

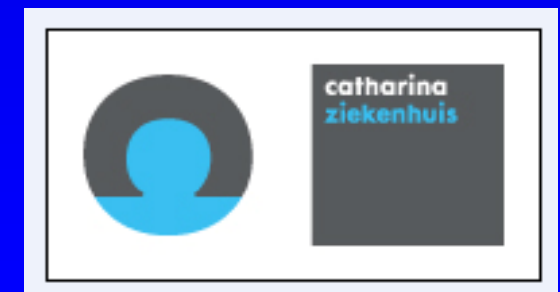
Imaging & Physiology Summit FFR Workshop

HYPEREMIA

Seoul, Korea, december 6th, 2013



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Is Hyperemia Essential ??

Correct Classification of Ischemic Stenosis

100 % certainty (holy grail)

FFR

95 %

hyperemia

resting Pd/Pa, iFR,
bSVr

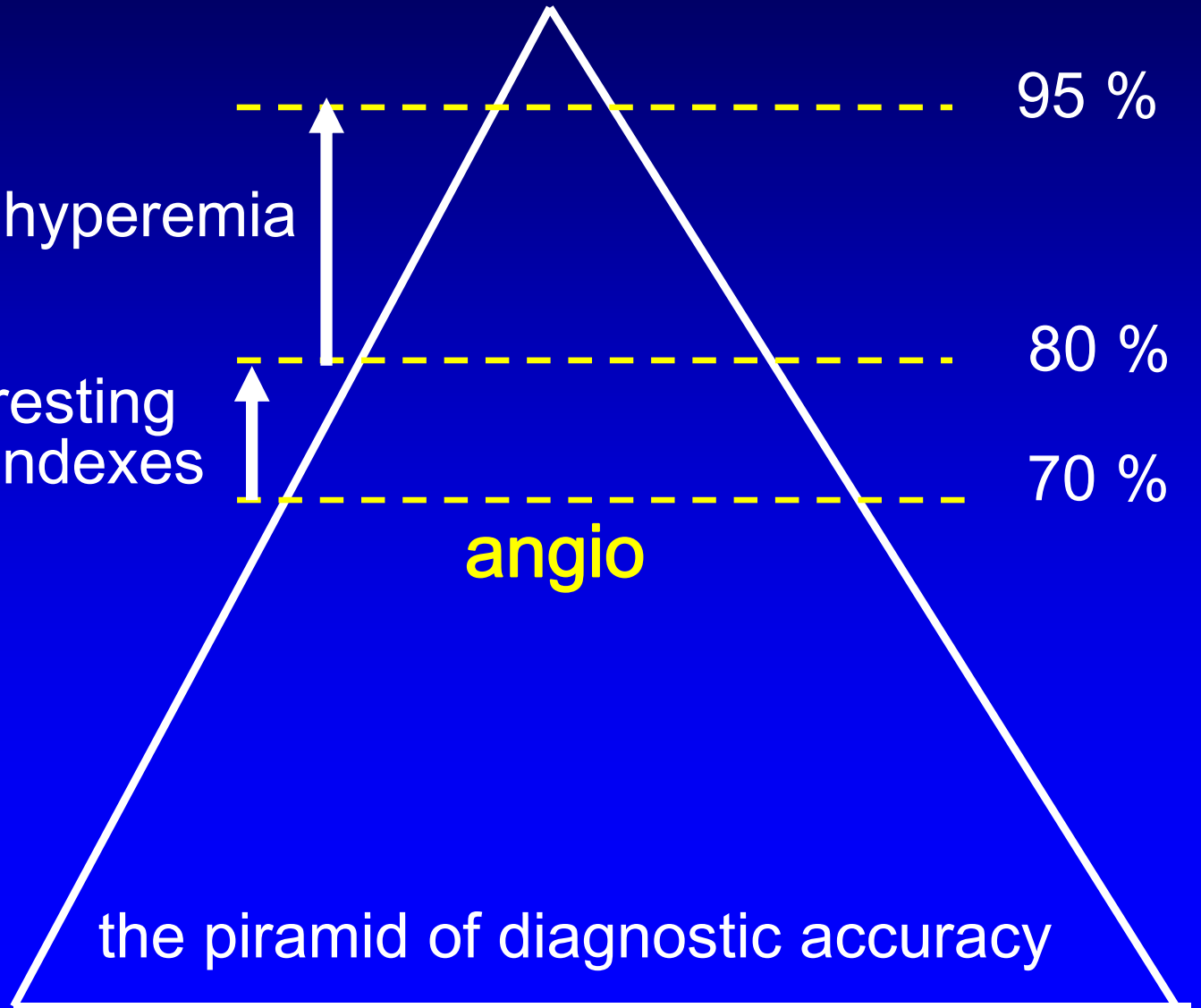
80 %

resting
indexes

70 %

angio

the pyramid of diagnostic accuracy



Is Hyperemia Essential ??



Yes, it is !!

→ *Session tomorrow morning 10 AM*

MAXIMUM VASODILATORY STIMULI

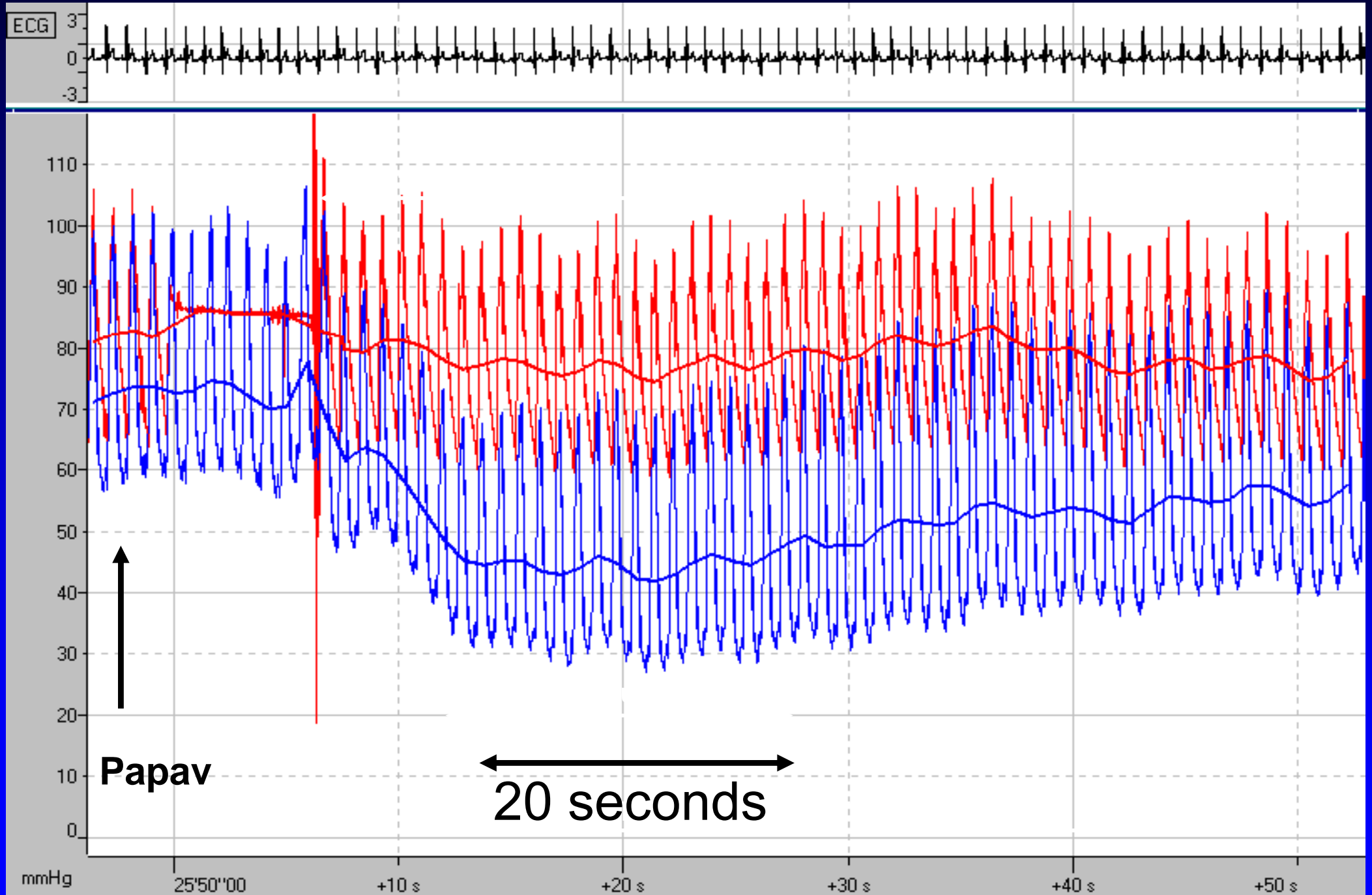
!! Maximum hyperemia is paramount !!

