Clinical Decision Making in Patients with Left Main Disease

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Conflict of Interest

- Abbott Medical Advisory Board
- Medtronic Coronary Scientific Advisory Board
- Resolute US National PI

2011 ACC/AHA PCI Guidelines

LM Subset By Anatomy, Risk and Predicted Outcome	
– Anatomy with a low risk of procedural complications and a high likelihood of good long-term outcome (SYNTAX score of ≤22, ostial or trunk left main CAD) , *AND* – Characteristics predict significantly increased risk of adverse surgical outcomes (STS-predicted risk of operative mortality ≥5%)	IIa B
UA/NSTEMI if not a CABG candidate	IIa B
STEMI when distal TIMI flow grade <3 and PCI can be performed more rapidly and safely than CABG	IIa C
– Anatomy low to intermediate risk of PCI procedural complications and intermediate to high likelihood of good long-term outcome (low-intermediate SYNTAX score of <33, bifurcation left main CAD), *AND* – Characteristics predict increased surgical risk (moderate-severe COPD, disability from prior stroke, or prior cardiac surgery; STS-predicted risk of operative mortality >2%)	IIb B
Unfavorable anatomy for PCI and good candidates for CABG	III B

Levine et al. J Am Coll Cardiol 2011

Clinical Decision Making

- Does the LM lesion needs to be treated? If so, which lesion (LM, LAD, Cx)?
- Can the LM lesion be treated with one stent (i.e. cross over technique)?
- Does the patient have diabetes?
- Are the lesions heavily calcified angiographically or post-CABG?
- Are there other lesions besides LM?

Clinical Decision Making

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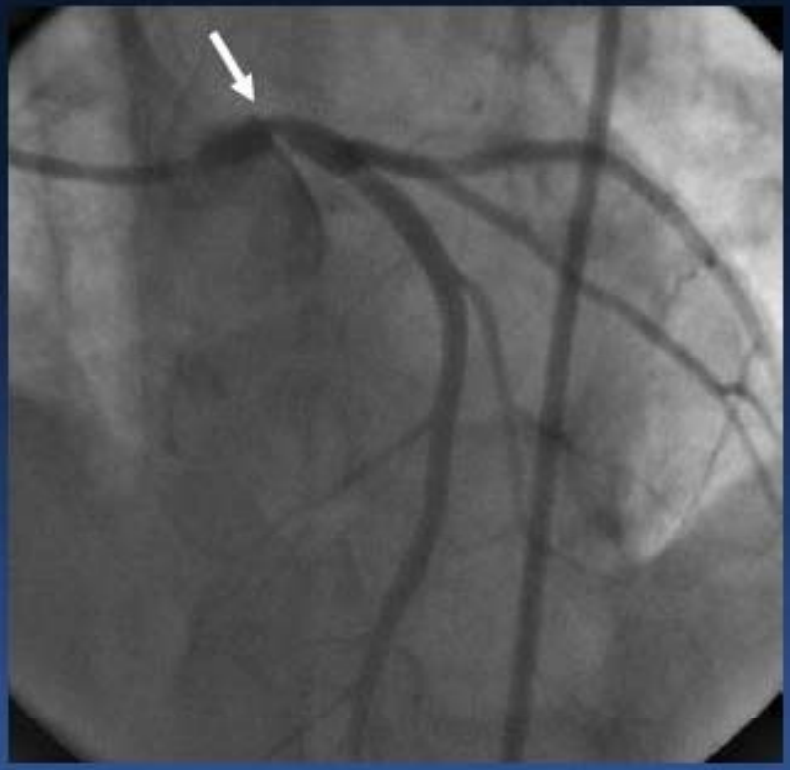
Visual Functional Mismatch



Visual : 80%

IVUS MLA : 6.2mm^2

FFR : 0.82

Treadmill test : Negative

Thallium spect : Normal

Stress Echo : Negative

Reverse Mismatch

Visual Estimation : 30%

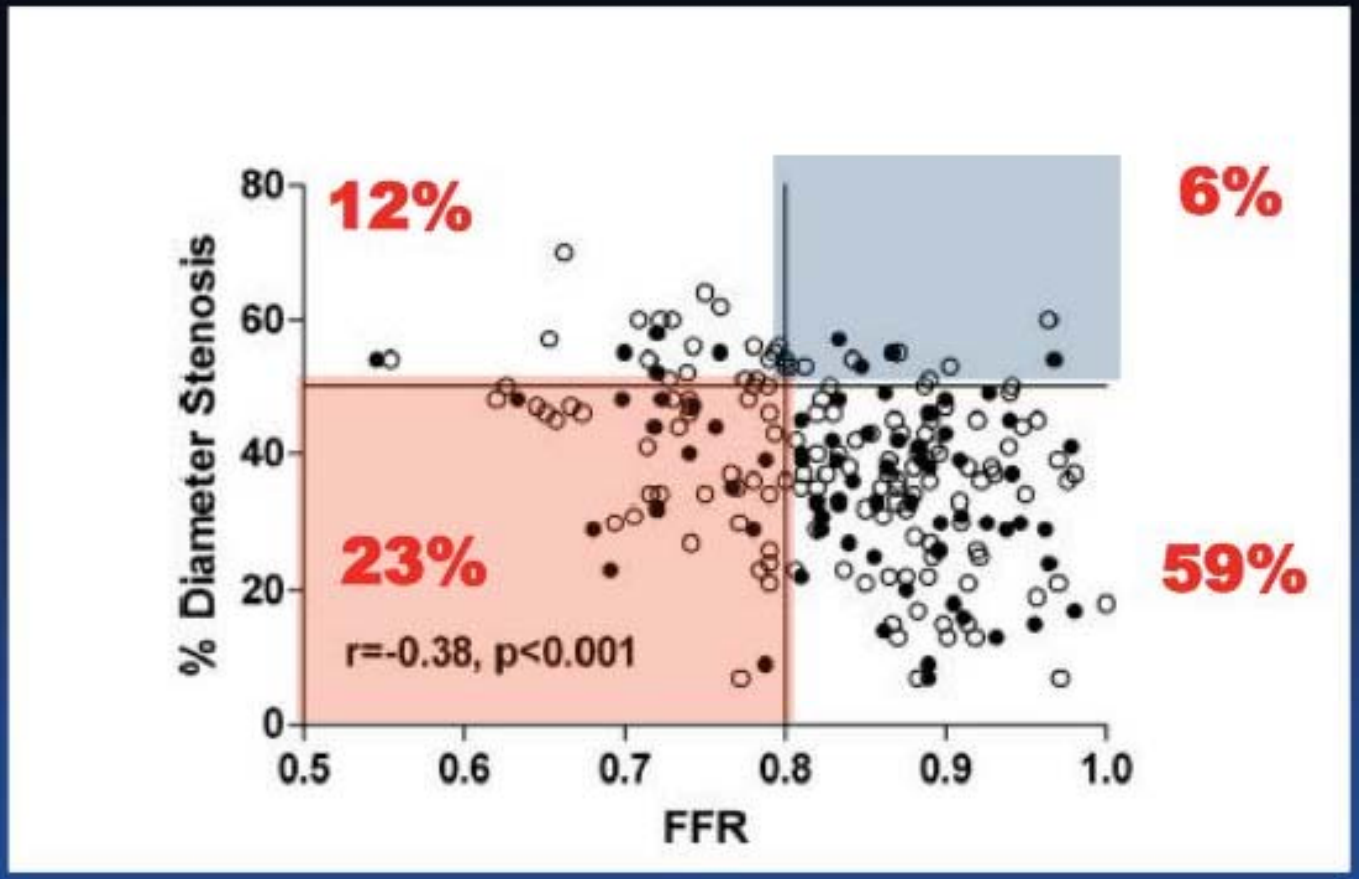
FFR : 0.70

IVUS MLA: 4.5 mm2

Treadmill test: + stage 2

Thallium spect : + large LAD

Mismatch
in intermediate LM Disease



Hamilos M, Circulation 2009; 120: 1505-1512

FFR is influenced by Many Lesion Specific Factors "Total Morphology"

- Reference vessel diameter (myocardium)
- Degree of diameter stenosis
- Lesion morphology
- Eccentricity
- Lesion length
- Plaque burden, Plaque rupture
- Surface roughness
- Viscous friction, flow separation, turbulence, and eddies

Univariable Analysis to Predict FFR <0.8

Variables	C-OR	95%CI	p-value
MLA within LM	0.312	0.164-0.593	<0.001
Plaque burden	1.095	1.031-1.164	0.003
Lesion length	1.192	1.038-1.368	0.013
Rupture	3.273	0.953-11.243	0.060
Angiographic DS	1.049	0.993 – 1.108	0.088
Lesion location	2.081	1.070 – 4.046	0.031
Male	0.511	0.127-2.057	0.345
Age	0.965	0.917-1.016	0.172
Diabetes melitus	1.062	0.304-3.710	0.924
Hypertension	1.3	0.412-4.101	0.654
Smoker	2.701	0.816-0.8945	0.104
Hyperlipidemia	1.167	0.324-4.200	0.814
Stable presentation	0.476	0.078-2.894	0.42

