Role of FFR in ACS: Still Doubtful?

Bon-Kwon Koo, MD, PhD

Seoul National University Hospital, Seoul, Korea

SNUH Seoul National University Hospital
Cardiovascular Center

FFR-guided PCI

Fractional flow reserve (FFR) is the current standard of care for the functional assessment of coronary stenosis.

5.4.1. FFR: Recommendation

CLASS IIa

1. FFR is reasonable to assess angiographic intermediate coronary lesions (50% to 70% diameter stenosis) and can be useful for guiding revascularization decisions in patients with SIHD (12,97, 484–486). *(Level of Evidence: A)*

Recommendations for the clinical value of intracoronary diagnostic techniques

Recommendations	Class[a]	Level[b]	Ref.[c]
FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	50,51,713
FFR-guided PCI in patients with multivessel disease.	IIa	B	54

FFR evidences……


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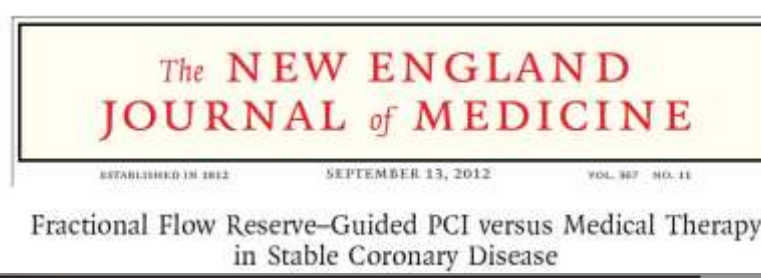
Long-Term Clinical
Outcome After Fractional Flo
Reserve-Guided Percutaneous
Intervention in Patients With Multivessel Disease

Alexandre Berger, MD,* Kees-Joost Botman, MD,* Philip A. MacCarthy, MD, PhD, MRCP,*
William Wijns, MD, PhD,* Jozef Bartunek, MD, PhD,* Guy R. Heyndrickx, MD, PhD,*
Nico H. J. Pijls, MD, PhD,† Bernard De Bruyne, MD, PhD*
Aalst, Belgium; and Eindhoven, the Netherlands


The NEW ENGLAND JOURNAL of MEDICINE

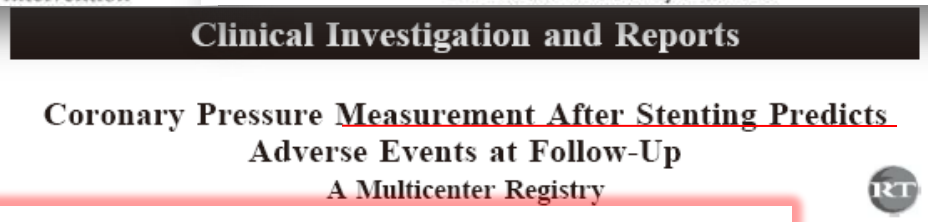
ESTABLISHED IN 1812 JANUARY 15, 2009 VOL. 360 NO. 3

Fractional Flow Reserve versus Angiography
for Guiding Percutaneous Coronary Intervention


The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 SEPTEMBER 13, 2012 VOL. 367 NO. 11

Fractional Flow Reserve–Guided PCI versus Medical Therapy
in Stable Coronary Disease


Clinical Investigation and Reports

Coronary Pressure Measurement After Stenting Predicts
Adverse Events at Follow-Up
A Multicenter Registry

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ers, MD;
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Cli
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Le
Native Coronary Arteries

Stefan Krüger, MD; Karl-Christian Koch, MD; Ira Kaumanns, MD;
Marc W. Merx, MD; Peter Hanrath, MD; and Rainer Hoffmann, MD

FFR in patients with ACS?


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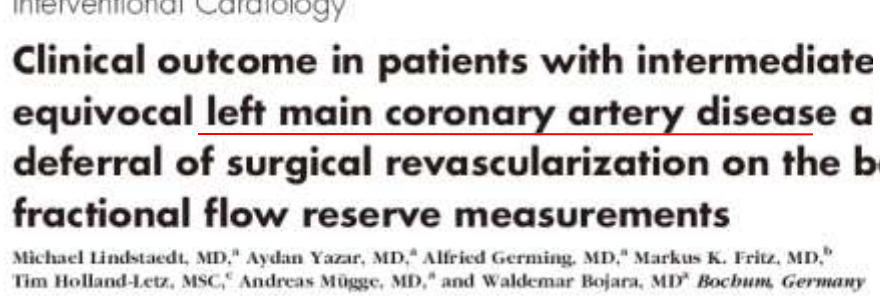
Physiologic Assessment of Jailed Side
Branch Lesions Using Fractional Flow Reserve

Bon-Kwon Koo, MD, PhD,* Hyun-Jai Kang, MD, PhD,* Tae-Jin Youn, MD, PhD,†
In-Ho Chae, MD, PhD,† Dong-Joo Choi, MD, PhD,† Hyo-Soo Kim, MD, PhD,*
Dae-Won Sohn, MD, PhD,* Byung-Hee Oh, MD, PhD, FACC,*
Myoung-Mook Lee, MD, PhD, FACC,* Young-Bae Park, MD, PhD,*
Yun-Shik Choi, MD, PhD,* Seung-Jae Tahk, MD, PhD‡
Seoul, Seongnam, Gyeonggi-


Interventional Cardiology

Clinical outcome in patients with intermediate equivocal left main coronary artery disease a deferral of surgical revascularization on the basis of fractional flow reserve measurements

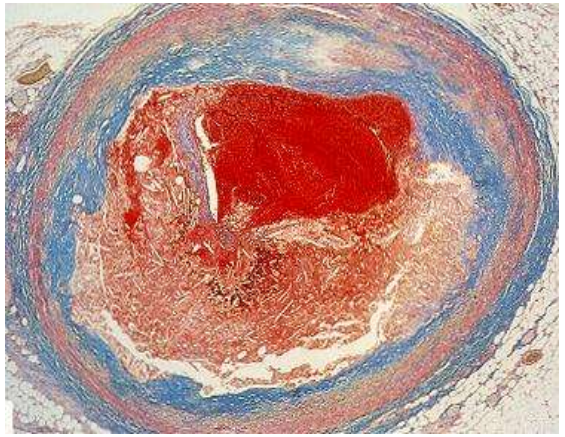
Michael Lindstaedt, MD,[a] Aydan Yazar, MD,[a] Alfried Germing, MD,[a] Markus K. Fritz, MD,[b]
Tim Holland-Letz, MSC,[c] Andreas Mügge, MD,[a] and Waldemar Bojara, MD[a] *Bochum, Germany*


Physiological evaluation of the provisional side-branch intervention strategy for bifurcation lesions using fractional flow reserve

Bon-Kwon Koo[1], Kyung-Woo Park[1], Hyun-Jae Kang[1], Young-Seok Cho[2],
Woo-Young Chung[2], Tae-Jin Youn[2], In-Ho Chae[2], Dong-Ju Choi[2], Seung-Jae Tahk[2],
Byung-Hee Oh[1], Young-Bae Park[1] and Hyo-Soo Kim[1]*

