Imaging- vs. Functional- vs. Angio-guided PCI: The State of the Art in 2024

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Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

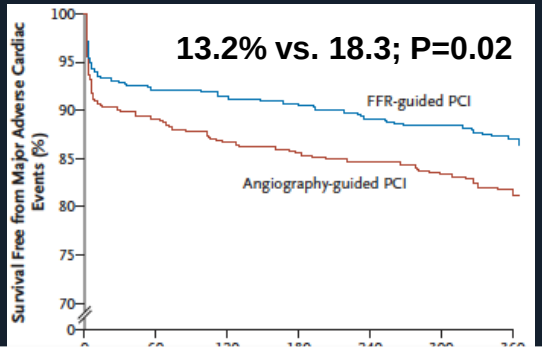
Affiliation/Financial Relationship	Company
• Consulting Fees/Honoraria	• Abbott Vascular/Biotronik/Boston Scientific/Amgen/Pfizer/Viatris/Inari

Clinical Outcomes with Functional Guided PCI-Variable

FAME (2009)

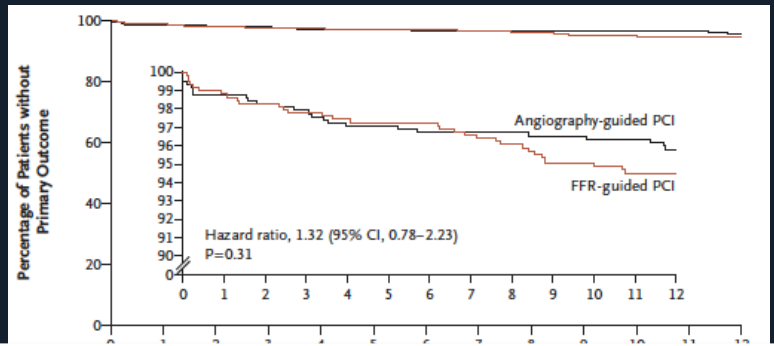
1005 pts with MVD (33% UA)

Result



FLOWER MI (2021)

1171 pts with STEMI and MVD



ACS- perhaps plaque characteristics more important than functional significance???

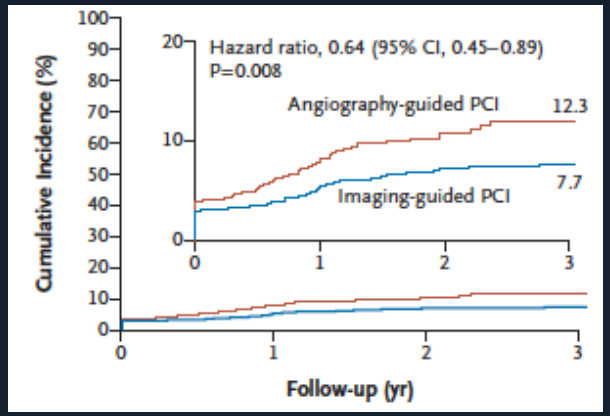
Tonino PAL et al. N Engl J Med 2009;360:213-24.

Puymirat E et al. N Engl J Med 2021;385:297-308.

Clinical Outcomes with Intravascular Imaging Guided PCI Variable

RENOVATE-COMPLEX-PCI (2023)

1639 pts with complex CAD

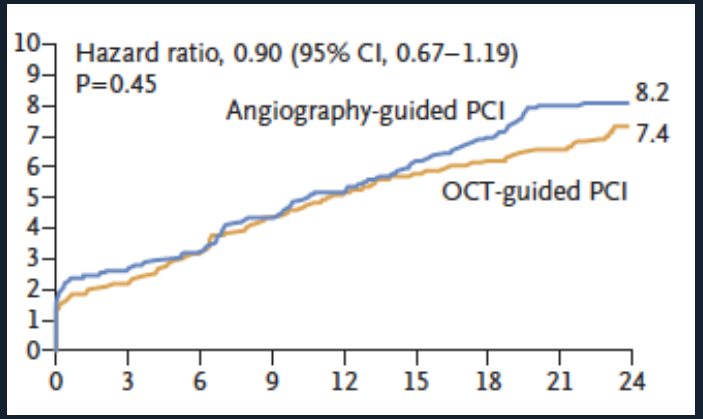


CV death: 1.7% vs. 3.8%; P<0.05
TLR: 2.6% vs. 4.4%; P>0.05

Lee JM et al. N Engl J Med 2023;388:1668-79.