Multivariable Analysis to Predict FFR

Independent predictors for FFR as continuous variable

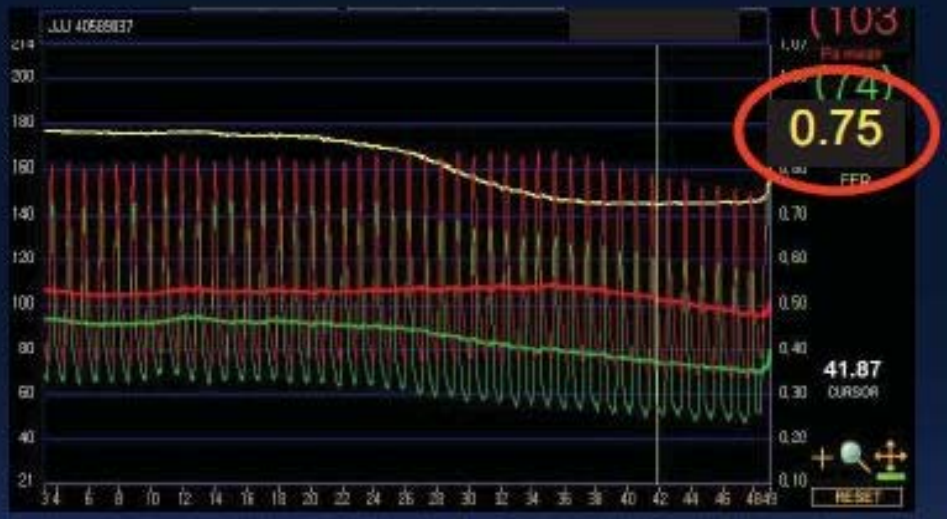
MLA (β=0.58, 95% CI=0.02 - 0.04, p<0.001)

Plaque rupture (β=-0.24, 95% CI= -0.09-0.01, p=0.036)

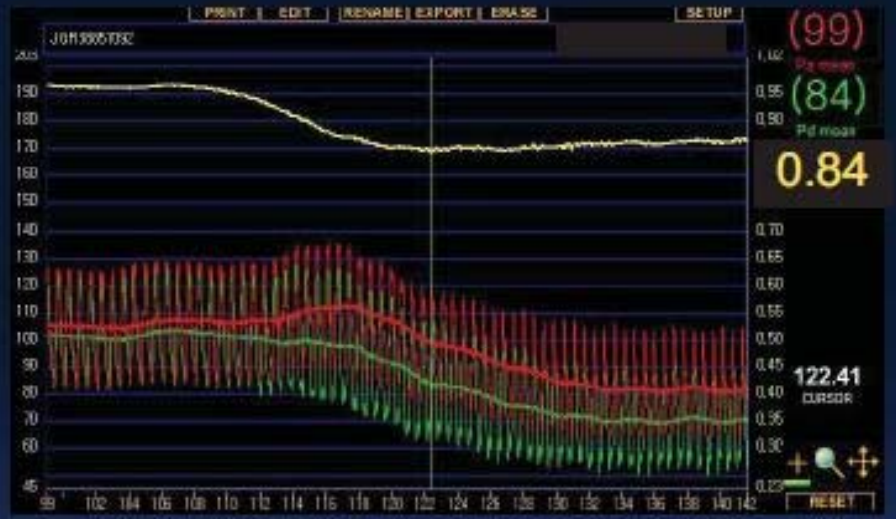
Kang SJ, Park SJ et al, JACC. Cardiovascular Interventions. 2011 Nov;4(11):1168-74.

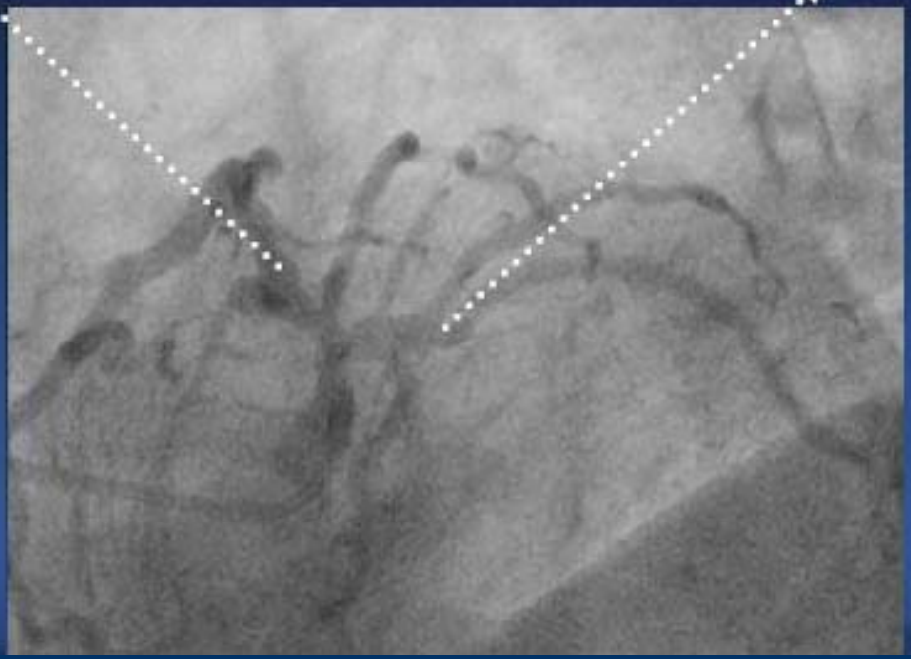
52/M, Atypical chest pain,
MDCT ; Diffuse, moderate stenosis at distal LM

