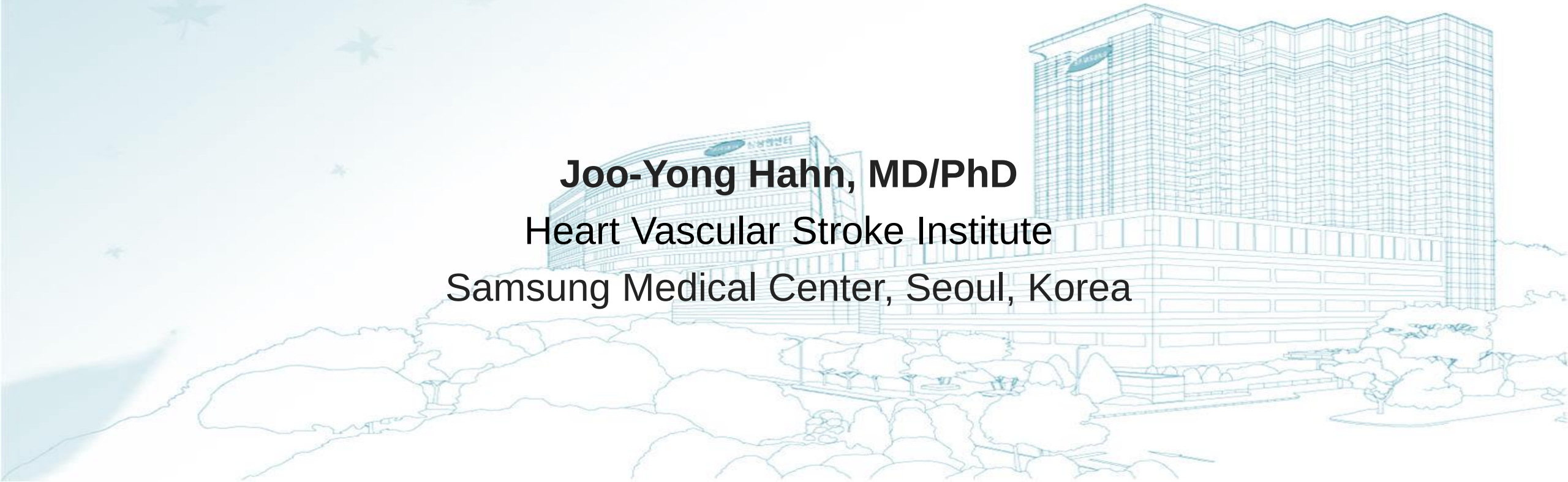
Samsung Medical Center
Sungkyunkwan University
School of Medicine

Why Do We Need Intravascular Imaging-guided Complex PCI?



Joo-Yong Hahn, MD/PhD
Heart Vascular Stroke Institute
Samsung Medical Center, Seoul, Korea

Disclosure

Grant support

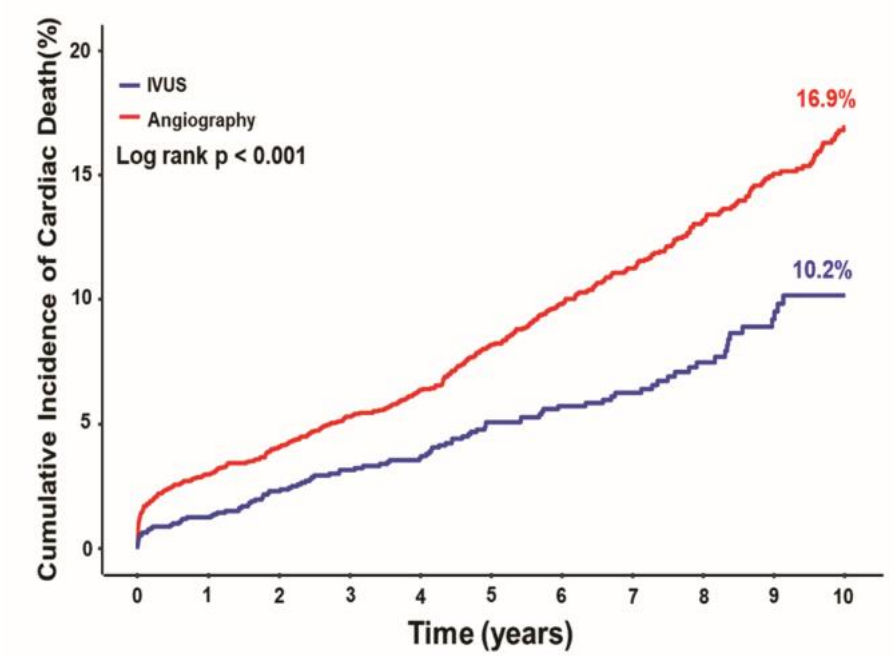
- National Evidence-based Healthcare Collaborating Agency, Ministry of Health & Welfare, Republic of Korea
- Abbott Vascular, Biosensors, Biotronik, Boston Scientific, Daiichi Sankyo, Donga-ST, Hanmi Pharmaceutical, and Medtronic

Consulting Fees/Honoraria

- Abbott Vascular, Amgen, Astra Zeneca, Biosensors, Biotronik, Boston Scientific, Daiichi Sankyo, MSD Korea, Novartis, Pfizer, and Sanofi-Aventis

Background

- Previous trials (CTO-IVUS, AVIO, HOME-DES-IVUS, IVUS-XPL, and ULTIMATE) have shown lower rates of major adverse clinical events after intravascular ultrasound (IVUS)-guided percutaneous coronary intervention (PCI) than after angiography-guided PCI but have not been considered definitive owing to limited sample size, short follow-up duration, or the inclusion of highly selected coronary-lesion subsets.
- Our group has already reported the long-term benefit of the use of IVUS in patients undergoing complex PCI in an observational study.[1]
  → A randomized trial with adequate sample size is needed to confirm the benefit of intravascular imaging-guided PCI in patients with complex coronary artery lesions.



