Long-term outcomes of clinical decision-making based on FFR

Mauro Echavarría Pinto MD, MSc, PhD

Cardiólogo Intervencionista

Hospital General ISSSTE Querétaro

Facultad de Medicina, Universidad Autónoma de Querétaro

Why does pressurewires work?

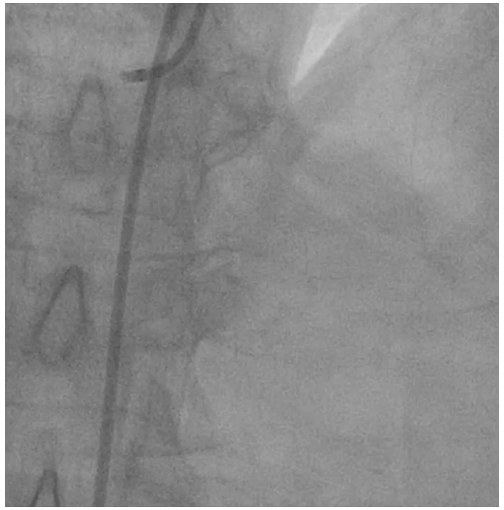
73 yo male with diabetes, progressive angina and heart failure, EF 35%

LAD iFR: 0.93

Ramus iFR: 0.35

LCx iFR: 0.97

RCA: 0.99



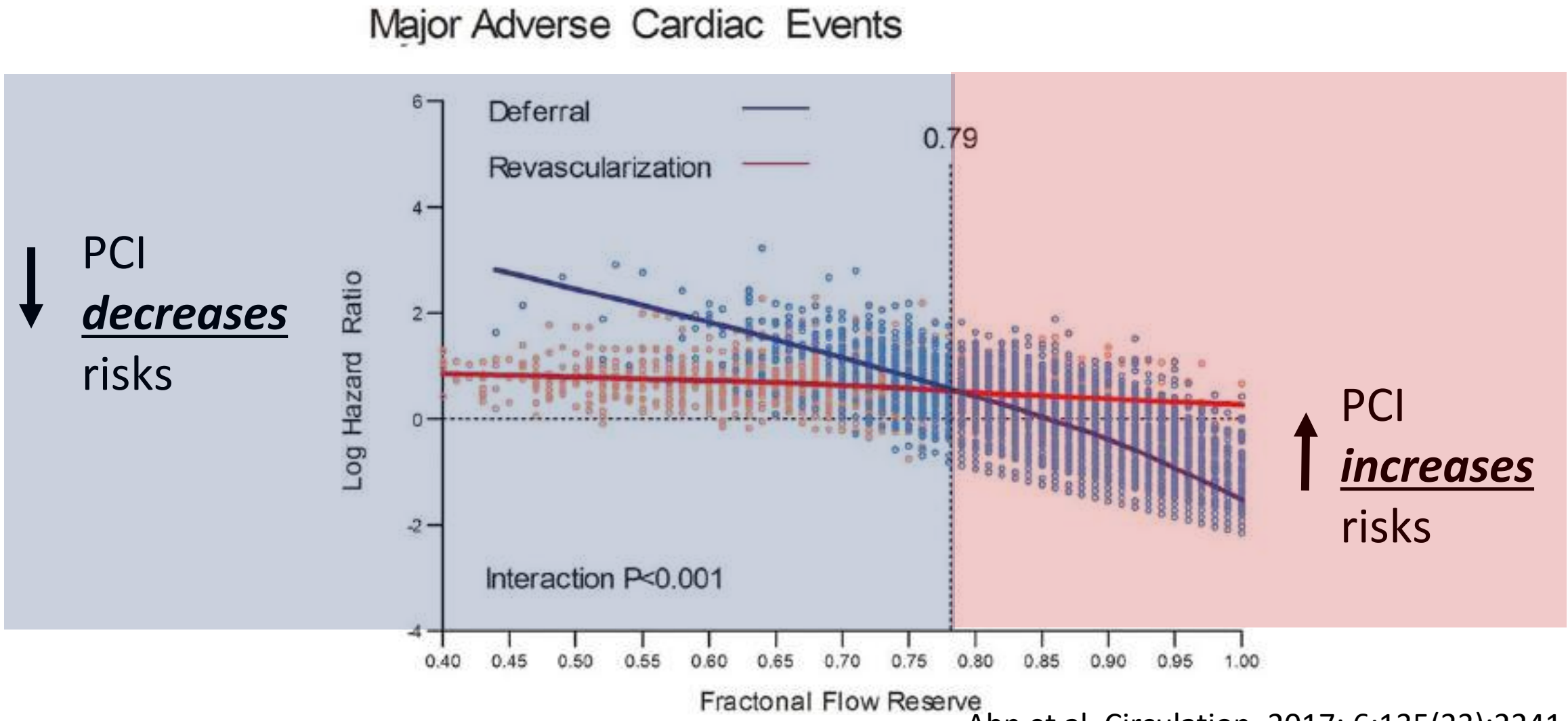
Risk of MACE if treated (natural history of coronary stents)			
5-10%	**5%**	**5-10%**	**5-10%**
Risk of MACE if deferred (natural history of disease)			
3%	**15%**	**3%**	**3%**

Madhavan et al. J Am Coll Cardiol 2020;75:590–604

Ahn et al. Circulation. 2017: 6;135(23):2241-2251.

IC physiology accurately discriminates stenosis at lower and higher risk of events, as compared to PCI.

IRIS-FFR Registry, n=5,846 pts

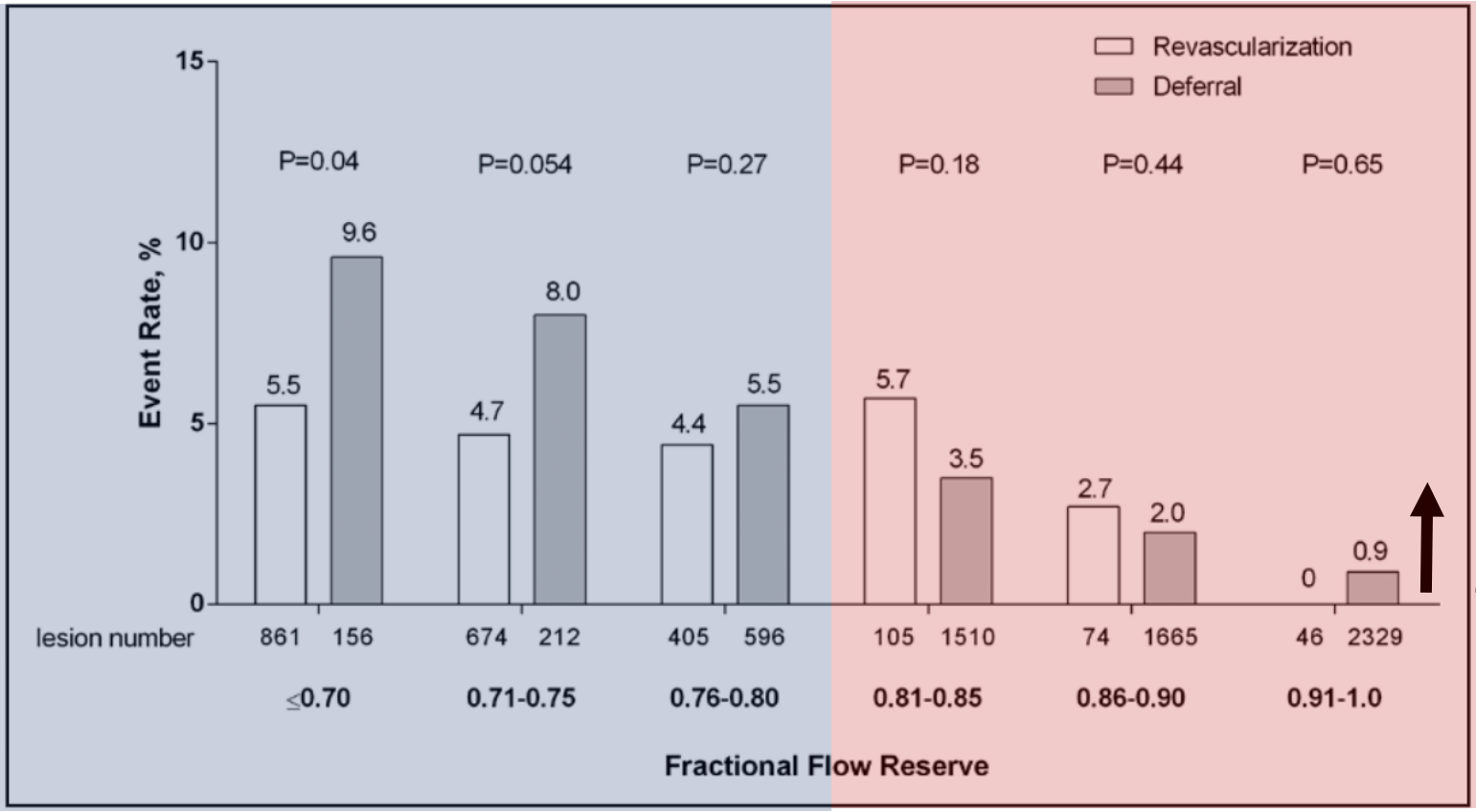


Ahn et al. Circulation. 2017: 6;135(23):2241-2251.

IC physiology accurately discriminates stenosis at lower and higher risk of events, as compared to PCI.

IRIS-FFR Registry, n=5,846 pts

PCI ***decreases*** risks



PCI ***increases*** risks

Ahn et al. Circulation. 2017: 6;135(23):2241-2251.

Analysis of risk

Angio guided-PCI:

- 4 stenosis, 1 significant, 3 non-significant
- 4 stenosis treated with 4 stents:
  - In one lesion stenting **decreased** risks
  - In 3 lesion stenting **increased** risks
- 6% annual risk of stent x4=24% annual risk of MACE

Annual risk of MACE: 24%
4 stents

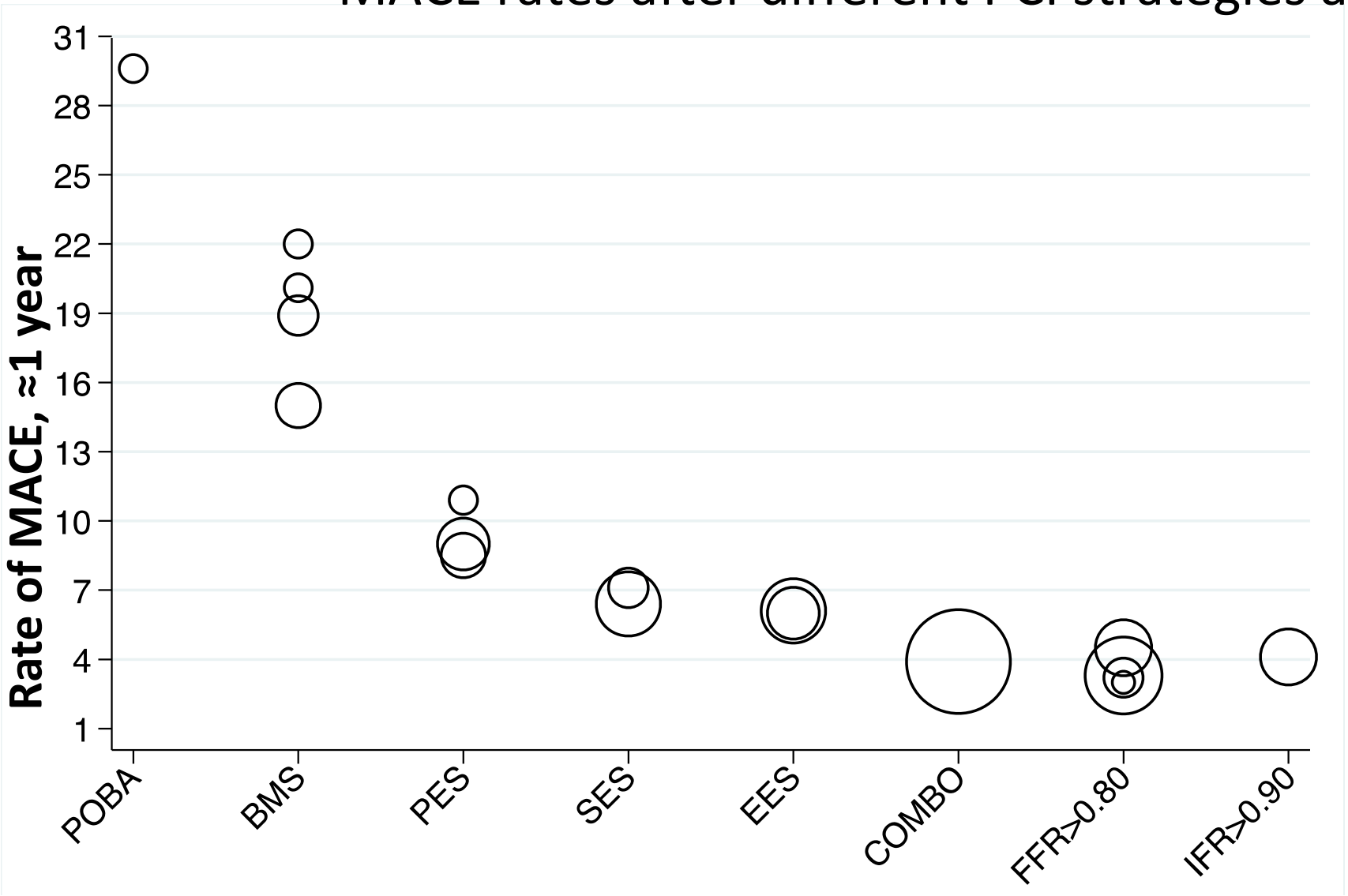
FFR-guided PCI:

- 4 stenosis, 1 significant, 3 non-significant
- 4 stenosis treated with 1 stent
  - In one lesion stenting **decreased** risks
  - In 3 deferred lesions **risk was NOT increased**
- 6% annual risk of stent + (3x3% annual risk of non isquemic lesion =9)=15% annual risk of MACE

Annual risk of MACE: 15%
1 stent

Overview of outcomes after PCI and FFR-based deferral

MACE rates after different PCI strategies and FFR deferral



Randomized trials

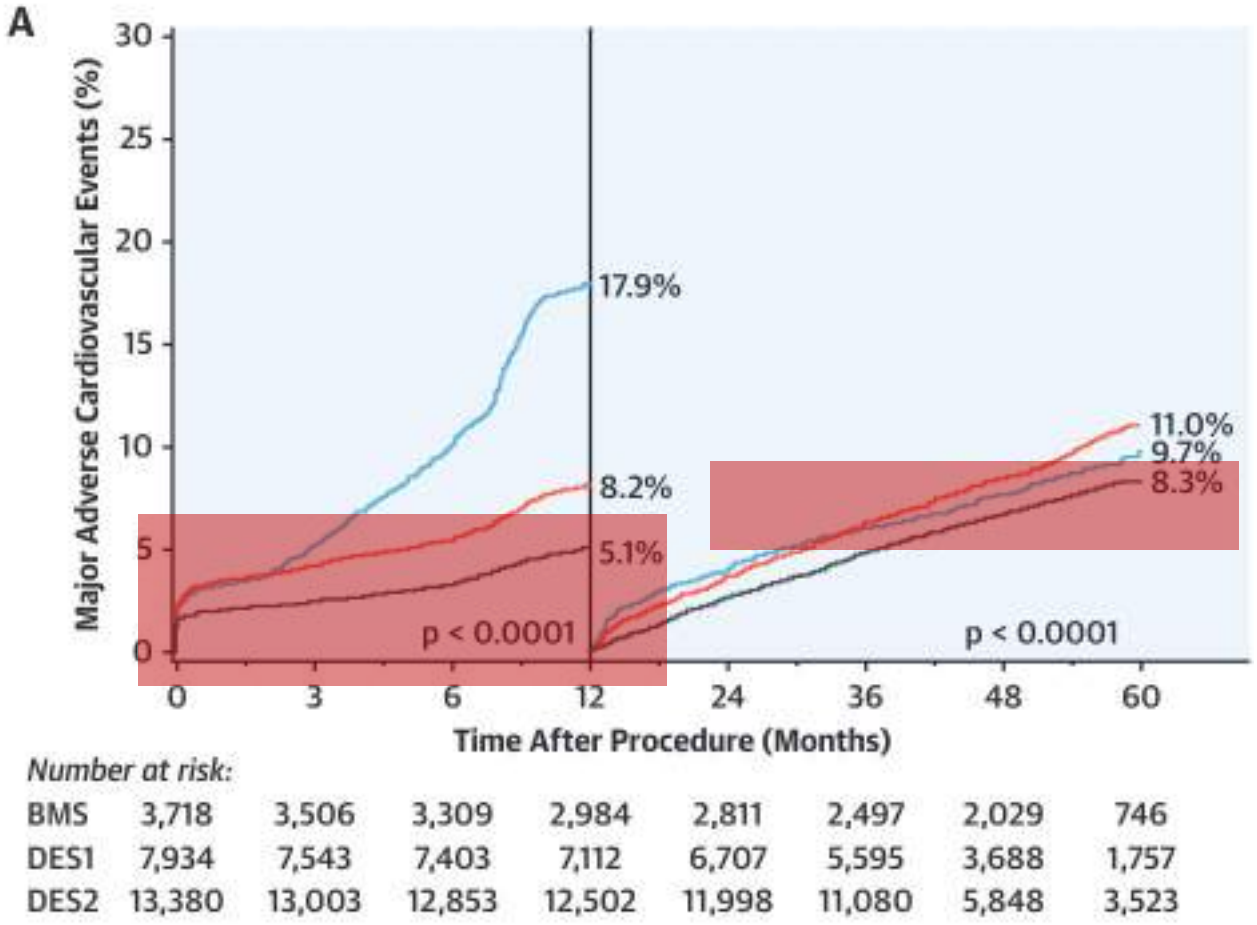
- BENESTENT. N Engl J Med 1994
- SIRIUS. N Engl J Med 2003
- TAXUS II. Circulation 2003
- TAXUS IV. N Engl J Med 2004
- COMPARE . Lancet 2010
- SORT OUT IV. JACC 2016
- FAME. N Engl J Med 2007
- FAME 2. N Engl J Med 2014
- DEFINE FLAIR. N Engl J Med 2017
- IFR SWEDHEART. N Engl J Med 2017

Registries

- IRIS FFR Registry. Circulation 2017
- COMBO Registry. ACC 2018

Stent-related adverse events versus physiology-based deferral

Metanalysis of >25,000 pt treated with DES in 19 RCT archived by the CRF



VS

MACE after FFR deferral: 3.72%

Weighted mean

Randomized physiology trials

- FAME. N Engl J Med 2007
- FAME 2. N Engl J Med 2014
- DEFINE FLAIR. N Engl J Med 2017
- IFR SWEDHEART. N Engl J Med 2017

Madhavan et al. J Am Coll Cardiol 2020;75:590–604

Rate of MACE after PCI in bifurcation lesions

DEFINITION study Prospective all -comers consecutive bifurcation registry, 3,660 true bifurcations treated with 2nd DES

One year event rate

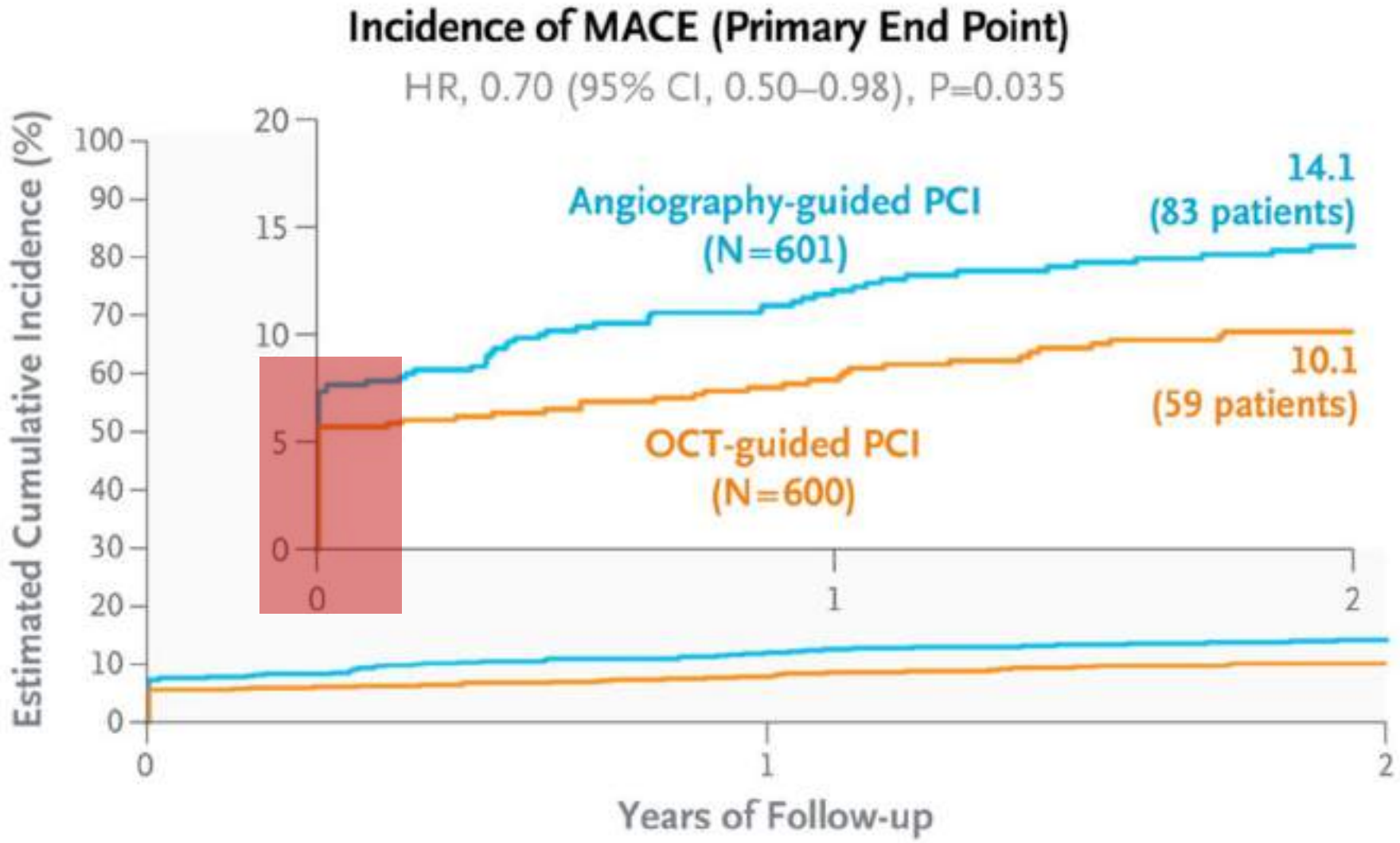
TABLE 4 Clinical Outcomes in Complex and Simple Groups of 3,660 Patients

	Complex (n = 1,108)	Simple (n = 2,552)	Adjusted HR (95% CI)	p Value
At 1 year				
Myocardial infarction	78 (7.0)	105 (4.1)	1.77 (1.31-2.39)	<0.001
Cardiac death	45 (4.1)	27 (1.1)	3.96 (2.45-6.42)	<0.001
Target lesion revascularization	66 (5.8)	96 (3.8)	0.35 (0.16-0.63)	0.003
Target vessel revascularization	87 (7.9)	126 (4.9)	0.46 (0.21-0.78)	0.001
Coronary artery bypass graft	9 (0.8)	3 (0.1)	1.88 (0.63-3.23)	0.004
Major adverse cardiac events	186 (16.8)	228 (8.9)	0.72 (0.51-0.93)	<0.001
Stent thrombosis	18 (1.6)	18 (0.7)	0.72 (0.56-0.84)	0.012

Chen et al JACC CI 2015

OCT-guided vs angio-guided PCI in clinically meaningful bifurcation lesions

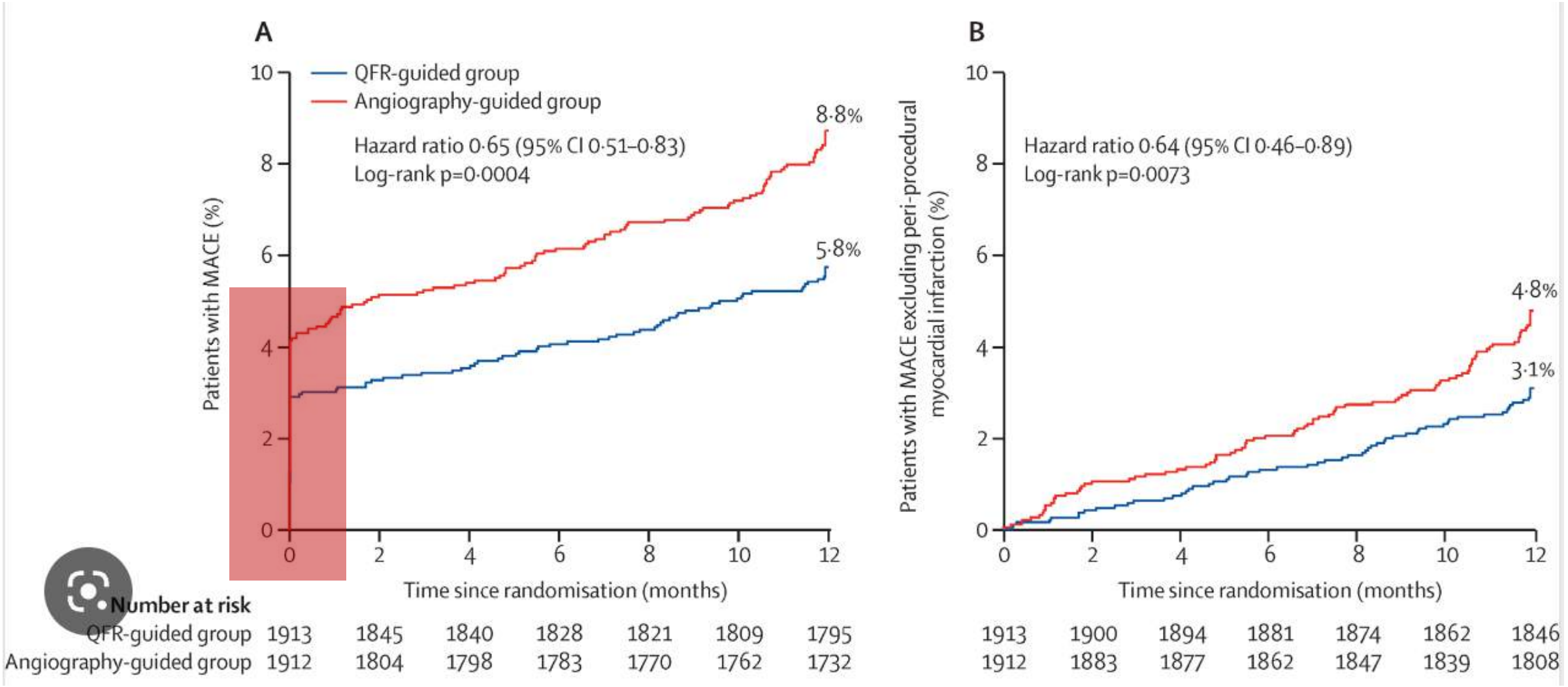
(OCTOBER trial: n:1201 pt)



Holm N. N Engl J Med 2023; 389:1477-1487

Angio-guided PCI or QFR-guided PCI

(FAVOR III CHINA, 3825 pt)

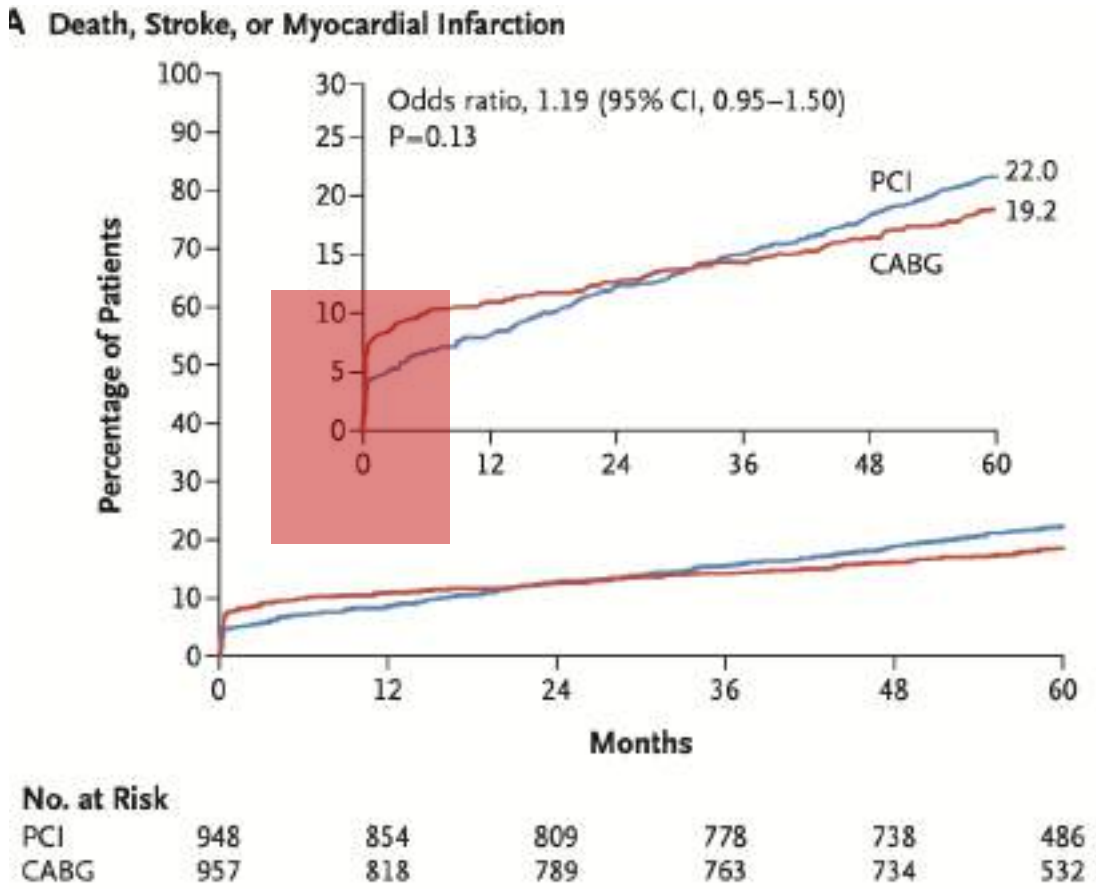


Xu B. et al. Lancet 2022

PCI is not a “risk-free” procedure

EXCEL trial primary endpoint

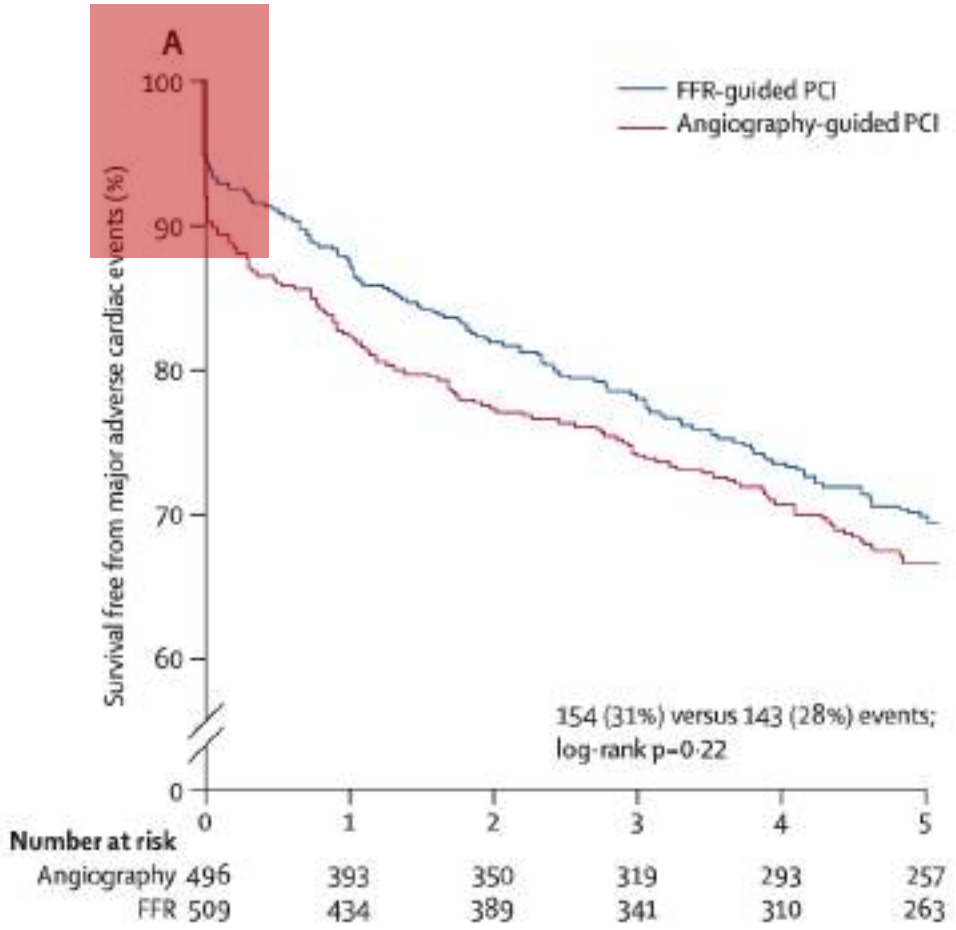
PCI vs CABG for intermediate LM complexity, n=1,905



Stone et al. N Engl J Med 2019;381:1820-30.

