IVUS MLA Criteria and FFR: Left Main and Non-Left Main

Soo-Jin Kang, MD., PhD.

Department of Cardiology, University of Ulsan College of Medicine
Asan Medical Center, Seoul, Korea

Disclosure Statement of Financial Interest

I, Soo-Jin Kang DO NOT have a financial interest /arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation

Meta-analysis of 11 Clinical Trials

1759 patients with 1953 lesions

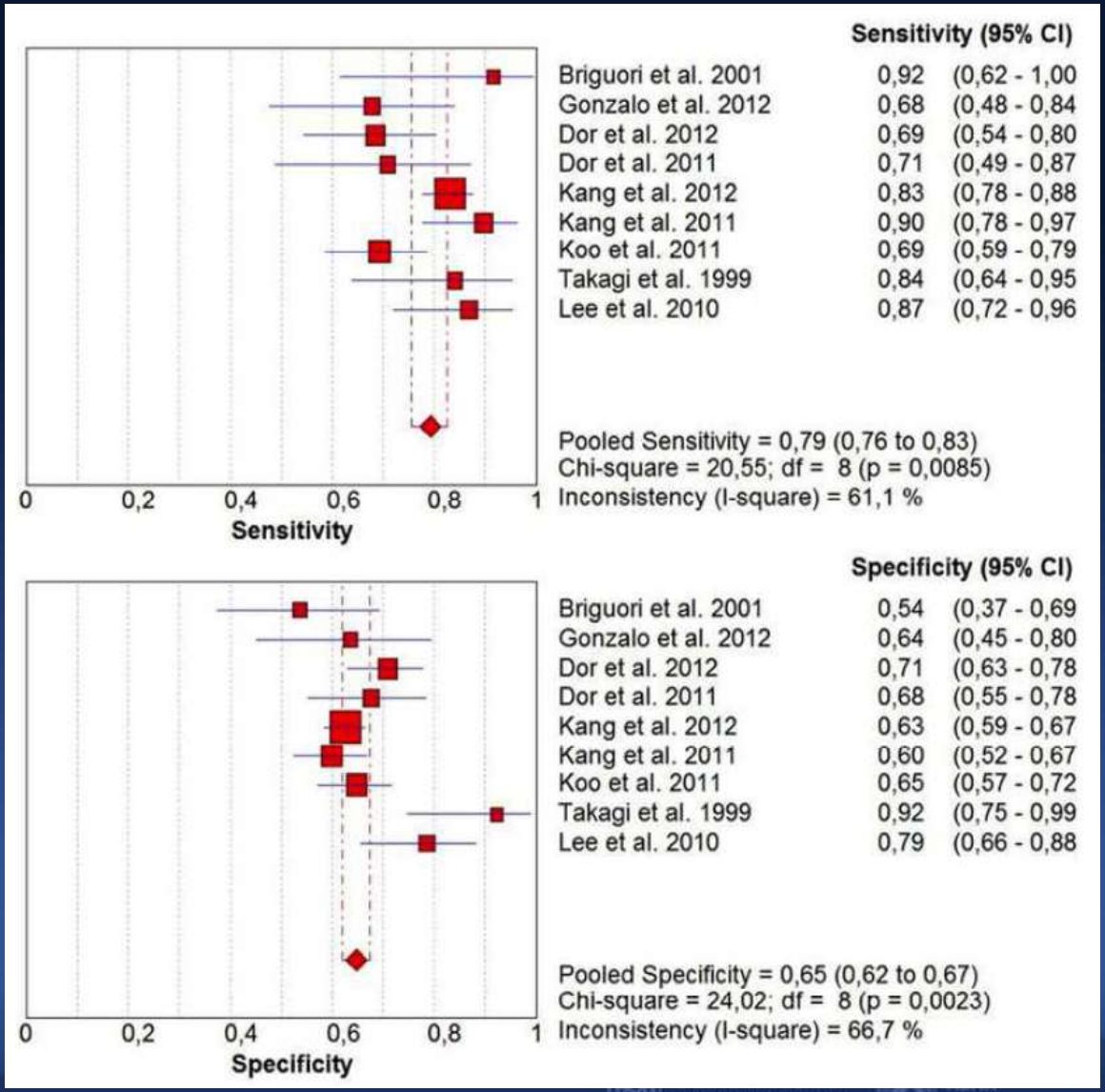