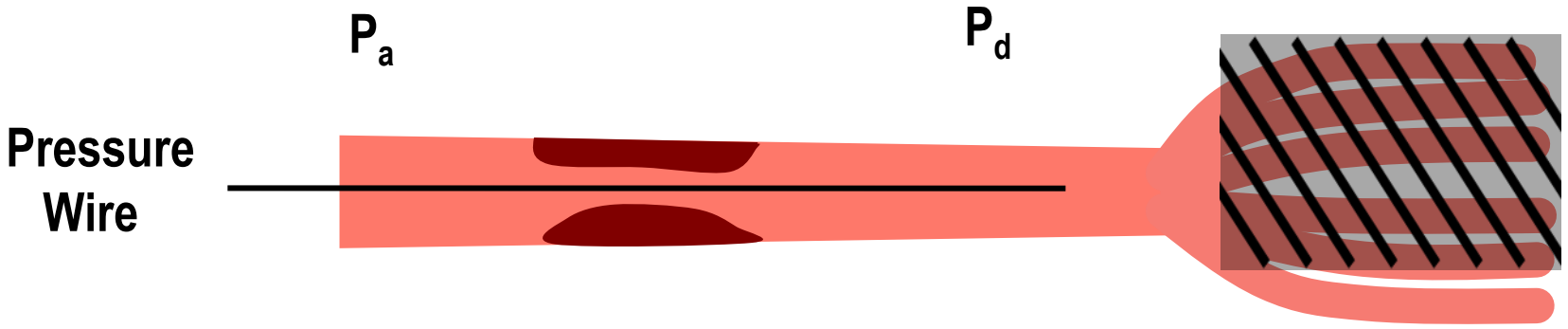
Unique features of ACS

- Unstable clinical condition
- Vulnerable plaque
- Plaque rupture
- Thrombus

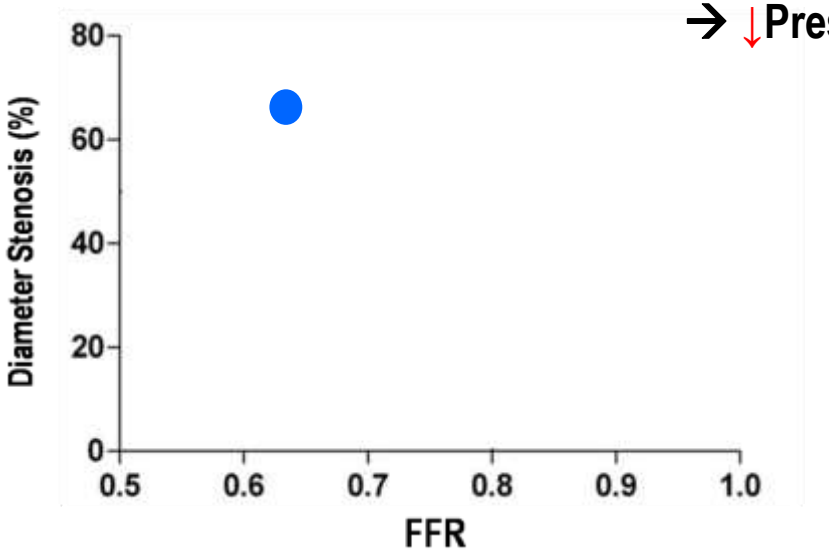


- Myocardial damage and microvascular dysfunction

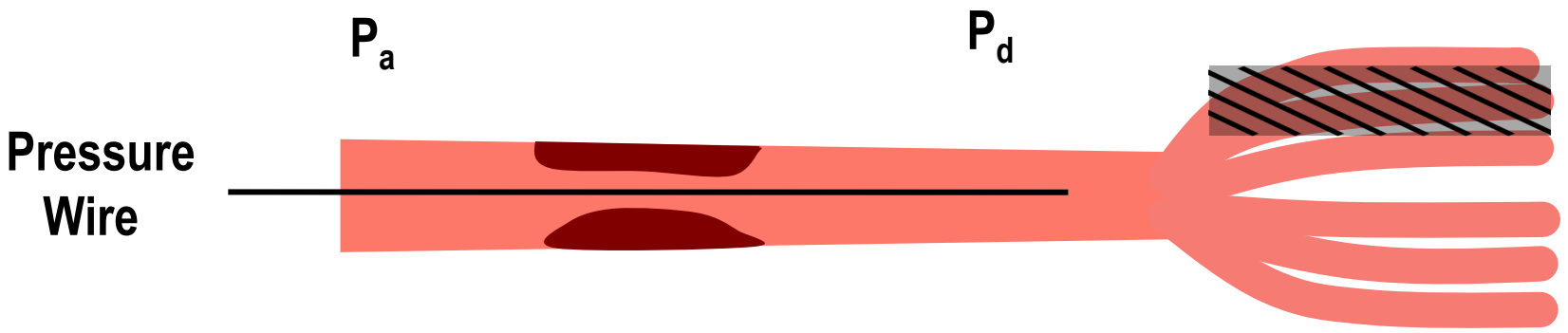
So, what's wrong with using FFR in ACS, especially in AMI?



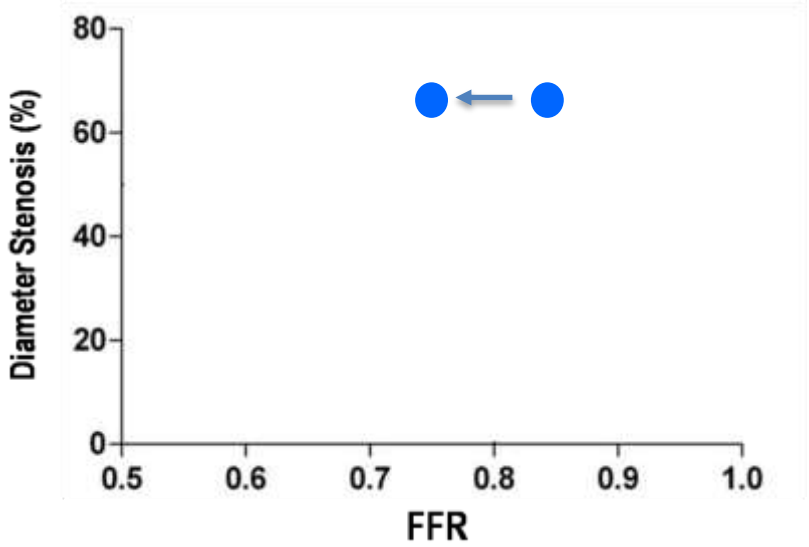
↑Resistance → ↓Flow
→ ↓Pressure gradient → ↑ FFR



So, what's wrong with using FFR in ACS, especially in AMI?



