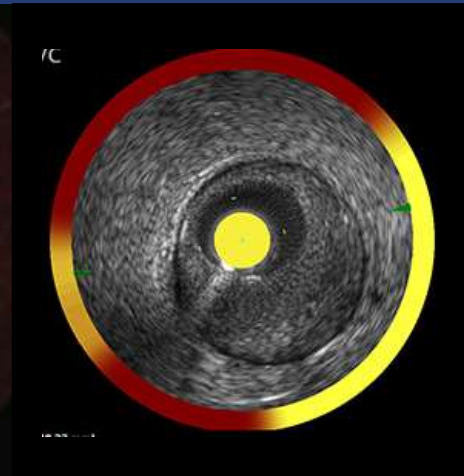
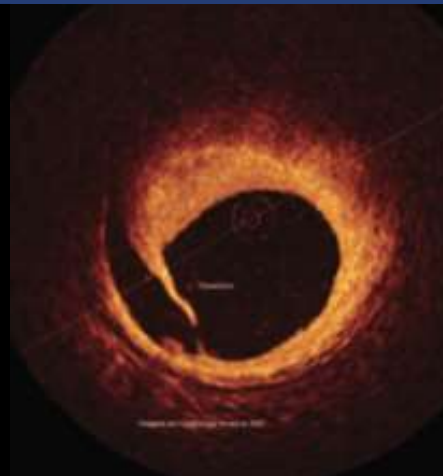
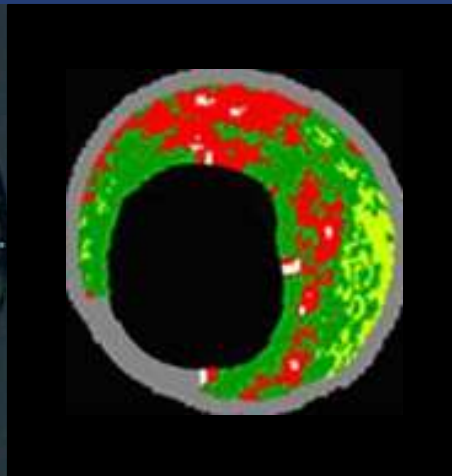
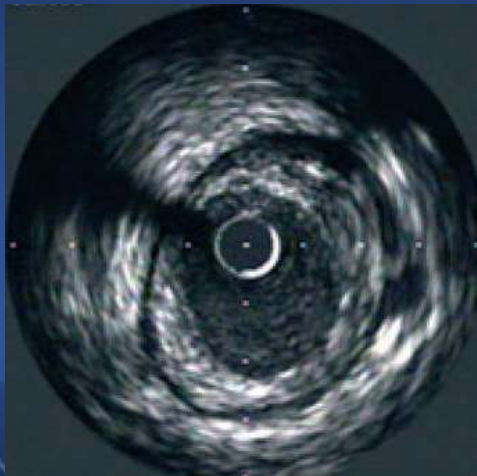


IVUS-guided PCI in DES era

Mineok Chang, MD.

University of Ulsan College of Medicine, Heart Institute
Asan Medical Center, Seoul, Korea

Why Still IVUS ?



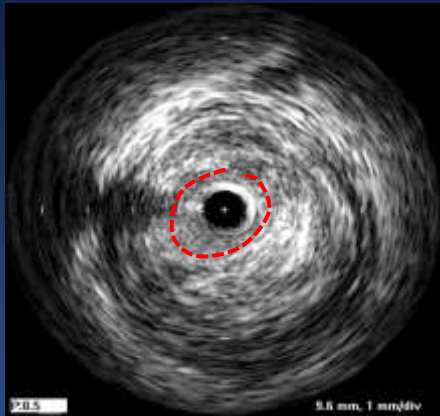
Impact of IVUS

Pre-Procedural lesion evaluation

- Anatomy (Reference Vessel Diameter, Negative Remodeling, Lesion length)
 - Plaque Characteristics
 - Mechanism of In-Stent Restenosis
- Treatment strategy
- Treat or Not
 - Device choice

Defining Reference Vessel Size, How Big ? How Severe ?

