Coronary Microvascular Resistance Estimated by A Nobel Dual-sensor (Pressure & Doppler Velocity) Guidewire Reflects Myocardial Viability After AMI

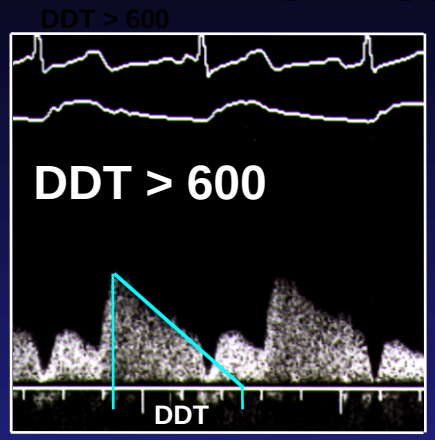
Takashi Akasaka MD
Department of Cardiovascular Medicine
Wakayama Medical University

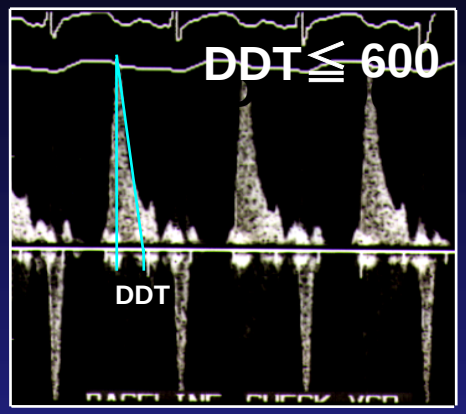
Backgrounds (1)

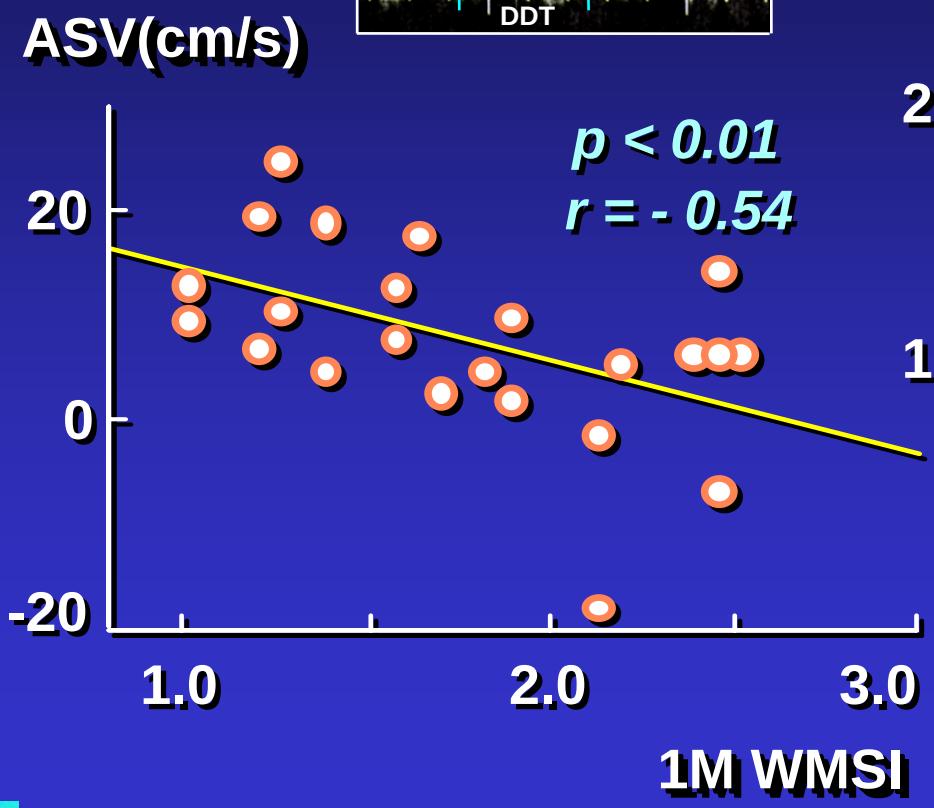
- **LV function recovery is the final goal of PCI in cases with AMI.**

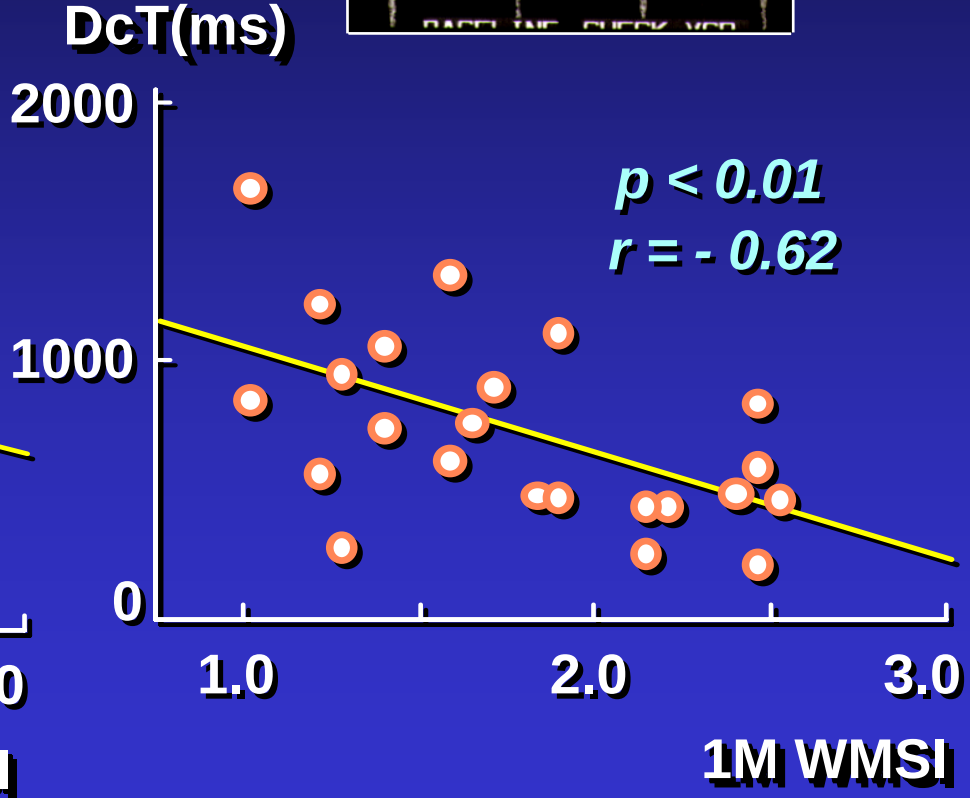
- **Many predictors of LV function recovery in AMI have been proposed previously.**

