Intracoronary Physiology in the Catheterization Laboratory in 2019 – A Paradigm Shift from FFR to iFR?

The Diagnostic and Interventional Cardiology Nurses Group – February 27 2019

Nigel S Jepson

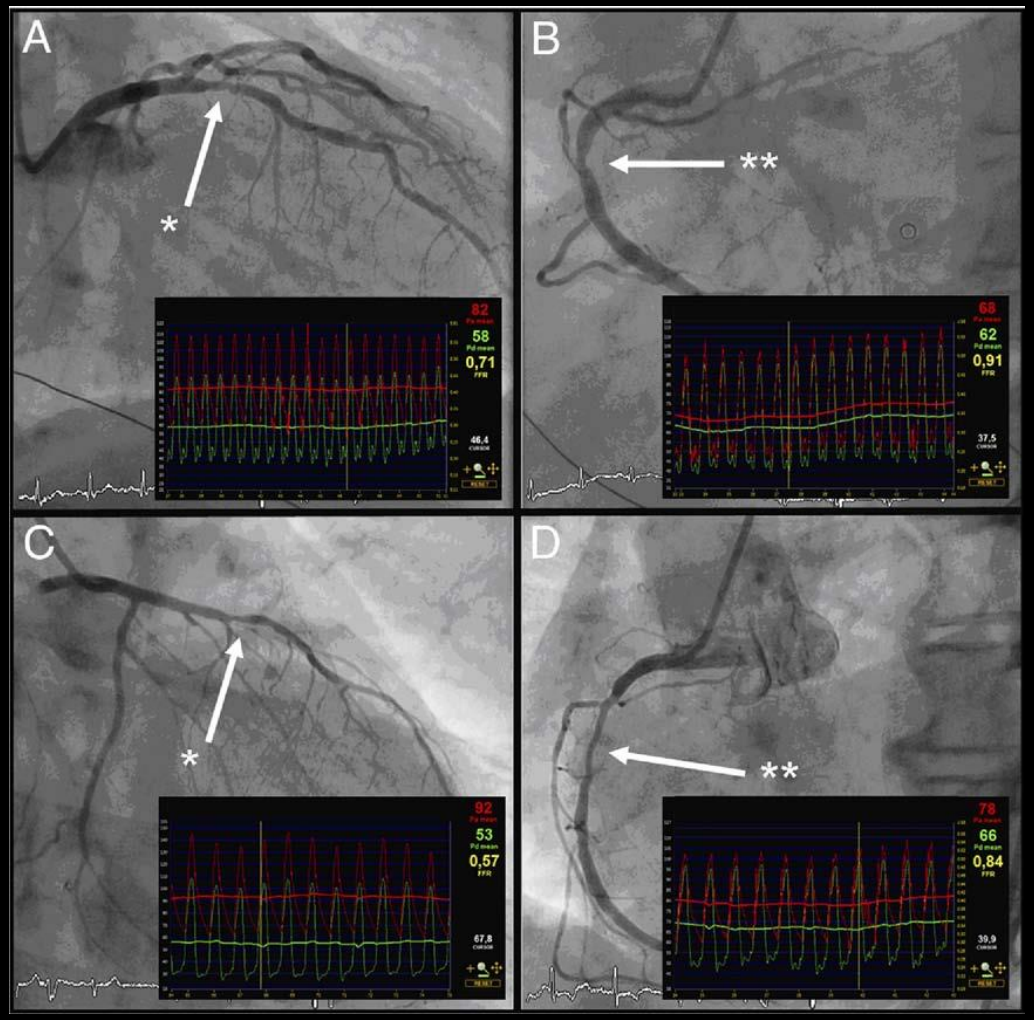
Director of Clinical Trials Unit, Prince of Wales Hospital
Director of Cardiac Catheterization Laboratories, Eastern Heart Clinic
A/Professor, Conjoint, University of New South Wales, Sydney, Australia

Limitations of Coronary Angiography

- 2D assessment of a 3D structure
- Large intra observer variability, improved with QCA
- Lumenogram which underestimates the extent of disease
- Eccentrici
- Foreshortening impacts assessment of severity
- % DS does not take lesion length into account therefore, resistance to flow for a given % DS is at best an educated guess
- Impact of serial stenoses is difficult to quantitate

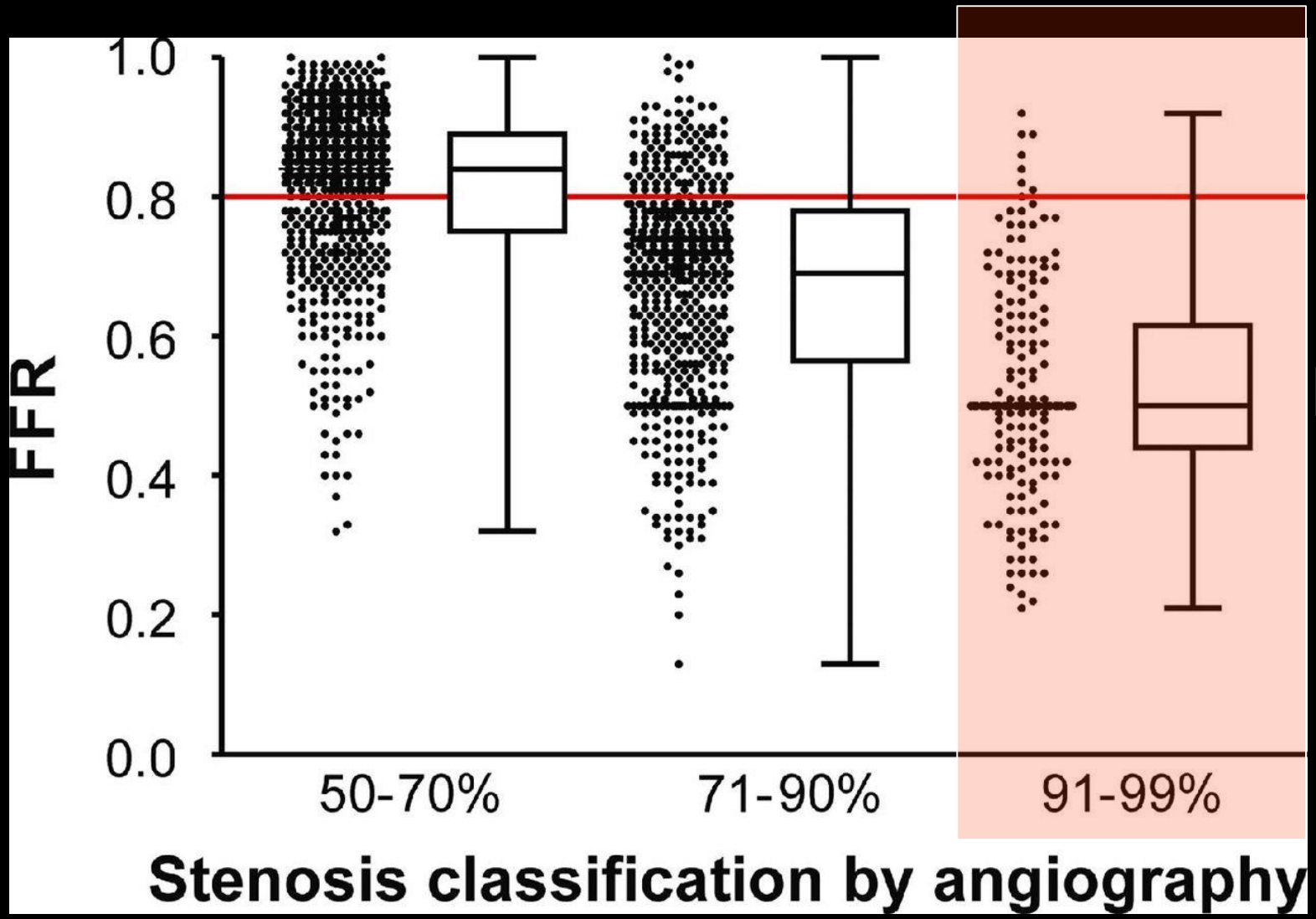
Structure vs Function

Angiography Similar…FFR Quite Different



Tonino PAL, et al. JACC 2010;55:2816–21

Angio/FFR Relationship – Stable IHD



96% functionally-significant

Tonino P et al. J Am Coll Cardiol 2010;55:2816–21

FFR modality (Fractional Flow Reserve)

Fractional flow reserve (FFR) *accurately measures the physiologic and hemodynamic significance of coronary stenoses.*

FFR measurement involves determining the ratio between the maximum achievable blood flow in the presence of a stenosis compared to the theoretical maximum flow in a normal coronary artery with a hypothetical absence of the stenosis.

Seamlessly switch between iFR and FFR modalities for your pressure measurement.

Fractional Flow Reserve (FFR): Basic Principles

Using Pressure to Get Flow

- ***Coronary pressure is simple to measure***
- ***Flow velocity is more challenging***

Fundamental Equation for relating Pressure and Flow:

$$P = Q \times R$$

Pressure = Flow x Resistance

or

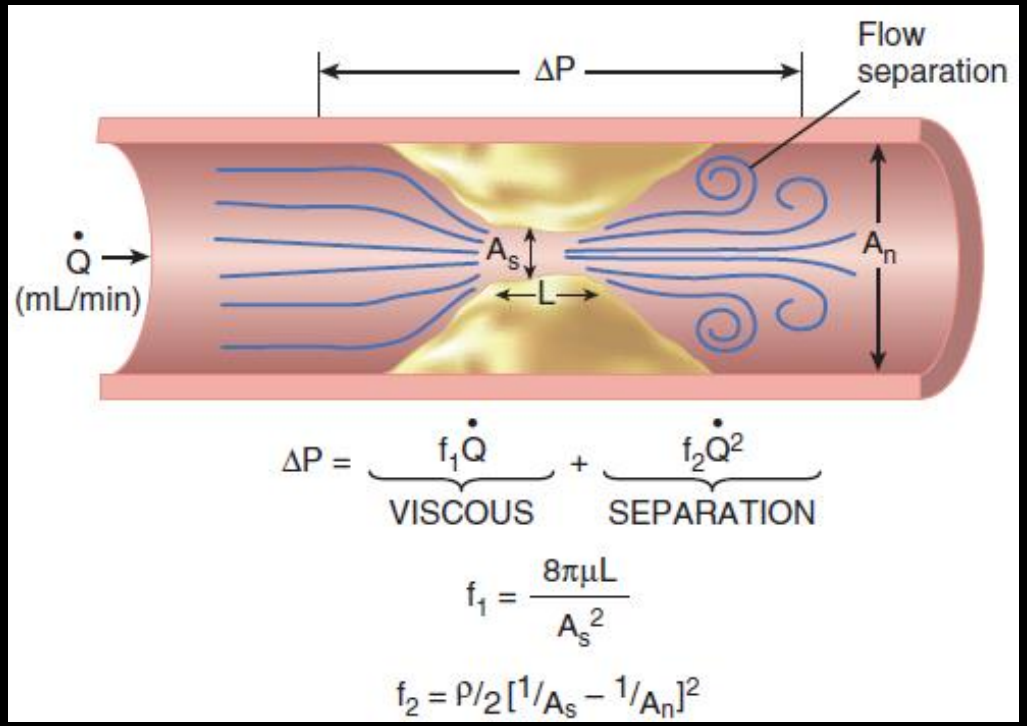
$$\Delta P \approx \Delta Q \times R$$

Change in Pressure = Change in Flow x Constant Resistance

When ***Resistance is Constant***, changes in Pressure are proportional to changes in Flow

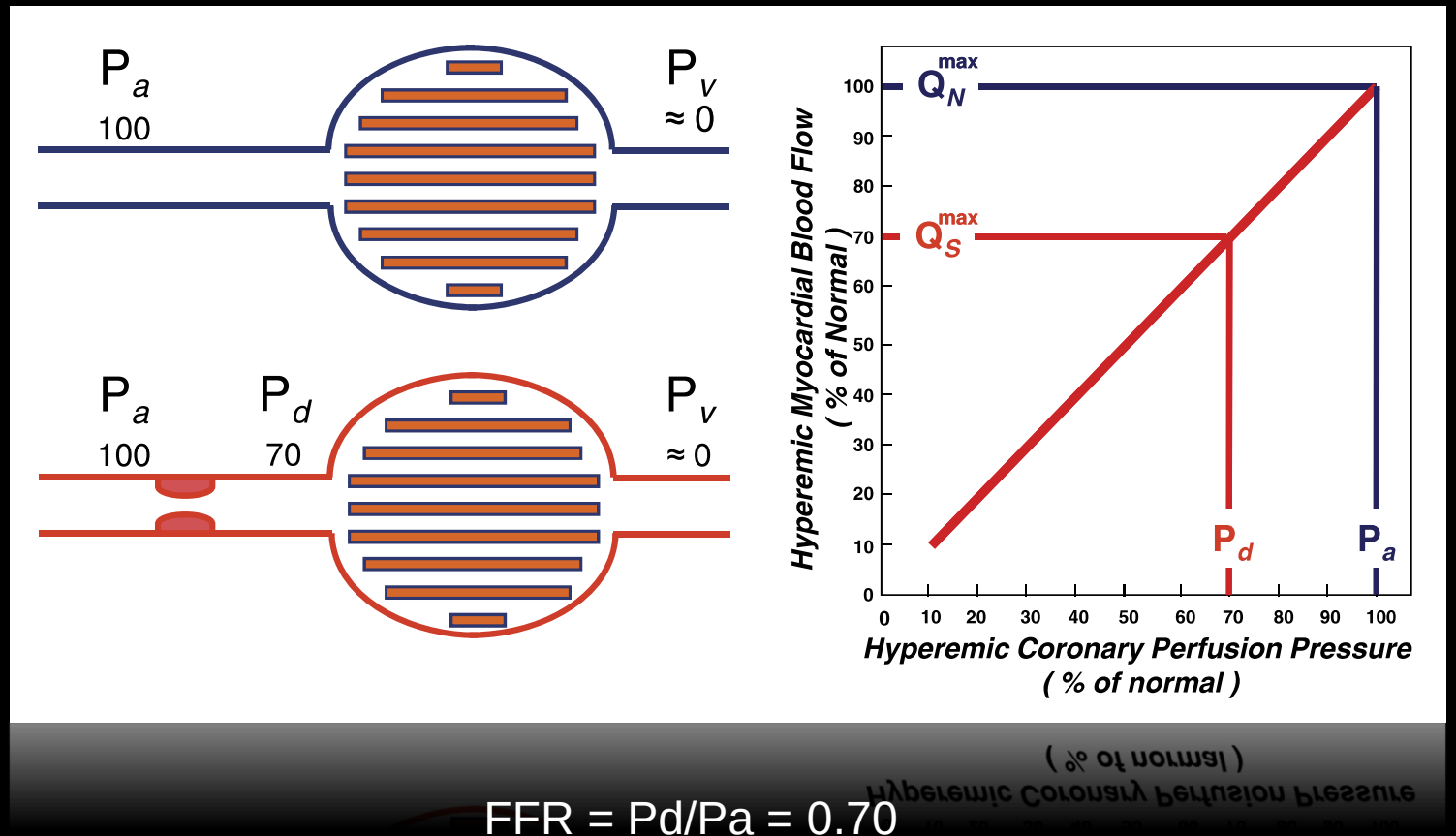
FFR: Basic Principles

- ***Coronary blood flow has 3 major resistance components: the epicardial vessel, the small arteries and arterioles (site of most autoregulation in normal vessels), and the intramyocardial capillary system.***
- ***Pressure drop across a stenosis is related to loss of energy due to viscous and separation loses as well as turbulence***



FFR: Basic Principles

FFR = Ratio of distal mean coronary pressure to mean aortic pressure in the stenotic vessel during maximum hyperaemia



FFR = Pd/Pa = 0.70

Pijls NH and Sels JWEM. JACC 2012;59:1045–57

FFR: Hyperaemic Stimuli

Epicardial vasodilation	
Isosorbide dinitrate	At least 200-μg ic bolus, at least 30 s before the first measurements
Microvascular vasodilation	
Adenosine or ATP ic	At least 40-μg ic bolus in the RCA, 40–80 μg in the LCA
Papaverine ic	10–12 mg in the RCA, 15–20 mg in the LCA
Adenosine or ATP iv	140 μg/kg/min (preferably through a central venous, e.g., femoral line)

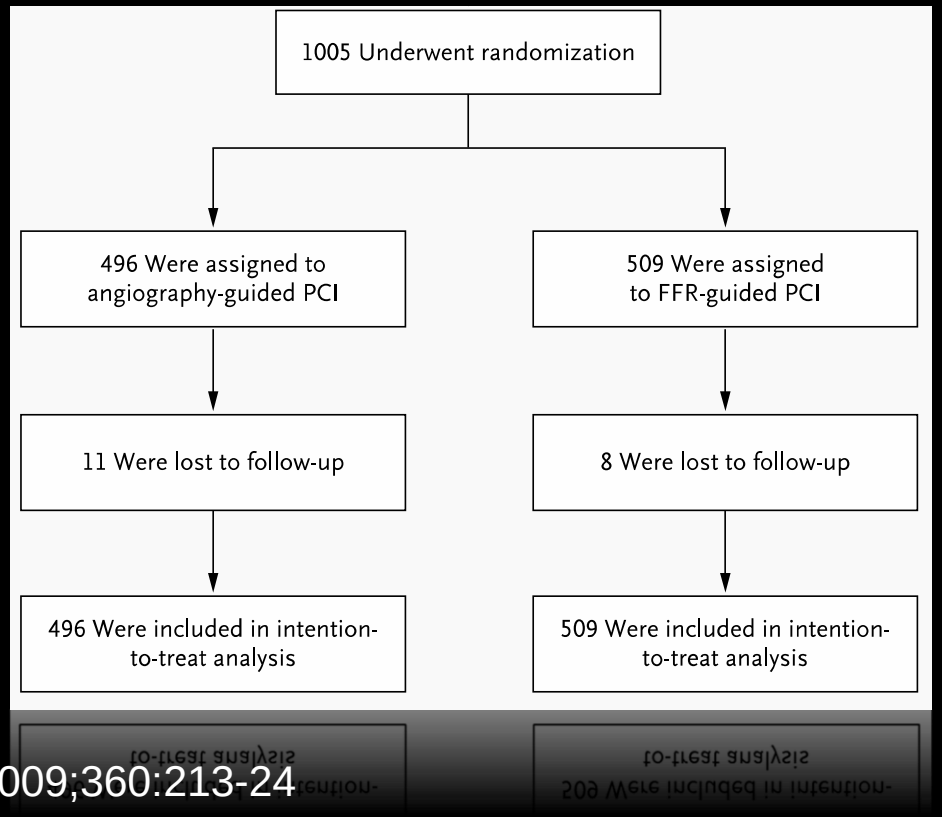
Pijls NH and Sels JWEM. JACC 2012;59:1045–57

FFR Landmark Studies

FFR Outcome Study	No.	Study Design	Questions	Outcome	Journal
DEFER (2007-2015)	325	Prospective, MC, RCT	Is it safe to DEFER stenting intermediate lesions with FFR>0.75	Less MACE; OMT with FFR>0.75	JACC
FAME (2009-2015)	750	Prospective, MC, RCT	Does FFR-Guided PCI vs. Angio-Guided PCI for MVD improve outcomes ?	Less MACE; Reduced cost with FFR	NEJM
FAME II (2012)	1220	Prospective, MC, RCT	Does FFR-Guided PCI + OMT vs. OMT ALONE, improve outcomes ?	Less MACE with FFR, and cost effective	NEJM

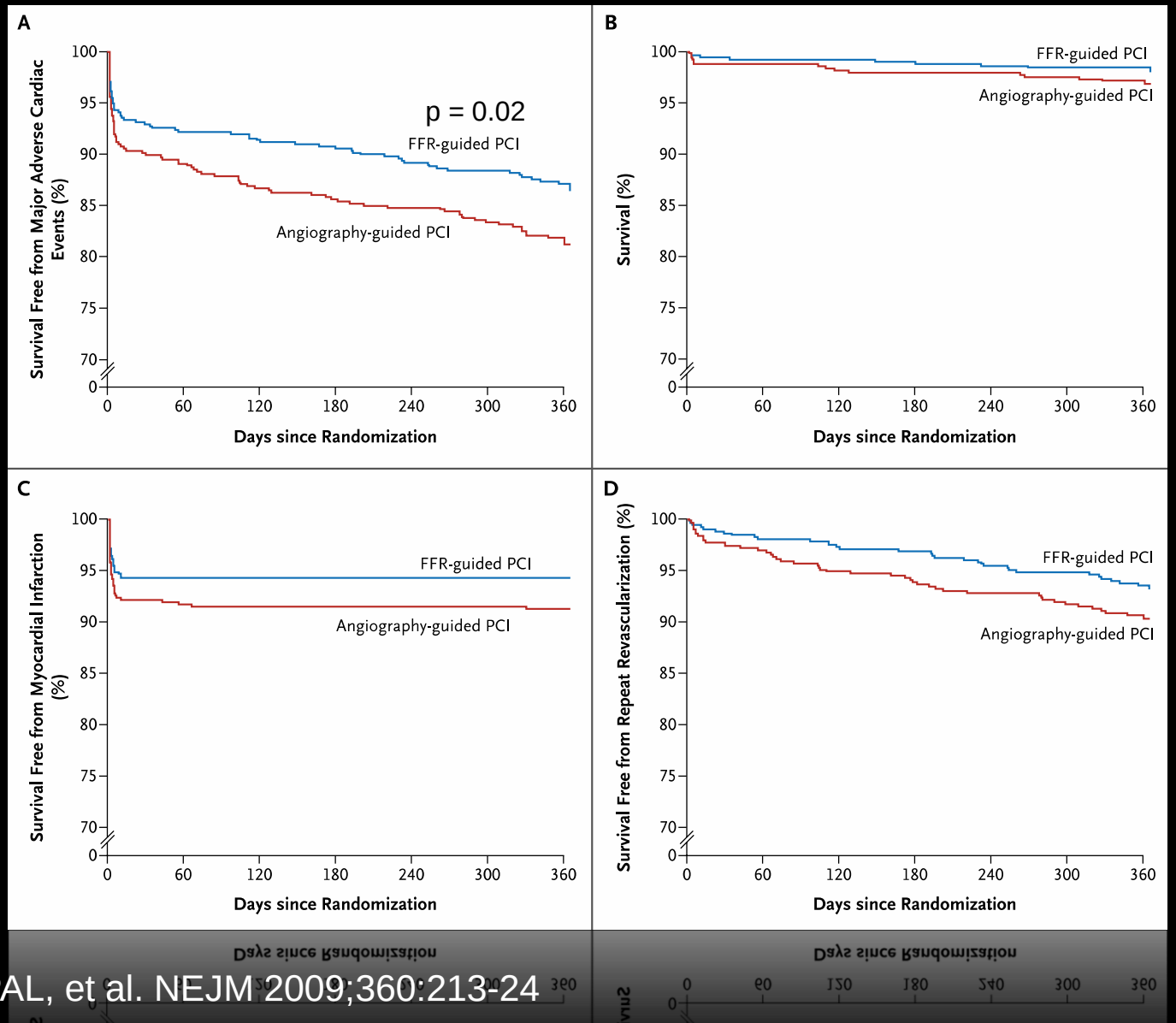
FAME

- *1005 patients with multivessel disease randomized to either angiographic or FFR guided PCI using 1st generation DES*
- *1 year follow up: composite of death, MI and any repeat revascularization*



Tonino PAL, et al. NEJM 2009;360:213-24

FAME: 1 Year Outcomes



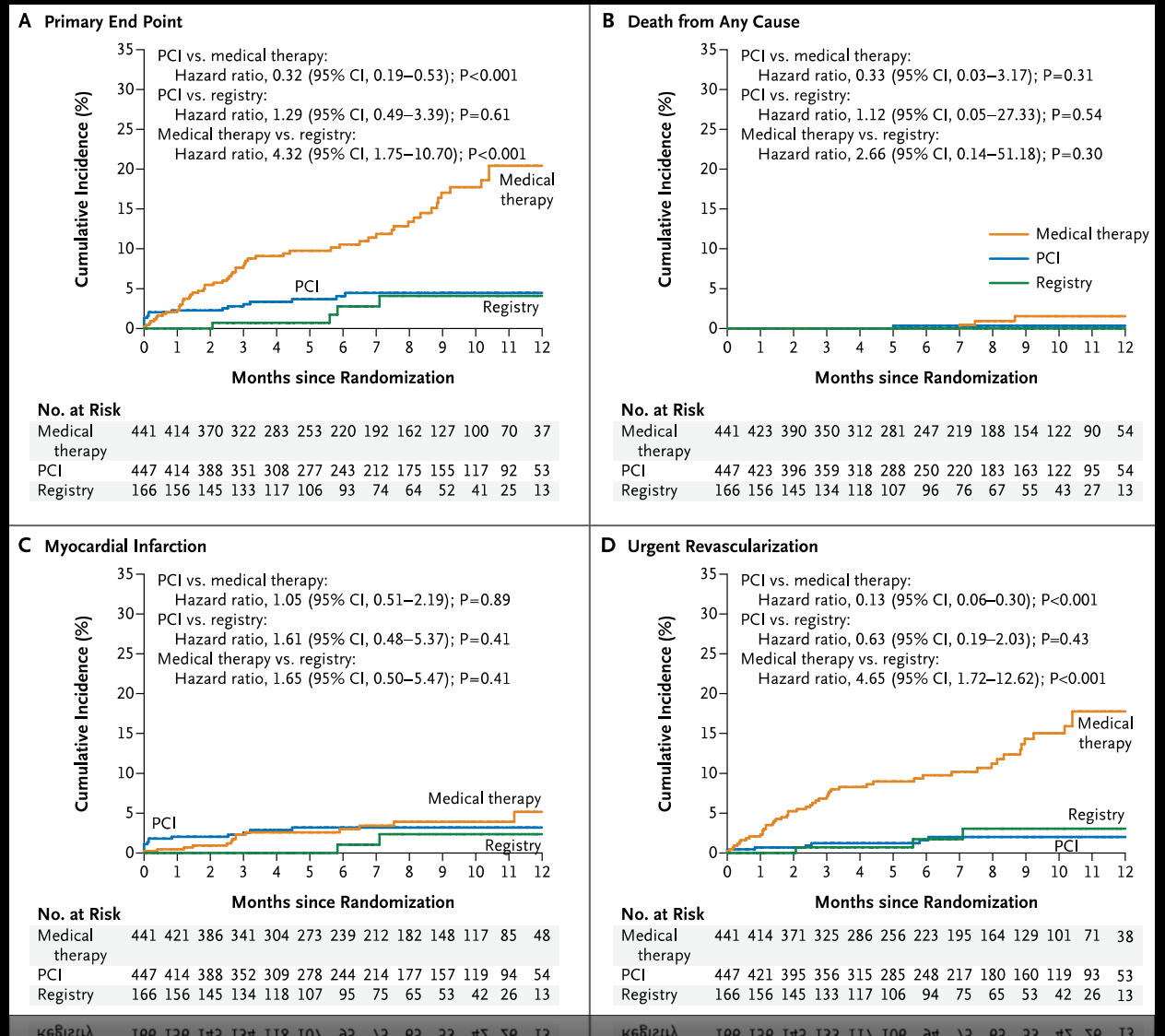
Tonino PAL, et al. NEJM 2009;360:213-24

FAME 2

- ***Stable CAD with at least one significant lesion by FFR. Slightly over 50% had single vessel disease***
- ***Tested the hypothesis of optimal medical therapy alone vs FFR guided intervention and optimal medical therapy***
- ***Primary endpoint was a composite of death, non fatal MI, or urgent revascularization at 24 months***
- ***Stopped prematurely after approximately 50% of the pre- specified patients had been randomized due to urgent revascularization in the OMT group***

De Bruyne B, et al. NEJM DOI: 10.1056/NEJMoa1205361

FAME 2



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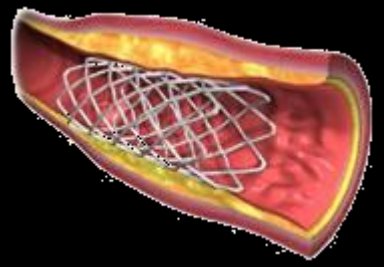
FFR Cut Point

0.8 1.0

Significant/ PCI	Non-Significant/ OMT

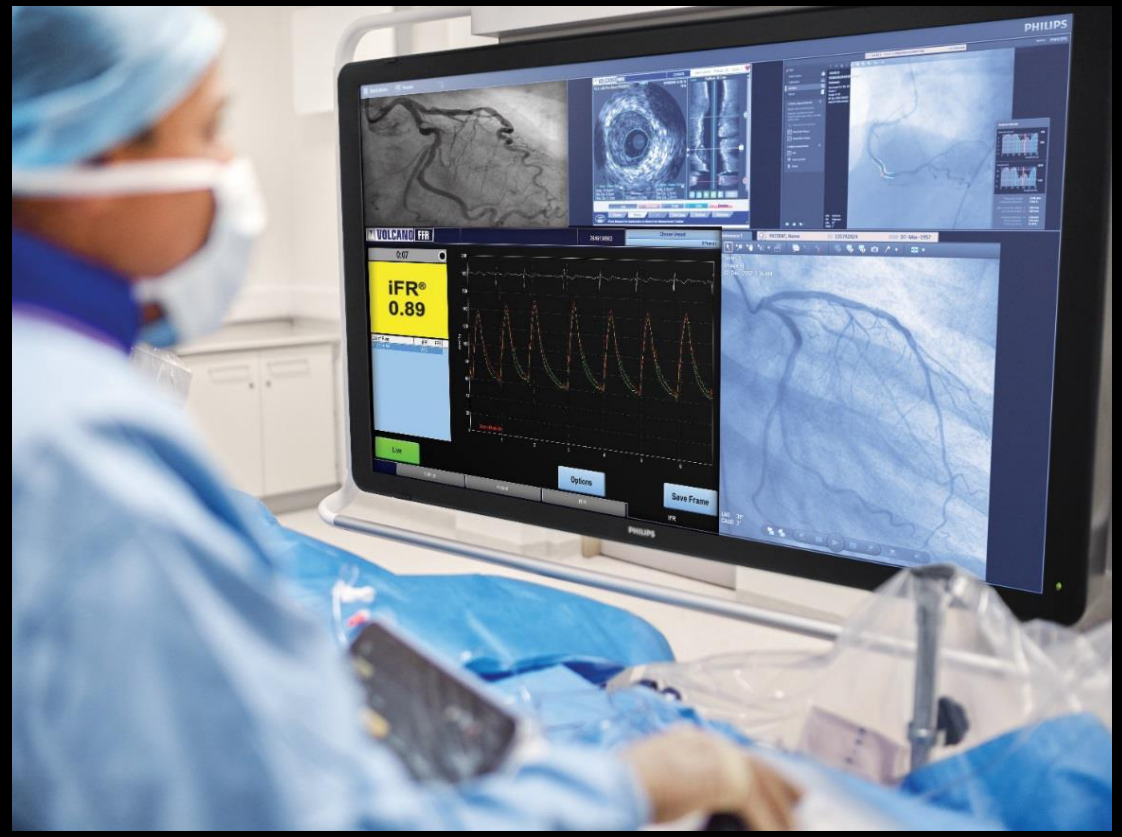


Significant

Non-Significant

iFR: The New Kid on the Block

iFR modality (Instant wave Free-Ratio)



Philips‘ proprietary instantaneous, trans-lesional pressure ratio, namely iFR, is measured during the wave-free period and assesses coronary lesion significance in a minimum of five heartbeats without the need for hyperaemic agents.

