When and How to Use Intracoronary Imaging in My Cath Lab

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Disclosure

- I, Do-Yoon Kang, have nothing to disclose.

When Do I Use the Intracoronary Imaging ?

When to Use Intracoronary Imaging?

- To Guide PCI

Asan Medical Center
– Imaging & Physiology Centered Cath Lab

- 4 Cath Labs for Coronary Procedure
- 6,075 CAG
- 2,564 PCI
- 2,758 Intravascular Imaging
- 1,765 FFR

Intracoronary Imaging Penetration Rate for PCI Guidance in AMC

> 95%

Why Do We Use Intracoronary Imaging in Almost PCI Cases?

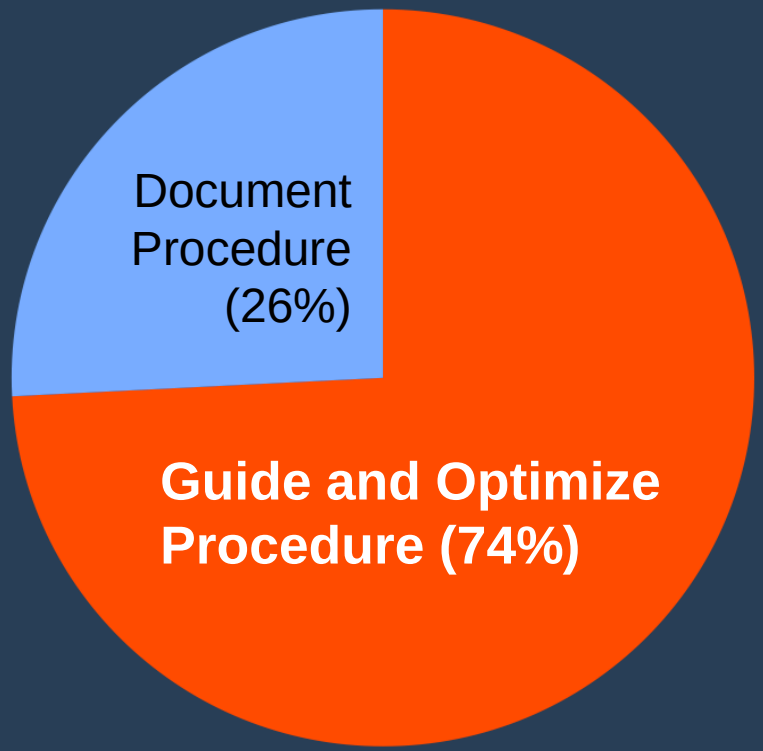
2 Fundamental Questions
For Interventional Cardiologists when Performing a PCI,

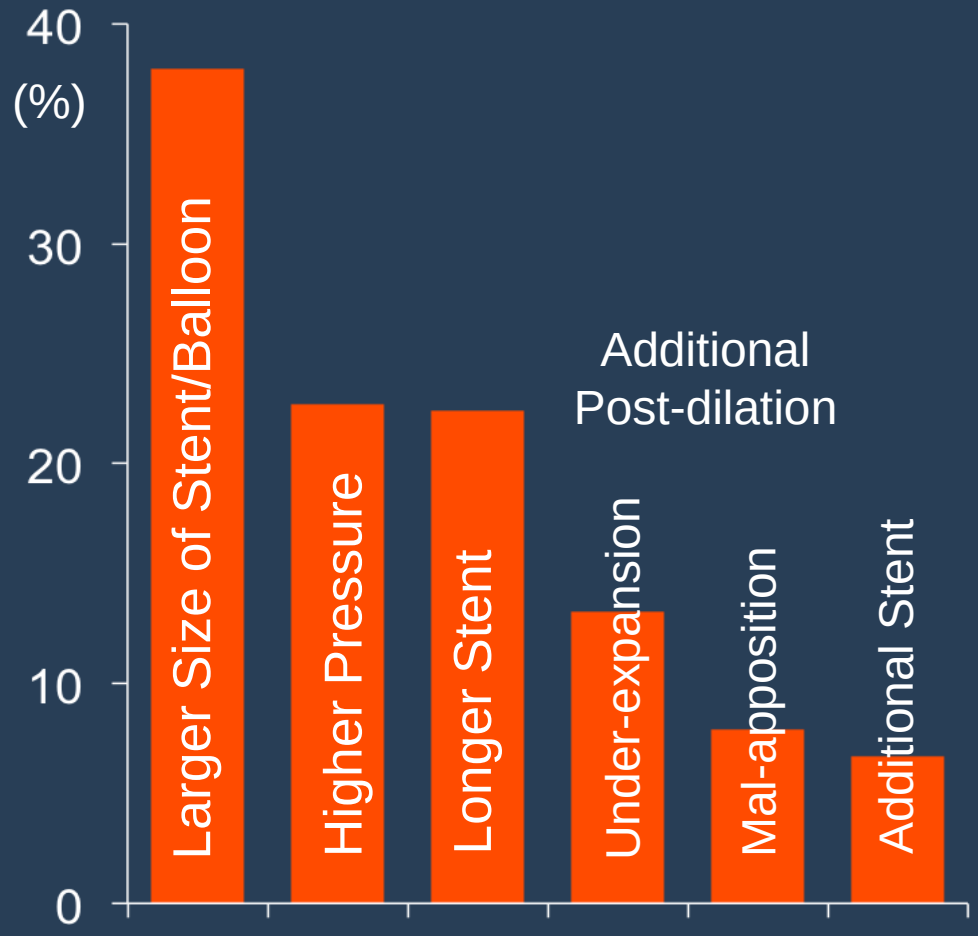
1. Is A Lesion Significant, Ischemia Producing and Should It be Treated ? ***Physiology Answers***

2. Has the PCI been Optimized ? ***Imaging Guides***

How Intravascular Imaging Changed Procedure?