1. Choi KH, Song YB, …, Hahn JY. JACC Cardiovasc Interv. 2019

Major coronary intravascular imaging trials published in 2023

- RENOVATE-COMPLEX-PCI (N Engl J Med 2023; 388:1668-1679)
  - Intravascular imaging (IVUS/OCT) vs. Angiography-guided PCI
  - 1,620 patients with complex lesions
- ILUMIEN IV (N Engl J Med 2023)
  - OCT vs. Angiography-guided PCI
  - > 2,490 patients with high-risk clinical characteristics (diabetes) and/or complex angiographic lesions
- OCTOBER (N Engl J Med 2023)
  - OCT vs. Angiography-guided PCI
  - 1,201 patients with complex bifurcation lesions
- OCTIVUS (Circulation 2023)
  - OCT vs. IVUS-guided PCI
  - 2,000 patients

RENOVATE-COMPLEX-PCI: Study Objective

- To investigate whether intravascular imaging-guided PCI using IVUS or optical coherence tomography (OCT) would improve clinical outcomes compared with angiography-guided PCI in patients with complex coronary artery lesions.

Working Hypothesis

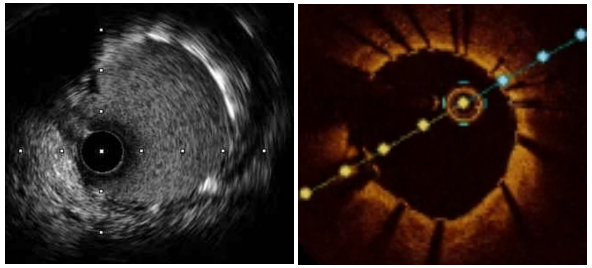
Intravascular imaging-guided PCI would reduce target vessel failure (a composite of cardiac death, target vessel-related myocardial infarction, and target vessel revascularization), compared with angiography-guided PCI in treatment of patients with complex coronary artery lesions.

Study Design

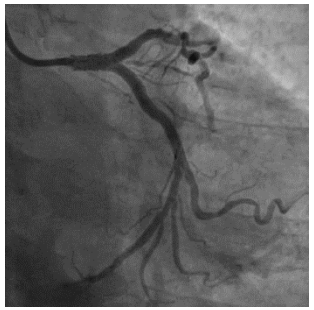
RENOVATE-COMPLEX-PCI (NCT03381872)

An investigator-initiated, prospective, multicenter, randomized, open-label trial at 20 sites in Korea

Patients with Complex Coronary Artery Lesions Undergoing PCI



Randomization (2:1) for Treatment Strategy of Target Lesions



Imaging-Guided Strategy

Angiography-Guided Strategy

For patients who had been assigned to the intravascular imaging group, the choice of IVUS or OCT was made at the operators' discretion.
Primary end point: target vessel failure (a composite of cardiac death, target vessel-related MI, or clinically-driven TVR)

