

Fractional Flow Reserve (FFR)

--Practical Set Up Pressure Measurement --

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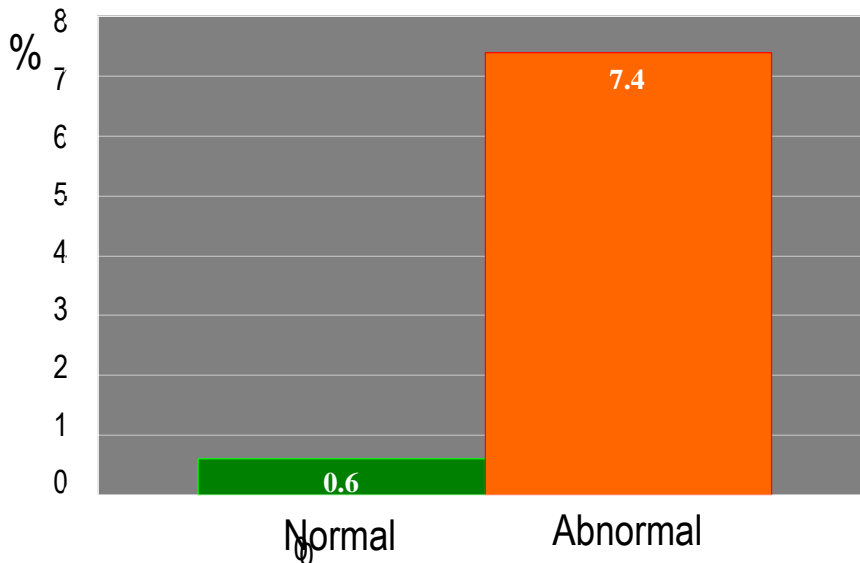


목차

- Fractional Flow Reserve (FFR)이란 무엇인가?
- FFR 결정수치와 임상근거
- PCI 시술과정의 FFR 임상적용
- Pressure wire를 이용한 FFR 측정의 Set-Up
- FFR측정시의 주의사항

관상동맥 중재시술을 하는 이유 : 심근허혈을 완화

- Studies such as Iskander et al. have shown that a person is significantly more likely to die or have a myocardial infarction (M.I.) if they have a lesion causing inducible ischemia compared to one that does not.
- Therefore it is essential to differentiate between both types of lesions.

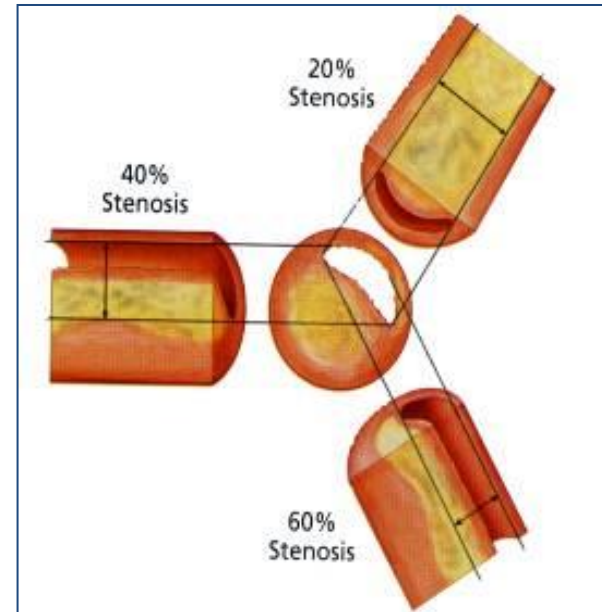
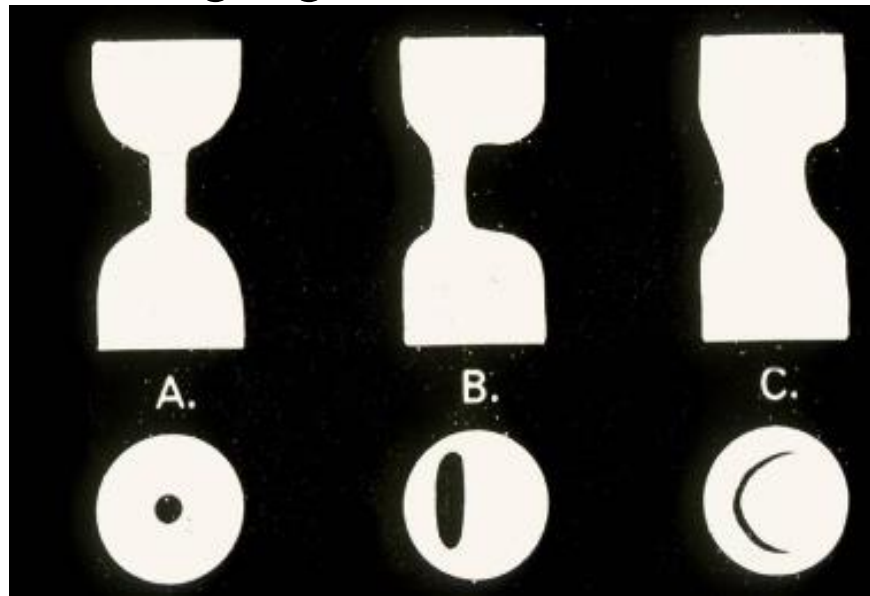


Average Annual Hard Events
(Death or MI) in > 12000 Patients

Iskander S, Iskandrian A E JACC 1998

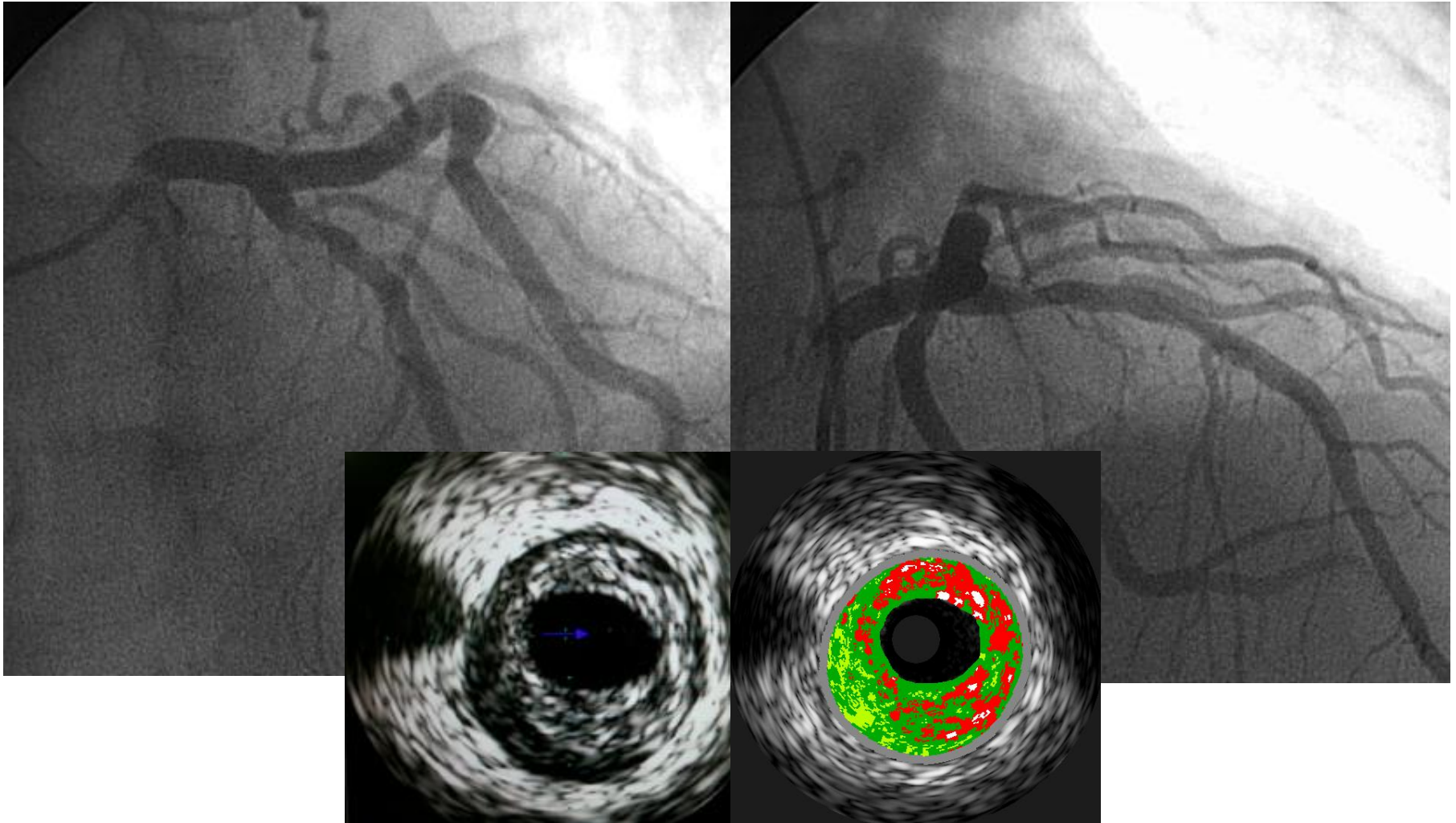
관상동맥 조영술의 한계

- 2-D angiograms facts



In a study of patients with LMCA stenoses (n=51), 4 experienced cardiologists achieved correct lesion classification **no more than 50% of the time** using angio when comparing to FFR as the gold standard.