ILUMIEN IV (2023)

2487 pts with DM or complex CAD



TLR: 4.5% vs. 4.3%
ST: 0.5% vs. 1.4%; P=0.02

Ziad A et al. N Engl J Med 2023;389:1466-76

2021 ACC/AHA Revascularization Guidelines

Intravascular Imaging

Diagnosis

2a	B-NR	In patients with intermediate stenosis of the left main artery, IVUS is reasonable to help define lesion severity
2a	C-LD	In patients with stent failure, IVUS or OCT is reasonable to determine the mechanism of stent failure

Post PCI Optimization

2a	B-R	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

Lawton JS, Tamis-Holland JE, Bangalore S, et al. J Am Coll Cardiol. 2021

2021 ACC/AHA Revascularization Guidelines

Functional/Physiology

Diagnosis

1	A

In patients with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenoses, the use of fractional flow reserve (FFR) or instantaneous wave-free ratio (iFR) is recommended to guide the decision to proceed with PCI

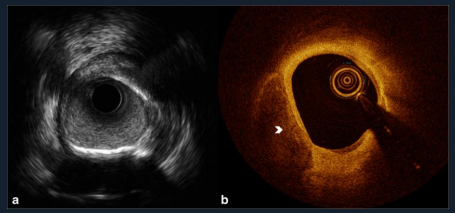
Post PCI Optimization

None

Lawton JS, Tamis-Holland JE, Bangalore S, et al. J Am Coll Cardiol. 2021

Research Objectives

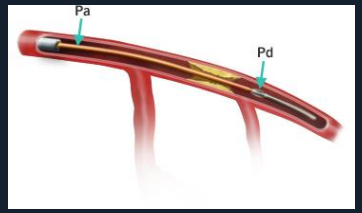
Intravascular imaging-guided



IVUS or OCT

VS.

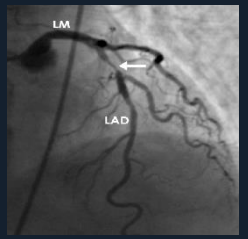
Functionally-guided



FFR, iFR, RFR, dFR, or QFR

VS.

Angiography-guided



- Clinical outcomes difference
- Whether results change based on ACS vs. non ACS trials

