Minimal Lumen Area Matched with Fractional Flow Reserve

Answers for 10 Questions

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Disclosure

I have nothing to disclose

Answers for 10 Questions

Q1. Why Should We Reconsider?

Q2. Does MLA 4.0mm^2 Still Work in Western?

Q3. Is OCT-MLA More Accurate?

Q4. Do We Need Criteria According to Vess Size?

Q5. Why Mismatch?

Q6. Why is it Different from 6.0mm^2?

Q7. Is LM Size Different Among Studies?

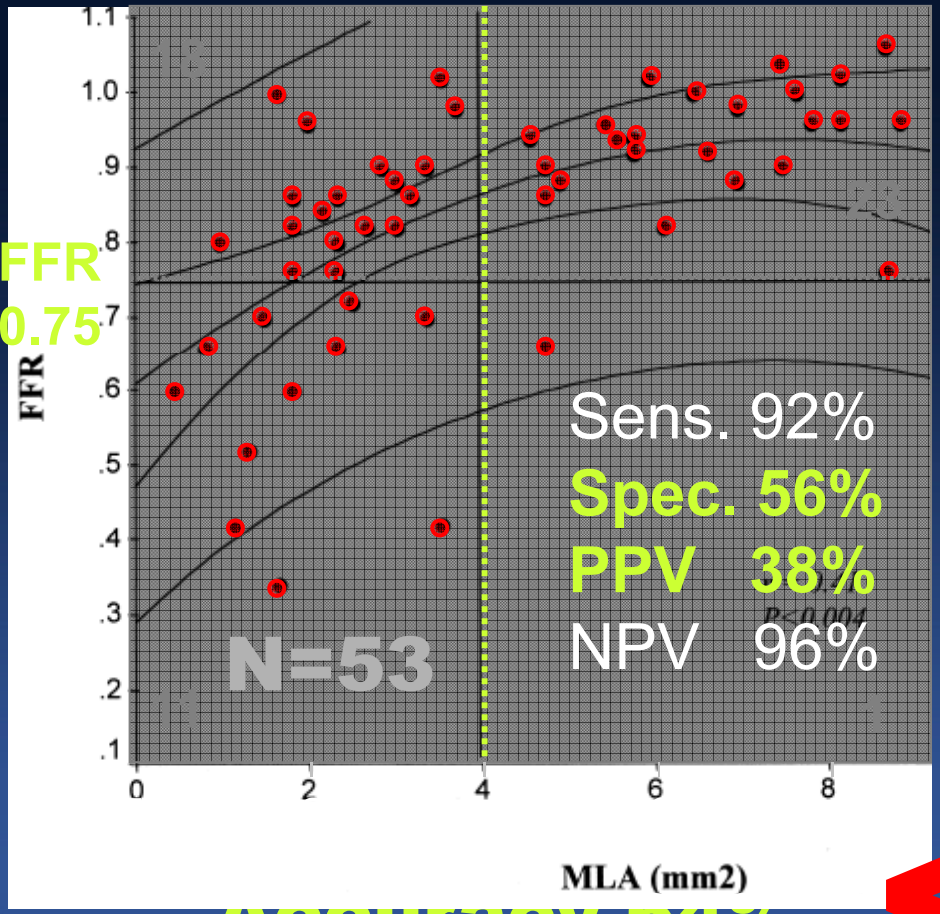
Q8. FFR Criteria Safe for Deferral?

Q9. Morphologic Criteria Safe for Deferral?

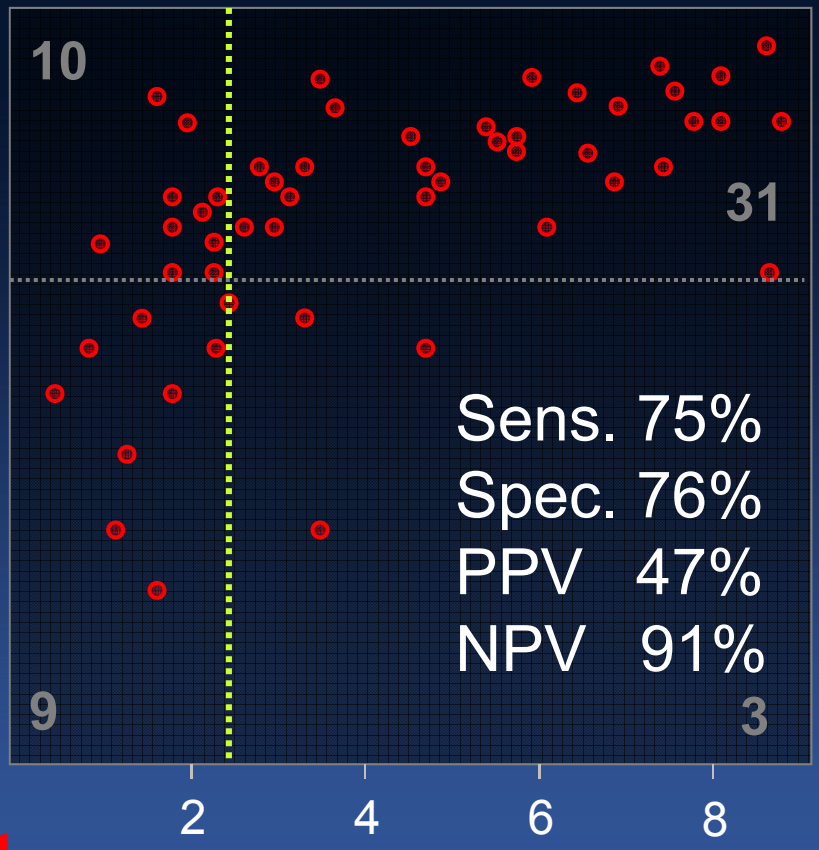
Q10. Treatment, Where Are We?

Q1. Why Should We Reconsider?

MLA 4.0mm^2



If MLA 2.5mm^2?