ADAPT-DES: Procedural Changes After IVUS in 74%



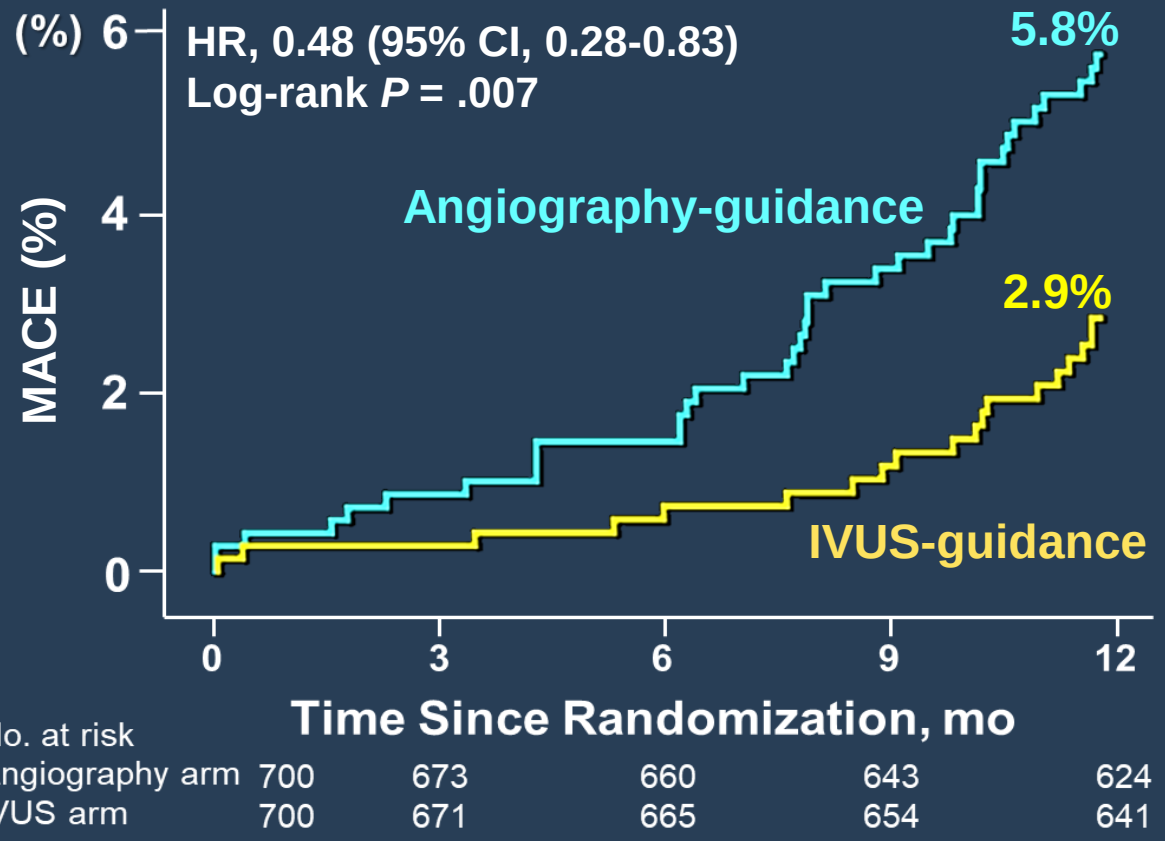


Witzenbichler et al. Circulation 2014;129:463-70

IVUS Improved Clinical Outcomes in Large RCTs

IVUS-XPL (Long lesions)

MACE (CD+TL-MI+ID-TLR)

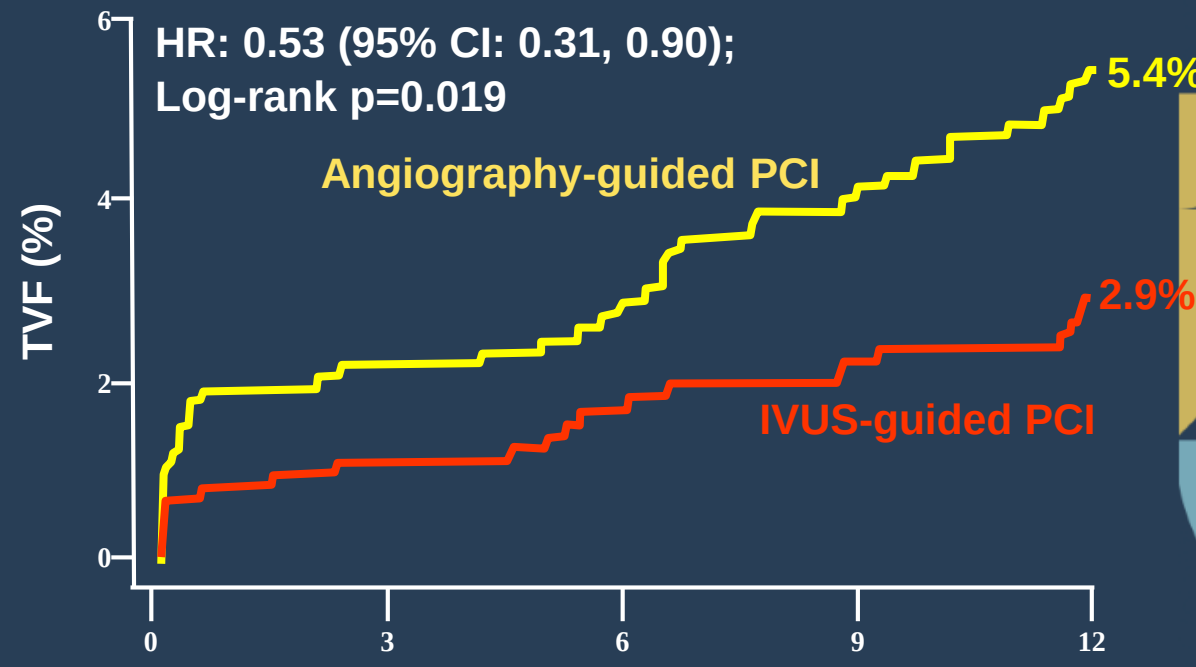


No. at risk					
Angiography arm	700	673	660	643	624
IVUS arm	700	671	665	654	641

Hong SJ, Hong MK et al. JAMA 2015;314:2155-63.

ULTIMATE (All-comer)

TVF (CD+TV-MI+CD-TVR)



No. at risk					
Angiography	724	706	698	685	676
IVUS	724	715	710	704	696

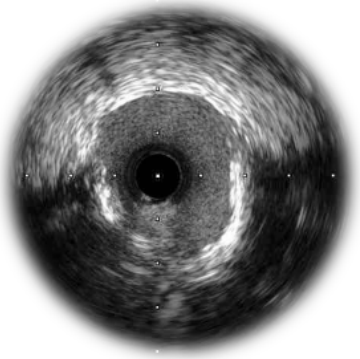
Zhang J et al. J Am Coll Cardiol 2018;72:3126-27.