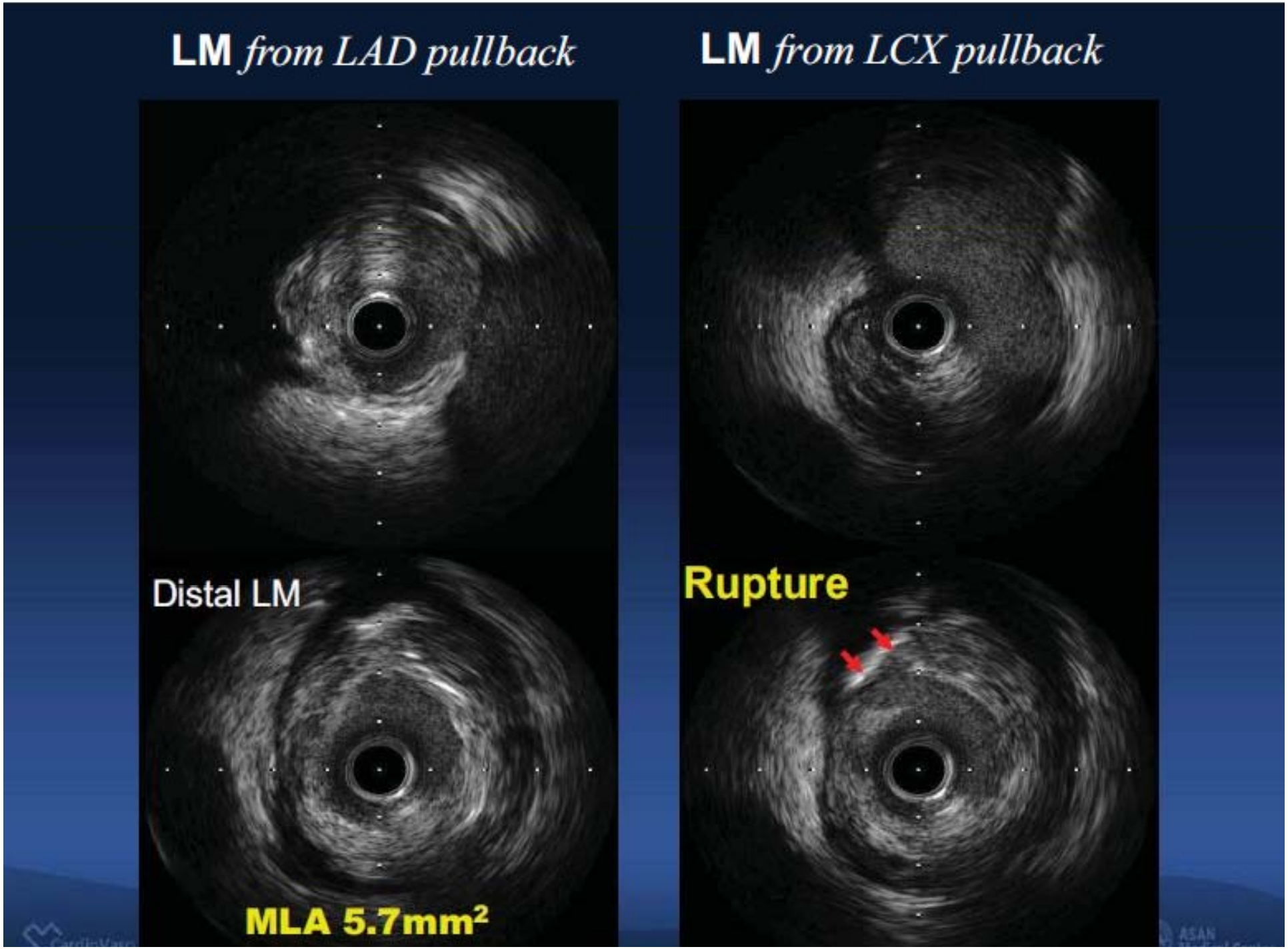
LAD, FFR



LCX, FFR






LM from LAD pullback
LM from LCX pullback
Distal LM
Rupture
MLA 5.7mm²

Clinical Decision Making

- Does the LM lesion needs to be treated? If so, which lesion (LM, LAD, Cx)?
- **Can the LM lesion be treated with one stent (i.e. cross over technique)?**
- Does the patient have diabetes?
- Are the lesions heavily calcified angiographically or post-CABG?
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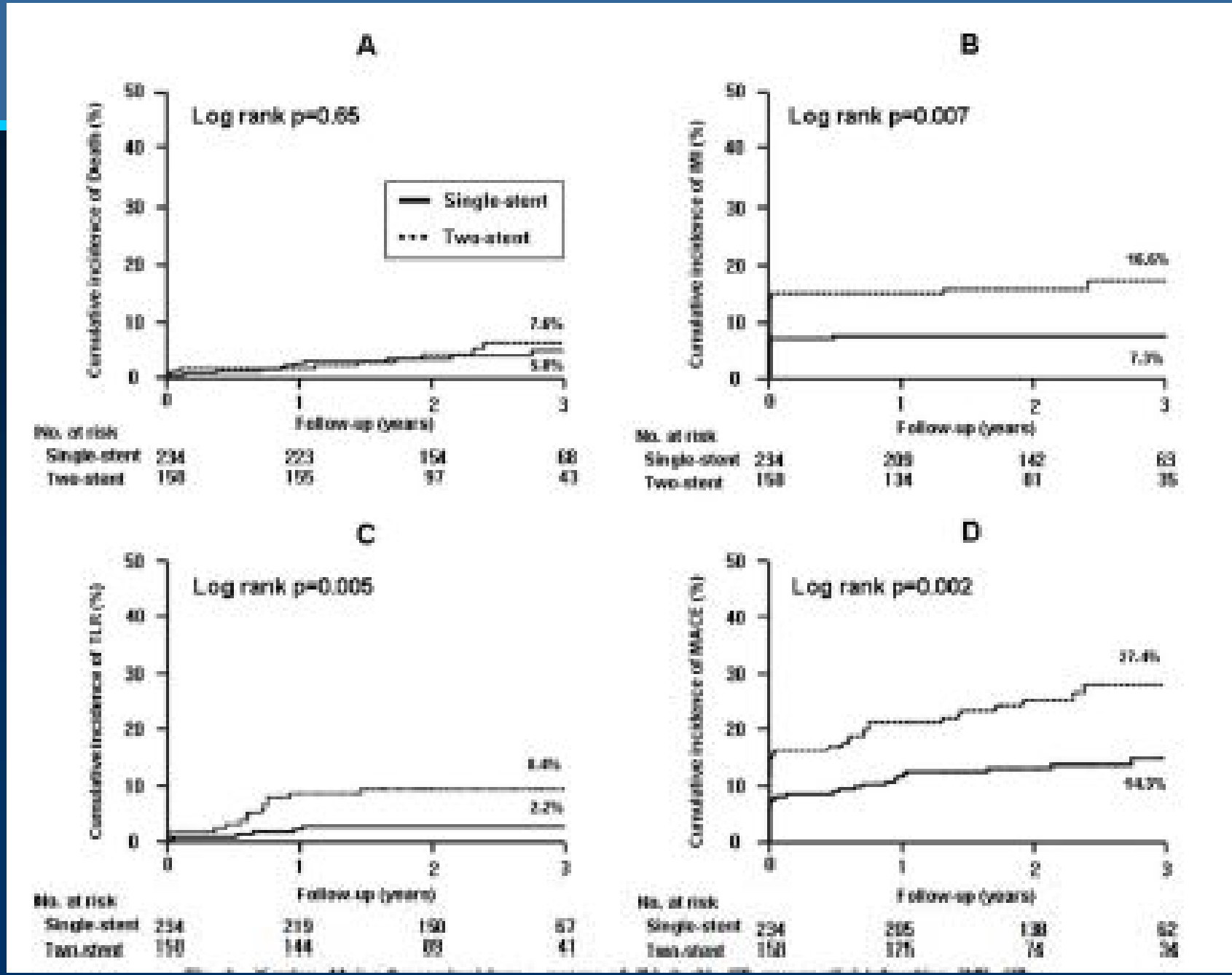
Distal LM Bifurcation PCI

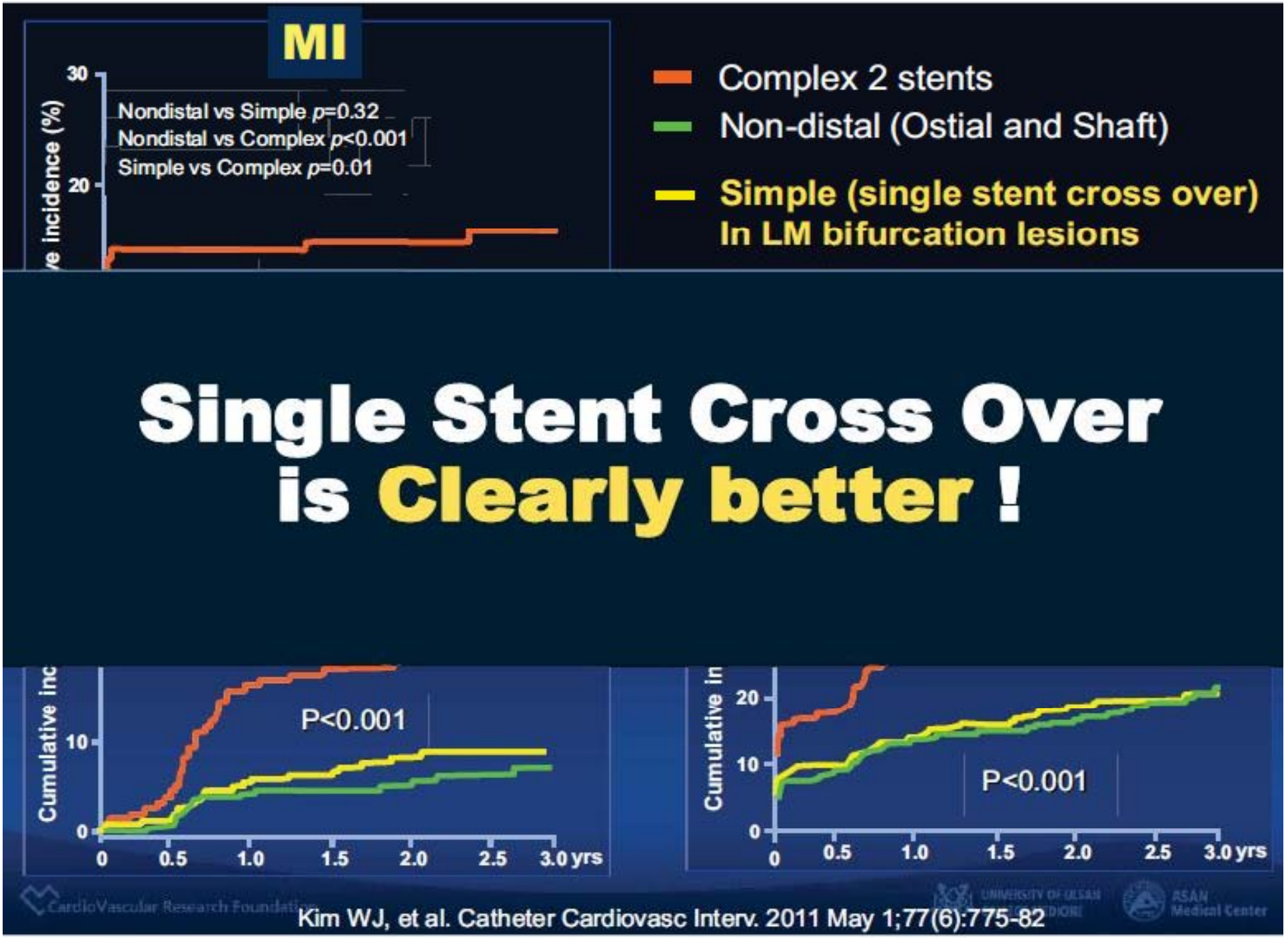
- Single Stent Cross Over
- 2 Stents Procedures