Inclusion and Exclusion Criteria

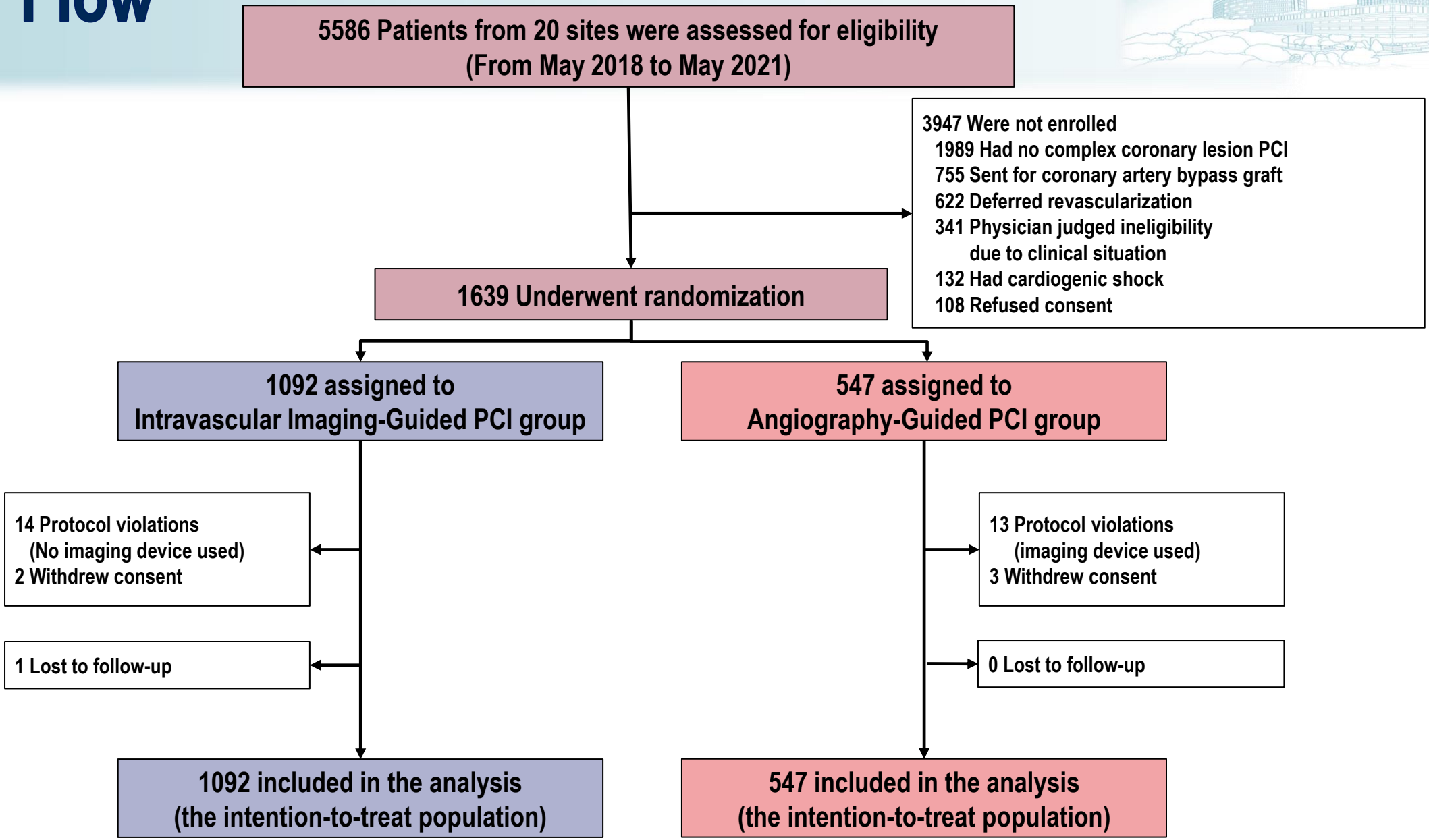
INCLUSION

1. Patients (≥ 19 years) with coronary artery disease requiring PCI
2. Patients with a **complex coronary artery lesion** defined as:
   - True bifurcation lesion (Medina 1,1,1/1,0,1/0,1,1) with side branch ≥2.5mm
   - Chronic total occlusion (≥3 months) as target lesion
   - Unprotected LM disease PCI (LM ostium, body, distal LM bifurcation including non-true bifurcation)
   - Long coronary lesions (implanted stent ≥38 mm in length)
   - Multi-vessel PCI (≥2 vessels treated at one PCI session)
   - Multiple stents needed (≥3 more stent per patient)
   - In-stent restenosis lesion as target lesion
   - Severely calcified lesion (encircling calcium in angiography)
   - Ostial coronary lesion (LAD, LCX, RCA)