IVUS Use was Associated with Better 10-yr Outcomes after LM PCI

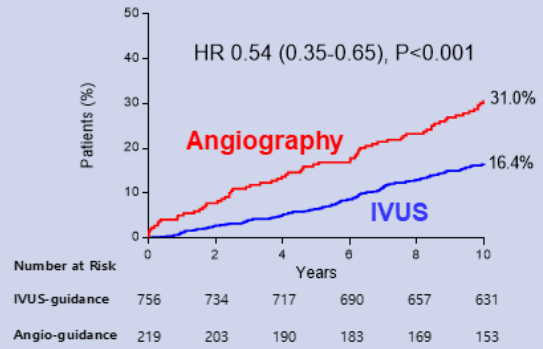
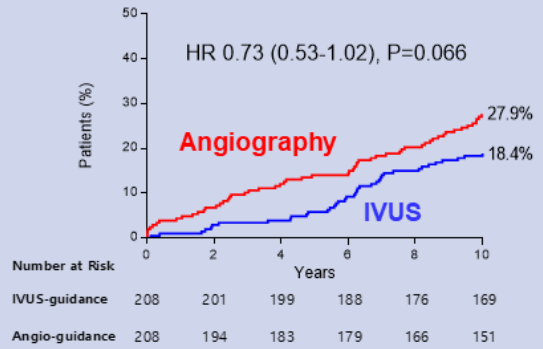
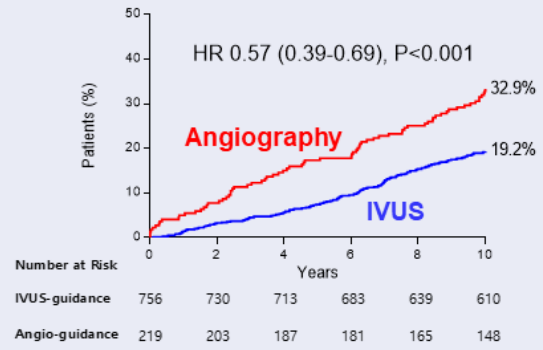
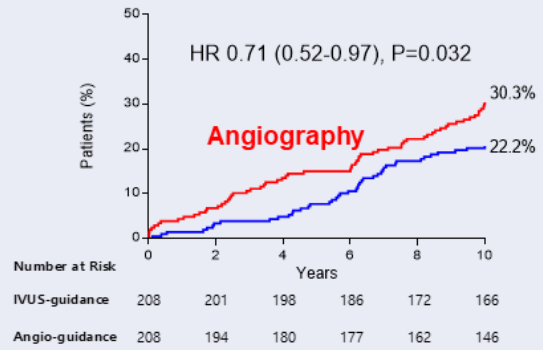
MAIN-COMPARE Registry

Left Main Disease

IVUS-guided PCI



10-Year Follow-up

	Overall Population	After Propensity-score Matching
All-cause death		
Composite of all-cause death, Q-wave MI, or stroke		

Kang DY et al, Circ Cardiovasc Interv. 2021.

2021 ACC/AHA PCI Guideline for Intracoronary Imaging

	COR	LOE
➢ In patients undergoing coronary stent implantation, IVUS can be useful for procedural guidance, particularly in cases of left main or complex coronary artery stenting, to reduce ischemic events	IIa	B
➢ In patients undergoing coronary stent implantation, OCT is a reasonable alternative to IVUS for procedural guidance, except in ostial left main disease	IIa	B
➢ In patients with stent failure, IVUS or OCT is reasonable to determine the mechanism of stent failure	IIa	C

Lawton JS et al. JACC 2021.

Why Do We Use Intracoronary Imaging in Almost PCI Cases?

Because We Believe that the Imaging-guidance Improves the Patients Outcome (especially in the Complex PCI)

When to Use Intracoronary Imaging?

- To Guide PCI (in Almost Cases)
- To Find the Cause of ACS without Clear Culprit (Sometimes)
- To Find Vulnerable Plaque (Research-Based)

Intracoronary Imaging to Find Vulnerable Plaque?

Enrollment Completed
Sep 2021

PREVENT Trial

Significant (DS >50%) Coronary Stenosis **with**
FFR > 0.80 **and with** ***Two*** **of the following**

1. IVUS MLA <4.0mm^2
2. IVUS Plaque Burden >70%
3. TCFA by OCT or VH-IVUS
4. Lipid-Rich Plaque on NIRS ($_{max}LCBI_{4mm}$>315)

R

PCI+OMT
N=800

OMT
N=800

Primary endpoint *at 2 years*:
CV death, MI, Hospitalization d/t unstable angina

OCT sub-study/ NIRS sub-study, (300 patients in each arm at 2 years)

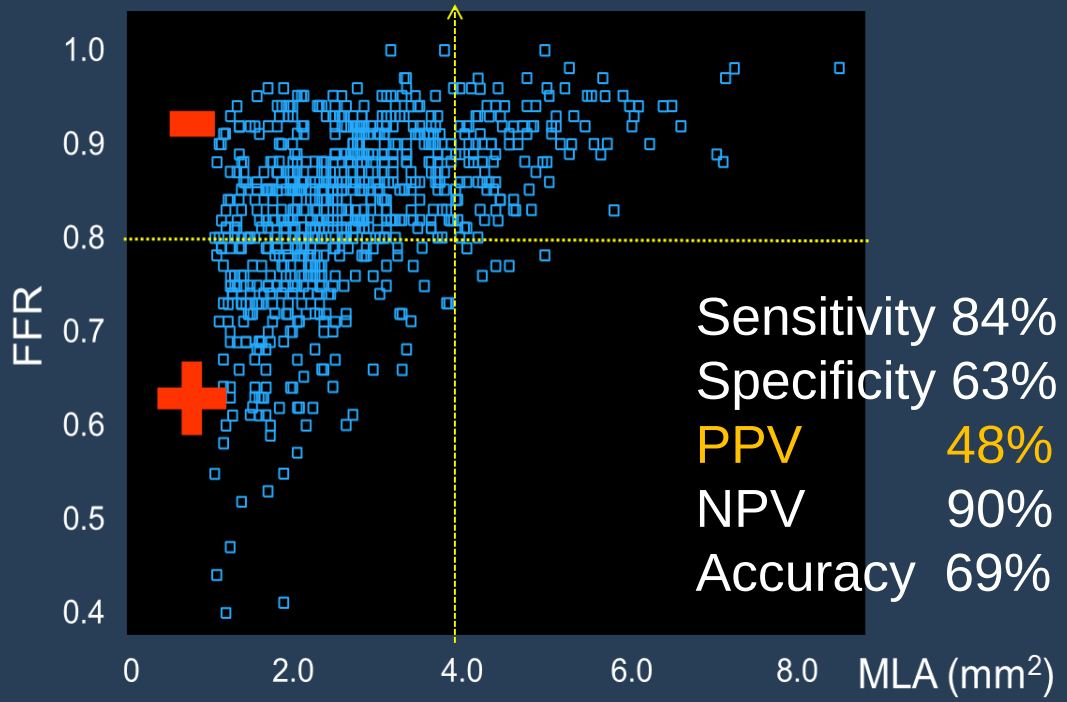
PI:
Seung-Jung Park ,MD

https://clinicaltrials.gov/ct2/show/NCT02316886

Intracoronary Imaging Use to Find Functionally Significant (FFR ≤0.80) Lesion ?