When, 1 vs. 2 stents

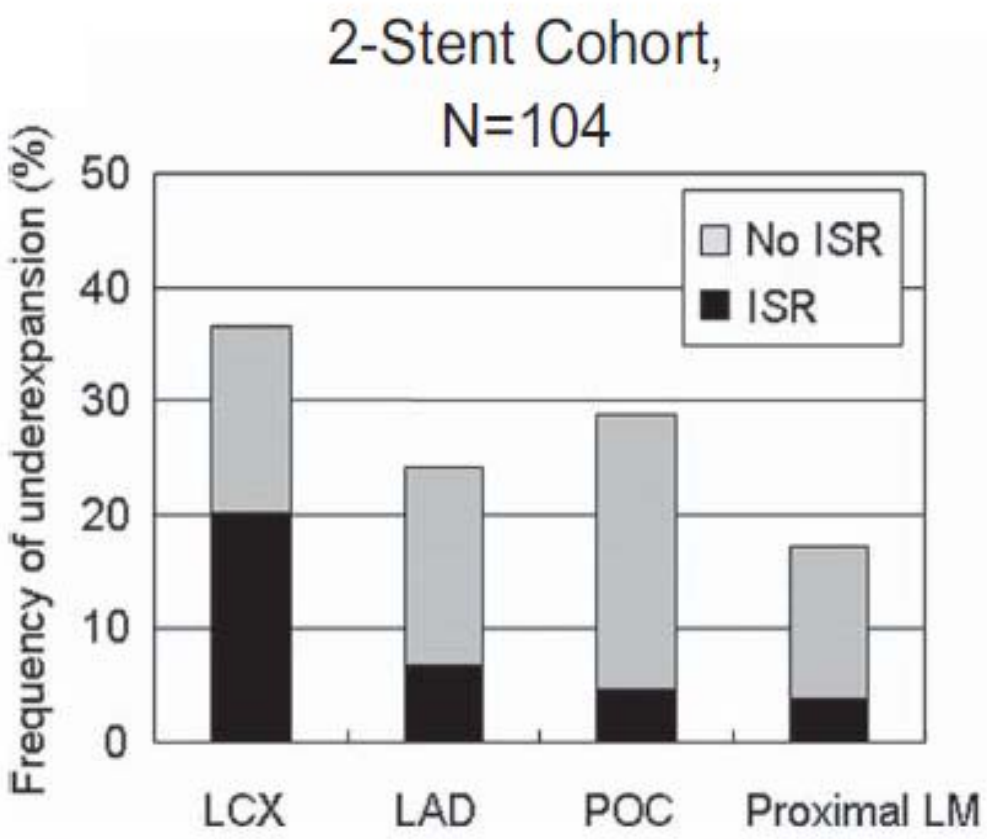
Single stent	• Normal ostial LCX with MEDINA 1.1.0. or 1.0.0. • Small LCX with < 2.5 mm in diameter • Diminutive LCX • Normal or focal disease in distal LCX
Two stent	• Diseased LCX with MEDINA 1.1.1., 1.0.1., or 0.1.1 • Large LCX with ≥ 2.5 mm in diameter • Diseased left dominant coronary system • Concomitant diffuse disease in distal LCX

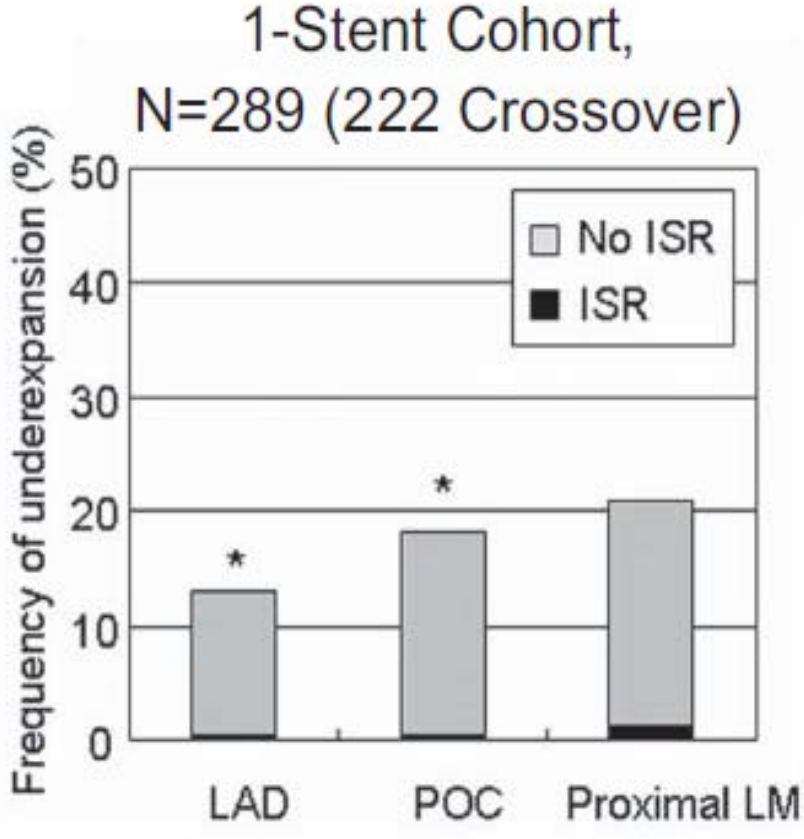
Park SJ, Kim YH. Colombo A, Issam D. Moussa et al. Textbook of Bifurcation Stenting


A
Log rank p=0.65
Single-stent
Two-stent
7.8%
5.8%
Follow-up (years)
No. at risk
Single-stent 234 223 154 68
Two-stent 158 155 97 43
B
Log rank p=0.007
16.6%
7.3%
Follow-up (years)
No. at risk
Single-stent 234 209 142 63
Two-stent 158 134 81 35
C
Log rank p=0.005
8.4%
2.2%
Follow-up (years)
No. at risk
Single-stent 234 219 150 67
Two-stent 158 144 89 41
D
Log rank p=0.002
37.4%
14.2%
Follow-up (years)
No. at risk
Single-stent 234 205 138 62
Two-stent 158 125 78 36


MI
30
20
ve incidence (%)
Nondistal vs Simple p=0.32
Nondistal vs Complex p<0.001
Simple vs Complex p=0.01
Complex 2 stents
Non-distal (Ostial and Shaft)
Simple (single stent cross over)
In LM bifurcation lesions
Single Stent Cross Over
is Clearly better !
Cumulative inc
10
0
P<0.001
0
0.5
1.0
1.5
2.0
2.5
3.0 yrs
Cumulative in
20
10
0
P<0.001
0
0.5
1.0
1.5
2.0
2.5
3.0 yrs
CardioVascular Research Foundation
UNIVERSITY OF ULSAN
ASAN
Medical Center
Kim WJ, et al. Catheter Cardiovasc Interv. 2011 May 1;77(6):775-82

Frequency of Stent Underexpansion
1 vs 2 Stent Techniques





2-stent: LCX stent most frequently underexpanded and results in ISR more than half of cases

1-stent: Underexpansion is less common compared with 2 stent techniques with lower ISR

The Spectrum of 2 stent Techniques

- **How should you choose between:**
  - T-stent, modified T-stent or TAP
  - Mini-crush (or step crush)
  - Culotte
  - V-stent
  - Y-stent (SKS-simultaneous kissing stents)

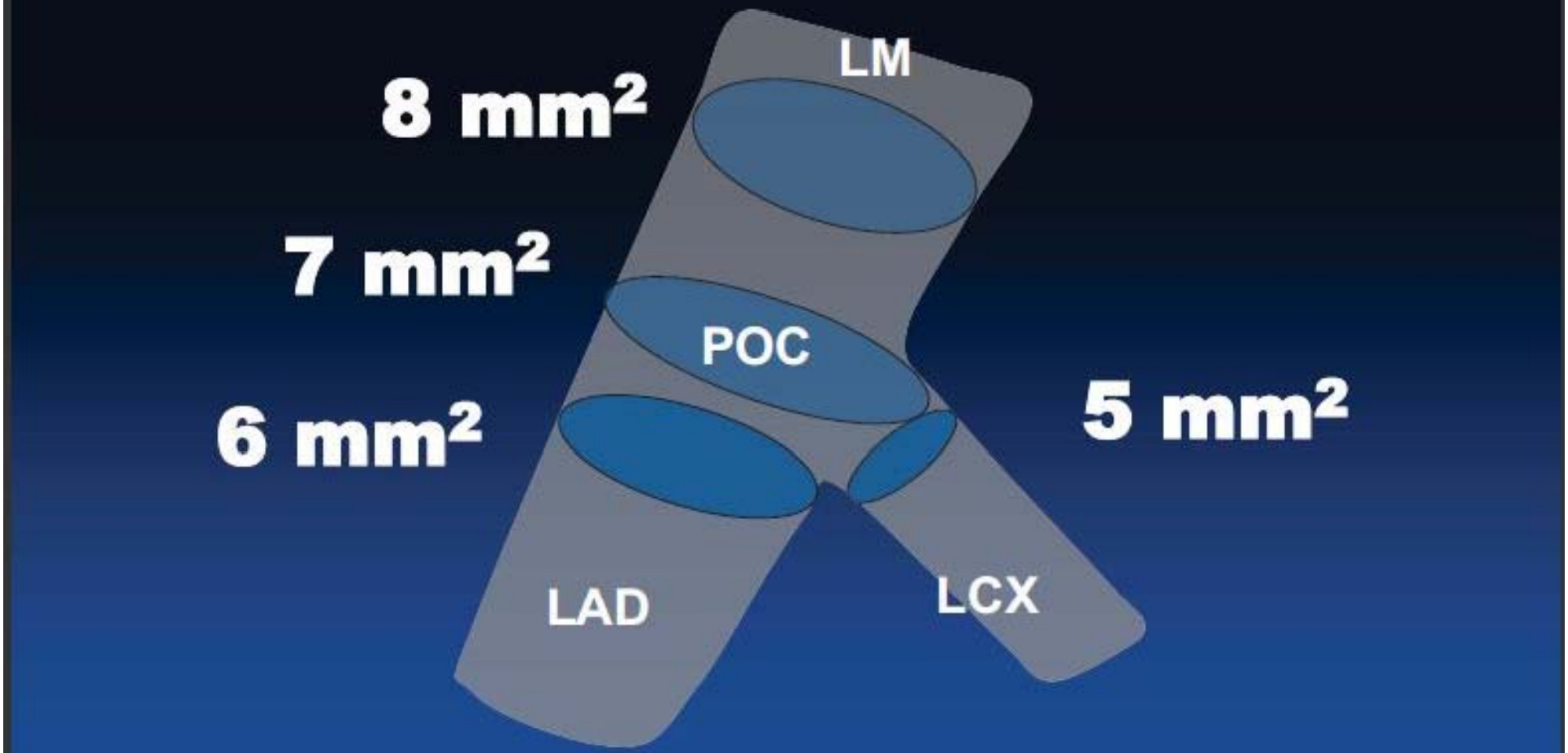
Planned 2 stent techniques for true LM distal bifurcation disease