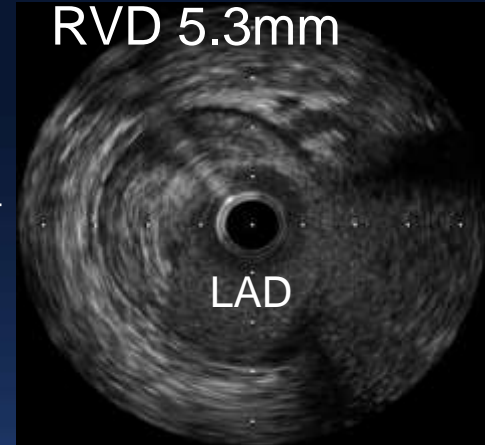
RVD 6.2mm



MLA 3.0mm²



RVD 5.3mm

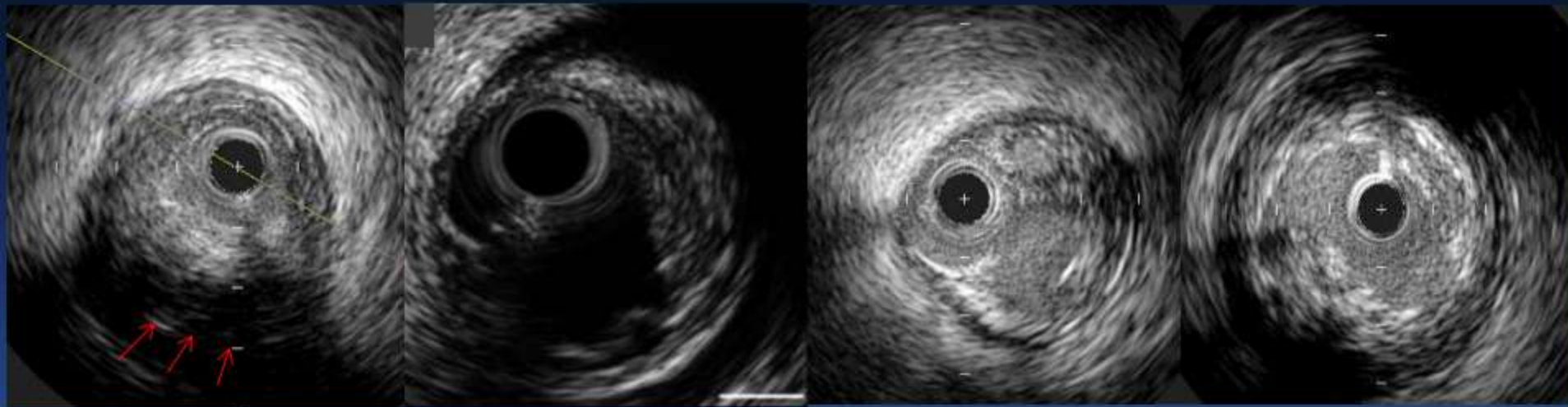


Defining *High Risk Plaque*,

Attenuated plaque

Plaque rupture

Thrombus



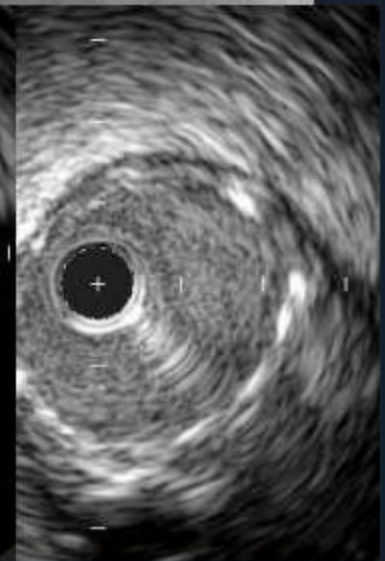
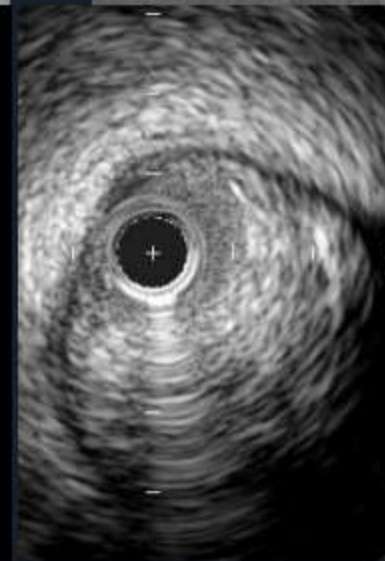