ASV & DcT vs LVWMSI



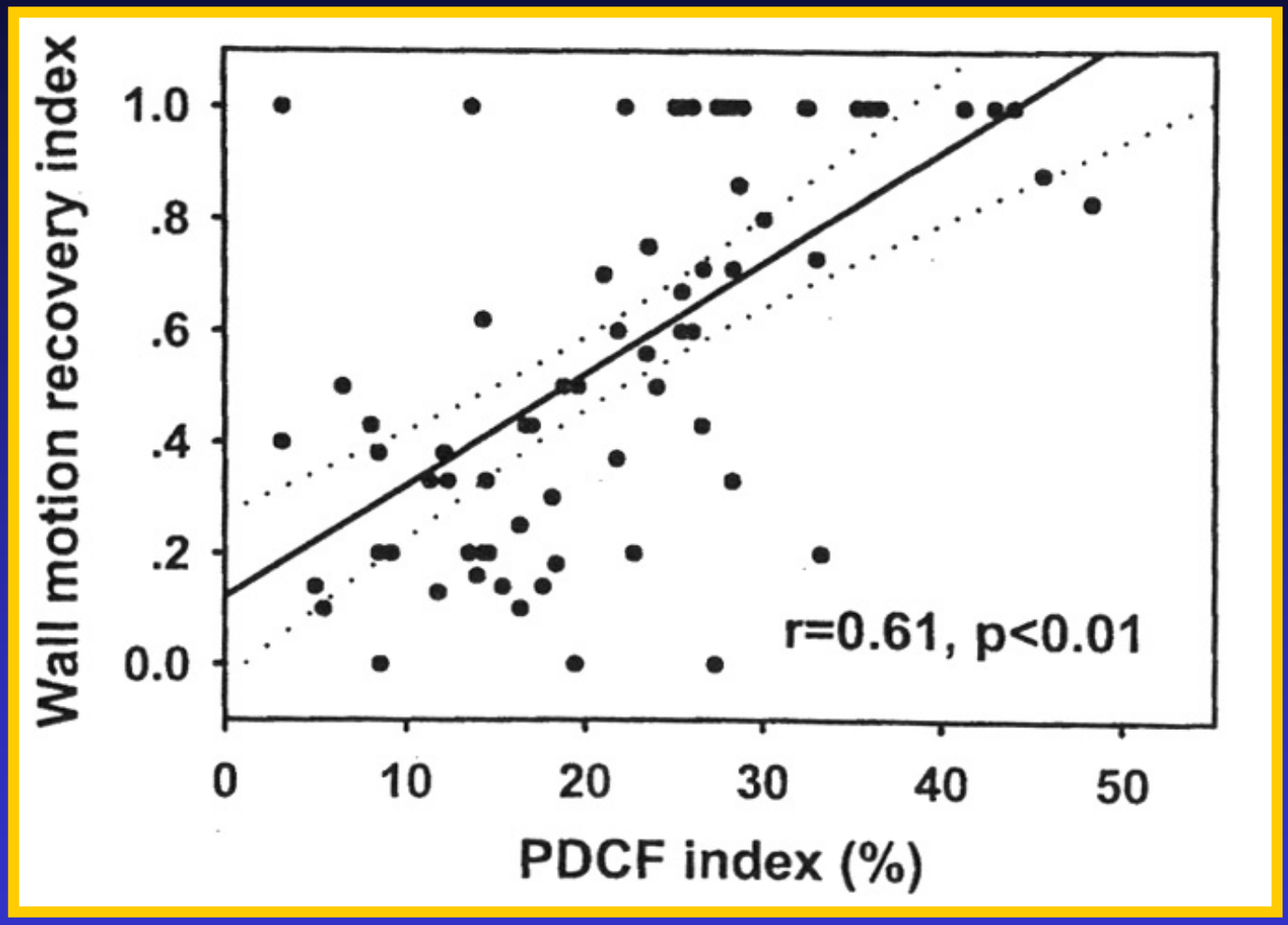






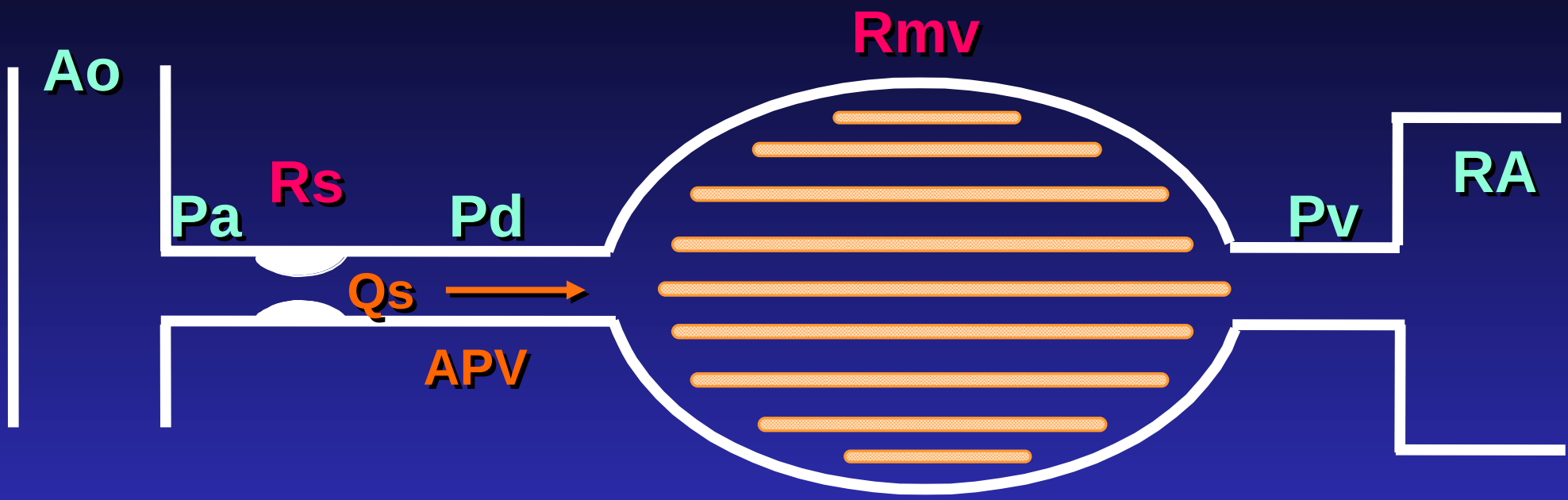
(Kawamoto T, Yoshida K, Akasaka T, et al. Circulation 1999;100: 339-345)

Relationship between Qc / Qn & LVWM recovery



(Lee CW, et al. J Am Coll Cardiol 2000;35:949-955)

Concept of hyperemic microvascular resistance



Qs: coronary flow through the stenosis

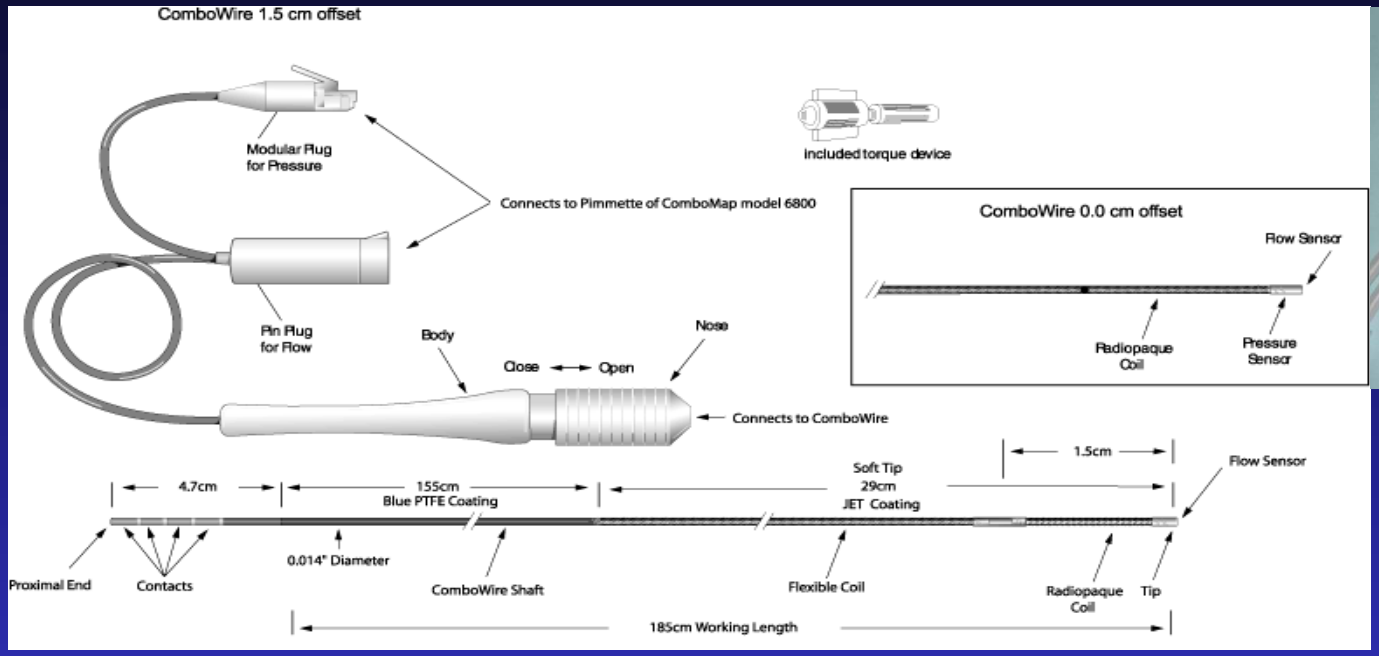
APV : time-averaged peak velocity

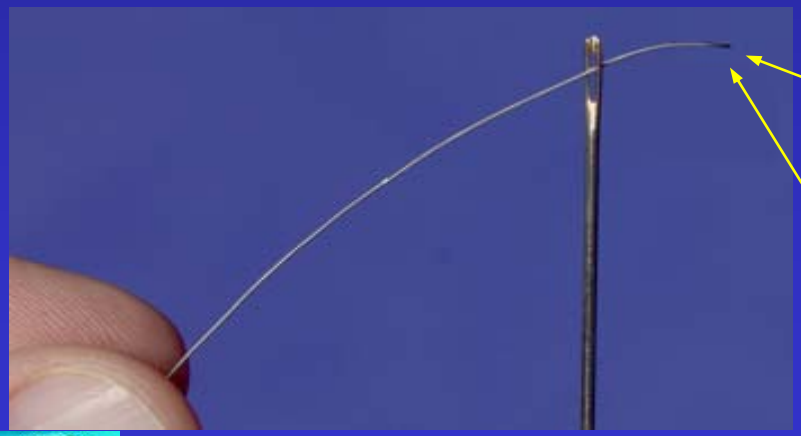
h-Rmv : hyperemic microvascular resistance = (Pd – Pv) HE / Qs HE

h-MRv : hyperemic microvascular resistance index = (Pd – Pv) HE / APV HE

IMR : index of microcirculatory resistance = Pa・Tmn・［(Pd– Pw) / (Pa– Pw)