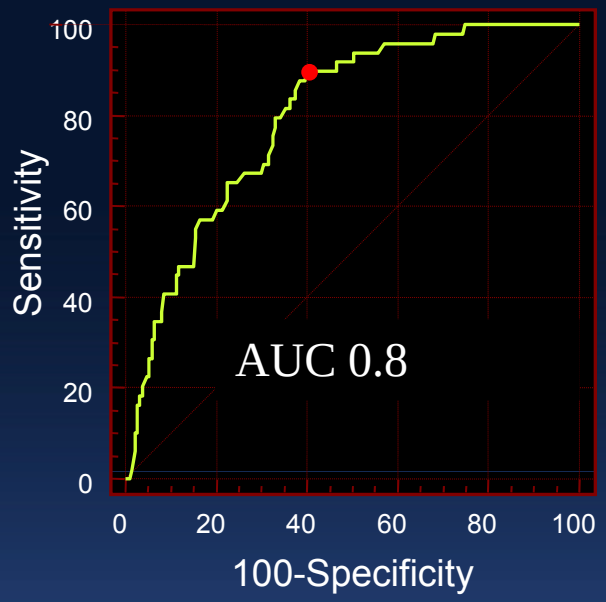


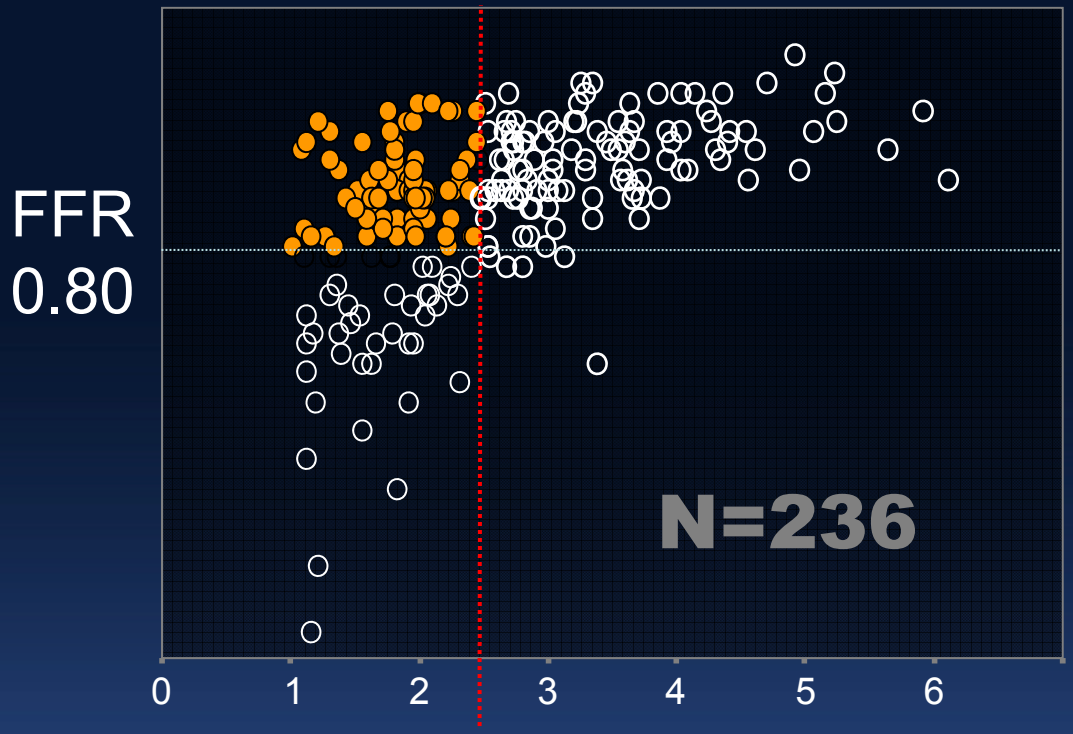
Accuracy 64%

Accuracy 76%

Briguori et al. AJC 2001;87:136-41

MLA 2.4mm^2



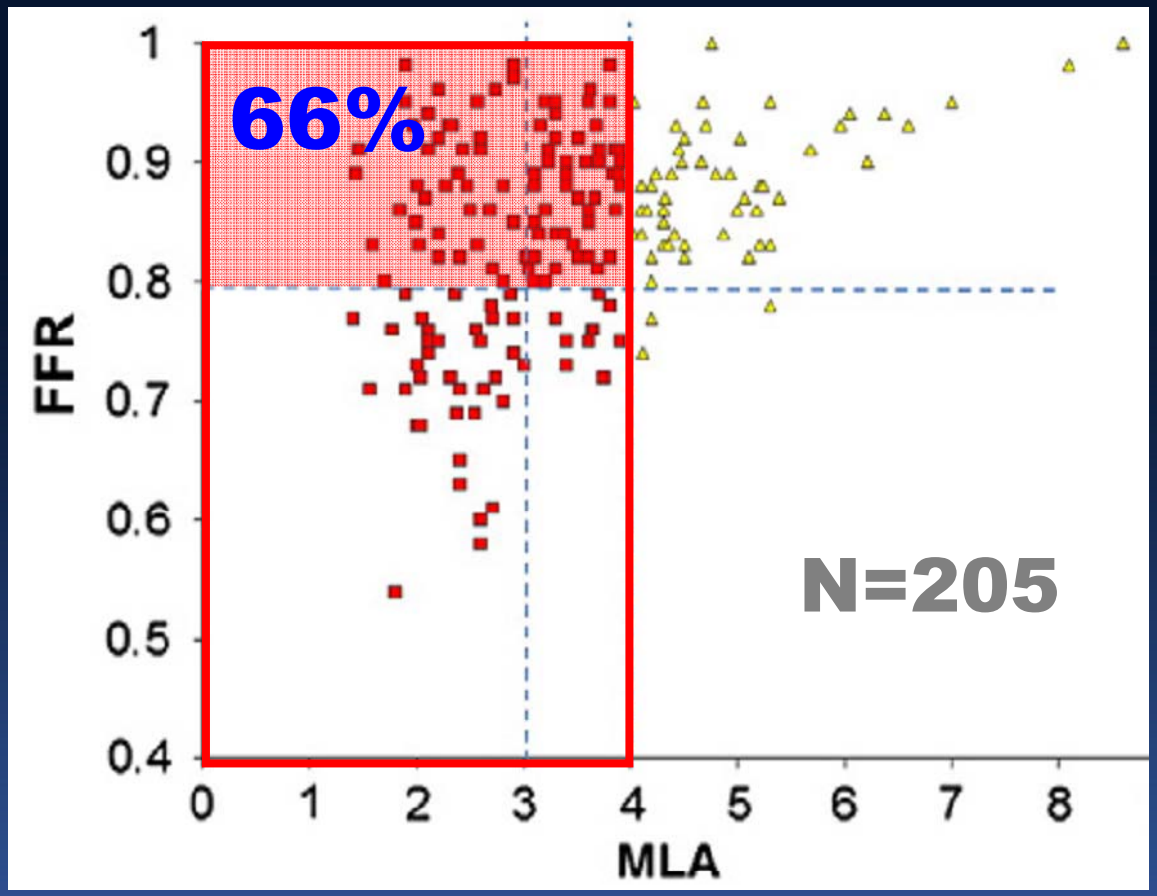


Sensitivity 90%
Specificity 60%
PPV 37%
NPV 96%
Accuracy 68%

40% of lesions with normal FFR were targets for unnecessary PCI

Kang et al. Circ Cardiovasc Interv 2011;4:65-71

Q2. Does MLA 4.0 Still Work in Western?



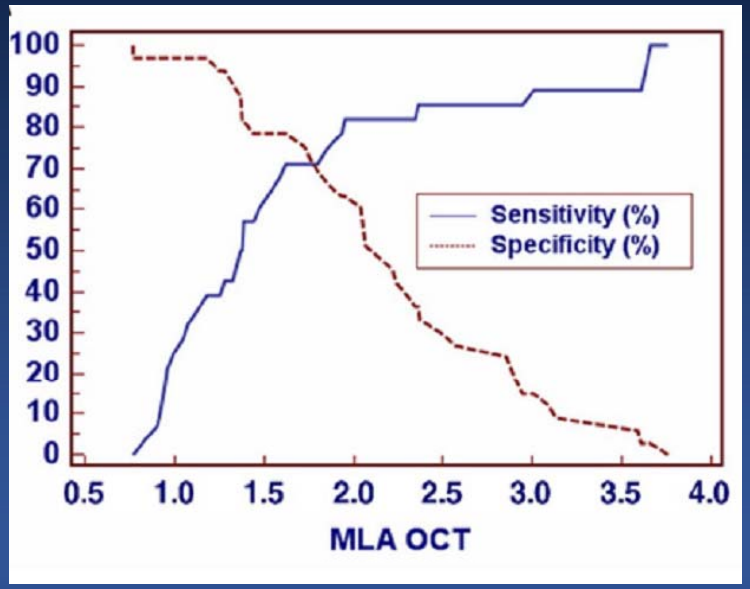
MLA 3.09mm^2
Sensitivity 69%
Specificity 72%
Accuracy 70%

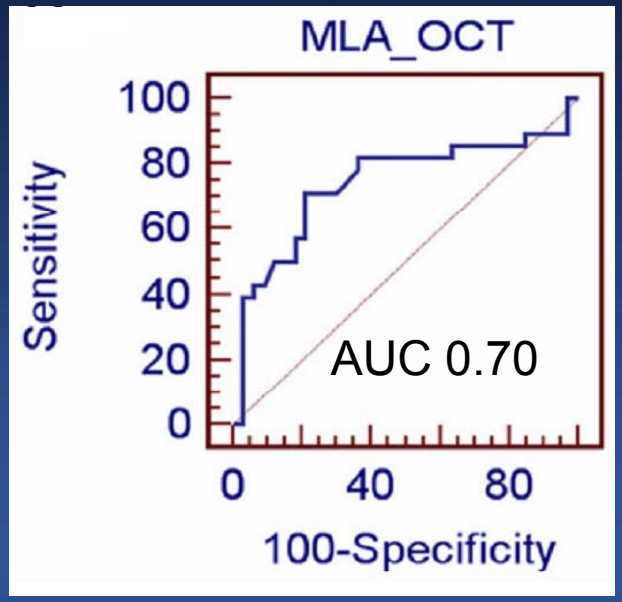
66% with MLA<**4.0**mm^2 had **FFR≥0.8**
53% with MLA<**3.0**mm^2

Ben-Dor et al. Cardiovasc Revasc Med 2012 (in press)

Q3. Is OCT-MLA More Accurate?

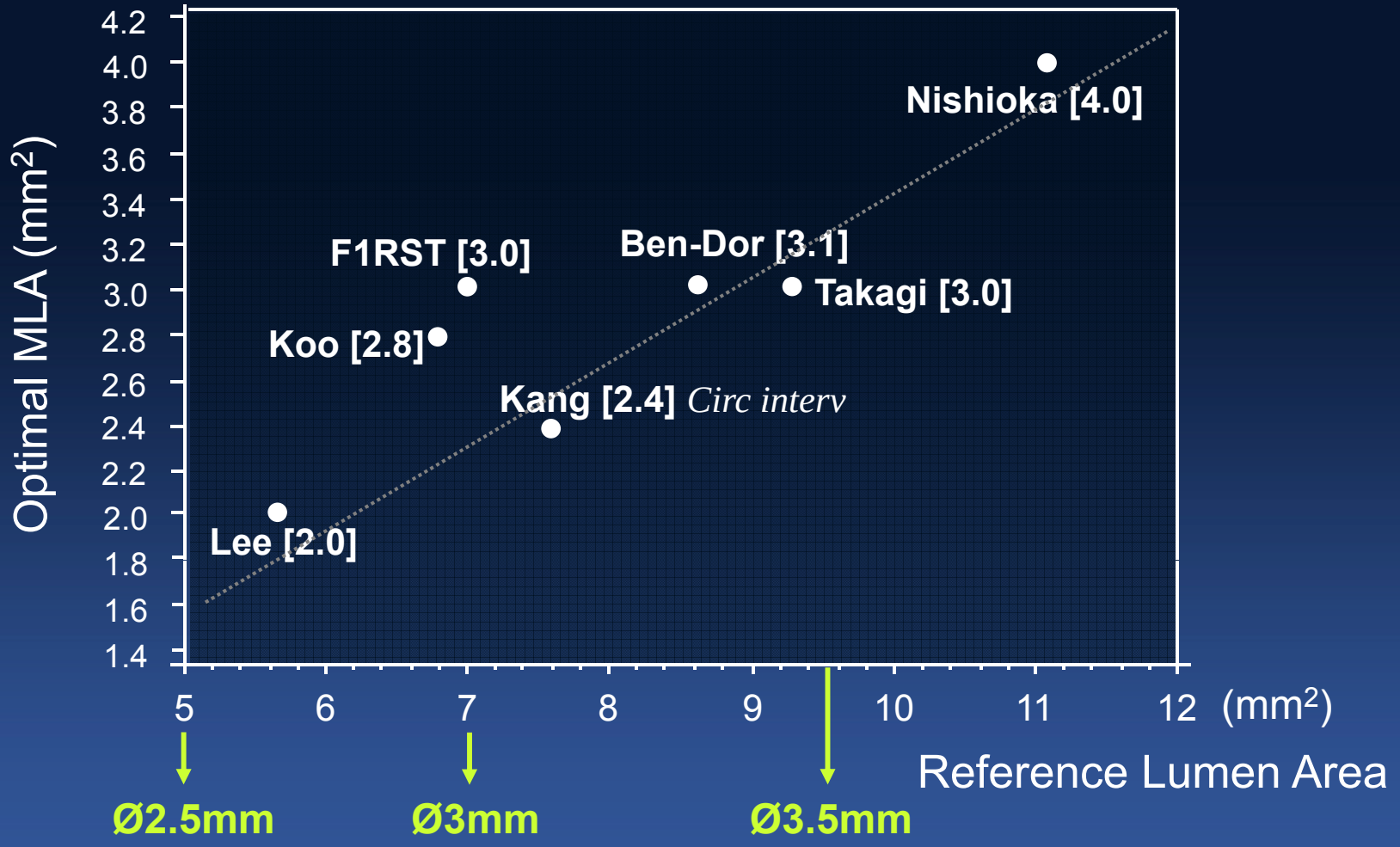
	FFR	MLA	AUC	Sens	Spec	PPV	NPV	Accuracy
IVUS	0.80	**2.36**	0.63	67%	65%	67%	65%	**66%**
OCT		**1.95**	0.70	82%	63%	66%	80%	**72%**