Partial recovery → ↓ FFR



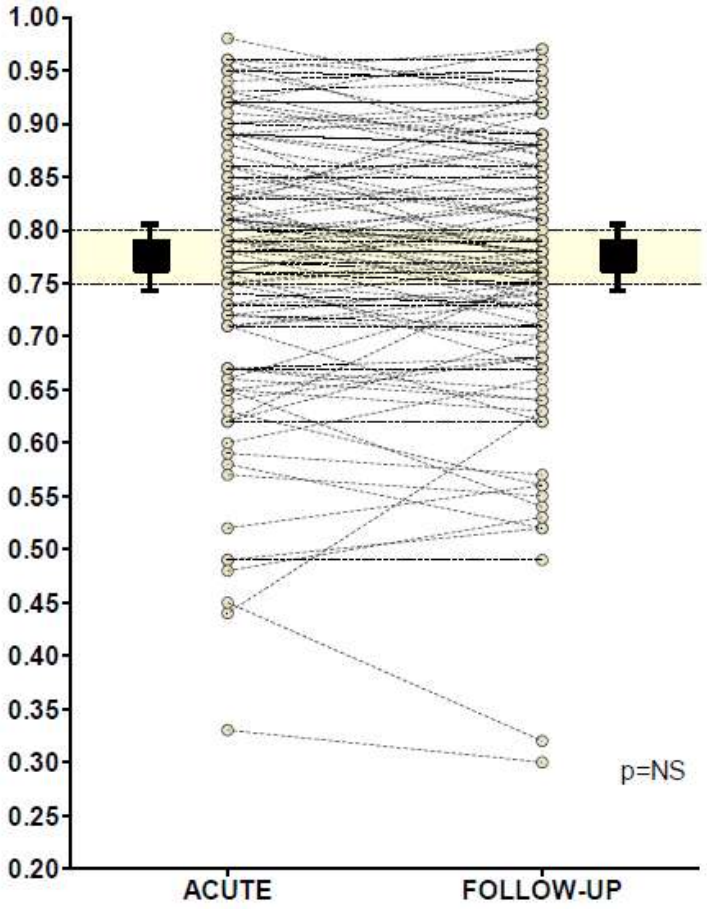
Influence of MI on FFR

	MI	No MI	*P*
Target lesion, n	22	21	
Pre-/postintervention, n	7/15	10/11	0.2
Diameter stenosis, %	43 ± 22	44 ± 16	0.9
MLD, mm	1.7 ± 0.8	1.6 ± 0.6	0.6
Length, mm	9.1 ± 4.0	7.3 ± 3	0.1
Reference diameter, mm	2.9 ± 0.5	2.8 ± 0.6	0.6
Flow velocity measurements			
APV (basal), cm/sec	17 ± 7	17 ± 8	0.8
APV (hyperemic), cm/sec	26 ± 13	36 ± 16	0.03
Coronary flow reserve	1.5 ± 0.3	2.1 ± 0.4	< 0.0001
Flow (hyperemic), ml/min	37 ± 26	48 ± 22	0.03
Pressure measurements			
Gradient (hyperemic), mm Hg	13 ± 11	21 ± 13	0.05

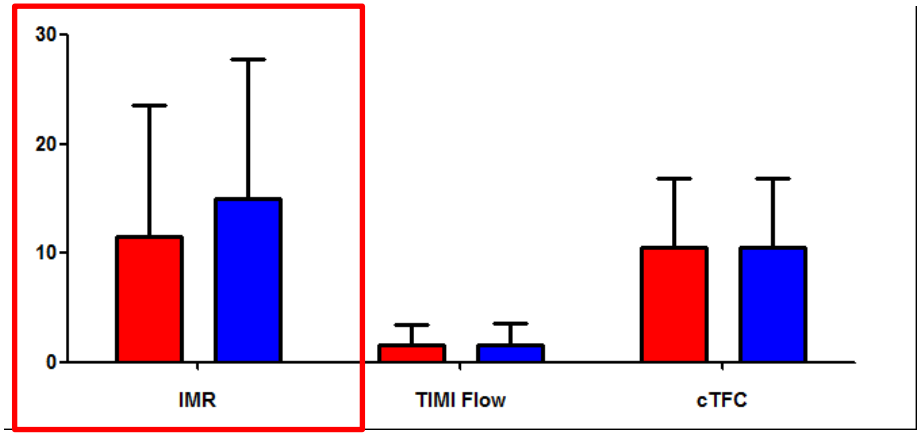
Cathet Cardiovasc Intervent 2001;54:427-434

Then, what about for non-culprit lesions?

101 patients with ACS (75 STEMI, 26 NSTEMI)
112 non-culprit stenoses – FFR at index and F/U (35±24 days)



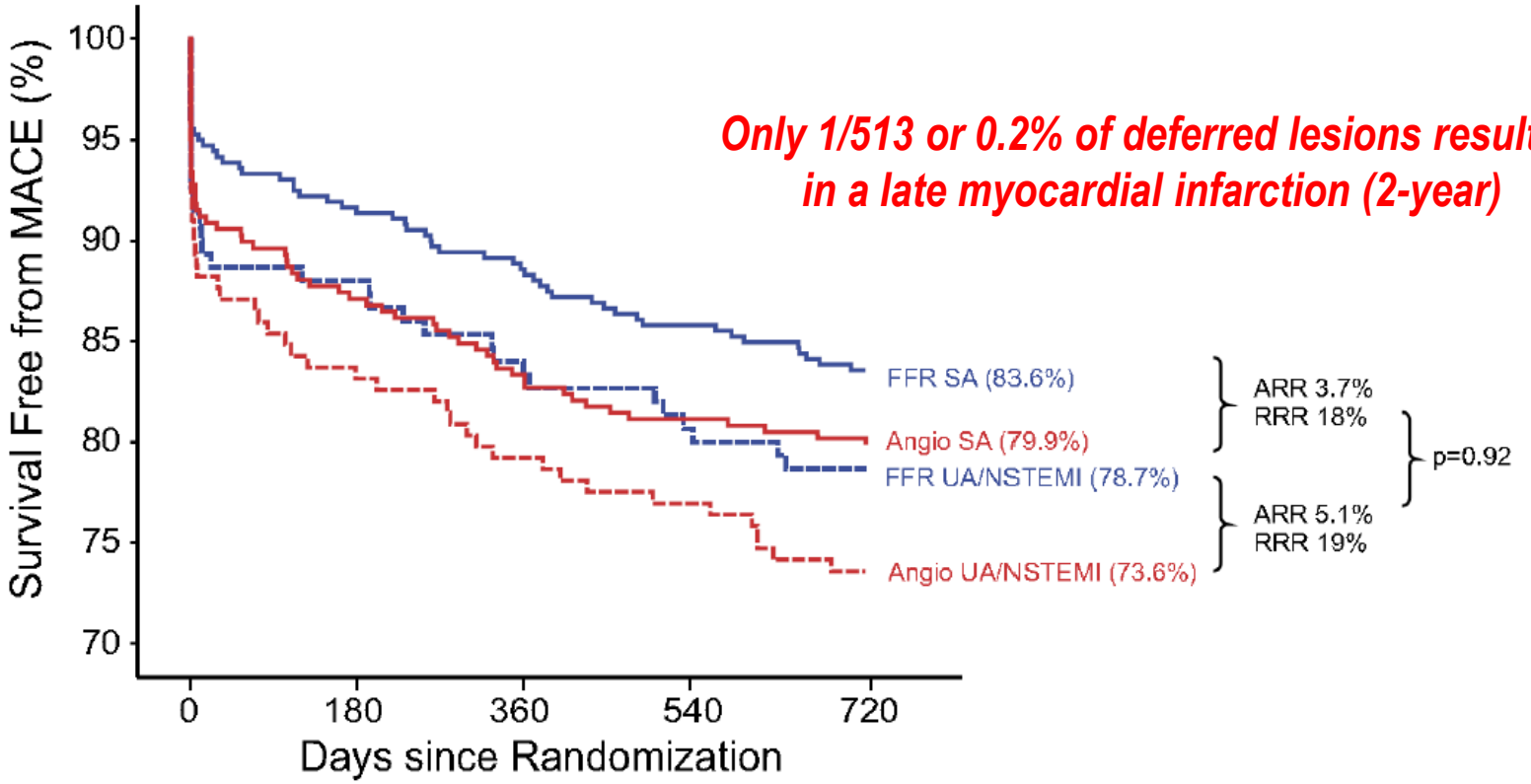
- **In only 2/112 non-culprit stenoses was the FFR>0.80 during ACS and <0.75 at follow-up**