Benefits

- • One wire, one system and multi-modality.
- • Achieve a 90% reduction in patient discomfort by not requiring hyperaemic agent, as is required by FFR.
- • Save 10% of procedural time with an iFR guided approach.
- Save 10% of procedural costs per patient with an iFR guided approach.

Using Pressure to Get Flow

- ***Coronary pressure is simple to measure***
- ***Flow velocity is more challenging***

Fundamental Equation for relating Pressure and Flow:

$$P = Q \times R$$

Pressure = Flow x Resistance

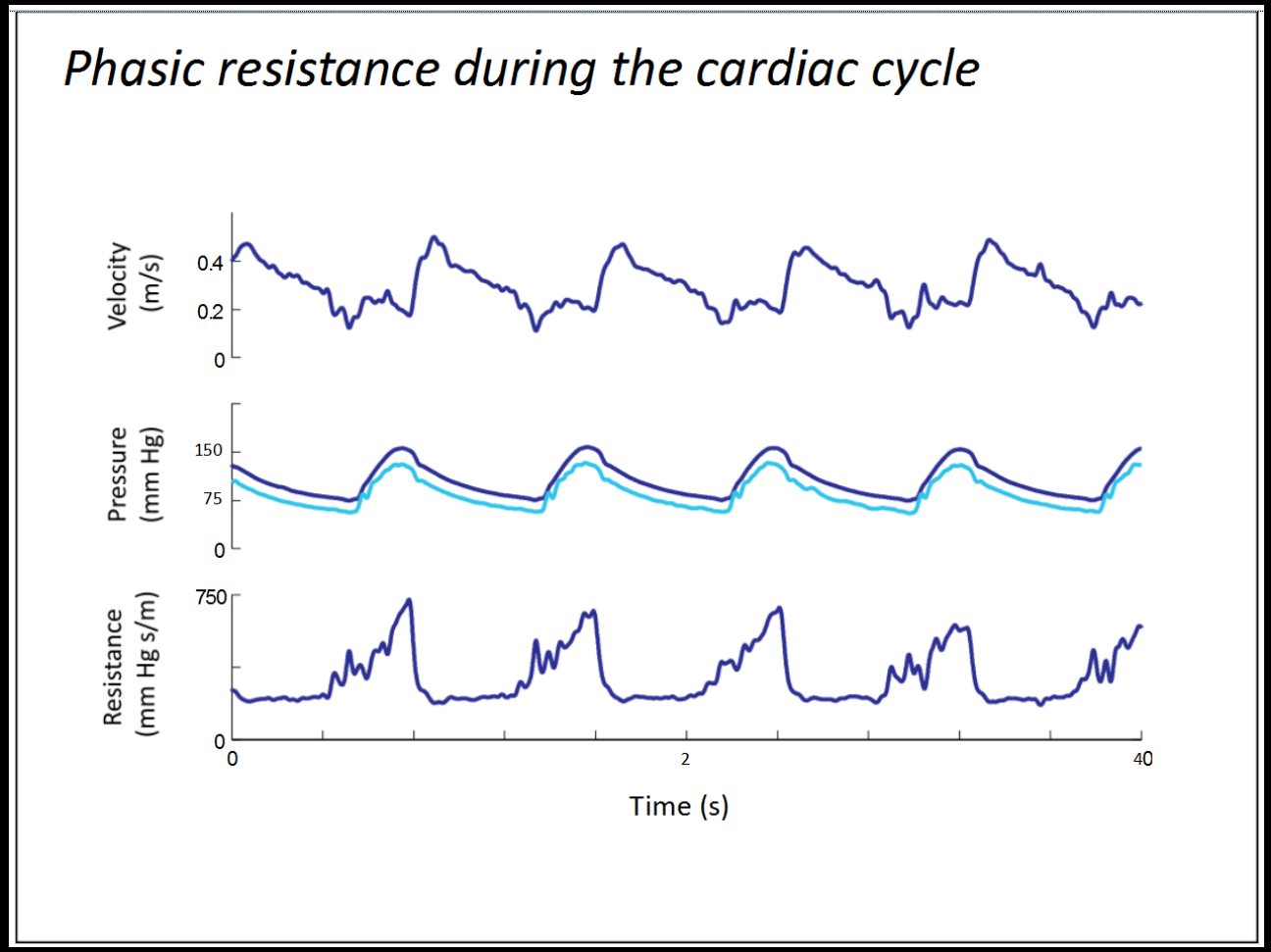
or

$$\Delta P \approx \Delta Q \times R$$

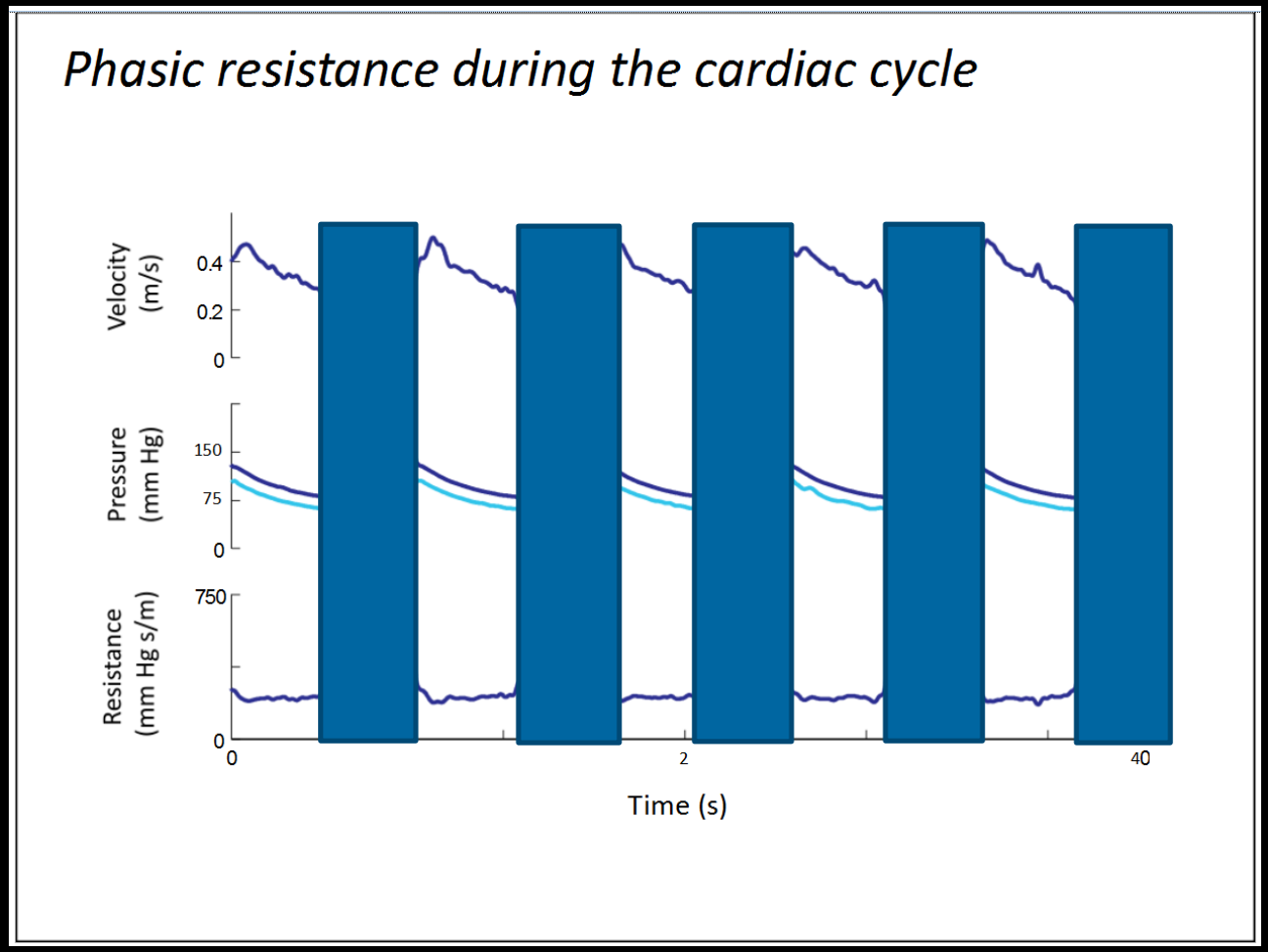
Change in Pressure = Change in Flow x Constant Resistance

When ***Resistance is Constant***, changes in Pressure are proportional to changes in Flow

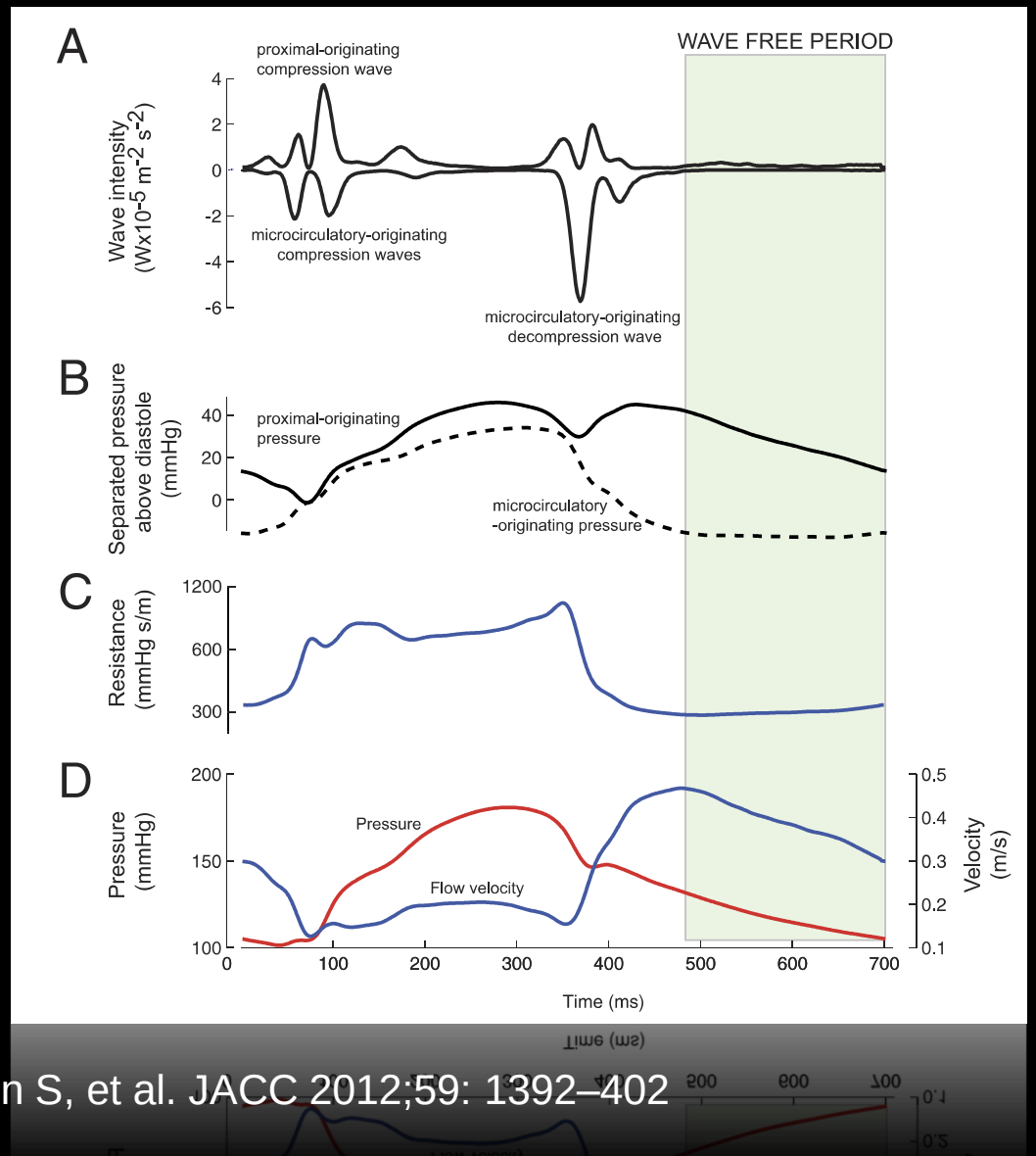
Resistance is Constant in the Wave-Free Period

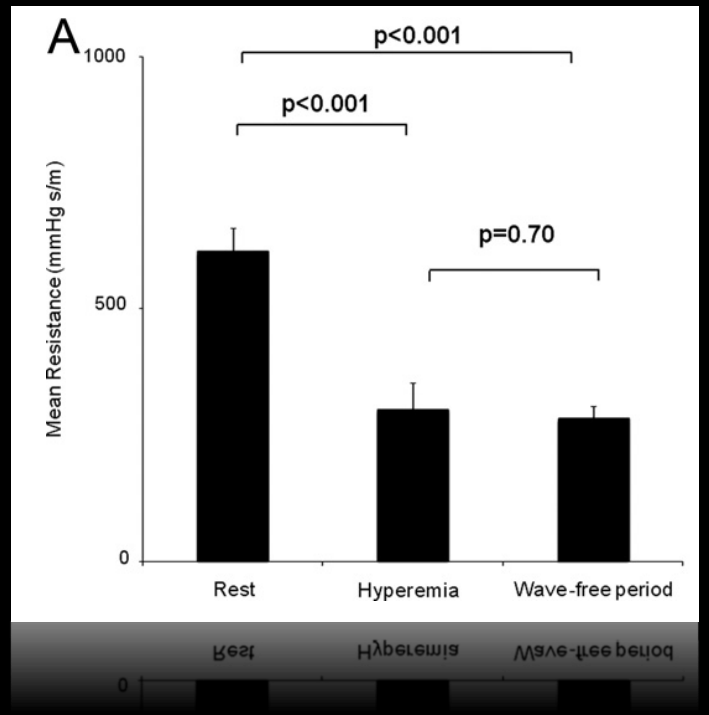


Resistance is Constant in the Wave-Free Period



Instant Wave-free Ratio (iFR): Concept

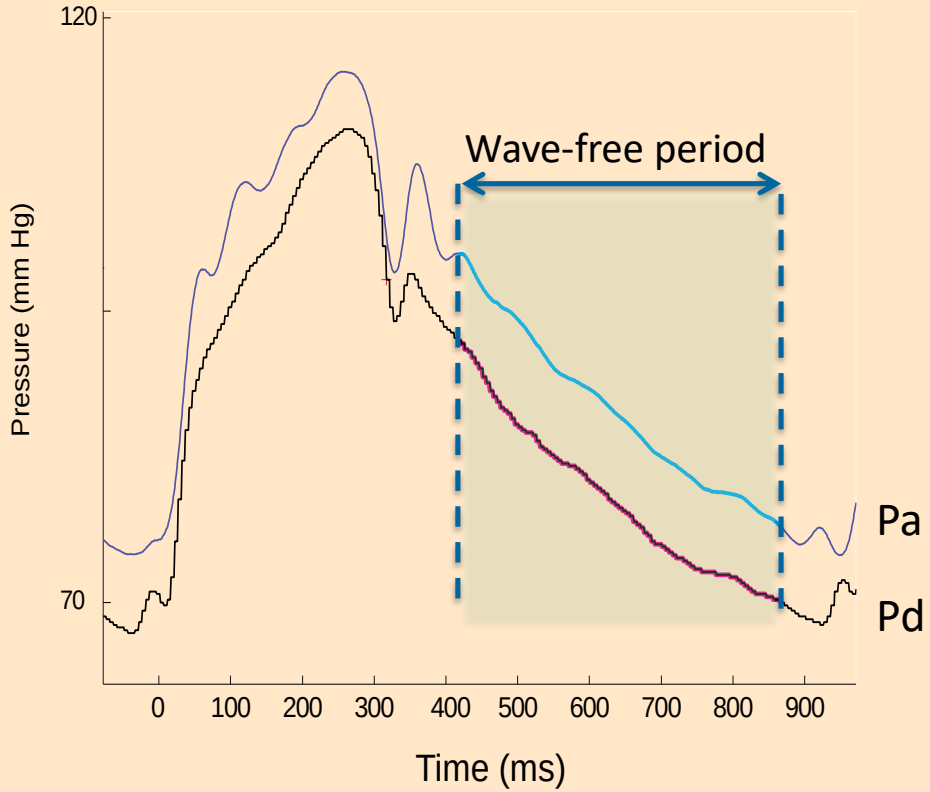




Sen S, et al. JACC 2012;59: 1392–402

Introduction of the iFR® Modality

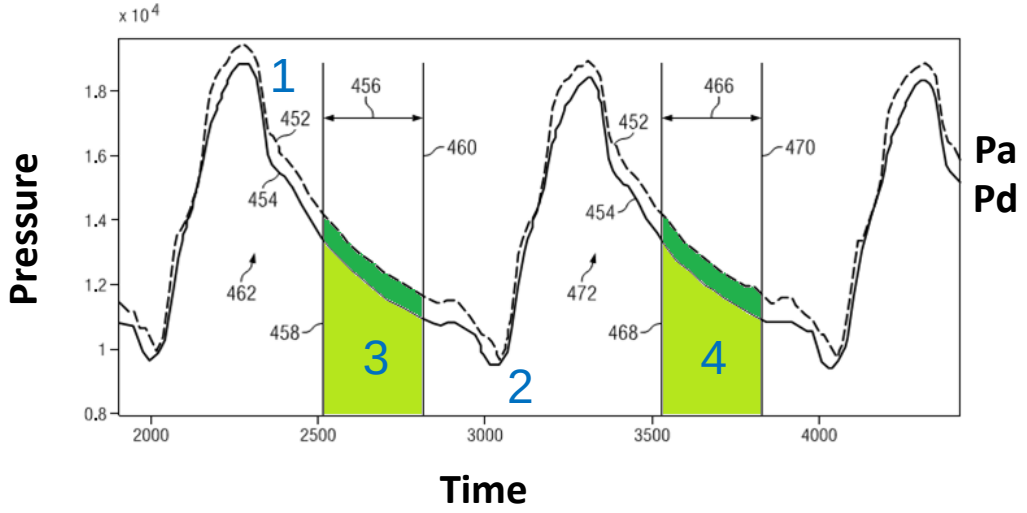
Definition: Instantaneous pressure ratio, across a stenosis during the wave-free period, when ***resistance is naturally constant*** and minimized in the cardiac cycle



How is iFR Calculated Now ?

1. Identify a landmark at the beginning of diastole
2. Identify the end of the cardiac cycle
3. Select a “diastolic window” using those landmarks
4. Calculate the iFR values for the first five cardiac cycles
5. Add additional cardiac cycles until a stable iFR value is obtained
6. Report the iFR value

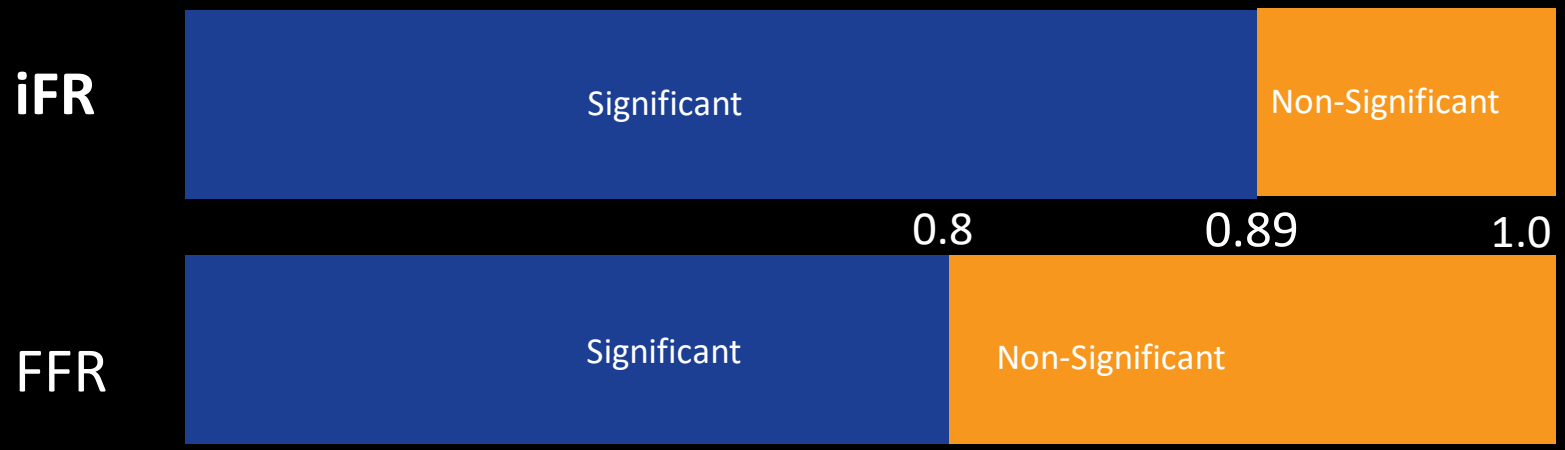
The step where ECG was previously used



The iFR® Modality Cut Point

An iFR cut point of 0.89 matches an FFR cut point of 0.80[1]

- **FFR and iFR have a different scale**

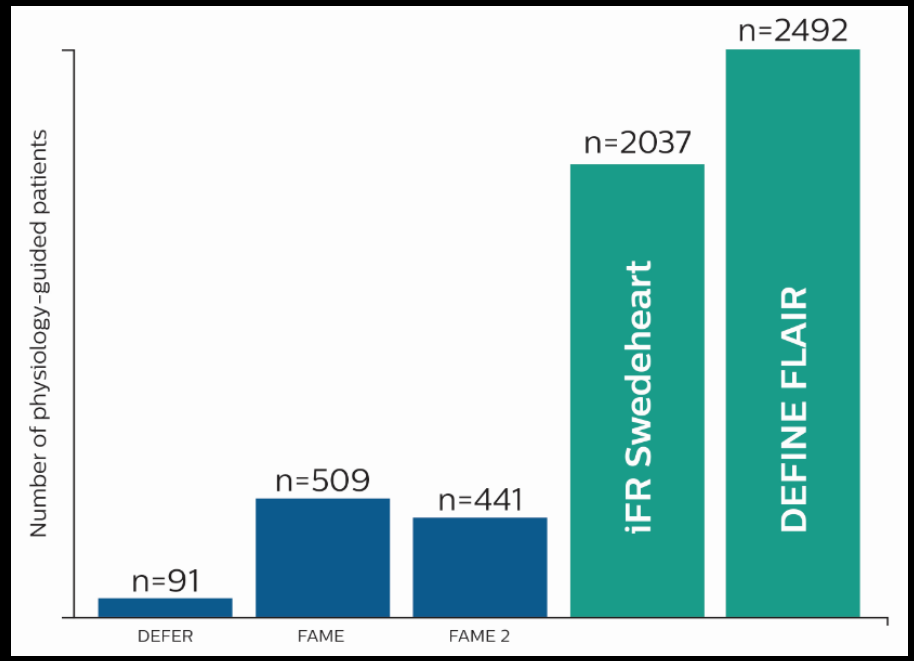


1. An iFR cut-point of 0.89 matches best with an FFR ischemic cut-point of 0.80 with a specificity of 87.8% and sensitivity of 73.0%. (iFR Operator's Manual 505-0101.23)

iFR Outcome Data

From the largest global physiology studies …

- DEFINE FLAIR and iFR Swedeheart are landmark physiology studies
- **4500+** patients, more than twice the combined patient population of previous landmark physiology studies
  - DEFINE FLAIR: n = 2492 patients
  - iFR Swedeheart: n = 2037 patients
- **2** prospective, randomized, controlled trials
- Published in The New England Journal of Medicine[1,2]



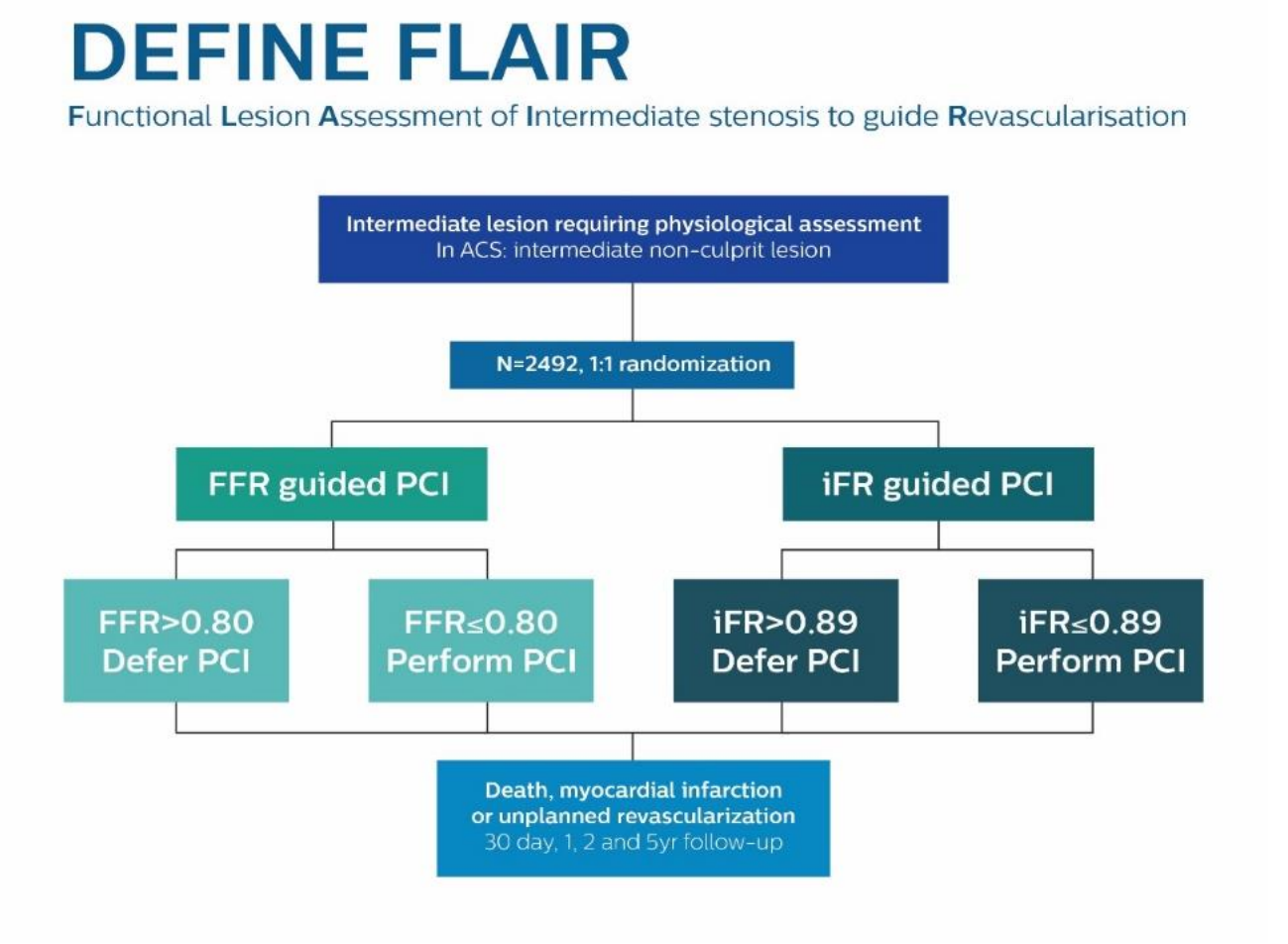
The NEW ENGLAND JOURNAL *of* MEDICINE

1. Davies JE, et al., DEFINE-FLAIR: A Multi- Centre, Prospective, International, Randomized, Blinded Comparison of Clinical Outcomes and Cost Efficiencies of iFR and FFR Decision-Making for Physiological Guided Coronary Revascularization. New England Journal of Medicine, epub March 18, 2017
2. Gotberg M, et al., Instantaneous Wave-Free Ratio Versus Fractional Flow Reserve Guided Intervention (IFR-SWEDEHEART): A Multicenter, Prospective, Registry-Based Randomized Clinical Trial. New England Journal of Medicine, epub March 18, 2017