Volcano ComboWire®



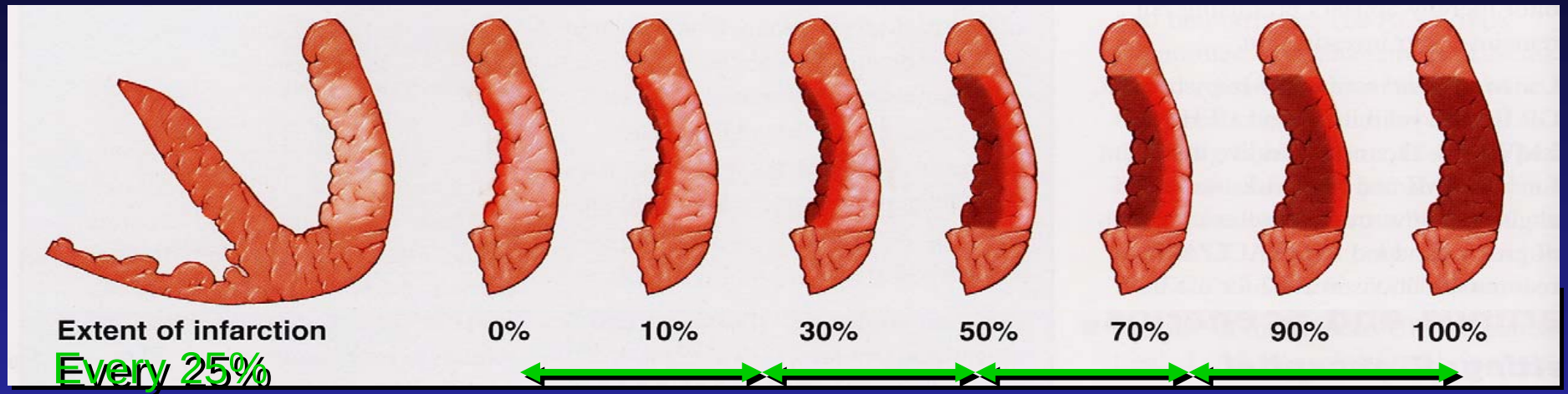


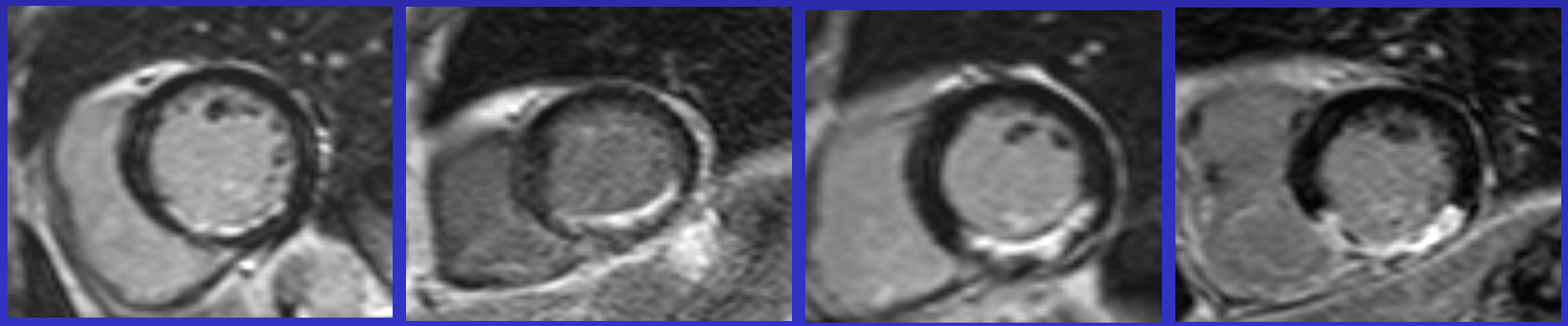
Doppler Velocity Transducer

Pressure Sensor

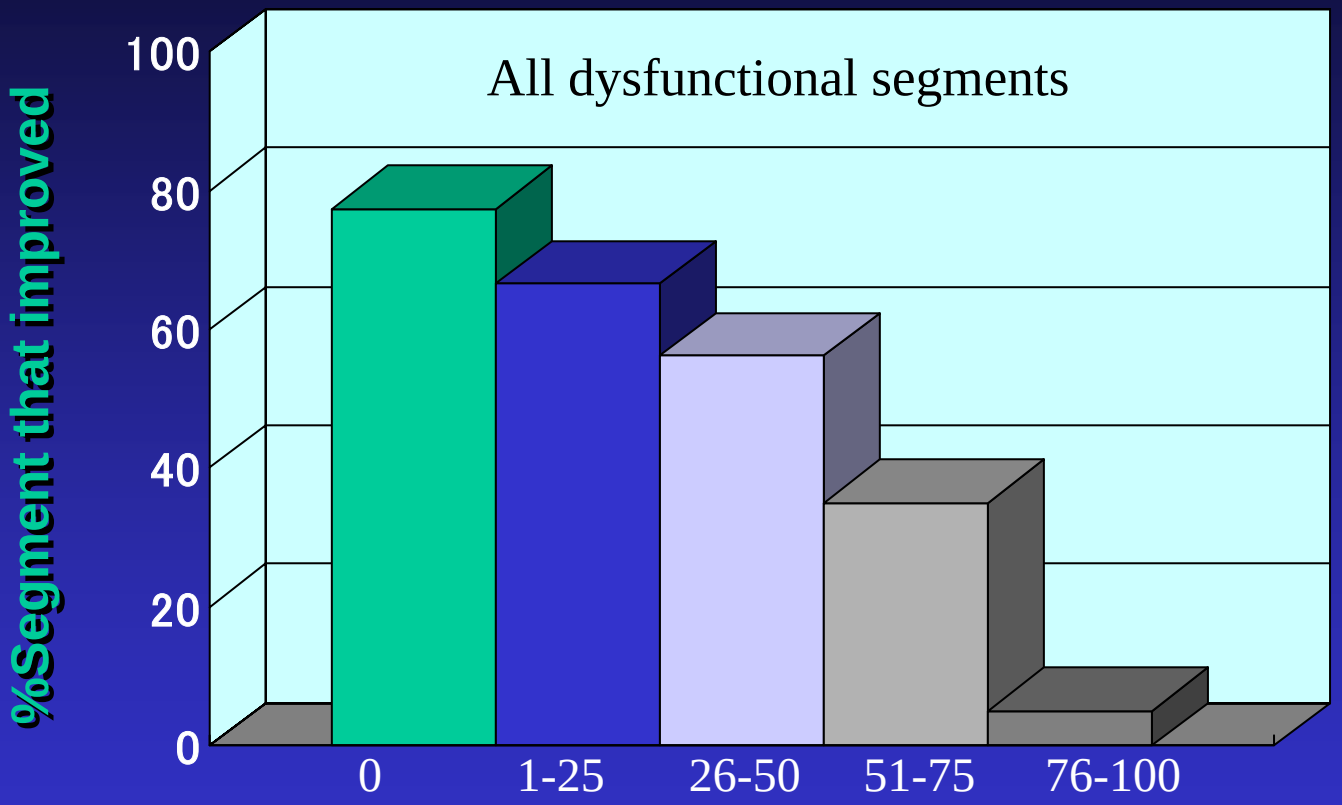
A dual-sensor (pressure and Doppler velocity) guidewire has an ability to estimate coronary microvascular resistance (MVR).

Transmural Extent of Infarction by delayed enhancement by MRI





Transmural Extent of Acute Myocardial Infarction Predicts Long-Term Improvement in Contractile Function



(Kim RJ, et al; N Eng J Med 2000; 343: 1445-53)

Objective

The aim of this study was to assess the relationship between MVR and the transmural extent of infarction (TEI) after primary percutaneous coronary intervention (PCI) in AMI.

Methods(1)

Study population

- 24 patients who underwent primary PCI for the first anterior AMI within 12 hours from the onset of symptoms

Exclusion criteria

- Left main trunk lesion
- History of prior MI
- Cardiogenic shock
- Renal insufficiency (serum creatinine ＞1.5mg/dl)
- Insulin-dependent diabetes mellitus
- Contraindications to MRI (pacemaker, atrial fibrillation, claustrophobia and so on)

Methods(2)

Primary percutaneous coronary intervention

- Thrombectomy
- Bare metal stent

Hemodynamic measurements and data analysis

- Immediately after PCI, a 0.014-inch dual-sensor guidewire was placed distal to the culprit lesion to take per-beat averages of pressure and flow velocity simultaneously.
- Microvascular resistance index (MVRI) during maximal hyperemia; [Mean distal pressure] / [Average peak flow velocity] (mmHg・cm^{-1}・s)
- Hyperemic agent; intravenous infusion of adenosine (150 μg / kg / min)

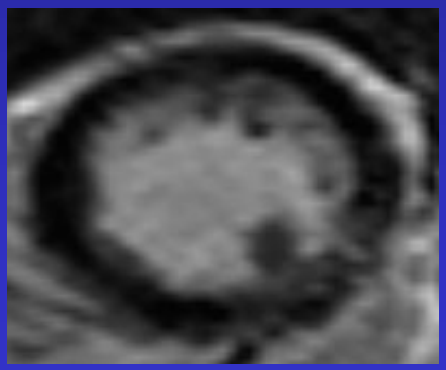
Creatine kinase (CK) and CK-MB fraction measurements

- Before and immediately after primary PCI, and every 3 hours for the first 24 hours after primary PCI.

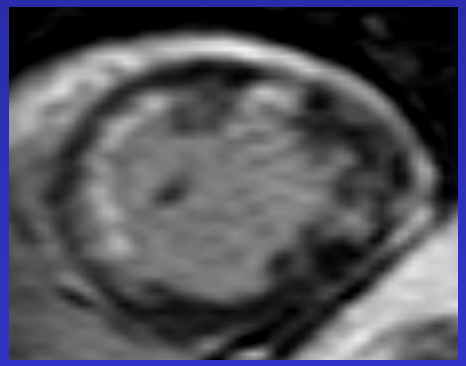
Methods(3)

Delayed contrast-enhanced MRI and data analysis

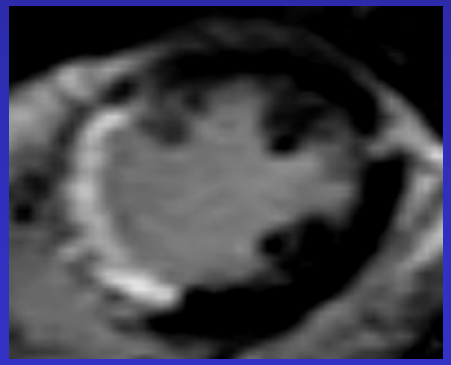
- Two weeks after the onset of AMI
- Gadolinium-diethlenetriamine pentaacetic acid (0.1mmol/kg)
- 1.5-T MR scanner (Gyroscan Intera CV, Philips, the Netherlands)
- Transmural extent of infarction (TEI) by delayed contrast-enhanced MRI; grade 1= 0 to 25% of hyperenhanced extent of left ventricular wall, grade 2= 26 to 50%, grade 3 = 51 to 75% and grade 4 =76 to 100%



grade 1



grade 2



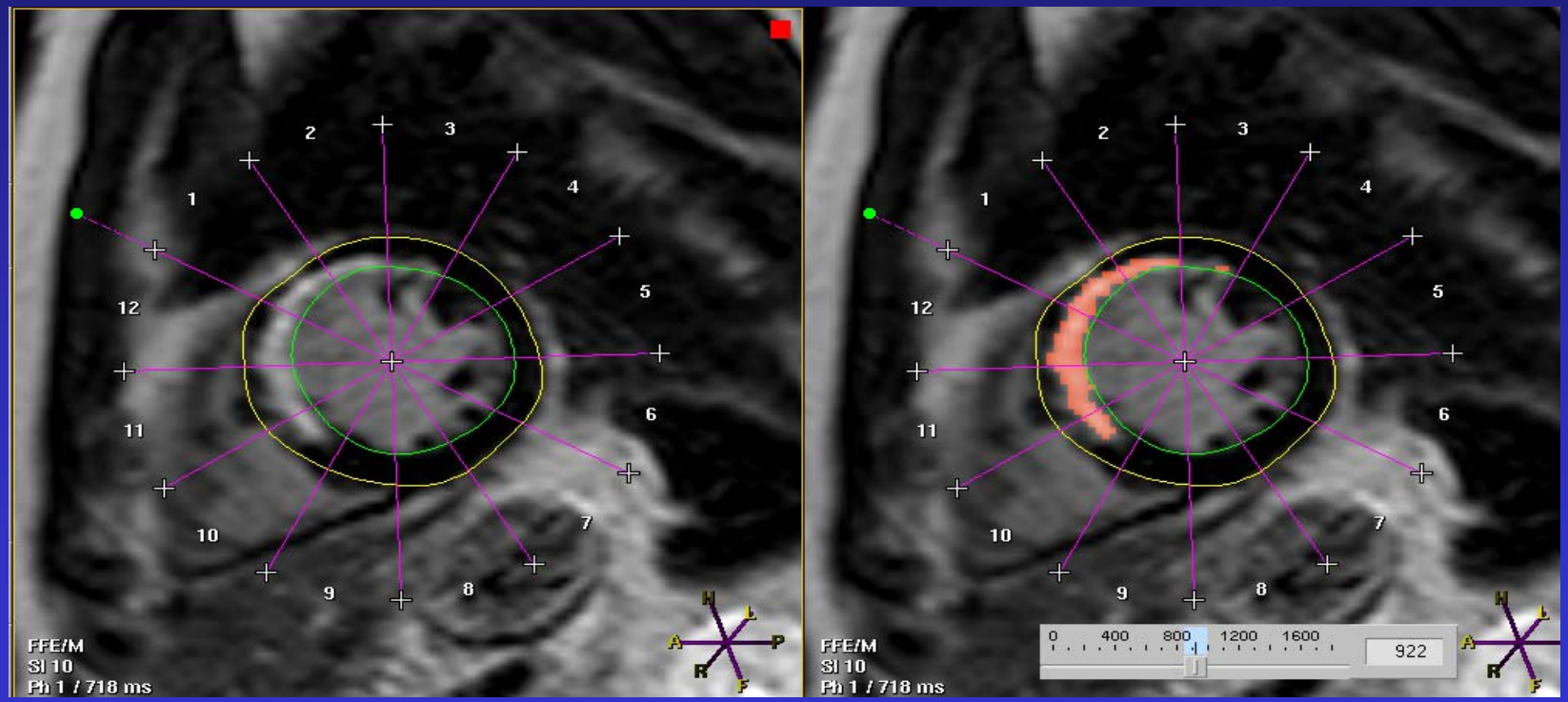
grade 3

grade 4

Methods(4)

- Infarct size by delayed ce-MRI (%LV);

[Sum of the volume of DE regions for all slices] / [Sum of the LV myocardial cross-sectional volumes] ×100

