When I use IVUS

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THESSALONIKI 2016

DETECTION OF CAD

ANATOMICAL EVALUATION OF CORONARIES

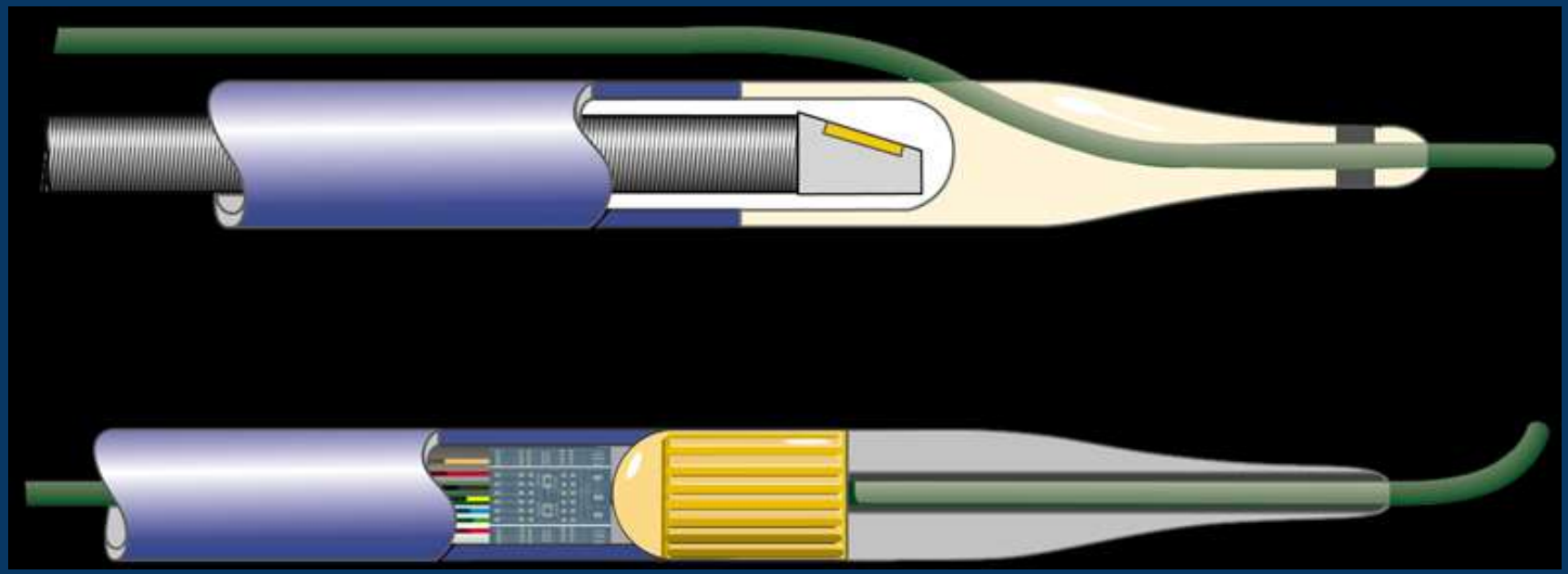
IVUS – OCT

MEASUREMENT OF CORONARY PHYSIOLOGY

FFR

IVUS Transducers

Mechanical Transducer – 40 MHz OptiCross (BosSci)



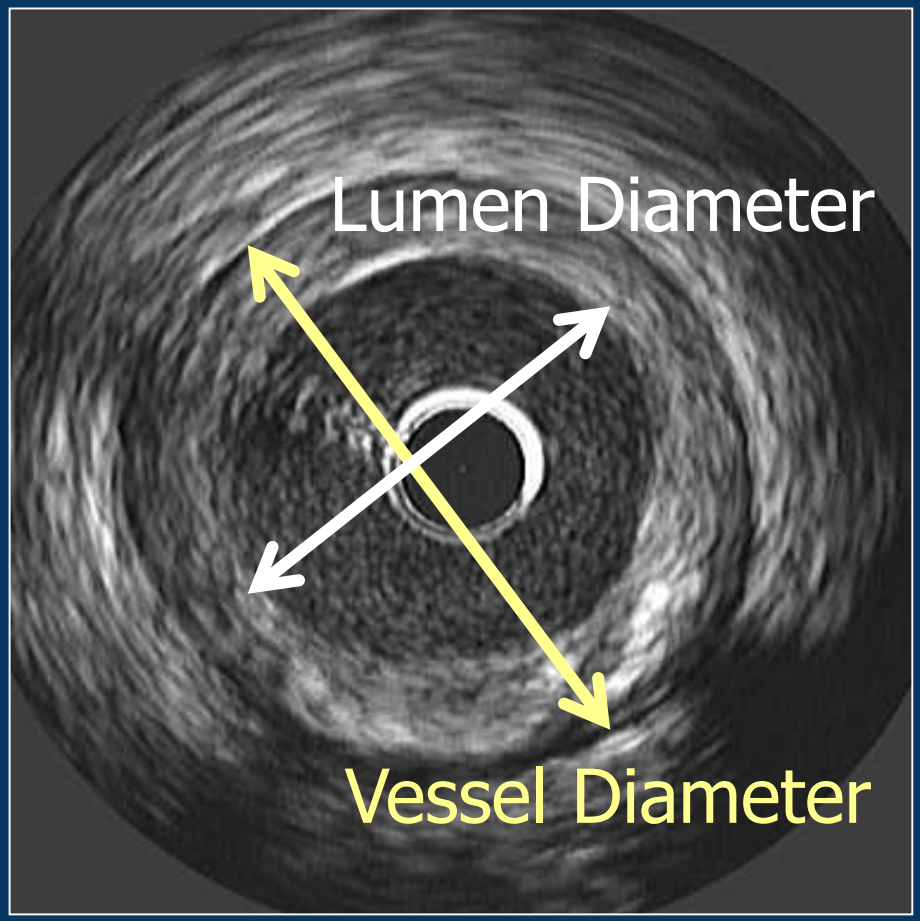
Solid-State Transducer – 25 MHz EagleEye (Volcano)

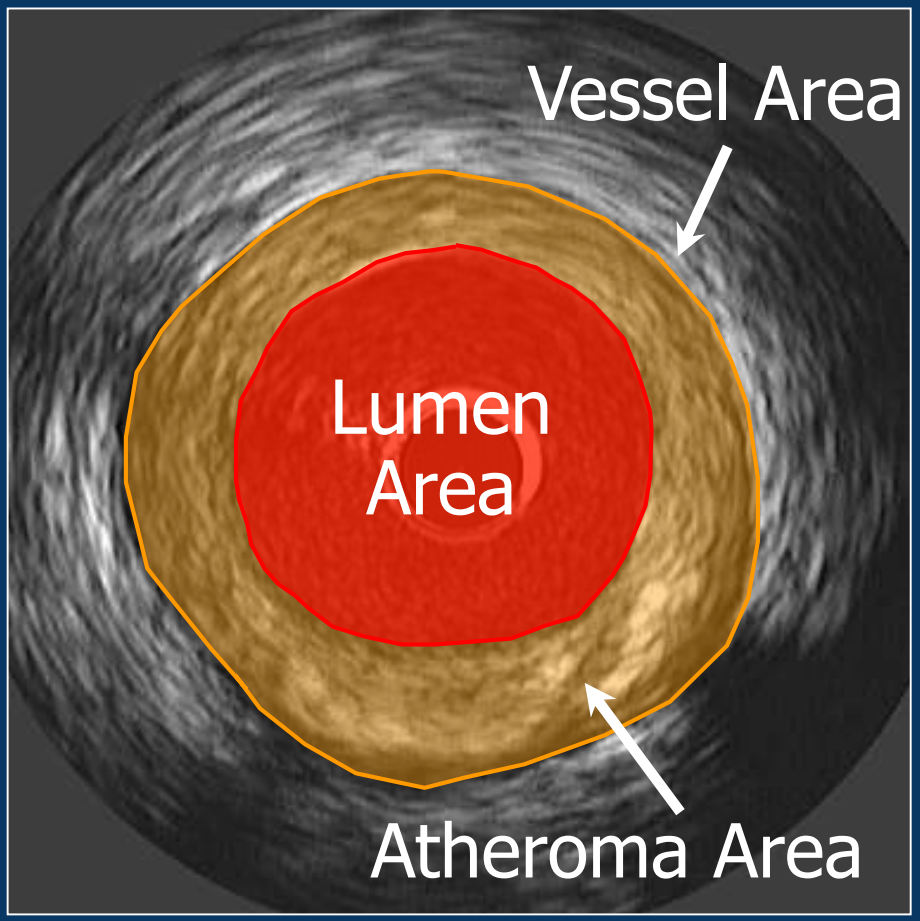
Diagnostic Applications of IVUS

- Identify specific disease
  - left main stem, ostial lesions
- Detect angiographically silent disease
  - transplant vasculopathy
- Identify plaque morphology
- Examine vessel when angiography is inconclusive
  - hazy lesions, presence or absence of thrombus or dissection
- Measure plaque load
- Measure true vessel size

IVUS Determination of Atheroma Area

Precise Planimetry of EEM and Lumen Borders with Calculation of Atheroma Cross-sectional Area





Angiography versus IVUS

ANGIOGRAPHY

2 dimensional

Planar

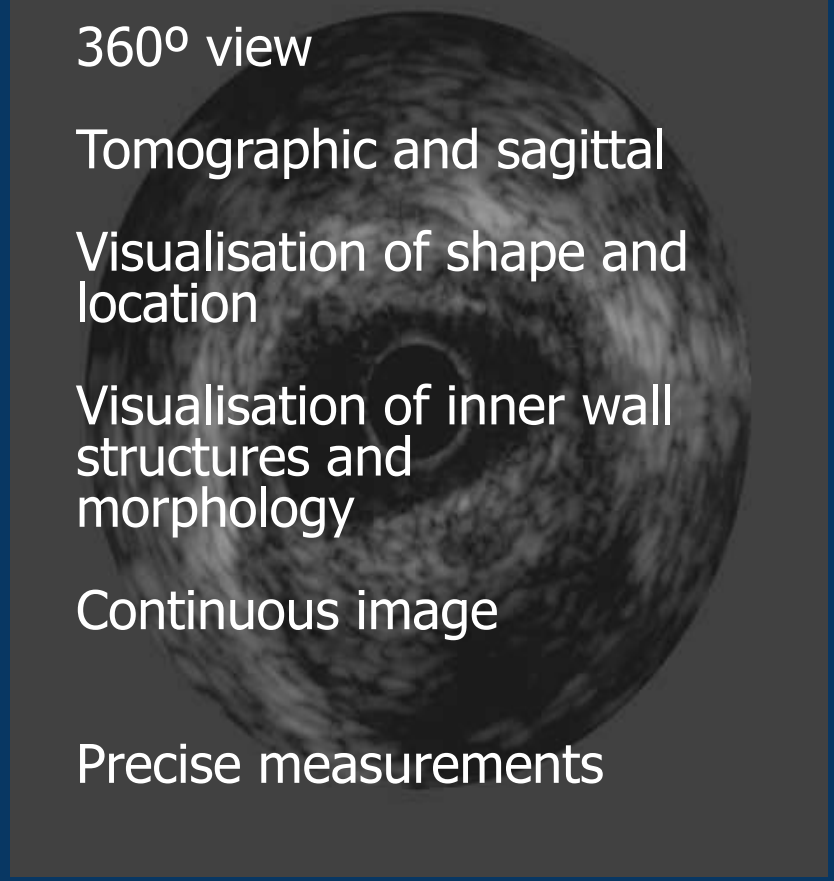
Shadow of lumen

Wall structures not imaged

Intermittent snapshots or repeat contrast injections necessary

QCA measurements prone to magnification errors

IVUS



360º view

Tomographic and sagittal

Visualisation of shape and location

Visualisation of inner wall structures and morphology

Continuous image

Precise measurements

Role of IVUS in management of angiographic intermediate lesion (40-70% stenosis)

- Remains a therapeutic dilemma, even for experienced interventional cardiologists.
- Fractional flow reserve (FFR) is considered the gold standard for intermediate lesion assessment.
- Several studies have reported fairly good correlation between anatomic data by IVUS and ischemia by physiological assessments, hence FFR can be accurately predicted.

Evidences for IVUS-MLA & FFR

- 236 intermediate lesions from 201 patients were included.
- Best cut-off value of MLA to predict an FFR <0.80 was 2.4mm^2 *(sensitivity of 90% and specificity of 60%).*

Kang SJ. Circ Cardiovasc Interv 2011;4:65–71.

- 92 intermediate lesions from 84 patients, MLA of <2.8 mm^2 and < 3.2 mm^2 best correlated with an FFR < 0.75 and < 0.80 respectively.

Ben-Dor Euro Intervention 2011;7:225–33 94

- Pts with intermediate lesions with smaller vessel (reference diameter <3.0 mm), the best predictors for FFR <0.75 were MLA <2.0 mm^2 *(sensitivity of 82% and specificity of 81%).*

Lee CH et al. Am J Cardiol 2010;105:1378–84.

Non left main lesion

- 53 intermediate lesions in 43 pts.
- Cut-off value of an MLA <4mm^2 also correlated moderately well with an FFR <0.75 with a sensitivity and specificity of 92% and 56% respectively.

Briguori C, Am J Cardiol 2001;87:136–41

- Low event rates were noted in 300 pts with intermediate lesions in whom intervention was deferred for an IVUS MLA ≥4 mm^2

Abizaid AS, Circulation 1999;100:256–61

IVUS criteria for a "significant" Non-LMCA stenosis

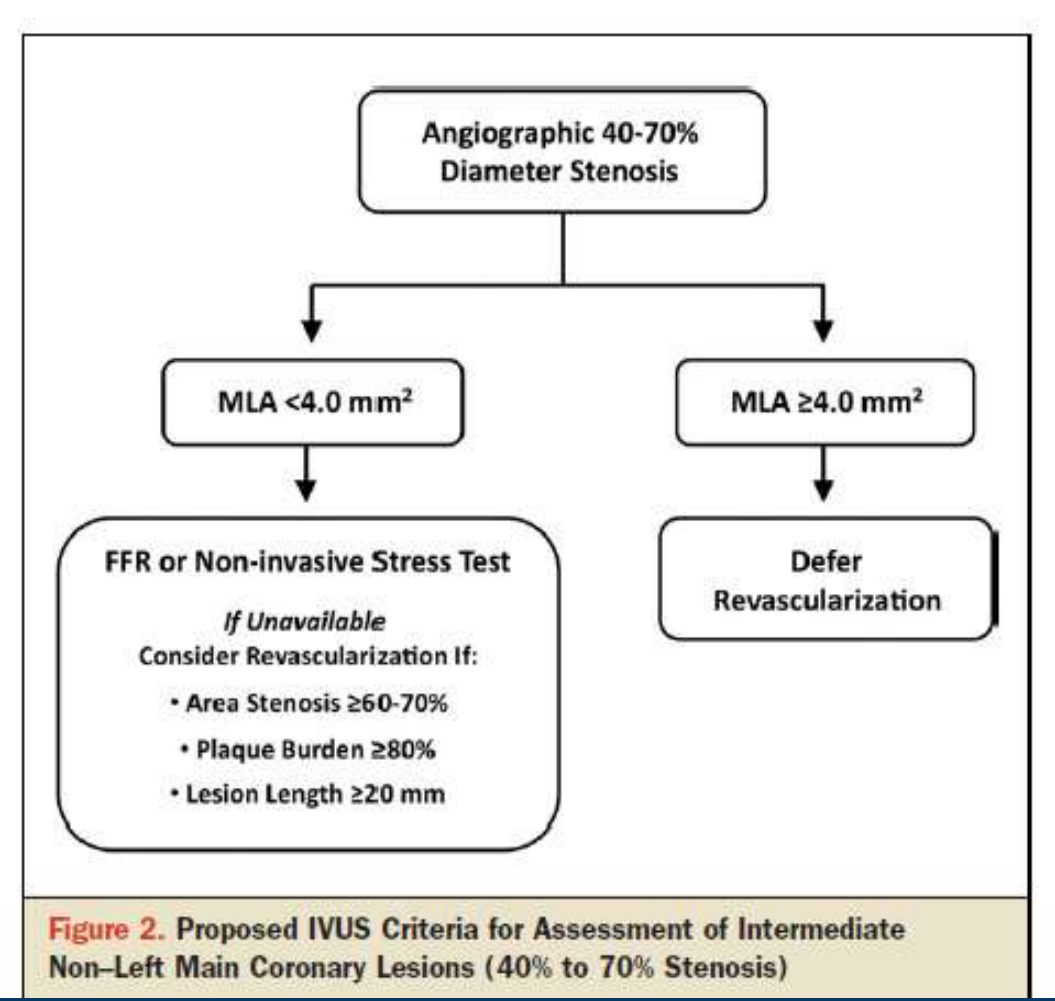


Figure 2. Proposed IVUS Criteria for Assessment of Intermediate Non–Left Main Coronary Lesions (40% to 70% Stenosis)

JACC: CARDIOVASCULAR INTERVENTIONS, VOL. 4, NO. 11, 2011 McDaniel *et al.*
NOVEMBER 2011: 1155–67

Left main intermediate lesions (30-60% stenosis)

- 55 pts with moderate left main stenosis, an MLA
- Cut-off value of 5.9 mm^2 (sensitivity of 93% and specificity of 95%) and a minimal lumen diameter of <2.8 mm (sensitivity of 93% and specificity of 98%) best correlated with FFR <0.75.

Jasti V, Circulation 2004;110:2831– 6.

- 354 patients with intermediate left main stenoses, an MLA value >6.0 mm^2 identified patients at low risk for adverse events with deferred revascularization.

de la Torre Hernandez. J Am Coll Cardiol 2011;58:351– 8

IVUS criteria for a "significant" LMCA stenosis

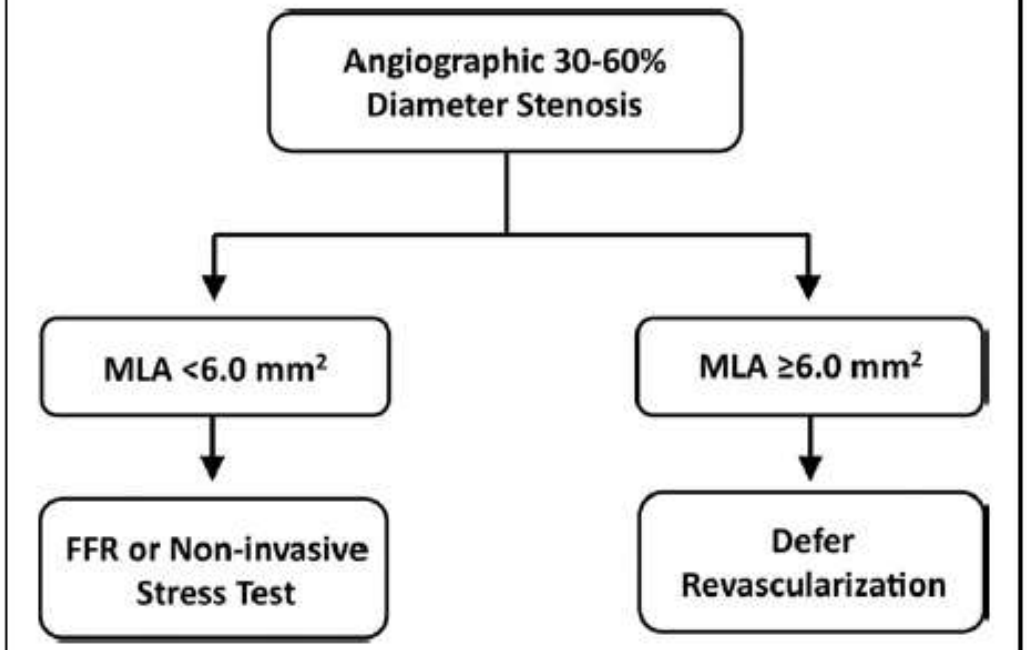


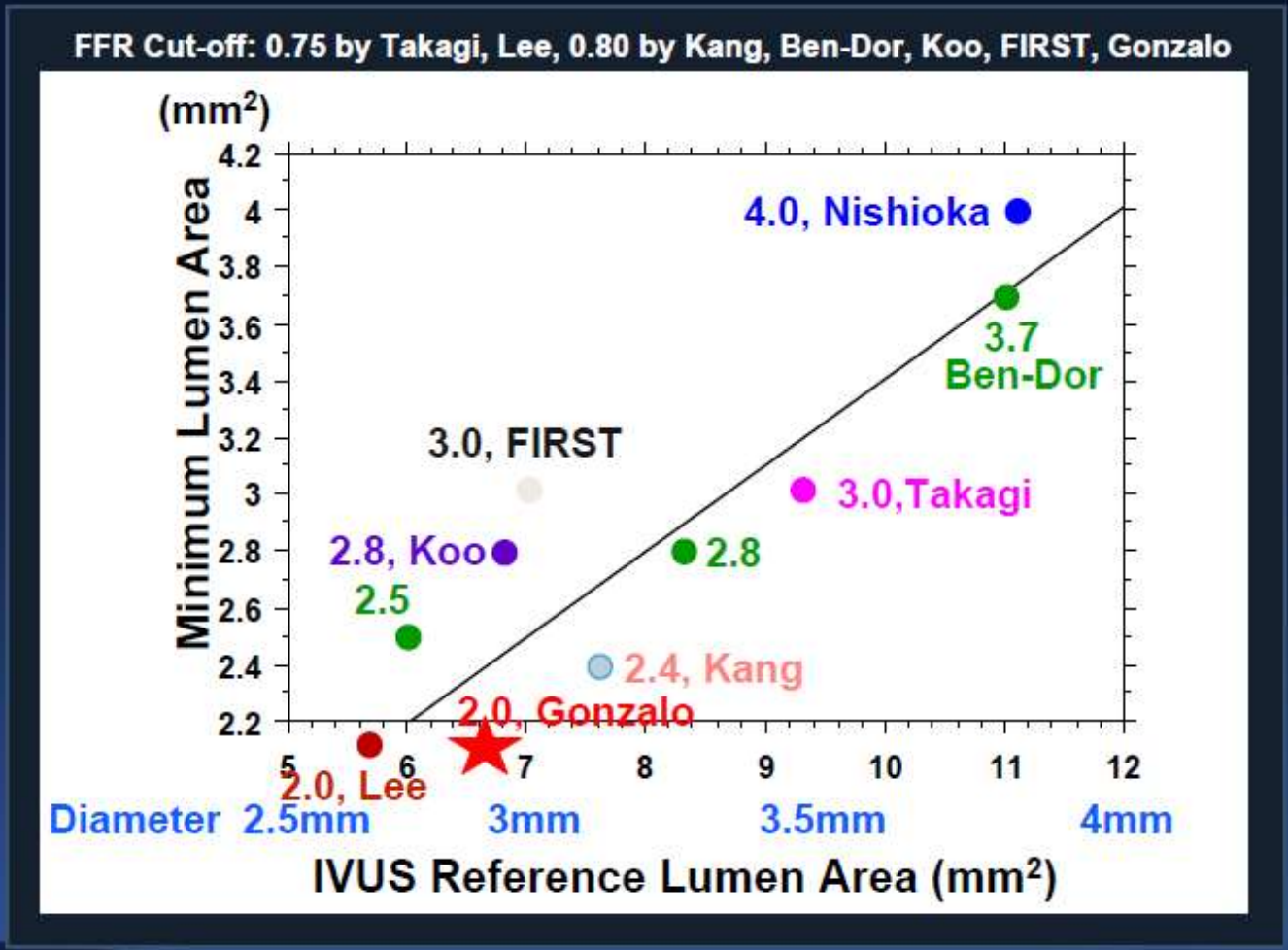
Figure 4. Proposed IVUS Criteria for the Assessment of Intermediate Left Main Coronary Lesions (30% to 60% Stenosis)

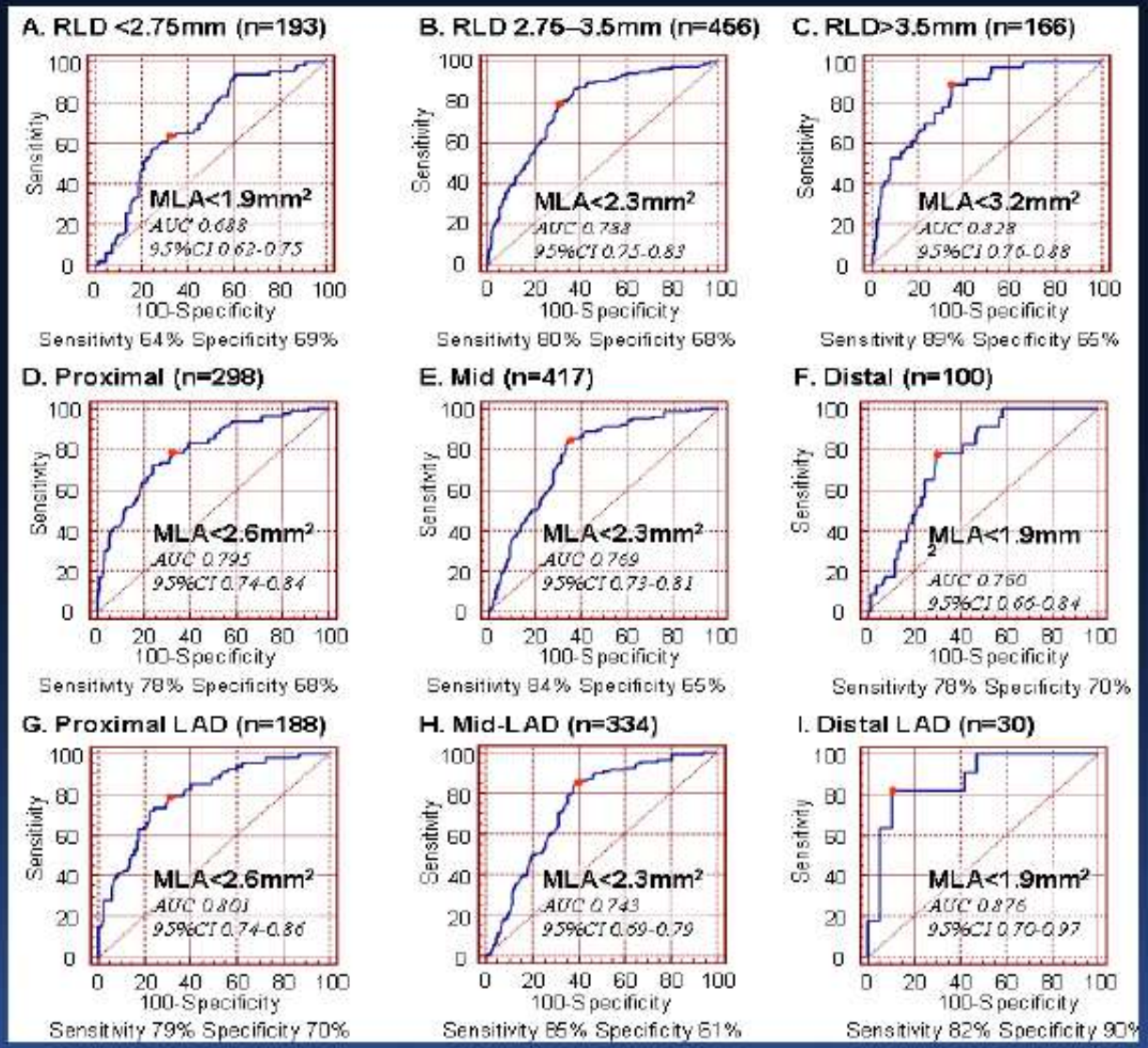
FFR remains the gold standard for the hemodynamic assessment of the intermediate left main lesions. However, if IVUS is used, it is reasonable to defer revascularization in patients with left main with an MLA ≥6.0 mm^2. For an MLA <6.0 mm^2, consideration should be given to performing FFR or noninvasive stress testing before revascularization as there may be discrepancy in the best IVUS MLA cutoff that correlates with FFR. Abbreviations as in Figures 1 and 2.