Kuno T ……..Bangalore S. J Am Coll Cardiol 2023;82:2167–2176

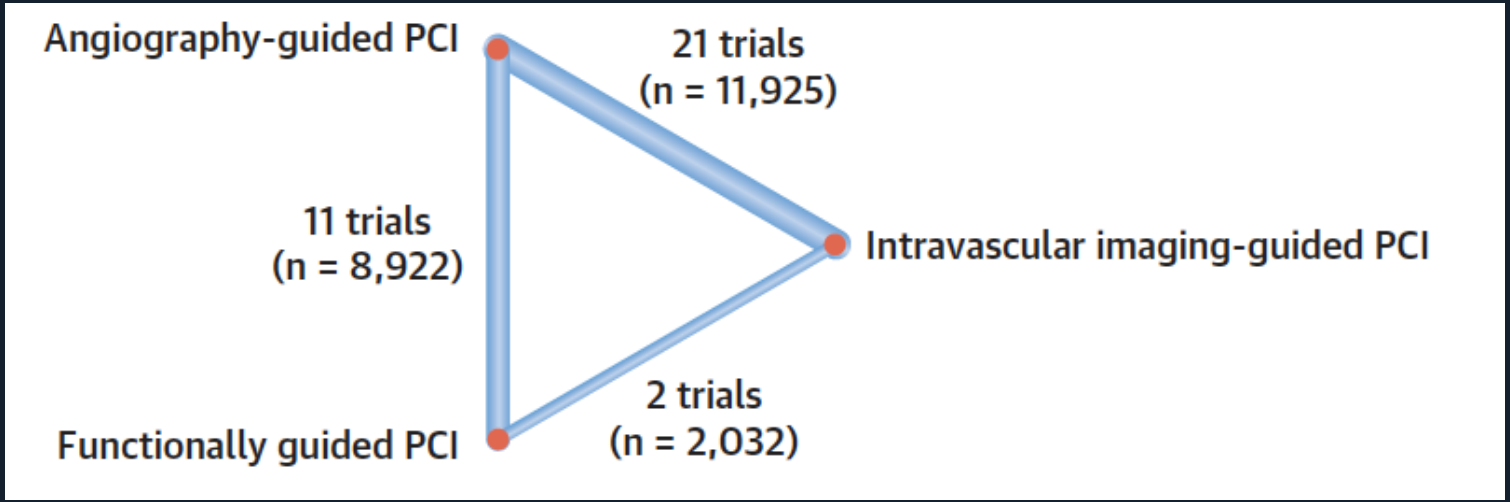
Outcomes

- Primary: MACE (trial defined)- composite of CV death, MI, and TLR
- Secondary:
  - All-cause death
  - Cardiovascular death
  - MI
  - Stent thrombosis
  - TLR

Kuno T ……..Bangalore S. J Am Coll Cardiol 2023;82:2167–2176

Results: Network

32 RCTs with 22,684 patients (19 ACS trials; 13 non ACS)

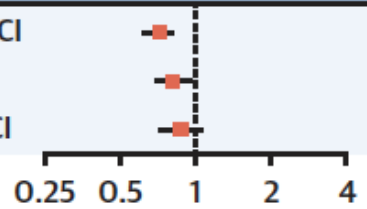


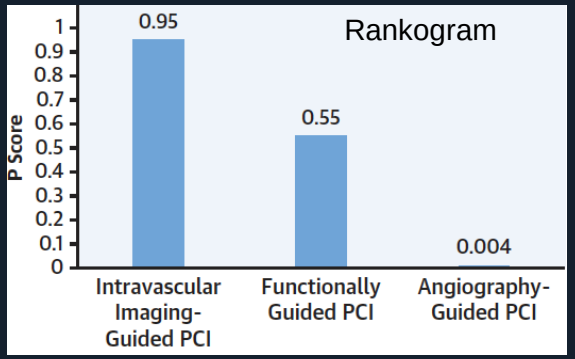
Kuno T ……..Bangalore S. J Am Coll Cardiol 2023;82:2167–2176

Results: MACE

32 RCTs with 22,684 patients

Comparison of the Strategies	RR (95% CI)
Intravascular imaging-guided vs Angiography-guided PCI	0.72 (0.62-0.82)
Functionally guided vs Angiography-guided PCI	0.81 (0.69-0.96)
Intravascular imaging-guided vs Functionally guided PCI	0.88 (0.72-1.07)





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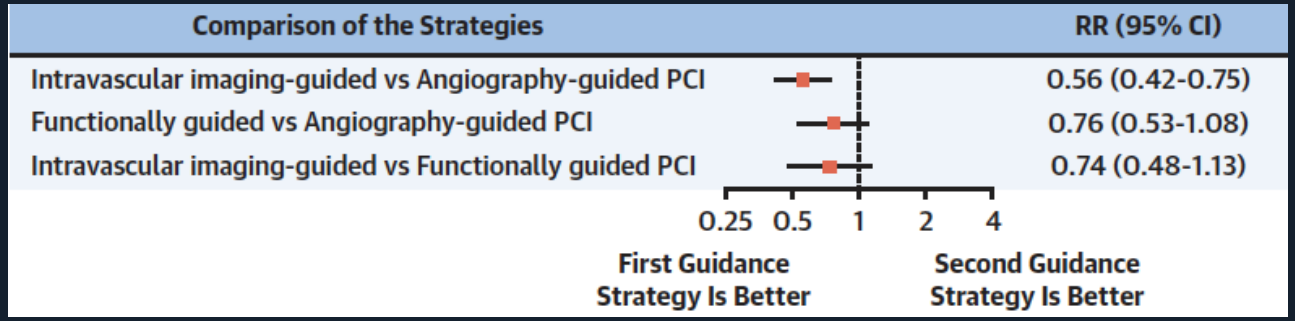
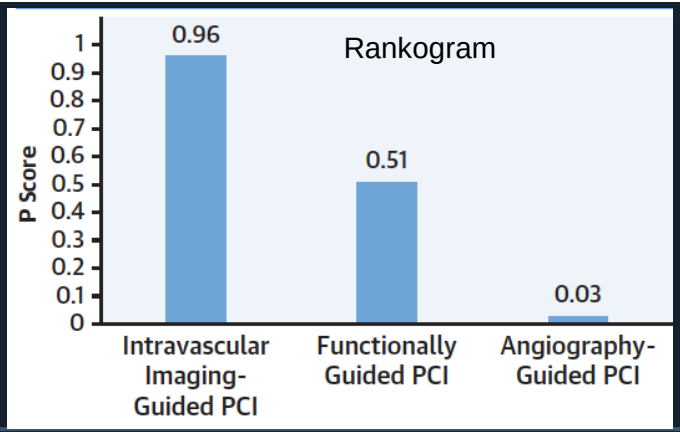
Results: CV Death