Gonzalo et al. J Am Coll Cardiol 2012;59:1080-9

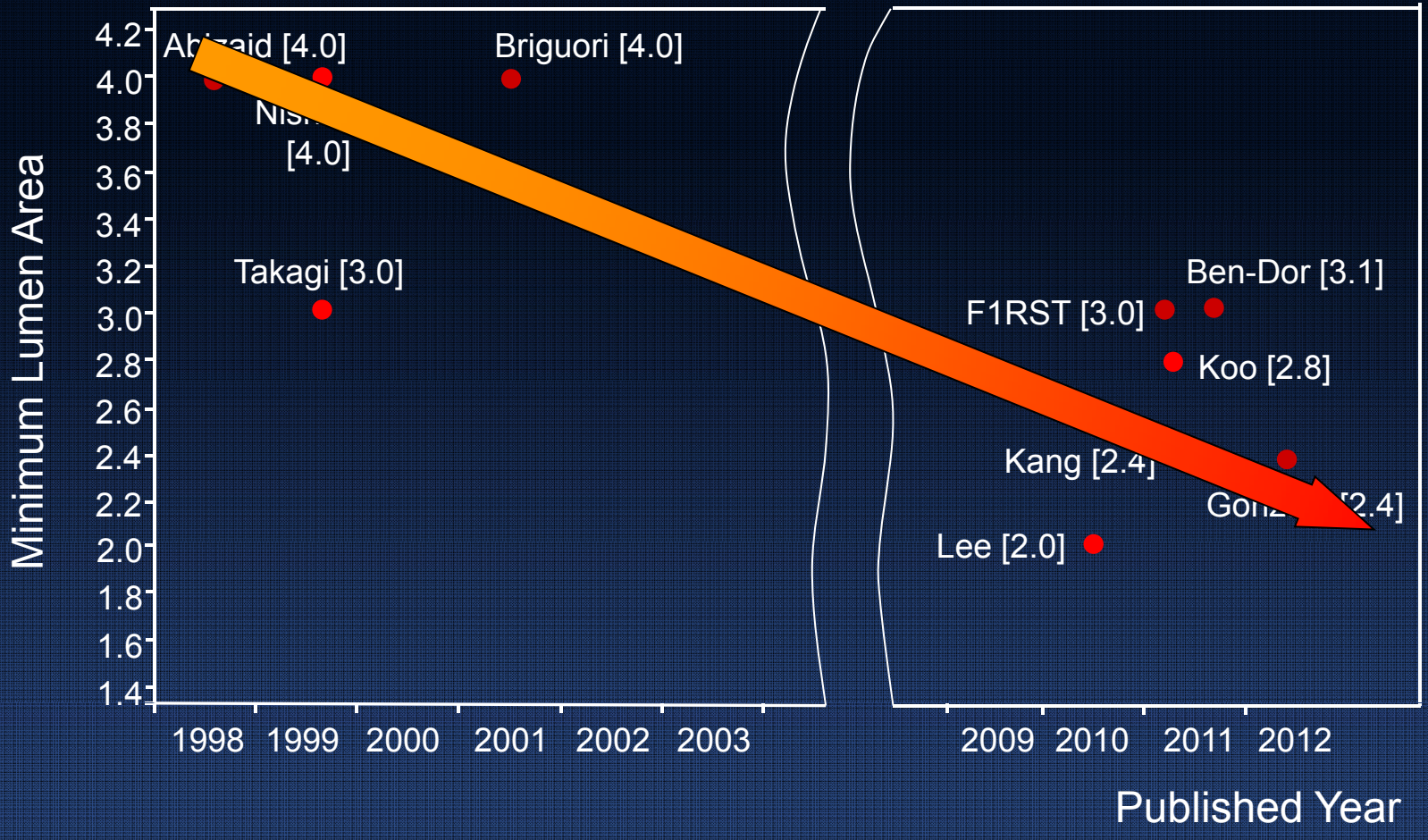
Q4. Do We Need a Specific Criteria According to Vessel Size?



Ben-Dor, Kang, Koo, F1RST, Gonzalo → **FFR< 0.80**

Takagi, Briguori, Lee → **FFR < 0.75,** Nishioka→ **thallium,** Abizaid→ **CFR<2.0**

MLA According to **Published Year**



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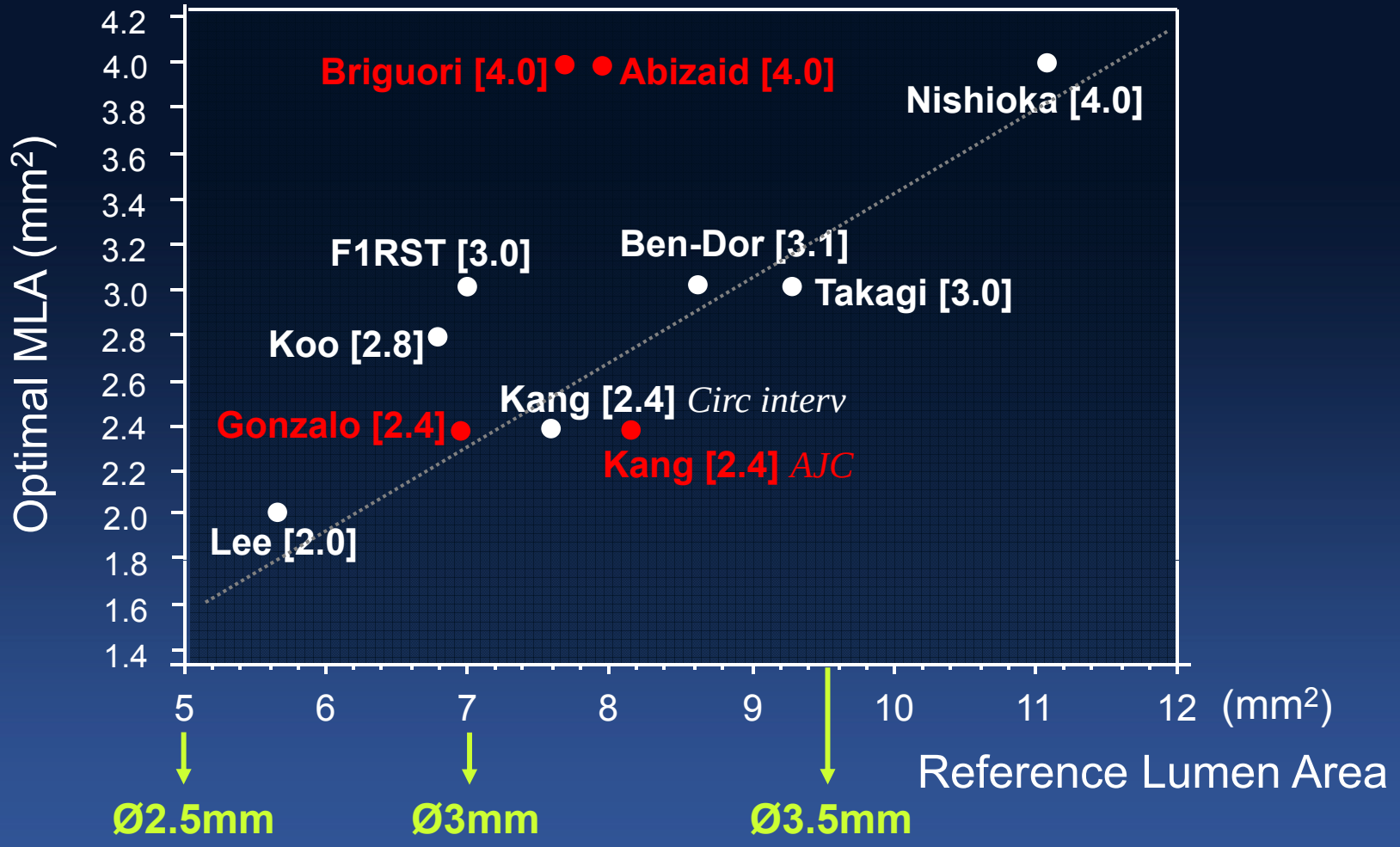

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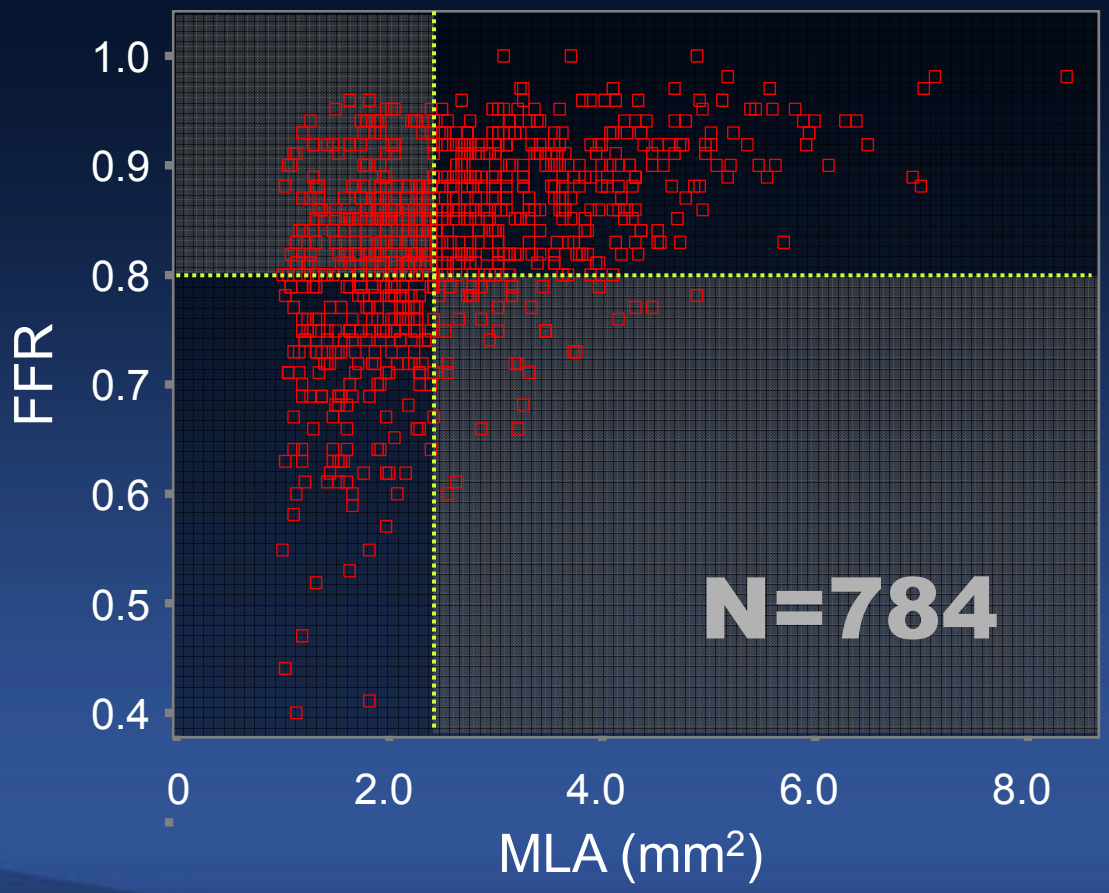
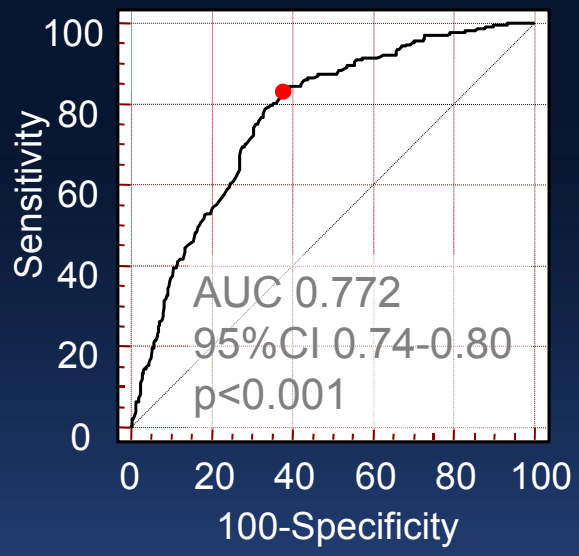
Usefulness of Minimal Luminal Coronary Area Determined by Intravascular Ultrasound to Predict Functional Significance in Stable and Unstable Angina Pectoris