CASE #M/62, acute resting chest pain



Fractional Flow Reserve_{myo} (심근분획혈류 예비력)

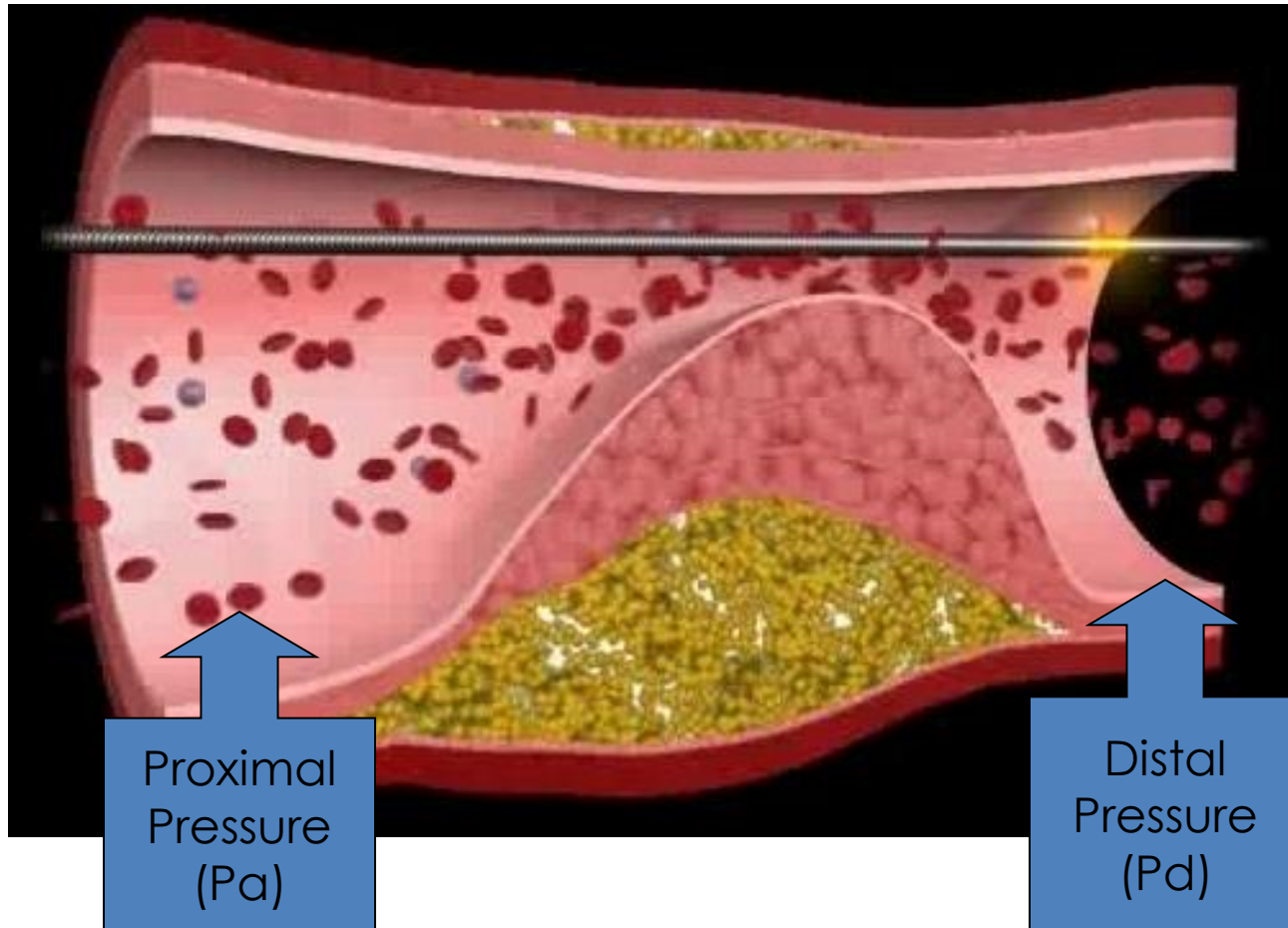
FFR_{myo}

Max. myocardial blood flow
In the presence of a stenosis

Normal maximum blood flow

* Maximum blood flow achieved by inducing hyperemia in the patient *

FFR 측정



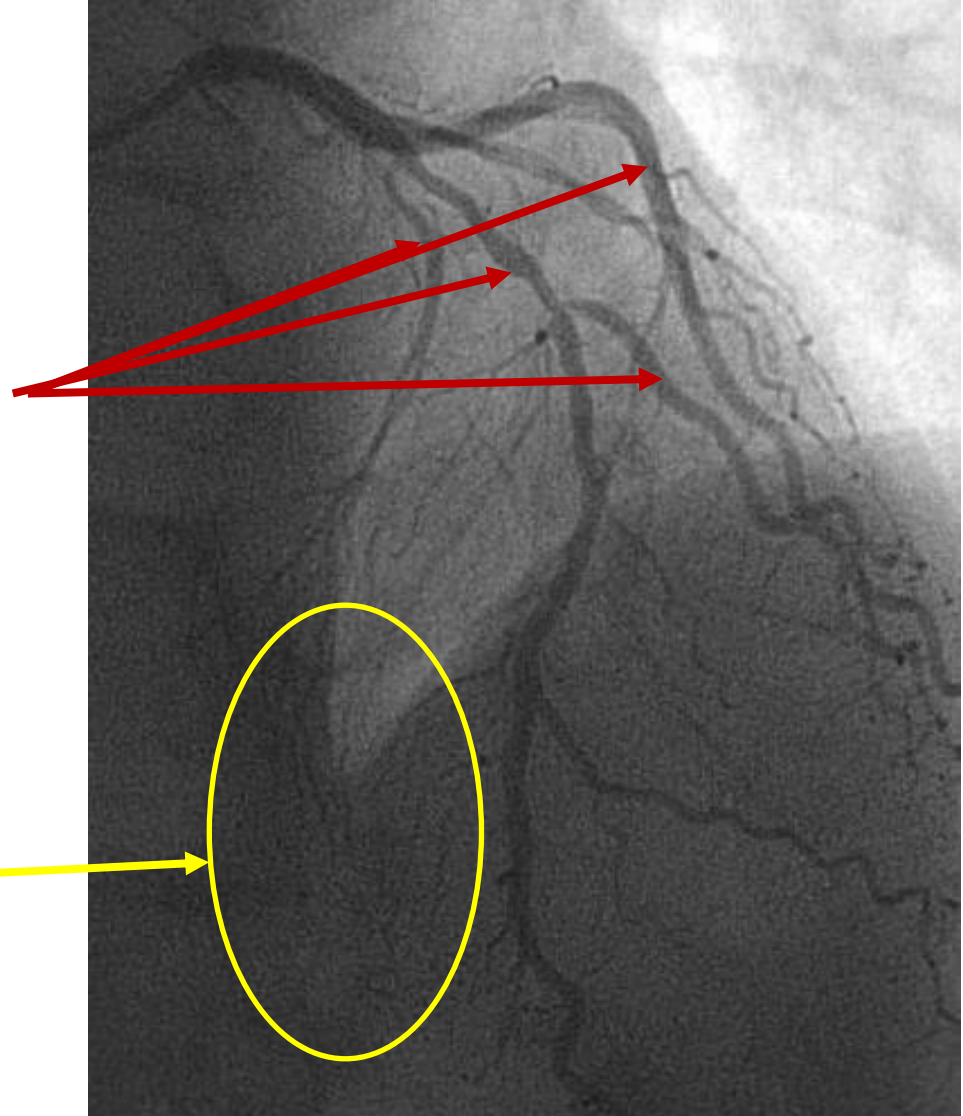
****A hyperemic agent is administered IV or IC to induce hyperemia in the patient****

FFR 이란 무엇인가?