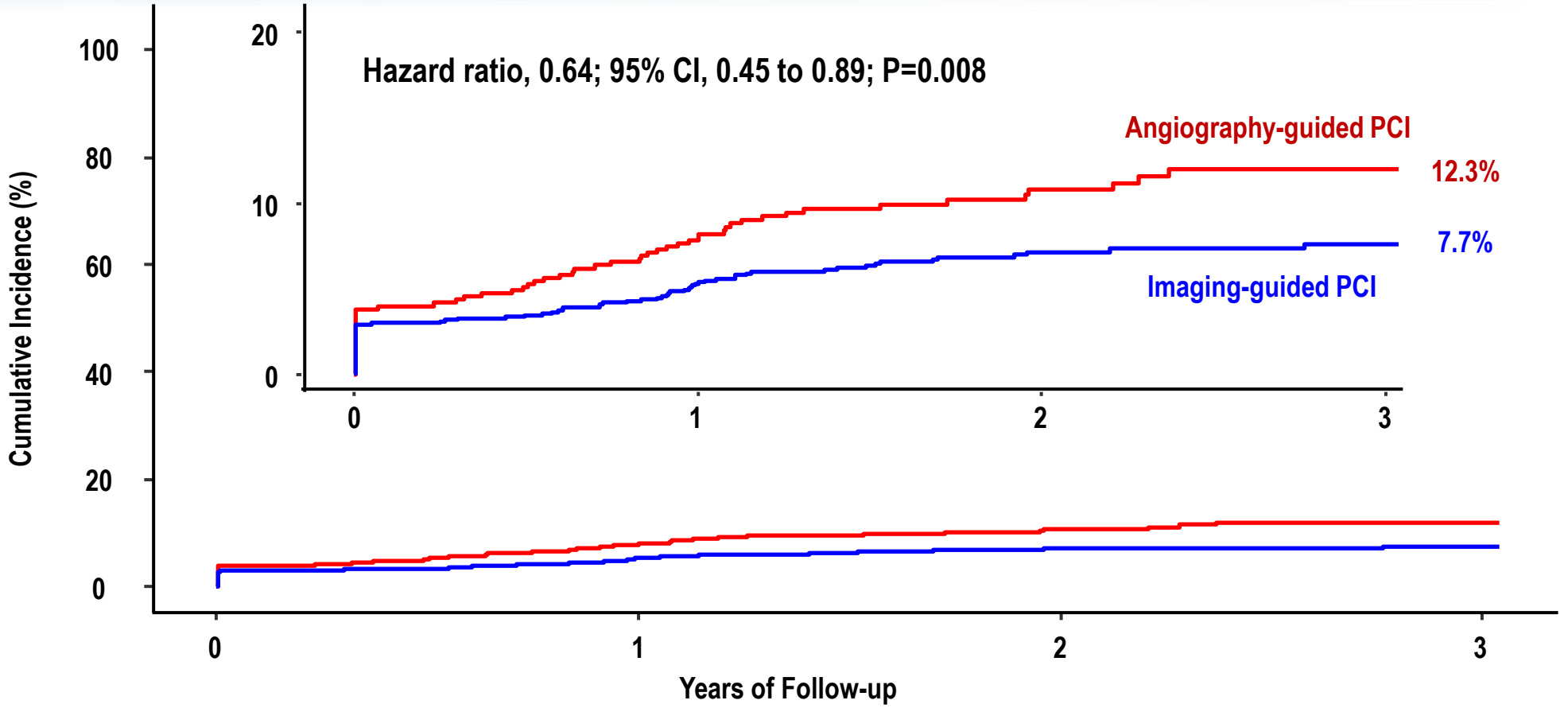
KEY EXCLUSION

1. Target lesions not amenable to PCI by operators' decision
2. Cardiogenic shock (Killip class IV) at presentation
3. Intolerance to Aspirin, Clopidogrel, Prasugrel, Ticagrelor, Heparin, or Everolimus
4. Known true anaphylaxis to contrast medium (not allergic reaction but anaphylactic shock)
5. Pregnancy or breast feeding
6. Non-cardiac co-morbid conditions are present with life expectancy <1 year or that may result in protocol non-compliance (per site investigator's medical judgment)
7. Unwillingness or inability to comply with the procedures described in this protocol.

Study Flow


5586 Patients from 20 sites were assessed for eligibility
(From May 2018 to May 2021)
3947 Were not enrolled
1989 Had no complex coronary lesion PCI
755 Sent for coronary artery bypass graft
622 Deferred revascularization
341 Physician judged ineligibility
due to clinical situation
132 Had cardiogenic shock
108 Refused consent
1639 Underwent randomization
1092 assigned to
Intravascular Imaging-Guided PCI group
547 assigned to
Angiography-Guided PCI group
14 Protocol violations
(No imaging device used)
2 Withdrew consent
1 Lost to follow-up
13 Protocol violations
(imaging device used)
3 Withdrew consent
0 Lost to follow-up
1092 included in the analysis
(the intention-to-treat population)
547 included in the analysis
(the intention-to-treat population)

Primary End Point: TVF



Number at risk				
Angiography-guided PCI	547	496	280	120
Imaging-guided PCI	1092	1023	591	255