32 RCTs with 22,684 patients





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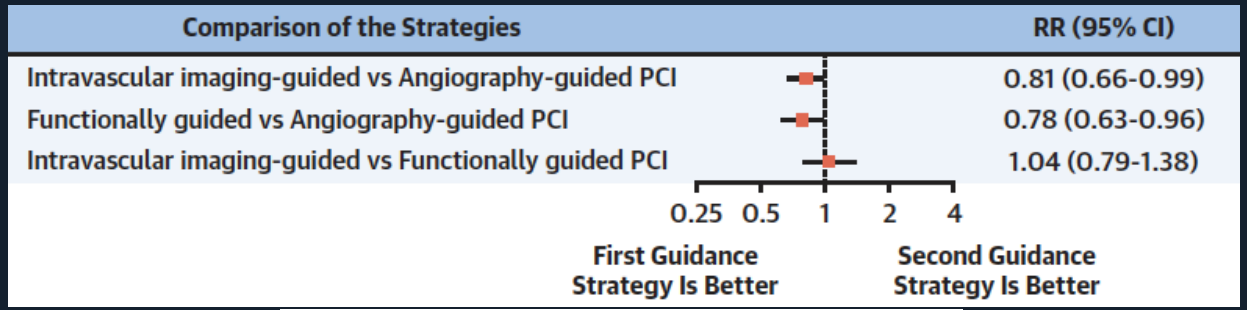
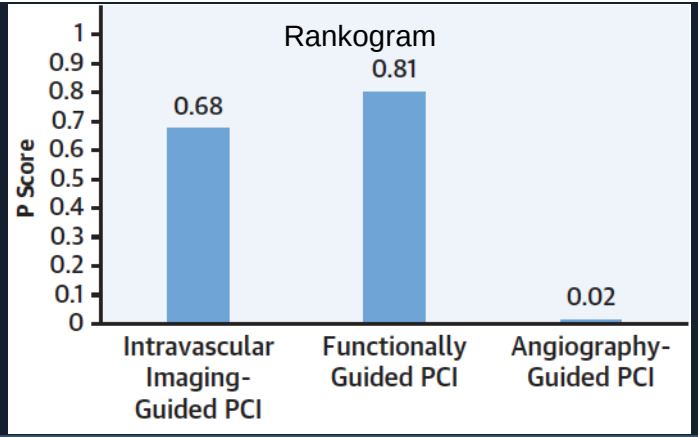
Results: MI