- PAPAVERINE i.c.
- ADENOSINE i.c.
- ADENOSINE i.v. infusion
- ATP i.c
- ATP i.v.
- REGADENOSON i.v. bolus

Intracoronary Papaverine

- cheap, globally available
- peak hyperemia sets-on after 30-45 sec and lasts for 30 seconds – 1 min
- always T-wave abnormalities, seldom TDP, VT
- dosage : 12 mg in RCA
20 mg LCA
- *PULL-BACK CURVE generally possible*

Intracoronary Bolus of Papaverine 20 mg



Intracoronary Adenosine

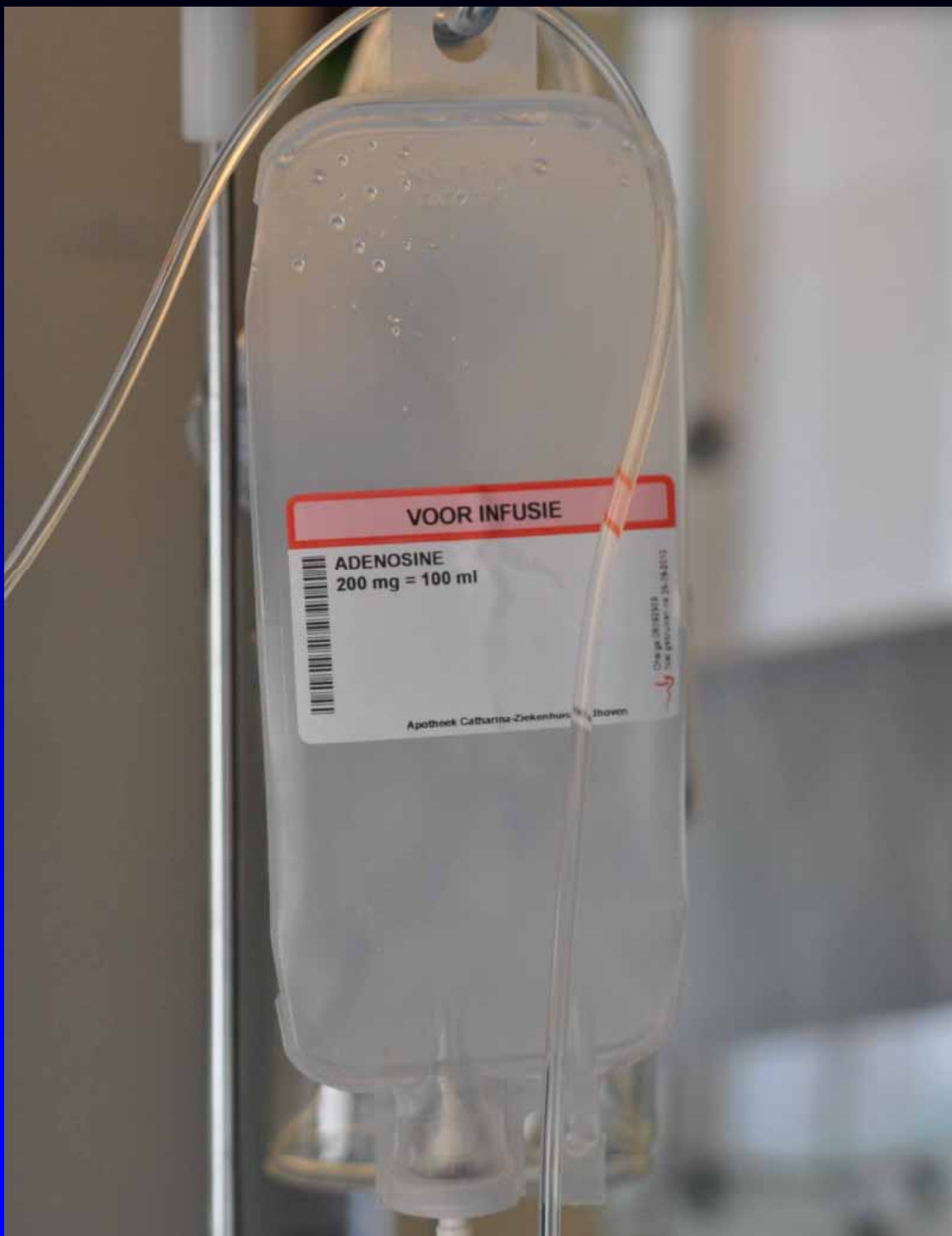
- frequently used by starting centers, very safe and cheap
- But.... *Also most tricky*
- Very short hyperemia → often overestimation of FFR
- Dosage often too low: use at least - 60 μ g in LCA
- 40 μ g in RCA
(*Catharina Hosp: "double until no add effect"*)
- No PULL-BACK CURVE

Intravenous Adenosine

- 140 ug /kg/min
preferably infusion by femoral or other central vein
- Extremely accurate; steady state within 1 – 2 min
maximum hyperemia in 99 % of all patients
- Burning, angina-like chest pain or feeling of dyspnoea. **HARMLESS !!!**
- Decrease of blood pressure and increase of heart rate by 10-15%
- Avoid Valsalva manoeuvres (fluctuations)