Study Design

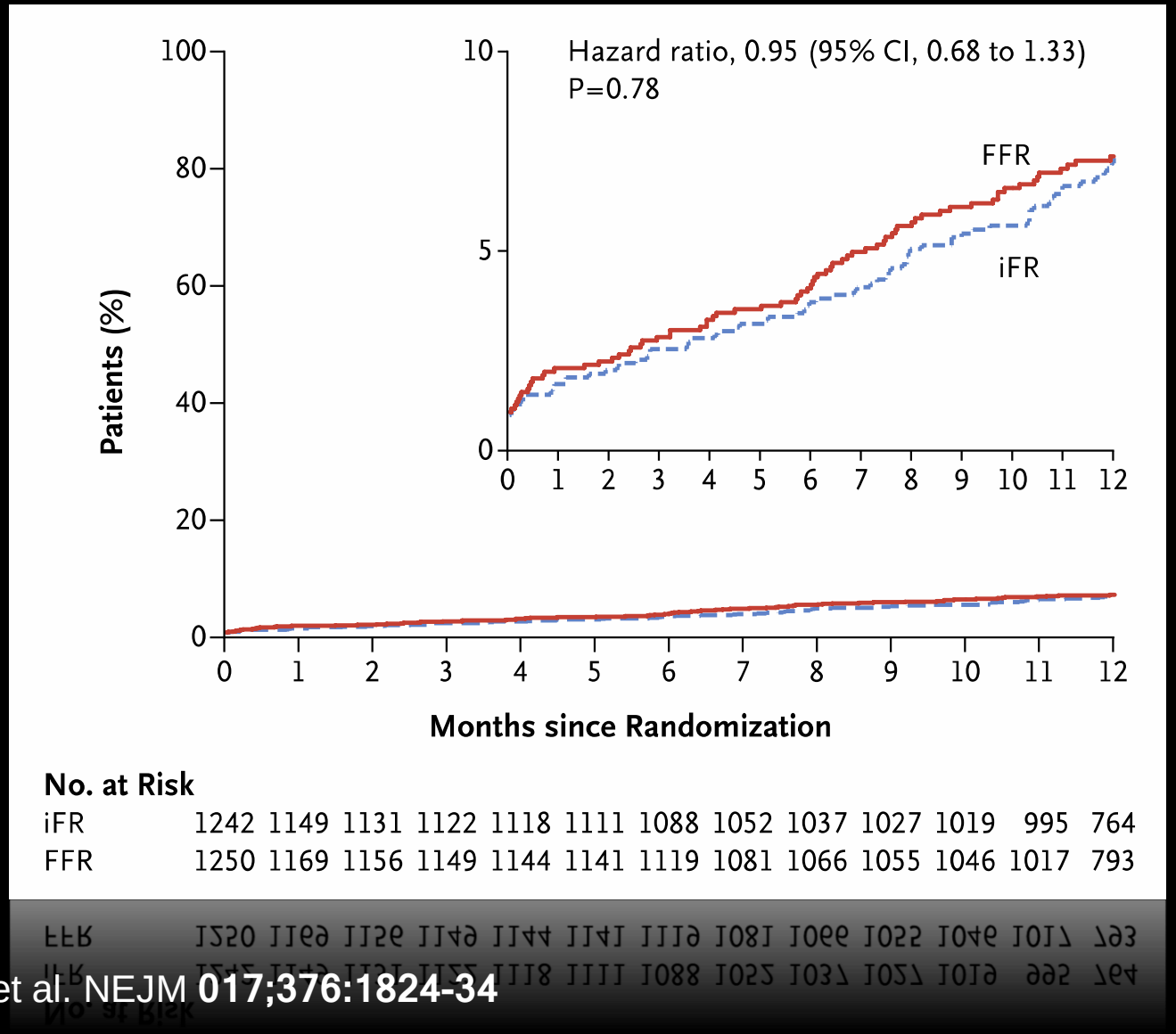
DEFINE FLAIR

Functional Lesion Assessment of Intermediate stenosis to guide Revascularisation



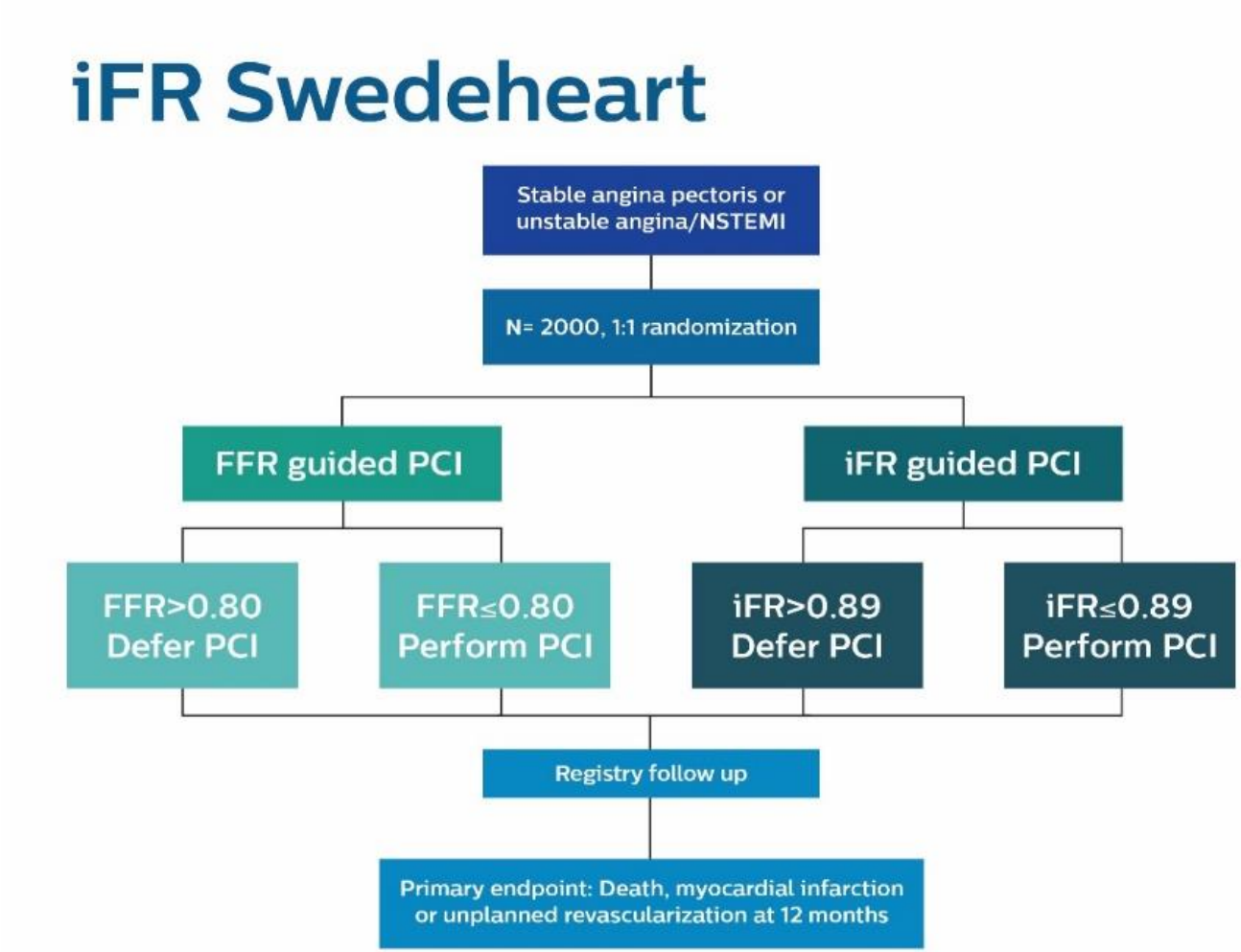
Non inferiority trial

DEFINE-FLAIR Primary End Point: Composite of death from any cause, nonfatal MI, or unplanned revascularization



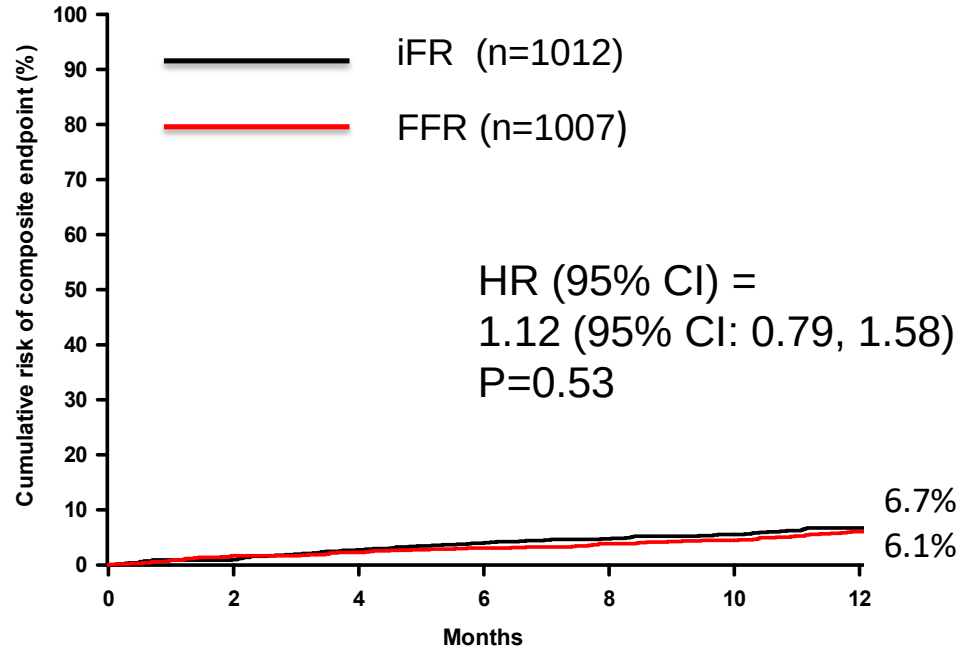
Davies JE, et al. NEJM **017;376:1824-34**

iFR-Swedeheart



Primary Endpoint at 12 months

(Death, MI, Unplanned revascularization)

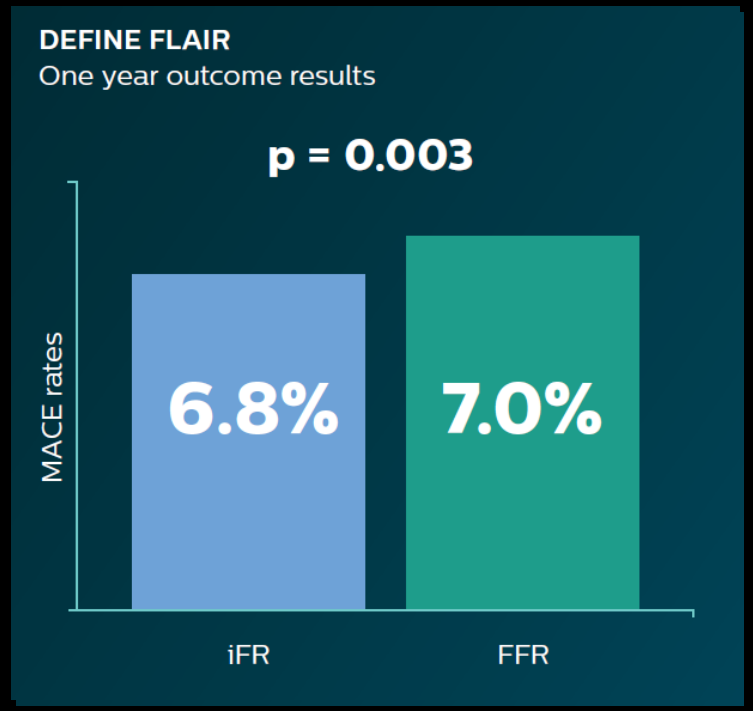


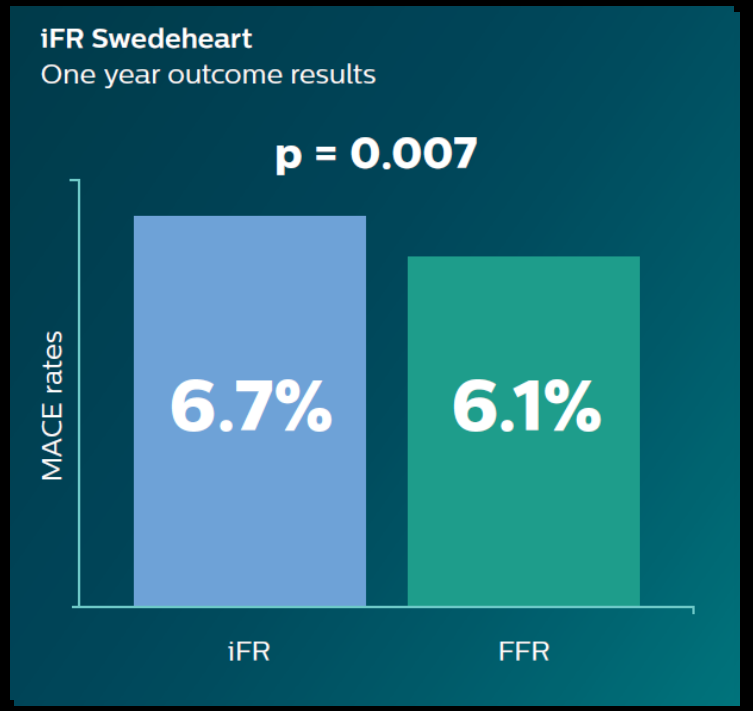
No. at Risk

iFR	1012	1002	984	971	963	956	944
FFR	1007	990	984	976	968	961	946

Consistent patient outcomes

- **An iFR-guided strategy is statistically comparable to an FFR-guided strategy for patient outcomes***
  - **Primary endpoint: major cardiovascular adverse event rates, assessed at 1-year**

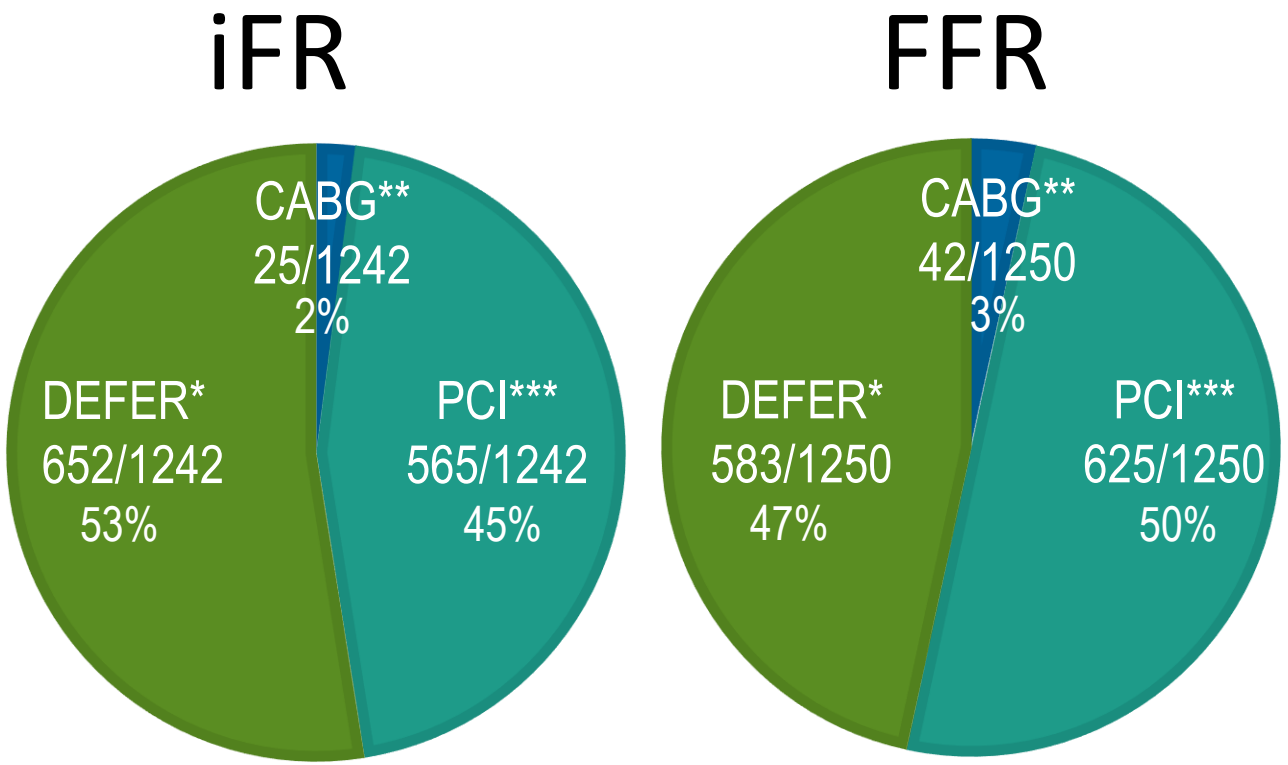




* p-values are for non-inferiority of an iFR-guided strategy versus an FFR-guided strategy with respect to 1-year MACE rates; pre-specified non-inferiority margins were 3.4% and 3.2% in DEFINE FLAIR and iFR Swedeheart, respectively

Treatment allocation with iFR and FFR

DEFINE FLAIR



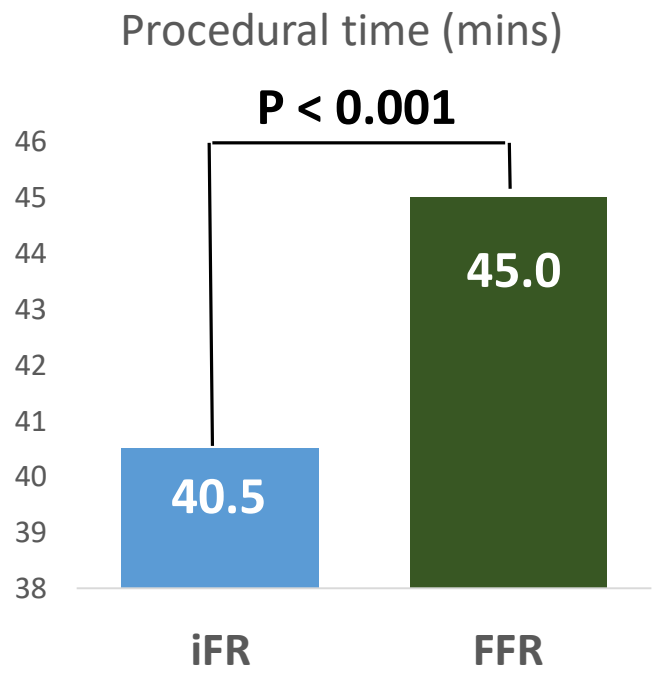
p for comparison between patients randomized to iFR and FFR

DEFER* p=0.003
CABG** p=0.04
PCI*** p=0.02

Significantly less revascularization based on iFR interrogation

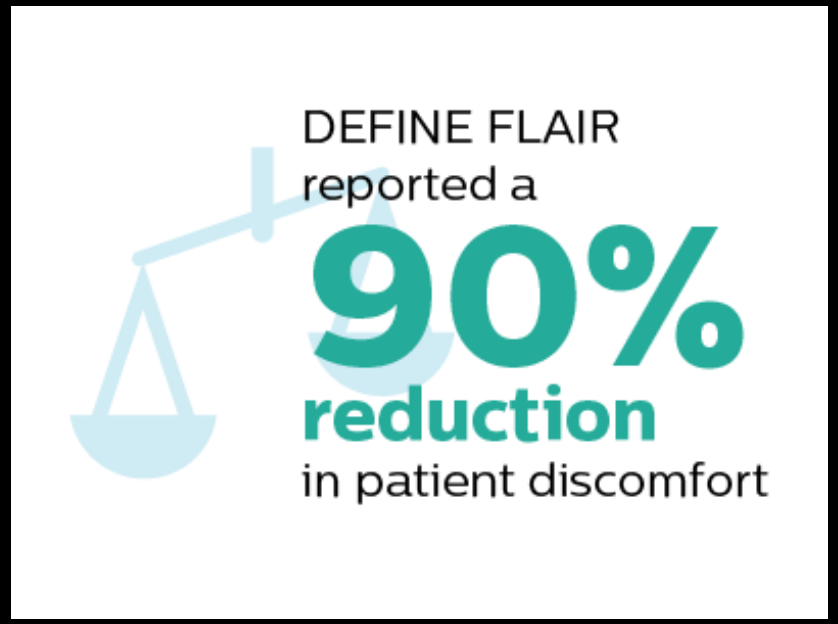
An iFR-guided strategy significantly decreases procedural time

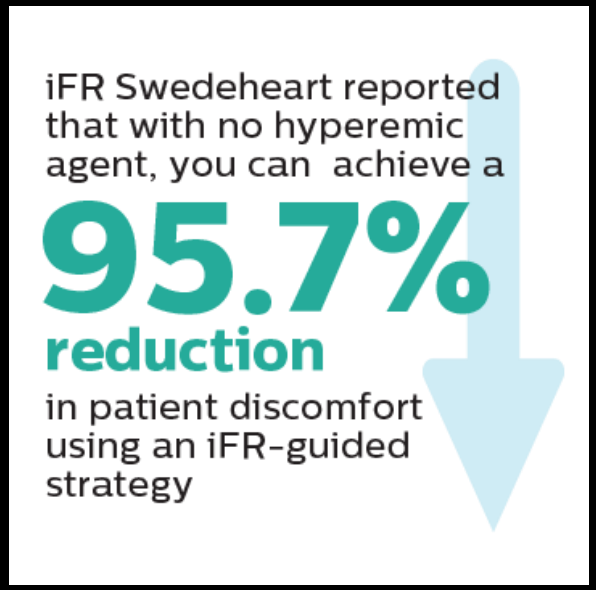
- ***DEFINE FLAIR reported an average procedural time of 40.5 minutes in the iFR arm, vs. 45.0 minutes in the FFR arm (p < 0.001)***
- ***This means a 10% reduction in procedural time***



An iFR-guided strategy significantly reduces patient discomfort

Validated in two of the largest physiologic outcomes studies





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Summary – FFR/iFR Rationale, Evidence and Practical Considerations

- Coronary angiography has significant limitations when used to assess the significance of coronary disease
- FFR is a tool that has broad application in the assessment of the functional significance of coronary disease
- It can be used in isolated as well as more complex lesion sets
- Insignificant lesions, as assessed by FFR, can be safely managed medically
- The newer iFR modality has been well demonstrated to produce comparable results (and clinical outcomes) to FFR in guiding revascularization decision making
- iFR offers advantages – shorter procedure times, no Adenosine, patient comfort

iFR and FFR – Are there any Differences?

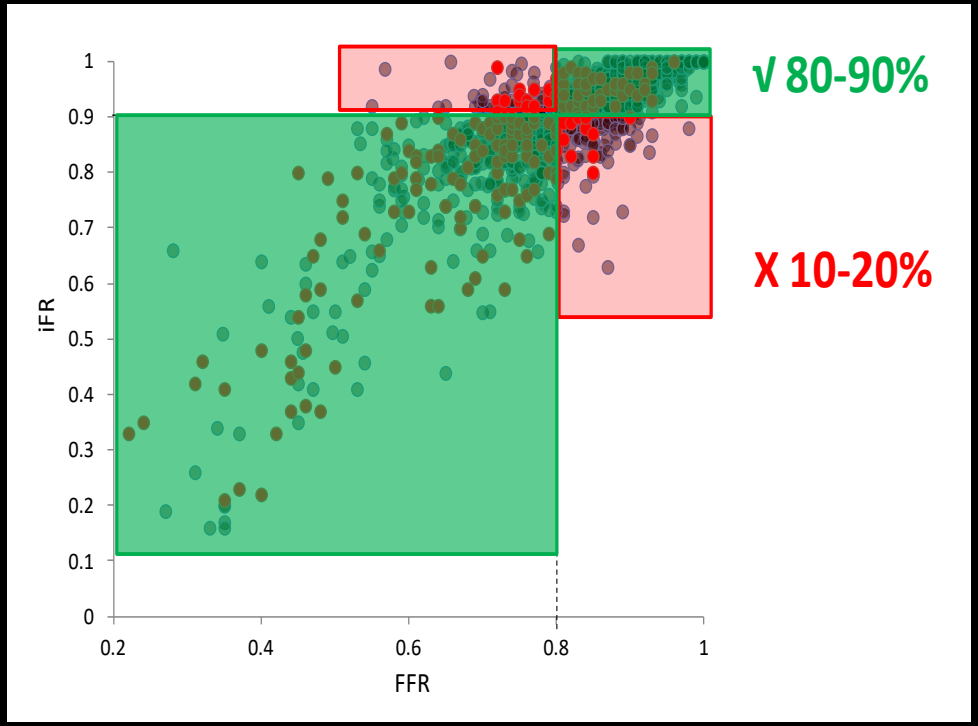
Polarizing Opinions - Passions Run High!

Some Take it Personally - iFR vs FFR

iFR FFR Discordance

iFR and FFR mismatch

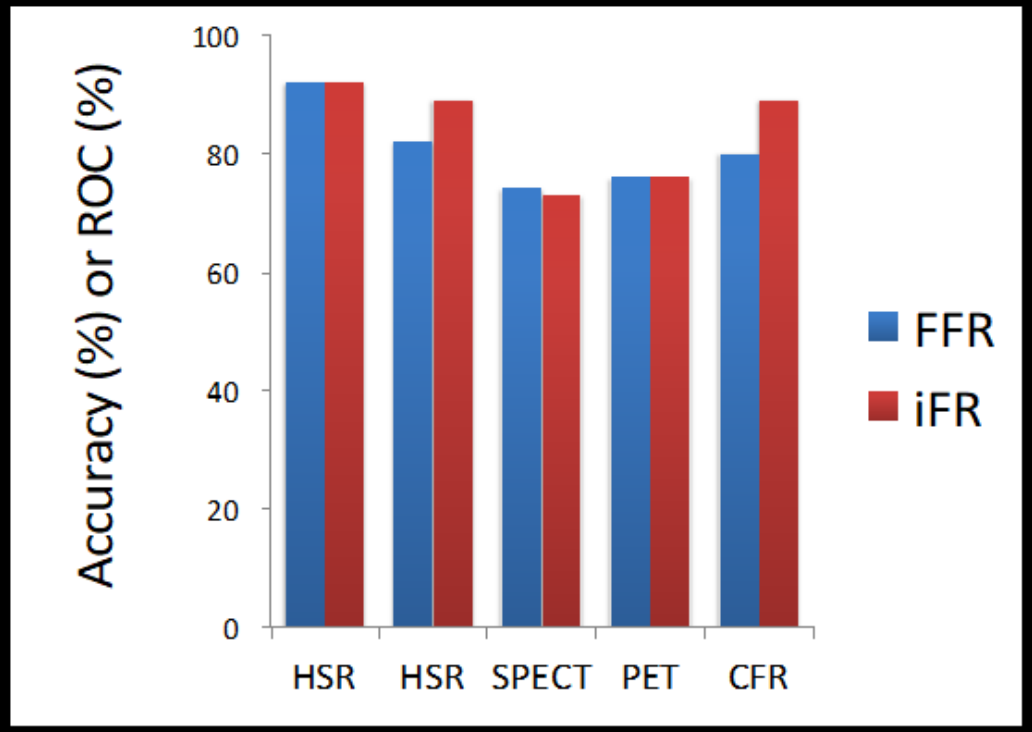
- *iFR and FFR agree in lesion classification in about 80-90% of cases (80% if more intermediate lesions are studies and 90% if more severe lesions are evaluated).*
- *These disagreements create a lot of anxiety and preoccupation amongst physicians, mainly because they interpret them as the iFR "getting it wrong" against FFR.*
- *iFR and FFR are fundamentally different: iFR is a resting index whilst FFR is a hyperaemic method.*

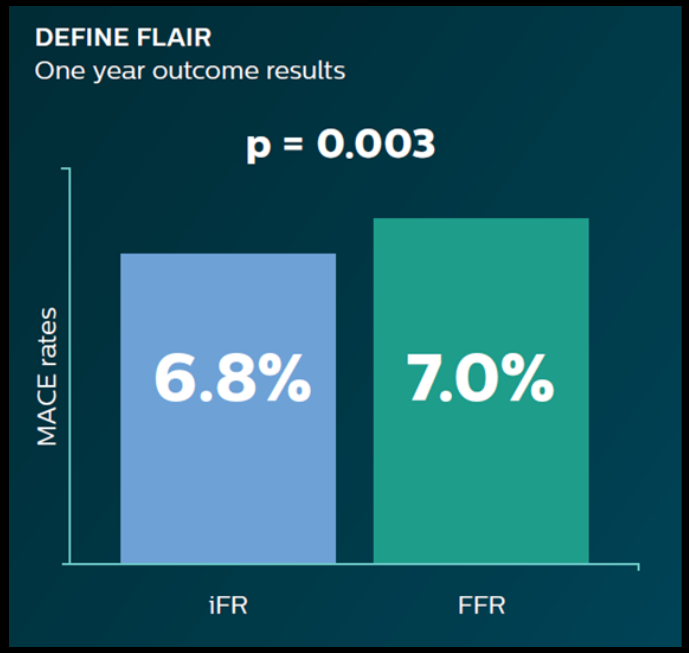


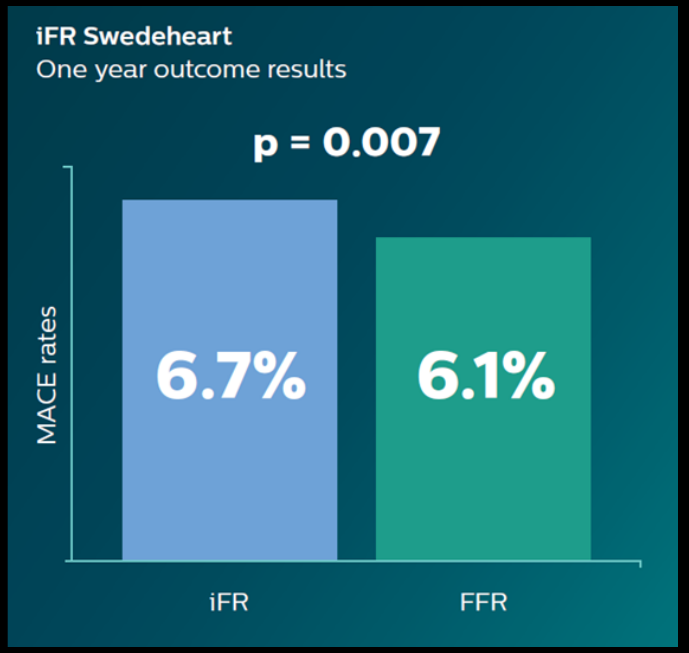
It is well established across many studies including more than 5000 stenoses that iFR and FFR agree in lesion classification (normal versus abnormal) in 80-90% of cases and disagree in the remaining 10-20%.

iFR and FFR mismatch

- ***Should iFR and FFR disagree, one should not assume that FFR is the correct answer.***
- ***When iFR and FFR were studied against other perfusion techniques (invasive flow, nuclear perfusion, PET) they were equally able to detect ischaemia***
- ***Non-inferiority in clinical outcomes***







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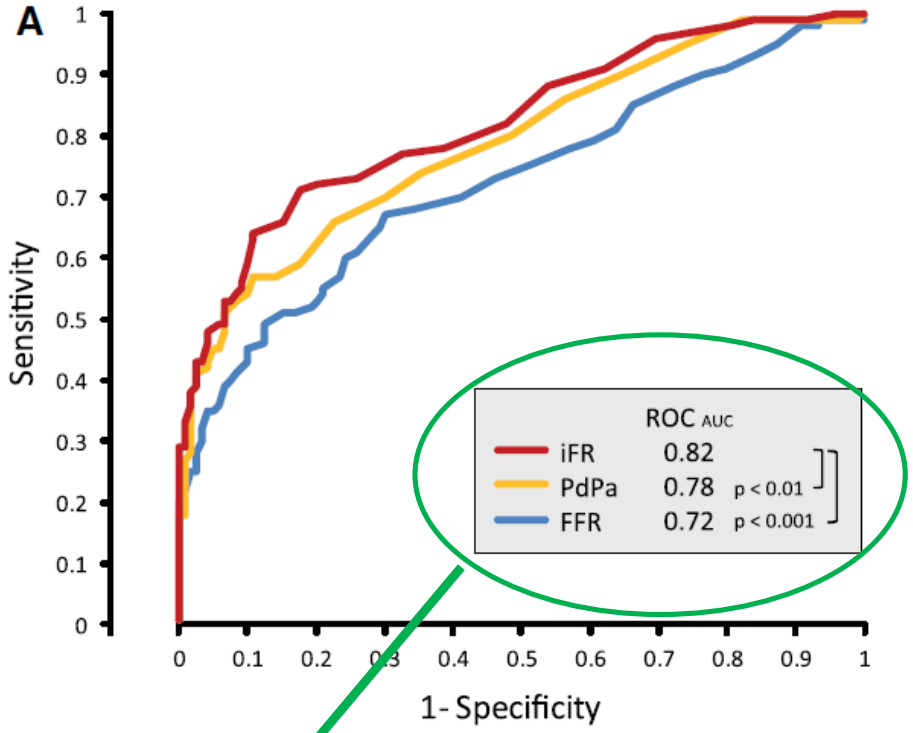
iFR and FFR equally match other perfusion modalities. That means that, when there is a mismatch between iFR and FFR, it is not possible to infer that iFR got it wrong and that FFR is always correct.