IVUS - FFR in intermediate lesions

	N	FFR	MLA	AUC	Sens	Spec	PPV	NPV	Accura
Takagi (1999 Circ)	51	0.75	**3.0**	–	83%	92%	–	–	–
Briguori (2001 AJC)	53	0.75	**4.0**	–	92%	56%	38%	96%	**64%**
Ben-Dor (2012 *)	205	0.80	**3.09**	0.73	69%	72%	–	–	**70%**
Kang (2011 Circ int)	236	0.80	**2.4**	0.80	90%	60%	37%	96%	**68%**
Kang (2012 AJC)	784	0.80	**2.4**	0.77	84%	63%	48%	90%	**69%**
Koo (2011 JACC int)	267	0.80	**2.75**	0.81	69%	65%	27%	81%	**67%**
Gonzalo (2012 JACC)	47	0.80	**2.36** IVUS	0.63	67%	65%	67%	65%	**66%**
Gonzalo (2012 JACC)	61	0.80	**1.95** OCT	0.70	82%	63%	66%	80%	**72%**

Cut-off MLA and Reference Area





All Subgroup-specific MLA, Accuracies <70-75%

Kang et al. Am J Cardiol 2012;109:94[illegible]5

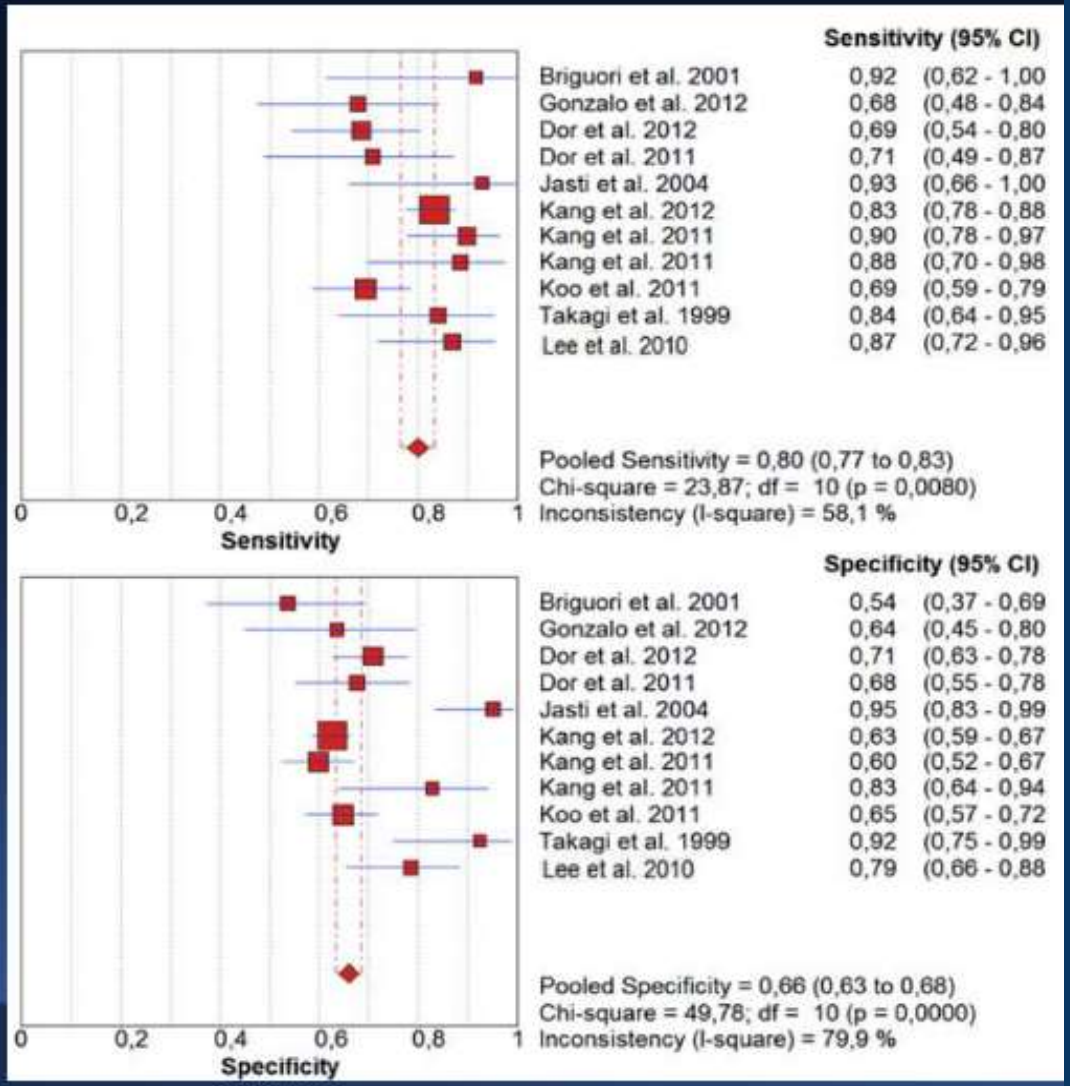
Meta-analysis of 11 Clinical Trials

1759 patients with 1953 lesions

Weighted **MLA 2.6** mm^2

Pooled sensitivity **79%**

Pooled specificity **65%**



Nascimento et al. Catheter Cardiovasc Interv 2014 84: 377-385

VERDICT + F1RST: Pooling

291 pts, 312 lesions

Lesions excluded*:
- No MLA (n=9)
- No FFR (n=6)

282 pts, 303 lesions

F1RST

350 pts, 367 lesions

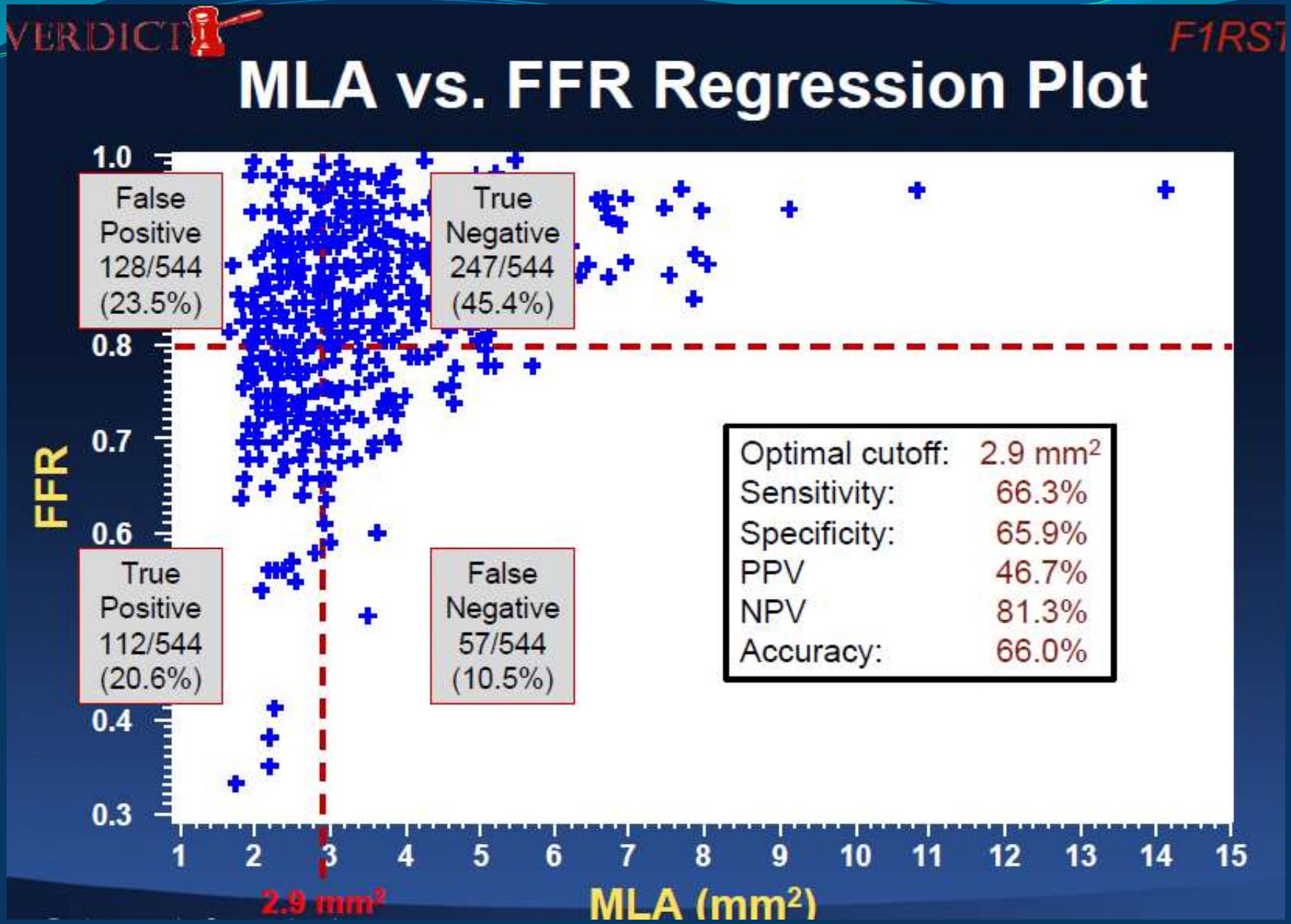
Lesions excluded*:
- Prior MI unless LVEF nl (n=53)
- LVEF<50% (n=34)
- STEMI (n=4)
- TIMI flow <3 (n=6)
- Left main lesion (n=2)
- Prior CABG (n=8)

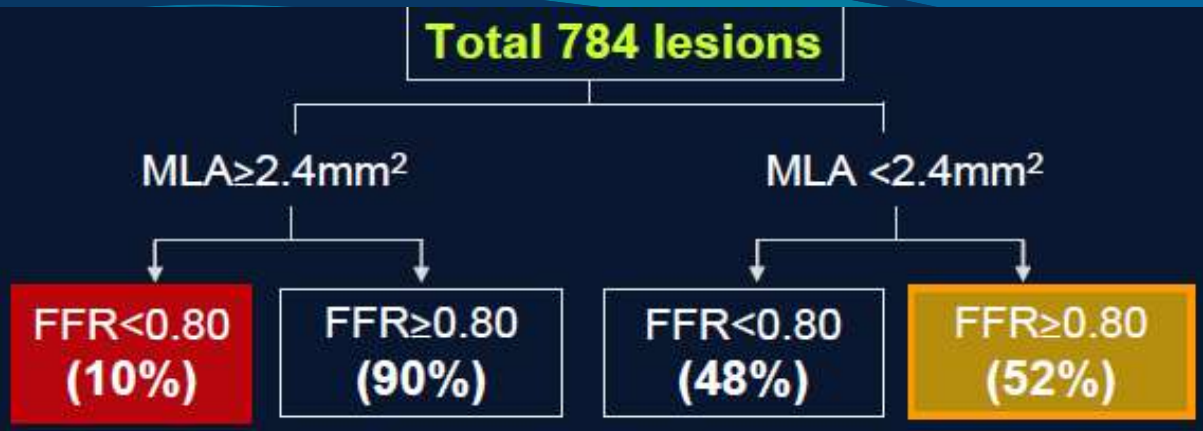
252 pts, 264 lesions

Exclude: No MLA (n=23)

234 pts, 241 lesions

MLA and FFR assessed in 544 intermediate lesions in 516 pts from 24 centers in 9 countries

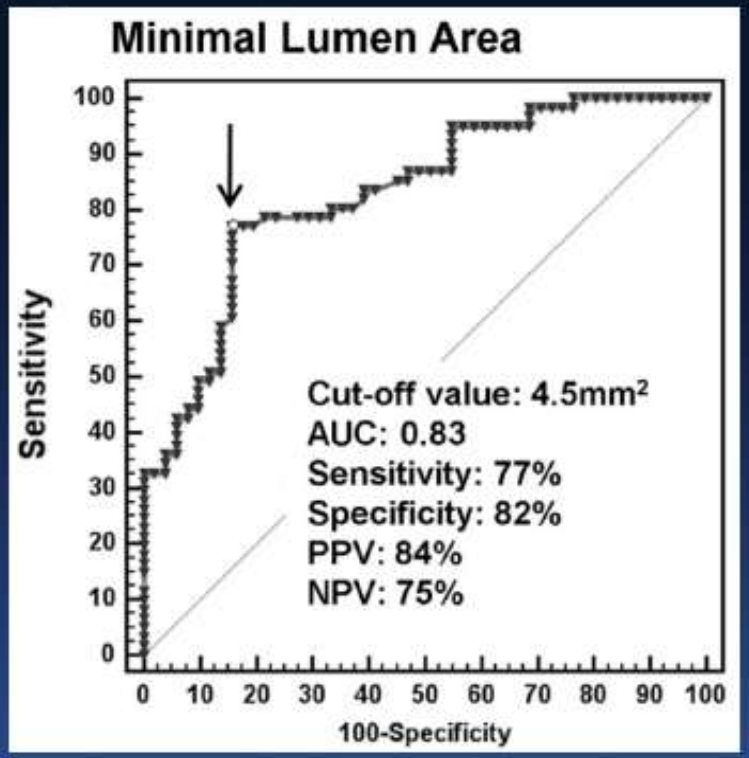

VERDICT
F1RST
MLA vs. FFR Regression Plot
False Positive 128/544 (23.5%)
True Negative 247/544 (45.4%)
True Positive 112/544 (20.6%)
False Negative 57/544 (10.5%)
Optimal cutoff: 2.9 mm²
Sensitivity: 66.3%
Specificity: 65.9%
PPV 46.7%
NPV 81.3%
Accuracy: 66.0%
FFR
1.0
0.8
0.7
0.6
0.4
0.3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
2.9 mm²
MLA (mm²)



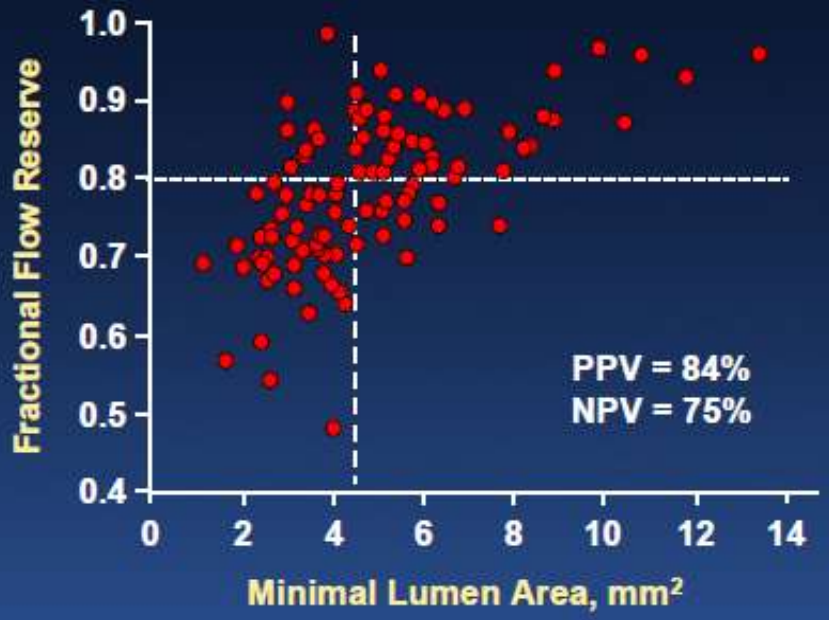
	Beta	p-value	Adjusted OR	95% CI
MLA<2.4 *but* FFR≥0.8 *"Mismatch"*				
Women	0.371	0.048	1.450	1.003 – 2.095
LAD location	-0.406	0.027	0.666	0.465 – 0.954
Reference lumen ø	-1.209	<0.001	0.298	0.204 – 0.437
Distal segment	0.704	0.002	2.021	1.293 – 3.159
MLA≥2.4 *but* FFR<0.8 *"Rev-mismatch"*				
Age	-0.062	<0.001	0.940	0.909 – 0.972
LAD location	0.813	0.071	2.256	0.932 – 5.460
Plaque rupture	2.410	<0.001	11.138	4.886 – 25.39

IVUS-MLA Predicts LM FFR<0.80

Pure 112 LM lesion of DS 30-80%, exclude distal stream disease

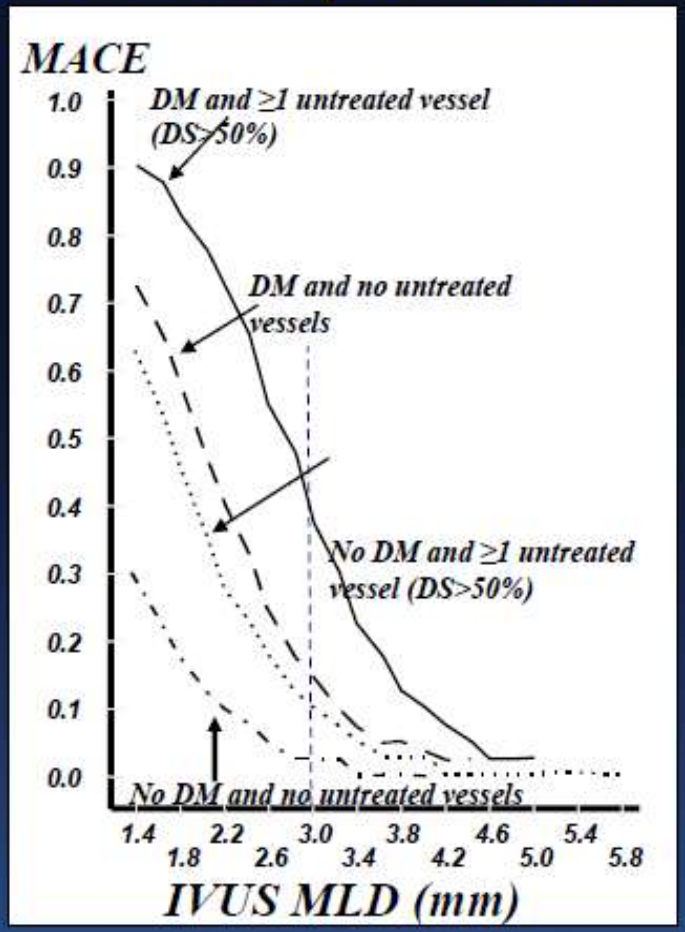


MLA 4.5mm²



Park et al. JACC Interv 2014;7: 868-874

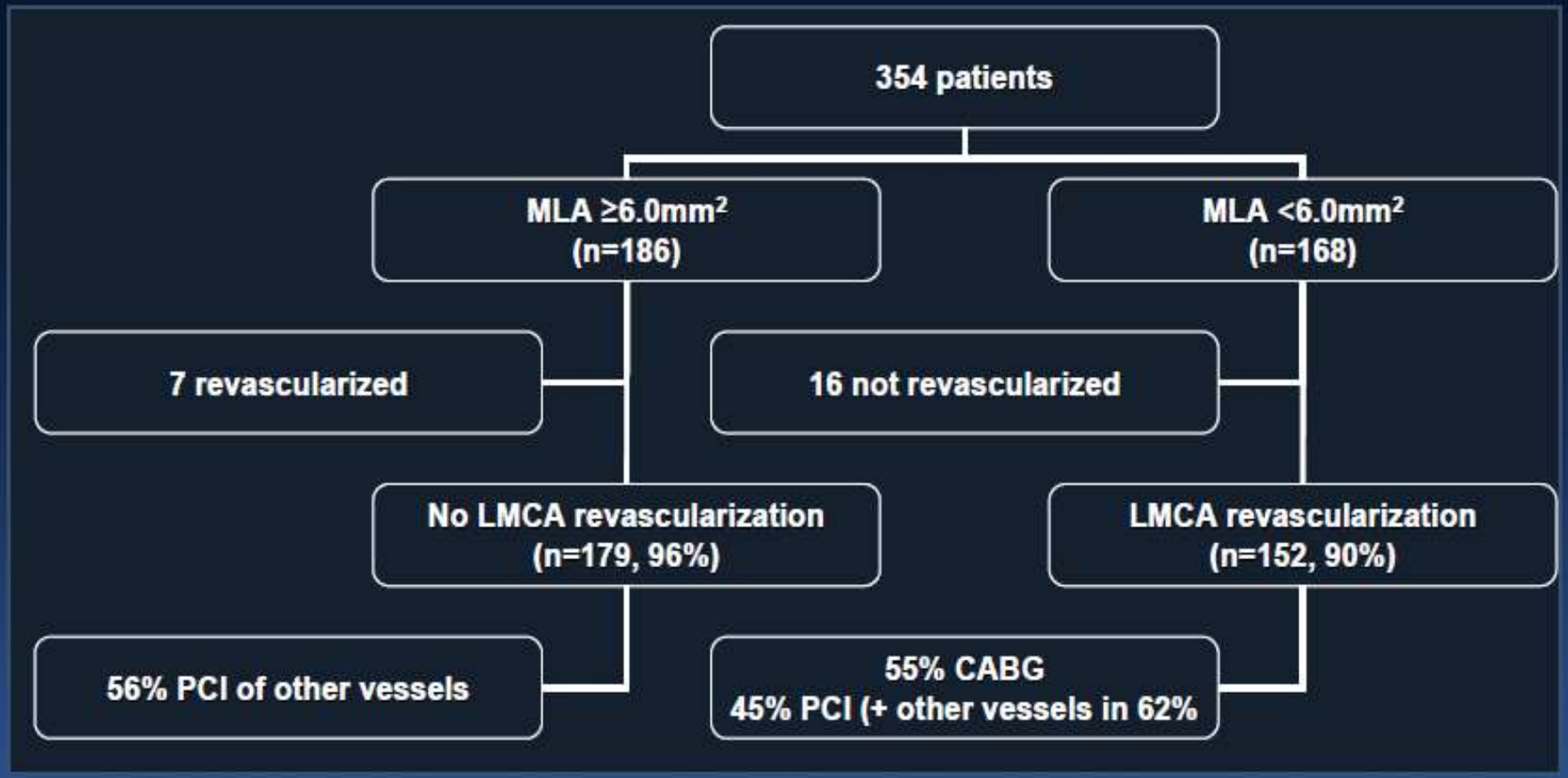
Follow-up of 122 pts with moderate LM



Independent predictors of MACE @11.7 months: DM (p=0.004), untreated lesion >50% (p=0.037), and IVUS MLD (p=0.005) – but NOT the plaque burden.