Ntalianis, et al. JACC Intv 2010

FFR-guided Strategy for NSTEMI/UA (Multivessel)

FAME sub-study (328 patients with NSTEMI/UA)



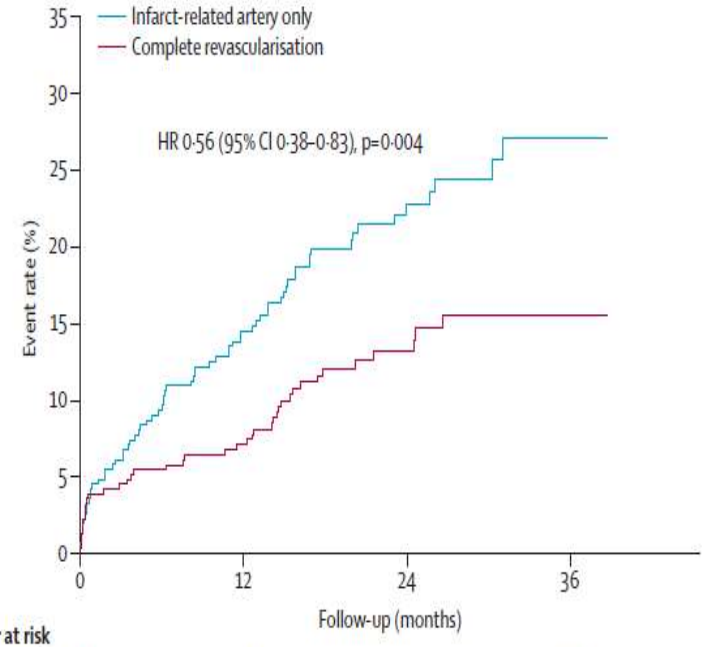
Only 1/513 or 0.2% of deferred lesions resulted in a late myocardial infarction (2-year)

No difference between SA and UA/NSTEMI

Sels, et al. JACC Intv 2011

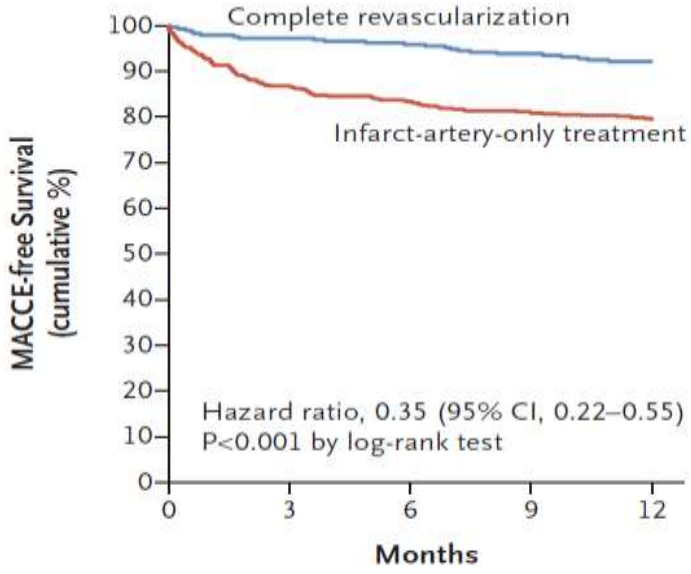
FFR-Guided CR vs. IRA only in STEMI with MVD

DANAMI-3-PRIMULTI



Number at risk				
Infarct-related artery only	313	271	142	53
Complete revascularisation	314	291	159	55

COMPARE-ACUTE



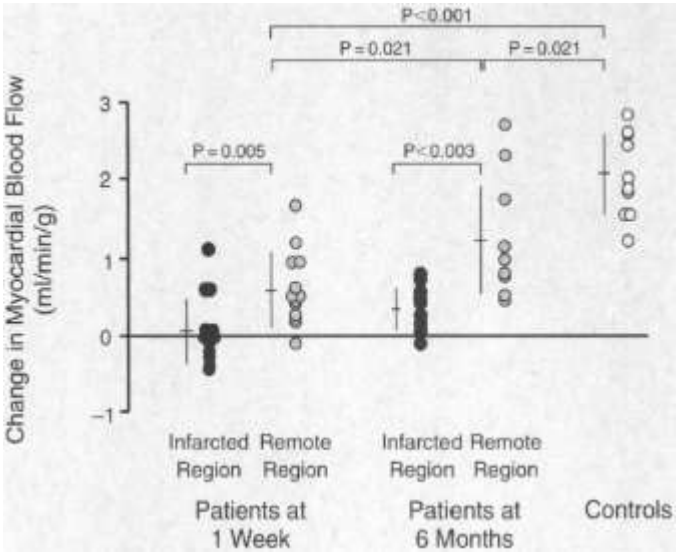
No. at Risk					
Complete revascularization	295	286	281	264	215
Infarct artery	590	512	492	457	371

Engstrom, et al. Lancet 2015;386:665-671
Smits, et al. N Engl J Med 2017;376:1234-1244

Why still doubtful?

REDUCED CORONARY VASODILATOR FUNCTION IN INFARCTED AND NORMAL MYOCARDIUM AFTER MYOCARDIAL INFARCTION

NEAL G. UREN, M.D., TOM CRAKE, M.D., DAVID C. LEFROY, M.R.C.P., RANIL DE SILVA, PH.D., GRAHAM J. DAVIES, M.D., AND ATTILIO MASERI, M.D.

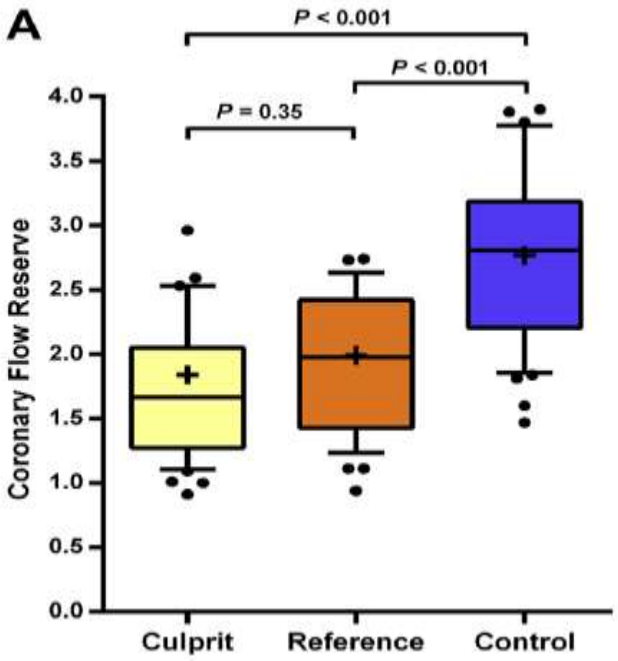


INDEX	MYOCARDIAL BLOOD FLOW (ml/min/g)			CORONARY VASCULAR RESISTANCE (mm Hg · min · g/ml)		
	PET AT 1 WK (N = 13)	PET AT 6 MO (N = 9)	P VALUE	PET AT 1 WK (N = 13)	PET AT 6 MO (N = 9)	P VALUE
Infarcted region						
Basal value	0.81±0.22	0.82±0.21	NS	110.3±48.7	116.9±45.8	NS
Peak after dipyridamole	0.91±0.51	1.20±0.45	0.053	118.0±61.0	107.8±104.4	NS
Coronary vasodilator response	1.12±0.50	1.42±0.37	0.05	—	—	—
Remote region						
Basal value	1.09±0.32†	1.09±0.18‡	NS	76.1±16.7§	83.3±21.0	NS
Peak after dipyridamole	1.70±0.72¶	2.38±0.89‖	0.006	55.1±18.4¶	43.7±14.8	0.018
Coronary vasodilator response	1.53±0.36**	2.19±0.69¶	0.011	—	—	—

