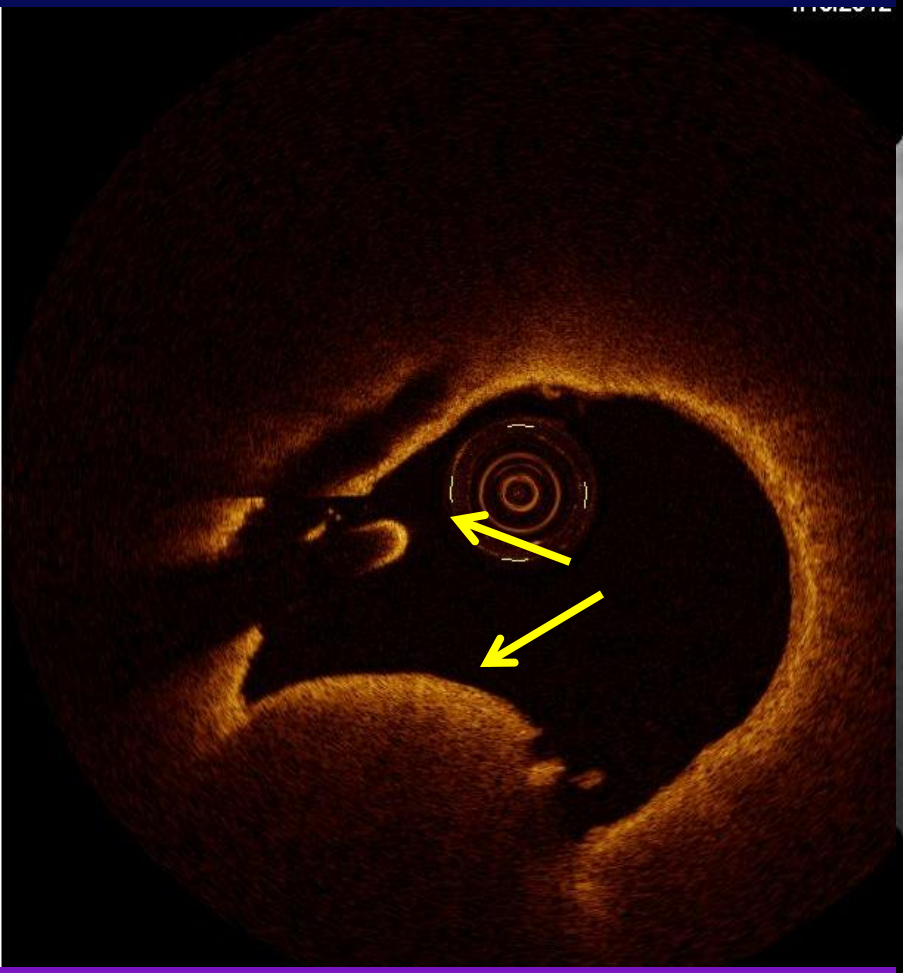
Goldstein et al, JACC Imaging 2010

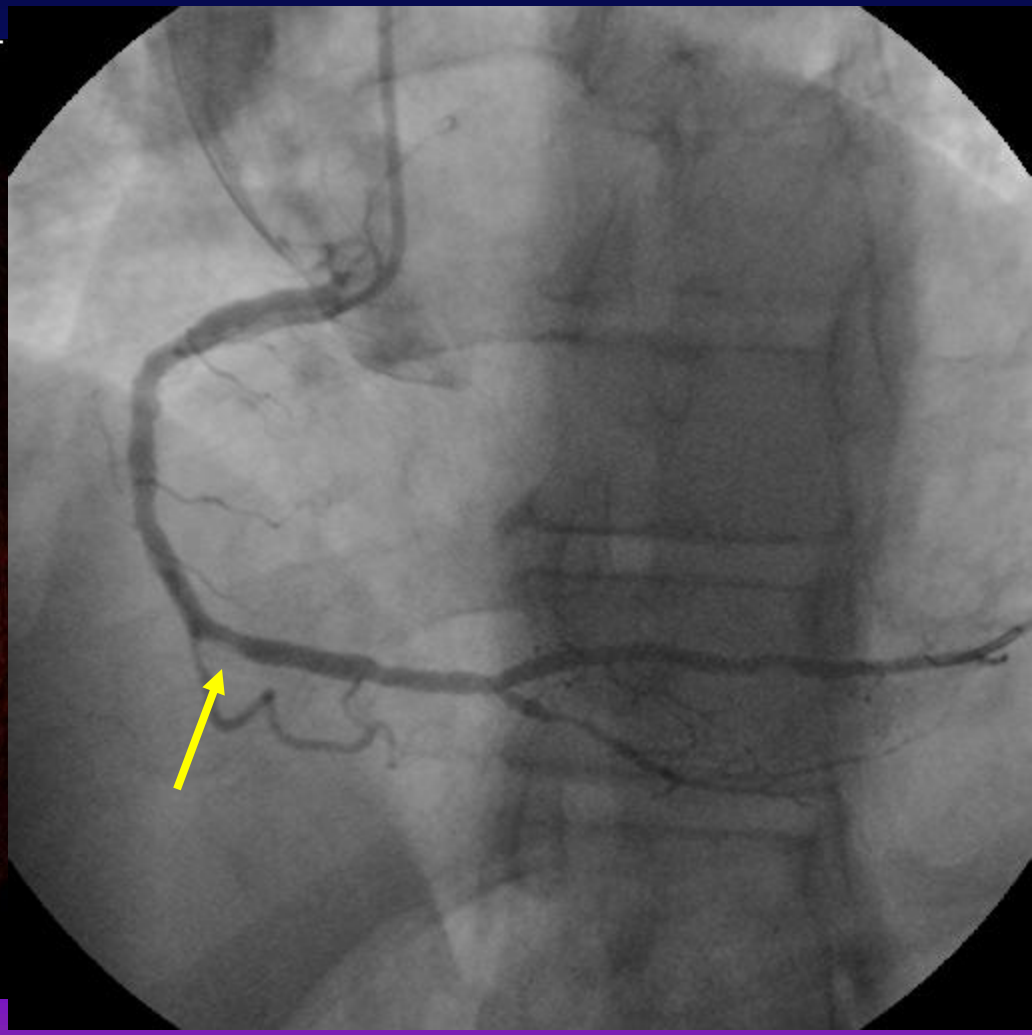
After DES Stenting (Xience 3.0 x 15 mm)





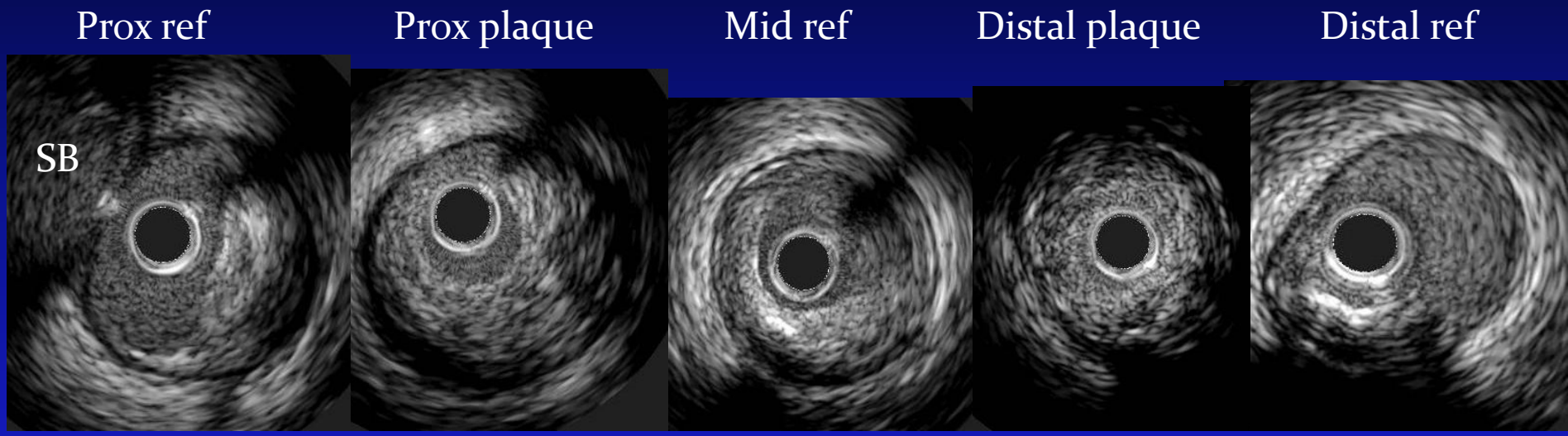
Missed plaque rupture





Stenting guidance

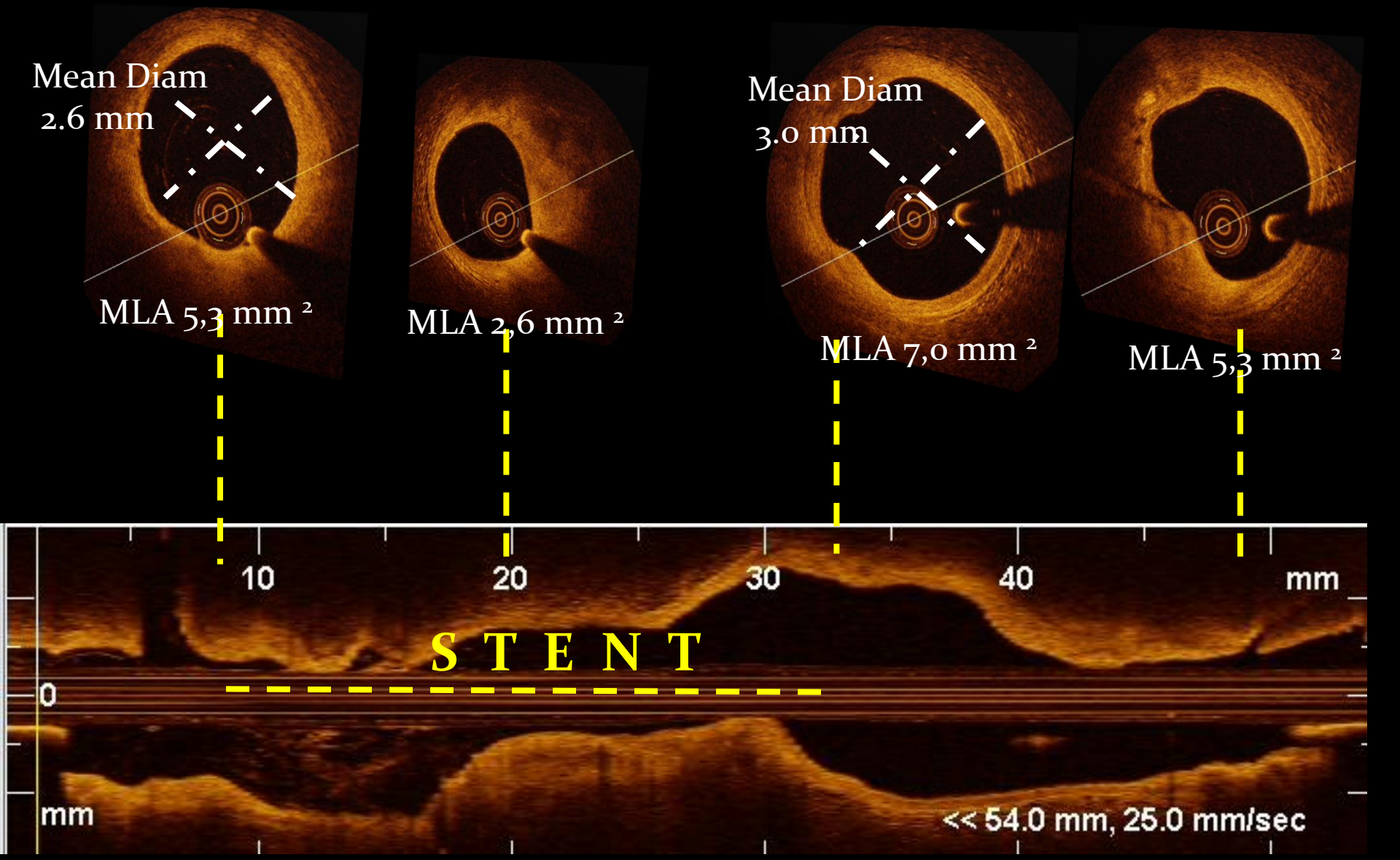
Example of Pre-intervention IVUS use



1. **Some calcifications**
2. **Clear assessment of plaque burden**
3. **Mesaurement of lesion lenght**

Strategy: Deployment of 2 DES (28 mm each) avoiding overlapping

Use of FD-OCT to measure lumen areas at the lesion site and references



Evidence that I.C. imaging makes the difference

Meta-analisi

Restenosi Angiografica Binaria

Studio	IVUS-Guidato	Angio-Guidato	Odds Ratios & 95% CI Fixed
RCT's			
SIPS, 1996	48/166 (29%)	66/190 (34,7%)	0,76 [0,49-1,20]
RESIST, 1997	16/71 (22,5%)	21/ 73 (28,7%)	0,72 [0,34-1,53]
OPTICUS, 1998	56/229 (24,4%)	52/228 (22,8%)	1,10 [0,71-1,69]
TULIP, 2001	15/73 (20,5%)	28/77 (36,4%)	0,45 [0,22-0,94]
Sub-Totale	135/539 (25%)	167/568 (29%)	0,81 [0,62-1,06]
Registri			
Albiero, 1995	29/158 (18,3%)	40/154 (26%)	0,64 [0,37-1,10]
Blasini, 1995	22/105 (20,9%)	32/107 (29,9%)	0,62 [0,33-1,16]
Sub-Totale	51/263 (19%)	72/261 (27,5%)	0,63 [0,42-0,95]
Totale	186/802 (23%)	239/829 (28,8%)	0,75 [0,60-0,94]

X2 Eterogeneità: 0,36

P=0,01

.01 .2 1 5 10

IVUS-guidato Meglio

Angio-guidato Meglio

Casella et al. Eur Heart Journal 2002. Abstract

- **884 patients undergoing IVUS-guided intracoronary DES implantation**
- **Propensity-score matched population undergoing DES implantation with angiographic guidance alone**

1 year outcome	IVUS	No IVUS	P
MACE	14,5	16,2	0.3
Death	5,77	7,1	0.24
TLR	5,1	7,2	0.07
Probable Stent Thrombosis	4,0	5,8	0.08
Definite Stent Thrombosis	0,7	2,0	0.014

Roy et al Eur Heart J 2008

Clinical Outcome of OCT vs Angiography Alone: the CLI-OPCI Study

F Prati et al.