32 RCTs with 22,684 patients





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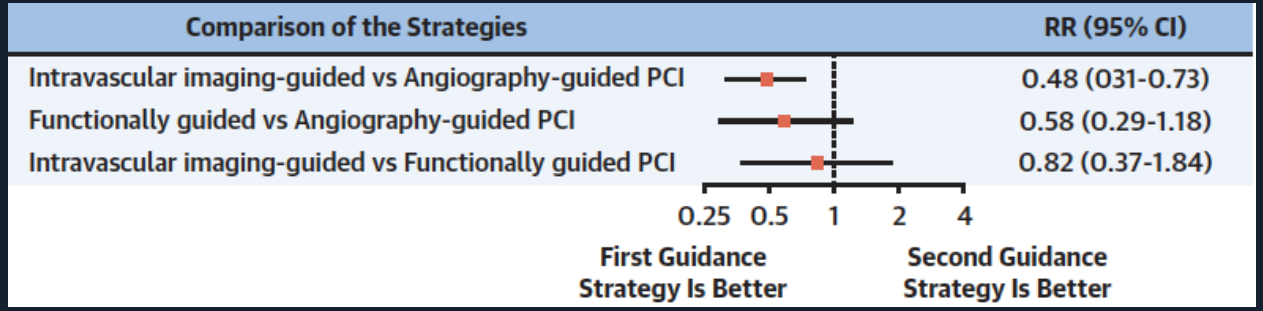
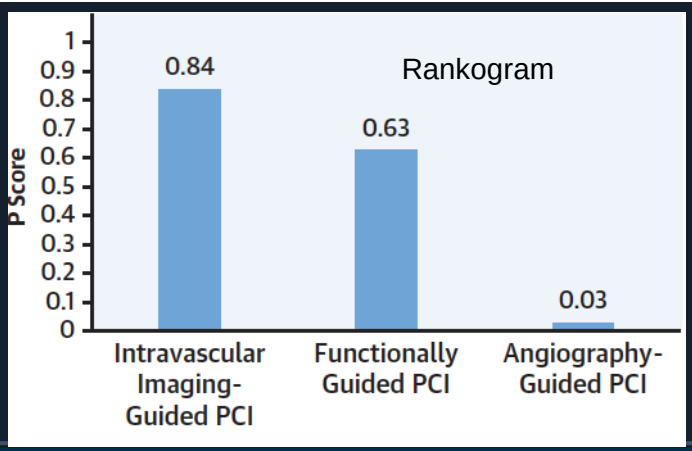
Results: Stent Thrombosis