No !

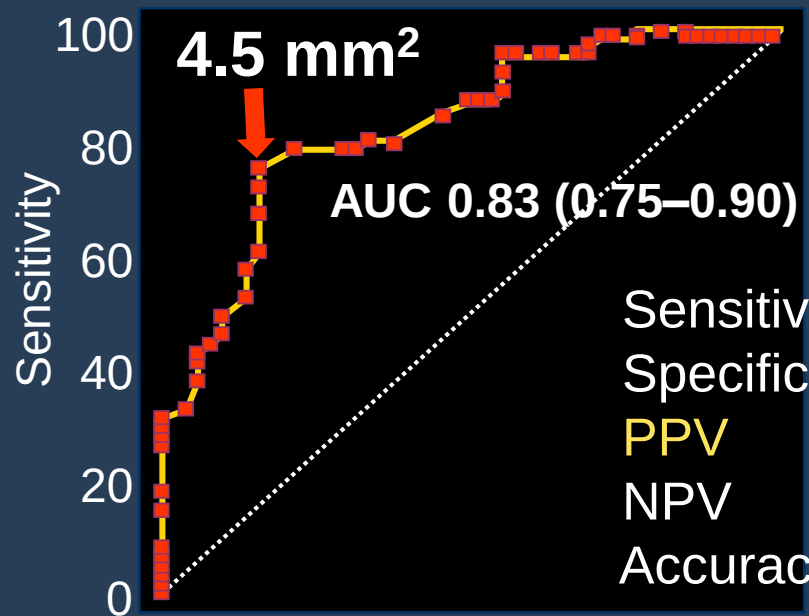
IVUS MLA - FFR in non-LM disease



Sensitivity 84%
Specificity 63%
PPV 48%
NPV 90%
Accuracy 69%

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

IVUS MLA - FFR in LM disease



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

Park SJ et al. JACC Interv, 2014;7(8):868-874

How Do I Use Intracoronary Imaging for PCI Guidance?

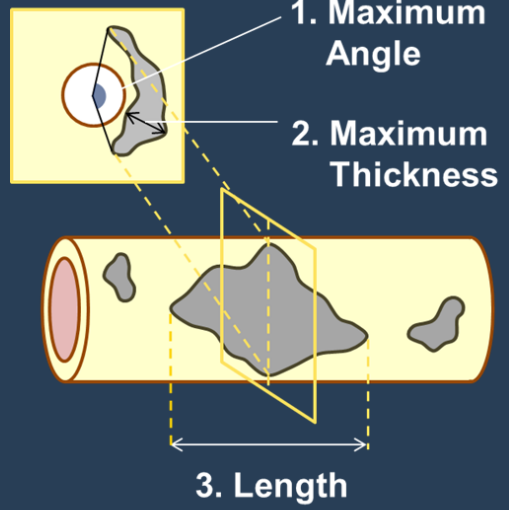
Role of Intravascular Imaging for PCI Guidance?

Optimize Acute Stent Results

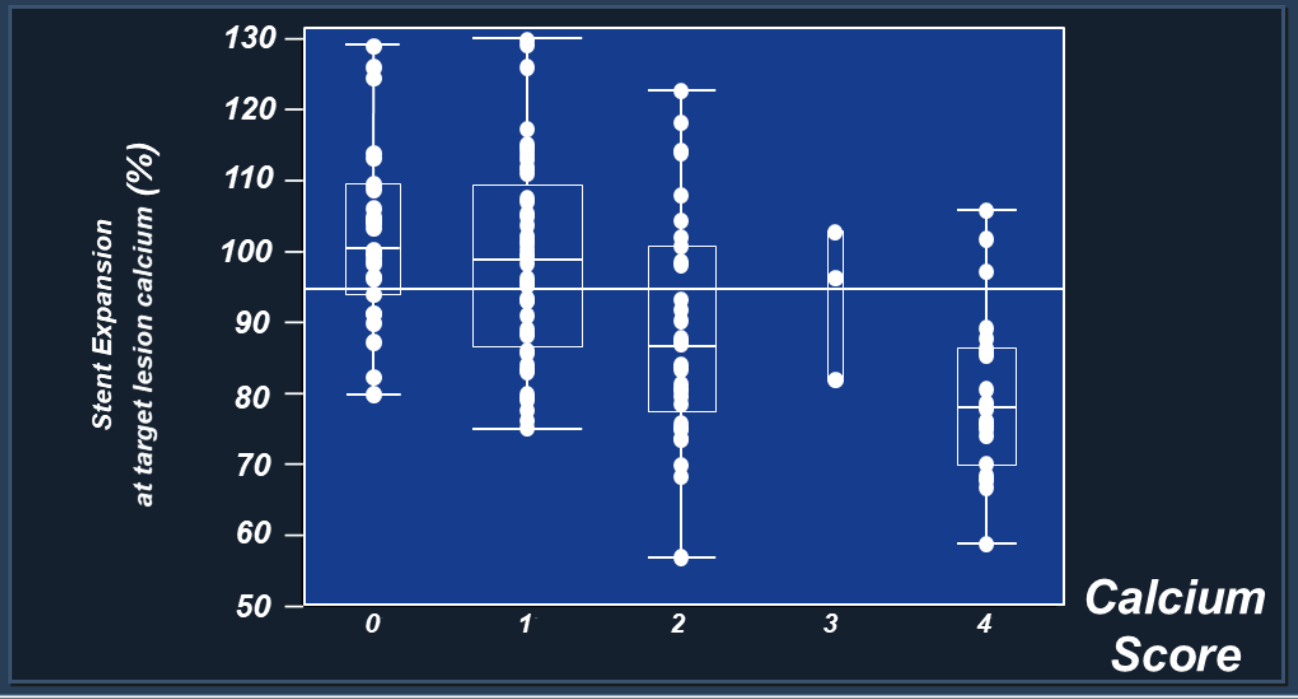
Intracoronary Imaging for Optimizing PCI

- Assess the plaque characteristics & Perform adequate pre-modification
- Confirm the result of the plaque modification in calcified lesion

Calcium Evaluation by Imaging Predicted Stent Expansion



OCT-based CVI Score		
Angle	≤ 180°	0 point
	> 180°	2 points
Thickness	≤ 0.5 mm	0 point
	> 0.5 mm	1 point
Length	≤ 5.0 mm	0 point
	> 5.0 mm	1 point
Total score: 0 to 4 points		



CVI score	0	1	2	3	4	p Value
Expansion at target lesion calcium, %	99	98	86	98	78	<0.01
Expansion at minimum stent area, %	91	85	80	82	69	<0.01

Fujino A et al. EuroIntervention. 2018;13:e2182-9.

