State of the Art Lecture:
What's the role of intravascular imaging in 2024?

Gary S. Mintz, MD

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0

Every Day Clinical Questions in the Cath Lab

- Is this lesion flow-limiting?
  - Non-LMCA
  - LMCA
- Pre-intervention lesion assessment
  - What is the culprit?
  - What is the likelihood of embolization during stent implantation?
- How do I guide and optimize stent results?
  - Is the lesion calcified?
  - What is the correct stent size and length?
  - Did I go a good job?
- Why did this stent thrombose or restenose?

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1

Conventional Wisdom

- In non-LMCA lesions in patients with stable CAD, use intracoronary physiology to assess ischemia. While the MLA is the IVI parameter that best correlates with ischemia and the NPV is high, the PPV is only 50%.
- Use intracoronary physiology or IVUS to assess the severity of a LMCA lesion.

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Then came FORZA and FLAVOUR

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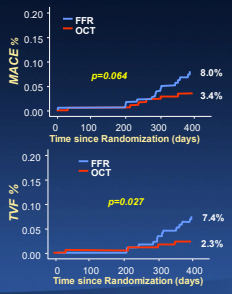
FORZA: A total of 350 pts (446 angiographically intermediate lesions) were randomized to FFR vs OCT

	OCT	FFR	p-value
#	174	176	
PCI performed	50.7%	29.3%	<0.001
13 months			
MACE or significant angina	8.0%	14.8%	0.048
All cause mortality	1.1%	1.7%	0.7
Non-fatal MI	0.6%	2.8%	0.098
TVR	2.3%	4.5%	0.25
Significant angina	4.8%	6.8%	0.5
Continued medical Rx	44.8%	62.5%	<0.001
Target vessel failure	2.3%	7.4%	0.027
Total Costs	3750 Euro	2577 Euro	<0.001



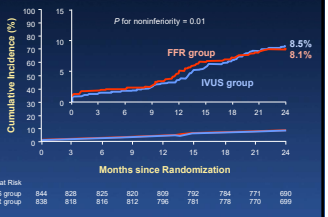
Burozotta et al. JACC Cardiovasc Interv. 2020;13:49-58.

4

FLAVOUR: Randomized FFR vs IVUS in 1682 patients with intermediate lesions (angiographic DS 40-70%)

	FFR	IVUS
%PCI	44.4%	65.3%
Stents per patient	0.6±0.9	0.9±1.0
% optimized	50.1%	54.8%
24-month MACE	8.1%	8.6%
PCI-optimized	12.3%	8.5%
Suboptimal PCI	11.8%	9.8%
Medical therapy	5.0%	5.9%

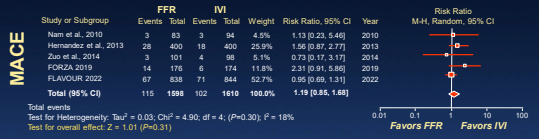
Each individual component of the primary endpoint was not different between FFR- and IVUS-guided PCI (all-cause death: 1.3% vs. 2.3%; MI: 1.9% vs. 1.7%; 5.7% vs. 5.3%; repeat revascularization: 5.7% vs. 5.3%) or periprocedural MI (1.2% vs. 0.9%).



Koo et al. N Engl J Med. 2022;387:779-789

5

FFR versus IVI to Guide Decision-Making for PCI in Intermediate Lesions: A Meta-Analysis



	FFR	IVI	RR (95%CI)	P-value
Rate of PCI	37.0%	60.3%	0.55 (0.45, 0.67)	P<0.001
All cause mortality	1.1%	1.9%	0.63 (0.33, 1.21)	P=0.17
Cardiac death	1.3%	1.3%	1.05 (0.50, 2.18)	P=0.91
Non-fatal MI	1.5%	1.0%	1.39 (0.73, 2.64)	P=0.31
TVR	3.3%	2.4%	1.38 (0.85, 2.23)	P=0.19

Liu et al. Cathet Cardiovasc Interv 2023;102:1198-1209

6

My takeaway:

If you optimize the PCI with IVUS or OCT guidance, you can use IVUS or OCT to assess intermediate non-LMCA lesion severity. The only downside is that IVUS or OCT guidance is associated with implantation of more stents compared to intracoronary physiology.

7

Meta-analysis of 12 LMCA deferral studies(5 IVUS, 7 FFR) involving 908 pts: median follow-up of 30.3 mos

	FFR	IVUS
#	343	563
Typical criterion for deferred revascularization	>0.80	MLA >6.0mm^2
Follow-up (median)	29.0 months	31.5 months
MACE per year	5.1%	6.4%
Death per year	2.6%	3.0%
Non-fatal MI per year	1.5%	0.5%
Revascularization per year	1.8%	2.2%
Predictors of MACE	Type 2 DM, lower dose of adenosine	Plaque burden, # of untreated diseased non-LMCA vessels, pt age, smoking, type 2 DM, any untreated vessel

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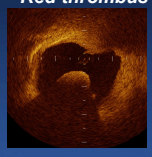
Cerrato et al. Int J Cardiol 2018;271:42-8

8

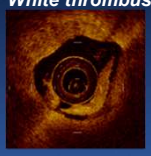
What is the culprit lesion?

As seen in the VANQWISH Trial, as many as 50% of NSTEMI patients either have no identifiable culprit or have multiple potential culprits. . .

Red thrombus



White thrombus



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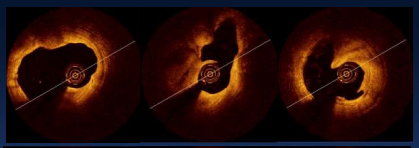
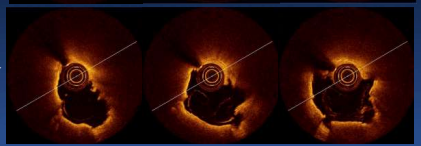
Kerensky et al. J Am Coll Cardiol 2002;39:1456-64

9

LAD



LCX



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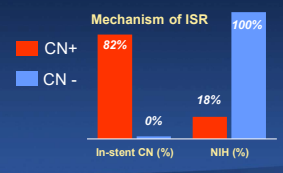
10

Outcomes after pts with ACS and IVUS-calcified nodules were treated with newer-generation DES



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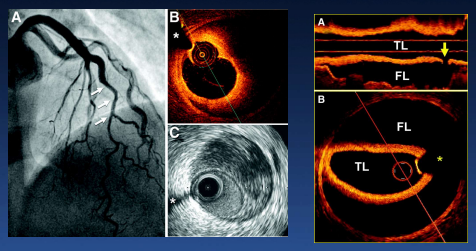
Sugane et al. Atherosclerosis 2021;318:70-75

11

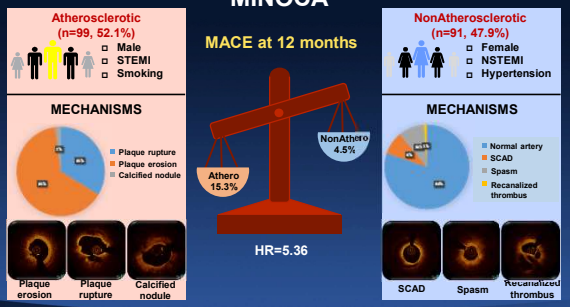
Spontaneous Coronary Artery Dissection



Alfonso. Circulation 2012;126:667-70
Alfonso et al. J Am Coll Cardiol 2012;59:1073-9

12

MINOCA



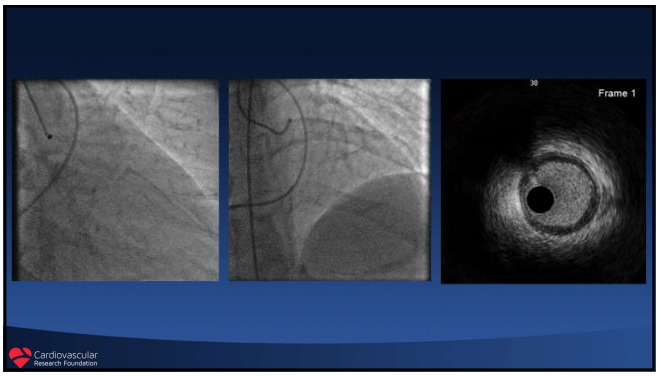
Zheng et al. JACC Cardiovasc Imaging 2023;16:521-32

13

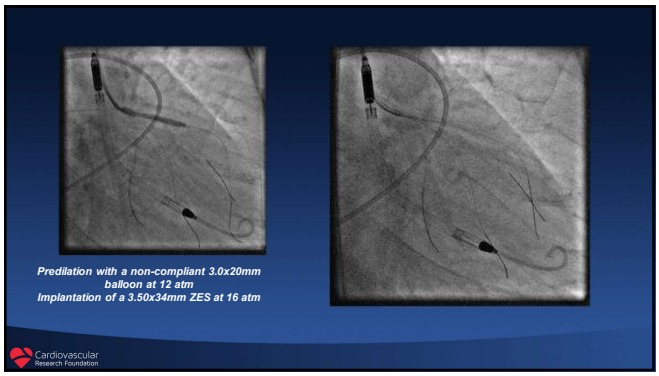
"Higher" probability of distal embolization. . .
The common denominator is presence of a TCFA

- **Attenuated plaque – grayscale IVUS**
  - Lee et al. JACC Cardiovasc Interv. 2009;2:65-72
  - Wu et al. Am J Cardiol 2010;105:49-53
  - Okura et al. Circ J 2007;71:648-53
  - Wu et al. JACC Cardiovasc Interv 2011;4:495-502
  - Lee et al JACC Cardiovasc Interv. 2011;4:483-91
  - Kubo et al. Cardiol Res Pract. 2011;687515
  - Fu et al. Eur Heart J 2012;33:372-83
  - Shiono et al. JACC Cardiovasc Interv 2013;6:847-53
  - Jang et al. Am J Cardiol 2013;111:968-72
  - Amano et al. Int Heart J 2016;57:285-91
  - Okutsu et al. Heart Vessels. 2018;33:1121-1128
- **VH- or IB-IVUS TCFA or large lipidic or necrotic core**
  - Claessen et al. JACC Cardiovasc Imaging 2012;5:S111-8
  - Amano et al. J Interv Cardiol. 2013 Jun;26(3):295-301
  - Ding et al. PLoS One. 2014 Nov 6;9(11):e106583
  - Matsu et al. EuroIntervention 2013;9:235-242
  - Ozaki et al. Circ J 2015;79:808-17
  - Daidoji et al. Catheter Cardiovasc Interv. 2015;85:43-50
  - Suda et al. Heart Vessels. 2016 Dec;31(12):1904-1914
  - Kitagawa et al. Atherosclerosis 2017;258:72-8
- **OCT-TCFA or plaque rupture**
  - Tanaka et al. Eur Heart J 2009;30:1348-55
  - Yonetsu et al. Int J Cardiol 2011;146:80-5
  - Lee et al. Circ Cardiovasc Intv 2011;4:378-86
  - Lee et al. J Am Coll Cardiol Intv 2011;4:483-91
  - Porto et al. Circ Cardiovasc Intv 2012;5:89-96
  - Imola et al. Am J Cardiol 2013;111:526-31
  - Ueda et al. Coron Artery Dis 2014;25:384-91
  - Higuma et al. JACC Cardiovasc Imaging 2015;17:1166-76
  - Lee et al. Circ Cardiovasc Intv 2015. doi: 10.1161/CIRCINTERVENTIONS.114.001727.
  - Kini et al. JACC Cardiovasc Interv 2015;8:937-45
  - Ikenaga, et al. Eur Heart J Cardiovasc Imaging. 2017;0:1-9
  - Hu et al. J Am Heart Assoc. 2017 Feb 24;6(3). pii: e004730
  - Soeda et al. Eur Heart J Cardiovasc Imaging. 2017;18:103-110
  - Uzu et al. J Cardiol 2017;70:545-53
  - Otsuka et al. Heart Vessels. 2020;35:451-62
  - Gui et al. Heart Surg Forum. 2023;26:E051-E055
  - Katayama et al. Int J Cardiol Heart Vasc. 2022 Jan 11;38:100953. doi: 10.1016/j.ijcha.2022.100953
- **Large lipid core plaque - NIRS**
  - **Goldstein et al. Circ Cardiovasc Interv 2011;4:429-437**
  - Stone et al. JACC Cardiovasc Interv 2015;8:927-36
  - Kini et al. JACC Cardiovasc Interv 2015;8:937-45
  - Sato et al. J Thromb Thrombolysis. 2018 Aug;46(2):203-210
  - Matsuoka et al. Cathet Cardiovasc Interv 2021;98:E695-E704
  - Terada et al. EuroIntervention. 2021;17:e959-e1026
  - Lim et al. J Clin Medlin Med 2022;11:5401. doi: 10.3390/jcm11185401.