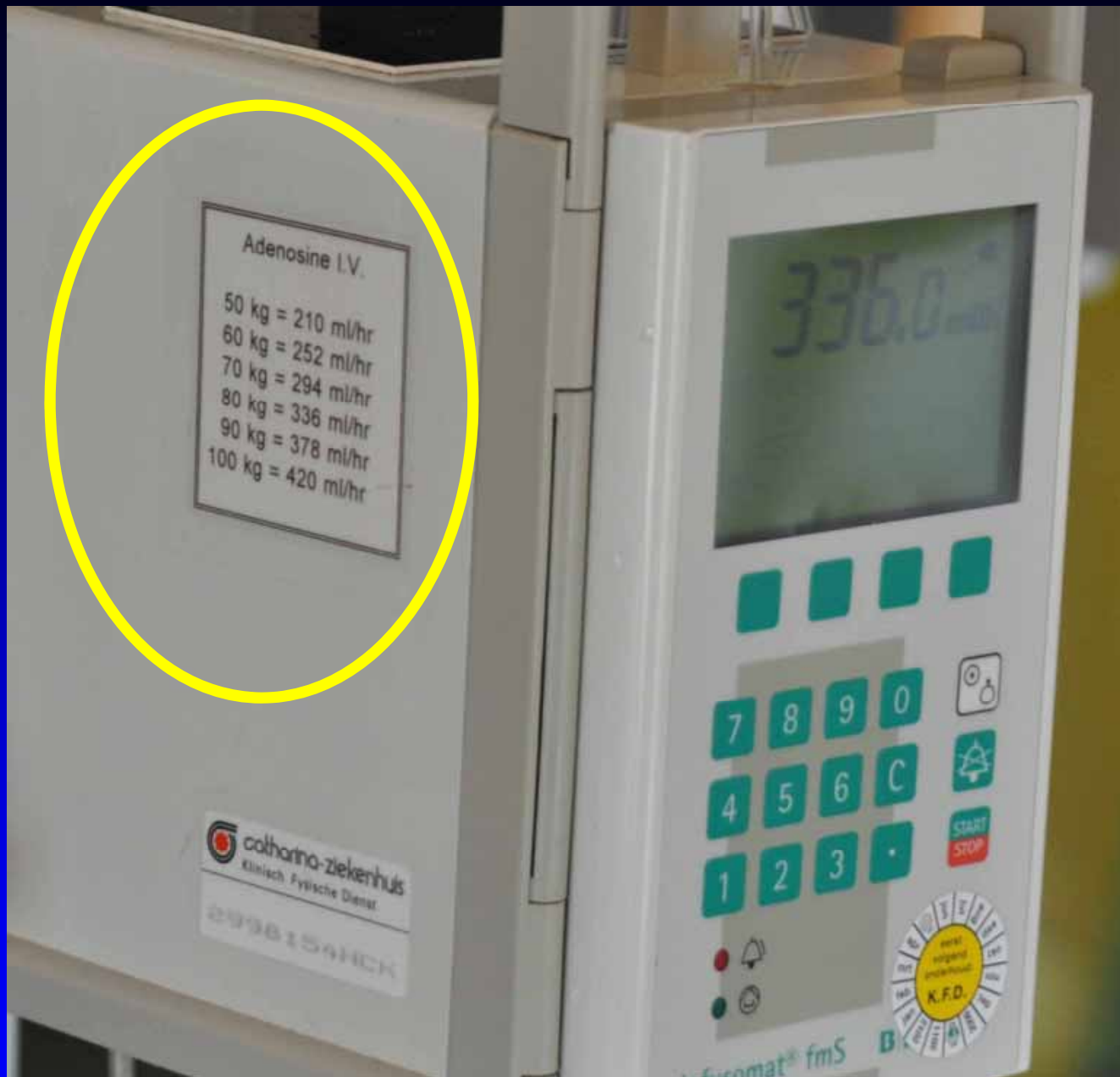


Venous sheath into femoral vein

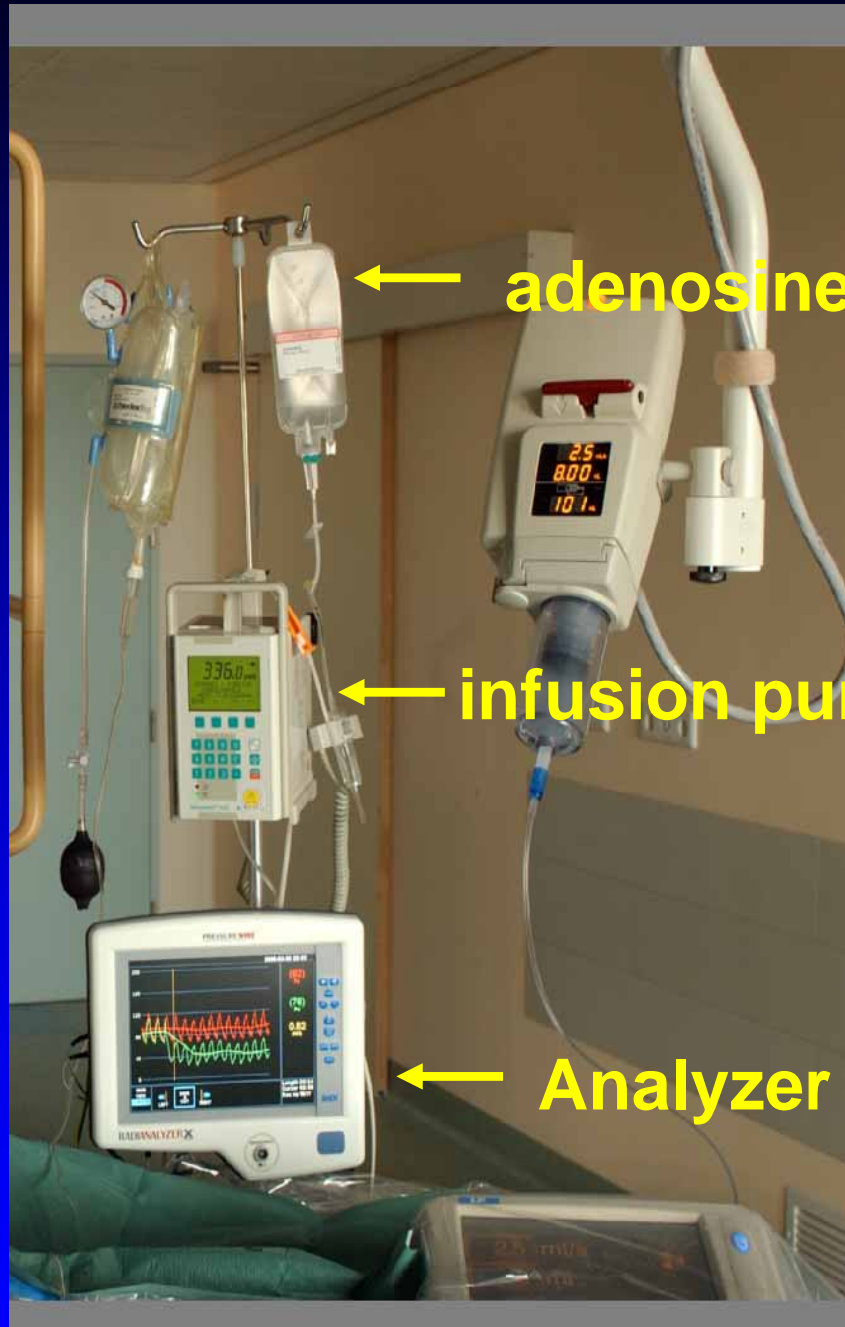


**Adenosine for
i.v. infusion**

**(standard bag
200 mg = 100 ml)**

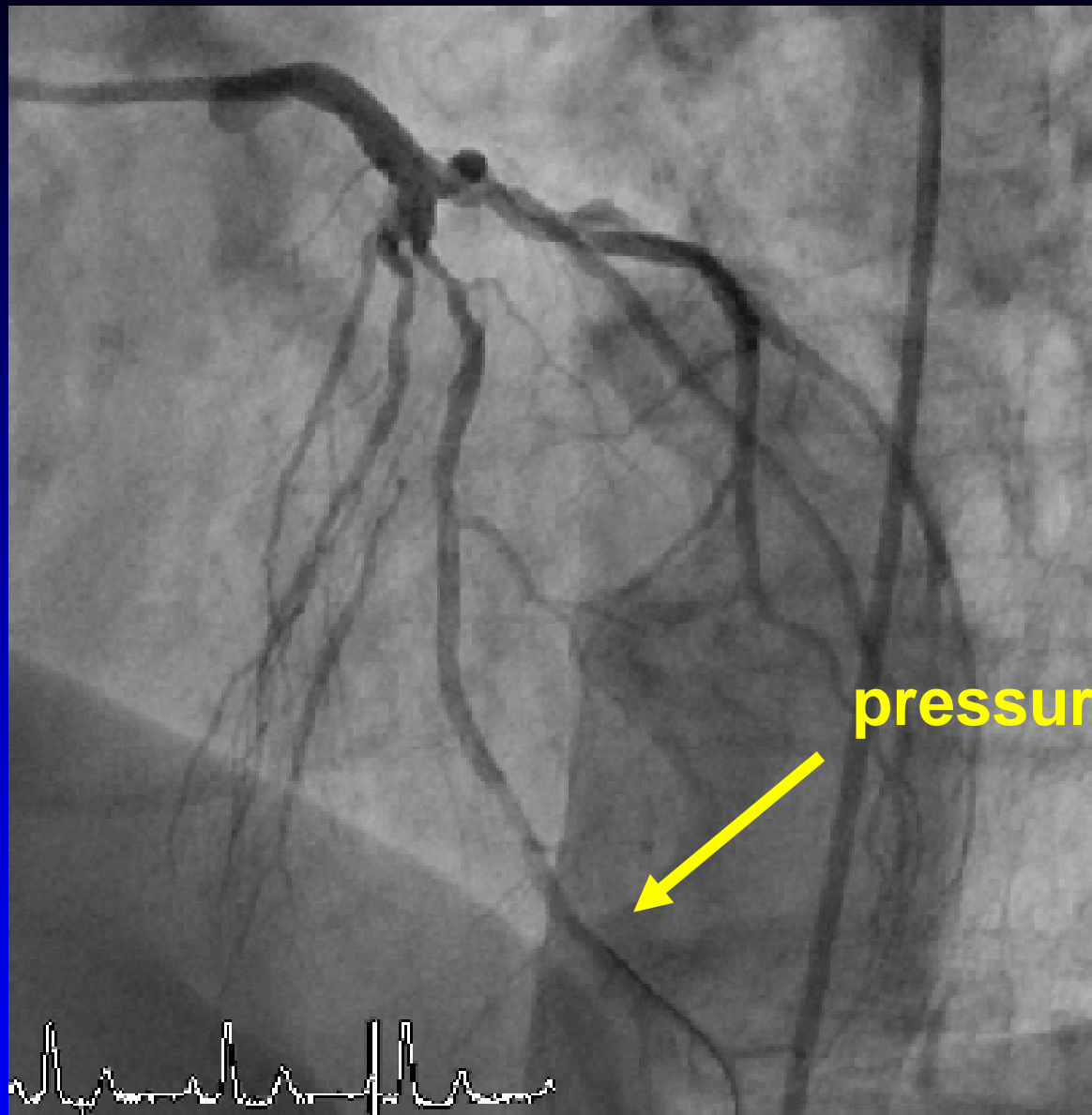