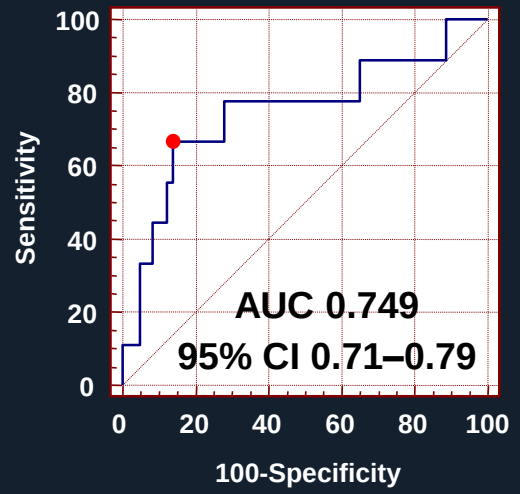
Intracoronary Imaging for Optimizing PCI

- Assess the plaque characteristics & Perform adequate pre-modification
- Confirm the result of the plaque modification in calcified lesion
- Select the clean landing zones (stent length), larger stent (lumen / vessel size)

The Best Cut-off of Edge Restenosis

Plaque Burden <55%

433 E-ZES

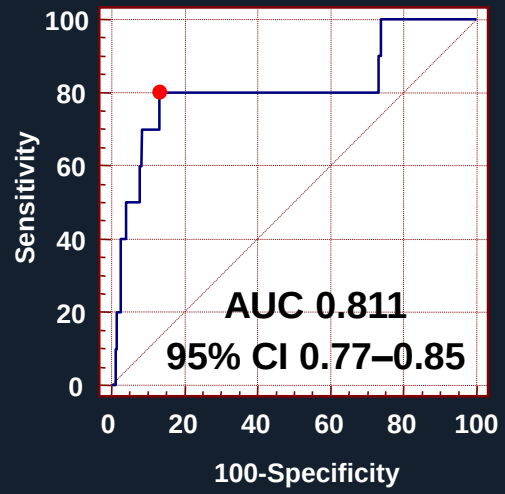


PB 56.3%

Sensitivity 67%

Specificity 86%

422 R-ZES

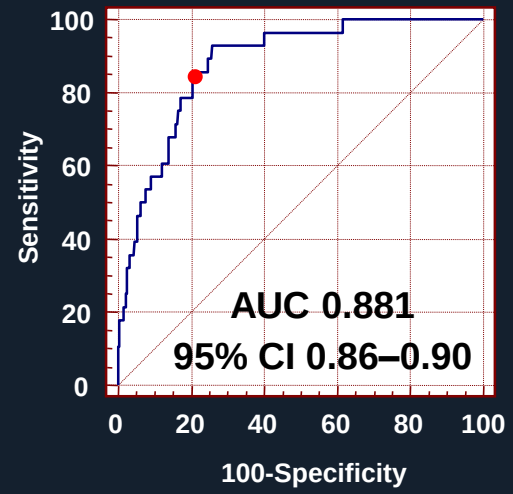


PB 57.3%

Sensitivity 80%

Specificity 87%