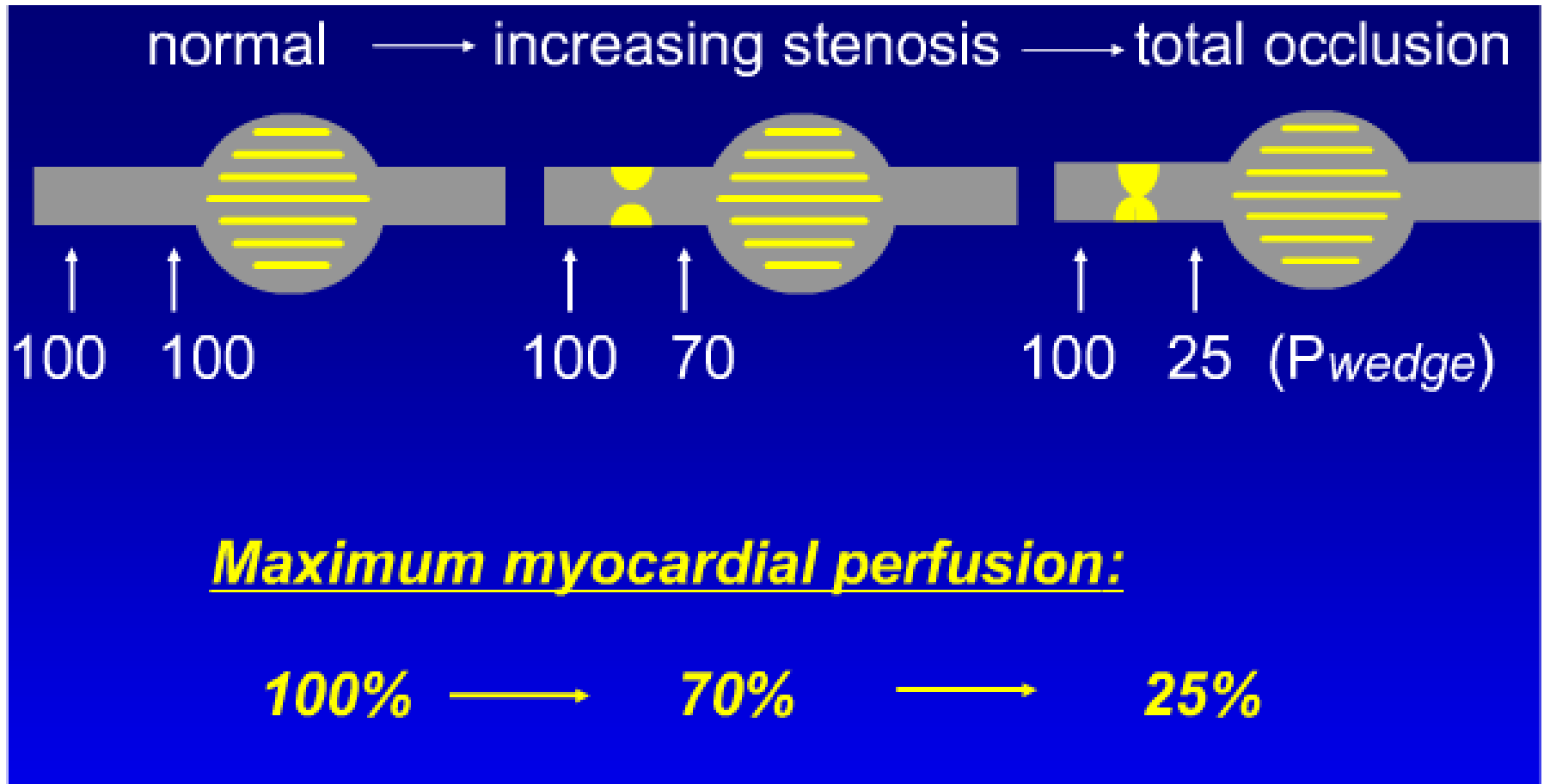
관상동맥의 해부학적 생리학적특성

>400 μ m
Conduit Vessels
= Epicardial coronary
arteries

<400 μ m
Resistive vessels
=arterioles &
capillaries



심근혈류량은 혈관내 관류압력에 비례



(Reactive) Hyperemia 심근충혈

- Concept
 - Minimize vascular resistance of the resistive vasculature
- Inducer
 - Ischemia: most potent
 - Adenosine, ATP, papaverine etc.
 - Increase 4-6 folds blood flow

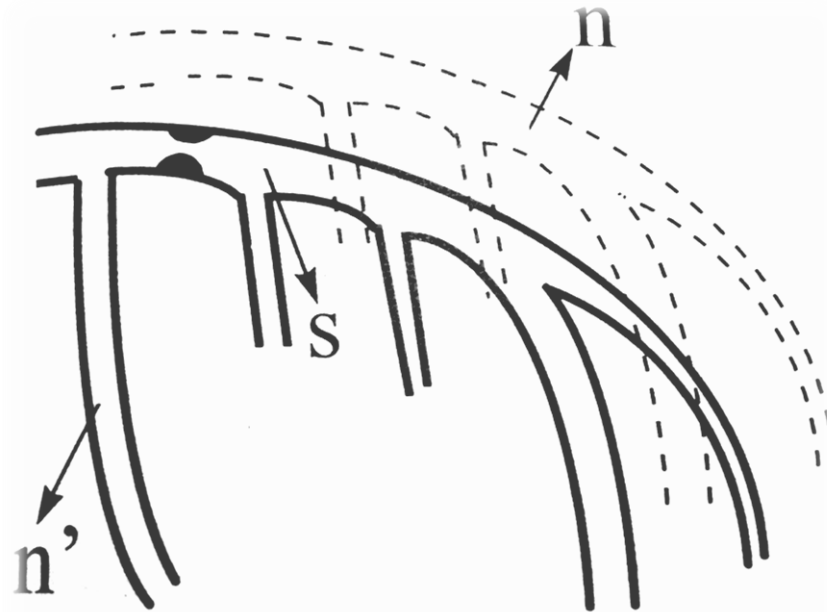
관상동맥 혈류 예비력 (Coronary Flow Reserve)

Absolute vs Relative vs Fractional
flow reserve

$$\frac{QS \max}{QS \text{ rest}}$$

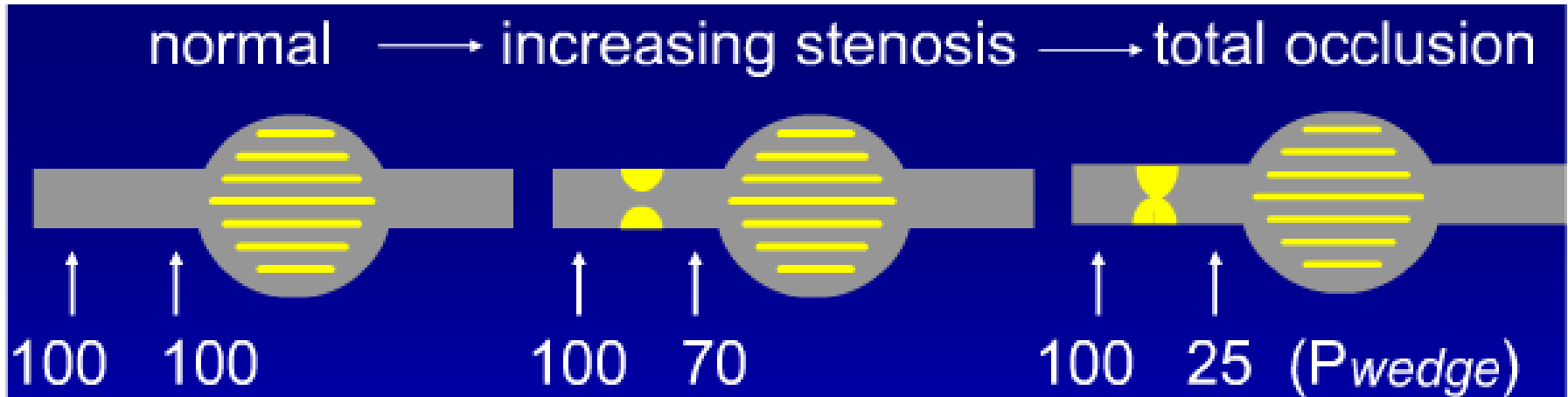
$$\frac{QS \max}{Qn' \max}$$

$$\frac{QS \max}{Qn \max}$$



Courtesy by Pijls NH, De Bruyne B, Coronary Pressure, 2nd edition, Kluwer, 2000

관상동맥 압력차의 비로 심근혈류량 추정



Maximum myocardial perfusion:

100% → 70% → 25%

FFR: 1.0 → 0.7 → 0.25

FFR의 정의

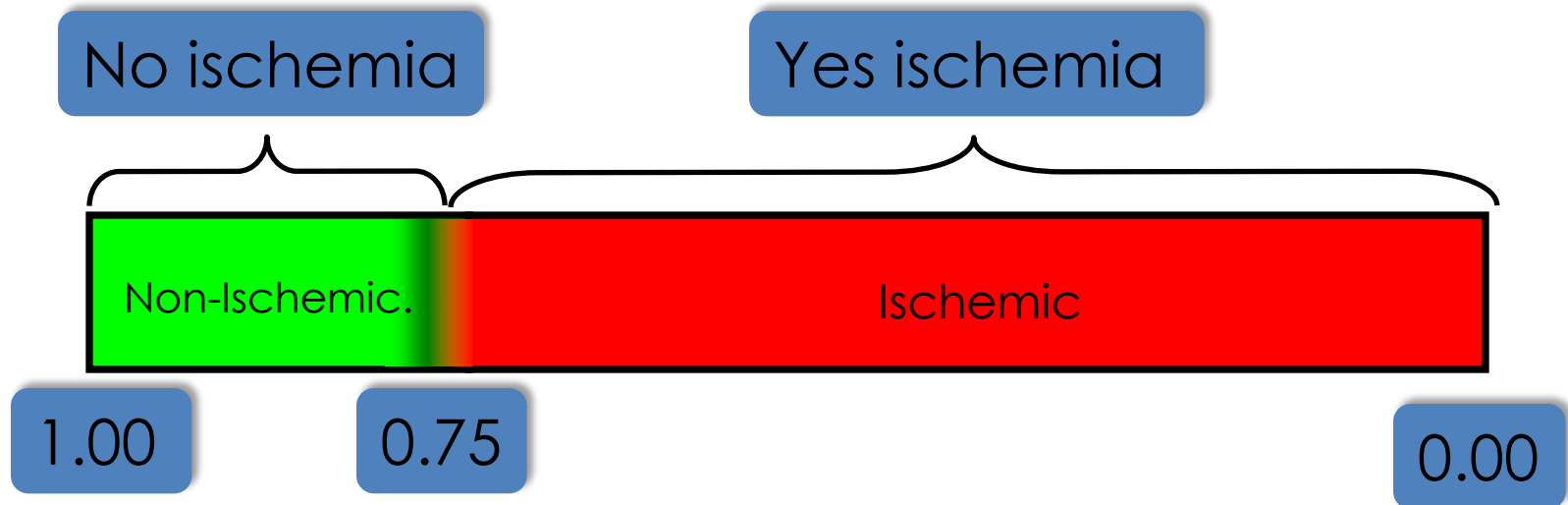
$$FFR_{myo} = \frac{P_d}{P_a}$$

P_a = mean aortic pressure at maximum hyperemia

P_d = mean distal coronary pressure at maximum hyperemia

FFR 결정 수치와 임상근거

FFR 결정수치



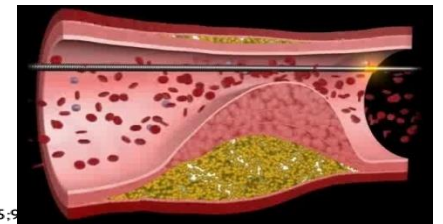
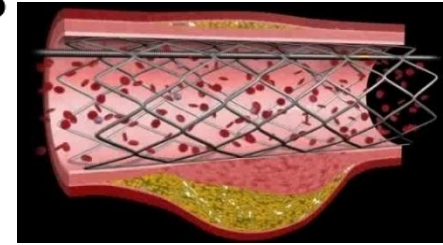
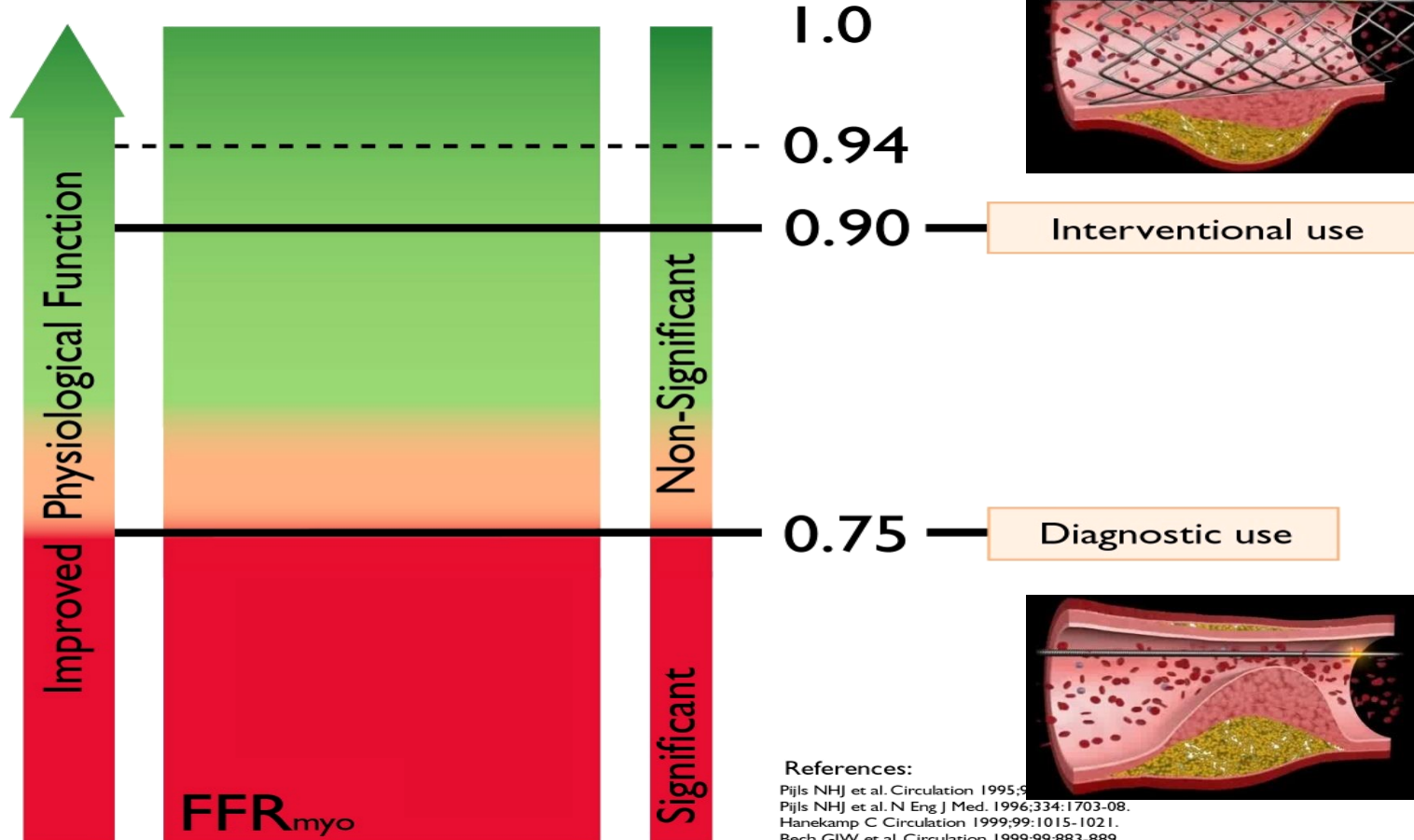
FFR < 0.75 → inducible ischemia (specificity 100 %)

FFR > 0.75 → no inducible ischemia (sensitivity 88 %)

Pijls, De Bruyne et al, NEJM 1996

FFR 결정수치

FFR for decision-making in the cath lab



References:

- Pijls NHJ et al. Circulation 1995;92:1027-34.
- Pijls NHJ et al. N Eng J Med. 1996;334:1703-08.
- Hanekamp C Circulation 1999;99:1015-1021.
- Bech GJW et al. Circulation 1999;99:883-889.
- Pijls NHJ and De Bruyne B. 2000. Coronary Pressure 2nd Edition. Kluwer Academic Publishers

Based on the teaching file of Paul G.Yock MD, Stanford University.

Note: The specificity of this cut-off value is 100% and the sensitivity is 88%.

FFR (myo)수치의 특성

- Lesion specific index
- Independent HR, BP & contractility
- 1.0 normal value for every situation
- Clear cut-off value: 0.75 & 0.90
- Account the collateral flow to myocardial perfusion
- Easy apply: just mean Pa/Pd pressure

FFR 측정의 임상적용

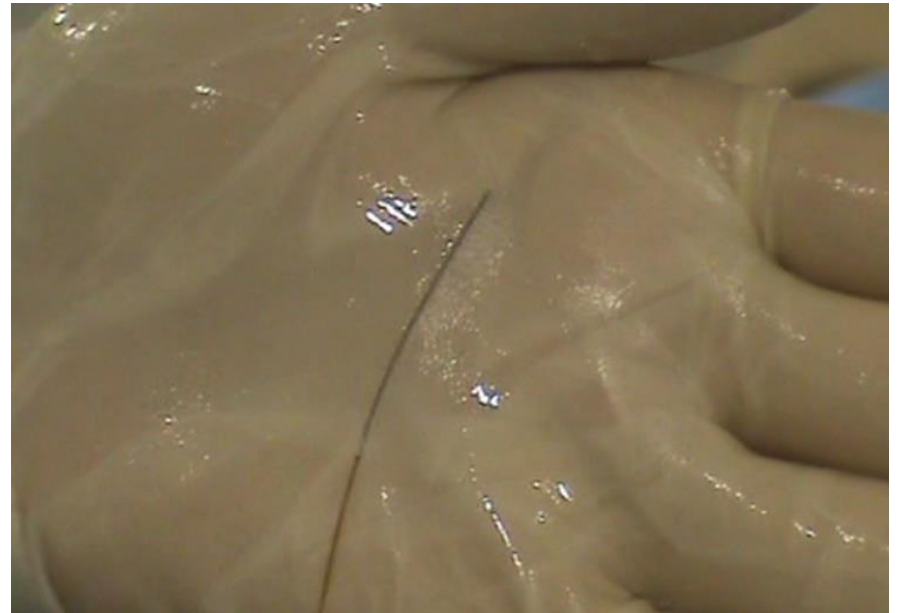
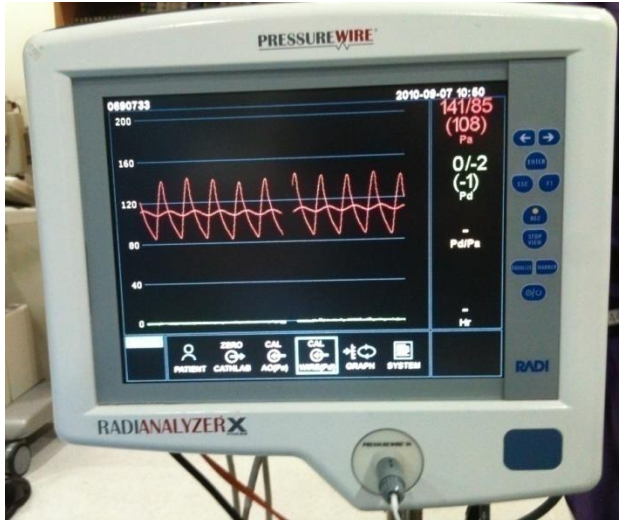
관상동맥 중재시술의 ‘애정남’?