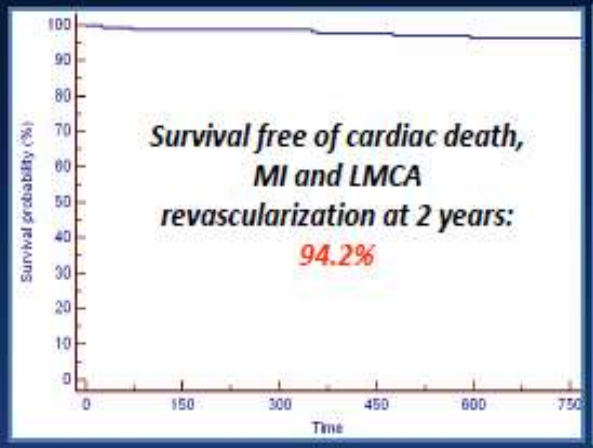
Abizaid et al. J Am Coll Cardiol 1999;34:707-15

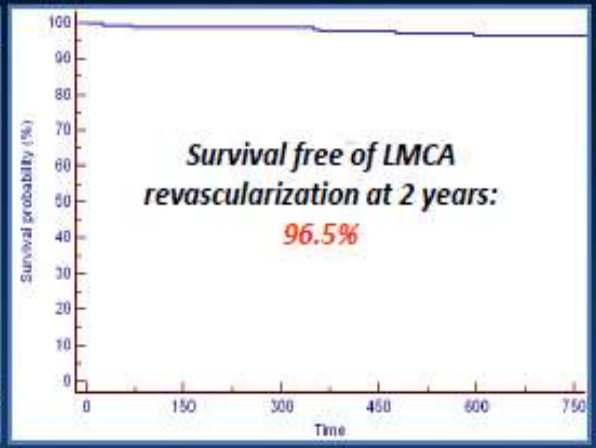
Prospective application of predefined IVUS criteria for revascularization of intermediate left main coronary artery lesions: Results at 2 years from the LITRO study



De La Torre Hernandez et al. J Am Coll Cardiol 2011;58:351-8

Clinical outcome of patients with deferred revascularization (MLA >6mm^2)

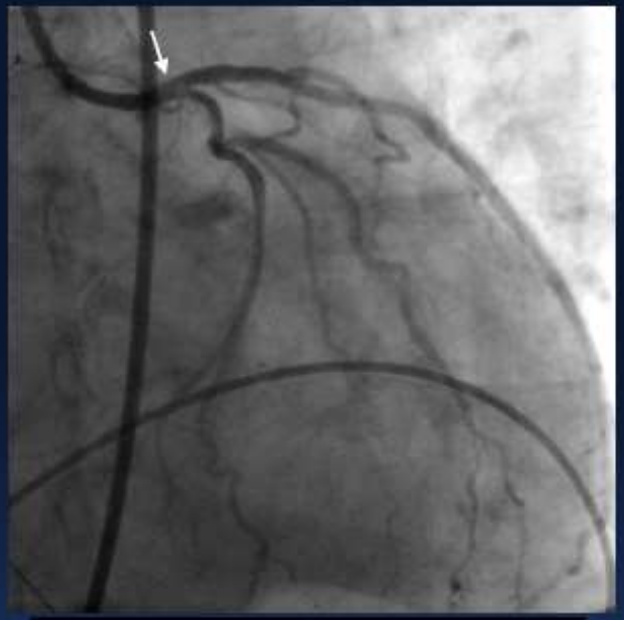


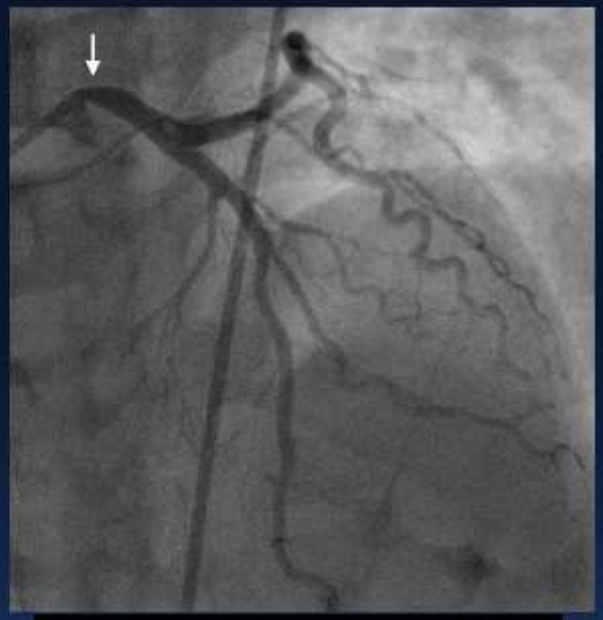


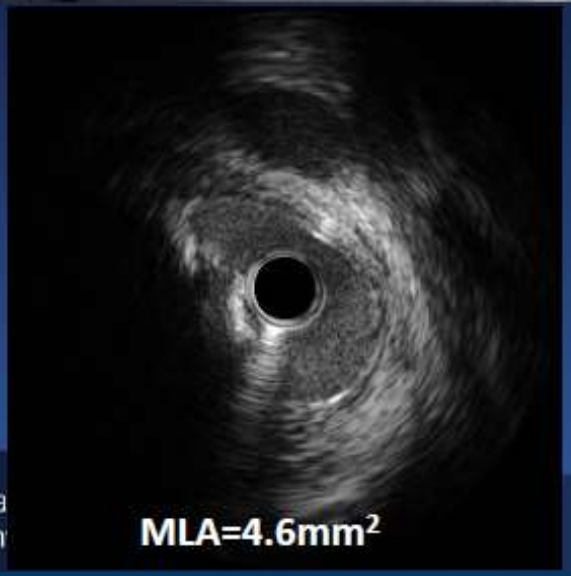
De La Torre Hernandez et al. J Am Coll Cardiol 2011;58:351-8

What are we looking at before intervention?