In Non-LM Lesions

Weighted **MLA 2.61**mm^2

To predict FFR <0.80

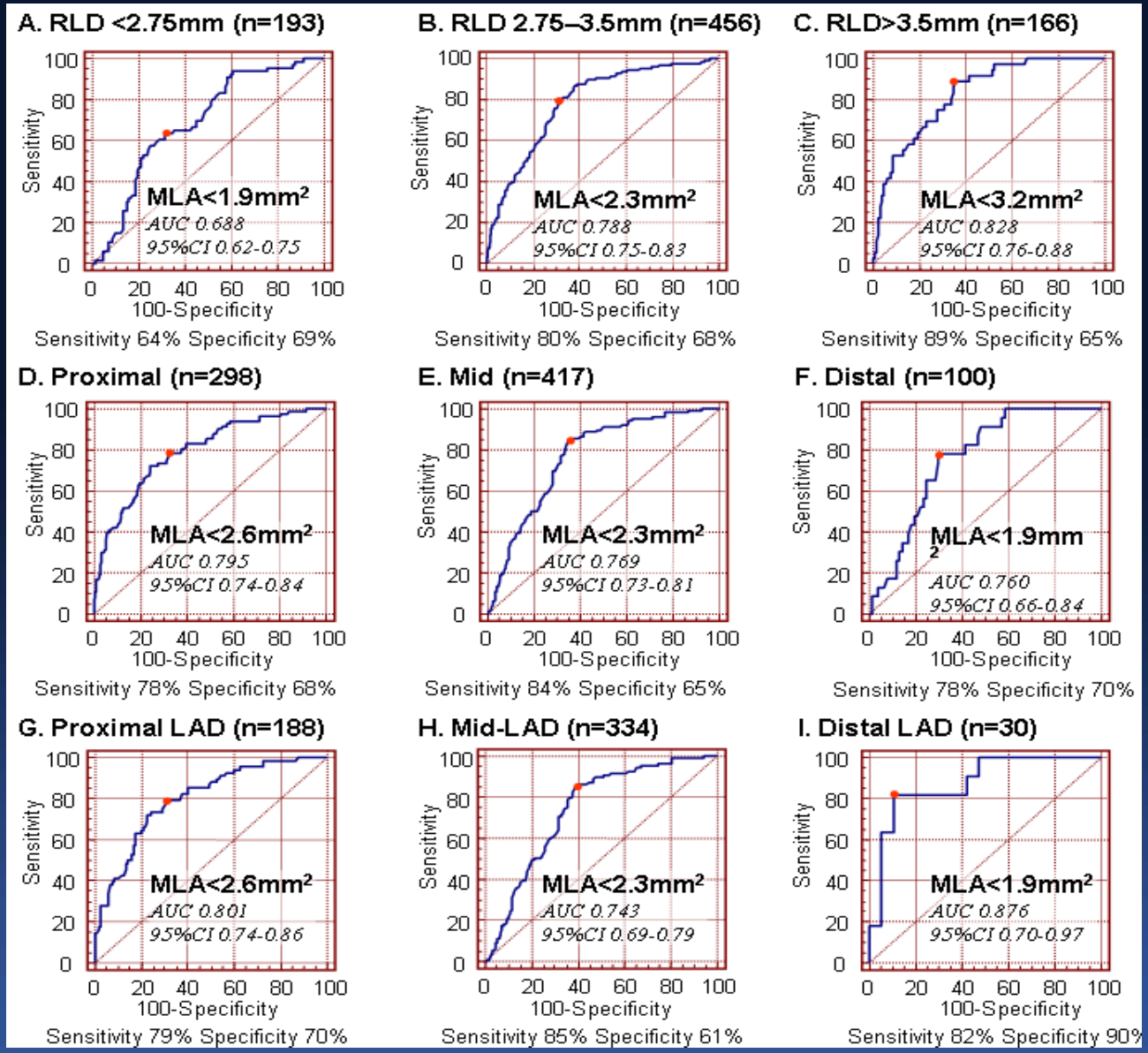
Pooled sensitivity **79%**

Pooled specificity **65%**



Nascimento et al. Catheter Cardiovasc Interv 2013 (in press)

	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%**
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%**
Gonzalo (2012 JACC)	61	0.80	7.1	**1.95** OCT	0.70	82%	63%	66%	80%	**72%**