14



15



Predilation with a non-compliant 3.0x20mm balloon at 12 atm
Implantation of a 3.50x34mm ZES at 16 atm

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16

Early IVUS observations regarding angiography during PCI that are still true today

- Atherosclerosis is ubiquitous and most of it is angiographically silent
- The angiogram is often misleading in assessing vessel size
- The angiogram is often misleading in assessing calcification
- A good angiographic result is not a guarantee of a good anatomic result

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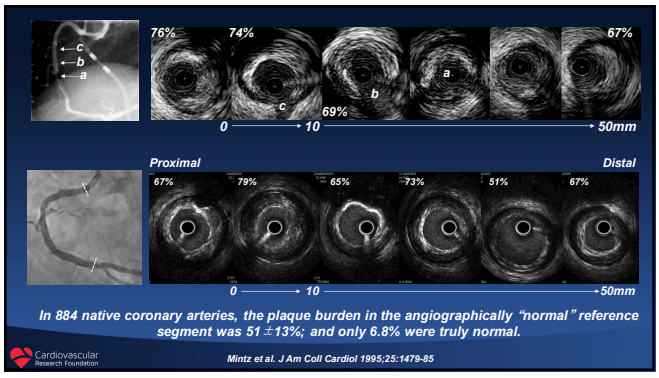
17



In 884 native coronary arteries, the plaque burden in the angiographically "normal" reference segment was 51 ±13%; and only 6.8% were truly normal.

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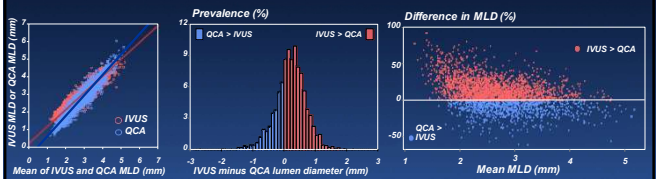
Mintz et al. J Am Coll Cardiol 1995;25:1479-85

18

IVUS vs QCA lumen dimensions in PROSPECT



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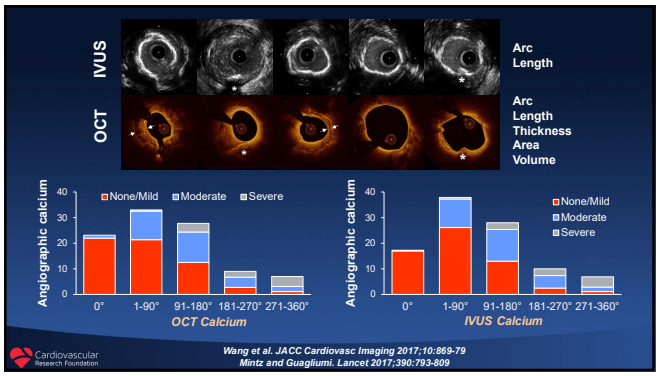
Goto et al. JACC Cardiovasc Imaging 2016;9:1011-3

19



20

Pre and post-OCT calcium scoring system predicting stent expansion

Test cohort of 128 pts

	Regression Coefficient	95% CI	P-value	Calcium Score		
Maximum calcium angle (per 180°)	-7.43	-12.6 to -2.21	<0.01	Maximum calcium angle	≤180°	0
					>180°	2
Maximum calcium thickness (per 0.5 mm)	-3.40	-6.35 to -0.45	0.02	Maximum calcium thickness	≤0.5mm	0
					>0.5mm	1
Calcium length (per 5 mm)	-3.32	-4.09 to -0.55	0.01	Calcium length	≤5mm	0
					>5mm	1

Validation cohort of 133 pts

Score	0 (n=27)	1 (n=45)	2 (n=34)	3 (n=3)	4 (n=24)	P-value
MSA, mm²	7.2 (5.4, 9.2)	6.3 (5.2, 8.4)	5.9 (4.8, 8.0)	6.7 (5.8, 7.1)	**5.7 (4.4, 7.4)**	0.21
Stent expansion at target lesion calcium, %	99 (93, 108)	98 (86, 109)	86 (77, 100)	98 (83, 104)	**78 (70, 86)**	<0.01
Stent expansion at MSA, %	91 (84, 95)	85 (78, 93)	80 (73, 93)	80 (73, 85)	**69 (60, 77)**	<0.01

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Fujino et al. EuroIntervention 2018;13:e2182-e2189

21

IVUS calcium score predicting stent expansion (as a continuous variable) in lesions with calcium >270°

Test cohort of 97 pts

	Regression Coeff	95% CI	P-value	Cut-off	Calcium Score	
Length of calcium >270° (per 5mm)	-5.5	-9.7, -1.2	0.01	5.0	≤5mm	0
					>5mm	1
Calcium Nodule	-10.2	-16.3 to -4.2	0.0009		absent	0
					present	1
Vessel diameter (per 1mm)	8.6	2.7 to 14.4	0.004	3.5	>3.5mm	0
					≤3.5mm	1
Circumferential calcium	-14.3	-25.0 to -3.5	0.009		absent	0
					present	1

Stent underexpansion (<70%) in the validation cohort of 97 pts

	Cut-off	C-statistics	Sensitivity	Specificity	PPV	NPV
Score	≥2	0.85 [0.77, 0.93]	89%	63%	48%	94%

In 67 lesions without angiographically visible calcium, but with a maximum IVUS angle of superficial calcium >270°, there were none with a calcium score of 4 and only 1 with stent underexpansion.

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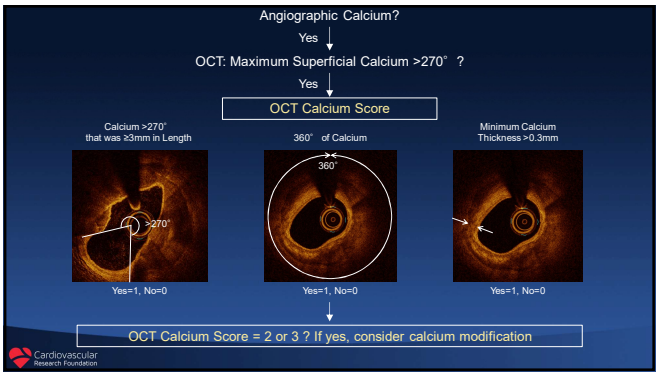
Zhang et al. Circ Cardiovasc Interv. 2021;14:e010296. doi: 10.1161/CIRCINTERVENTIONS.120.010296

22



23

Pressure			Balloon size (mm)						
atm	kPa		2.50	2.75	3.00	3.25	3.50	3.75	4.00
3.0	304		2.19	2.38	2.65	2.87	3.03	3.28	3.59
4.0	405		2.25	2.44	2.71	2.94	3.11	3.35	3.67
5.0	507		2.29	2.48	2.76	3.00	3.17	3.41	3.74
6.0	608		2.34	2.53	2.81	3.05	3.23	3.47	3.81
7.0	709		2.38	2.57	2.86	3.10	3.29	3.53	3.87
8.0	811		2.41	2.61	2.90	3.14	3.33	3.58	3.92
9.0	912		2.44	2.64	2.93	3.18	3.37	3.62	3.96
10.0	1013		2.47	2.67	2.96	3.21	3.41	3.66	3.99
11.0	1115		2.49	2.69	2.99	3.23	3.44	3.69	4.03
12.0	1216	Nominal	2.51	2.71	3.01	3.25	3.46	3.72	4.05
13.0	1317		2.52	2.73	3.03	3.27	3.49	3.74	4.08
14.0	1419		2.54	2.75	3.04	3.29	3.51	3.77	4.10
15.0	1520		2.55	2.76	3.06	3.31	3.53	3.78	4.12
16.0	1621		2.56	2.78	3.08	3.32	3.54	3.80	4.14
17.0	1723		2.58	2.79	3.09	3.34	3.56	3.82	4.16
18.0	1824		2.59	2.80	3.10	3.35	3.57	3.84	4.17
19.0	1925		2.60	2.82	3.12	3.36	3.59	3.85	4.19
20.0	2024		2.61*	2.83*	3.13*	3.38*	3.61*	3.87*	4.21*

Using this compliance chart, what is the stent diameter after implanting a 3.0mm stent at 18atm?

A) 2.32mm
B) 2.58mm
C) 2.84mm
D) 3.10mm

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24

Pressure			Balloon size (mm)						
atm	kPa		2.50	2.75	3.00	3.25	3.50	3.75	4.00
3.0	304		2.19	2.38	2.65	2.87	3.03	3.28	3.59
4.0	405		2.25	2.44	2.71	2.94	3.11	3.35	3.67
5.0	507		2.29	2.48	2.76	3.00	3.17	3.41	3.74
6.0	608		2.34	2.53	2.81	3.05	3.23	3.47	3.81
7.0	709		2.38	2.57	2.86	3.10	3.29	3.53	3.87
8.0	811		2.41	2.61	2.90	3.14	3.33	3.58	3.92
9.0	912		2.44	2.64	2.93	3.18	3.37	3.62	3.96
10.0	1013		2.47	2.67	2.96	3.21	3.41	3.66	3.99
11.0	1115		2.49	2.69	2.99	3.23	3.44	3.69	4.03
12.0	1216	Nominal	2.51	2.71	3.01	3.25	3.46	3.72	4.05
13.0	1317		2.52	2.73	3.03	3.27	3.49	3.74	4.08
14.0	1419		2.54	2.75	3.04	3.29	3.51	3.77	4.10
15.0	1520		2.55	2.76	3.06	3.31	3.53	3.78	4.12
16.0	1621		2.56	2.78	3.08	3.32	3.54	3.80	4.14
17.0	1723		2.58	2.79	3.09	3.34	3.56	3.82	4.16
18.0	1824		2.59	2.80	3.10	3.35	3.57	3.84	4.17
19.0	1925		2.60	2.82	3.12	3.36	3.59	3.85	4.19
20.0	2024		2.61*	2.83*	3.13*	3.38*	3.61*	3.87*	4.21*

Using this compliance chart, what is the stent diameter after implanting a 3.0mm stent at 18atm?