iFR has significantly higher correlation to CFR



Diagnostic performance of FFR and iFR		
	FFR	iFR
Cut-off*	0.8	0.89
Diagnostic accuracy	67%	74%
Sensitivity	68%	73%
Specificity	66%	74%
PPV	62%	70%
NPV	72%	77%

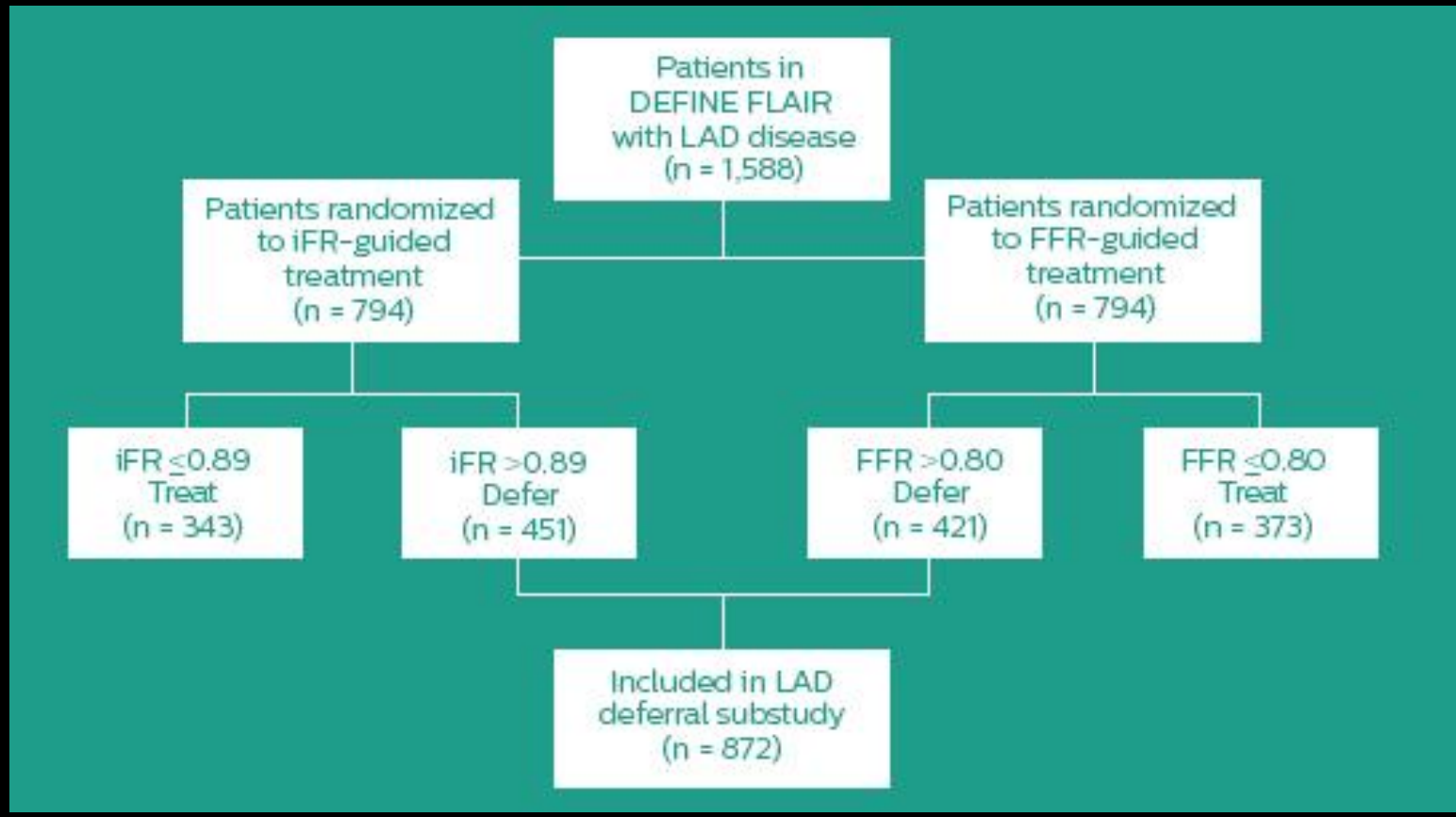
* Cut-off: Highest sum of sensitivity and specificity to match a CFVR of 2.0

- ***An appropriate explanation from ROC curve results***

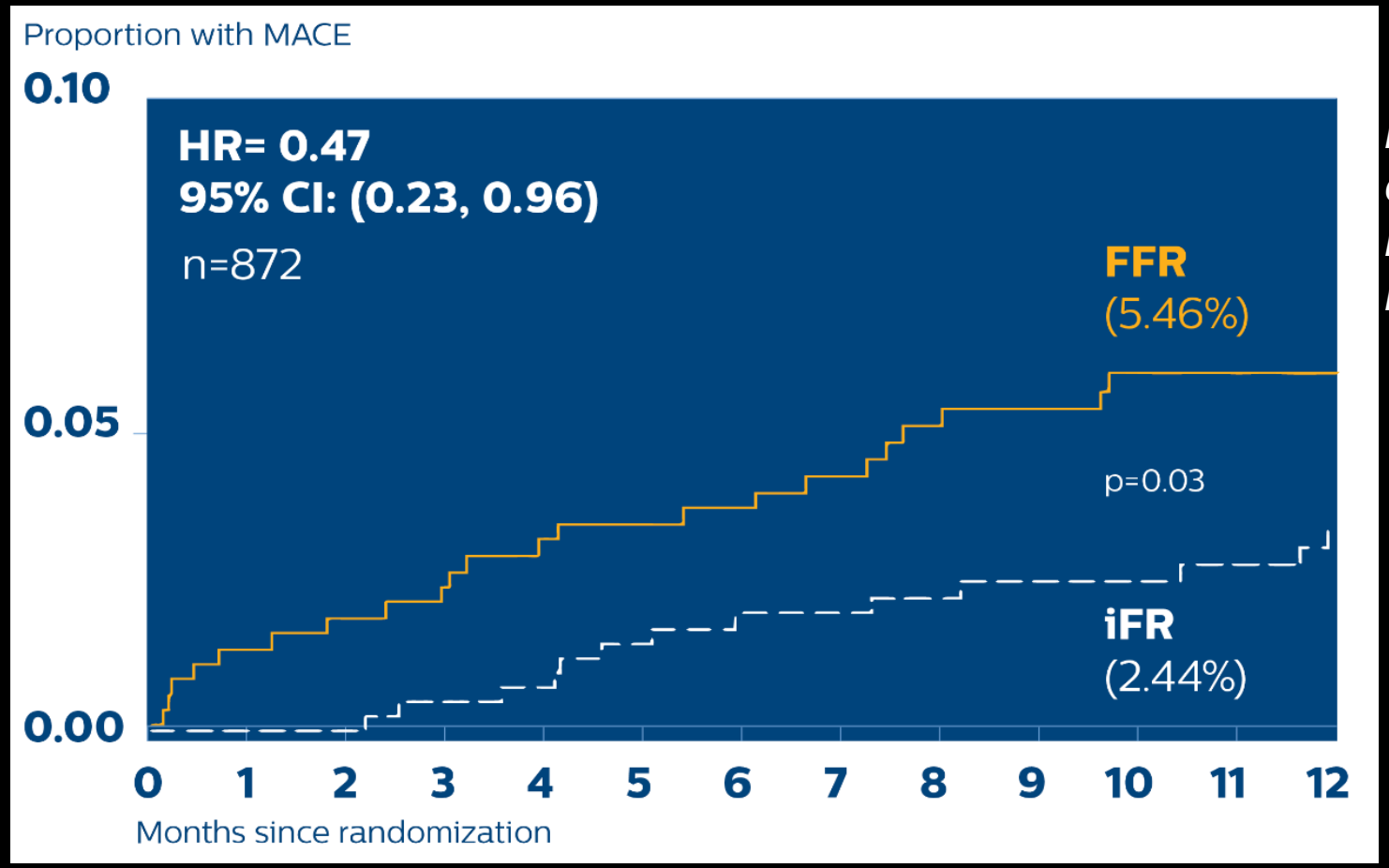
Petraco et al., Circ Cardiovasc Interv. 2014 Aug;7(4):492-502

LAD sub-study

Patients were included from the DEFINE FLAIR trial. This analysis was focused on patients who had lesions within their LAD, and who then went on to be deferred on the basis of intracoronary physiology (either iFR or FFR). The total number of patients included in the LAD deferred analysis was 872[1].



Results LAD deferral



MACE was defined as a composite of cardiovascular death, myocardial infarction (MI) and unplanned revascularisation at one year[1]

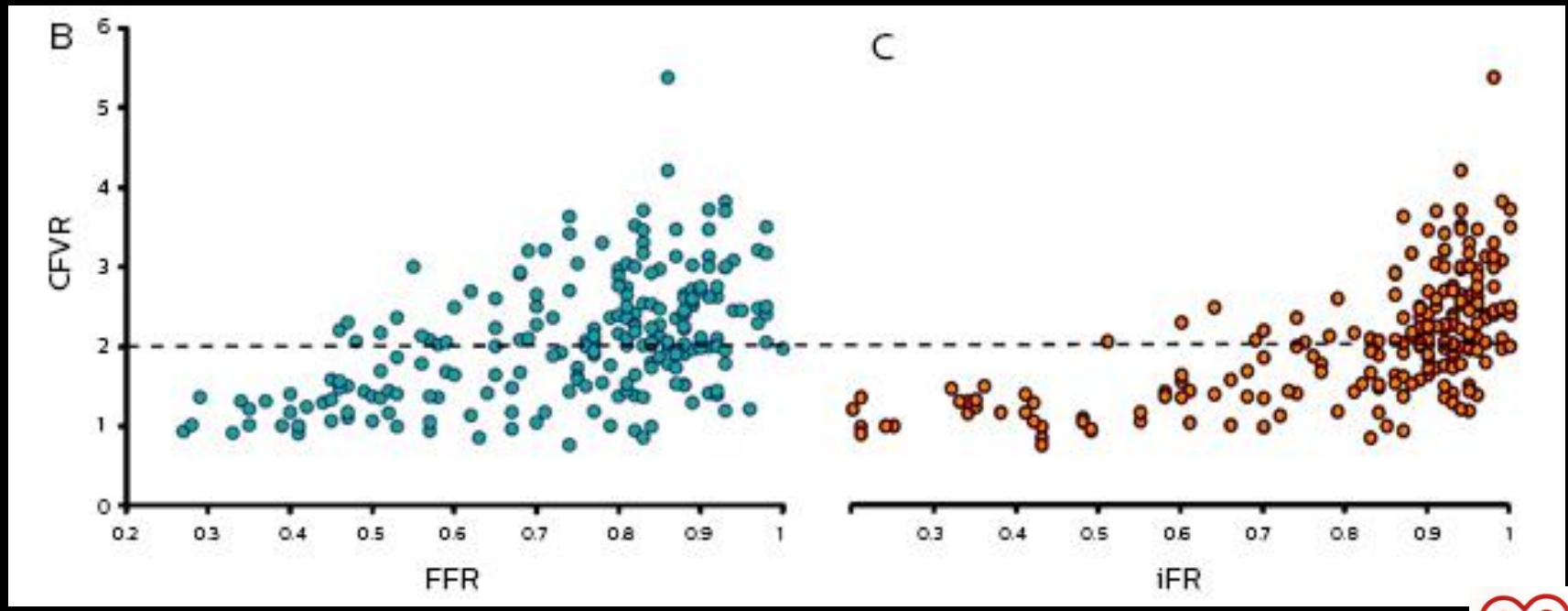
Reduction of 53% MACE rate (comparing iFR vs. FFR) at 1 year

Explanation

Coronary Flow Reserve

iFR and CFR agreement has been demonstrated to be significantly closer than that of FFR and CFR. [3] Therefore the proportion of patients in which iFR is normal and CFR abnormal is lower; possibly explaining the lower event rate in the iFR deferred patients.[4]

CFR is the most powerful predictor of events [5,6,7]
FFR and CFR discordance can be as high as 40% [8]
CFR and iFR have a higher concordance[3]



iFR/FFR – Acute Coronary Syndrome Patients

FFR of culprit lesion in ACS

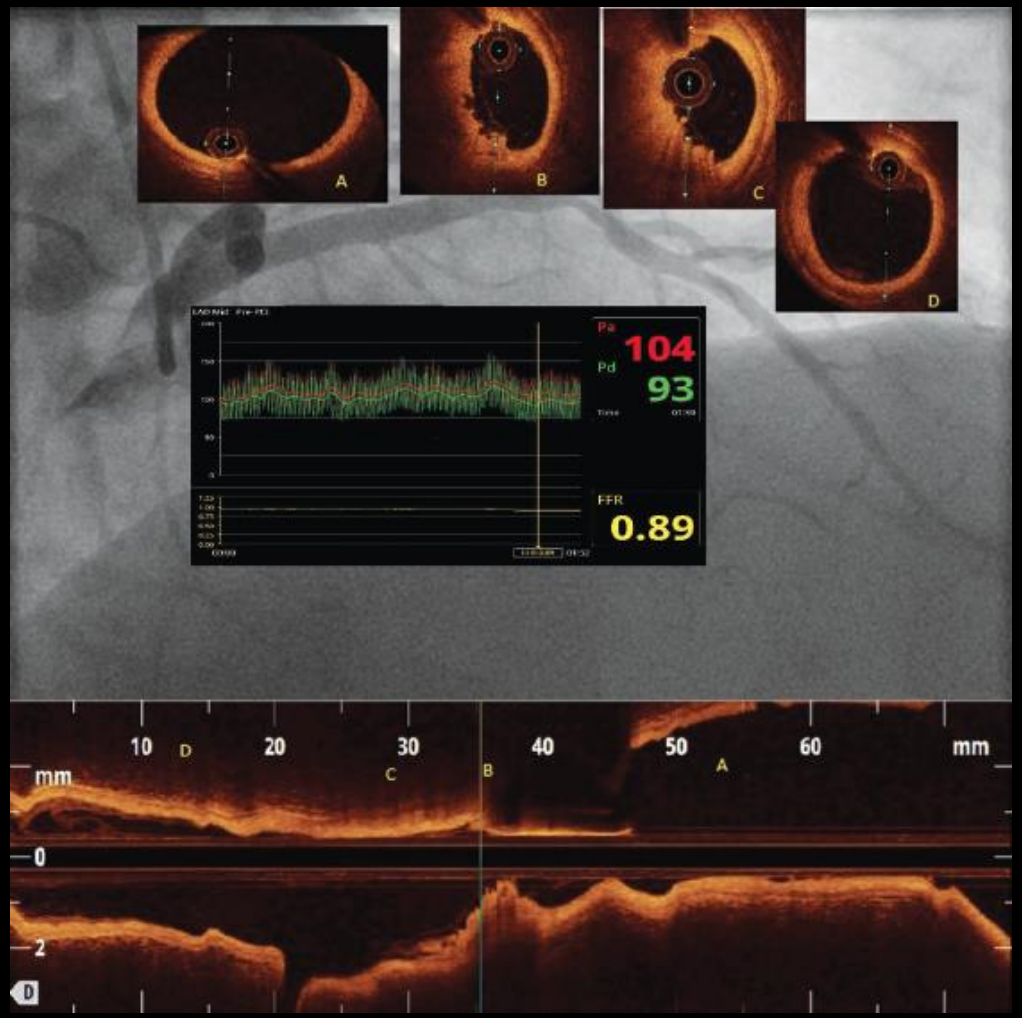


TABLE 1 Indications for FFR-Based Decision Making

Vessel	SIHD	NSTE-ACS	STEMI
Clear culprit	Yes	No	No
Nonculprit	Yes	Yes	Yes

FFR = fractional flow reserve; NSTE-ACS = non-ST-segment elevation acute coronary syndrome; SIHD = stable ischemic heart disease; STEMI = ST-segment elevation myocardial infarction.

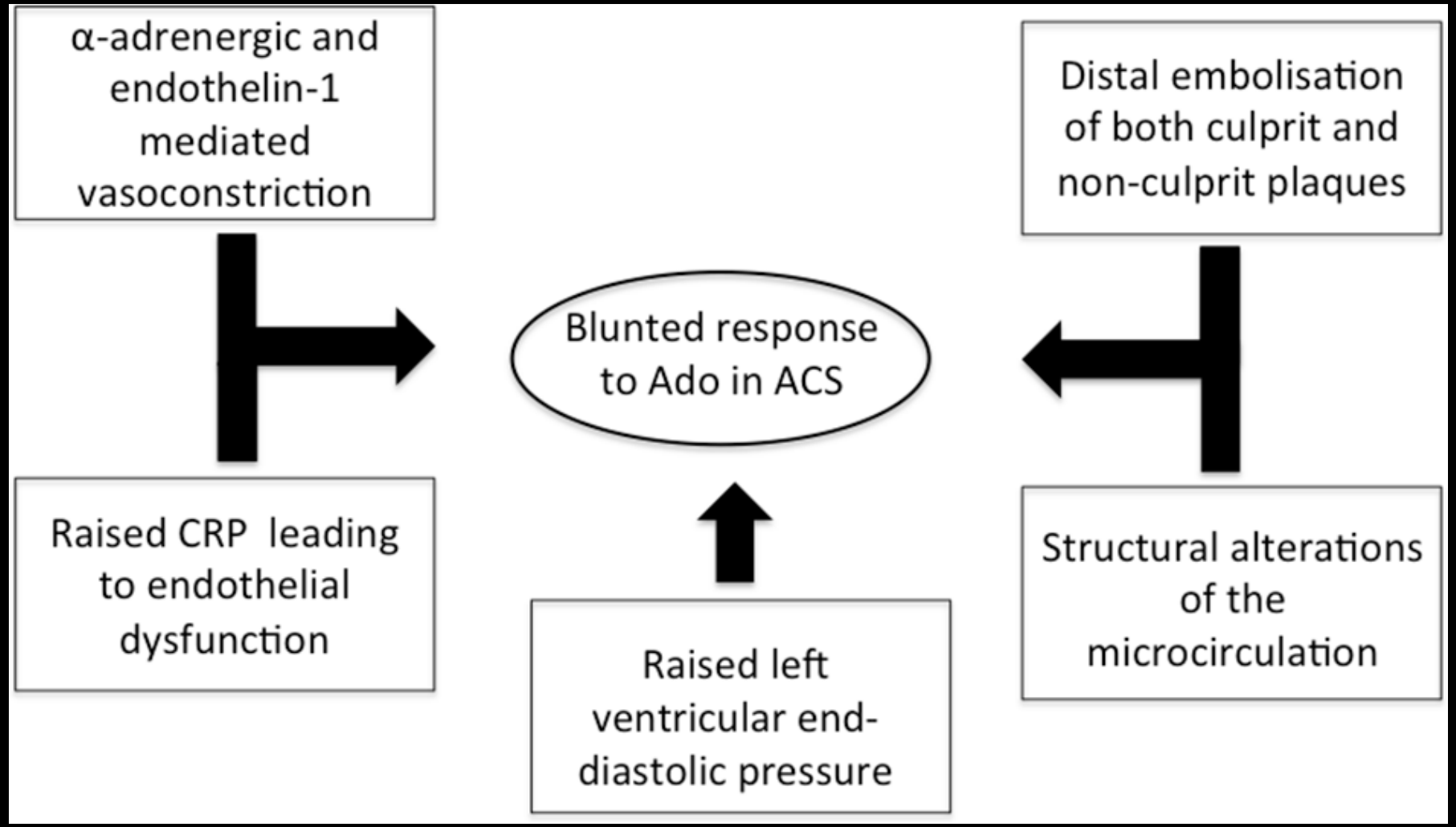
Variable Degree of Reversible Microvascular Stunning

→ *Maximum Achievable Flow is Less*

→ *Smaller Gradient and Higher FFR across Any Given Stenosis*

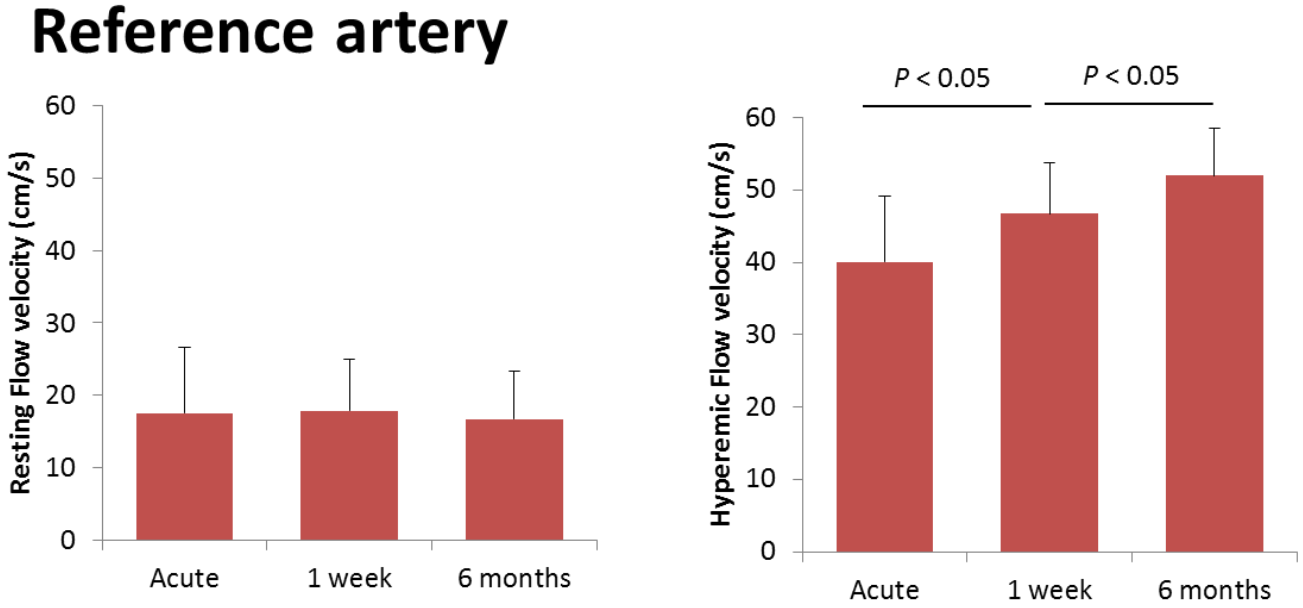
Hakeem A et al. EuroIntervention 2015;11:e1-e2
Fearon W, De Bruyne B, Pijls N. JACC 2016; 11:2 016:1192 – 4

FFR in ACS - What's the issue?



Niccoli et al., Open Heart 2017

STEMI: Physiology data in non-culprit vessels

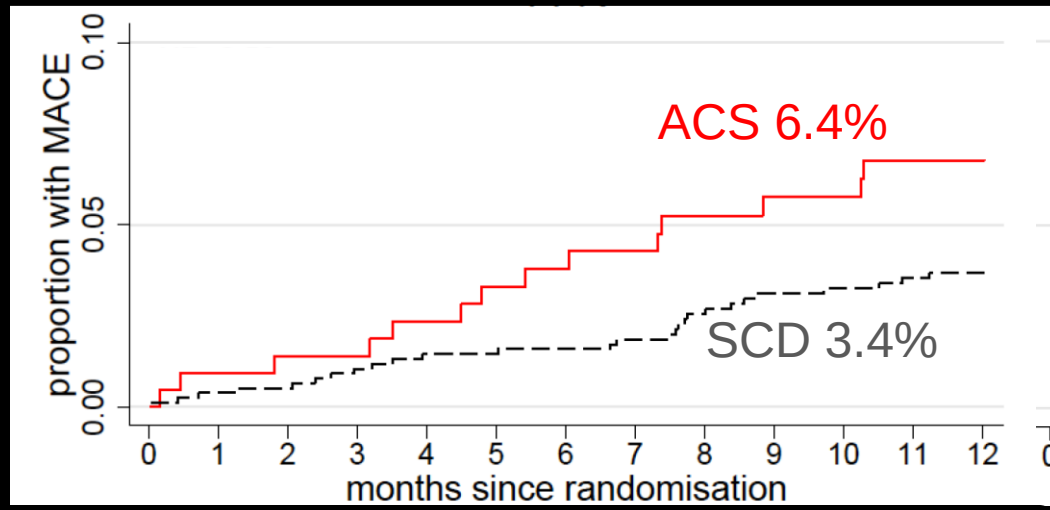


In STEMI, non-culprit rest flow is unaffected, while hyperemic flow is drastically blunted acutely and recovers over >6 months

Bax et al., Am J Cardiol 2006

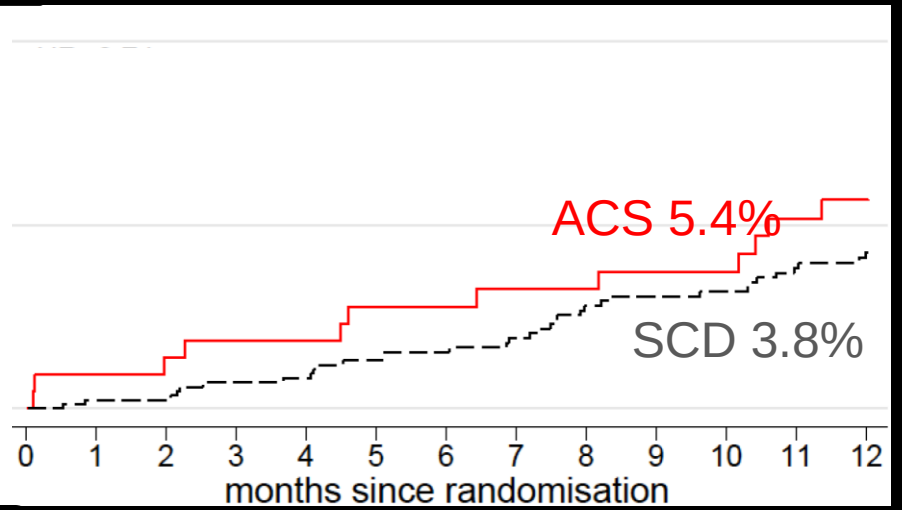
NSTE-ACS:DEFINE-FLAIR & iFR-SWEDEHEART
Deferred patients by FFR or iFR

FFR



In FFR-deferred patients, MACE is significantly higher in ACS than SCAD

iFR



In iFR-deferred patients, MACE is similar in ACS and SCAD

Escaned, EuroPCR 2017

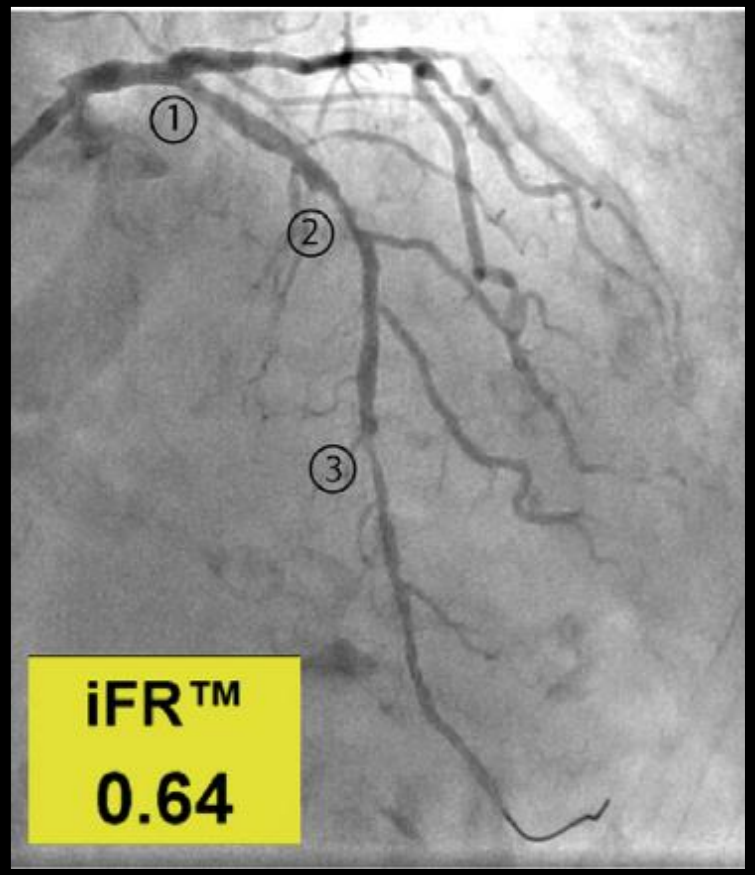
iFR Pullback – Serial Lesions

iFR Pullback

iFR Scout pullback technology reveals the physiologic profile of the entire vessel. By manually pulling the pressure guide wire along the length of the vessel and/ or serial lesions, iFR Scout technology identifies the physiological significance and ischemic contribution of each individual lesion.

iFR Scout pullback is performed with the Verrata and Verrata Plus pressure guide wire.

iFR Pullback

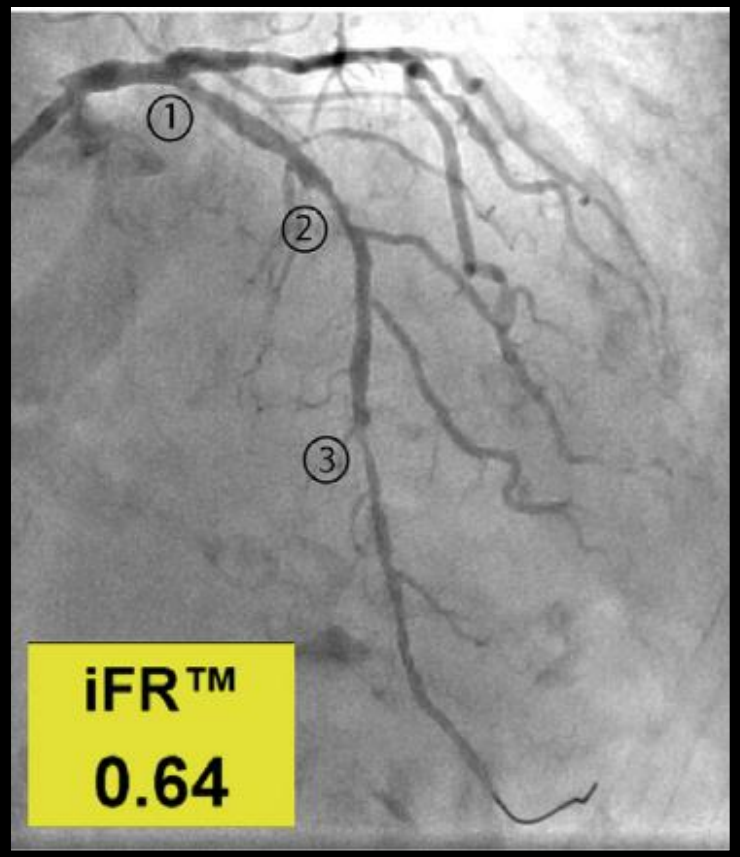


Historically, a distal FFR or iFR value would be used to justify stenting this LAD with multiple lesions

