IVUS-guided PCI with Everolimus-Eluting Stents or Bypass Surgery for Multivessel Coronary Artery Disease : Post-hoc Analysis of the BEST Extended Follow-up Study

Jinho Lee, MD, PhD

Assistant Professor

Department of Cardiology, Kyung Hee University Hospital, Seoul, Korea

Disclosure

- I, Jinho Lee, have NO conflict of interest related to this presentation

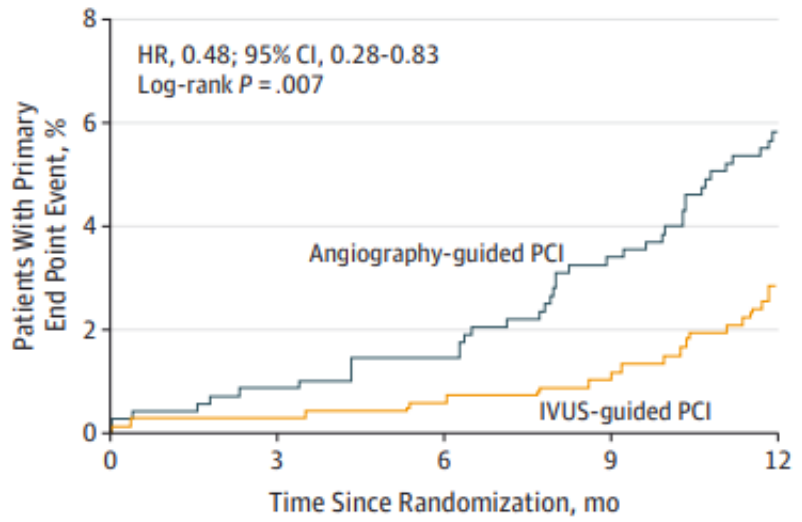
Background

- Previous studies

  - Intravascular ultrasonography (IVUS)- guided percutaneous coronary intervention (PCI) improved clinical outcomes compared with coronary angiography (CAG)-guided PCI in complex coronary artery disease

Effect of Intravascular Ultrasound–Guided vs Angiography-Guided Everolimus-Eluting Stent Implantation
The IVUS-XPL Randomized Clinical Trial

A All patients



No. at risk

PCI					
Angiography-guided	700	673	660	643	624
IVUS-guided	700	671	665	654	641

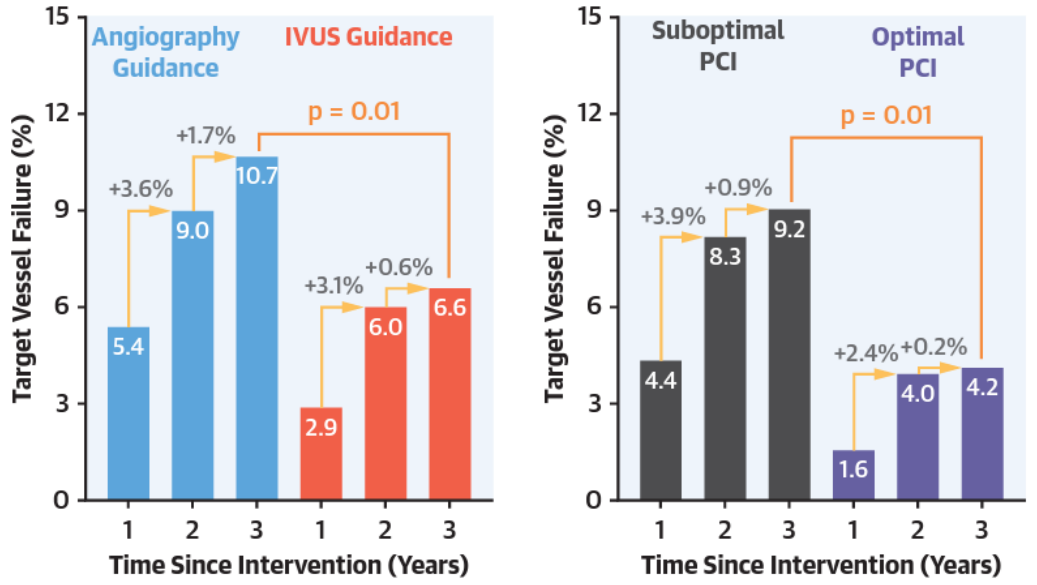
Cumulative incidence curves for the primary end point of cardiac death, target lesion–related myocardial infarction, and target lesion revascularization. HR indicates hazard ratio; IVUS, intravascular ultrasound; PCI, percutaneous coronary intervention.

Hong SJ et al., JAMA. 2015 Nov 24;314(20):2155-63

3-Year Outcomes of the ULTIMATE Trial Comparing Intravascular Ultrasound Versus Angiography-Guided Drug-Eluting Stent Implantation

Xiao-Fei Gao, MD,[a,*] Zhen Ge, MD,[a,*] Xiang-Quan Kong, PhD,[a,*] Jing Kan, MBBS,[a] Leng Han, MD,[b] Shu Lu, MD,[c] Nai-Liang Tian, MD,[a] Song Lin, MD,[a] Qing-Hua Lu, MD,[d] Xiao-Yan Wang, MD,[e] Qi-Hua Li, MD,[f] Zhi-Zhong Liu, PhD,[a] Yan Chen, MD,[g] Xue-Song Qian, MD,[h] Juan Wang, MD,[b] Da-Yang Chai, MD,[c] Chong-Hao Chen, MD,[e] Tao Pan, MBBS,[a] Fei Ye, MD,[a] Jun-Jie Zhang, MD, PhD,[a] Shao-Liang Chen, MD, PhD,[a] for the ULTIMATE Investigators

CENTRAL ILLUSTRATION 3-Year Follow-Up of the IVUS-Guided Drug-Eluting Stents Implantation in All-Comers Coronary Lesions Trial



Gao, X.-F. et al. J Am Coll Cardiol Intv. 2021;14(3):247-57.

