Post PCI FFR
What does it mean and should we measure it?

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Busan, Korea, 2017
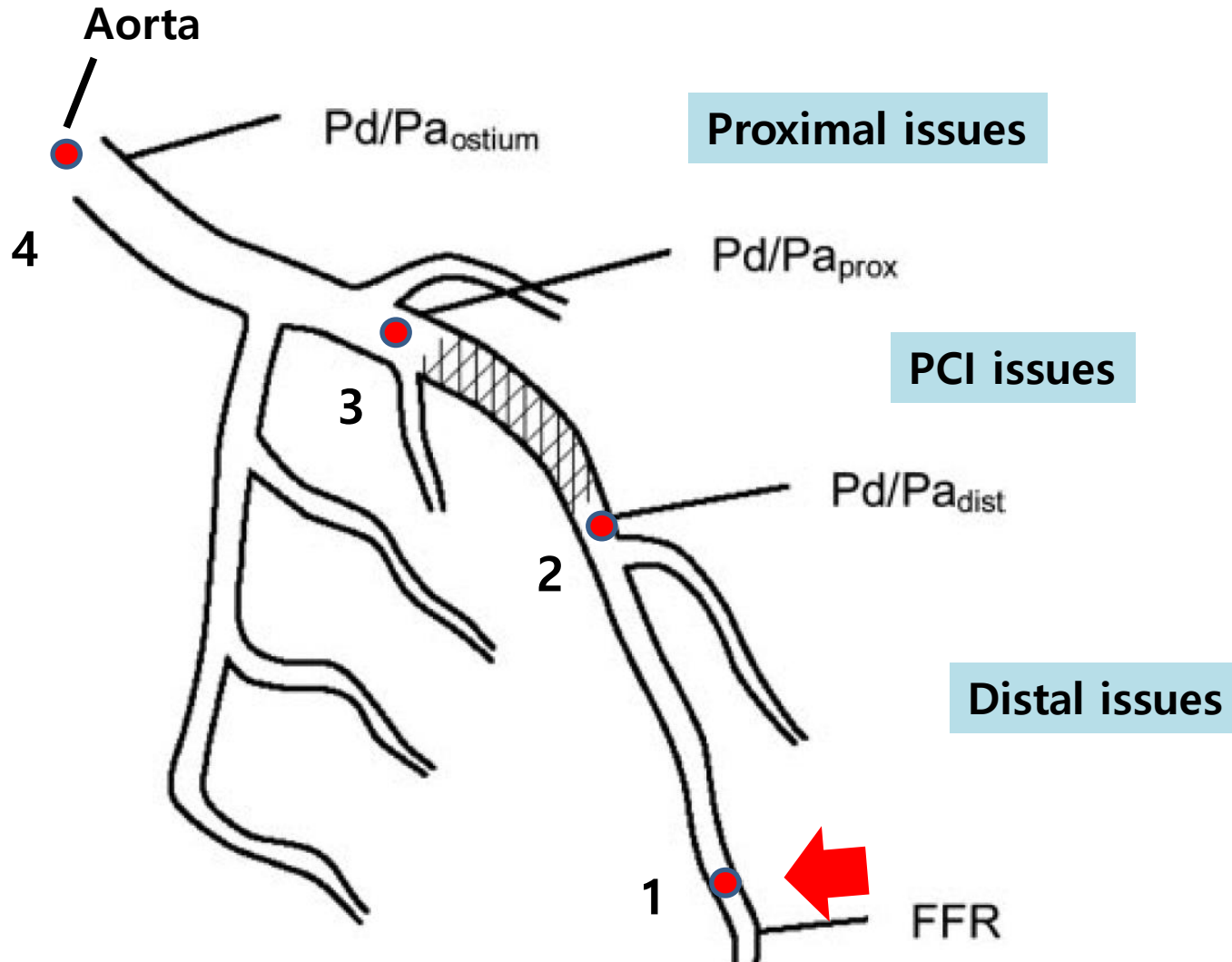
JCR 2017 COI Disclosure

Name of Presenter
Seung-Jea Tahk, M.D., PhD.

SJ Tahk has no financial conflicts of interest to disclose concerning this presentation.

Post PCI FFR
In-Depth Geographic Analysis

Post PCI FFR is summation of issues of whole vessel

Aorta

Pd/Pa_{ostium}

Proximal issues

4

Pd/Pa_{prox}

3

PCI issues

Pd/Pa_{dist}

2

Distal issues

1

FFR

Complete pressure pullback on sustained stable maximal hyperemia is mandatory for in-depth geographic analysis of post PCI FFR
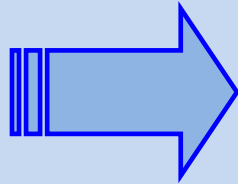
Post Stent FFR in real clinical setting
FFR-guided Stent Delivery in **diffuse long lesion** (n=51)

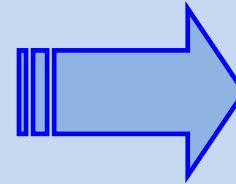**Pre PCI**
Stenting with SDS
(at RBP: 16-18 atm)
if Post Stent FFR<0.95
Adjunctive High Pressure
(>20 atm, HPB)

FFR
IVUS

FFR
IVUS*

FFR
IVUS*

*IVUS: documentary IVUS

Pressure measurement: RADI Medical System, Uppsala, Sweden
IVUS: 40MHz Atlantis SR Pro, Galaxy 2 Ultrasound Imaging System, Boston Scientific Corporation, Natick, MA, USA

51 Lesions

Stenting with SDS at RBP

FFR ≥0.95

FFR < 0.95

11 Lesions (21.5%)

MLA 7.2±1.6 mm^2 **MLA < 5 mm^2 : (2)**
%DS 13.7±12.1 %

40 Lesions (79.5%)

MLA 5.6±1.6 mm^2 **MLA < 5 mm^2 :(14)**
%DS 26.3±12.5 %

Adjunctive High Pressure

18 Lesions (35.3%)

FFR ≥0.95

FFR < 0.95

29 Lesions (56.8%)

MLA 7.3±1.8 mm^2 **MLA < 5 mm^2 : (2)****
%DS 5.9±2.2 %

22 Lesions (43.2%) *

MLA 6.1±2.2 mm^2 **MLA < 5 mm^2 :(8)****
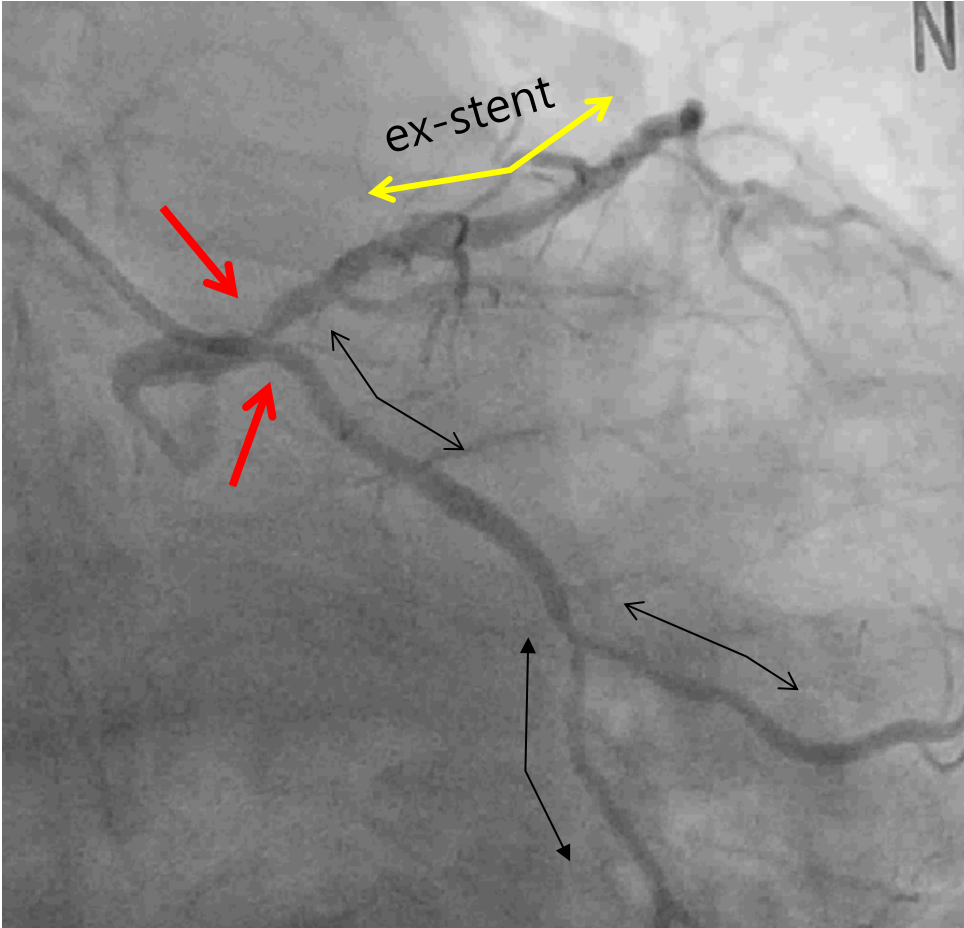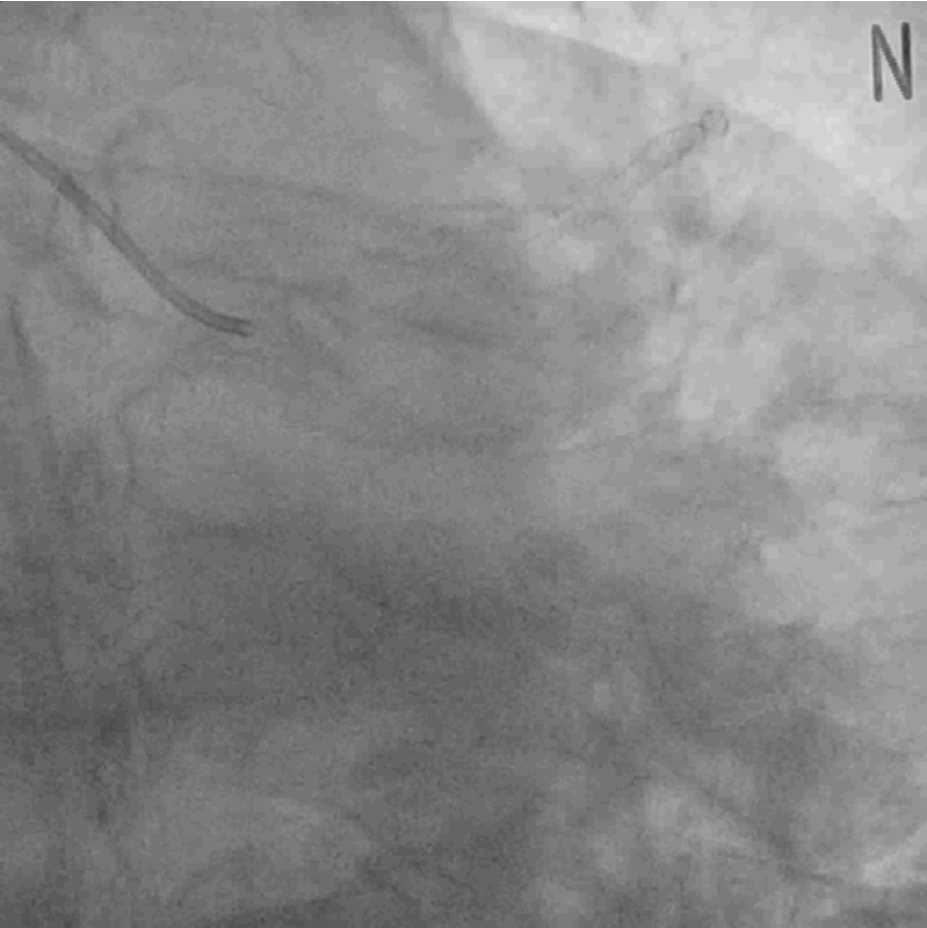%DS 9.7±6.1 %

* **In 22/51 (43.2%) of pts, Post PCI FFR < 0.95 even after HPB.**
** **10/51 (19.6%) of IVUS MSA < 5.0mm^2**
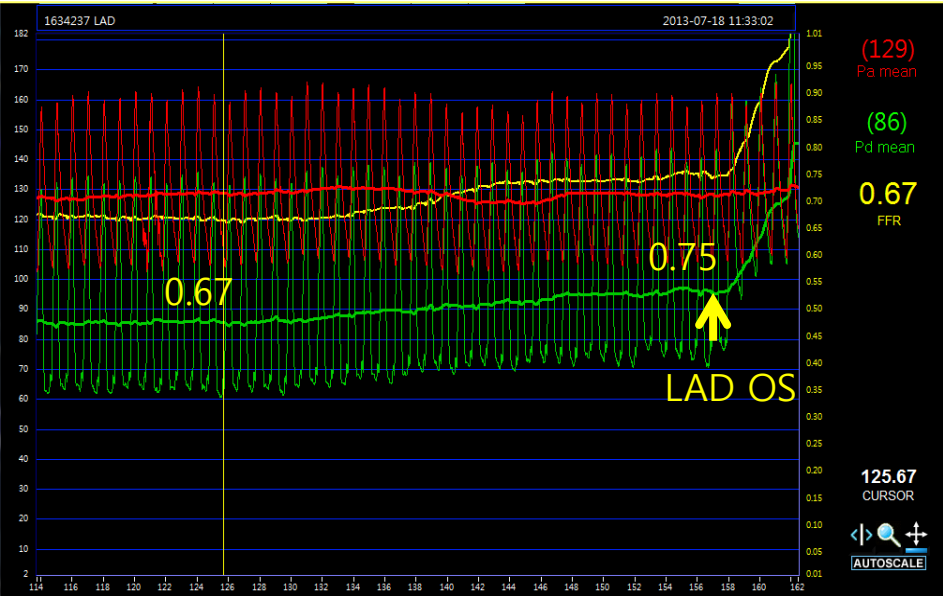
BCV of Post Stent FFR for IVUS MSA ≥5.0 mm^2

Final FFR

BCV : 0.94
Sensitivity : 72%
Specificity : 79%
AUC: 0.78 (0.64-0.91)