Eurointervention 2012

Rome Heart Research

Angiography alone versus angiography plus optical coherence tomography to guide decision making during percutaneous coronary intervention: the CLI-OPCI study

Francesco Prati, MD, Luca Di Vito, MD, Giuseppe Biondi-Zoccai, MD, Michele Occhipinti, MD, Alessio La Manna MD, Francesco Burzotta, MD, Vito Ramazzotti, MD, Carlo Trani MD, Laura Materia, PharmD, Corrado Tamburino MD, Italo Porto MD, Alberto Cremonesi MD.

- Department of Interventional Cardiology, San Giovanni- Hospital, Rome, Italy (FP, VR, FI, AM, IP); Centro per la Lotta contro l'Infarto – Fondazione Onlus, Rome, Italy (FP, LDV, GBZ, MO, LM,); Division of Cardiology, University of Catania, Catania, Italy (MO, ALM, CTA); Institute of Cardiology, Catholic University, Rome, Italy (FB, C TR,); Sansavini Foundation, Cotignola, Italy (AC)

Methods

- Consecutive patients undergoing PCI with angiographic plus OCT guidance (OCT group) at three high OCT-volume Italian centers between 2009 and 2011 were included.
- Patients in the OCT group (335 pts) were matched 1:1 with randomly-selected patients undergoing during the same month PCI with angiographic only guidance (Angio group).
- All patients provided written informed consent, and ethical approval was waived given the observational and retrospective design.

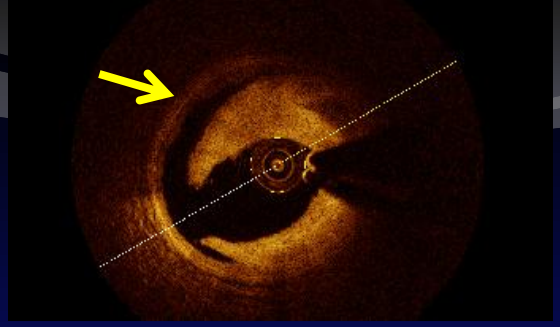
Euro-PCR 2012, Eurointervention 2012

- OCT was performed after the achievement of an optimal angiographic result
- The following definitions of sub-optimal OCT results were adopted

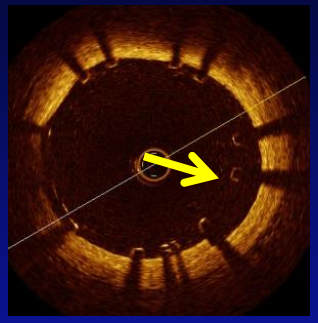
Definitions of Sub-Optimal results after stenting

Submitted Euro-PCR 2012

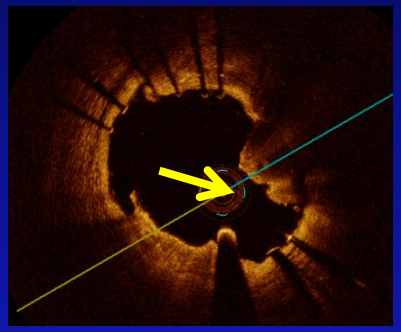
Edge dissection.
Width > 200 μ



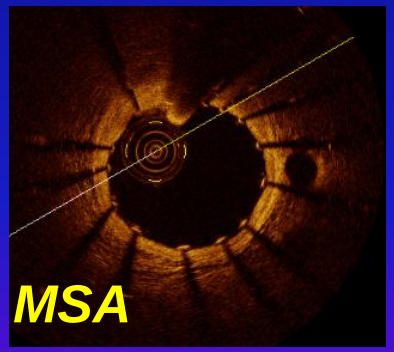
Stent malapposition.
Distance > 200 μ

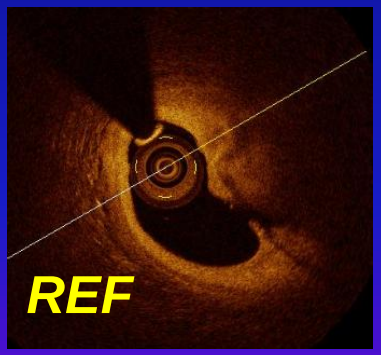


Thrombus. Thickness > 200 μ



Absence of residual stenosis adjacent to stent endings (MLA <4.0 mm^2)





Underexpansion

In-stent MLA ≥90% of the average reference lumen area or ≥100% of lumen area of the reference segment with the lowest lumen area

End-points

- The primary end-point of the study was the 12-month rate of cardiac death or non-fatal myocardial infarction (MI).
- Additional end-points were short-term rates of death, cardiac death, and non-fatal MI, and 12-month rates of death, cardiac death, non-fatal MI, target lesion repeat revascularization (TLR) and definite stent thrombosis.
- All outcomes were defined in keeping with the Academic Research Consortium recommendations.

Eurointervention 2012

Baseline characteristics

	Angiographic group (N=335)	Optical coherence tomography group (N=335)	P value
Age, years	67.0±11.5	64.8±11.5	0.016
Female gender	82 (24.5%)	73 (21.8%)	0.409
Hypertension	244 (73.8%)	253 (75.5%)	0.427
Diabetes mellitus	97 (29.0%)	81 (24.2%)	0.162
Current smoking	113 (33.7%)	115 (34.3%)	0.063
Dyslipidemia	176 (53.3%)	214 (64.5%)	0.002
Prior myocardial infarction	72 (21.5%)	76 (22.7%)	0.709
Prior percutaneous coronary intervention	78 (23.5%)	115 (34.3%)	0.002
Prior coronary artery bypass grafting	29 (8.7%)	22 (6.6%)	0.308
Admission diagnosis			0.005
ST-elevation myocardial infarction	123 (36.7%)	86 (25.7%)	
Non-ST-elevation acute coronary syndrome	85 (25.4%)	112 (33.4%)	
Stable coronary artery disease	127 (37.9%)	137 (40.9%)	
Left ventricular ejection fraction, %	52.8±10.4	53.8±10.2	0.303
Post-procedural serum creatinine (mg/dL)	1.1±0.4	1.1±0.3	0.954

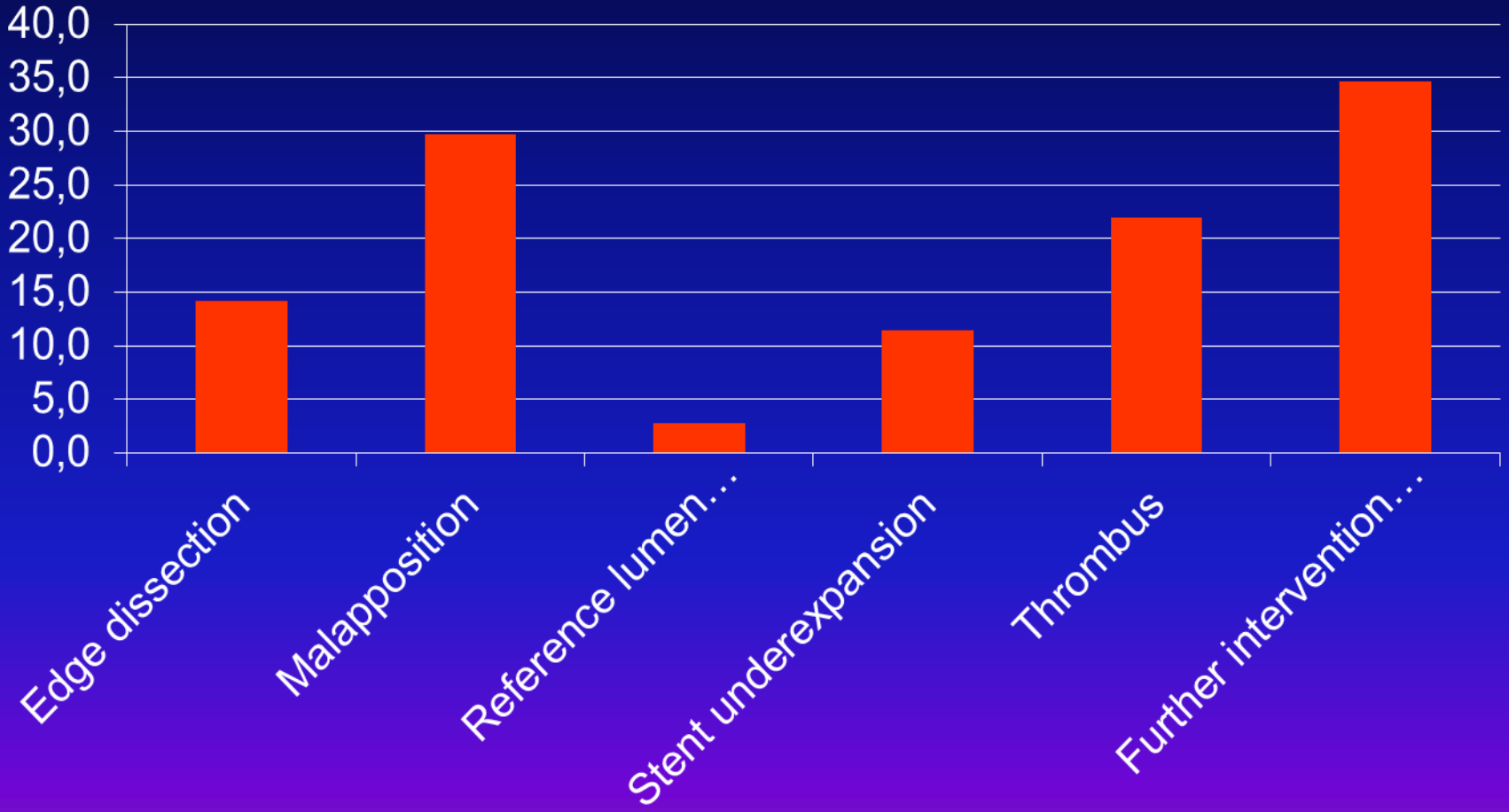
Procedural results

	Angiographic guidance group (N=335)	Angiographic plus optical coherence tomography guidance group (N=335)	P value
Number of diseased vessels			0.007
1	159 (47.9%)	122 (36.8%)	
2	108 (32.8%)	144 (43.4%)	
3	68 (19.3%)	69 (19.6%)	
Left main disease	8 (2.4%)	22 (6.6%)	0.009
American College of Cardiology/American Heart Association type B2/C lesion	287 (86.7%)	244 (72.8%)	<0.001
PCI on left anterior descending	179 (53.4%)	204 (60.9%)	0.050
Multivessel PCI	52 (15.5%)	78 (23.3%)	0.011
Stent length per patient (mm)	26.0±15.6	29.0±16.6	0.024
Drug-eluting stent usage	146 (43.6%)	212 (63.3%)	<0.001
Stent overlap	25 (7.5%)	49 (14.6%)	0.003
Maximum balloon diameter (mm)	3.0±0.5	3.1±0.4	0.037
Maximum dilation pressure (ATM)	16.7±2.5	16.7±2.8	0.823
Contrast (mL)	220±56	240±74	0.784

Eurointervention 2012

Results

335 pts with OCT guidance



Eurointervention 2012

Clinical results

	Angiographic guidance group (N=335)	Angiographic plus optical coherence tomography guidance group (N=335)	P value
In-hospital events			
Cardiac death	3 (0.9%)	2 (0.6%)	0.010
Non-fatal myocardial infarction	22 (6.5%)	13 (3.9%)	0.096
Events at 1-year follow-up			
Death	23 (6.9%)	11 (3.3%)	0.035
Cardiac death	15 (4.5%)	4 (1.2%)	0.010
Myocardial infarction	29 (8.7%)	18 (5.4%)	0.096
Target lesion repeat revascularization	11 (3.3%)	11 (3.3%)	1.0
Definite stent thrombosis	2 (0.6%)	1 (0.3%)	0.624
Cardiac death or myocardial infarction	**43 (13.0%)**	**22 (6.6%)**	**0.006**
Cardiac death, myocardial infarction, or repeat revascularization	50 (15.1%)	32 (9.6%)	0.034

Eurointervention 2012

Results

- Unadjusted analyses showed that the OCT group had a lower 12-month risk of cardiac death (p=0.010), cardiac death or MI (p=0.006), and the composite of cardiac death, MI, or repeat revascularization (p=0.044).
- Even at extensive multivariable analysis adjusting for baseline and procedural differences, angiographic plus OCT guidance was associated with a lower risk of cardiac death or MI (OR=0.49 [0.25-0.96], p=0.037).
- Finally, even propensity score-adjusted analysis exploiting bootstrap resampling confirmed the association between OCT and the 12-month rate of cardiac death or non-fatal MI (OR=0.37 [0.10-0.90], p=0.050).

Eurointervention 2012

Mechanism Of Stent Thrombosis (MOST) Study: a prospective multicentre non-randomized registry.