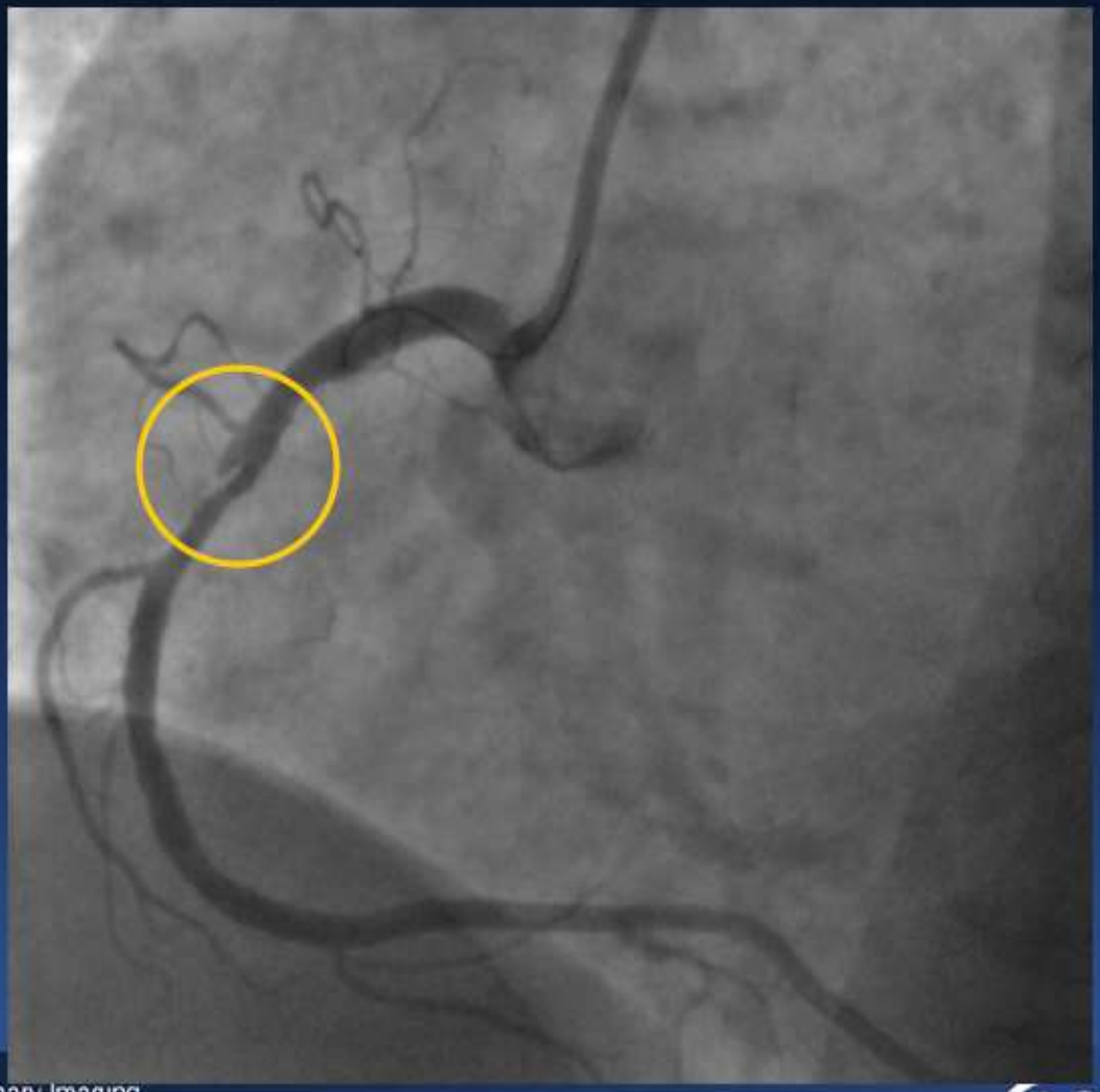
Discrepancy between Angio and IVUS



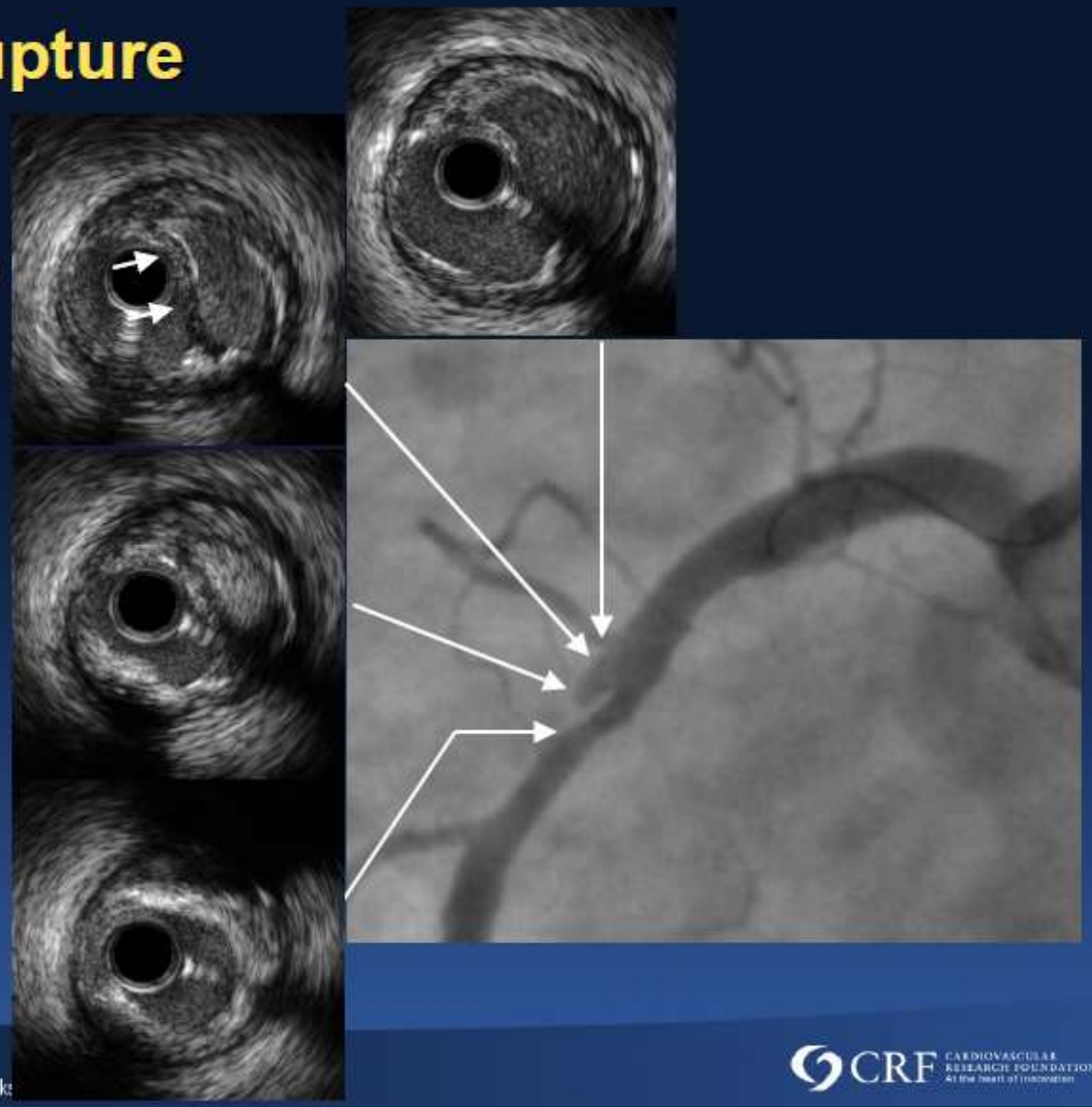




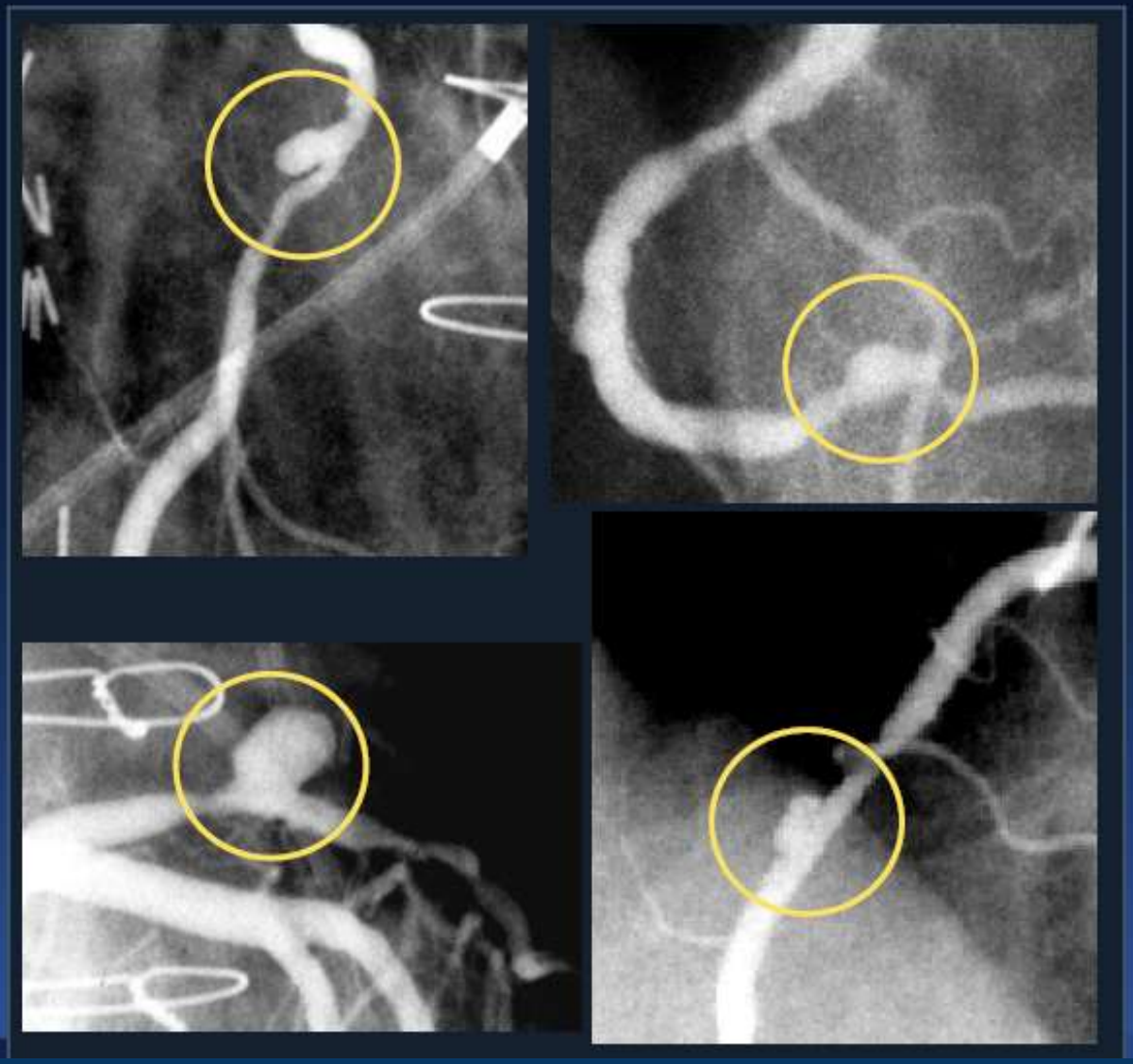
Angiographic ulceration



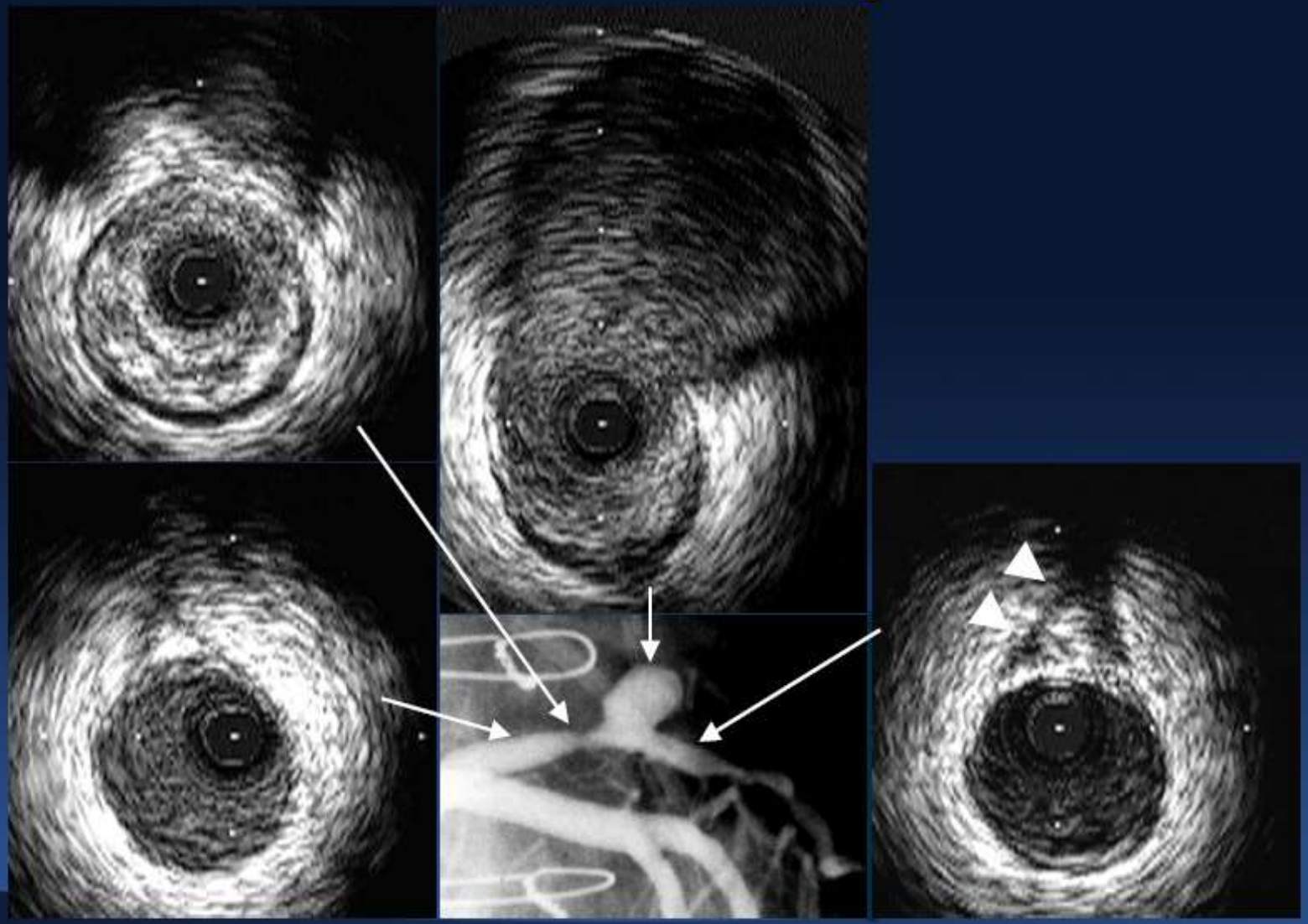
Plaque Rupture



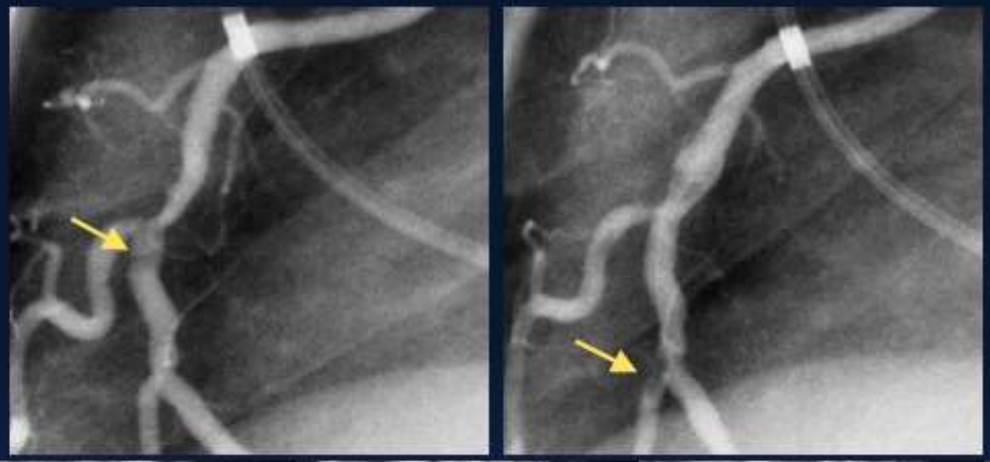
Angiographical Coronary Aneurysm

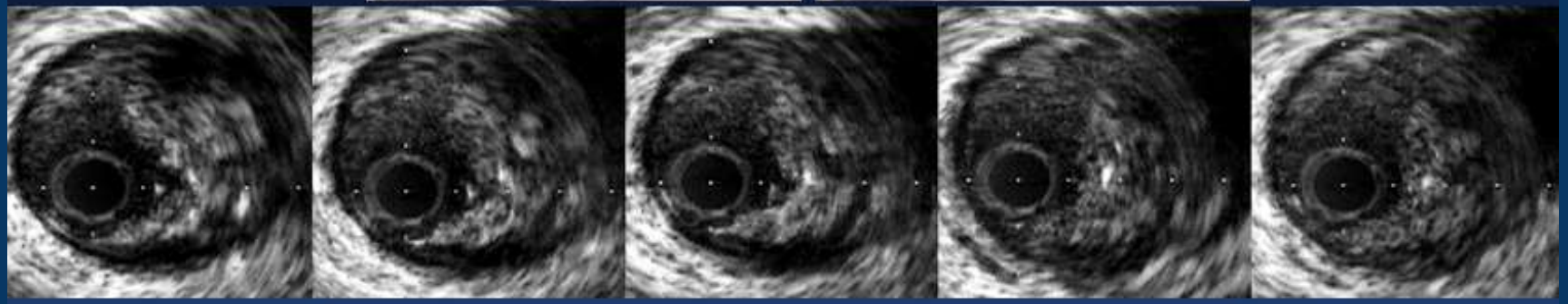


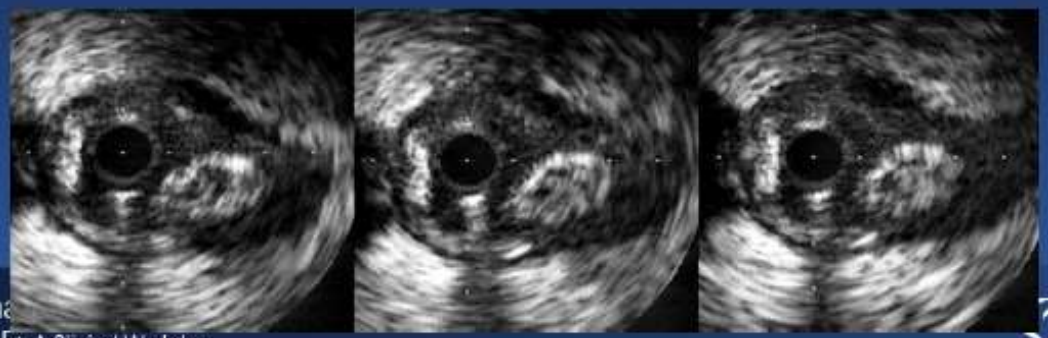
Pseudo Aneurysm



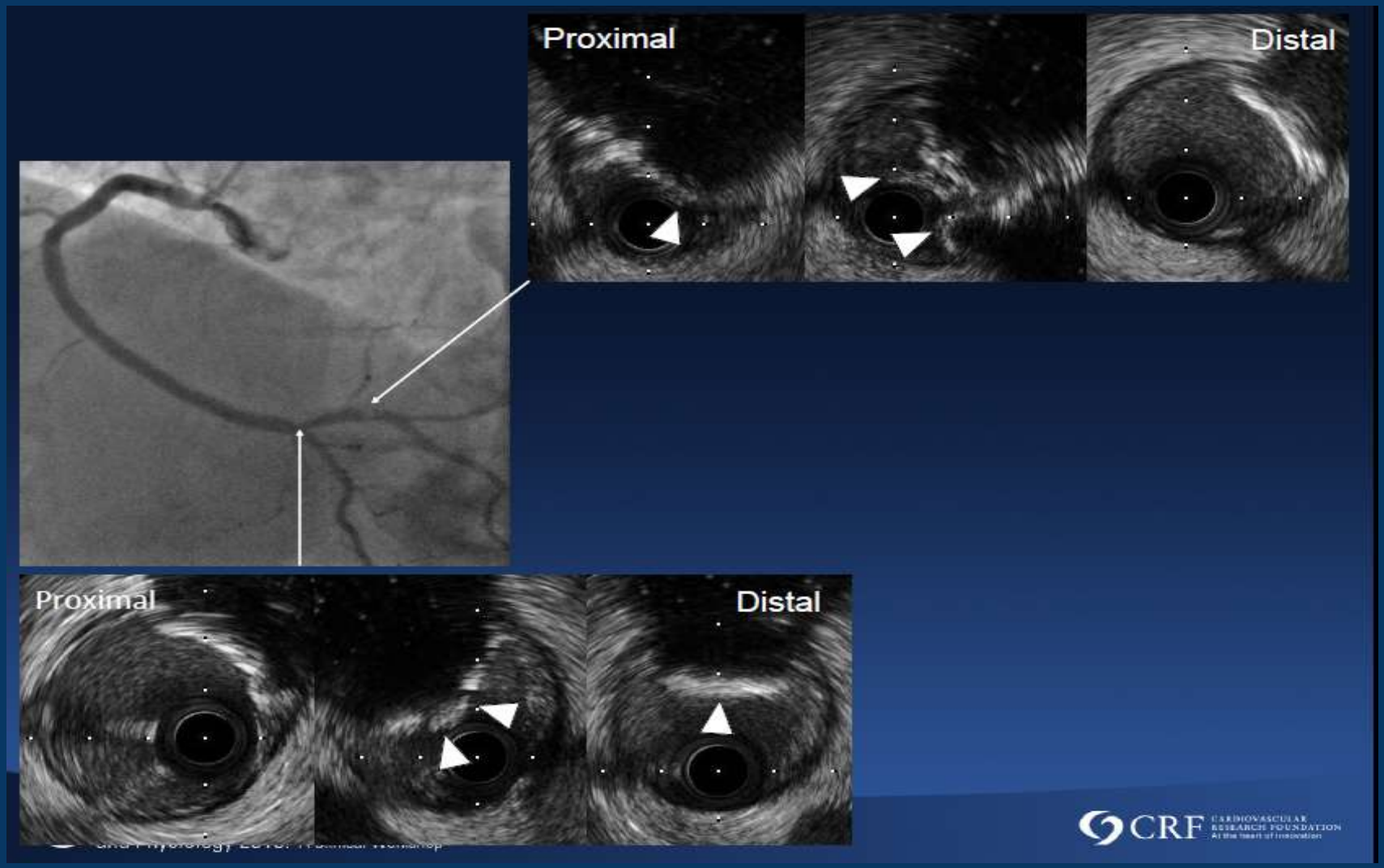
Thrombus in Both Main & Branch





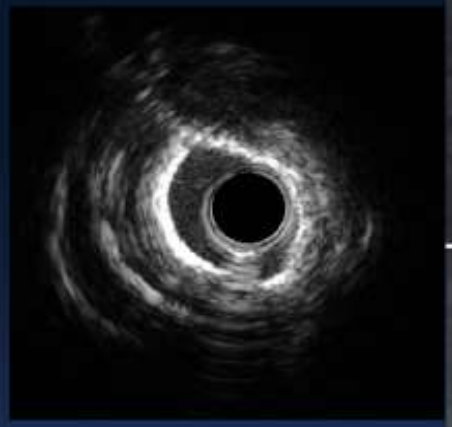


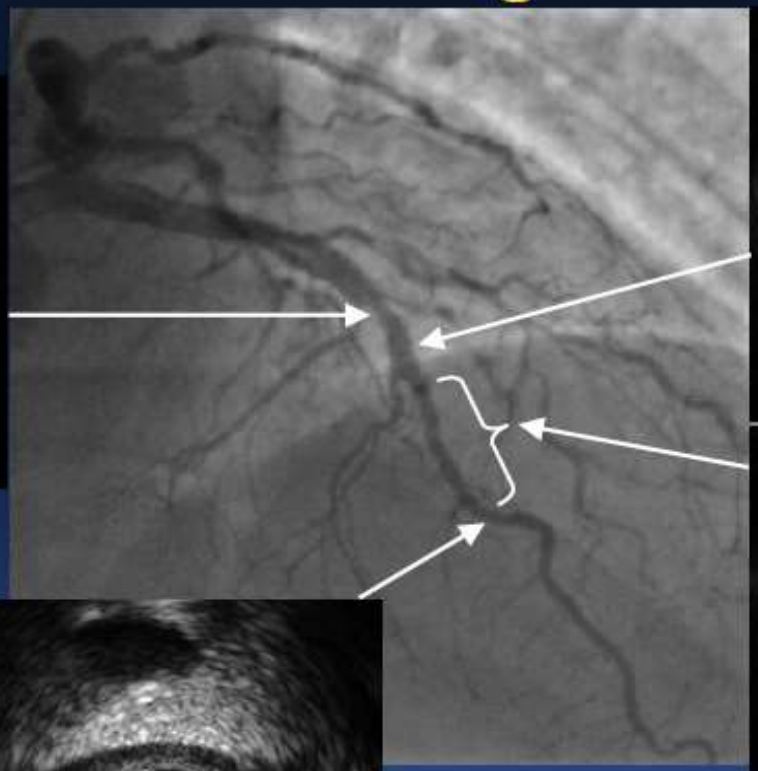
Calcified lesion

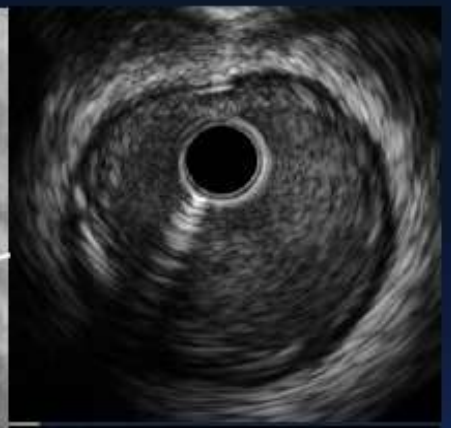


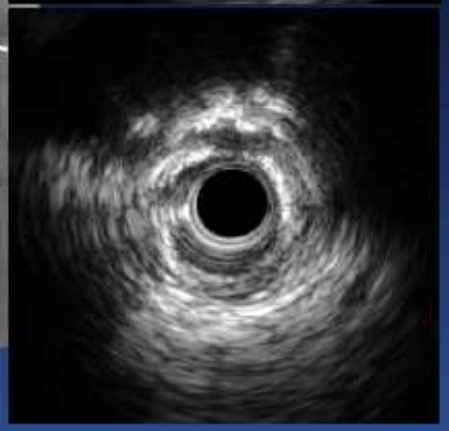
Haziness in the mid LAD

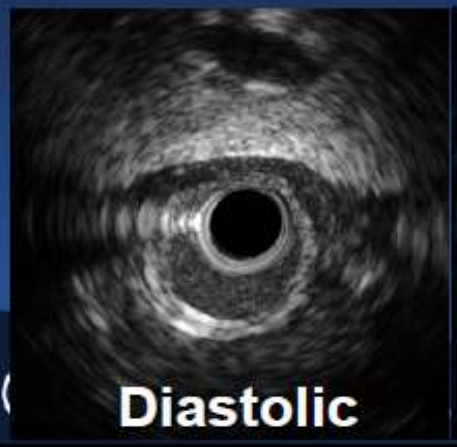
"Muscle Bridge"



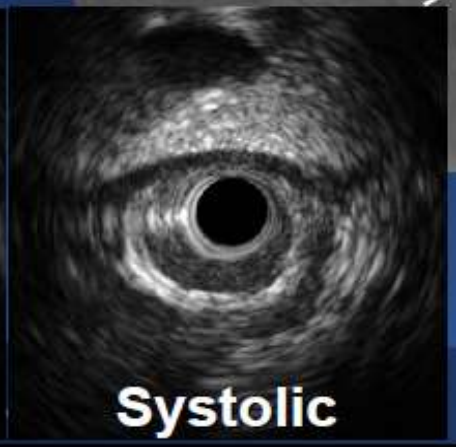








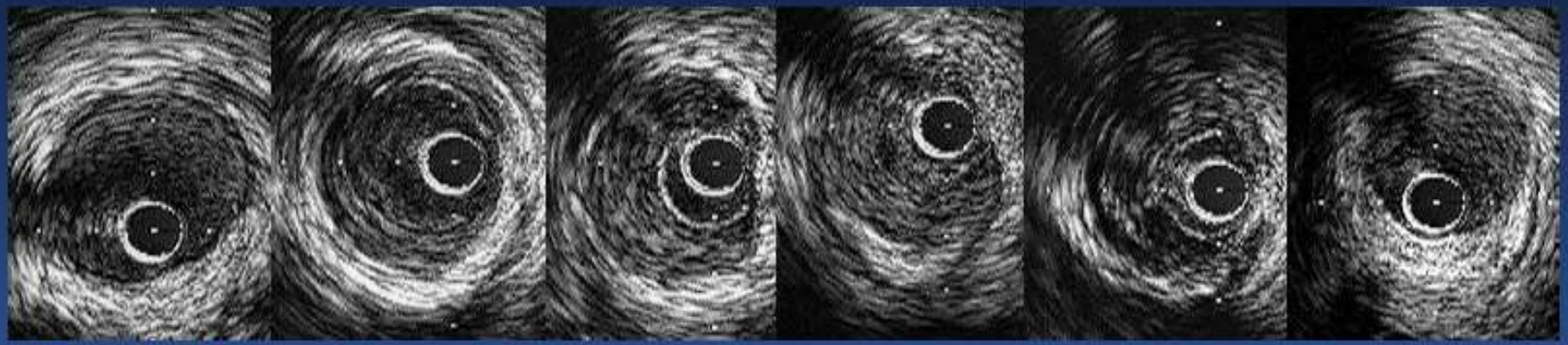
Diastolic



Systolic

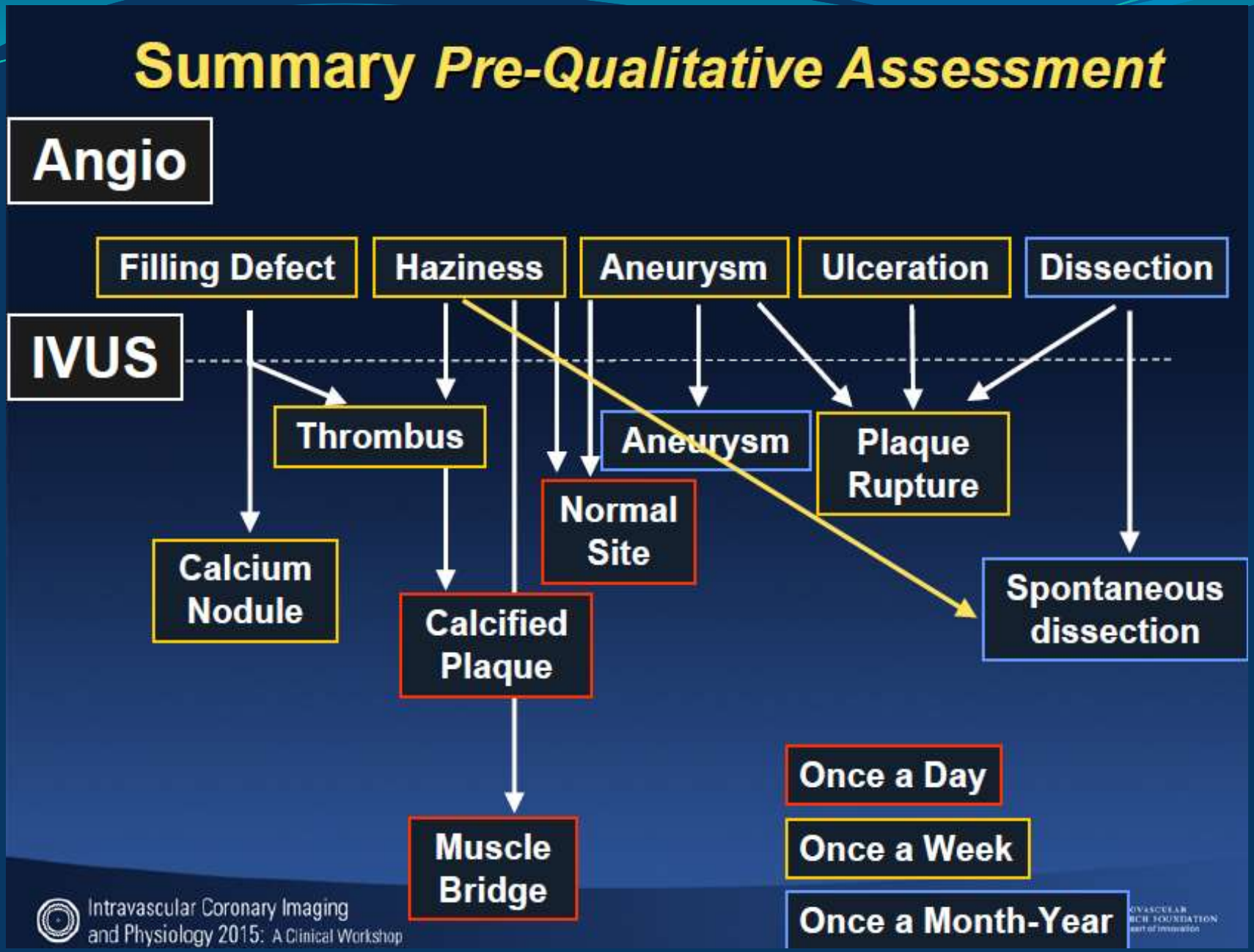
Inside the muscle bridge, no plaque at all!

55y.o. Female, AMI

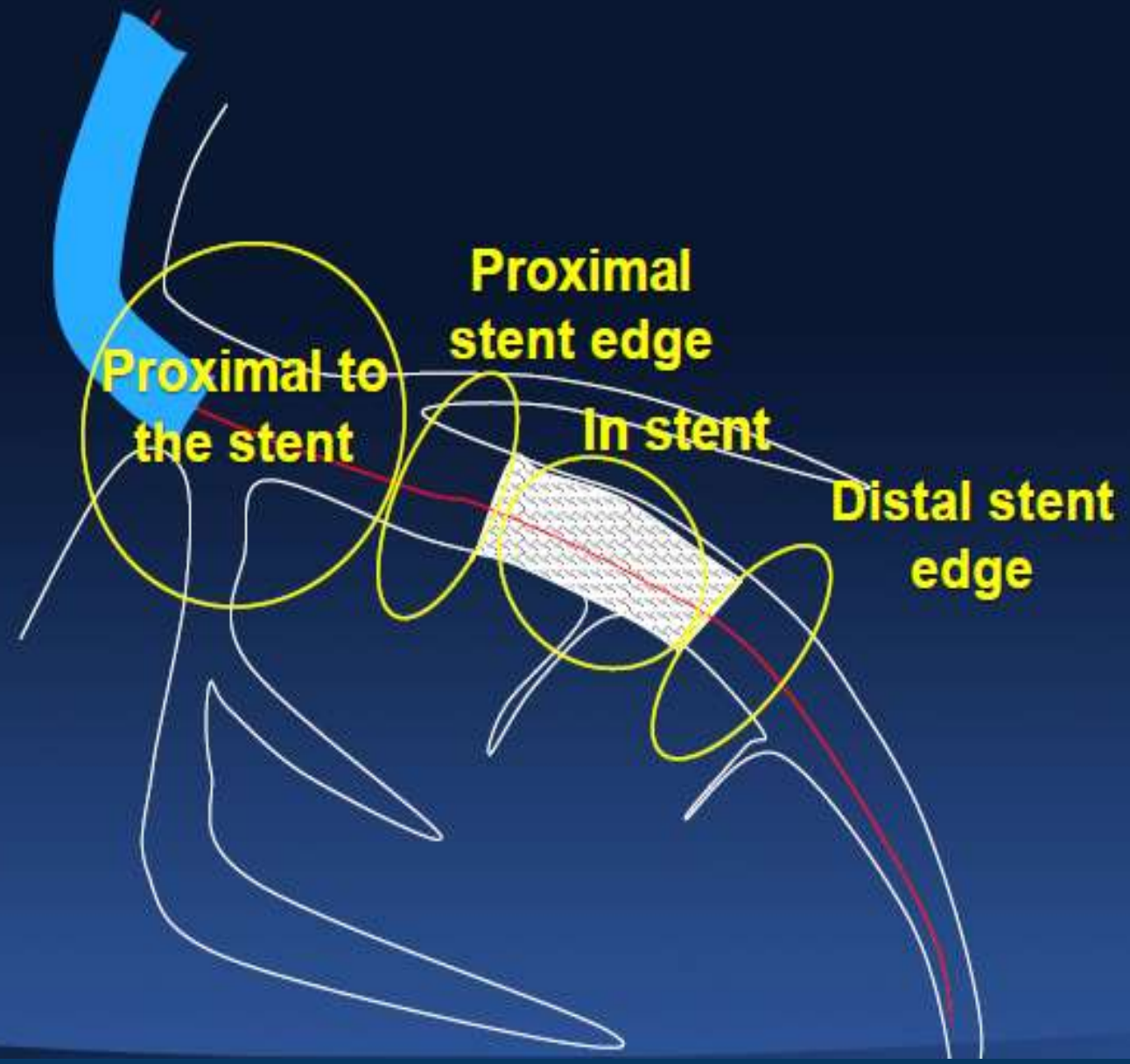


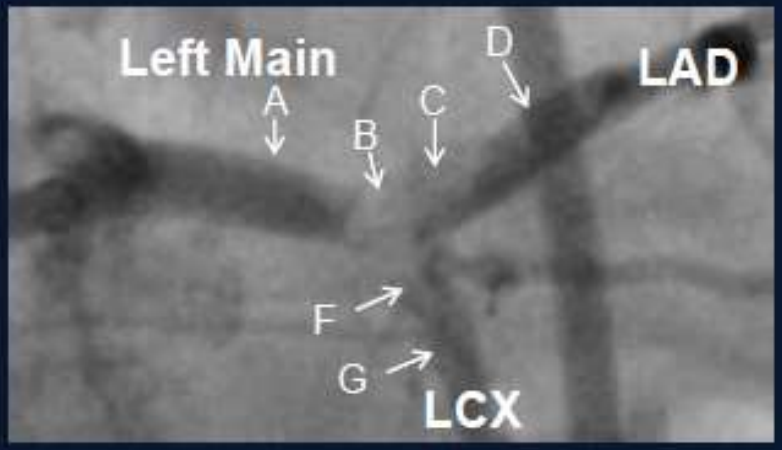
Proximal

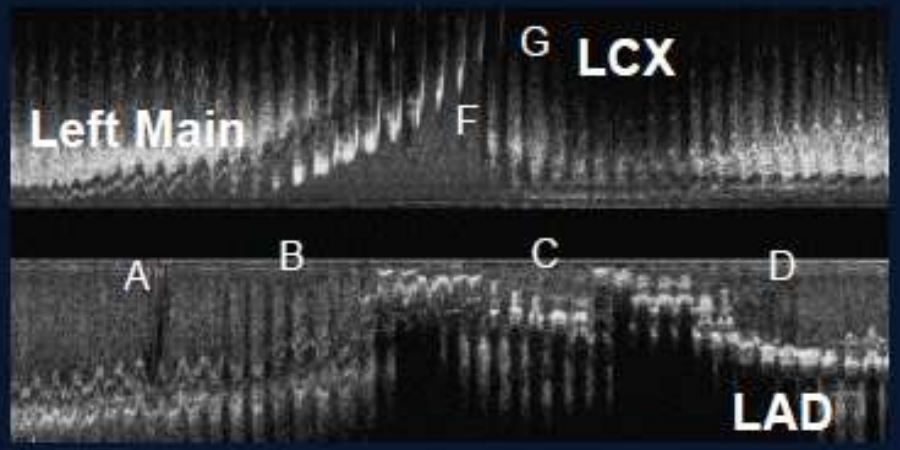
"Spontaneous Dissection"

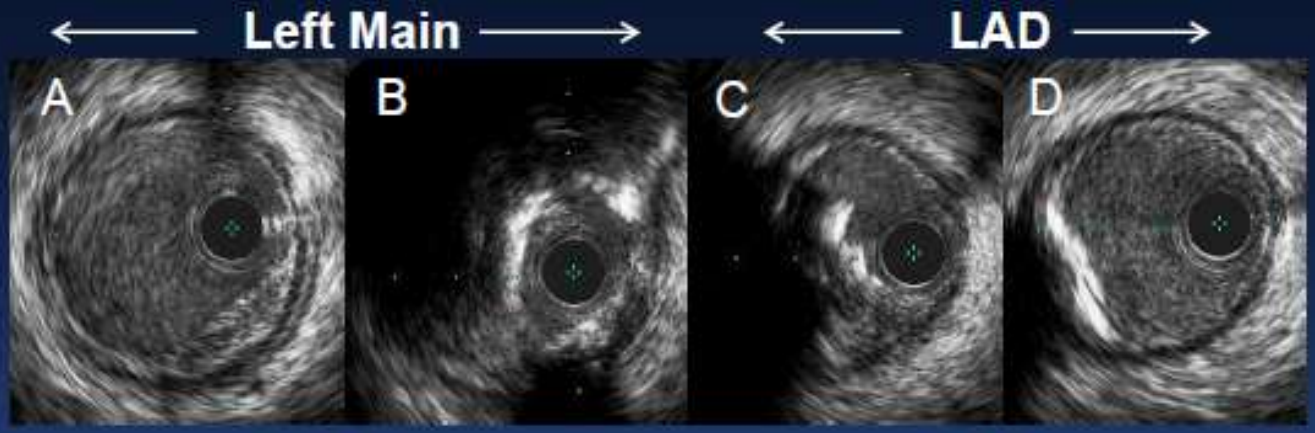

Summary Pre-Qualitative Assessment
Angio
Filling Defect
Haziness
Aneurysm
Ulceration
Dissection
IVUS
Thrombus
Aneurysm
Plaque Rupture
Normal Site
Calcium Nodule
Calcified Plaque
Spontaneous dissection
Muscle Bridge
Once a Day
Once a Week
Once a Month-Year
Intravascular Coronary Imaging and Physiology 2015: A Clinical Workshop