100-Specificity

AUMC Database
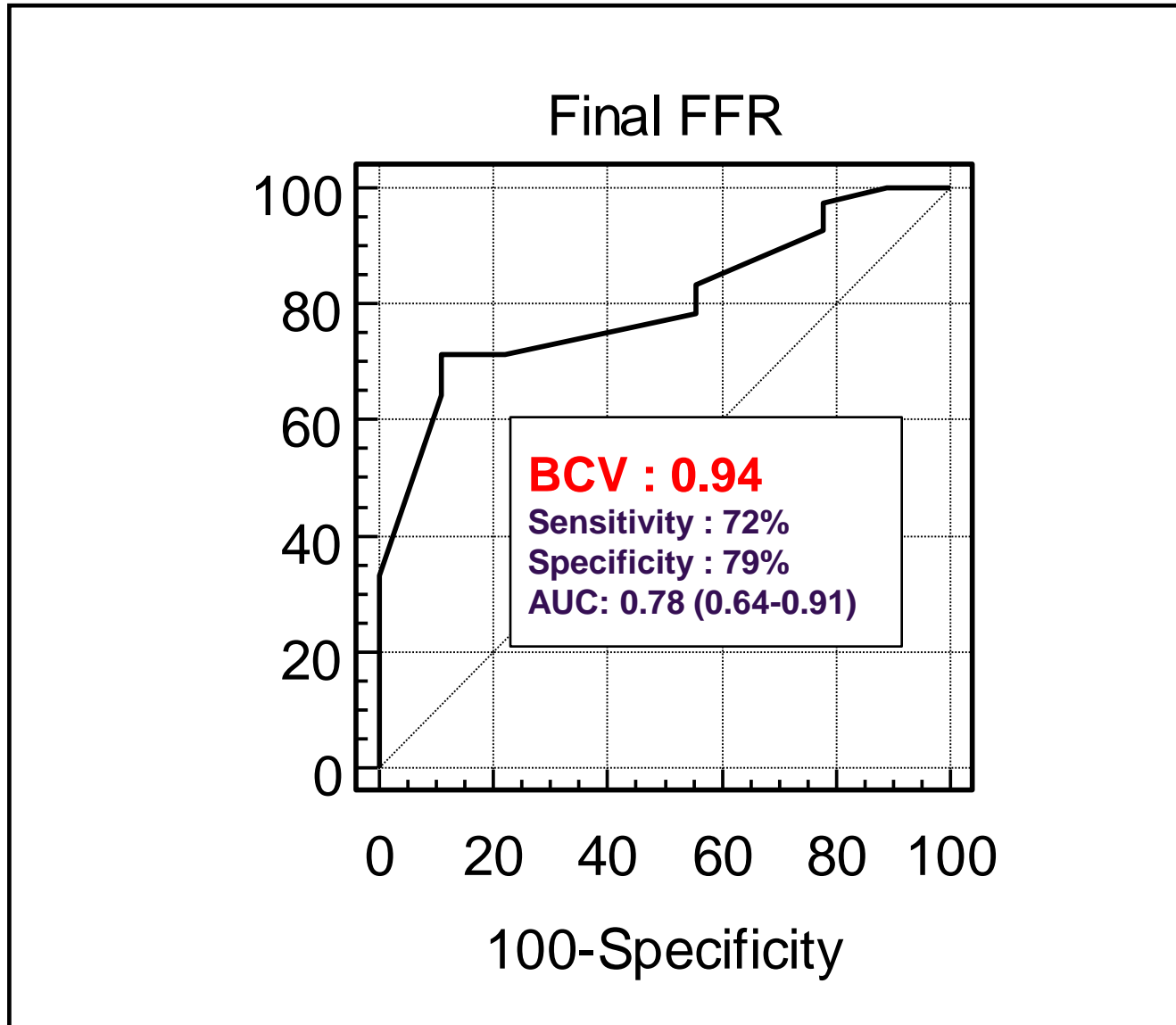
Multiple Stenosis

Multiple Stenosis
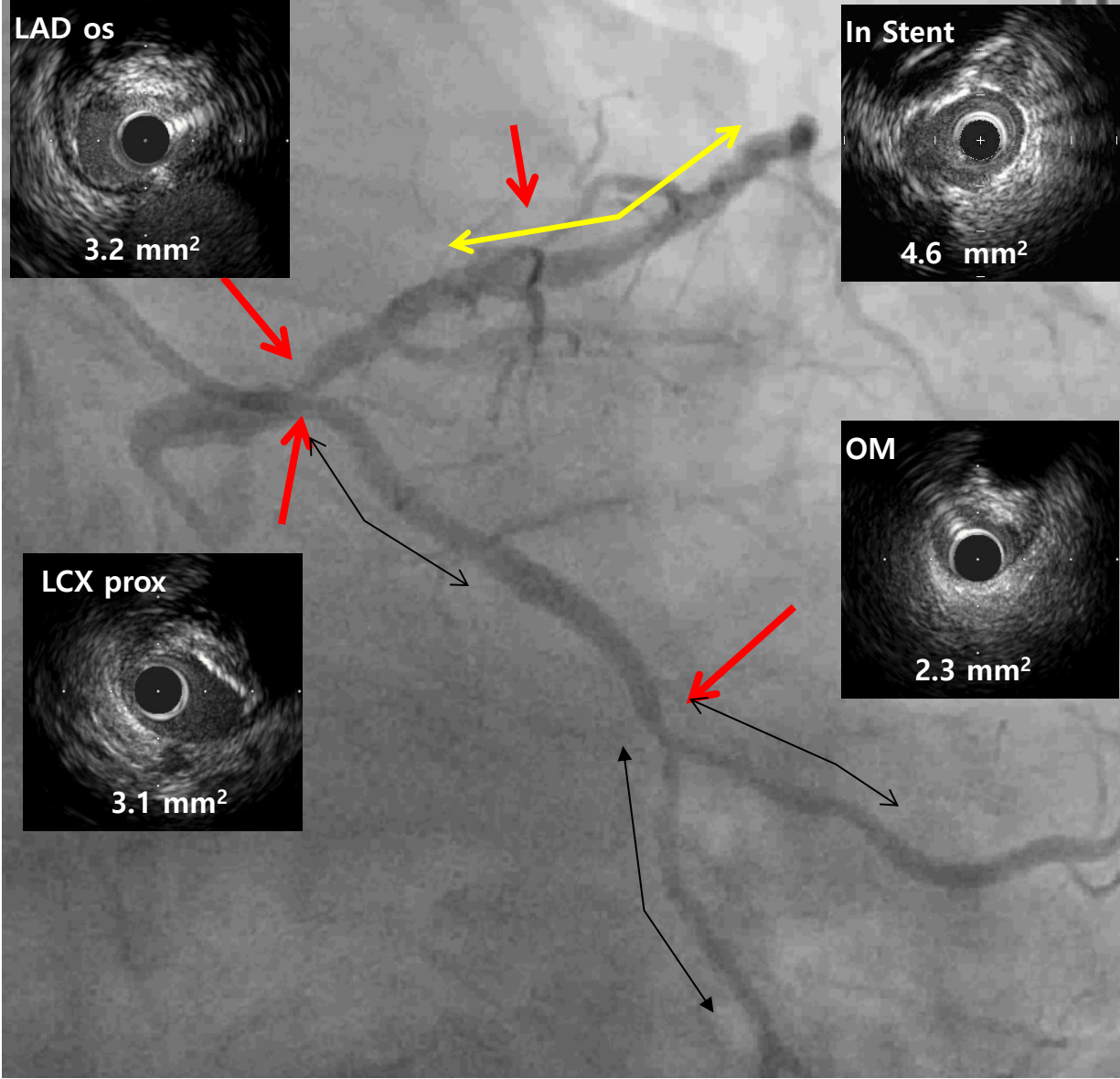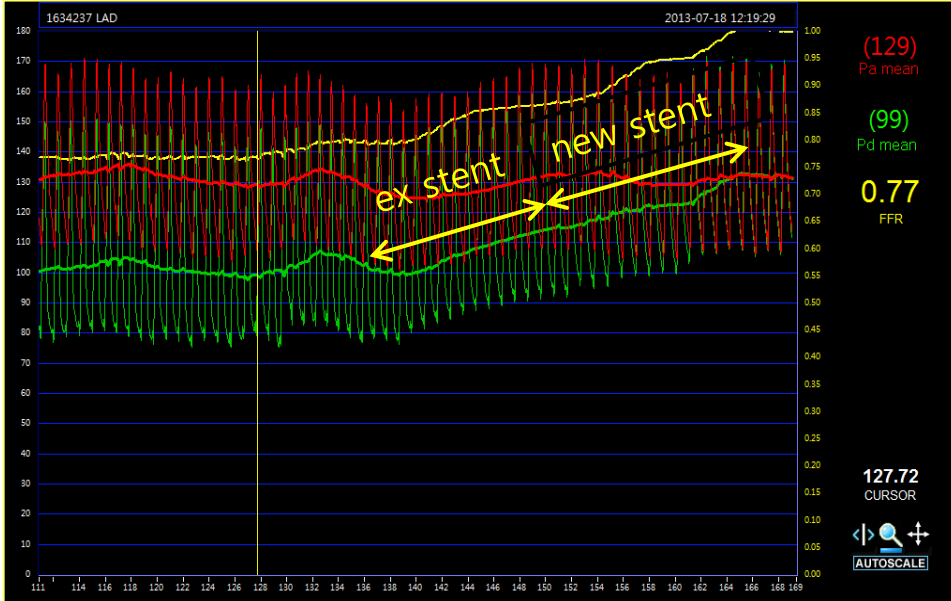
Pre PCI FFR

LAD→LM

OM→LM
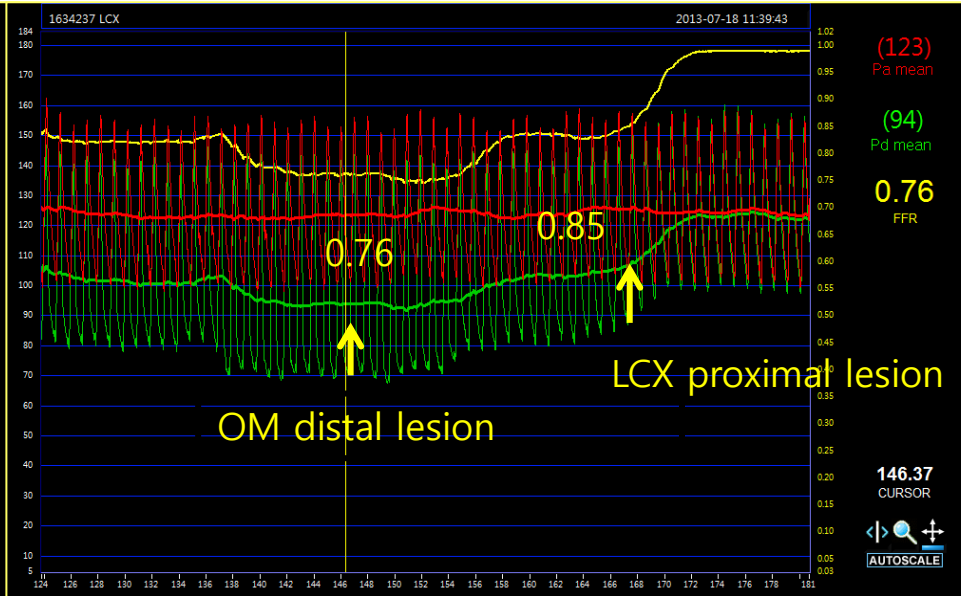
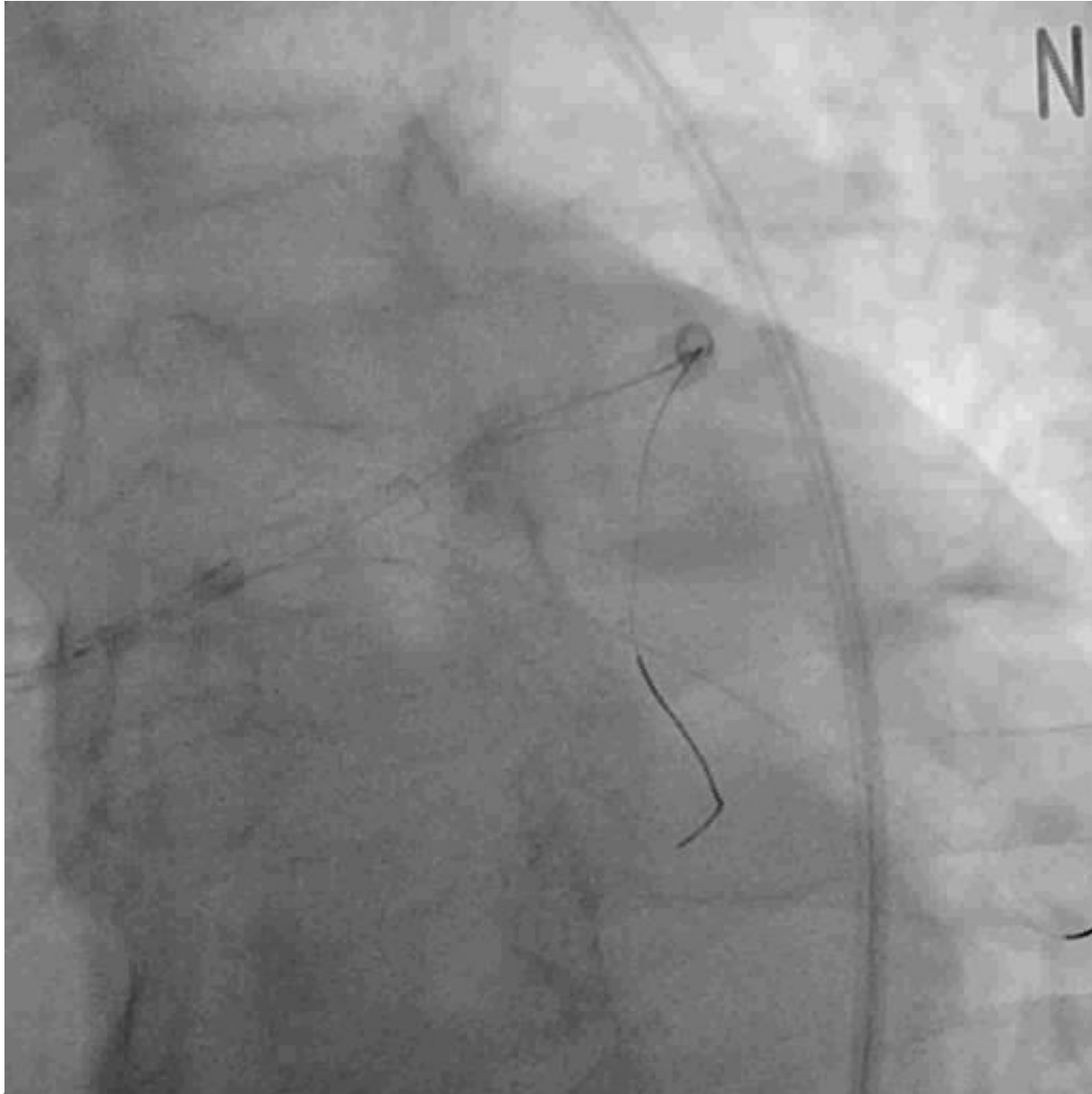# Post LAD-LM stent – Jailed LCX OS