Sens. 84%
Spec. 63%
PPV 48%
NPV 90%
Accuracy 69%

Kang et al. Am J Cardiol 2012;109:947-53

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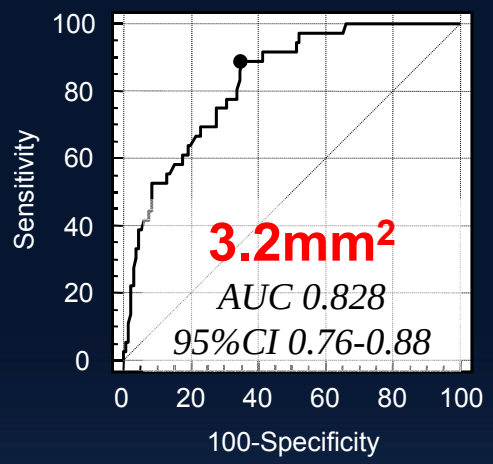
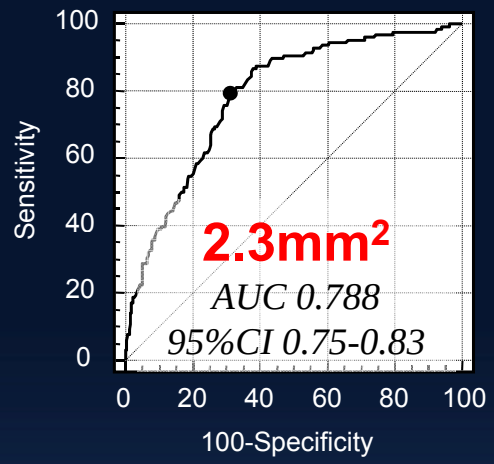
RLD>3.5mm [161]



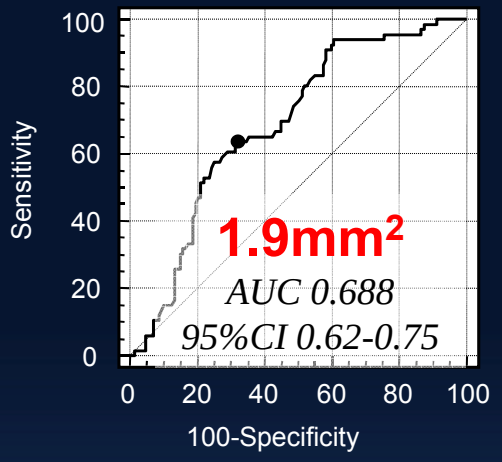
Sens 89% Spec 65%

RLD 2.75–3.5mm [439]



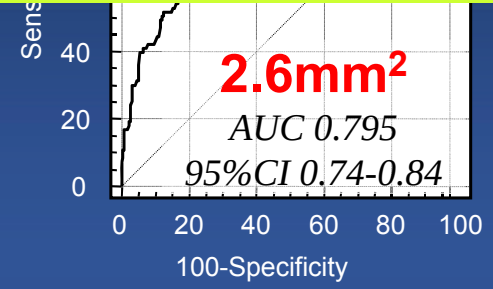
Sens 80% Spec 68%

RLD<2.75mm [184]

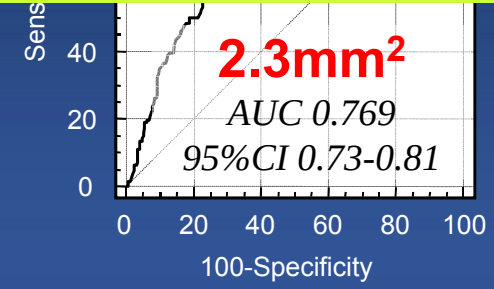


Sens 64% Spec 69%

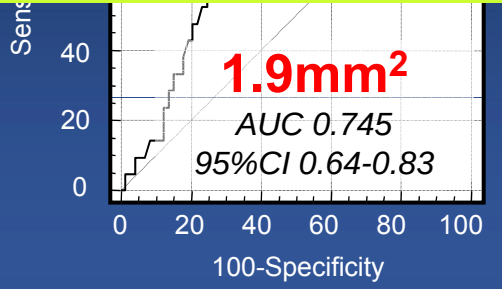
All Subgroup-Specific MLA Accuracies <70-75%



Sens 78% Spec 68%



Sens 84% Spec 65%



Sens 76% Spec 70%

Kang et al. Am J Cardiol 2012;109:947-53

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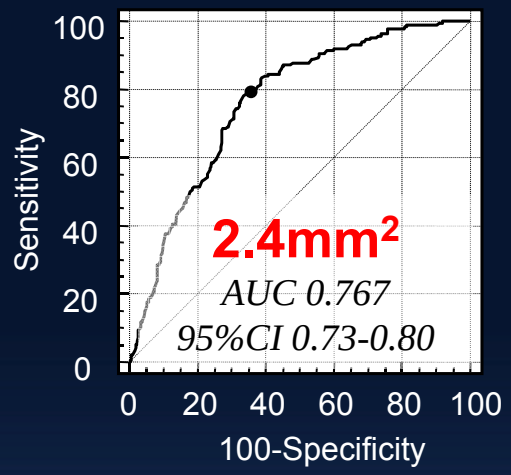
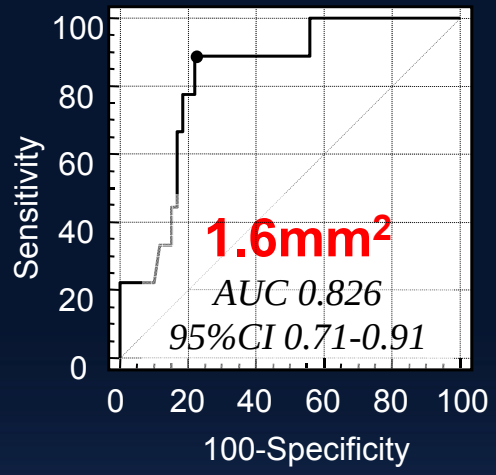
LAD [528]



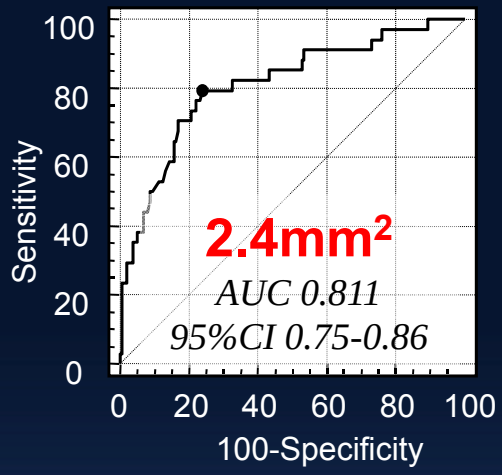
Sens 80% Spec 64%

LCX [68]



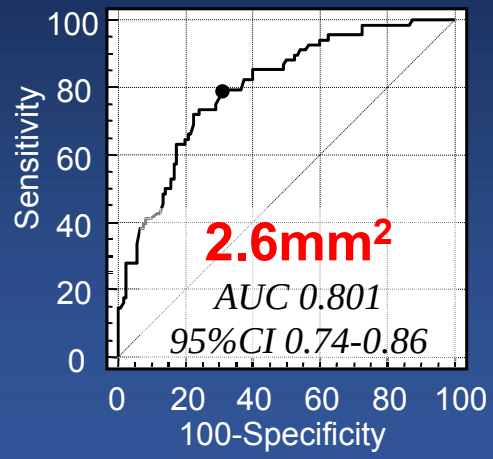
Sens 89% Spec 77%

RCA [188]



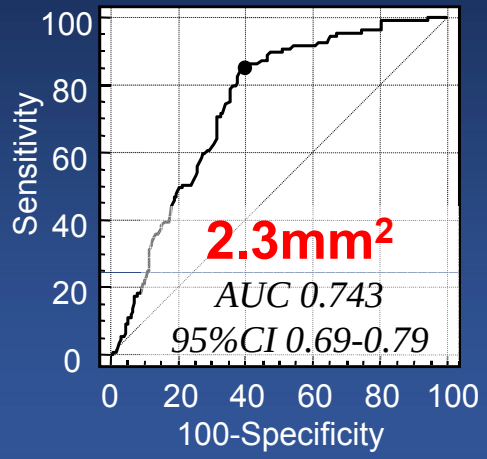
Sens 79% Spec 77%

Proximal LAD [180]