A) 2.32mm

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25

Predictors of DES Early ST, Restenosis, MACE, or DoCE

	IVUS		OCT
	Early ST	Restenosis/MACE	Restenosis/MACE/DoCE
Small MSA or underexpansion in stable lesions Small MLA in ACS/MI lesions	•Fuji 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;2:429-34 •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 •Fuji et al. Circulation 2004;109:1085-1088 •Kang et al. Circ Cardiovasc Interv 2011;4:9-14 •Choi et al. Am J Cardiol 2012;109:482-88 •Song et al. Catheter Cardiovasc Interv 2014;83:873-8 •Kang et al. PLoS One 2013;10;153:e0140421 •Hong et al. JAMA 2015;314:2155-63 •Lee et al. Rev Esp Cardiol 2017;70:88-95 •Kakgil et al. Catheter Cardiovasc Interv. 2019 Jan 31. doi: 10.1002/ccd.28105. •Kim et al. Eurolntervention. 2020;16:e480-e488 •Park et al. JACC Cardiovasc Interv 2020;13:1453-13 •Labellele et al. Eurolntervention. 2020;16:201-9 •Sugane et al. Atherosclerosis. 2021;318:75-5 •Kwon et al. Eurolntervention. 2021;17:e839-e846 •Choi et al. Cureo Artery Dis 2021;32:154-8 •Fujimura et al. JACC Cardiovasc Interv. 2021;14:1638-50 •Lee et al. Circ Cardiovasc Interv. 2021;14:e011124. •Komaki et al. Int J Cardiol 2021;334:31-36 •Yamamoto et al. Circ Cardiovasc Interv. 2022;16:e012922. doi: 10.1161/CIRCINTERVENTIONS.122.012922 •Watanabe et al. Am J Cardiol 2022;202:164-72	•Fred et al. JACC Cardiovasc Imaging 2015;8:1297-305 •Fred et al. Circ Cardiovasc Interv. 2016;9. pii: e003706. •Geeta et al. Circulation 2015;132:1030-9 •Mitsui et al. Cather Cardiovasc Interv. 2015;87:E29-14 •Fred et al. Eurolntervention. 2016;11:e443-e451 •Matsuo et al. Catheter Cardiovasc Interv. 2020;96:E291-E297 •Kim et al. JACC Cardiovasc Imaging 2022;15:126-37 •Lee et al. SciRep. 2022;12:3781- doi: 10.1038/s41598-022-3077-0 •Bonnaghoi et al. Eur Heart J Cardiovasc Imaging 2023. doi: 10/1093/ehjci/jeac072
Edge problems (geographic miss, secondary lesions, large plaque burden, dissections, etc)	•Fuji 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;2:429-34 •Choi et al. Circ Cardiovasc Interv 2011;4:239-47	•Sakuma et al. Am J Cardiol 2005;96:1251-3 •Liu et al. Am J Cardiol 2009;103:321-6 •Costa et al. Am J Cardiol. 2008;101:1794-11 •Kang et al. Am J Cardiol 2010;111:1408-16 •Kobayashi et al. Circ Cardiovasc Interv. 2016;9:e003533 •Calvert et al. Catheter Cardiovasc Interv 2016;88:240-7 •Park et al. JACC Cardiovasc Interv 2020;13:1453-13	•Fred et al. JACC Cardiovasc Imaging 2015;8:1297-305 •Fred et al. Circ Cardiovasc Interv. 2016;9. pii: e003706. •Choi et al. Circ Cardiovasc Interv. 2016;9:e004031 •Fred et al. Eurolntervention. 2016;11:e443-e451 •van Zandvoort et al. Circ Cardiovasc Interv. 2020;13:e008695 •Bonnaghoi et al. Eur Heart J Cardiovasc Imaging 2023. doi: 10/1093/ehjci/jeac072
Protrusion in ACS/MI Irregular Protrusion			
Stent length (>40mm)			
Asymmetry/Eccentricity			
Acute malapposition			

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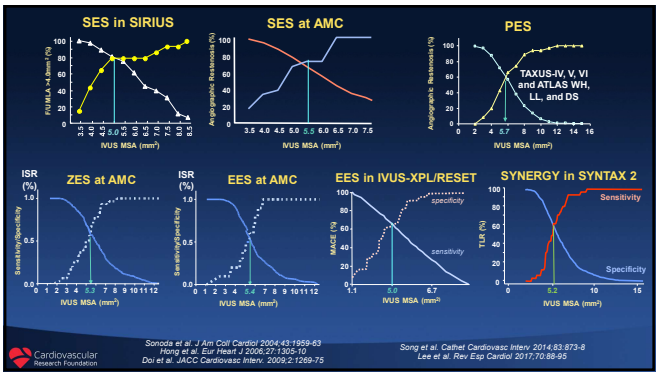
26



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

Song et al. Cathet Cardiovasc Interv 2014;83:873-8
Lee et al. Rev Esp Cardiol 2017;70:88-95

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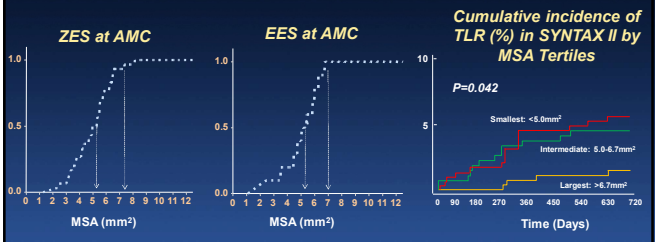
27

Predicting Freedom From Angiographic Restenosis with Second Generation DES



Song et al. Cathet Cardiovasc Interv 2014;83:873-8
Katagiri et al. Cathet Cardiovasc Interv 2019;93:E225-E234

28

Stent expansion evaluated by OCT and device oriented cardiac events

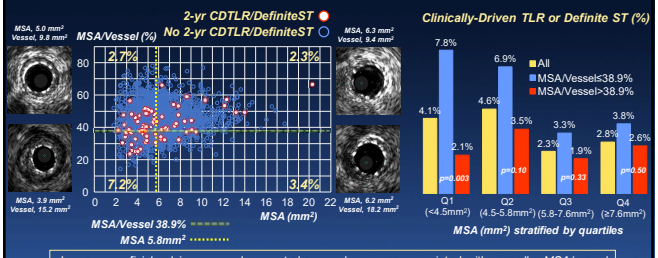
(1071 pts with 1123 native coronary artery lesions treated with new-generation DES)

Suboptimal criterion	Suboptimal	Optimal	HR (95% CI)	P-value
MSA <5.0mm²	23/307 (7.5%)	21/764 (2.7%)	3.90 (1.99-7.65)	<0.001
MSA/average reference lumen <90%	30/762/ (3.9%)	14/309 (4.5%)	1.32 (0.62-2.81)	0.5
MSA/average reference lumen <80%	20/441 (4.5%)	24/630 (3.8%)	1.33 (0.69-2.55)	0.4
MSA/distal reference lumen <100%	31/695 (4.5%)	13/374 (3.5%)	1.38 (0.67-2.86)	0.4
MSA/distal reference lumen <90%	24/442 (5.7%)	20/647 (3.1%)	2.16 (1.12-4.19)	0.022

Lee et al. Sci Rep 2023;13:3781. doi: 10.1038/s41598-023-30717-6

29

Stent expansion in ADAPT-DES



Larger superficial calcium arc and percent plaque volume were associated with a smaller MSA/vessel area, whereas the larger volume of attenuated (i.e., lipidic) plaque and use of larger balloons or higher balloon pressures were associated with greater MSA/vessel area ratios.

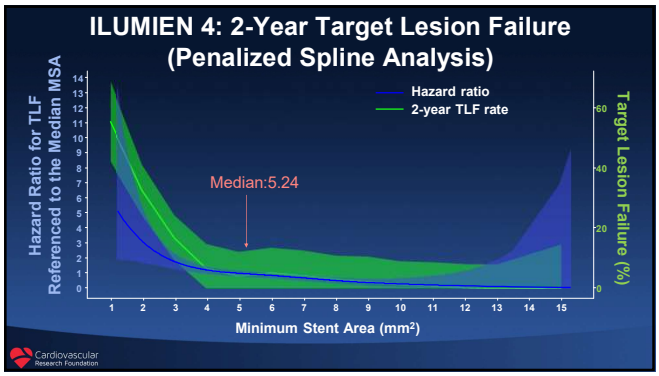
Fujimura et al. JACC Cardiovasc Interv 2021;14:1639-1650

30

ILUMIEN 4: OCT Findings Independently Associated With Clinical Endpoints (Adjusted Analysis)

Outcome	OCT variable	Hazard ratio (95% CI)	P value
Target lesion failure	Minimal stent area, per 1 mm²	0.76 (0.68, 0.86)	<0.0001
	Proximal edge dissection, any	1.77 (1.20, 2.62)	0.004
Cardiac death or TV-MI	Minimal stent area, per 1 mm²	0.82 (0.70, 0.95)	0.009
	Stent length, per 5 mm	1.08 (1.02, 1.15)	0.009
Ischemia-driven TLR	Intra-stent flow area, per 1 mm²	0.72 (0.62, 0.84)	<0.0001
	Proximal edge dissection, any	1.88 (1.16, 3.03)	0.01
	Plaque or thrombus protrusion, major	1.95 (0.97, 3.92)	0.06
Stent thrombosis	Minimal stent expansion, per 10%	0.71 (0.55, 0.93)	0.01

31


ILUMIEN 4: 2-Year Target Lesion Failure
(Penalized Spline Analysis)
Hazard Ratio for TLF
Referenced to the Median MSA
Target Lesion Failure (%)
Hazard ratio
2-year TLF rate
Median:5.24
Minimum Stent Area (mm²)
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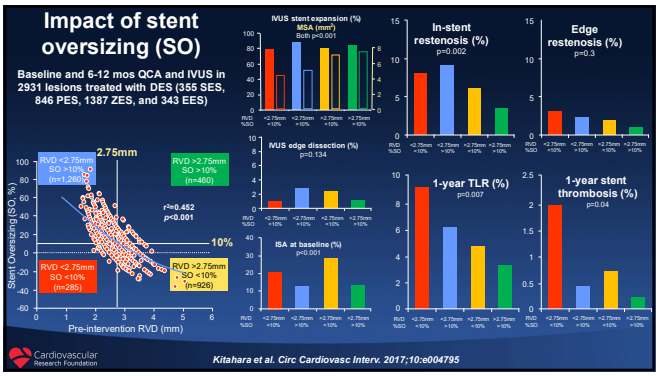
32


Impact of stent
oversizing (SO)
Baseline and 6-12 mos QCA and IVUS in
2931 lesions treated with DES (355 SES,
846 PES, 1387 ZES, and 343 EES)
IVUS stent expansion (%)
MSA (mm²)
Both p<0.001
In-stent
restenosis (%)
p=0.002
Edge
restenosis (%)
p=0.3
IVUS edge dissection (%)
p=0.134
1-year TLR (%)
p=0.007
1-year stent
thrombosis (%)
p=0.04
ISA at baseline (%)
p<0.001
2.75mm
RVD <2.75mm
SO >10%
(n=1,26
RVD >2.75mm
SO >10%
(n=460)
r²=0.452
p<0.001
10%
RVD <2.75mm
SO <10%
(n=285)
RVD >2.75mm
SO <10%
(n=926)
Stent Oversizing (SO, %)
Pre-intervention RVD (mm)
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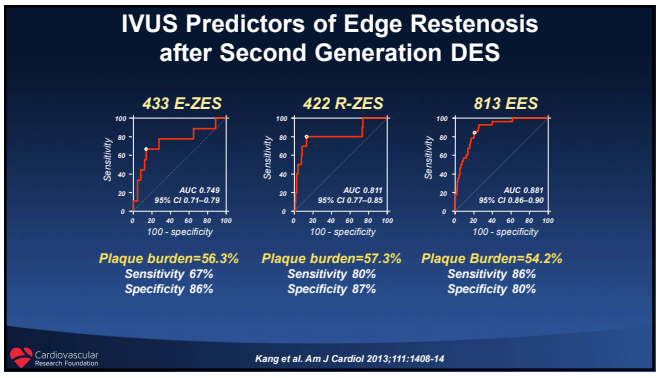
Kitahara et al. Circ Cardiovasc Interv. 2017;10:e004795