Subgroup-specific MLA, accuracies <70-75%

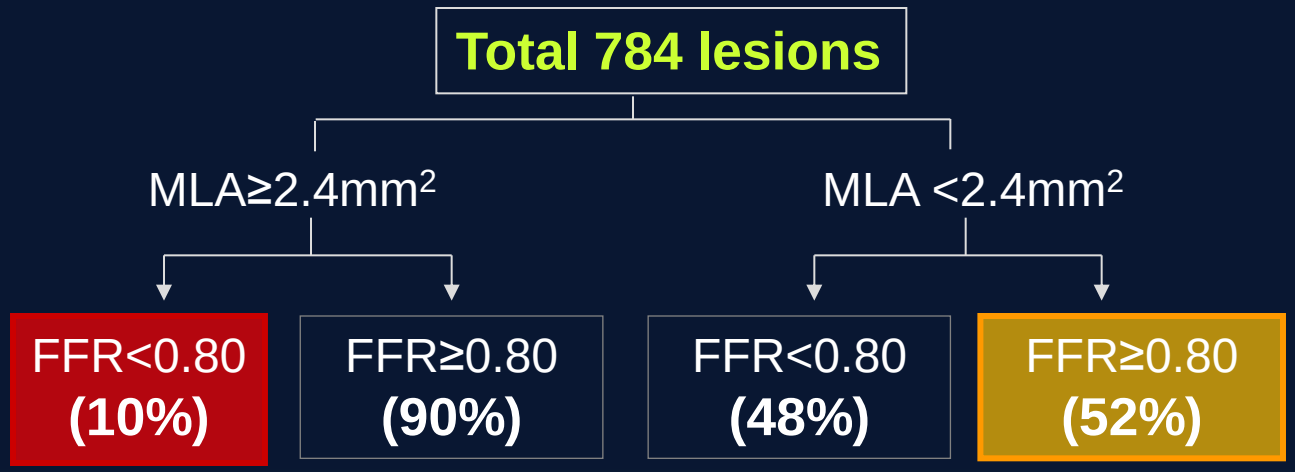
Kang et al. Am J Cardiol 2012;109:947-5

Subgroup-specific MLA

544 intermediate lesions assessed in 516 pts from 24 centers

FFR ≤0.80 in 169/544 lesions (31.1%) and 167/516 pts (32.4%)

	N	MLA cutoff	C-statistic	Accuracy
All lesions	544	2.9 mm^2	0.66	66.0%
LAD	296	2.9 mm^2	0.64	63.5%
LCX	110	2.4 mm^2	0.72	77.3%
RCA	138	2.8 mm^2	0.75	77.5%
Proximal	259	3.0 mm^2	0.76	74.9%
Mid	195	2.6 mm^2	0.63	65.6%
Distal	90	3.0 mm^2	0.63	51.1%
RVD <3.0 mm	322	2.6 mm^2	0.65	66.1%
RVD ≥3.0 mm	219	3.0 mm^2	0.71	72.6%
Length ≤12.3 mm	272	3.0 mm^2	0.67	64.7%
Length >12.3 mm	269	2.8 mm^2	0.69	68.8%