FAME study 5 year follow up

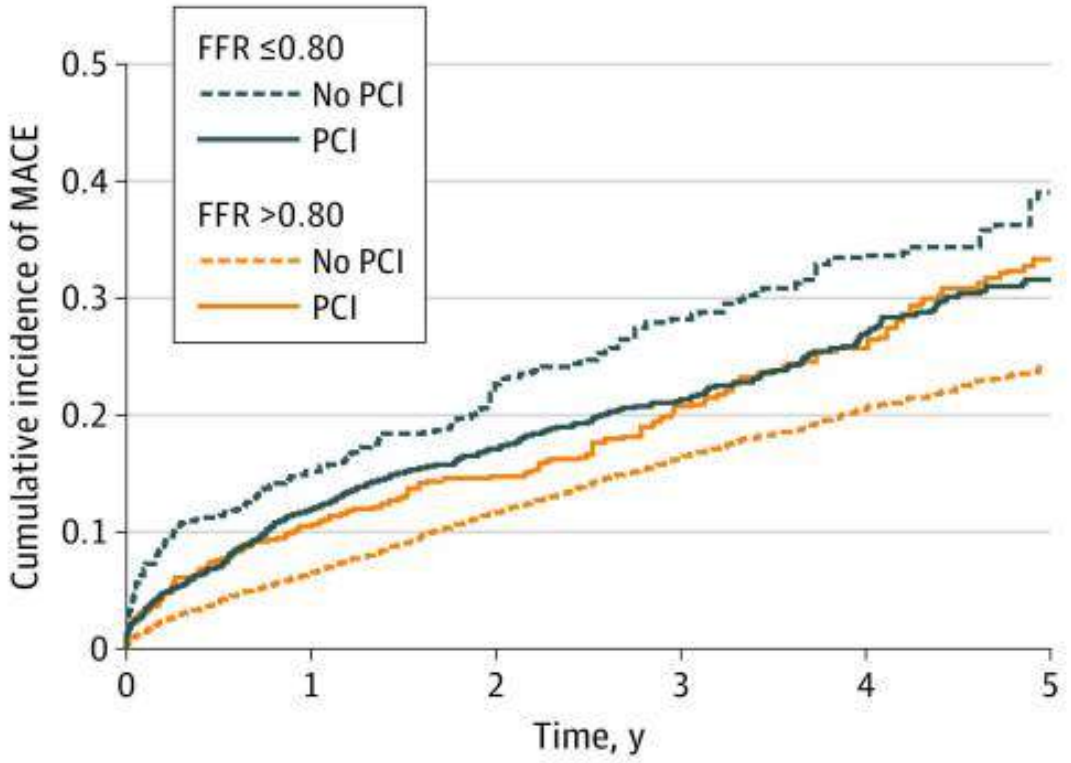
FFR vs angio guided PCI in MVD, n=1,005



Van Nunen et al. Lancet 2015

Trust the guidewire value: Multicenter registry, 9,106 pt, FU 5 years

- Positive FFR lesions:
  - n, 2693:
  - 75.3% had PCI
- Negative FFR lesions:
  - n, 6,413 pt
  - 12.6% had PCI



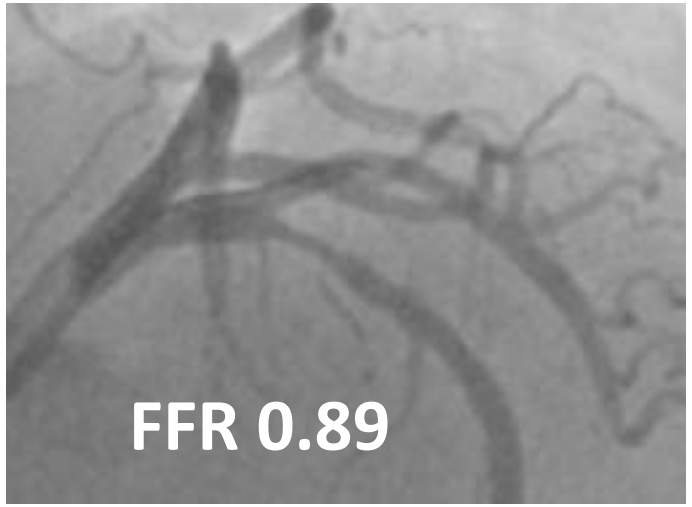
No. at risk						
FFR ≤0.80						
No PCI	674	572	410	269	175	75
PCI	2022	1781	1299	868	511	236
FFR >0.80						
PCI	817	730	568	410	270	129
No PCI	5604	5238	3751	2534	1540	690

Sud et al. JAMA. 2020 Dec 15;324(23):2406-2414

MI arising from FFR negative lesions is <1% at 5 years

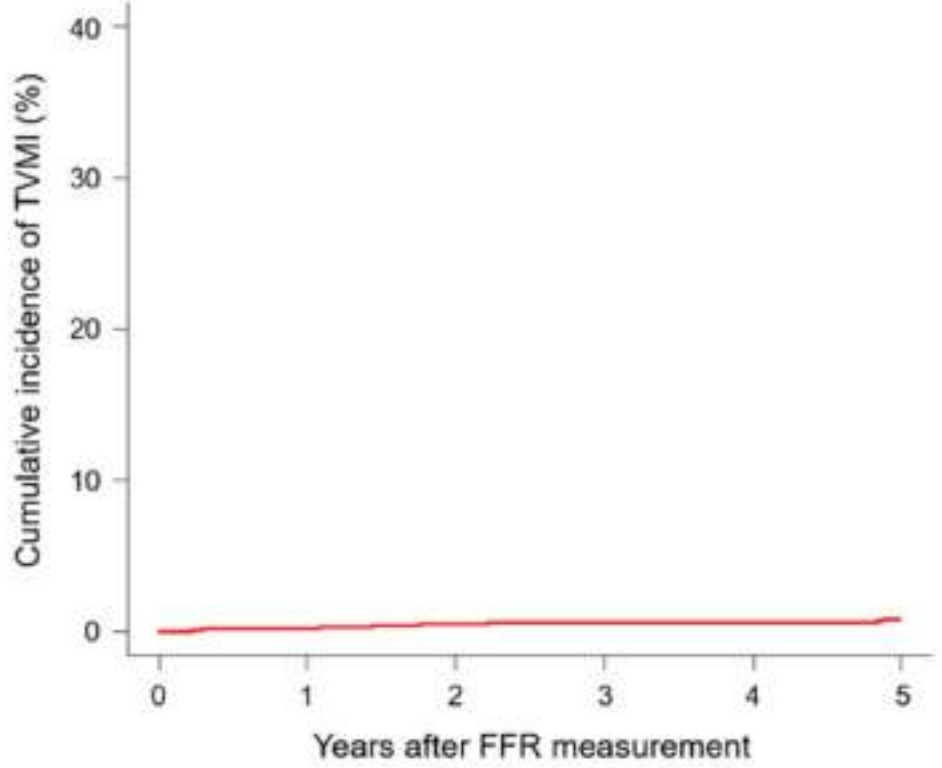
J-Confirm Registry, 1,447 lesions from 1,263 pt from 23 centers in Japan

C



Intervals	0	1 Year	2 Years	3 Years	4 Years	5 Years
N of lesions at risk	1447	1382	1285	1193	1108	814
Cumulative incidence	0.0%	2.2%	5.1%	6.8%	8.4%	9.8%

D

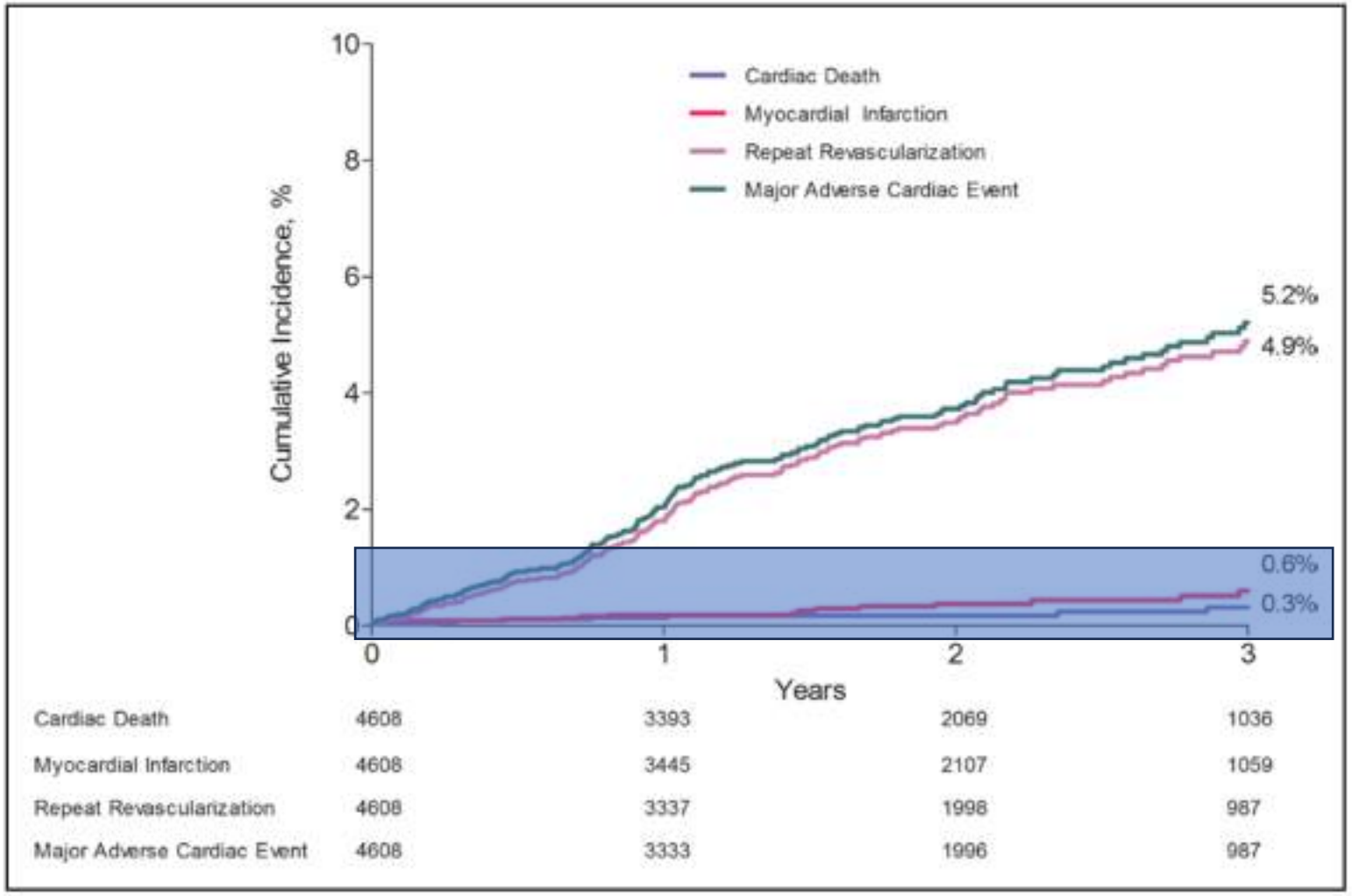


Intervals	0	1 Year	2 Years	3 Years	4 Years	5 Years
N of lesions at risk	1447	1418	1366	1286	1210	889
Cumulative incidence	0.0%	0.21%	0.49%	0.57%	0.57%	0.83%

https://doi.org/10.1161/CIRCINTERVENTIONS.119.008355Circulation: Cardiovascular Interventions. 2020;13:e008355

MI arising from FFR negative lesions is <1% at 5 years

Iris-FFR Registry, 4,608 lesions deferred because FFR>0.80

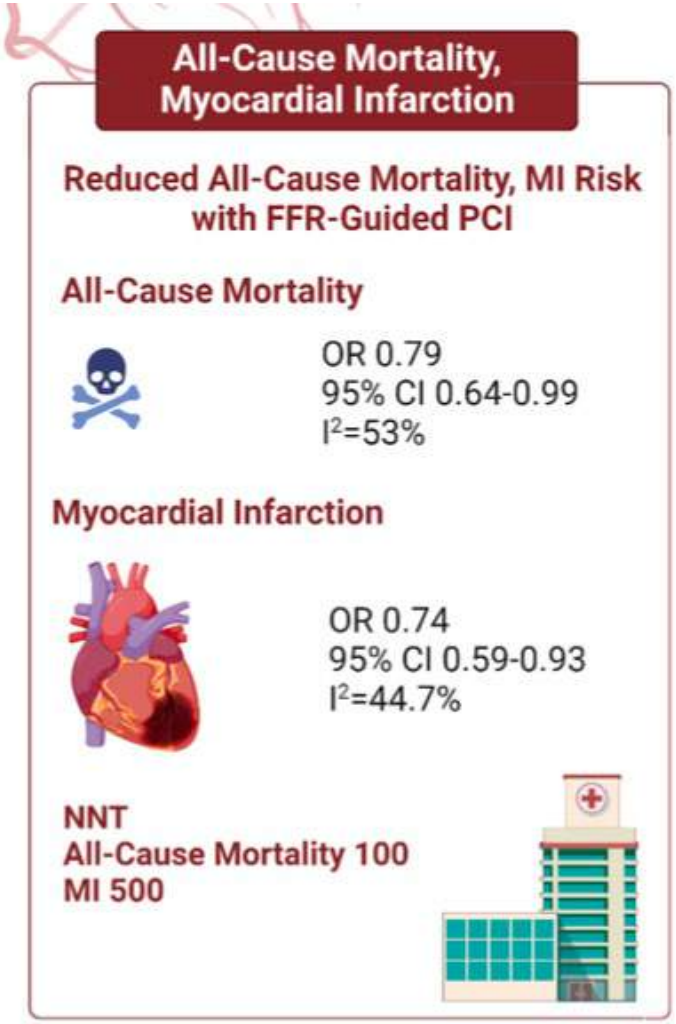


Ahn et al. Circulation. 2017: 6;135(23):2241-2251.

Fractional-flow Reserve Use in Coronary Artery Revascularization: A 78,897 Patients Systematic Review and Meta-Analysis

As compared to non-physiology-guided revascularization (including imaging-guided PCI and CABG), **FFR guided PCI reduced the risk of**:

1. **All-cause mortality in 21%** (OR 0.79 95% CI 0.64-0.99, I2=53%)
2. **Myocardial infarction in 26%** (OR 0.74 95% CI 0.59-0.93, I2=44.7%)
3. **NNT to prevent one death: 100 patients**



Sánz Sanchez J, Echavarría-Pinto M, García-García HM, I-Science, aug 2023

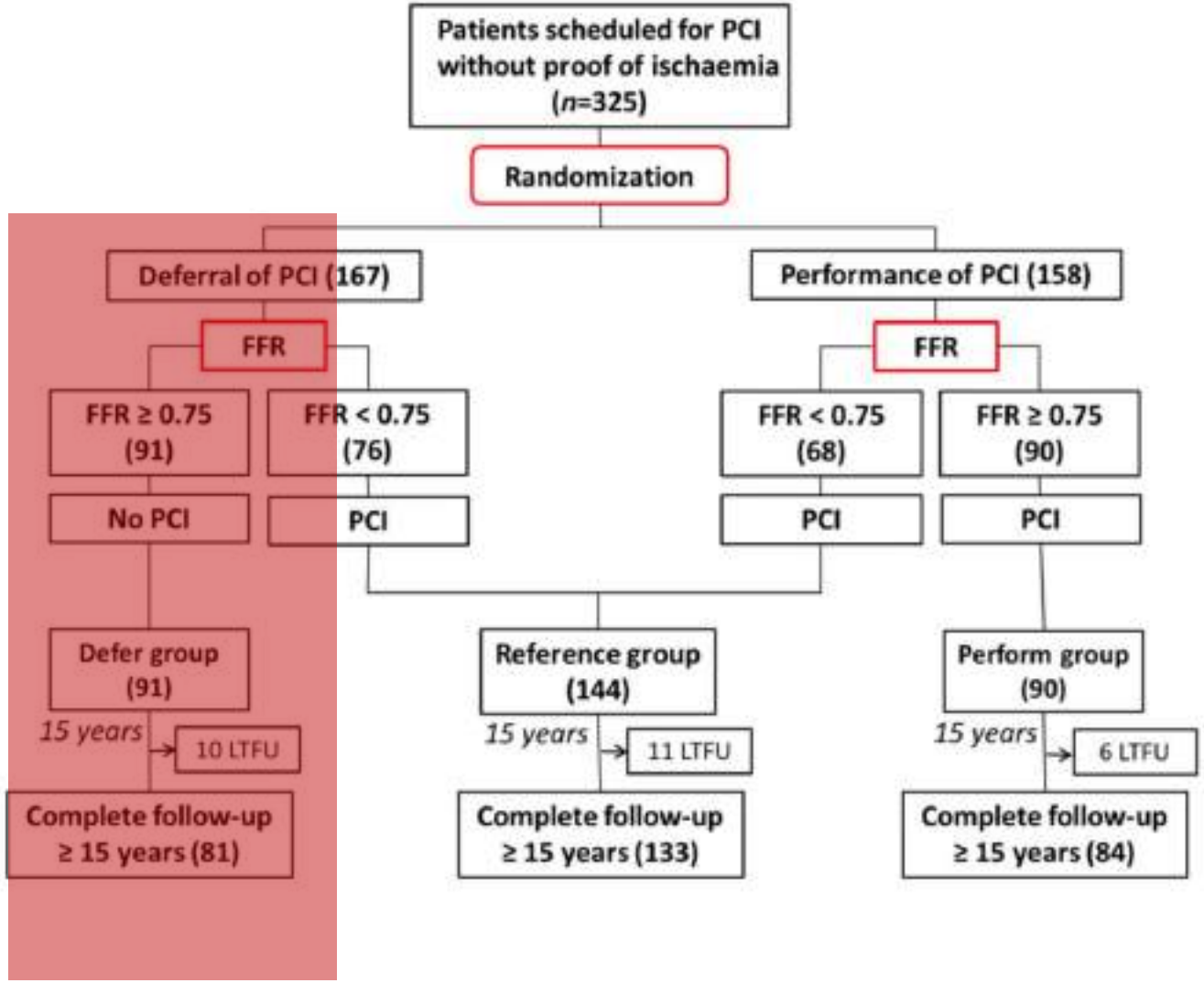
2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: Physiology has the highest level of recommendation

Recommendations for the Use of Coronary Physiology to Guide Revascularization With PCI
Referenced studies that support the recommendations are summarized in Online Data Supplement 5.

COR	LOE	RECOMMENDATIONS
1	A	1. 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 (1-6).
3: No benefit	B-R	2. In stable patients with angiographically intermediate stenoses and FFR >0.80 or iFR >0.89, PCI should not be performed (7-10).

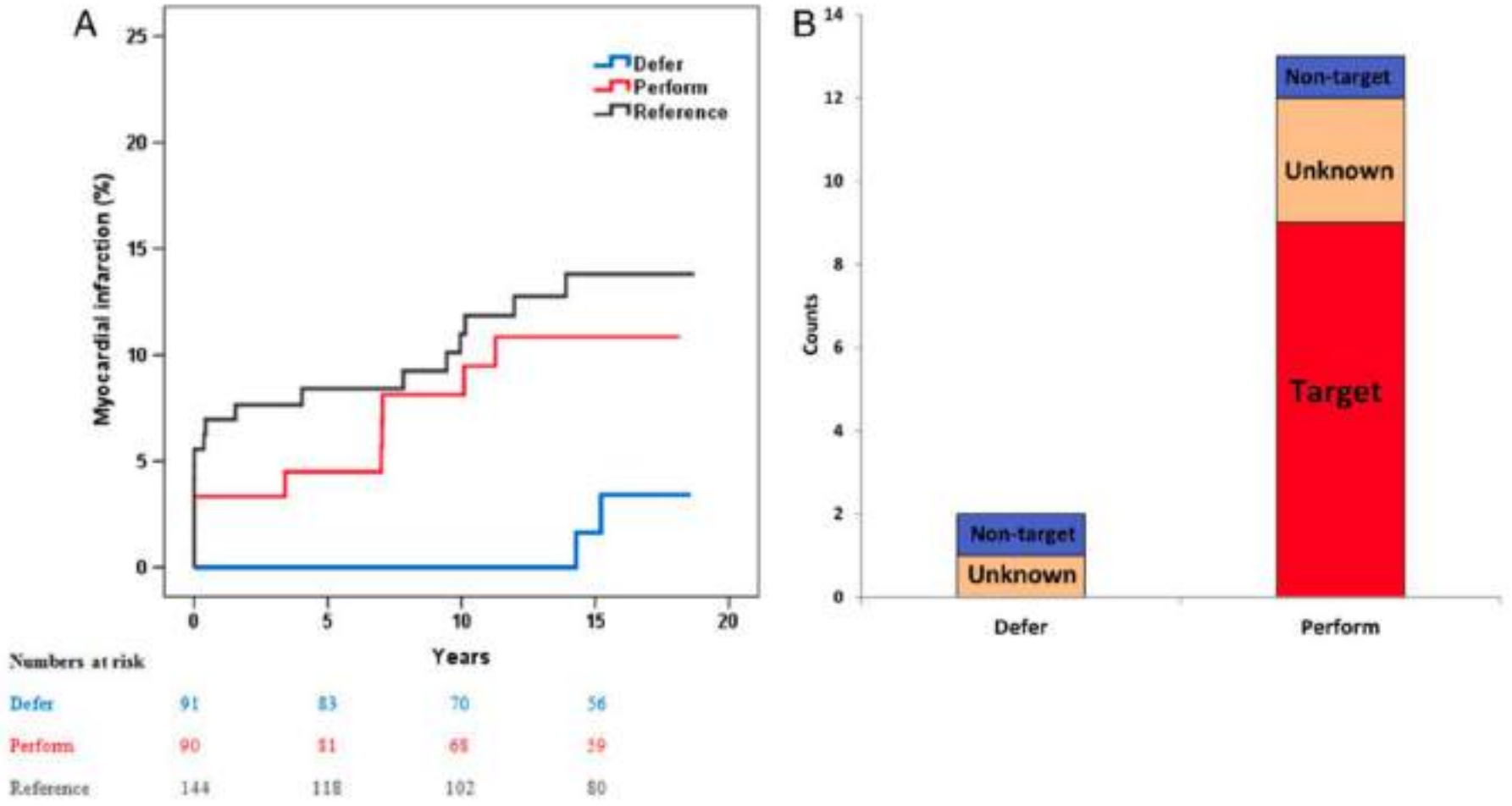
Lawton A. et al. JACC 2022

FFR-deferral and long term outcomes: DEFER trial, 325 pt where FFR was measured, if FFR>75 pt were randomized to PCI or PCI deferral



Zimmerman et al. European Heart Journal (2015) 36, 3182–3188

FFR-deferral and long term outcomes: DEFER trial, 325 pt where FFR was measured, if FFR>75 pt were randomized to PCI or PCI deferral

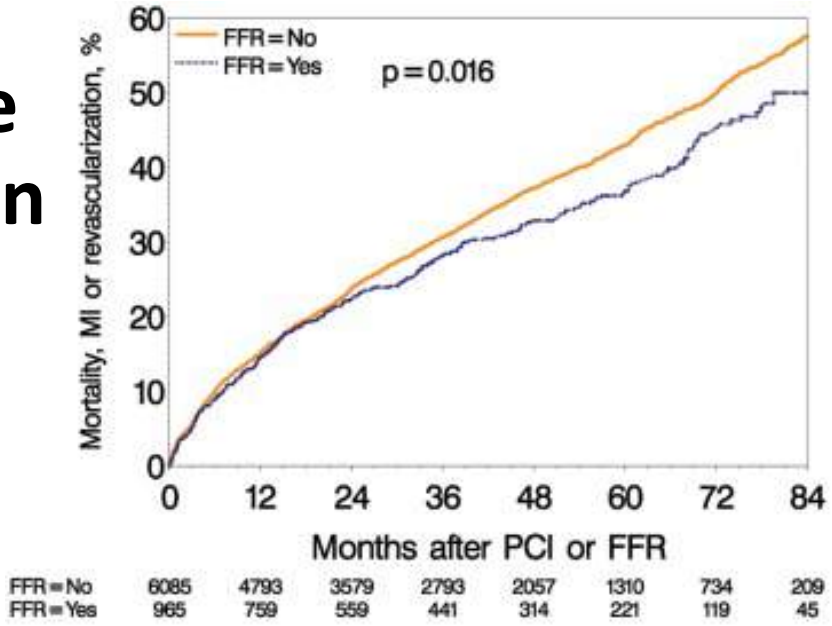


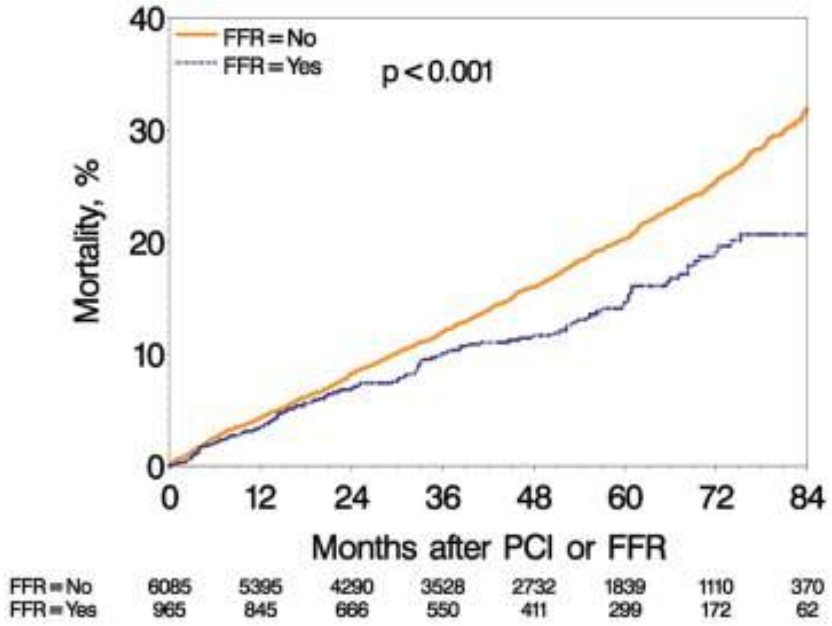
Zimmerman et al. European Heart Journal (2015) 36, 3182–3188

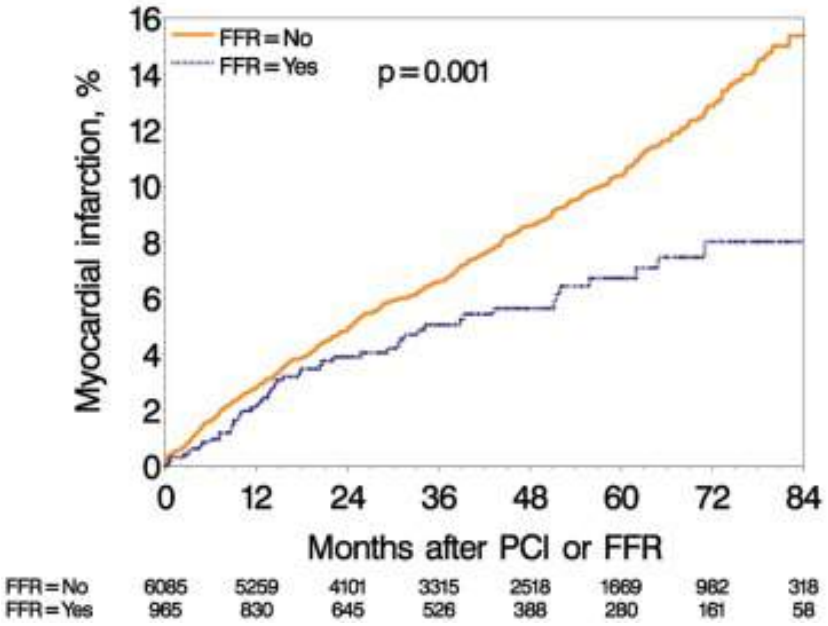
“FFR-believers” have better PCI results than “non-FFR believers”

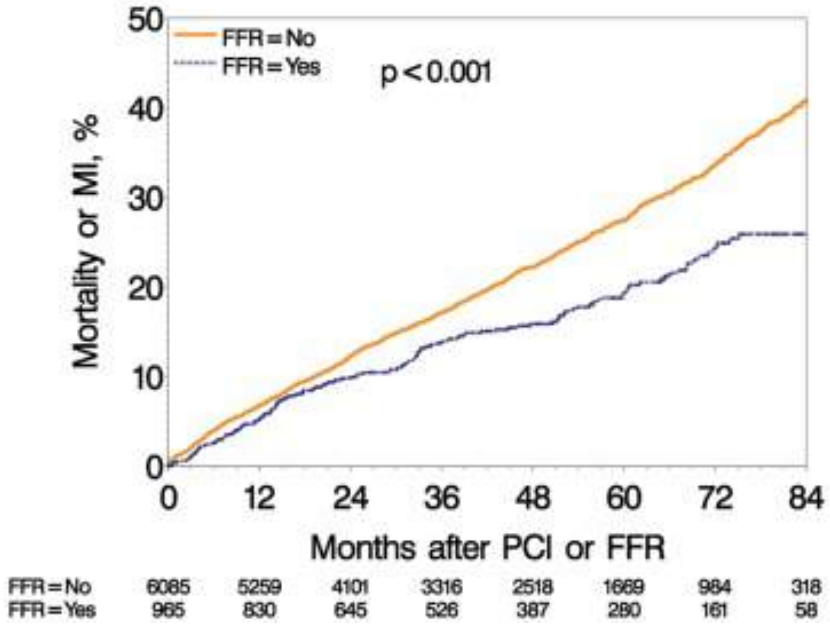
Mayo Clinic PCI long-term PCI cohort

(7,358 pt treated with or without FFR, follow-up for 7 years)



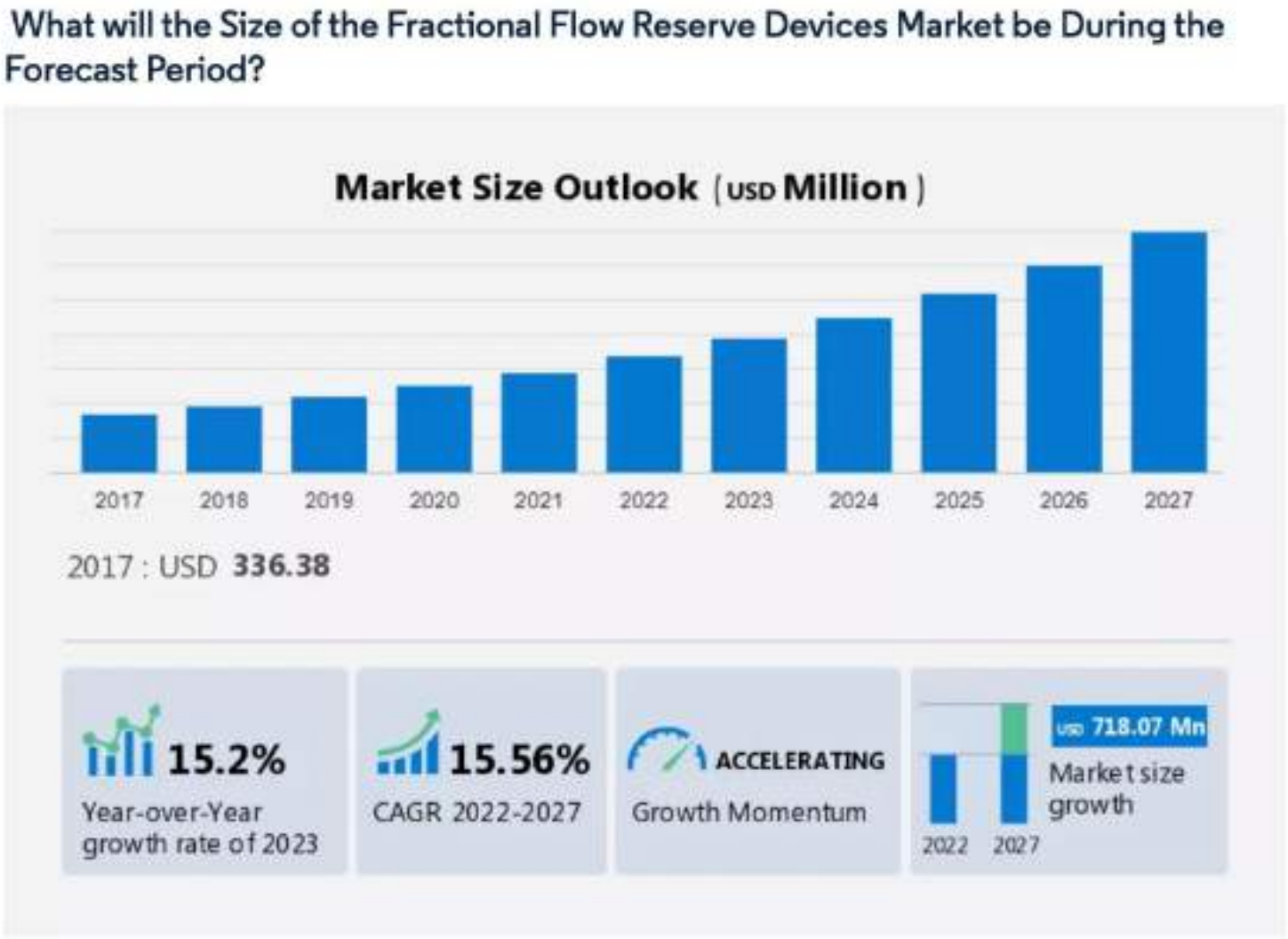






Li J et al. Eur Heart J . 2013 May;34(18):1375-83.

Physiology use is increasing worldwide



https://www.researchandmarkets.com/reports/1882092/intravascular_ultrasound_ivus_global_market?gclid=CjwKCAiA9qKbBhAzEiwAS4yeDYx7WqsfBJxJzgSZEmkFplyv93OReupF72DMIOxDH-q5NFsyve2F7hoCdkAQAvD_BwE

Stents in FFR negative, vulnerable plaques: PREVENT trial, 1606 pt with ”vulnerable” FFR>0.80 plaques, randomized to PCI or OMT

Trial of bystander disease

1. Clinically meaningfull, FFR positive stenosis were treated before randomization

2. Only after, all untreated, non-culprit lesions “that were clearly not responsible for the presenting clinical syndrome with an angiographic diameter stenosis of 50% or more by site visual estimation were functionally assessed by FFR”.

Definition of vulnerable plaques, 2 of the following 4 characteristics:

1. MLA<4 m^2 by IVUS or OCT

2. PB>70% by IVUS

3. Lipid-rich plaque by NIRS [maxLCBI4mm] >315)

4. Thin-cap fibroatheroma by radiofrequency IVUS or OCT

Park et al. Lancet 2025. Volume 403, Issue 10438, 4–10 May 2024, Pages 1753-1765

Stents in FFR negative, vulnerable plaques: PREVENT trial, 1606 pt with ”vulnerable” FFR>0.80 plaques, randomized to PCI or OMT

Imaging use:

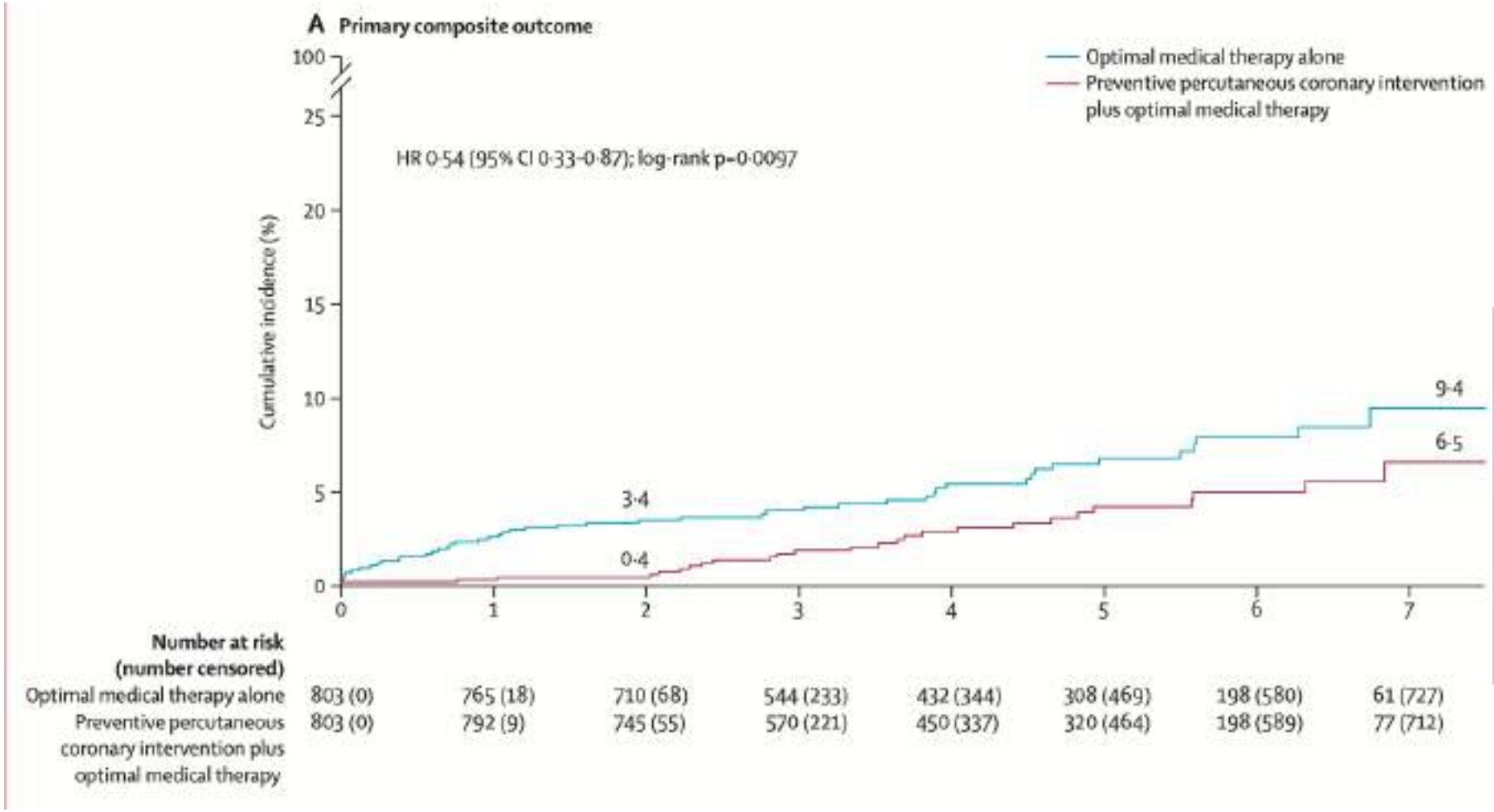
1. IVUS: 95%
2. Radiofrequency IVUS: 71%
3. NIRS : 42%
4. OCT: 5%

Observe characteristics of vulnerable plaques:

1. MLA<4 m^2 in 97%
2. PB>70% in 96%
3. Lipid-rich plaque by NIRS in 11%
4. Thin-cap fibroatheroma 5%

Park et al. Lancet 2025. Volume 403, Issue 10438, 4–10 May 2024, Pages 1753-1765

Stents in FFR negative, vulnerable plaques: PREVENT trial, 1606 pt with ”vulnerable” FFR>0.80 plaques, randomized to PCI or OMT



- Death from any cause: p=NS
- Death from cardiac cause: p=NS
- All MI: p=NS
- TV-MI: p=NS

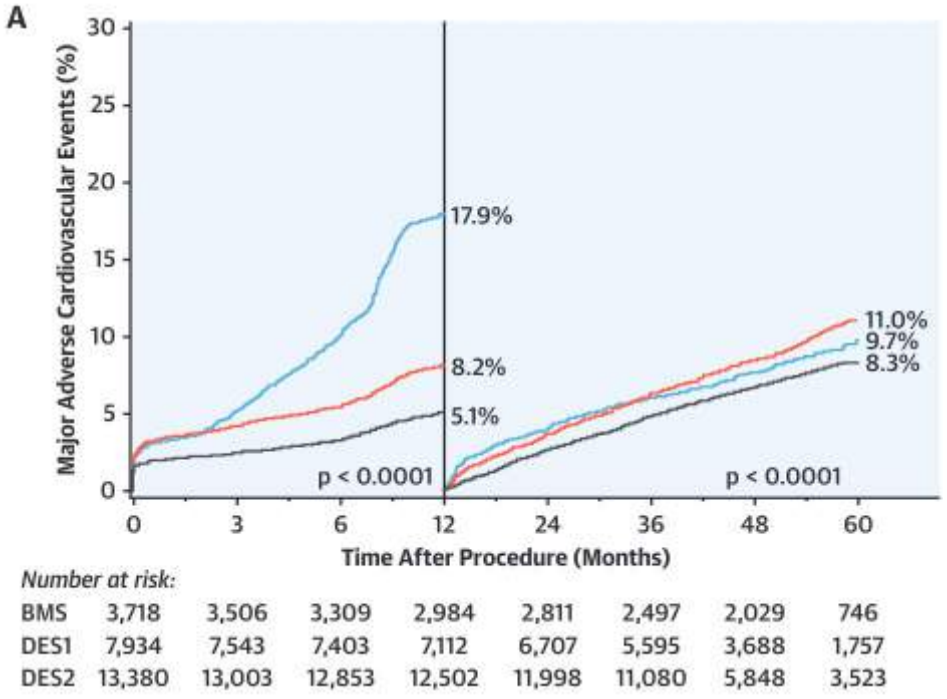
- Any revasc: HR 0.66 (0.44 to 0.98)
- Isquemia driven revasc: HR 0.44 (0.25 to 0.77)
- Hospitalization for unstable angina 0.19 (0.06 to 0.54)

Park et al. Lancet 2025. Volume 403, Issue 10438, 4–10 May 2024, Pages 1753-1765

Events in PREVENT trial were much lower than in all other stents trials, interpretation with caution is advised

Metanalysis, >25,000 pt from 19 RCT:

Rate of MACE after 2nd-gen DES at **1 year**: **5.1%**



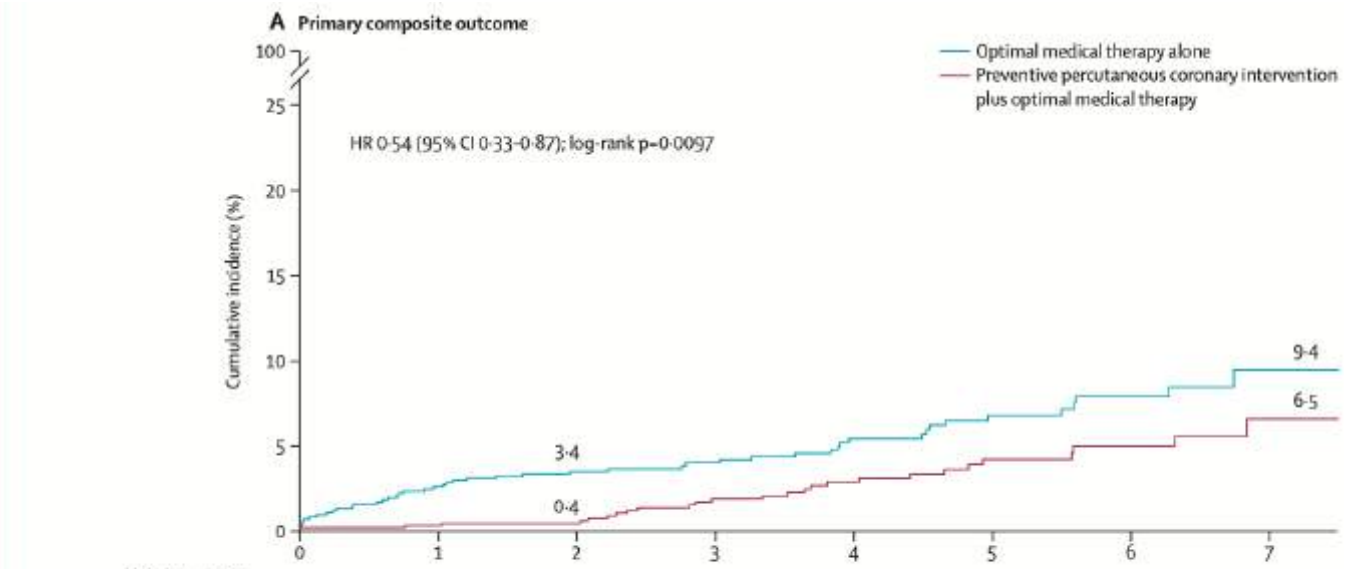
Number at risk:

BMS	3,718	3,506	3,309	2,984	2,811	2,497	2,029	746
DES1	7,934	7,543	7,403	7,112	6,707	5,595	3,688	1,757
DES2	13,380	13,003	12,853	12,502	11,998	11,080	5,848	3,523

Madhavan et al. J Am Coll Cardiol 2020;75:590–604

PREVENT trial, 1,606 pt single RCT:

Rate of MACE after 2nd gen DES at **2 years**: **0.4%**



Number at risk (number censored)								
Optimal medical therapy alone	803 (0)	765 (18)	710 (68)	544 (233)	432 (344)	308 (469)	198 (580)	61 (727)
Preventive percutaneous coronary intervention plus optimal medical therapy	803 (0)	792 (9)	745 (55)	570 (221)	450 (337)	320 (464)	198 (589)	77 (712)

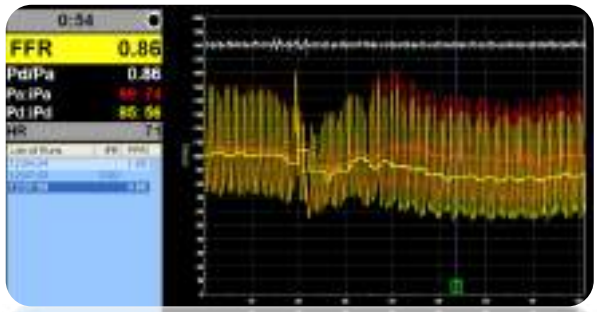
Park et al. Lancet 2025. Volume 403, Issue 10438, 4–10 May 2024, Pages 1753-1765

Functional assessment of coronary artery disease

1980

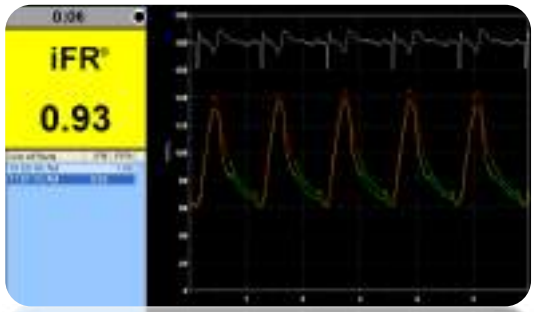
Angiography

1993



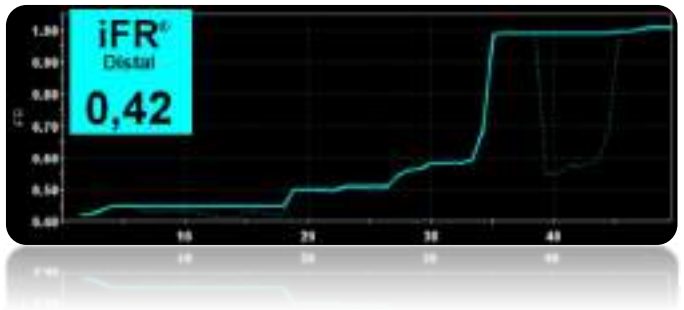
Hyperemic indices

2017



Baseline indices

2018

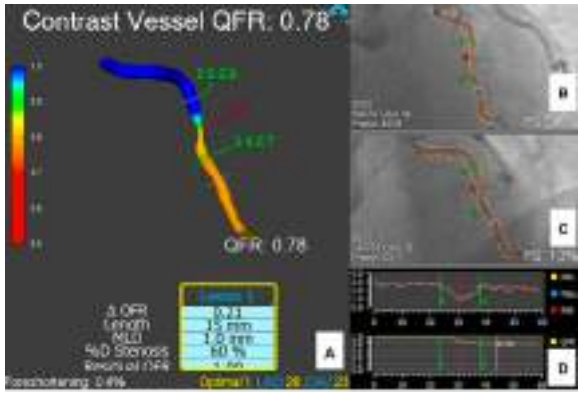


Pullback curves

2019

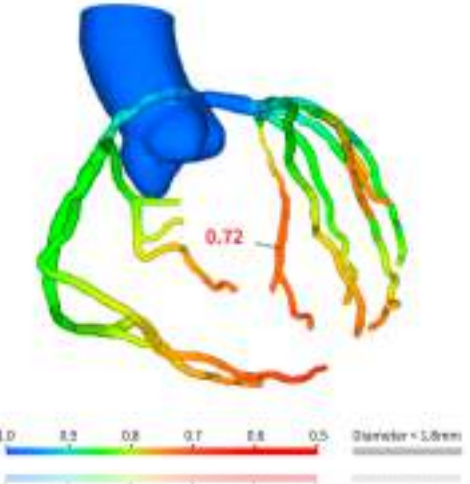
Corregistration

2022



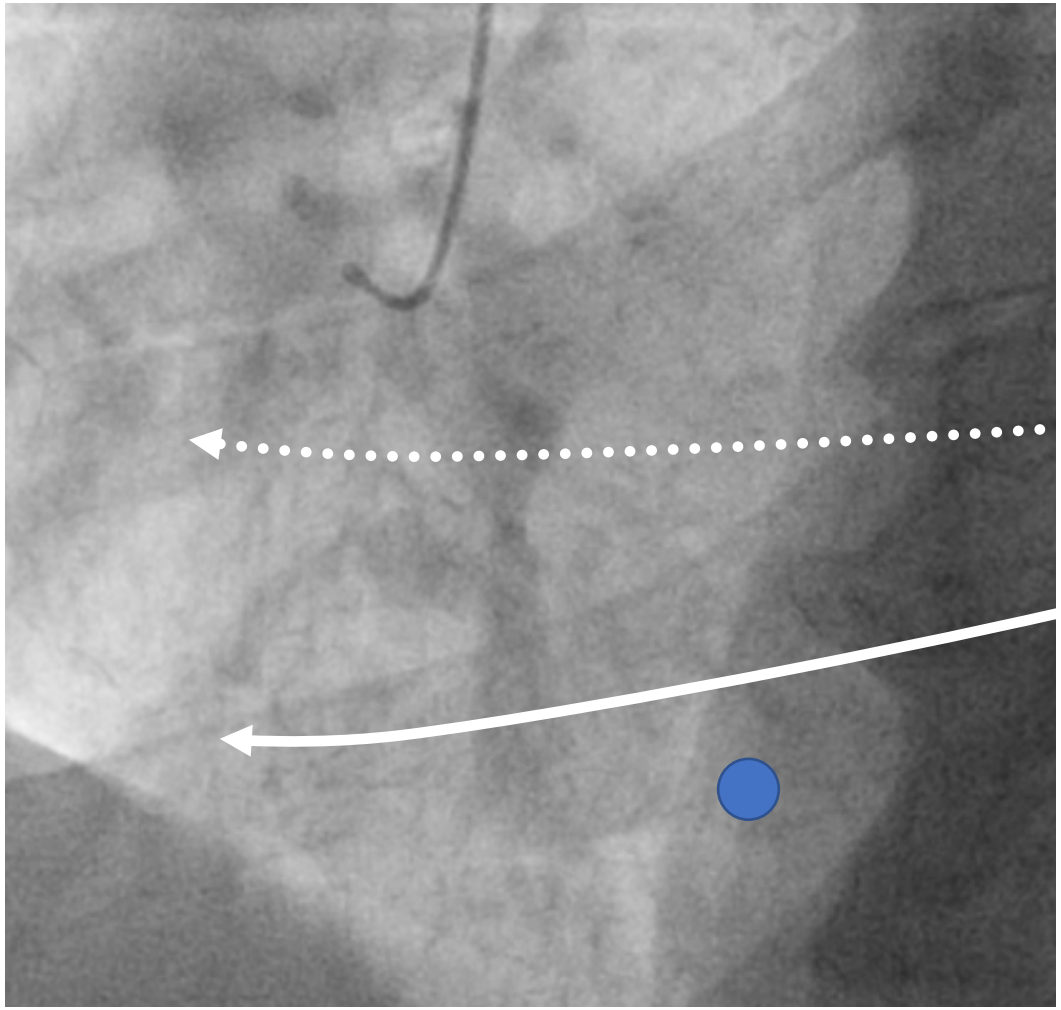
Indices derived from angiography

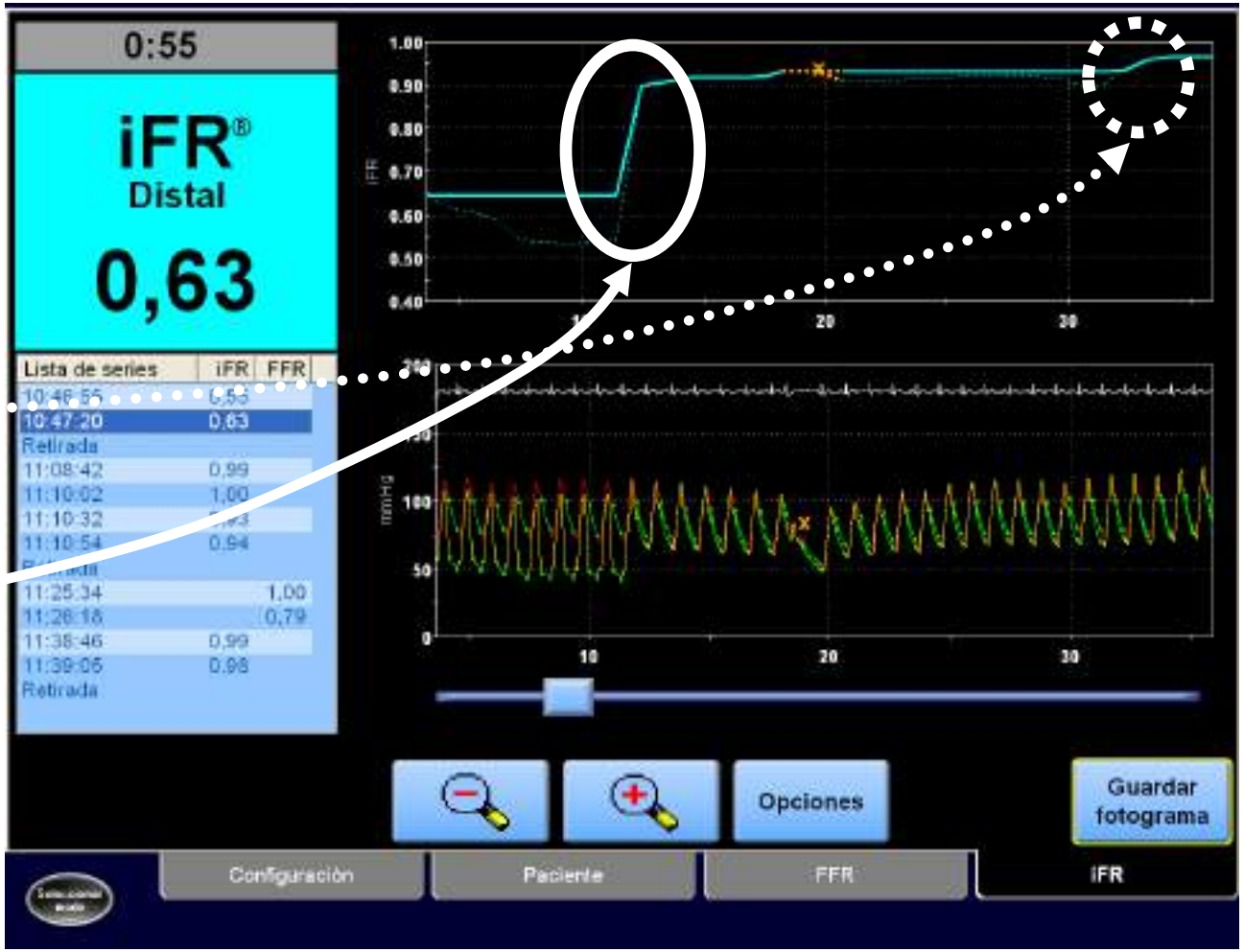
2022



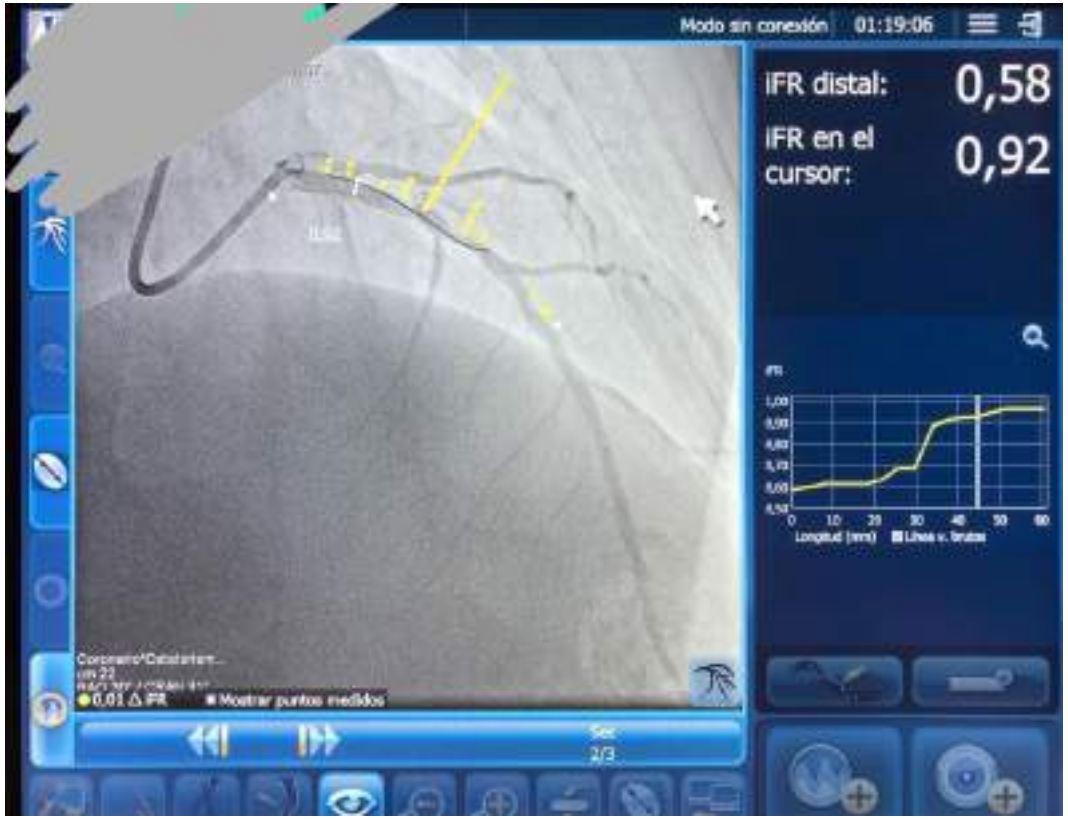
Indices derived from CT

Functional assessment of coronary artery disease





Precise identification of the pattern and location of the pressure loss



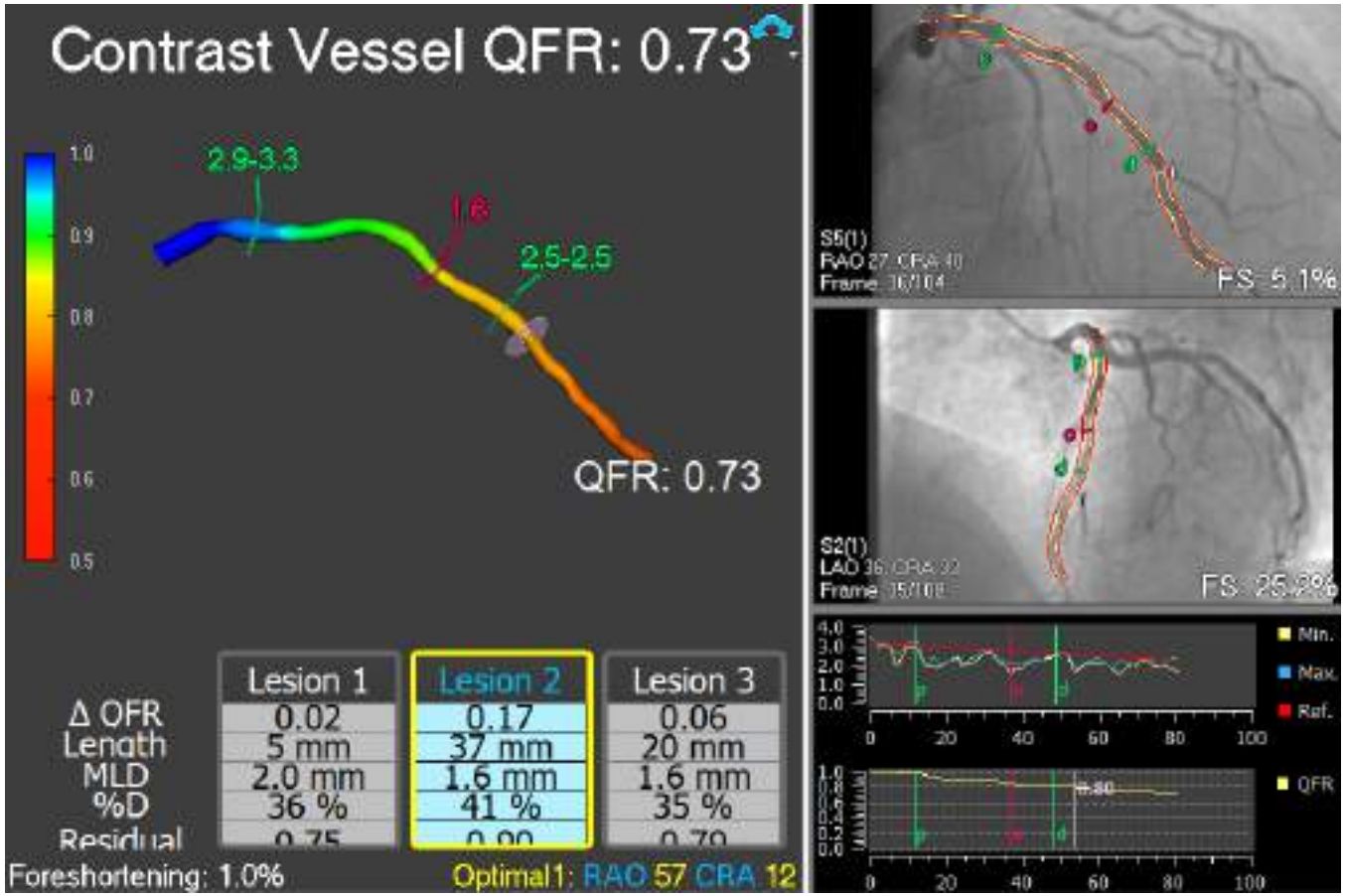
DIFFUSE

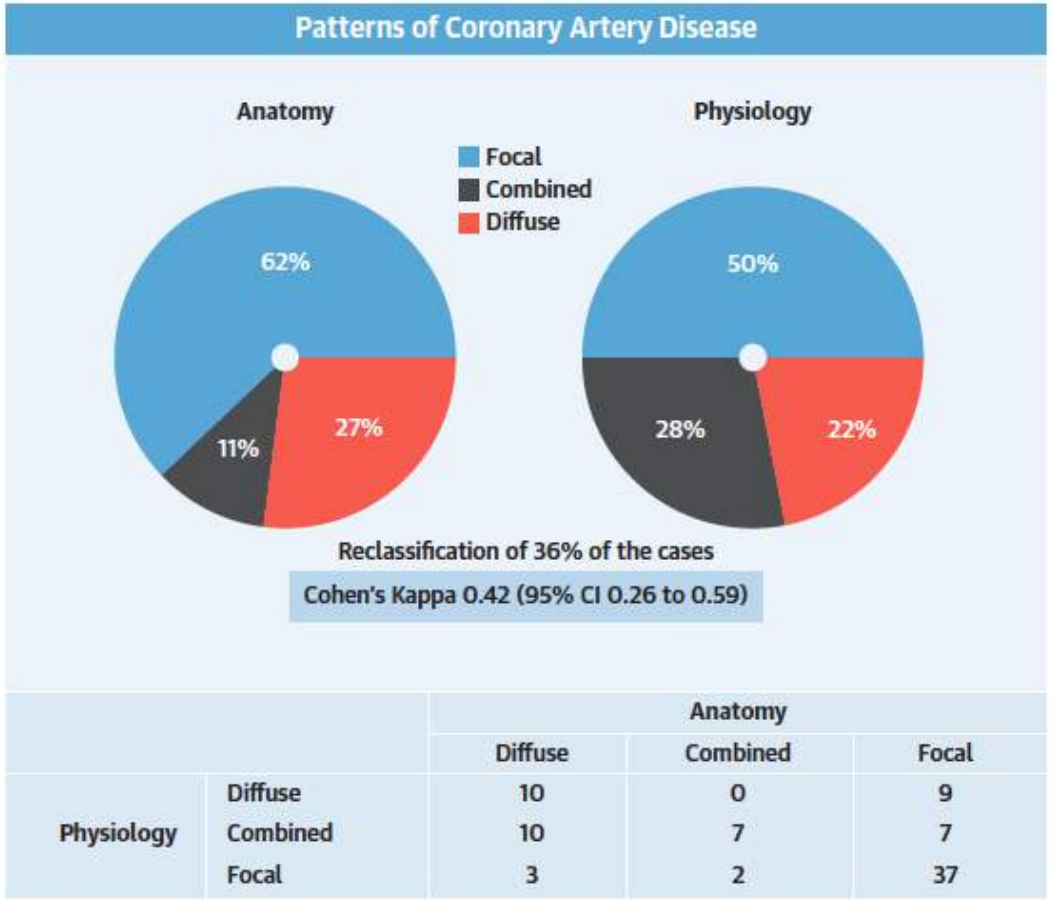
- Diffuse atheroma
- Often no clear landing zone
- Likely small increase in flow

FOCAL

- Focal atheroma
- Often clear landing zone
- Likely large increase in flow

Diffuse epicardial disease: frequent and frustrating entity to treat

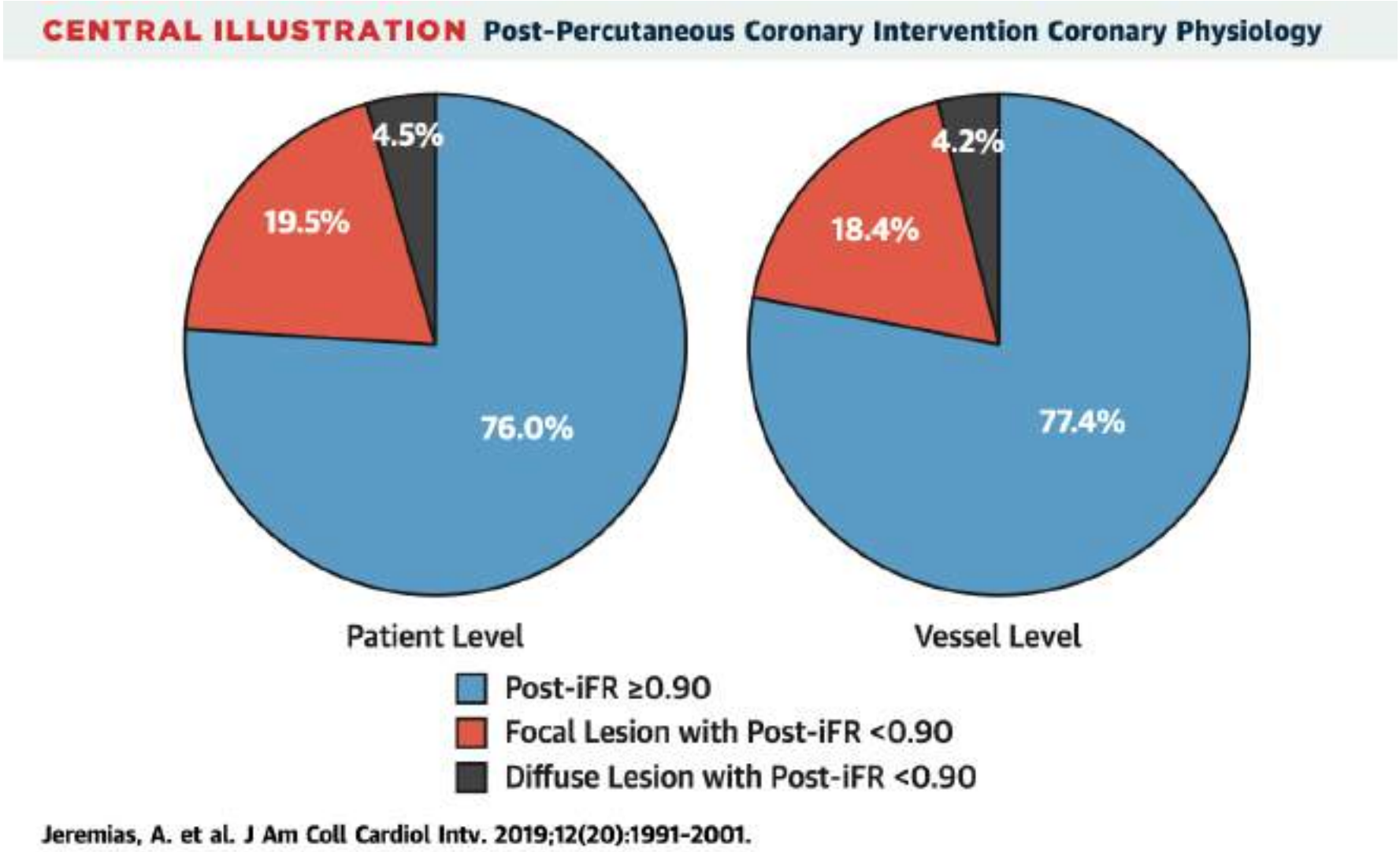




		Anatomy		
		Diffuse	Combined	Focal
Physiology	Diffuse	10	0	9
	Combined	10	7	7
	Focal	3	2	37

Collet C et al. J Am Coll Cardiol 2019;74:1772–84

Blinded iFR pullback post-PCI: Define PCI study, n=562 vessels



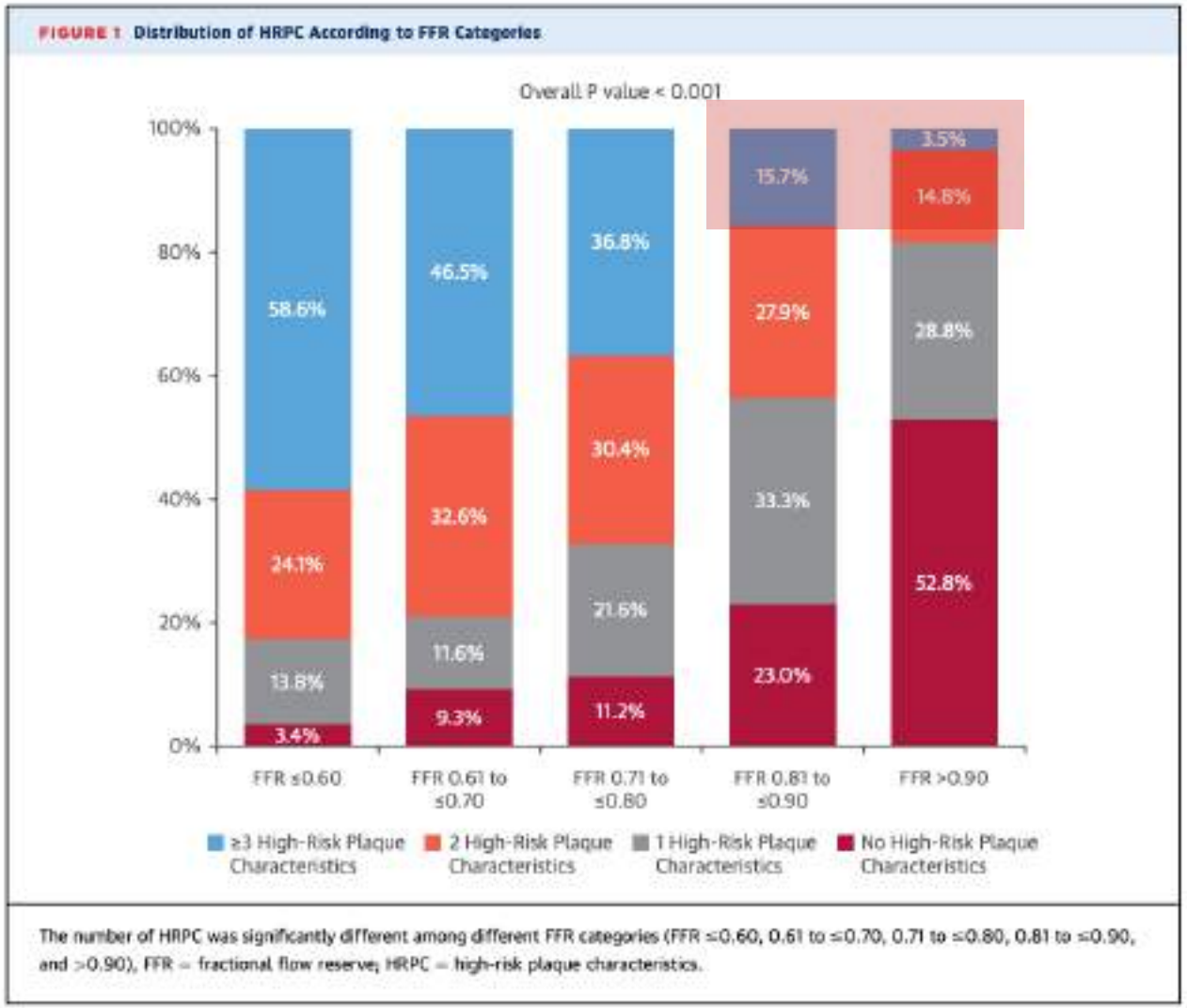
Jeremias A. et al. J Am Coll Cardiol Intv 2019;12:1991–2001

Vulnerable plaques by CT and FFR are very closely related

3V FFR Friends, n=772 vessels evaluated

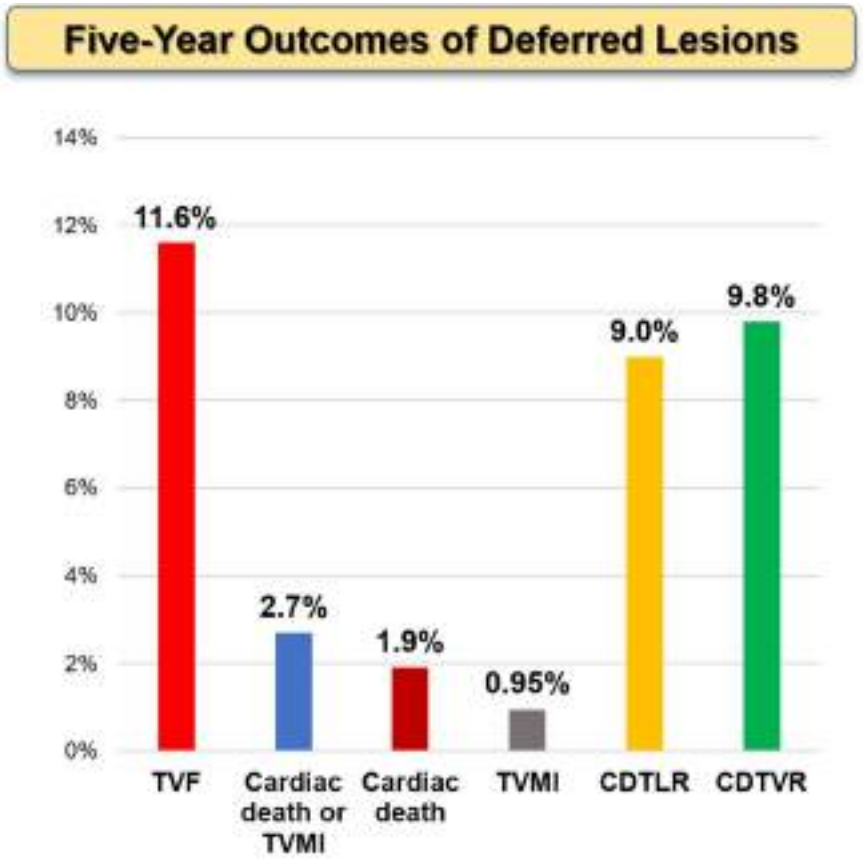
High-Risk Plaque Characteristics

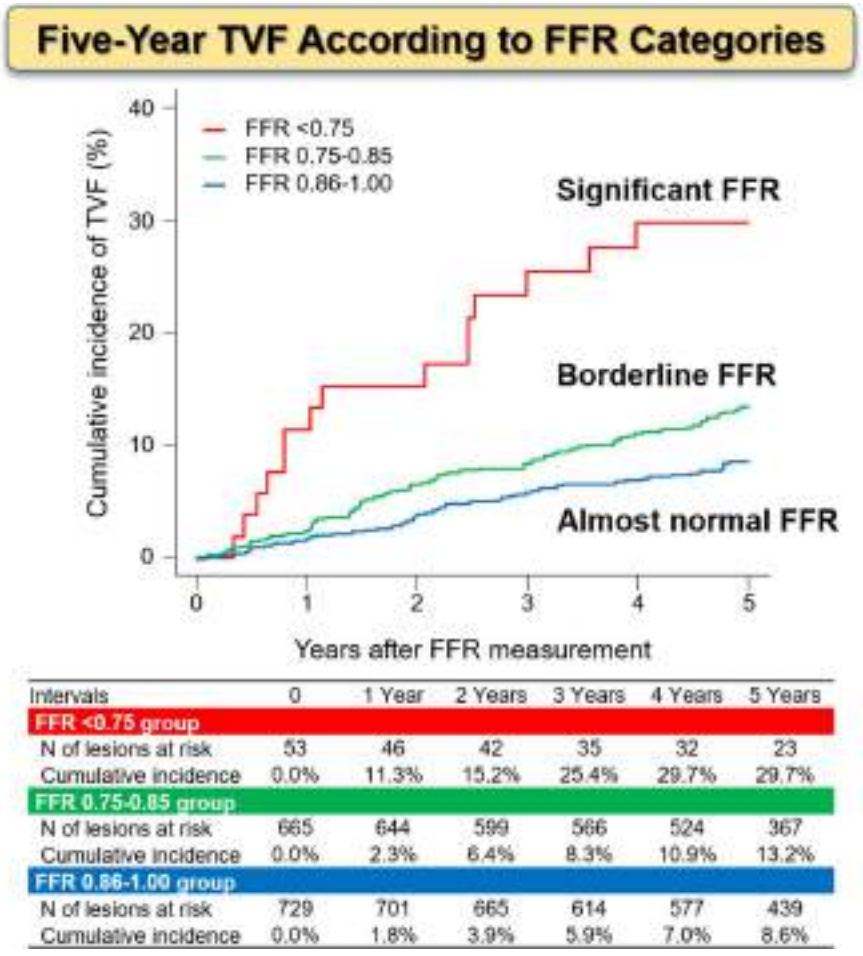
- Minimum lumen area <4 mm^2
- Plaque burden ≥70%
- Low attenuating plaque
- Positive remodeling
- Napkin-ring sign
- Spotty calcification



Lee J et al. J Am Coll Cardiol 2019;73:2413–24

FFR-deferral and adverse events: J-Confirm Registry, 1,447 lesions from 1,263 pt from 23 centers in Japan