1634237 이경ㅇ
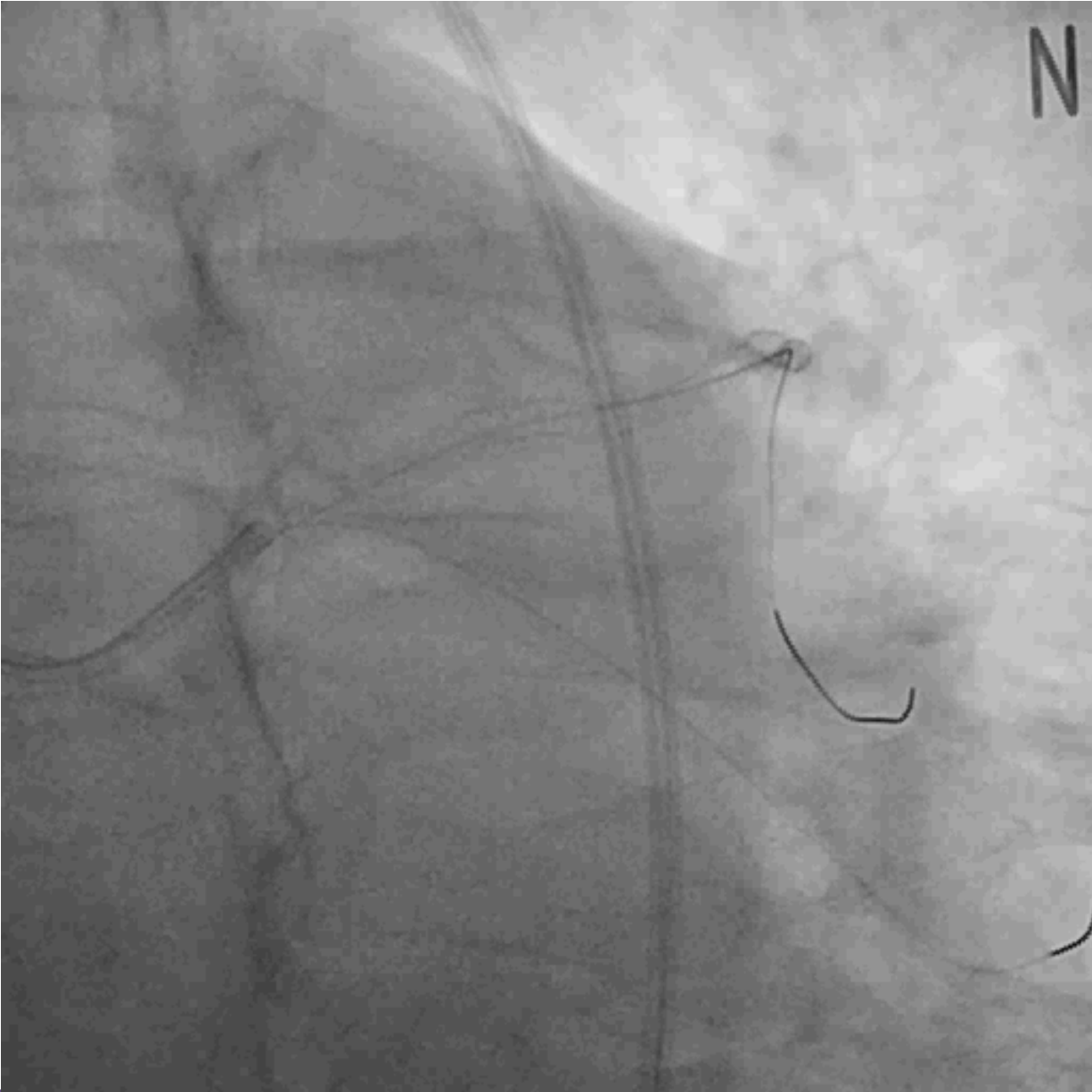
Post LAD-LM Stent FFR

LAD→LM

OM→LM
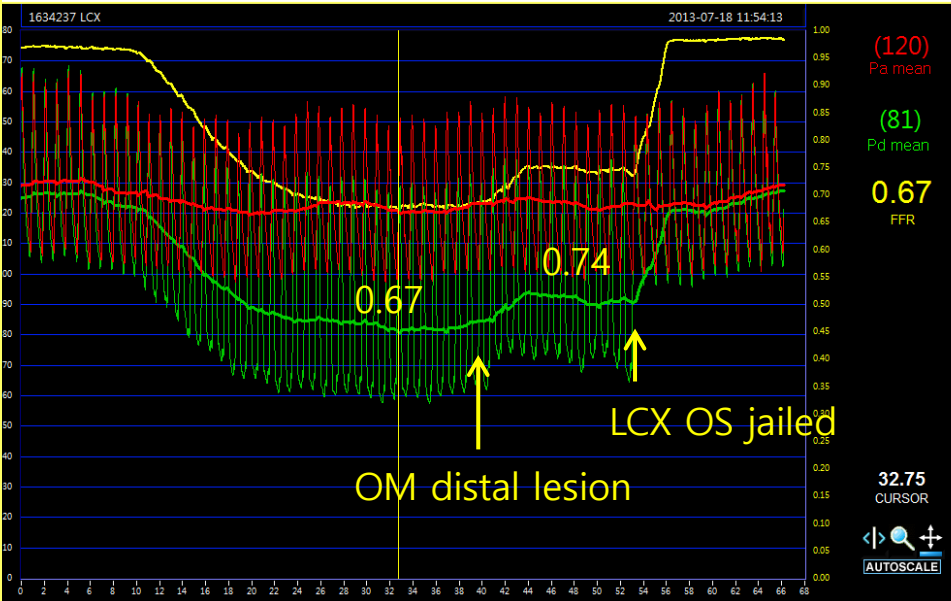
LCX provisional T stent with final kissing ballooning

1634237 이경ㅇ

Post LAD-LM/ LCX stent FFR

OM→LM

LCX→LM
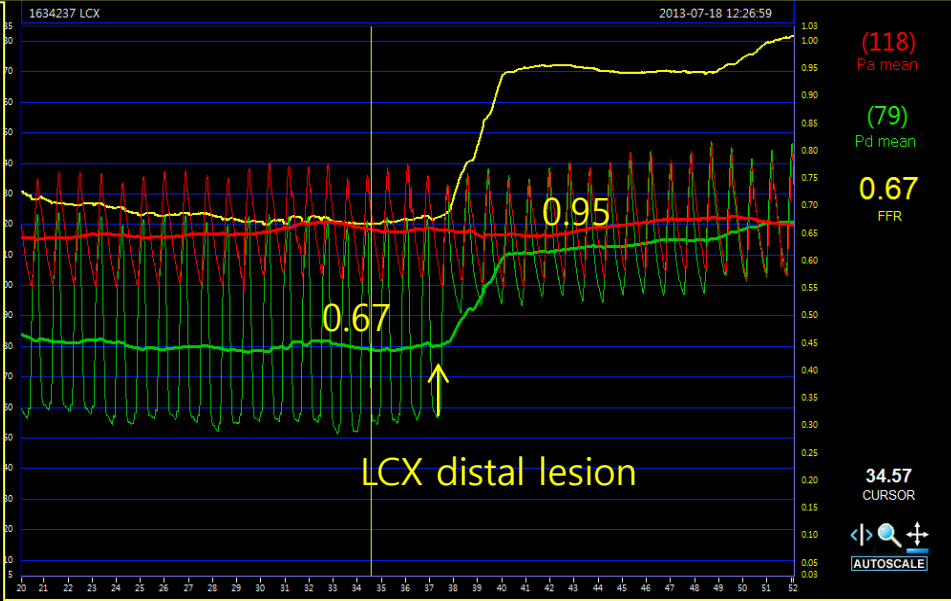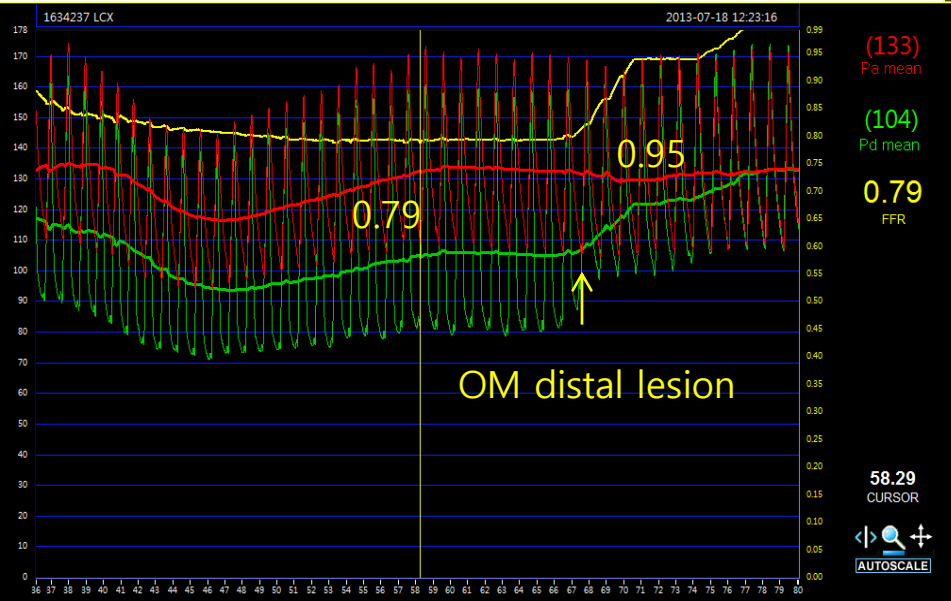
Pre PCI FFR
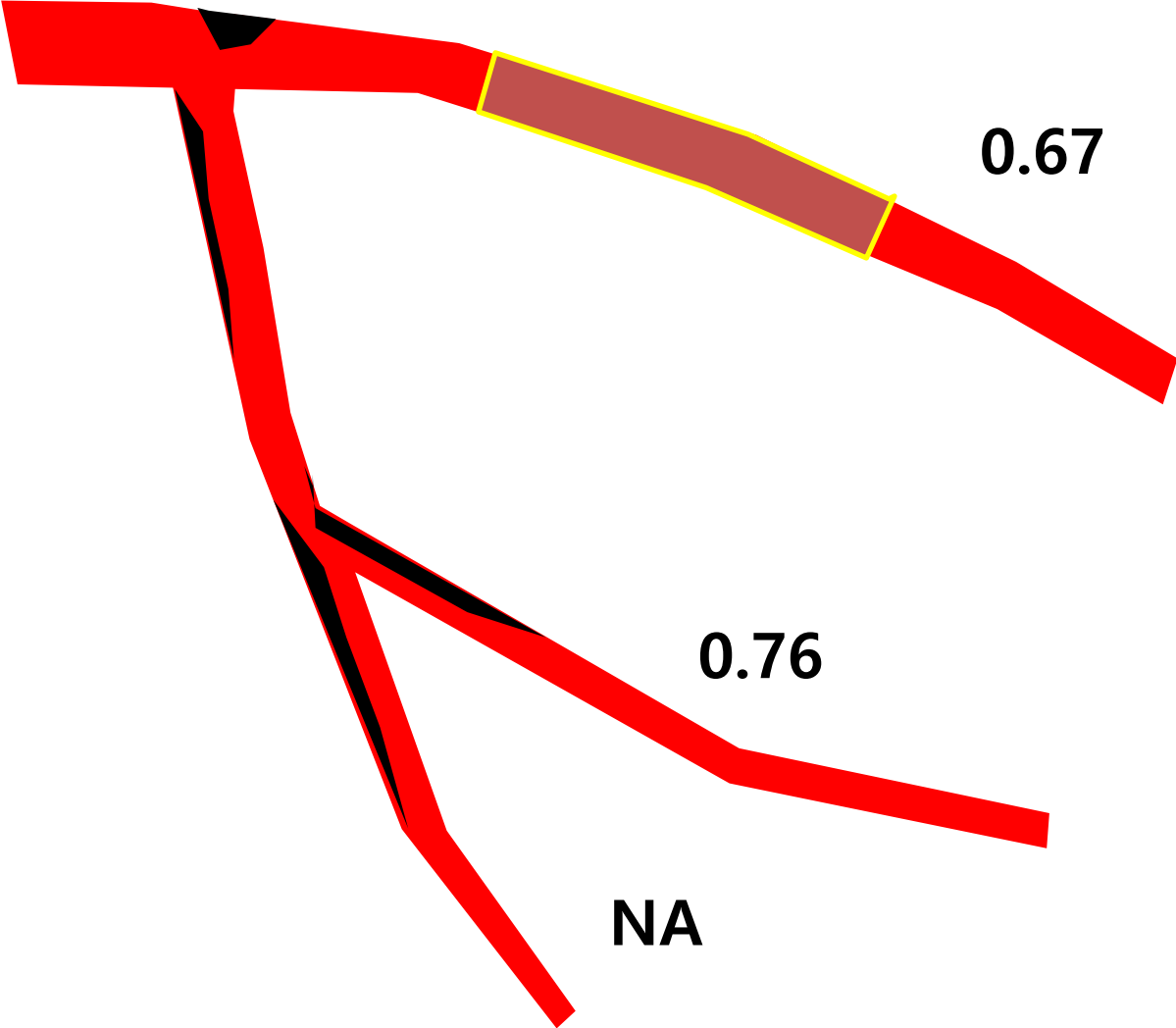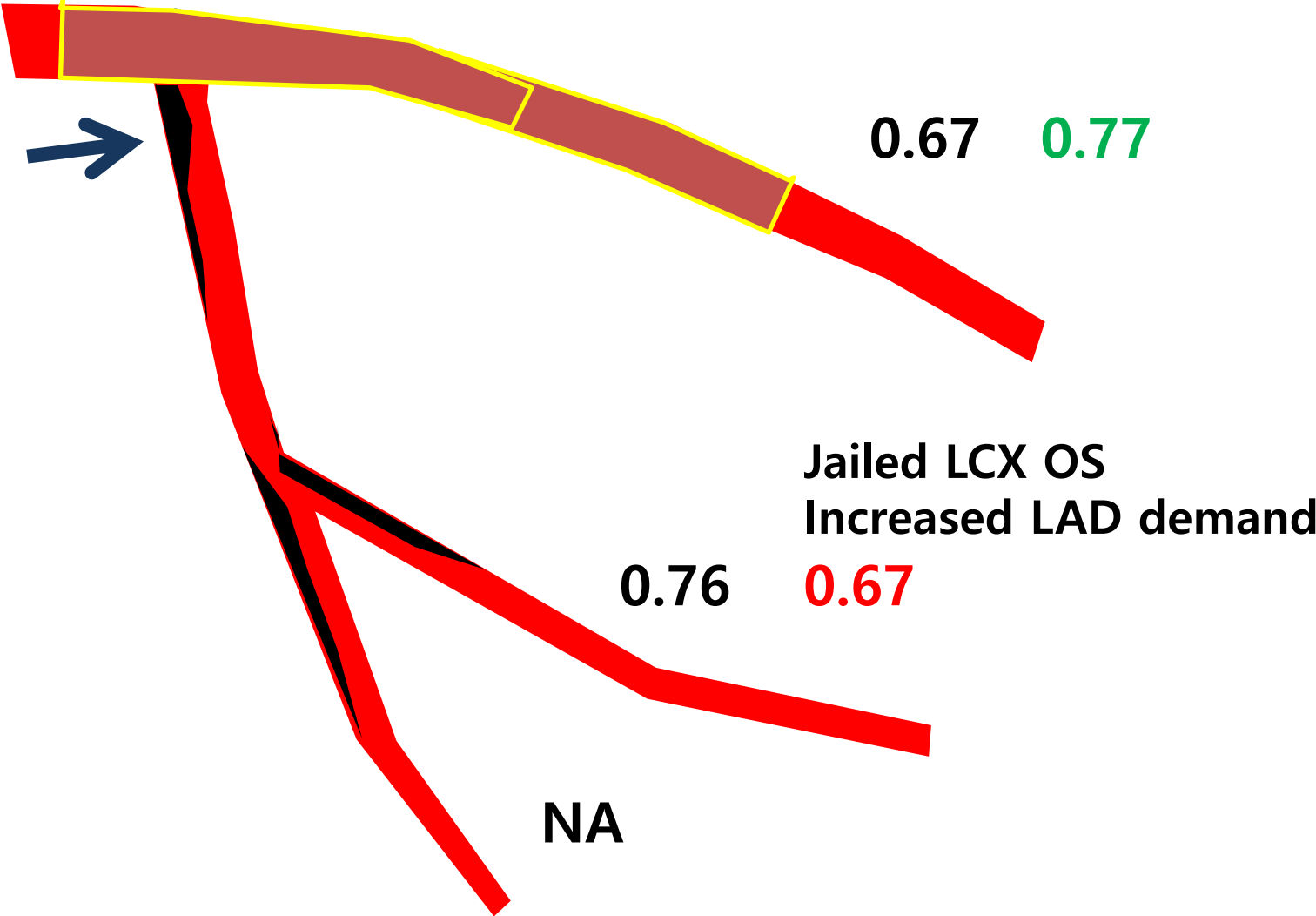
0.67

0.76

NA

Post LAD-LM stent FFR

0.67 0.77

Jailed LCX OS
Increased LAD demand
0.76 0.67

NA

Post LAD-LM/ LCX stent FFR

Diffuse

Post PCI complete pull-back pressure tracing showed ...