Eurointervention. 2013

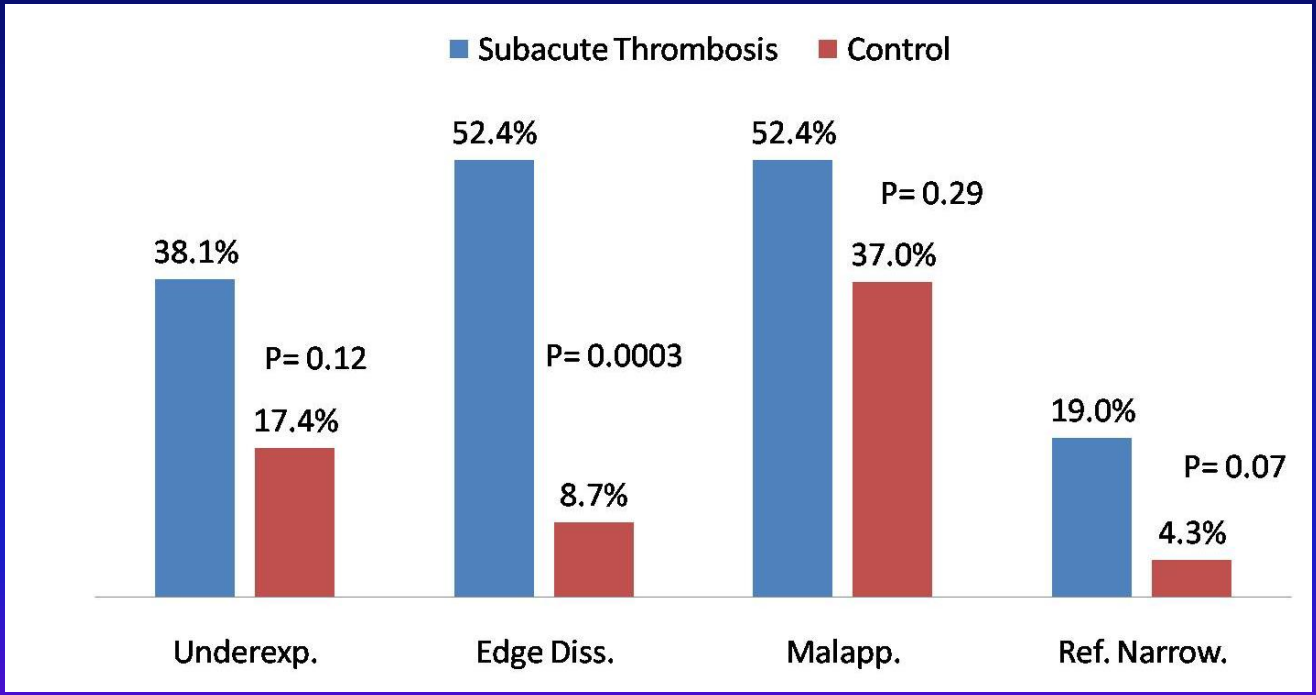
		Thrombus Site	Control	p
Subacute Stent Thrombosis	**Minimum SA (mm^2)**	**2.1 (1.3-4.5)**	**3.0 (2.4-5.0)**	**0.05**
Late Stent Thrombosis	**Minimum SA (mm^2)**	**3.5 (2.4-5.7)**	**3,6 (2.5-5.7)**	**0.97**

Subacute ST had a significant stent underexpansion while late/very late ST had a greater stent strut malapposition distance

G Parodi, A La Manna, L Di Vito, M Valgimigli, M Fineschi, B Bellandi, G Niccoli, B Giusti, R Valenti, A Cremonesi, G Biondi-Zoccai, F Prati

Suboptimal stent deployment in presence of sub-acute thrombosis: a comparative FD-OCT study

21 stent cases with subacute thrombosis vs 42cases from a control group from the RHR database

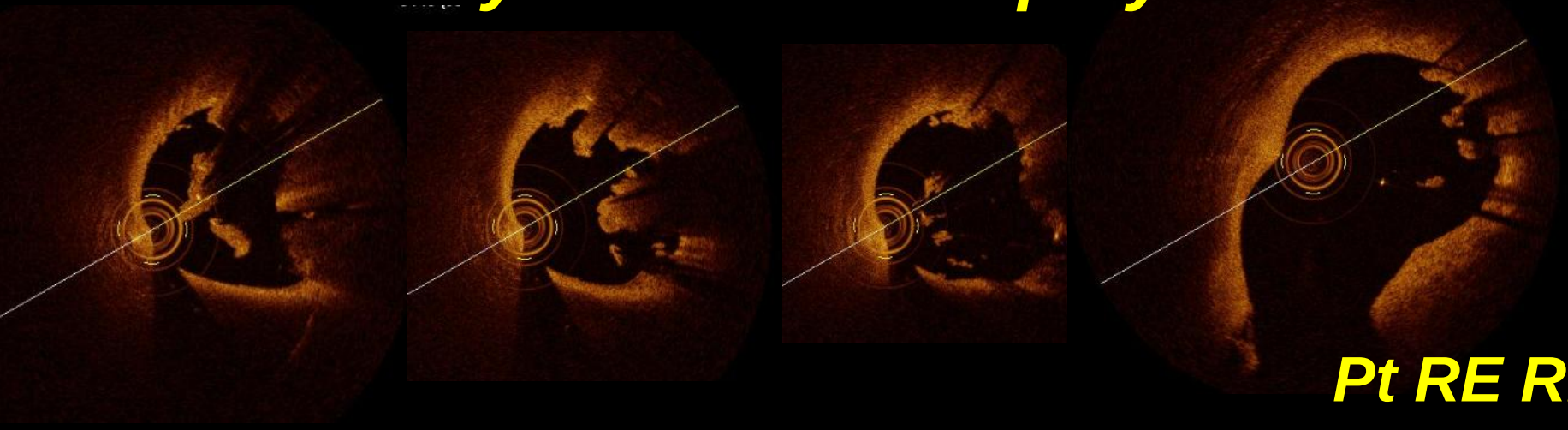


F Prati , T Kodama, L Di Vito , V Ramazzotti, A Chisari , V Marco , A Cremonesi , G Parodi , M Albertucci , F Alfonso . ***PCR 2013***

Examples of sub-optimal OCT results in pts with Subacute Thrombosis.

From the MOST Registry

STEMI 8 days after DES deployment



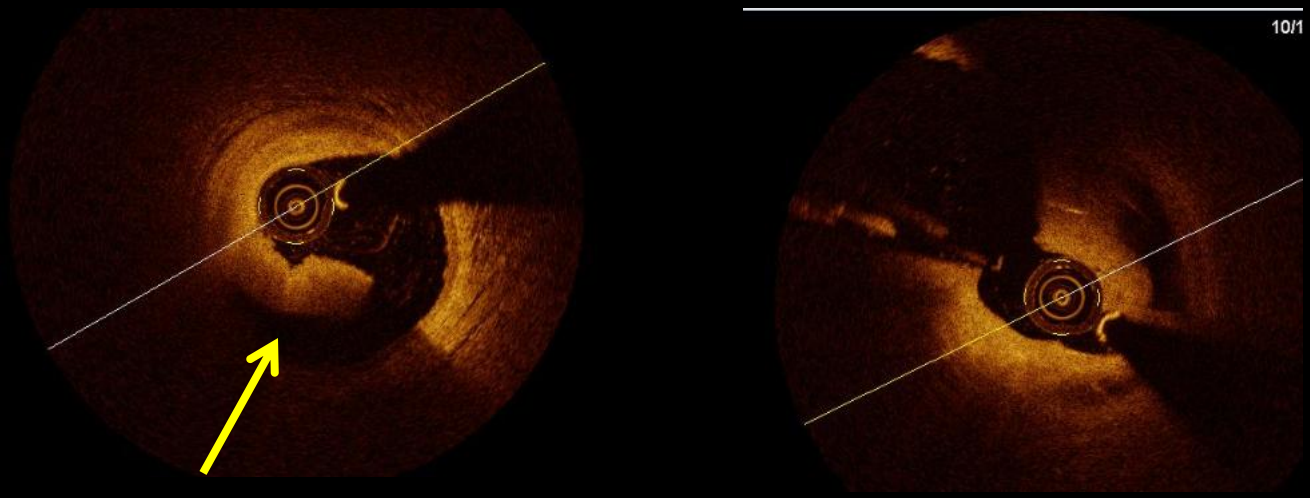
Pt RE RI

Marked proximal stent malapposition

RHR

Examples of sub-optimal OCT results in pts with Subacute Thrombosis. From the MOST Registry

STEMI four days after DES deployment



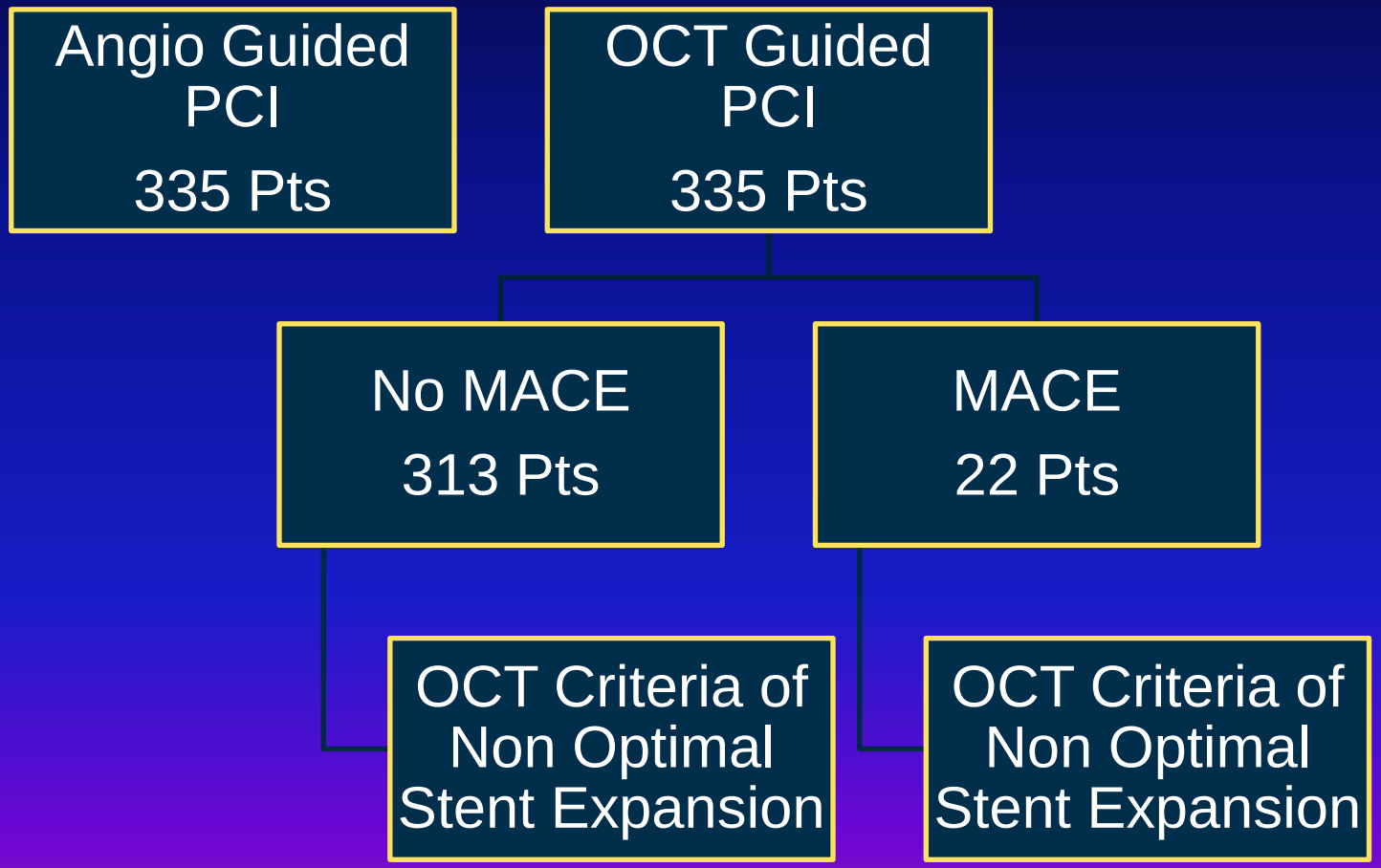
Pt. CA MA

Distal stent dissection

RHR

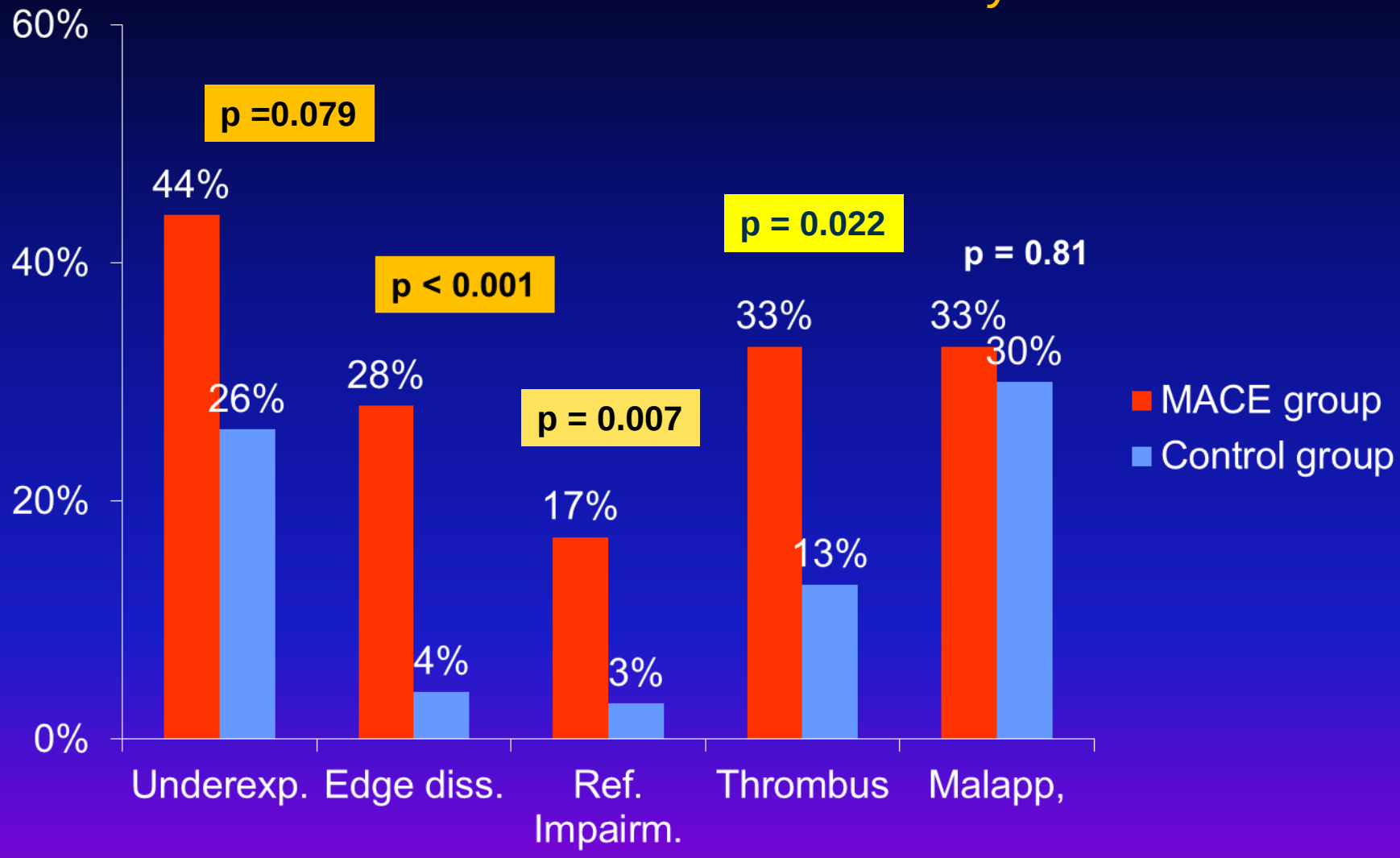
TCT 2011

Incidence of Non Optimal stent deployment in the OCT arm of the CLI-OPCI srudy.
Comparison between the two groups with and without MACE at 1 Year.