Changes in Coronary Blood Flow After Acute Myocardial Infarction

Insights From a Patient Study and an Experimental Porcine Model

Guus A. de Waard, MD,[*] Maurits R. Hollander, MD,[†] Paul F.A. Teunissen, MD,[*] Matthijs F. Jansen, MD,[*] Elise S. Eerenberg, MD,[†] Aernout M. Beek, MD, PhD,[*] Koen M. Marques, MD, PhD,[*] Peter M. van de Ven, PhD,[‡] Ingrid M. Garrelds, MSc,[‖] A.H. Jan Danser, PhD,[‖] Dirk J. Duncker, MD, PhD,[*] Niels van Royen, MD, PhD[*]



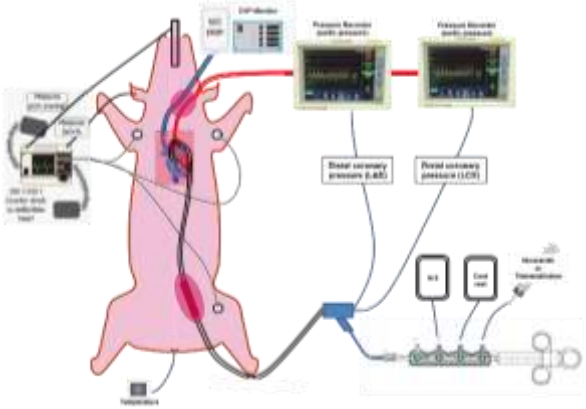
de Waard, et al. JACC Intv 2016

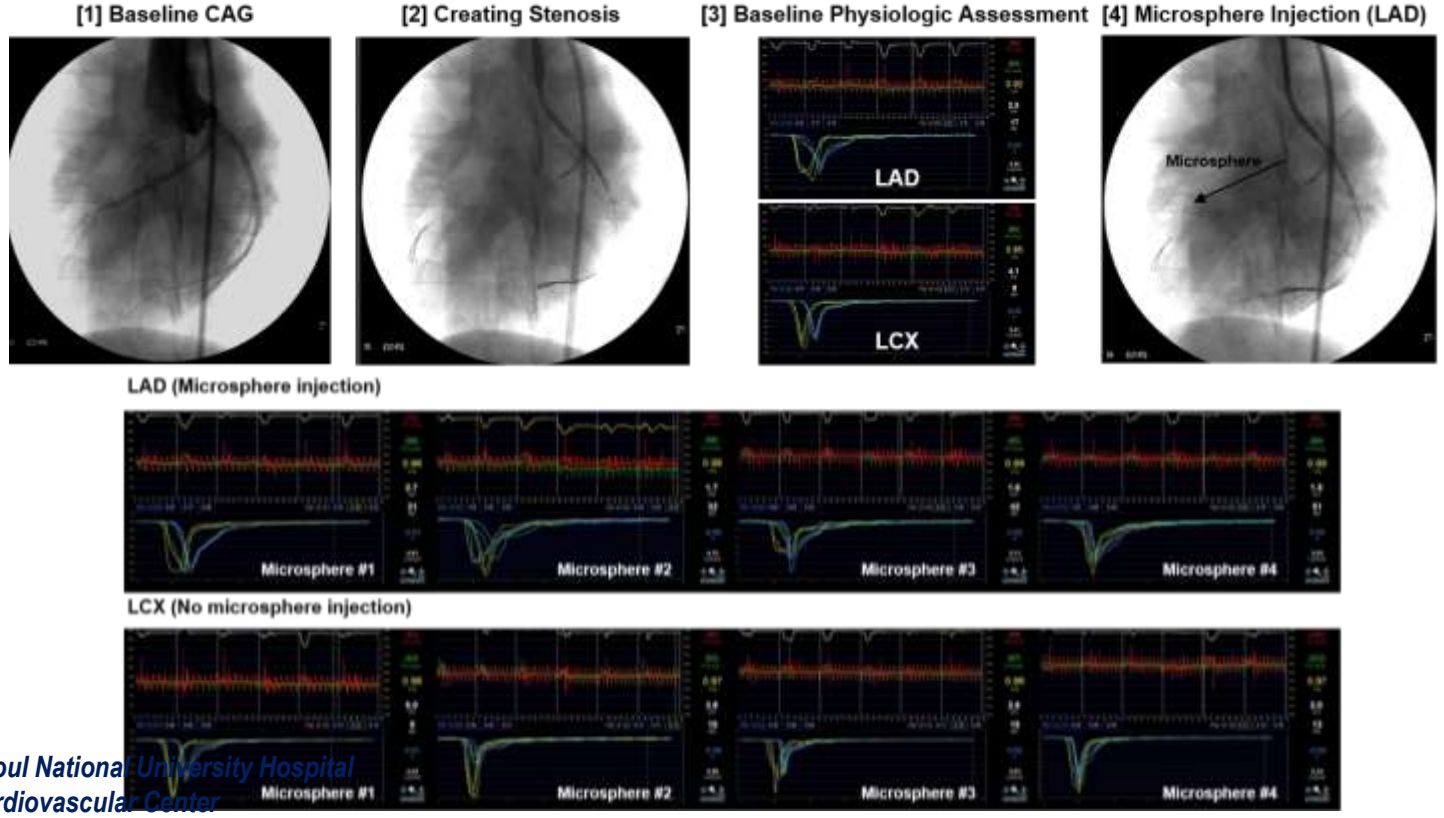
JACC: CARDIOVASCULAR INTERVENTIONS
VOL. ■, NO. ■, 2018

PUBLISHED BY ELSEVIER

Influence of Local Myocardial Damage on Index of Microcirculatory Resistance and Fractional Flow Reserve in Target and Nontarget Vascular Territories in a Porcine Microvascular Injury Model