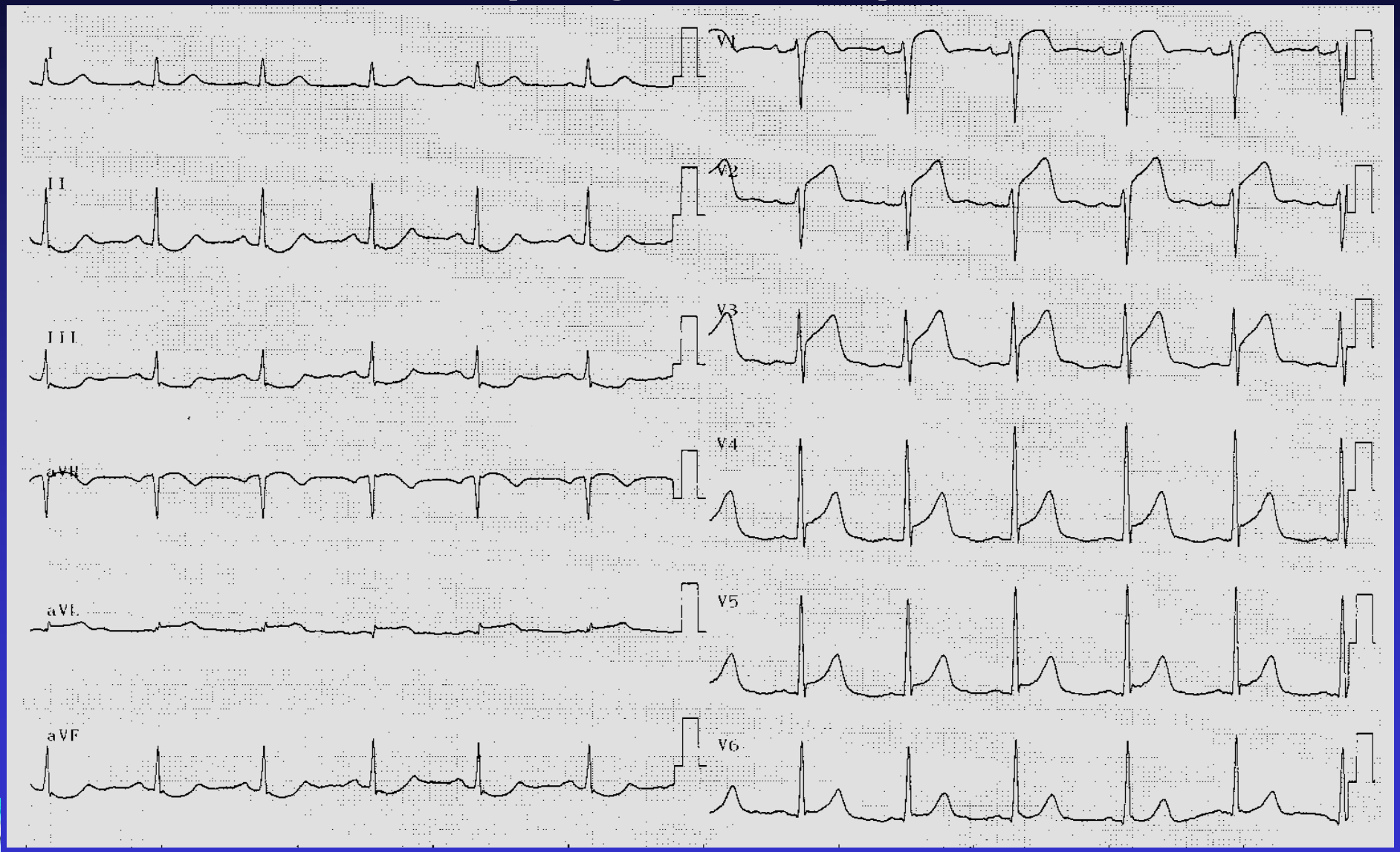


Patient characteristics

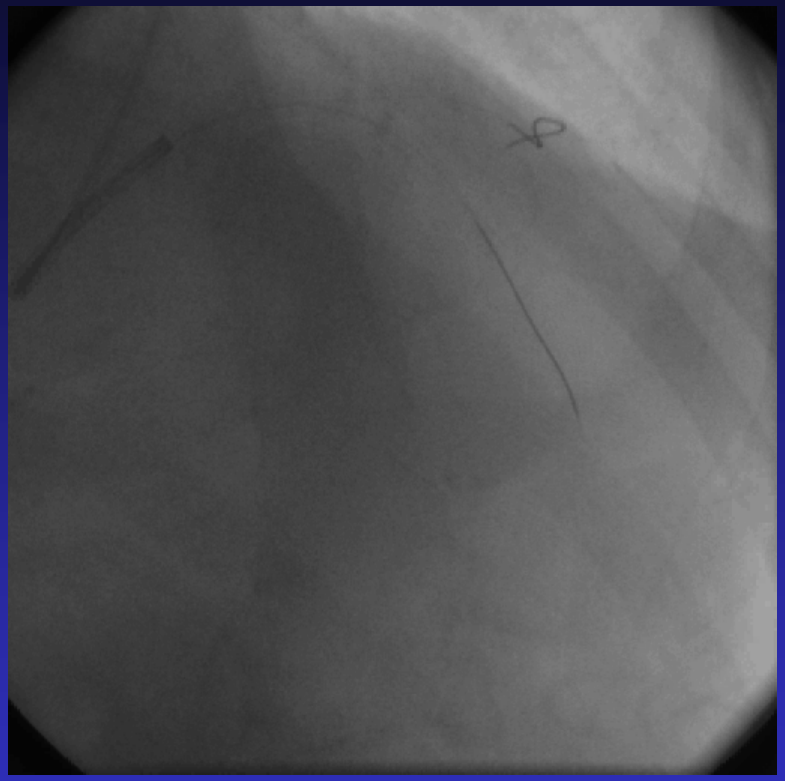
	n=24
Age, years	65 ± 11
Male sex n, (%)	17 (81)
Non-insulin dependent-diabetes mellitus n, (%)	7 (29)
Hypertension n, (%)	14 (58)
Dyslipidemia n, (%)	9 (38)
Current smoking n, (%)	9 (38)
Family history of coronary aretry disease n, (%)	12 (57)
Culprit vessel	
LAD	24 (100)
Time to the evaluation of coronary microcirculation (hour)	4.96 ±2.1

ECG at the time of admission

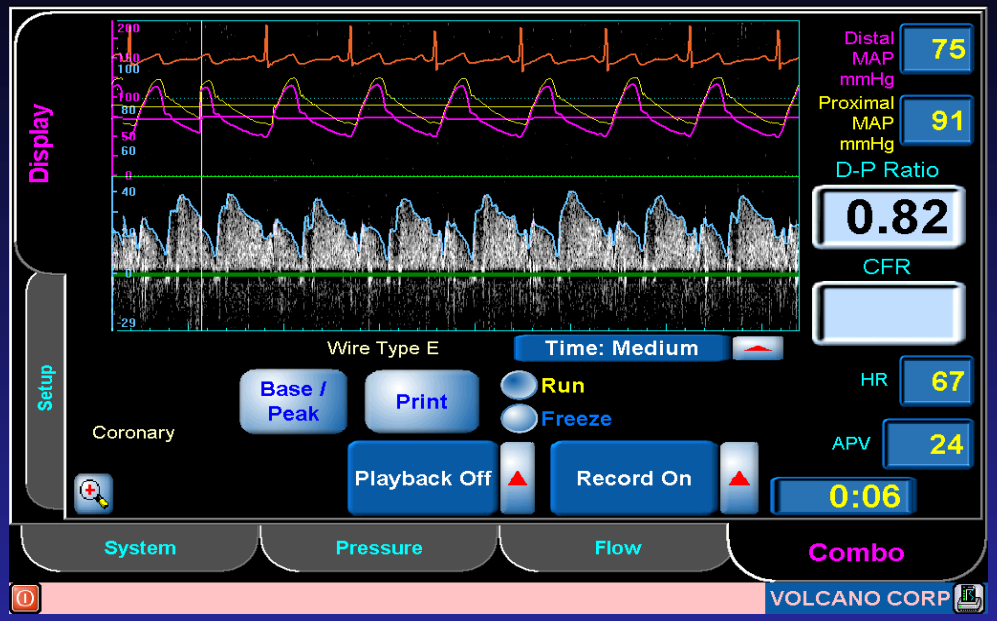
(70 y.o., male)