- Single vessel intermediate lesions
- Serial lesions
- Multi-vessel disease
- Bifurcations and jailed side branches
- Left Main disease
- Secondary lesions
- In-stent restenosis

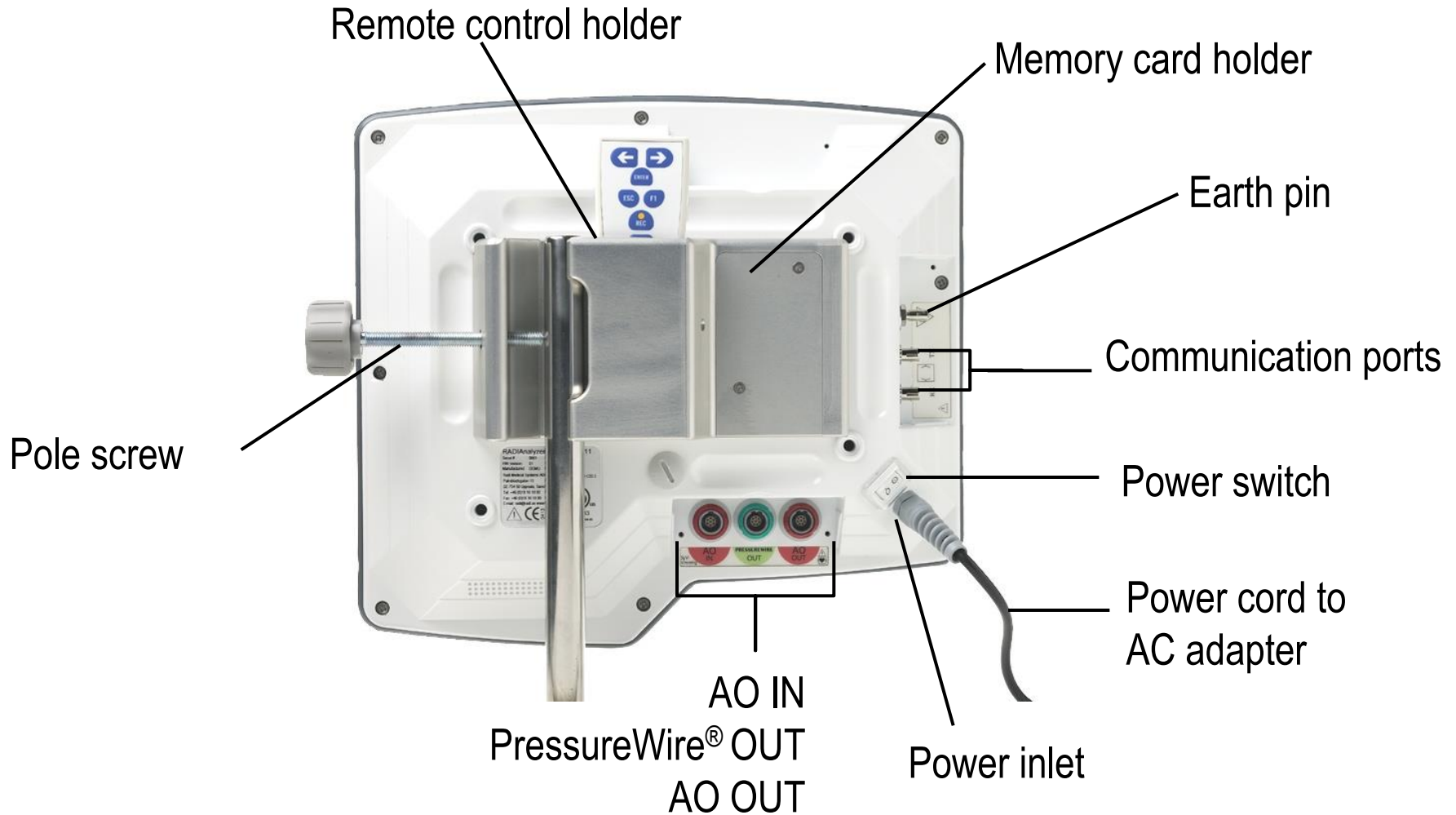
Pressure wire를 이용한 FFR 측정의 Set-Up



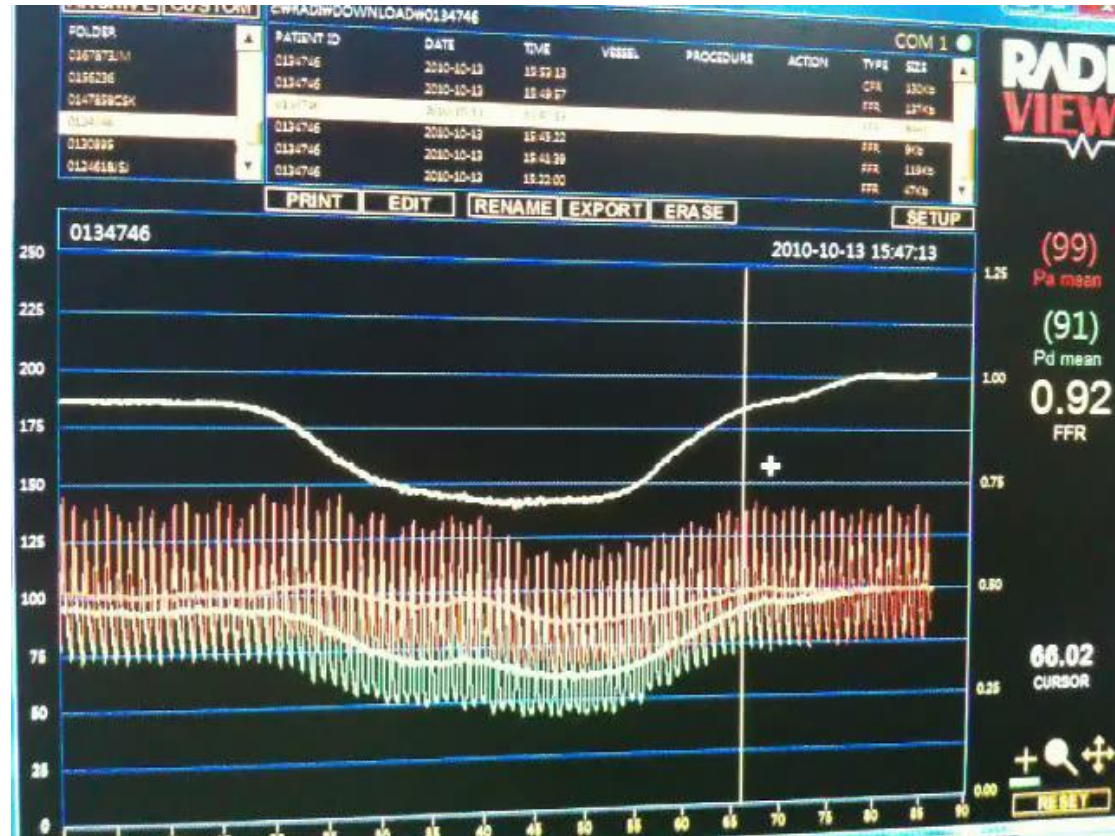
FFR 측정장비



RADI™ Analyzer



RADI View™ 2.2 Software



FFR 측정의 실제

- Step 1 Pressure wire and analyzer setting



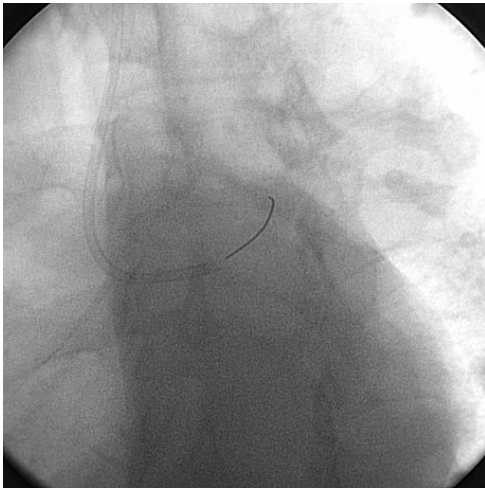
영점보정

- Step-by-step startup guide

<p>1. ZERO 2. AO 3. WIRE</p>	<p>ZERO CATHLAB CHANNELS NOW, THEN PRESS ENTER</p> <p>Test AO 200 mmHg OK Test WIRE 200 mmHg</p>	
<p>1. ZERO 2. AO 3. WIRE</p>	<p>OPEN AO TRANSDUCER TO AIR AND PRESS ENTER</p> <p>CAL</p>	
<p>1. ZERO 2. AO 3. WIRE</p>	<p>FLUSH WIRE COIL, PLACE FLAT AND PRESS ENTER</p> <p>CAL</p>	
<p>MAIN VIEW CURSOR</p>	<p>← SAVE & EXIT →</p> <p>LEFT RIGHT</p>	