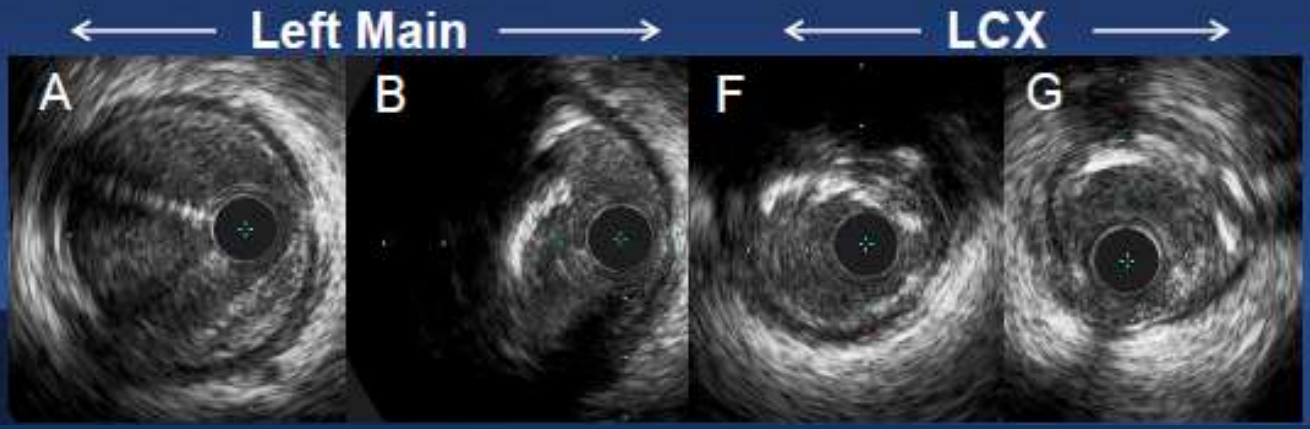
Post Stent Evaluation

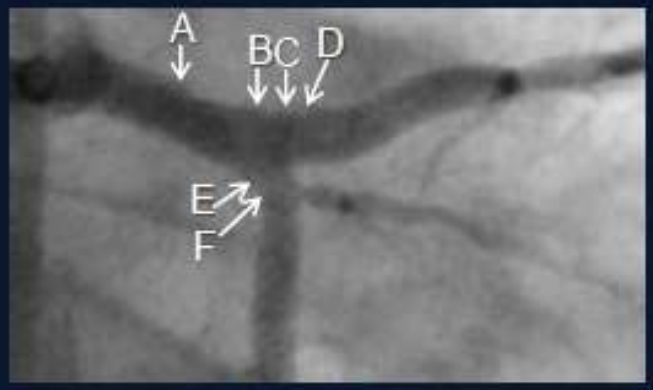


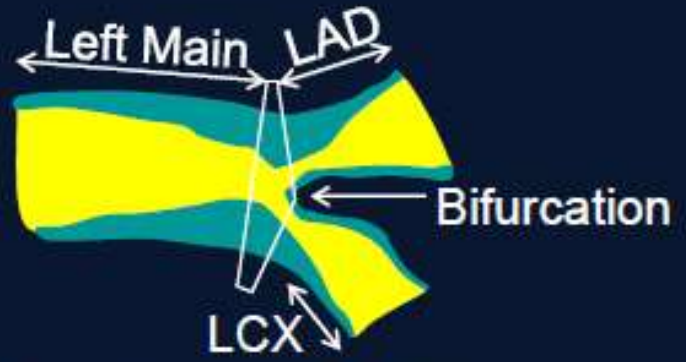

Left Main
LAD
A
B
C
D
F
G
LCX

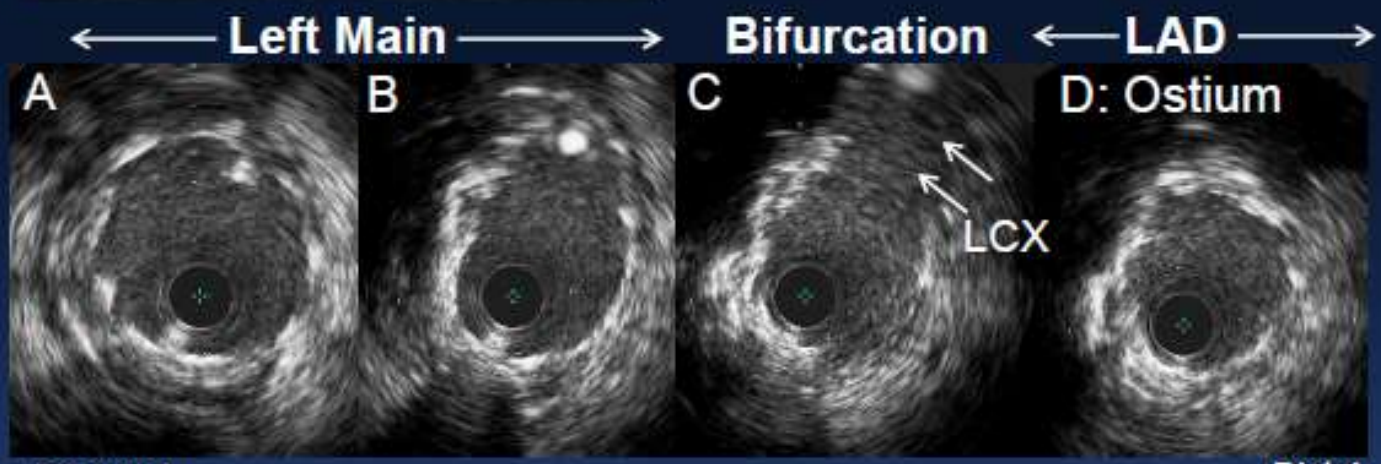

G
LCX
Left Main
F
A
B
C
D
LAD

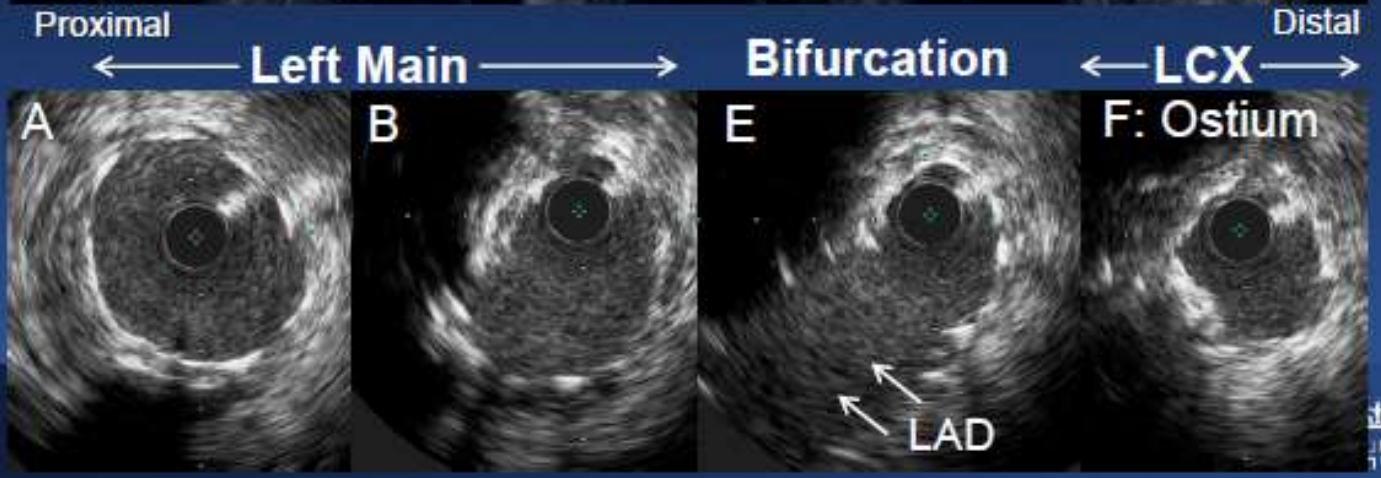

Left Main
LAD
A
B
C
D

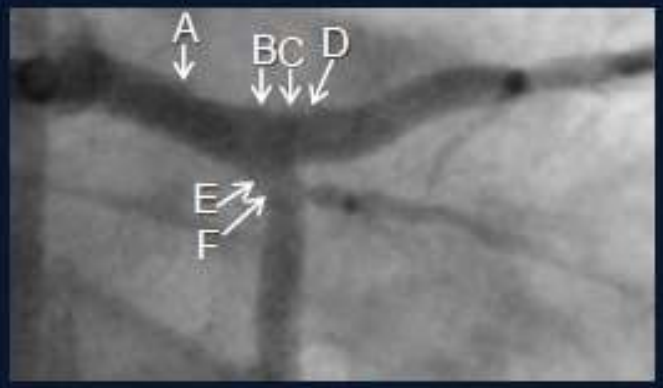

Left Main
LCX
A
B
F
G

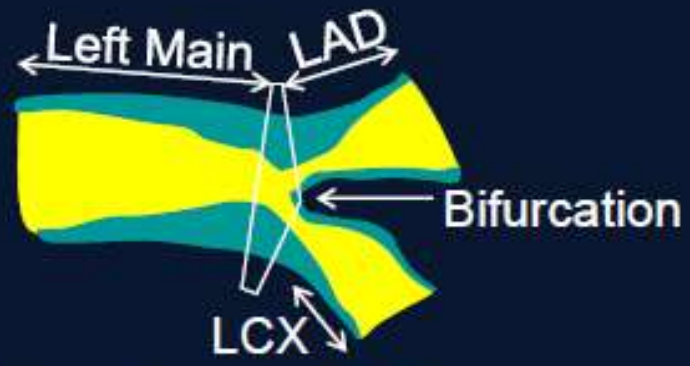

A
BC
D
E
F

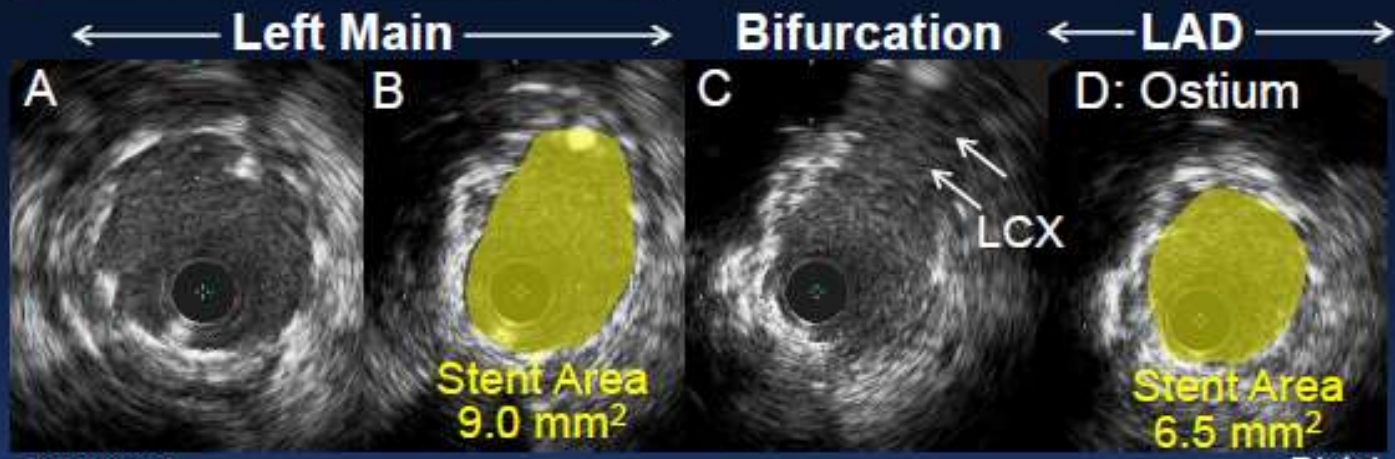

Left Main
LAD
Bifurcation
LCX

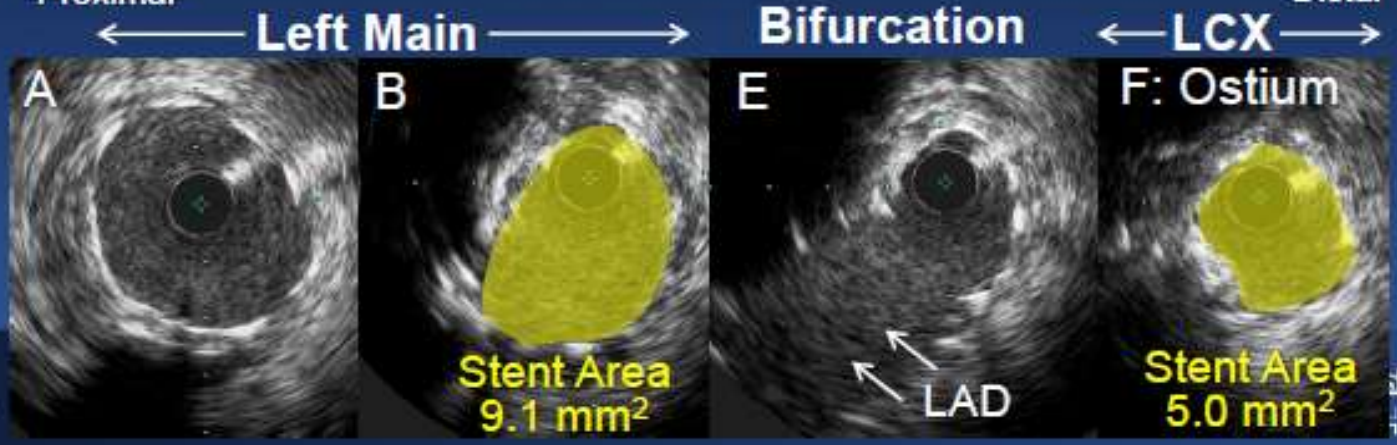

Left Main
Bifurcation
LAD
A
B
C
D: Ostium
LCX


Proximal
Distal
Left Main
Bifurcation
LCX
A
B
E
F: Ostium
LAD


A
BC D
E
F


Left Main
LAD
Bifurcation
LCX


Left Main
Bifurcation
LAD
A
B
C
D: Ostium
LCX
Stent Area
9.0 mm²
Stent Area
6.5 mm²
Proximal
Distal

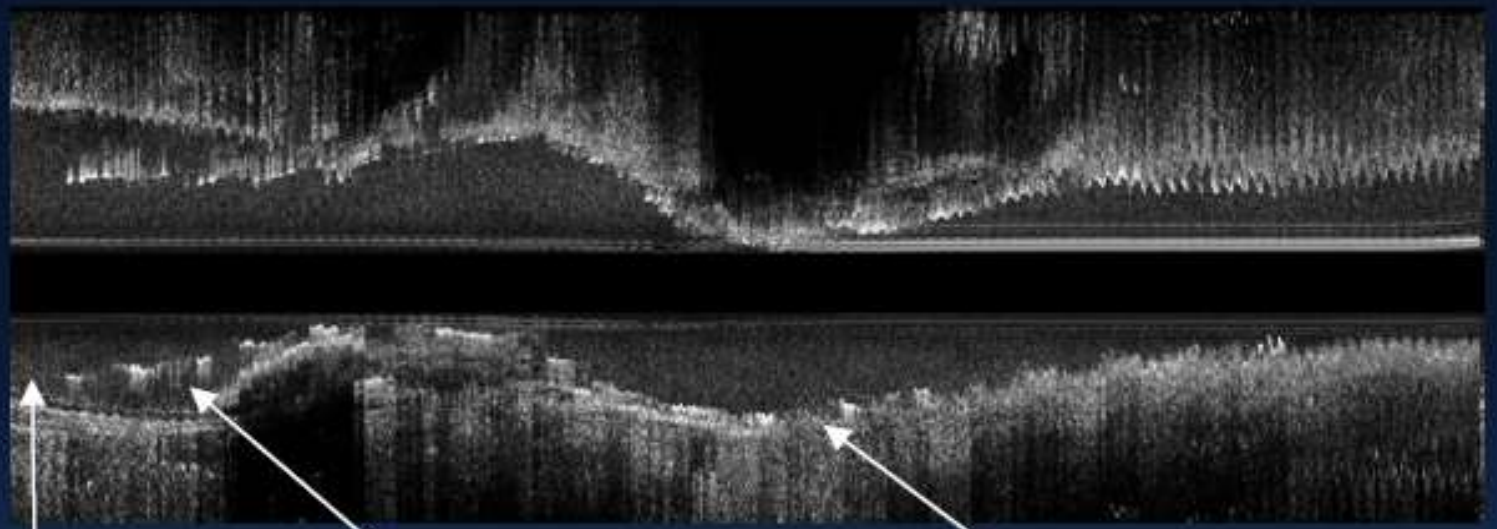

Left Main
Bifurcation
LCX
A
B
E
F: Ostium
Stent Area
9.1 mm²
LAD
Stent Area
5.0 mm²

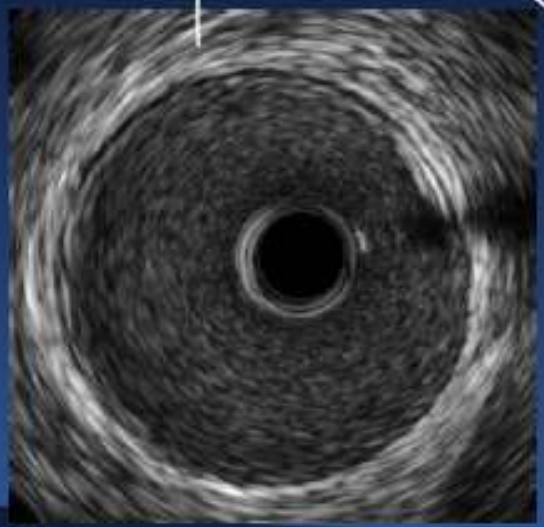
2011 General Consensus on LMCA Bifurcation Lesion

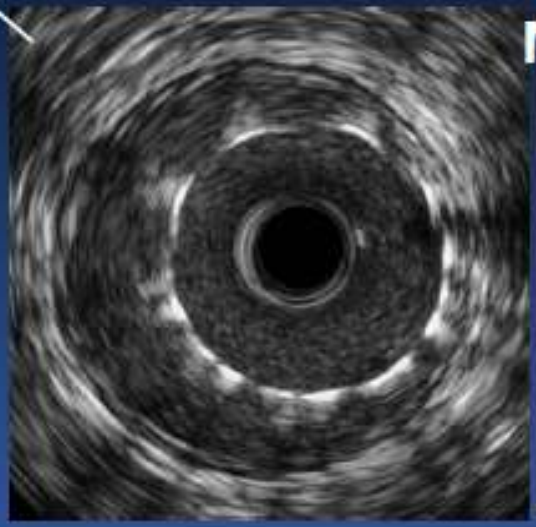
- For distal/bifurcation ULMCA lesions, every effort should be made to achieve the greatest possible lumen dimensions before stent deployment and post dilation should be performed to achieve a minimum stent area of
  - *LMCA lesion >8.5 mm2,*
  - *origin LAD> 5.5 mm2 and*
  - *origin LCX >5.5 mm2*

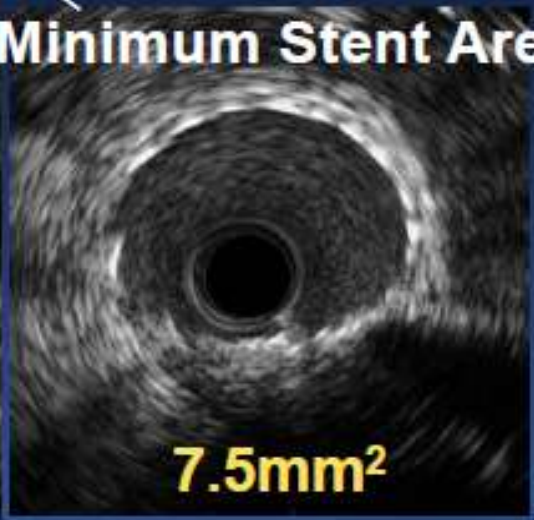
Leon MB et al. 8th Annual Chronic Total Occlusion and Left Main Coronary Intervention Summit, February 2011, New York, NY