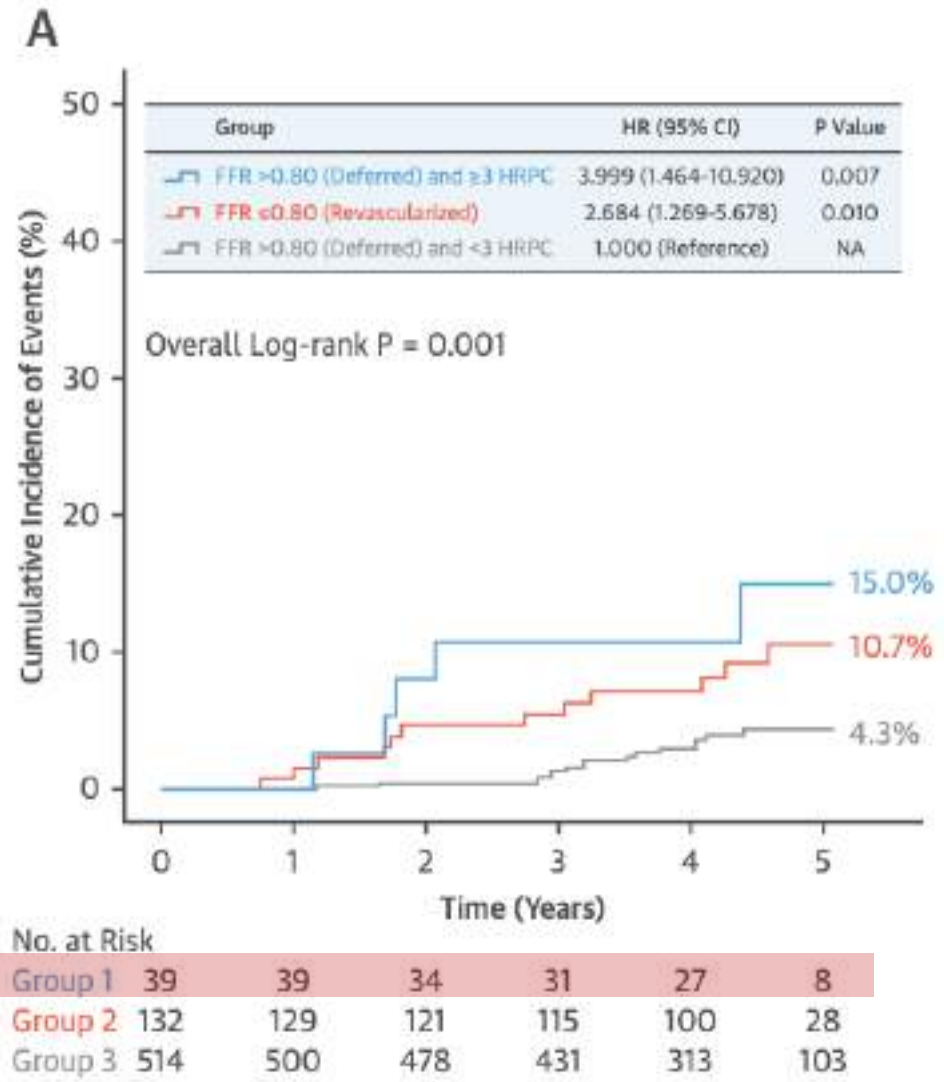


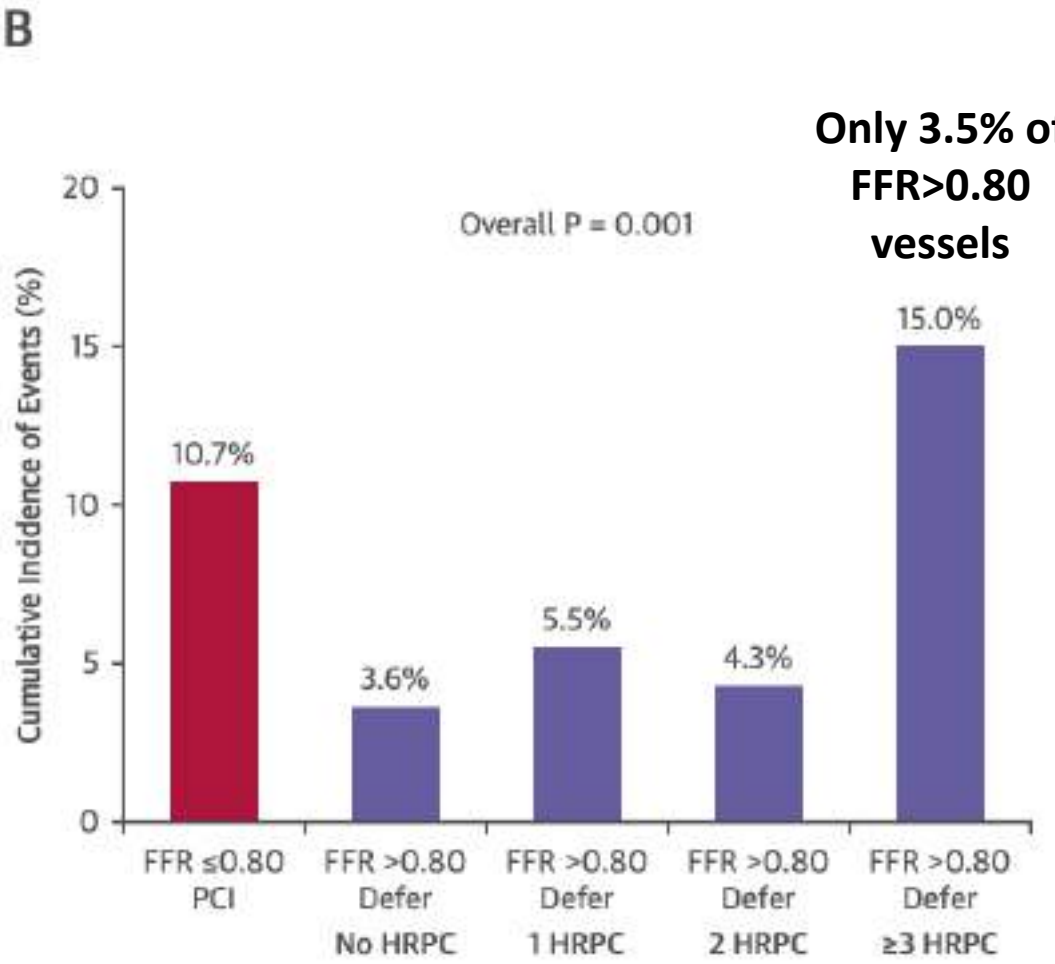
Intervals	0	1 Year	2 Years	3 Years	4 Years	5 Years
FFR <0.75 group						
N of lesions at risk	53	46	42	35	32	23
Cumulative incidence	0.0%	11.3%	15.2%	25.4%	29.7%	29.7%
FFR 0.75-0.85 group						
N of lesions at risk	665	644	599	566	524	367
Cumulative incidence	0.0%	2.3%	6.4%	8.3%	10.9%	13.2%
FFR 0.86-1.00 group						
N of lesions at risk	729	701	665	614	577	439
Cumulative incidence	0.0%	1.8%	3.9%	5.9%	7.0%	8.6%

https://doi.org/10.1161/CIRCINTERVENTIONS.119.008355Circulation: Cardiovascular Interventions. 2020;13:e008355

Vulnerable plaques by CT and FFR are very closely related

3V FFR Friends, n=772 vessels evaluated





Only 3.5% of FFR>0.80 vessels

Lee J et al. J Am Coll Cardiol 2019;73:2413–24

Precise identification of the pattern and location of the pressure loss

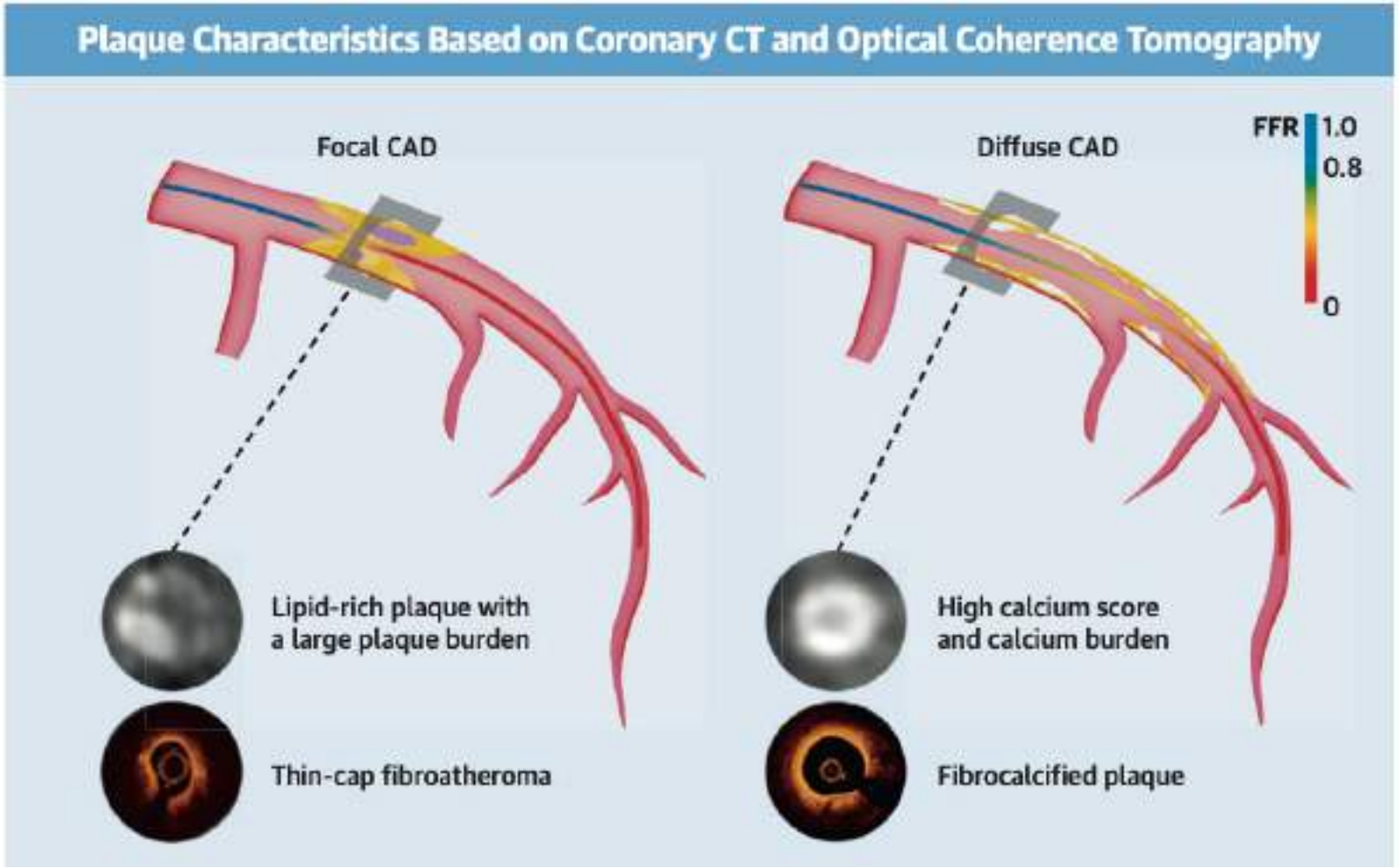
Patients With Hemodynamically Significant Coronary Artery Disease (CAD)

Focal CAD (High PPG)

Diffuse CAD (Low PPG)

Sakai et al. J Am Coll Cardiol Imaging 2023

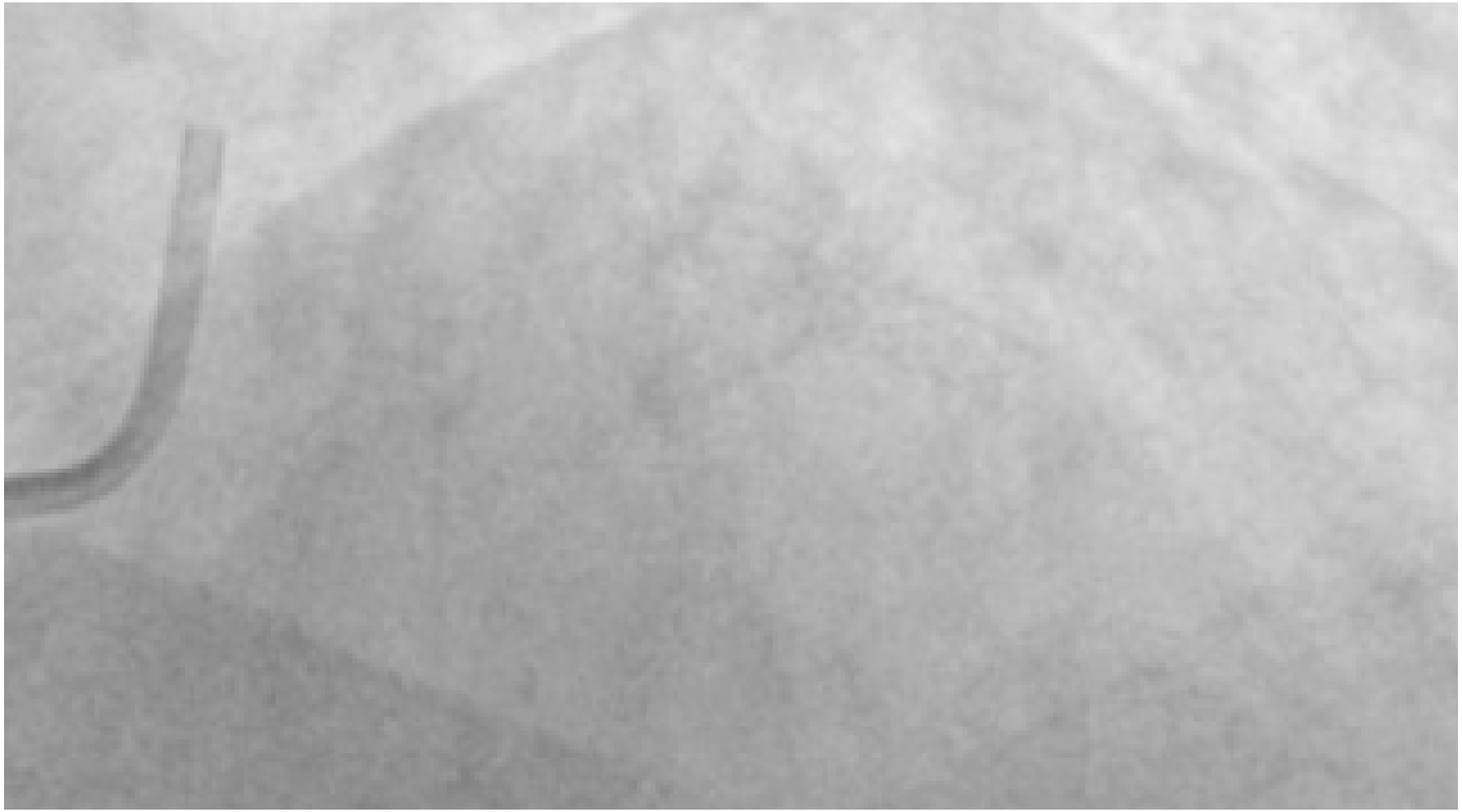
Precise identification of the pattern and location of the pressure loss



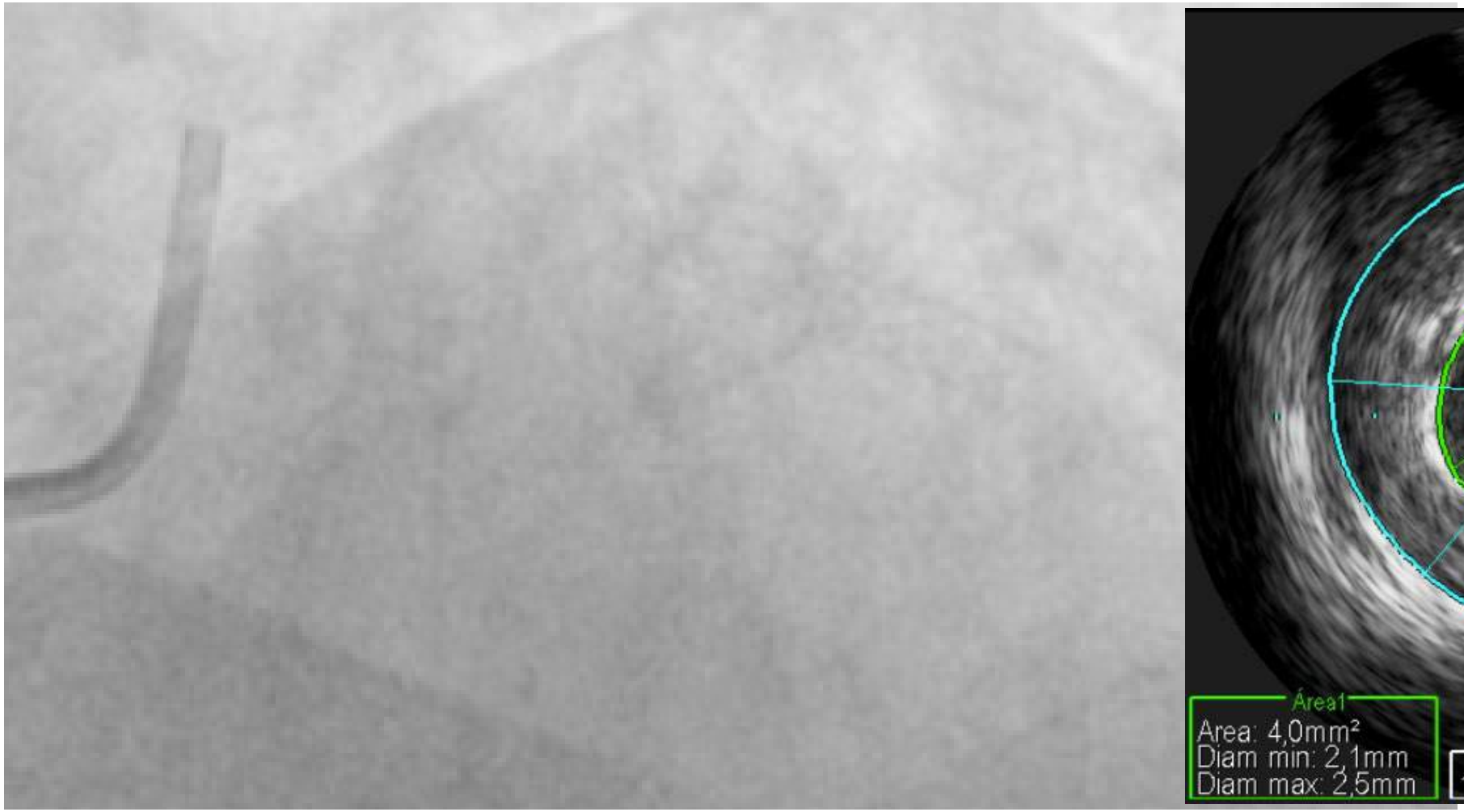
Sakai et al. J Am Coll Cardiol Imaging 2023

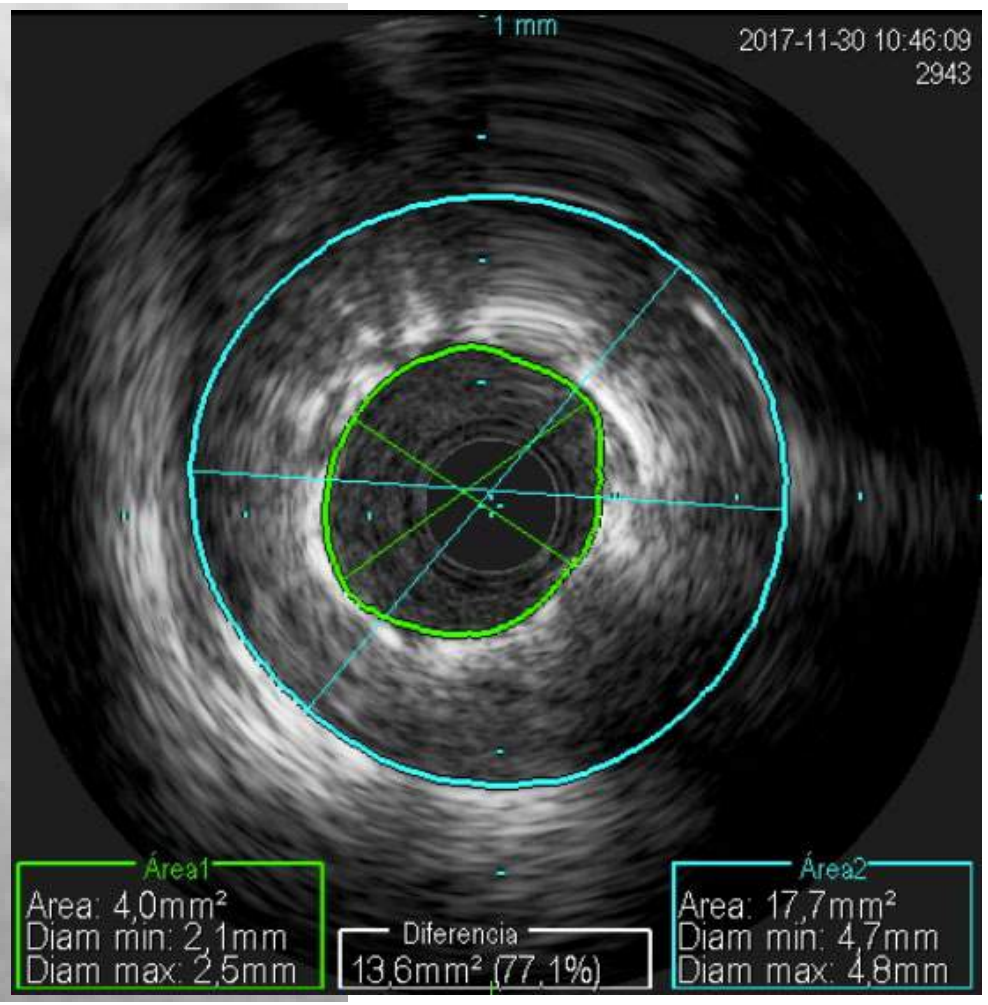
Why imaging?

Is this stent well expanded and apposed?



Is this stent well expanded and apposed?





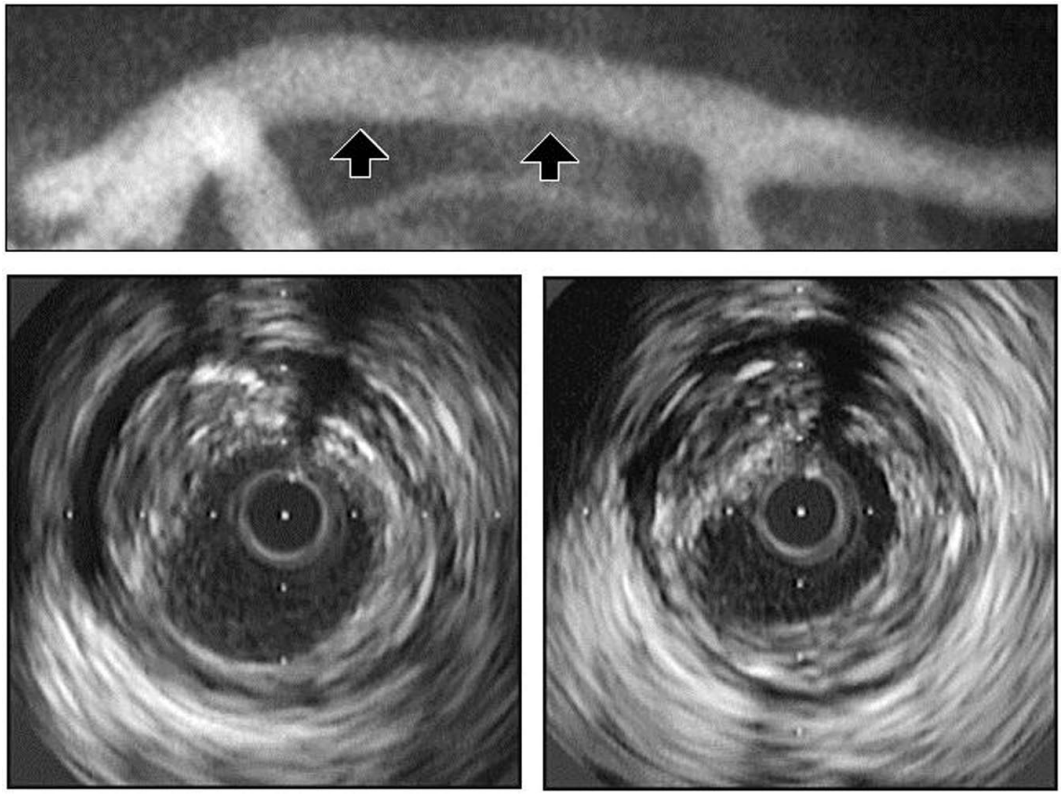
Angiography alone is not good enough…

Limitations of Coronary Angiography: An Underestimated Problem?

Circulation, october, 1982

D. KATRITSIS, M.D., M. WEBB-PEPLOE, M.D., F.R.C.P.

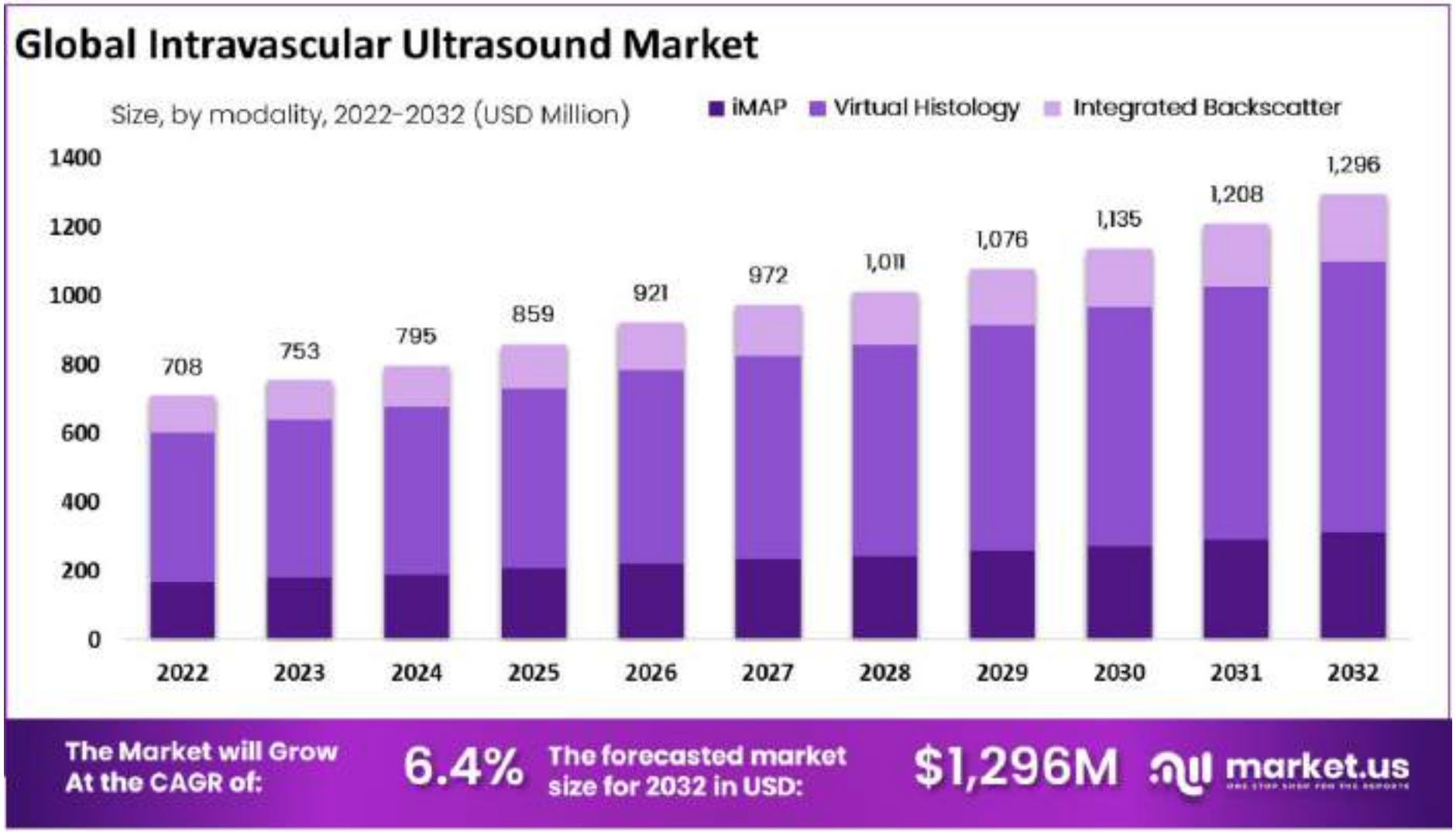
Department of Cardiology, St. Thomas's Hospital, London, England



- **Diagnostic accuracy for coronary plaque**
  - Sensitivity 24-78%
  - Specificity 49-100%
  - Negative predictive value 7-81%

Worldwide use of IVUS is estimated to grow significantly in the next decade

Worldwide use of IVUS is estimated to grow significantly in the next decade



https://www.linkedin.com/pulse/revolutionizing-cardiovascular-care-unveiling-next-frontier-wilcox-b8bwf/

Intravascular Imaging Guidance for PCI:

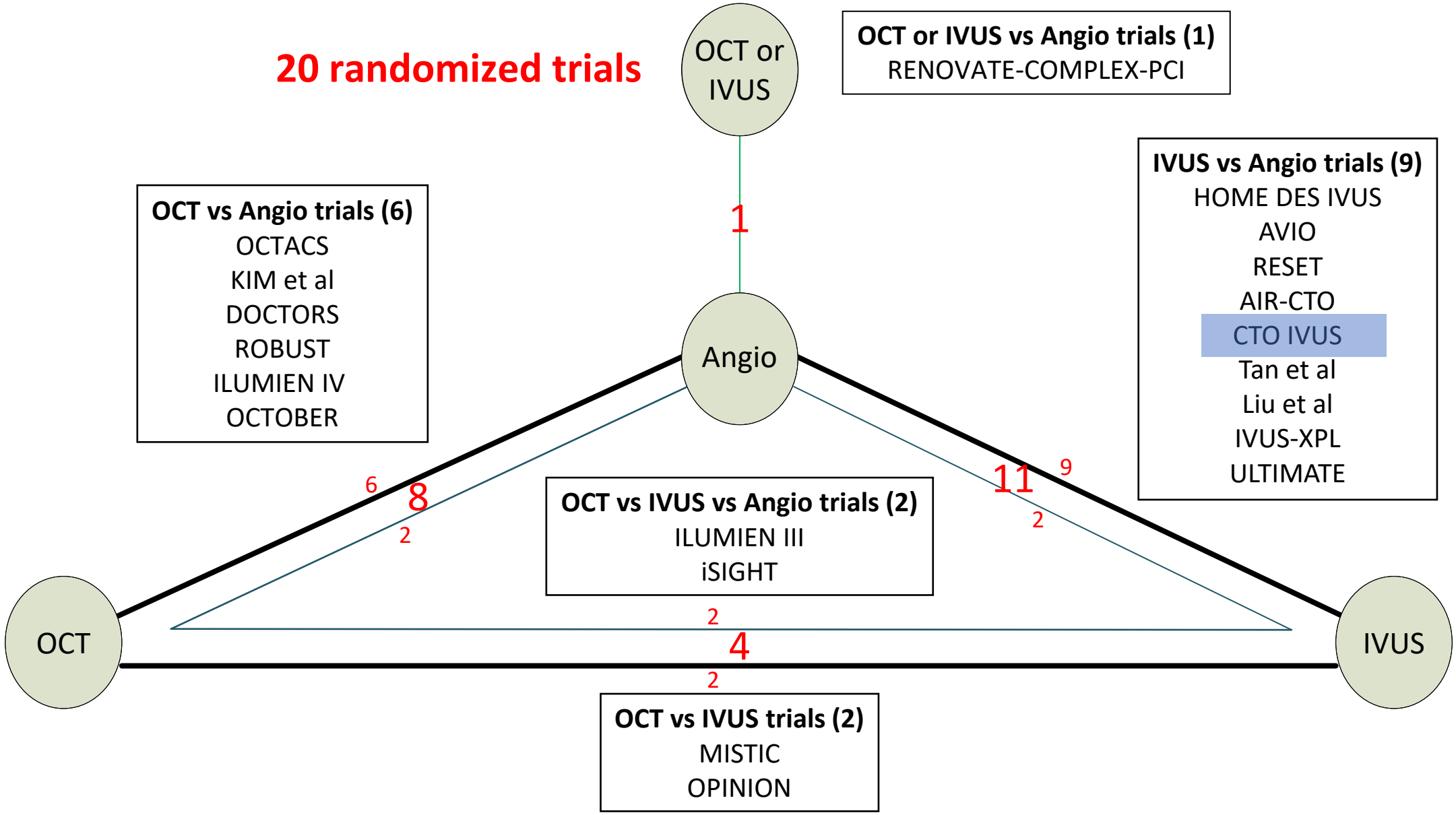
A "Real-Time" Updated Network Meta-analysis

Gregg W. Stone MD

on behalf of

Evald H. Christiansen, Ziad A. Ali, Lene N Andreasen,
Akiko Maehara, Yousif Ahmad, Ulf Landmesser, Niels R. Holm

Nodal Map of Direct Relationships



Network Evidence: All Outcomes

IVI-guided (OCT or IVUS) PCI vs Angiography-guided PCI

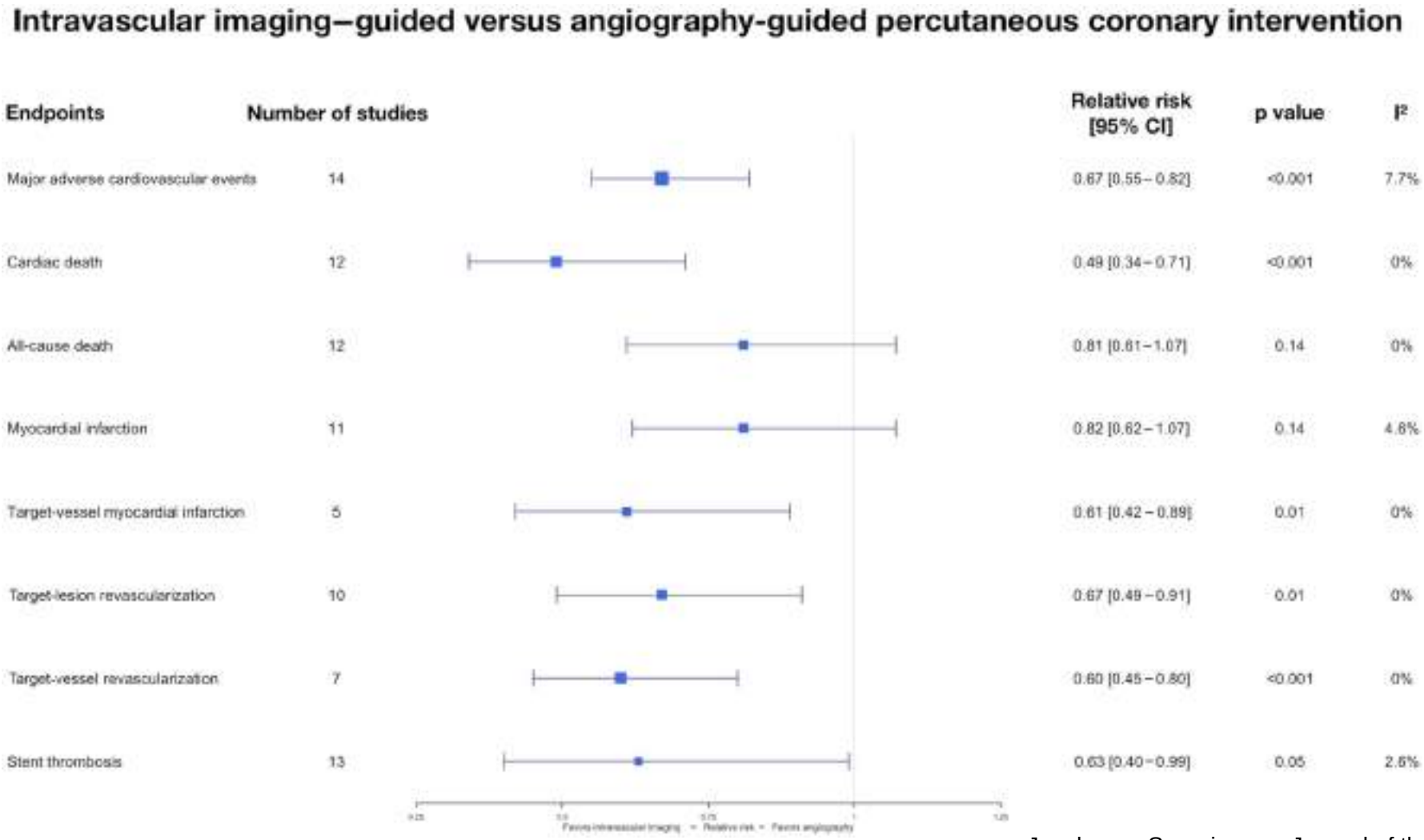
Outcome	N trials	N pts	N events	Direct estimate	% evidence	Indirect estimate	% evidence	Network estimate
TLF	18	11,502	963	0.69 [0.61, 0.78]	100	-	-	**0.69 [0.61, 0.78]**
- Cardiac death	17	11,385	174	0.54 [0.40, 0.74]	100	-	-	**0.54 [0.40, 0.74]**
- TV-MI	17	11,385	393	0.80 [0.66, 0.97]	100	-	-	**0.80 [0.66, 0.97]**
- TLR	17	11,417	497	0.71 [0.59, 0.85]	100	-	-	**0.71 [0.59, 0.85]**
Stent thrombosis	17	11,385	89	0.48 [0.31, 0.76]	100	-	-	**0.48 [0.31, 0.76]**
All-cause death	17	11,385	318	0.75 [0.60, 0.93]	100	-	-	**0.75 [0.60, 0.93]**
All MI	17	11,385	480	0.82 [0.69, 0.98]	100	-	-	**0.82 [0.69, 0.98]**
TVR	17	11,417	589	0.71 [0.61, 0.84]	100	-	-	**0.71 [0.61, 0.84]**

Conclusions

The present network meta-analysis from 20 RCTs in 12,428 pts with follow-up ranging from 6-60 months demonstrates that:

- Compared with angiography-guided PCI, IVI-guided PCI with OCT or IVUS reduces **TLF by 31%**, driven by 46%, 20%, and 29% reductions in cardiac death, TV-MI, and TLR respectively
- IVI-guided PCI also reduces **stent thrombosis by 52%**, all MI by 18%, and **all-cause death by 25%**
- Outcomes were similar for OCT-guided PCI and IVUS-guided PCI