- ***Where should the stent be placed?***
- ***How many stents will you need?***
- ***Was normal blood flow returned?***

Nijjer S, et al. "Pre-Angioplasty Instantaneous Wave-Free Ratio (iFR) Pullback Provides Virtual Intervention and Predicts Hemodynamic Outcome for Serial Lesions and Diffuse Coronary Artery Disease. JACC: Cardiovascular Interventions 2014; 12: 1386-1396.

iFR Pullback



FFR can be used to make pullback measurements, but there are issues -

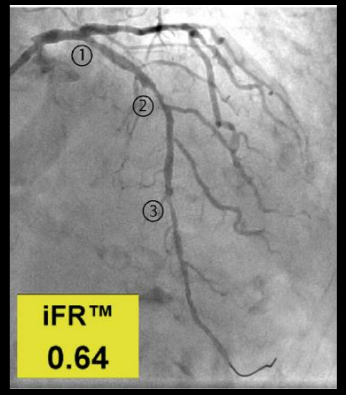
- ✓ *Requires IV hyperaemia*
- ✓ *Can be difficult to interpret*
- ✓ *Requires an additional FFR pullback assessment after treating the first lesion to assess the "updated" severities of the remaining two lesions*
- ✓ *Requires hyperaemia for a final "post" FFR assessment to document success*

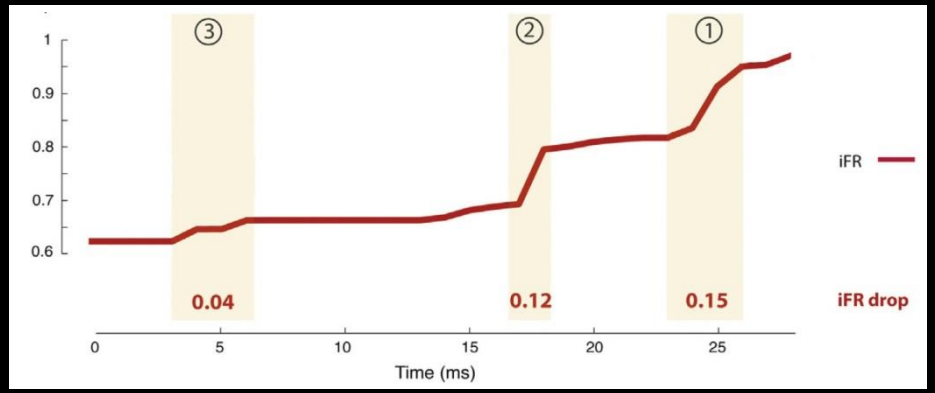
"Serial Lesion FFR Made Simple." www.cathlabdigest.com. Web. January 20, 2015
Nijjer S, et al. "Pre-Angioplasty Instantaneous Wave-Free Ratio (iFR) Pullback Provides Virtual Intervention and Predicts Hemodynamic Outcome for Serial Lesions and Diffuse Coronary Artery Disease. JACC: Cardiovascular Interventions 2014; 12: 1386-1396

…to Guidance

iFR pullback assessments document the ischemic contribution of each lesion without the confounding effect observed with FFR pullback assessments, providing guidance in the determination of a therapeutic plan

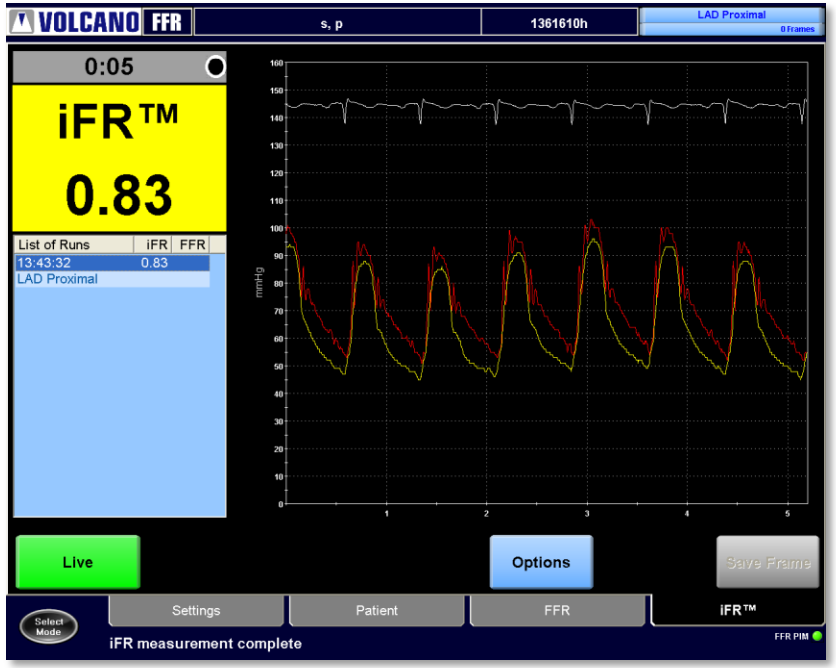
- ***Fast: No need for IV hyperaemic agents (pre- or post- PCI)***
- ***Easy: Does not require interim reassessments as each lesion is treated***

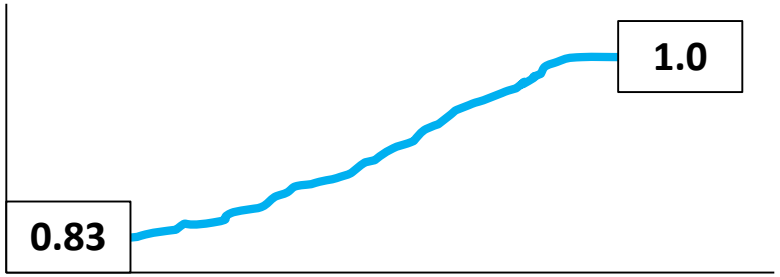




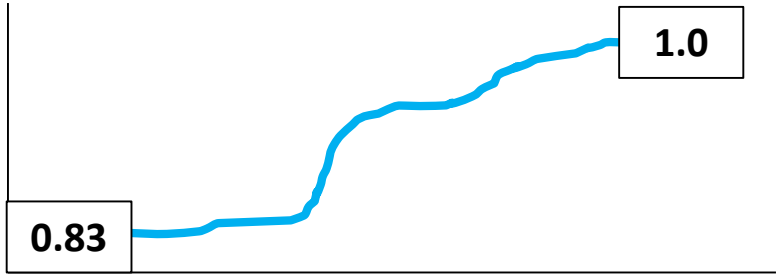
Adapted from Nijjer S, et al. "Pre-Angioplasty Instantaneous Wave-Free Ratio (iFR) Pullback Provides Virtual Intervention and Predicts Hemodynamic Outcome for Serial Lesions and Diffuse Coronary Artery Disease. JACC: Cardiovascular Interventions 2014; 12: 1386-1396.

Diffuse vs. Focal Disease





Scenario 1: Diffuse Disease



Scenario 2: Focal Disease

Simulated case for educational purpose

iFR Co-registration

SyncVision precision guidance system

The SyncVision precision guidance system is a real-time image processing system used in diagnostic cardiac catheterization procedures and PCI to help plan and guide procedures.

In conjunction with the CORE Integrated system, SyncVision

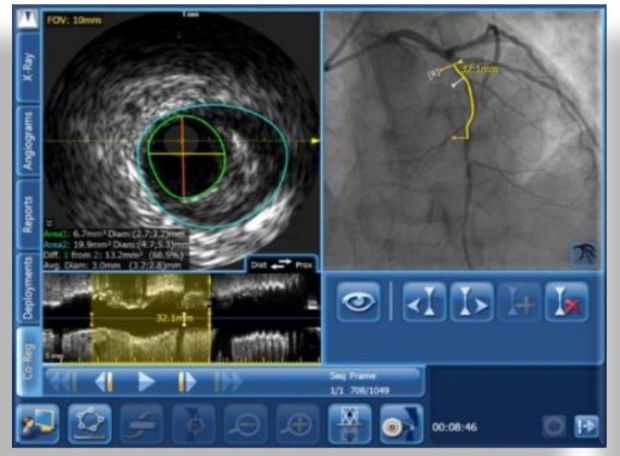
- •Enhances live fluoroscopy and angiography for improved vessel and device visualization.
- •Co-registers angiography and intravascular ultrasound (IVUS) images to localize the IVUS image in the angiogram, and facilitates easy length and area measurements of the vessel using a manual IVUS pullback.
- •Co-registers angiography and iFR pullback to identify regions of ischemia, facilitate stent sizing and estimate post-stent iFR.

SyncVision precision guidance system

Angio+ Enhanced Angiography

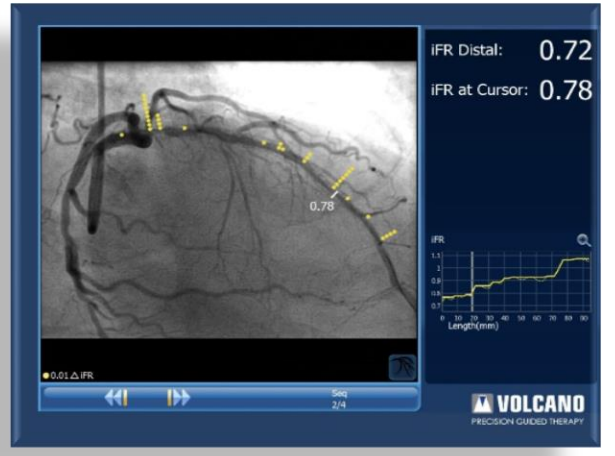
- Vessel Enhancement
- QCA
- Device Detection

IVUS Co-Registration



- Localization of IVUS with angiography
- Easy vessel length/area/diameter measurements without pullback device

iFR Co-Registration



- iFR drop is displayed on angio
- Vessel length measurement without pullback device
- Move from physiologic justification to physiologic guidance

iFR Co-Registration

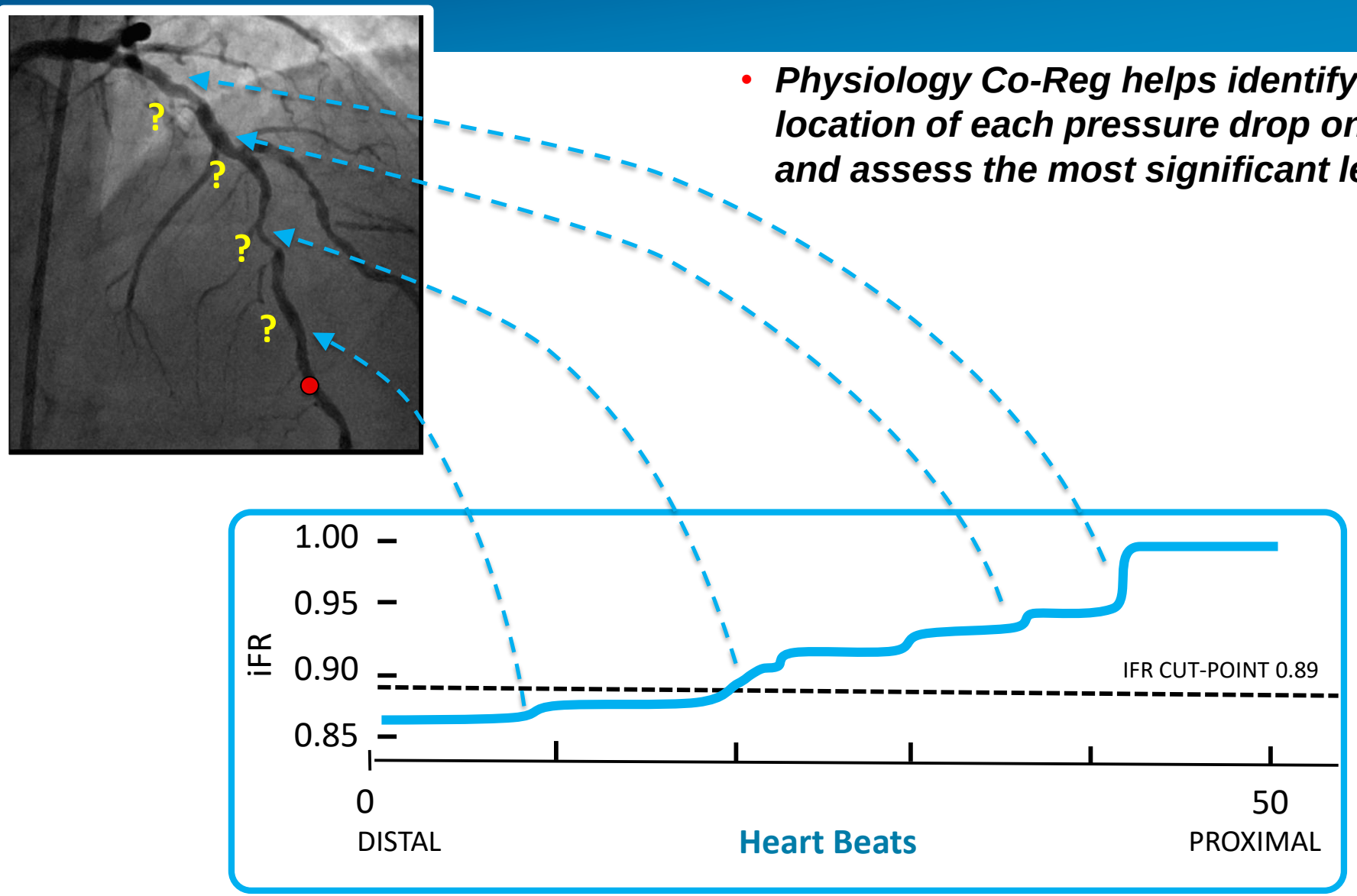
- ***Synchronises iFR Pullback and Angiogram Images, and accurately maps physiology data image along the angiogram***

- ***Performed by manual iFR pullback***

- ***Enables physiology-guided procedural planning***

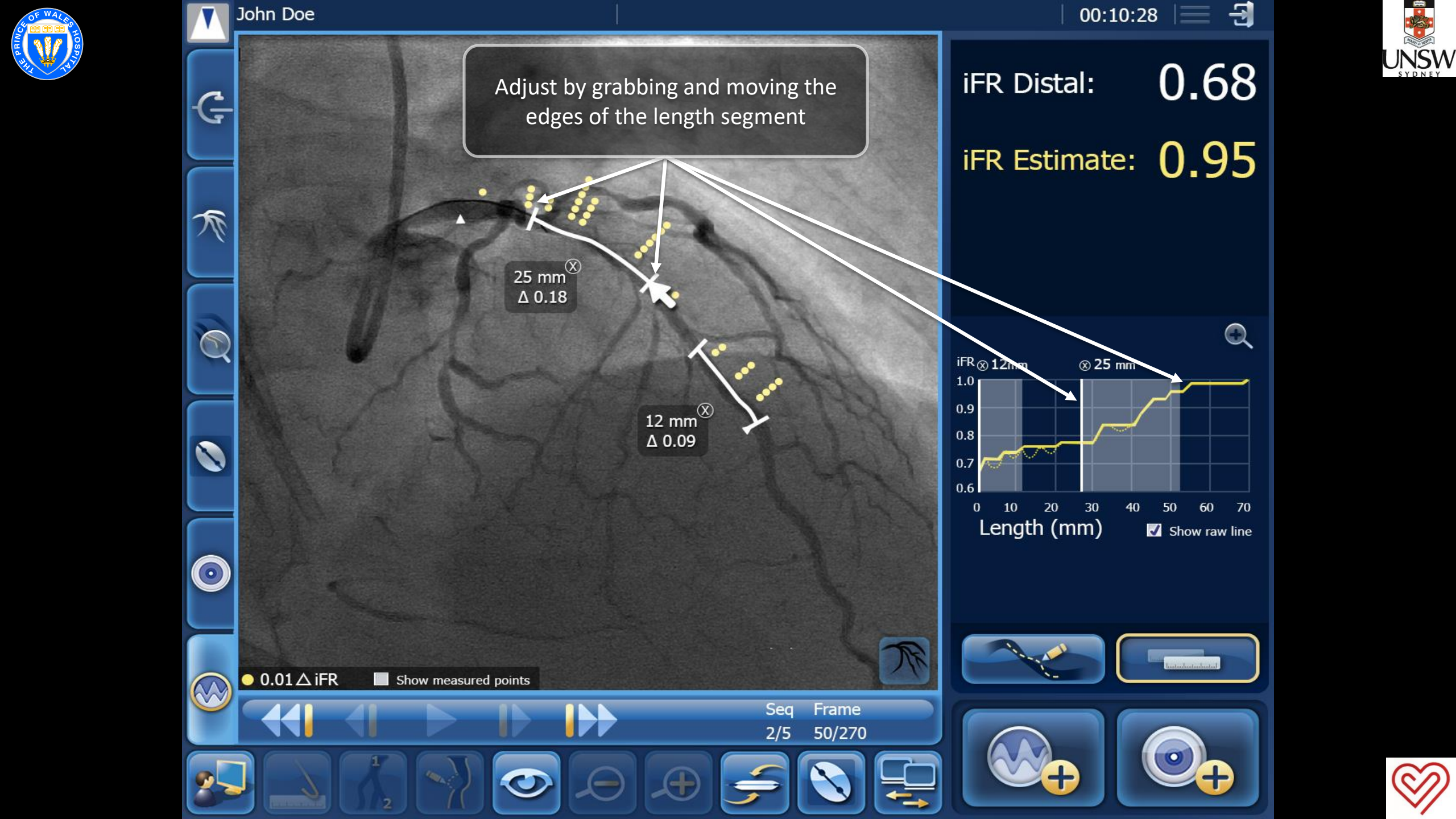
  - ✓ ***Identify lesions***
  - ✓ ***Assess physiological significance in serial lesions***
  - ✓ ***Distinguish Focal vs. Diffuse disease***
  - ✓ ***Measure lesion length***
  - ✓ ***Perform virtual PCI/ Determine functional gain of selected lesions in planning PCI Strategy***

Physiology pullback stenosis mapping



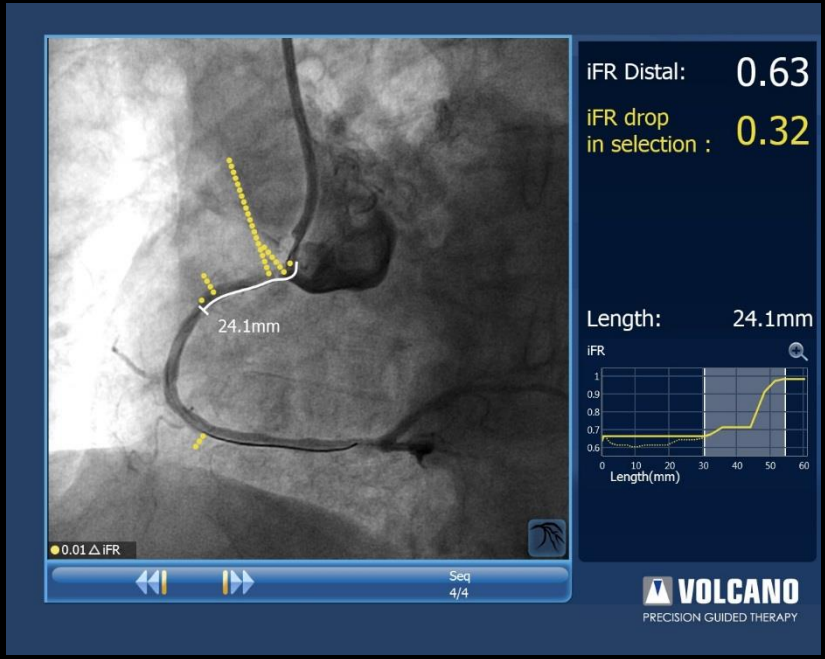
- ***Physiology Co-Reg helps identifying the exact location of each pressure drop on the anatomy and assess the most significant lesion***

PHILIPS

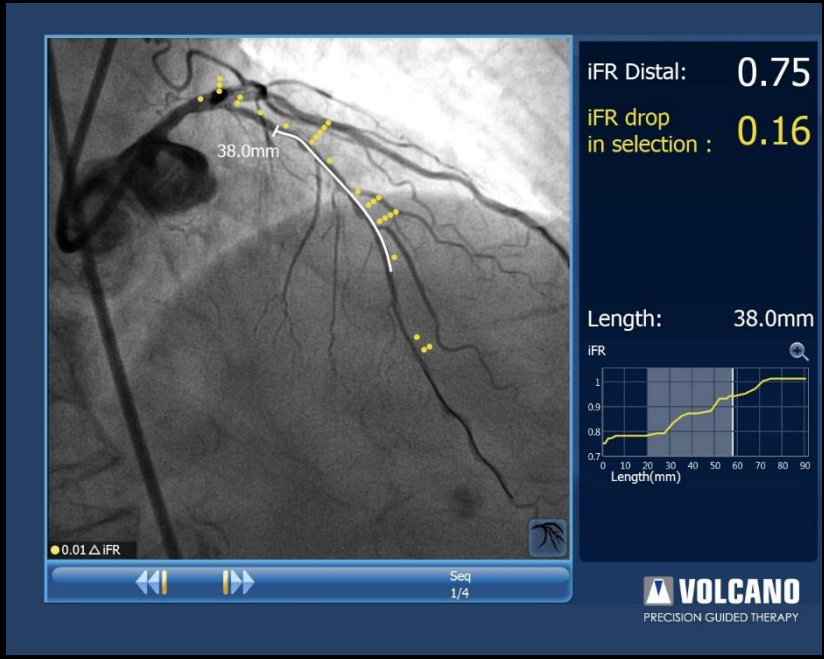

John Doe
00:10:28
Adjust by grabbing and moving the edges of the length segment
25 mm
Δ 0.18
12 mm
Δ 0.09
iFR Distal: 0.68
iFR Estimate: 0.95
iFR
12mm
25 mm
1.0
0.9
0.8
0.7
0.6
0 10 20 30 40 50 60 70
Length (mm)
Show raw line
0.01 Δ iFR
Show measured points
Seq 2/5
Frame 50/270

Understand Focal vs Diffuse Disease

iFR co-registration graphically displays the iFR drop along the angiogram, highlighting which portion of the vessel is ischemic.



Focal Disease



Diffuse Disease

Real World iFR/FFR PCI Guidance

Case Presentation

61 year old male -

- **Presentation** — Exertional dyspnoea, >6/12 (SAP) - limiting
- **Background** — Anterior STEMI 2002 – lysis (non-obstructive CAD, no revasc)
- **Medications** — Metoprolol, Rosuvastation, Irbesartan, Clopidogrel (>DAPT)
- **Investigations** — *ECG* – SR, normal, no Q waves

  eGFR >90, Plt 517, Hb 134 g/L

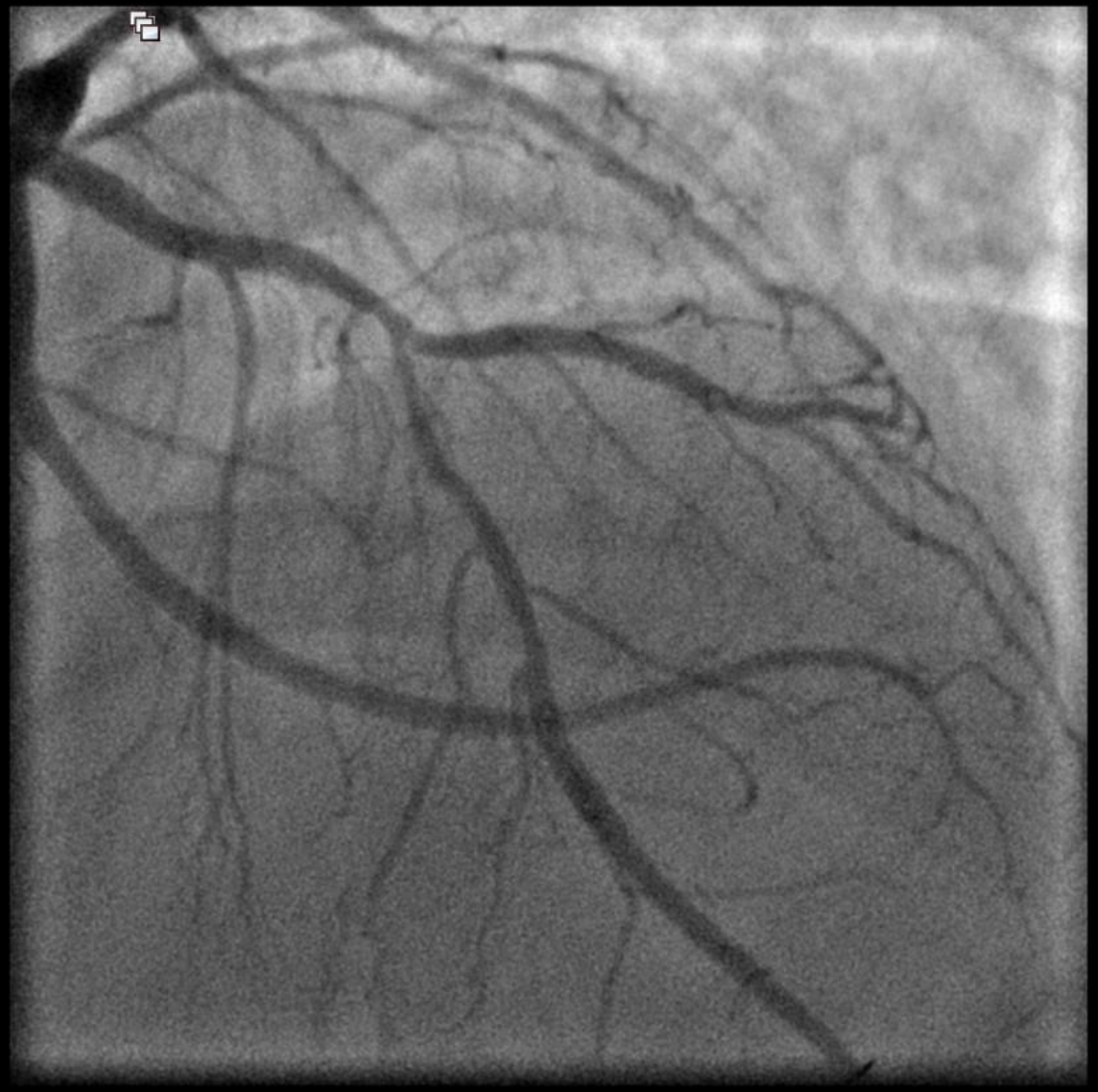
  TTE - normal LV size and function, normal valvular function

  Stress Echo - 6 mins Bruce, HR 135bpm, chest pain but no ischaemia

  CTCA - CAS 939, heavily calcified mid LAD, possibly severe obstruction, minor RCA and Cx disease

Case Presentation

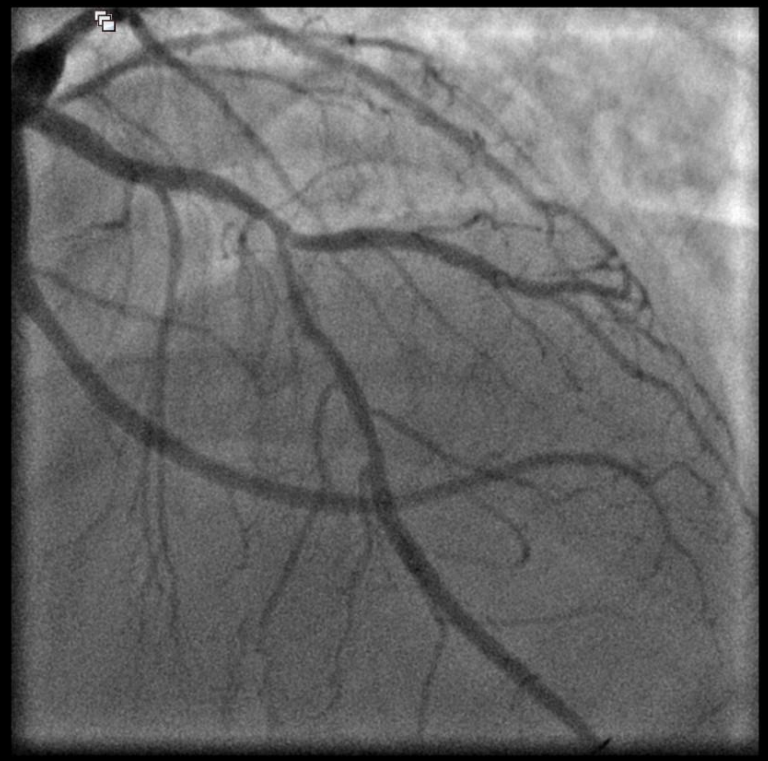
Case Presentation

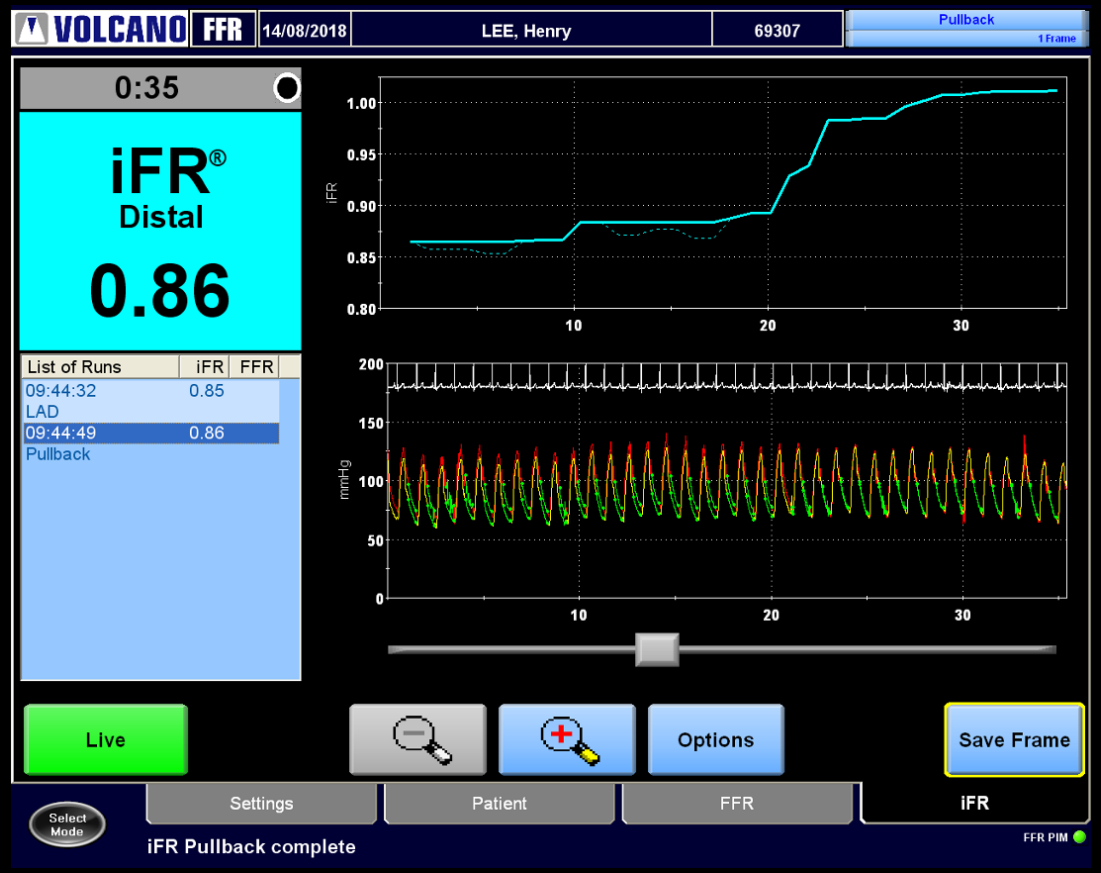


Case Presentation

Case Presentation

Physiological Assessment





iFR - 0.86

Case Presentation

Anatomical SYNTAX Score

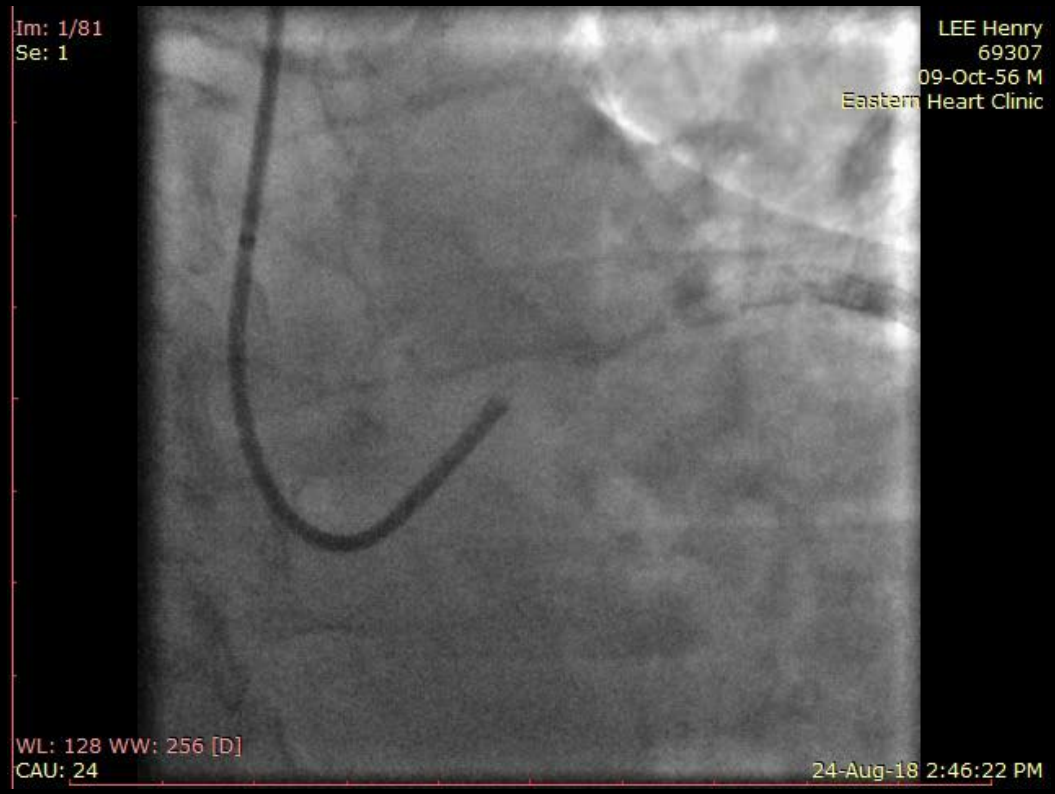
Mid LAD		5
	1,1,0	1
	> 20 mm	1
	heavy calcification	2
PDA (RCA)		2
TOTAL:		11