Technique	When to choose
T, modified T, TAP:	75-90' angled LCX
Culotte:	Y bif with matched LAD/LCX dia.
Mini-crush (or step crush):	Y bif with LAD/LCX dia mismatch.
V-stent:	Medina 0,1,1 (true LMEQ ds)
SKS:	Short LM, unstable pt

End with a FKB inflation with all 2-stent techniques

IVUS Stent Optimization

(Stent Cross-sectional Area)



Kang, Park et al. Circulation. Cardiovascular Interventions. 2011 Dec 1;4(6):562-9.

Clinical Decision Making

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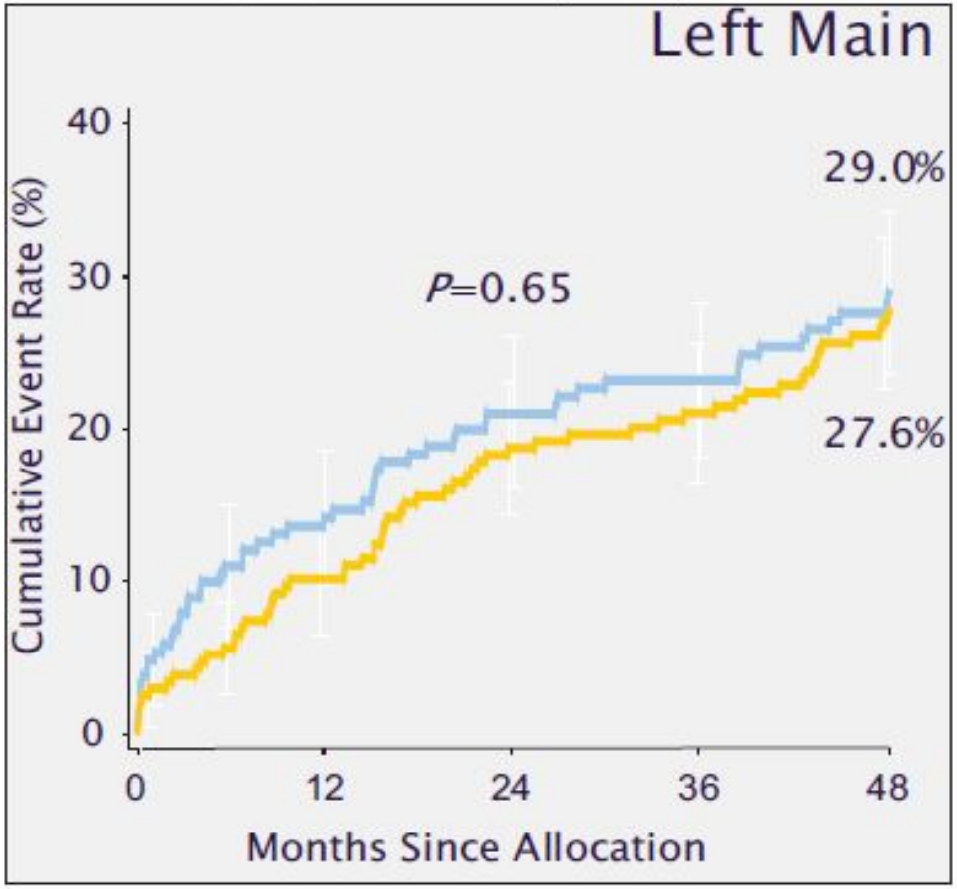
SYNTAX

LM Subgroup: 1 and 4 Year Outcomes

Endpoint	CABG (%)			Taxus (%)			*P* value
	1 Year	$\Delta^{1\text{-}4\ Yrs}$	4 Year	1 Year	$\Delta^{1\text{-}4\ Yrs}$	4 Year	
Death	4.4	4.0	8.4	4.2	2.9	7.3	0.64
Stroke	2.7	1.3	4.0	0.3	0.9	1.2	0.02
MI	4.1	0	4.1	4.3	2.6	6.9	0.14
Revascularization	6.7	5.0	11.7	12.0	8.0	20.0	0.004
Death/stroke/MI	9.1	5.2	14.3	7.0	6.0	13.0	0.60
MACCE	13.6	8.7	22.3	15.8	9.0	26.8	0.20

MACCE at 4 Years Stratified by Baseline SYNTAX Score

Tercile SYNTAX Low to Intermediate Scores 0-32



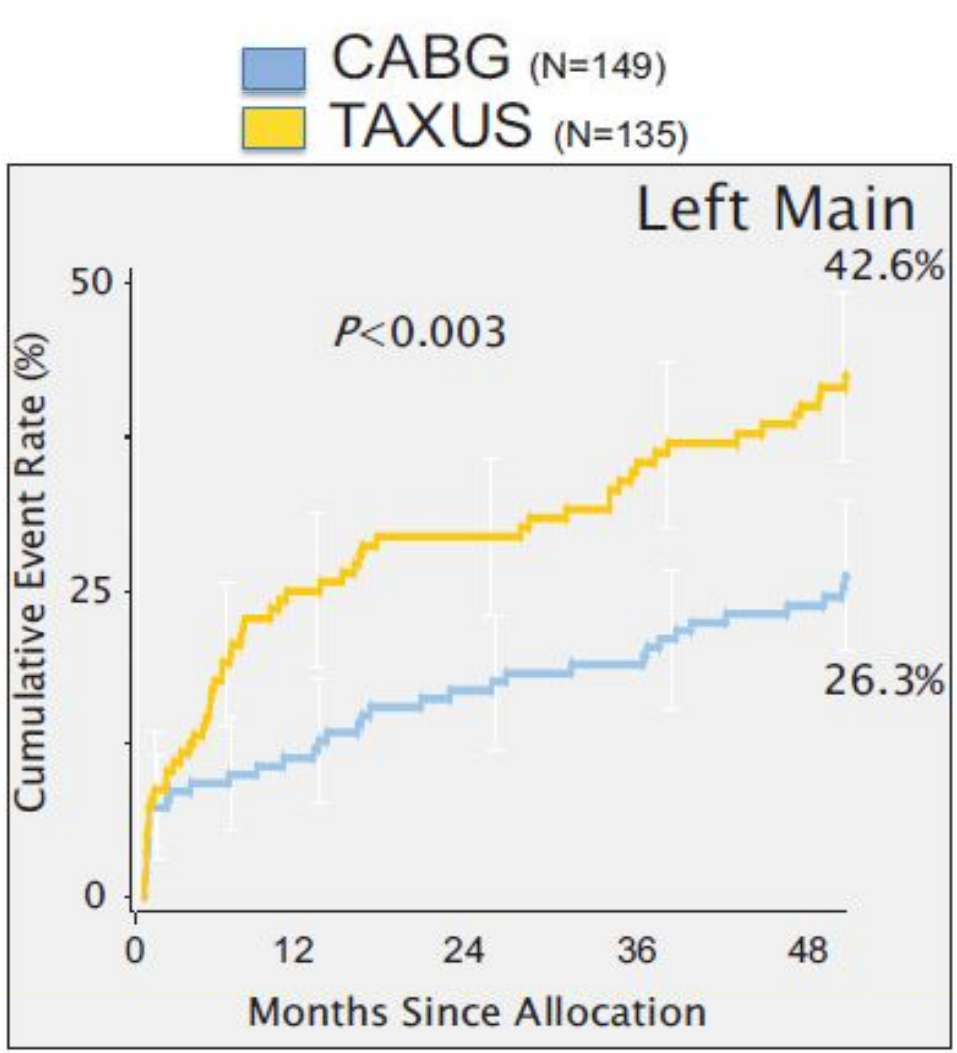
	CABG		PCI	*P* value
Death	11.8%	>	7.5%	0.12
CVA	3.9%	>	1.4%	0.11
MI	3.8%	<	5.1%	0.55
Death, CVA or MI	17.1%	>	13.5%	0.25
Revasc.	16.9%	<	19.1%	0.57