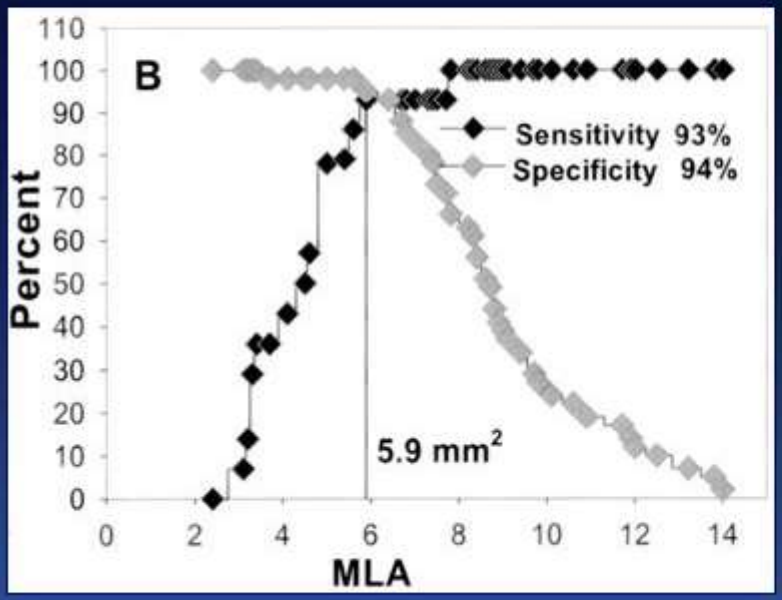


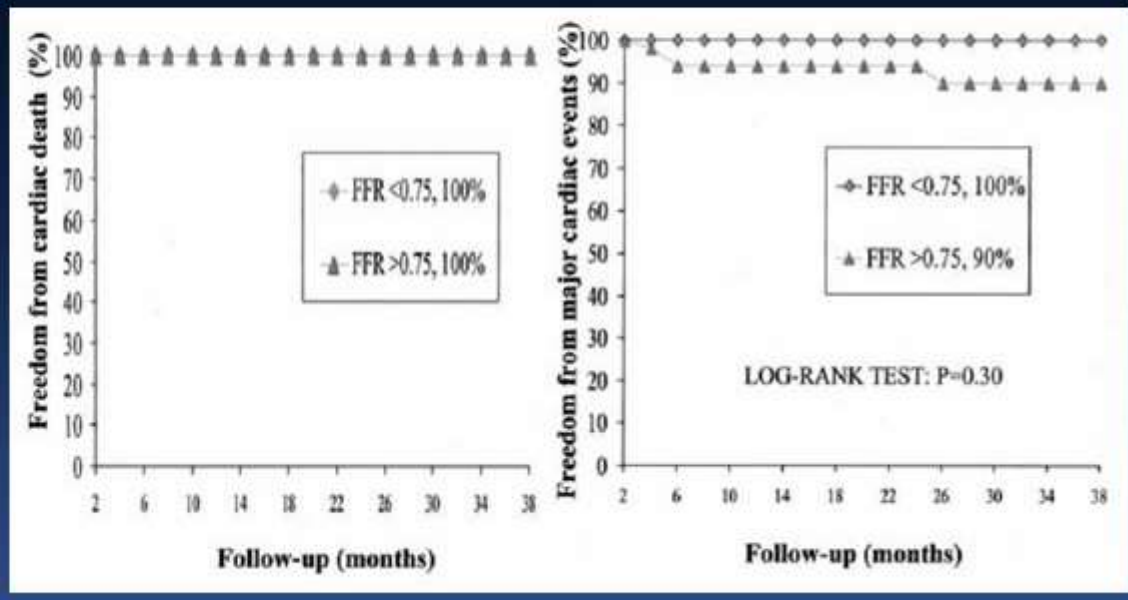
	Beta	p-value	Adjusted OR	95% CI
MLA<2.4 but FFR≥0.8 "Mismatch"				
Women	0.371	0.048	1.450	1.003 – 2.095
LAD location	-0.406	0.027	0.666	0.465 – 0.954
Reference lumen ø	-1.209	<0.001	0.298	0.204 – 0.437
Distal segment	0.704	0.002	2.021	1.293 – 3.159
MLA≥2.4 but FFR<0.8 "Rev-mismatch"				
Age	-0.062	<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

Kang et al. Am J Cardiol 2012;109:947-5

Cut-off for Predicting LM FFR<0.75
*LM MLA 6.0*mm^2

- 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)

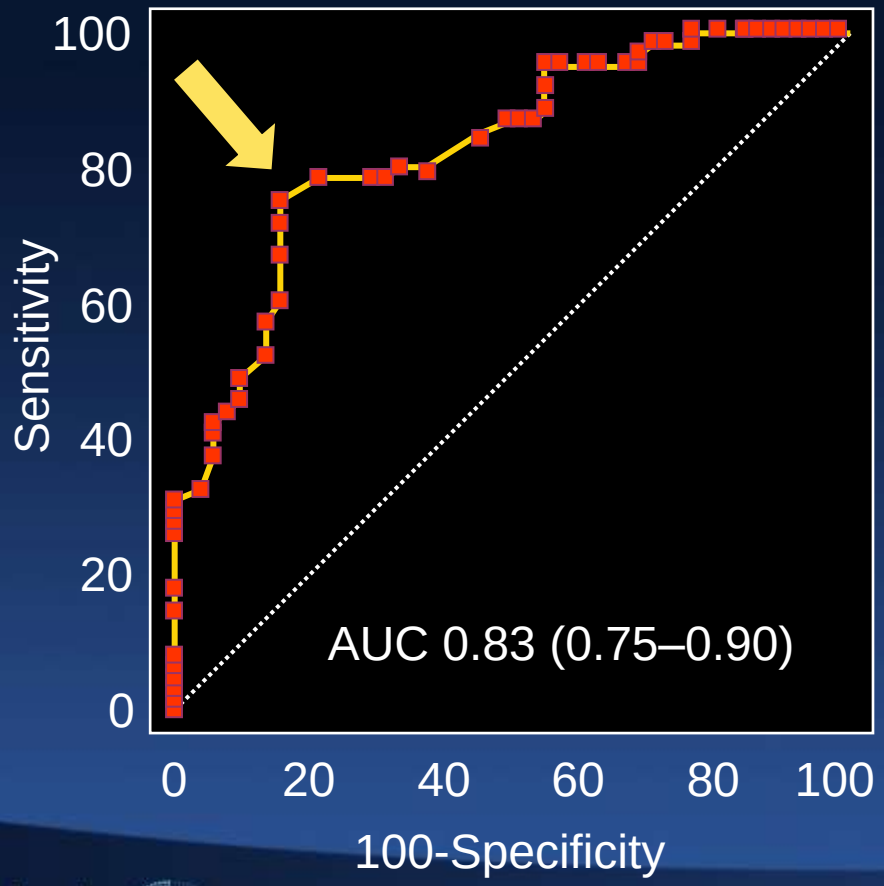




Jasti et al. Circulation 2004;110:2831-6

New LM MLA 4.5mm^2

Matched with FFR <0.80
Ostial and Shaft LM Disease (N=112)