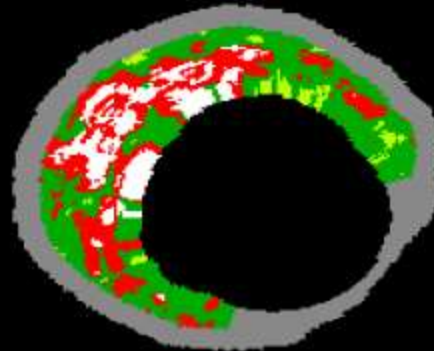
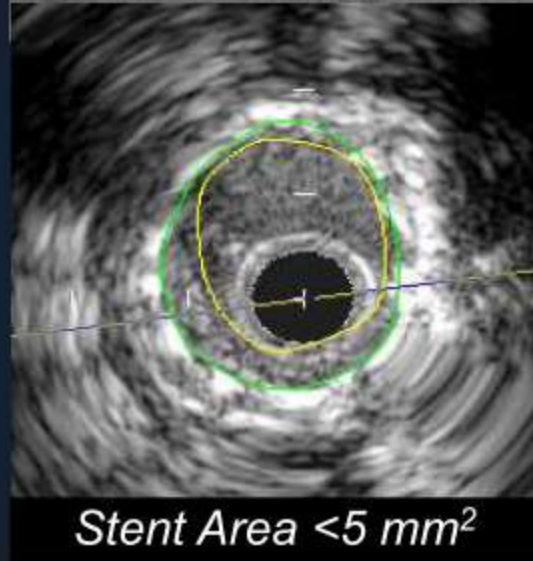
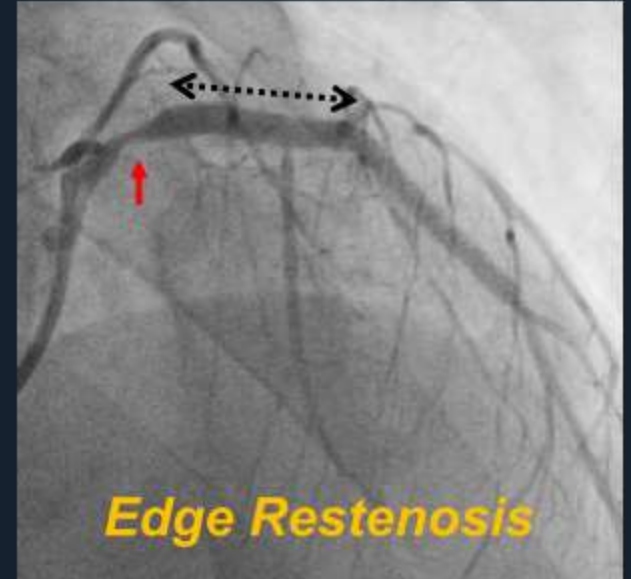
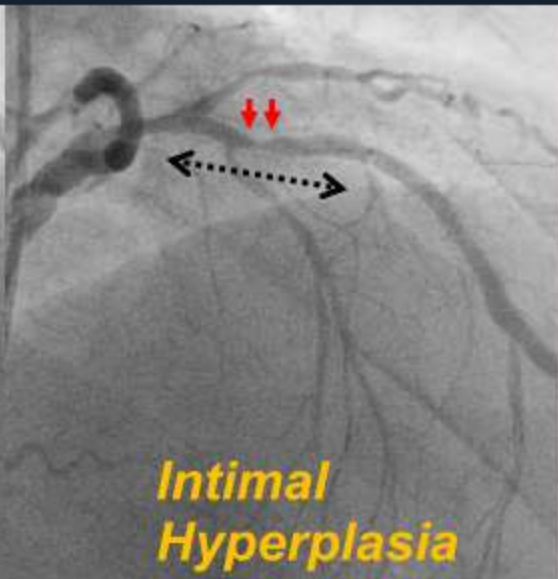
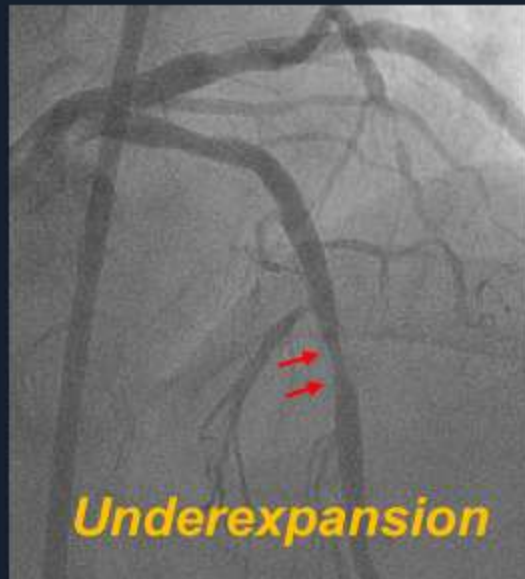
Higher rate of microvascular obstruction after PCI.