813 EES



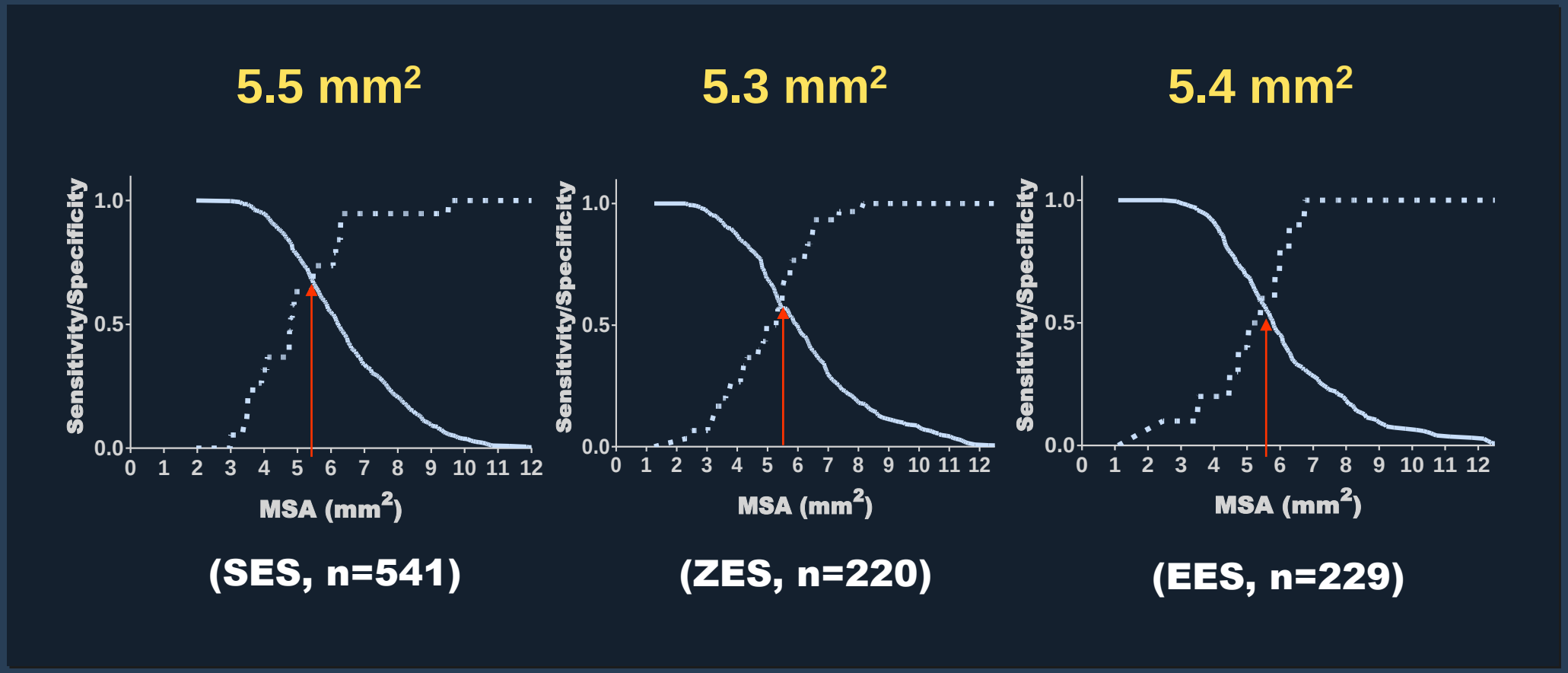
PB 54.2%

Sensitivity 86%

Specificity 80%

Kang SJ et al. Am J Cardiol 2013

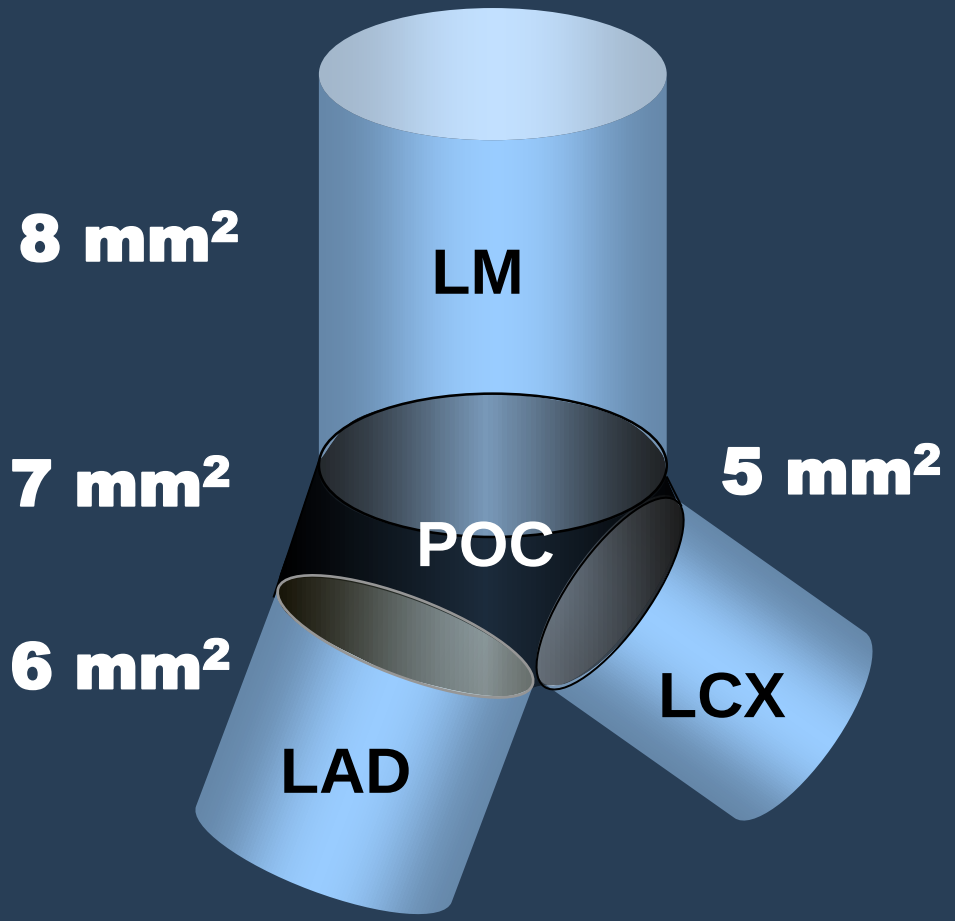
Effective Stent Area (> 5.0 mm^2), Can Make Lower TLR <2%

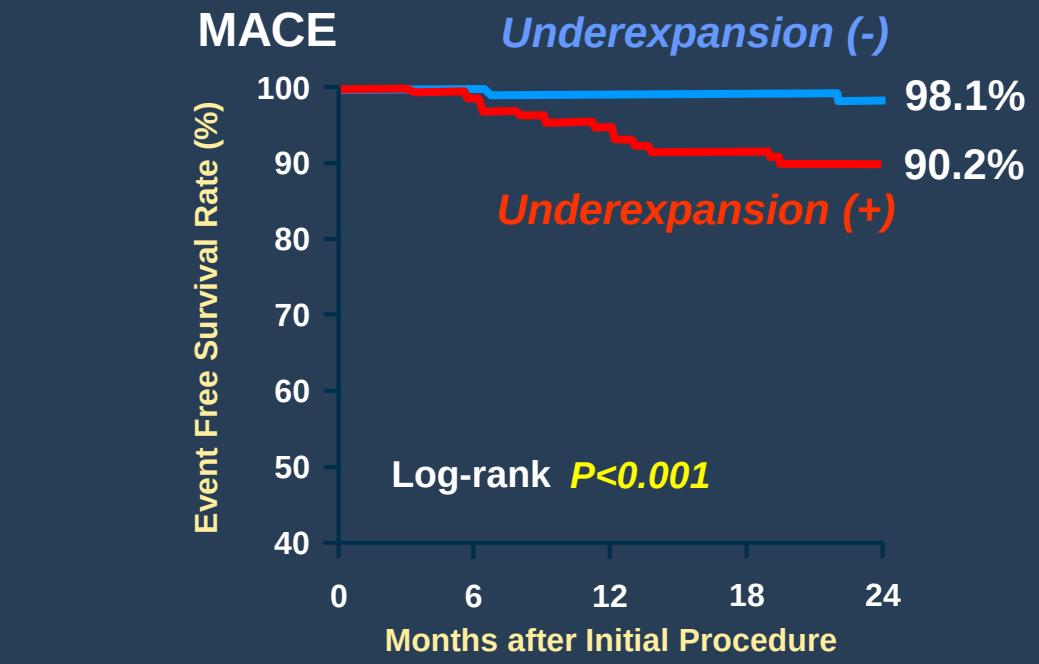


Song HG et al, Catheterization and Cardiovascular Interventions. 2012.

Stent Area after LM Bifurcation PCI : Bigger the Better

Rule of 5, 6, 7, 8





No. at risk

Underexpansion (+)	133	131	126	121	75
Underexpansion (-)	260	260	255	246	129

Kang SJ et al. Circ Cardiovasc Interv 2011;4:562-9.