33


IVUS Predictors of Edge Restenosis
after Second Generation DES
433 E-ZES
422 R-ZES
813 EES
Sensitivity
100 - specificity
AUC 0.749
95% CI 0.71–0.79
AUC 0.811
95% CI 0.77–0.85
AUC 0.881
95% CI 0.86–0.90
Plaque burden=56.3%
Sensitivity 67%
Specificity 86%
Plaque burden=57.3%
Sensitivity 80%
Specificity 87%
Plaque Burden=54.2%
Sensitivity 86%
Specificity 80%
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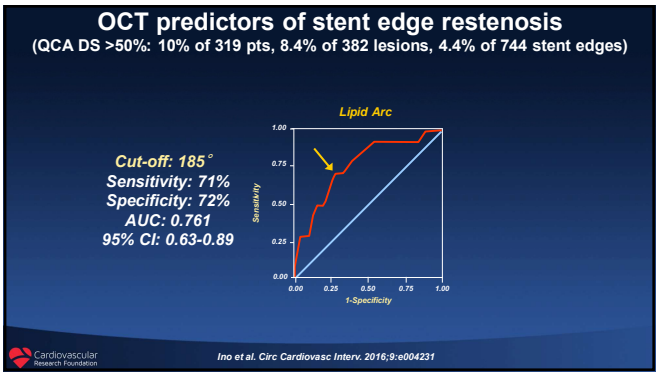
Research Foundation
Kang et al. Am J Cardiol 2013;111:1408-14

34


OCT predictors of stent edge restenosis
(QCA DS >50%: 10% of 319 pts, 8.4% of 382 lesions, 4.4% of 744 stent edges)
Lipid Arc
Cut-off: 185°
Sensitivity: 71%
Specificity: 72%
AUC: 0.761
95% CI: 0.63-0.89
Sensitivity
1-Specificity
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Ino et al. Circ Cardiovasc Interv. 2016;9:e004231

35

What about acute stent malapposition as included in MLD-MAX and IVUS 1-2-3 criteria for optimal stent implantation?

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36

Acute malapposition is detected in 17% by IVUS and 55% by OCT after routine stenting

	Study	#	IVUS	OCT
Hong et al. Circulation. 2008;113:414-9	AMC	663	7%	
Steinberg et al. JACC Cardiovasc Interv 2010;3:486-94	Combined TAXUS	1200	8%	
Guo et al. Circulation 2010;122:1077-84	HORIZONS-AMI	263	36%	
Choi et al. Circulation Cardiovasc Interv 2011;4:239-47		401	37%	
Kang et al. Circ Cardiovasc Interv 2011;4:562-9		403	7%	
Van der Hoen et al. JACC Cardiovasc Interv 2008;1:192-201	MISSION-AMI	184	38%	
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;7:99-96		356		62%
Kawamori et al. EIU Cardiovasc Imaging 2013;14:865-75		40		65%
Shimamura et al. EIU Cardiovasc Imaging 2015;16:23-8		77		100%
Soeda et al. Circulation 2015;132:1020-9		1001		39%
CLI-OPCI				
Prati et al. JACC Cardiovasc Imaging 2015;8:1297-305	CLI-OPCI-II	1002		49%
Prati et al. Circ Cardiovasc Interv. 2016;9. pii: e003726	CLI-OPCI ACS	588		48%
Romagnoli. Catheter Cardiovasc Interv 2017;90:586-75		864		72.3%
Bernelli et al. Circ J 2016;80:895-905	OCTAVIA	114		72%
Kim et al. J Interv Cardiol 2016;29:216-24		122		48%
		168	37%	
Wang et al. J Am Heart Assoc. 2016;5. pii: e004438. doi: 10.1161	ADAPT-DES	2430	13%	
Ali et al. Lancet. 2016;388:2618-28	ILUMIEN III	204		36%
		146	18%	
Agarwal et al. Catheter Cardiovasc Interv 2017;90:225-232		110		75%
Lee et al. Circ Cardiovasc Interv. 2018;11:e007192	DETECT-OCT	390		45%
Ladisinec et al. Eurointervention. 2020;16:201-9	NOBLE	224	5%	
Kim et al. JACC Cardiovasc Imaging 2022;15:126-37		1246		67%
Watanabe. Cathet Cardiovasc Interv 2022;100:1000-9		396	27%	
Yamamoto et al. Circ Cardiovasc Interv. 2023;16:e012922 doi: 10.1161/CIRCINTERVENTIONS.123.012922	OPTIVUS-Complex PCI	1907	37%	
Overall			17%	55%

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37

Studies showing a relationship between acute stent malapposition and events

Kim et al. JACC Cardiovasc Imaging 2022;15:126-37				
Watanabe. Cathet Cardiovasc Interv 2022;100:1000-9				

Studies showing NO relationship between acute stent malapposition and events

Hong et al. Circulation. 2008;113:414-9			Agarwal et al. Catheter Cardiovasc Interv 2017;90:225-232	
Steinberg et al. JACC Cardiovasc Interv 2010;3:486-94	Combined TAXUS		Lee et al. Circ Cardiovasc Interv. 2018;11:e007192	DETECT-OCT
Guo et al. Circulation 2010;122:1077-84	HORIZONS-AMI		Ladisinec et al. Eurointervention. 2020;16:201-9	NOBLE
Choi et al. Circulation Cardiovasc Interv 2011;4:239-47				
Kang et al. Circ Cardiovasc Interv 2011;4:562-9			Yamamoto et al. Circ Cardiovasc Interv. 2023;16:e012922 doi: 10.1161/CIRCINTERVENTIONS.123.012922	OPTIVUS-Complex PCI
Van der Hoen et al. JACC Cardiovasc Interv 2008;1:192-201	MISSION-AMI			
Bezerra et al. JACC Cardiovasc Interv 2013;6:228-36			Romagnoli et al. Eur Heart J Cardiovasc Imaging. 2023 Dec 21;25(1):49-57.	CLI-OPCI II
Kubo et al. JACC Cardiovasc Imaging 2013;6:1095-1104	OPUS-CLASS			ILUMIEN IV
Im et al. Circ Cardiovasc Interv 2014;7:99-96				FORZA
Kawamori et al. EIU Cardiovasc Imaging 2013;14:865-75				
Shimamura et al. EIU Cardiovasc Imaging 2015;16:23-8				
Soeda et al. Circulation 2015;132:1020-9				
Prati et al. JACC Cardiovasc Imaging 2015;8:1297-305				
Prati et al. Circ Cardiovasc Interv. 2016;9. pii: e003726	CLI-OPCI			
Romengoli. Catheter Cardiovasc Interv 2017;90:586-75				
Bernelli et al. Circ J 2016;80:895-905	OCTAVIA			
Kim et al. J Interv Cardiol 2016;29:216-24				
Wang et al. J Am Heart Assoc. 2016;5. pii: e004438. doi: 10.1161	ADAPT-DES			
Ali et al. Lancet. 2016;388:2618-28	ILUMIEN III			

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38

In non-LMCA or ostial LAD lesions. . .

- **The MSA is the most consistent predictor of events after DES implantation, and an MSA of at least ≈5.5mm² should be the goal in a non-LMCA lesion with no geographic miss or complications.**
- **If an MSA of 5.5mm² cannot be achieved, then a measure of relative stent expansion should be the next goal.**

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39

The benefits of IVI guidance are dependent on the % of DES-treated lesions that are optimized according to these IVI criteria

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40

Reference	Study	Optimal Post-PCI Criteria	Achieved
Hong. JAMA. 2015;314:2155-63	IVUS -XPL	MLA > distal RLA	54%
Zhang. J Am Coll Cardiol. 2018;72:3126-37	ULTIMATE	MSA >5mm² or >90% of distal reference lumen Plaque burden <50% within 5mm proximal and distal to stent edge No edge dissection involving media with length >3mm	53%
Ali. Lancet 2016;388:2618-28	ILUMIEN III	MSA >90% in both proximal and distal halves of the stent relative to the closest RLA	41%
Kim. Eurointervention 2020;16:e480-8	Yonsei Meta-Analysis	MSA ≥5.5mm² or 80% of mean RLA	59%
Leone. J Am Heart Assoc. 2019;8:e012772. doi: 10.1161/JAHA.119.012772	FORZA-FFR	FFR ≥0.90	47%
	FORZA-OCT	No major stent malapposition (>350µm, or <350µm >200µm for a length >600µm), MSA >75% of the RLA; No major edge dissection (length >500µm)	65%
Koo et al. N Engl J Med. 2022;387:779-789	FLAVOUR-FFR	FFR≥0.88 or a difference <0.05 across the stent	50%
	FLAVOUR-IVUS	MLA ≥5.5mm² and plaque burden at stent edge ≤55% or in-stent MLA ≥ distal RLA	55%
Yamamoto et al. JACC Asia 2023;3:211-225	OPTIVUS	MSA > distal RLA [stent length ≥28mm], and MSA >0.8 × average RLA [stent length <28mm]	40%
Lee. N Engl J Med 2023;388,1688-79	RENOVATE COMPLEX PCI	MSA >80% of the mean RLA or absolute MSA >5.5mm² (for the LMCA, >7mm² distally and >8mm² proximally) and no major dissection (<5mm from the edge of the stent and extending to the medial layer with a dissection angle >60° or length >3mm) or malapposition (>0.4mm or >1mm long)	56%
Ali. N Engl J Med. 2023;389:1466-76	ILUMIEN IV	MSA >90% in proximal and distal segments of the stent relative to the closest RLA	41%
Kang. Circulation. 2023;148:1195-1206	OCTIVUS: IVUS	MSA >5.5mm² by IVUS or >4.5mm² by OCT; MSA >80% of the mean reference lumen area; avoidance of a landing zone in a plaque burden >50% or lipid-rich tissue at the stent edge; no major stent malapposition or edge dissection	60%
	OCTIVUS: OCT		53%
Kang. J Am Coll Cardiol 2024;83:401-413	OCTIVUS: Complex lesions — IVUS		46%
	OCTIVUS: Complex lesions — OCT		38%

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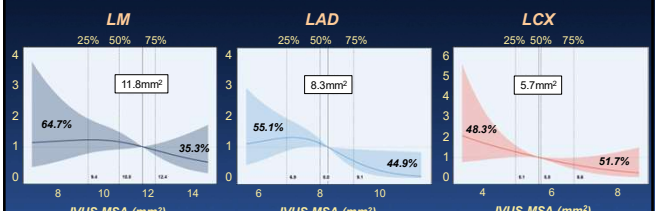
41

Adjusted HR for 5 year MACE after LMCA PCI @AMC
(292 pts treated with 2 stents using the crush technique)



13.8% vs 8.7%, log-rank p=0.24
17.4% vs 9.3%, log-rank p=0.002
17.7% vs 6.6%, log-rank p=0.005