Cumulative KM Event Rate ± 1.5 SE; log-rank P value
Site-reported Data; ITT population

Serruys P. TCT2011

MACCE at 4 Years Stratified by Baseline SYNTAX Score

Tercile SYNTAX High Score ≥33



	CABG		PCI	*P* value
Death	10.5%	<	17.9%	0.06
CVA	4.9%	>	1.6%	0.14
MI	6.1%	<	10.9%	0.18
Death, CVA or MI	18.5%	<	23.1%	0.33
Revasc.	11.8%	<	31.3%	<0.001

Cumulative KM Event Rate ± 1.5 SE; log-rank P value
Site-reported Data; ITT population

Serruys P. TCT2011

PCI vs. CABG for Left Main Disease
Meta-analysis of 4 RCTs, 1,611 Patients

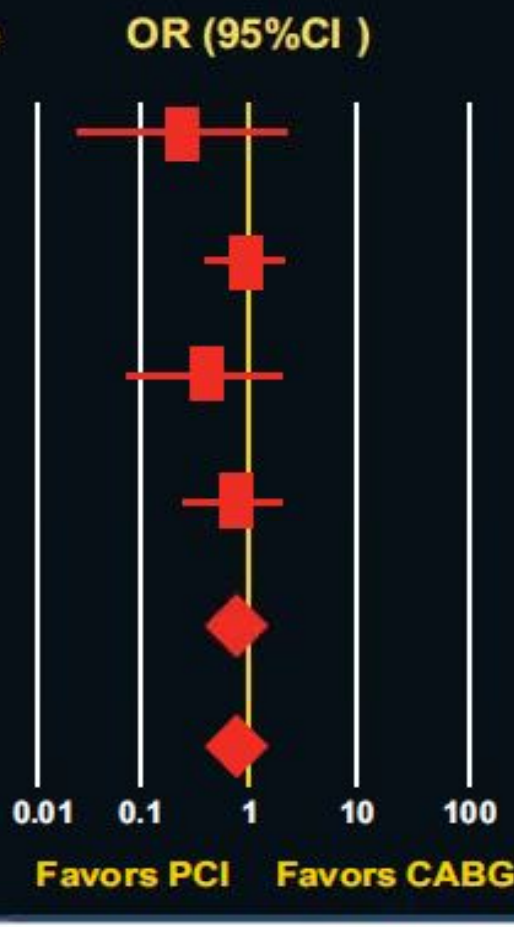
Trial	LEMANS	SYNTAX LM	Boudriot et al.	PRECOMBAT
Year	2008	2009	2010	2011
N total	105	705	201	600
Age, mean years	61	65	68	62
Male	67%	74%	75%	77%
Diabetes	18%	25%	36%	32%
Distal LM involved	58%	61%	71%	65%
+0/1/2/3 VD, %	0/9/23/68	13/20/31/36	29/31/27/14	10/17/32/41
Syntax Score, mean	25	30	24	25
Log Euroscore, mean	3.4	3.9	2.5	2.7
LIMA-LAD	81%	97%	99%	94%

Capodanno et al, *JACC* 2011;58:1426-32

PCI vs. CABG for Left Main Disease
Meta-analysis of 4 RCTs, 1,611 Patients

1 Year Mortality

	PCI	CABG	OR (95%CI)	*p*-Value
LEMANS	1/52	4/53	0.24 (0.03-2.23)	0.21
SYNTAX left main	15/355	15/336	0.94 (0.45-1.96)	0.88
Boudriot et al.	2/100	5/101	0.39 (0.07-2.07)	0.27
PRECOMBAT	6/300	8/300	0.75 (0.26-2.17)	0.59
Fixed effects estimate	3.0% (24/807)	4.1% (32/790)	0.74 (0.43-1.28)	0.29
Random effects estimate			0.74 (0.43-1.28)	0.29
I^2=0%				

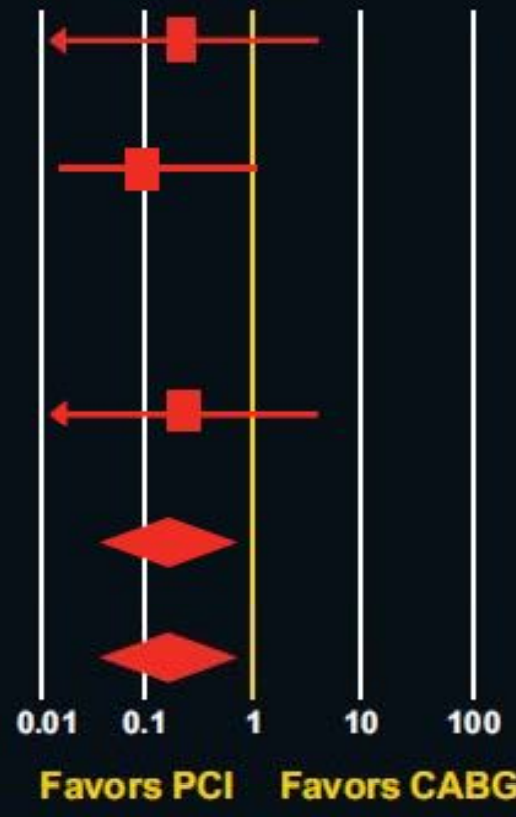


Capodanno et al, *JACC* 2011;58:1426-32

PCI vs. CABG for Left Main Disease
Meta-analysis of 4 RCTs, 1,611 Patients

1 Year Stroke

	PCI	CABG	OR (95%CI)	*p*-Value
LEMANS	0/52	2/53	0.20 (0.01-4.09)	0.30
SYNTAX left main	1/355	8/336	0.12 (0.01-0.93)	0.04
Boudriot et al.				
PRECOMBAT	0/300	2/300	0.20 (0.01-4.16)	0.30
Fixed effects estiamate	0.1% (1/707)	1.7% (12/689)	0.15 (0.03-0.67)	0.01
Random effects estimate			0.15 (0.03-0.67)	0.01
I^2=0%				