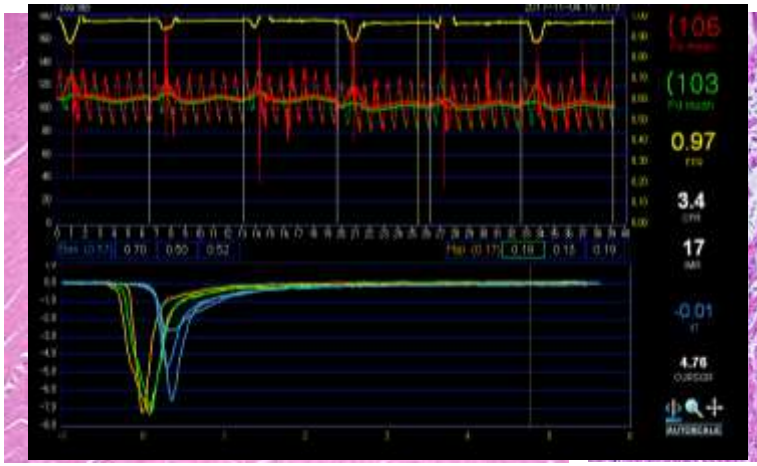
Joo Myung Lee, MD, MPH, PhD,[a] Hyun Kuk Kim, MD, PhD,[b] Kyung Seob Lim, DVM, PhD,[c] Jun-Kyu Park, PhD,[d] Ki Hong Choi, MD,[a] Jonghanne Park, MD,[e] Doyeon Hwang, MD,[e] Tae-Min Rhee, MD,[f] Jeong Hoon Yang, MD,[a,d] Eun-Seok Shin, MD, PhD,[b] Chang-Wook Nam, MD, PhD,[i] Joon-Hyung Doh, MD, PhD,[j] Joo-Yong Hahn, MD, PhD,[a] Bon-Kwon Koo, MD, PhD,[a,k] Myung Ho Jeong, MD, PhD[c]

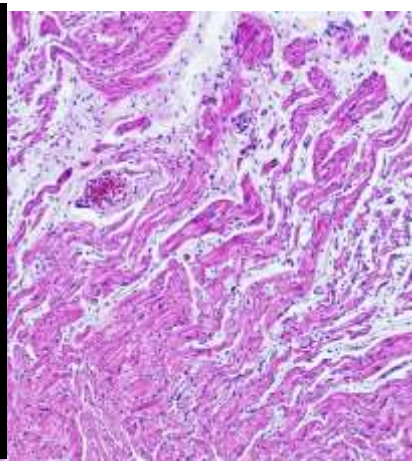


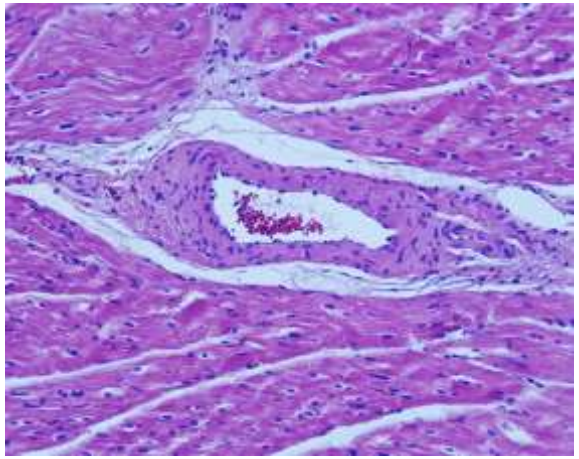


Pathologic change vs. IMR

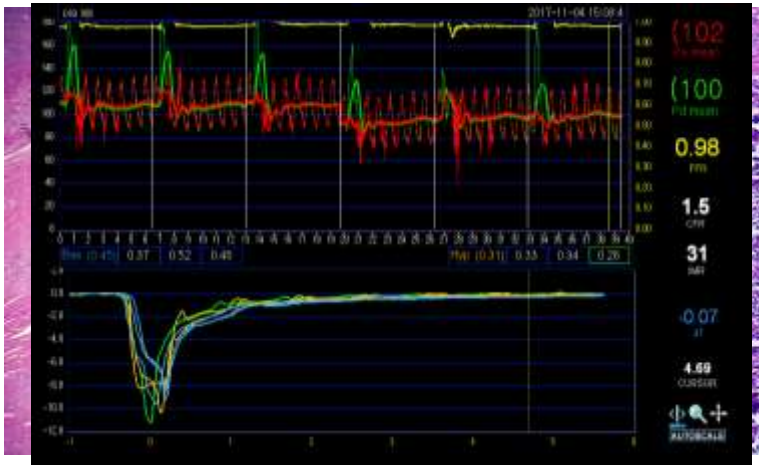
No microvascular injury

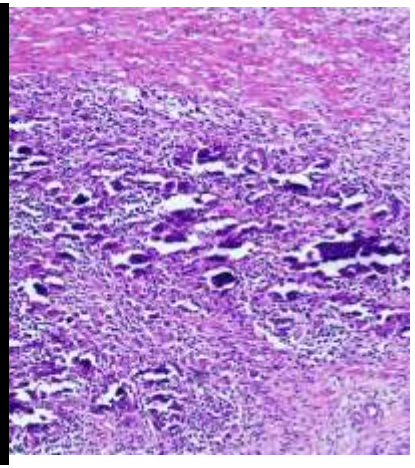


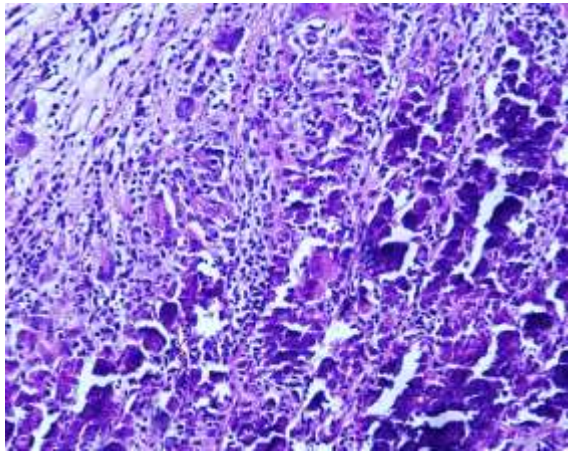




Microsphere injection







Courtesy of HK Kim, MD, PhD

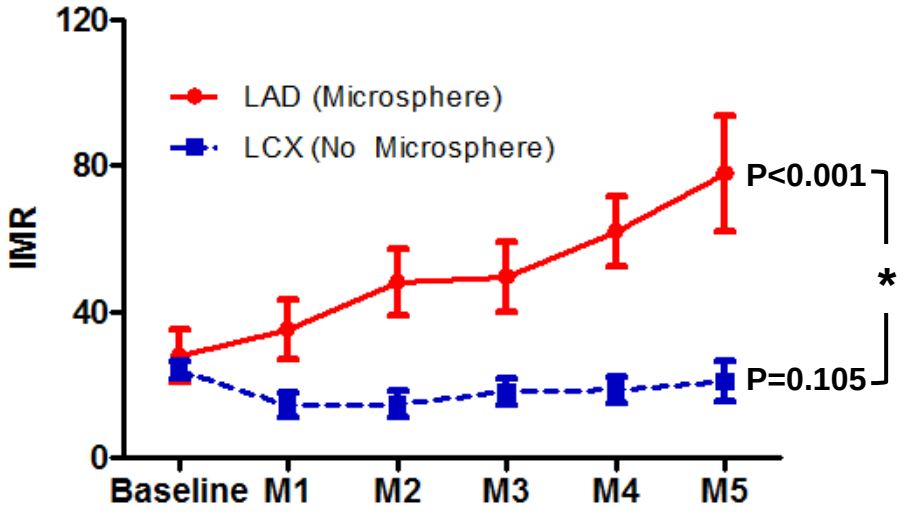
Baseline characteristics

Animals (N=12)	
Body weight, kg	25.0 (24.0-27.0)
Interrogated Vessels (N=24)	
Reference vessel diameter, mm	
LAD	2.90 (2.83-3.09)
LCX	2.88 (2.51-3.61)
Area stenosis, %	
LAD	48.1 (40.8-50.4)
LCX	47.9 (31.1-62.9)
Fractional flow reserve	
LAD	0.92 (0.81-0.95)
LCX	0.95 (0.93-0.97)
Index of microcirculatory resistance	
LAD	16.2 (9.2-24.5)
LCX	17.3 (9.9-23.9)