Gao, X,-F. et al. J Am Coll Cardiol Intv. 2021;14(3):247-57

The NEW ENGLAND JOURNAL of MEDICINE

RESEARCH SUMMARY

Intravascular Imaging–Guided or Angiography-Guided Complex PCI

Lee JM et al. DOI: 10.1056/NEJMoa2216607

CLINICAL PROBLEM

During percutaneous coronary intervention (PCI), guidance with intravascular imaging, with the use of intravascular ultrasonography or optical coherence tomography (OCT), can optimize stent implantation. However, for patients with complex coronary-artery lesions, data regarding clinical outcomes after intravascular imaging–guided PCI as compared with outcomes after angiography-guided PCI are limited.

CLINICAL TRIAL

Design: A prospective, multicenter, open-label, randomized trial in South Korea evaluated whether intravascular imaging–guided PCI would result in better clinical outcomes than angiography-guided PCI in adults with complex coronary-artery lesions.

Intervention: 1639 patients were assigned in a 2:1 ratio to undergo either intravascular imaging–guided PCI, with the use of ultrasonography or OCT, or angiography-guided PCI. The primary end point was target-vessel failure, which was defined as a composite of death from cardiac causes, target-vessel–related myocardial infarction, or clinically driven target-vessel revascularization.

RESULTS

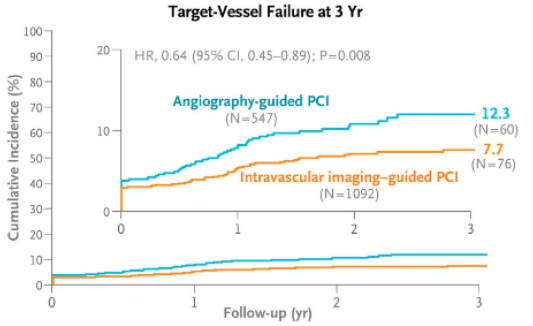
Efficacy: At a median follow-up of 2.1 years, the incidence of target-vessel failure was lower in the intravascular imaging group than in the angiography group.

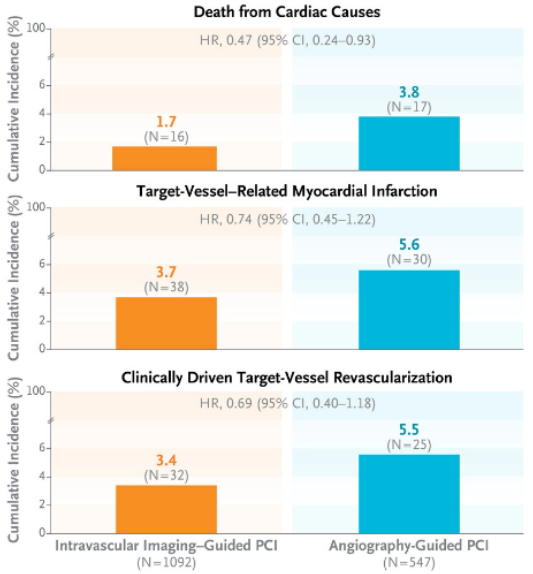
Safety: The incidence of procedure-related complications during the index hospitalization appeared to be similar in the two groups.

LIMITATIONS AND REMAINING QUESTIONS

- The trial was unblinded, and the operator could not be unaware of the patient's assigned group.
- Stent optimization as defined on the basis of intravascular imaging occurred in less than half the patients.
- All the patients were East Asian, and more than half the patients were enrolled at one trial center, which potentially limits the generalizability of the findings.