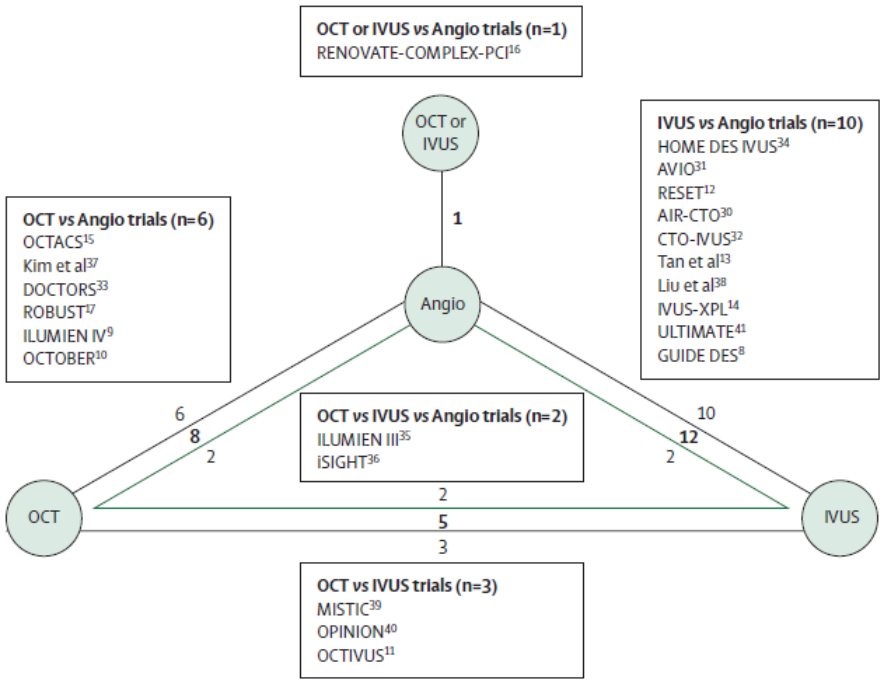
Primary and Secondary End Points

End Point	Total (N=1639)	Imaging-guided PCI (N=1092)	Angiography-guided PCI (N=547)	Hazard Ratio (95% CI)*	P Value
Primary end point — no. (%)					
Target vessel failure	**136 (9.2)**	**76 (7.7)**	**60 (12.3)**	**0.64 (0.45-0.89)**	**0.008**
Secondary end points — no. (%)					
Target vessel failure without procedure-related MI	88 (6.3)	48 (5.1)	40 (8.7)	0.59 (0.39-0.90)	
Cardiac death or target-vessel related MI	96 (6.4)	53 (5.3)	43 (8.5)	0.63 (0.42-0.93)	
All-cause death	70 (5.6)	42 (5.3)	28 (6.4)	0.71 (0.44–1.15)	
Cardiac death	33 (2.4)	16 (1.7)	17 (3.8)	0.47 (0.24-0.93)	
Myocardial infarction	75 (5.0)	43 (4.4)	32 (6.2)	0.78 (0.48-1.25)	
Target-vessel related MI	68 (4.3)	38 (3.7)	30 (5.6)	0.74 (0.45-1.22)	
Spontaneous MI	17 (1.2)	8 (0.9)	9 (1.8)	0.66 (0.23-1.90)	
Procedure-related MI	52 (3.2)	30 (2.7)	22 (4.0)	0.77 (0.43-1.35)	
Non-target vessel related MI	8 (0.8)	5 (0.8)	3 (0.8)	1.24 (0.24-6.40)	
Repeat revascularization	87 (6.6)	55 (6.3)	32 (7.1)	0.95 (0.60-1.48)	
Target vessel revascularization	57 (4.1)	32 (3.4)	25 (5.5)	0.69 (0.40-1.18)	
Target lesion revascularization	44 (3.2)	24 (2.6)	20 (4.4)	0.66 (0.36-1.22)	
Definite stent thrombosis	5 (0.3)	1 (0.1)	4 (0.7)	0.25 (0.02-2.75)	
Contrast induced nephropathy†	40 (2.4)	26 (2.4)	14 (2.6)	0.99 (0.51-1.92)	

Conclusions

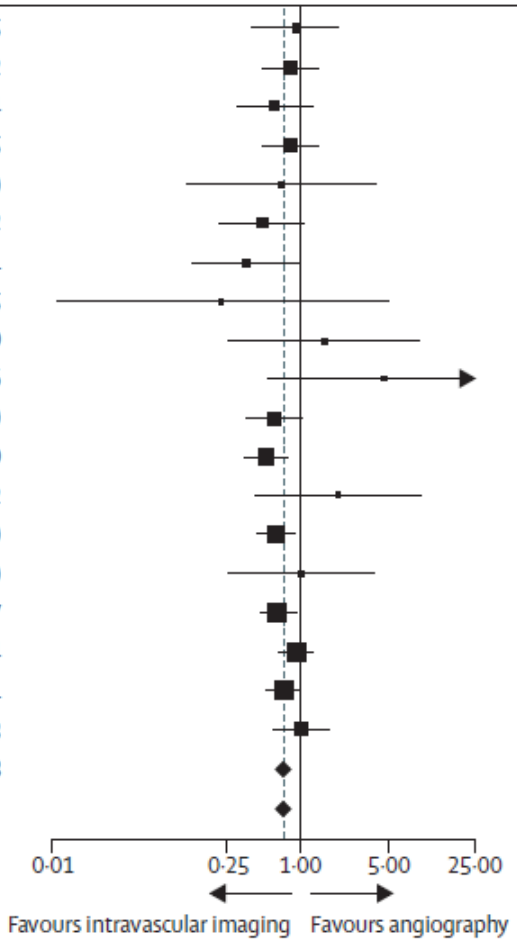
- ***Among patients with complex coronary artery lesions,*** **intravascular imaging-guided PCI reduced a composite of cardiac death, target vessel-related myocardial infarction, or clinically driven target vessel revascularization** compared with **angiography-guided PCI.**
- The **RENOVATE-COMPLEX-PCI** supports the intravascular imaging-guided PCI in patients with complex coronary lesions.

Intravascular imaging-guided PCI: network meta-analysis



	Intravascular imaging		Angiography		RR (95% CI)	Weight (random)	Weight (fixed)
	Events	N	Events	N			
HOME DES IVUS (2010)[34]	11	105	12	105	0·92 (0·42–1·98)	2·5%	2·0%
AVIO (2013)[31]	23	142	29	142	0·79 (0·48–1·30)	5·9%	4·9%
RESET (2013)[12]	12	269	20	274	0·61 (0·30–1·23)	3·0%	3·3%
AIR-CTO (2015)[30]	21	115	26	115	0·81 (0·48–1·35)	5·5%	4·4%
Kim et al (2015)[37]	2	58	3	59	0·68 (0·12–3·91)	0·5%	0·5%
Tan et al (2015)[13]	8	61	17	62	0·48 (0·22–1·03)	2·5%	2·8%
CTO-IVUS (2015)[32]	5	201	14	201	0·36 (0·13–0·97)	1·5%	2·4%
OCTACS (2015)[15]	0	40	2	45	0·22 (0·01–4·54)	0·2%	0·3%
DOCTORS (2016)[33]	3	120	2	120	1·50 (0·26–8·82)	0·5%	0·3%
ROBUST (2018)[17]	5	105	1	96	4·57 (0·64–38·43)	0·3%	0·2%
Liu et al (2019)[38]	22	167	37	169	0·60 (0·37–0·97)	6·2%	6·2%
IVUS-XPL (2020)[14]	36	700	70	700	0·51 (0·35–0·76)	19·5%	11·8%
ILUMIEN III (2021)[35]	8	289	2	142	1·97 (0·42–9·13)	0·6%	0·5%
ULTIMATE (2021)[41]	47	714	76	709	0·61 (0·43–0·87)	11·6%	12·9%
iSIGHT (2021)[36]	6	101	3	49	0·97 (0·25–3·72)	0·8%	0·7%
RENOVATE-COMPLEX-PCI (2023)[16]	76	1092	60	547	0·63 (0·46–0·88)	13·5%	13·5%
ILUMIEN IV (2023)[9]	76	1233	86	1254	0·90 (0·67–1·21)	15·6%	14·4%
OCTOBER (2023)[10]	59	600	83	601	0·71 (0·52–0·97)	14·2%	14·0%
GUIDE DES (2023)[8]	29	765	29	763	1·00 (0·60–1·65)	5·7%	4·9%
Fixed-effect model	**449**	**6877**	**572**	**6153**	**0·71 (0·63–0·80)**	–	**100·0%**
Random-effect model (primary analysis)					**0·71 (0·63–0·80)**	**100·0%**	–