32 RCTs with 22,684 patients

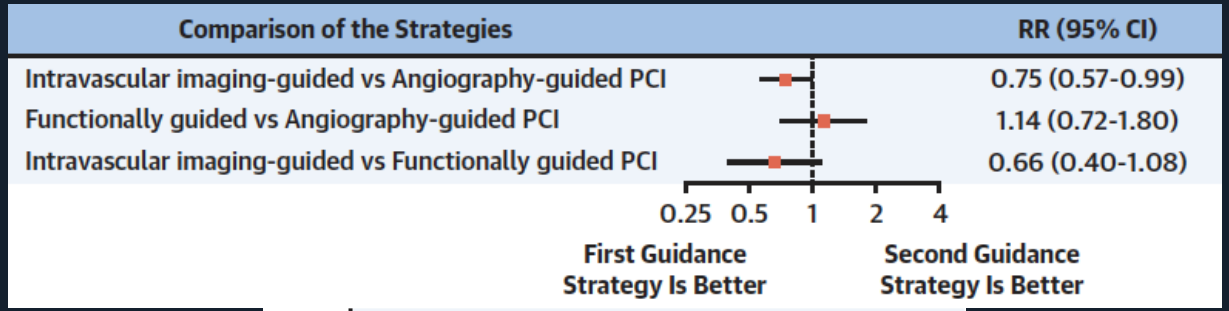


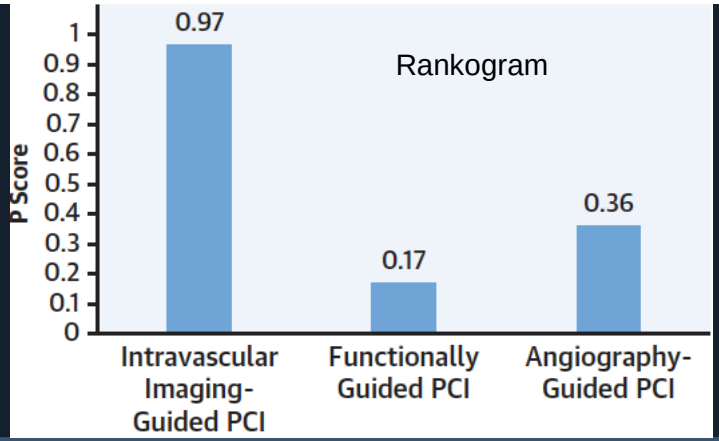


Kuno T ……..Bangalore S. J Am Coll Cardiol 2023;82:2167–2176

Results: TLR

32 RCTs with 22,684 patients





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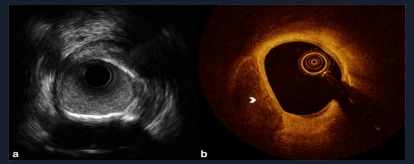
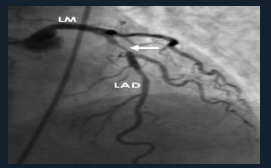
Subgroup Analysis: ACS Trials





MACE	Best		Worst
CV Death	Best		Worst
MI	Best	Best	Worst
Stent Thrombosis	Best		Worst
TLR	Best	Worst	

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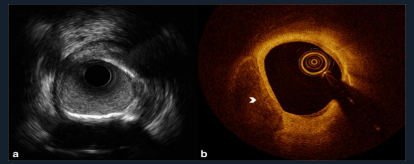
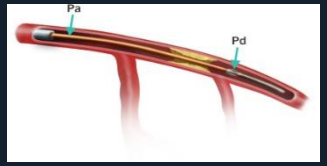
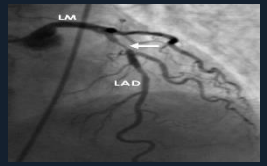
Subgroup Analysis: Non-ACS Trials







MACE	Best		Worst
CV Death	Best		Worst
MI	Best	Best	Worst
Stent Thrombosis	Best		Worst
TLR	Best		Worst

Kuno T ……..Bangalore S. J Am Coll Cardiol 2023;82:2167–2176

Intravascular Imaging, Functional, or Angiographically Guided Coronary Intervention

Limitations

- Functional guidance was mainly used for PCI lesion selection, whereas in most studies, imaging guidance was used to optimize stent implantation in lesions selected on the basis of angiography

Intravascular Imaging vs. Angiography Guided PCI

Network Meta-Analysis

22 trials with15 964 patients and mean 25 months of follow up

IVI-guided PCI vs. Angio

- Target lesion failure (RR 0·71 [95% CI 0·63–0·80]; p<0·0001)
- Cardiac death (RR 0·55 [95% CI 0·41–0·75]; p=0·0001)
- TV-MI (RR 0·82 [95% CI 0·68–0·98]; p=0·030)
- TLR (RR 0·72 [95% CI 0·60–0·86]; p=0·0002)
- Stent thrombosis (RR 0·52 [95% CI 0·34–0·81]; p=0·0036)
- Myocardial infarction (RR 0·83 [95% CI 0·71–0·99]; p=0·033)
- All-cause death (RR 0·75 [95% CI 0·60–0·93]; p=0·0091)

- Outcomes similar for OCT-guided vs IVUS guided PCI

Stone GS et al. Lancet. 2024

Intravascular Imaging, Functional, or Angiographically Guided Coronary Intervention

Summary

- Intravascular imaging-guided PCI and functionally guided PCI were both associated with superior outcomes compared with angiography-guided PCI
- Intravascular imaging-guided PCI was ranked as the best for reduction of CV events in both ACS and non-ACS cohorts
- Alternatively, angiography guided PCI was consistently ranked the worst for most of the outcomes

Comparison of Intravascular Imaging, Functional, or Angiographically Guided Coronary Intervention

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ABSTRACT

BACKGROUND In patients undergoing percutaneous coronary intervention (PCI), it remains unclear whether intravascular imaging guidance or functional guidance is the best strategy to optimize outcomes and if the results are different in patients with vs without acute coronary syndromes (ACS).