Defining *Vulnerable Plaque*,

<u>Variable</u>	<u>HR [95% CI]</u>	<u>P value</u>
$PB_{MLA} \geq 70\%$	5.03 [2.51, 10.11]	<0.0001
$MLA \leq 4.0 \text{ mm}^2$	3.21 [1.61, 6.42]	0.001
VH-TCFA	3.35 [1.77, 6.36]	0.0002

Independent Predictors of Non-Culprit Lesion Level Events
by Cox Proportional Hazards regression

Defining Mechanism of **ISR**,



Functional significance...?

Meta-analysis of 11 Clinical Trials

1759 pts with 1953 lesions

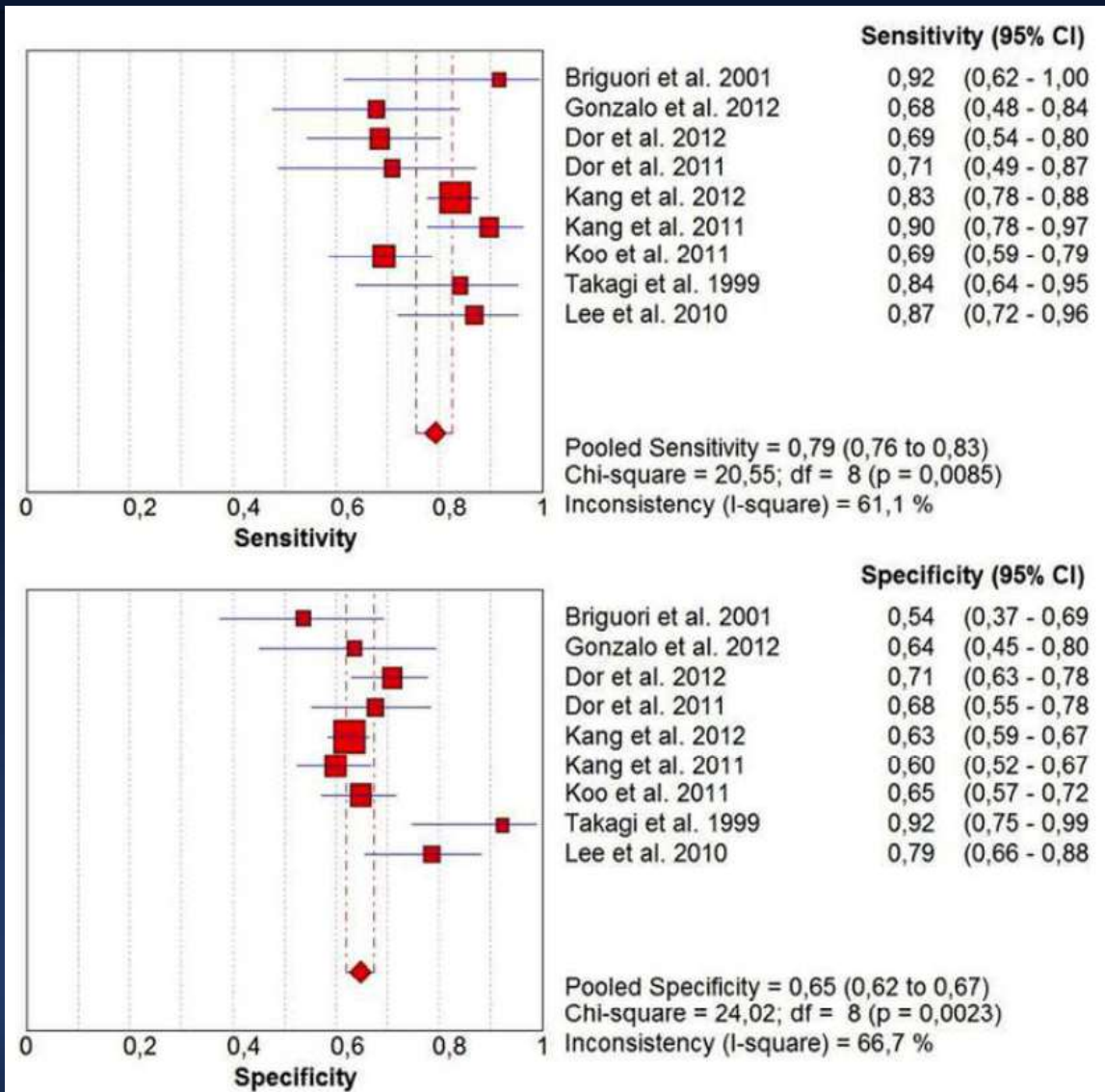
Predict **FFR < 0.80**

Weighted **MLA 2.61 mm²**

Pooled sensitivity **79%**

Pooled specificity **65%**

*Smaller Cut-Off
Poor Accuracy*

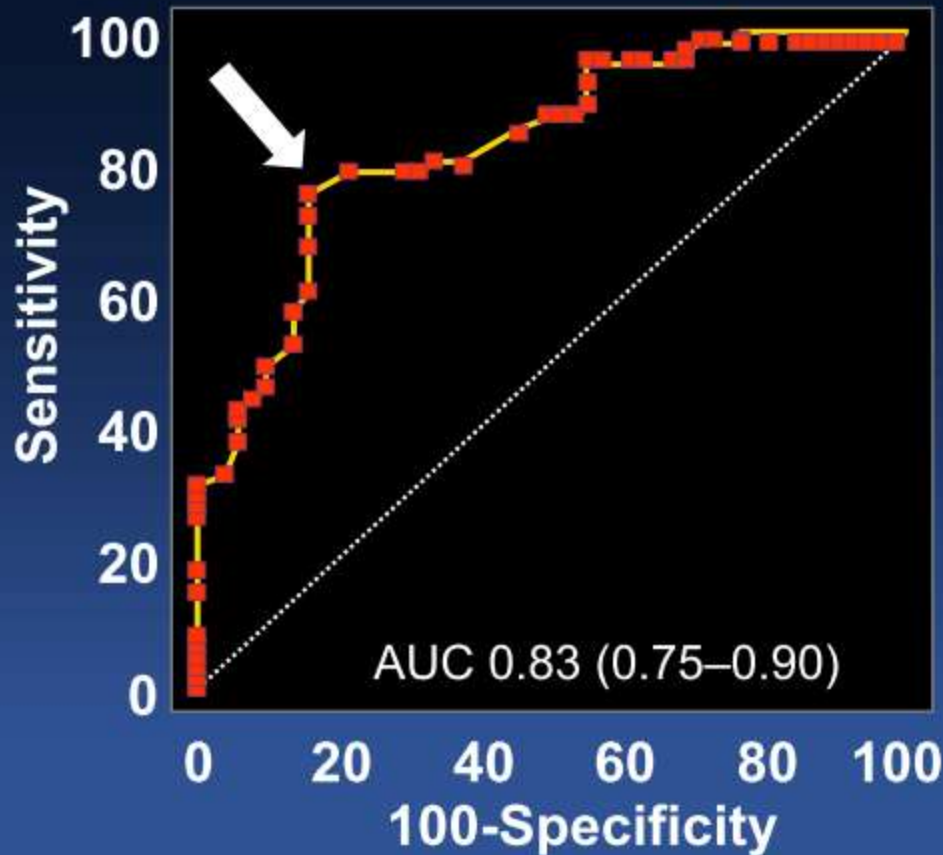


IVUS MLA for Functional Significance

	N	FFR	RLA	MLA	AUC	Sens	Spec	PPV	NPV	Accu
Takaki (1999 Circ)	51	0.75	9.3	3.0	–	83%	92%	–	–	–
Briguori (2001 AJC)	53	0.75	7.8	4.0	–	92%	56%	38%	96%	64%
Lee (2010 AJC)	94	0.75	5.9	2.0	0.80	82%	81%	–	–	81%
Kang (2011 Circ int)	236	0.80	7.6	2.4	0.80	90%	60%	37%	96%	68%
Ben-Dor (2012)	205	0.80	8.6	3.09	0.73	69%	72%	–	–	70%
Koo (2011 JACC int)	267	0.80	6.8	2.75	0.81	69%	65%	27%	81%	67%
Gonzalo (2012 JACC)	47	0.80	7.1	2.36	0.63	67%	65%	67%	65%	66%
Kang (2012 AJC)	784	0.80	8.2	2.4	0.77	84%	63%	48%	90%	69%
Waksman (2013 JACC)	367	0.80	–	3.07	0.65	64%	65%	40%	83%	–