Acute Stent Malapposition



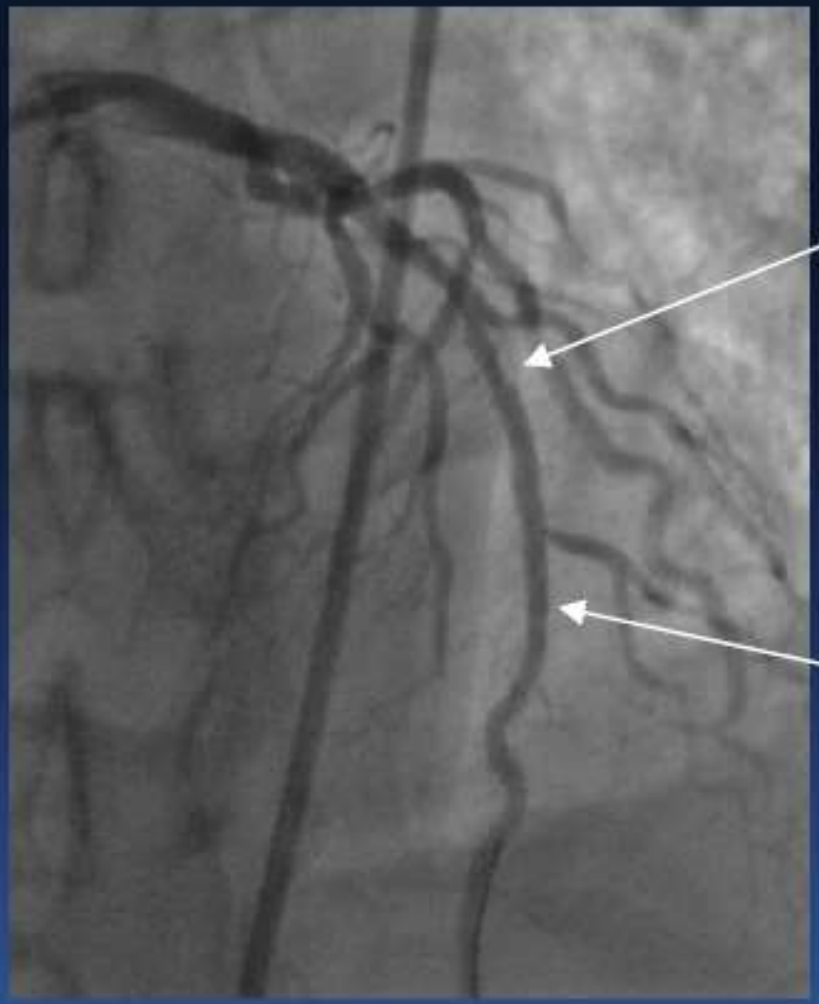


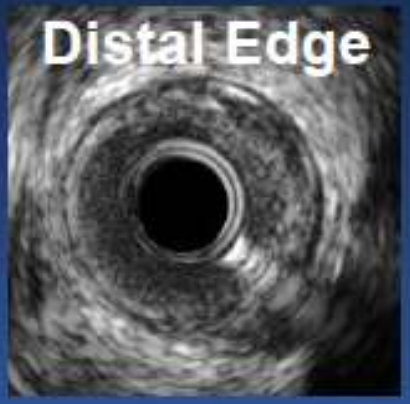




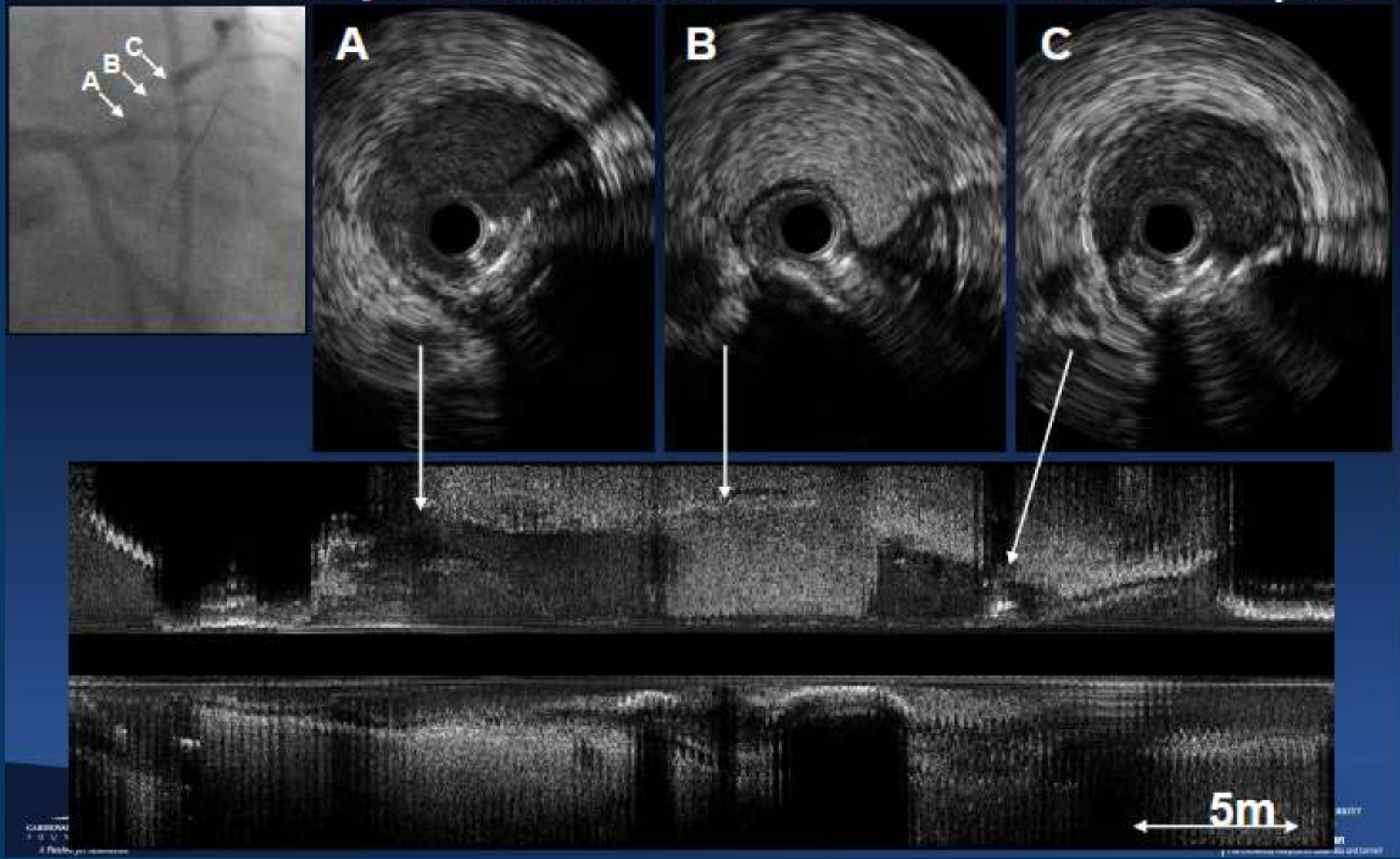
Malapposition

Stent Edge Dissection

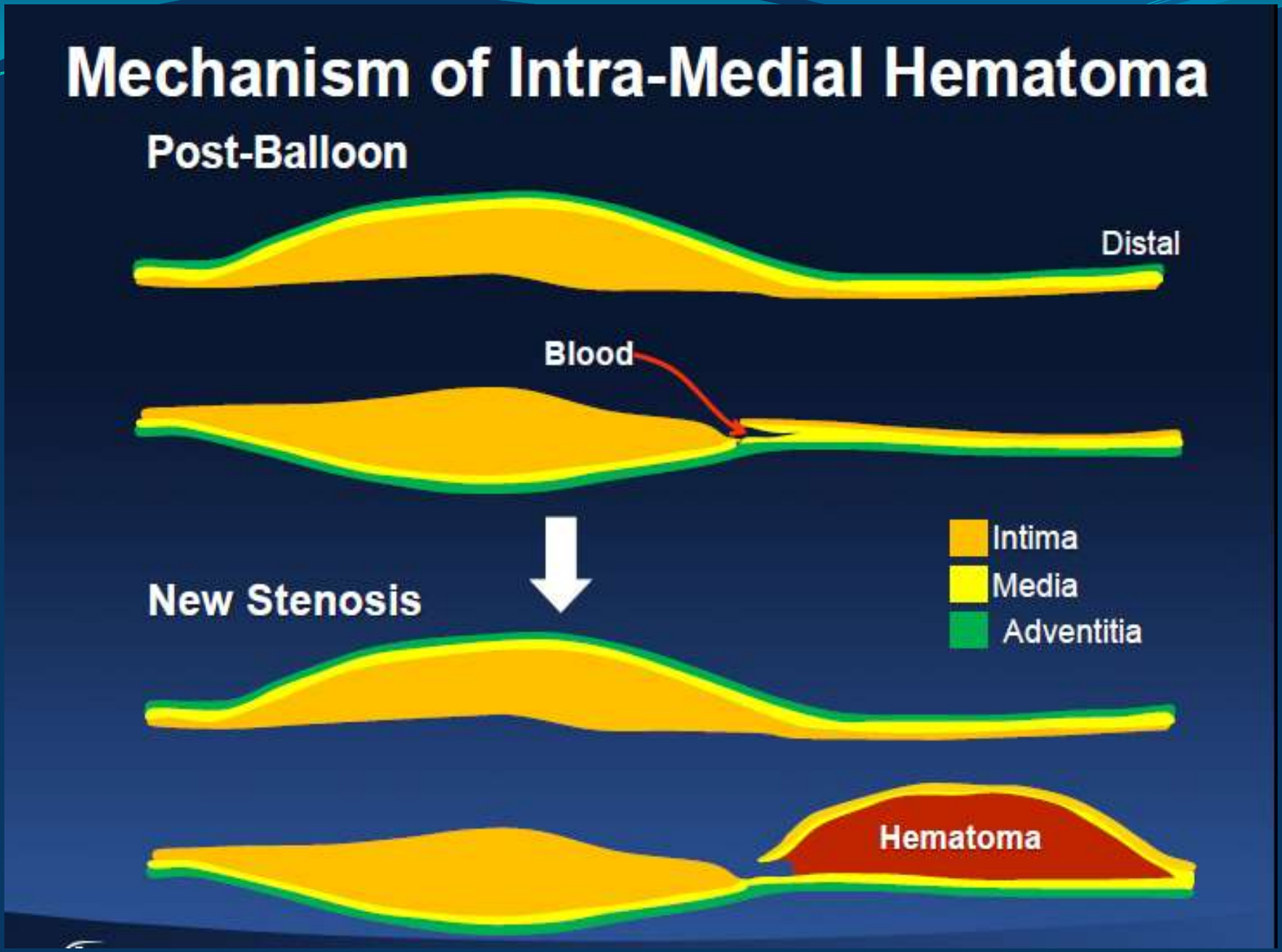




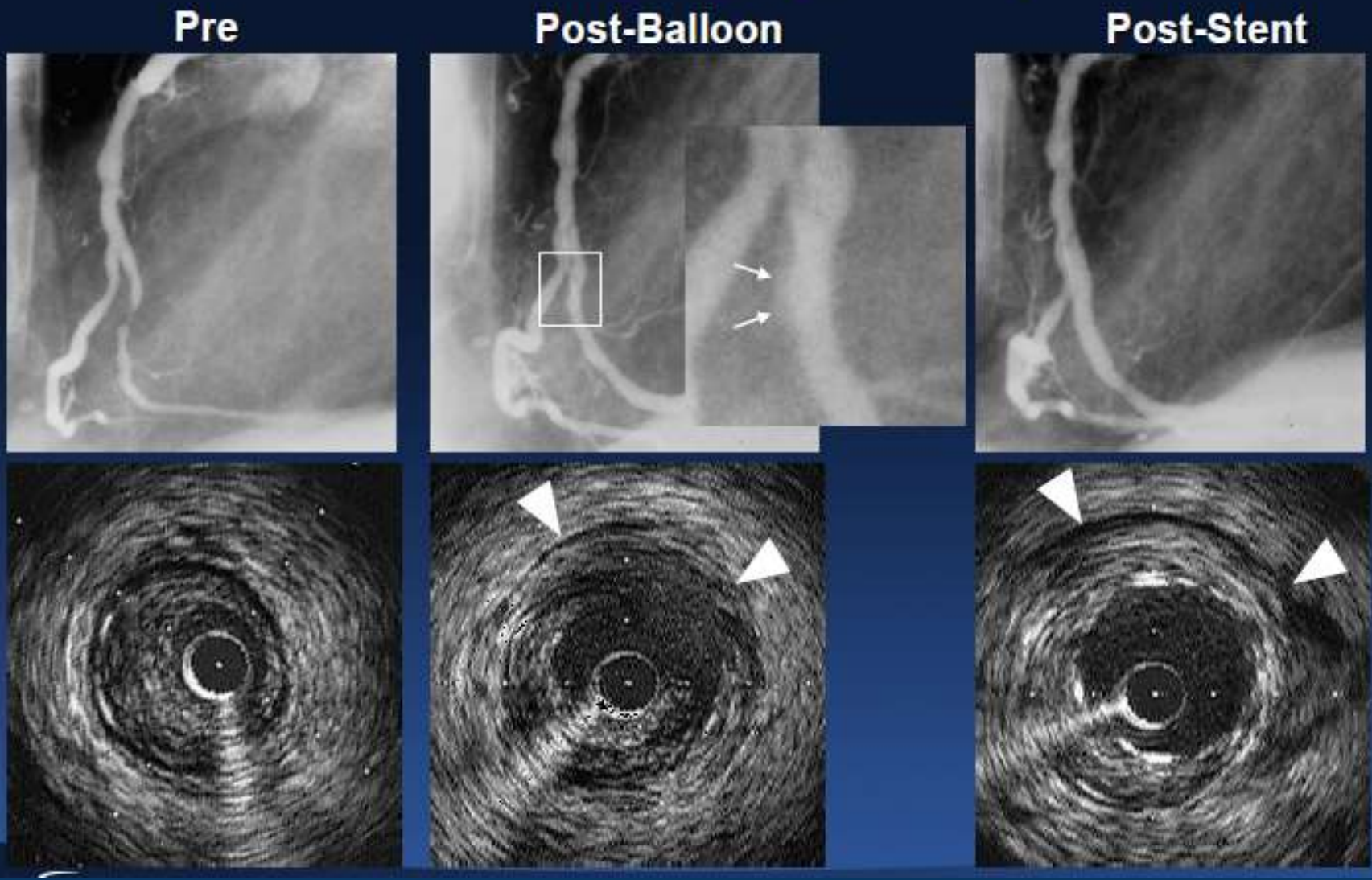
Intramural Hematoma



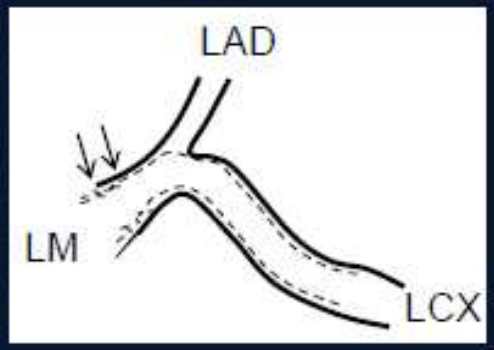
Mechanism of Intra-Medial Hematoma

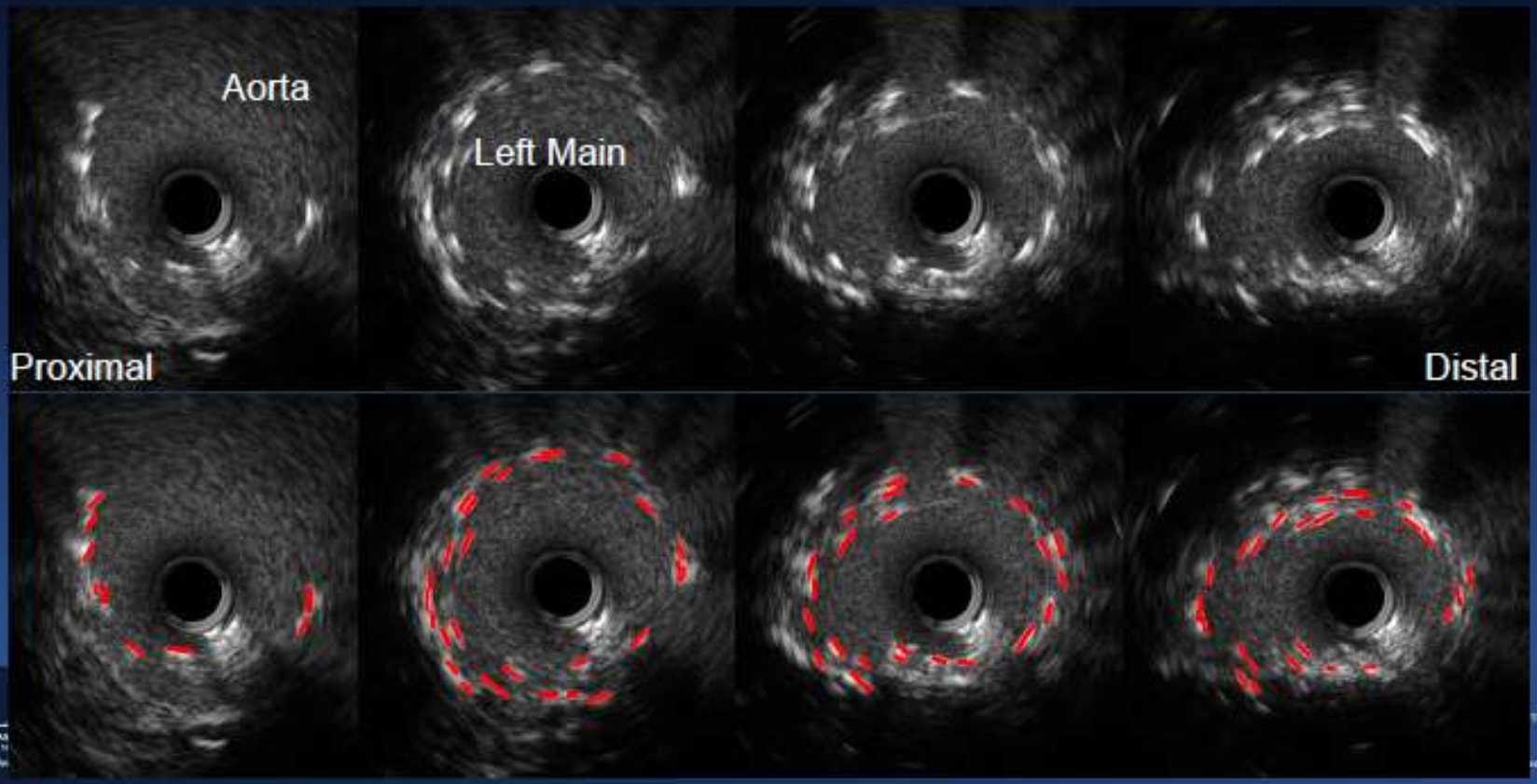


Perforation - angiographically unclear -

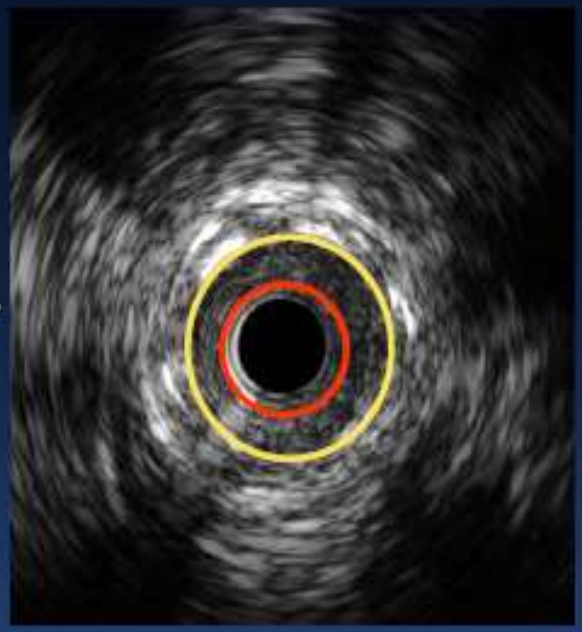


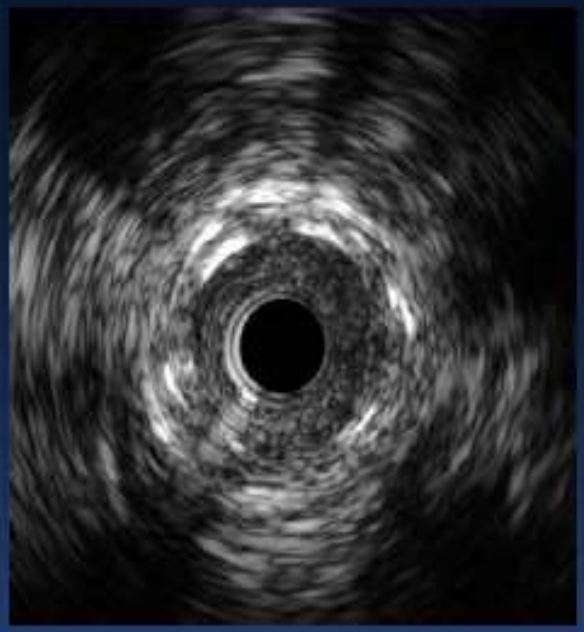
Stent Deformation





In-stent Restenosis due to Under-expansion

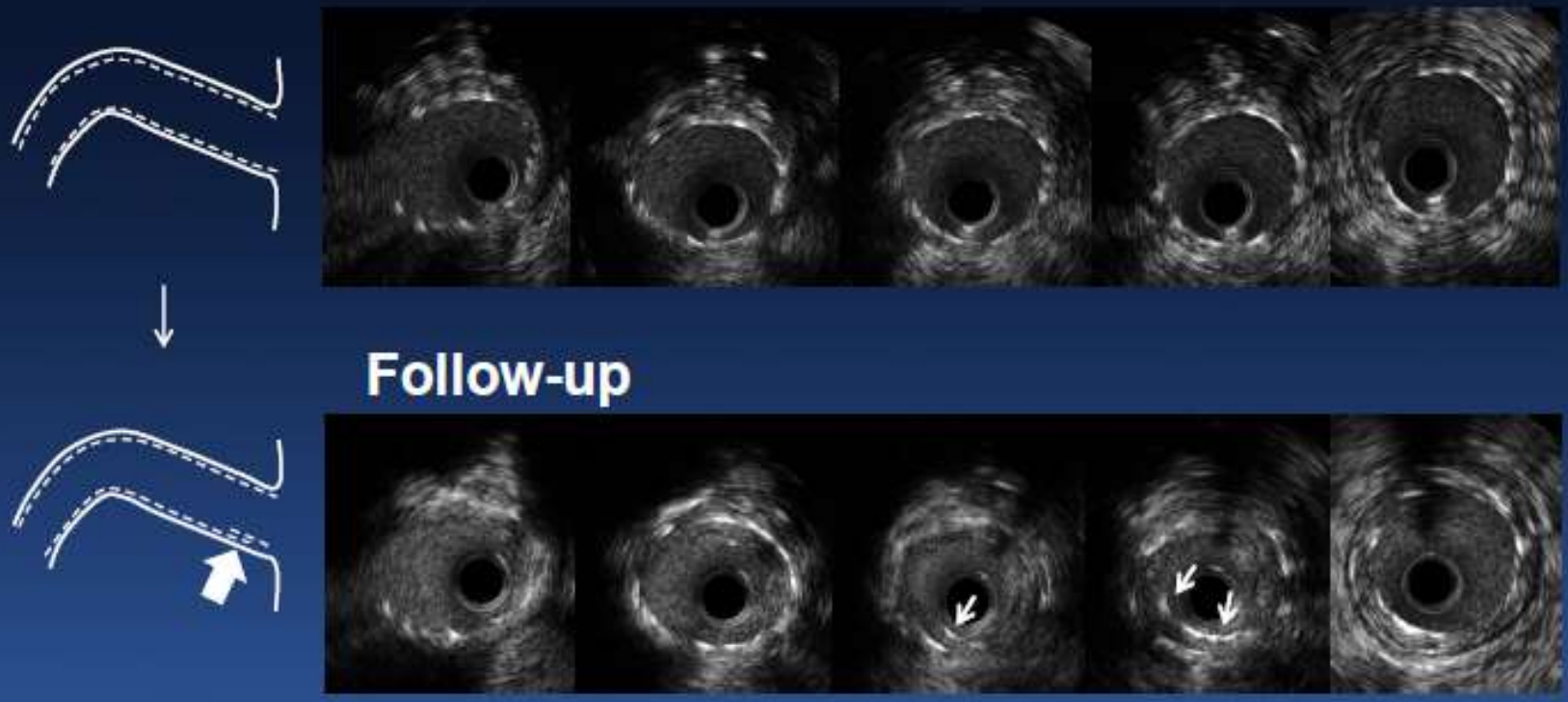




MLA 1.3mm^2

Stent 4.3mm^2

Fracture/Deformation of EES Relates to Restenosis



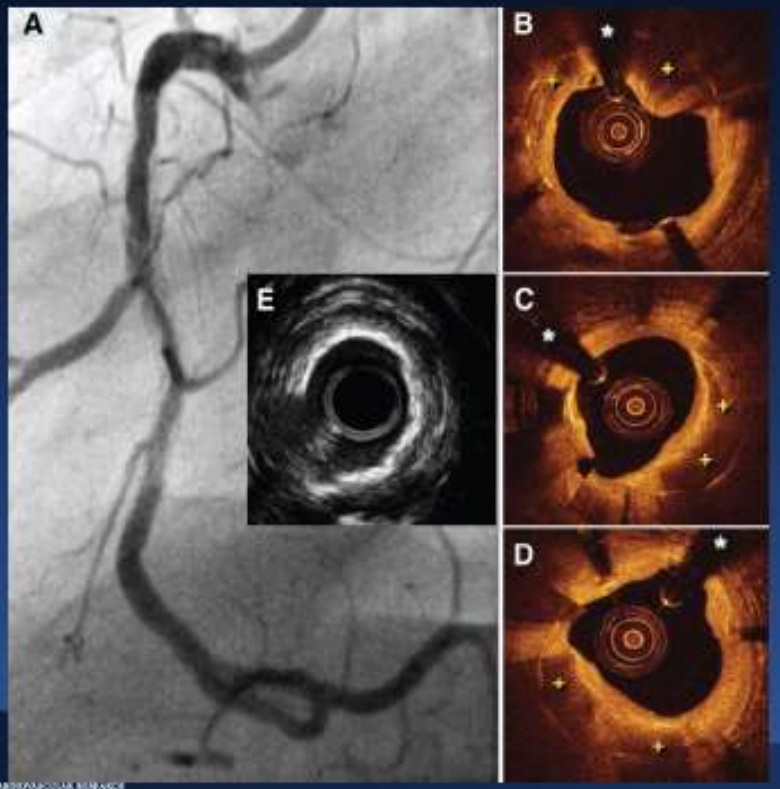
Inaba et al. Eurointervention, *In press*

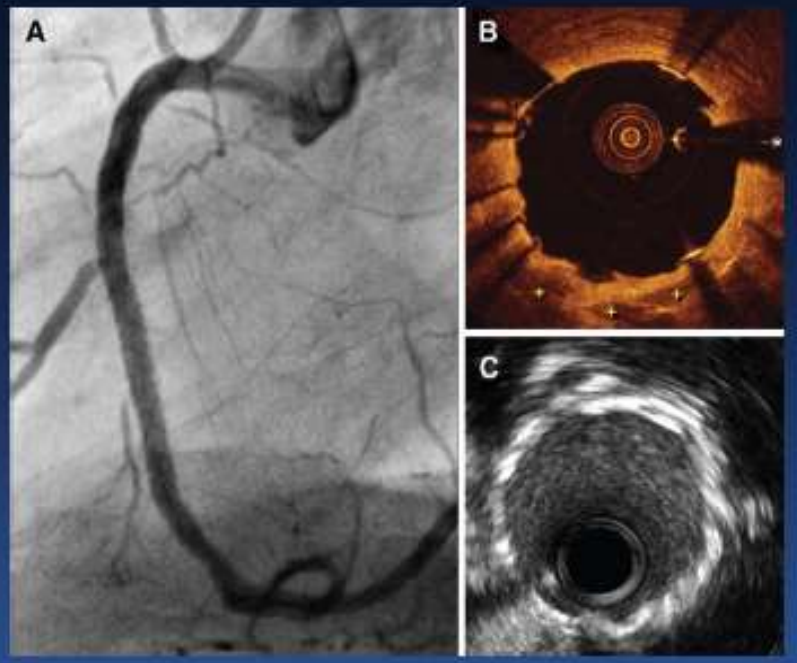
Images and Case Reports in Interventional Cardiology

Calcified In-Stent Restenosis

A Rare Cause of Dilation Failure Requiring Rotational Atherectomy

Fernando Alfonso, MD; Jorge Sandoval, MD; Christian Nolte, MD



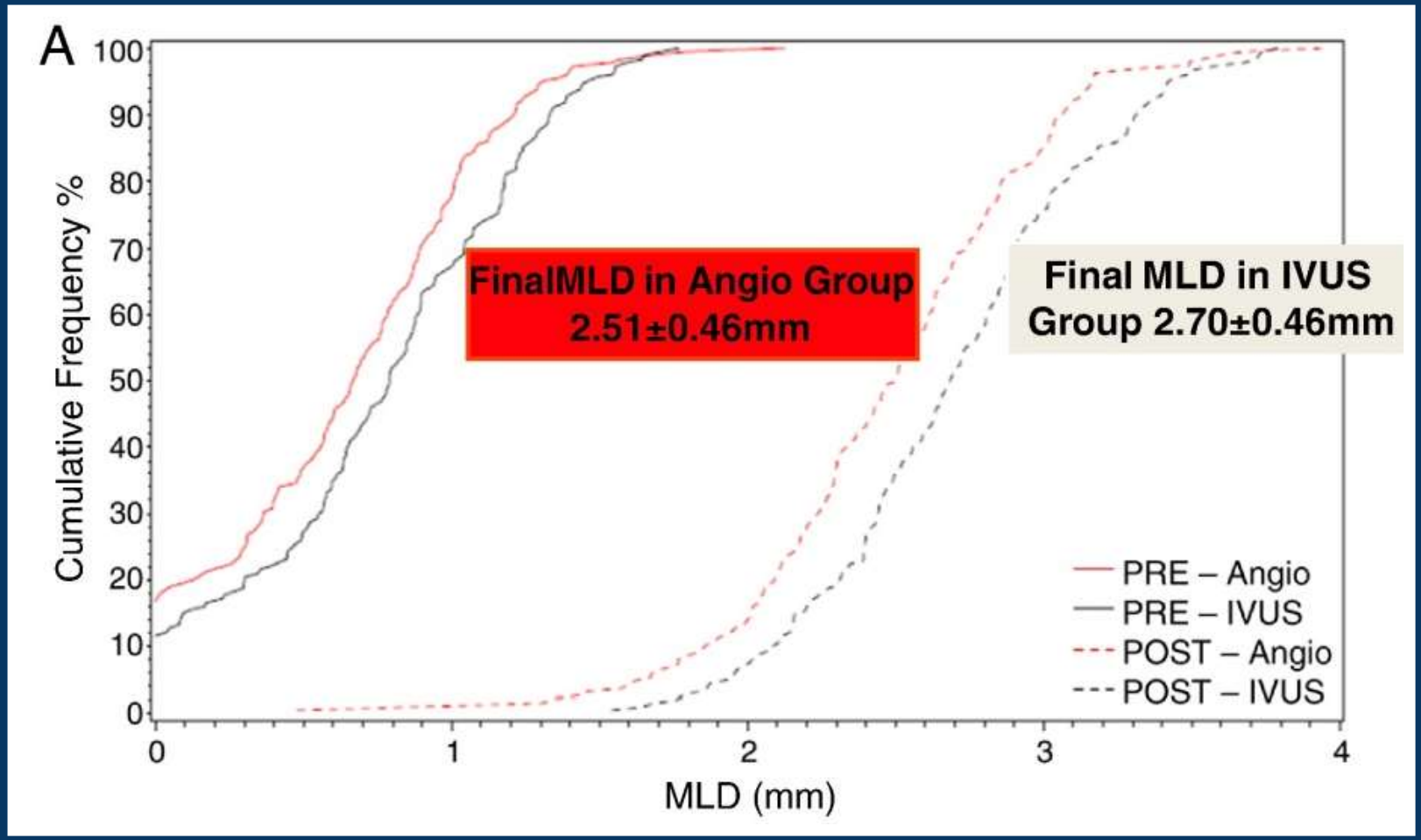


A prospective, randomized trial of intravascular-ultrasound guided compared to angiography guided stent implantation in complex coronary lesions: (The AVIO trial), 2013

- Randomized, multicentre, international, open label, investigator driven study, n=284 patients.
- Aim was to evaluate if IVUS optimized DES implantation was superior to angiographic guidance alone in complex lesions.
- ***Complex lesions were defined*** as one of the following:
  - Long lesions (>28 mm)
  - CTO: total occlusion of duration >3 mths
  - Lesions involving a bifurcation
  - Small vessels ≤2.5mm
  - Patients requiring 4 or more stents
- Primary study endpoint: post procedure in lesion minimal lumen diameter.
- All patients were pretreated with ticlopidine or clopidogrel plus Aspirin & loading dose of 300 mg of clopidogrel if required.
- The *Optimal balloon size* was determined by averaging the media to media diameters of distal and proximal stent segments as well as at the sites of maximal narrowing within the stent.