0.67 **0.77**

?

0.76 **0.67** **0.79**

0.67

Post PCI Trans-Stent FFR and Stent Expansion

Induction of hyperemia: Intracoronary continuous infusion

Guiding Catheter

Adenosine Infusion via microcatheter

Microcatheter

Pressure Wire

Yoon MH et al. Am

4.Pd/Pa@ostium

3.FFR@prox. edge

2.FFR@dist. edge

1.FFR

'Trans-stent FFR gradient'

$\Delta FFR_{stent} = (3) - (2)$

'Corrected ΔFFR_{stent} by stent length'
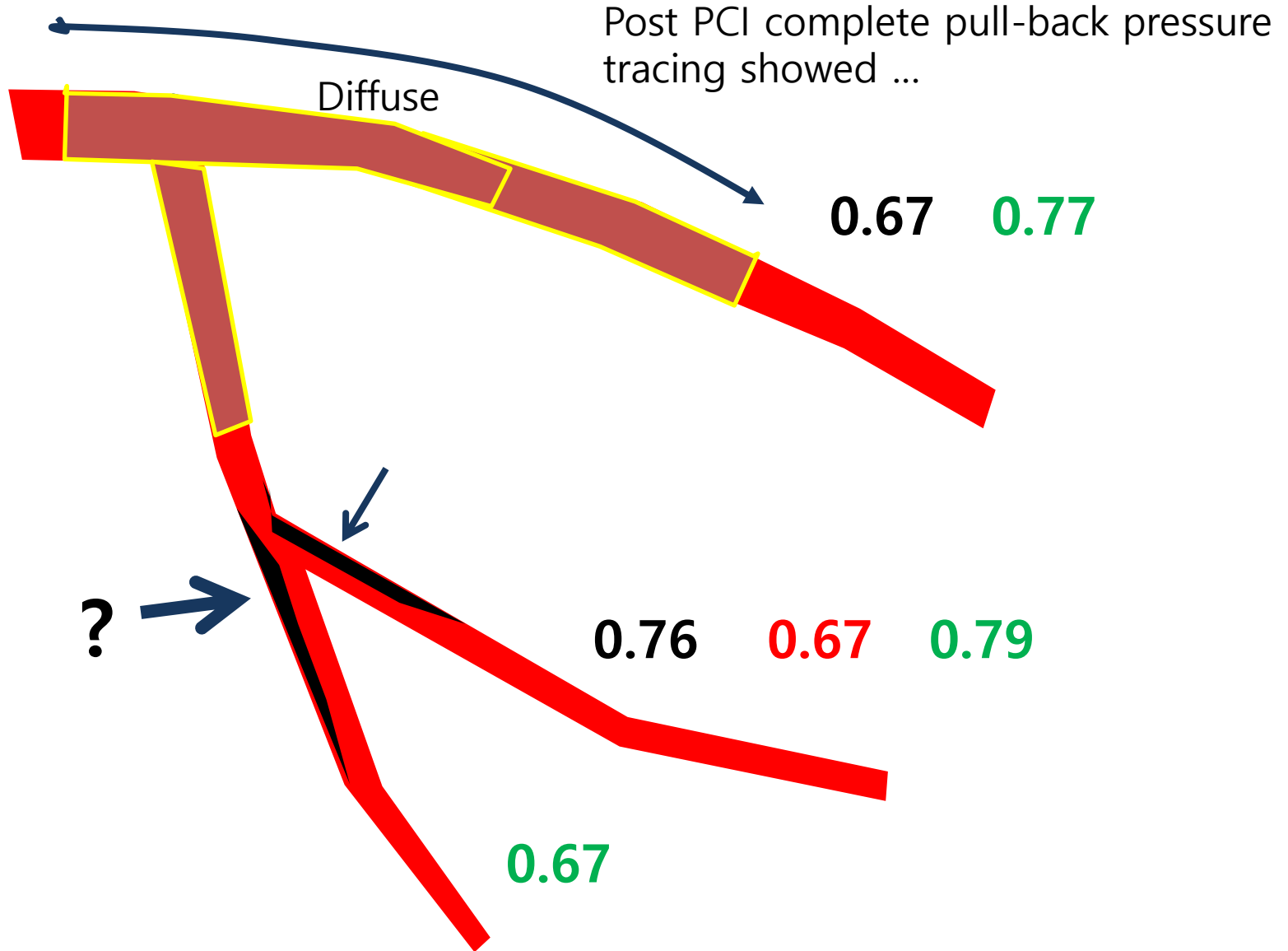
$\Delta FFR_{stent/length} = \Delta FFR_{stent} / stent\ length \times 100$
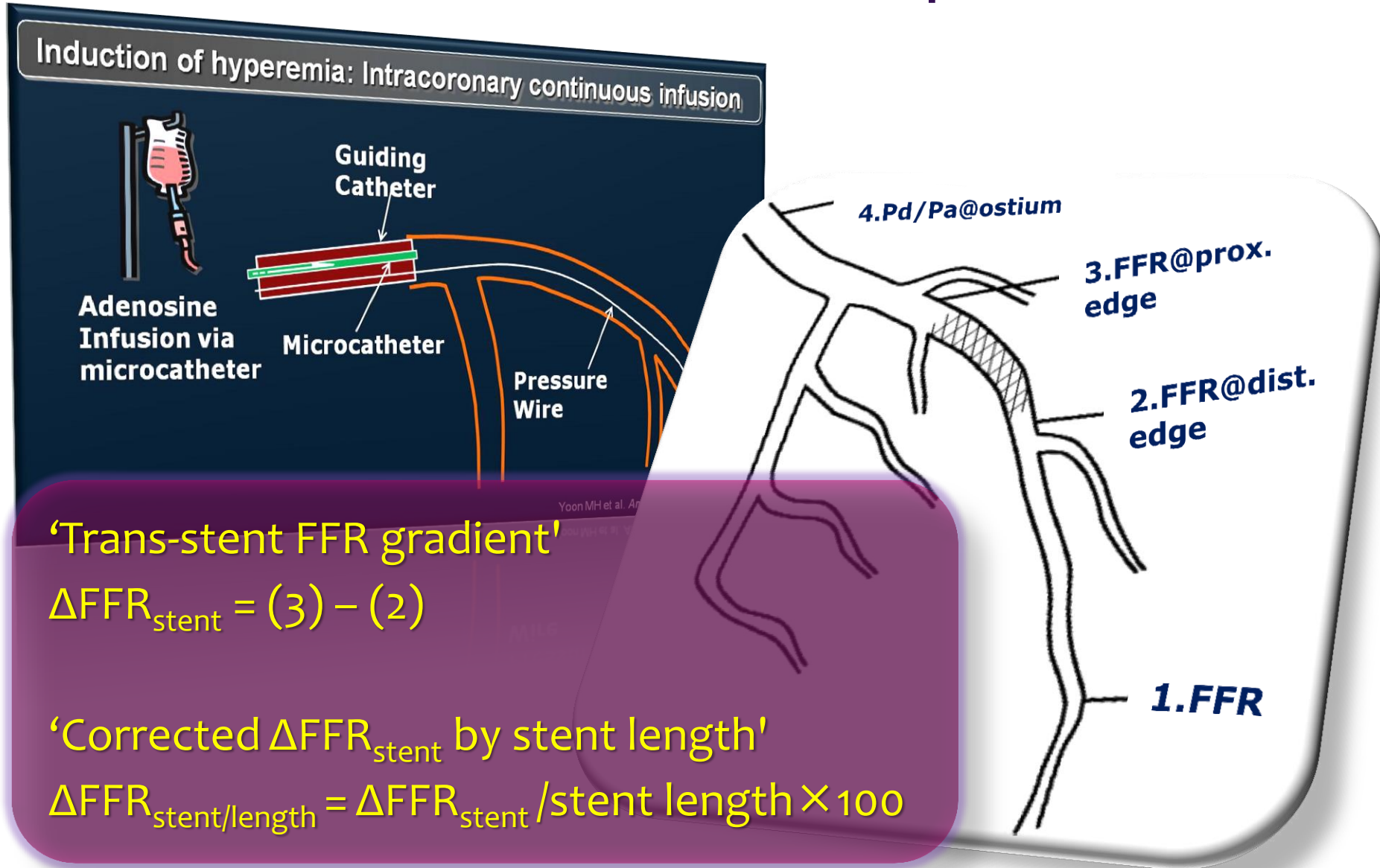
Post PCI Trans-Stent FFR and Stent Expansion

**Diagnostic value of ΔFFR$_{stent/length}$ ≤ 0.140
to predict optimal IVUS MSA (5-6 mm^2) after DES implantation**

	Final MSA (n=93)					
	≥ 5.0 mm^2	< 5.0 mm^2	≥ 5.5 mm^2	< 5.5 mm^2	≥ 6.0 mm^2	< 6.0 mm^2
≤ 0.140	70	4	66	8	57	17
> 0.140	14	5	10	9	12	7
Sensitivity	83 %		87 %		83 %	
Specificity	56 %		53 %		56 %	
PPV	95 %		89 %		77 %	
NPV	26 %		48 %		63 %	