SYNTAX II Score

PCI	SYNTAX II Score	19.8
	PCI 4 yr Mortality	3.0%
CABG	SYNTAX II Score	21.5
	CABG 4 yr Mortality	3.4%

PCI Recommended

Imaging Guided PCI – Final



Imaging Guided PCI – 24th August 2018

iFR Guidance - *Case Presentation*

37 year old male -

- **Presentation** — Exertional angina >6/12 (SAP), then rest pain
- **Background** — Positive FH, Dyslipidaemia
- **Medications** — Aspirin, Atorvastatin, Metoprolol
- **Investigations** — *ECG* – SR, NAD

  eGFR >90, Plt 373, Hb 141 g/L

  TTE - normal LV size and function, normal valvular function

  EST - 7 min Bruce protocol, typical angina, 2-4 mm ST depression (inferolateral) after 4 mins, inducible posterior and lateral hypokinesia by echo

iFR Guidance - *Case Presentation*

DummyPatName!
Feb-12-2019
Se: 1 (14)
Im: 36/61

Filtered
Innova Filter 3
Zoom:1.6
W:245
C:133
DummyPerfPhys!

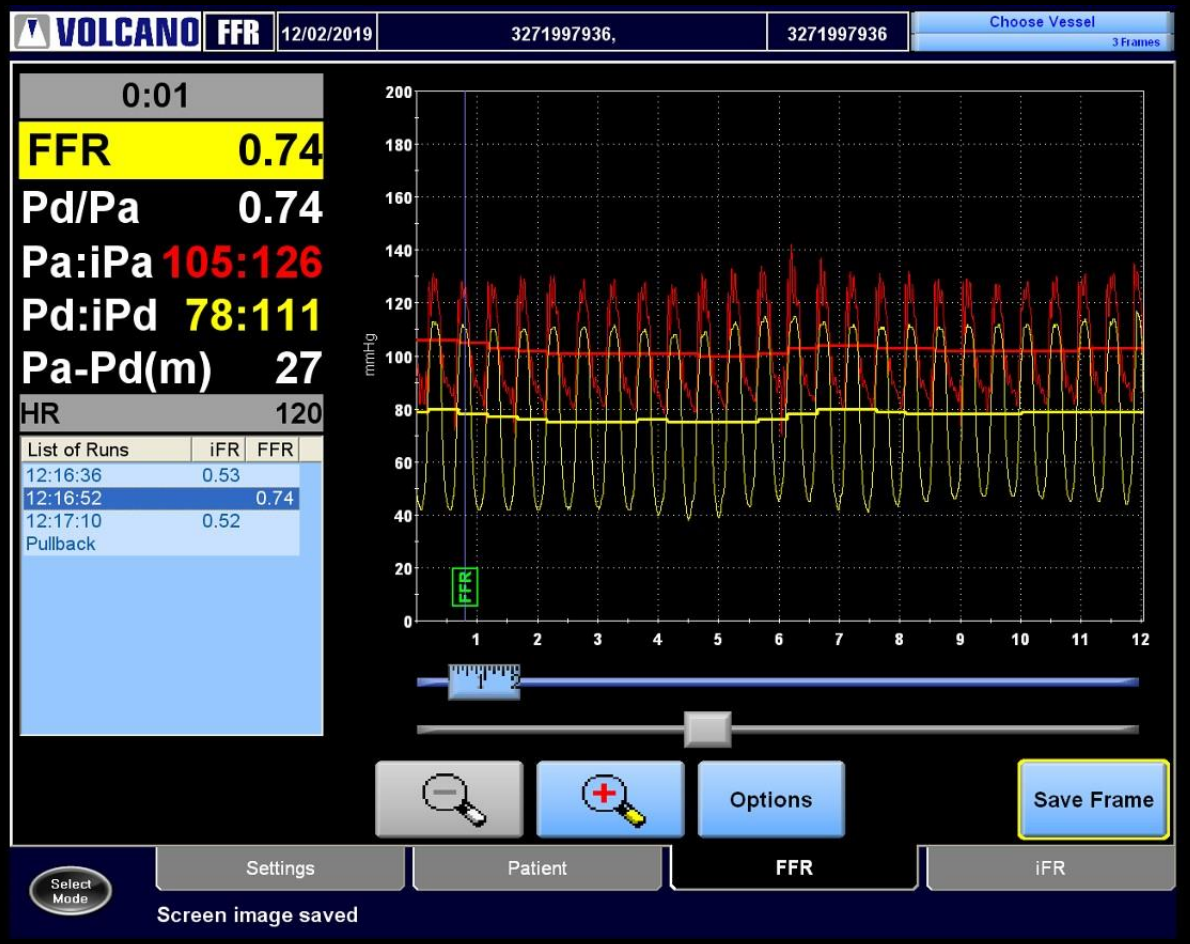
DummyInstName
Prima
12:23:47 PM

RAO: 12.4°
CAU: 15.2°
mAs: 178.0
Tilt: 0.0°

iFR Guidance - *Case Presentation*

DummyPatName!
Feb-12-2019
Se: 1 (4)(SC)
Im: 1/1

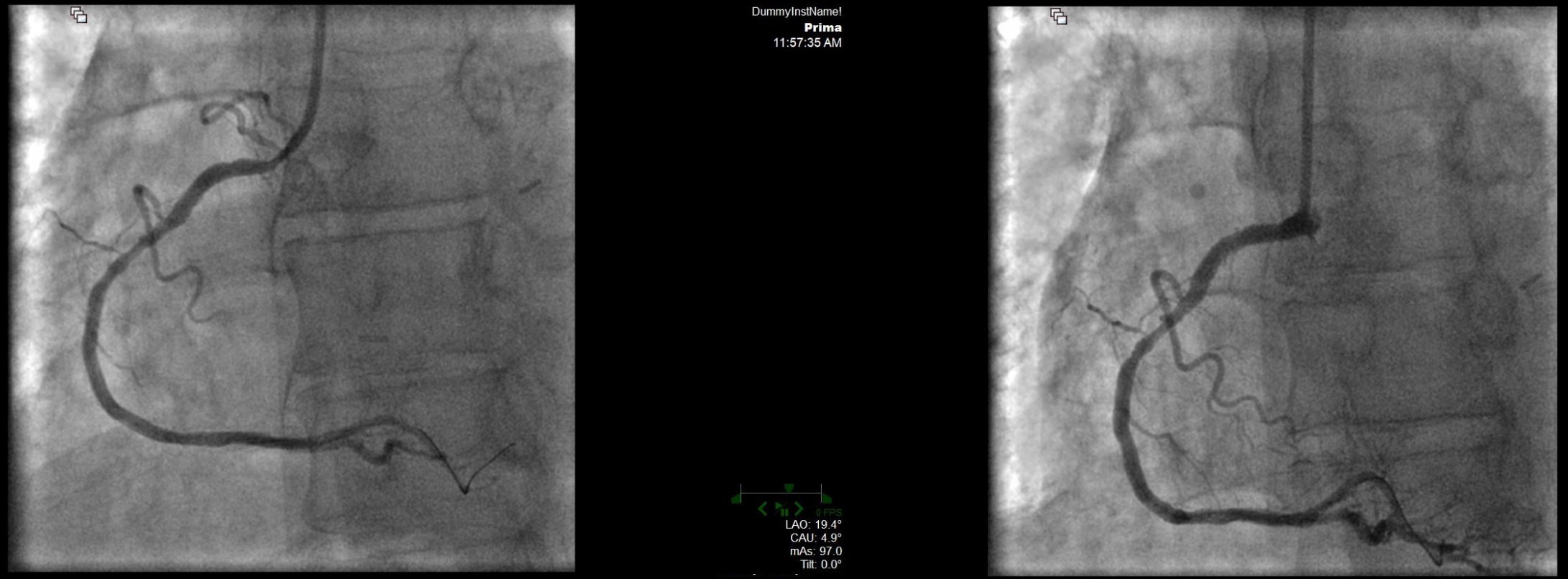
Zoom:0.9
W:255
C:128



Dummy

iFR Guidance - *Case Presentation*

Hybrid Revascularization – robotic LIMA, PCI RCA/Cx



iFR 0.94 after ostial DES (staged Cx TBA)

iFR/FFR in Multi-vessel Disease

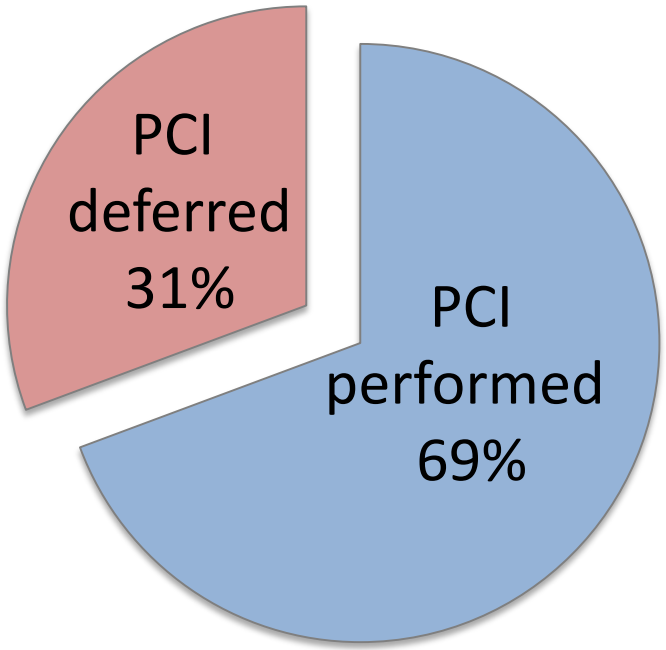
Components of the SYNTAX II strategy

- SYNTAX Score II (incorporating clinical and anatomical variables) to guide Heart Team decisions on myocardial revascularisation.
- Physiology-based revascularisation (hybrid use of iFR and FFR).
- Third generation DES (thin strut, biodegradable polymer, everolimus-eluting Synergy™ stent [EES]).
- IVUS-guided optimisation of stent deployment (modified MUSIC criteria).
- Contemporary CTO revascularization techniques.
- Guideline-directed medical therapy.

Escaned J et al. EuroIntervention. 2016 Jun 12;12(2):e224-34

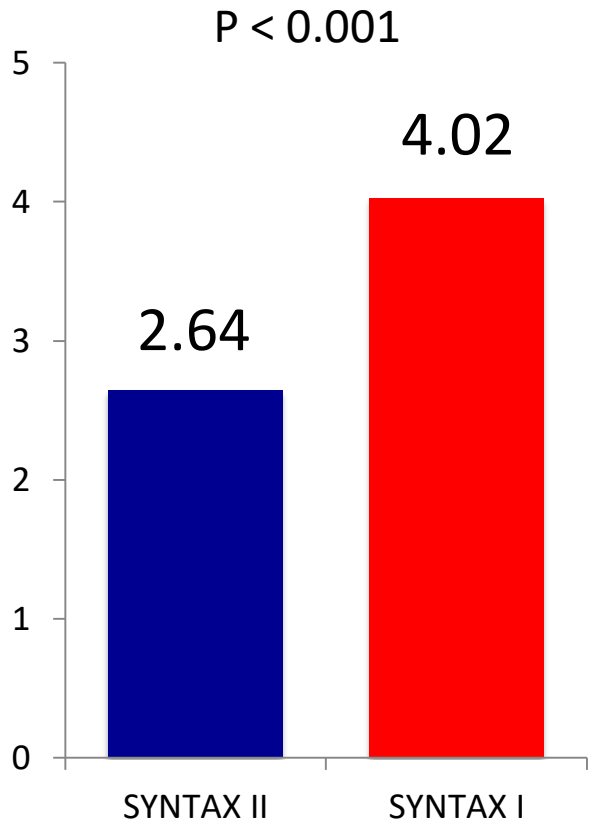
Impact of intracoronary physiology on PCI

Lesion treatment after iFR/FFR interrogation (n=1177)

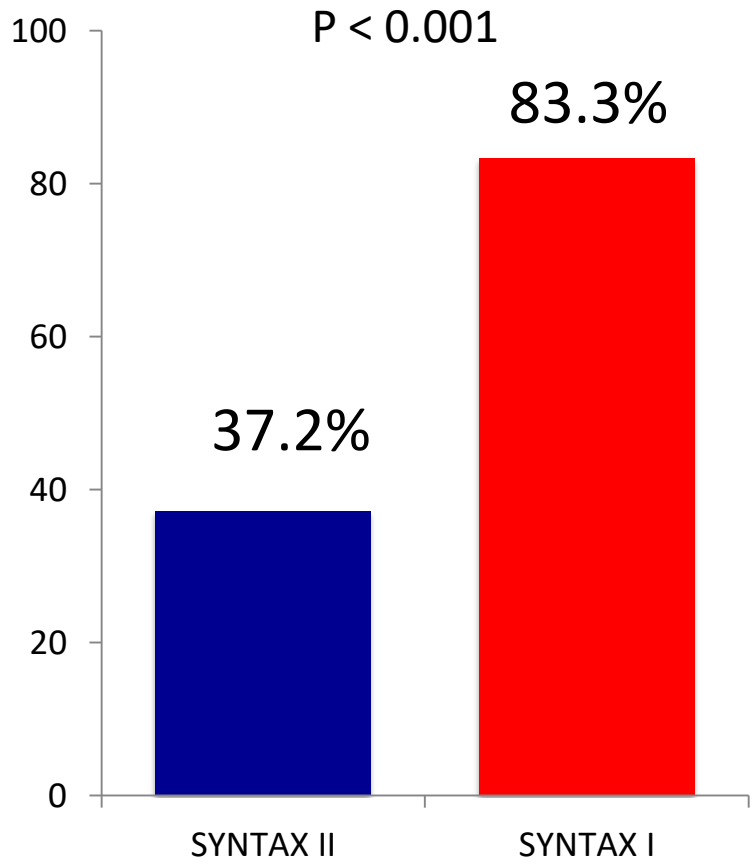


SYNTAX II

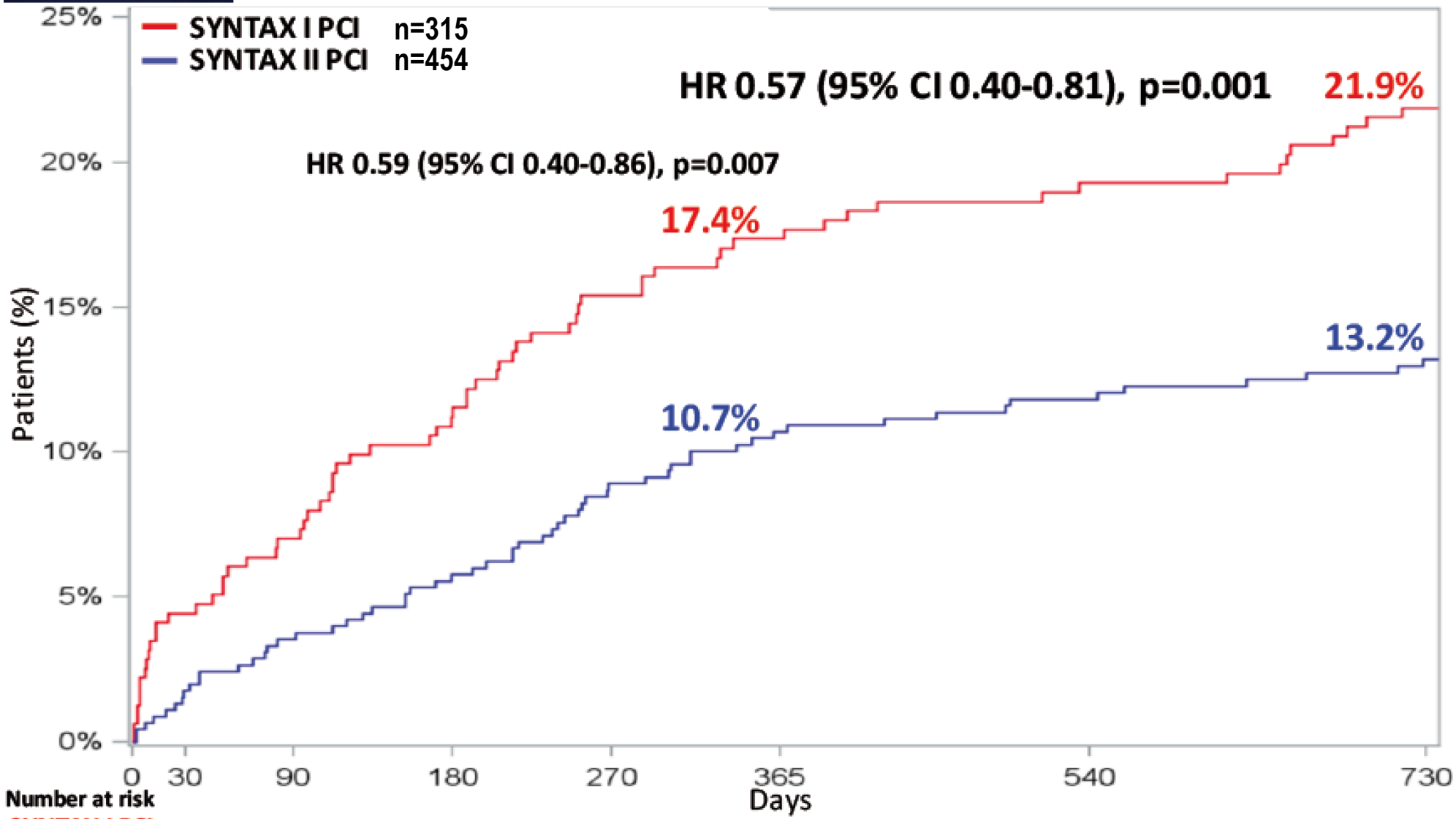
Lesions treated per patient (n) in SYNTAX II and SYNTAX I



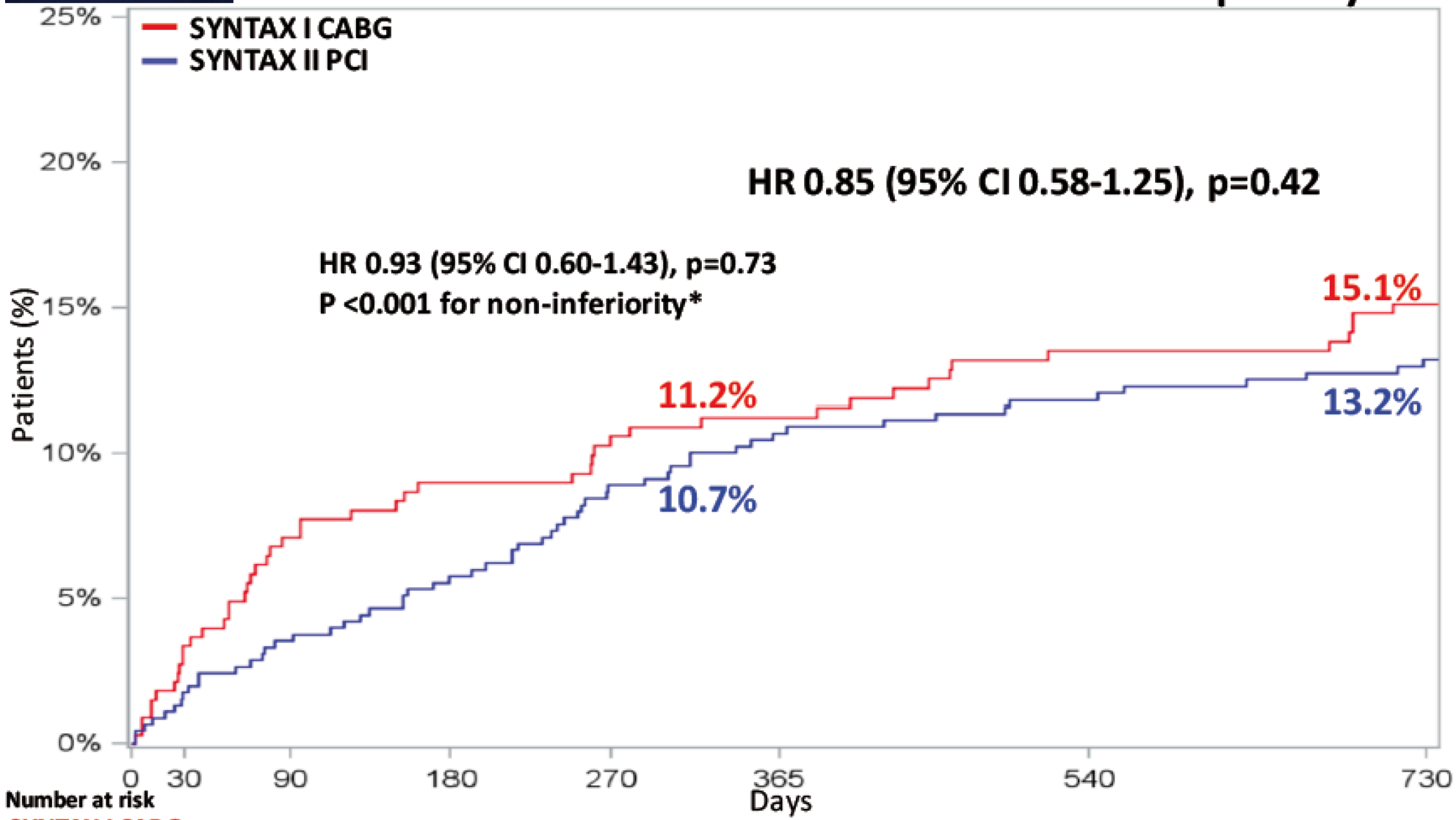
Cases of three-vessel PCI (%) in SYNTAX II and SYNTAX I



Primary endpoint: MACCE up to 2 years



Exploratory End-Point: MACCE PCI vs. CABG
up to 2 years



Number at risk

SYNTAX I CABG	334	313	295	289	279	277	268	263
SYNTAX II PCI	454	442	433	422	407	399	391	347

ESC Guidelines – Myocardial Revascularization 2018 Update

Recommendations on functional testing and intravascular imaging for lesion assessment

Recommendations	Class[a]	Level[b]
When evidence of ischaemia is not available, FFR or iwFR are recommended to assess the haemodynamic relevance of intermediate-grade stenosis.[15,17,18,39]	I	A
FFR-guided PCI should be considered in patients with multivessel disease undergoing PCI.[29,31]	IIa	B
IVUS should be considered to assess the severity of unprotected left main lesions.[35–37]	IIa	B

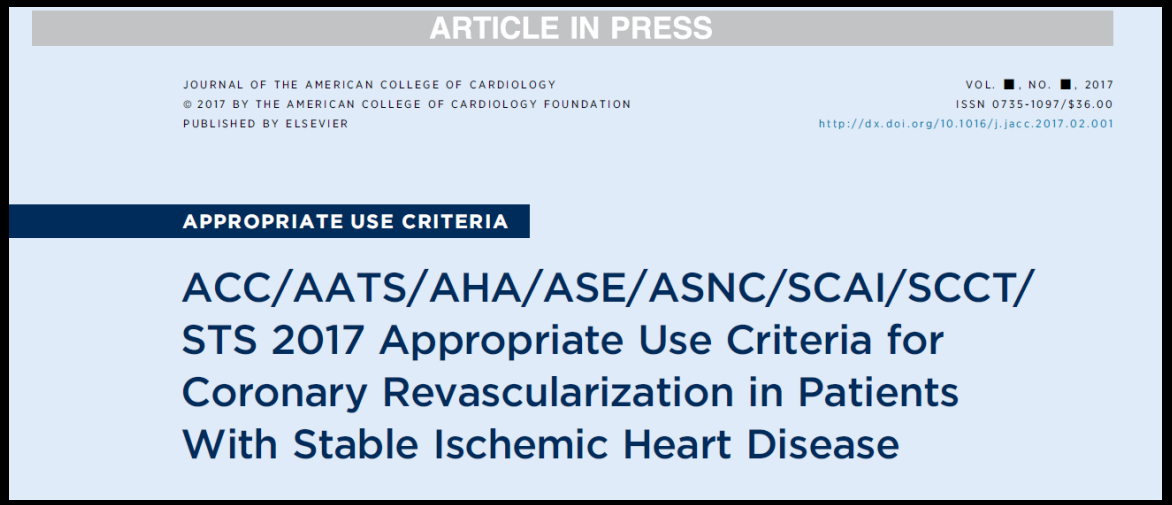
FFR = fractional flow reserve; iwFR = instantaneous wave-free ratio; IVUS = intravascular ultrasound; PCI = percutaneous coronary intervention.
[a]Class of recommendation.
[b]Level of evidence.

ESC guidelines

ESC Guidelines (2018) recommend that with documented ischaemia or hemodynamically relevant lesions defined by FFR ≤ 0.80 or with iFR ≤ 0.89 or > 90% stenosis in a major coronary vessel [9].

Extent of CAD (anatomical and/or functional)		Class	Level
For prognosis	Left main disease with stenosis >50%.[a]	I	A
	Proximal LAD stenosis >50%.[a]	I	A
	Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%).[a]	I	A

iFR is backed by Appropriate Use Criteria



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http://dx.doi.org/10.1016/j.jacc.2017.02.001

APPROPRIATE USE CRITERIA

ACC/AATS/AHA/ASE/ASNC/SCAI/SCCT/
STS 2017 Appropriate Use Criteria for
Coronary Revascularization in Patients
With Stable Ischemic Heart Disease

1. When available, each clinical scenario includes the patient's clinical status/symptom complex, ischemic burden as determined by noninvasive functional testing, burden of coronary atherosclerosis as determined by angiography, and additional invasive testing evaluations by invasive physiology (e.g., FFR, instantaneous wave-free ratio) or intravascular imaging.

Where FFR is indicated:

*iFR measurements with appropriate normal ranges may be substituted for FFR.

., ACC/AATS/AHA/ASE/ASNC/SCAI/SCCT/STS 2017 Appropriate Use Criteria for Coronary Revascularization in Patients With Stable Ischemic Heart Disease. JACC epub March 2017

Thankyou for your Attention!