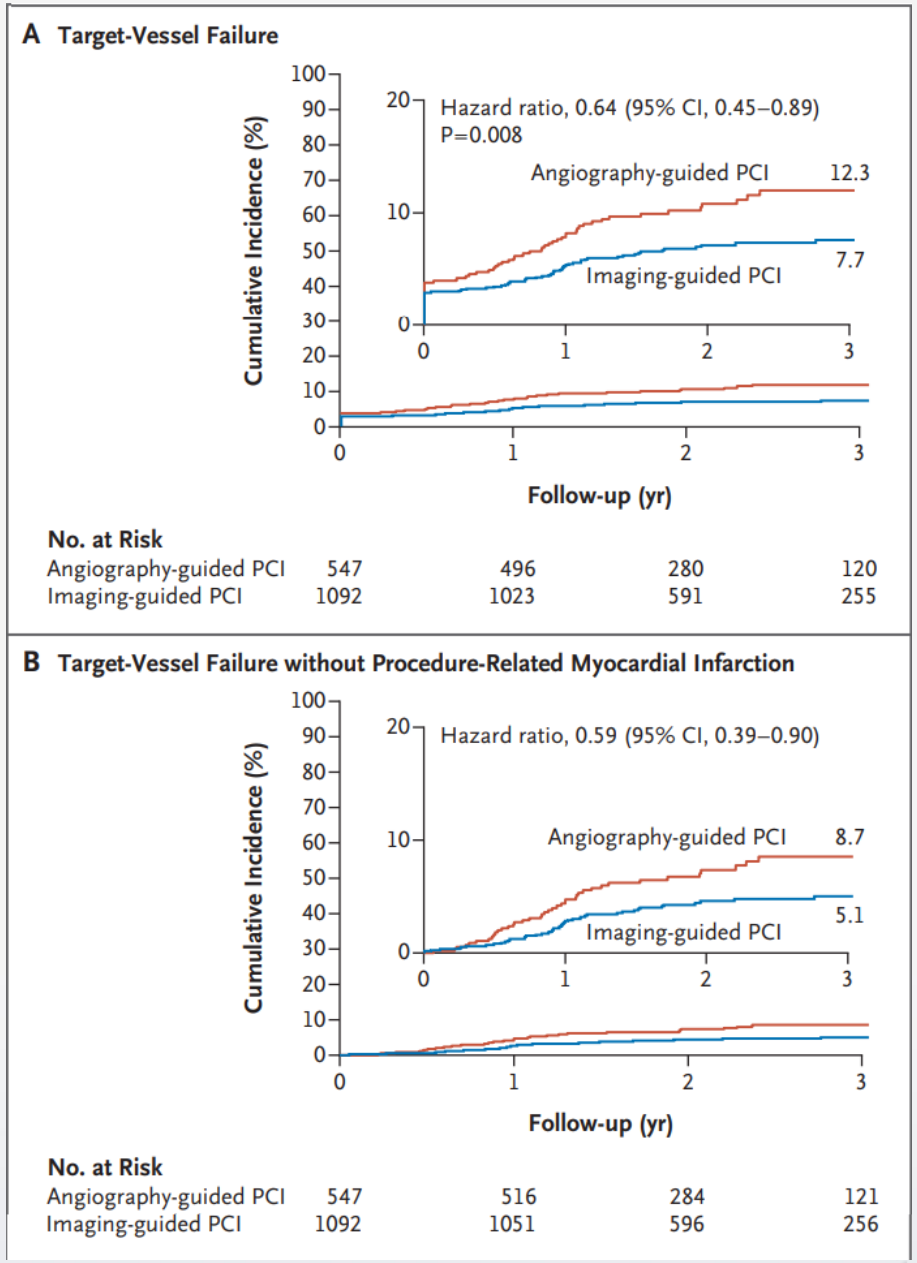
Links: Full Article | NEJM Quick Take | Editorial





CONCLUSIONS

Among patients with complex coronary-artery lesions, intravascular imaging–guided PCI led to a lower incidence of a composite of death from cardiac causes, target-vessel–related myocardial infarction, or clinically driven target-vessel revascularization than angiography-guided PCI.



JM Lee et al., N Engl J Med. 2023 May 4;388(18):1668-1679

2021 ACC/AHA Guideline

Recommendations for Use of Intravascular Imaging
Referenced studies that support the recommendations are summarized in Online Data Supplement 25.

COR	LOE	Recommendations
2a	B-R	1. 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.[1-10]
2a	B-R	2. In patients undergoing coronary stent implantation, OCT is a reasonable alternative to IVUS for procedural guidance, except in ostial left main disease.[11-13]
2a	C-LD	3. In patients with stent failure, IVUS or OCT is reasonable to determine the mechanism of stent failure.[14-17]

2018 ESC Guideline

Recommendations	Class[a]	Level[b]
IVUS or OCT should be considered in selected patients to optimize stent implantation.[603,612,651–653]	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions.[35]	IIa	B

2021 ACC/AHA Guideline

Recommendations for Patients With Complex Disease
Referenced studies that support the recommendations are summarized in Online Data Supplement 13.

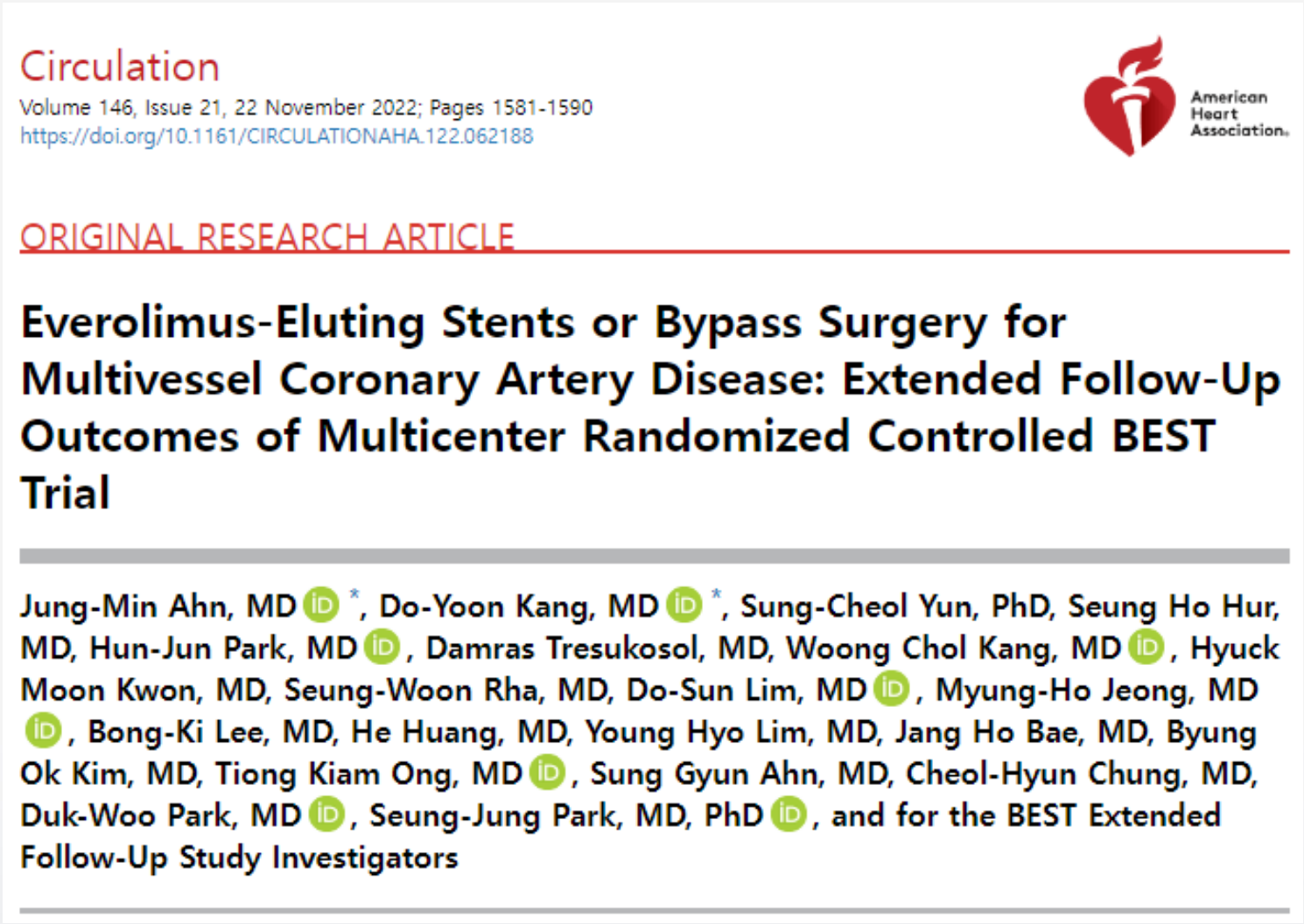
COR	LOE	Recommendations
1	B-R	1. In patients who require revascularization for significant left main CAD with high-complexity CAD, it is recommended to choose CABG over PCI to improve survival.[1,2]
2a	B-R	2. In patients who require revascularization for multivessel CAD with complex or diffuse CAD (eg, SYNTAX score >33), it is reasonable to choose CABG over PCI to confer a survival advantage.[2-5]