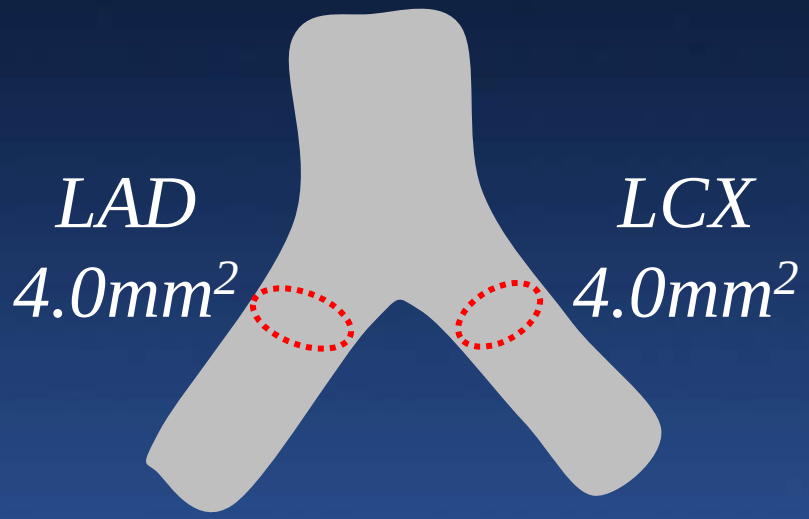
Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%

Park SJ et al. JACC Interv 2014;7:868–74

Geometric Abstraction

Old MLA cut-off 6.0mm^2 was obtained from *Murray's law* considering an **MLA 4.0mm^2** as ischemic threshold of both LAD and LCX

LM 6.0mm^2

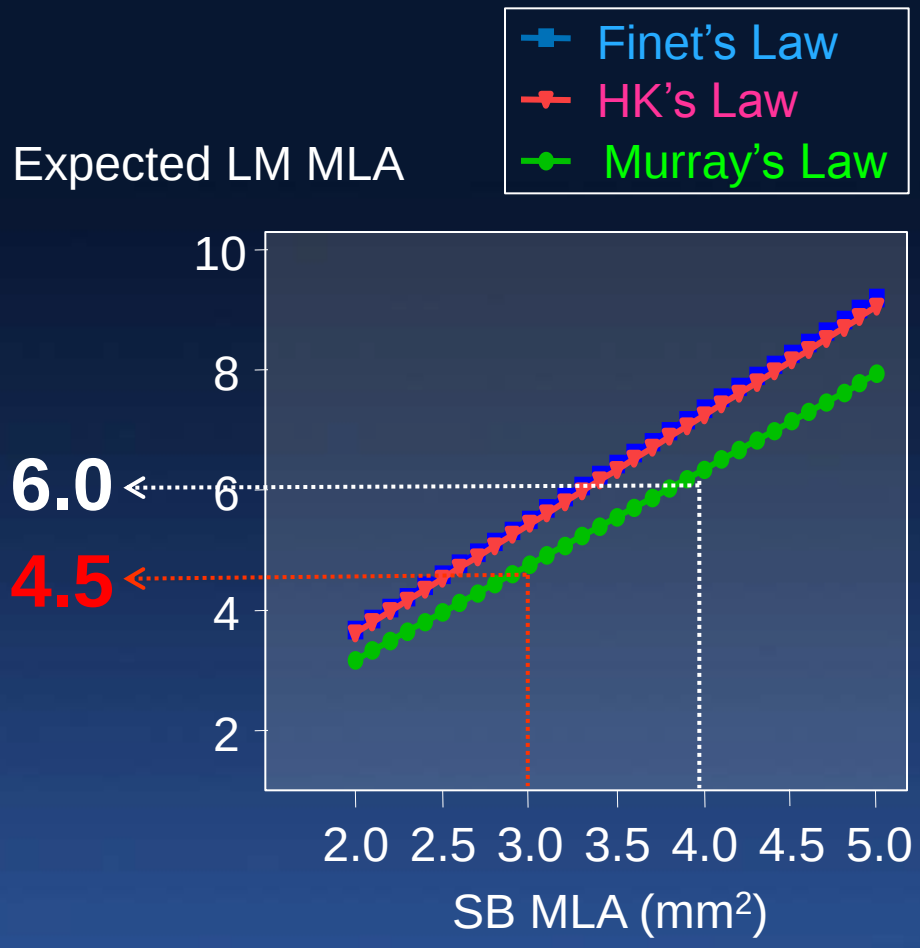


LAD	LCX	LM (Murray's)
4.0	***4.0***	***6.35***
4.0	3.9	6.27
4.0	3.8	6.19
4.0	3.7	6.11
4.0	3.6	6.04
4.0	3.5	5.96

De La Torre Hernandez et al. JACC 2011;58:351-8
Jasti et al. Circulation 2004;110:2831-6

False Assumption…
The used cut-off 4.0mm² is too Big!