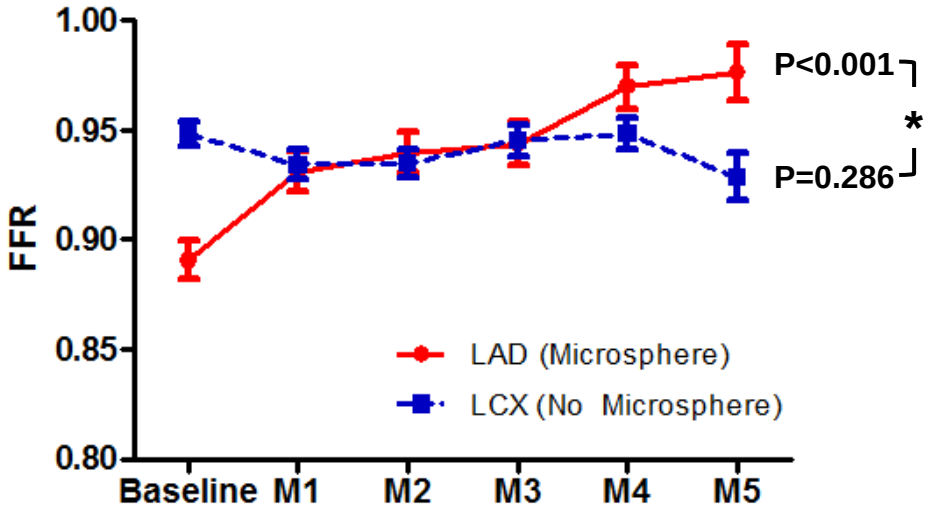
Lee JM & Kim HK, ..., Koo BK, Jeong MH, JACC Intv, 2018

Changes in Culprit/Non-culprit vessels

IMR



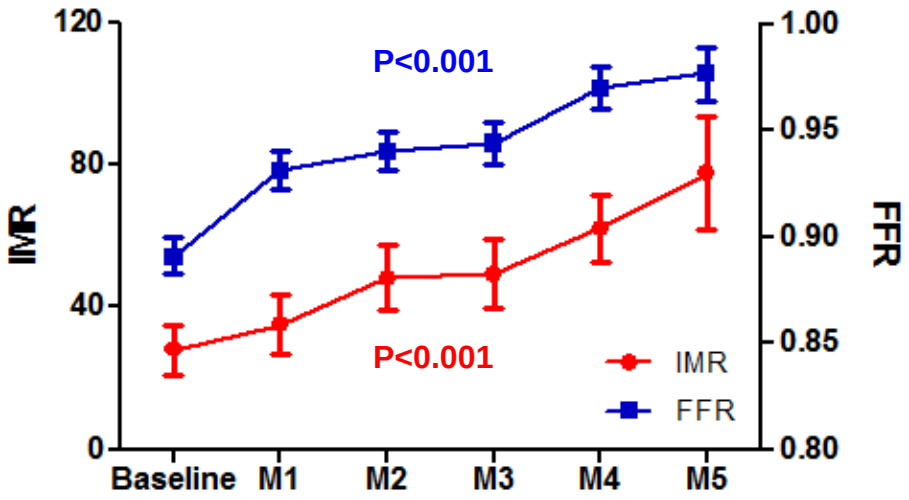
FFR



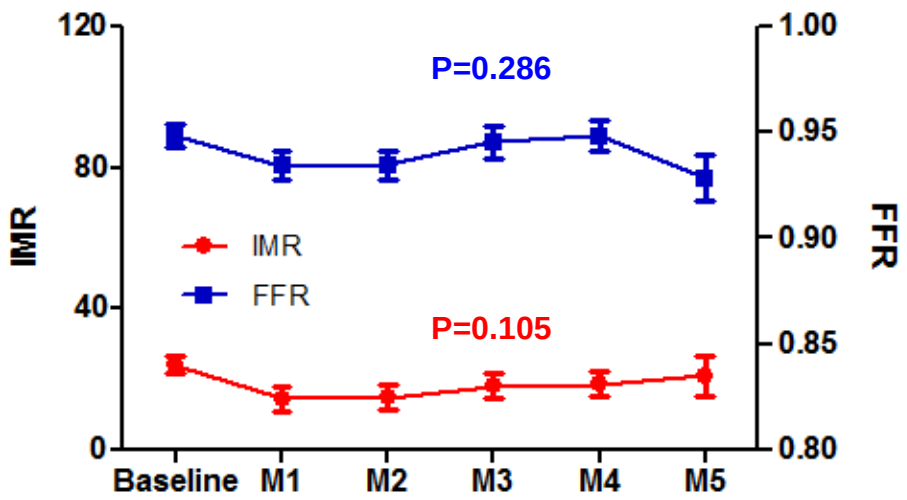
Lee JM & Kim HK, ..., Koo BK, Jeong MH, JACC Intv, 2018

Changes in Culprit/Non-culprit vessels

LAD (Culprit)