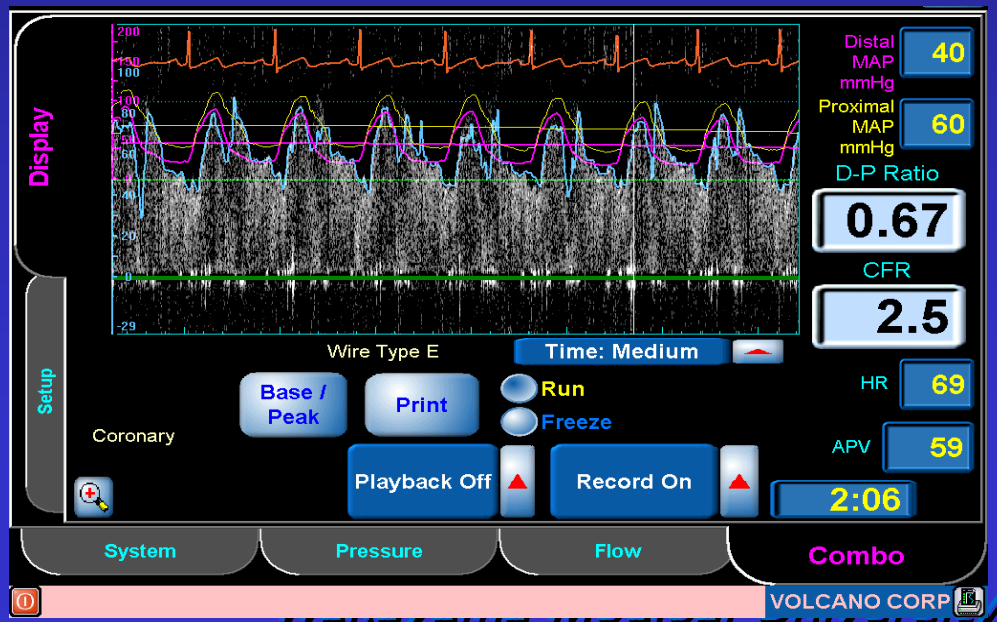
Combowire



Baseline



Hyperemia

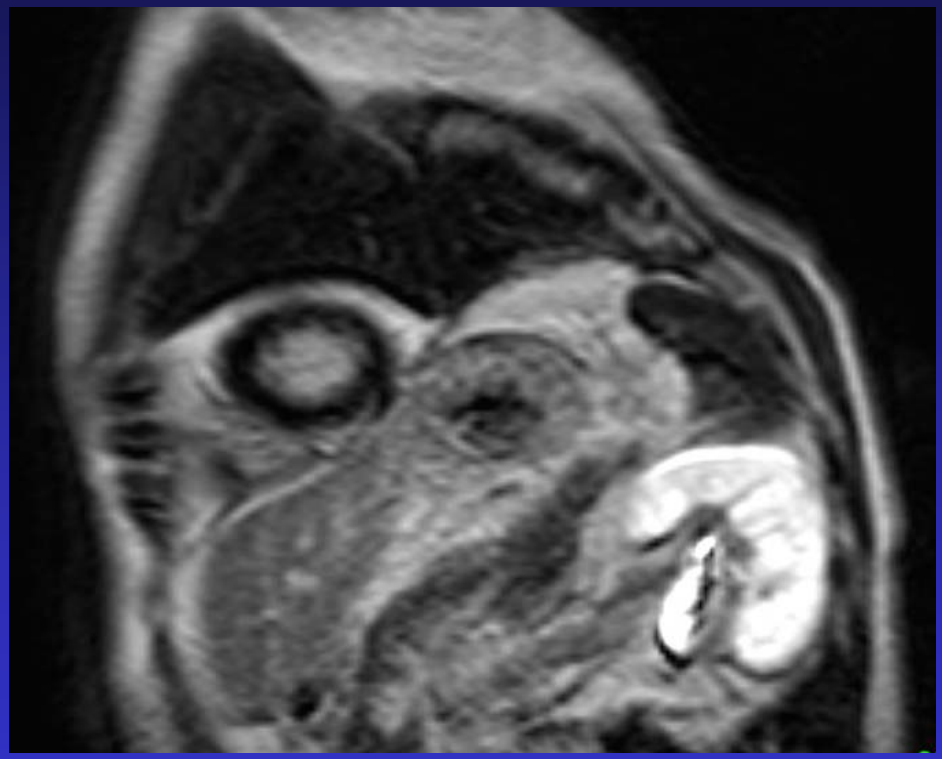


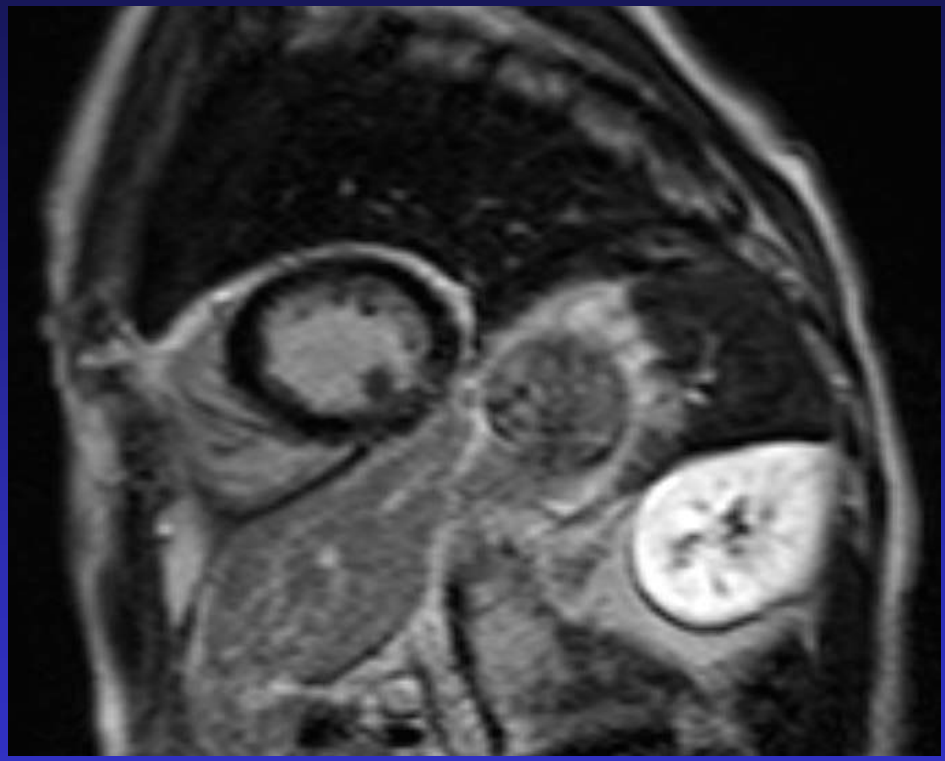
h-MVr = h-Pd / h-APV

= 40 / 59

= 0.68 (mmHg/cm・sec^{-1})

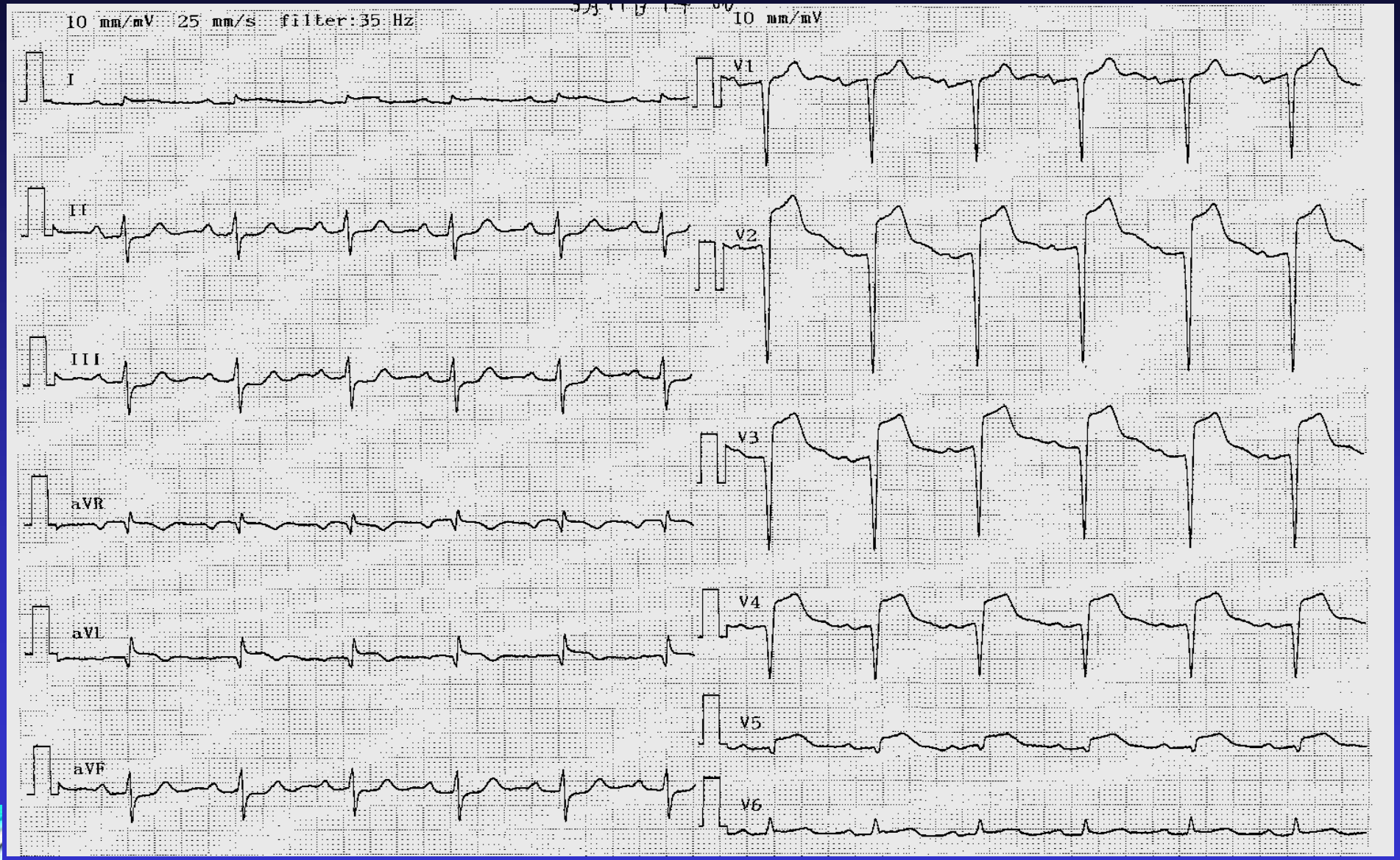
Contrast-enhanced MRI (two weeks after primary PCI)



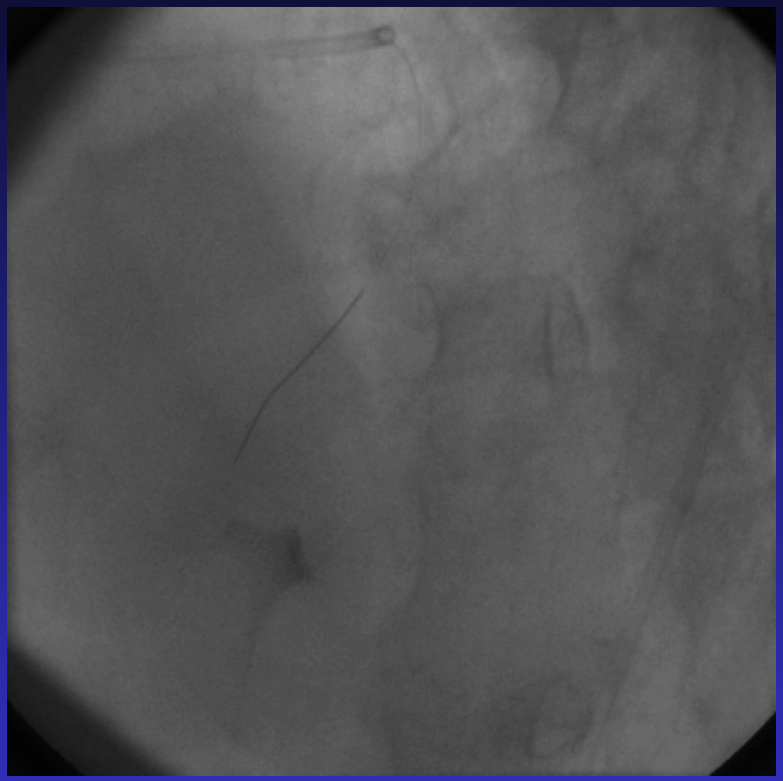


Transmural extent of hyperenhancement Grade 0, peak CK 185 → avoted MI

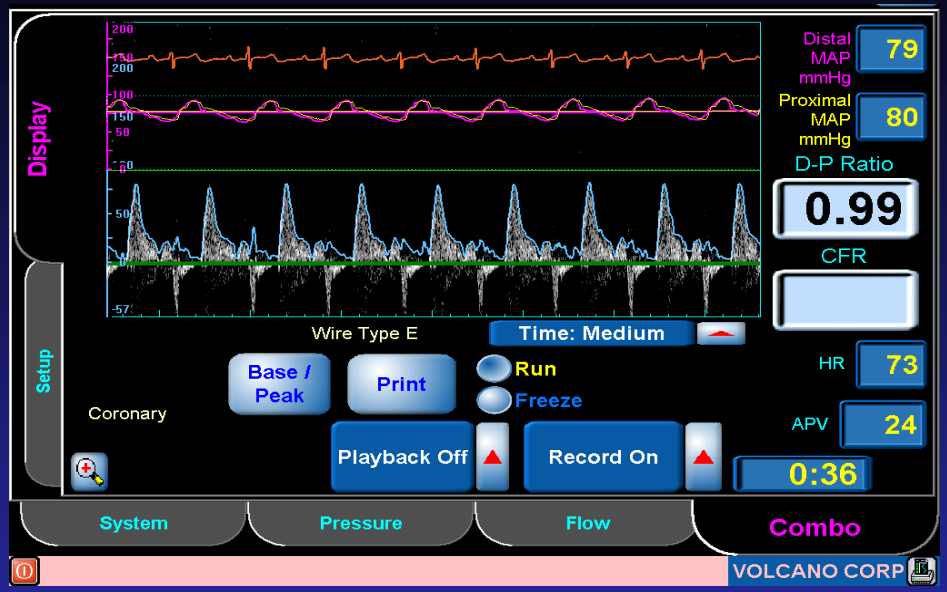
ECG at the time of admission
(64 y.o., male)