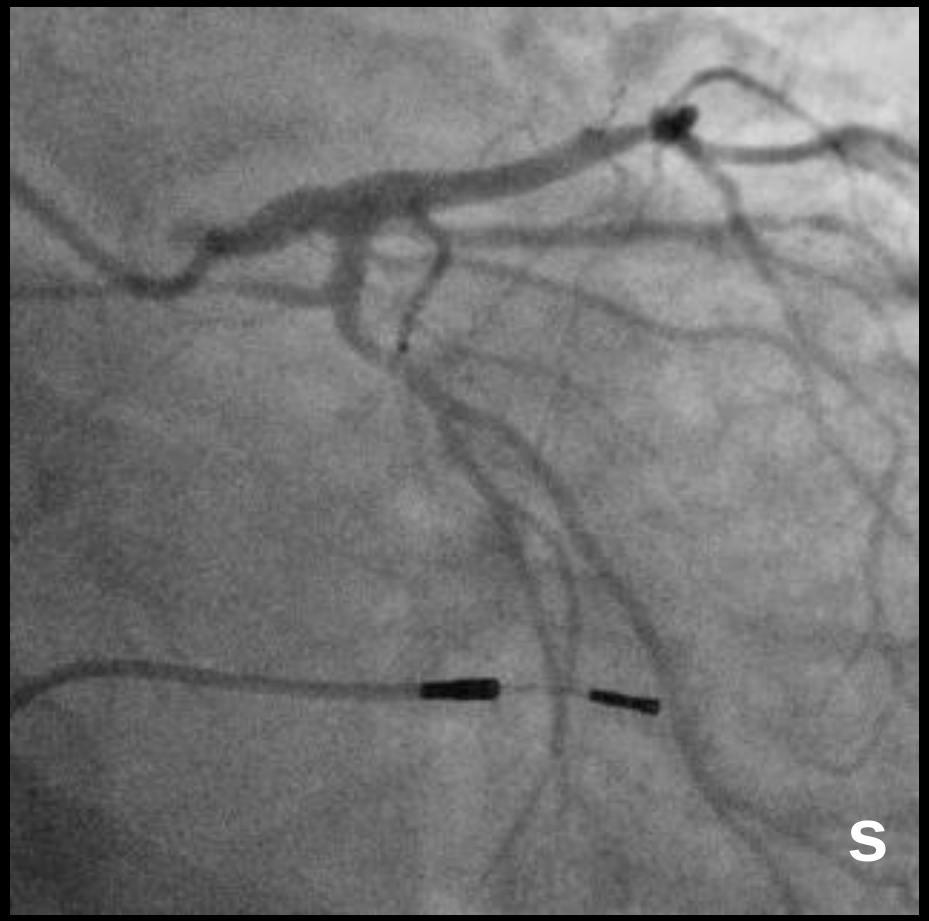
Real World iFR/FFR PCI Guidance

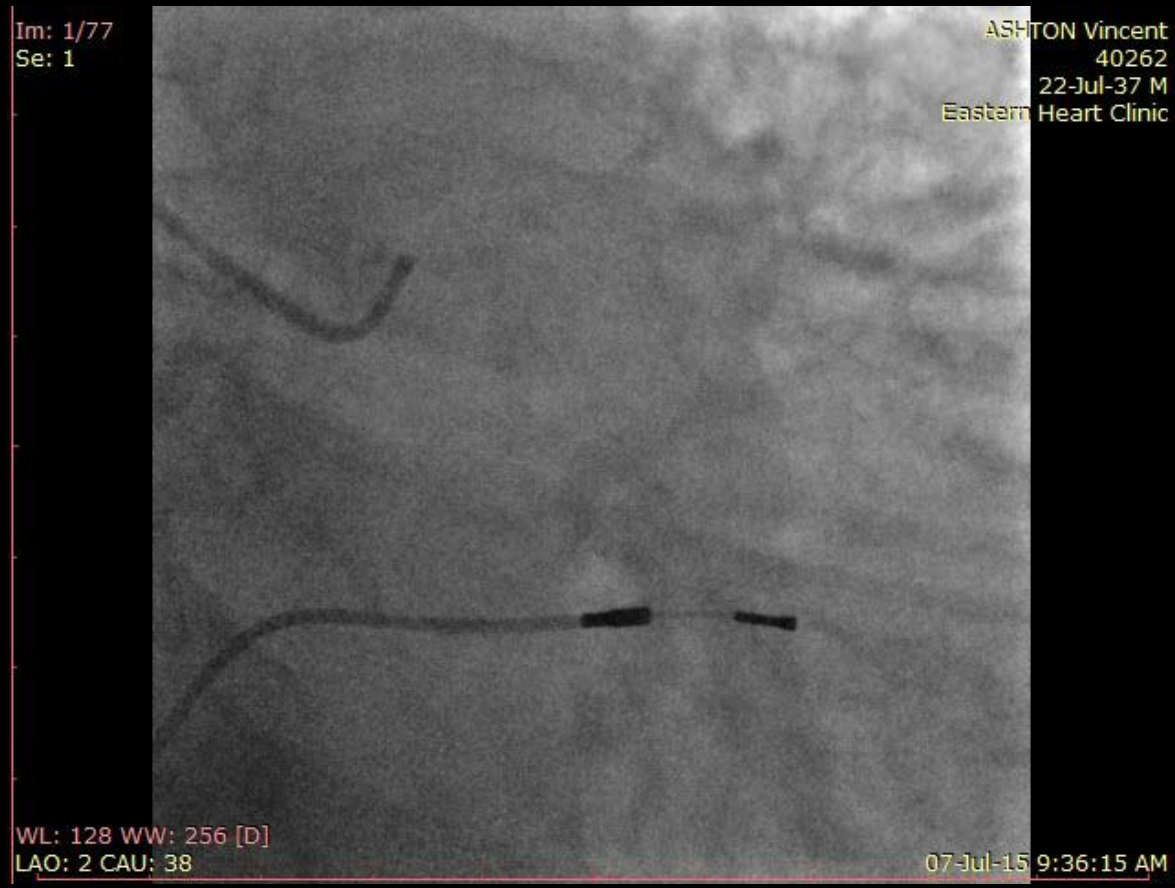
SYNTAX II Strategy - *Case Presentation*

78 year old male -

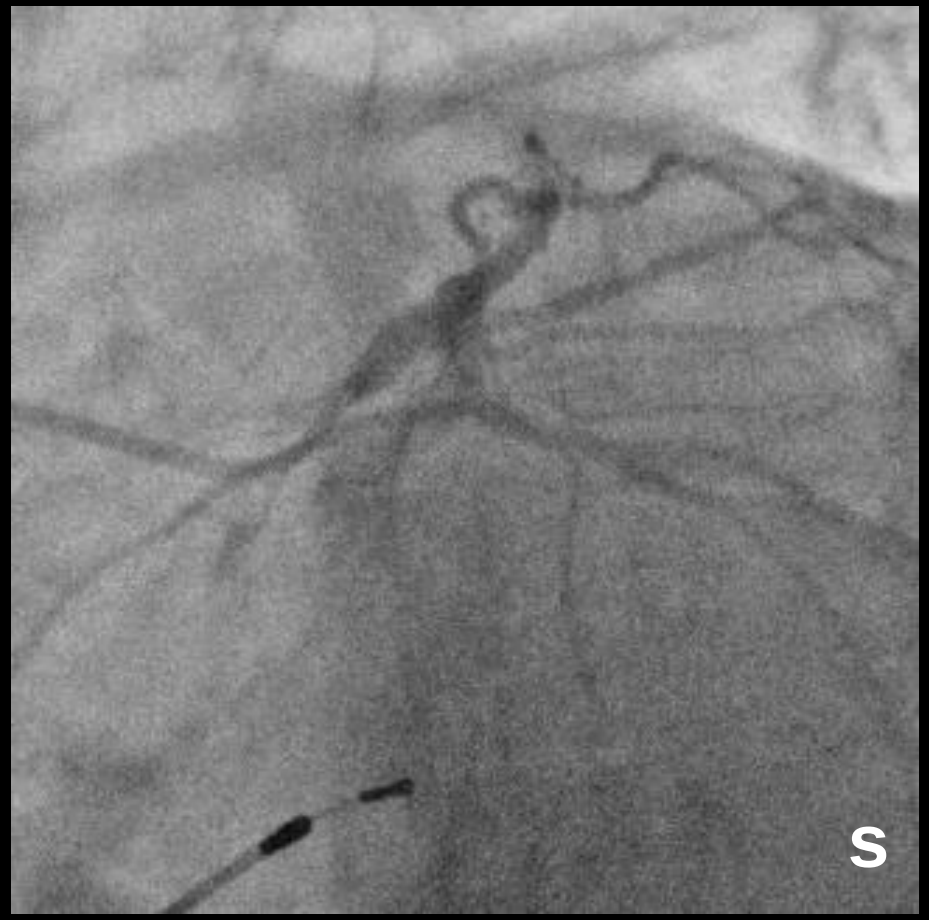
♥ **Presentation**	Exertional Dyspnoea, angina >6/12 (SAP)
♥ **Background**	COPD (mild), Chronic AF (CHADsVASC 2), PPM, Dyslipidaemia
	Awaiting bilateral TKR
♥ **Medications**	Metoprolol, Rosuvastation, Gemfibrozil, Warfarin, PPI
♥ **Investigations**	*ECG* – AF, ventricular pacing
	eGFR 82, Plt 177, Hb 123 g/L
	TTE - normal LV size, discrete apical hypokinesia overall normal LV function, normal valvular function
	Persantin Sestamibi - antero-apical, inferior ischaemia

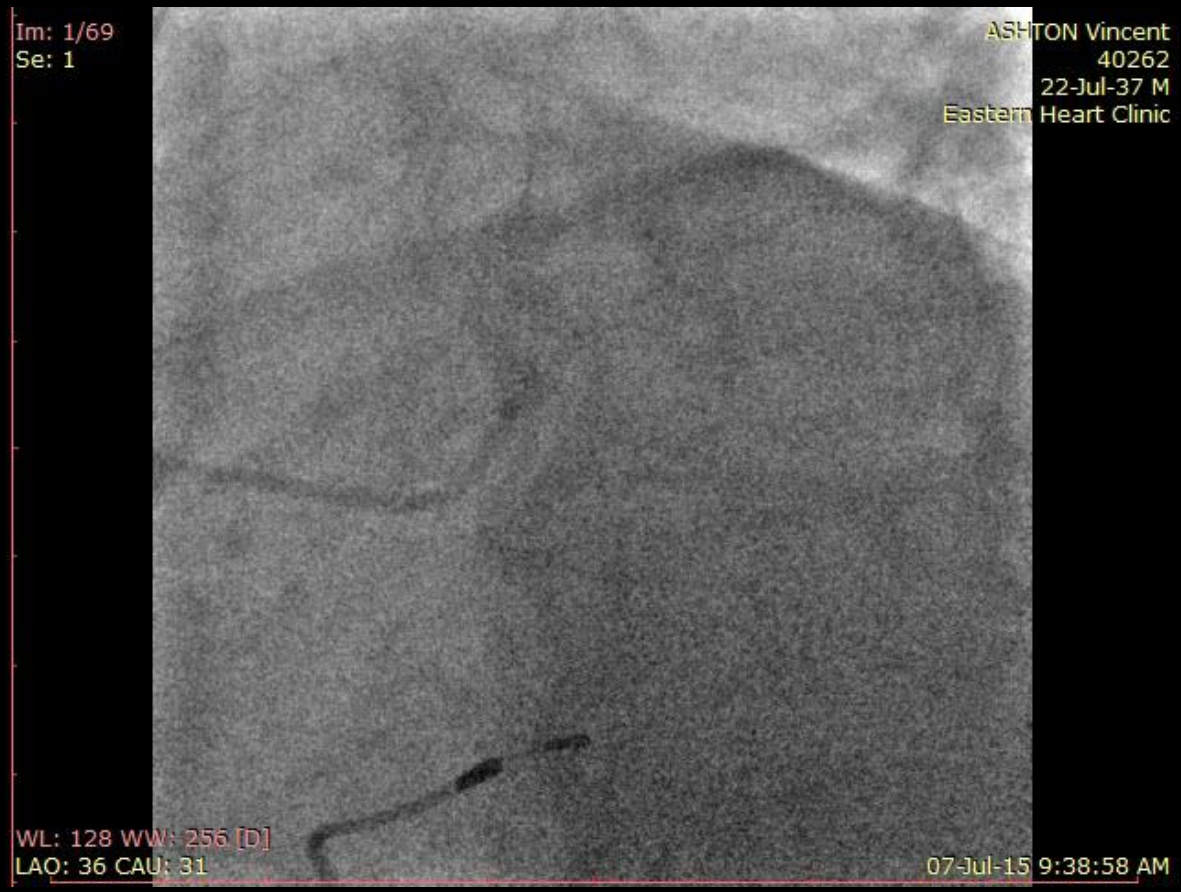
SYNTAX II Strategy - *Case Presentation*





SYNTAX II Strategy - *Case Presentation*





SYNTAX II Strategy - *Case Presentation*

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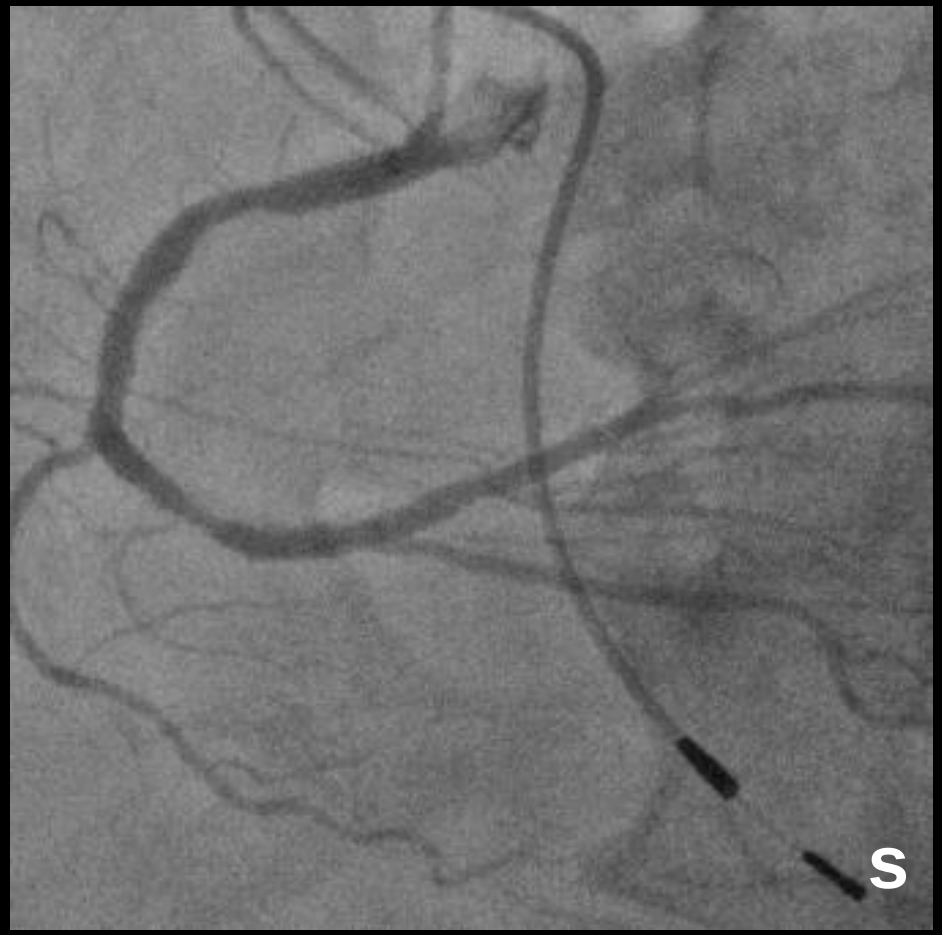
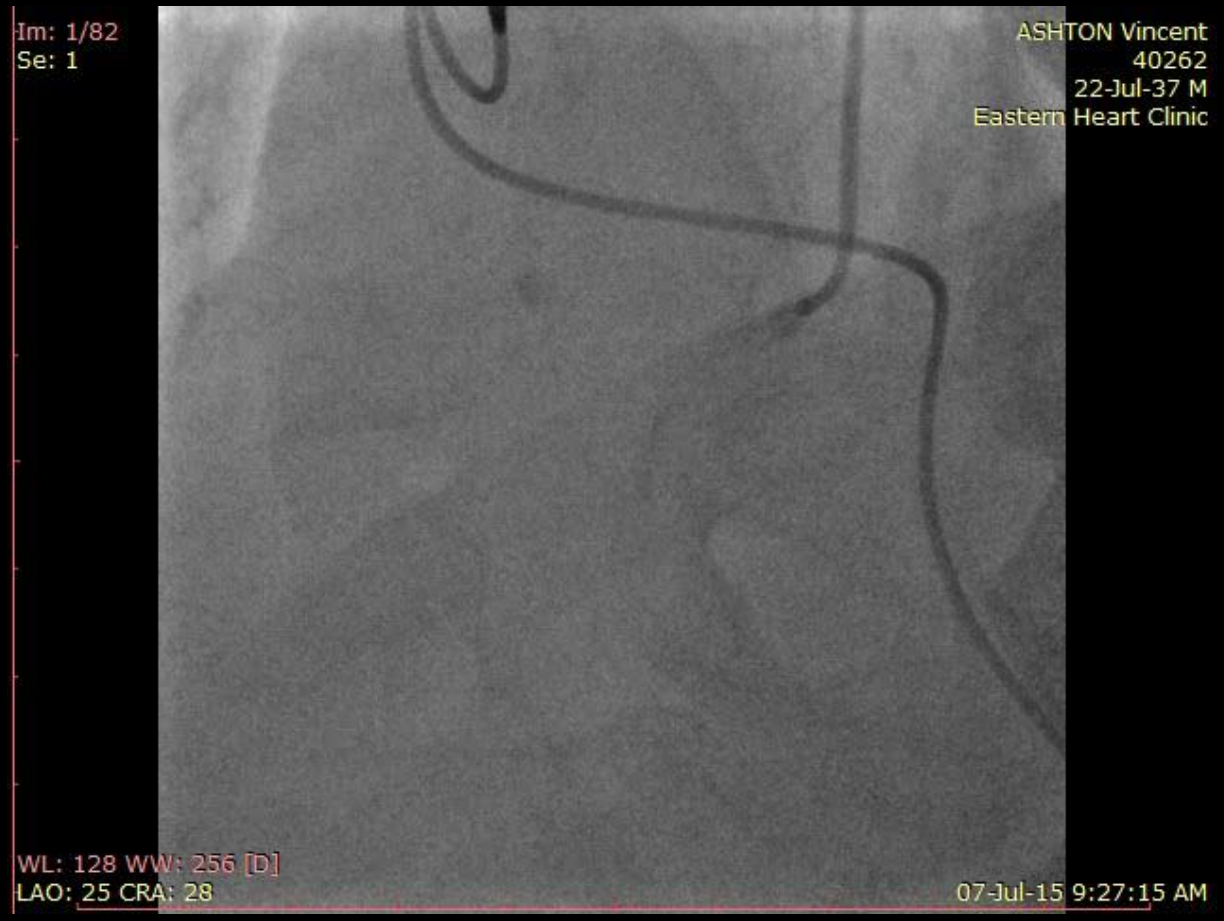




SYNTAX II Strategy - *Case Presentation*

Anatomical SYNTAX Score

Mid LAD bifurcation	7
Ostial left main	11
RCA	4
TOTAL:	22

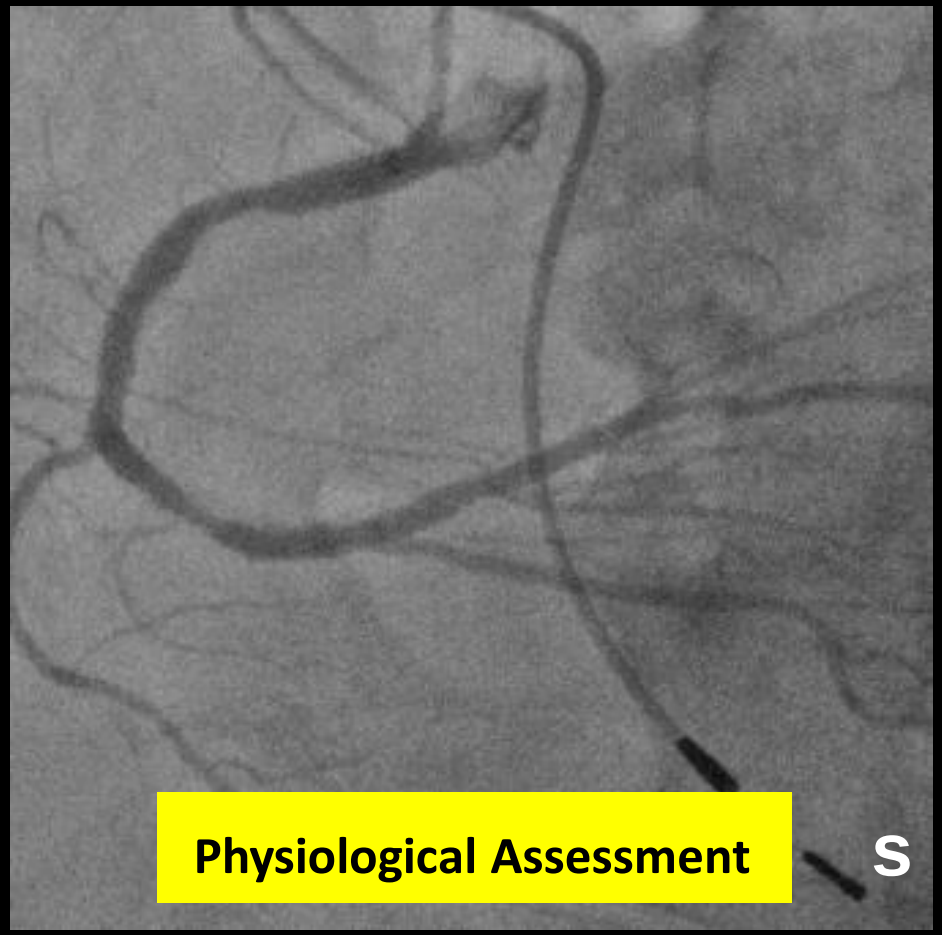
SYNTAX II Score

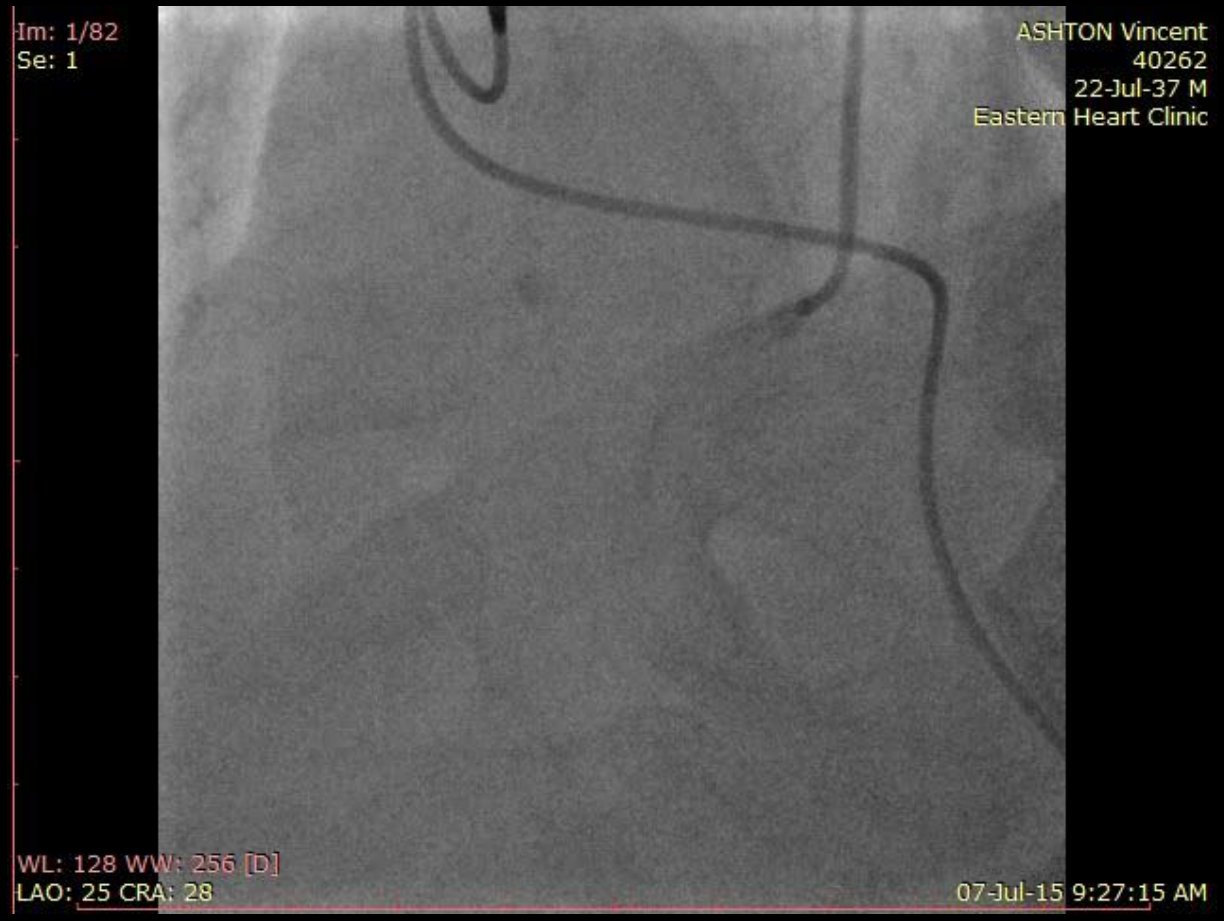
PCI	SYNTAX II Score	31.3
	PCI 4 yr Mortality	7.5%
CABG	SYNTAX II Score	51.7
	CABG 4 yr Mortality	35.3%

PCI Recommended (imaging + physiology guidance)

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach, Live Case ANZET 2015

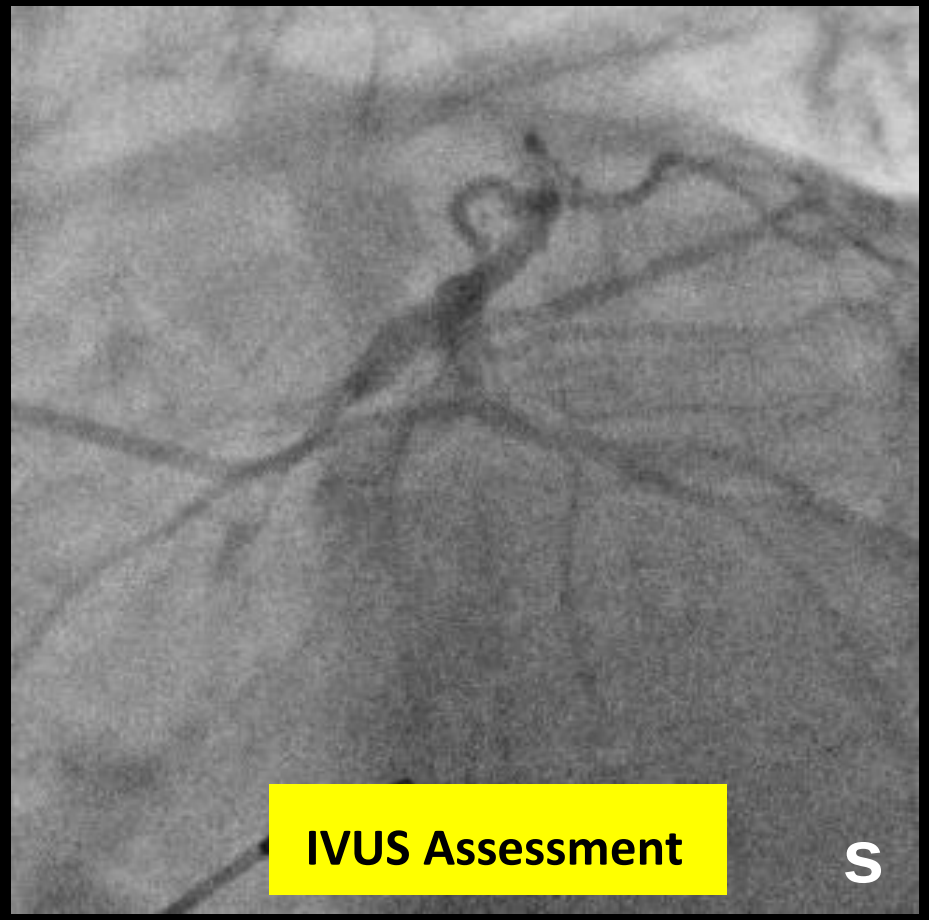


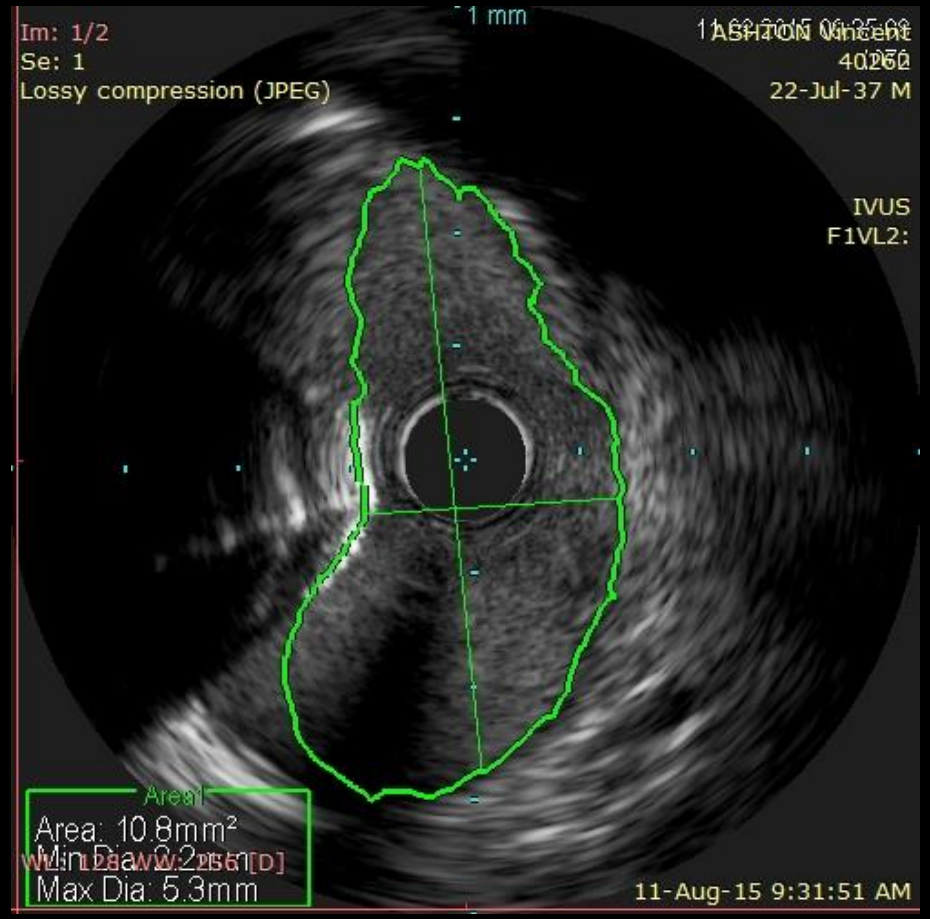


iFR 0.95, FFR 0.89

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach, Live Case ANZET 2015





IVUS LMS - MLA > 10mm²

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach

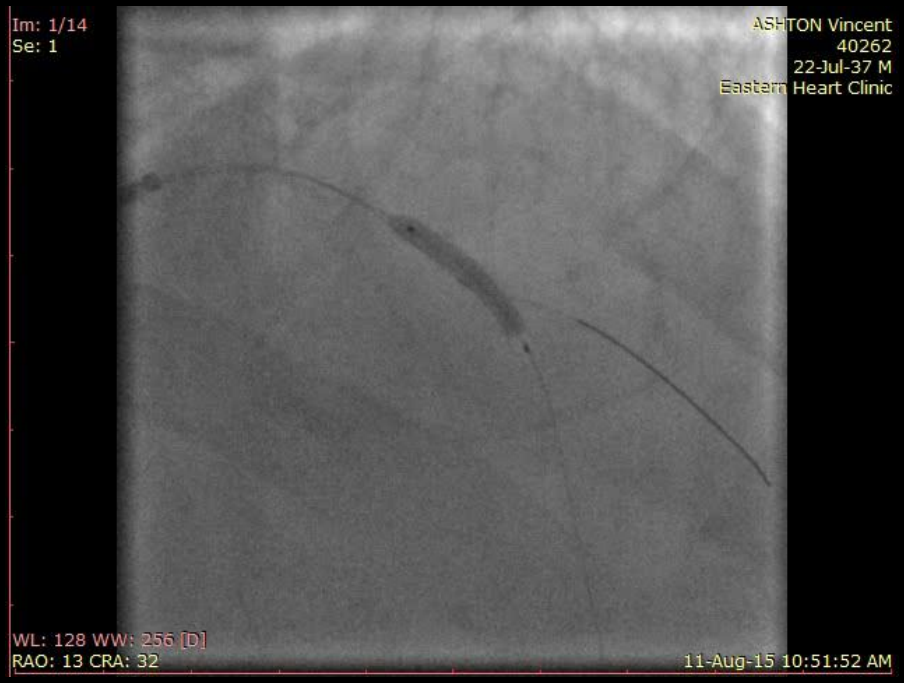
SYNTAX Score = 7, Live Case ANZET 2015

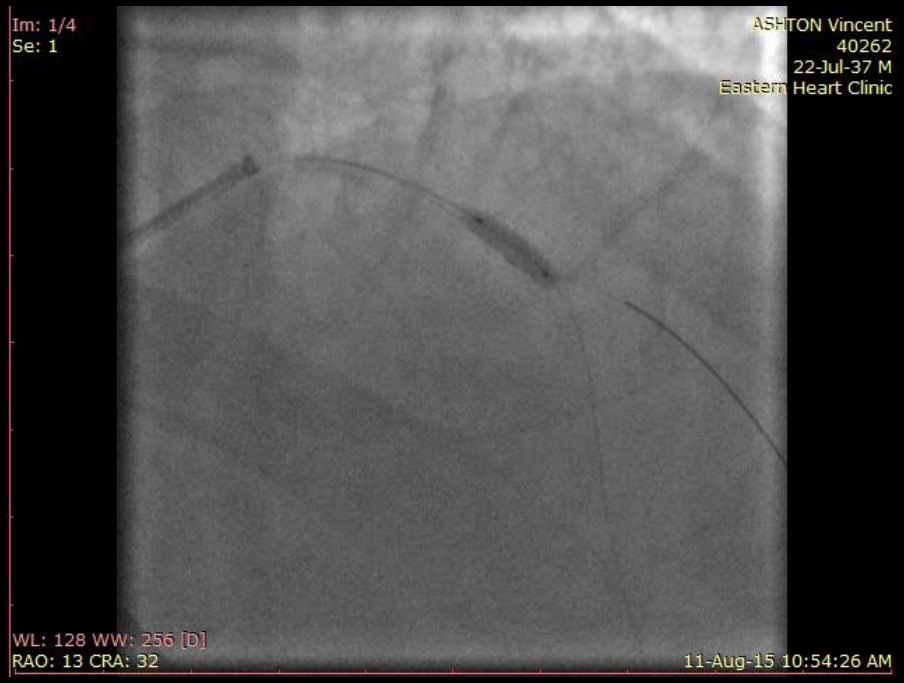
Provisional strategy – IVUS guidance
3.0 mm pre-dilatation