2018 ESC Guideline

Recommendations according to extent of CAD	CABG		PCI	
	Class[a]	Level[b]	Class[a]	Level[b]
One-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,101,139–144]	I	A	I	A
Two-vessel CAD				
Without proximal LAD stenosis.	IIb	C	I	C
With proximal LAD stenosis.[68,70,73]	I	B	I	C
Left main CAD				
Left main disease with low SYNTAX score (0 - 22).[69,121,122,124,145–148]	I	A	I	A
Left main disease with intermediate SYNTAX score (23 - 32).[69,121,122,124,145–148]	I	A	IIa	A
Left main disease with high SYNTAX score (≥33).[c 69,121,122,124,146–148]	I	A	III	B
Three-vessel CAD without diabetes mellitus				
Three-vessel disease with low SYNTAX score (0 - 22).[102,105,121,123,124,135,149]	I	A	I	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c 102,105,121,123,124,135,149]	I	A	III	A
Three-vessel CAD with diabetes mellitus				
Three-vessel disease with low SYNTAX score 0–22.[102,105,121,123,124,135,150–157]	I	A	IIb	A
Three-vessel disease with intermediate or high SYNTAX score (>22).[c 102,105,121,123,124,135,150–157]	I	A	III	A

Method

- Sub-study of BEST Extended trial
- Prospective, Open-label, Multi-centered, Randomized trial
- Patients were enrolled between July 2008 to September 2013
- PCI with everolimus-eluting stent versus CABG in angiographic multivessel coronary artery disease



Circulation
Volume 146, Issue 21, 22 November 2022; Pages 1581-1590
https://doi.org/10.1161/CIRCULATIONAHA.122.062188

American Heart Association.

ORIGINAL RESEARCH ARTICLE

Everolimus-Eluting Stents or Bypass Surgery for Multivessel Coronary Artery Disease: Extended Follow-Up Outcomes of Multicenter Randomized Controlled BEST Trial

Jung-Min Ahn, MD *, Do-Yoon Kang, MD *, Sung-Cheol Yun, PhD, Seung Ho Hur, MD, Hun-Jun Park, MD, Damras Tresukosol, MD, Woong Chol Kang, MD, Hyuck Moon Kwon, MD, Seung-Woon Rha, MD, Do-Sun Lim, MD, Myung-Ho Jeong, MD, Bong-Ki Lee, MD, He Huang, MD, Young Hyo Lim, MD, Jang Ho Bae, MD, Byung Ok Kim, MD, Tiong Kiam Ong, MD, Sung Gyun Ahn, MD, Cheol-Hyun Chung, MD, Duk-Woo Park, MD, Seung-Jung Park, MD, PhD, and for the BEST Extended Follow-Up Study Investigators

Ahn JM et al., Circulation. 2022 Nov 22;146(21):1581-1590.