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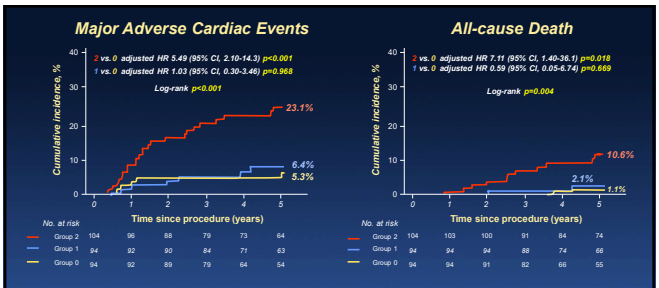
Kim et al. Circ Cardiovasc Interv. 2024;17:e013006. DOI: 10.1161/CIRCINTERVENTIONS.123.013006

42



Overall MACE = 12% @ 5 yrs

- *Group 2: LAD MSA <8.3mm² and LCX MSA <5.7mm² (n=104)*
- *Group 1: LAD MSA <8.3mm² or LCX MSA <5.7mm² (n=94)*
- *Group 0: LAD MSA ≥8.3mm² and LCX MSA ≥5.7mm² (n=94)*

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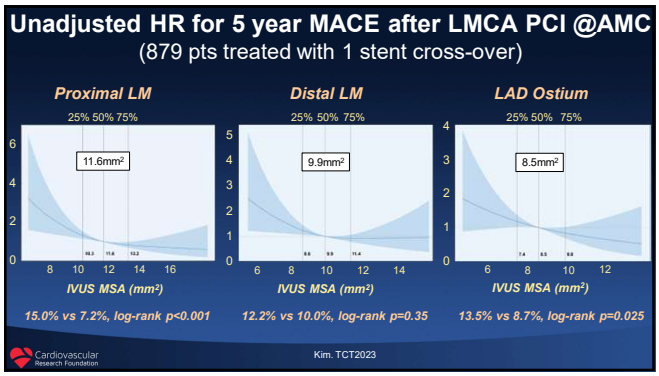
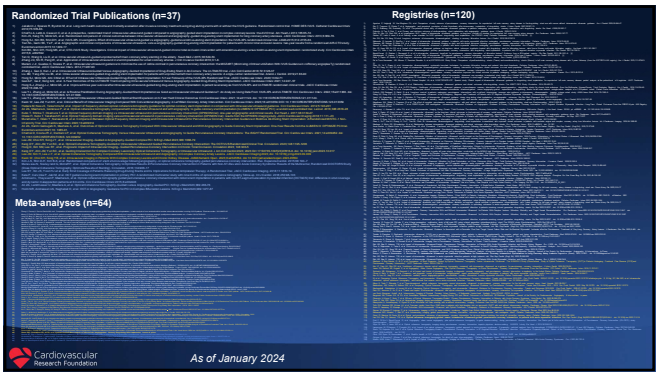
Kim et al. Circ Cardiovasc Interv. 2024;17:e013006. DOI: 10.1161/CIRCINTERVENTIONS.123.013006

43


Unadjusted HR for 5 year MACE after LMCA PCI @AMC
(879 pts treated with 1 stent cross-over)
Proximal LM
Distal LM
LAD Ostium
25% 50% 75%
11.6mm²
9.9mm²
8.5mm²
IVUS MSA (mm²)
15.0% vs 7.2%, log-rank p<0.001
12.2% vs 10.0%, log-rank p=0.35
13.5% vs 8.7%, log-rank p=0.025
Cardiovascular Research Foundation
Kim. TCT2023

44


Randomized Trial Publications (n=37)
Registries (n=120)
Meta-analyses (n=64)
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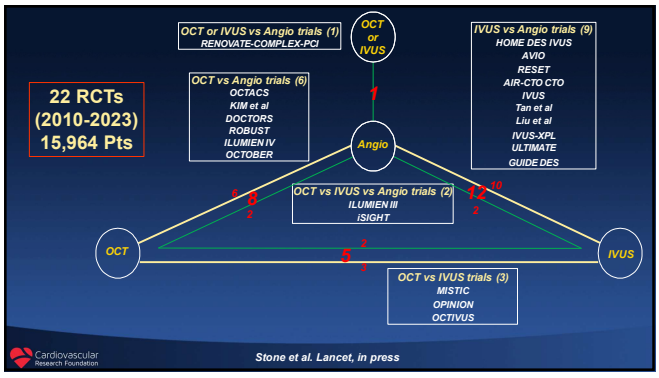
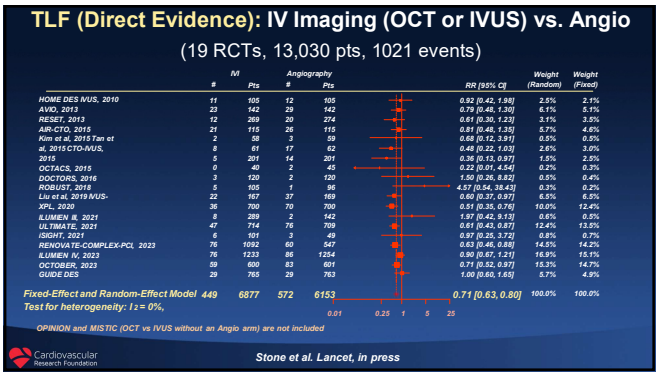
As of January 2024

45


22 RCTs
(2010-2023)
15,964 Pts
OCT or IVUS vs Angio trials (1)
RENOVATE-COMPLEX-PCI
OCT or IVUS
OCT vs Angio trials (6)
OCTACS
KIM et al
DOCTORS
ROBUST
ILUMIEN IV
OCTOBER
IVUS vs Angio trials (9)
HOME DES IVUS
AVIO
RESET
AIR-CTO CTO
IVUS
Tan et al
Liu et al
IVUS-XPL
ULTIMATE
GUIDE DES
Angio
OCT vs IVUS vs Angio trials (2)
ILUMIEN III
iSIGHT
OCT
IVUS
OCT vs IVUS trials (3)
MISTIC
OPINION
OCTIVUS
Cardiovascular Research Foundation
Stone et al. Lancet, in press

46


TLF (Direct Evidence): IV Imaging (OCT or IVUS) vs. Angio
(19 RCTs, 13,030 pts, 1021 events)
IVI
Angiography
Weight (Random)
Weight (Fixed)
RR [95% CI]
HOME DES IVUS, 2010 105 12 105 0.92 [0.42, 1.98] 2.5% 2.1%
AVIO, 2013 142 29 142 0.79 [0.48, 1.30] 6.1% 5.1%
RESET, 2013 269 20 274 0.61 [0.30, 1.23] 3.1% 3.5%
AIR-CTO, 2015 115 26 115 0.81 [0.48, 1.35] 5.7% 4.6%
Kim et al, 2015 Tan et al, 2015 CTO-IVUS, 2015 58 3 59 0.68 [0.12, 3.91] 0.5% 0.5%
OCTACS, 2015 61 17 62 0.48 [0.22, 1.03] 2.6% 3.0%
DOCTORS, 2016 201 14 201 0.36 [0.13, 0.97] 1.5% 2.5%
ROBUST, 2018 40 2 45 0.22 [0.01, 4.54] 0.2% 0.3%
Liu et al, 2019 IVUS-XPL, 2020 120 2 120 1.50 [0.26, 8.82] 0.5% 0.4%
ILUMIEN II, 2021 105 1 96 4.57 [0.54, 38.43] 0.3% 0.2%
ULTIMATE, 2021 167 37 169 0.60 [0.37, 0.97] 6.5% 6.5%
iSIGHT, 2021 700 70 700 0.51 [0.35, 0.76] 10.0% 12.4%
RENOVATE-COMPLEX-PCI, 2023 289 2 142 1.97 [0.42, 9.13] 0.6% 0.5%
ILUMIEN IV, 2023 714 76 709 0.61 [0.43, 0.87] 12.4% 13.5%
OCTOBER, 2023 101 3 49 0.97 [0.25, 3.72] 0.8% 0.7%
GUIDE DES 1092 60 547 0.63 [0.46, 0.88] 14.5% 14.2%
1233 86 1254 0.90 [0.57, 1.21] 16.9% 15.1%
600 83 601 0.71 [0.52, 0.97] 15.3% 14.7%
765 29 763 1.00 [0.60, 1.65] 5.7% 4.9%
Fixed-Effect and Random-Effect Model 449 6877 572 6153 0.71 [0.63, 0.80] 100.0% 100.0%
Test for heterogeneity: I2 = 0%,
0.01 0.25 1 5 25
OPINION and MISTIC (OCT vs IVUS without an Angio arm) are not included
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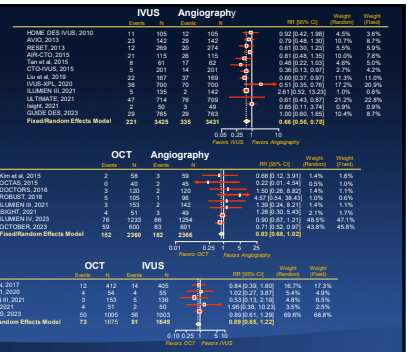
47

TLF (Direct Evidence)

IVUS vs. Angio
12 trials, 6856 pts, 556 events
RR 0.66, 95% CI 0.56-0.78

OCT vs. Angio
8 trials, 4726 pts, 334 events
RR 0.83, 95% CI 0.68-1.02

OCT vs. IVUS
5 trials, 3324 pts, 154 events
RR 0.89, 95% CI 0.65-1.22



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48

IVI (IVUS or OCT) vs Angiography

IVUS vs OCT

Outcome	RCTs	Pts	Events	Direct Estimate	RCTs	Pts	Events	Direct Estimate	Indirect Estimate	Network Estimate
TLF	19	13,030	1021	0.71 [0.63, 0.80]	5	3324	154	0.89 [0.65, 1.22]	1.25 [0.96, 1.64]	1.08 [0.89, 1.33]
Cardiac death	18	12,913	178	0.55 [0.41, 0.75]	5	3324	25	1.06 [0.50, 2.22]	1.09 [0.54, 2.19]	1.07 [0.65, 1.79]
TV-MI	18	12,913	442	0.82 [0.68, 0.98]	5	3324	41	0.63 [0.34, 1.20]	1.02 [0.68,1.53]	0.89 [0.64, 1.25]
TLR	18	12,945	507	0.72 [0.60, 0.86]	5	3324	98	0.88 [0.59, 1.30]	1.47 [1.00, 2.15]	1.14 [0.87, 1.50]
Stent thrombosis	19	13,030	98	0.53 [0.35, 0.82]	5	3324	6	0.67 [0.17, 2.72]	0.95 [0.39, 2.32]	0.86 [0.40, 1.82]
All cause death	18	12,913	331	0.75 [0.60, 0.93]	5	3324	67	1.08 [0.67, 1.72]	0.90 [0.55, 1.47]	0.99 [0.71, 1.39]
All MI	18	12,913	531	0.84 [0.71, 0.99]	5	3324	59	0.71 [0.39, 1.27]	1.06 [0.74, 1.54]	0.95 [0.69, 1.29]
TVR	18	12,945	600	0.72 [0.62, 0.85]	5	3324	137	1.06 [0.76, 1.47]	1.47 [1.04, 2.09]	1.23 [0.97, 1.57]

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49

TLF (Network Evidence): Pairwise Comparison, Random Effects Model

Comparison	Proportion of Evidence	RR [95% CI]	$P_{consistency}$ *
IVUS vs Angio			
Direct estimate (12 trials, 6,856 patients)	0.85	0.66 [0.56, 0.78]	
Indirect estimate	0.15	0.92 [0.63, 1.36]	0.12
Network estimate	1.00	0.70 [0.60, 0.81]	
OCT vs Angio			
Direct estimate (8 trials, 4,726 patients)	0.75	0.83 [0.68, 1.02]	
Indirect estimate	0.25	0.57 [0.40, 0.82]	0.07
Network estimate	1.00	0.76 [0.63, 0.91]	
IVUS or OCT vs Angio			
Direct estimate (1 trial, 1,639 patients)	1.00	0.63 [0.46, 0.88]	
Indirect estimate	0		
Network estimate	1.00	0.63 [0.46, 0.88]	
OCT vs IVUS			
Direct estimate (5 trials, 3,324 patients)	0.43	0.89 [0.65, 1.22]	
Indirect estimate	0.57	1.25 [0.96, 1.64]	0.10
Network estimate	1.00	1.08 [0.89, 1.33]	