Infusion rate simply adjusted according to body weight (....kg →ml/min)



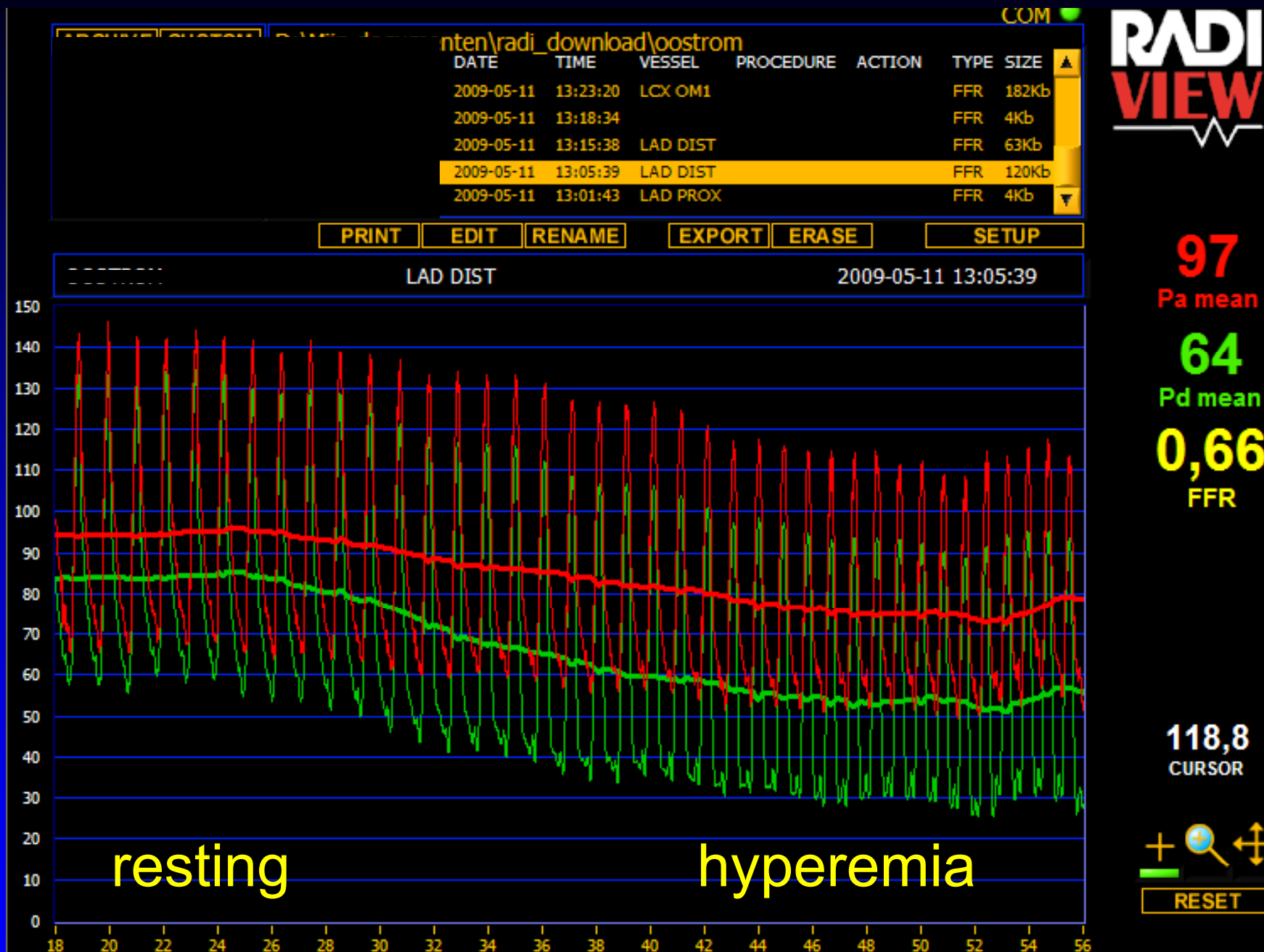
- *no preparation in the lab*
- *no difficult calculations*
- *no risk of dosage error*
- *no loss of time*