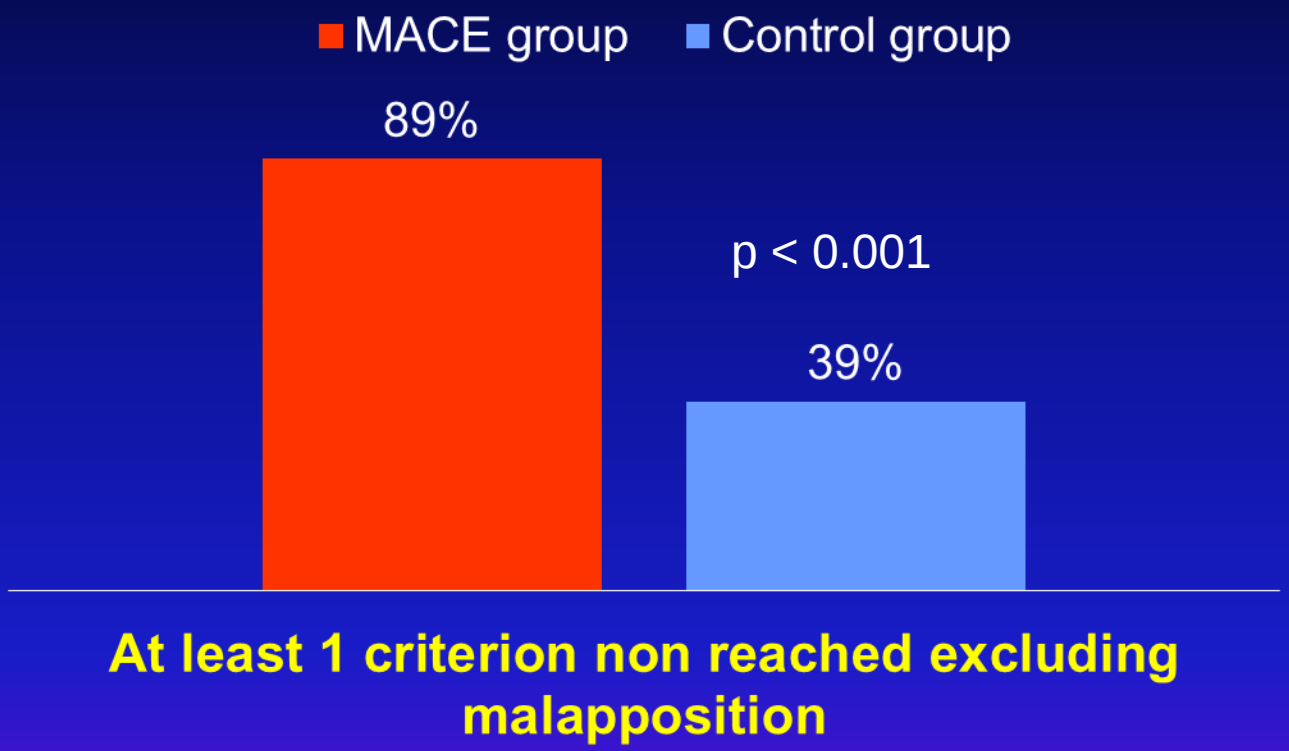
A Chisari. F Prati et al. ESC 2013

Incidence of Non Optimal stent deployment in the OCT arm of the CLI-OPCI study.



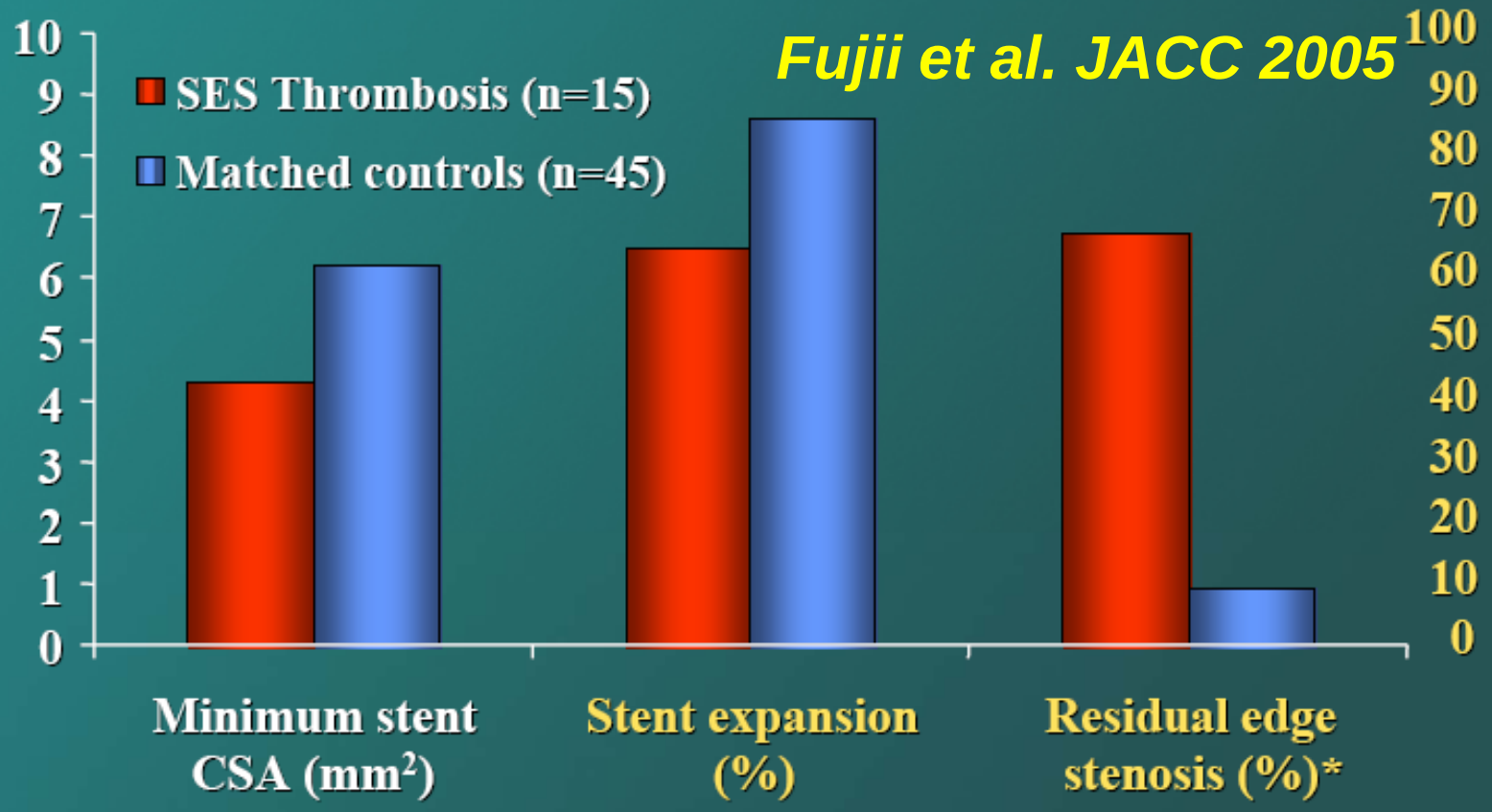
A Chisari. F Prati et al. ESC 2013

Incidence of Non Optimal stent deployment in the OCT arm of the CLI-OPCI study.



A Chisari. F Prati et al. ESC 2013

Predictors of Cypher Thrombosis @ CRF



- 2,575 patients were treated with 4,722 Cypher stents.
- 21 (0.8%) had stent thrombosis of whom 15 had IVUS
- 12/15 SES thrombosis lesions has stent CSA <5.0mm² (vs 13/45 controls)

*Residual edge stenosis = edge lumen CSA <4.0mm² & plaque burden >70%.

ADAPT-DES

	Stent Thromb.	NO Stent Thromb.	P Value
Reference lumen CSA (mm2)	**8.4**	**8.1**	**0.78**
Minimum Lumen CSA (mm2)	5.4	5.8	0.82
- MLA<5mm2	40%	33.7%	0.74
- MLA<4mm2	20%	15.4%	0.66
Stent expansion* (%)	**69.9**	**73.1**	**0.68**
Plaque burden at prox ref (%)	63.6	48.7	0.022
Attenuated plaque in prox. site	60%	26.6%	0.027
Mean stent expansion* (%)	107	88	0.097
Max tissue protrusion area (mm2)	**1.9**	**0.7**	**0.016**
Stent malapposition	**20%**	**12.6%**	**0.36**
Proximal edge dissection	0.0%	3.2%	1.0
Distal edge dissection	**25.0%**	**4.0%**	**0.039**

A Mehara TCT 2012

The CLI-OPCI III.
Registry of FD-OCT Guidance for Coronary Intervention

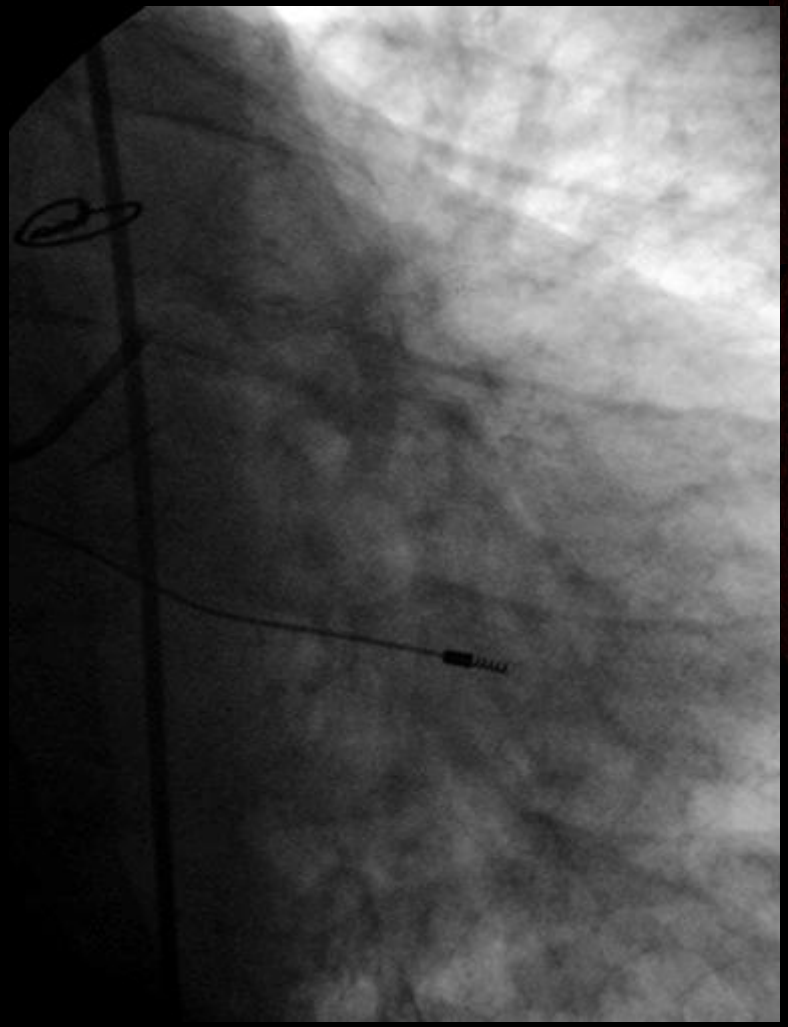
From March 2008 to March 2013

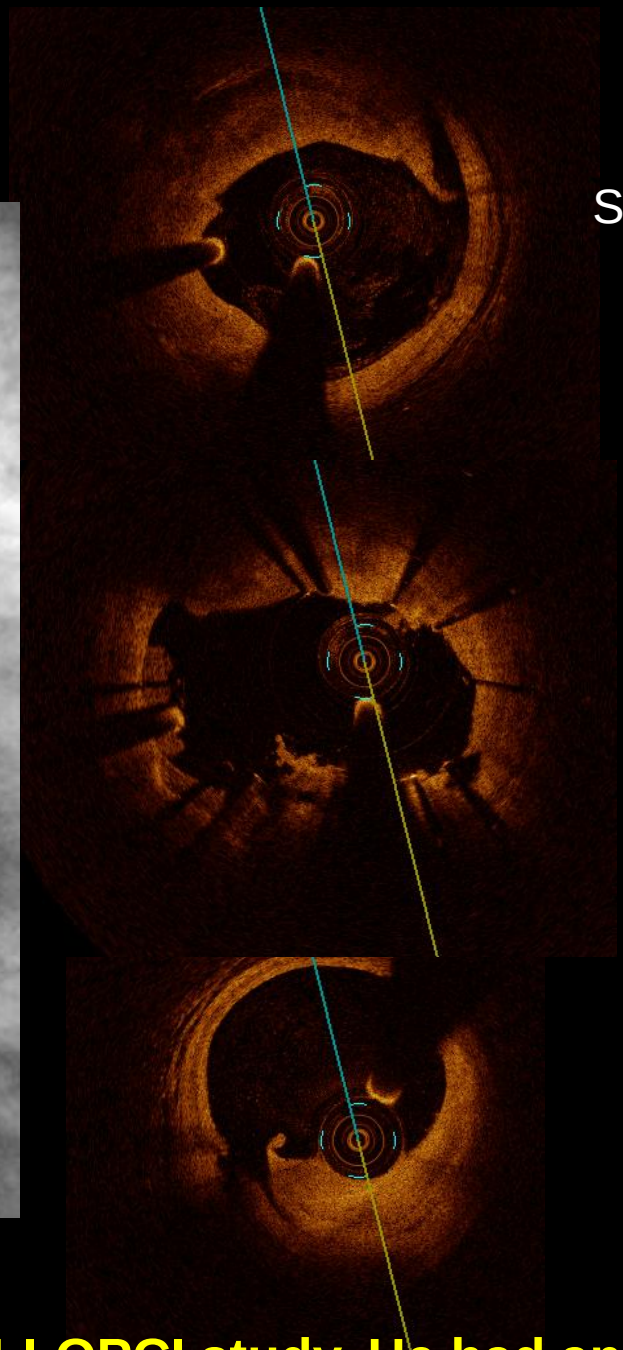
- 1000 Coronary Intervention with FD-OCT final look and at least one year clinical FU
- Data available by March 2014

RHR **Rome Heart Research**

Dissections on OCT are not all the same

I am glad I used OCT…..