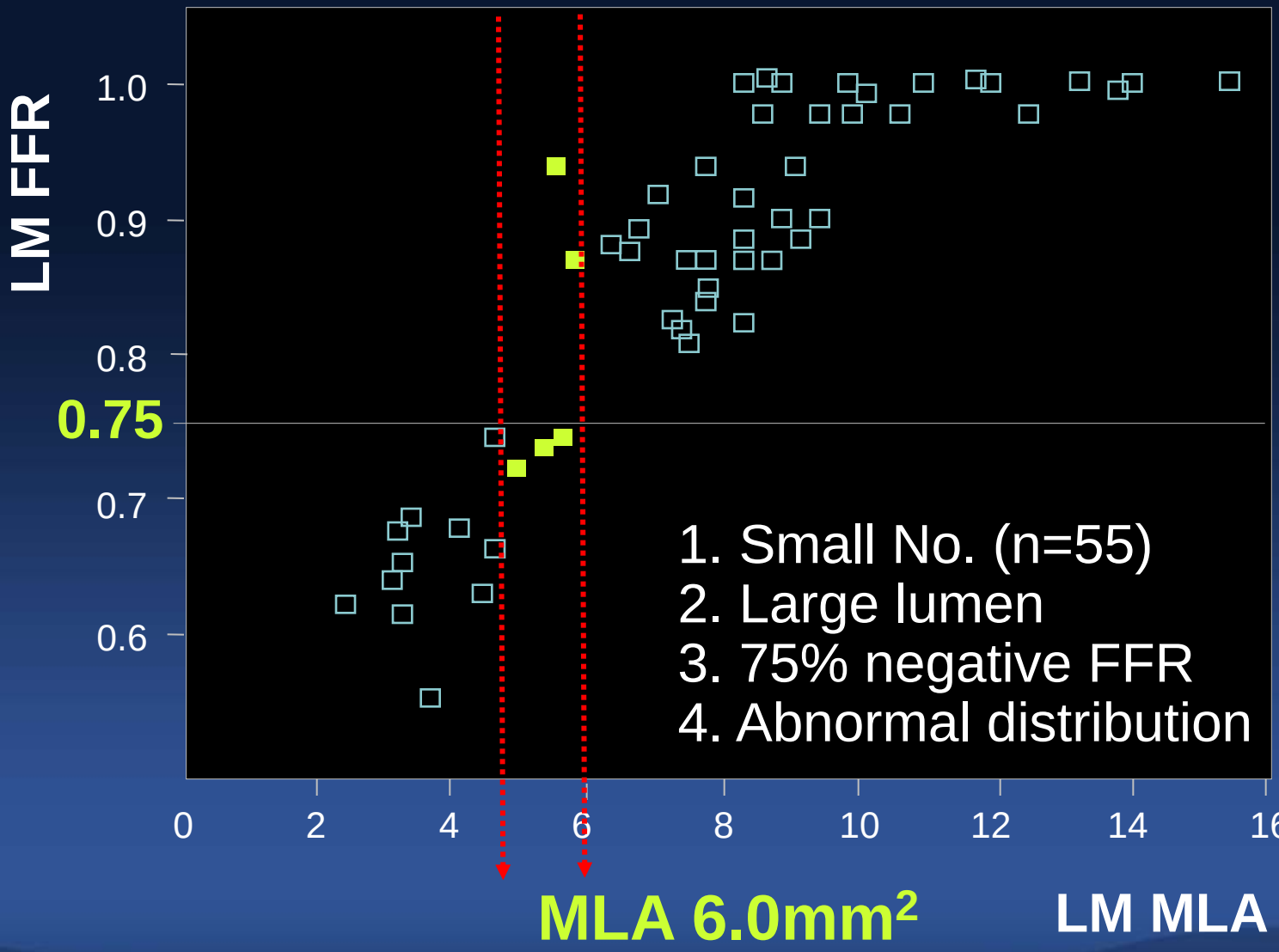
LAD	LCX	LM (Murray's)
3.0	3.0	4.76
3.0	2.9	4.68
3.0	2.8	4.60
3.0	**2.7**	**4.53**
3.0	2.6	4.45
3.0	2.5	4.37