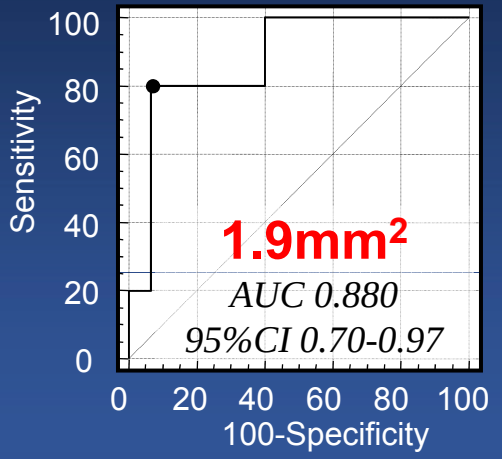
Sens 79% Spec 70%

Mid-LAD [323]



Sens 85% Spec 61%

Distal LAD [25]

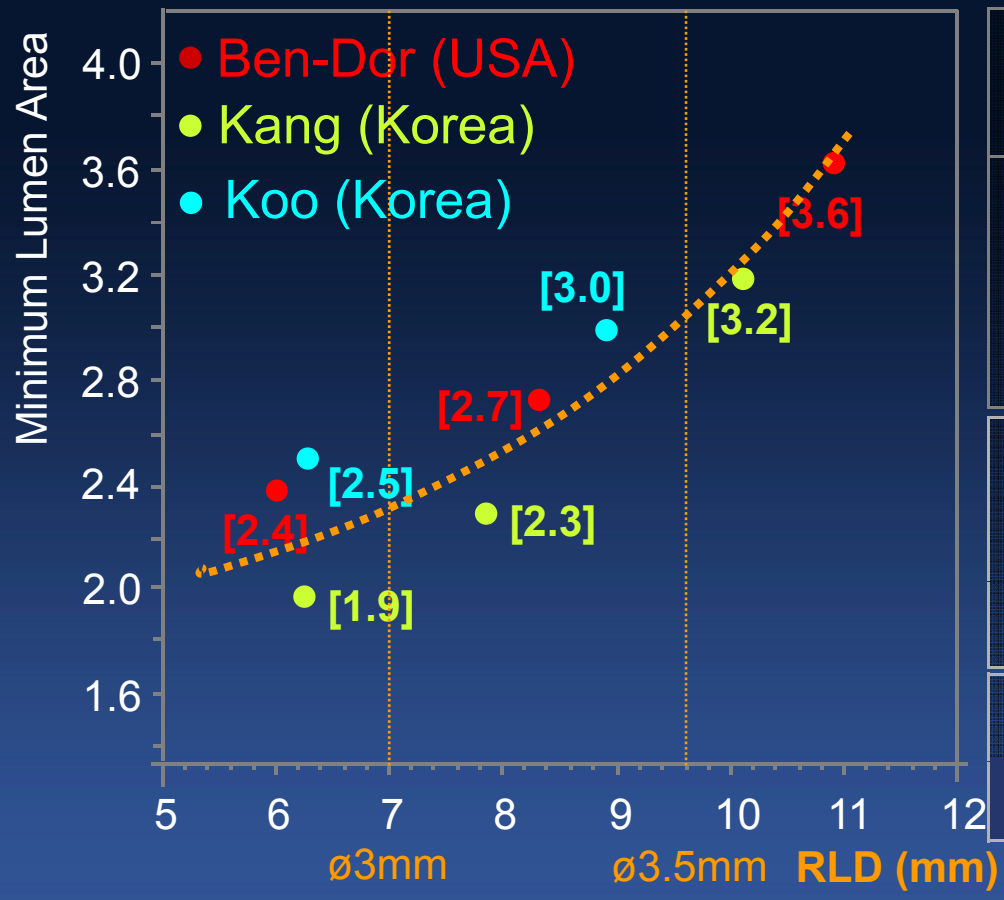


Sens 80% Spec 93%

Kang et al. Am J Cardiol 2012;109:947-53

Intravascular ultrasound lumen area parameters for assessment of physiological ischemia by fractional flow reserve in intermediate coronary artery stenosis

Itsik Ben-Dor, Rebecca Torguson, Teshome Deksissa, Anh B. Bui, Zhenyi Xue, Lowell F. Satler, Augusto D. Pichard, Ron Waksman *



	RLD mm	MLA mm^2	AUC
Ben-Dor	>3.5	3.6	**0.70**
N=205	3.0–3.5	2.7	**0.77**
	<3.0	2.4	**0.74**
Kang	>3.5	3.2	**0.83**
N=784	2.75–3.5	2.3	**0.79**
	<2.75	1.9	**0.69**
Koo	>3.0	3.0	**0.70**
N=784	<3.0	2.5	**0.61**

Ben-Dor et al. Cardiovasc Revasc Med 2012 (in press)
Kang et al. Am J Cardiol 2012;109:947-53
Koo et al. JACC Interv 2011;4:803-11

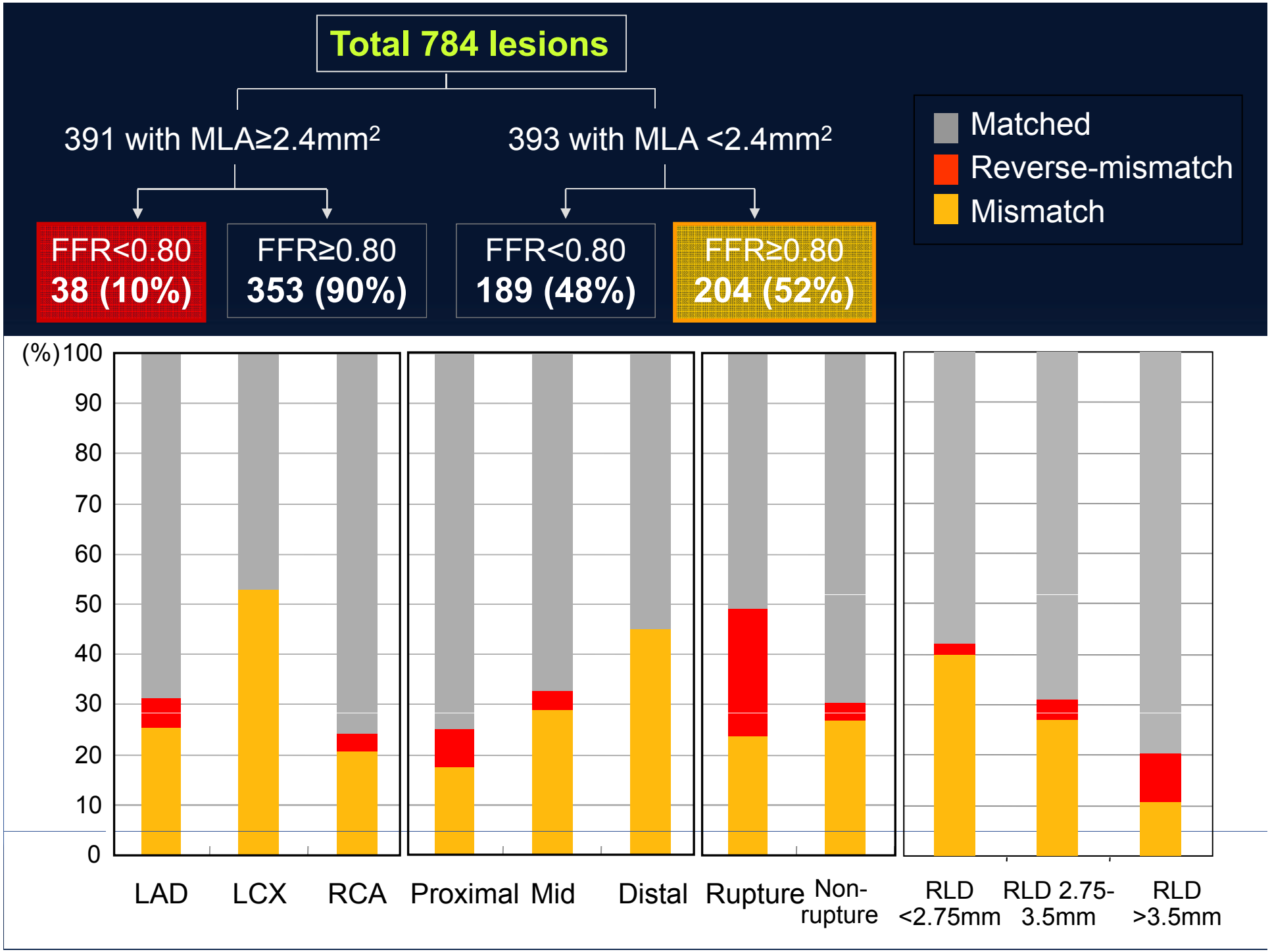
Q5. Why Mismatch?

Nov 2009-June 2011, **1000 consecutive patients** (1129 lesions with DS >30%) who underwent pre-PCI IVUS and FFR *(ClinicalTrials.gov NCT01366404)*

Factors Affecting FFR

	Beta	p-value	95% CI
Age	0.008	<0.001	0.004 - 0.011
LAD location	-0.386	<0.001	-0.462 - 0.311
Lesion length	-0.006	<0.001	-0.009 - 0.003
Plaque rupture	-0.165	0.020	-0.302 - 0.027
Minimal lumen area	0.185	<0.001	0.149 - 0.222
Plaque burden	-0.006	<0.004	-0.009 - 0.003

AMC data


Total 784 lesions
391 with MLA≥2.4mm²
393 with MLA <2.4mm²
FFR<0.80
38 (10%)
FFR≥0.80
353 (90%)
FFR<0.80
189 (48%)
FFR≥0.80
204 (52%)
Matched
Reverse-mismatch
Mismatch
(%)
100
90
80
70
60
50
40
30
20
10
0
LAD
LCX
RCA
Proximal
Mid
Distal
Rupture
Non-rupture
RLD <2.75mm
RLD 2.75-3.5mm
RLD >3.5mm

Predictors for Discordances

	Beta	p-value	Adjusted OR	95% CI
MLA<2.4 *but* FFR≥0.8 *"Mismatch"*				
Female gender	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