Significant dissection .
Prox Edge

In-Stent asimmetry
wth thrombus

Mild dissection .
Distal Edge

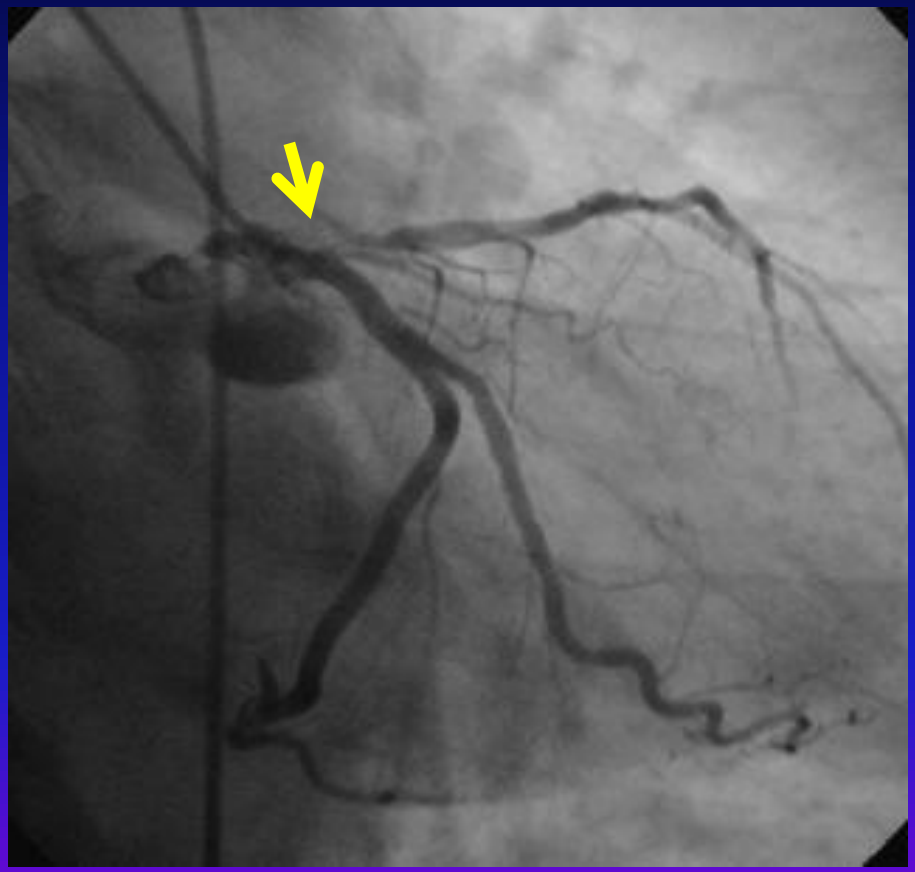
Pt in the OCT arm of the CLI-OPCI study. He had an AMI at 1Y FU

Left main and complex cases

I am glad I used OCT…..

65 –Year-old male

- ***effort angina and positive stress testing.***

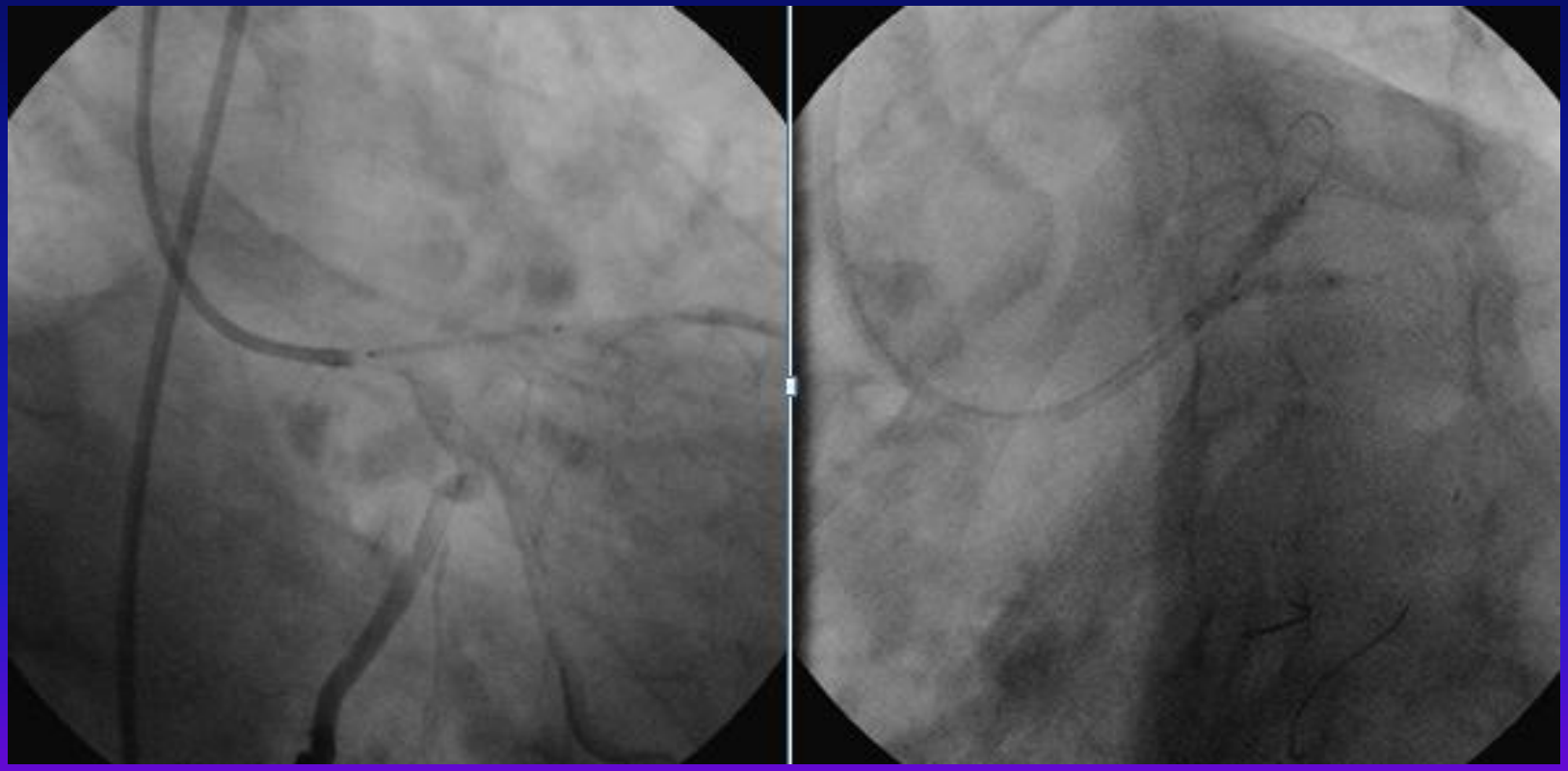


Severe stenosis in the ostial-proximal LAD

Stent Resolute Integrity 3,5 x 22 mm and

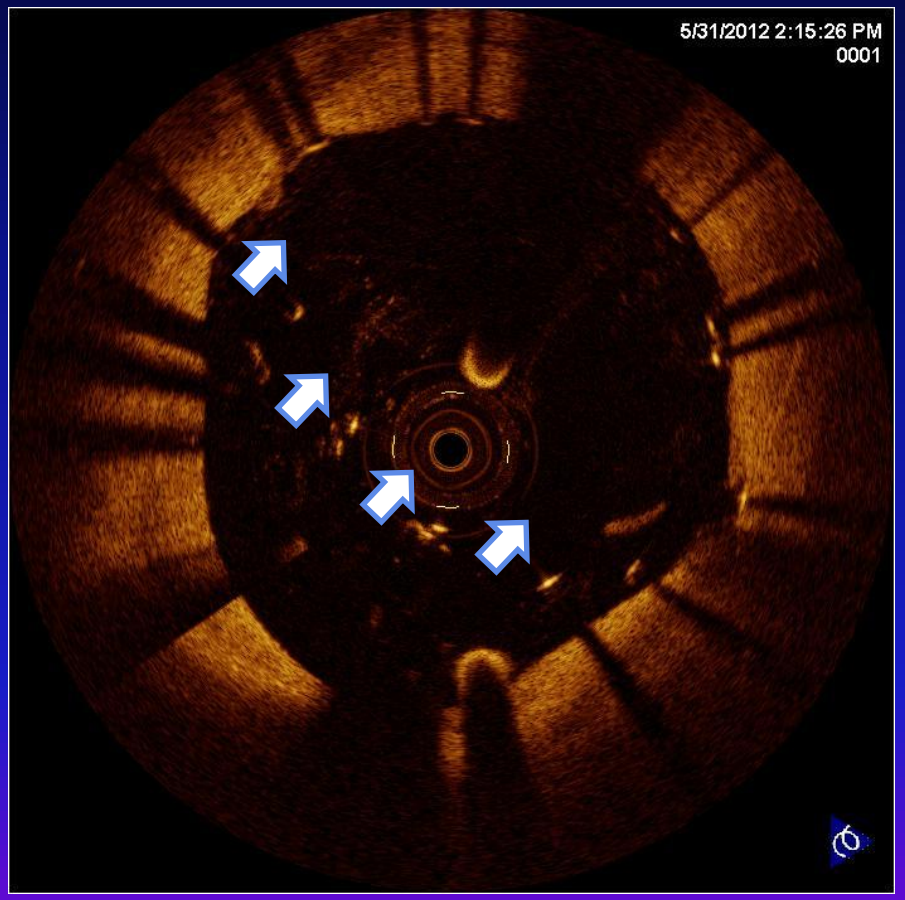
Kissing dilatation with ball. 3 x15 mm in the LM-LAD and 3 X 12 mm in the LCX

High pressure inflation with a 4,0 x 10 mm ball.

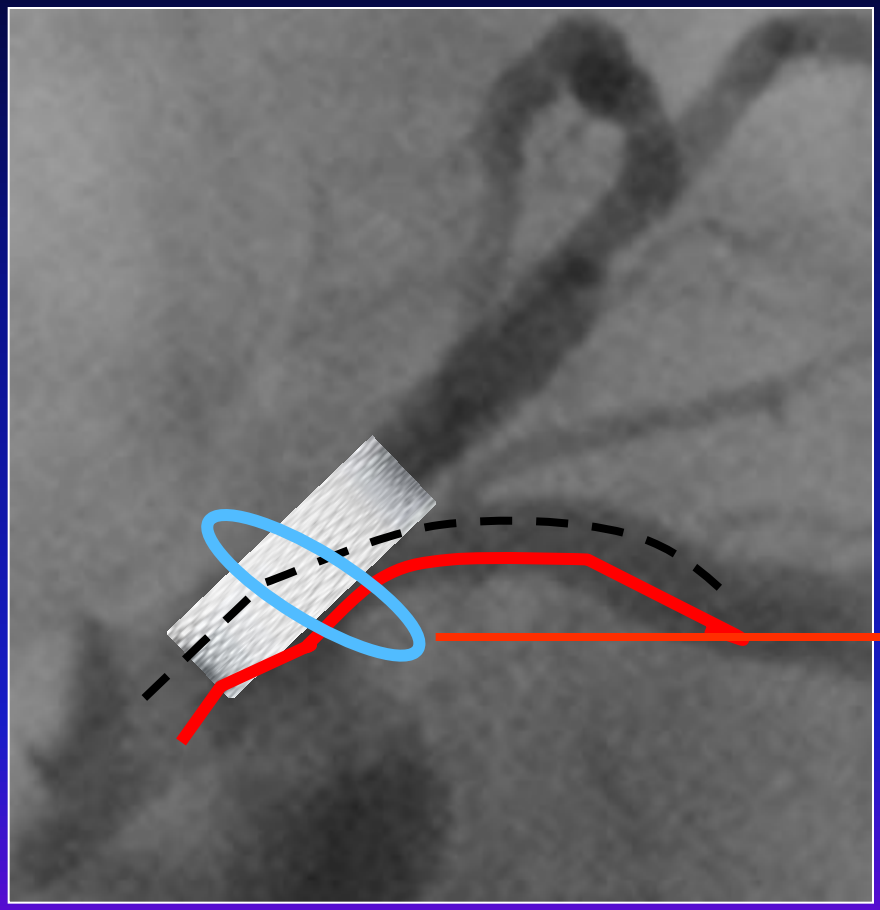


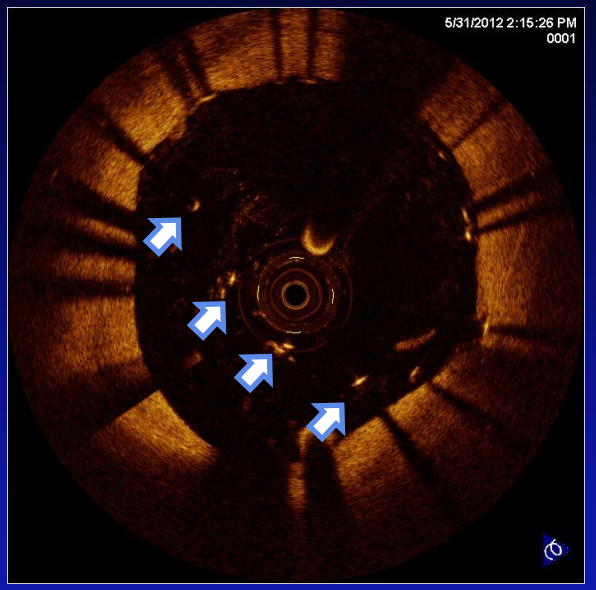
Optimal angiographic result

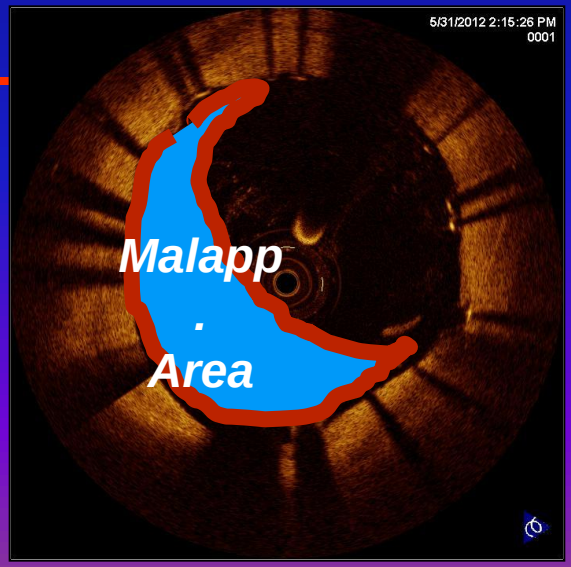
FD-OCT: marked underexpansion of the stent with a large area of malapposition