IVUS MLA 4.5 mm^2 for LM Disease

Matched with $\text{FFR} < 0.80$



Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%
Accuracy	80%

*IVUS MLA $< 4.5 \text{ mm}^2$
Can Predict Functional
Significance of LM Stenosis.*

Impact of IVUS

Post PCI Optimization

- Stent underexpansion
- Stent thrombosis
- Edge dissections
- Incomplete stent apposition

→ Improves Clinical Outcomes

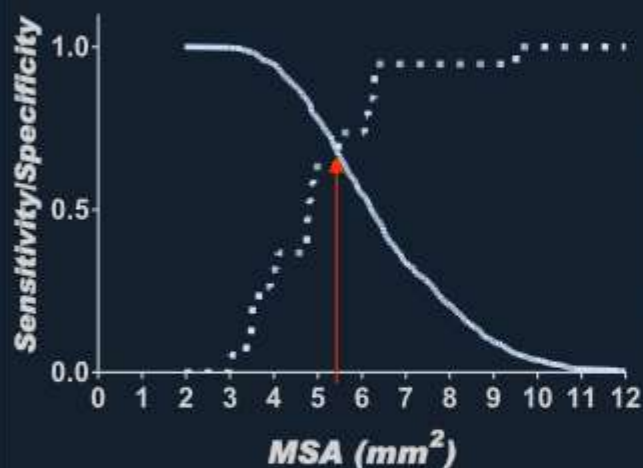
Under-Expansion Associated with **DES** Thrombosis

	Population	DES	Endpoint	Rate of Underexpansion
Fujii ¹	15 ST vs. 45 controls	SES	ST <1 month	<5.0mm ² in 80% vs. 29%
Okabe ²	13 ST vs. 27 controls	DES	ST <1 year	<5.0mm ² in 79% vs. 40%
Liu ³	20 ST vs. 50 controls	DES	ST <1 year	<5.0mm ² in 85% vs. 26%

¹ *J Am Coll Cardiol* 2005;45:995-8 ² *Am J Cardiol* 2007;100:615-20 ³ *JACC interv* 2009;2:428-34

Under-Expansion Associated with **DES Restenosis**

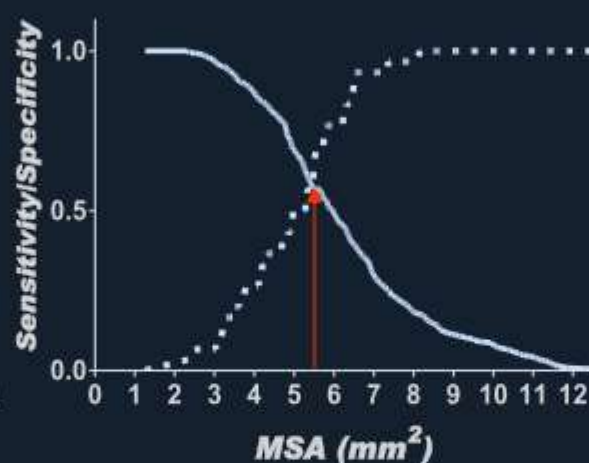
(SES, n=541)



5.5 mm²

Sensitivity 72.2%
Specificity 66.3%
(AUC 0.74)

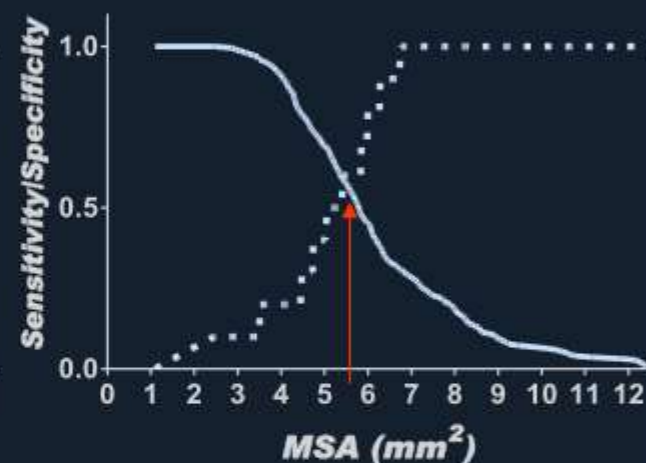
(ZES, n=220)



5.3 mm²

Sensitivity 56.7%
Specificity 61.8%
(AUC 0.67)

(EES, n=229)

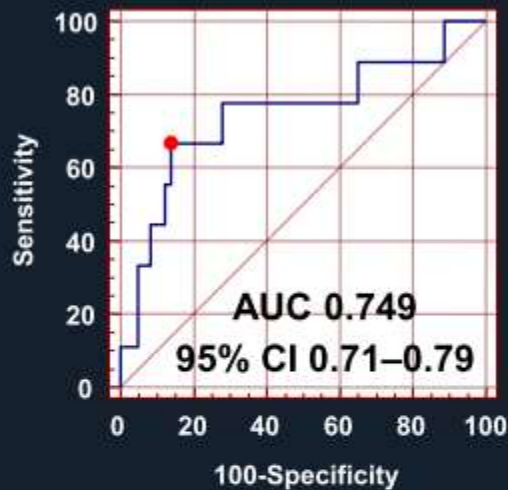


5.4 mm²

Sensitivity 60.0%
Specificity 59.9%
(AUC 0.64)