Huo et al. Eurointervention 2012;7:1310-6

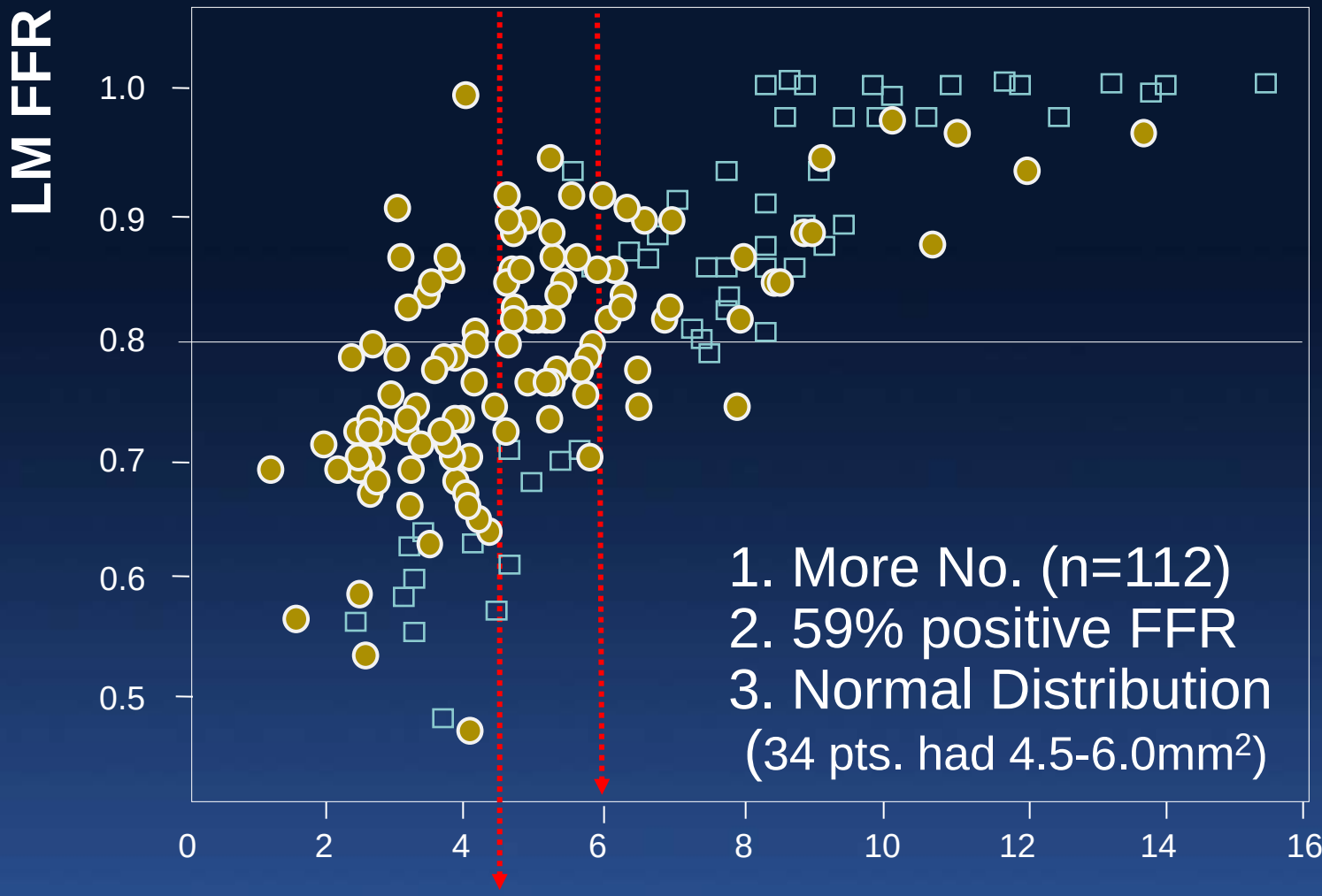
In-vivo Validation

Jasti's data (n=55)



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

AMC New Data (n=112)