Post PCI Trans-Stent FFR and Stent Expansion

Stent 3.5x18

Trans Stent FFR gradient

0.91 →→ 0.99

$\Delta FFR_{stent/length}$ **= 0.08/18 x100 = 0.44 (>0.14)**

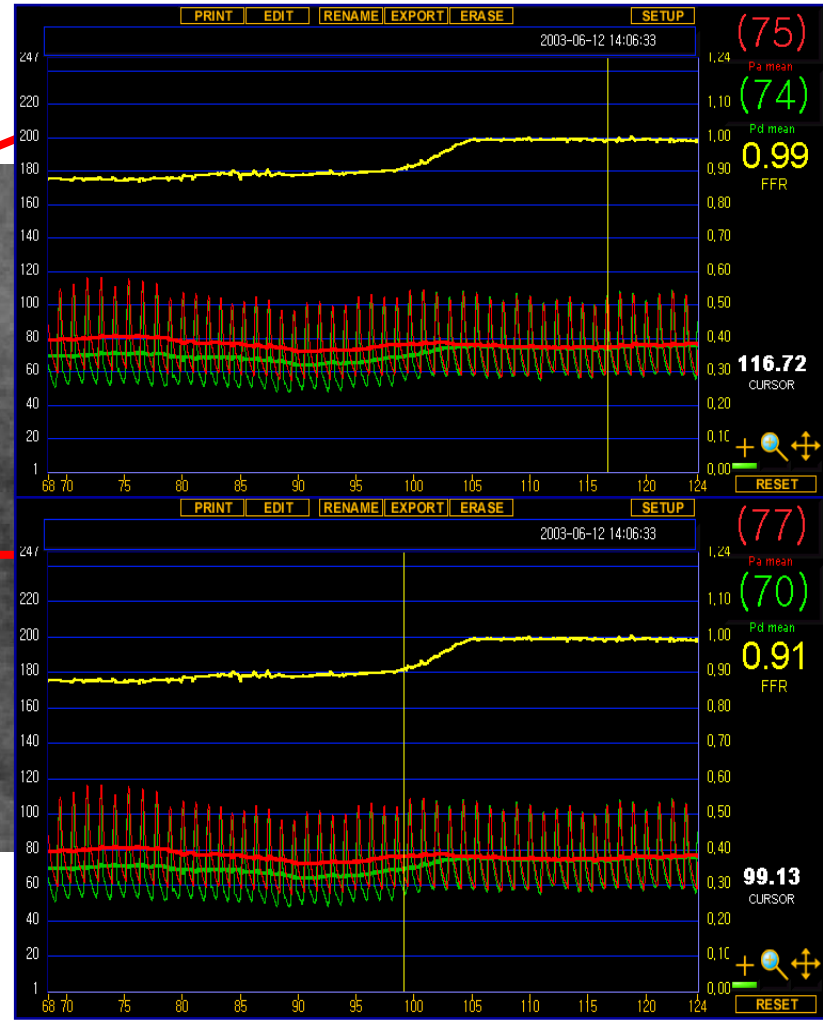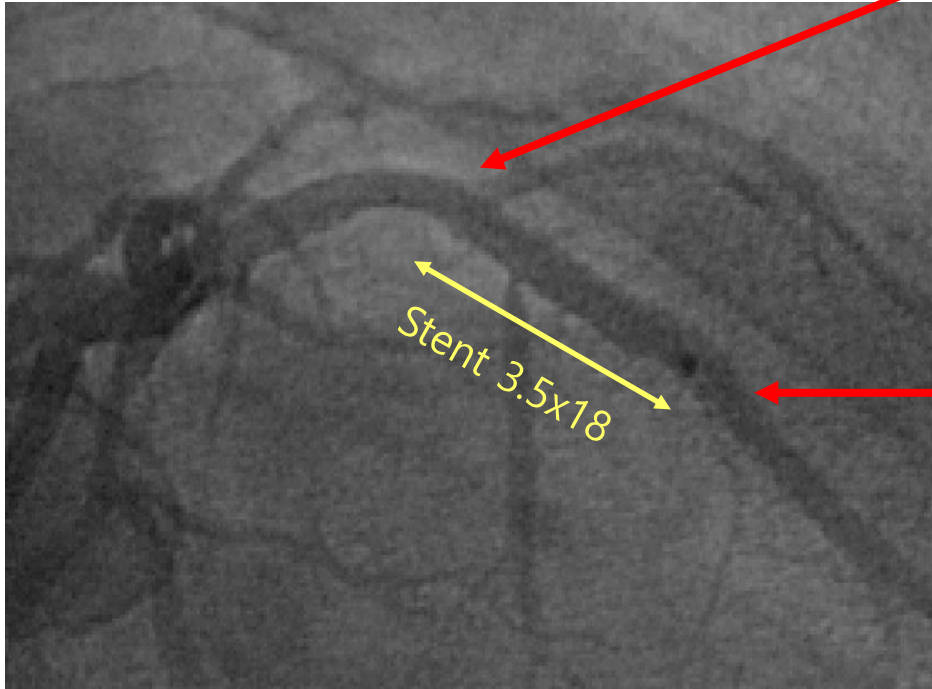IVUS showed stent under-expansion at proximal edge
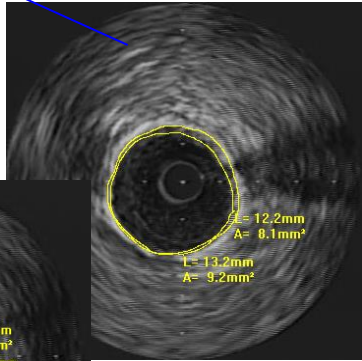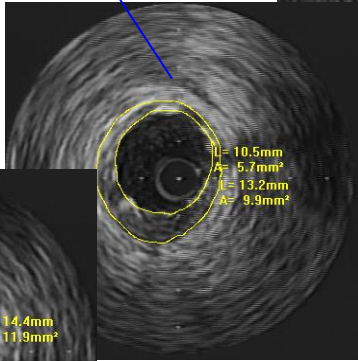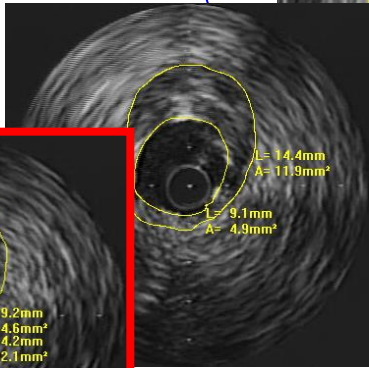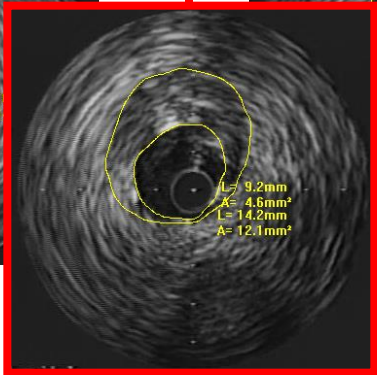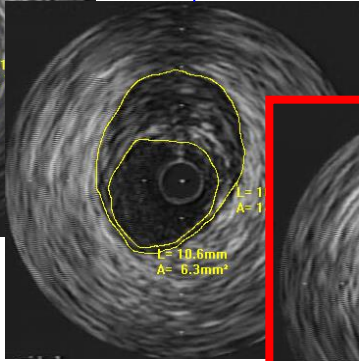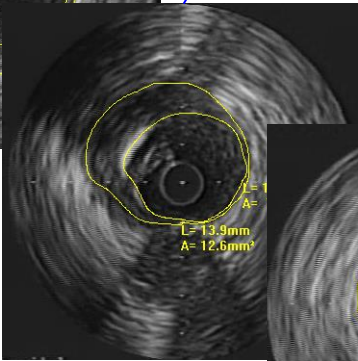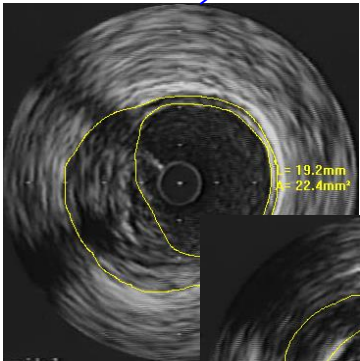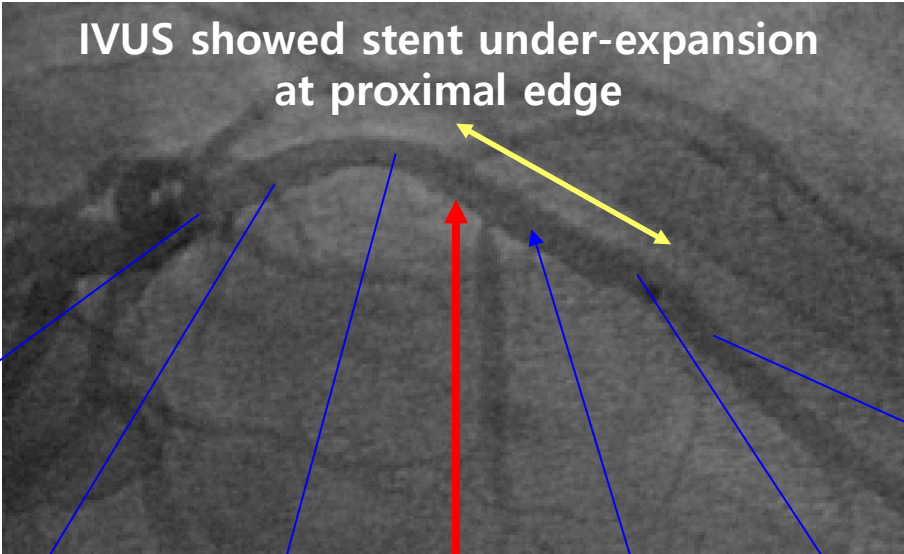
MSA 4.6 mm²

Multiple lesions in LAD
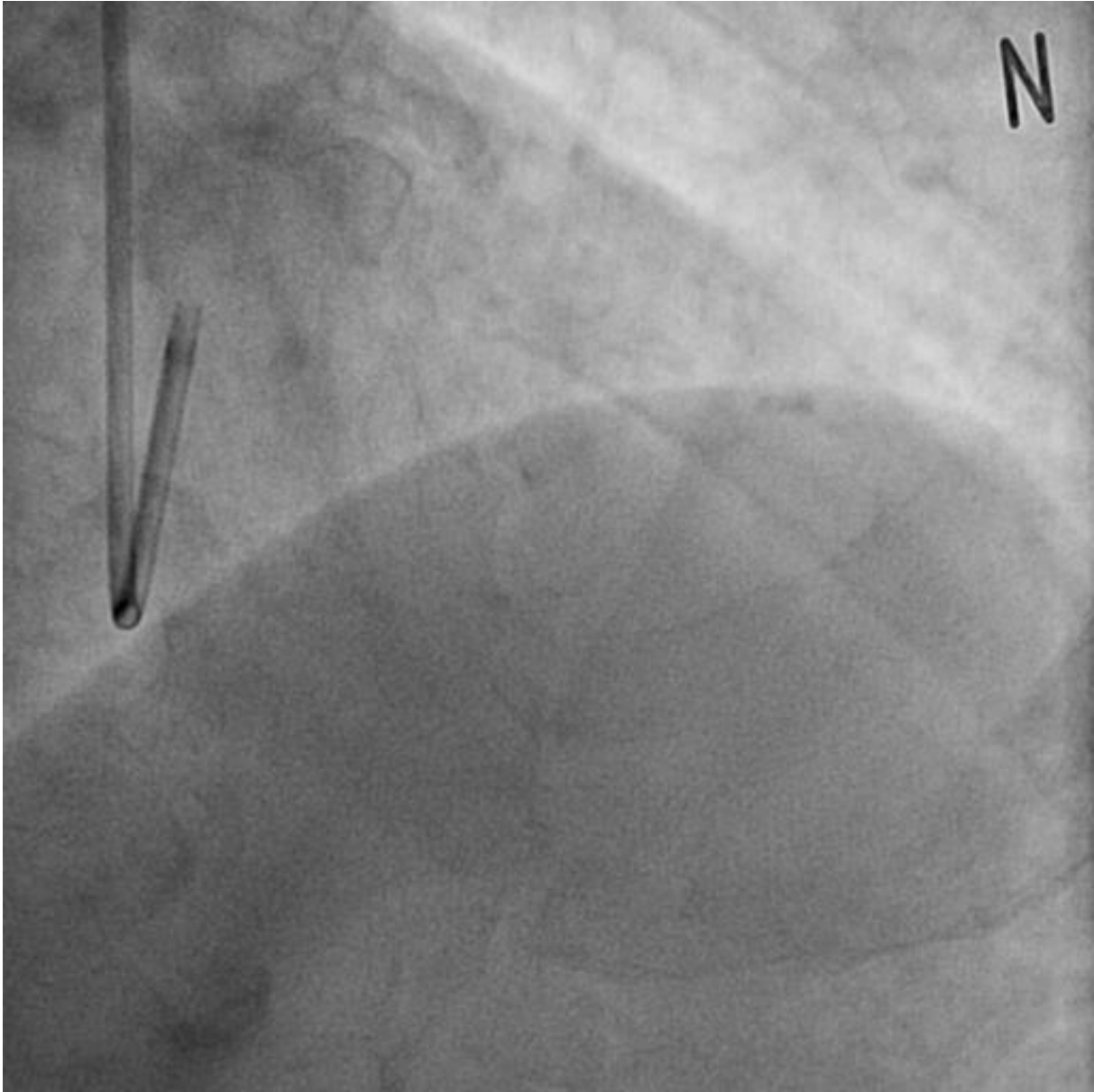
Post Stent Angiography

Post PCI Trans-Stent FFR and Stent Expansion

IVUS MSA 5.0 mm²

IVUS MLA 4.5 mm²

Stent 3.0x28

0.82

0.85

Trans Stent FFR gradient
0.82 →→ 0.85
$\Delta FFR_{stent/length}$ = 0.03/28 x100 = **0.11 (<0.14)**
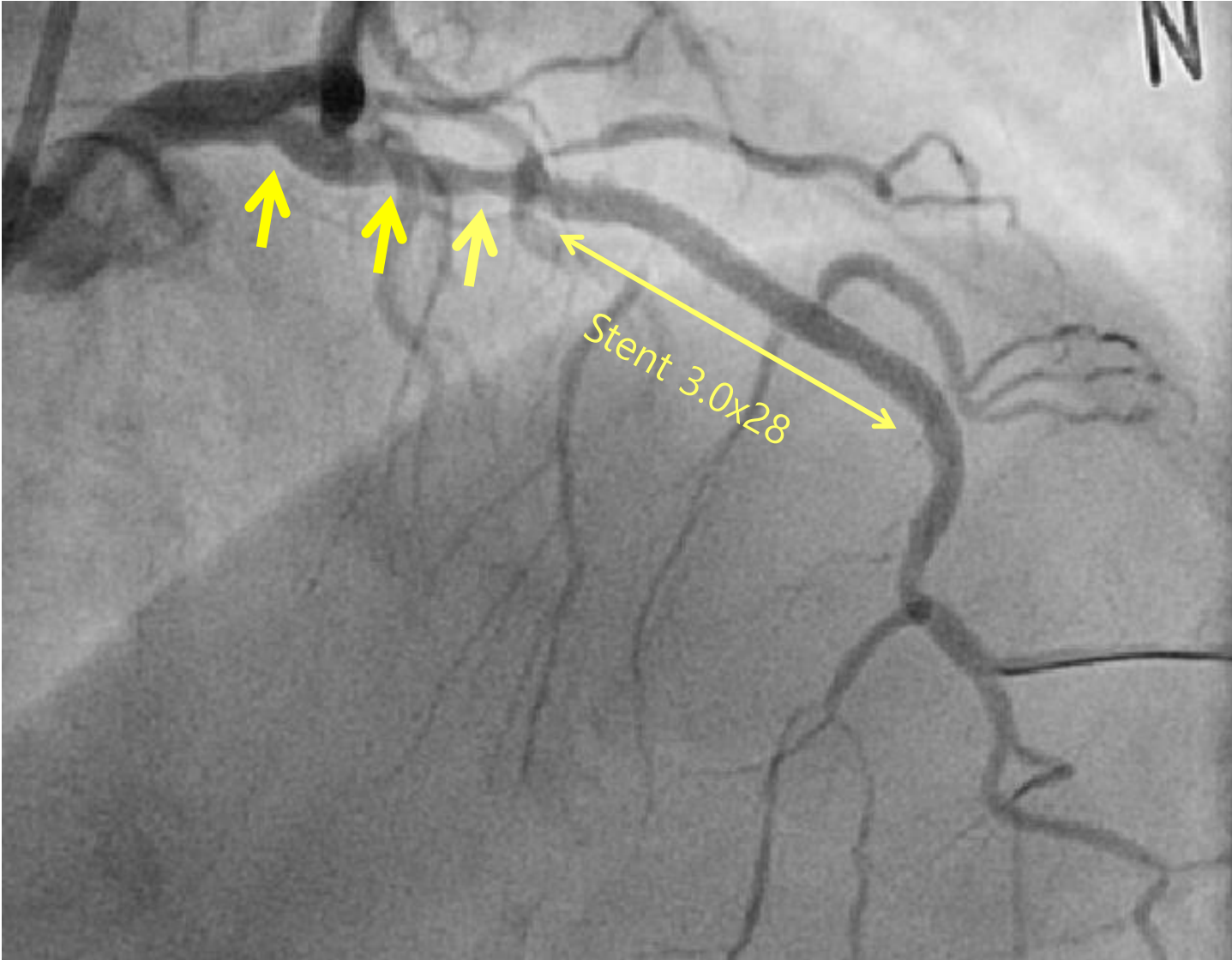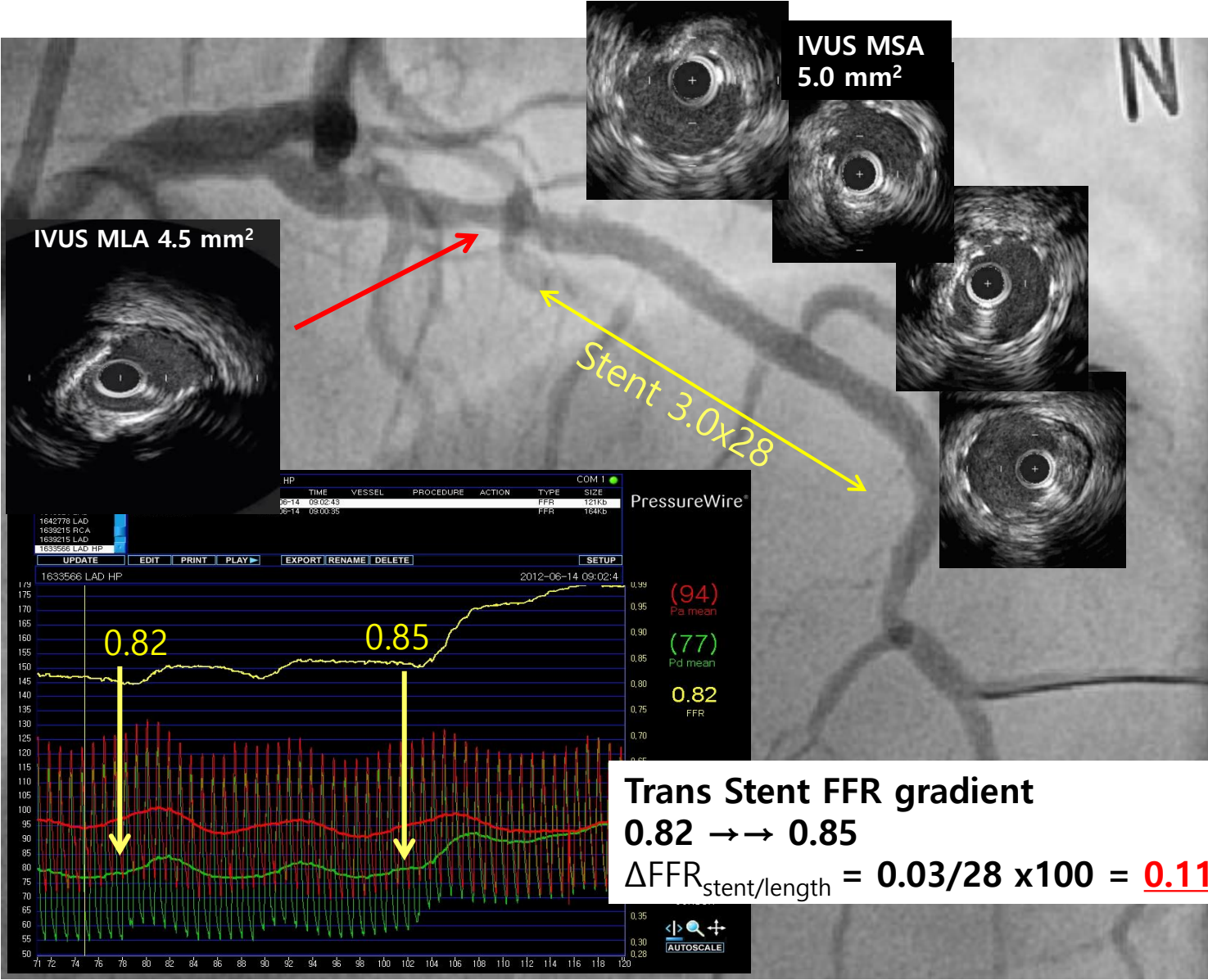
Post PCI Trans-Stent FFR represents stent expansion and edge problem

	Psd/Psp	
	>0.95	≤0.95
IVUS criteria		
Adequate	39	2
Inadequate	10	9
--		
Inadequate stent expansion	8	8
Asymmetric dilation	2	1
Stent edge dissection	0	3
Incomplete apposition of the stent	1	2
Incomplete coverage of the plaque	0	2

The detailed findings of IVUS are listed below the dotted line. As for the inadequate findings, there existed sometimes more than one in one vessel. Final judgment of inadequate by IVUS was carried out per vessel. Psd/Psp, a ratio of coronary pressure at the stent distal edge compared to the coronary pressure at the proximal edge; IVUS, intravascular ultrasound.