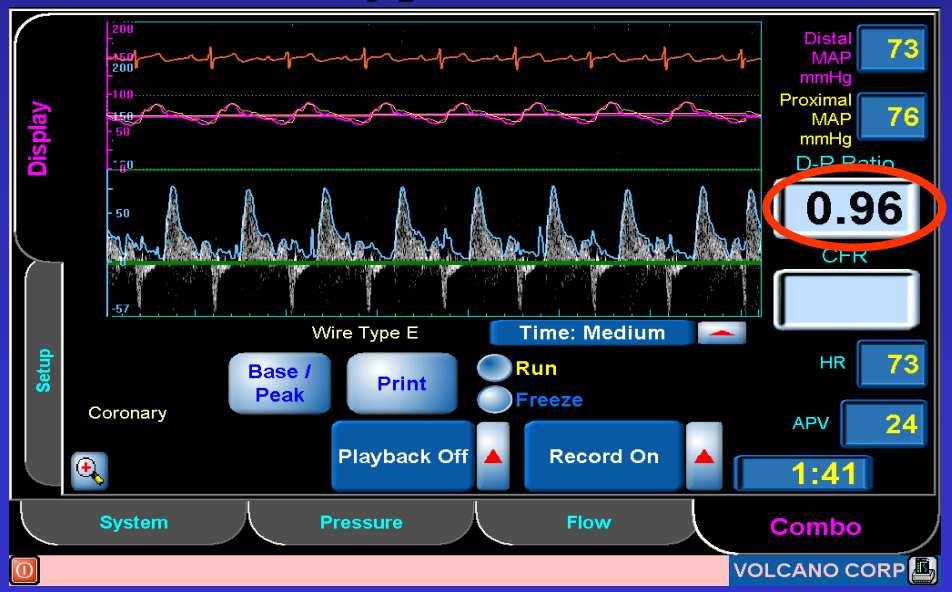
Combowire



Baseline



Hyperemia



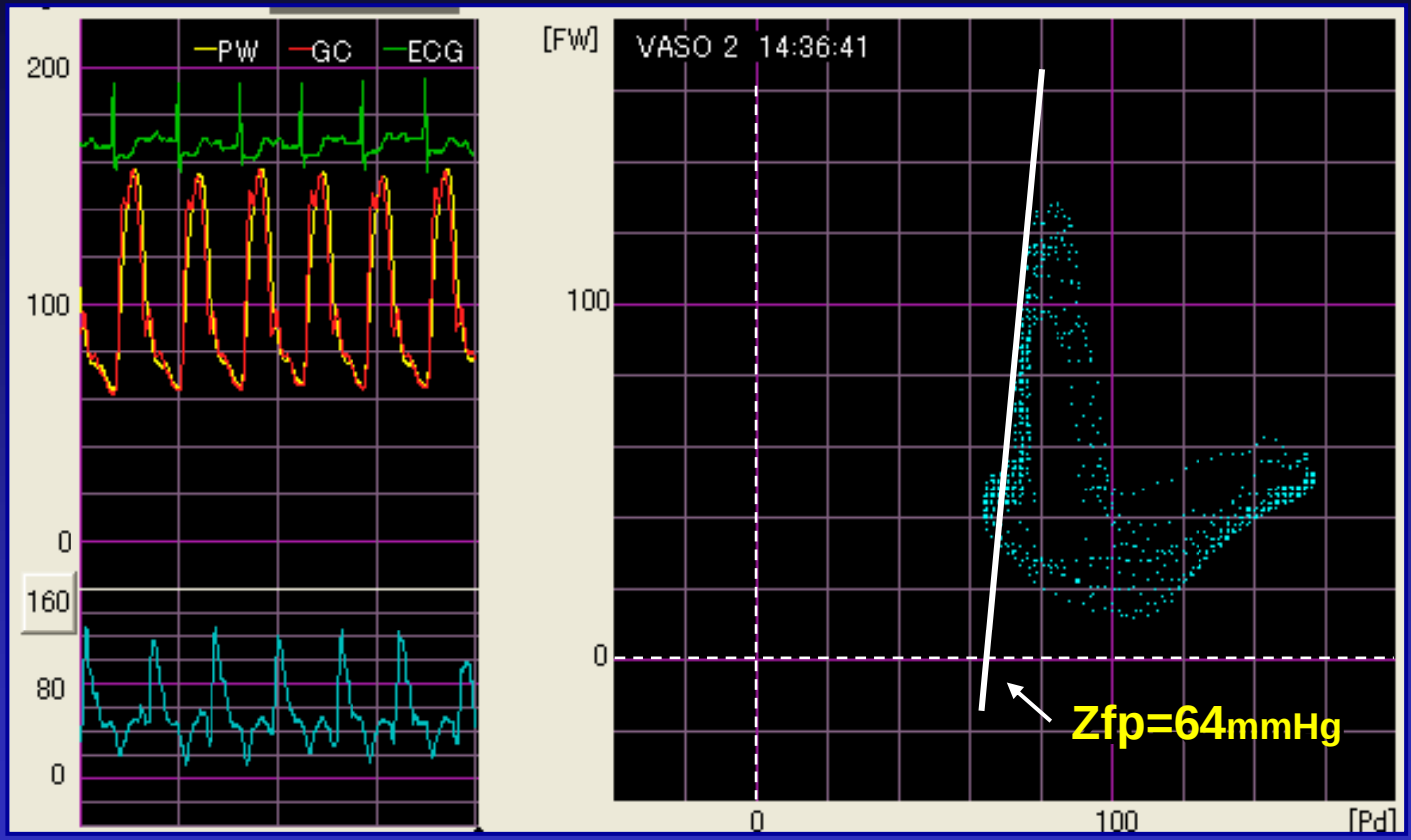
h-MVr = h-Pd / h-APV

= 73 / 24

= 3.04 (mmHg/cm・sec^{-1})

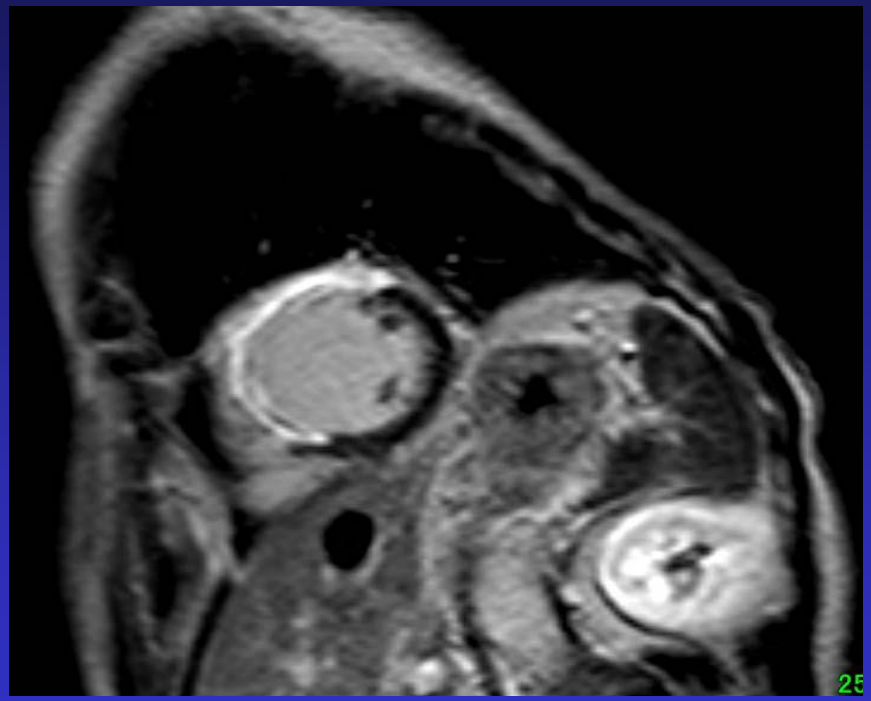
Wakayama Medical University

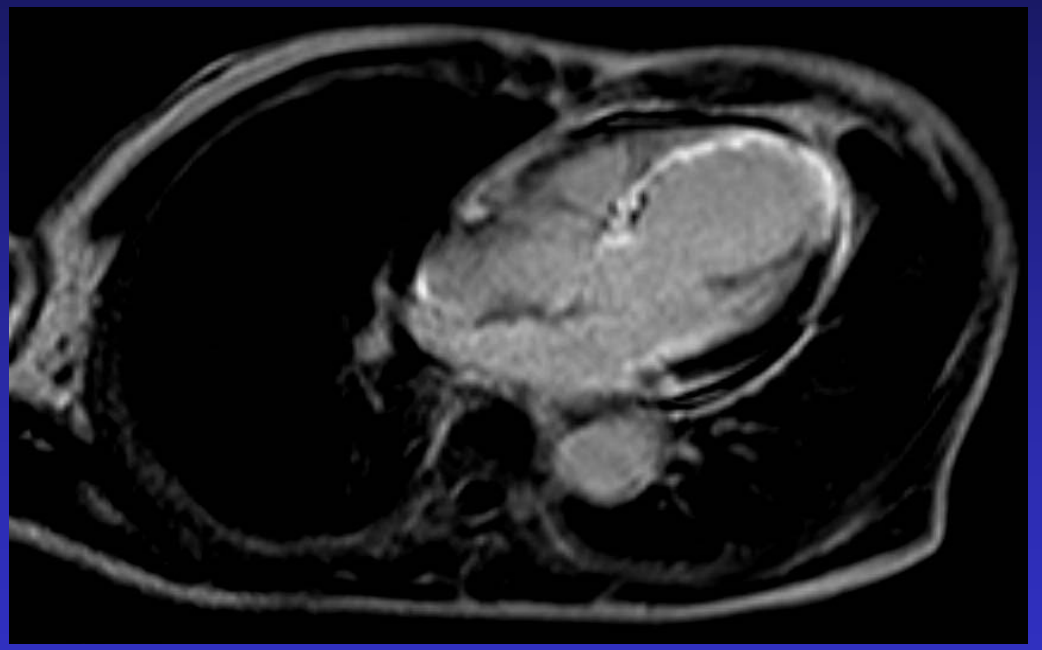
Pressure-flow loop



Coronary microvascular resistance estimated by a novel dual-sensor (pressure and Doppler velocity) guidewire reflects myocardial viability after myocardial infarction