Plaque Burden <55% *Reduced edge restenosis*

433 E-ZES

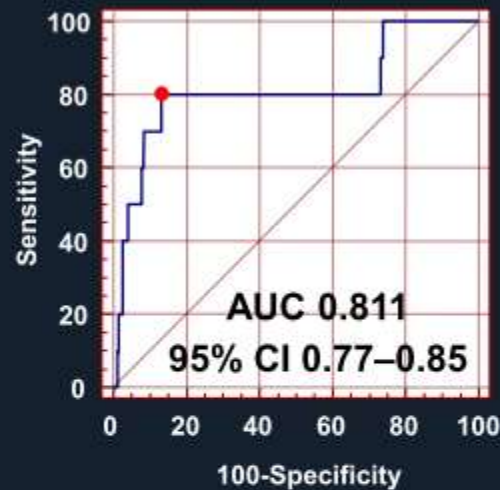


PB 56.3%

Sensitivity 67%

Specificity 86%

422 R-ZES

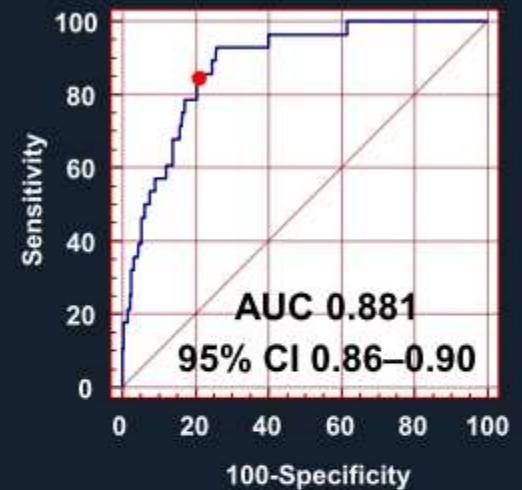


PB 57.3%

Sensitivity 80%

Specificity 87%

813 EES



PB 54.2%

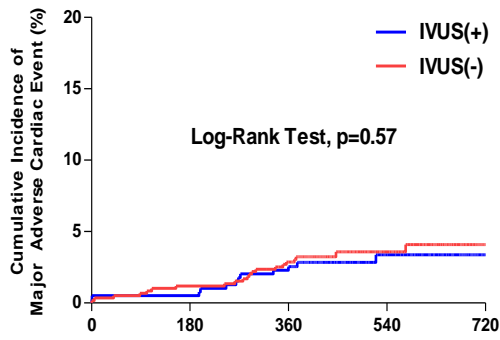
Sensitivity 86%

Specificity 80%

Stent Length >23 mm

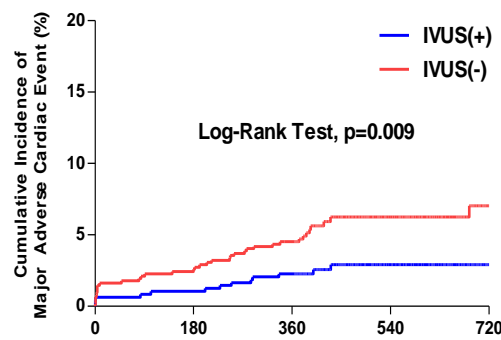
IVUS-Guided PCI IS Better

(A) Stent Length ≤ 22 mm



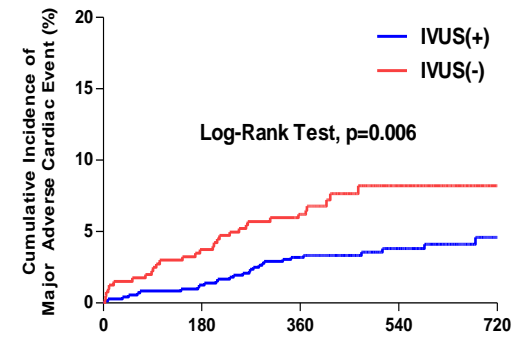
No. at risk	Days after Initial Procedure				
	0	180	360	540	720
IVUS(+)	395	393	386	169	55
IVUS(-)	603	595	582	214	100

(B) Stent Length 23-32mm



No. at risk	Days after Initial Procedure				
	0	180	360	540	720
IVUS(+)	487	482	476	221	72
IVUS(-)	622	607	592	219	81