0.25 0.5 1 2 4

Favors 1st Modality *Favors 2nd Modality*

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50

Meta-analysis of 20 RCTs (11,698 pts) comparing IVI vs Angio-guided PCI

	Rate Ratio (95% CI)	Risk for Angio-guided PCI	Absolute risk reduction (95% CI) for IVI-guided PCI	Category of Evidence
SYNTAX 0-22				
Cardiac Death	0.53 (0.39 to 0.72)	48 per 1000	23 (29 to 13) fewer	High
MI	0.81 (0.68 to 0.97)	78 per 1000	15 (25 to 2) fewer	High
ST	0.44 (0.27 to 0.72)	16 per 1000	9 (12 to 4) fewer	High
TVR	0.74 (0.61 to 0.89)	108 per 1000	28 (42 to 12) fewer	High
TLR	0.71 (0.59 to 0.86)	121 per 1000	28 (42 to 12) fewer	High
All cause death	0.81 (0.64 to 1.02)	89 per 1000	17 fewer (32 fewer to 2 more)	Moderate
SYNTAX 22-32				
Cardiac Death	0.53 (0.39 to 0.72)	88 per 1000	41 (54 to 25) fewer	High
MI	0.81 (0.68 to 0.97)	112 per 1000	21 (36 to 3) fewer	High
ST	0.44 (0.27 to 0.72)	19 per 1000	11 (14 to 5) fewer	High
TVR	0.74 (0.61 to 0.89)	113 per 1000	29 (44 to 12) fewer	High
TLR	0.71 (0.59 to 0.86)	128 per 1000	37 (57 to 18) fewer	High
All cause death	0.81 (0.64 to 1.02)	138 per 1000	26 fewer (50 fewer to 3 more)	Moderate
SYNTAX ≥33				
Cardiac Death	0.53 (0.39 to 0.72)	136 per 1000	64 (83 to 38) fewer	High
MI	0.81 (0.68 to 0.97)	101 per 1000	19 (32 to 3) fewer	High
ST	0.44 (0.27 to 0.72)	23 per 1000	13 (17 to 6) fewer	High
TVR	0.74 (0.61 to 0.89)	145 per 1000	38 (57 to 16) fewer	High
TLR	0.71 (0.59 to 0.86)	164 per 1000	48 (67 to 23) fewer	High
All cause death	0.81 (0.64 to 1.02)	192 per 1000	26 fewer (69 fewer to 4 more)	Moderate

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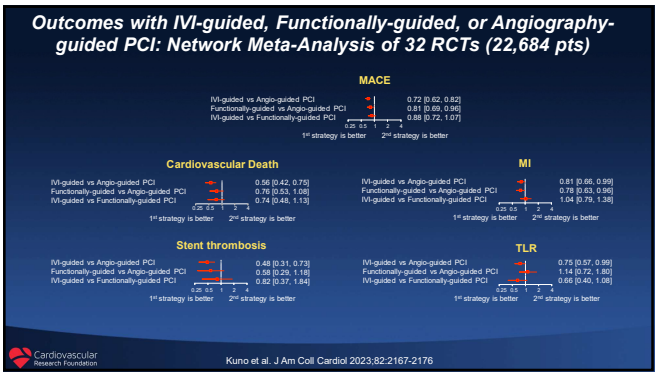
Khan et al. BMJ 2023 doi: 10.1136/bmj-2023-077848 | BMJ 2023;383:e077848

51

Outcomes with IVI-guided, Functionally-guided, or Angiography-guided PCI: Network Meta-Analysis of 32 RCTs (22,684 pts)



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Kuno et al. J Am Coll Cardiol 2023;82:2167-2176

52

	Rate Ratio (95% CI)	Risk for Angio-guided PCI	Absolute risk reduction (95% CI) for IVI-guided PCI	Category of Evidence
SYNTAX 0-22				
Cardiac Death	**0.53 (0.39 to 0.72)**	**48 per 1000**	**23 (29 to 13) fewer**	**High**
MI	0.81 (0.68 to 0.97)	78 per 1000	15 (25 to 2) fewer	High
ST	0.44 (0.27 to 0.72)	16 per 1000	9 (12 to 4) fewer	High
TVR	0.74 (0.61 to 0.89)	108 per 1000	28 (42 to 12) fewer	High
TLR	0.71 (0.59 to 0.86)	121 per 1000	28 (42 to 12) fewer	High
All cause death	0.81 (0.64 to 1.02)	89 per 1000	17 fewer (32 fewer to 2 more)	Moderate
SYNTAX 22-32				
Cardiac Death	**0.53 (0.39 to 0.72)**	**88 per 1000**	**41 (54 to 25) fewer**	**High**
MI	0.81 (0.68 to 0.97)	112 per 1000	21 (36 to 3) fewer	High
ST	0.44 (0.27 to 0.72)	19 per 1000	11 (14 to 5) fewer	High
TVR	0.74 (0.61 to 0.89)	113 per 1000	29 (44 to 12) fewer	High
TLR	0.71 (0.59 to 0.86)	128 per 1000	37 (57 to 18) fewer	High
All cause death	0.81 (0.64 to 1.02)	138 per 1000	26 fewer (50 fewer to 3 more)	Moderate
SYNTAX ≥33				
Cardiac Death	**0.53 (0.39 to 0.72)**	**136 per 1000**	**64 (83 to 38) fewer**	**High**
MI	0.81 (0.68 to 0.97)	101 per 1000	19 (32 to 3) fewer	High
ST	0.44 (0.27 to 0.72)	23 per 1000	13 (17 to 6) fewer	High
TVR	0.74 (0.61 to 0.89)	145 per 1000	38 (57 to 16) fewer	High
TLR	0.71 (0.59 to 0.86)	164 per 1000	48 (67 to 23) fewer	High
All cause death	0.81 (0.64 to 1.02)	192 per 1000	26 fewer (69 fewer to 4 more)	Moderate

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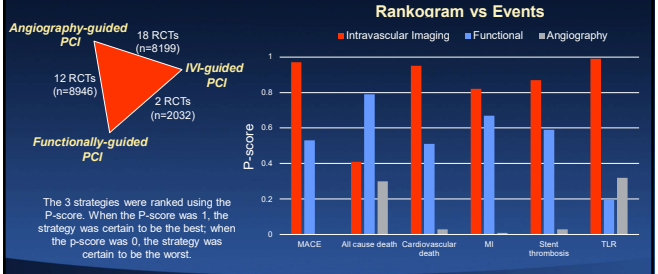
Khan et al. BMJ 2023 doi: 10.1136/bmj-2023-077848 | BMJ 2023;383:e077848

53

Outcomes with IVI-guided, Functionally-guided, or Angiography-guided PCI: Network Meta-Analysis of Randomized Trials



The 3 strategies were ranked using the P-score. When the P-score was 1, the strategy was certain to be the best; when the p-score was 0, the strategy was certain to be the worst.

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Kuno et al. J Am Coll Cardiol 2023;82:2167-2176

54

Subgroups

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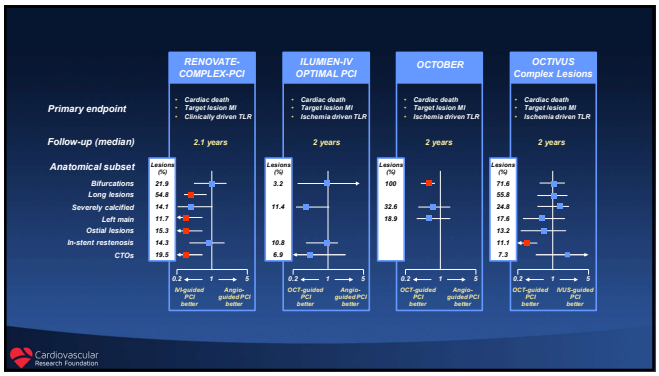
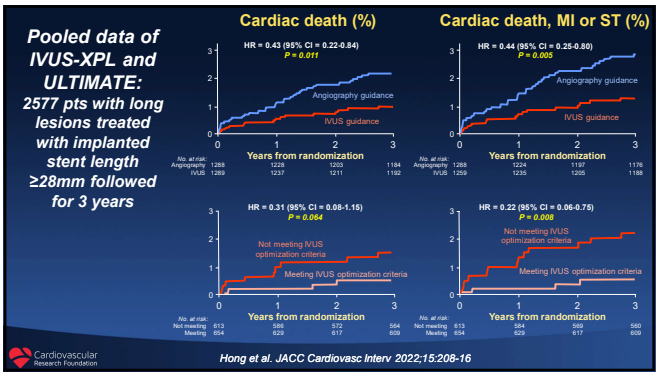
55



56



57

Meta-analysis of IVUS-Guided vs Angiography-Guided PCI in Pts with Acute MI

(8 observational studies and 1 RCT with a total of 838,902 pts)

IVUS guidance	Angiography guidance	All cause mortality	MACE	Cardiac Death	TVR
40,323	790,966	0.70 [0.59-0.82]	0.86 [0.74-0.99]	0.62 [0.29-1.33]	0.83 [0.73-0.95]
35,083 STEMI	778,523 STEMI	0.79 [0.66-0.95]	0.86 [0.74-0.99]		

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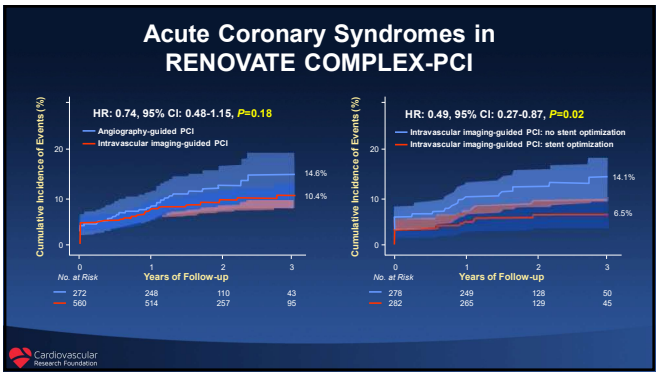
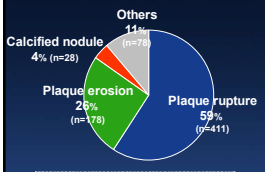
Groenland et al, Int J Cardiol 2022;353:35-42

58

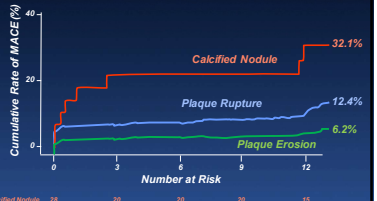


59

MACE Stratified by ACS Causes in TACTICS Registry



Others	
Significant stenosis	64 (9.1%)
Coronary spasm	7 (1.0%)
Ectasia	3 (0.4%)
Embolism	3 (0.4%)
Spontaneous coronary dissection	1 (0.1%)



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Shinke. TCT2022

60

Preliminary data suggests that thrombotic erosions have a better prognosis compared to plaque ruptures and, perhaps, can be treated without stenting

Prati et al. JACC Cardiovasc Imaging 2012;13:6:283-7

Hu et al. J Am Heart Assoc. 2017 Feb 24;6(3). pii: e004730

Xing et al Circ Cardiovasc Interv. 2017;10:e005860. DOI: 10.1161/CIRCINTERVENTIONS.117.005860

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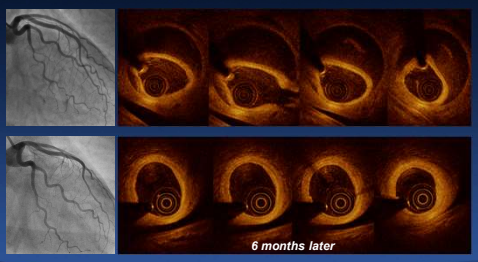
61

An otherwise healthy 57-year-old female with no risk factors for CAD presented with acute chest pain. Electrocardiography showed no abnormalities although both serum CK-MB and troponin I were elevated. She was discharged after clinical management with aspirin, clopidogrel, and low-molecular weight heparin.