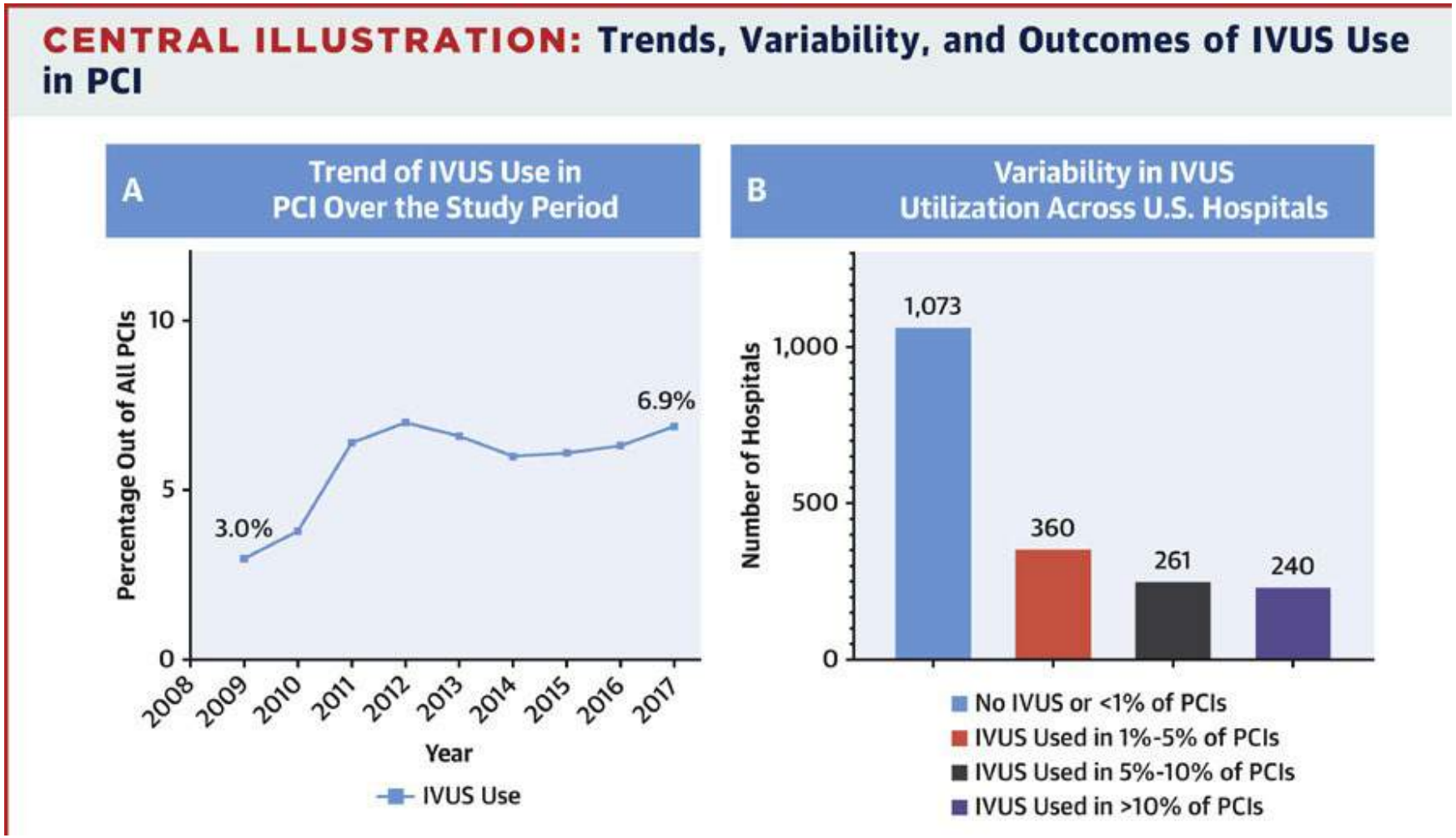
Angio-guided vs IVUS-guided meta-analysis of all RCT trials



Jayakumar Sreenivasan. Journal of the American Heart Associatio Intravascular Imaging–Guided Versus Angiography-Guided Percutaneous Coronary Intervention: A Systematic Review and Meta-Analysis of Randomized Trials, Volume: 13, Issue: 2, DOI: (10.1161/JAHA.123.031111)

Still and in spite of all the positive evidence, IVUS use remains low

IVUS was used in 5.6% of all PCI patients from US (n: 1,877,177 pt)



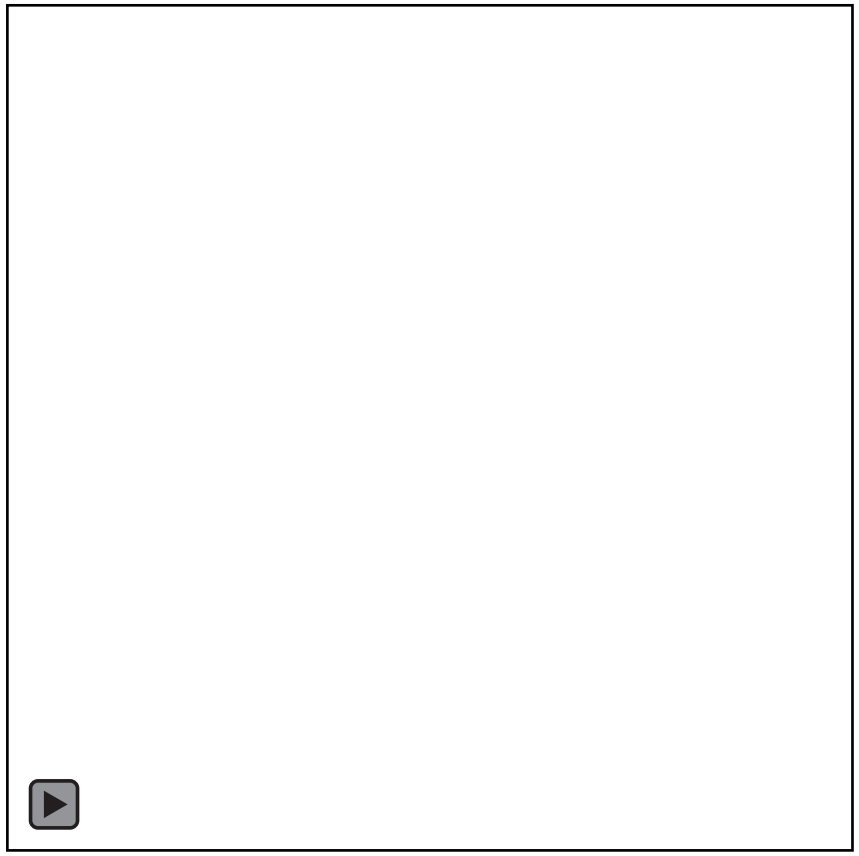
Mentias A. J Am Coll Cardiol Intv 2020;13:1880–90

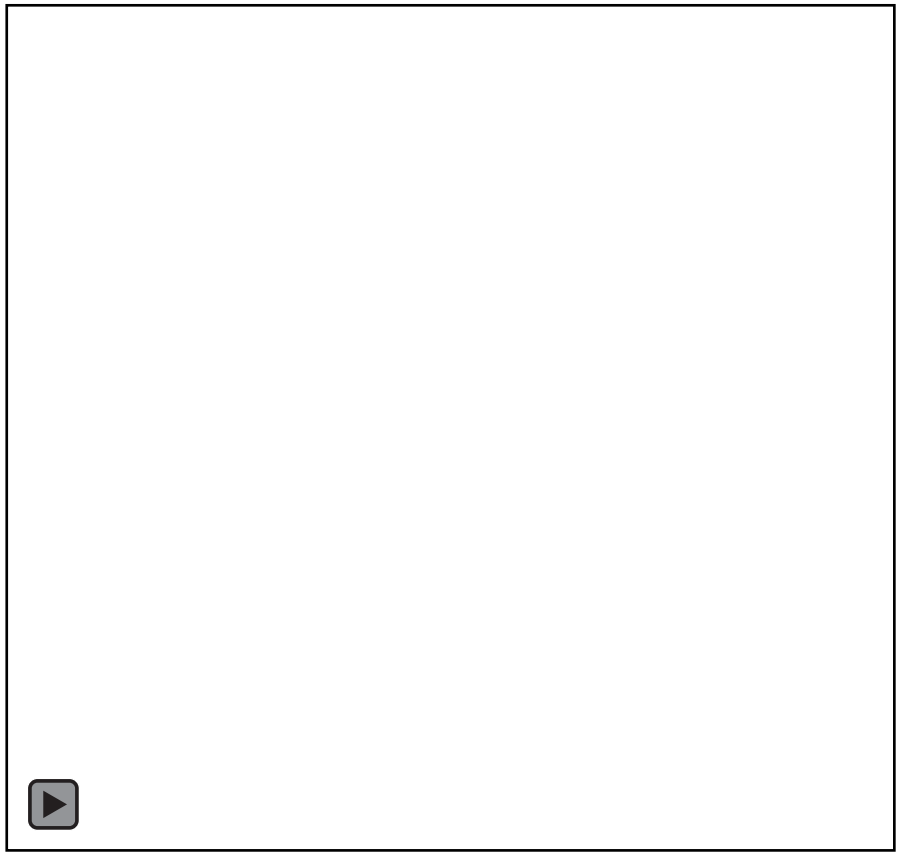
Modern PCI: complex and precise at the same time

Modern PCI following SYNTAX II strategy

- Male 72 yo
- Diabetes and hypertension
- CCS 2 angina

- Normal baseline echo
- Anterior and inferior ischaemia in stress echo

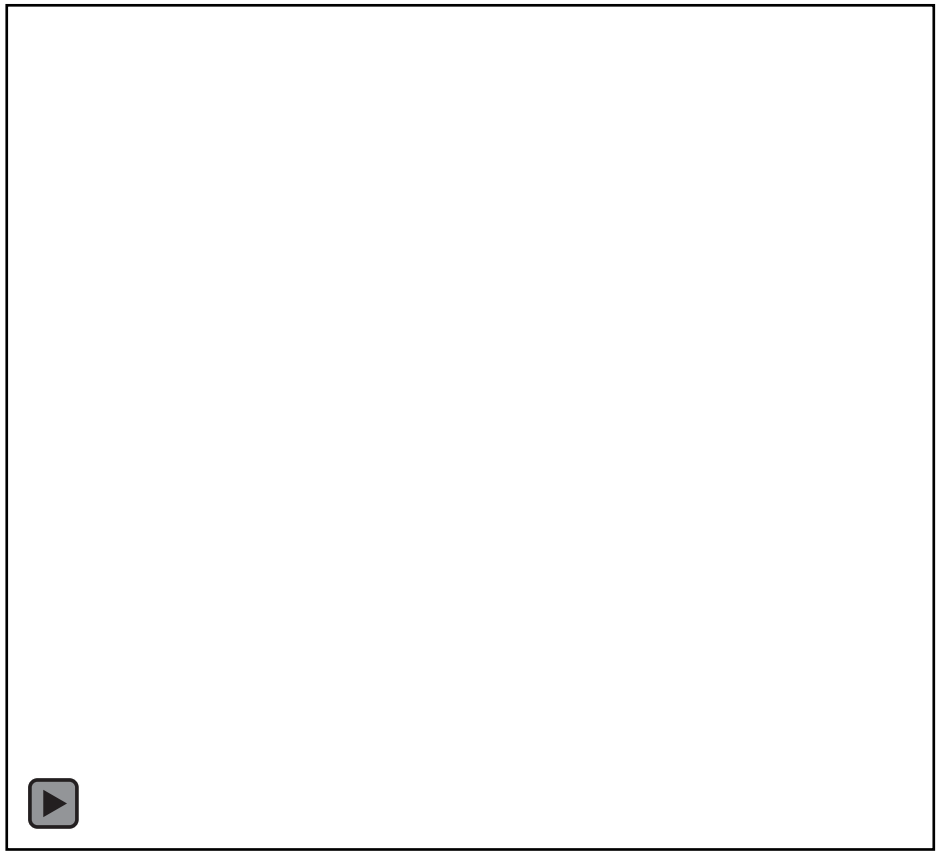




Modern PCI following SYNTAX II strategy

- Male 72 yo
- Diabetes and hypertension
- CCS 2 angina

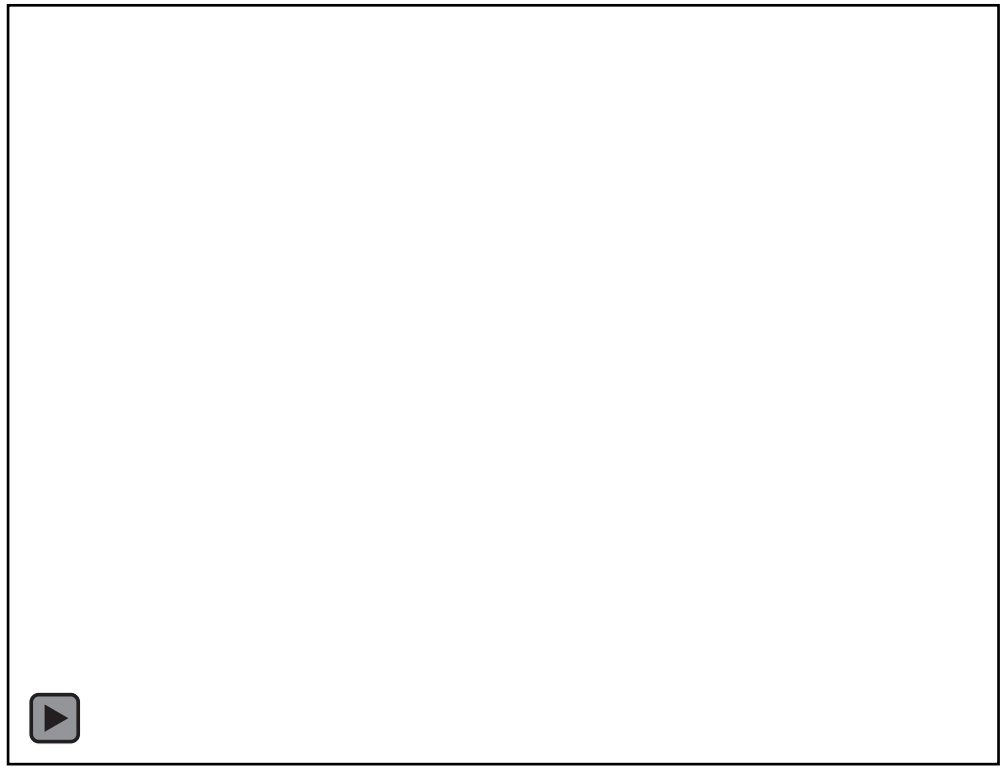
- Normal baseline echo
- Anterior and inferior ischaemia in stress echo

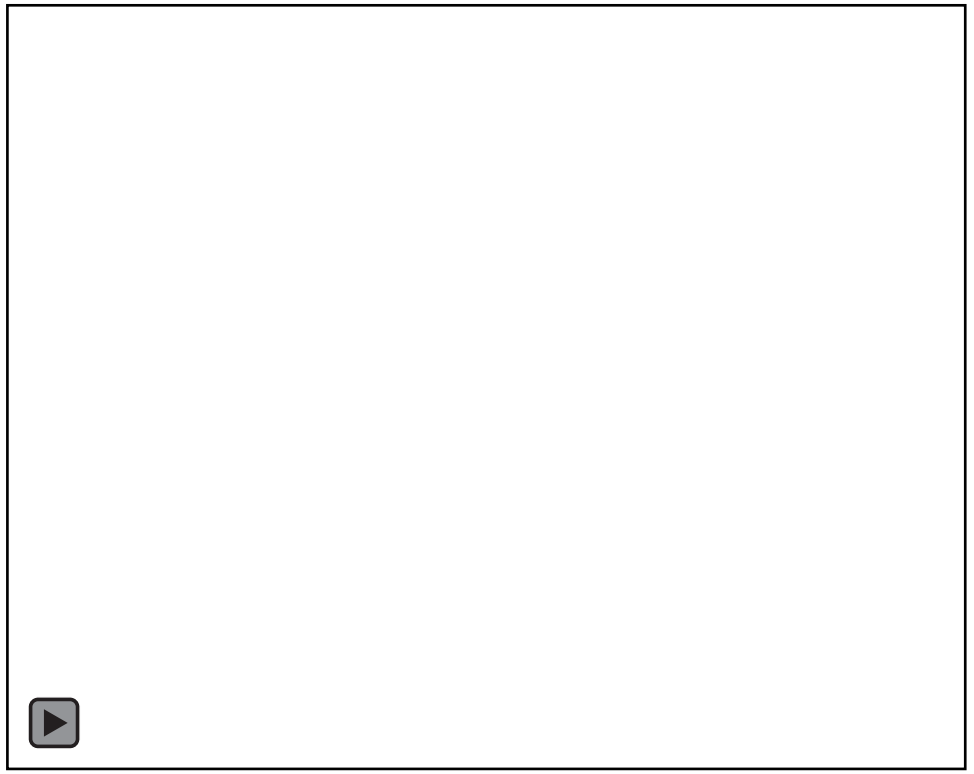


Modern PCI following SYNTAX II strategy

- Male 72 yo
- Diabetes and hypertension
- CCS 2 angina

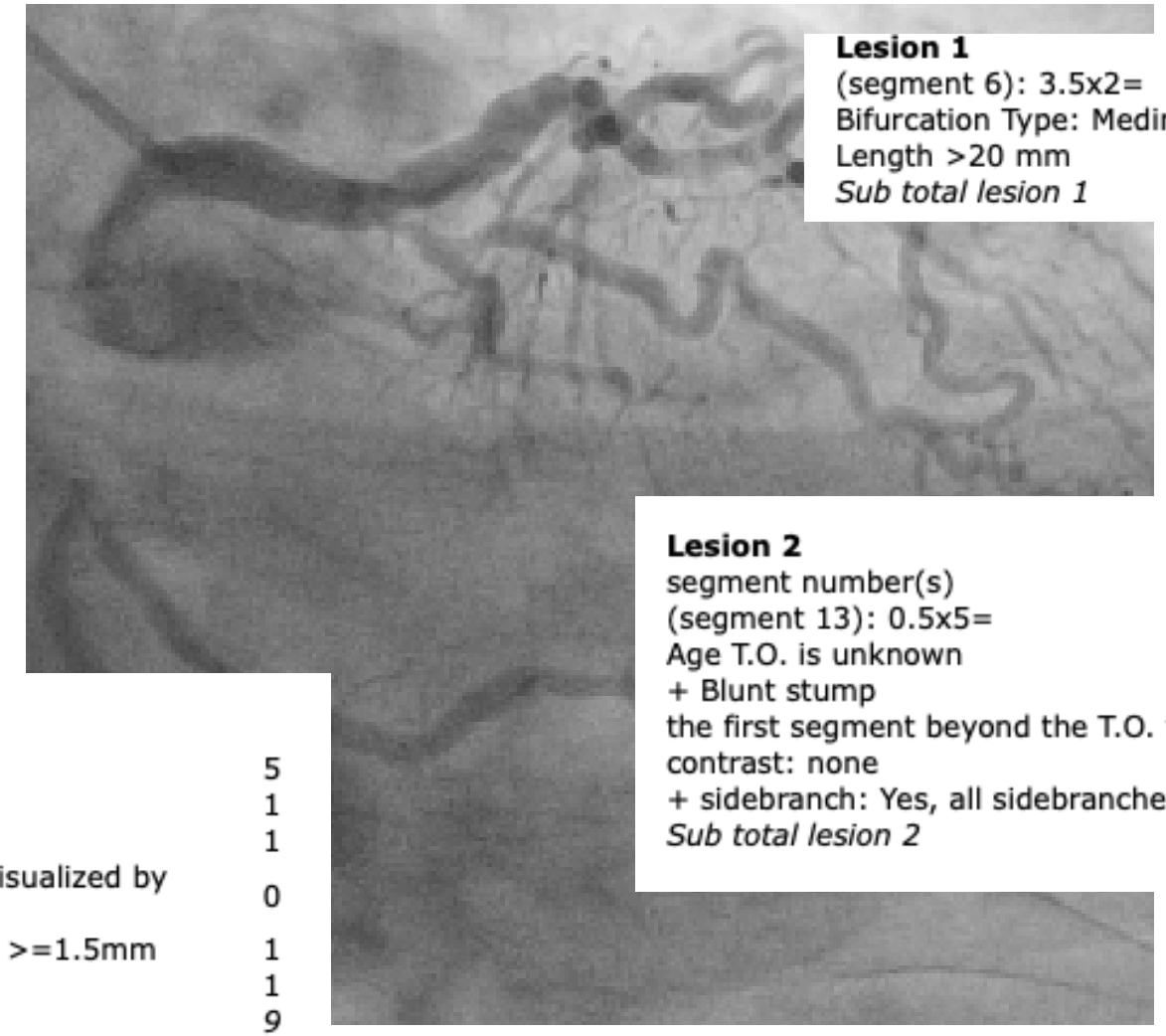
- Normal baseline echo
- Anterior and inferior ischaemia in stress echo





Risk stratification with SYNTAX I and II scores

- SYNTAX score: 25.5
- SYNTAX II score:
  - PCI 4y, mortality: 7.9%
  - CABG 4y, mortality: 7.2%
  - **Recommendation: CABG or PCI**



Lesion 1

(segment 6): 3.5x2=	7
Bifurcation Type: Medina 1,1,1:	2
Length >20 mm	1
Sub total lesion 1	*10*

Lesion 2

segment number(s)	
(segment 13): 0.5x5=	2.5
Age T.O. is unknown	1
+ Blunt stump	1
the first segment beyond the T.O. visualized by contrast: none	1
+ sidebranch: Yes, all sidebranches >=1.5mm	1
Sub total lesion 2	*6.5*

Lesion 3

segment number(s)	
(segment 3): 1x5=	5
Age T.O. is unknown	1
+ Bridging	1
the first segment beyond the T.O. visualized by contrast: 4	0
+ sidebranch: Yes, all sidebranches >=1.5mm	1
Bifurcation Type: Medina 1,0,0:	1
Sub total lesion 3	*9*

TOTAL:	*25.5*

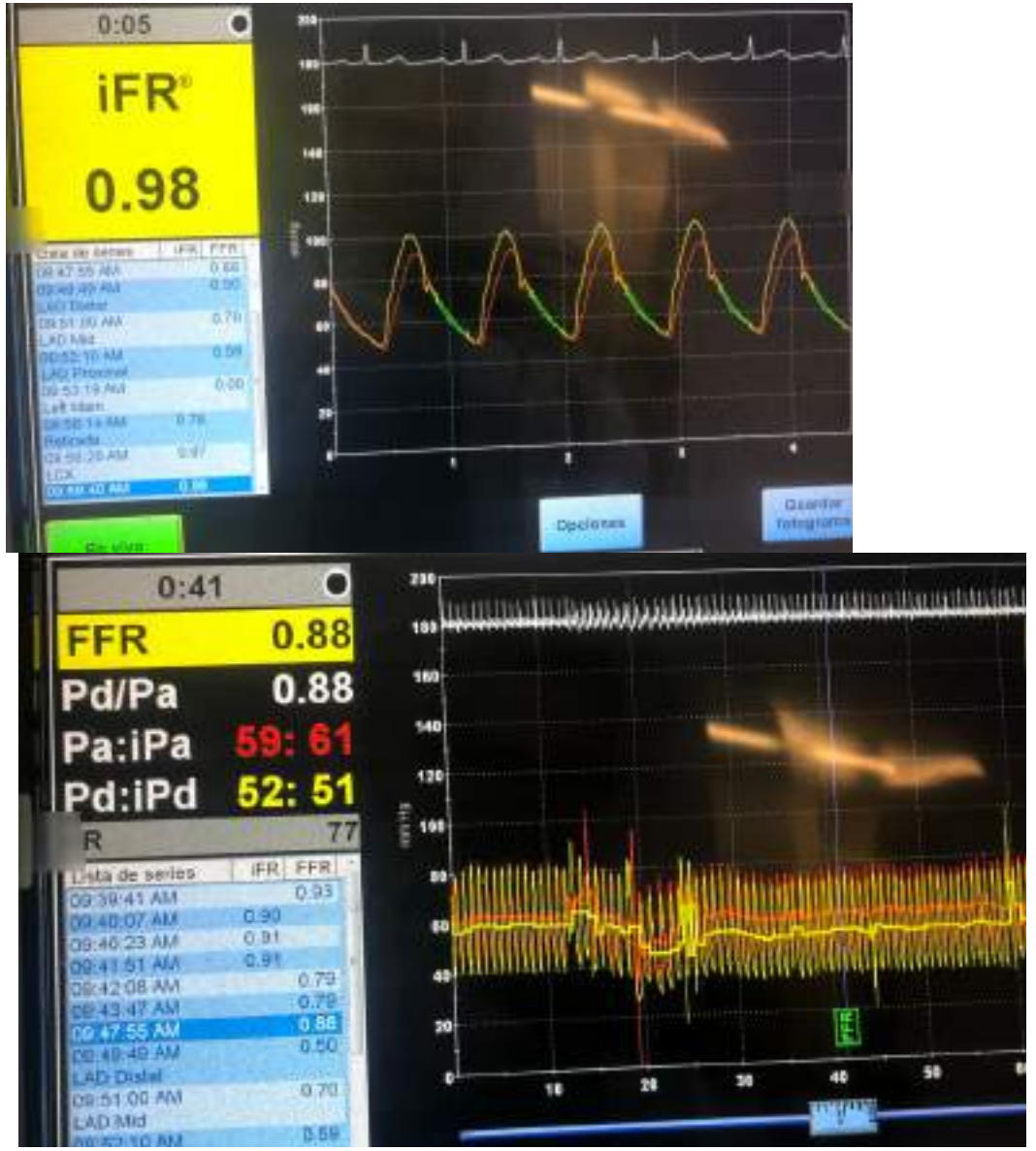
Modern PCI following SYNTAX II strategy

	CABG		PCI	
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

Heart TEAM advised physiological assessment of LAD disease

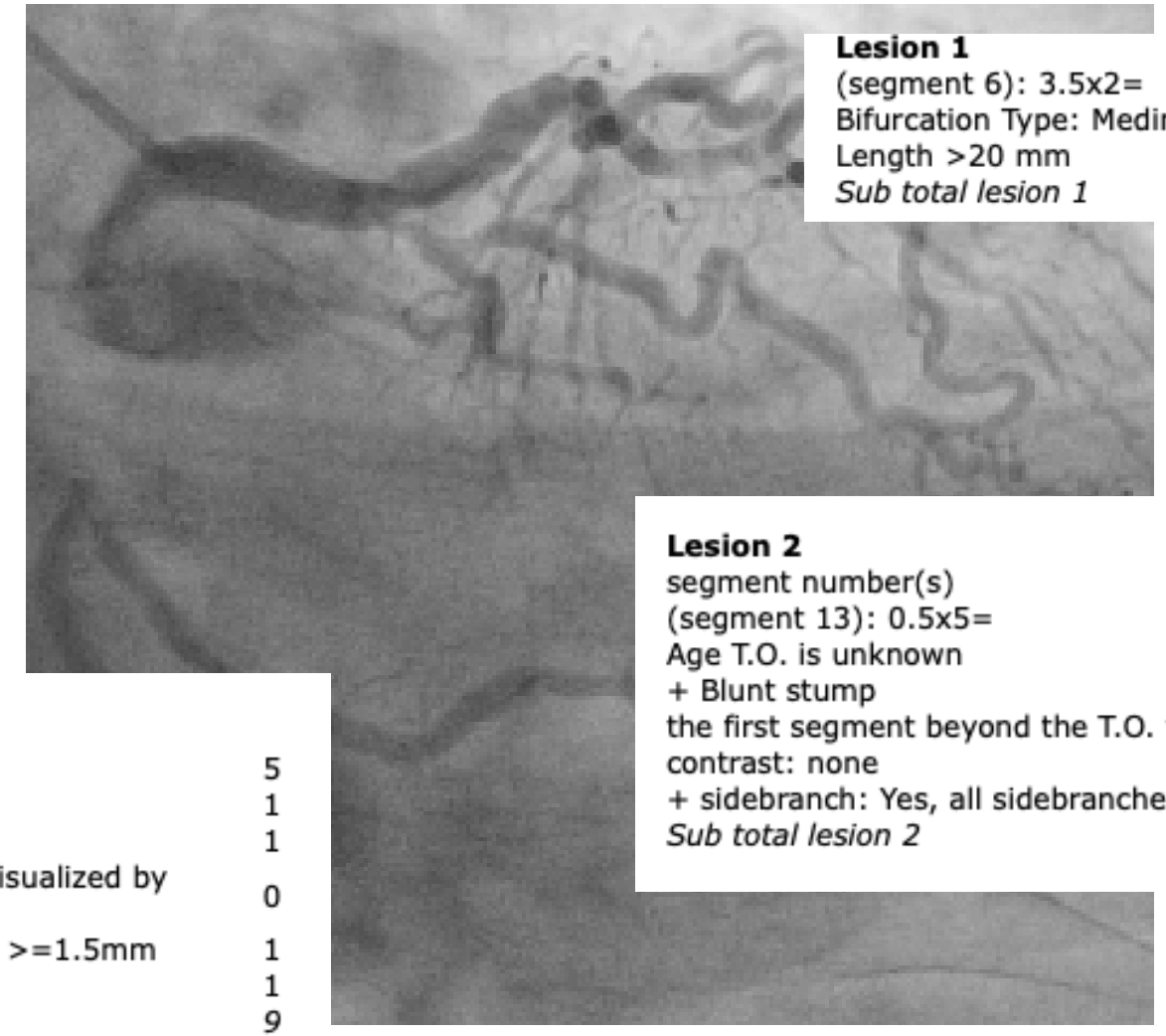
European Heart Journal (2018) 40, 87–165

Physiology assessment of LAD disease



Risk stratification with SYNTAX I and II scores

- SYNTAX score: 25.5
- **Functional SYNTAX score: 15**
- SYNTAX II score:
  - PCI 4y, mortality: 7.9%
  - CABG 4y, mortality: 7.2%
  - Recommendation: CABG or PCI



Lesion 1

(segment 6): 3.5x2=	7
Bifurcation Type: Medina 1,1,1:	2
Length >20 mm	1
Sub total lesion 1	*10*

Lesion 2

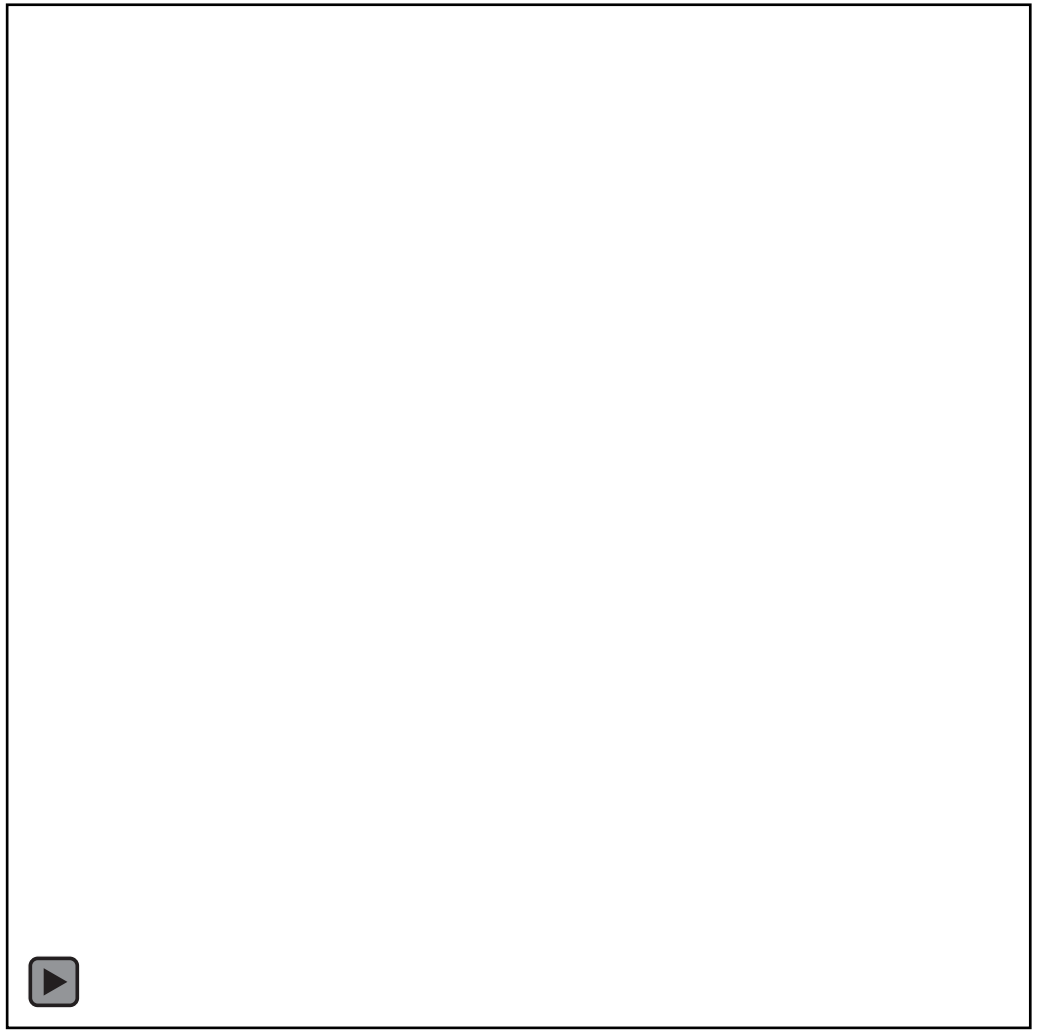
segment number(s)	
(segment 13): 0.5x5=	2.5
Age T.O. is unknown	1
+ Blunt stump	1
the first segment beyond the T.O. visualized by contrast: none	1
+ sidebranch: Yes, all sidebranches >=1.5mm	1
Sub total lesion 2	*6.5*

Lesion 3

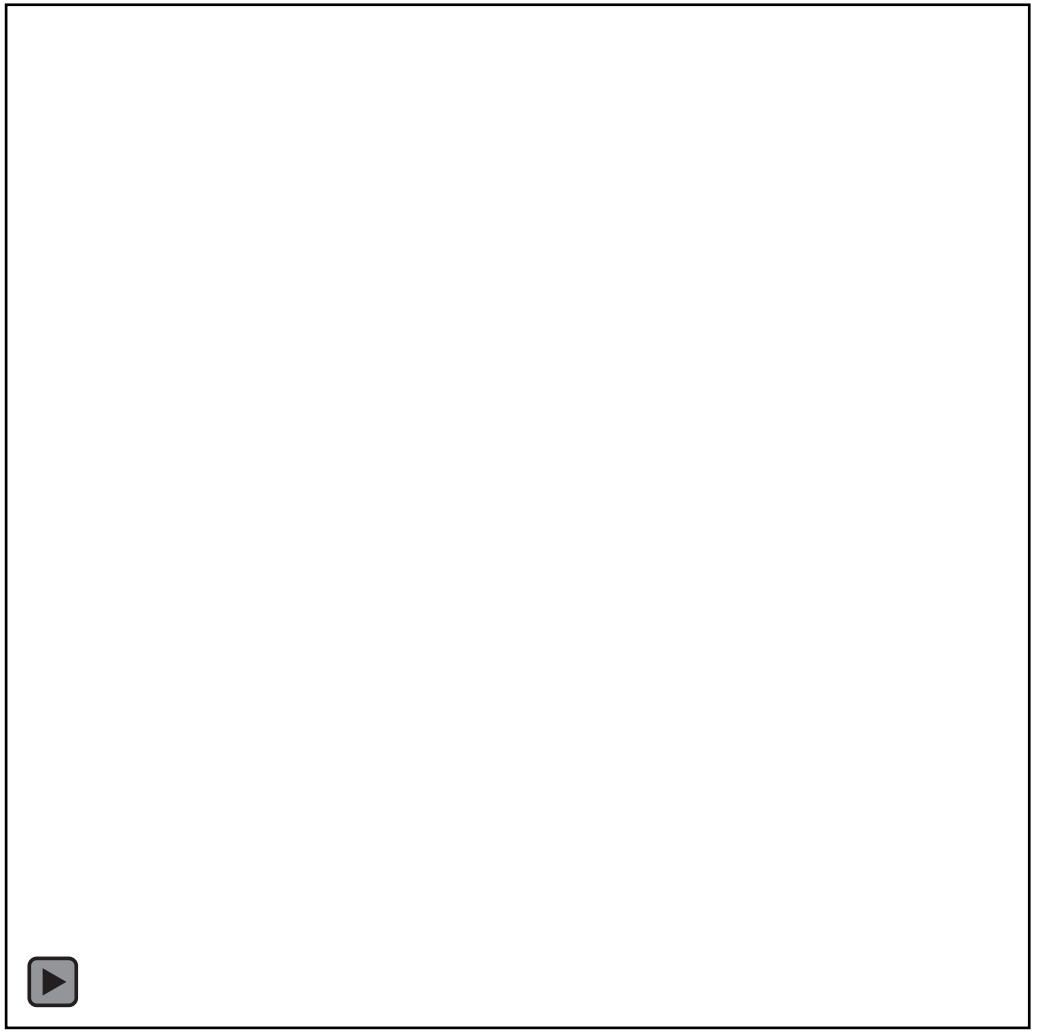
segment number(s)	
(segment 3): 1x5=	5
Age T.O. is unknown	1
+ Bridging	1
the first segment beyond the T.O. visualized by contrast: 4	0
+ sidebranch: Yes, all sidebranches >=1.5mm	1
Bifurcation Type: Medina 1,0,0:	1
Sub total lesion 3	*9*