Age, female, LAD location, distal segment, plaque rupture, reference lumen ø

AMC data

MLA Criteria in Non-LM

	N	FFR	RLA	MLA	AUC	Sens	Spec	PPV	NPV	Accu
Briguori (2001 AJC)	53	0.75	7.8	**4.0**	–	92%	56%	38%	96%	**64%**
Ben-Dor (2012 *)	205	0.80	8.6	**3.09**	0.73	69%	72%	–	–	**70%**
Kang (2011 Circ int)	236	0.80	7.6	**2.4**	0.80	90%	60%	37%	96%	**68%**
Kang (2012 AJC)	784	0.80	8.2	**2.4**	0.77	84%	63%	48%	90%	**69%**
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** IVUS	0.63	67%	65%	67%	65%	**66%**

Furthermore, the accuracies of specific MLA criteria optimized by vessel size still remain poor

Best IVUS-MLA Criteria for LM

To identify Functionally Significant Stenosis

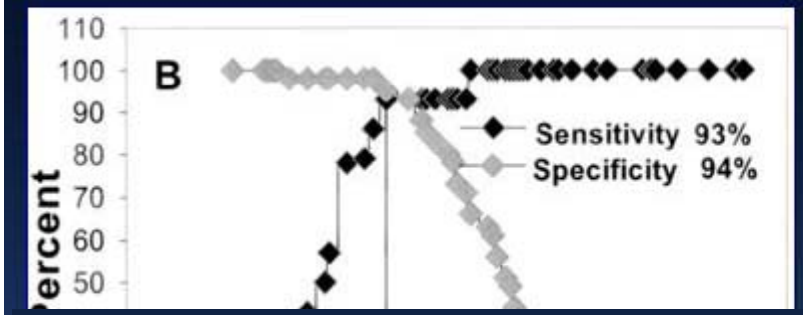
	IVUS Criteria	To predict	Outcomes
Jasti[1]	MLD 2.8mm MLA **5.9**mm^2	FFR 0.75	38-month Survival / MACE-free
Fassa[2]	MLA **7.5**mm^2	3-yr MACE	MACE-free 88% with medical Tx 79% with revascularization
Fassa[2]	MLA **9.6**mm^2	3-yr MACE	The best cut-off value on ROC based on MACE in deferred lesions
Abizaid[3]	MLD 3.0mm	1-yr MACE	60% in MLD<2.0mm 3% in MLD>3.0mm

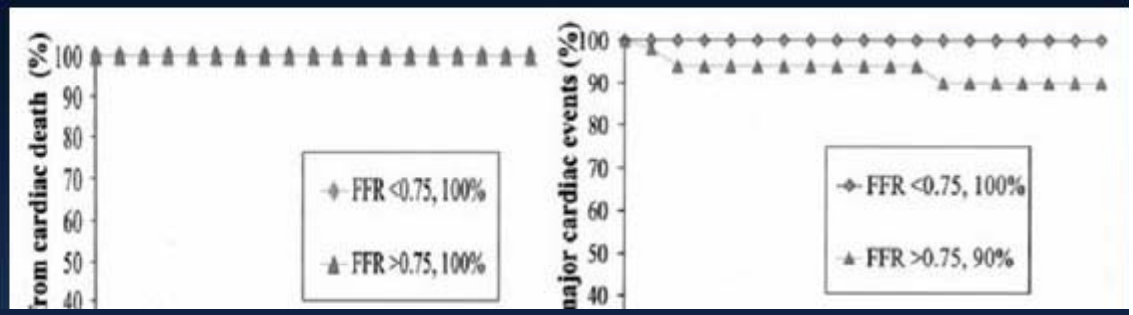
The cut-off and its accuracy still remains debatable

[1]Circulation 2004;110:2831–6, [2] JACC2005;45:204–11, [3]JACC 1999;34:707-15

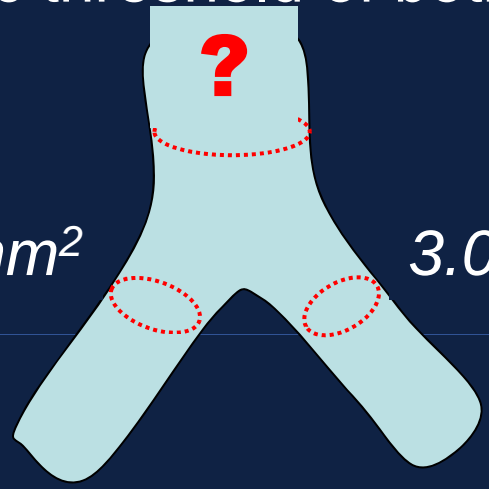
MLA< 6.0mm^2 Predicts LM FFR<0.75

- Sum of lumen areas of two daughter vessels (Each of LAD and LCX should be 4.0mm^2)= 150% of the parent LM
- Murray's Law (*LM* r^3 = *LAD* r^3 +*LCX* r^3)





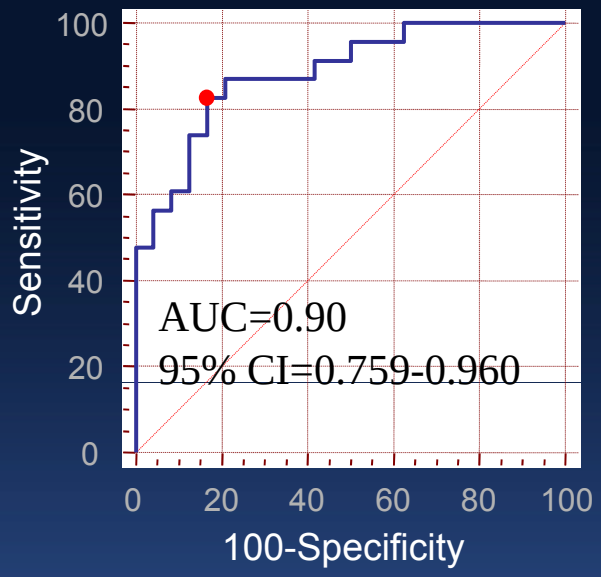
Obtained from Murray's law considering an **MLA 4.0mm^2** as ischemic threshold of both branches



3.0mm^2 *3.0mm^2*

IVUS-MLA Predicting FFR<0.80

55 Isolated LM with DS 30-80%

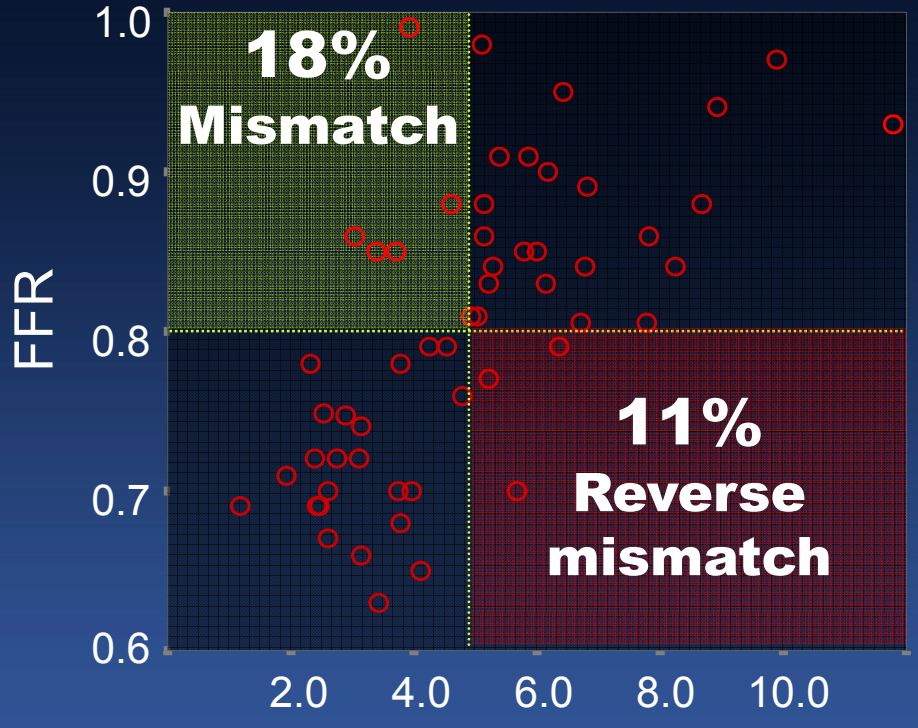


If MLA 6.0mm^2

Sens 96%, Spec 47%

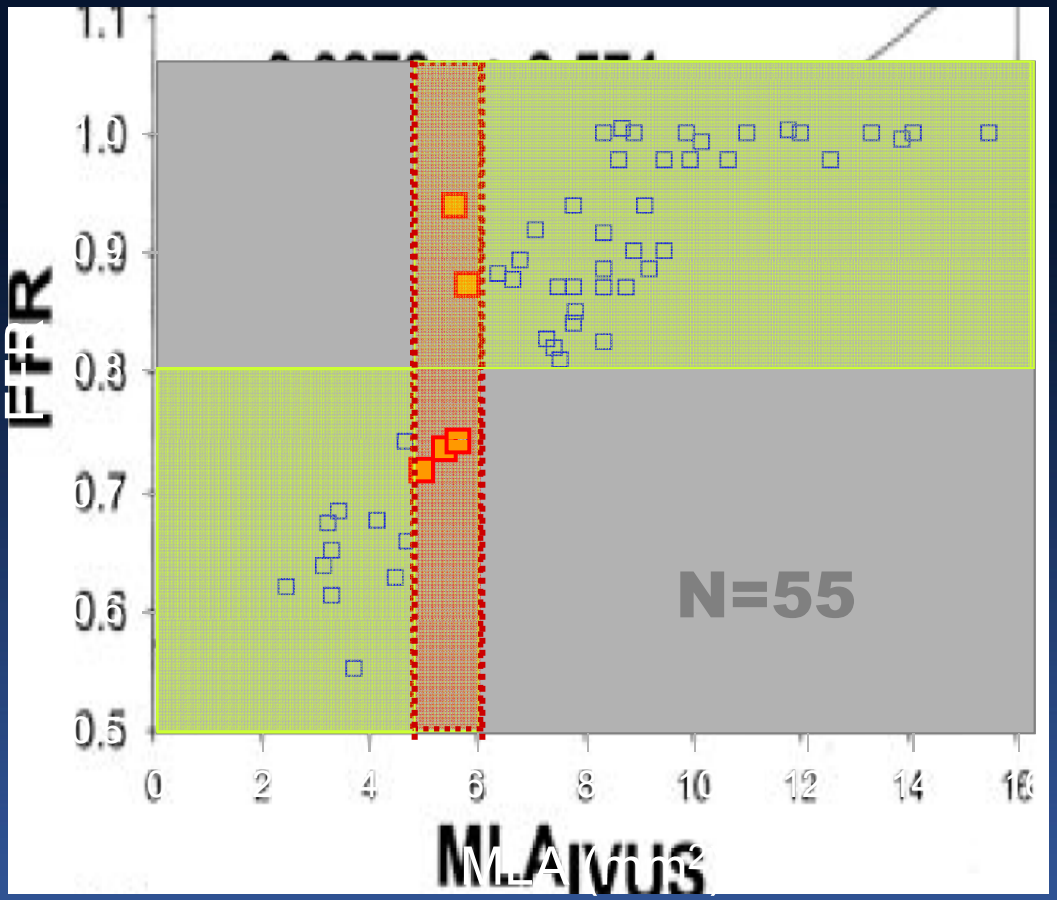
Accuracy 73%

MLA 4.8mm^2



Kang et al. JACC Interv 2011;4:1168-74

Q6. Why is it Different from 6.0mm²?