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Cade et al. Einstein (Sao Paulo). 2016;14:435-6

62

Kim et al. Catheter Cardiovasc Interv 2020;95:696-703

Choi et al. JACC Cardiovasc Interv 2021;14:2431-43

Kim et al. J Am Heart Assoc. 2022;11:e023481. DOI: 10.1161/JAHA.121.023481

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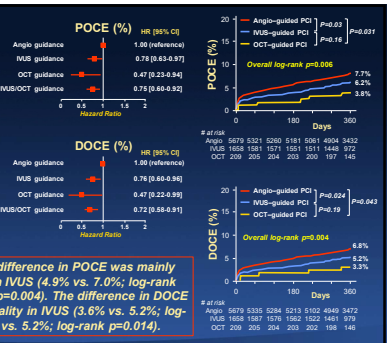
63

IVUS and OCT-guided primary PCI in the KAMIR Registry

- KAMIR (Korean AMI Registry) is an online, open-label registry at 20 sites that was established in 2011 with the help of the Korean NIH
- From 11/2011 to 12/2015, 11,731 STEMI pts underwent 1° PCI: 9072 with angio-guidance and 2333 with IVUS and 277 with OCT to optimize stent expansion, apposition, and lesion coverage.



In the propensity-score matched cohort, difference in POCE was mainly driven by reduced all-cause mortality with IVUS (4.9% vs. 7.0%; log-rank p=0.002) and OCT (1.9% vs. 7.0%; log-rank p=0.004). The difference in DOCE was mainly driven by reduced cardiac mortality in IVUS (3.6% vs. 5.2%; log-rank p=0.009) and OCT-guided PCI (1.4 vs. 5.2%; log-rank p=0.014).

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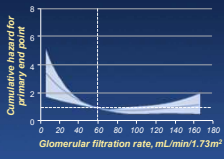
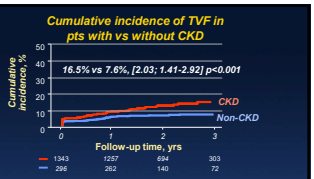
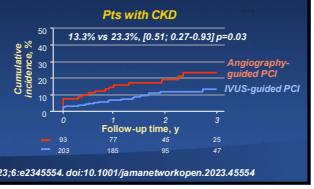
Kim et al. Catheter Cardiovasc Interv 2020;95:696-703

64

RENOVATE COMPLEX PCI: IVUS-Guided vs Angiography-Guided PCI Stratified by the Presence of CKD







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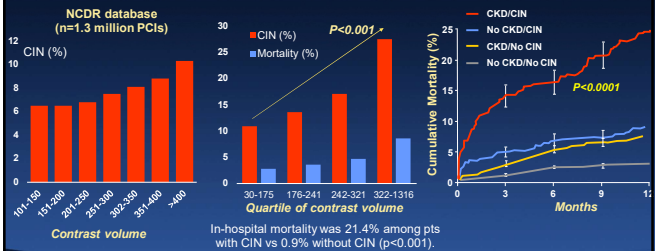
Kwon et al. JAMA Network Open. 2023;6:e2345554. doi:10.1001/jamanetworkopen.2023.45554

65

Prevalence of and Mortality from Contrast-Induced Nephropathy



In-hospital mortality was 21.4% among pts with CIN vs 0.9% without CIN (p<0.001).

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Amin et al. JAMA Cardiol 2017;2:1007-12
Marenzi et al. Ann Intern Med 2009;150:170-7
Dangas et al. Am J Cardiol 2005; 95:13-19

66

Algorithmic approach to DES implantation and optimization made zero-contrast PCI possible

Raber et al. Eur Heart J. 2018;39:3281-3300

Ali et al. Eur Heart J. 2016;37:3090-95

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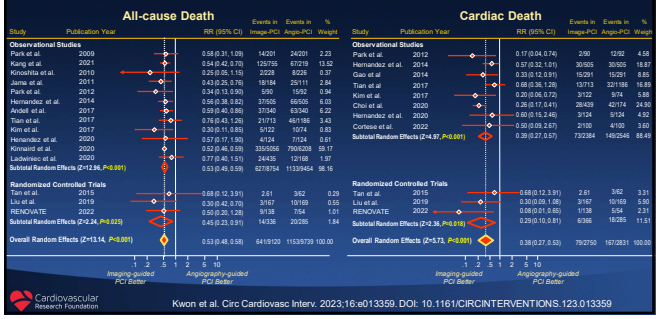
67

LMCA PCI: Meta-analysis of 18 studies (15 observational and 3 RCTs) with 21,701 pts (10,904 IVI-guided PCI and 10,797 angiography-guided)

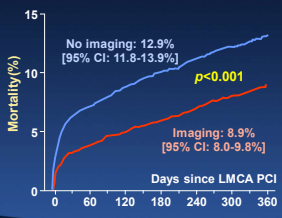


Kwon et al. Circ Cardiovasc Interv. 2023;16:e013359. DOI: 10.1161/CIRCINTERVENTIONS.123.013359

68

LMCA PCI: British Cardiovascular Intervention Society (BCIS) Registry

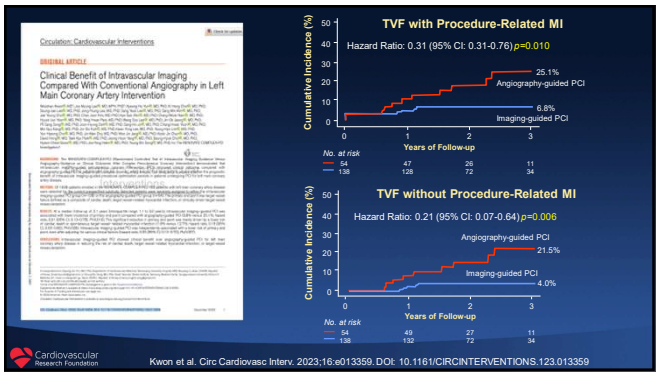
(11,264 LMCA PCI, 5056 imaging [98% IVUS]-guided, with imaging use increasing from 30% in 2007 to 50% in 2014)



- *Overall, there was a 34% mortality reduction with IVUS guidance.*
- *Operators with greater LMCA-PCI volumes had better outcomes and greater mortality benefit with IVUS guidance.*
- *There was a 59% mortality benefit among operators in the quartile with the highest number of LMCA procedures*

Kinnaird et al. JACC Cardiovasc Interv 2020;13:346-357

69



Kwon et al. Circ Cardiovasc Interv. 2023;16:e013359. DOI: 10.1161/CIRCINTERVENTIONS.123.013359

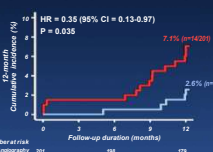
70

Randomized IVUS vs Angiographic Guided CTO Intervention

Primary endpoint (Cardiac death, MI, TVR)

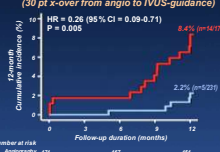
Angiography-guided group
IVUS-guided group

Intention to Treat



	IVUS	Angio	P-value
Cardiac death/MI	0%	2%	0.045
TVR	2.6%	5.2%	0.186

Per Protocol
(30 pt x-over from angio to IVUS-guidance)



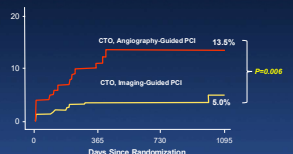
	IVUS	Angio	P-value
Cardiac death/MI	0%	2.3%	0.019
TVR	2.2%	6.1%	0.049

Kim et al. Circ Cardiovasc Interv. 2015 Jul;8(7):e002592

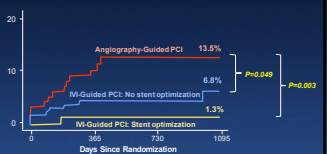
71

Prognostic Impact of IVI-Guided CTO-PCI in RENOVATE COMPLEX PCI RCT

TVR Stratified by Presence of CTO and Treatment (%)



TVF Stratified by Treatment Groups and Stent Optimization (%)



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Hong et al. *Circulation*. 2023;148:903–5

72

IVI vs Angiography in Bifurcation Lesions

Study	Endpoint	Events	P-value
Kim et al. Am J Cardiol 2010;106:612–8	All cause mortality	HR 0.31 [0.13–0.74]	0.008
Kim et al. Am Heart J 2011;161:180–7	Death/MI	HR 0.44 [0.12–0.96]	0.04
Patel et al. Am J Cardiol. 2012;109:960-5	Death/MI	OR 0.38 [0.20-0.74]	0.005
Maehara et al. J Am Coll Cardiol 2013;62:B21-B22	ST/Cardiac Death/MI	HR 0.45 [0.27, 0.74]	0.001
Chen et al. Catheter Cardiovasc Interv. 2013;81:456-63	Cardiac Death	0.6% vs 5.3%	<0.001
Chen et al. Circ Cardiovasc Interv 2017;10:e004497	MI	1.8% vs 5.4%	0.043
Zhang et al. J Am Coll Cardiol 2018;72:3126-37	TVF	HR 0.40 [0.16–0.98]	
Chen et al. Int J Cardiovasc Imaging 2018;34:1685-96.	MACE	15.2% vs 22.4%	0.01
	Cardiac Death	1.3% vs 6.5%	0.002
Choi et al. JACC Cardiovasc Interv 2019;12:607-20	Cardiac Death	HR 0.68 [0.50-0.93]	0.017
Shlofmitz et al. Am Heart J 2020;221:74-83	MACE	9% vs 18%	
Yang et al. Medicine (Baltimore) 2020;99:e20798	<1yr MACE	OR 0.55 [0.42–0.70]	<0.001
	≥1yr Cardiac Death	OR 0.36 [0.23-0.57]	<0.001
Franchin et al. Am J Cardiol 2021;156:24–31	Stent Thrombosis	HR 0.42, CI 0.23 to 0.78	0.006
Holm et al., NEJM 2023;389:1477-87	MACE	0.68 (0.46–1.00)	0.033

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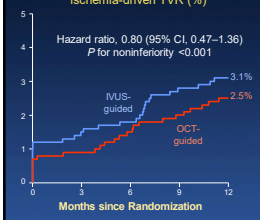
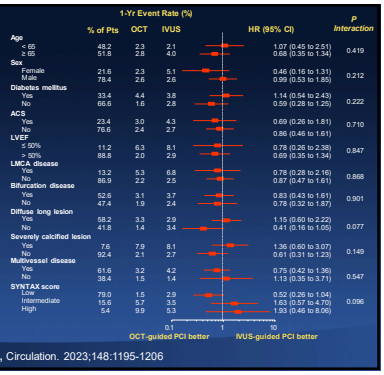
73

OCTIVUS

Composite of cardiac death, TV-MI, or ischemia-driven TVR (%)

Hazard ratio, 0.80 (95% CI, 0.47–1.36)
P for noninferiority <0.001





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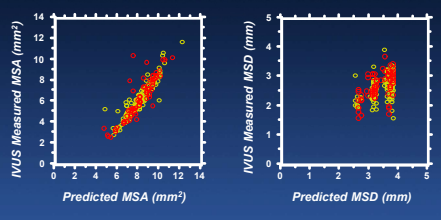
Kang et al., Circulation. 2023;148:1195-1206

74

Manufacturer's Compliance Charts Cannot Be Used to Guarantee Adequate Stent Expansion

DES achieve an average of only 75% of the predicted MSD (66% of MSA)



Takano et al. J Am Coll Cardiol 2001;38:1622-7
de Rebamar Costa et al, Am J Cardiol 2005;96:74-8
de Rebamar Costa et al, Am Heart J 2007;153:297-303
He et al. Am J Cardiol 2010;105:1272-5

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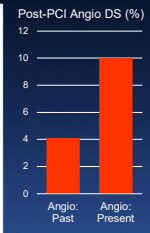
75

Does IVI experience improve angiography-guided PCI results?