(C) Stent Length ≥ 33 mm

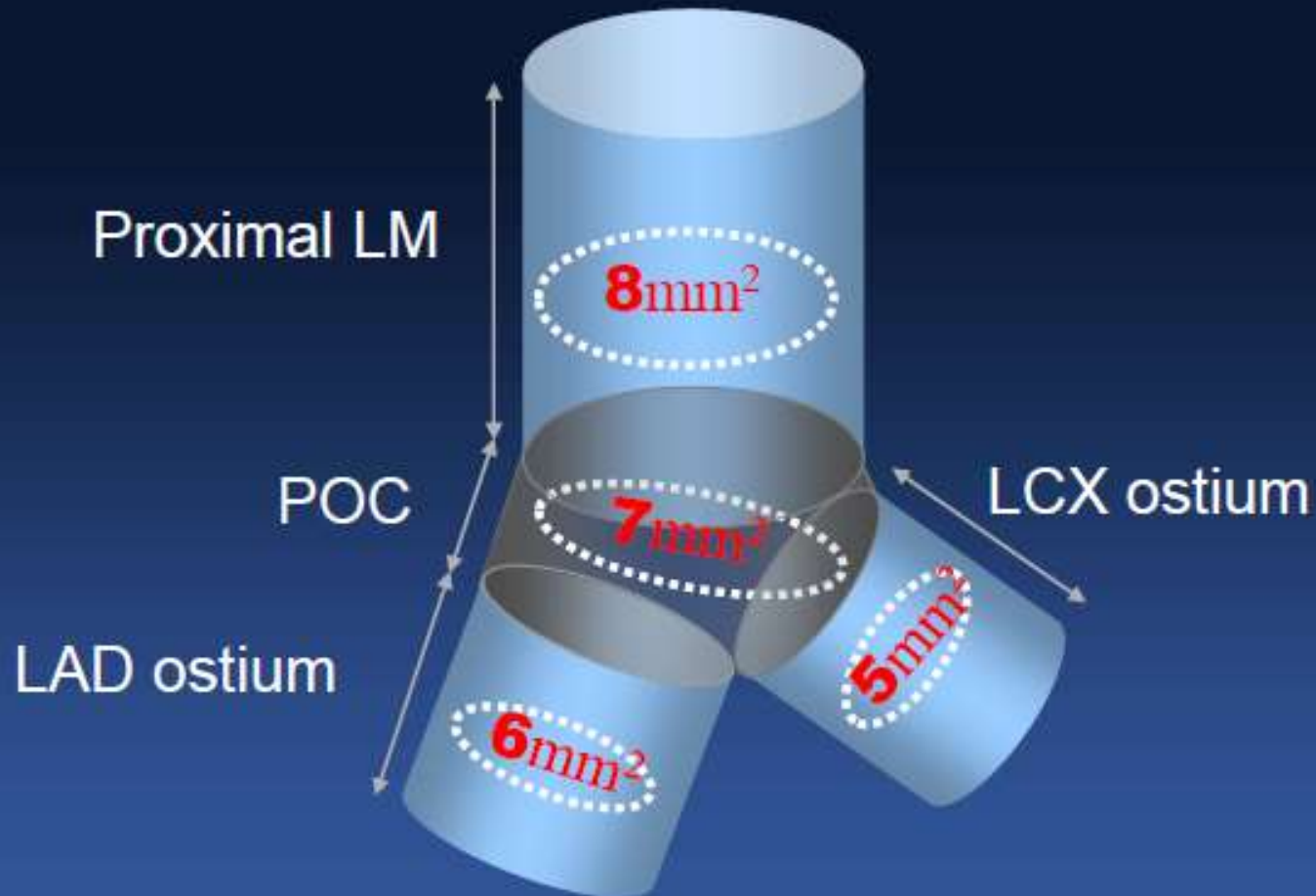


No. at risk	Days after Initial Procedure				
	0	180	360	540	720
IVUS(+)	734	724	709	355	116
IVUS(-)	403	388	376	125	38

IRIS-DES Registry Analysis, (n=3244 pts, IVUS 1616, No IVUS 1628)

LM Stent Optimization

Restenosis rate <5%, TLR<2%



Clinical Benefit ?

ADAPT-DES Registry (n=8,583)

24 month outcomes	IVUS (n=3,361)	Angiography (n=5,221)	P-value
MACE	4.9%	7.4%	<0.001
Cardiac death	1.7%	2.4%	0.03
MI	3.5%	5.6%	<0.001
TLR	4.8%	6.0%	0.02
TVR	8.3%	9.8%	0.02
Stent Thrombosis	0.7%	1.5%	0.002

Meta-analysis

	Year	RCT	Non - RCT	Pt. No.	HR (p-value)				
					MACE	Death	MI	TLR	ST
Zhang et al EuroInt	2012	1	10	19,619	0.87 (0.008)	0.59 (0.001)	0.82 (ns)	0.9 (ns)	0.58 (0.001)
Klersy et al Int J Cardiol	2013	3	9	18,707	0.80 (0.001)	0.60 (0.001)	0.59 (0.001)	0.95 (ns)	0.58 (0.007)
Jang et al JACC Interv	2104	3	12	24,869	0.79 (0.001)	0.64 (0.001)	0.57 (0.001)	0.76 (0.01)	0.59 (0.002)
Ahn et al Am J Cardiol	2014	3	14	26,503	0.74 (0.001)	0.61 (0.001)	0.57 (0.001)	0.81 (0.046)	0.59 (0.001)

HOME DES IVUS RCT (n=210), 1st DES

Post-PCI QCA	IVUS (n=105)	Angiography (n=105)	P-value
Stent length, mm	39.3±13.1	39.2±12.3	0.90
Post-dilatation, %	76%	57%	<0.001
Final balloon size, mm	3.14±0.43	3.04±0.42	<0.001
Final MLD, mm	2.64±0.42	2.56±0.39	<0.001
12 month outcomes	IVUS	Angiography	P-value
MACE	2.9%	5.8%	0.007
Cardiac death	0.4%	0.7%	0.48
Target lesion-MI	0.0%	0.1%	0.32
Ischemic-driven TLR	2.5%	5.0%	0.02
Stent Thrombosis	0.3%	0.3%	>0.99

RESET Long Lesions RCT (n=543), 2nd DES

Post-PCI QCA	IVUS (n=269)	Angiography (n=274)	P-value
Stent length, mm	32.4(28.0-45.9)	32.3(28.0-44.6)	0.84
Post-dilatation, %	54.6%	44.5%	0.03
Final balloon size, mm	3.1 ± 0.4	3.1 ± 0.4	0.87
Final MLD, mm	2.55(2.35-2.80)	2.55(2.29-2.81)	0.50
12 month outcomes	IVUS	Angiography	P-value
MACE	4.5%	7.3%	0.16
Cardiac death	0.0%	0.4%	1.00
MI	0.0%	0.7%	0.50
TVR	4.5%	6.6%	0.28
Stent Thrombosis	.8%	15.5%	ns