RCA-CTO PCI, wire escalation

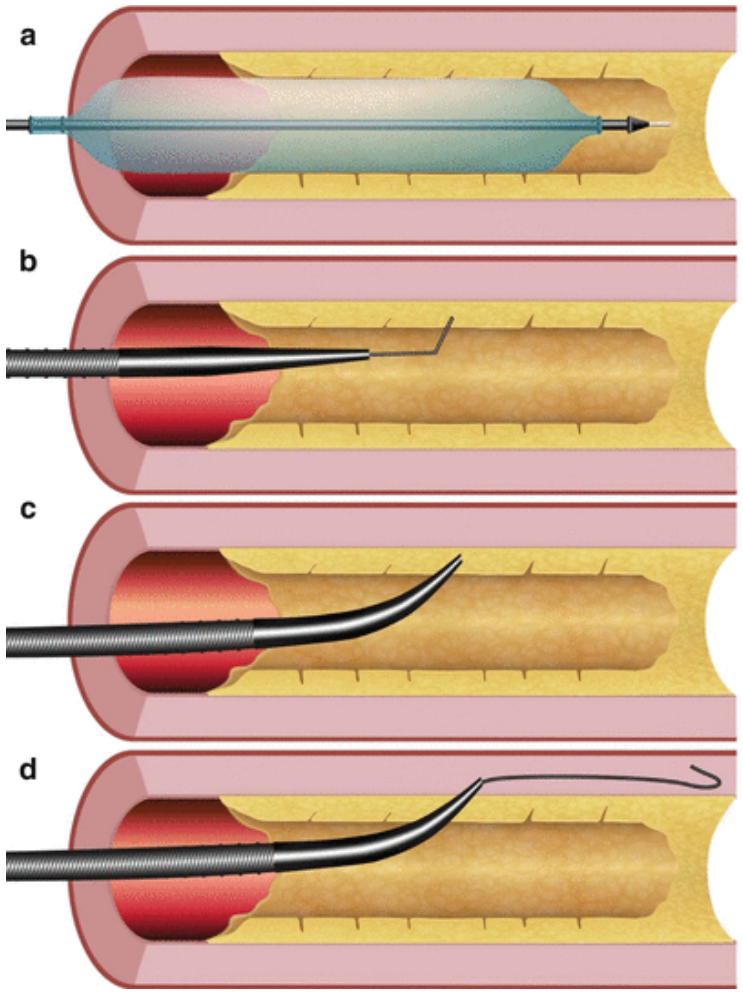
XB3.5 7F radiall, AL 0.75 7F con sideholes femoral

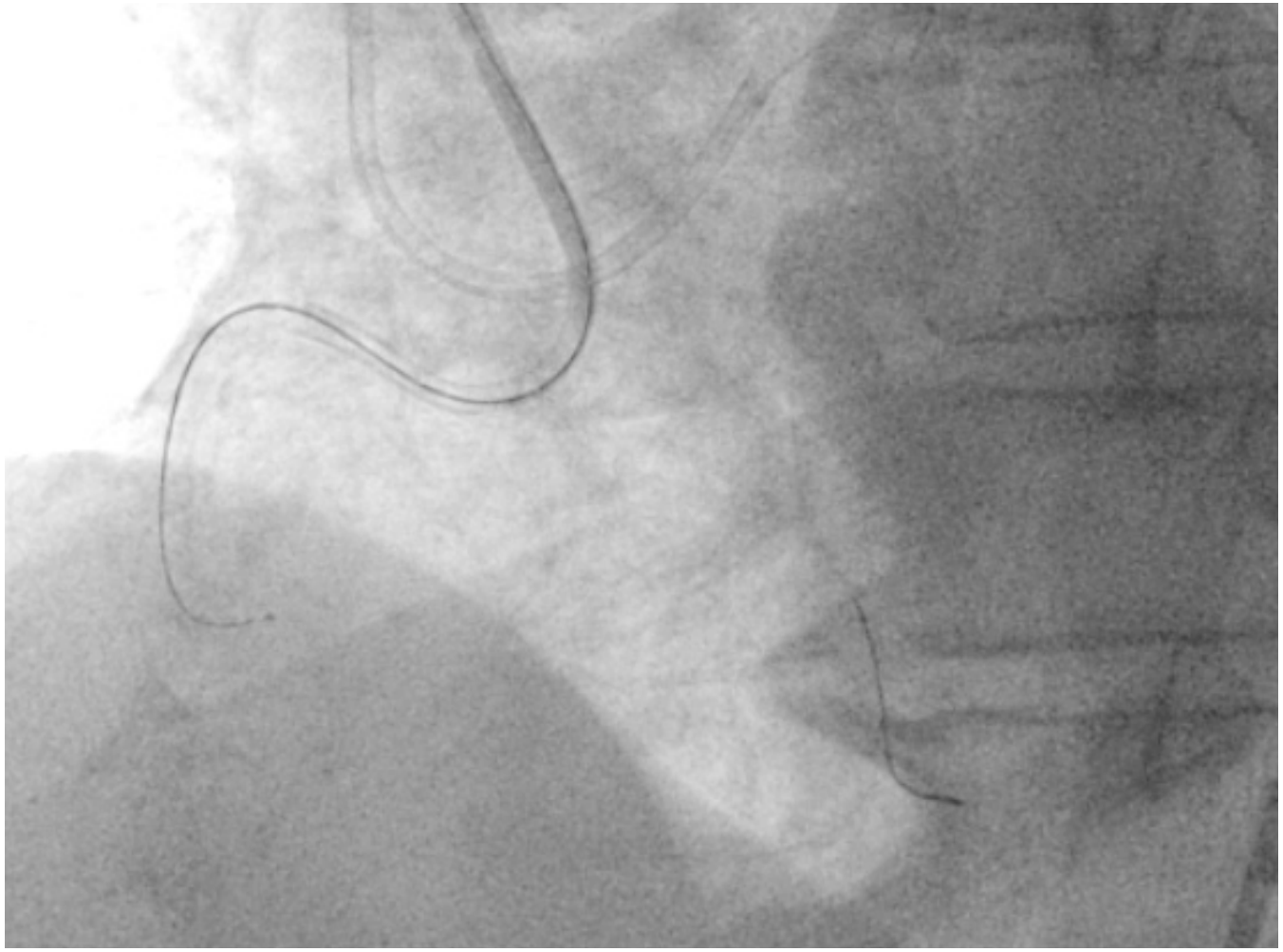


Safety wire a DA, finecross con BMW hasta cap proximal



“Scratch and go“

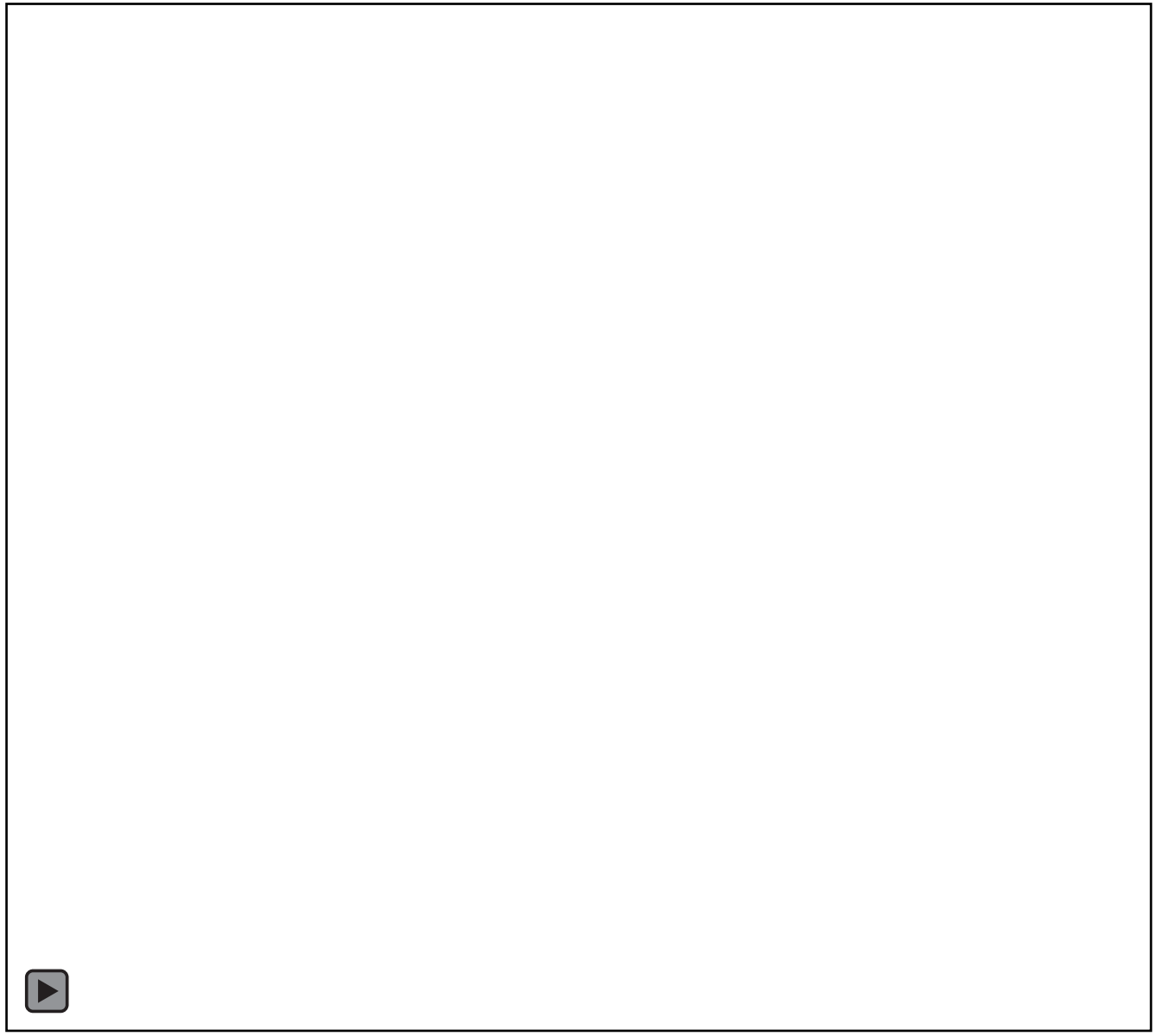




2.0 balloon over miracle 6 to open SIS, miracle 6 in SIS, then knuckle with Fielder XT

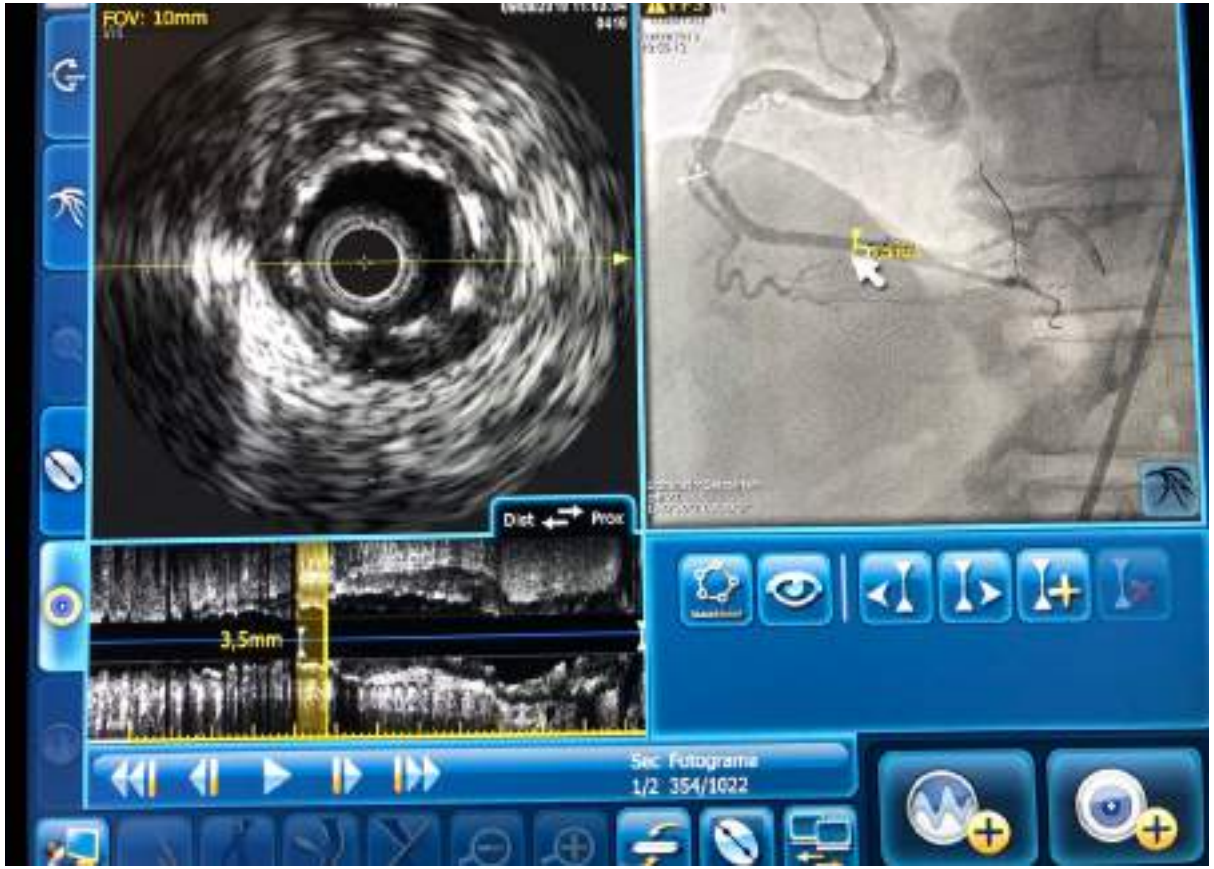
Wire escalation, limited antegrade subintimal tracking and reentry

1. AWE/ADR re entry with Hornet 14
2. Wire De-escalation
3. Trapping balloon para retirar MC
4. Miracle 6 for PDA Accessment
5. Wire De-escalation



Vessel stenting and PCI optimization

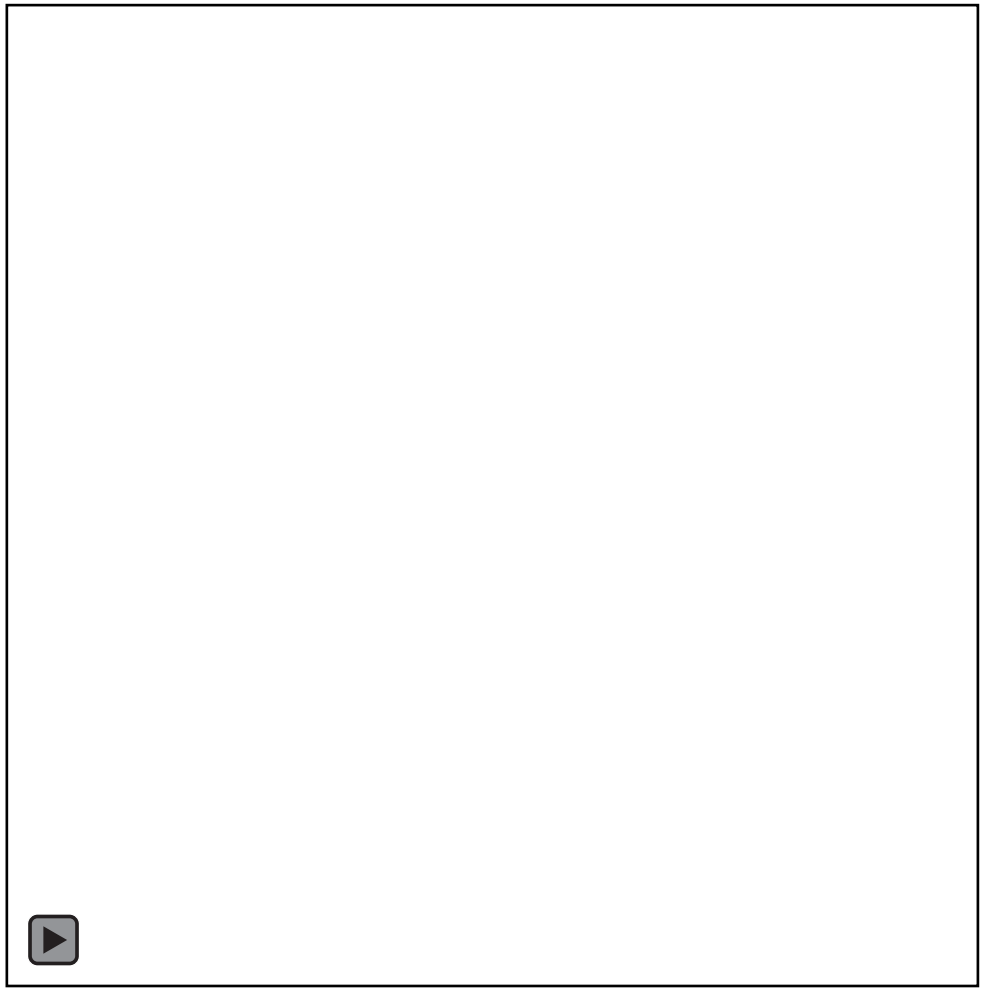
Arteria de 5mm por IVUS



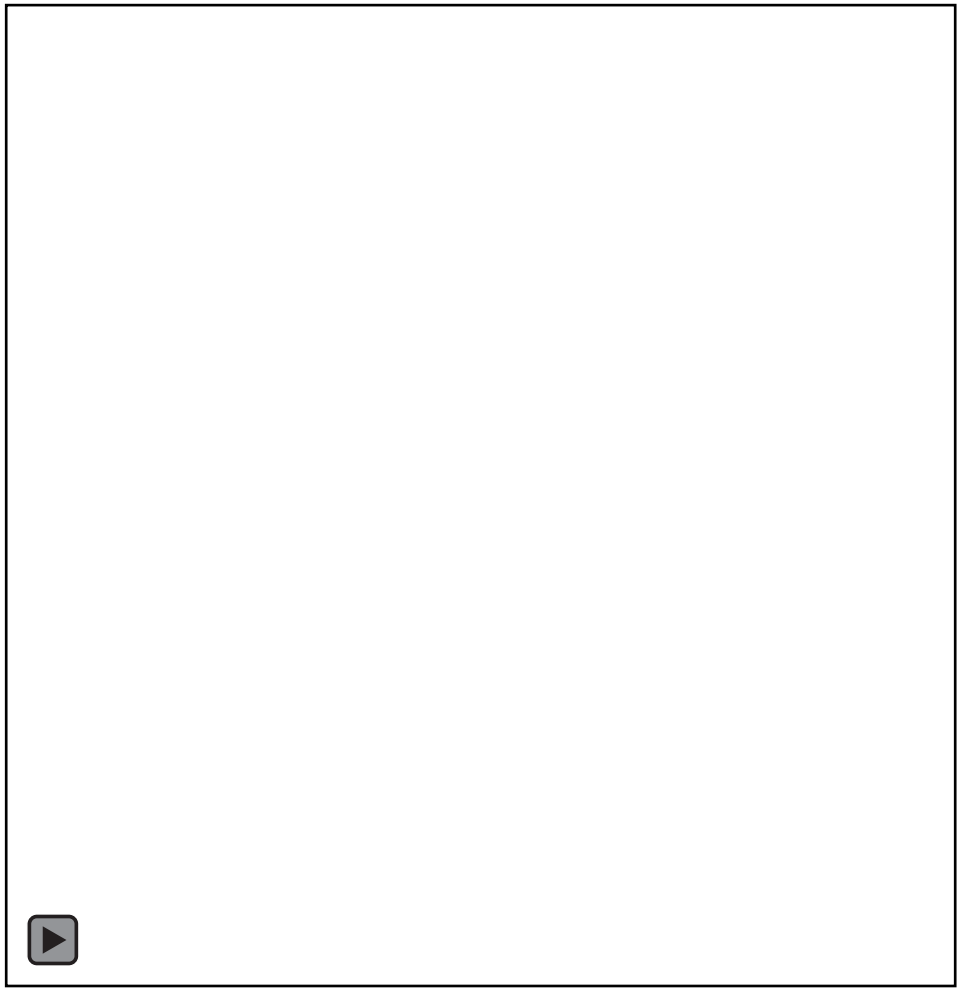
2 stents 3.5x48mm y 4x24mm optimizados a 5mm
Provisional a PL

CTO-PCI to circumflex

AWE con Pilot 200



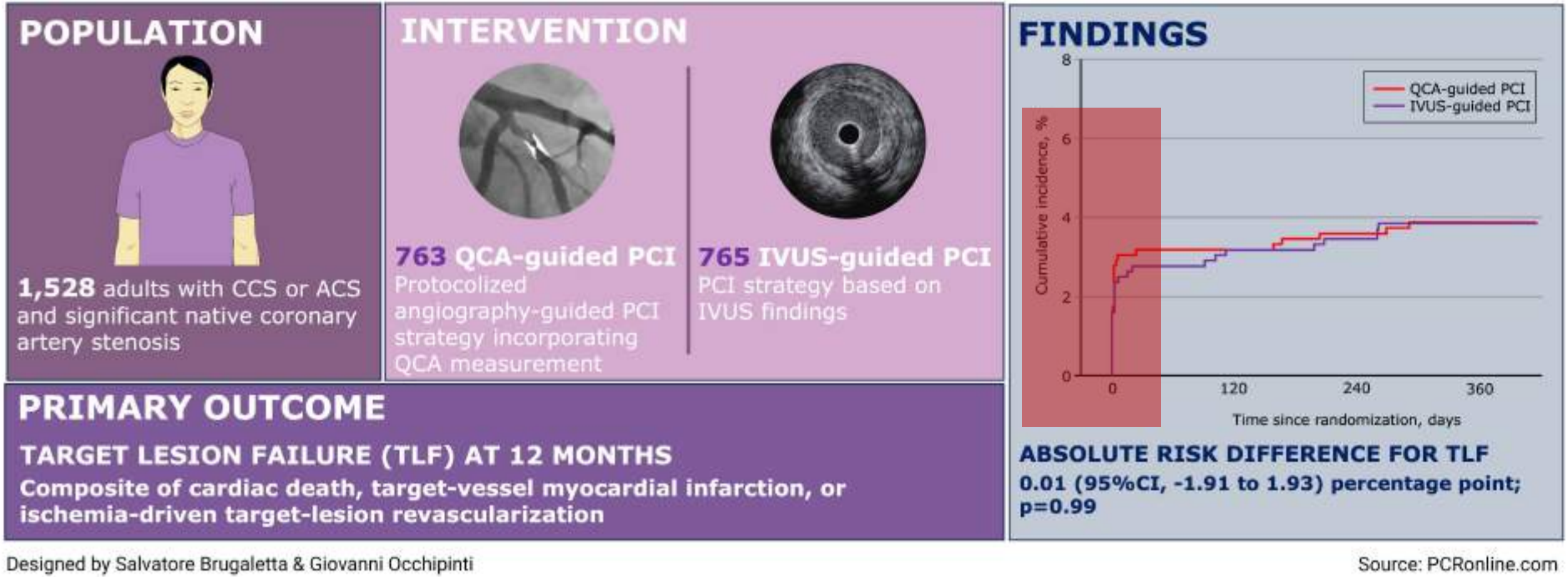
Stent 3x38mm, POT a 3.5 proximal



Guided-DES trial:

QCA-guided vs angio-guided PCI in simple lesions (mean Syntax of 13), n:1528 pt

<u>Standardized QCA strategy with mandated post-dilation</u>



JAMA Cardiol. Published online March 13, 2024. doi:10.1001/jamacardio.2024.0059

Guided-DES trial:

QCA-guided vs angio-guided PCI in simple lesions (mean Syntax of 13), n:1528 pt

Standardized QCA strategy with mandated post-dilation

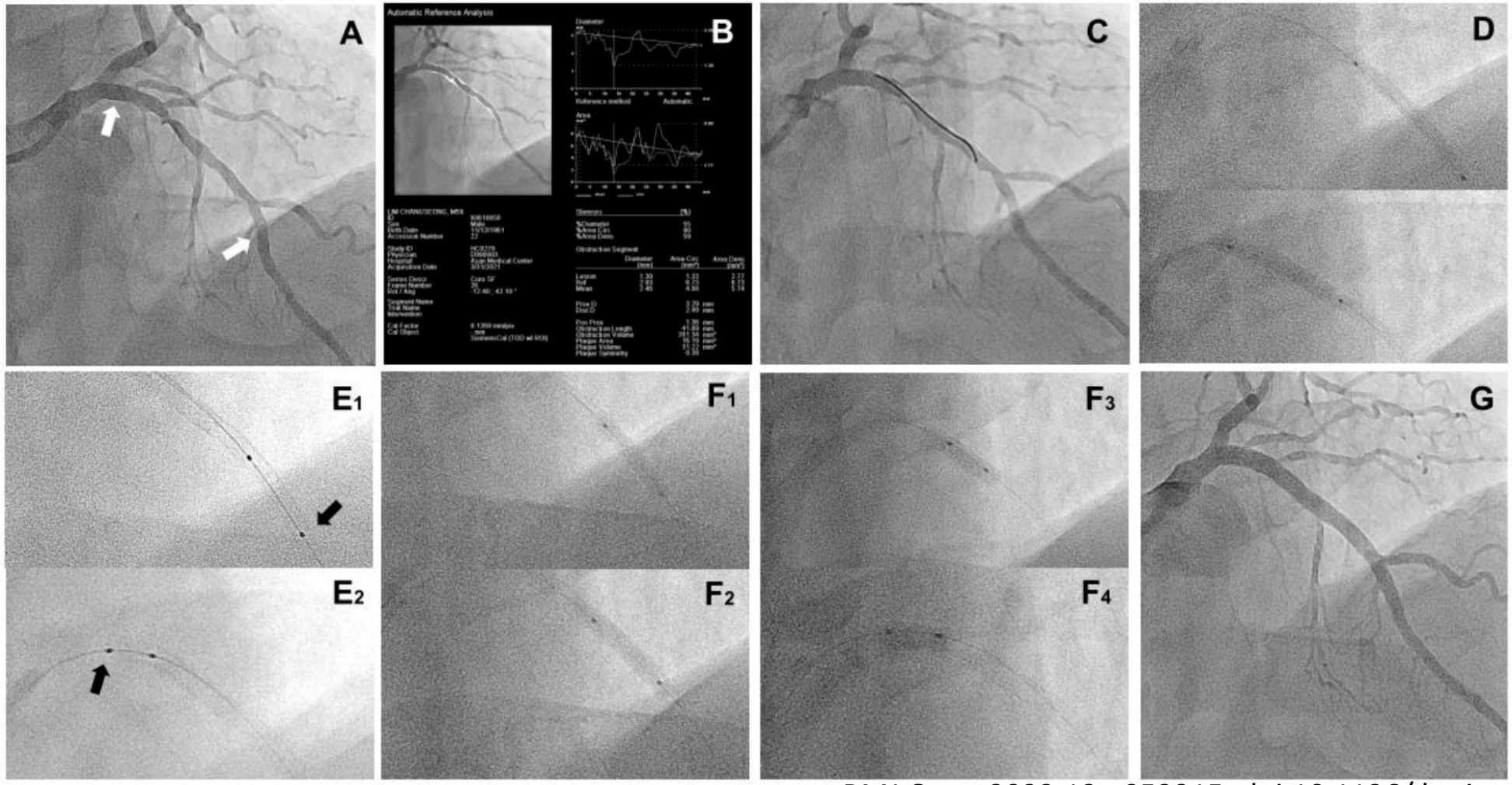
Design by angiogram
- obtain the best angiographic images adequately filled with contrast media - identify the landing zones (normal or normal-looking area)
Sizing by QCA
- measure the lumen diameter at the reference segments by QCA - calculate the adjusted QCA diameter (target diameter) = measured QCA value + 5~10% of the measured QCA value
Finish by post-dilation
- Stent selection & deployment: choose the stent size to reach the target diameter of the distal reference segment and inflate the stent balloon up to the target diameter - Stent optimization at its edge and within the stent: high-pressure post-dilation to achieve minimal residual stenosis (diameter stenosis<10%) assessed by stent boost imaging

BMJ Open 2022;12:e052215. doi:10.1136/ bmjopen-2021-052215

Guided-DES trial:

QCA-guided vs angio-guided PCI in simple lesions (mean Syntax of 13), n:1528 pt

<u>Standardized QCA strategy with mandated post-dilation</u>



BMJ Open 2022;12:e052215. doi:10.1136/ bmjopen-2021-052215

Guided-DES trial:

QCA-guided vs angio-guided PCI in simple lesions (mean Syntax of 13), n:1528 pt

Standardized QCA strategy with mandated post-dilation

Supplemental Table 1. Adjusted QCA values (target diameters) of the reference segments derived from the QCA measurements

Measured value	Target diameter	Measured value	Target diameter
≤ 3.5mm	**+ 10%**	**3.6–3.9mm**	**+ 6~9%**
2.0	2.2	3.6	3.92
2.1	2.31	3.7	4.0
2.2	2.42	3.8	4.07
2.3	2.53	3.9	4.13
2.4	2.64	**≥ 4.0mm**	**+ 5%**
2.5	2.75	4.0	4.2

BMJ Open 2022;12:e052215. doi:10.1136/ bmjopen-2021-052215

Tips and tricks for appropriate pressure wire assessment

Pressurewire assessment

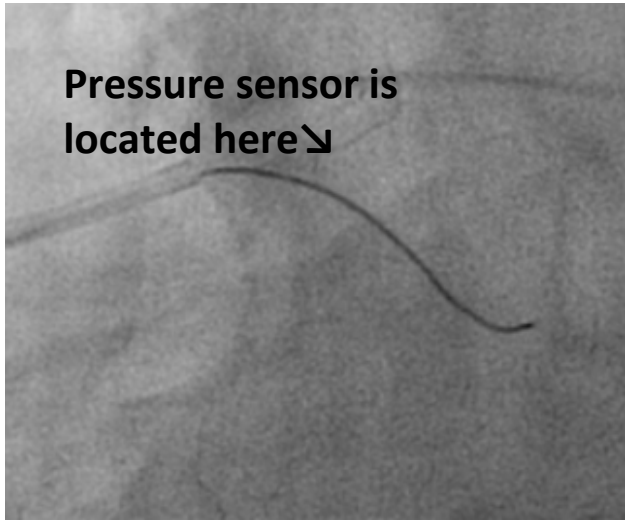
Step-by-step (1/2)

- **1. Set-up**
  - Informed consent, guiding catheter, total anticoagulation, and IC nitrates are always required. Calibration of pressures is a critical technical aspect for correct measurements. Take your time and train your team.
- **2. Aortic pressure calibration**
  - a. Place tuhoy valve at the level of right atrium and open valve to atmospheric pressure.
  - b. Zero aortic pressure of cathlab (wait until solid zero)
  - c. Zero aortic pressure of Polaris (wait until solid zero)
- **3. Pressurewire calibration**
  - a. Flush comet pressurewire
  - b. Connect pressurewire and allow it to zero at the level of right atrium.
  - b. Advance wire and place sensor at tip of guiding catheter.
  - c. Remove needle introducer and press equalize.

Pressurewire assessment

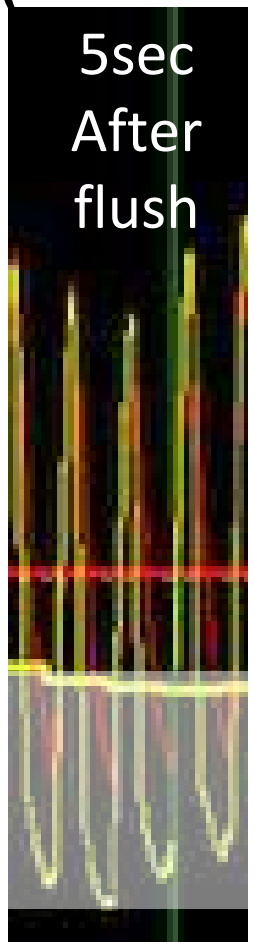
Step-by-step (2/2)

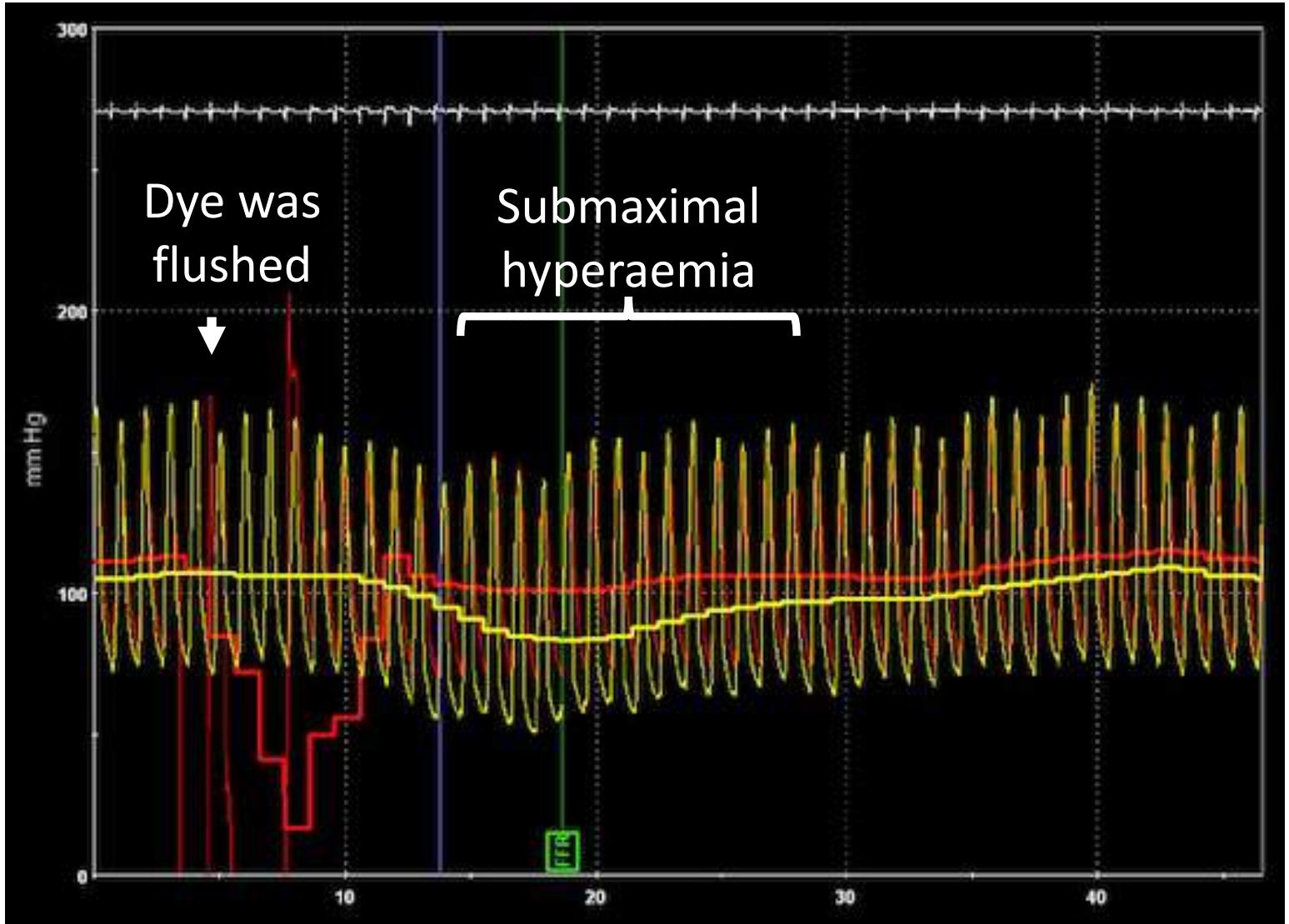
- **4. Equalization of distal and aortic pressure**
  - a. Shape tip of wire as required.
  - b. Advance wire into guiding catheter until sensor reaches guiding catheter tip.
  - c. Remove needle introducer and press equalize.
- **5. Advance pressure wire and getting ready to measure**
  - a. Advance pressure wire and place sensor at least 2 cm distal to lesion (needle introducer can be used but should be removed again before measurement)
  - b. Remove needle introducer.
  - c. Administer nitrates.
  - d. Flush guiding catheter and wait for 15 seconds.
  - e. De-engage guiding catheter.
- **6. Measure DFR**



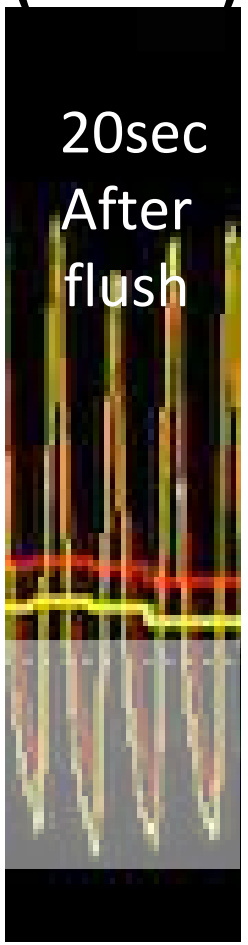
Cross the lesion, flush and wait (10-15sec) before making pressure measurements

iFR: 0.67 (incorrect)





iFR: 0.93 (correct)



DFR

Dyastolic hyperaemic free ratio

- Validated against instantaneous wave free ratio (iFR)
- Clinically equivalent to iFR
- Cut-off: 0.90

Johnson N et al. European Heart Journa 2019; 40, 2585–2594

Common pitfall of all non-hyperemic indices:

False positive results due to residual dye in guiding catheter

Residual dye in guiding catheter lead to false-positive results (DFR: 0.88)

After appropriate flush of guiding catheter, true DFR is negative (DFR 0.98)

FFR

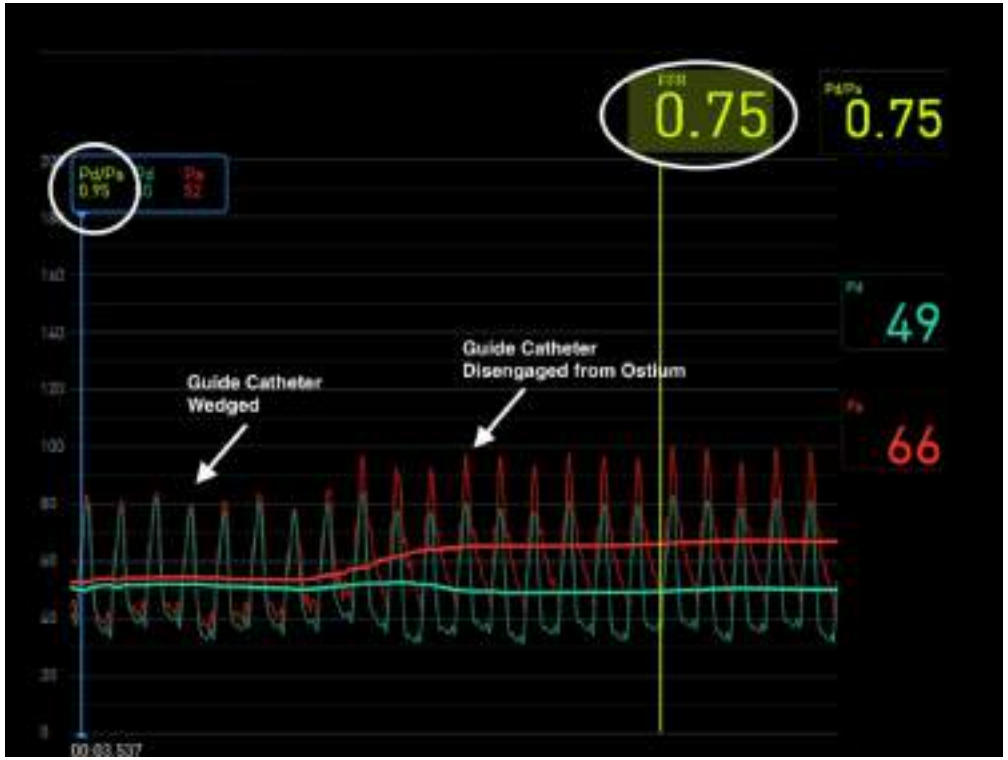
Fractional flow reserve

- Validated against non-invasive assessment of myocardial ischaemia.
- Strong predictor of clinical events.
- Cut-off: 0.80.
- Requires hyperaemia. IC is simpler and equivalent to IV hyperemia. Hence, IC is recommended.