Method

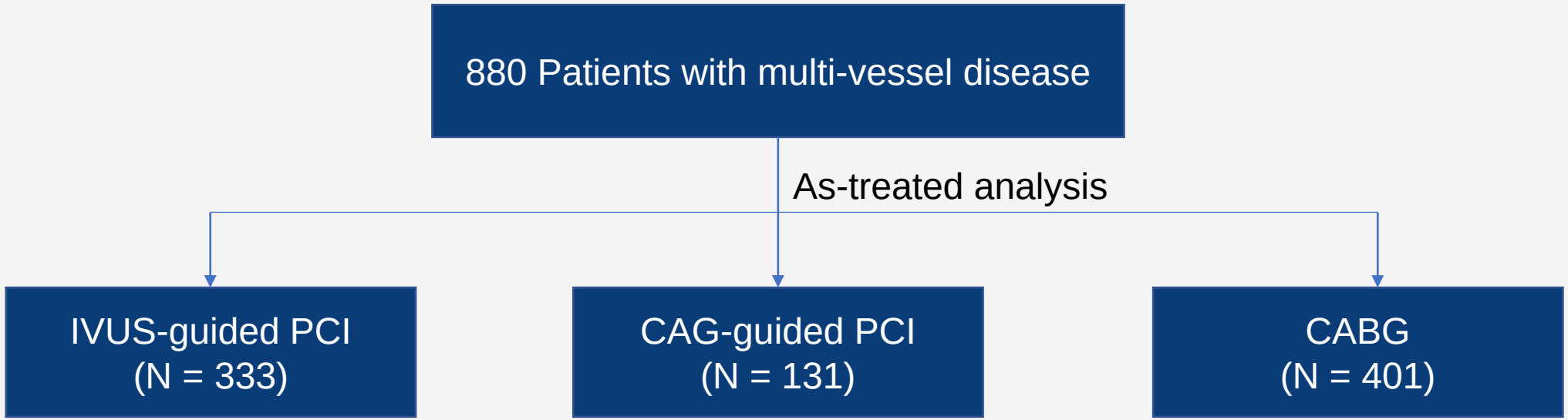
- Among 880 patients with MVD enrolled in the BEST Extended Follow-up study
- As-treated Analysis

- 333 patients underwent IVUS-guided PCI
- 131 patients underwent CAG-guided PCI
- compared with 401patients underwent CABG

- during a median follow-up of 11.8 years

- **The primary endpoint**
  - the composite of death from any cause, myocardial infarction, or target-vessel revascularization

Method



median follow-up of 11.8 years

The primary endpoint
(the composite of death from any cause, myocardial infarction, or target-vessel revascularization)

Result

- Baseline Characteristics of Patients

Clinical Characteristics	Angiography-guided PCI (n=131)	IVUS-guided PCI (n=333)	CABG (n=401)	P value
Age	65.7 ± 10.0	63.7 ± 9.0	64.5 ± 9.4	0.12
Male sex	84 (64.1)	233 (70.0)	301 (75.1)	**0.04**
BMI	24.5 ± 3.7	24.9 ± 2.7	24.9 ± 2.8	0.30
Medically treated diabetes	59 (45.0)	134 (40.2)	164 (40.9)	0.62
Hypertension	95 (72.5)	217 (65.2)	265 (66.1)	0.29
Hyperlipidemia	42 (32.1)	200 (60.1)	213 (53.1)	<**0.001**
Current smoker	28 (21.4)	66 (19.8)	76 (19.0)	0.82
Previous PCI	6 (4.6)	28 (8.4)	34 (8.5)	0.31
Previous myocardial infarction	10 (7.6)	16 (4.8)	27 (6.7)	0.41
Previous congestive heart failure	8 (6.1)	7 (2.1)	12 (3.0)	0.08
Previous stroke	13 (9.9)	24 (7.2)	32 (8.0)	0.62
Chronic renal failure	5 (3.8)	4 (1.2)	7 (1.7)	0.16
Peripheral vascular disease	6 (4.6)	10 (3.0)	10 (2.5)	0.47
Chronic obstructive pulmonary disease	4 (3.1)	3 (0.9)	6 (1.5)	0.23
Clinical presentation				**0.006**
Stable angina	46 (35.1)	173 (52.0)	186 (46.4)	
Unstable angina	62 (47.3)	134 (40.2)	182 (45.4)	
Recent acute myocardial infarction	23(17.6)	26(7.8)	33 (8.2)	
Ejection fraction	58.6 ± 10.6	59.5 ± 7.4	59.7 ± 8.3	0.42

Result

- Baseline Characteristics of Patients, According to Study Group.

Characteristics	Angiography-guided PCI (n=131)	IVUS-guided PCI (n=333)	CABG (n=401)	P value
Diseased vessels				**0.03**
Three vessel disease	102 (77.9)	242 (72.7)	324 (80.8)	
Two vessel disease	29 (22.1)	91 (27.3)	77 (19.2)	
CTO	26 (19.8)	104 (31.2)	130 (32.4)	**0.02**
Bifurcation	45 (34.4)	210 (63.1)	247 (61.6)	**<0.001**
Heavy calcified lesion	38 (29.0)	111 (33.3)	118 (29.4)	0.46
EuroSCORE ≥ 6	29 (22.1)	32 (9.6)	46 (11.5)	**0.001**
SYNTAX score	22.2 ± 7.4	24.9 ± 7.4	25.5 ± 7.9	**<0.001**