- Residual pressure gradient across the stent (trans stent FFR: Psd/Psp) can reflect not only an <u>insufficient stent expansion</u> but also <u>issues with stent edges</u>.
- The decision of optimum stent deployment as assessed by IVUS and pressure pullback was mismatched in 20% of cases, therefore careful attention should be paid to decoding the pressure pullback findings.

N Tanaka et al. J Cardiol, 2017

Post PCI FFR and Edge Dissection

	Dissection type				p Value
	A	B	C	D	
	(n = 24)	(n = 21)	(n = 1)	(n = 5)	
Proximal RD, mm	2.97 ± 0.40	2.94 ± 0.53	2.34	2.67 ± 0.42	0.290
Distal RD, mm	2.49 ± 0.56	2.50 ± 0.50	1.75	1.81 ± 0.30	0.022
MLD, mm	2.19 ± 0.43	2.10 ± 0.61	1.42	0.77 ± 0.44	0.002
DS, %	17.2 ± 8.4	22.7 ± 13.8	26.0	64.8 ± 17.4	0.002
LL, mm	7.1 ± 2.2	7.8 ± 3.8	15.0	17.0 ± 5.2	0.005
FFR	0.87 ± 0.09	0.86 ± 0.07	0.72	0.57 ± 0.08	0.002

- FFR correlates well with an angiographic type of edge dissection.
- FFR-guided management may be safe and effective for mild edge dissections such as types A and B.

Left main disease: pre PCI

LM MLA 6.2mm²

LM

(93) Pa mean
(67) Pd mean
0.71 FFR
75.20 CURSOR
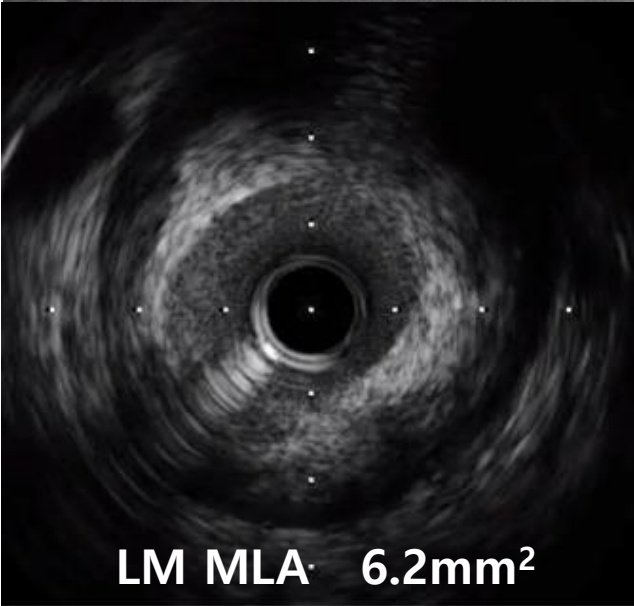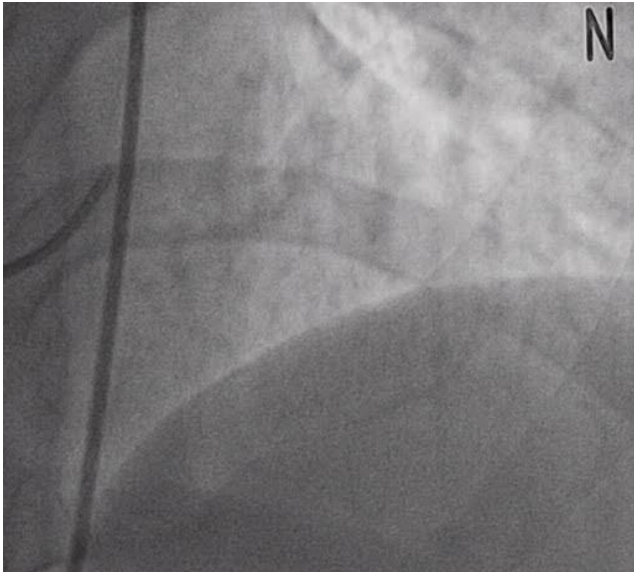
Left main disease: Post PCI FFR and Distal Issue

Distal Spasm
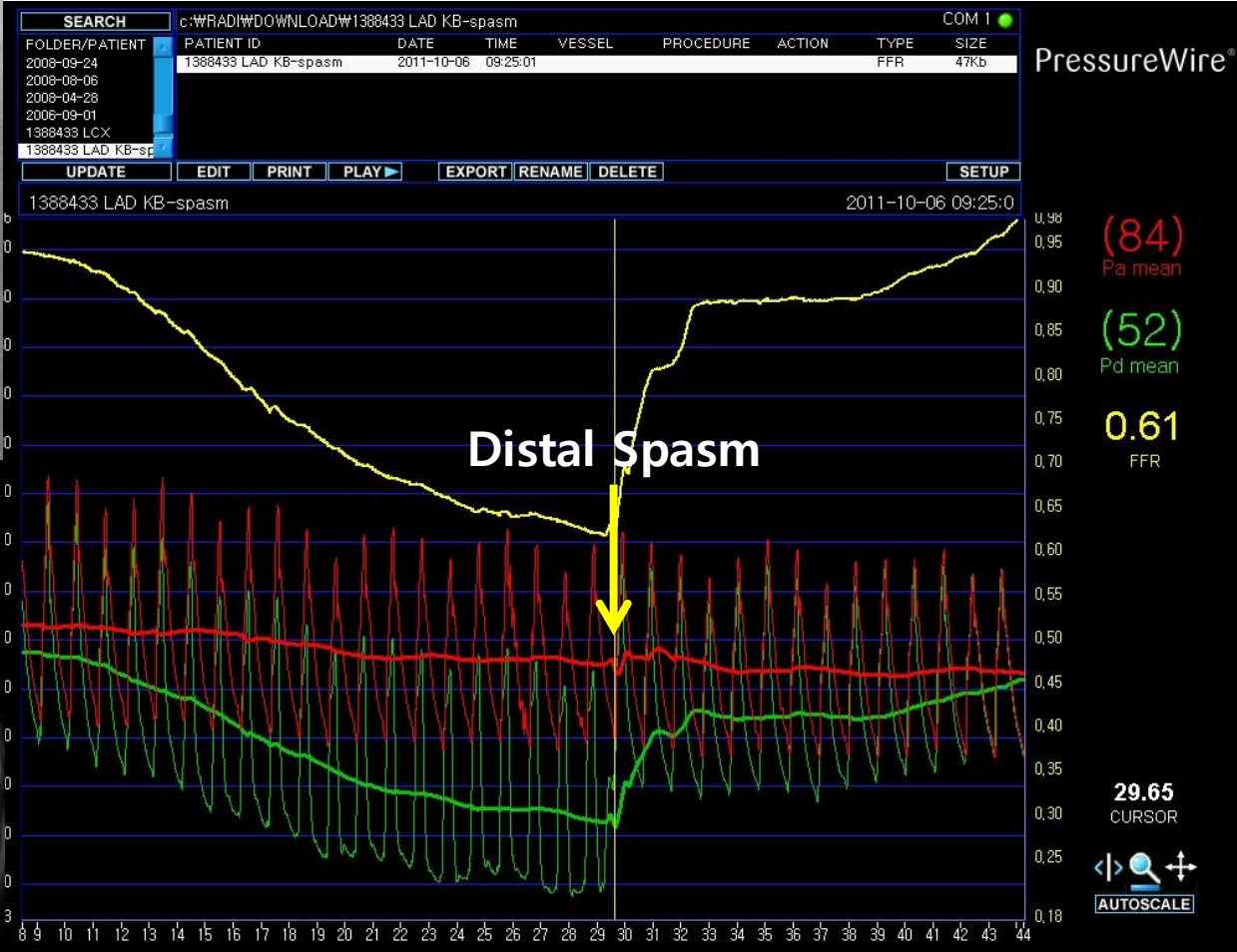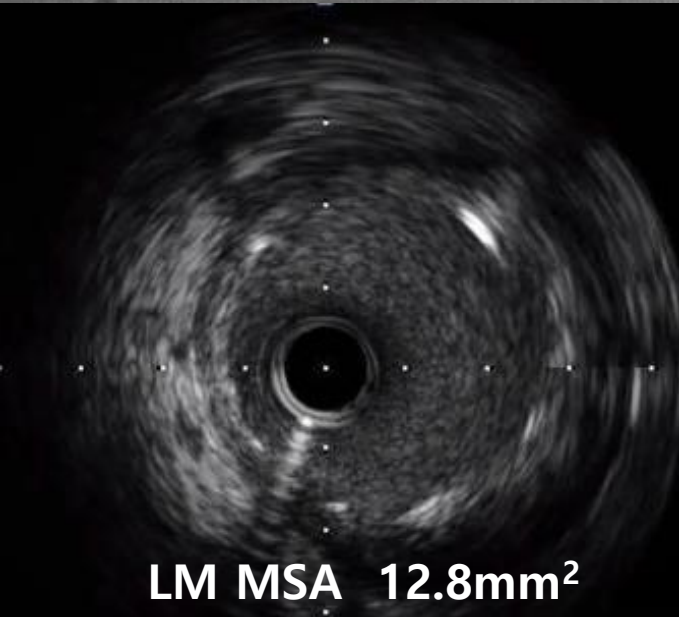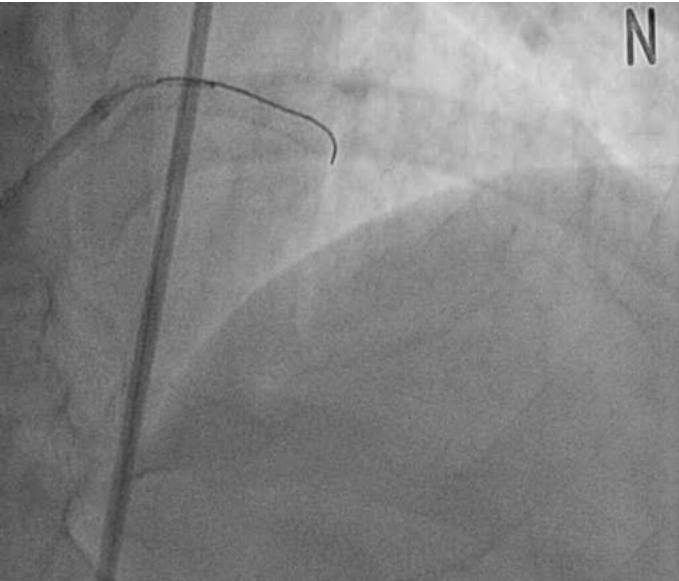
LM MSA   12.8mm²

Post PCI FFR and Prognostic Value

Post PCI (BMS) FFR – Distribution and MACE (n=750)

65% of post PCI FFR <0.96

Legend: MACE(%), Frequency(%)

x-axis (Post Stent FFR): 0.96-1.0, 0.91-0.95, 0.86-0.90, 0.81-0.85, 0.76-0.80

MACE(%) values: 5, 6, 16, 22, 30
Frequency(%) values: 35, 32, 17, 8, 6

N Pijls et al. Circulation 2002
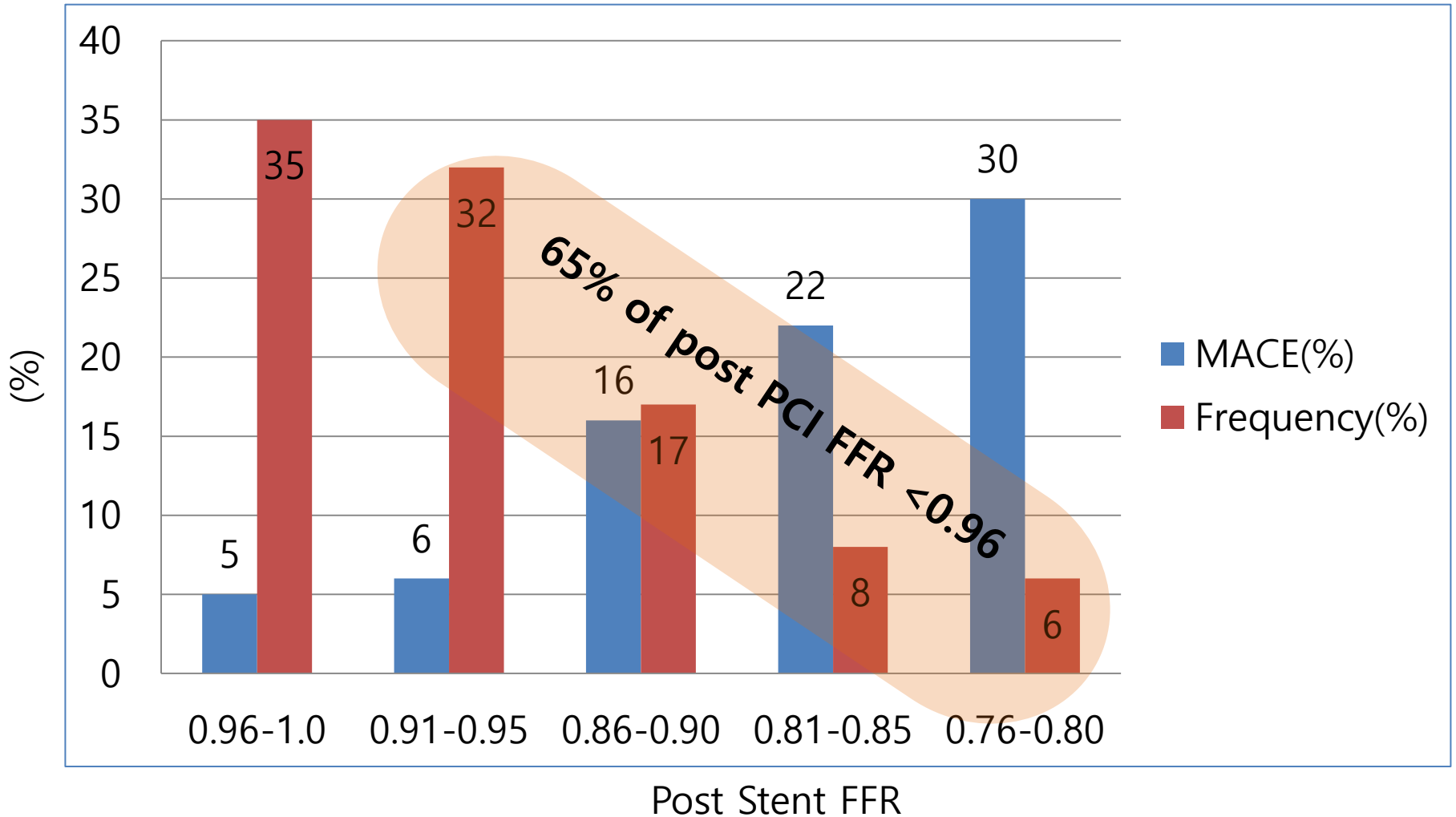
BCV of Post DES FFR for prediction of MACE (n=80)