Neuman FJ et al. European Heart Journal 2019; 40, 87–165

Common pitfall of FFR:

Check, avoid and correct wedging of aortic pressure. It may lead to false negative FFR values.



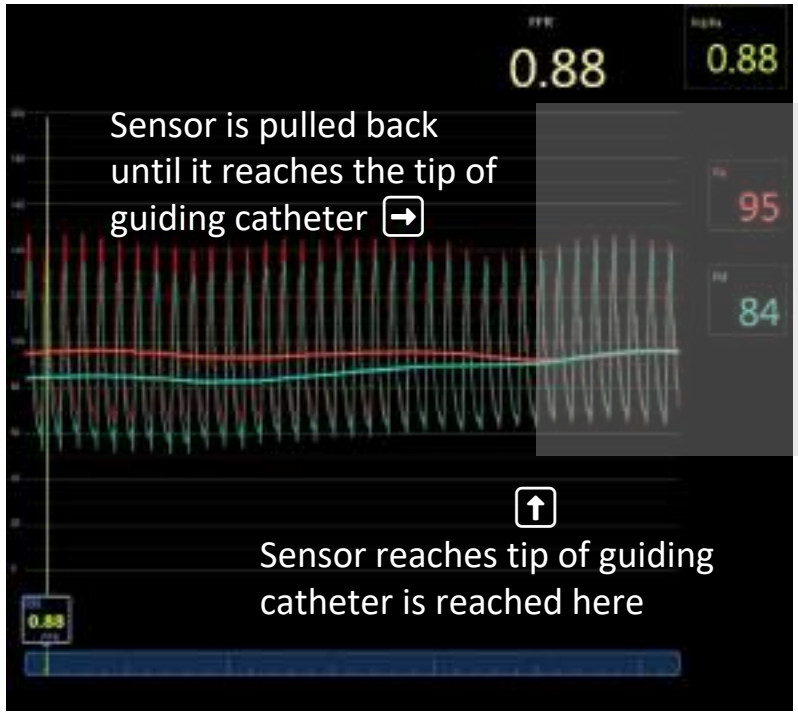
Pressure pullback

- Pressure sensor pullback until tip of guiding catheter is always recommended to check for absence of pressure drift.
- If pressure drift is documented, DFR and FFR values could be wrong. Hence, pressurewire should be re-equalized and measurements repeated.

Pressure pullback:

While recording, slowly remove pressure sensor until tip of guiding catheter. Distal and aortic pressure should be the same.

These implies that DFR and FFR values were measured correctly.



Both distal and aortic pressure are the same. Hence, calibration was mantained, and DFR and FFR are correct.

Co-register pressure pullbacks with angiography

- While recording pressure pullbacks, mentally co-register pressures with live fluoroscopy searching for anatomical landmarks of pressure jumps.
- These anatomical landmarks on fluoroscopy will be useful for IVUS and PCI.

A pressure jump was observed just below the upper part of this costal arch.

Costal arch

Pressure jumped here, establishing the distal segment of the stenosis causing the pressure loss

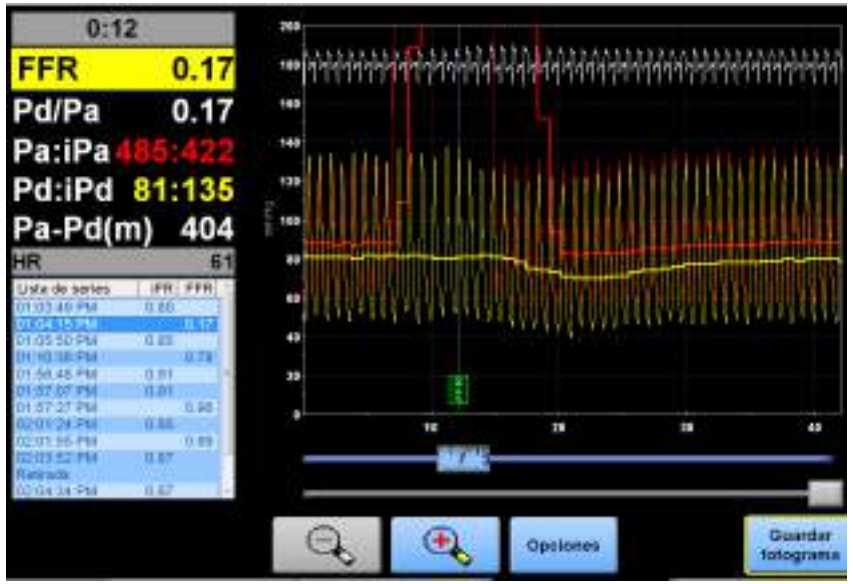
Preparation and administration of intracoronary adenosine

- **1. Requirements**
  - a. One adenosine vial (6mg per 2ml) and three 10ml-syringes.
- **2. Preparation of adenosine**
  - a. Load syringe 1 with 1cc (3mg) of adenosine and dilute it to 10ml with saline 0.9% (1ml of dilution=300mcg of adenosine)
  - b. Load syringe 2 with 1cc (300 mcg of adenosine) of syringe 1 and dilute it to 10ml with saline 0.9% (1ml of dilution=30mg of adenosine)
  - c. Syringe 2 has now 300 mcg of adenosine in 10ml of diluted saline
- **3. Administration of adenosine**
  - a. Charge syringe 3 with 10 ml of saline (will be used to flush adenosine)
  - b. With a brisk inyection, administer diluted adenosine of syringe 2: 5ml in RCA (150mcgr) and 10ml in LCA (300mcgr of adenosine) and immediately flush with saline from syringe 3
  - c. Recommended dose: 100-200 mcgr of adenosine in RCA, and 200-400mcgr in LCA.

Check where FFR is calculated and relocate if required

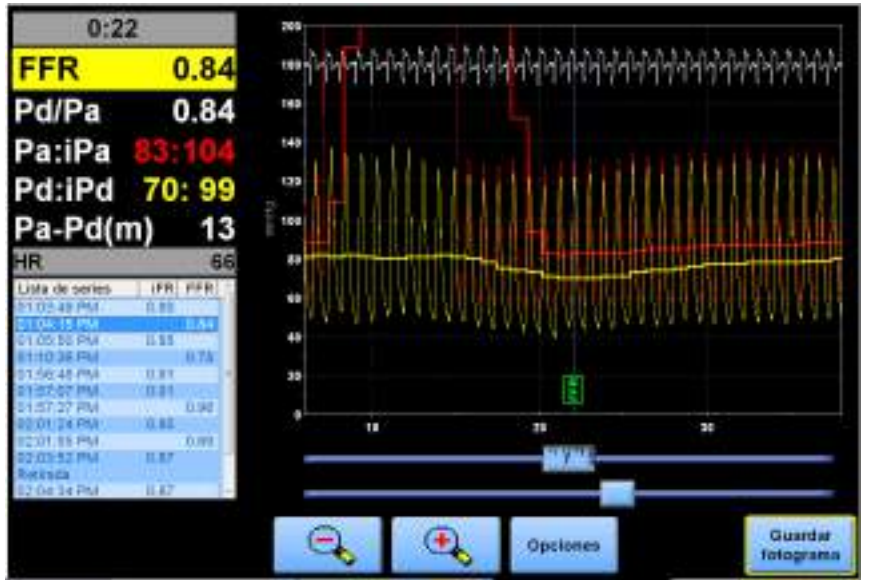
- 1. Most consoles report the minimum Pd/Pa ratio in the trace as the FFR.
- 2. The minimum Pd/Pa value can occur during pressure artifacts.
- 3. This pitfall is less comon with Polaris due to the smart minimum FFR algorithm.

The minimum Pd/Pa developed during adenosine inyection (pressure artifact)



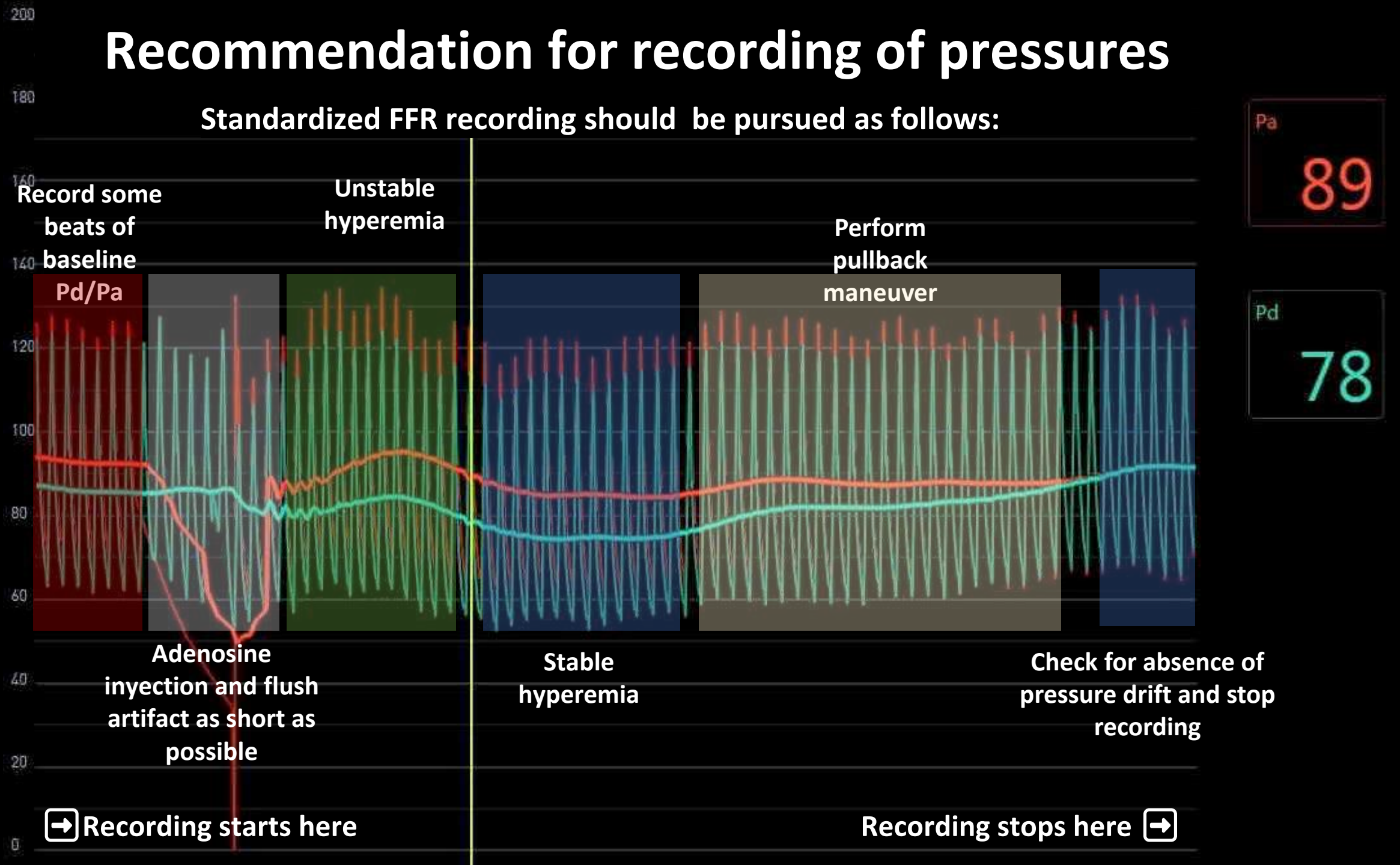
Hence, the FFR 0.17 is incorrect and should be relocated

FFR is relocated out of the pressure artifact
True FFR is 0.84

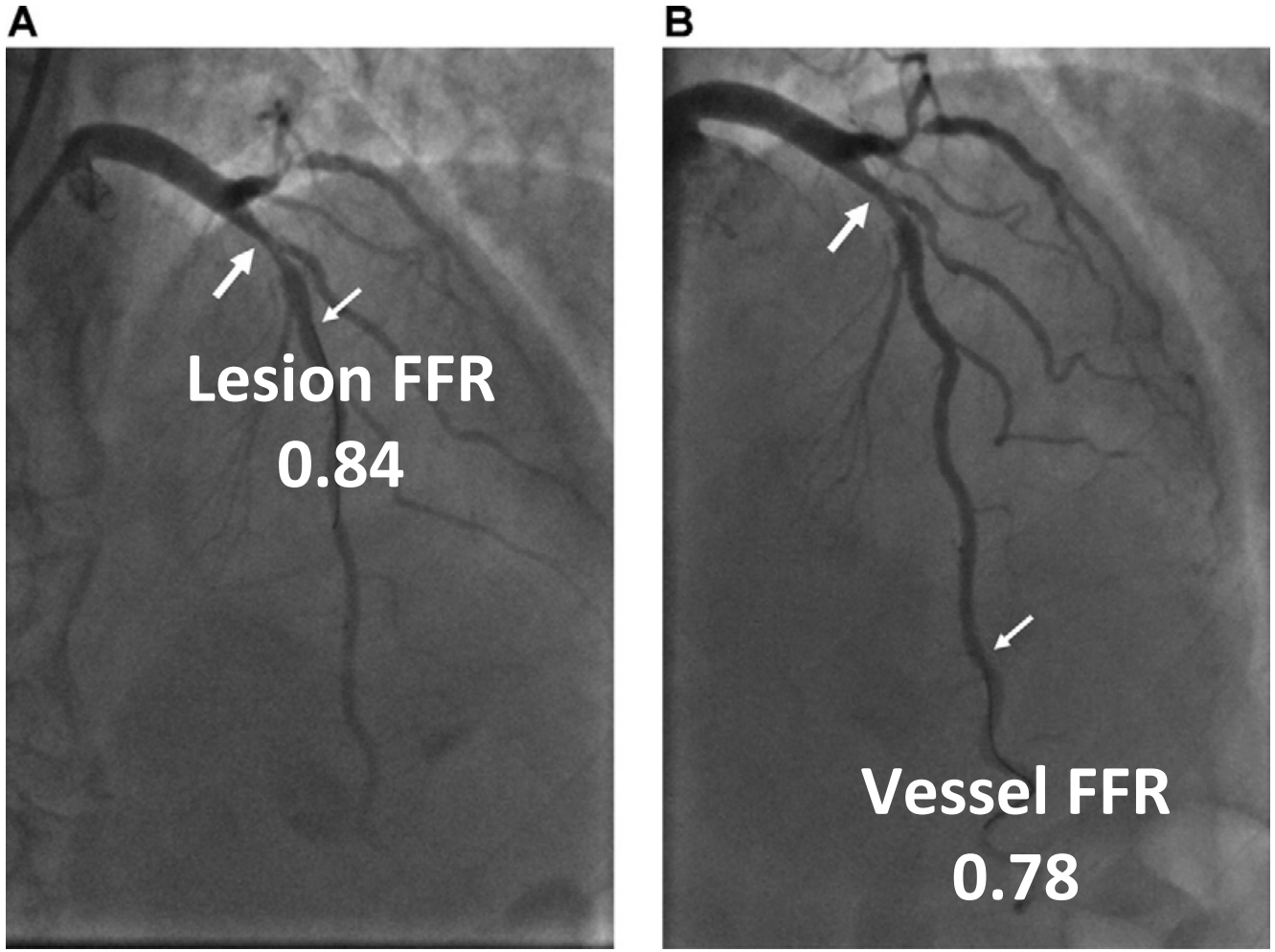


Recommendation for recording of pressures

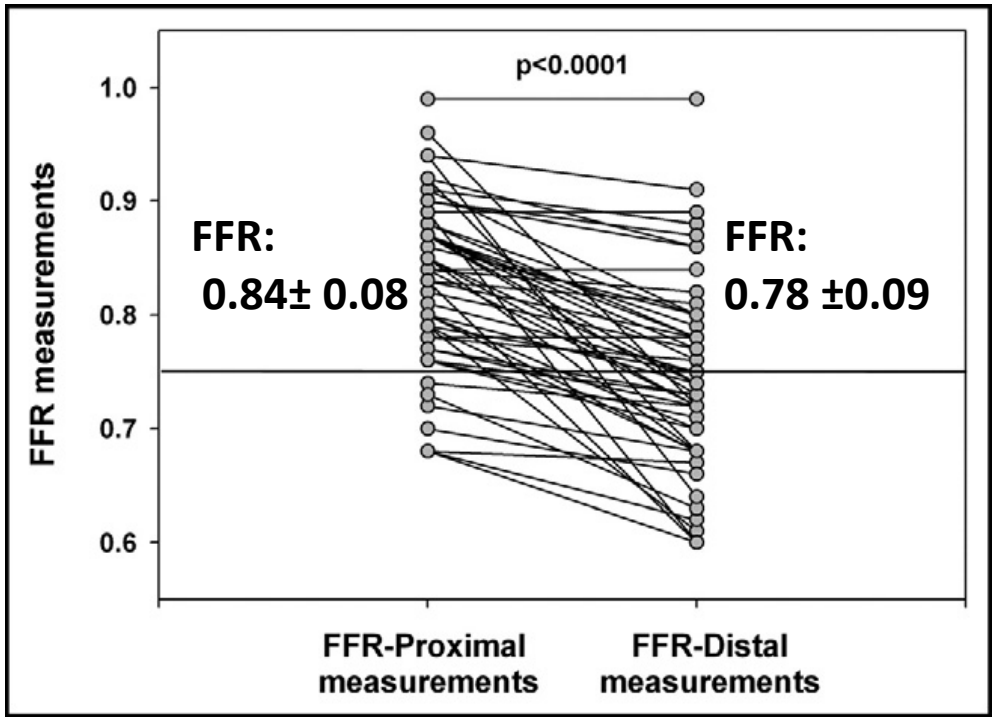
Standardized FFR recording should be pursued as follows:



The more distal the wire, the lower the FFR value



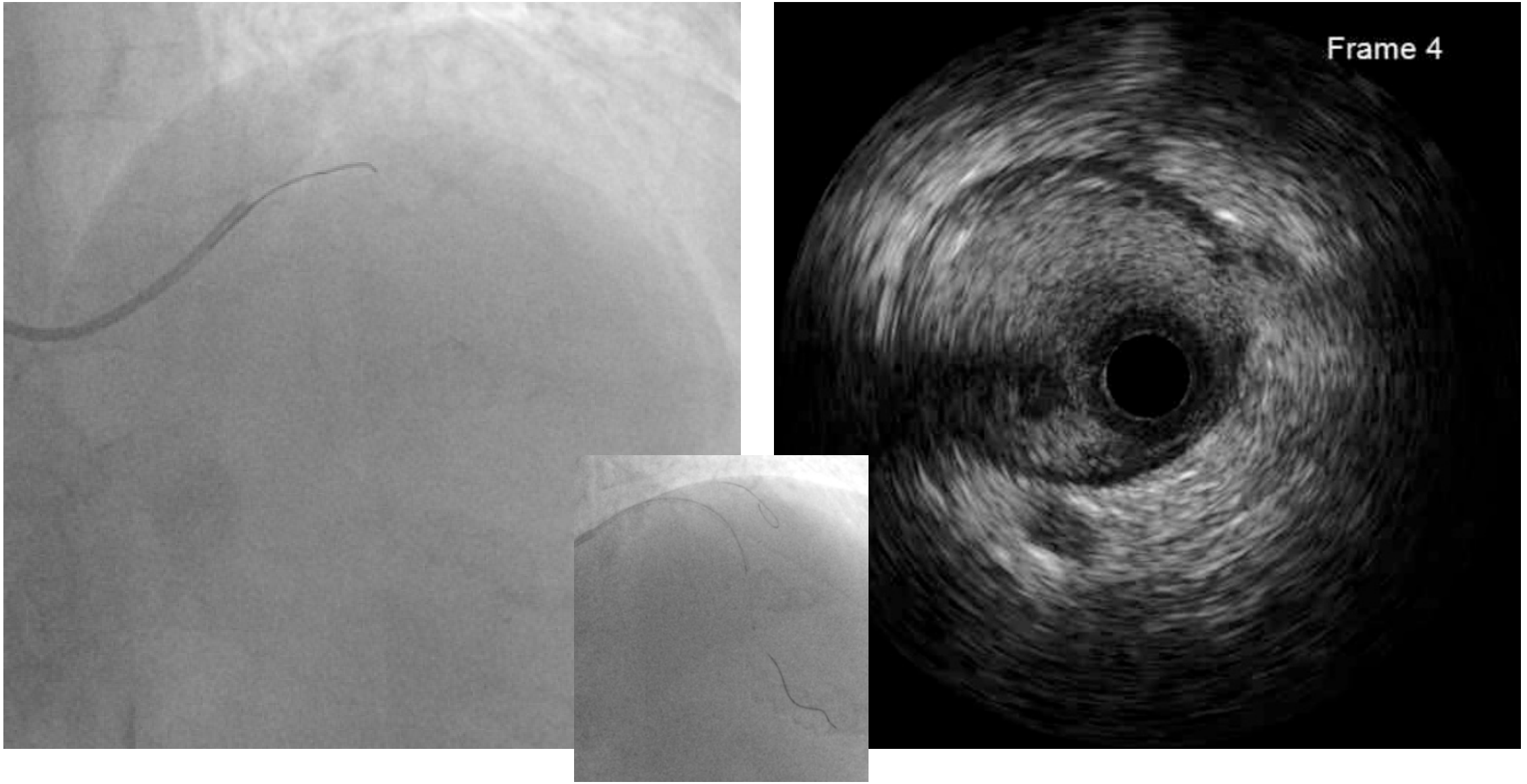
- FFR measured 2-3cm distal to the stenosis and also as distal as possible
- N=100 vessels



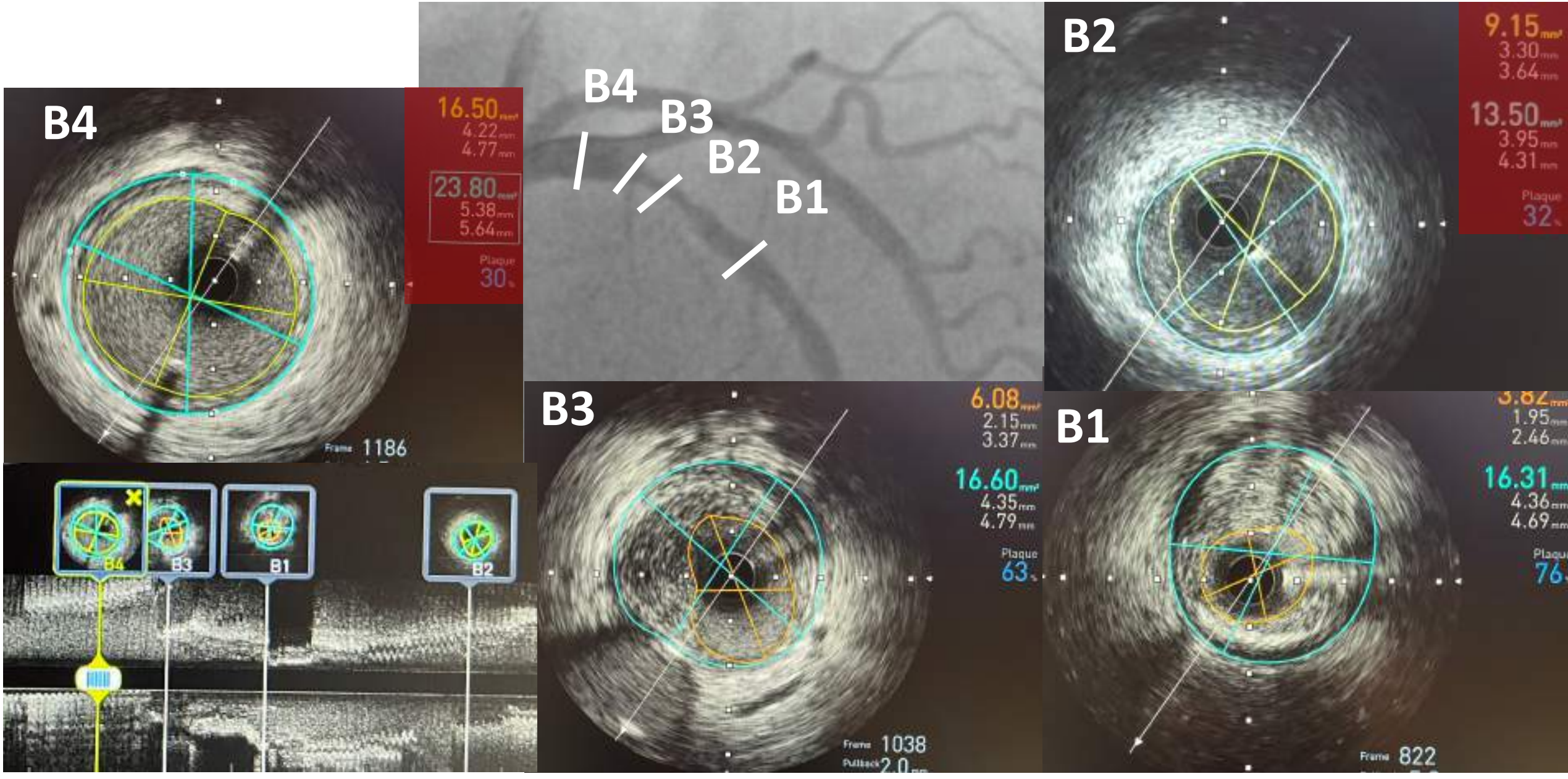
Rodes Cabau J et al. Am J Cardiol 2011;108:483– 490

Why imaging?

Pre-PCI IVUS assessment

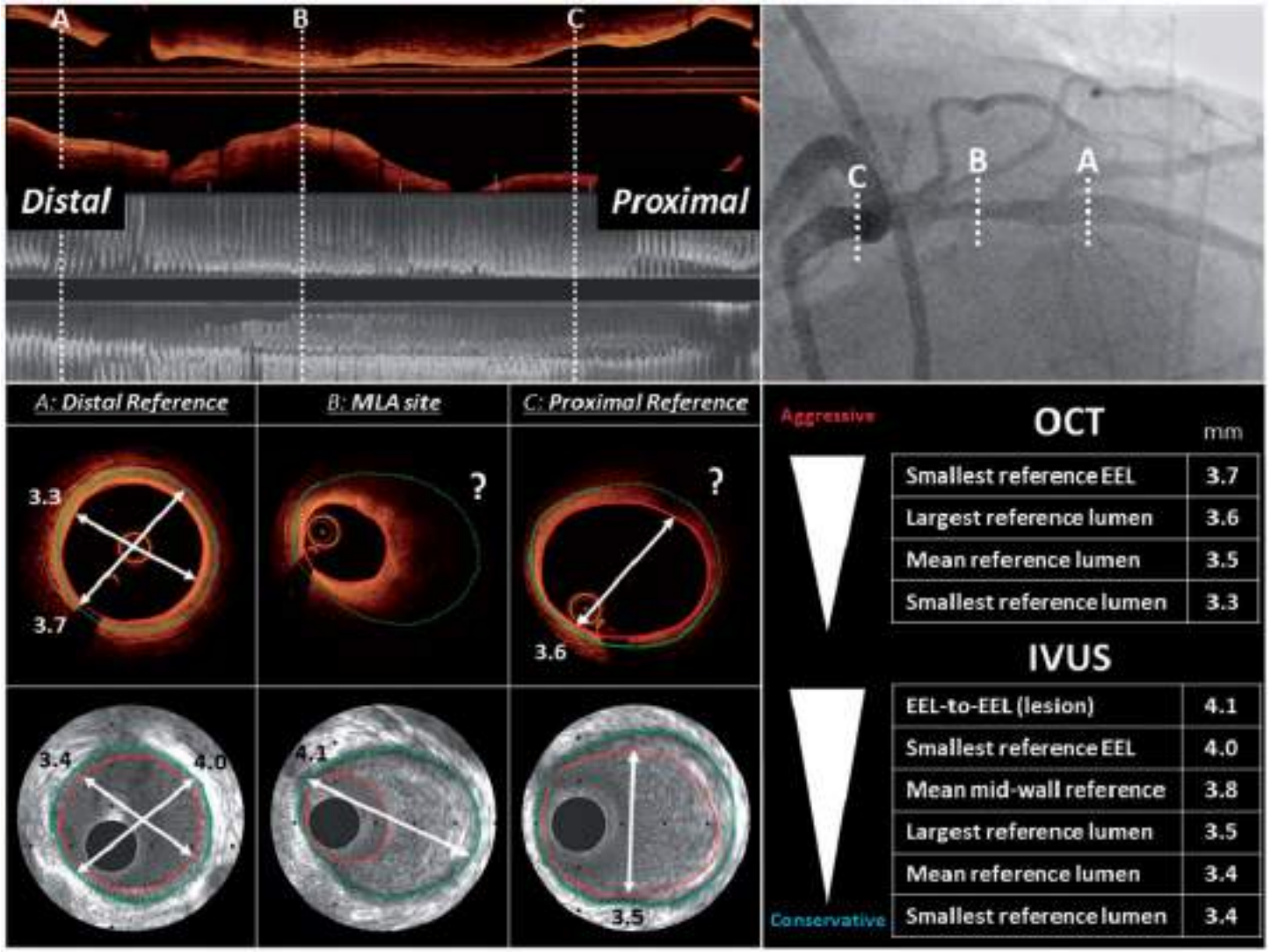


Pre-PCI quantitative measurements



EAPCI consensus of imaging use for PCI guidance

"Mean distal lumen diameter with up rounding stent (0–0.25mm) is recommended (e.g. 3.76=4.0mm)"

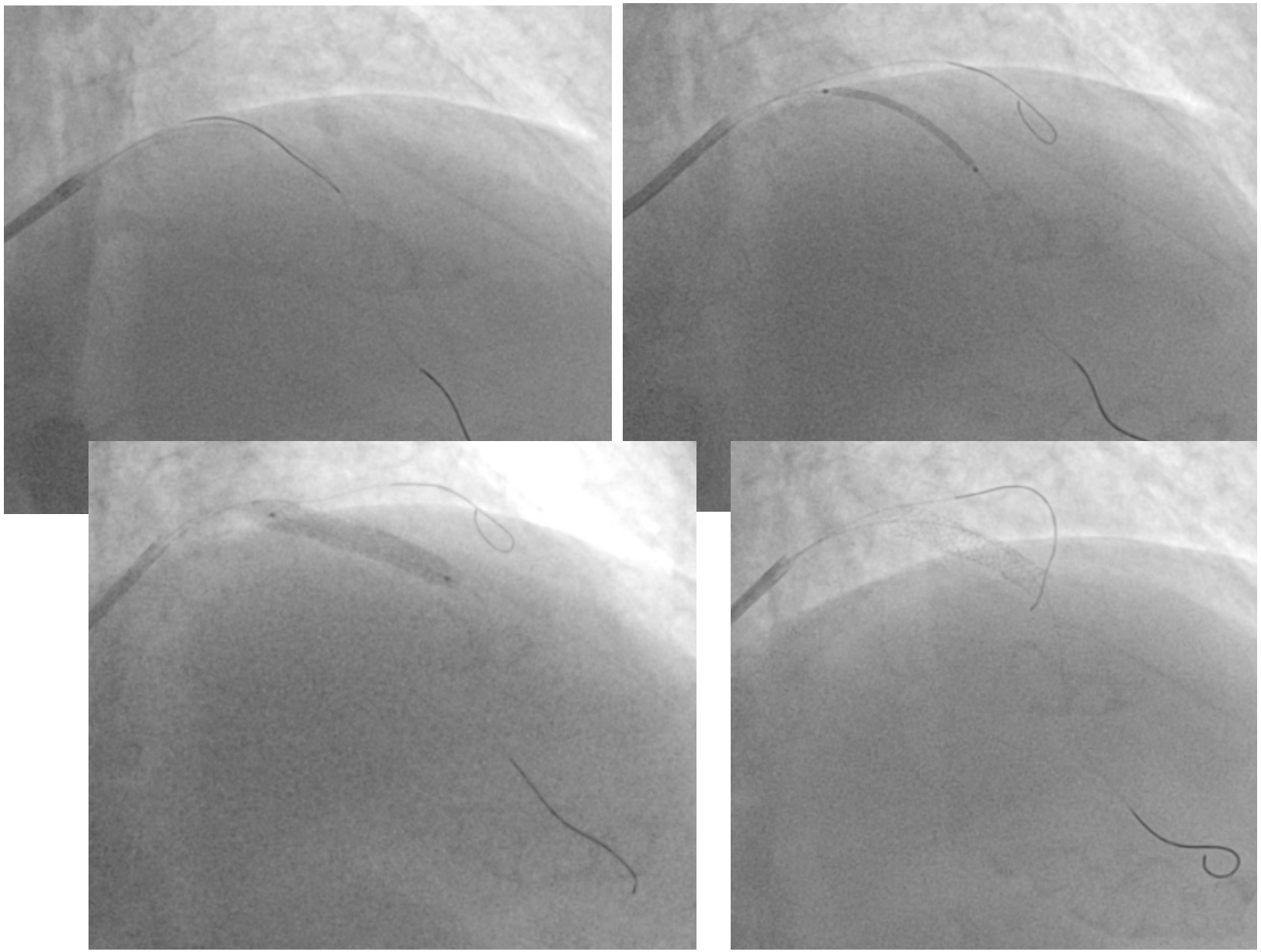


Raber L et al. EHJ 2018

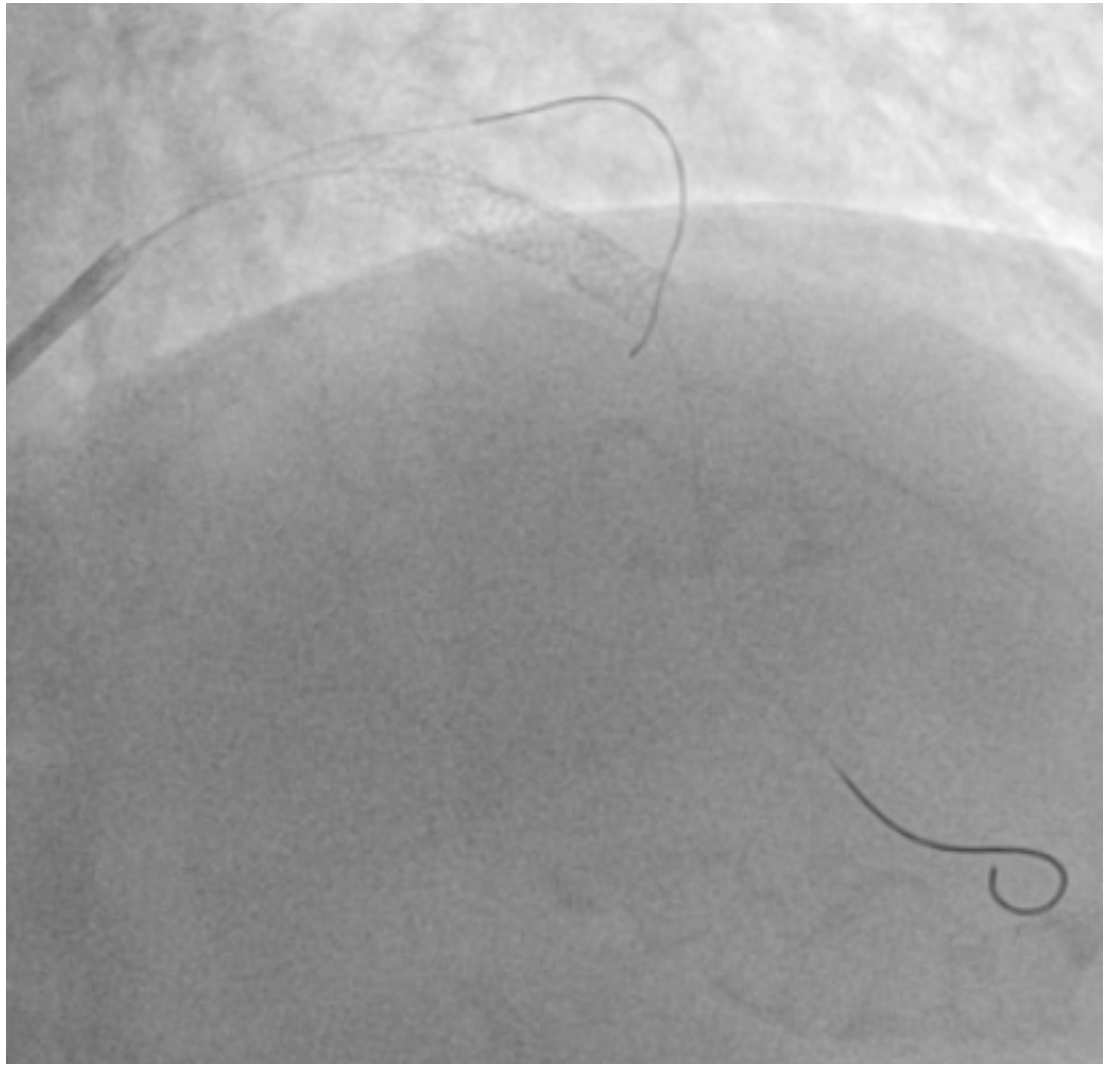
Stent sizing and implantation

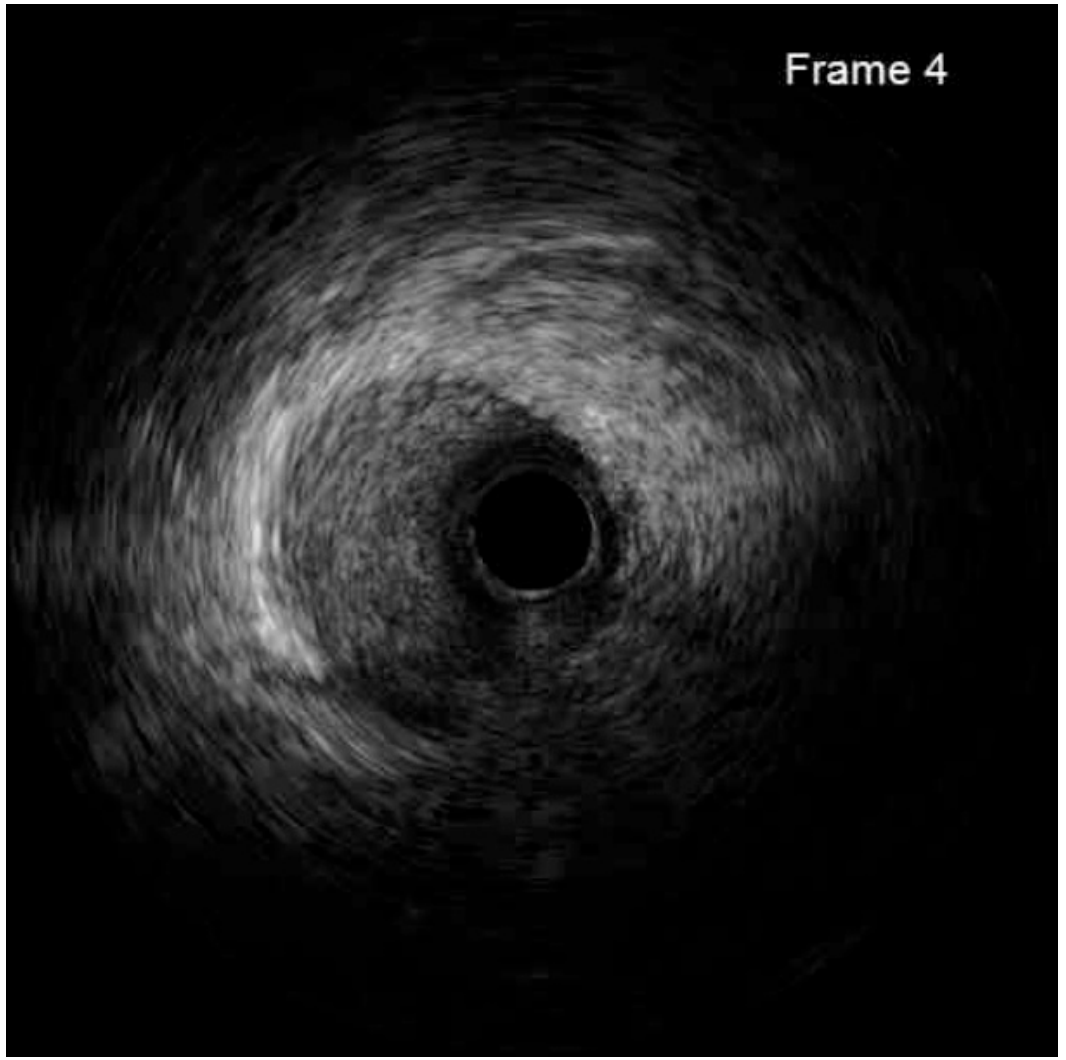
- **Conservative**
  - Mean distal lumen diameter: (3.3+3.64)/2=3.47mm
  - **Stent: 3.5-3.75mm**
- **Agressive**
  - Smalles reference EEL: 3.95mm
  - **Stent: 4mm**
- **IVUS lenght**
  - **23+7mm= 31mm**