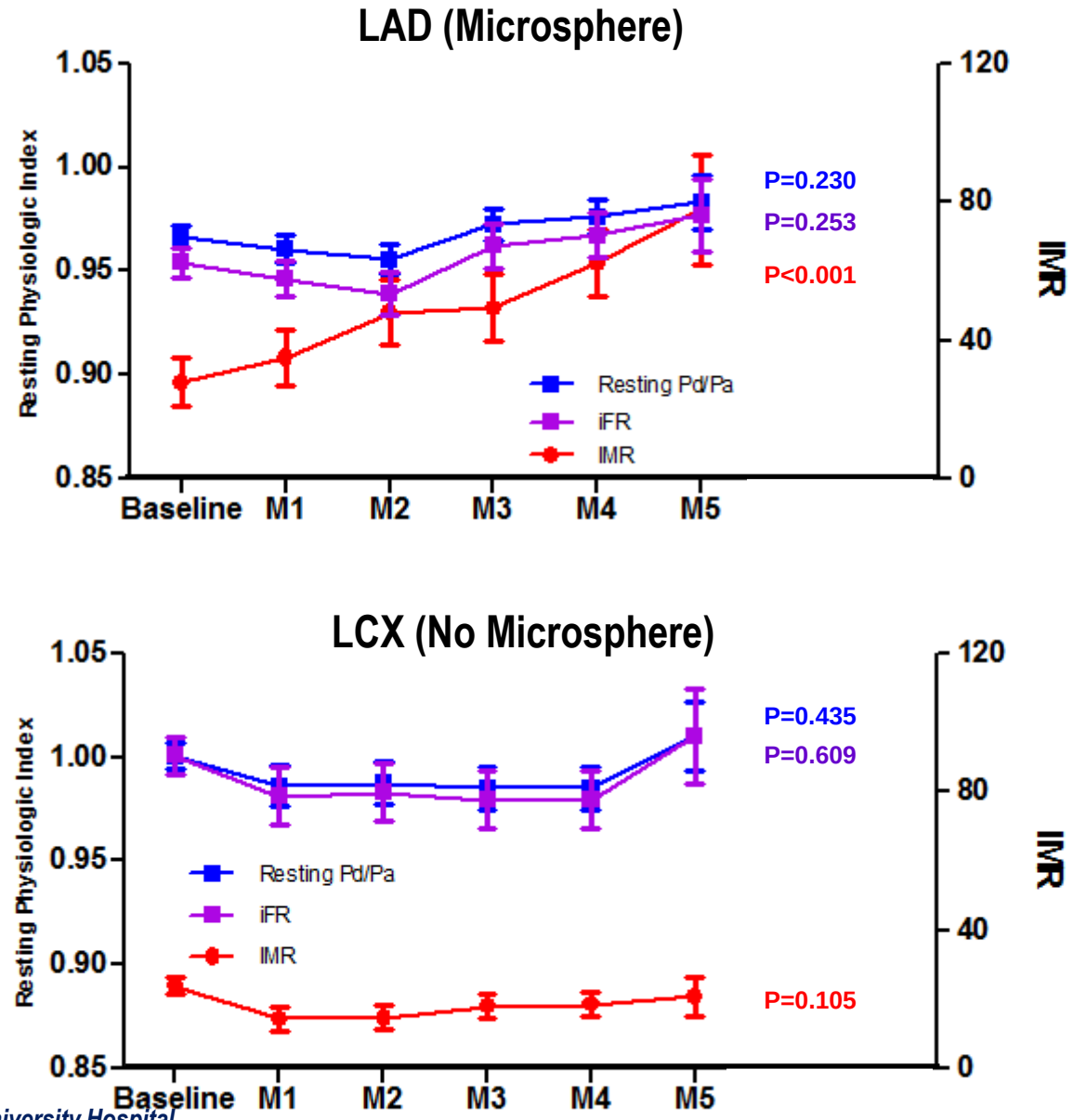


LCX (Non-culprit)



Lee JM & Kim HK, ..., Koo BK, Jeong MH, JACC Intv, 2018

Changes in Culprit/Non-culprit vessels: Resting Indexes



EDITORIAL COMMENT

Fractional Flow Reserve in Nonculprit Vessel During STEMI

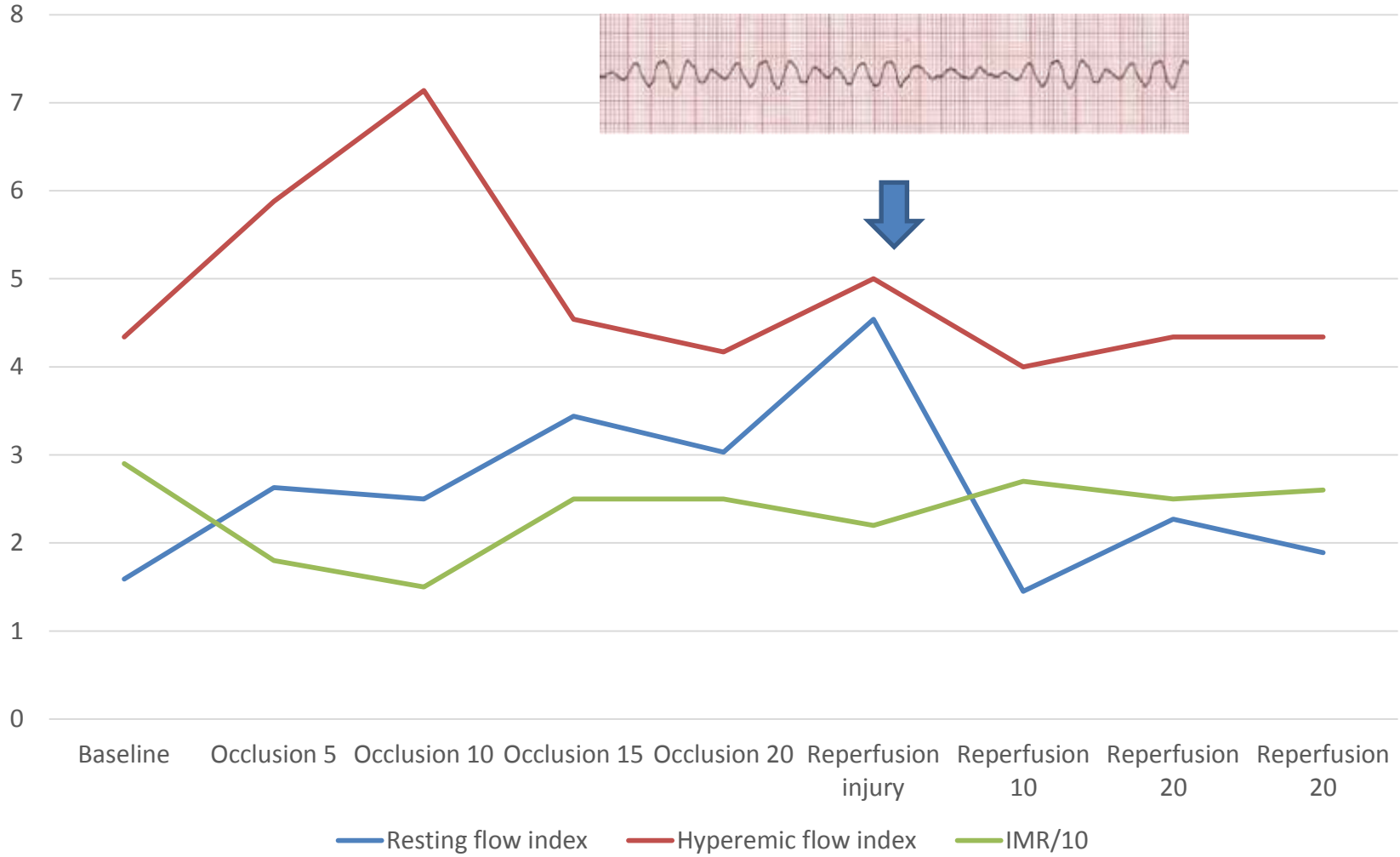
Reliable or Prone to Error?*

Marc D. Feldman, MD, Amit K. Gupta, MD

The study by Uren et al. (10) was conducted in the fibrinolysis era in subjects more than a week after infarct and is not reflective of current practice. de Waard et al (11) used an intracoronary Doppler wire for their study, which introduces variability in measurements due to the unpredictable location of the Doppler crystal in the coronary lumen, resulting in inconsistent signal acquisition. As a result, only two-thirds of measurements could be used in their final analysis. This may have led to underestimation of

Why is there a discrepancy with the older published reports? There were weaknesses in prior studies.

Stable IMR in a non-culprit vessel in a balloon occlusion model



Courtesy of HK Kim, MD, PhD

Role of FFR in ACS: ~~Still Doubtful?~~

EDITORIAL COMMENT

Fractional Flow Reserve in Acute Coronary Syndromes*

William F. Fearon, MD,† Bernard De Bruyne, MD, PhD,‡ Nico H.J. Pijls, MD, PhD§

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.

JUST DO IT!