- *very cheap (can be made in the hospital pharmacy in many countries)*



pressure wire

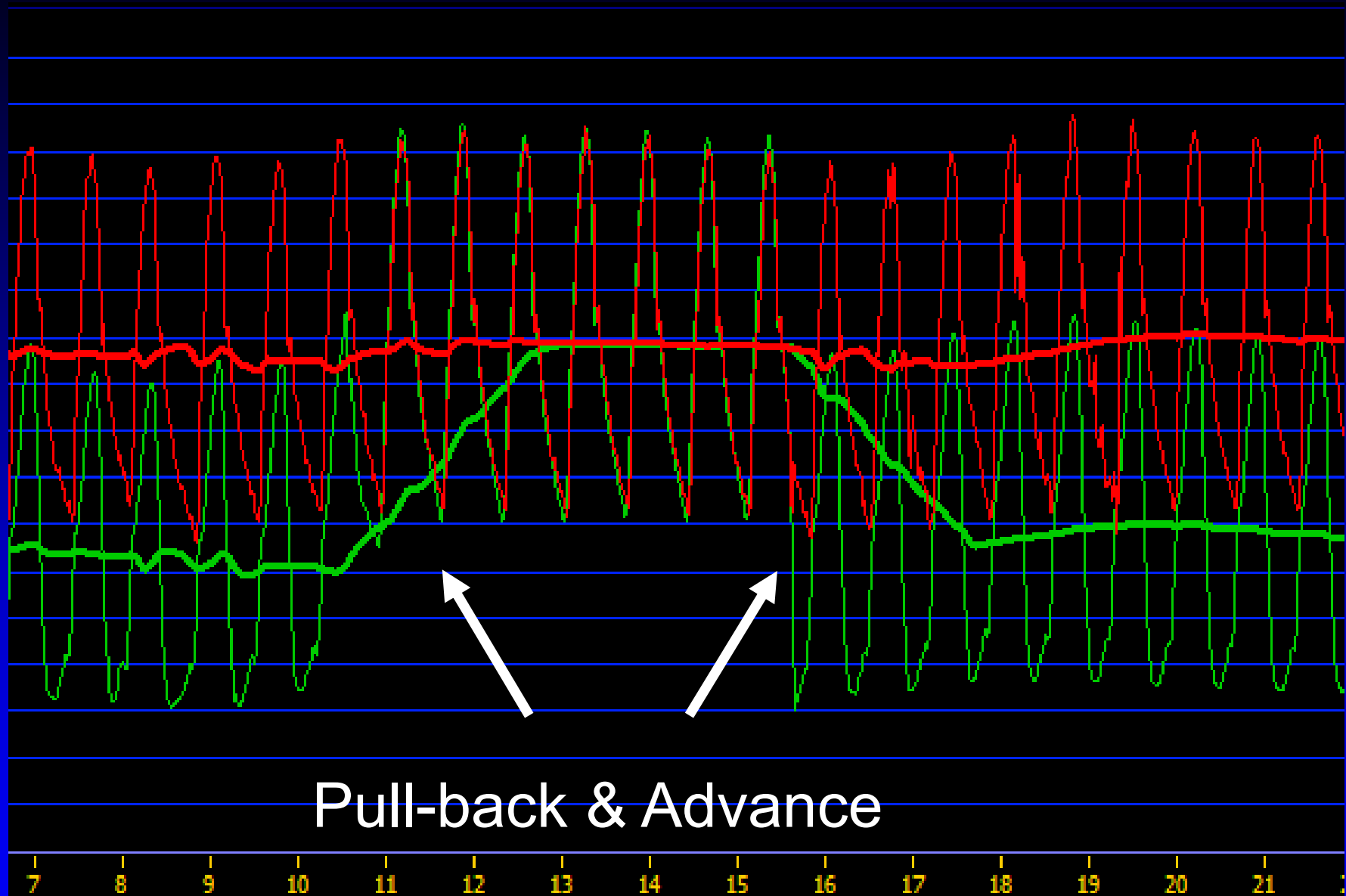
advance pressure wire through stenosis
and ***induce hyperemia*** → **FFR**



FFR LAD (i.v. adenosine) = 0.66 → need for stent



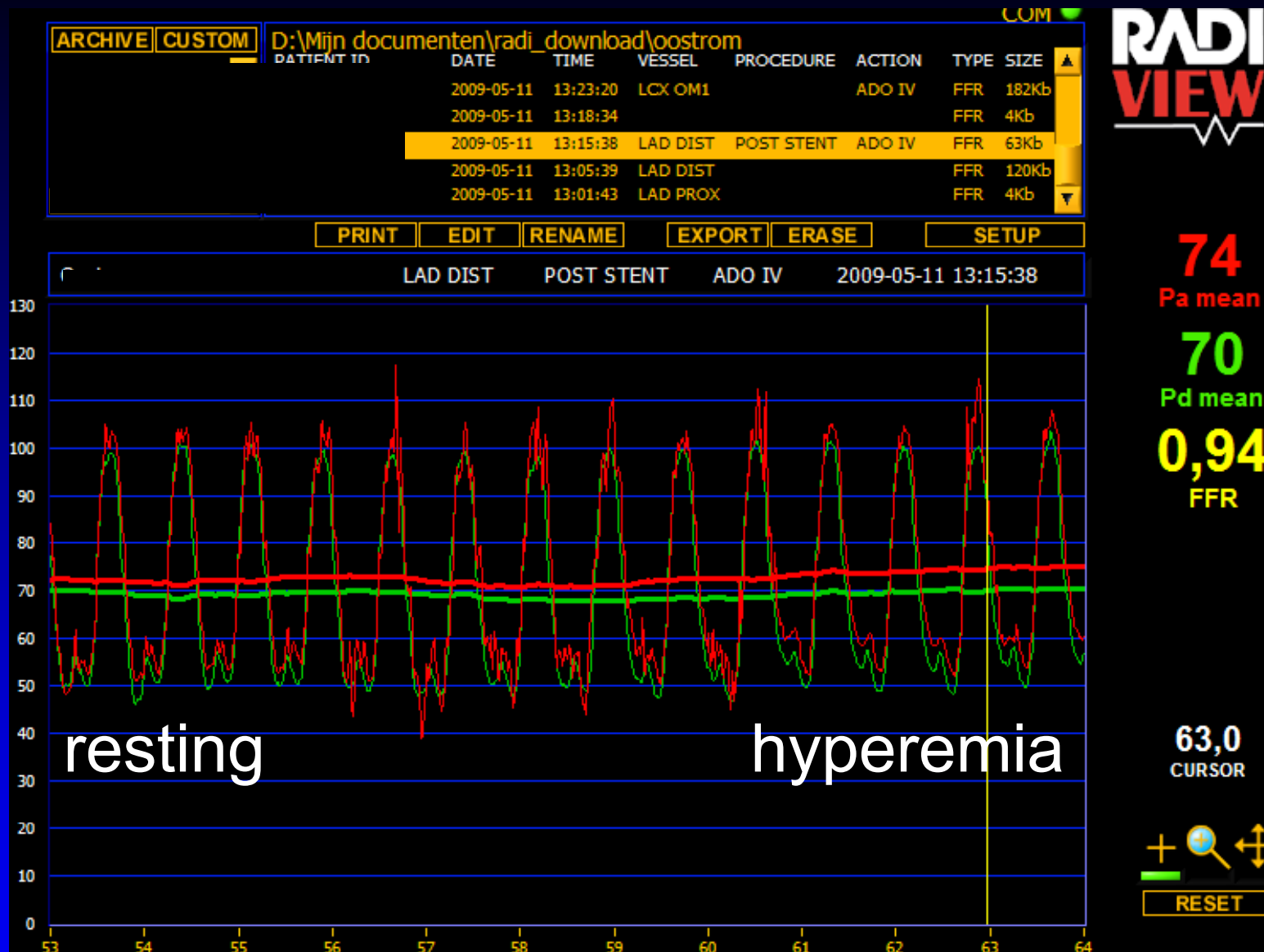
Make *pullback recording* for optimal information