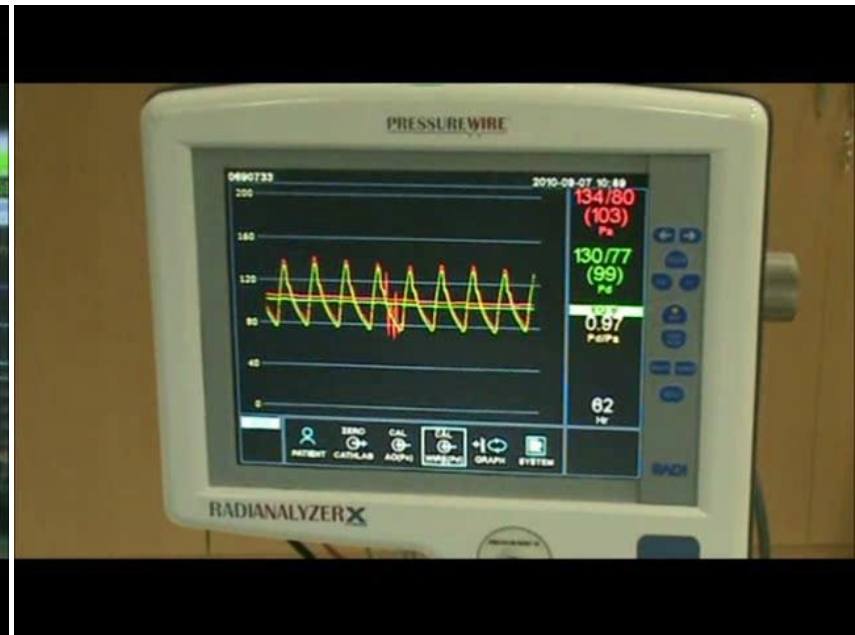
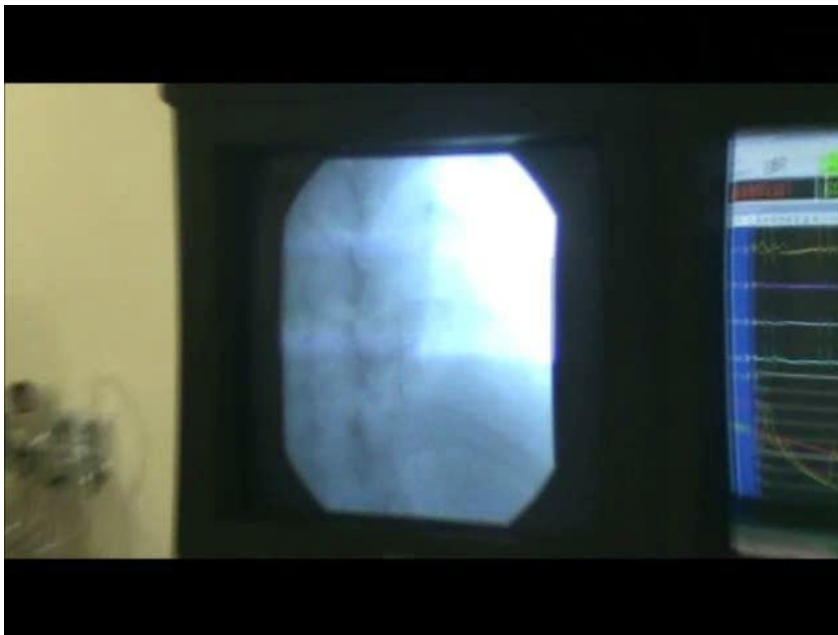
FFR 측정의 실제

- Step 2 Pa/Pd pressure equalization



FFR 측정의 실제

- Step3
Wiring, check baseline pressure gradient and induce hyperemia

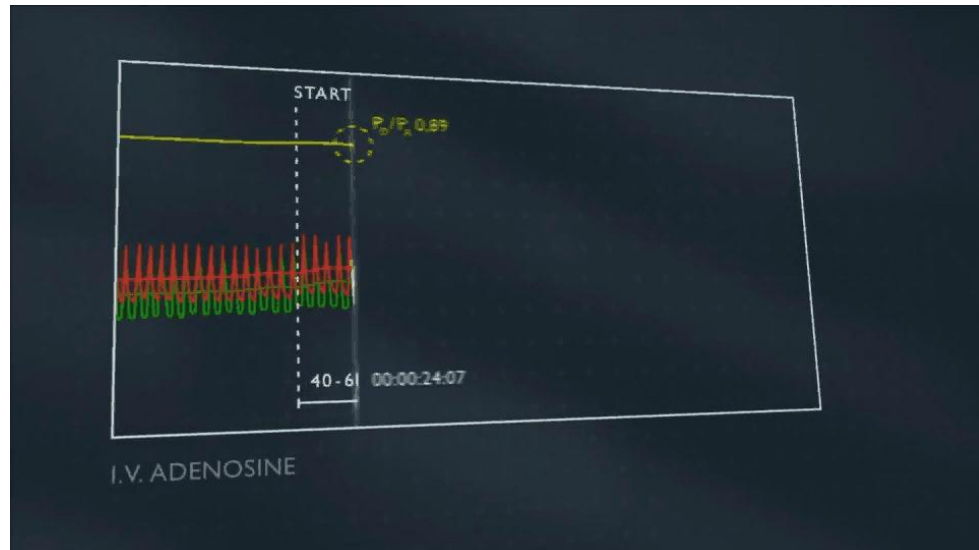


혈류 충혈 유도 (inducing hyperemia)

- Hyperemic stimuli by adenosine
- Route:
IC bolus,
IV infusion,
IC infusion
- Dose:
 - IC bolus: RCA 24-40 μ g,
LCA 40-80 μ g
 - IV infusion: 140 μ g/kg/min
 - IC infusion: 240 μ g/kg/min



아데노신 주입을 이용한 Hyperemia

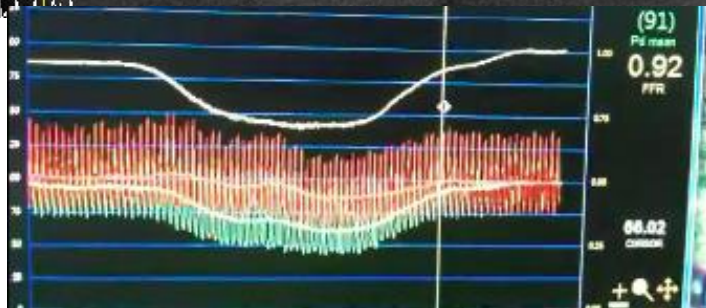
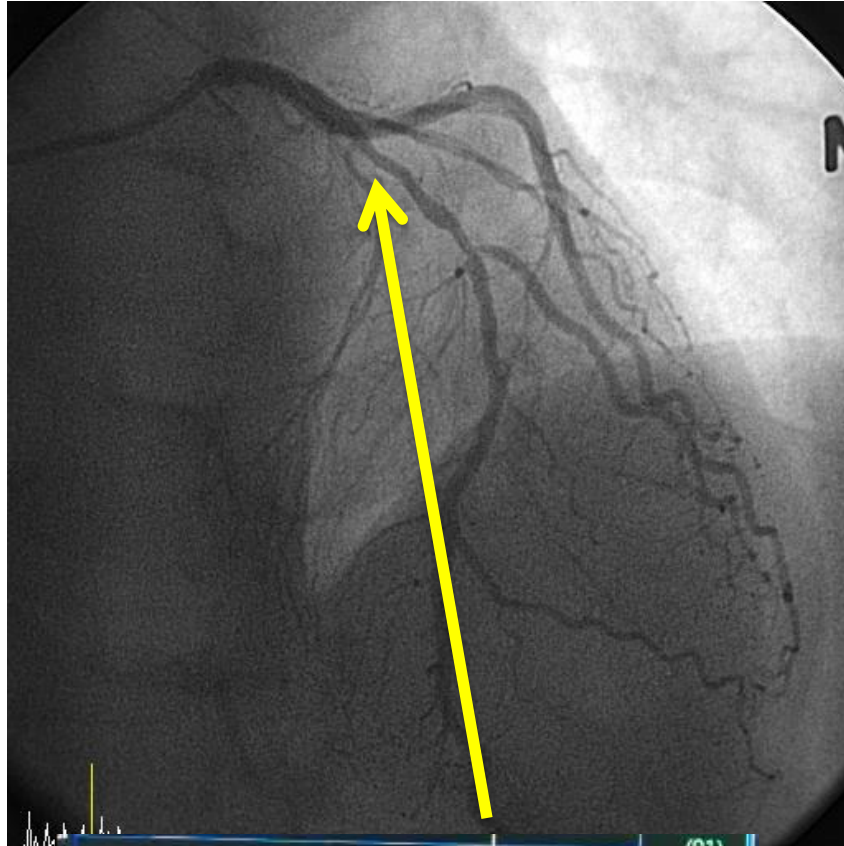