Test for heterogeneity: I^2=2%, χ^2=18·33 (p=0·43)
Test for overall effect (fixed): Z=–5·72 (p<0·0001)
Test for overall effect (random): Z=–5·60 (p<0·0001)

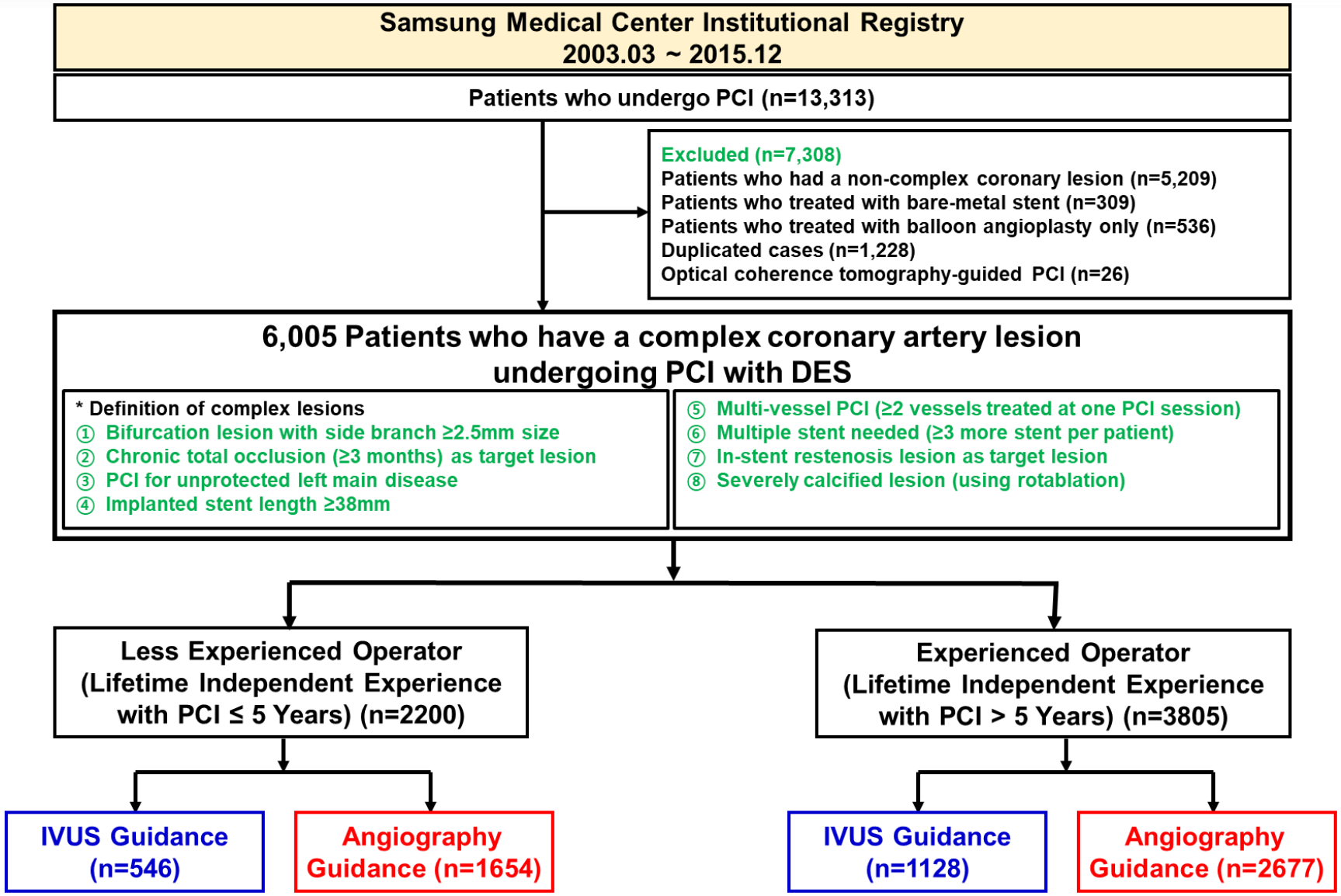


Barriers to widespread use of intravascular imaging

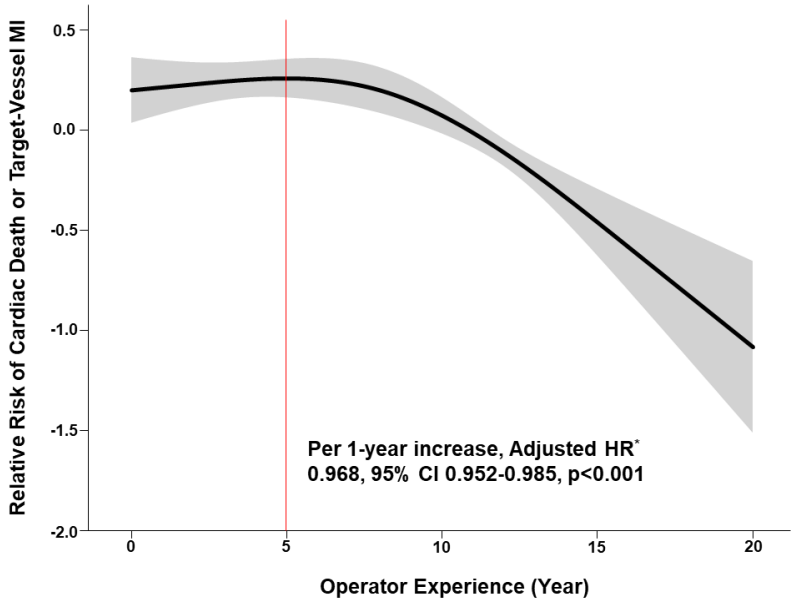
- Physician barriers
  - Inexperience in the technical aspects of intravascular imaging and image interpretation
  - lack of knowledge of or confidence in studies demonstrating the clinical benefits of intravascular imaging
  - Additional time

- Cost-effectiveness

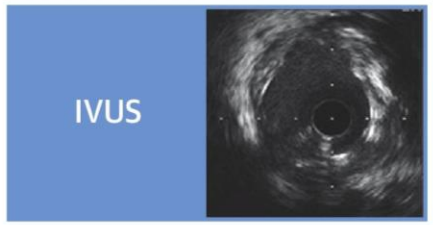