Pull-back recording for detailed spatial information about distribution of lesions along the complete artery



Stent has been placed: LAD after stenting



measurement of **FFR after stenting** to assess result

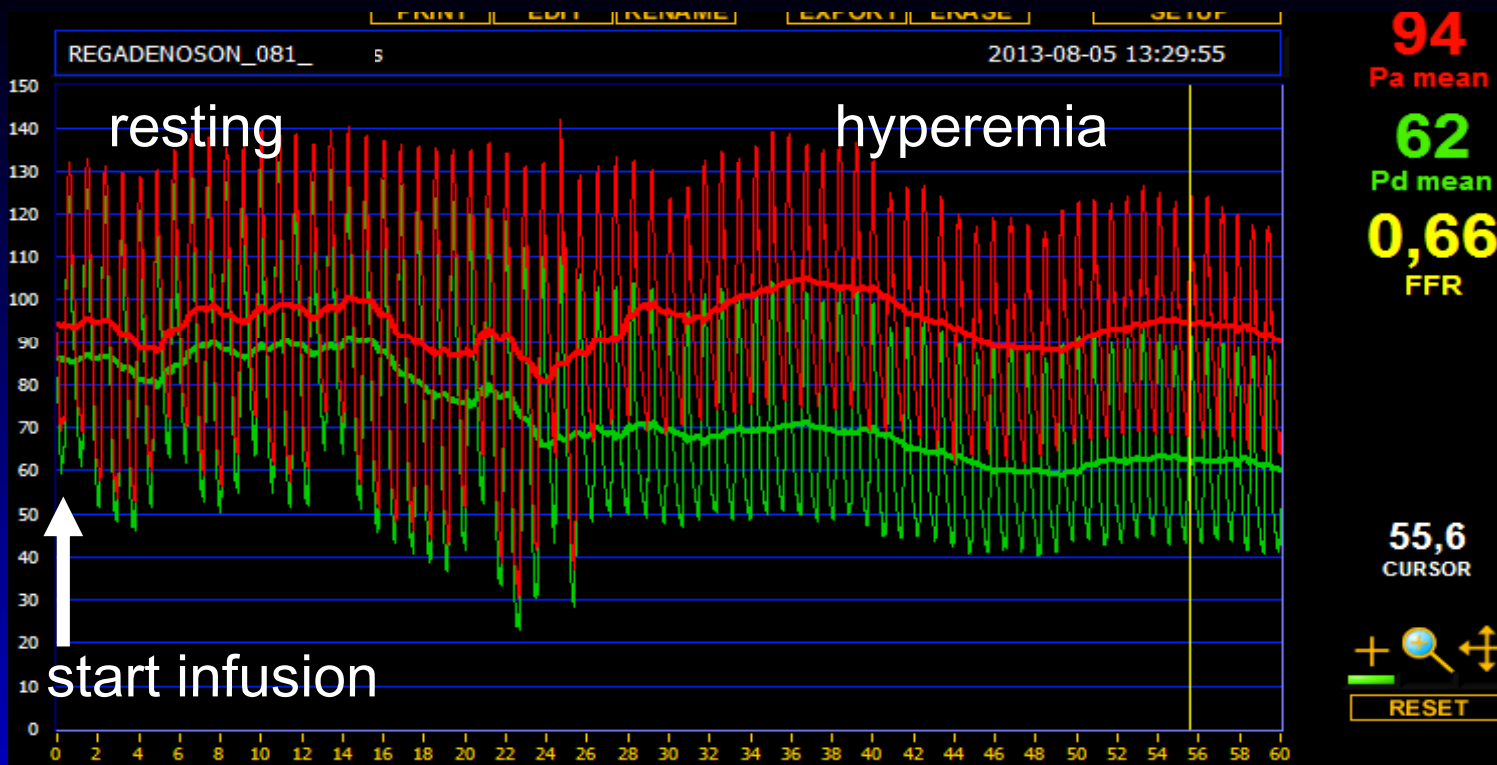
FFR = 0.94



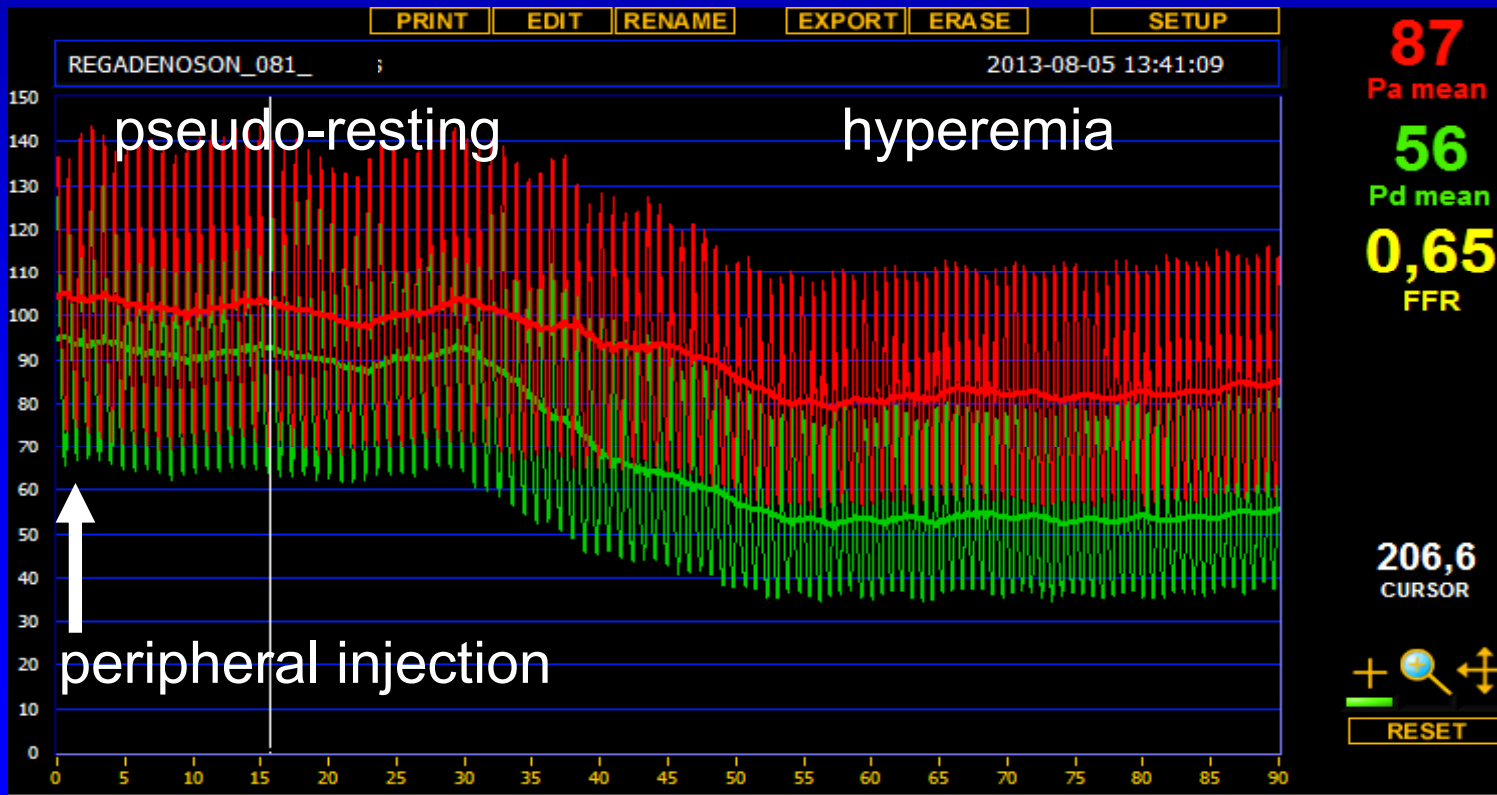
At the end, when sensor is back at tip of guiding catheter, verify **absence of drift**