	Angio: Past (N=2146)	Angio: Present (N=547)	IPTW	P value
TVF	193 (10.2%)	39 (8.9%)	0.93	0.2
Cardiac death or MI	120 (6.4%)	26 (6.0%)	0.93	0.3
All-cause death	146 (7.8%)	29 (6.9%)	0.93	0.3
Cardiac death	91 (4.8%)	18 (4.2%)	0.91	0.3
MI	53 (2.8%)	12 (2.6%)	0.92	0.5
TV MI	42 (2.1%)	9 (1.8%)	0.90	0.4
Non-TV MI	11 (0.7%)	3 (0.8%)	1.01	0.9
TVR	103 (5.7%)	23 (5.1%)	0.95	0.5
TLR	60 (3.3%)	18 (4.0%)	1.05	0.6
Definite ST	20 (1.2%)	4 (2.2%)	0.89	0.6

PAST: Derived from the institutional registry of Samsung Medical Center
- Choi et al. JACC Cardiovasc Interv 2019;12:607-20
- Lee et al. Sci Rep 2022;12:8237. doi: 10.1038/s41598-022-12339-6

PRESENT: RENOVATE COMPLEX PCI

Kwon et al. J Am Coll Cardiol Intv 2024;17:292–303

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76

Diagnosis of Stent Failure

	Bare Metal Stents				Drug-eluting Stents				
	Stent Thrombosis		Restenosis		Stent Thrombosis			Restenosis	
	<30d	>1y	<5y	>5y	<30d	30d - 1y	>1y	<18m	>18m
Intimal hyperplasia		IVUS OCT	IVUS OCT	IVUS OCT			IVUS OCT	IVUS OCT	IVUS OCT
Procedure-related complications including underexpansion	IVUS OCT		IVUS OCT		IVUS OCT			IVUS OCT	
Late malapposition or aneurysm							IVUS OCT		
Vessel wall inflammation							x		
Stent fracture	IVUS OCT	IVUS OCT			IVUS OCT		IVUS OCT		IVUS OCT
Delayed healing						x			
Uncovered stent struts/fibrin deposition						OCT	OCT		
Neoatherosclerosis		OCT NIRS		OCT NIRS			OCT NIRS		OCT NIRS

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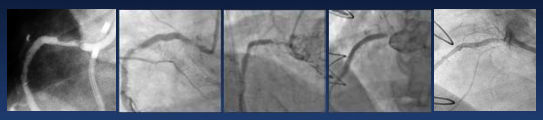
77



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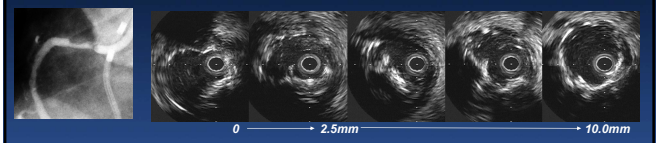

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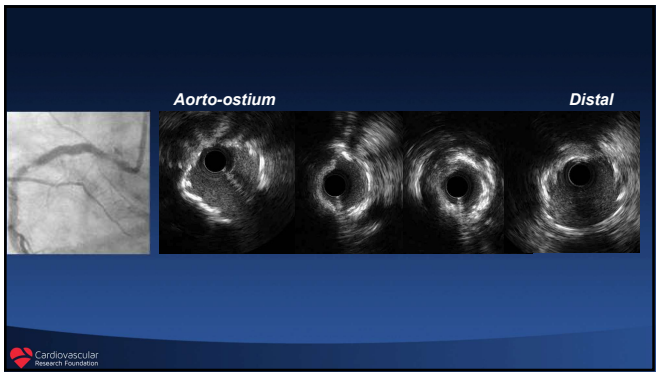
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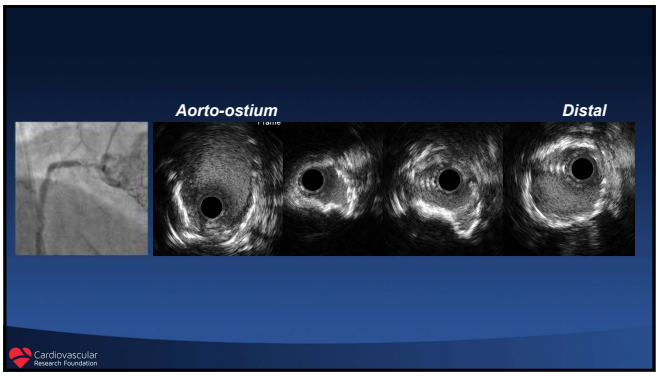
80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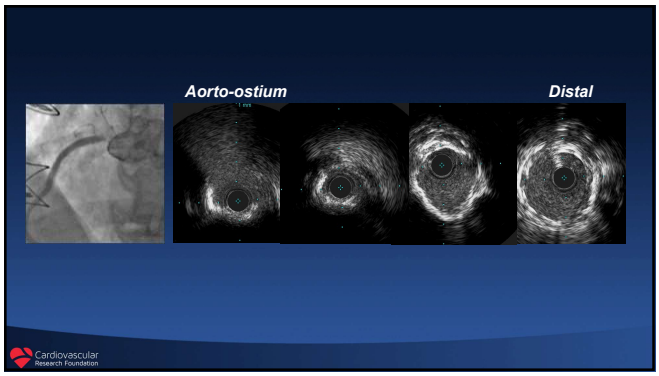
81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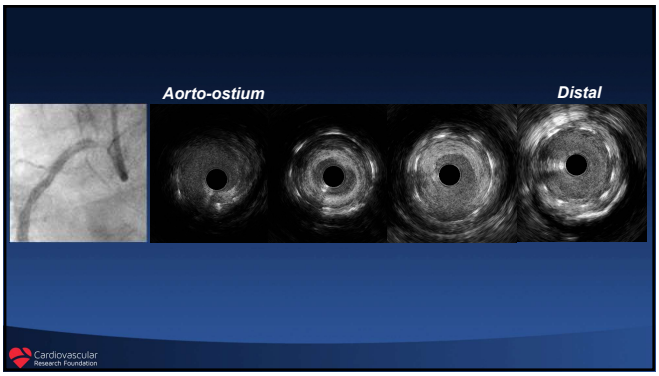
82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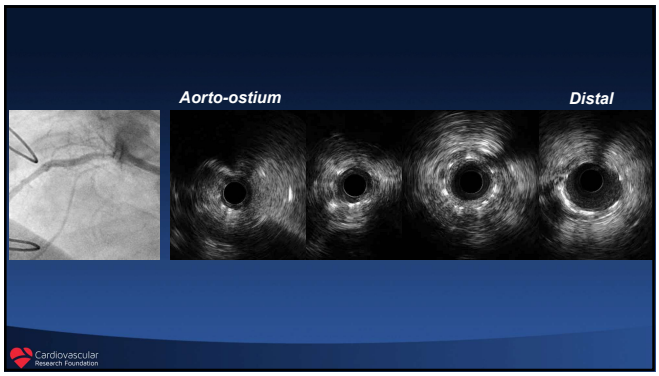
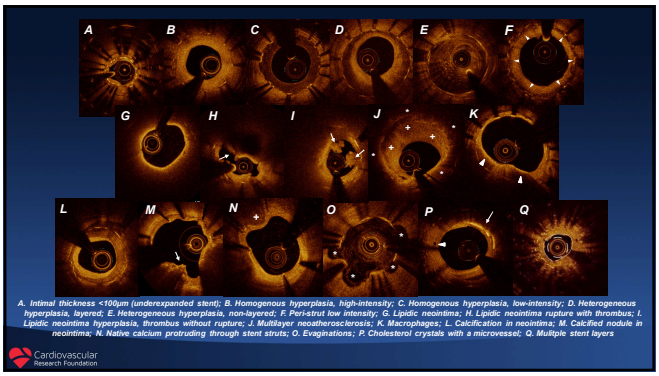


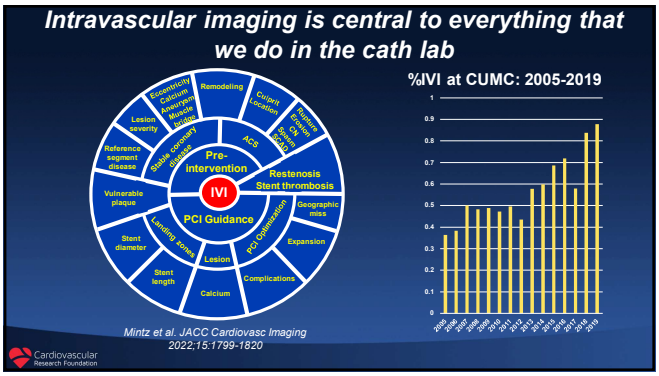
84



85

Clinical problem	FFR	NHPR	IVUS	RF-IVUS	OCT	NIRS
Assessing lesion severity						
Non-LMCA*	++	++	+		+	
Tandem lesions	+	++				
LMCA*	++		++			
Identifying the culprit lesion			±		++	±
Identifying vulnerable plaque				+	+	+
PCI Guidance						
Predicting distal embolization			+	+	+	+
Calcium			+		++	
Guiding CTO intervention			++			
Routine DES optimization*			++		++	
Jailed sidebranch	++					
LMCA stenting			++			
Minimizing contrast			++			
Assessing stent failure			+		++	

86



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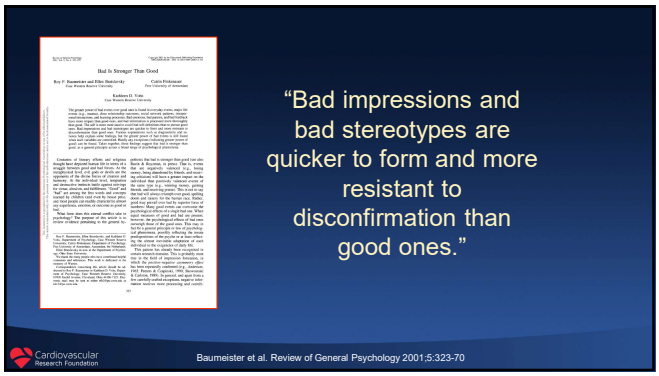
Bad Is Stronger Than Good
“Bad impressions and bad stereotypes are quicker to form and more resistant to disconfirmation than good ones.”
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Baumeister et al. Review of General Psychology 2001;5:323-70

88


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89