Prognostic Impact of Operator Experience and IVUS Guidance on Long-Term Clinical Outcomes

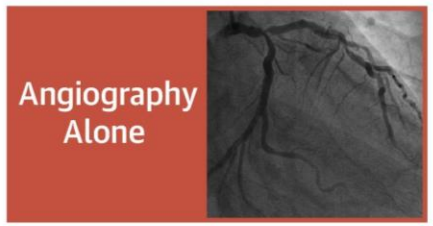


Differential Benefits of IVUS Guidance According to Operator Experience During Complex PCI

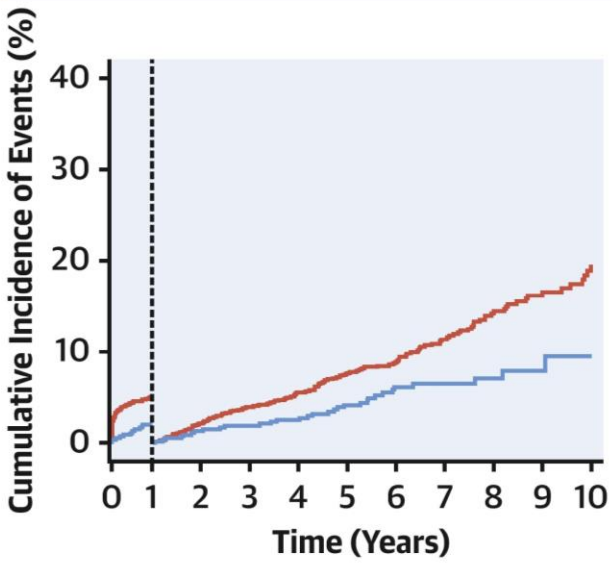


Patients Undergoing Complex PCI
(Bifurcation, CTO, Unprotected LM, ISR, Long Stent Length, Multivessel PCI, ≥3 Stents, and Severely Calcified) N = 6,005



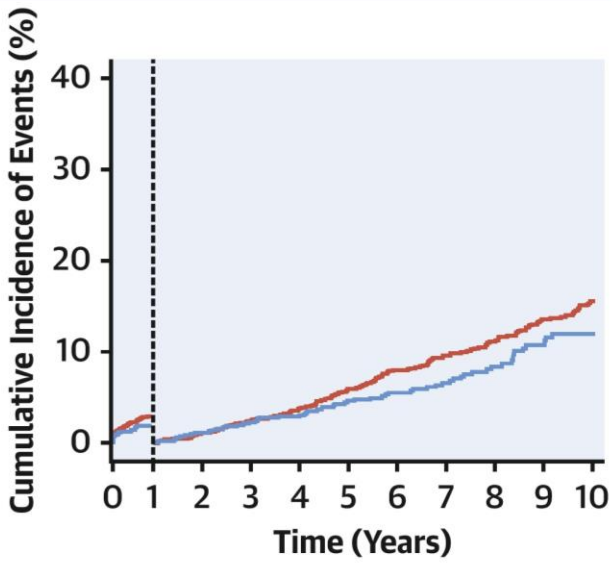


10-Year Risk of Cardiac Death or TVMI



Less Experienced Operator
(Independent PCI Experience ≤5 Years)