Alaide Chieffo et al. Am Heart J 2013;165:65-72

AVIO trial: Primary study end point. Baseline and final MLD in angiography as compared to IVUS guided



Alaide Chieffo et al. Am Heart J 2013;165:65-72

Impact of intravascular ultrasound-guided percutaneous coronary intervention on long-term clinical outcomes in a real world population, 2013

- To compare long term clinical outcomes between IVUS guided and angiography guided PCI in large **"real world" registry.**
- Between1998 -2006, 8371 pts who underwent IVUS (n = 4,627) or angiography (n = 3,744) guided PCI were enrolled with 3 yrs of follow up.
- Results: 3 year mortality rate was significantly lower in IVUS guided group than in angiography guided group (96.4% ± 0.3% vs. 93.6% ± 0.4%, $p < 0.001$)
- Similarly, in DES population, 3 year mortality was significantly lower in IVUS guided PCI (HR 0.46; 95% CI 0.33-0.66, $p < 0.001$) group.
- In contrast, IVUS guided PCI did not reduce the risk of mortality in the bare metal stent population (HR 0.82; 95% CI 0.60-1.10, $p = 0.185$).
- However, risks of MI(HR 0.95; 95% CI 0.63-1.44, $P = 0.810$), TVR (HR 1.00; 95% CI 0.86-1.15, $p = 0.944$), and stent thrombosis (HR 0.82; 95% CI 0.53-1.07, $p = 0.109$) were not associated with IVUS guidance.
- Conclusion: IVUS guided PCI may reduce long term mortality when compared with conventional angiography guided PCI. This may encourage the routine use of IVUS for PCI in patients undergoing DES implantation.

Hur SH et al Catheter Cardiovasc Interv,2013 Feb;81(3):407-16

IVUS guided PCI in SVG:

Outcome of undersized drug-eluting stents for percutaneous coronary intervention of saphenous vein graft lesions

- To determine outcome with undersized DES for PCI of SVG lesions.
- Using IVS, 209 SVG lesions were treated with DES(153 SES and 56 PES).
- Lesions were divided into 3 groups according to the ratio of stent diameter to average IVUS reference lumen diameter: group I <0.89; group II 0.9 to 1.0; and group III >1.0.

- Results: Incidence of CK-MB elevation >3 times normal was 6% in group I, 9% in group II and 19% in group III (p = 0.025).
- No significant differences were found in incidence of TLR (group I=13%; group II=9%; and group III=15%; p = 0.5) or target vessel revascularization (group I= 13%; group II=13%; and group III= 15%; p = 0.9) among the 3 groups.

- Conclusion: Use of undersized DES to treat SVG lesions is associated with a reduction in frequency of post PCI CK-MB elevation without an increase in 1 year events.

Yong YJ et al. Am J Cardiol. 2010 Jan 15;105(2):179-85

IVUS Predictors of DES Early Thrombosis & Restenosis

	Early Thrombosis	Restenosis
Small MSA or underexpansion in stable lesions **Small MLA in ACS/MI lesions**	•*Fujii et al. J Am Coll Cardiol 2005;45:995-8* •*Okabe et al. Am J Cardiol. 2007;100:615-20* •*Liu et al. JACC Cardiovasc Interv. 2009;2:428-34* •*Choi et al. Circ Cardiovasc Interv 2011;4:239-47*	•*Sonoda et al. J Am Coll Cardiol 2004;43:1959-63* •*Hong et al. Eur Heart J 2006;27:1305-10* •*Doi et al JACC Cardiovasc Interv. 2009;2:1269-75* •*Fujii et al. Circulation 2004;109:1085-1088* •*Kang et al. Circ Cardiovasc Interv 2011;4:9-14* •*Choi et al. Am J Cardiol 2012;109:455-60* •*Song et al. Catheter Cardiovasc Interv 2014;83:873-8*
Edge problems (geographic miss, secondary lesions, large plaque burden, dissections, etc)	•*Fujii et al. J Am Coll Cardiol 2005;45:995-8* •*Okabe et al., Am J Cardiol. 2007;100:615-20* •*Liu et al. JACC Cardiovasc Interv. 2009;2:428-34* •*Choi et al. Circ Cardiovasc Interv 2011;4:239-47*	•*Sakurai et al. Am J Cardiol 2005;96:1251-3* •*Liu et al. Am J Cardiol 2009;103:501-6* •*Costa et al, Am J Cardiol, 2008;101:1704-11* •*Kang et al. Am J Cardiol 2013;111:1408-14* •*Kobayashi et al. ACC2014*
Stent length (>40mm)		•*Hong et al. Eur Heart J 2006;27:1305-10*

Five meta-analyses assessing IVUS vs angiography-guided DES implantation

					HR (p-values)					
Reference	**Yr**	**RCT**	**Non-RCT**	**Pts**	**MACE**	**Death**	**MI**	**ST**	**TLR**	**TVR**
Zhang et al Eurointervention	2012	1	10	19,619	0.87 (p=0.008)	0.59 (p<0.001)	0.82 (p=0.13)	0.58 (p<0.001)	0.90 (p=0.3)	0.90 (p=0.2)
Propensity score matched sub-analysis				5,300	0.86 (p=0.06)	0.73 (p=0.04)	0.63 (p=0.01)	0.57 (p=0.004)	0.85 (p=0.3)	0.94 (p=0.6)
Klersy et al Int J Cardiol	2013	3	9	18,707	0.80 (p<0.001)	0.60 (p<0.001)	0.59 (p=0.001)	0.58 (p=0.007)	0.95 (p=0.8)	
Jang et al. JACC Cardiovasc Interv	2014	3	12	24,869	0.79 (p=0.001)	0.64 (p<0.001)	0.57 (p<0.001)	0.59 (p=0.002)	0.76 (p=0.01)	0.81 (p=0.01)
Propensity score matched sub-analysis				13,545	0.79 (p=0.01)	0.58 (p=0.01)	0.56 (p=0.04)	0.52 (p=0.004)	0.85 (p=0.3)	0.93 (p=0.3)
Ahn et al. Am J Cardiol	2014	3	14	26,503	0.74 (p<0.001)	0.61 (p<0.001)	0.57 (p<0.001)	0.59 (p<0.001)	0.81 (p=0.046)	0.82 (p=0.022)
Zhang et al. BMC Cardiovaasc Disorders	2015	3	17	29,068	0.77 (p<0.001)	0.62 (p<0.001)	0.64 (p<0.001)	0.59 (p<0.001)	0.81 P=0.005)	0.86 (p=0.012)
Propensity score matched sub-analysis				8,331	0.79 (p<0.001)	0.64 (p<0.001)	0.69 (p<0.001)	0.55 (p<0.001)	0.92 (p=0.34)	0.82 (p=0.028)
Complex lesions or ACS				6,393	0.69 (p<0.001)	0.52 (p<0.001)		0.64 (p<0.001)		

Meta-analysis of 8 Randomized Trials of IVUS vs Angio-Guided DES Implantation

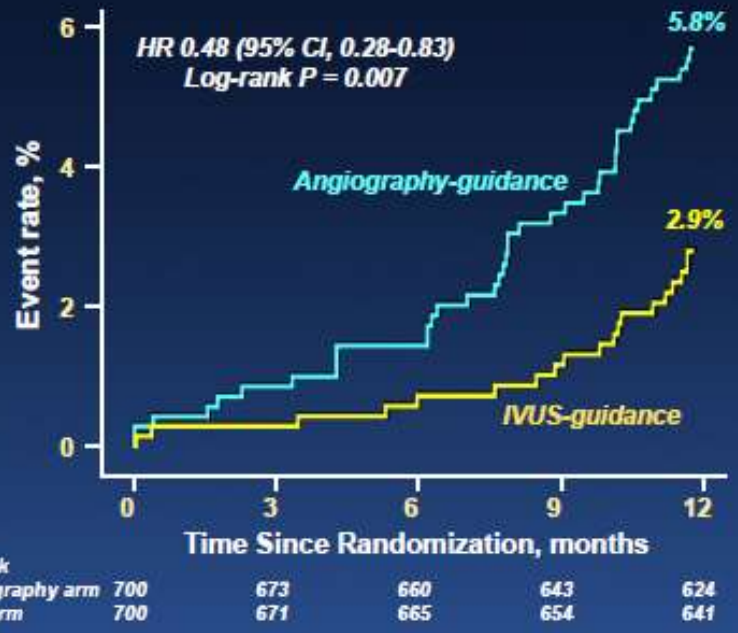
Study	Year	#		OR	IVUS MACE	Angio MACE
IVUS-XLP	2015	1400		0.49	19/700	39/700
CTO-IVUS	2015	402		0.37	5/201	14/201
AIR-CTO	2015	230		0.82	25/115	29/115
Tan-LM	2015	123		0.42	8/61	17/62
MOZART	2014	83		0.41	2/41	5/42
RESET	2013	543		0.60	12/269	20/274
AVIO	2013	284		0.67	24/142	33/142
Home-DES	2010	210		0.91	11/105	12/105
OVERALL		3275		0.59	106/1634	169/1641
			IVUS better / Angio better		6.5%	10.3%

Event	IVUS events	Angio events	OR	95% CI	P-value
MACE	6.5%	10.3%	0.59	0.46-0.76	<0.0001
CV mortality	0.5%	1.2%	0.46	0.21-1.00	0.05
MI	0.9%	1.6%	0.58	0.30-1.11	0.10
TLR	4.1%	6.6%	0.60	0.43-0.84	0.003
TVR	5.5%	8.7%	0.61	0.41-0.91	0.02
ST	0.6%	1.3%	0.49	0.24-0.99	0.04

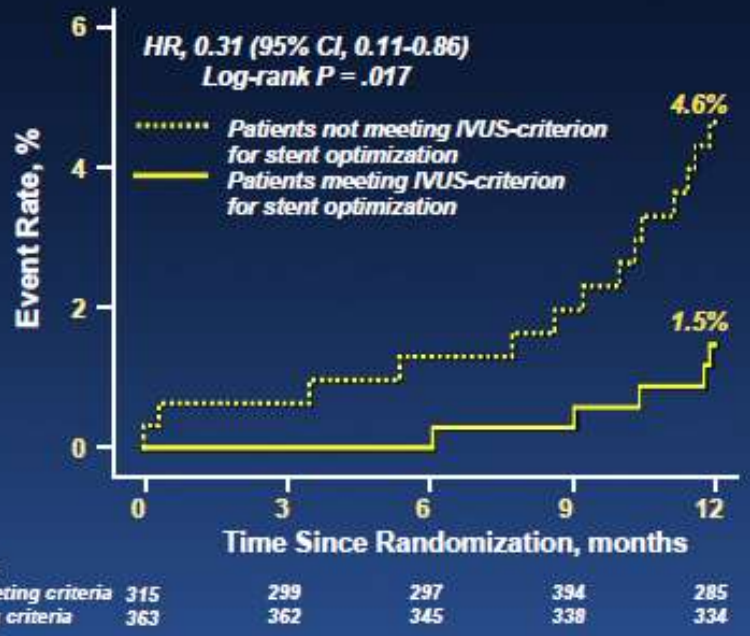
Elgendy et al. Circ Cardiovasc Interv 2016,

Effect of IVUS-Guided vs. Angiography-Guided Everolimus-Eluting Stent Implantation: The 1400 patient IVUS-XPL Randomized Clinical Trial

Primary End Point – Intention-to-Treat Analysis



IVUS-Guided Acute Optimization



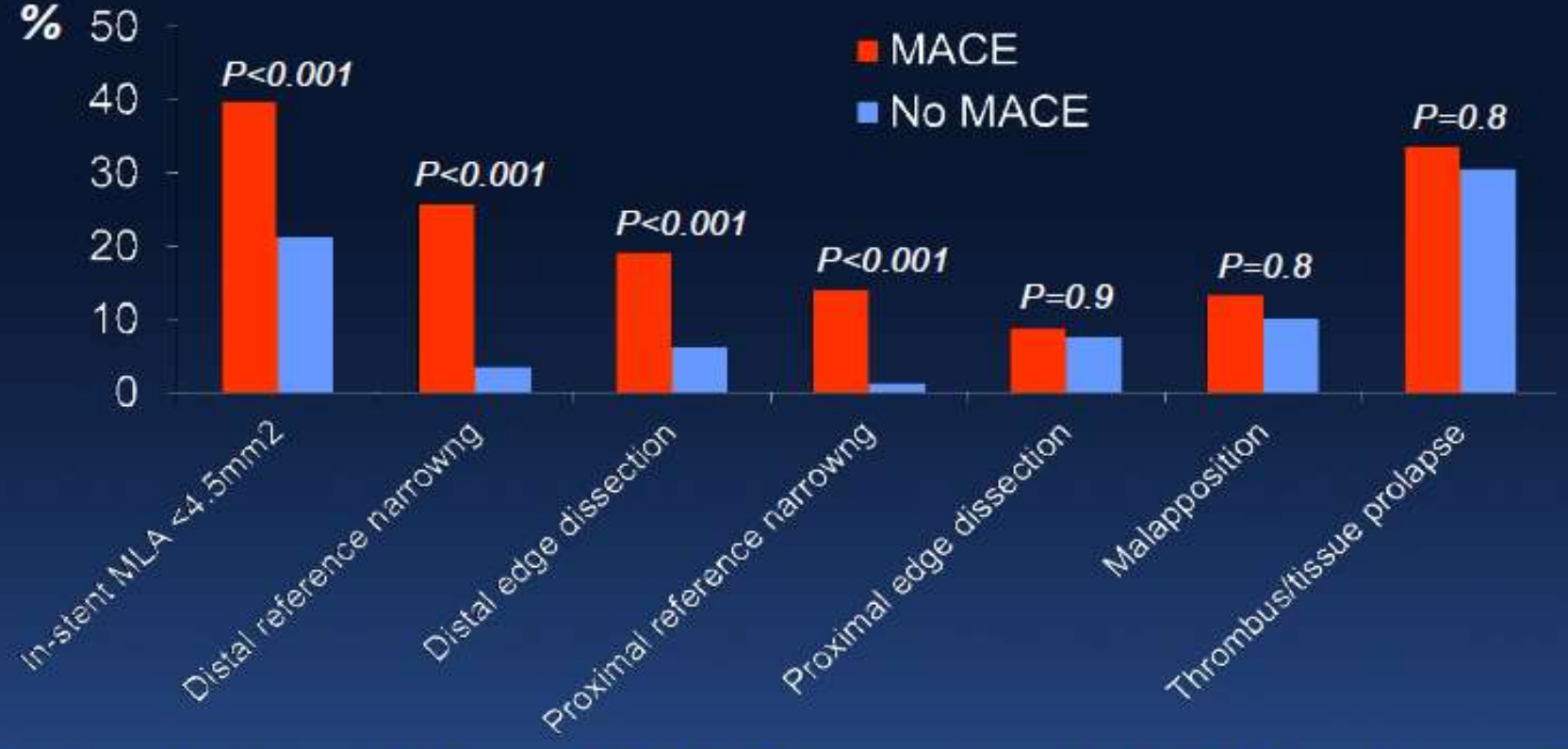
Hong et al. JAMA 2015;314:2155-63

MACE in 7 Studies of IVUS vs Angio-guided DES for LMCA Disease

Study	# Pts	Follow-up	Angio-guided	IVUS-guided	HR	95%CI	P-value
Agostoni et al. Am J Cardiol 2005;95:644-7	58	1.5 years	20%	8%			0.18
Park et al. Circ Cardiovasc Interv 2009;2:167-77	682	3 years			0.31	0.19-0.51	
Propensity score matched	290				0.64	0.39-1.04	0.074
de la Torre Hernandez et al. JACC Cardiovasc Interv 2014;7:244-54*	1010	3 years	11.7%	16.0%			0.006
Gao et al. Patient Pref Adherence 2014;8:1-11	1016	1 year	14.8%	27.7%			<0.001
Propensity score matched	582		16.2%	24.4%			0.014
Tan et al. Saudi Med J 2015;36:549-53**	123	2 years	13.1%	29.3%			0.031
XuBo. TCT2015	1899	3 years	11.1%	13.2%	0.83	0.69-1.00	0.06
ADAPT-DES	317	2 years	10.2%	5.6%	0.54	0.23-1.26	0.15

**propensity-score matched*
***randomized*

929 pts (989 lesions) in CLI-OPI II registry
MACE (death, MI, ST, or TLR in 12.2%) @ 1 yr



Indepdent predictors of MACE were in-stent MLA <4.5mm^2, proximal or distal reference narrowing, or distal edge dissection

Prati et al. JACC Cardiovasc Imaging 2015;8:1297-305

OPINION

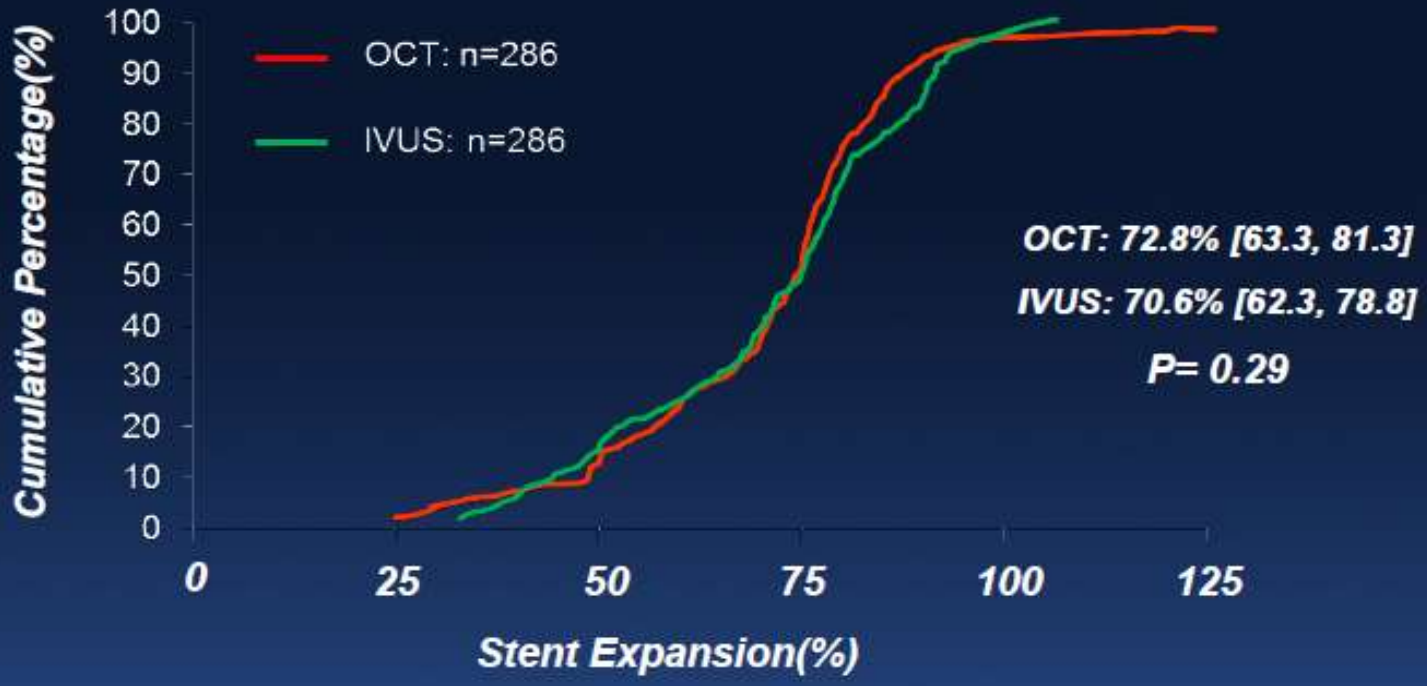
Randomized comparison of OCT vs IVUS

	OCT	IVUS	P value
#	400	400	
Heavy calcification	8%	13%	0.011
Total contrast, ml	164±66	138±56	<0.001
Stent diameter. mm	2.93±0.39	2.99±0.40	0.032
Maximum balloon, mm	3.15±0.79	3.28±1.20	0.072
In-stent			
MLD, mm	2.56±0.44	2.63±0.46	0.058
DS	12±6	11±5	0.021
Acute gain, mm	1.63±0.49	1.75±050	0.003
In-segment			
MLD, mm	2.25±0.52	2.28±0.52	0.5
DS	21±9	21±9	0.9
Acute gain, mm	1.33±0.54	1.40±0.53	0.11

Akasaka, EurpPCR 2015

ILUMIEN II

(OCT-guided stenting pts in ILUMIEN I matched to IVUS-guided stenting pts in ADAPT-DES)



Matched for 4 potential confounders: the presence of moderate or severe angiographic calcification; angiographic lesion length and reference vessel diameter; and whether proximal and/or distal) were available for calculation of stent expansion (an OCT lesion with both references was matched with a corresponding IVUS lesion with both references, and an OCT lesion with only a proximal or distal reference was matched with a corresponding IVUS lesion with only a proximal or distal reference)

Maehara et al. JACC Cardiovasc Interv .2015;8:1704

Frequency of acute stent malapposition

	Study	#	IVUS	OCT
Steinberg et al. JACC Cardiovasc Interv 2010;3:486-94	Combined TAXUS	1200	8%	
Guo et a. Circulation 2010;122:10-77-84	HORIZONS-AMI	263	36%	
Van der Hoven JACC Cardiovasc Interv 2008;1:192-201	MISSION-AMI	184	35%	
Sousa et al. ACC 2014	ADAPT-DES	1982	11%	
Bezerra et al. JACC Cardiovasc Interv 2013;6:228-36		26	42%	96%
Kubo et al. JACC Cardiovasc Imaging 2013;6:1095-1104	OPUS-CLASS	100	14%	39%
Im et al. Circ Cardiovasc Interv 2014;7:88-96		356		62%
Kawamori et al. EHJ Cardiovasc Imaging 2013;14:865-75		40		65%
Shimamura et al. EHJ Cardiovasc Imaging 2015;16:23-8		77		100%
Soeda et al. Circulation 2015;132:1020-9		1001		39%
Prati et al. JACC Cardiovasc Imaging, in press	CLI-OPCI-II	1002		49%
Prati et al. unpublished	CLI-OPCI ACS	588		48%
Overall			13%	49%

Resolution of acute stent malapposition

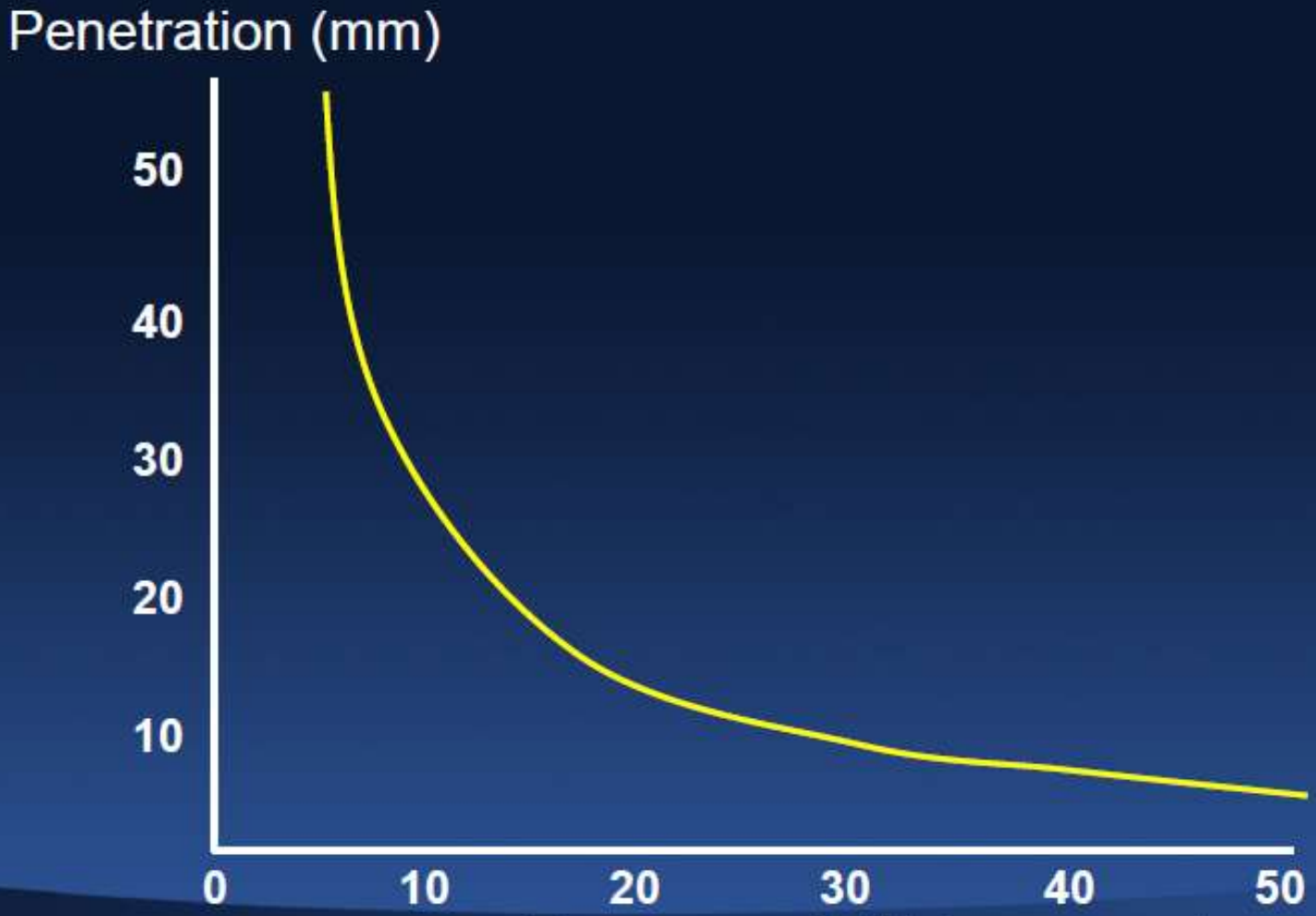
	Study	IVUS		OCT	
		ASM	% resolution	ASM	% resolution
Steinberg et al. JACC Cardiovasc Interv 2010;3:486-94	Combined TAXUS	96	55%		
Guo et a. Circulation 2010;122:10-77-84	HORIZONS-AMI	94	39%		
Van der Hoven JACC Cardiovasc Interv 2008;1:192-201	MISSION-AMI	67	58%		
Im et al. Circ Cardiovasc Interv 2014;7:88-96				221	69%
Kawamori et al. EHJ Cardiovasc Imaging 2013;14:865-75				26	77%
Shimamura et al. EHJ Cardiovasc Imaging, In Press				77	68%
		257	**50%**	**324**	**69%**

Technologic improvements since 1991

- Higher frequency transducers (40 vs 20 MHz)
- Smaller catheters (<3F vs 4.5F)
- Integrated motorized pullback
- Improved handling
- New hardware systems
- Built-in systems

There had been no major new developments in the last 15 years.