FFR 측정의 실제

- Step 4. check hyperemic FFR

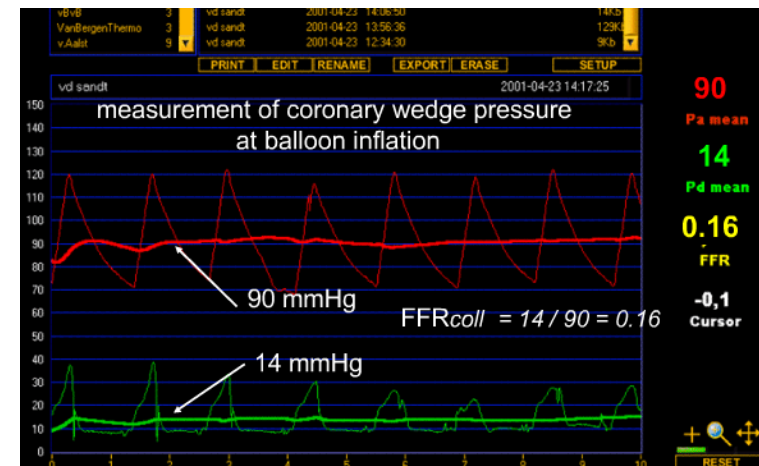


FFR 결과 확인 및 분석



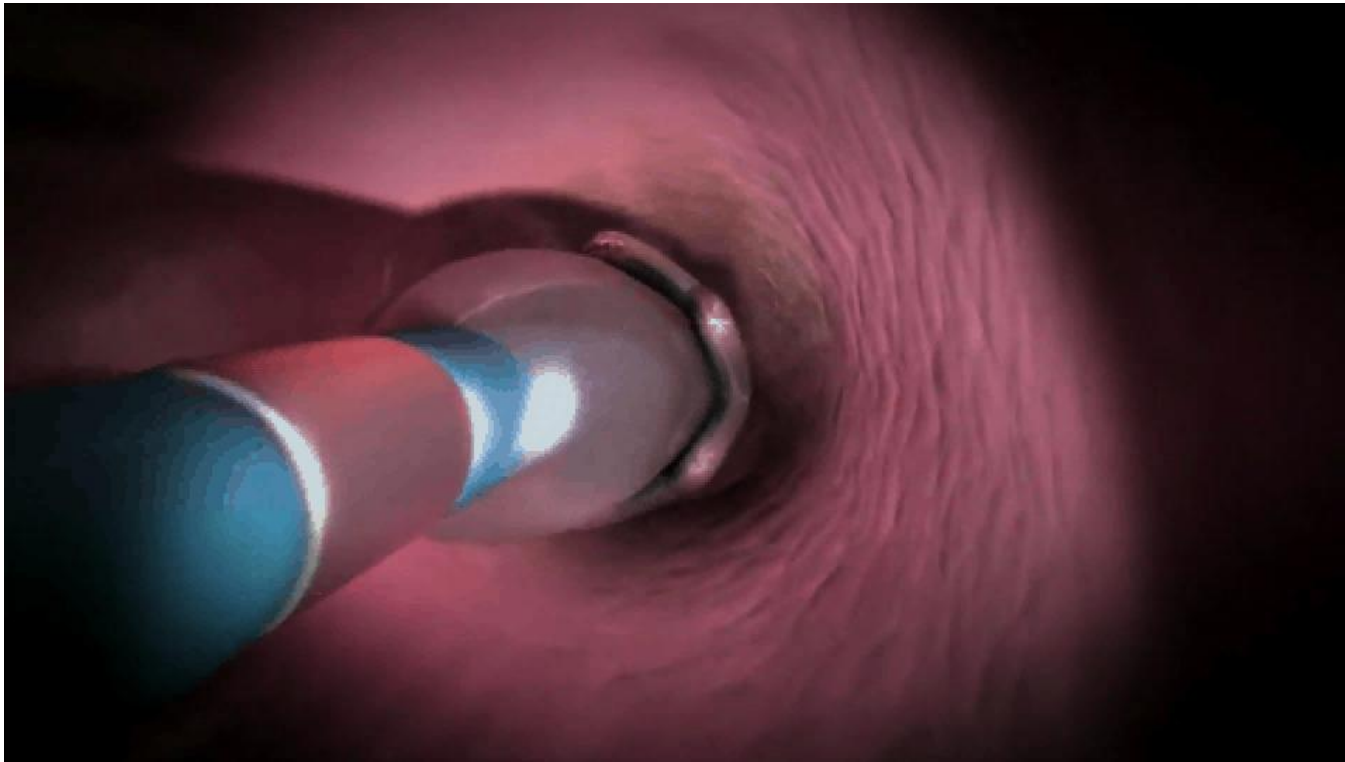
FFR 측정의 실제

- Step 5. check IVUS & perform PCI
- as a primary angioplasty GW
- pressure wire give us additional hemodynamic informations
- coronary wedge pressure, immediate post ballooning & stenting pressure gradient



FFR 측정의 실제

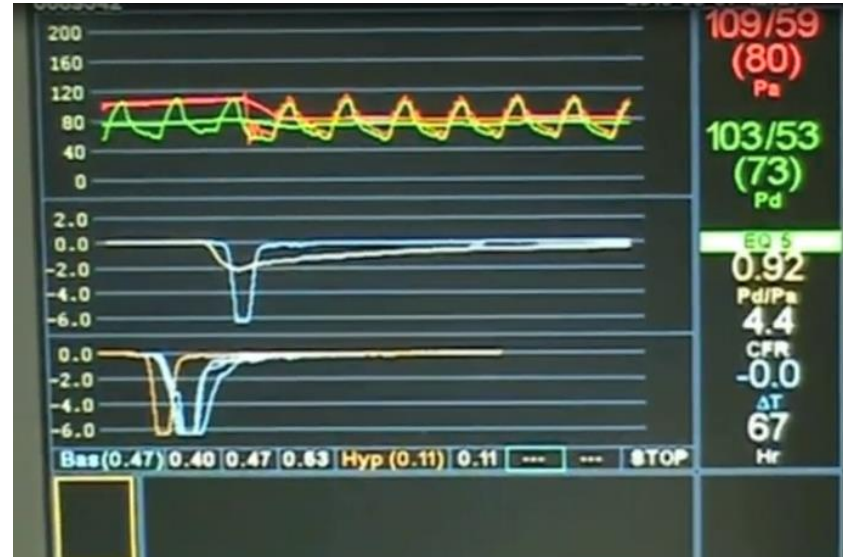
- Step 6
Post stent FFR



CFR/IMR 측정의 실제



CFR/IMR 측정결과



FFR 측정시 주의사항

FFR 측정의 허점 및 문제 해결

- Possible cause of underestimation severity
 - Sub-maximal hyperemia
 - Guiding catheter wedging
 - Other devices in the guiding catheter
 - Pressure signal reversion

→ high FFR value

- Pressure signal drift

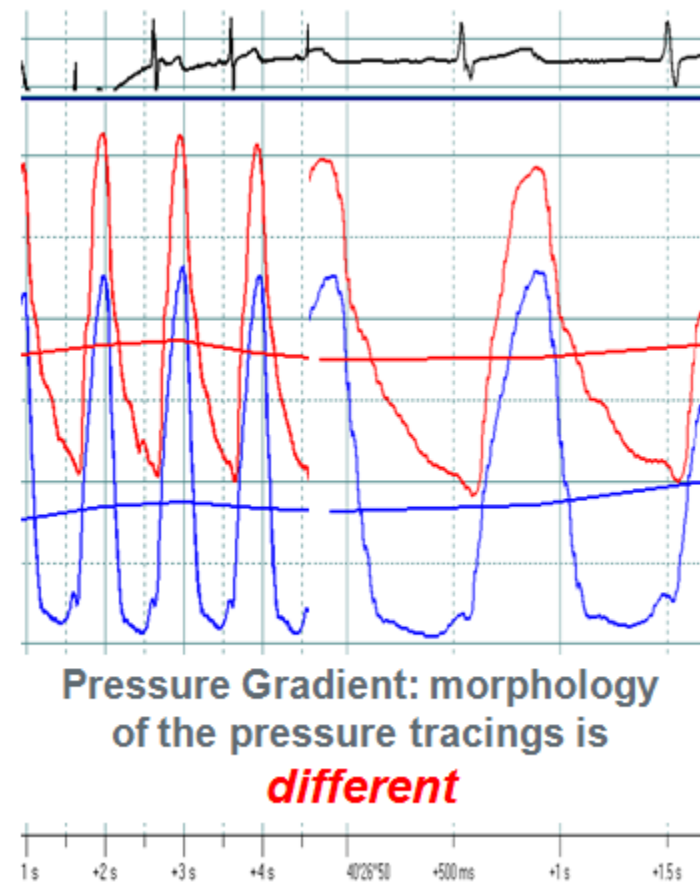
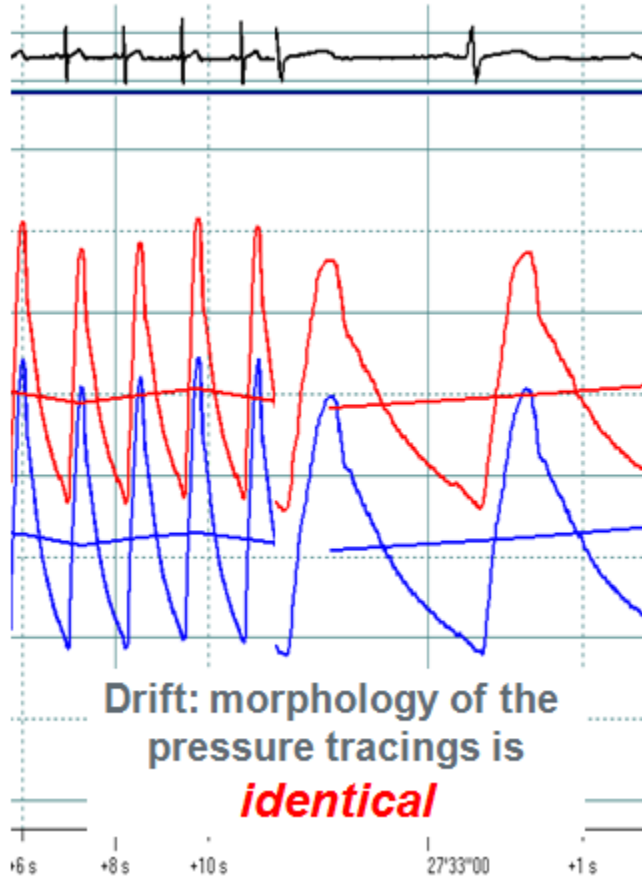
Pressure Signal Drift

- Procedure time after equalization
- Guiding cath damping

To avoid..