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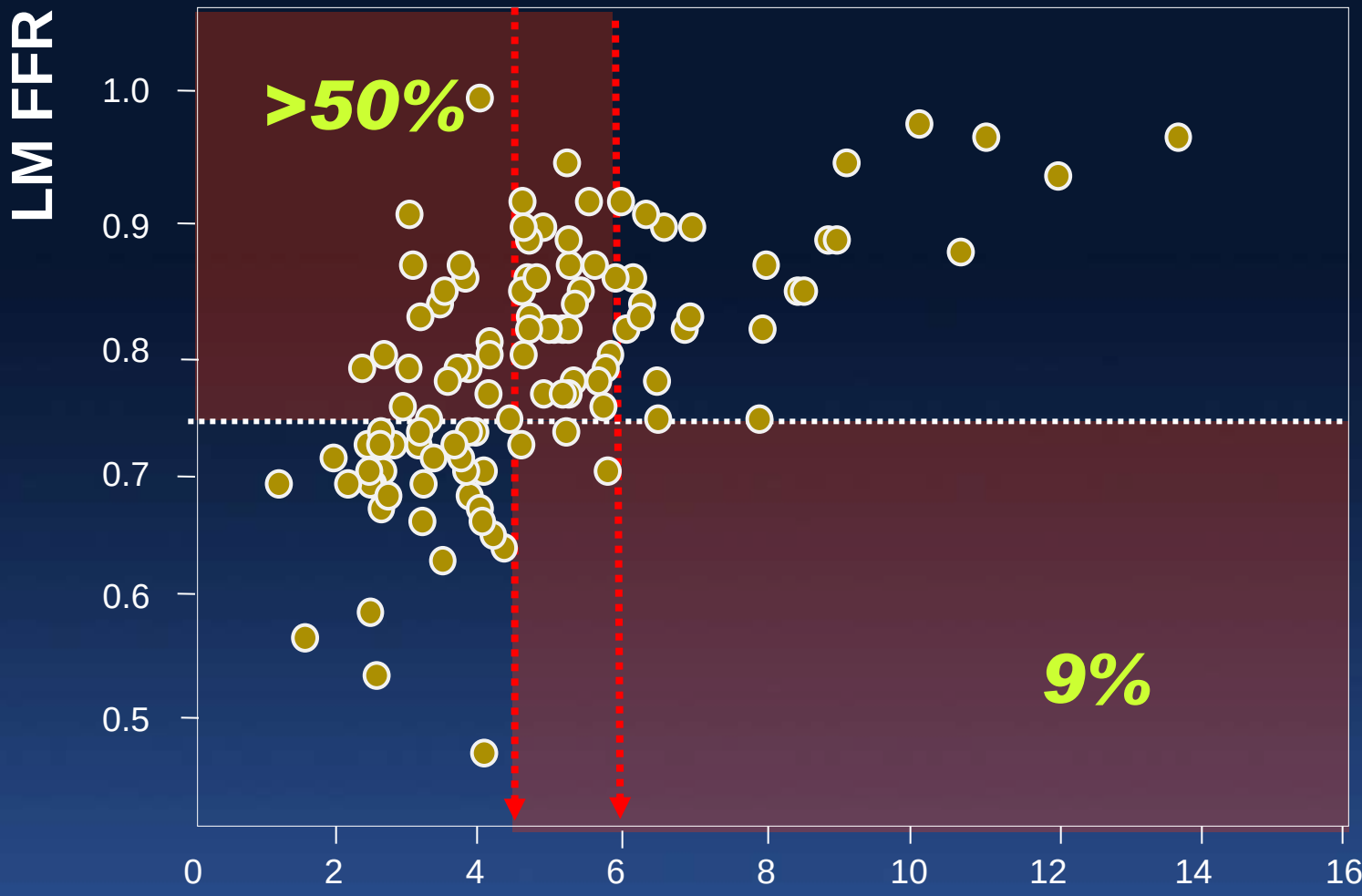

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- **Old data (MLA 6.0mm^2)** included downstream SB disease, and 32 of 55 (58%) were distal LM lesions that usually extend to the SB ostia
- **Recent data (MLA 4.5mm^2)** evaluated only pure LM lesions, which more reliably assessed the impact of LM-MLA on functional significance

TABLE 1. Baseline Clinical, Angiographic, and IVUS Characteristics of Patients (n=55)

Age, y	62±11
Diabetes mellitus, n	20
Hypertension, n	50
Smoking, n	39
Prior bypass surgery, n	13
Ostial LM stenosis, n	20
Mid-LM stenosis, n	3
Distal LM stenosis, n	32

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

Ethnic Difference in LMCA Morphology

	Asian	White	p
No.	99	99	
Age, years	68±9	68±10	0.80
Men	77 (78%)	72 (73%)	0.41
BSA, m^2	1.7±0.1	1.9±0.2	<0.001
BMI, kg/m^2	24±3	28±4	<0.001
MLA, mm^2	5.2±1.8	6.2±1.4	<0.001
Plaque burden, %	58 ±0	49±12	<0.001
Normalized EEM,mm^2	**20.7±4.5**	**19.3±4.2**	**0.024**
Normalized lumen,mm^2	8.6±2.6	9.7±2.7	<0.001

The ethnic difference poorly supported the relevance of using 6.0mm^2

Rusinova et al. Am J Cardiol 2013;111:979-8

Independent Factors of LM FFR<0.80

	Odds ratio	95% CI	p
Model 1			
Plaque rupture	4.47	1.35 – 14.8	0.014
BMI, kg/m^2	1.19	1.00 – 1.41	0.05
Age, yrs	0.95	0.90 – 1.00	0.031
MLA, mm^2	0.37	0.25 – 0.56	<0.001
Model 2 including Echo-LV mass			
LV mass, g	1.01	1.00 – 1.03	0.03
Age, yrs	0.94	0.90 – 0.99	0.021
MLA, mm^2	0.34	0.21 – 0.54	<0.001

The suboptimal accuracy of LM-MLA is not surprising

Park SJ et al. JACC Interv 2014;7:868–74

Conclusions

- In non-LM lesions, use of IVUS-MLA is not recommended for decision making to treat or not
- In pure LM lesions, IVUS-MLA 4.5mm^2 may be alternatively used to assess ischemia
- FFR still remains as the gold standard