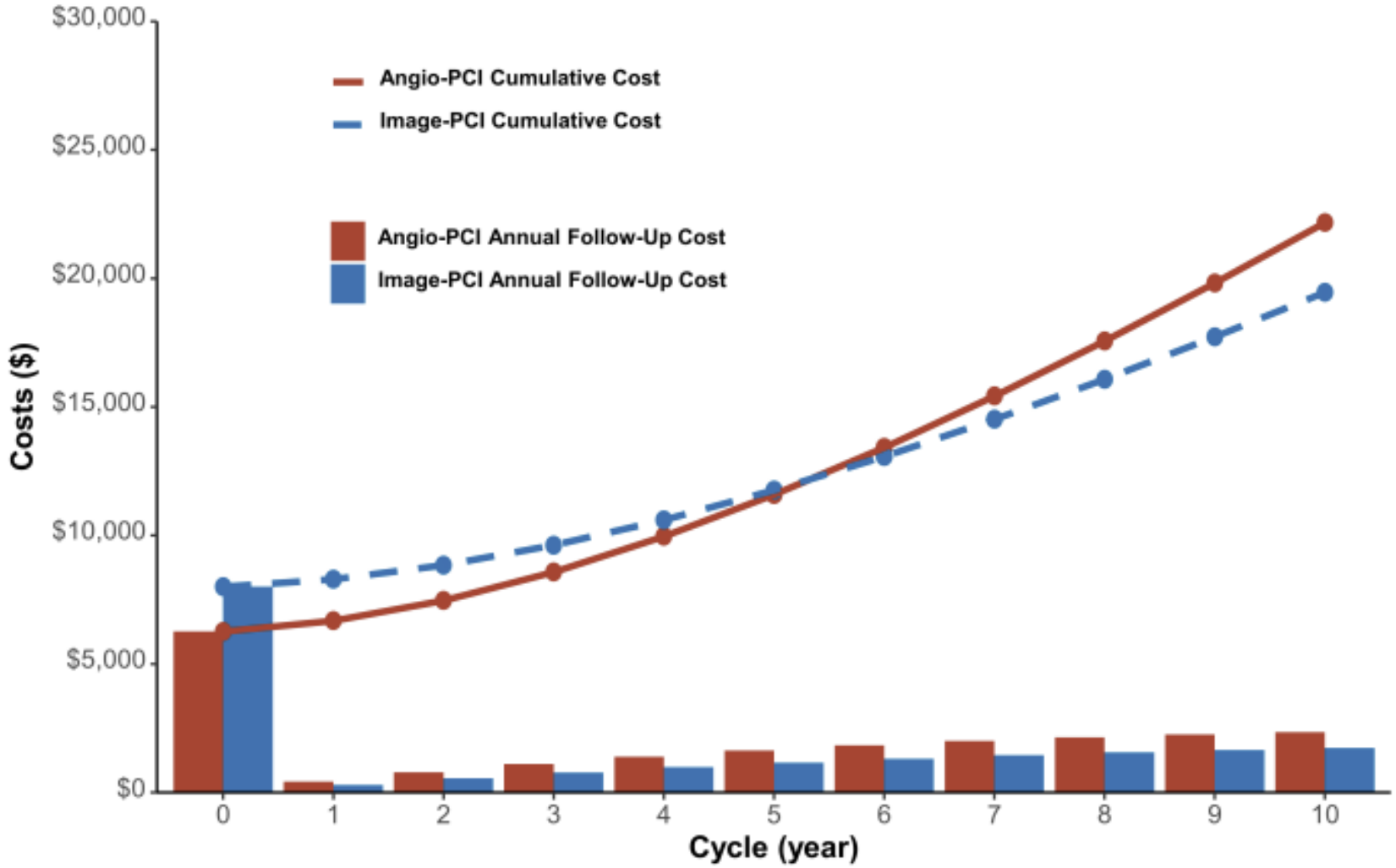
51.8% Risk Reduction
P < 0.001



Experienced Operator
(Independent PCI Experience >5 Years)

26.6% Risk Reduction
P = 0.013

Medical Costs by Intravascular Imaging
<RENOVATE-COMPLEX-PCI prespecified analysis>



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Cost-Effectiveness of Imaging-Guided PCI vs. Angiography-Guided PCI <RENOVATE-COMPLEX-PCI prespecified analysis>

	Cost*		QALYs		Cost-Effectiveness
	Total	Incremental	Total	Incremental	ICER ($/QALY)
Within trial (3 years, unit cost)					
Angiography-guided PCI	7,236	Reference	2.31	Reference	
Intravascular Imaging-guided PCI	8,661	1,426	2.34	0.025	57,040
Simulation (transition probability from trial)					
Angiography-guided PCI	49,519	*Reference*	7.89	*Reference*	
Intravascular Imaging-guided PCI	40,455	-9,063	8.80	0.910	Dominant
Simulation (transition probability from meta-analysis)					
Angiography-guided PCI	49,519	*Reference*	7.89	*Reference*	
Intravascular Imaging-guided PCI	46,811	-2,707	8.24	0.356	Dominant

* Exchange rate was calculated with ratio between 1 dollar ($) and 1,200 Korean won (₩).

Abbreviations: ICER, Incremental Cost-effectiveness ratio; PCI, percutaneous coronary intervention; QALYs, quality-adjusted life years.

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Summary

- I believe that intravascular imaging-guided PCI would improve outcomes in patients with complex coronary artery lesions.
- The choice of IVUS or OCT according to patients and lesion characteristics might maximize the benefit of intravascular imaging.
- PCI by experienced operators and use of IVUS during complex PCI were independently associated with lower long-term risks of cardiac death or TVMI. The beneficial effects of IVUS were more prominent for less experienced operators.
- Intravascular imaging seems to be cost-effective and can be cost-saving in the long run.
- To raise the adoption rates of intravascular imaging-guided PCI, education and support for practicing interventional cardiologists is of great importance.

감사합니다.
Thank you for your attention.