MLA 6.0mm²

Sens 100%, Spec 95%

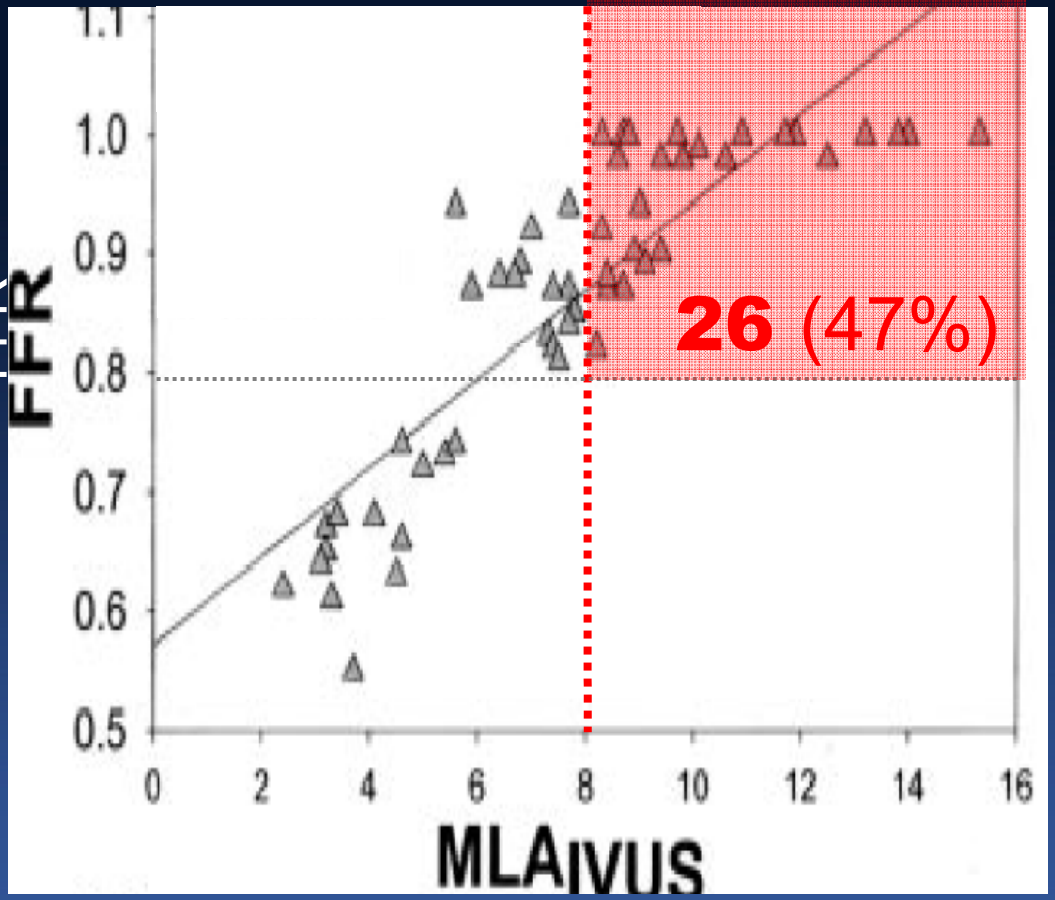
Accuracy 96%

If MLA 4.8mm²

Accuracy 95%

Jasti et al. Circulation 2004;110:2831–6

Q6. Why is it Different from 6.0mm²?



MLA 4.8mm²

Sens 89%, Spec 83%

Accuracy 86%

0.75

If add 26

with larger MLA >8.0

→ Accuracy 90%

Inclusion of extremely mild lesions makes the overall accuracy better

Kang et al. JACC Interv 2011;4:1168-74

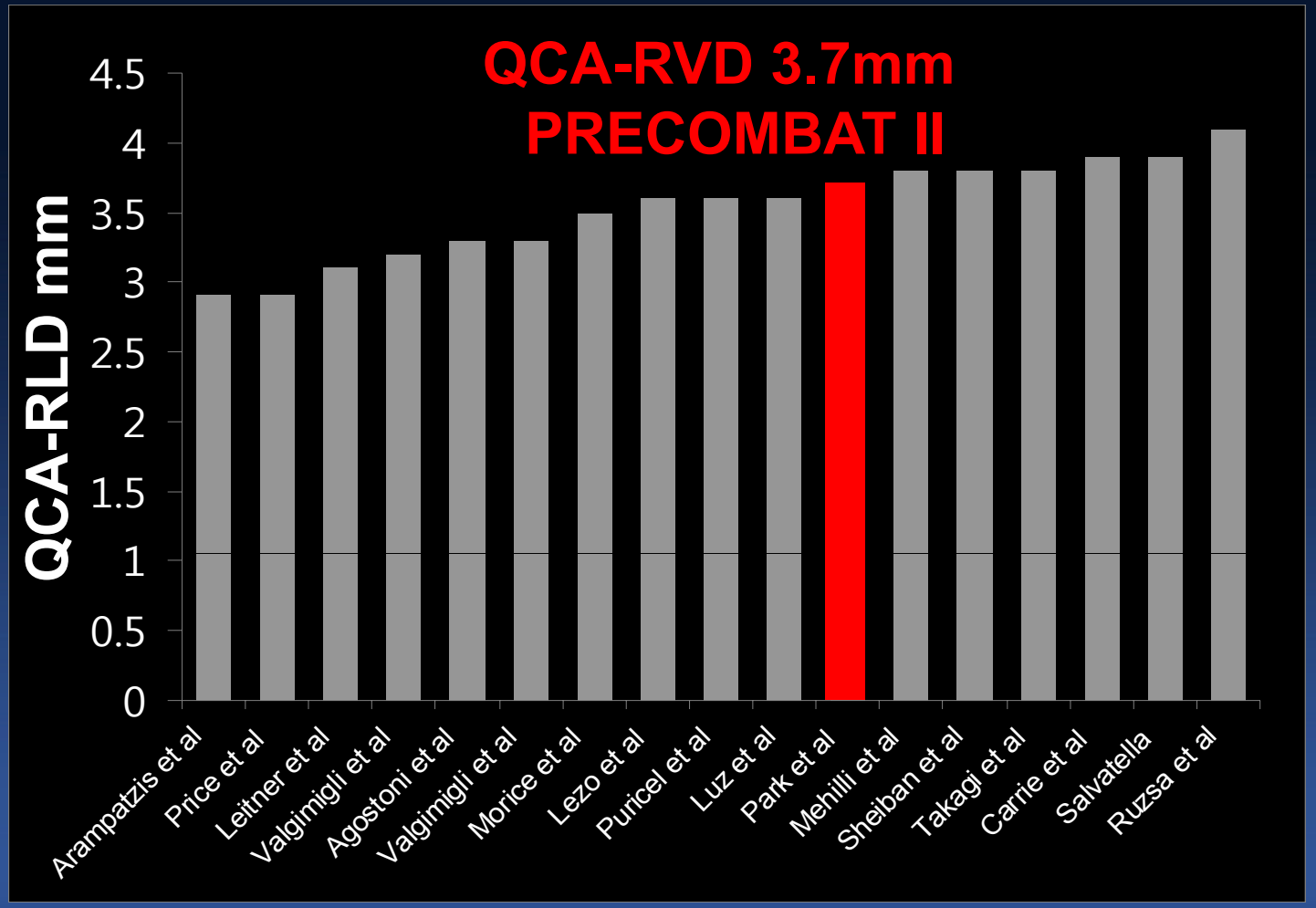
Q7. Is LM Size Different Among Studies?

	Jasti	Abizaid	Kang
N	55	122	55
IVUS criteria	**MLA 5.9mm²**	**MLD 3.0mm**	**MLA 4.8mm²**
Validated with	FFR<0.75	MACE	FFR<0.80
FFR<0.80	25%	–	47%
Proximal RLD, mm	**4.2±1.0**	**3.9±0.8**	**3.9±0.6**
QCA-MLD, mm	2.1±0.9	2.3±0.8	2.0± 0.5
IVUS-MLA, mm²	7.7±3.0	9.3±5.3	4.9±2.4

Jasti et al. Circulation. 2004;110:2831-6
Abizaid et al. J Am Coll Cardiol 1999;34:707–15
Kang et al. JACC Interv 2011;4:1168-74

Reference Vessel Size in LM PCI

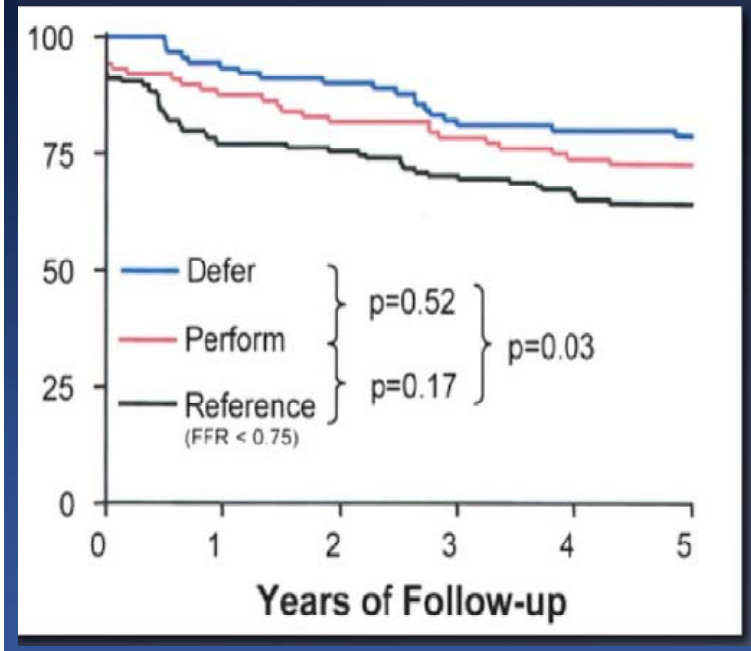
2309 USA/EU Patients in 17 Studies



Q8. FFR Criteria Safe for Deferral?