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach

SYNTAX Score = 7, Live Case ANZET 2015





Provisional strategy –
3.0 x 23 mm EES
3.5 mm NC POT

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach

SYNTAX Score = 7, Live Case ANZET 2015

Final Result -
SB opening 2.25 mm
Re-POT 3.5 mm NC

SYNTAX II Strategy - *Case Presentation*

DAPT – RRA approach

SYNTAX Score = 7, Live Case ANZET 2015

78 year old male -

♥ **Post-PCI**

Triple therapy 3mths (DAPT + warfarin)

Warfarin + Clopidogrel until 12 mths

Bilateral TKRs after 13 mths (on SAPT)

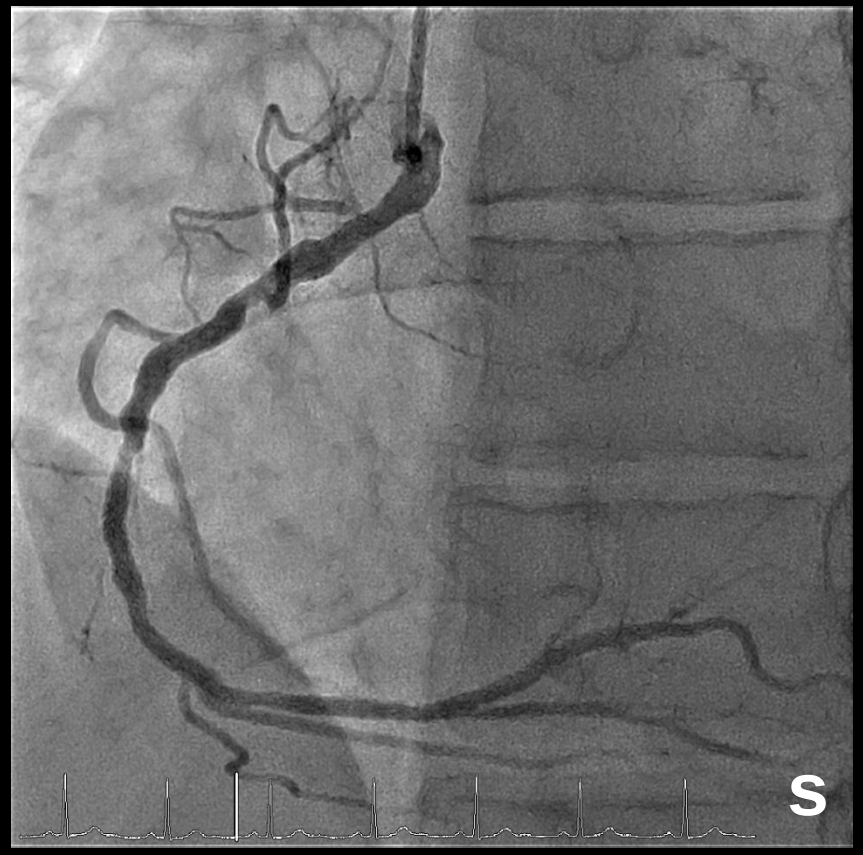
No MACE events over 3.5 years

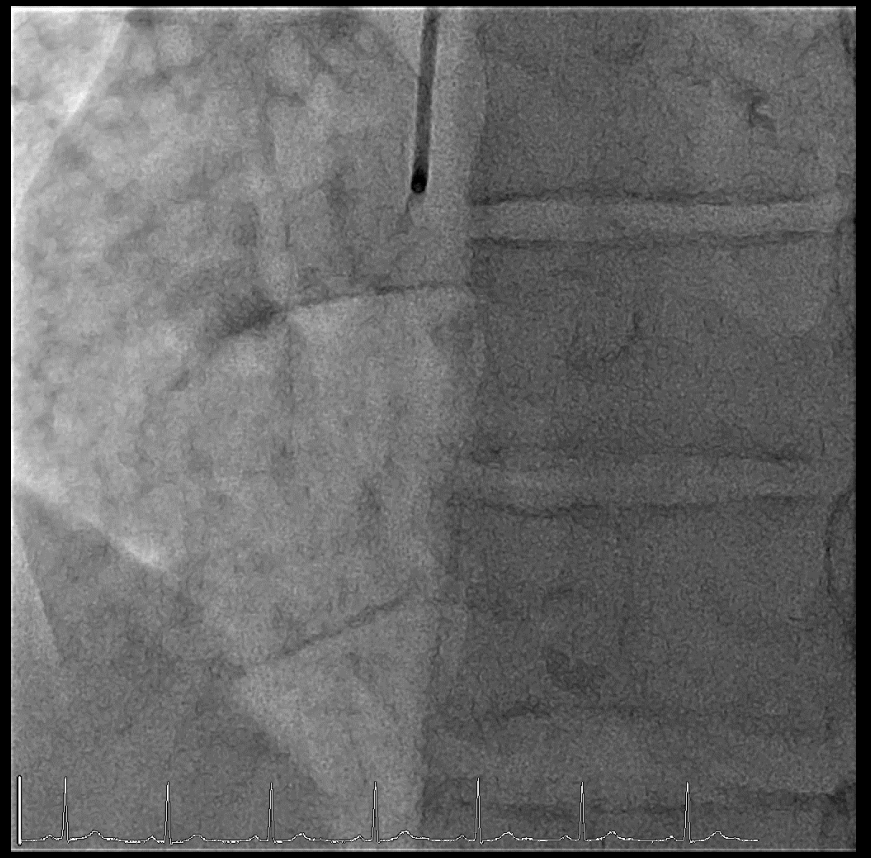
SYNTAX II Strategy - *Case Presentation*

59 year old male -

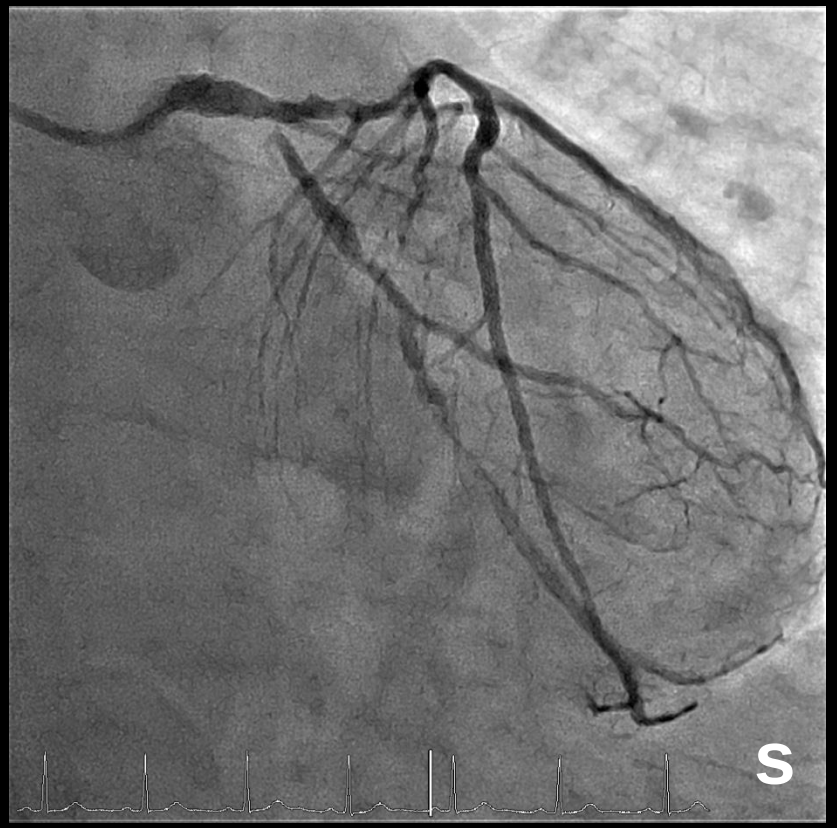
♥ **Presentation**	**Exertional angina <1/12**
♥ **Background**	**Hypertension, dyslipidaemia, HIV infection**
♥ **Medications**	**Metoprolol, Rosuvastation, Perindopril, Atripla**
♥ **Investigations**	***ECG* – SR, normal intervals**
	eGFR >90, Plt 221, Hb 135 g/L, viral load undetectable
	***TTE* - normal LV size and systolic function** **normal valvular function**
	***EST* - positive at 5.5 min Bruce protocol** **HR 131 – angina, ST depression 2mm** **distal + mid lateral, posterior hypokinesia**

SYNTAX II Strategy - *Case Presentation*

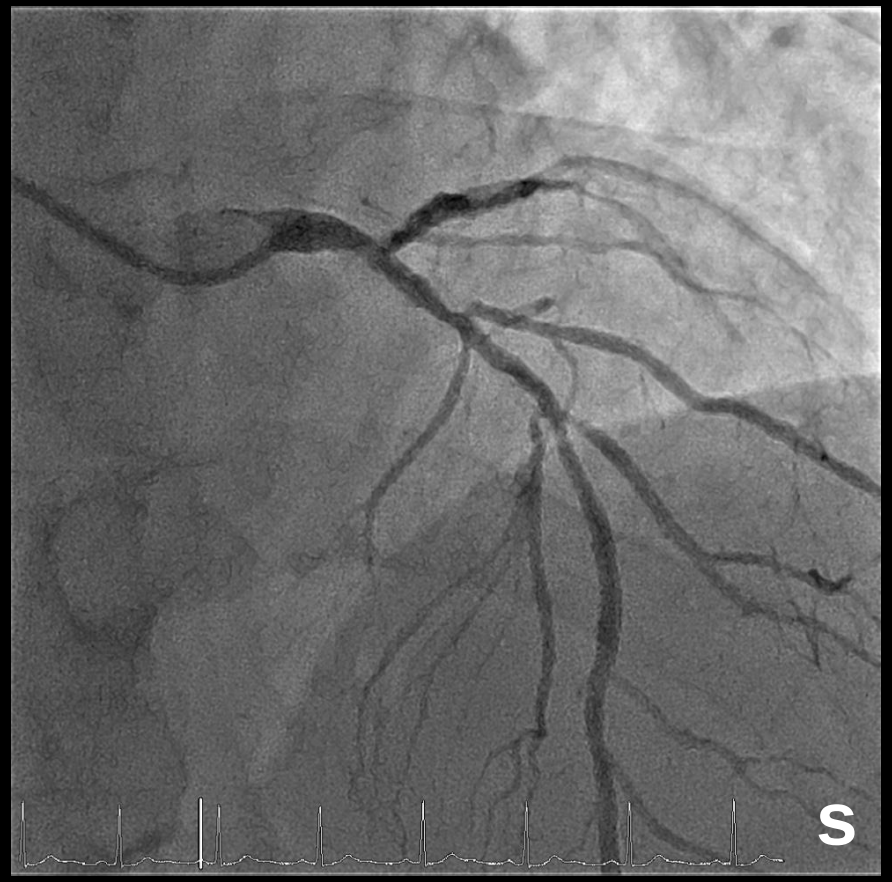


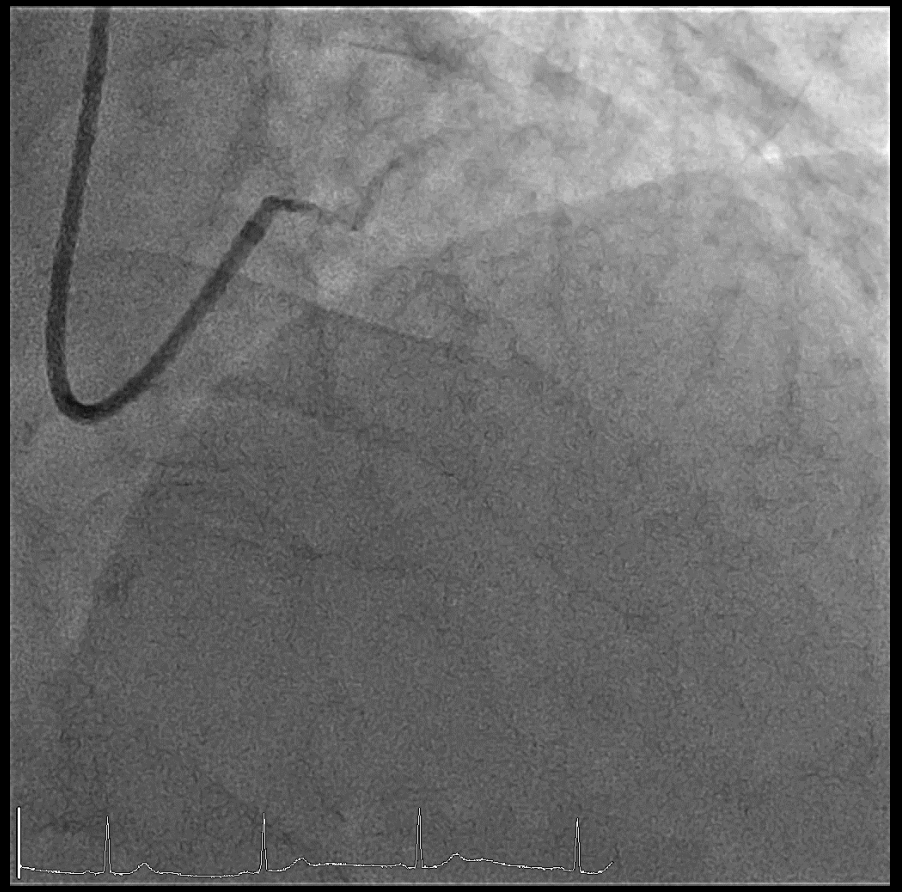


SYNTAX II Strategy - *Case Presentation*

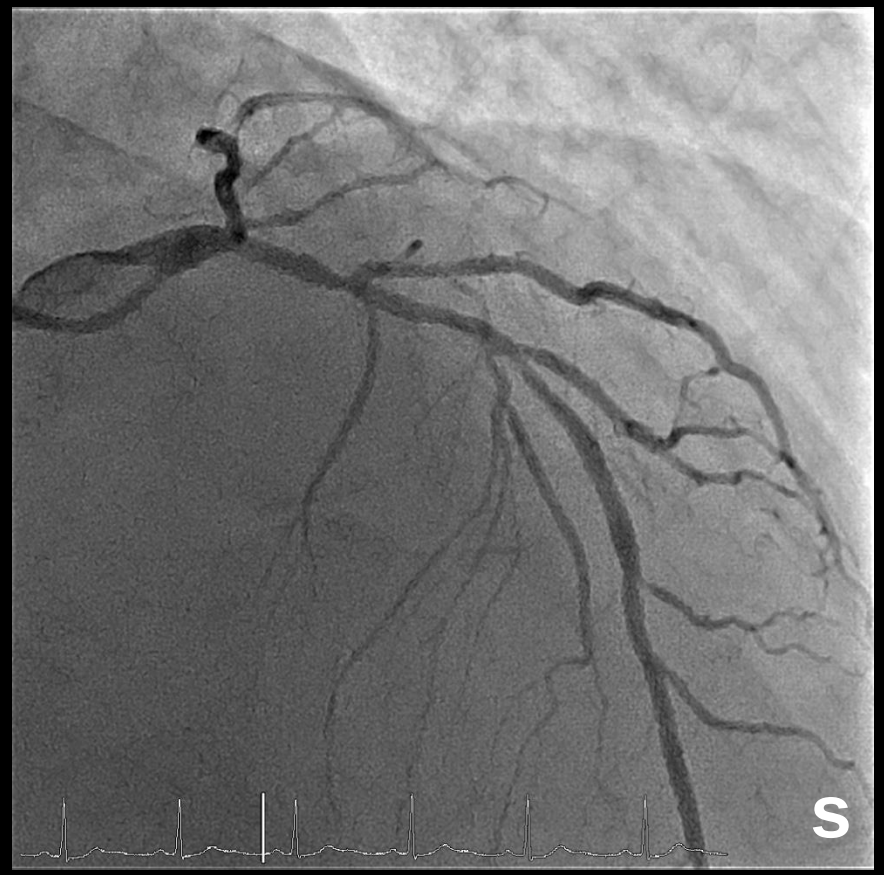


SYNTAX II Strategy - *Case Presentation*





SYNTAX II Strategy - *Case Presentation*



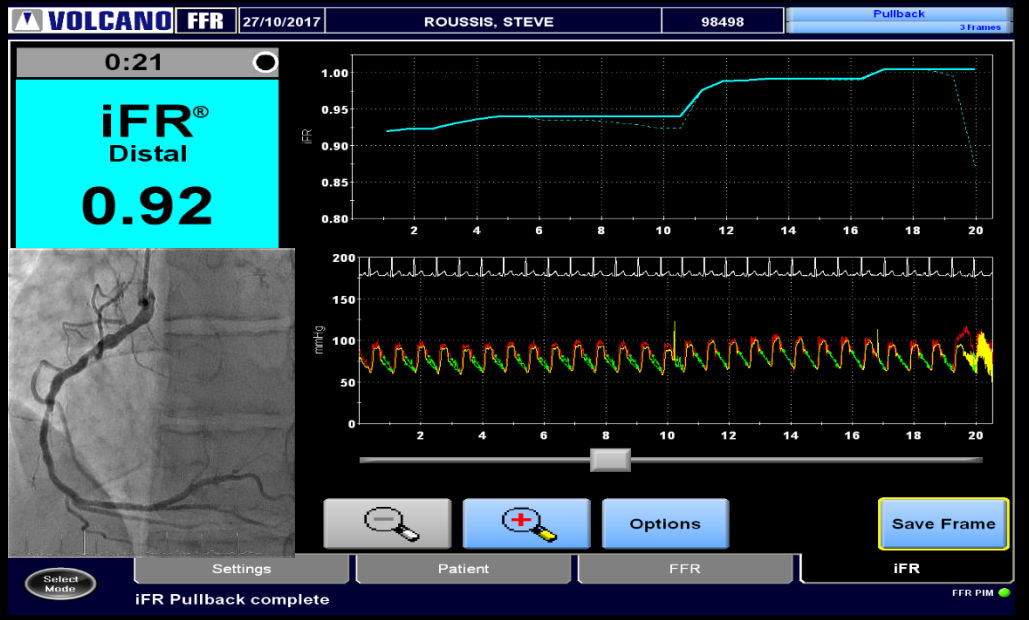
SYNTAX II Strategy - *Case Presentation*

Management Options

- **Angiogram** — critical ostial circumflex lesion 0,0,1
  diffuse moderate prox-mid LAD disease
  diffuse non-occlusive RCA disease
- **PCI vs CABG** — strategy –
  - physiology guided?
  - imaging (intra-coronary) guided?

SYNTAX II Strategy - *Case Presentation*

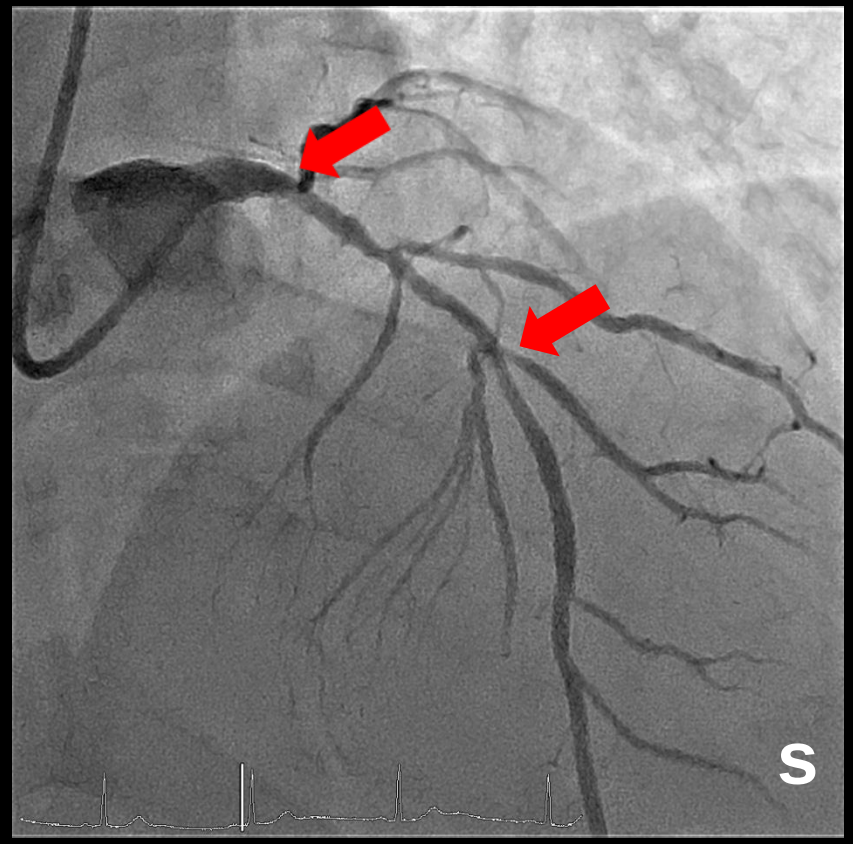
Physiological Assessment

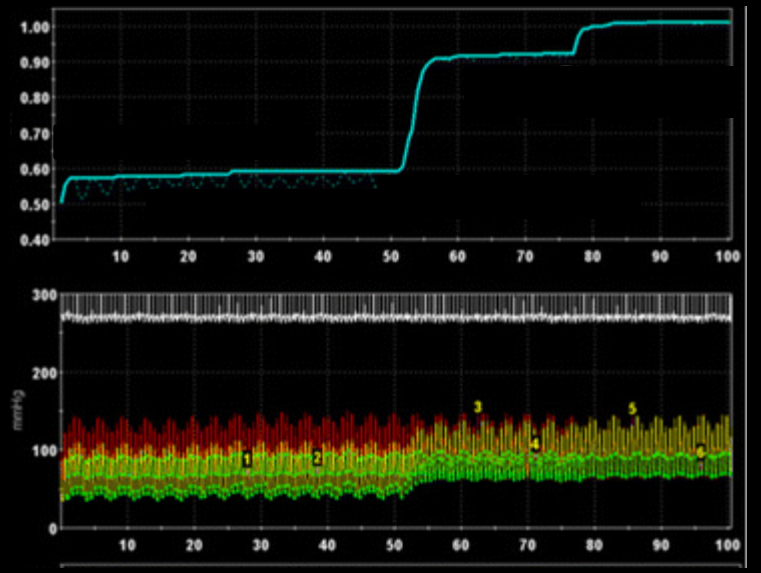


iFR - 0.92, FFR 0.83

SYNTAX II Strategy - *Case Presentation*

Physiological Assessment





iFR - 0.55 (normalized dLMS)

SYNTAX II Strategy - *Case Presentation*

Management Options

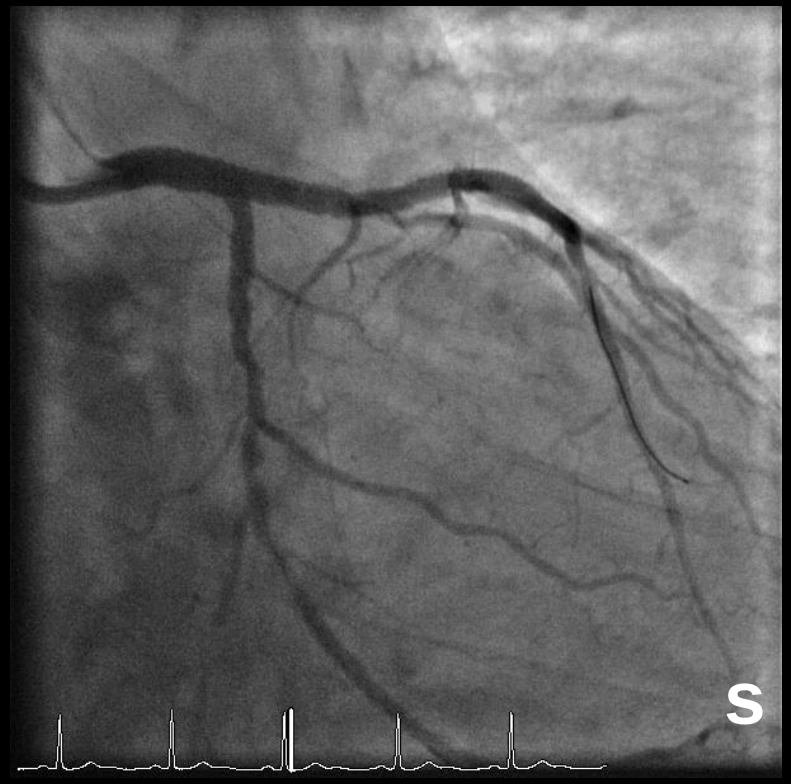
♥ **Angiogram**	critical ostial circumflex lesion 0,0,1 diffuse moderate prox-mid LAD disease diffuse non-occlusive RCA disease
♥ **iFR**	significant proximal + mid LAD disease functional dLMS 1,1,1 lesion
♥ **SYNTAX score**	31
♥ **SYNTAX II**	PCI 4 yr Mortality 3.7%, CABG 4 yr Mortality 4.1%
♥ **Heart Team discussion**	CABG recommended

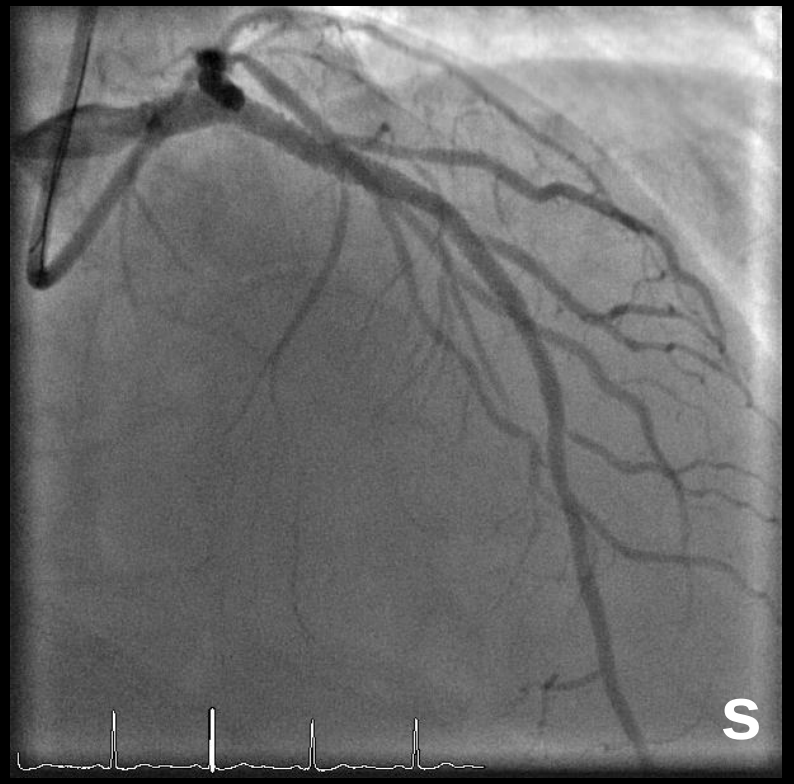
→ Surgeon ambivalent

→ Patient adamant PCI (Excel Suitable, refused DK crush V) – IVUS guided

SYNTAX II Strategy - *Case Presentation*

DK Crush – Two Stent Technique





Final Result

SYNTAX II Strategy - *Case Presentation*

DK Crush – Two Stent Technique

59 year old male -

♥ **Post-PCI** DAPT 12 mths (planned longer)

No MACE events over 2 years