Intracoronary Imaging for Optimizing PCI

- Assess the plaque characteristics & Perform adequate pre-modification
- Confirm the result of the plaque modification in calcified lesion
- Select the clean landing zones (stent length), larger stent (lumen / vessel size)
- Select the larger-sized noncompliant balloon for post-dilation

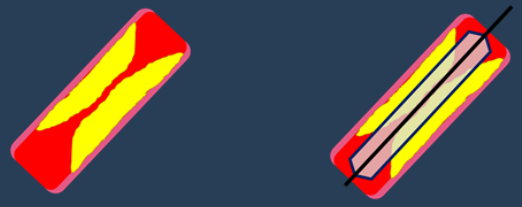
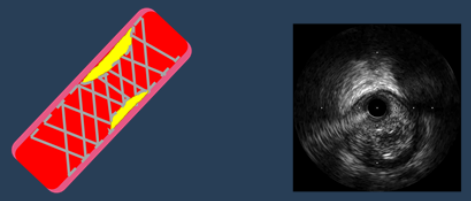
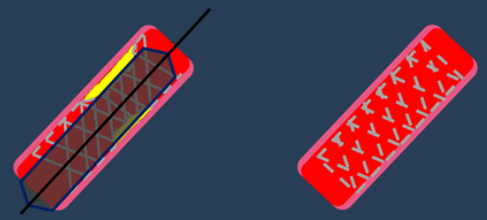
Imaging-Guided Complex PCI in IRIS-DES Registry

- From IRIS-DES Registry (NCT01186133) Between 2008 and 2017.
- A total 9525 patients with single complex coronary lesions were enrolled in this analysis.
- Complex coronary lesions were included
    1. LMCA
    2. Bifurcation
    3. Diffuse lesion (>30mm)
    4. Severely calcified lesion
    5. In-stent restenosis
- Primary outcome : composite of cardiac death, target vessel MI and TVR

Park HB et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

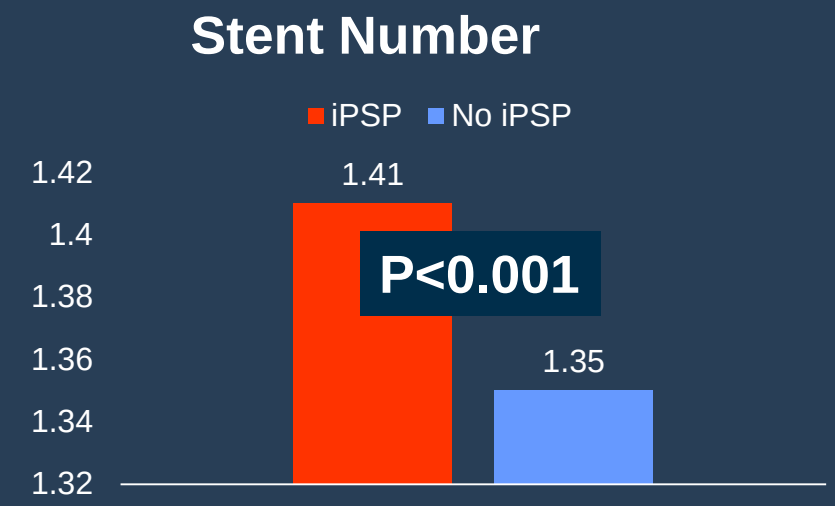
Imaging-Guided PSP

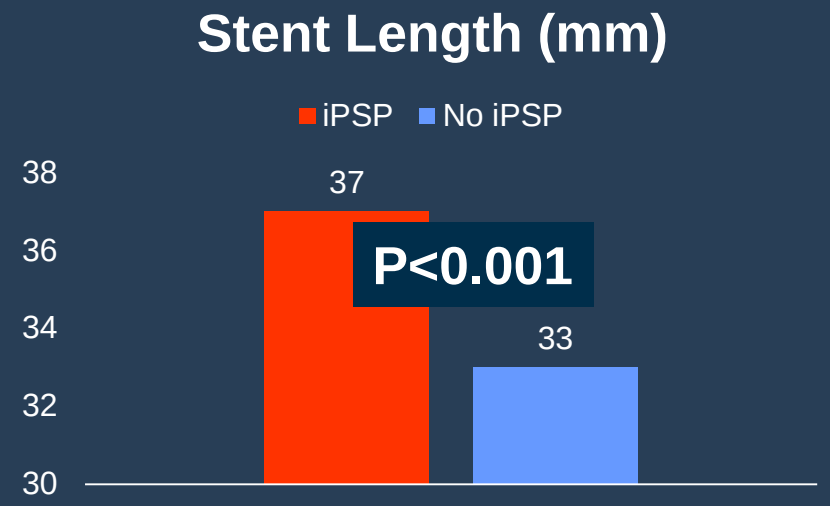
Under the Intracoronary Imaging Guidance

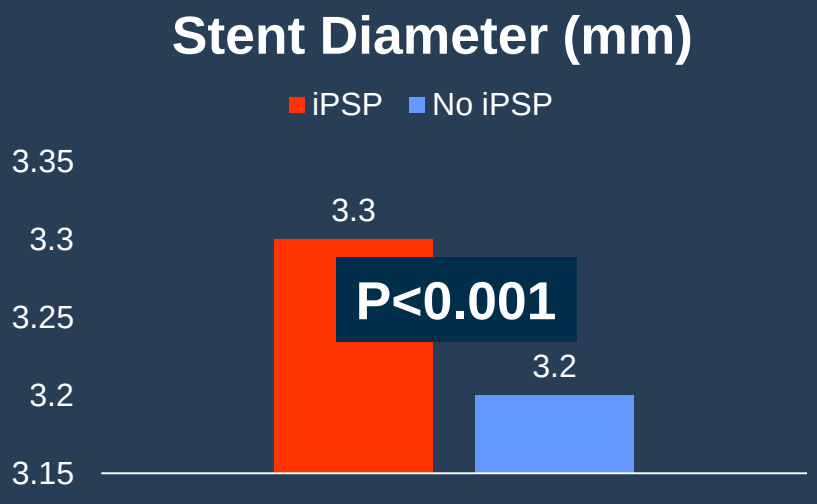
Inspection of lesion characteristic by IVUS	**Selection of stent size and length by IVUS**	**Surveillance of stent outcomes**
Calcification Plaque burden and configuration Opening of side branch	Stent landing zone configuration Lesion length Reference vessel size	Stent apposition Stent area Procedural complications
P Pre-dilation	S Stent Sizing	P Post-dilation
		
Lesion pre-modification for stent delivery and expansion: High pressure balloon Cutting or scoring balloon Rota-ablation	Full lesion coverage Adequate stent size	Complete stent apposition Sufficient stent area No geographic miss No procedural complications