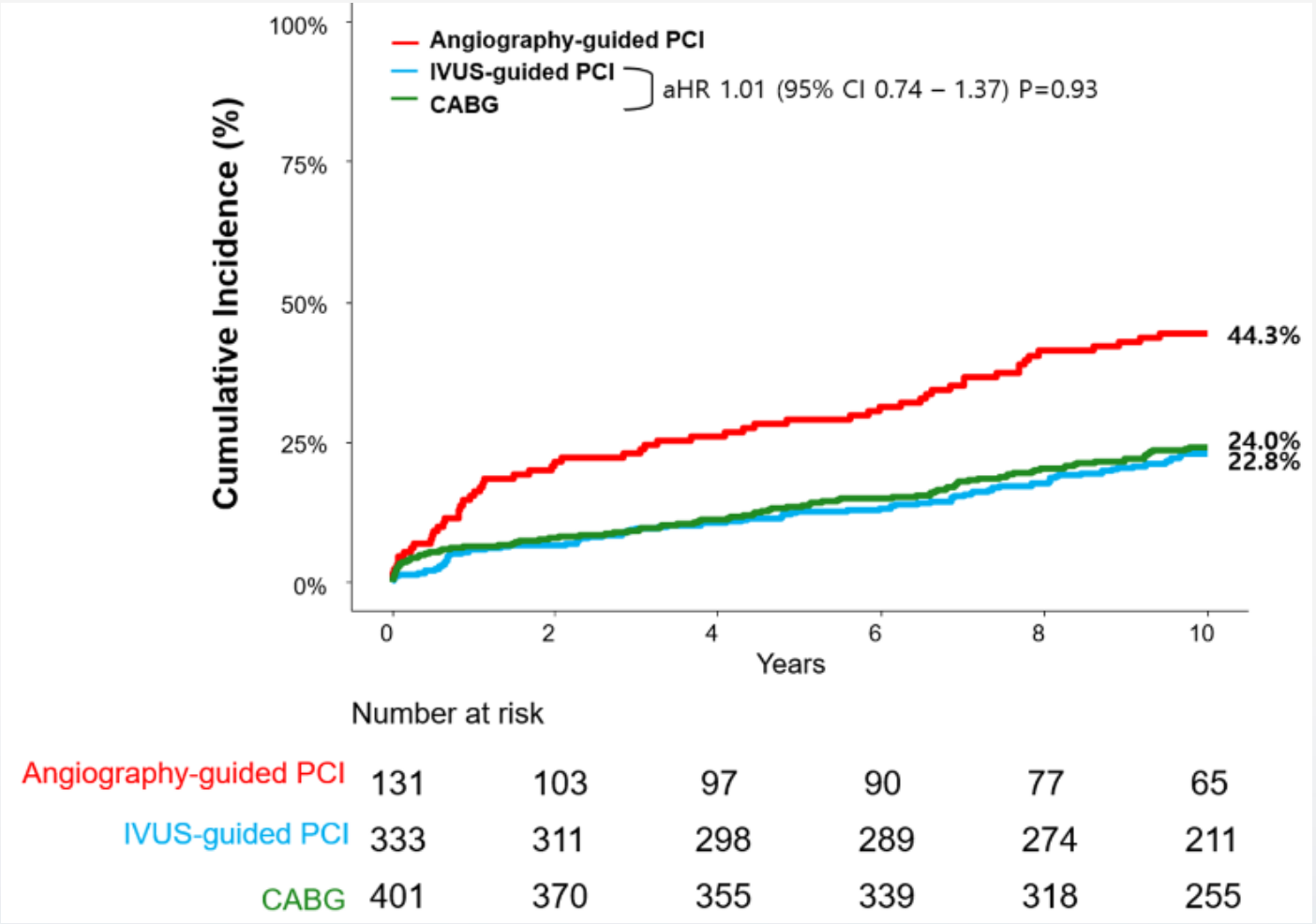
Result

- Procedural Characteristics of Patients Among 3 groups

Characteristics	Angiography-guided PCI (n=131)	IVUS-guided PCI (n=333)	CABG (n=401)	P value
Complete revascularization	70 (53.4%)	166 (49.8%)	274(68.3%)	<0.001
Number of stents	3.13 ± 1.28	3.47 ± 1.47	NA	0.03
Total length of stents	71.62 ±31.12	91.2 ± 39.54	NA	**<0.001**
Stent diameter, mm	3.00 ± 0.35	3.23 ± 0.28	NA	**<0.001**
Total number of Graft	NA	NA	3.09	NA
LIMA to LAD	NA	NA	398 (99.3)	NA
Off-pump CABG	N	NA	205 (51.1)	NA