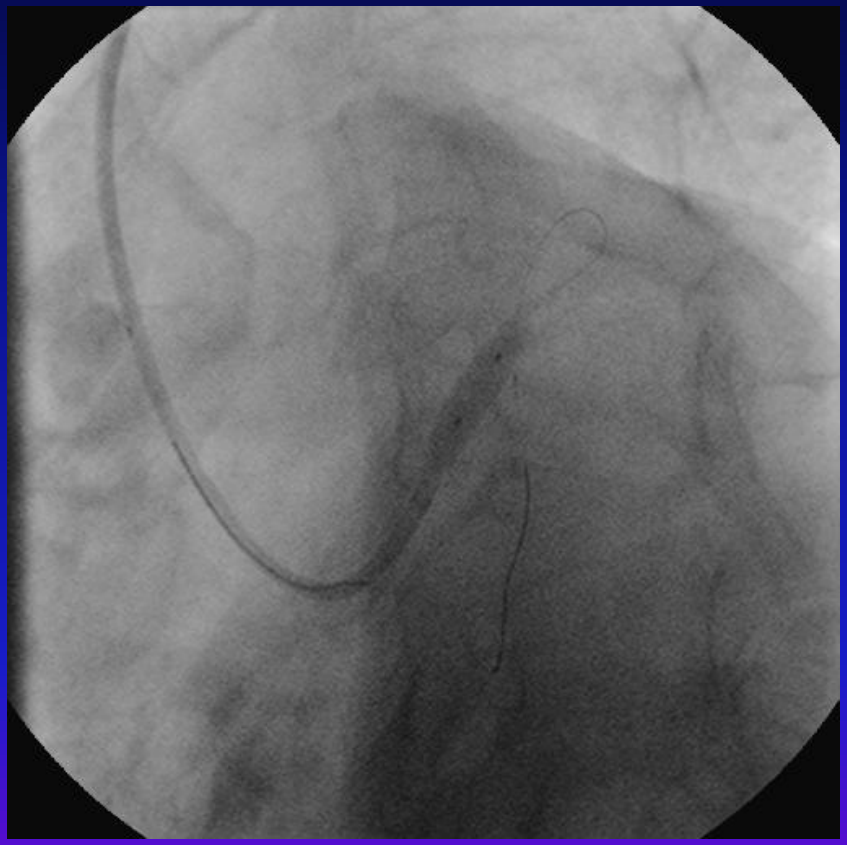
The guide–wire made a wrong path to enter the LCx through the stented LM



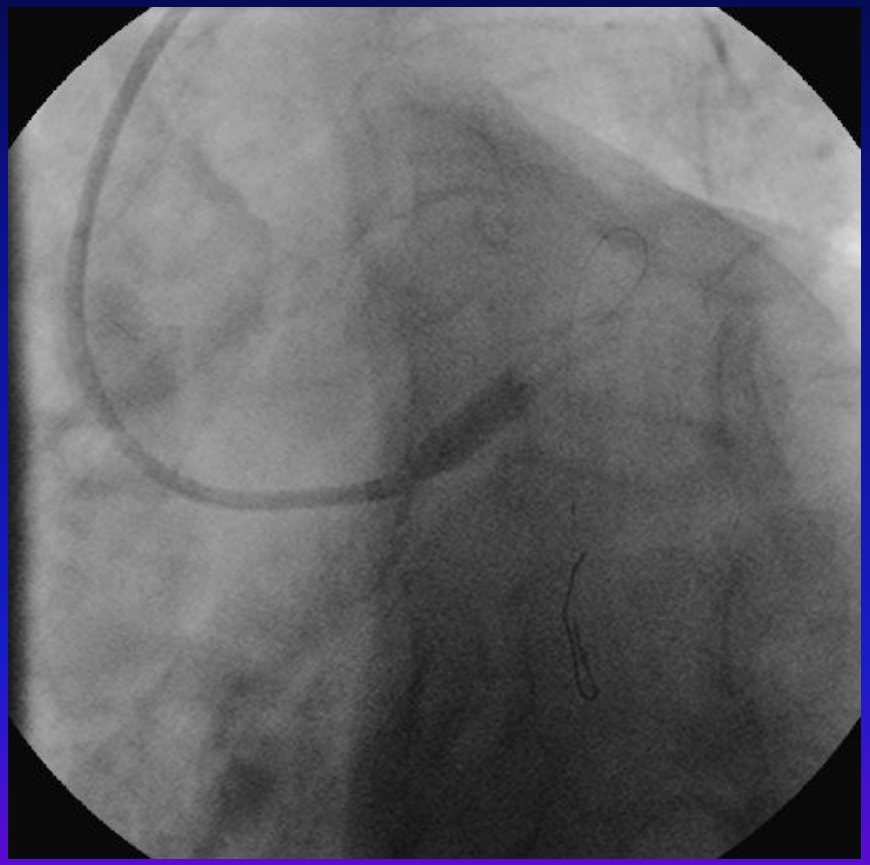




Additional intra-stent dilatation with a non compliant balloon 4,5 x10 mm and lastly with a compliant one 5 x 12 mm.