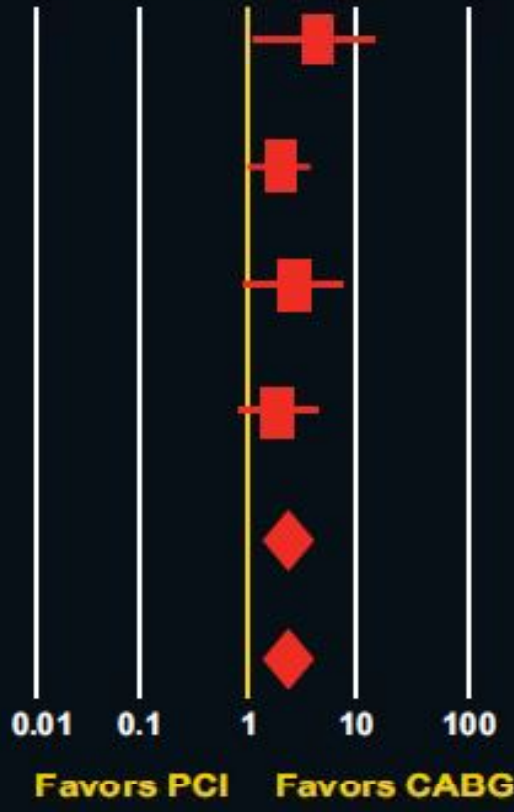
Capodanno et al, *JACC* 2011;58:1426-32

PCI vs. CABG for Left Main Disease
Meta-analysis of 4 RCTs, 1,611 Patients

1 Year Repeat Revascularization

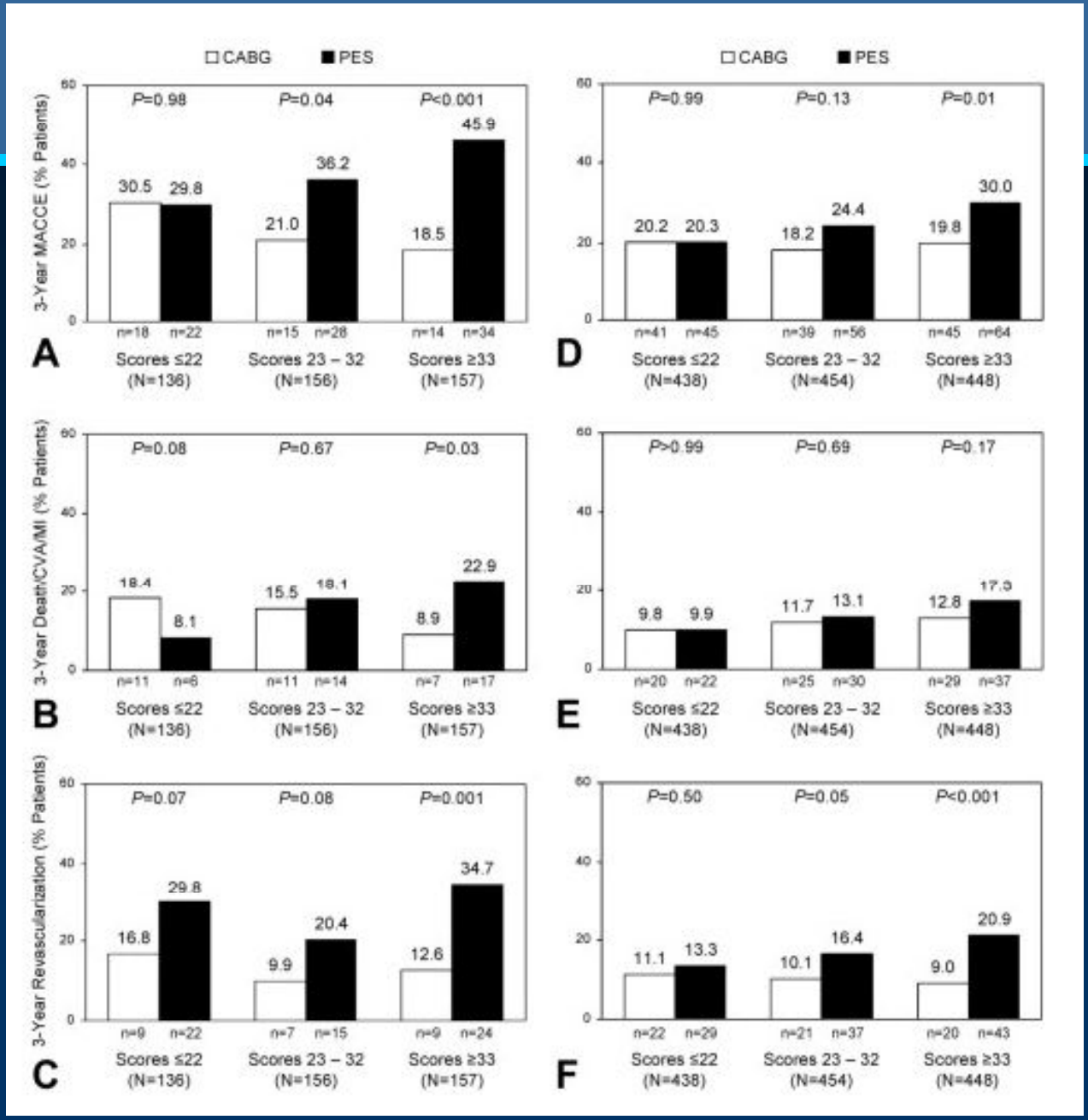
	PCI	CABG	OR (95%CI)	*p*-Value
LEMANS	15/52	5/53	3.89 (1.30-11.68)	0.02
SYNTAX left main	45/355	22/336	2.07 (1.22-3.53)	0.007
Boudriot et al.	14/100	6/101	2.58 (0.95-7.01)	0.06
PRECOMBAT	18/300	10/300	1.85 (0.84-4.08)	0.13
Fixed effects estiamate	11.4% (92/807)	5.4% (43/790)	2.25 (1.54-3.28)	<0.001
Random effects estimate			2.25 (1.54-3.28)	<0.001

I^2=0%



Capodanno et al, *JACC* 2011;58:1426-32

Three years SYNTAX: Diabetes



Clinical Decision Making

- Does the LM lesion needs to be treated? If so, which lesion (LM, LAD, Cx)?
- Can the LM lesion be treated with one stent (i.e. cross over technique)?
- Does the patient have diabetes?
- **Are the lesions heavily calcified angiographically or post-CABG?**
- **Are there other lesions besides LM?**

Diagnostic Cath

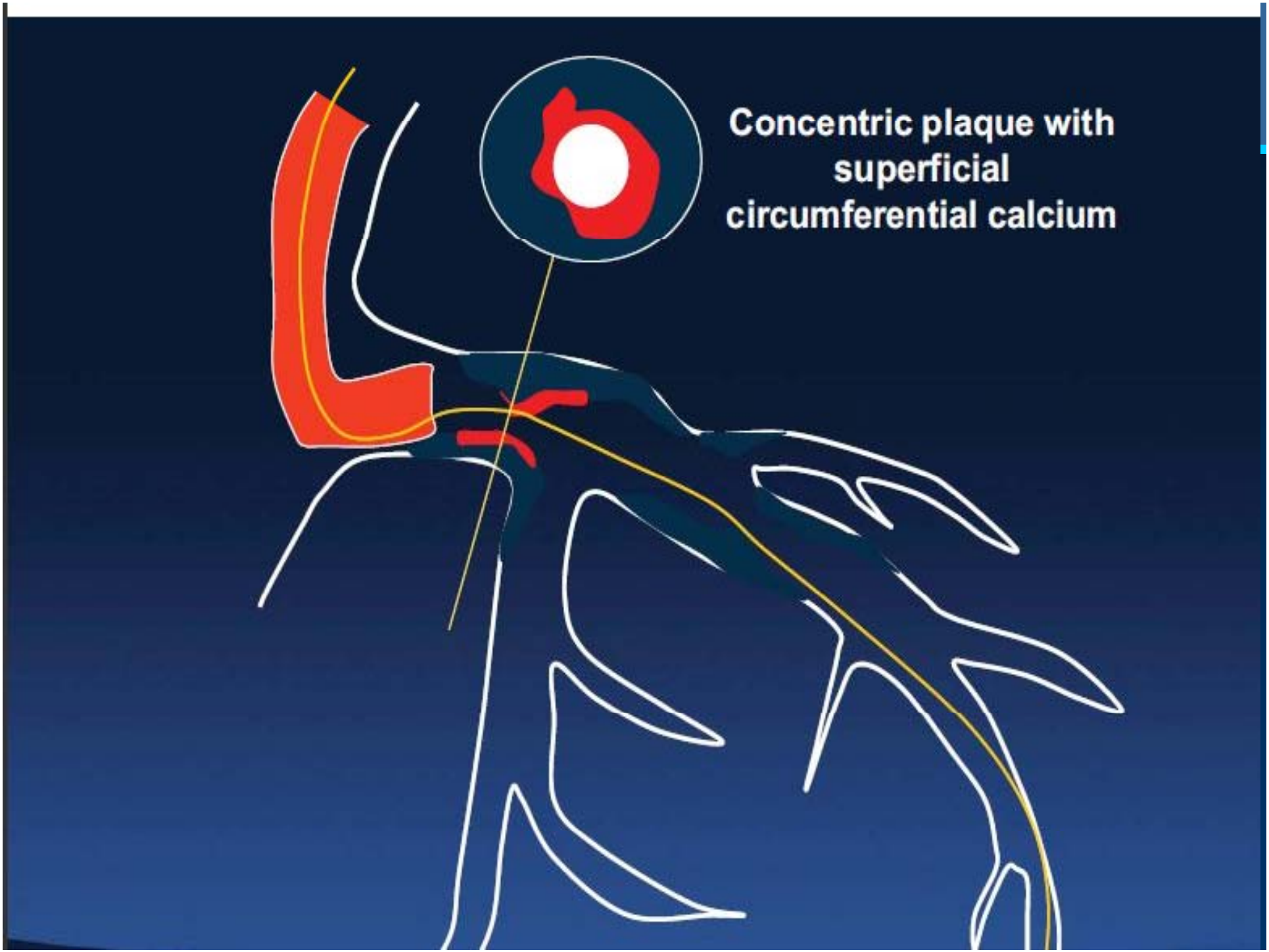
Calcified 90% Bifurcating Left Main LAD and Circ RCA Normal

Calcified LM stenoses

- Prevents delivery of stents
- Leads to underexpansion of stents
- Often results in plaque shift, jailing of SB

Therefore,

- Scoring/cutting balloons are first choices
- Rotational atherectomy is difficult if both LAD and Cx need to be treated
- Distal embolization can be a problem
- Often calcified LM is associated with diffuse disease in LAD and Cx