Single bolus i.v. regadenoson

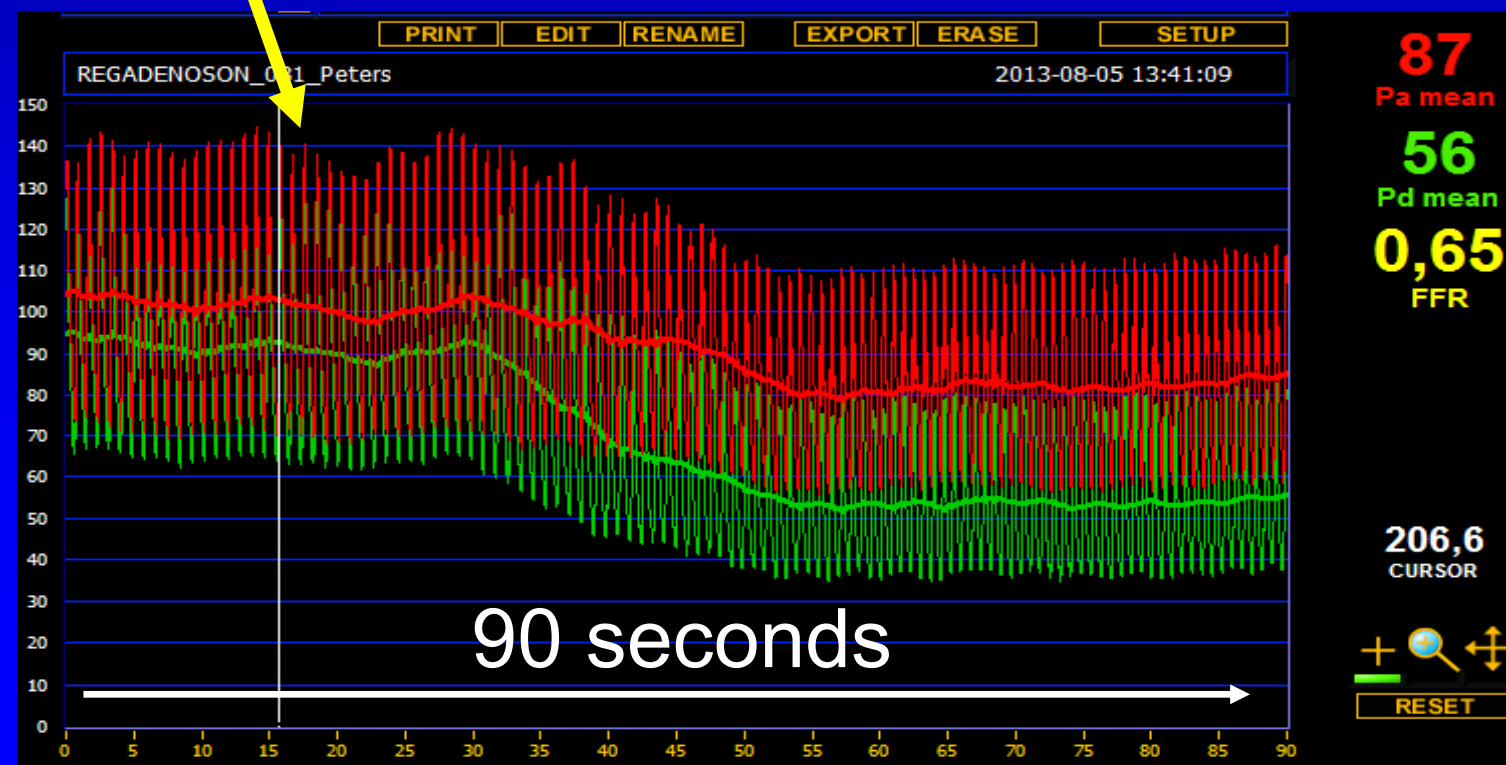
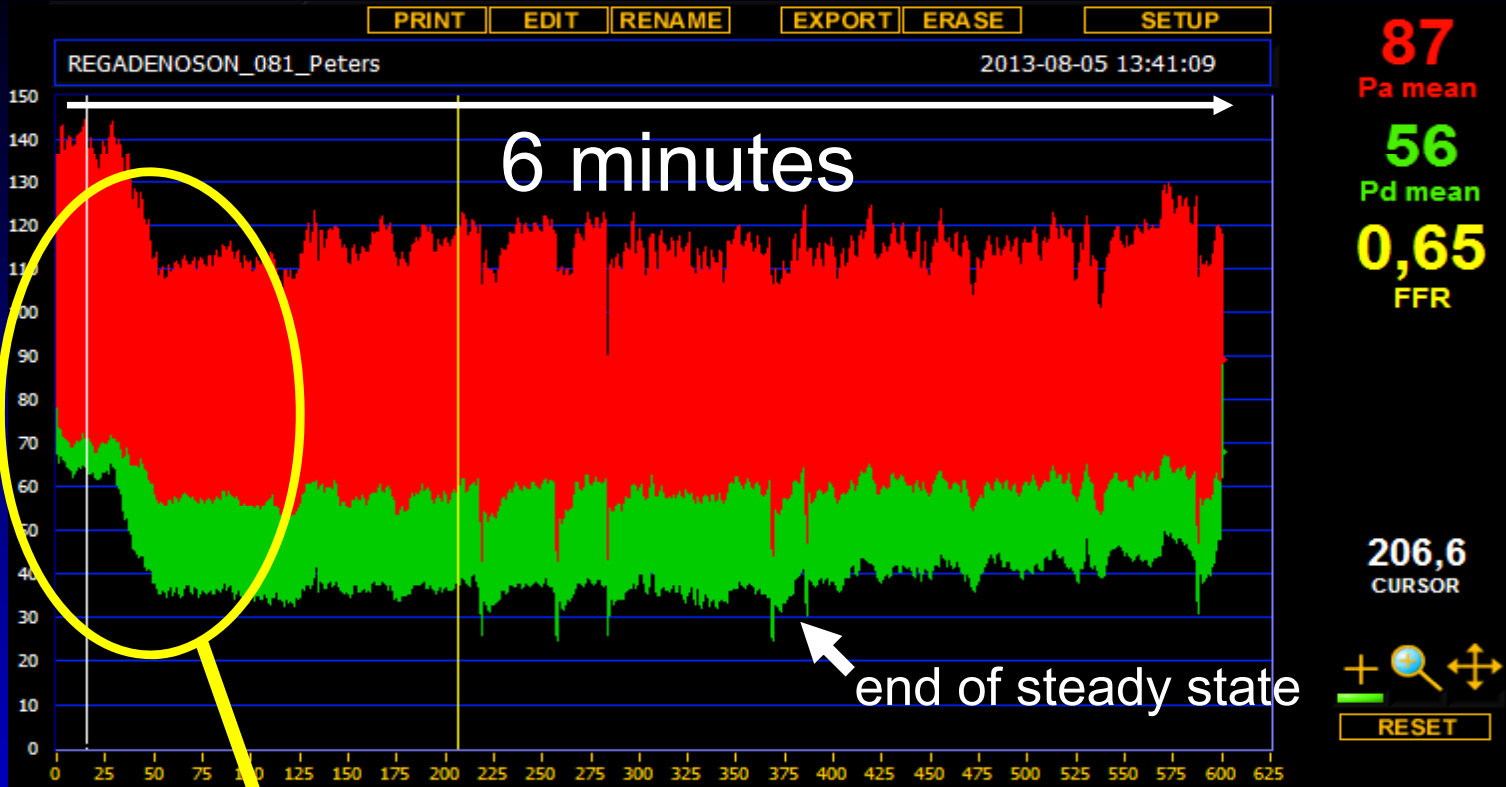
- newer and reliable stimulus
- single bolus 400 microgram, either in central or peripheral vein (equally effective)
- hyperemia identical to central venous adenosine infusion
- no side effects, except the “well-known” innocent chest pain
- hyperemic plateau very variable : 20 sec – 10 min
- price: ~ 70 Euro/pat