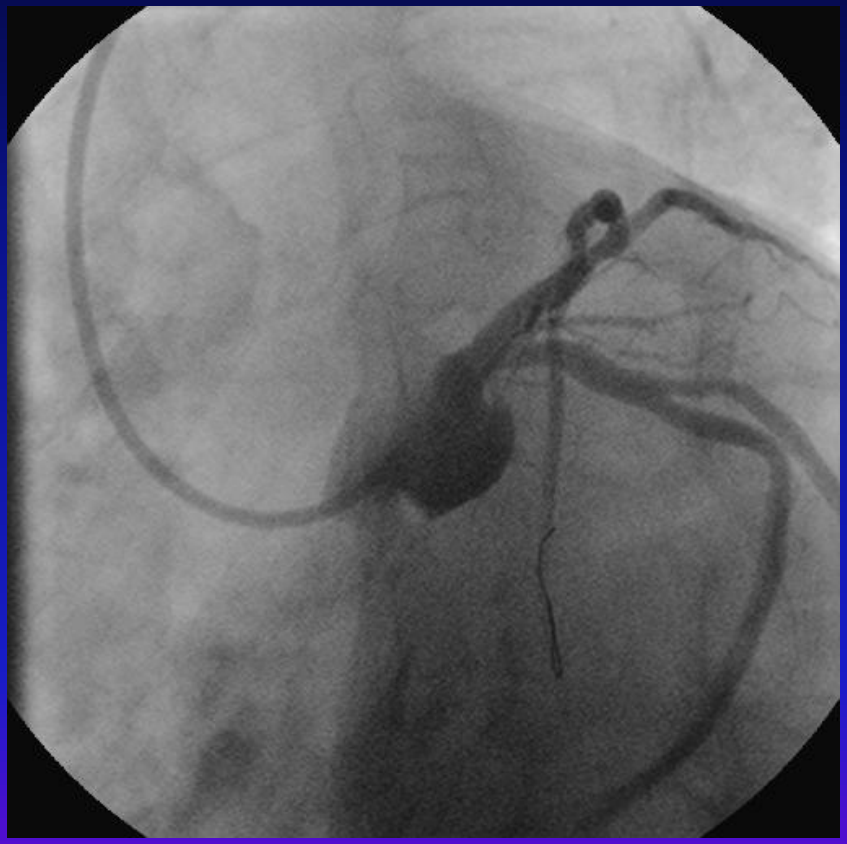


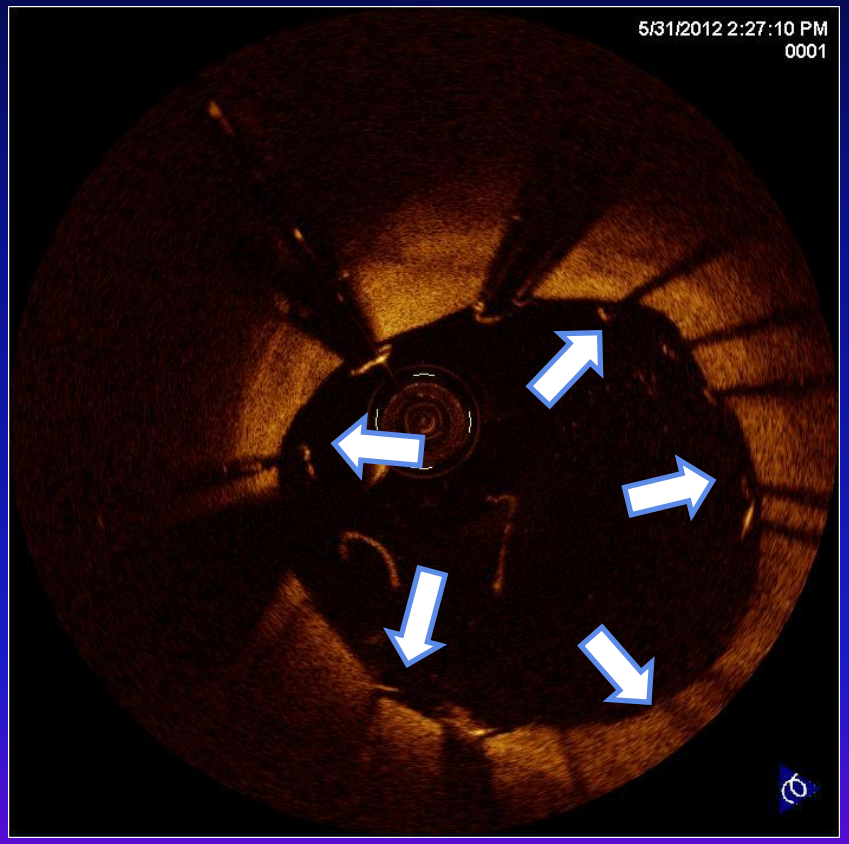
n.c balloon 4,5 x10 mm



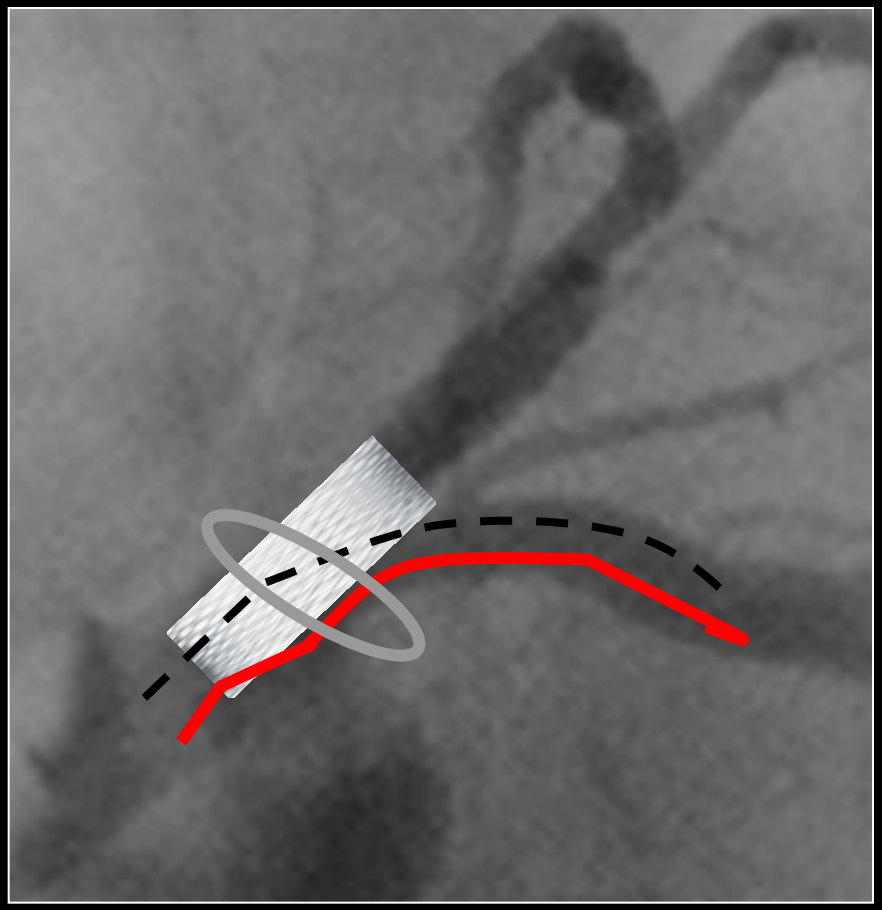
Compl. balloon 5 x 12 mm

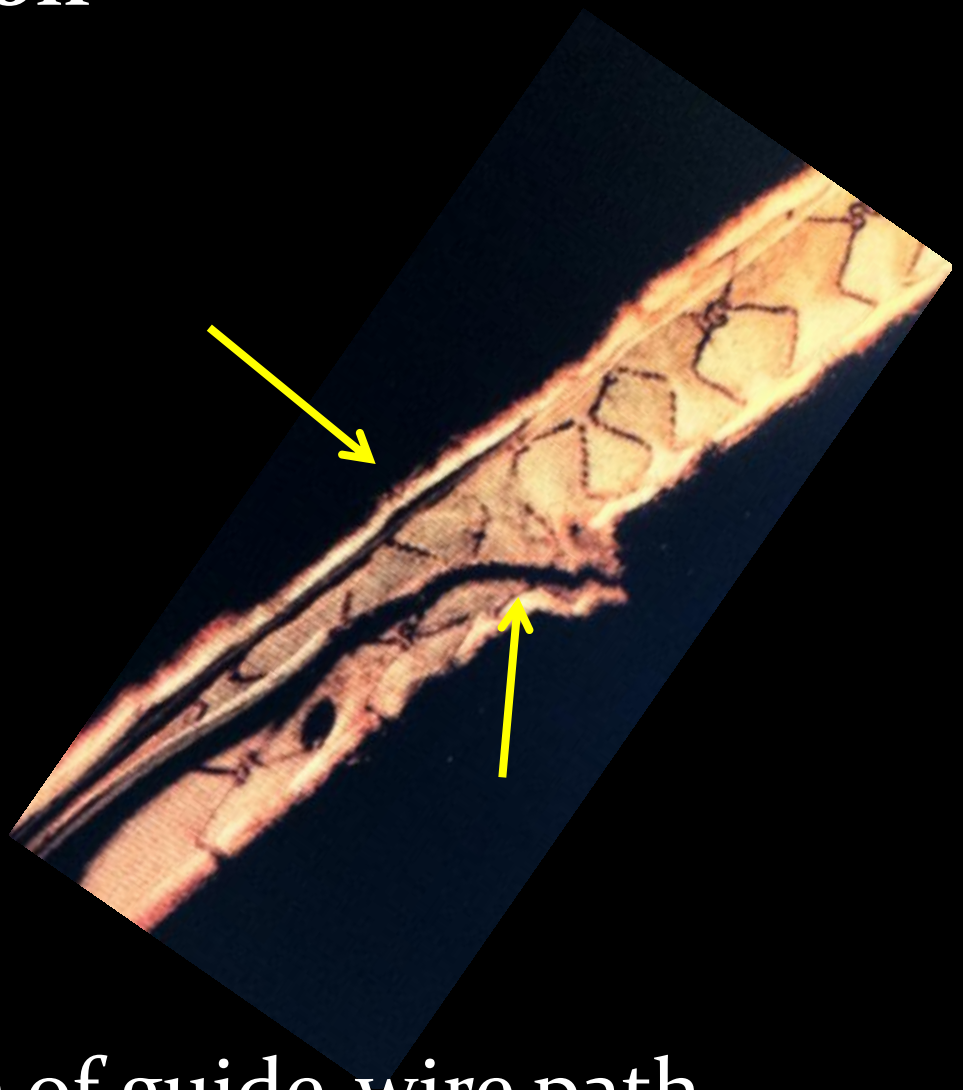
Improved OCT result





The novel Optics OCT System (St Jude). 3-D Reconstruction



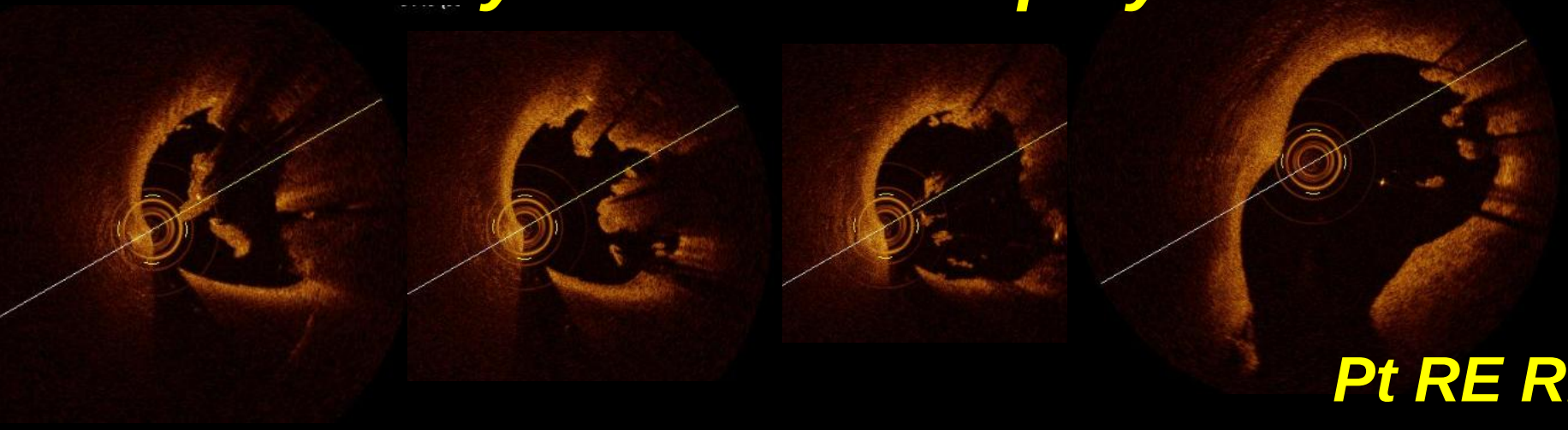


Easy identification of guide-wire path

Examples of sub-optimal OCT results in pts with Subacute Thrombosis.

From the MOST Registry

STEMI 8 days after DES deployment



Pt RE RI

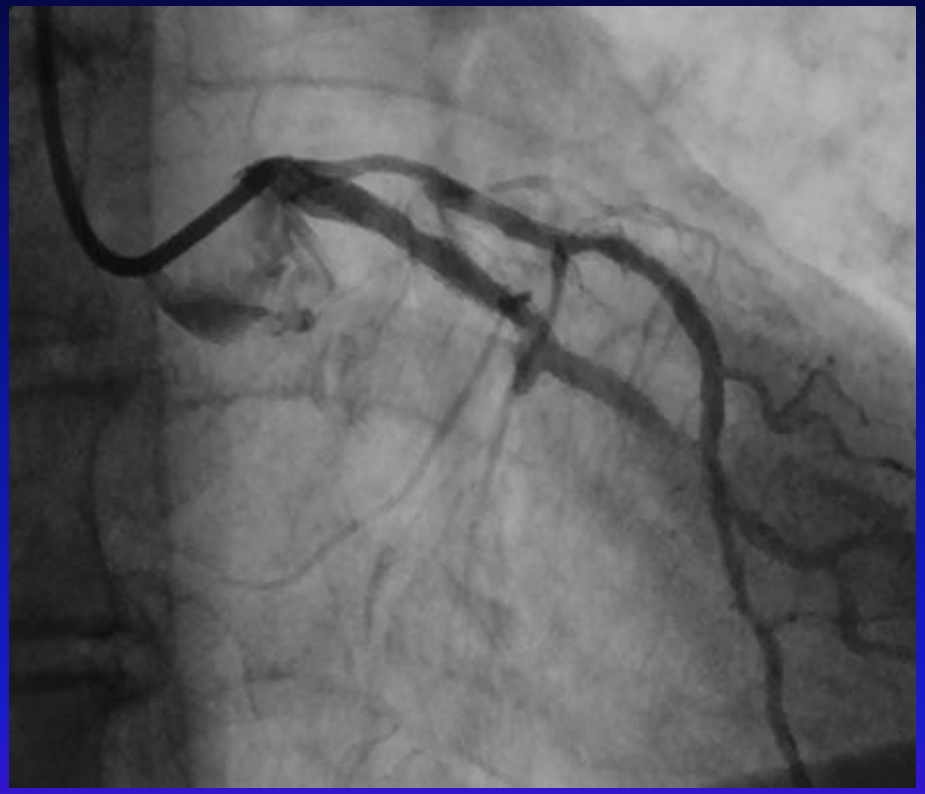
Marked proximal stent malapposition

RHR

- **When angiography leaves doubts**

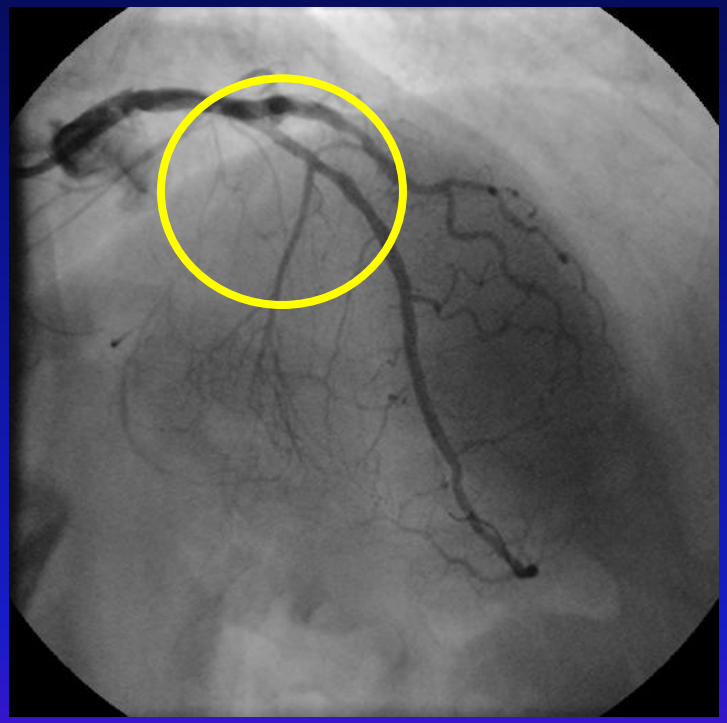
I am glad I used OCT…..

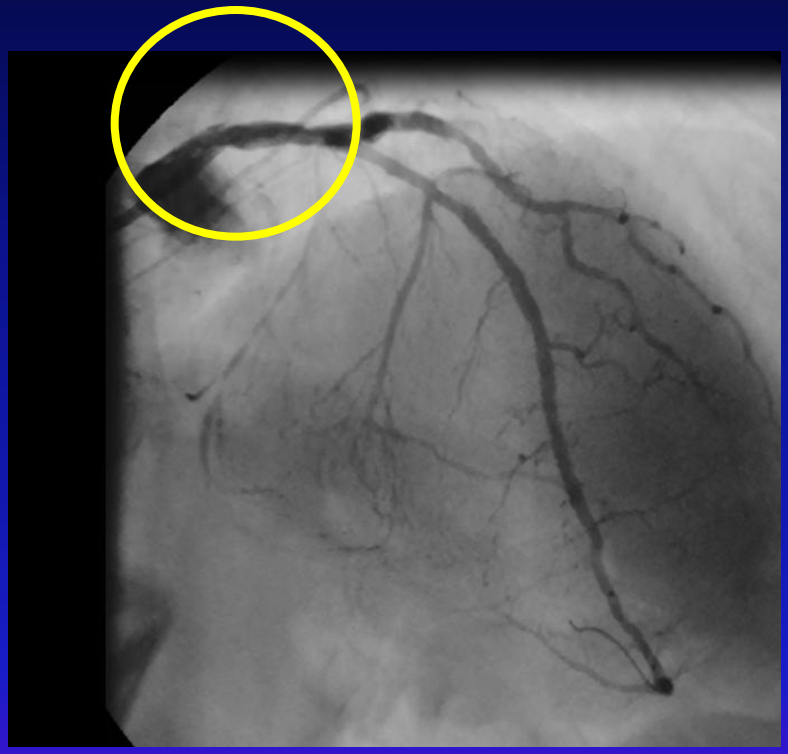
65 Y/o pt with recent effort angina



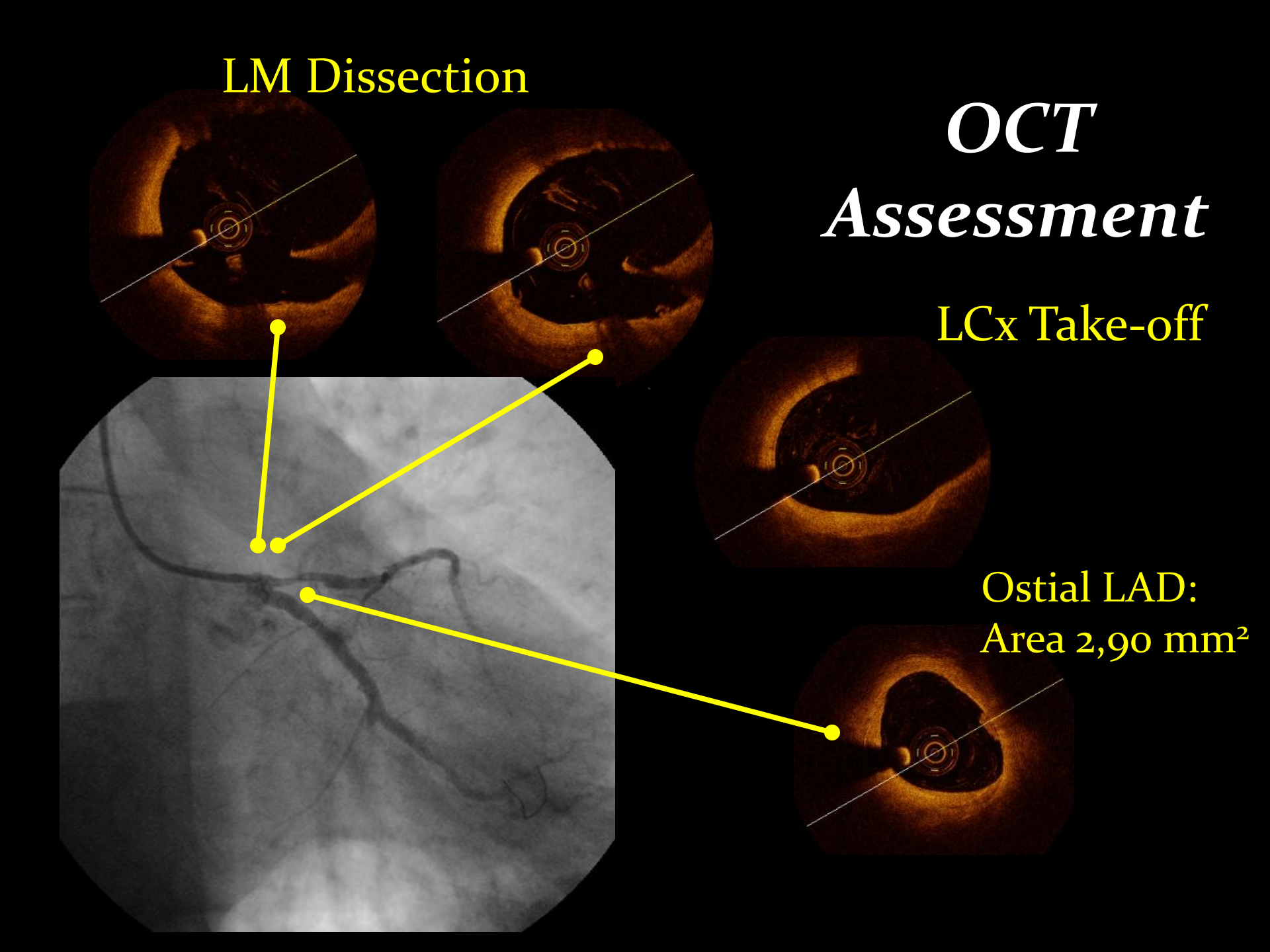
Ambiguos lesion in the mid LAD

After DES positioning in the mid LAD (Xience 2,75 x 15)