AVIO RCT (n=282)

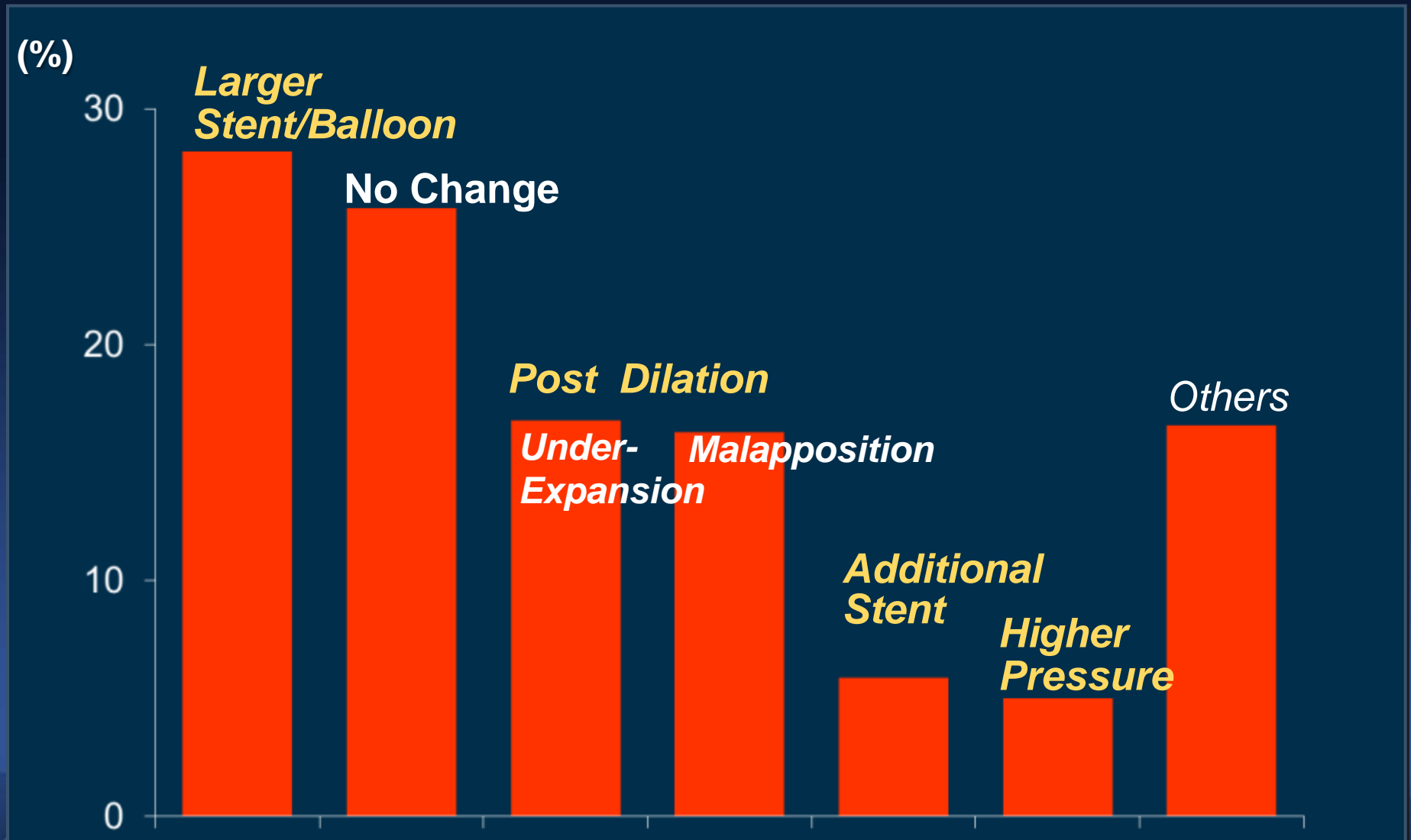
Post-PCI QCA	IVUS (n=142)	Angiography (n=142)	P-value
Stent length, mm	23.9±6.7	23.2±6.5	0.49
Final balloon size, mm	3.4±0.5	3.2±0.4	<0.001
Final MLD, mm	2.7±0.5	2.5±0.5	<0.001

24 month outcomes	IVUS	Angiography	P-value
MACE	16.9%	23.2%	ns
Cardiac death	0.0%	1.4%	ns
MI	7.0%	8.5%	ns
TLR	9.2%	11.9%	ns
TVR	9.8%	15.5%	ns

IVUS-XPL RCT (n=1,400), 2nd DES

Post-PCI QCA	IVUS (n=700)	Angiography (n=700)	P-value
Stent length, mm	39.3 ± 13.1	39.2 ± 12.3	0.90
Post-dilatation, %	76%	57%	<0.001
Final balloon size, mm	3.14 ± 0.43	3.04 ± 0.42	<0.001
Final MLD, mm	2.64 ± 0.42	2.56 ± 0.39	<0.001
12 month outcomes	IVUS	Angiography	P-value
MACE	2.9%	5.8%	0.007
Cardiac death	0.4%	0.7%	0.48
Target lesion-MI	0.0%	0.1%	0.32
Ischemic-driven TLR	2.5%	5.0%	0.02
Stent Thrombosis	0.3%	0.3%	>0.99

IVUS Already Changed our Procedure !



***IVUS should be considered for
the better procedure and
the superior patient outcomes !***