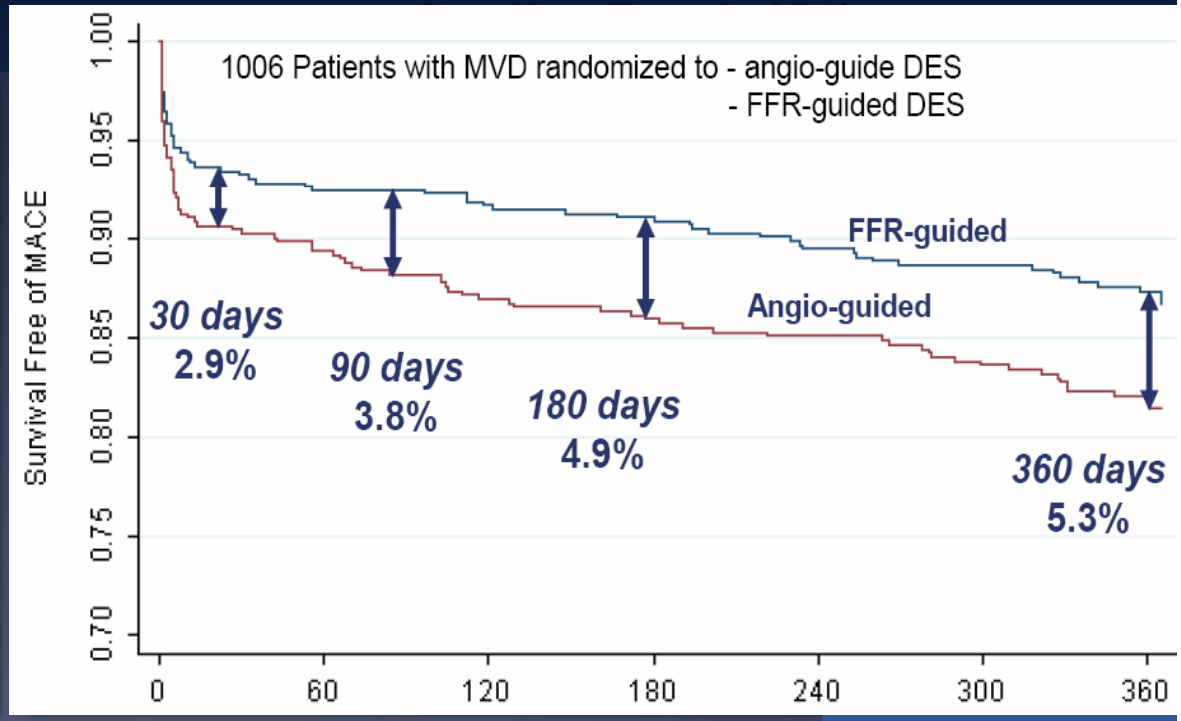
DEFER
FFR >0.75

Event-Free Survival (%)



Pijls et al. J Am Coll Cardiol 2007;49:2105-11

FAME
FFR >0.80

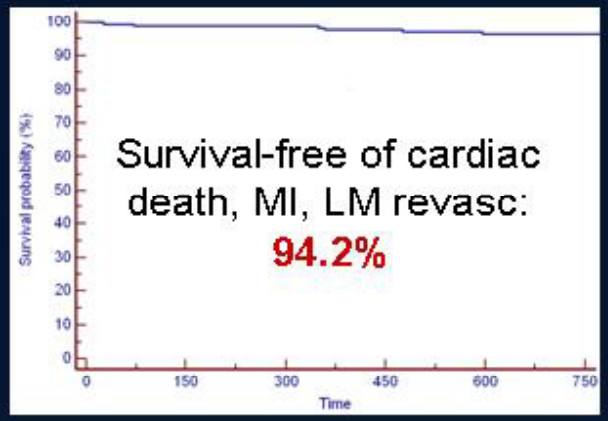


Tonino et al. N Engl J Med 2009;360:213-24

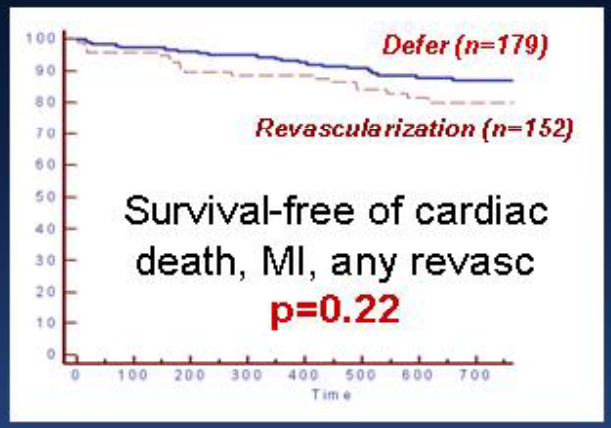
Q9. Morphologic Criteria for Deferral?

LITRO Study

2-Year Outcome of Deferred Lesions with MLA >6mm^2



2-Year Outcome of Deferred vs. Revasc



Nobody deferred the lesions with MLA<6.0 in a prospective trial

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

CardioVascular Research Foundation
University of Ulsan College Medicine
Asan Medical Center

Prospective app

- 44% age<75 years
- 31% high surgical risk
- 50% lung/renal comorbidity
- 75% bifurcations
- 38% heavy calcification
- 38% problem for dual anti-platelets

M

7 revascularized

16 were not treated

No LM revascularization
(n=179, 96%)

LM revascularization
(n=152, 90%)

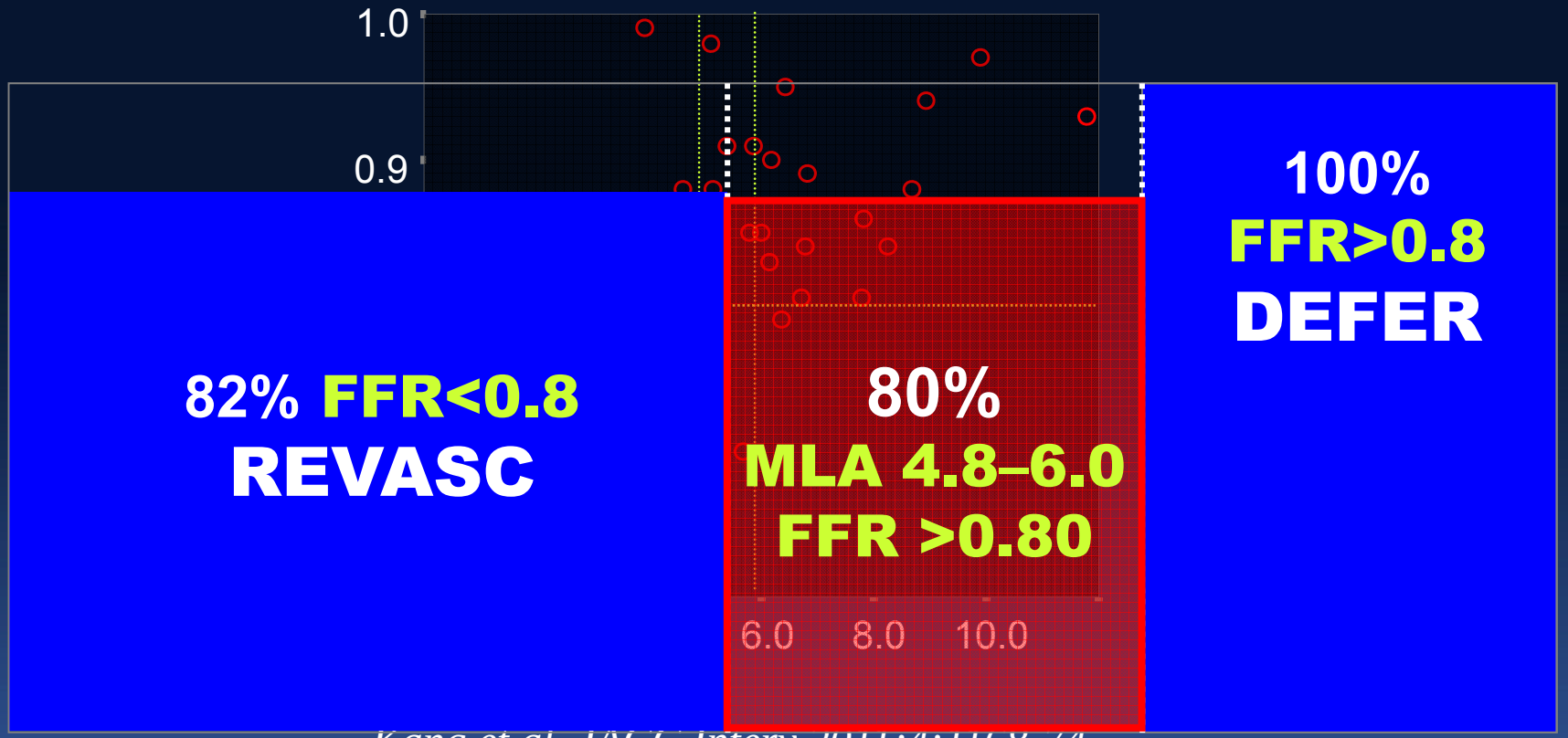
56% PCI of other vessels

55% CABG
45% PCI + other vessels 62%

- Cardiac death-free survival→ **86%** (vs. 98% DEFER)
- Composite events-free survival* → **63%** (vs. 87% DEFER)

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

Q10. Treatment, Where Are We?



Kang et al. JACC Interv 2011;4:1168-74

MLA 4.8 ← → MLA 6.0

Conclusions

Because IVUS-MLA is only one of various factors affecting coronary hemodynamics, even the subgroup-specific criteria were inaccurate to identify ischemia-inducing stenosis

Don’t Use a Larger MLA
Just Measure FFR