Result

Primary Composite Endpoint

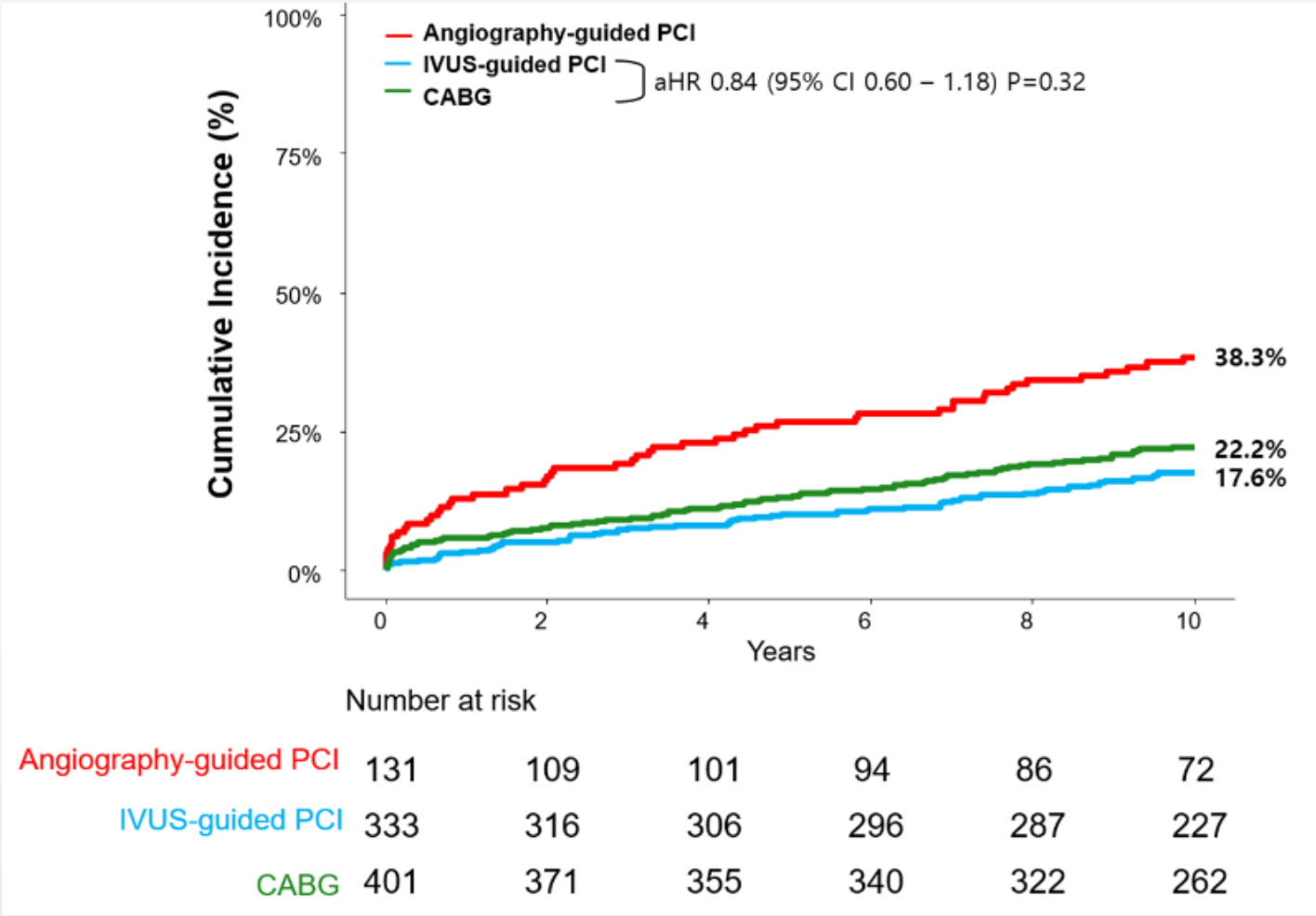


Number at risk

Angiography-guided PCI	131	103	97	90	77	65
IVUS-guided PCI	333	311	298	289	274	211
CABG	401	370	355	339	318	255

Result

Death, Stroke , Myocardial infarction

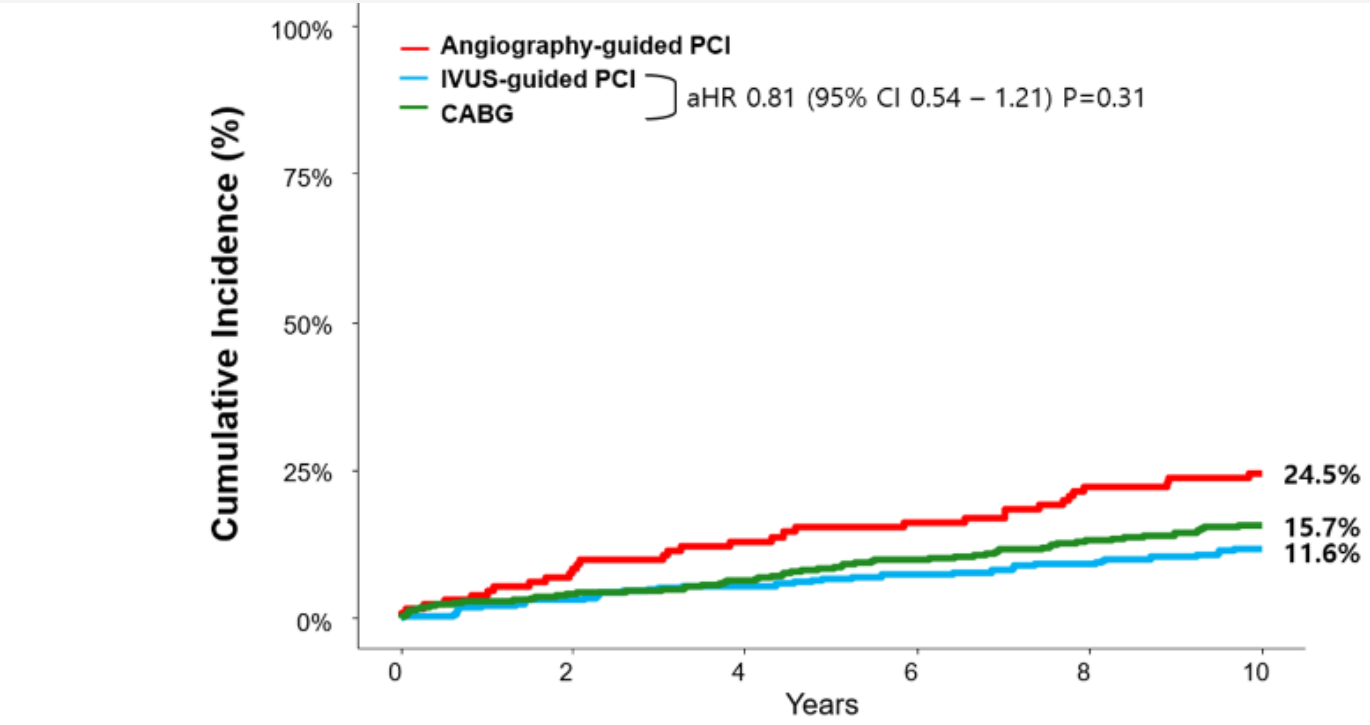


Number at risk

Angiography-guided PCI	131	109	101	94	86	72
IVUS-guided PCI	333	316	306	296	287	227
CABG	401	371	355	340	322	262