BCV : 0.90

sensitivity 67%, specificity 58%
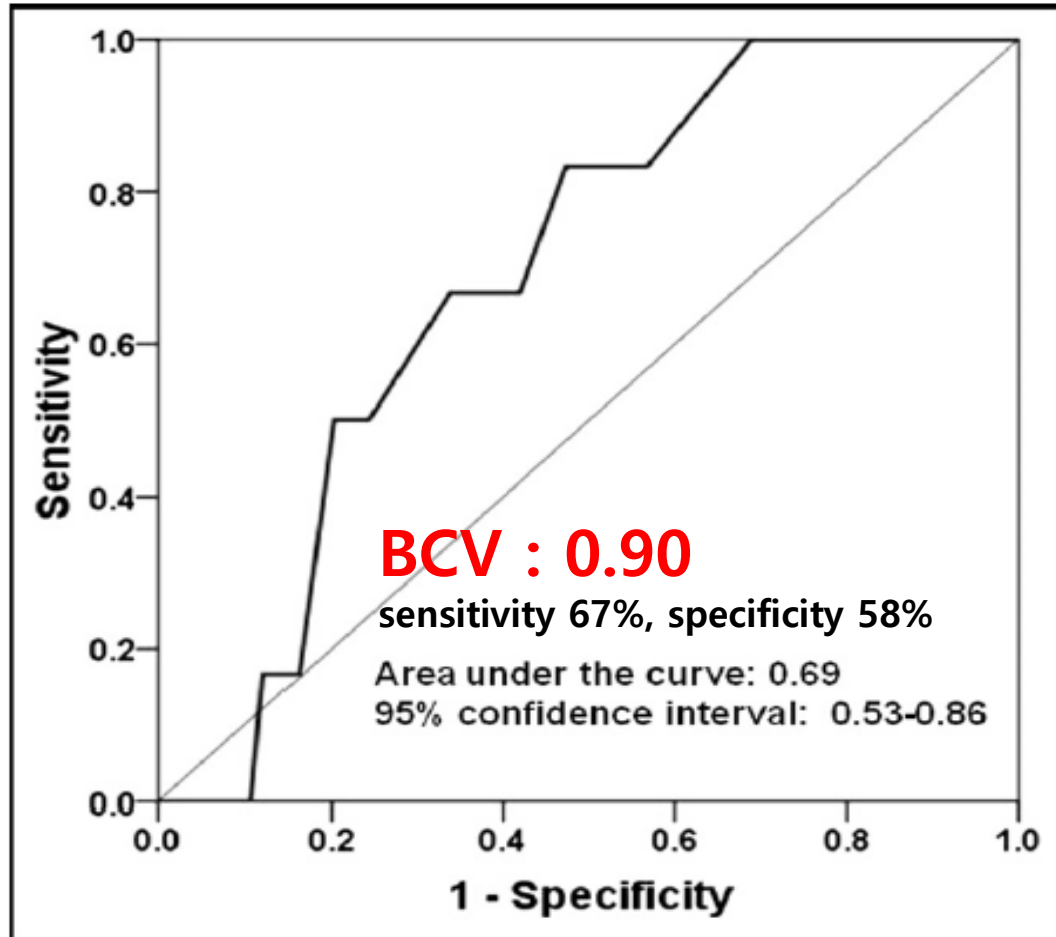
Area under the curve: 0.69
95% confidence interval: 0.53-0.86

Figure 3. Receiver operating characteristic curve analysis used to find cutoff FFR as predictor of 1-year rate of MACE.

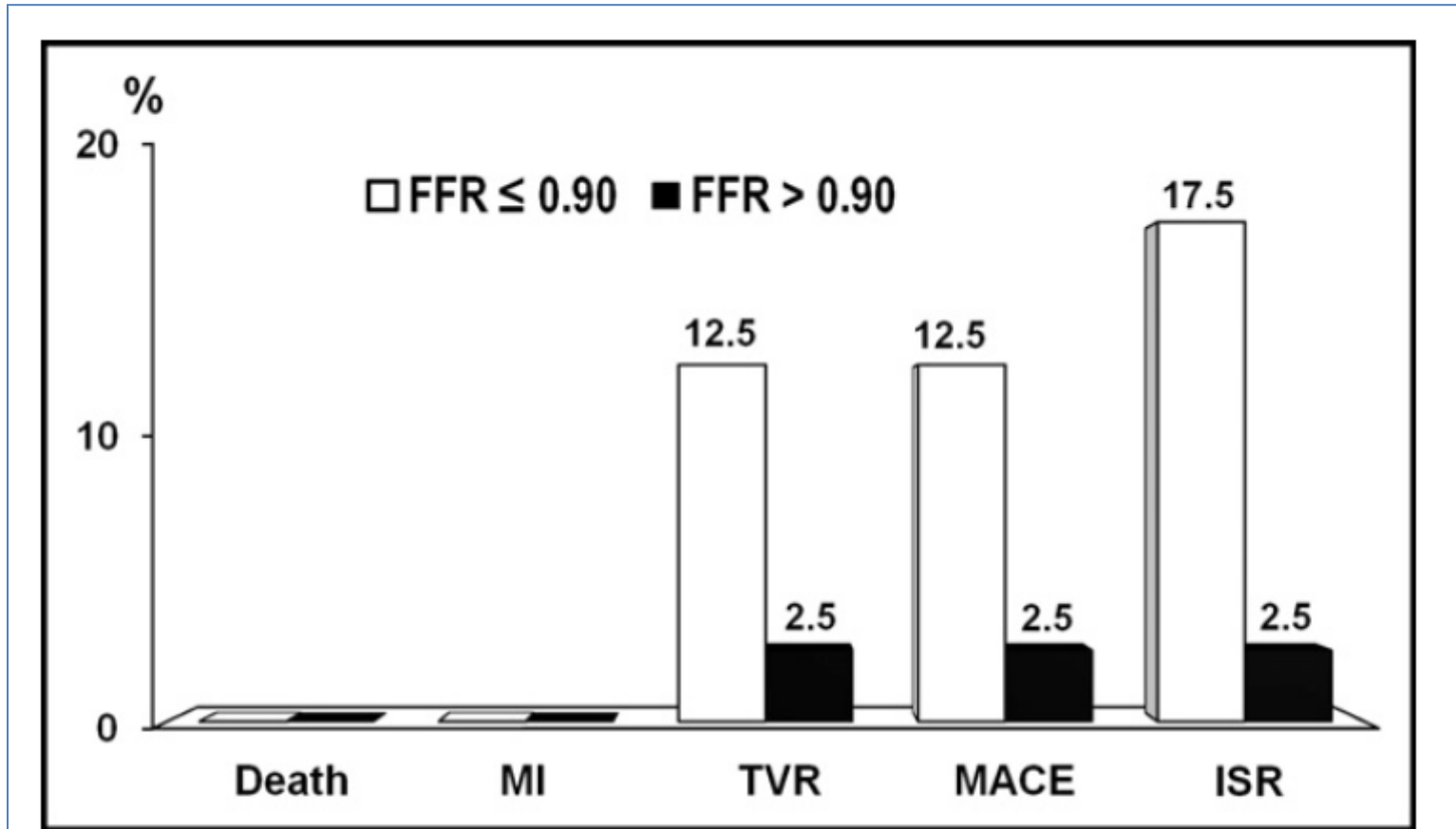CW Nam et al. AJC 2011

Post DES FFR and MACE
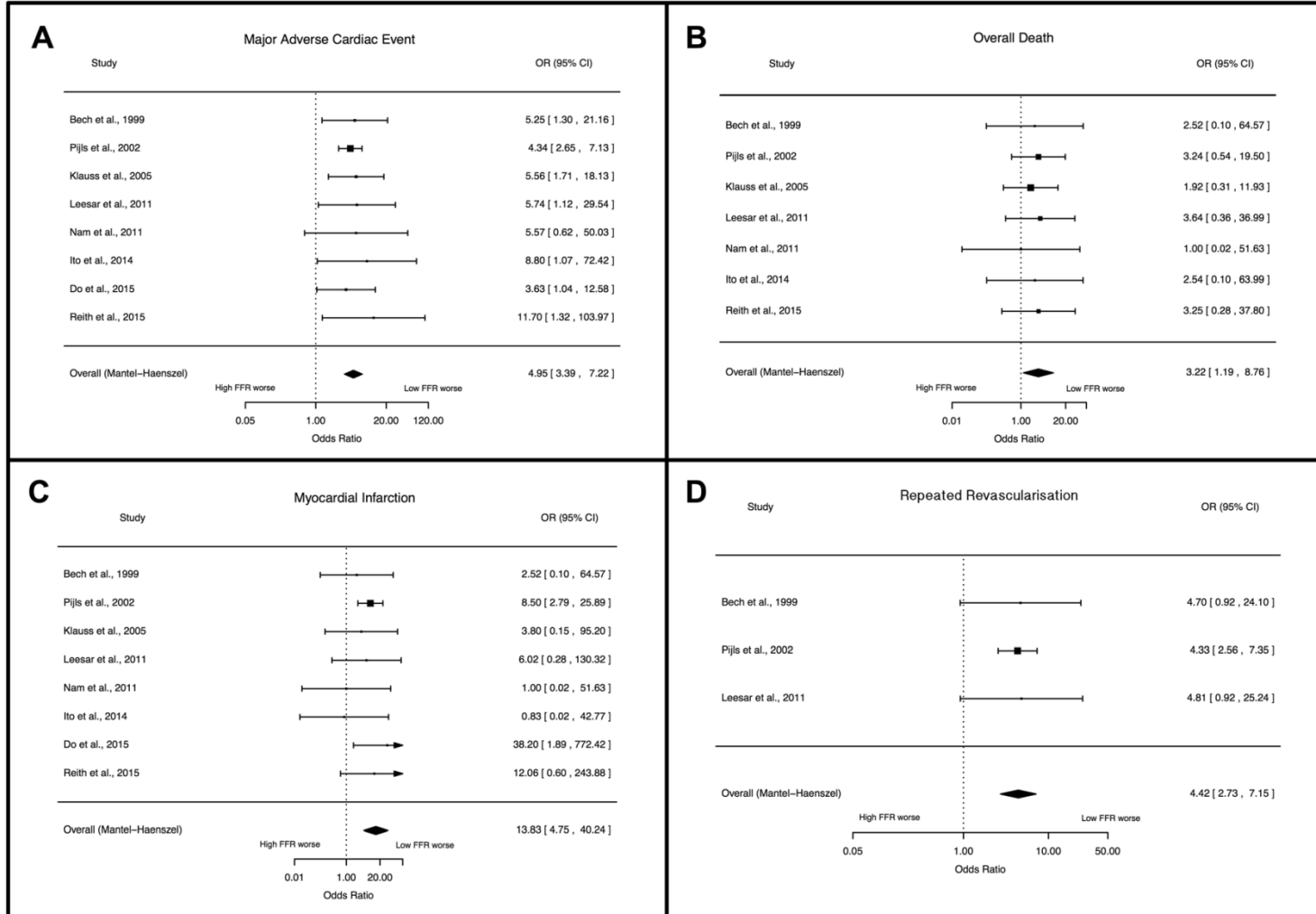

Figure 1. One-year clinical outcomes according to median value of FFR after DES implantation. MI = myocardial infarction; TVR = target-vessel revascularization; ISR = in-stent restenosis. p <0.05.
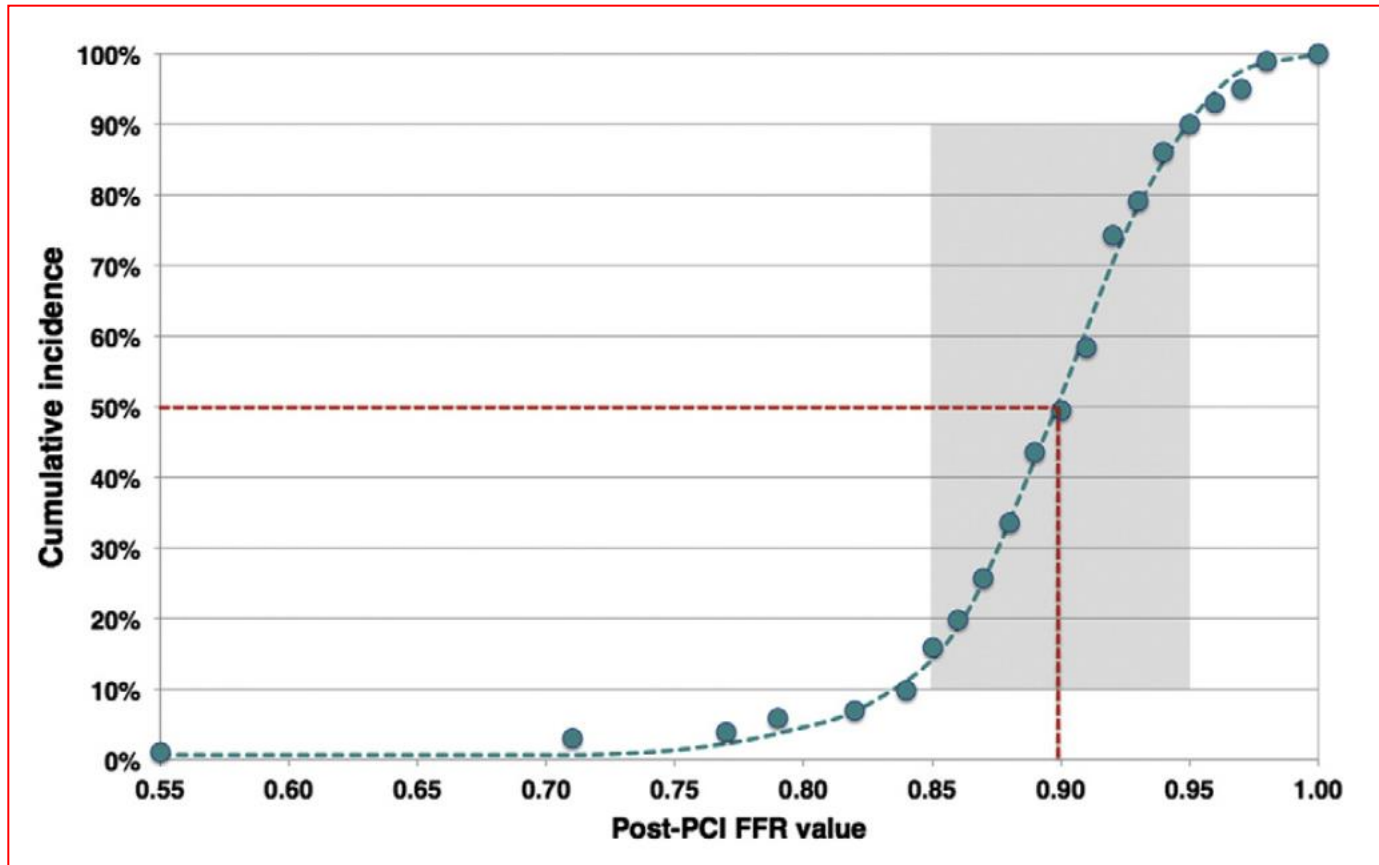
Post PCI FFR: MACE