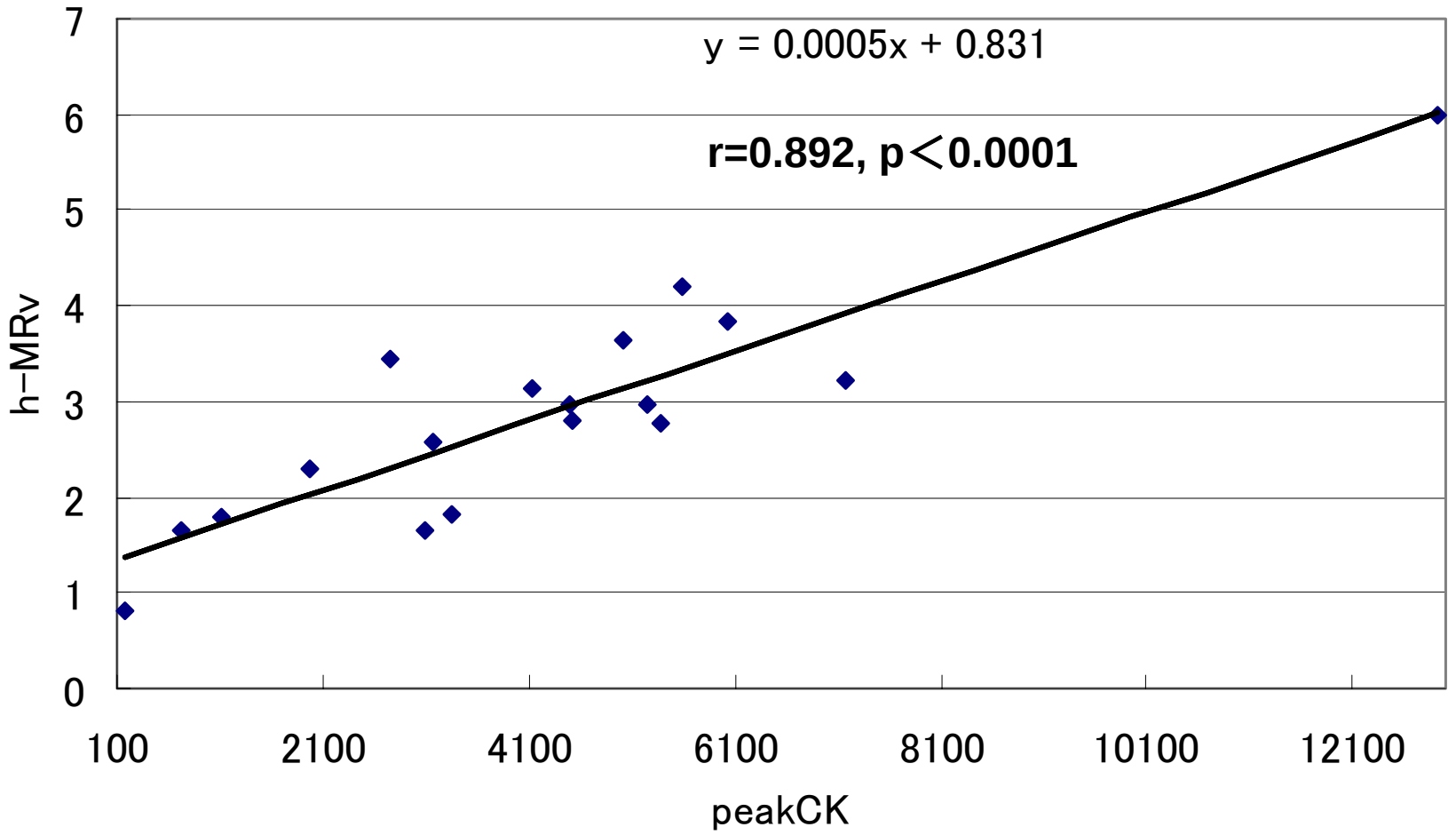
Contrast-enhanced MRI (two weeks after primary PCI)



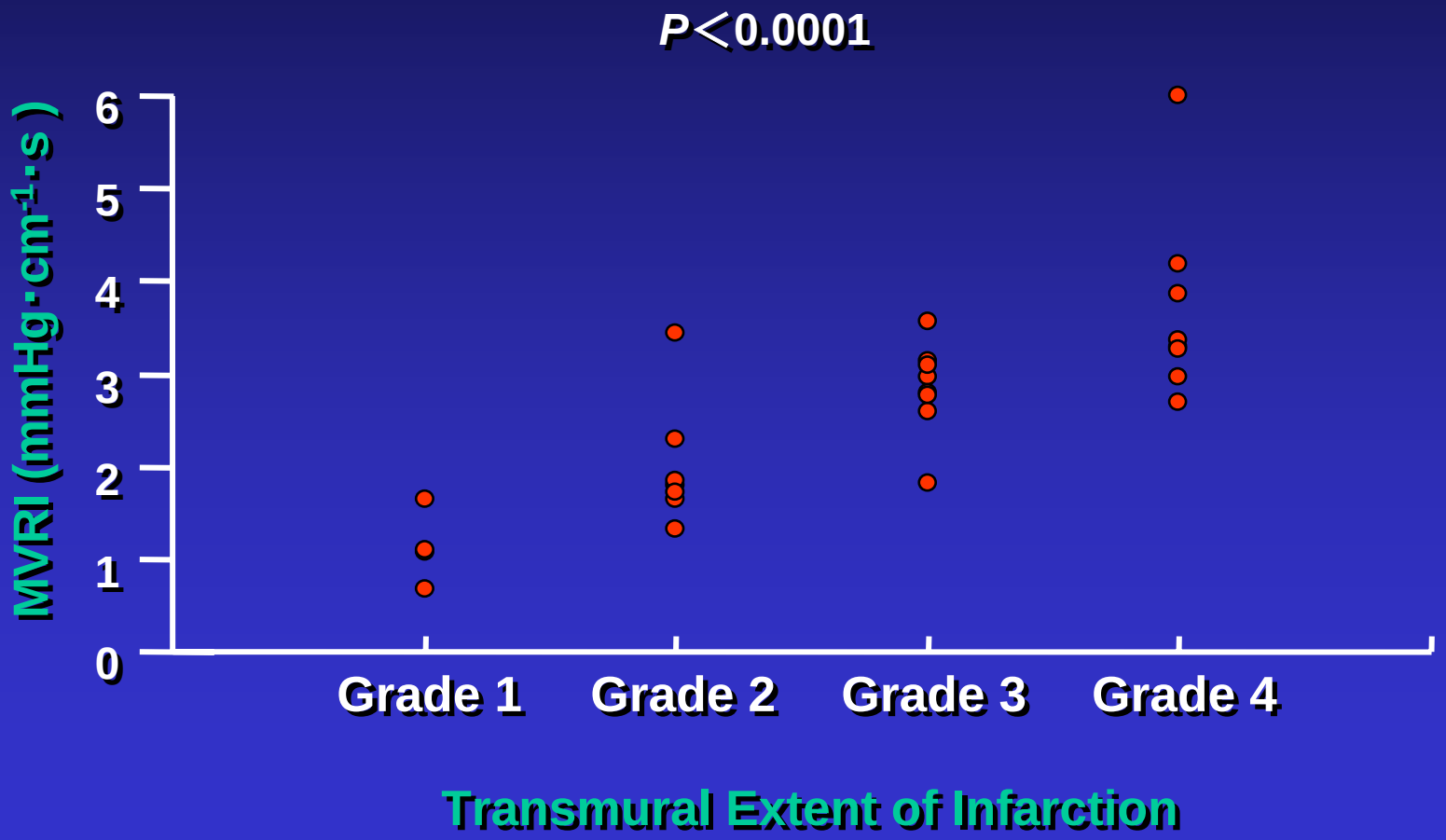


Transmural extent of hyperenhancement Grade 4, peak CK 7182 → transmural MI

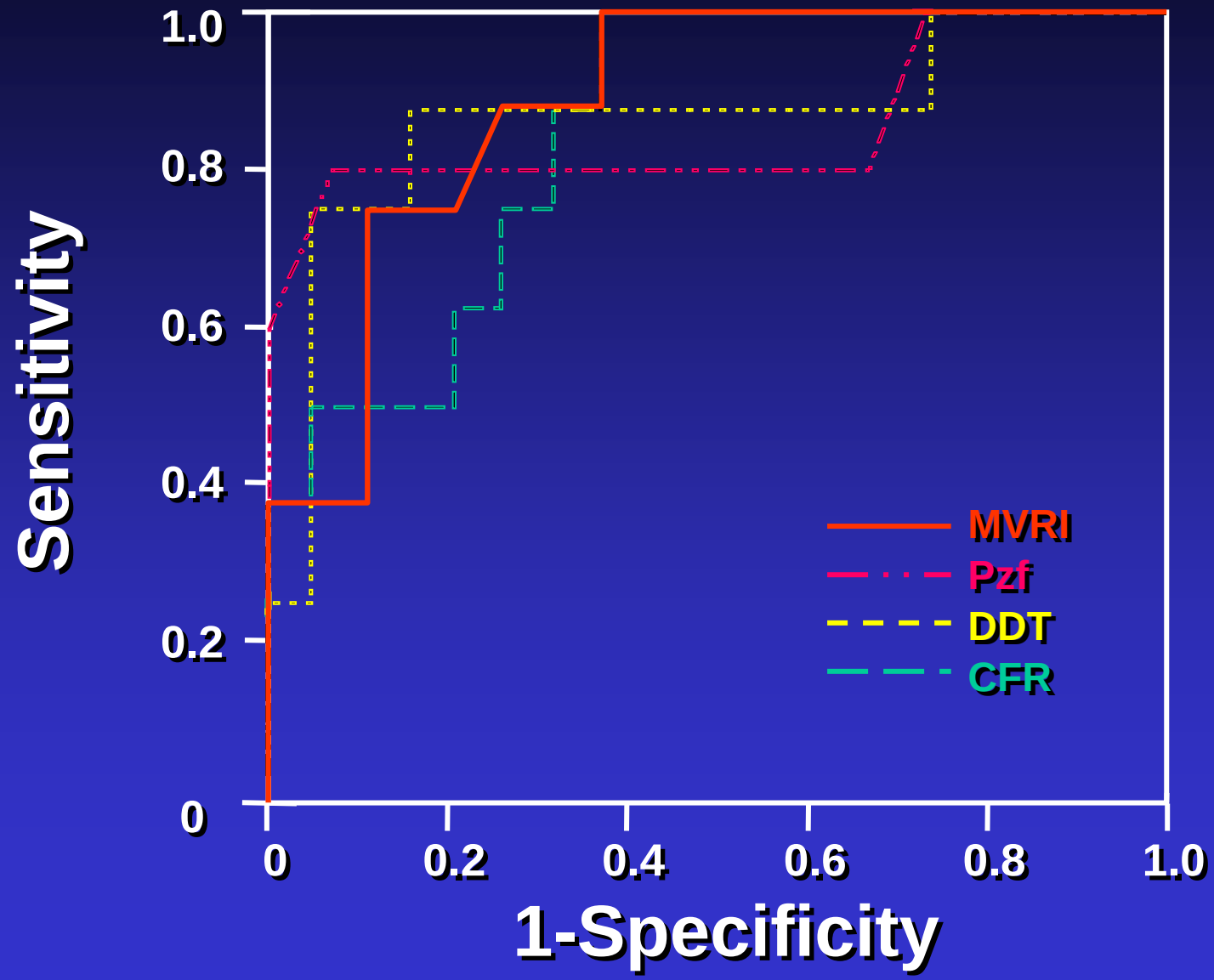
Relationship between hyperemic microvascular resistance and peak CK



Relationship between hyperemic microvascular resistance and transmural extent of MI by de-MRI



ROC curve in each index



Summary

1. The condition of coronary microcirculation is an important determinant of myocardial viability and clinical outcomes in AMI.