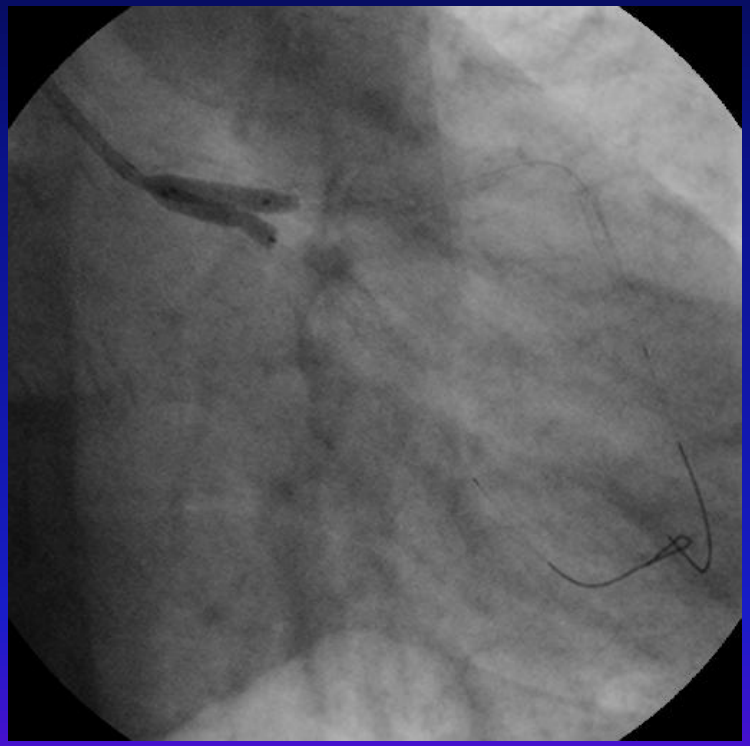


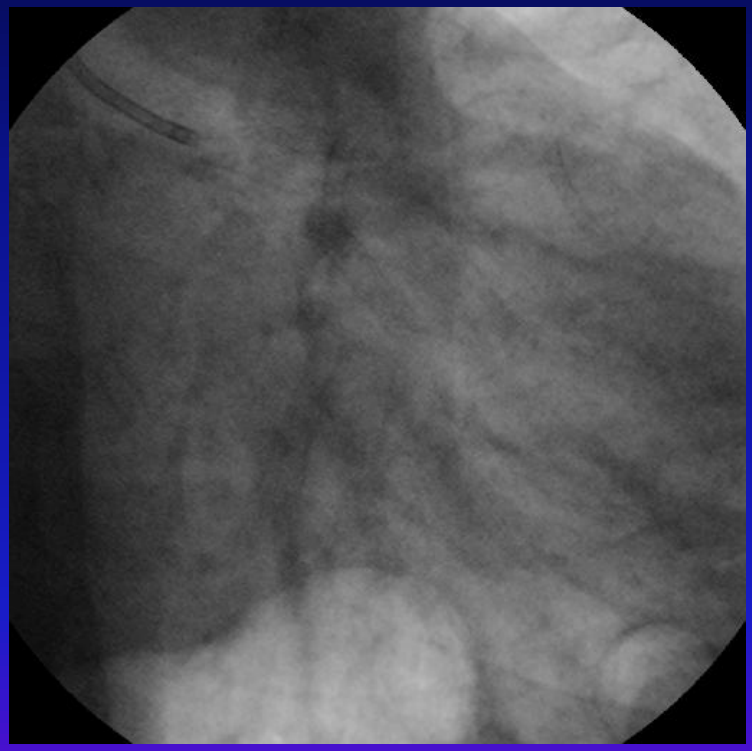


How to treat the prox LAD lesion ?
Is the LM dissected ?

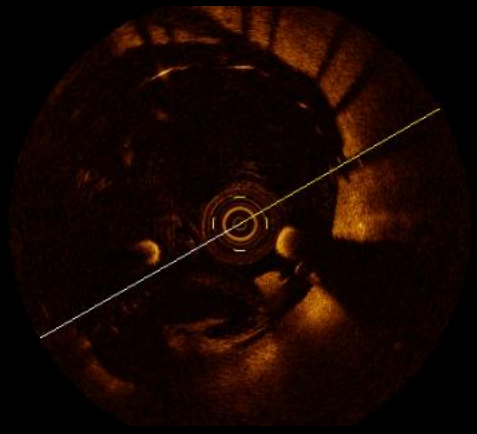

LM Dissection
OCT
Assessment
LCx Take-off
Ostial LAD:
Area 2,90 mm²

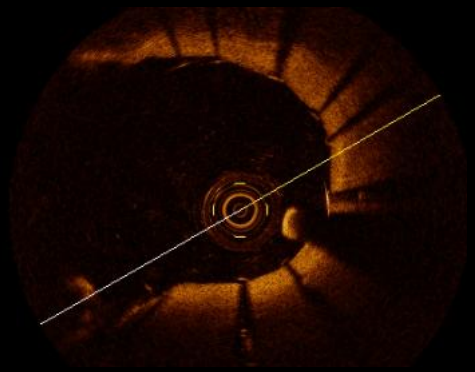
DES positioning (Xience) 3,5 mm with final kissing (3,5 x 3.0 mm)



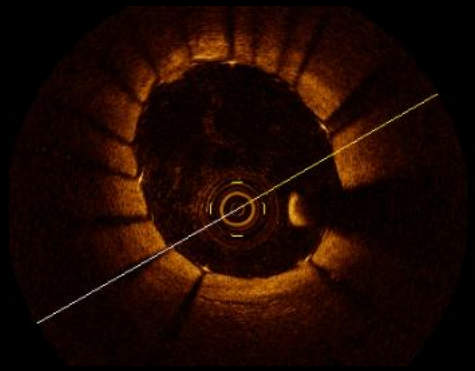


Mild stent malapposition
in the LM



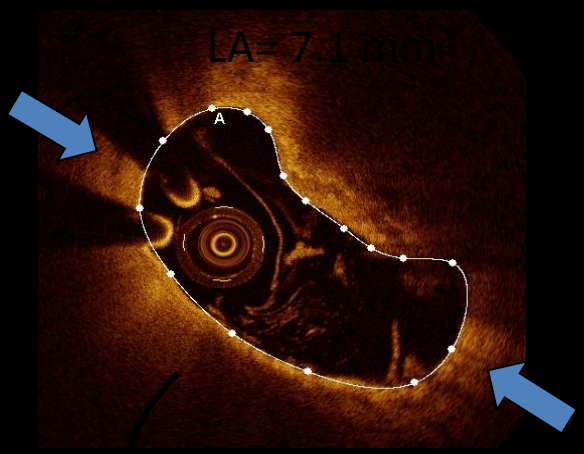


LCx Take-off

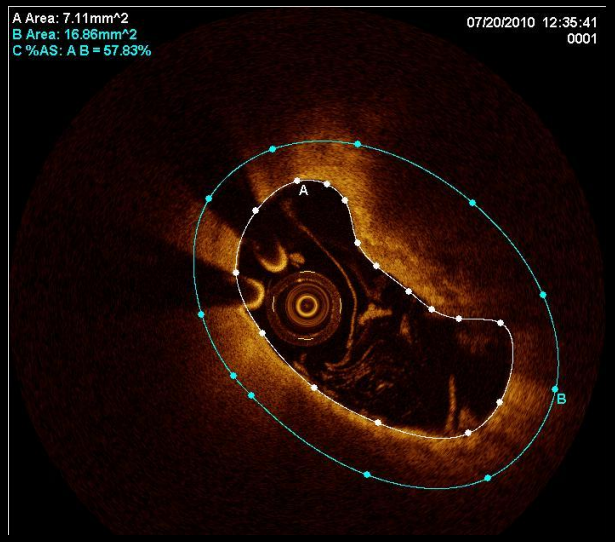


Ostial LAD:
Area 7,90 mm²

Distal lesion in the LM

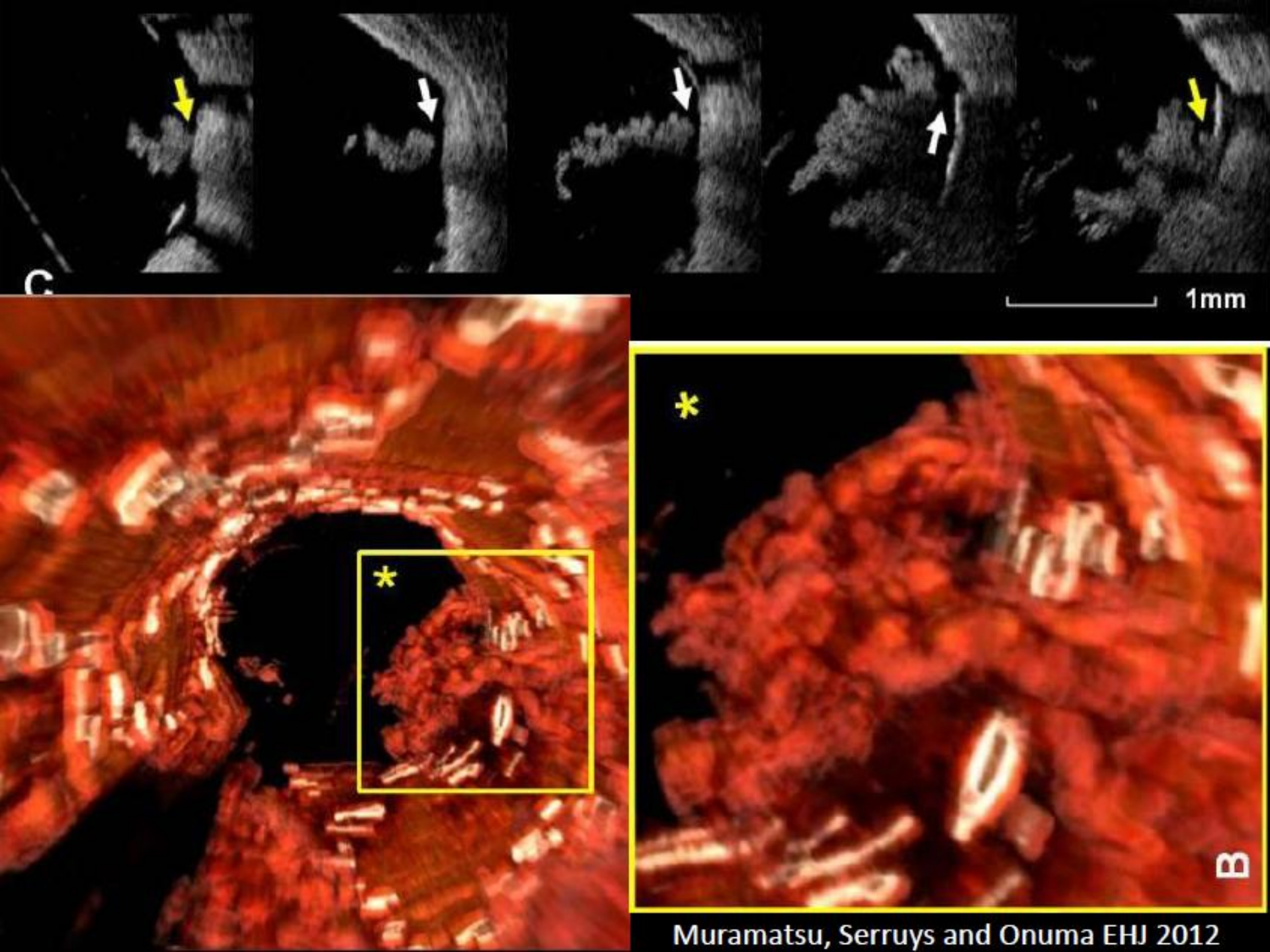


Diseased LM with eccentric plaque
Large plaque burden !?



Treat also the Left Main

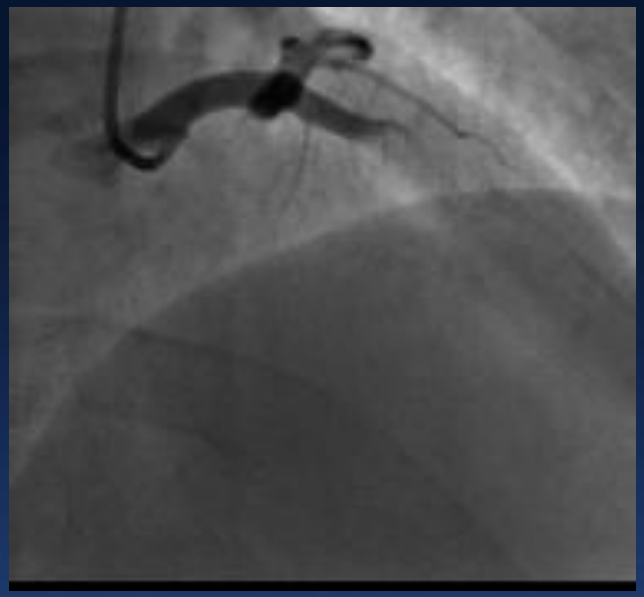
I.C. Imaging for treatment of STEMI



Muramatsu, Serruys and Onuma EHJ 2012

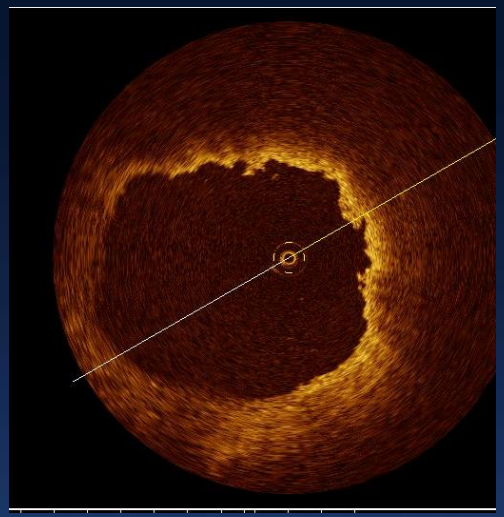
55 Y/O Male with Anterior STEMI

Treatment with Thrombus-aspiration *only*



LAD Total Occlusion

Mild Residual Stenosis Timi 3 flow



Large MLA at OCT

I Concepts

OCT-Based Diagnosis and Management of STEMI Associated With Intact Fibrous Cap

Francesco Prati, MD, PhD,*† Shiro Uemura, MD, PhD,‡ Geraud Souteyrand, MD, PhD,§

Renu Virmani, MD, Pascal Motreff, MD, PhD,§ Luca Di Vito, MD, PhD,*†

Giuseppe Biondi-Zoccai, MD, PhD,†¶ Jonathan Halperin, MD,#

Valentin Fuster, MD, PhD,#** Yukio Ozaki, MD, PhD,†† Jagat Narula, MD, PhD#

Rome, Italy; Nara, Toyoake, Japan; Clermont-Ferrand, France; New York, New York;

Gaithersburg, Maryland; and Madrid, Spain

JACC Imaging 2013

FD- OCT imaging after aspiration thrombectomy to identify plaque erosion as the cause in 31 patients presenting with ST-segment elevation myocardial infarction.

40% of patients with subcritically occlusive plaque were treated with dual antiplatelet therapy without percutaneous revascularization (group 1), and the remaining 60% of patients underwent angioplasty and stenting (group 2).

At a median follow-up of 753 days, all patients were asymptomatic, regardless of stent implantation.

OCT Example Post-aspiration Result

JACC Imaging 2013

Conclusions

Use imaging modalities to:

- Avoid useless interventions
- Identify culprit lesions in patients with ACS using FD-OCT to visualize fresh thrombus
- Define plaque anatomy and localize the LP site in the effort of reducing distal embolization
- Improve clinical results after stenting identifing sub-optimal results
- Improve treatment of AMI and possibly avoid stenting