OBJECTIVES The purpose of this study was to evaluate clinical outcomes with imaging-guided PCI or functionally guided PCI when compared with conventional angiography-guided PCI.

METHODS We searched PUBMED and EMBASE for randomized controlled trials investigating outcomes with intravascular imaging-guided, functionally guided, or angiography-guided PCI. The primary outcome from this network meta-analysis was trial-defined major adverse cardiovascular event (MACE)—a composite of cardiovascular death, myocardial infarction (MI), and target lesion revascularization (TLR). PCI strategies were ranked (best to worst) using P scores.

RESULTS Our search identified 32 eligible randomized controlled trials and included a total of 22,684 patients. Compared with angiography-guided PCI, intravascular imaging-guided PCI was associated with reduced risk of MACE (relative risk [RR]: 0.72; 95% CI: 0.62-0.82), cardiovascular death (RR: 0.56; 95% CI: 0.42-0.75), MI (RR: 0.81; 95% CI: 0.66-0.99), stent thrombosis (RR: 0.48; 95% CI: 0.31-0.73), and TLR (RR: 0.75; 95% CI: 0.57-0.99). Similarly, when compared with angiography-guided PCI, functionally guided PCI was associated with reduced risk of MACE and MI. Intravascular imaging-guided PCI ranked first for the outcomes of MACE, cardiovascular death, stent thrombosis, and TLR. The results were consistent in the ACS and non-ACS cohorts.

CONCLUSIONS Angiography-guided PCI had consistently worse outcomes compared with intravascular imaging-guided and functionally guided PCI. Intravascular imaging-guided PCI was the best strategy to reduce the risk of cardiovascular events. (J Am Coll Cardiol 2023;82:2167-2176) © 2023 by the American College of Cardiology Foundation.

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EDITORIAL COMMENT

Lesion Selection and Optimizing PCI

Intravascular Hemodynamics, Imaging, or Both?*

Cindy L. Grines, MD, Allison DuPont, MD

In this issue of the *Journal of the American College of Cardiology*, Kuno et al[1] performed a network meta-analysis of 32 trials that randomized 22,684 patients undergoing percutaneous coronary intervention (PCI) to receive either intracoronary physiology with fractional flow reserve (FFR), angiography-guided PCI, or intravascular imaging.

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Compared with angiography-guided PCI, use of either intracoronary physiology or imaging was associated with reduced risk of myocardial infarction, cardiovascular death, and major adverse cardiovascular events (MACE). Although there were no significant differences in individual endpoints comparing intracoronary physiology and imaging, a ranking strategy found intravascular imaging to be superior in reduction of MACE, stent thrombosis, and target lesion revascularization. This paper is an important addition to our knowledge base on the management of coronary artery disease. It adds the most recent studies and adds more credibility to a relevant review paper that overviewed available evidence regarding intravascular imaging.[2] Although the network meta-analysis is impressive, and hopefully will influence guidelines[3] to elevate intravascular imaging from Class IIa to Class I, we believe there remains a time and place for both technologies. Among the 32 randomized trials, nearly all of the FFR studies were performed pre-PCI to determine lesion significance, and most of the imaging studies were used for stent optimization. One should keep that in mind when interpreting the results of this important network meta-analysis.

Clearly, angiography alone has its shortcomings. It is well known that angiographic assessment of lesion severity is limited by foreshortening, overlap of branches, and interobserver variability. Moreover, invasive cardiologists routinely underestimate the severity of diffuse disease and long lesions, often due to the lack of a normal reference segment.

It is generally accepted that intracoronary physiology measurements are superior to imaging at determining stable lesion significance pre-PCI.[4] However, values derived from FFR are a continuum, and use of a cutoff value of 0.8 may not be appropriate in all lesions. For example, in the FAME-2 (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation 2) trial, patients with FFR between 0.81 and 0.90 had significantly higher MACE than those with FFR values between 0.91 and 1.00.[5] Are we to ignore those "nonobstructive" lesions? Perhaps verification with intravascular imaging would allow better risk stratification of lesions with abnormal, but not significant FFR.

We believe that imaging may not be as helpful to determine lesion significance because coronary lumen size varies based on the amount of myocar-