2. There would be some indexes to speculate micro-circulation condition such as CFR, DDT, Pzf and microvascular resistance index.

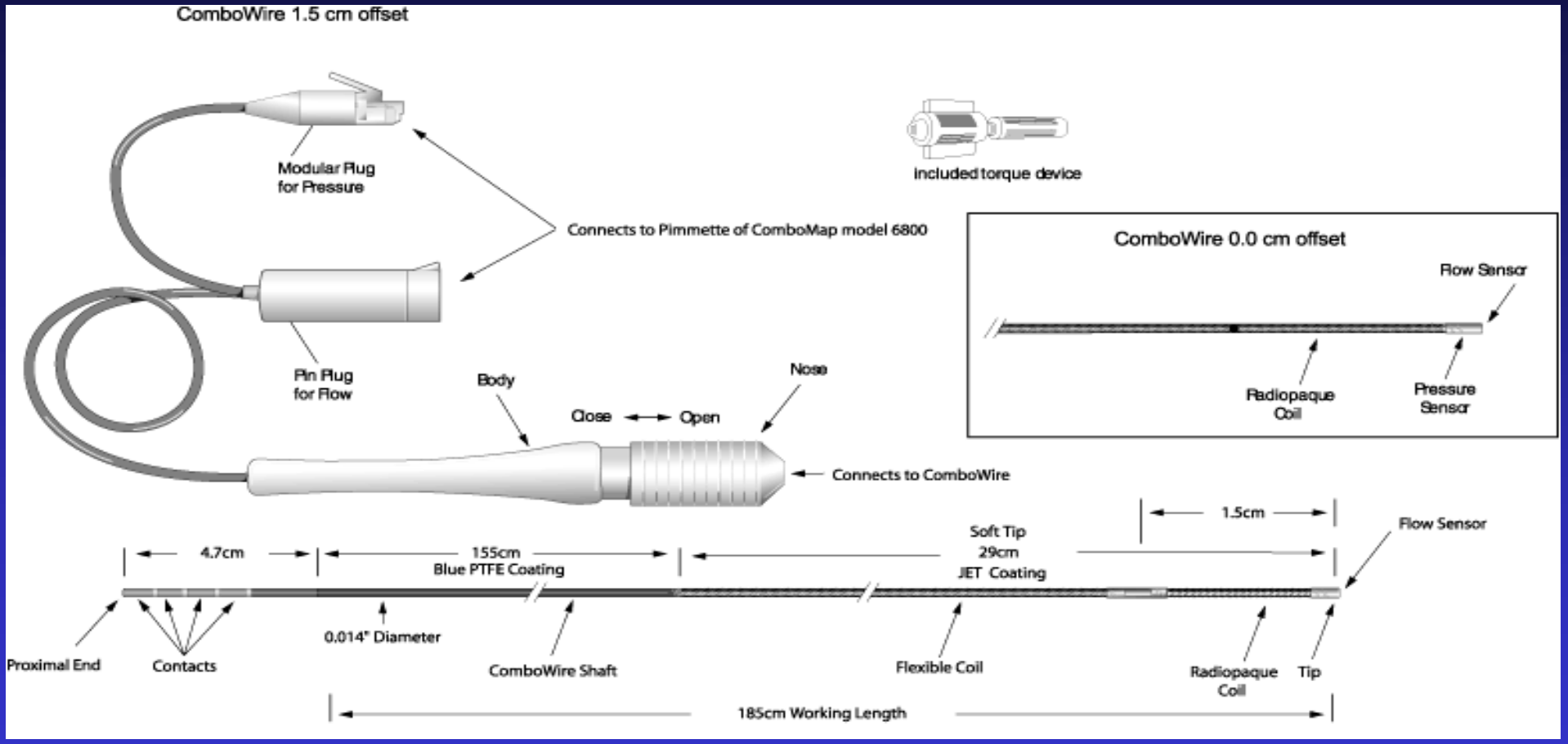
3. A 0.014-inch dual-sensor (pressure and Doppler velocity) guidewire (Combowire™)may allow us to estimate these indexes at the same time.

Conclusion

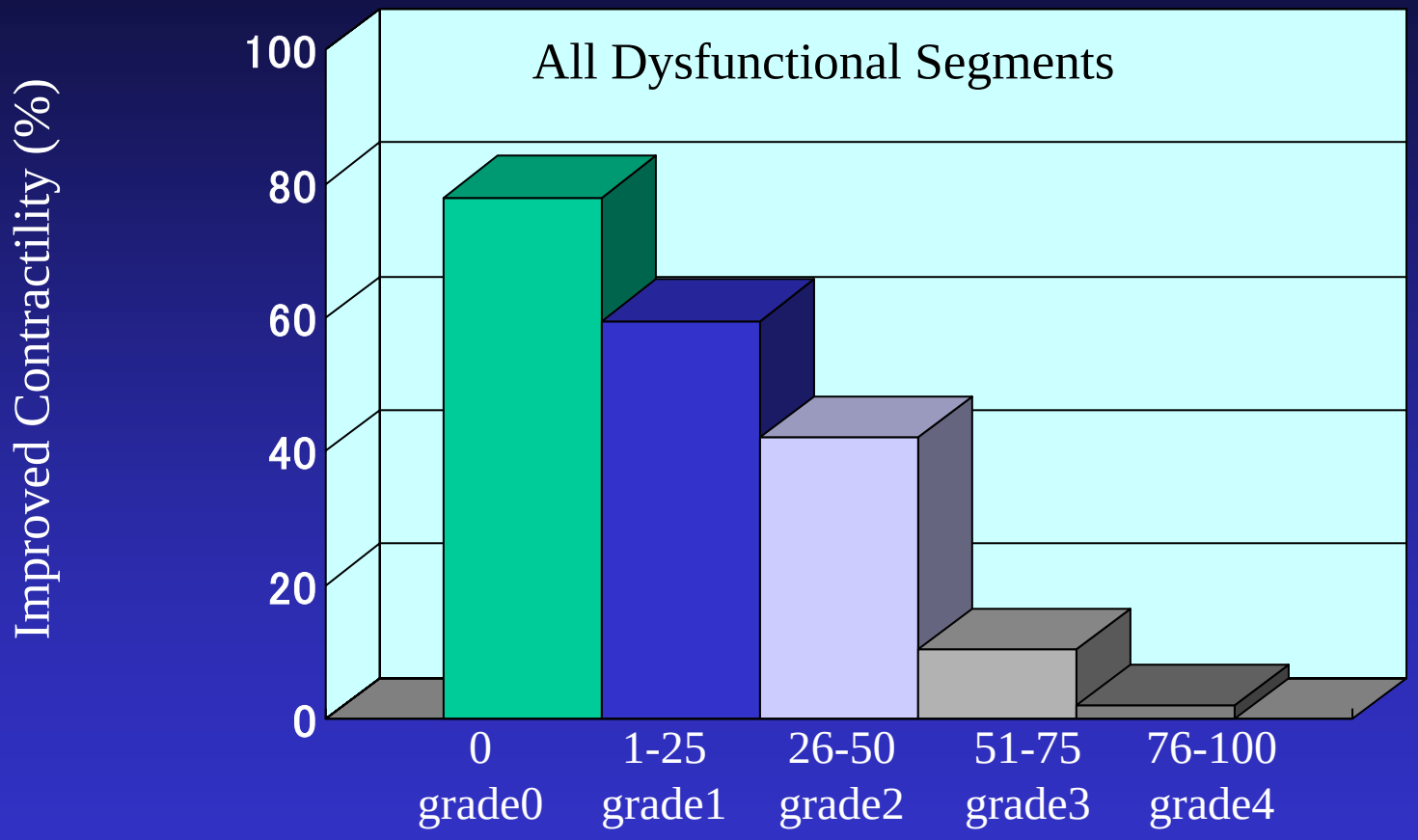
Within the indexes to speculate micro-circulation condition such as CFR, DDT, Pzf and microvascular resistance index (MVRI), MVRI is the best predictor of the LV functional recovery.

Relationship between hyperemic microvascular resistance and transmural extent of MI by de-MRI

Combowire configuration



Relation between the Transmural Extent of Hyperenhancement before Revasculaization and the Likelihood of Increased Contractility after Revascularization



(Kim RJ, et al; N Eng J Med 2000; 343: 1445-53)

Case 1: 70 y.o., male

Main complaint) chest pain

Coronary risk factor) current smoking

family history of coronary artery disease

P. I.) Feb. 8, 2007 Admission to our hospital with

continuous chest pain lasted > 30 minutes at rest.

ECG: ST segment elavation in aVL, V1-5 leads

Echocardiogaraphy: akinesis in the LAD territory

Emergency CAG:

#6: 99% (collateral flow from RCA), #13: 100% (CTO)

Labo. data (emergency room):

WBC 11500, CRP 0.10mg/dl, CK 43IU/l, CK-MB 13IU/l,

GOT 15IU/l, GPT 16IU/l, LDH 215IU/l, TroponinT(-)

Case 2 : 64 y.o., male

Main Complaint) chest pain

Coronary risk factor) current smoking

P.I.) March 11, 2007 Admission to our hospital with aggravating chest pain at rest

ECG: QS pattern in V1-4 leads, abnomal Q in aV_L

ST segment elavation in I, aV_L, V1-5 leads

Echocardiogaraphy: akinesis in the LAD territory

Emergency CAG:

#6: 100% (collateral flow ; none)

Labo. data (emergency room):

WBC 9400, CRP0.60mg/dl, CK 1535IU/l, CK-MB 113IU/l, GOT 155IU/l, GPT 38IU/l, LDH 493IU/l, TroponinT(+)