Frequency and Penetration



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Columbia University Medical Center
NewYork-Presbyterian

ACIST: HD-IVUS

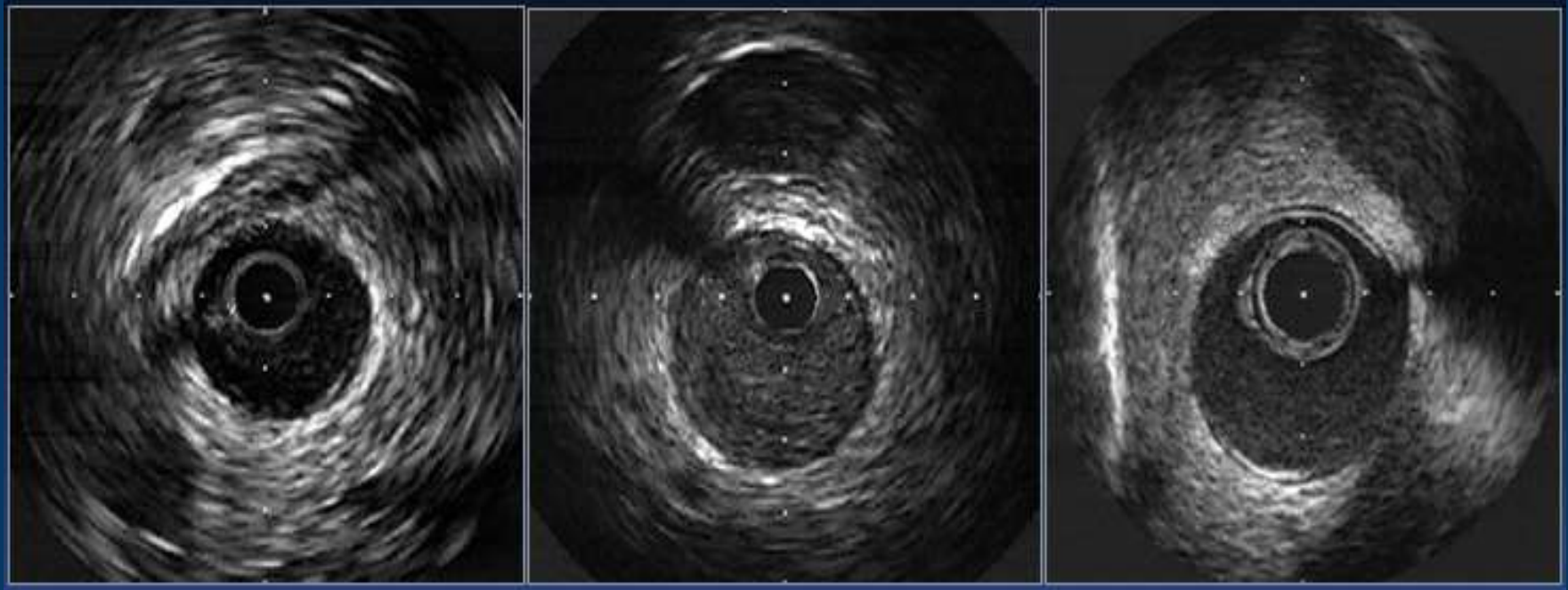
Duration of a 7-cm pullback

Up to 20x faster pullback

- **Reduces procedure time from minutes to seconds**
- **Minimizes motion artifacts and ischemic risk**

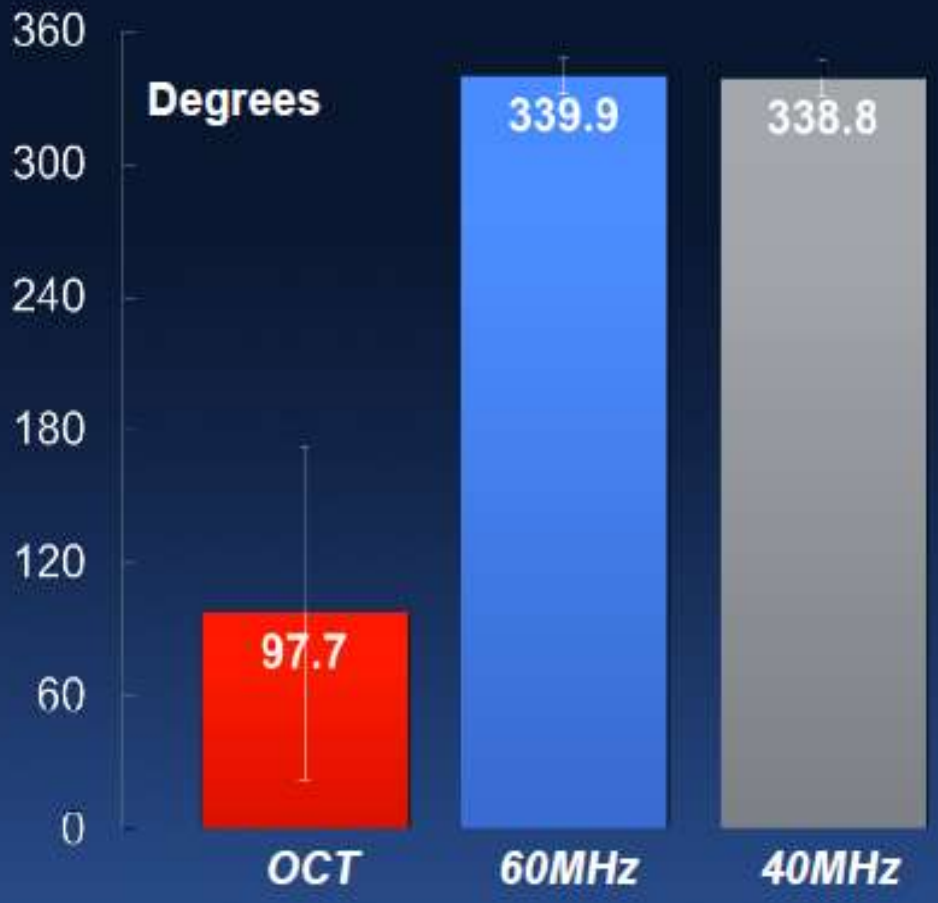
Center Frequency and Image Resolution

Early Experiment at Stanford



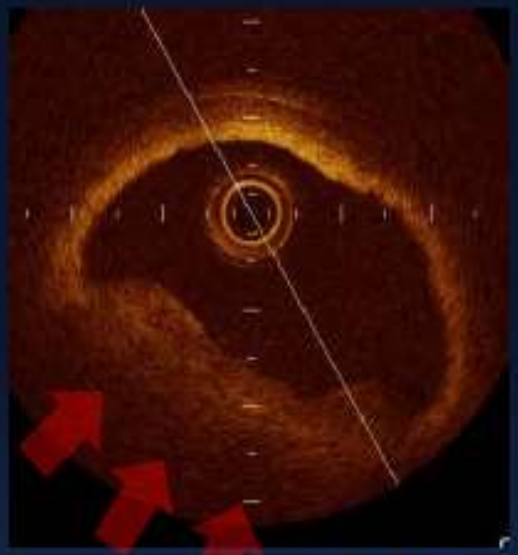
30 MHz 40 MHz 50 MHz

Visibility of EEM

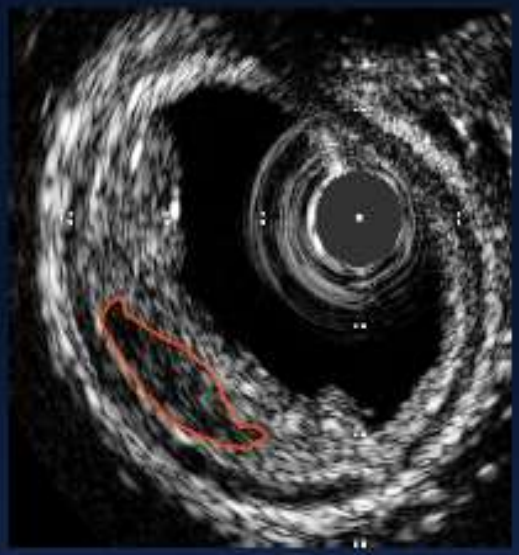


p<0.0001

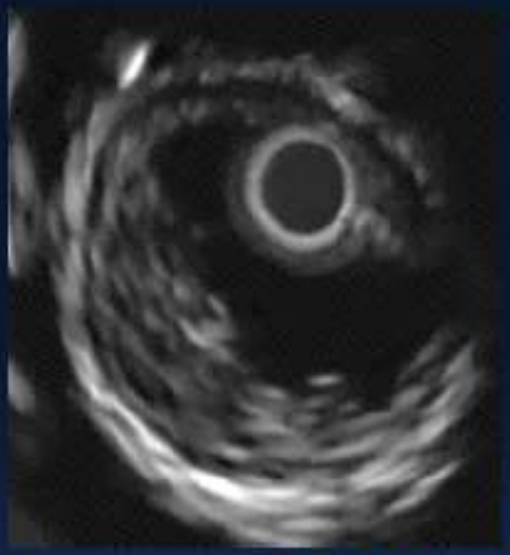
Lipid Cores



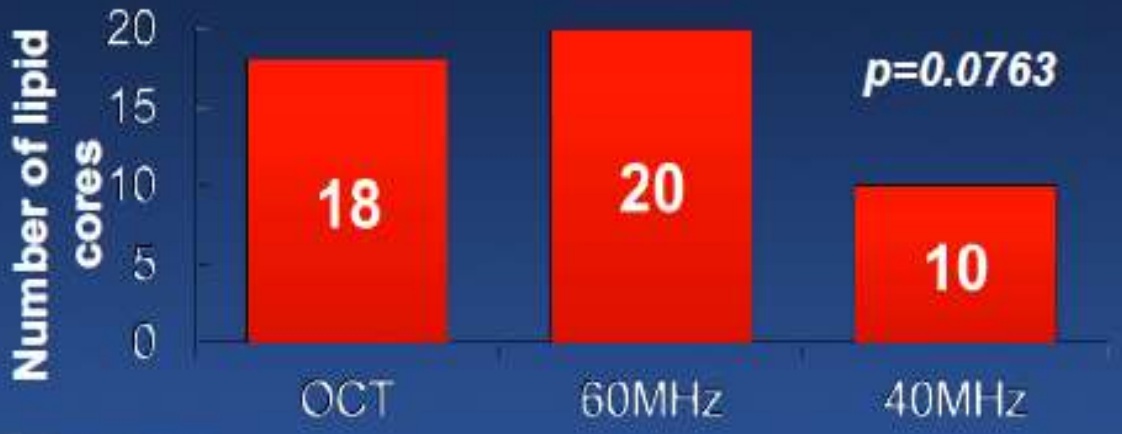
OCT



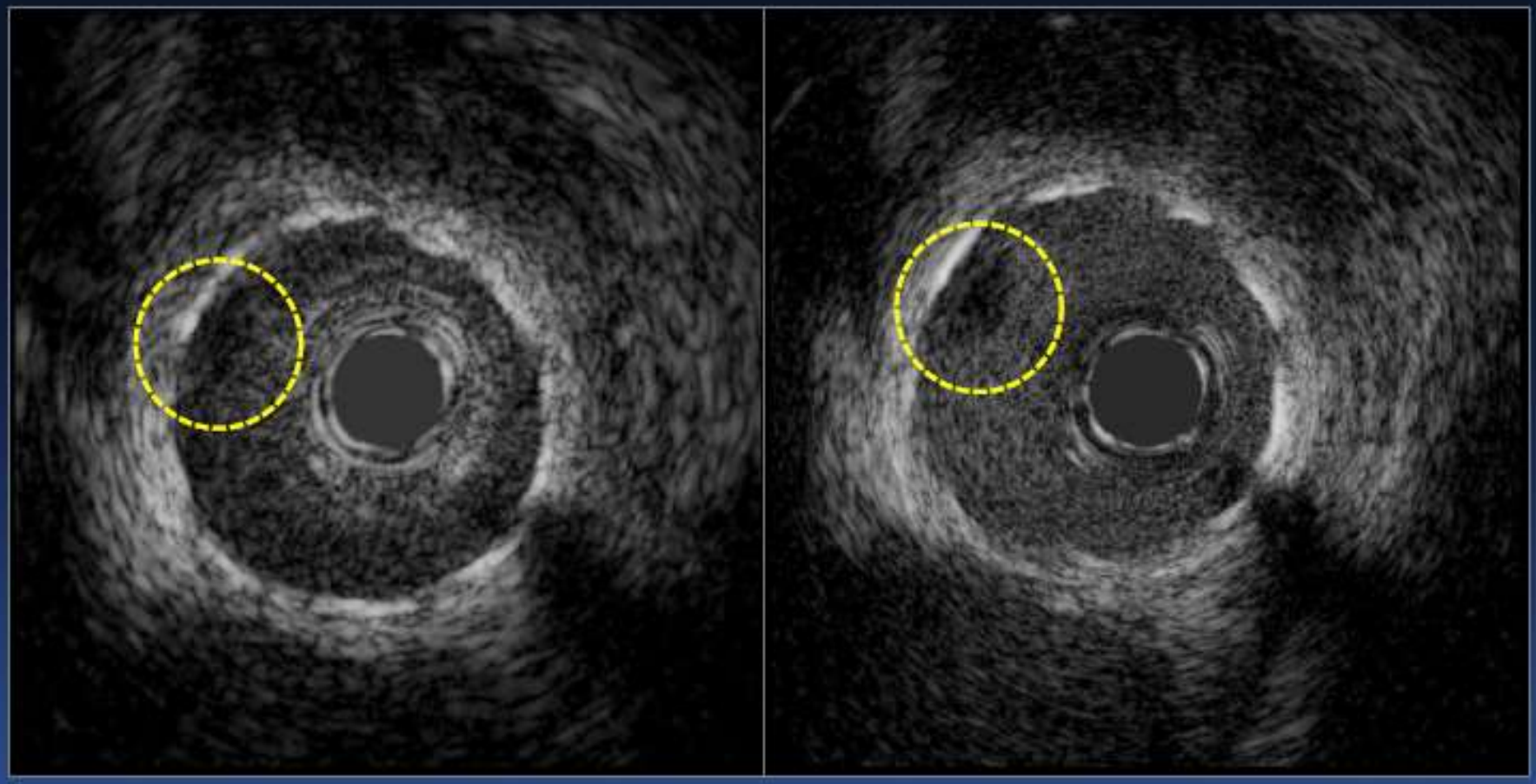
60MHz



40MHz



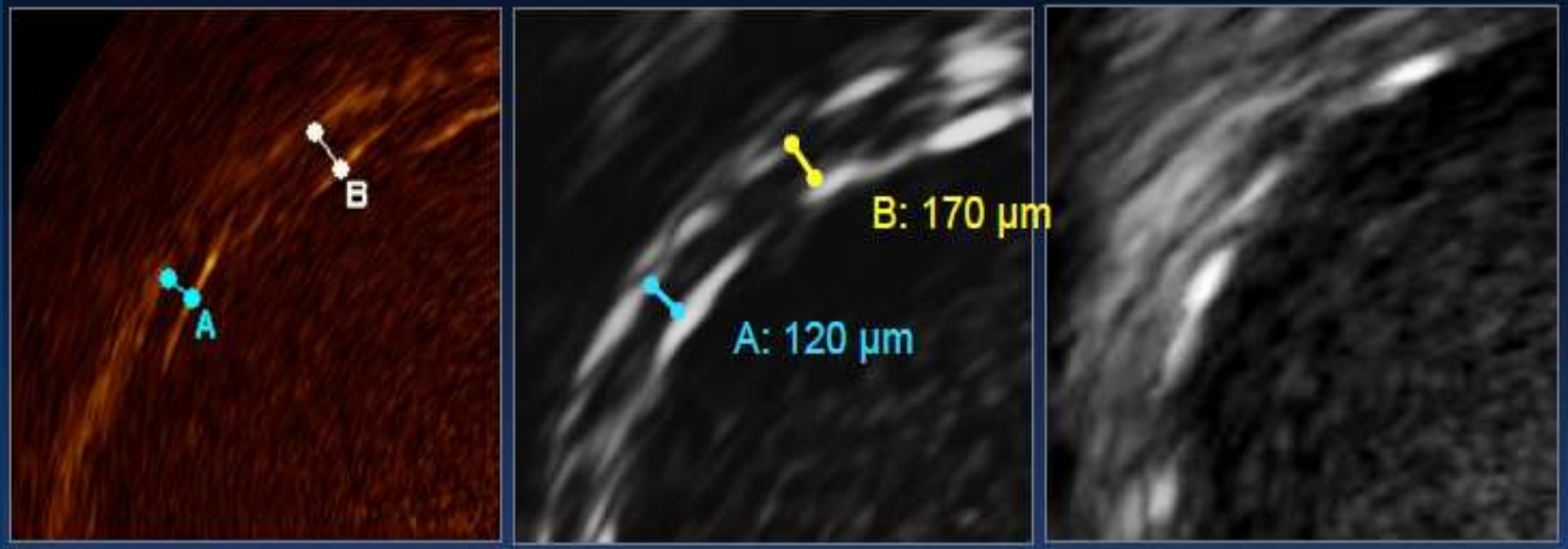
Fresh Thrombus Detected by HD-IVUS



40 MHz

60 MHz

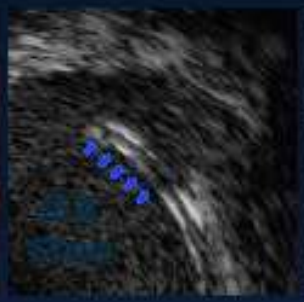
Stent Apposition: In Vivo Comparison

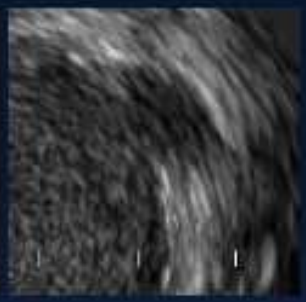


OCT
(with flush)

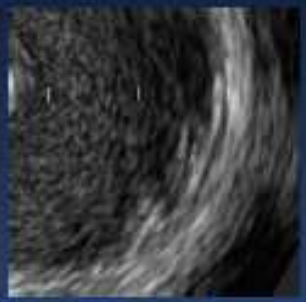
HD-IVUS 50 MHz
(in blood)

IVUS 40MHz
(in blood)

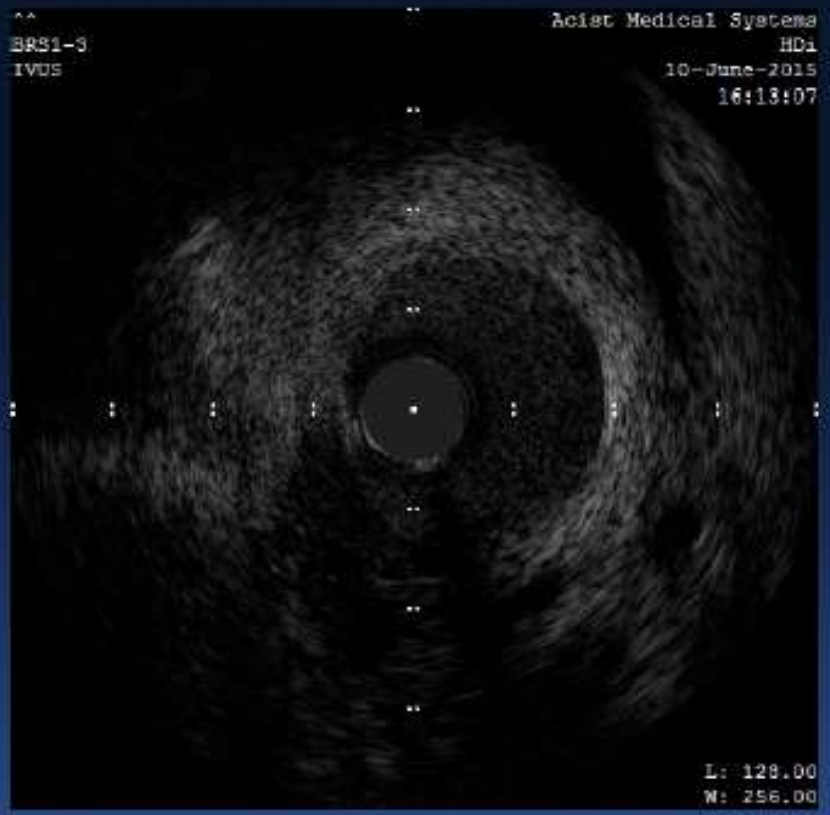




OCT 60MHz HD-IVUS 40MHz IVUS



OCT 60MHz HD-IVUS 40MHz IVUS



Courtesy of Yasu Honda

Okada et al. Assessment of Bioresorbable Scaffold With a Novel High-Definition 60MHz IVUS Imaging System: Comparison With Conventional 40MHz IVUS and Optical Coherence Tomography

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European Heart Journal (2014) **35**, 2541–2619
doi:10.1093/eurheartj/ehu278

ESC/EACTS GUIDELINES

2014 ESC/EACTS Guidelines on myocardial revascularization

Recommendations for the clinical value of intracoronary diagnostic techniques

Recommendations	Class[a]	Level[b]	Ref.[c]
FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	50,51,713
FFR-guided PCI in patients with multivessel disease.	IIa	B	54
IVUS in selected patients to optimize stent implantation.	IIa	B	702,703,706
IVUS to assess severity and optimize treatment of unprotected left main lesions.	IIa	B	705
IVUS or OCT to assess mechanisms of stent failure.	IIa	C	
OCT in selected patients to optimize stent implantation.	IIb	C	

Anatomical measurement can give many informations useful to take the right decision during PCI

Physiology assesement by FFR can predict ischemia

The combination can be the gold standard

Thank

you