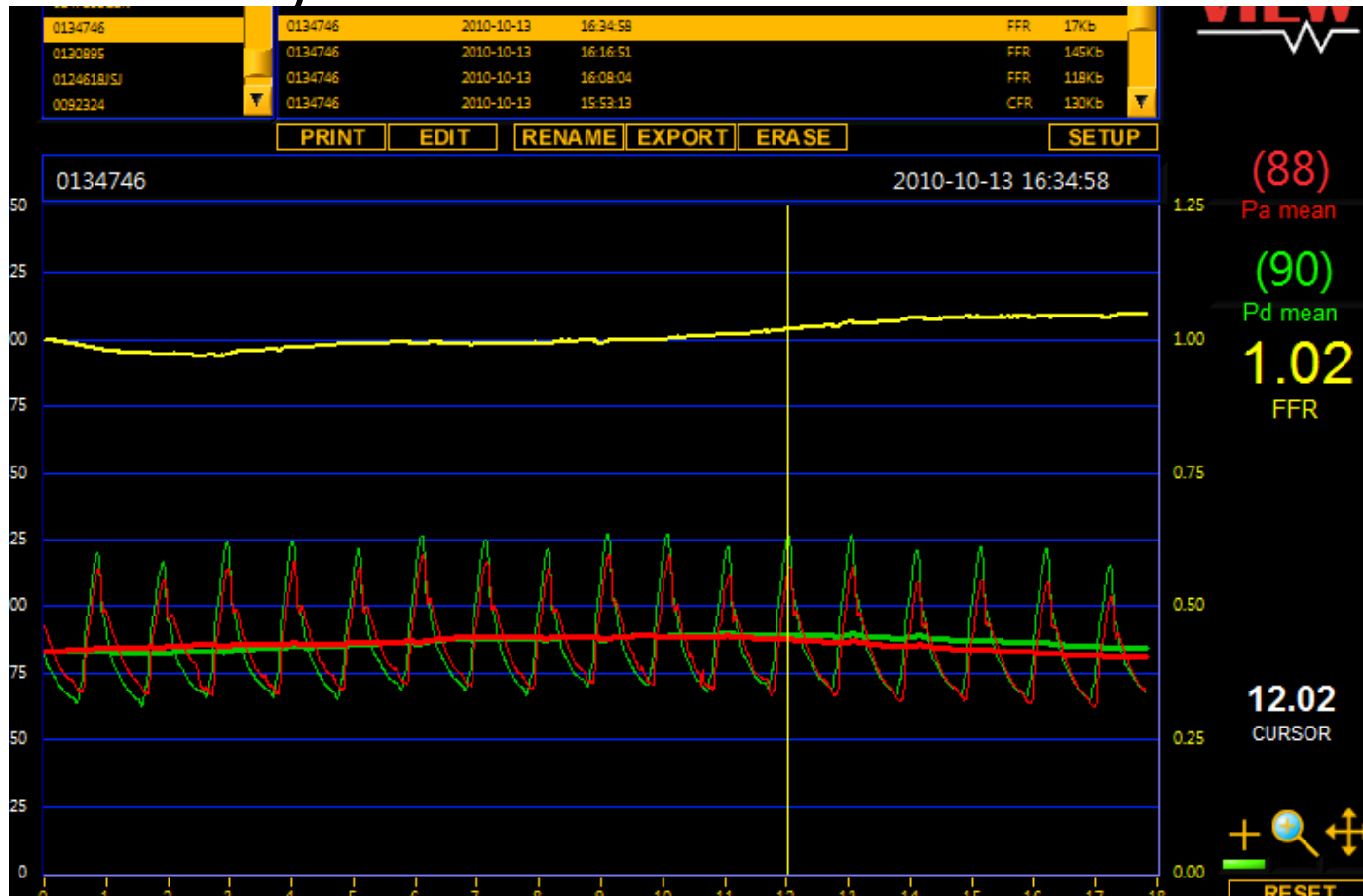
- Keep the eyes both pressure graph pattern
- Equal pressure should be re-confirmed.

Pressure Signal Drift



Pressure Signal Reversion

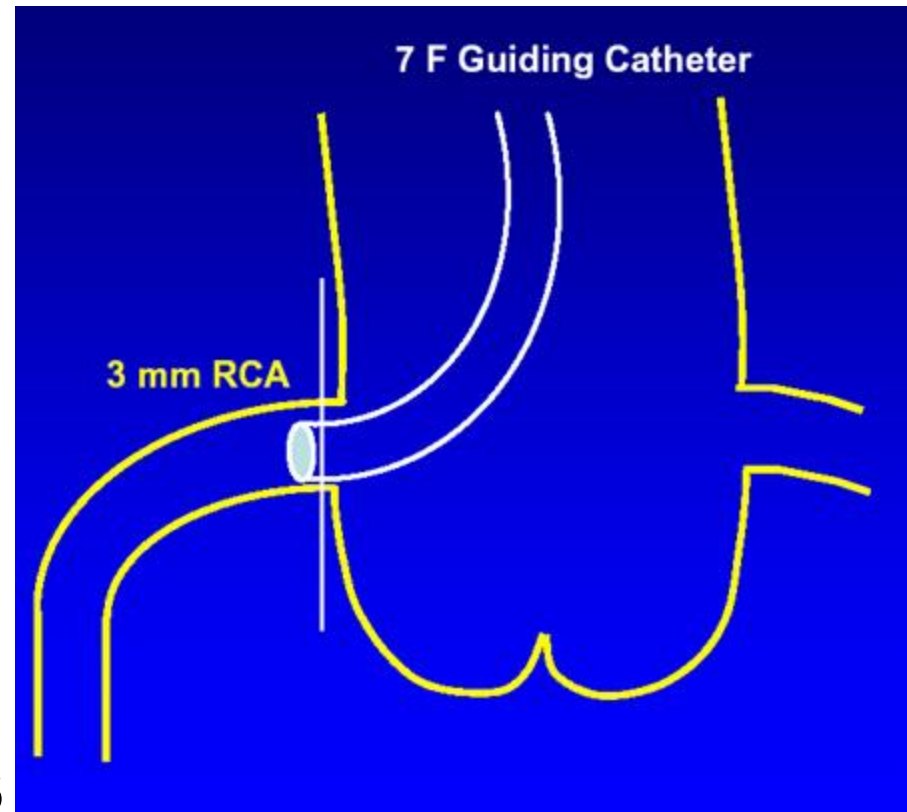
- Affected by lesion location: LCX & RCA



Possible Device Related Problems Compromising Pressure Measurement

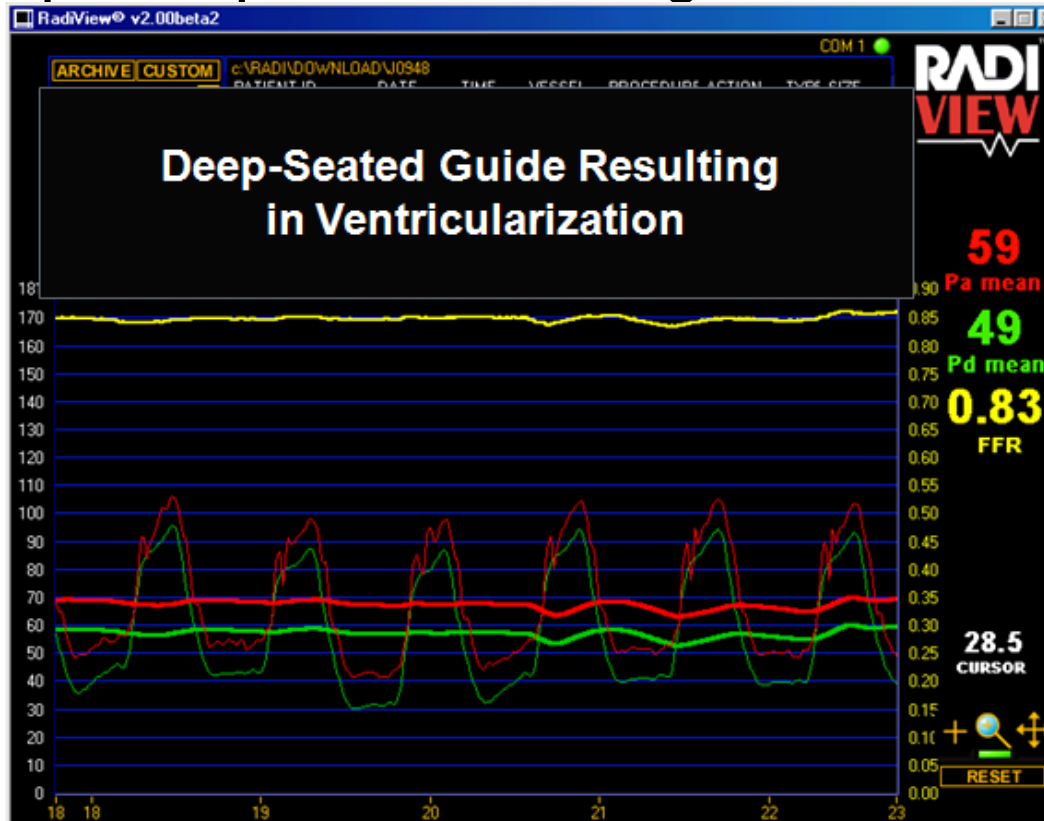
- Guiding catheter
- Guidewire Introducer
- Balloon catheter
- Micro-catheter
- Guidewire

→ Acts like ostial stenosis



Guiding Catheter Trouble

- Side hole guiding catheter
- Inappropriate position or alignment



숙련과정이 필요하다.

- Some learning period for everybody
 - To manipulate pressure wire
 - To make reliable hyperemia and pressure
 - To interpretate FFR result
- Safe?
 - Transient AV block
 - Broncho-spasm

Experts say “Yes” & I think so.

요약

- PCI Under Pressure Measurement

One of the reliable and helpful technique making up for the anatomical imaging.

관상동맥 중재시술의 ‘애정남’이 될 수 있다.

경청해 주셔서 감사합니다.