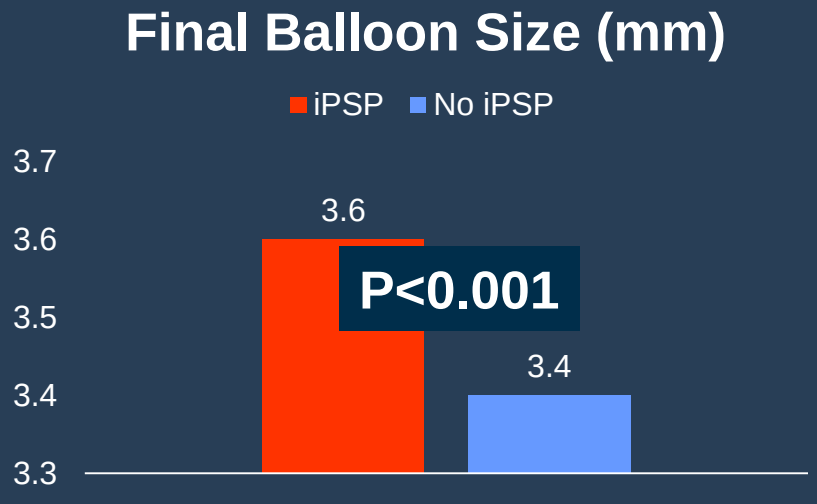
Park HB, Ahn JM, Park SJ et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

Imaging-Guided PSP, What Is Different?









Park HB et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

Imaging-Guided Complex PCI – Better Clinical Outcome

	Crude cumulative incidence (%)			Multivariate analysis		PS matching		IPTW	
	iPSP	No iPSP	P	HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
Primary outcome	**5.7**	**8.0**	**0.001**	**0.74 (0.61-0.90)**	**0.003**	**0.71 (0.56-0.90)**	**0.005**	**0.71 (0.63-0.81)**	**<0.001**
Cardiac death	2.3	3.6	0.003	0.73 (0.53-0.99)	0.047	0.78 (0.53-1.15)	0.20	0.62 (0.51-0.75)	0.003
Target vessel MI	0.2	0.5	0.19	0.68 (0.30-1.55)	0.36	0.78 (0.29-2.09)	0.62	0.65 (0.38-1.10)	0.10
TVR	3.4	4.6	0.02	0.73 (0.57-0.94)	0.02	0.68 (0.50-0.92)	0.01	0.74 (0.63-0.87)	<0.001

Park HB et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

Post-dilation was the Most Significant Event Predictor Among 3 Components of iPSP

	Univariate analysis		Multivariate analysis*	
	HR (95% CI)	P value	HR (95% CI)	P value
Pre-dilation	0.89 (0.69-1.15)	0.374	0.84 (0.64-1.11)	0.216
Stent-sizing	0.79 (0.67-0.93)	0.004	0.89 (0.74-1.07)	0.219
Post-dilation	**0.79 (0.67-0.94)**	**0.006**	**0.80 (0.67-0.96)**	**0.016**

Park HB et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

Post-Balloon Size was Larger With IVUS

Pre-dilation	IVUS	Post-dilation	No. of patients (%)	Stent diameter (mm)	Post balloon size (mm)	Annualized event rate	Adjusted HR (95% CI)	P value
No	**No**	Yes	129 (1.4)	3.04 ± 0.41	3.10 ± 0.81	3.04 %	0.81 (0.35-1.85)	0.613
				Δ +0.05 (P=0.550)				
Yes	**No**	Yes	1719 (18.0)	3.08 ± 0.38	3.12 ± 0.86	3.07 %	0.80 (0.53-1.21)	0.297
				Δ +0.04 (P=0.104)				
No	Yes	Yes	309 (3.2)	3.43 ± 0.41	3.79 ± 0.70	2.04%	0.72 (0.39-1.35)	0.306
				Δ +0.35 (P<0.001)				
Yes	Yes	Yes	3374 (35.4)	3.26 ± 0.39	3.58 ± 0.60	1.98%	0.63 (0.42-0.93)	0.022
				Δ +0.32 (P<0.001)				

Park HB et al. JACC Cardiovasc Interv. 2020;13:1403-1413.

Intracoronary Imaging for Optimizing PCI

- Assess the plaque characteristics & Perform adequate pre-modification
- Confirm the result of the plaque modification in calcified lesion
- Select the clean landing zones (stent length), larger stent (lumen / vessel size)
- Select the larger-sized noncompliant balloon for post-dilation
- Post-stenting surveillance for stent expansion & edge problem

With Intravascular Imaging,

I Can Implant Bigger Stent,

With Higher Pressure Post-dilation,

Safely.

Small Details Make a Big Difference !

He is the Keyman
For Successful
Imaging-guided PCI !

The Key for Successful, Fluent Imaging-Guided PCI ?

Education of Cath Lab Professionals

Which Imaging Device Do I Use ?

	OCT	IVUS
Wave source	Near-infrared light	Ultrasound
Axial resolution, μm	1-2	38-46
Penetration depth in soft tissue, mm	1-2	>5
Blood clearance	Needs Contrast	Not required
Plaque burden at lesion	-	+
Aorto-ostial visualization	-	+
Cross-sectional calcium evaluation	Thickness, angle	Angle only
Lipidic plaque evaluation	Lipidic plaque, cap thickness	Attenuated plaque

Maehara A et al., J Am Coll Cardiol Img 2017;10:1487-503
Koganti S et al., Interv Cardiol 2016;11:11-16

OCT vs. IVUS in My Daily Practice

	OCT	IVUS
LM disease		Better
Ostial lesion		Better
Bifurcation	Delicate	Convenient
Long lesion	It saves time	1 mm/s pullback also saves time
CTO		Better
In-stent restenosis	Better	
Renal dysfunction or CHF		Better

OCTIVUS Trial

Pragmatic RCT Comparing OCT vs. IVUS-guided PCI

Enrollment Completed
Jan 2022

Optical Coherence Tomography versus Intravascular Ultrasoun
Guided Percutaneous Coronary Intervention

OCTIVUS Trial

Patients with CAD undergoing PCI (N=2,000)

R

OCT-guided PCI
(N=1,000)

IVUS-guided PCI
(N=1,000)

Primary Endpoint: Target Vessel Failure at 1 year
(Composite of cardiac death, target-vessel MI and ischemia-driven TVR)

Clinical follow-up at 1, 6, 12 months, then 3 and 5 years

PI:
Seung-Jung Park ,MD.
Duk-Woo Park, MD.

Kang DY et al. Am Heart J. 2020 Oct;228:72-80.

Conclusion

- Intracoronary imaging–guided PCI is the evidence-based approach for the best clinical outcome.
- Imaging enables safe and effective PCI with larger stent & balloon, resulting in a larger final stent area.
- Team education is important for procedural fluency in routine use of imaging.
- Practice makes perfect. Routine use of intracoronary imaging would make perfect PCI team.

Thank you for your attention !