8 studies, 1999-2016, n=1,337, balloon/BMS/DES, meta analysis

Best cut-off of Post PCI FFR for MACE: 0.89-0.96

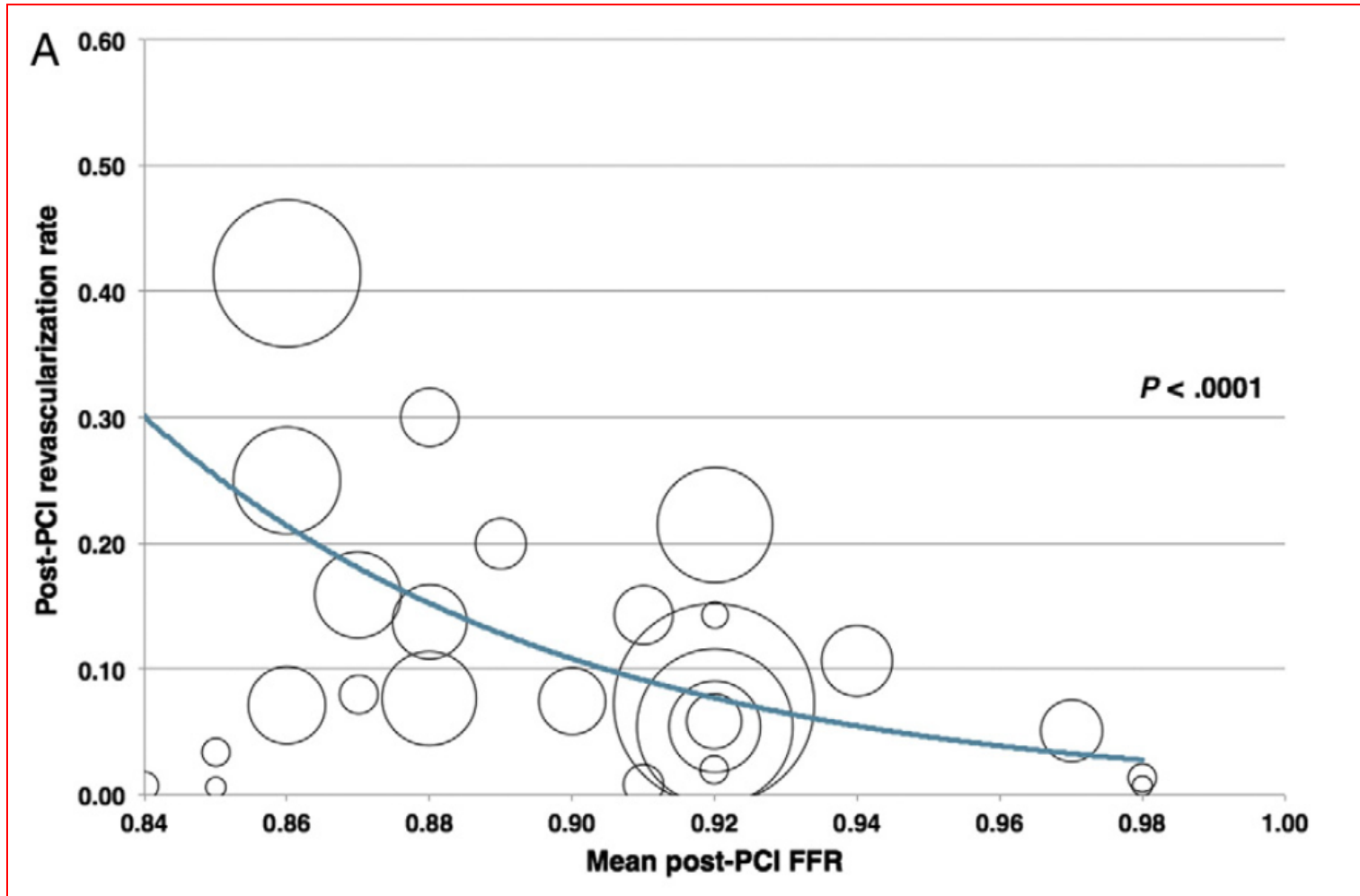M. Wolfrum et al. BMC Cardiovascular Disorders (2016)

Post PCI FFR

105 studies, 1995-2015, n= 7,470, balloon/BMS/DES, meta analysis

Cumulative post-PCI FFR values incidence showed by the blue line and dots. **80% of studies presented post-PCI FFR values between 0.85 and 0.95 (shaded zone) and that, in 50% of studies, 0.90 was obtained (red lines).**
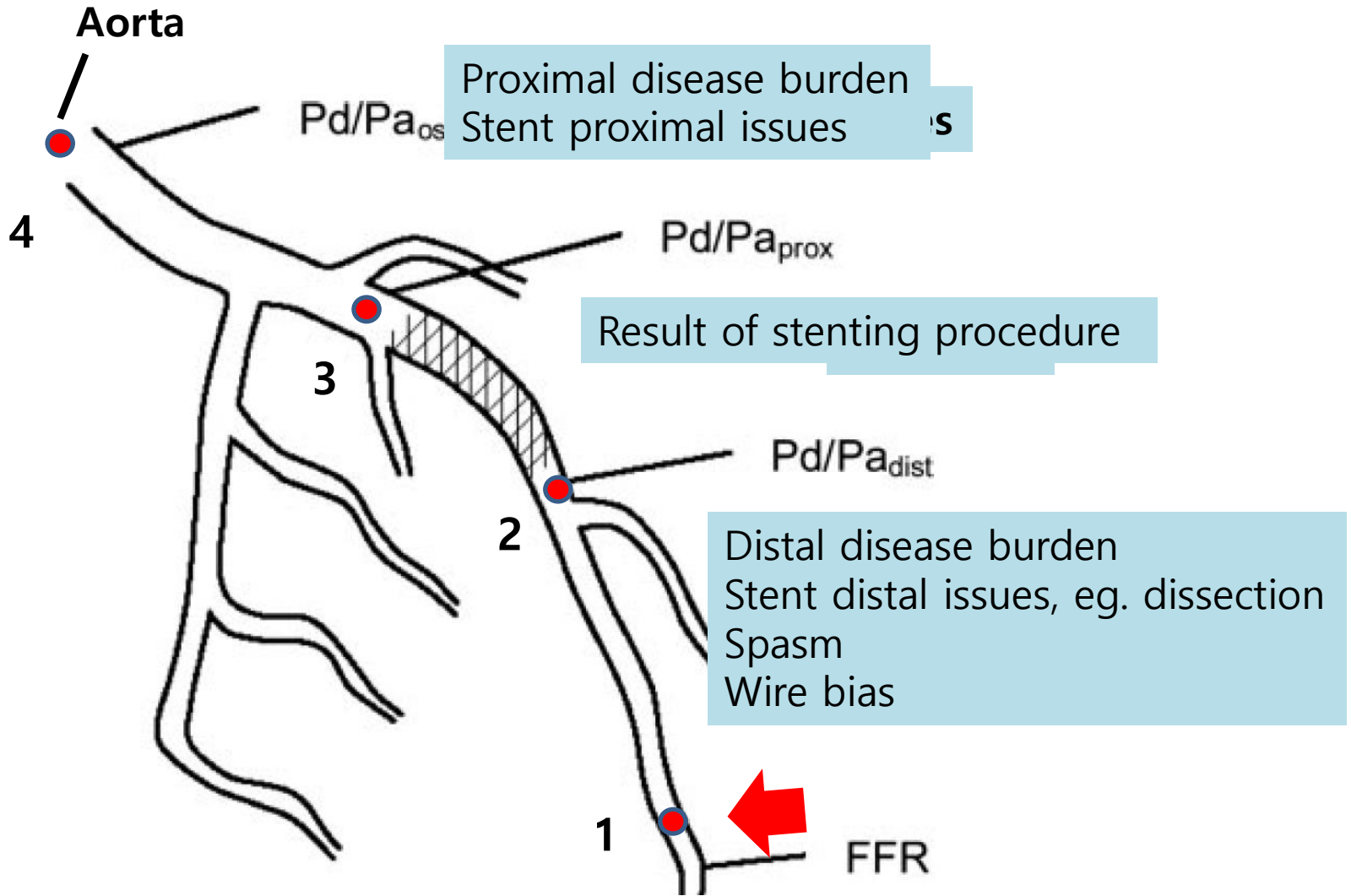
Post PCI FFR: revascularizarion rate

Data show that the higher the post-PCI FFR value, the lower the risk of repeat PCI. **Post-PCI FFR ≥0.90 is associated with <10% risk of repeat PCI.**

Post PCI FFR: MACE
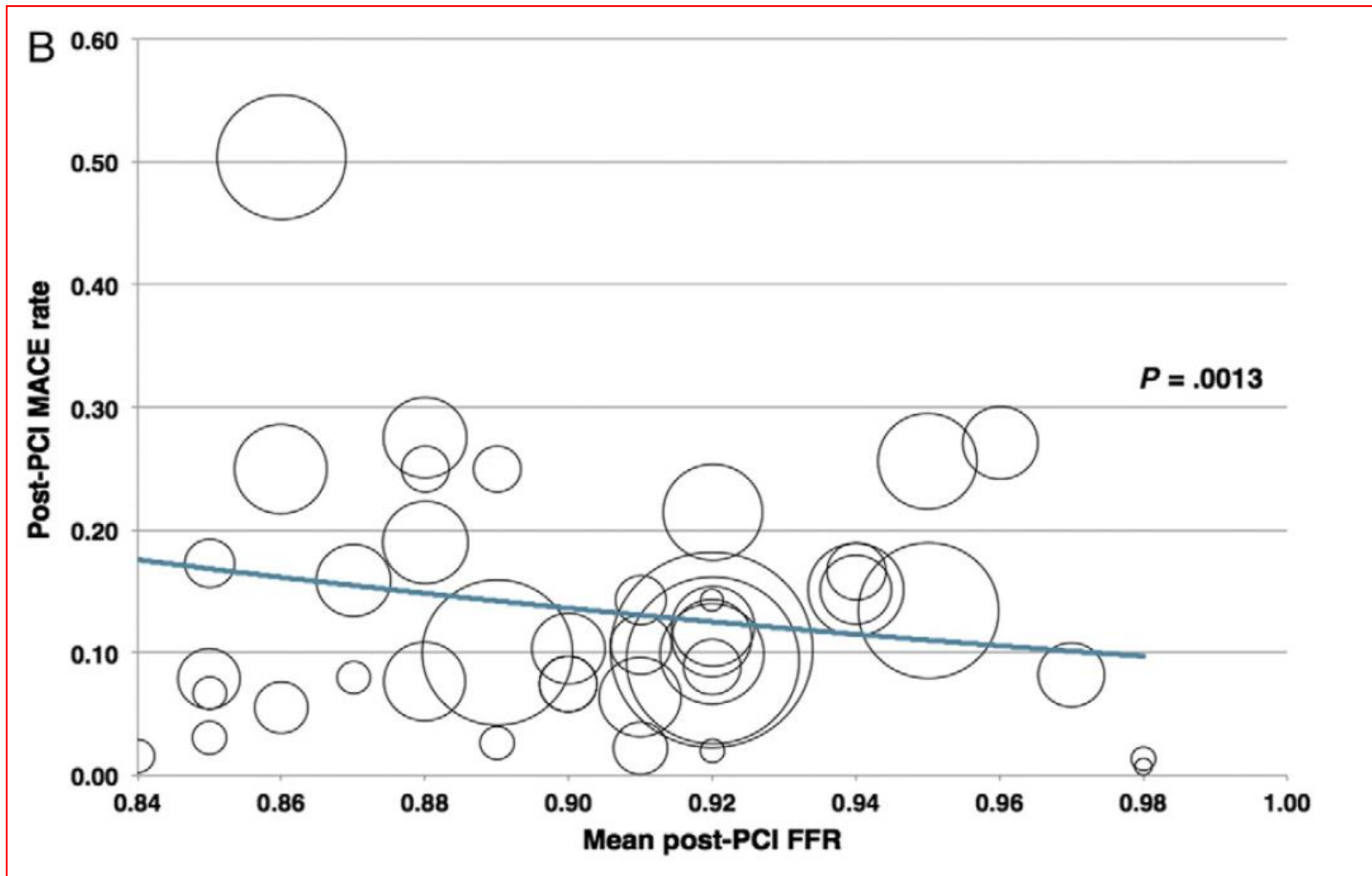
Data show that **the higher the post-PCI FFR value, the lower the risk of MACE.**

G Rimac et al. Am Heart J, 2017

Post PCI FFR is summation of issues of whole vessel

Aorta

Pd/Pa_{os}

Proximal disease burden
Stent proximal issues

Pd/Pa_{prox}

Result of stenting procedure

Pd/Pa_{dist}

Distal disease burden
Stent distal issues, eg. dissection
Spasm
Wire bias

4

3

2

1

FFR

Complete pressure pullback on sustained stable maximal hyperemia is mandatory for in-depth geographic analysis of post PCI FFR

Post PCI FFR

- **What does it mean?**
- Post PCI FFR is summation of
    - PCI completeness
    - Residual plaque or disease burden untreated
    - Post PCI complications and/or bias, transient issues.
- **Should we measure it?**
    - Yes.
    - Especially, when we have suboptimal PCI result and/or significant residual disease untreated.
- Post PCI FFR, represents both PCI result and residual disease burden, therefore, showed significant prognostic value.

Your PCI .....

Just a Food or Luxury cuisine

is your Choice....

Thank You for Attention…