Stent 4x34mm

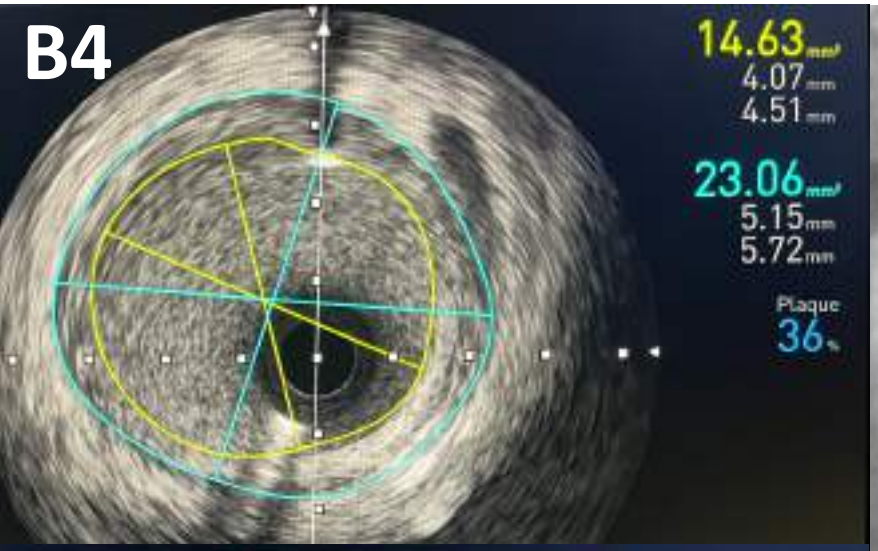


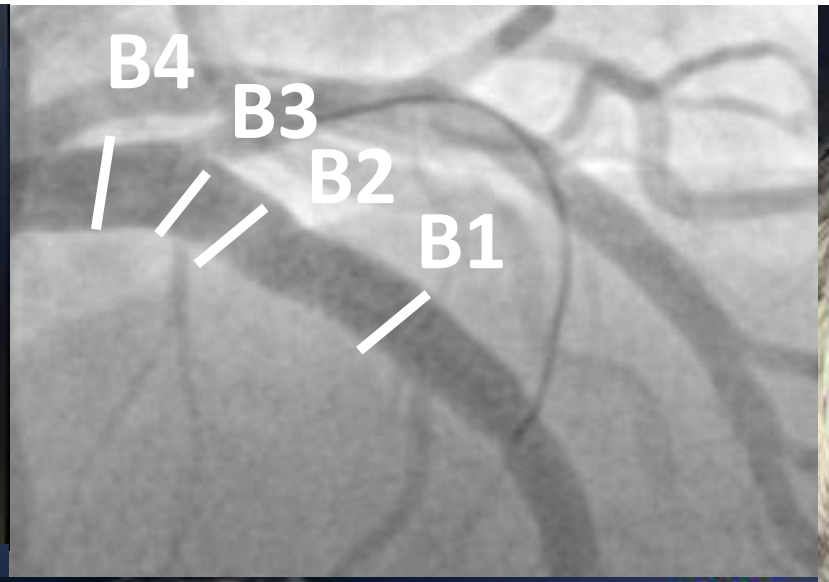
Post-PCI result: angio and IVUS

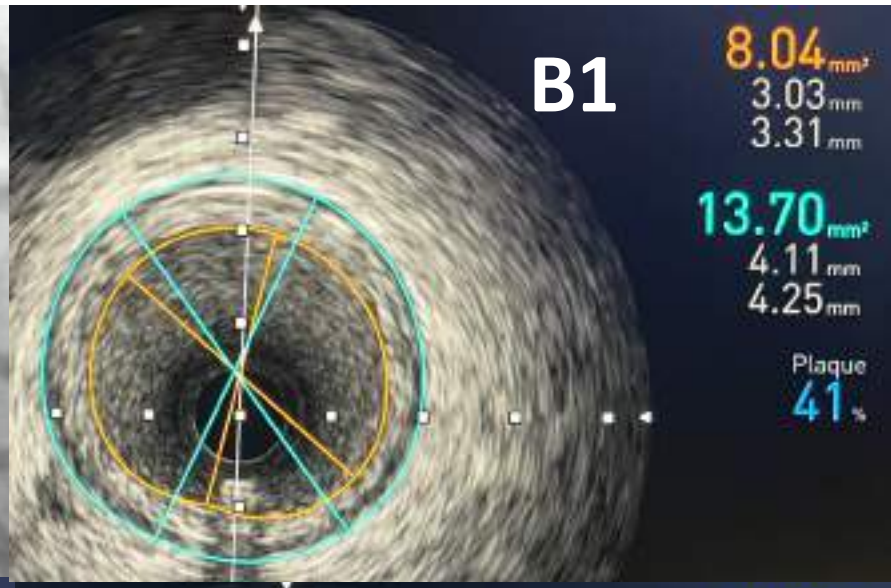


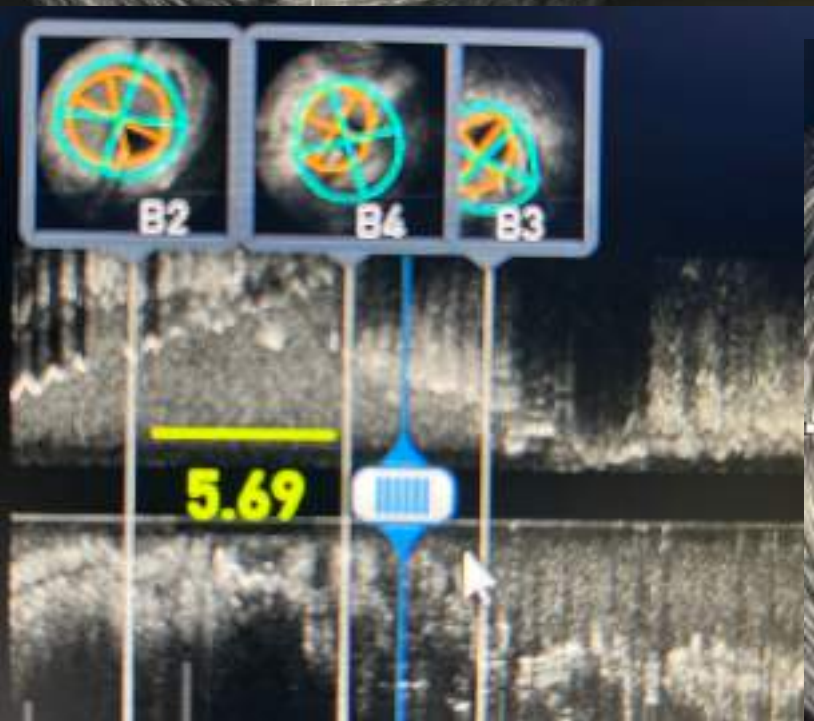


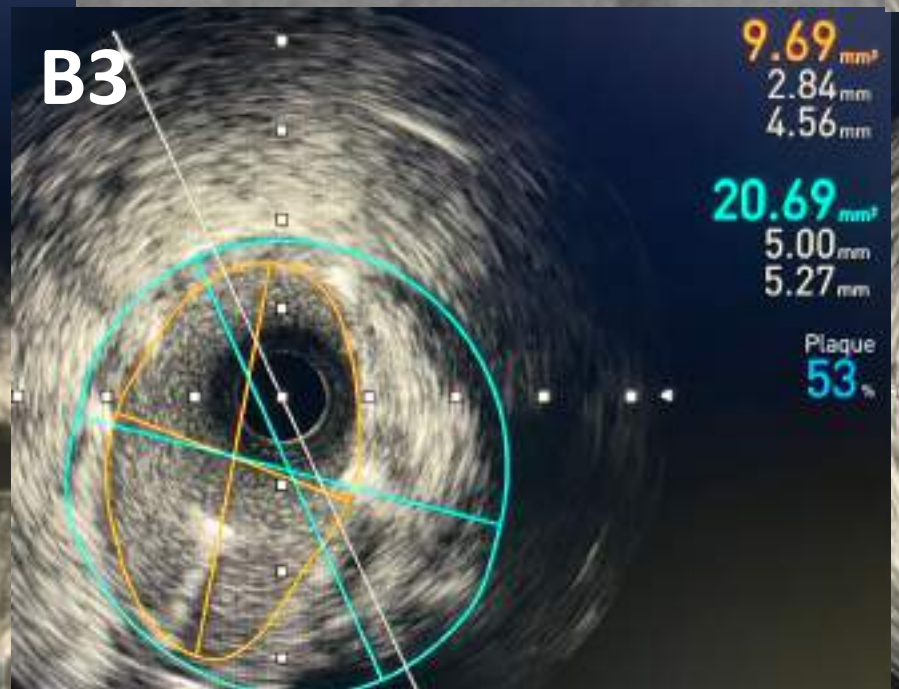
Post-PCI quantitative measurements

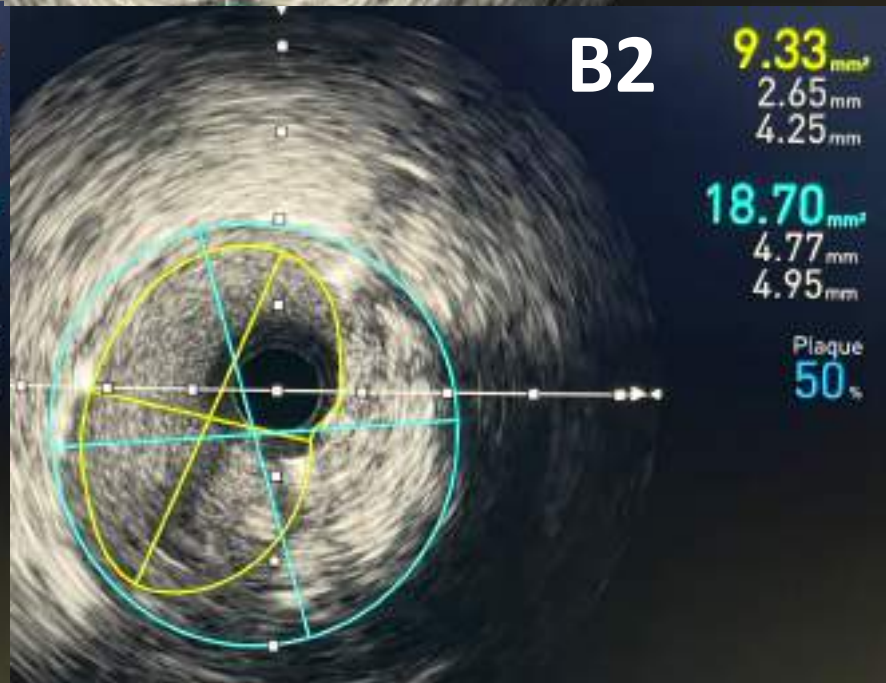






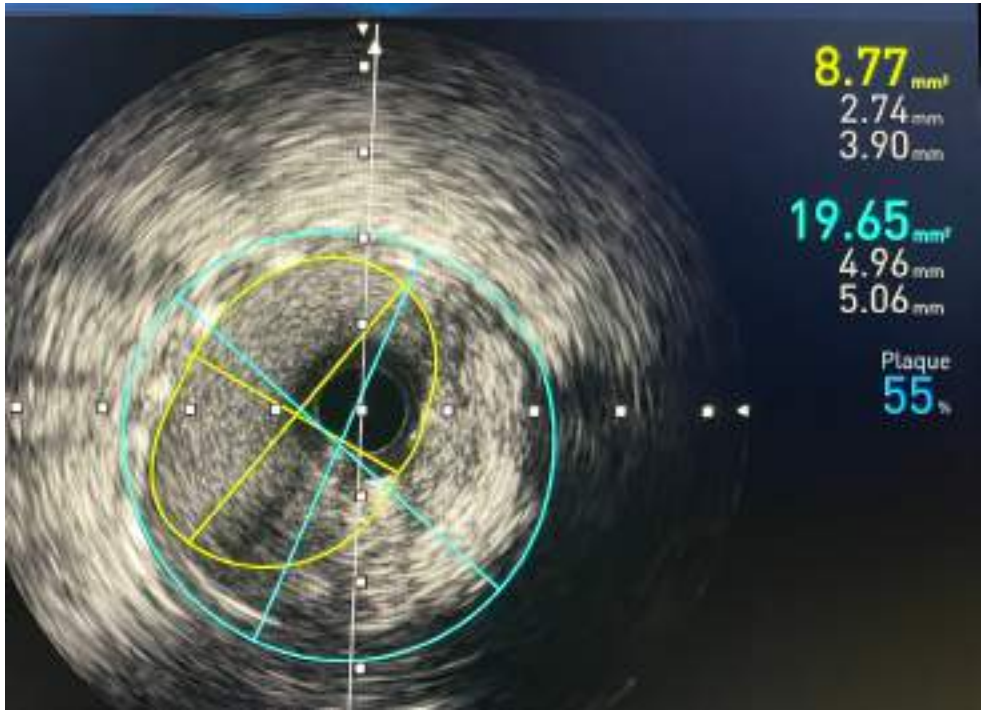




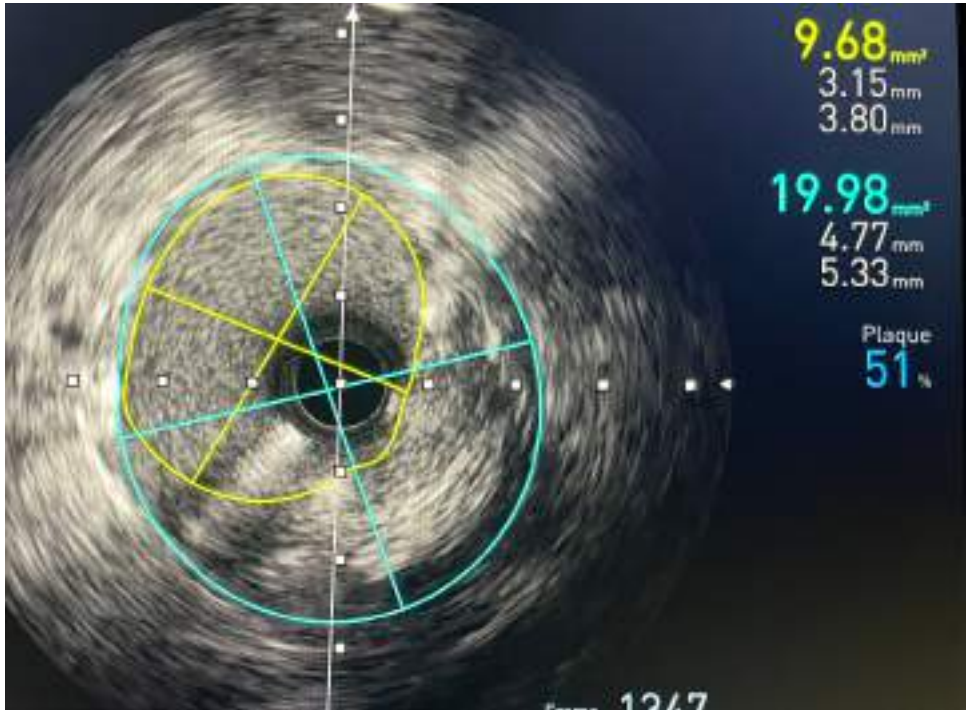


Final result after POT with 4.5mm NC balloon

- **Before final POT**
  - Stent expansion 116%
  - Eccentricity 0.37



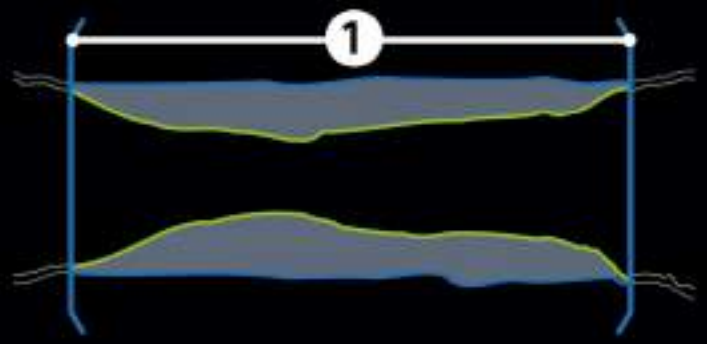
- **After final POT**
  - Stent expansion 118%
  - Eccentricity 0.34



Pre-stent workflow

IVUS 1 2 3 ESSENTIALS

1 | Establish lesion length and define landing zones



Normal

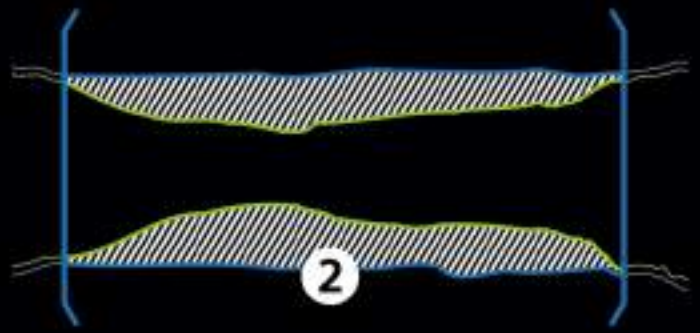
<50% Plaque burden

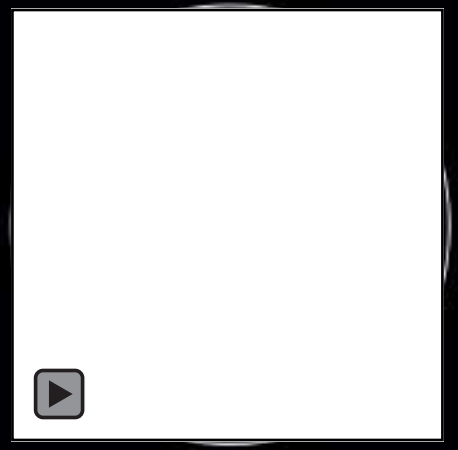
Diseased

Pre-stent workflow

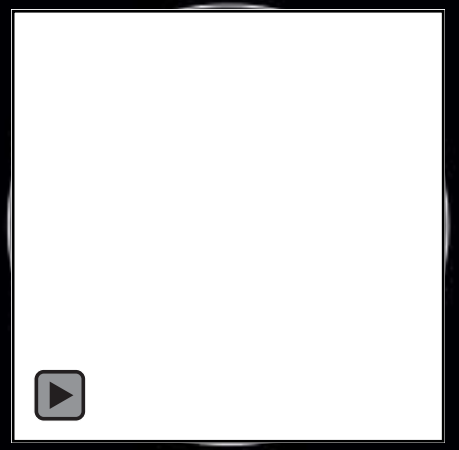
IVUS 1 2 3 ESSENTIALS

2 | Assess plaque morphology

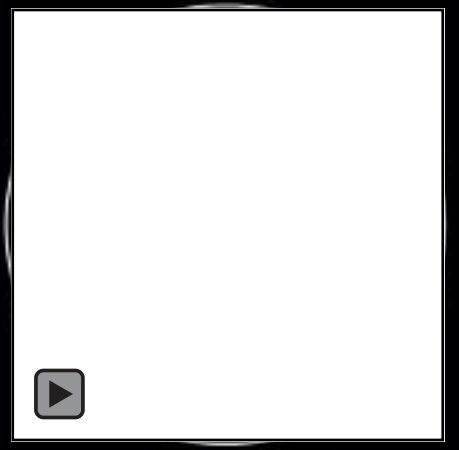




Lipidic



Fibrotic

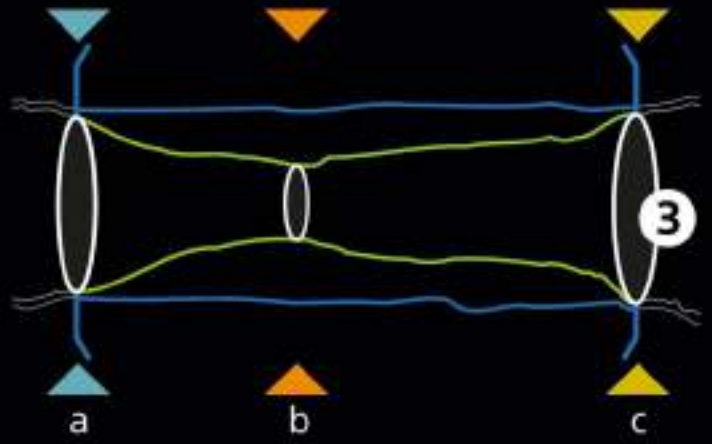


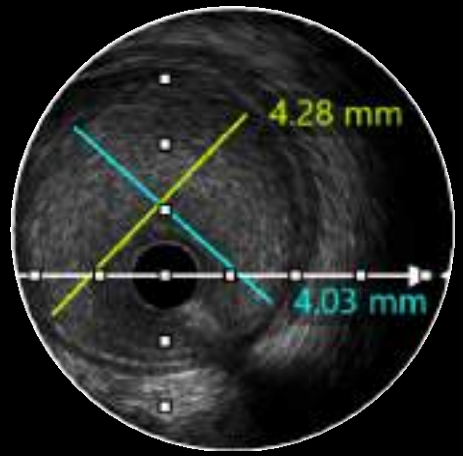
Calcium

Pre-stent workflow

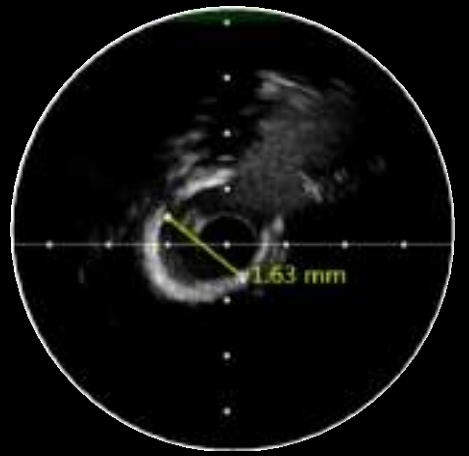
IVUS 1 2 3 ESSENTIALS

3 | Measure the vessel size

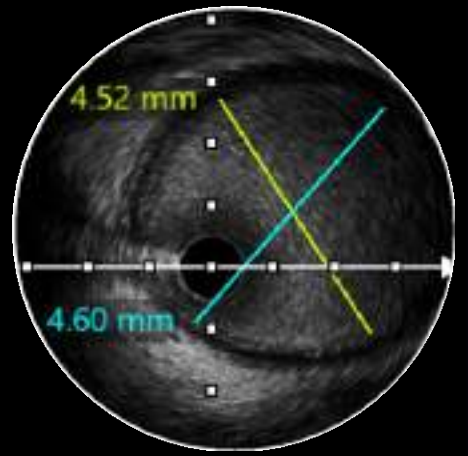




a Distal



b Stenosis



c Proximal

Post-stent workflow

IVUS 1 2 3 ESSENTIALS

1 | Check for geographic miss (a) and edge dissection (b)

Optimal landing zone

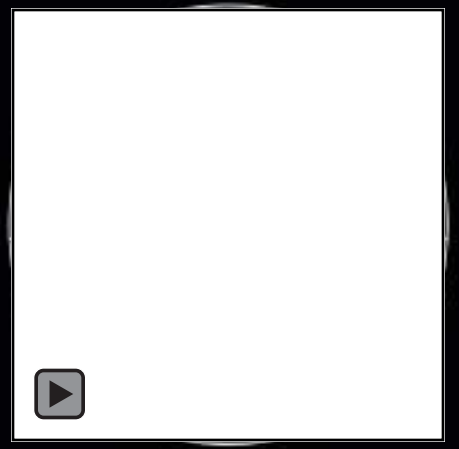
Geographic miss (a)

Edge dissection (b)

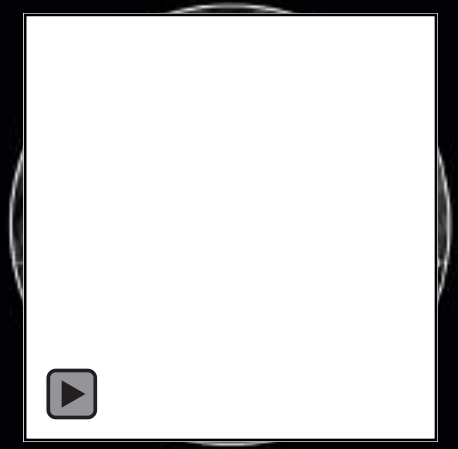
Post-stent workflow

IVUS 1 2 3 ESSENTIALS

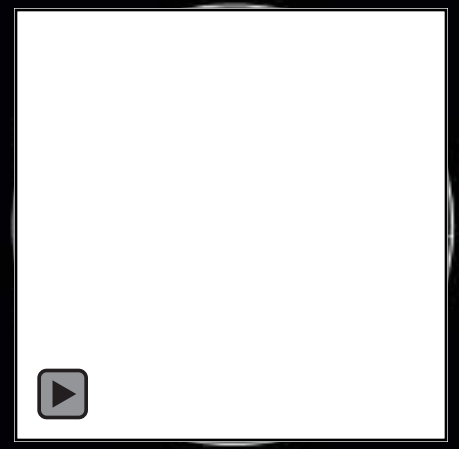
2 | Check for malapposition



✓ Apposed



✗ Malapposed

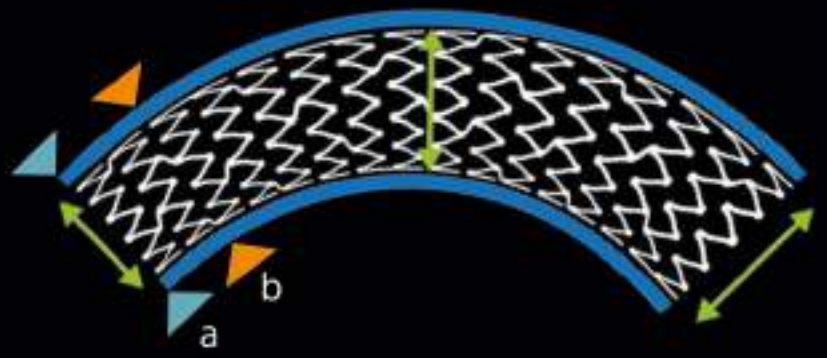


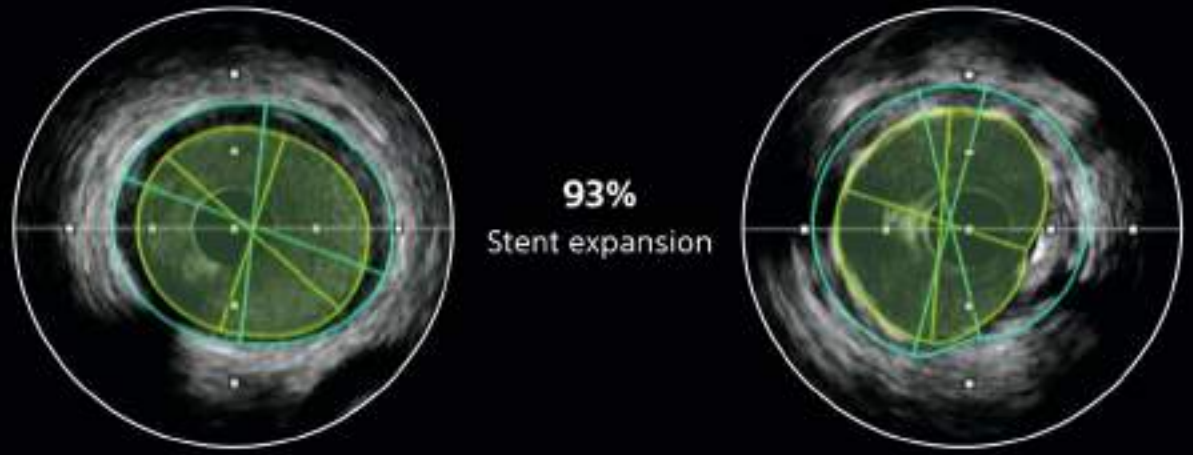
Side branch

Post-stent workflow

IVUS 1 2 3 ESSENTIALS

3 | Check for optimal stent expansion





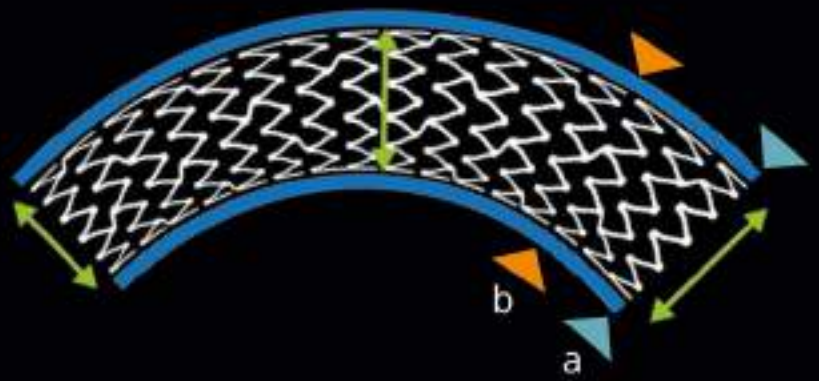
a Distal lumen reference

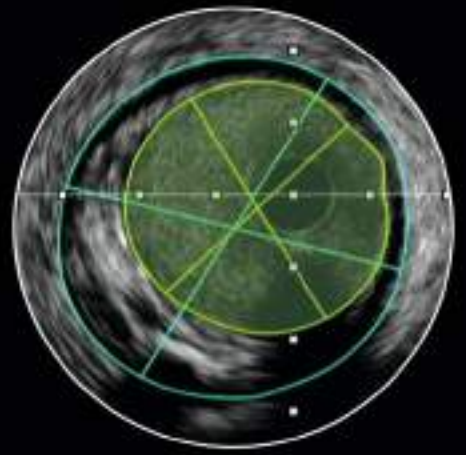
b Stent area

Post-stent workflow

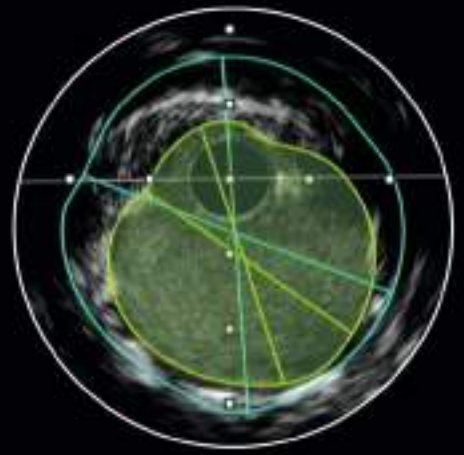
IVUS 1 2 3 ESSENTIALS

3 | Check for optimal stent expansion





95%
Stent expansion



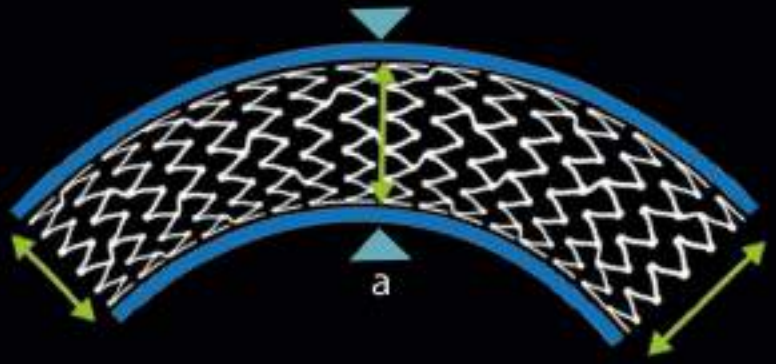
a Proximal lumen reference

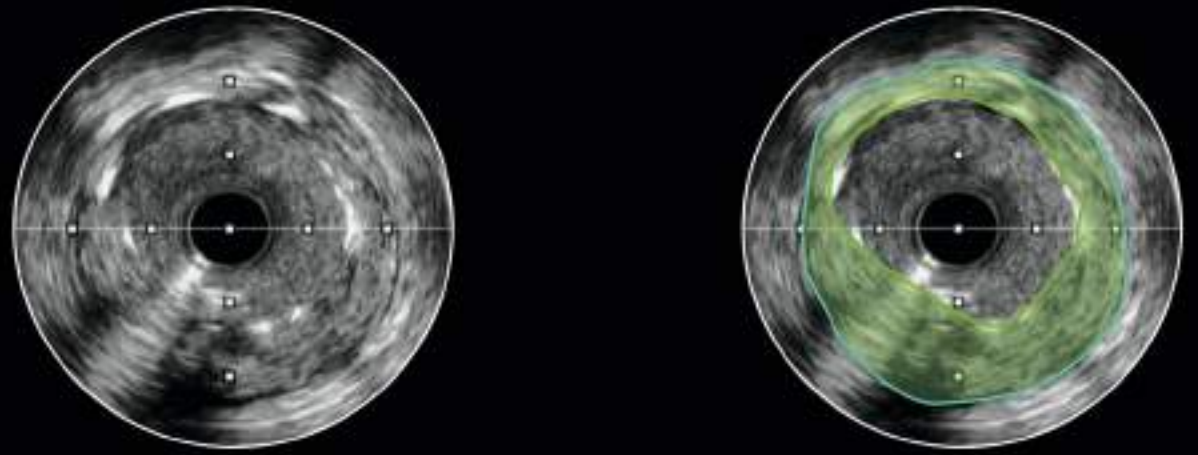
b Stent area

Post-stent workflow

IVUS 1 2 3 ESSENTIALS

3 | Check for optimal stent expansion





a Under-expanded