Result

Death from Any Cause

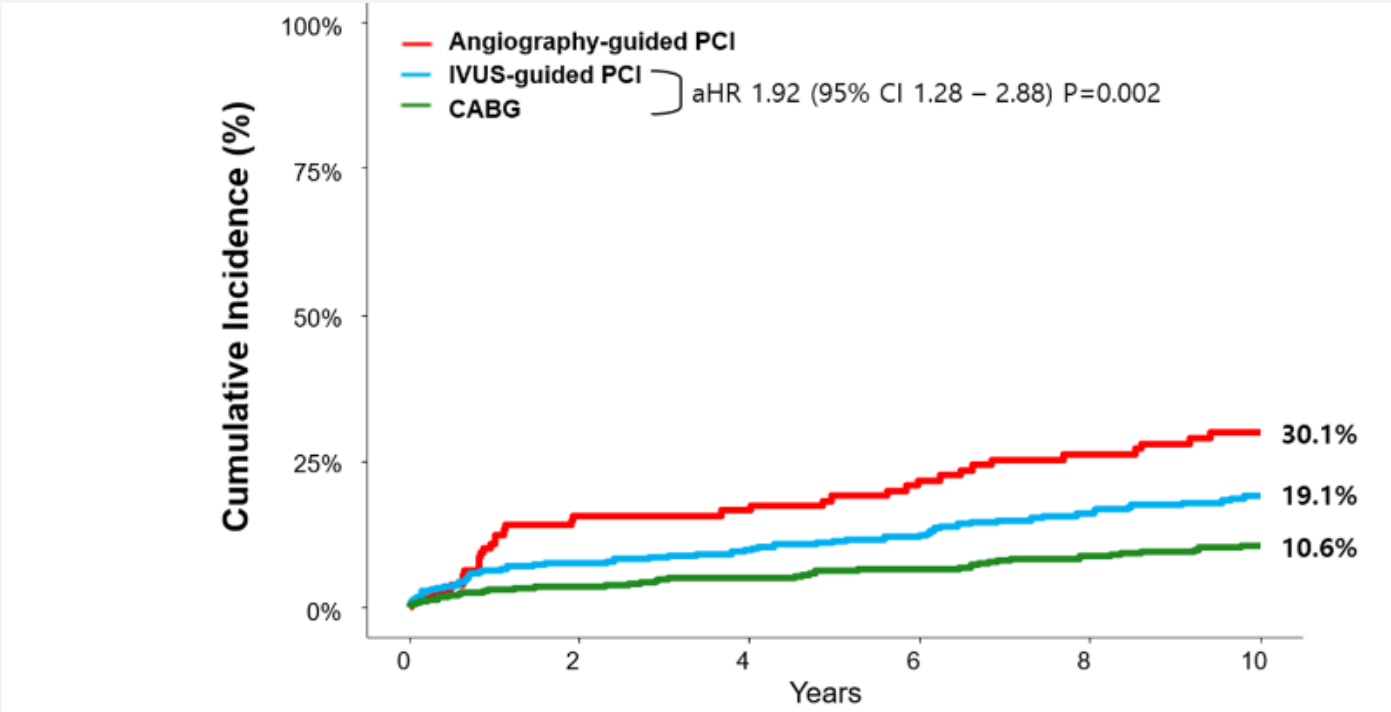


Number at risk

Angiography-guided PCI	131	120	114	110	102	88
IVUS-guided PCI	333	323	315	309	303	245
CABG	401	385	374	360	347	283

Result

Any Repeat Revascularization



Number at risk

Angiography-guided PCI	131	102	98	90	77	65
IVUS-guided PCI	333	299	284	272	255	199
CABG	401	373	357	339	318	254

Result

- Primary and Secondary Outcome at Long-Term Follow-up according to IVUS guidance

Outcomes	Treatment	Number of events (%)	cHR	Univariate analysis 95% CI			aHR	Multivariate analysis 95% CI		
				Lower	Upper	P value		**Lower**	**Upper**	**P value**
Primary Endpoint Death, MI, TVR	Angiography-guided PCI	58 (44.3%)	2.190	1.579	3.036	<0.001	2.131	1.501	3.026	**<0.001**
	IVUS-guided PCI	75 (22.8%)	0.933	0.689	1.263	0.654	0.985	0.722	1.343	**0.922**
	CABG (reference)	95 (24.0%)	1 (ref)				1(ref)			
Death, Stroke, or MI	Angiography-guided PCI	50 (38.3%)	1.950	1.378	2.760	<0.001	1.976	1.363	2.864	**<0.001**
	IVUS-guided PCI	58 (17.6%)	0.764	0.549	1.065	0.112	0.848	0.604	1.191	**0.341**
	CABG (reference)	88 (22.2%)	1 (ref)				1(ref)			
Death from any cause	Angiography-guided PCI	32 (24.5%)	1.665	1.087	2.551	0.019	1.571	0.993	2.488	**0.054**
	IVUS-guided PCI	38 (11.6%)	0.721	0.482	1.080	0.113	0.818	0.540	1.239	**0.343**
	CABG (reference)	62 (15.7%)	1 (ref)				1 (ref)			
Any RR	Angiography-guided PCI	36 (30.1%)	3.253	2.068	5.119	<0.001	3.154	1.960	5.076	**<0.001**
	IVUS-guided PCI	60 (19.1%)	1.909	1.276	2.857	0.002	1.651	1.093	2.494	**0.017**
	CABG (reference)	**39 (10.6%)**	**1 (ref)**				**1 (ref)**			

Conclusion

- Post-hoc analysis of the BEST extended follow-up trial,

  IVUS-guided PCI would narrow the gap of treatment effect between PCI and CABG

  for the treatment of MVD

- Suggesting the potential clinical benefit of routine IVUS use during PCI for MVD

- Further larger randomized trials are warranted to confirm or refute these findings