Concentric plaque with
superficial
circumferential calcium

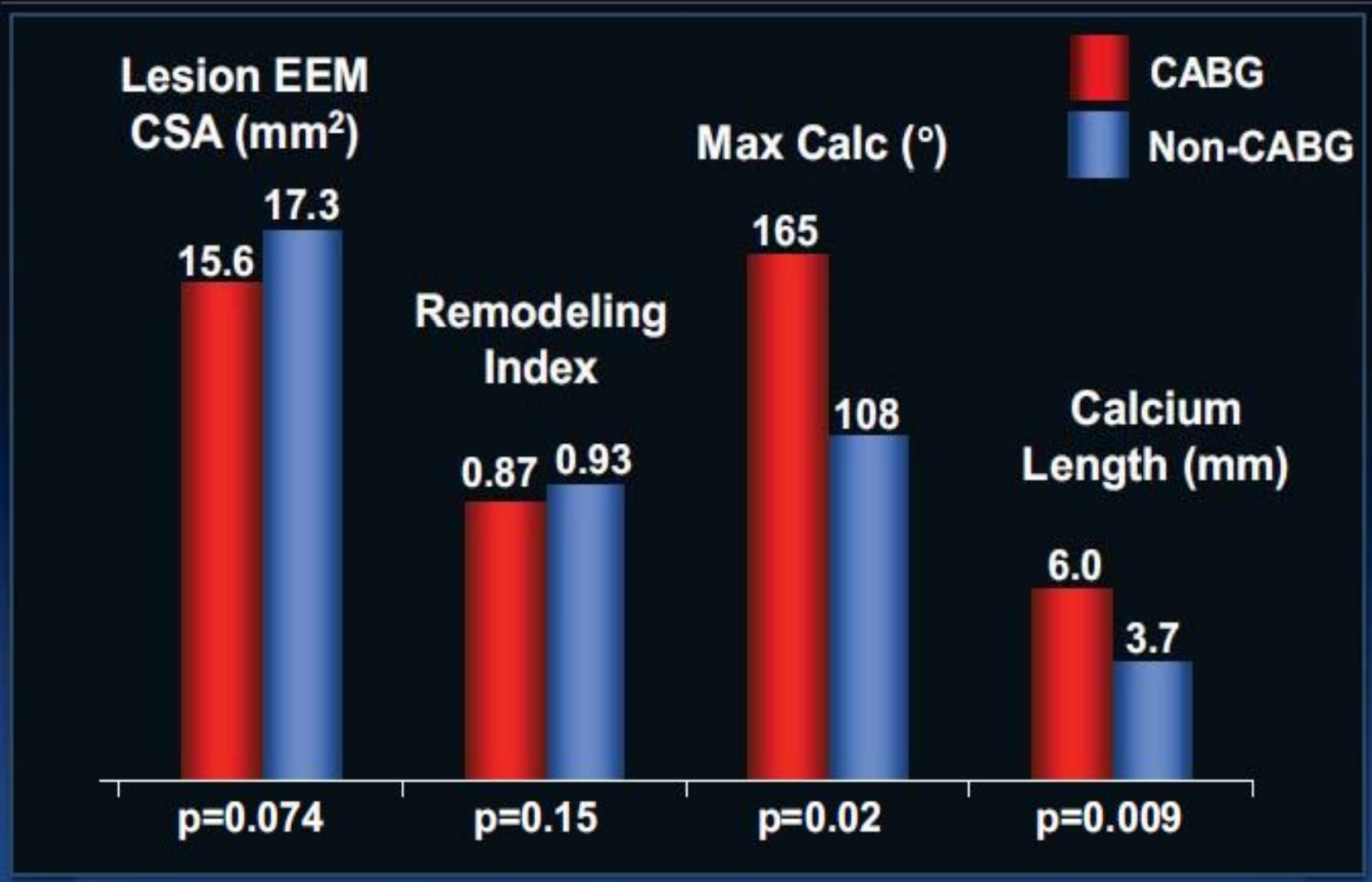
Lesion Modification, Not Calcium Removal

Concentric plaque with superficial circumferential calcium

Make one thin segment in circumferential calc

Good dissection before stent

Difference Between CABG vs non-CABG LMCA Lesions (n=86)



Quantification and Impact of Untreated CAD After PCI: The Residual SYNTAX Score

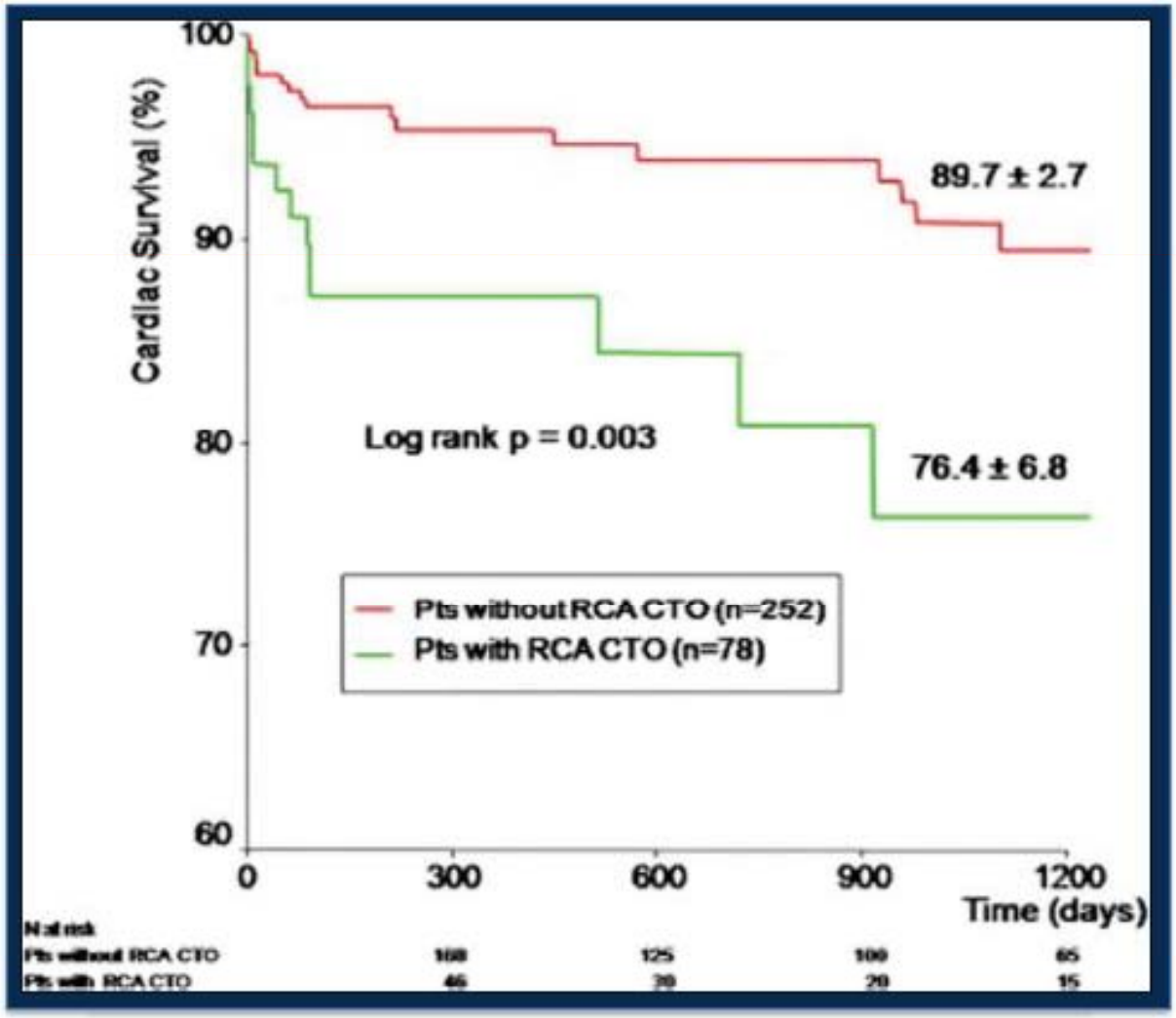
New scoring strategy analyzed in 2,686 angiograms from pts with moderate- and high-risk ACS; pts stratified into Syntax tertiles.

- 30-day, 1-year rates of ischemic events were higher in the incomplete vs. complete revascularization group
- In the baseline intermediate- and high-risk tertiles, incomplete revascularization with a residual Syntax score > 8 is associated with increased mortality ($P = 0.001$)
- Degree of incomplete revascularization varied greatly despite strong correlation between baseline and residual scores

Implications: Residual Syntax score is useful to quantify and risk-stratify residual stenosis after PCI.

Généreux P, et al. *J Am Coll Cardiol*. 2012;Epub ahead of print.

Survival Following LM PCI
Impact of Right Coronary Artery Total Occlusion



N=330 (24% RCA CTO)

Predictors of 3-Year Mortality:
RCA CTO,
EuroSCORE

Migliorini, A. et al. J Am Coll Cardiol 2011;58:125-130

Clinical Decision Making

- Does the LM lesion needs to be treated? If so, which lesion (LM, LAD, Cx)?
  - Make sure Rx is really needed esp if high risk
- Can the LM lesion be treated with one stent (i.e. cross over technique)?
  - If only need cross over is needed, procedure is simplier and results are excellent
- Does the patient have diabetes?
  - Likelihood of higher ISR rates esp in IDDM, though NIDDM may not be much higher risk
- Are the lesions heavily calcified angiographically or post-CABG?
  - Procedure is more complicated with likely poorer outcome
- Are there other lesions besides LM?
  - May be CABG is better