central
venous
adenosine
Infusion
140 $\mu\text{g}/\text{kg}/\text{min}$

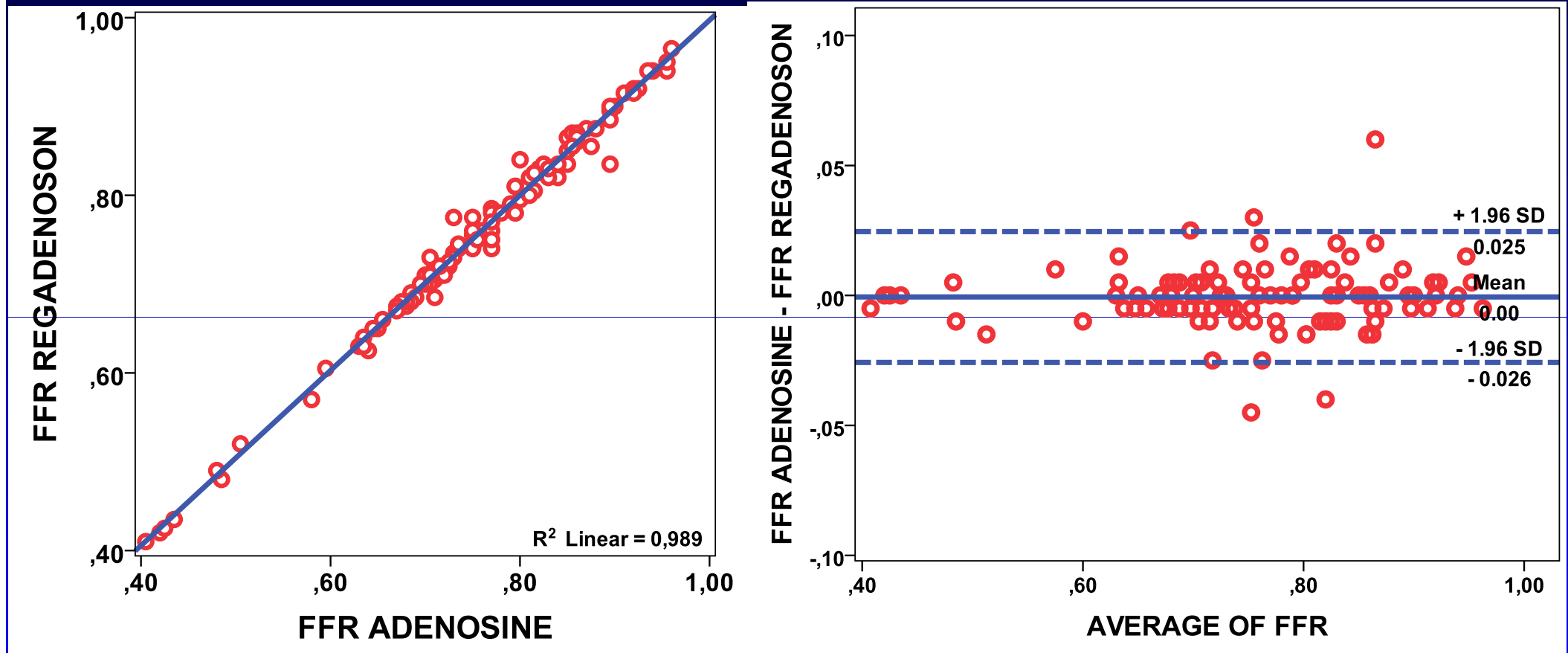


Single bolus
Peripheral
Injection of
400 μg of
regadenoson



peripheral
single bolus
injection of
400 μg of
regadenoson

Regadenoson vs Adenosine (N=100)



- Mean Difference 0.00 ± 0.01

➔ *More about Regadenoson: tomorrow morning at 09.40 a.m.*

Importance of Maximum Hyperemia (3):

If in doubt:

- ***higher dosage of stimulus***
(i.c. adenosine up to 80 μg RCA; ≥ 120 μg LCA)
- ***other route*** (i.v. adenosine instead of i.c.)
- ***other drug*** (papaverine 12 mg RCA; 20 mg LCA
regadenoson 400 microgr as i.v. bolus*)
- ***i.c. adenosine on top of i.v. adenosine***

**under review*

Circulation 2003; 107: 1877-1883

Circulation 2014; submitted

Hybrid Approach ??

- If Pd/Pa at rest (or comparable indices, like iFR) is ≤ 0.80 , as a matter of fact FFR will also be ≤ 0.80 and hyperemia in itself is not strictly mandatory to decide upon inducible ischemia
- but without hyperemia, you cannot make a meaningful *pull-back recording* and you are losing a lot of valuable information
- and without hyperemia and FFR , you cannot judge how much a patient improved by stenting:
you don't know where you came from
(“*did FFR go from 0.78 to 0.91 or from 0.65 to 0.91 ?*”)

→ ***You lose a lot of valuable information in a lot of patients***

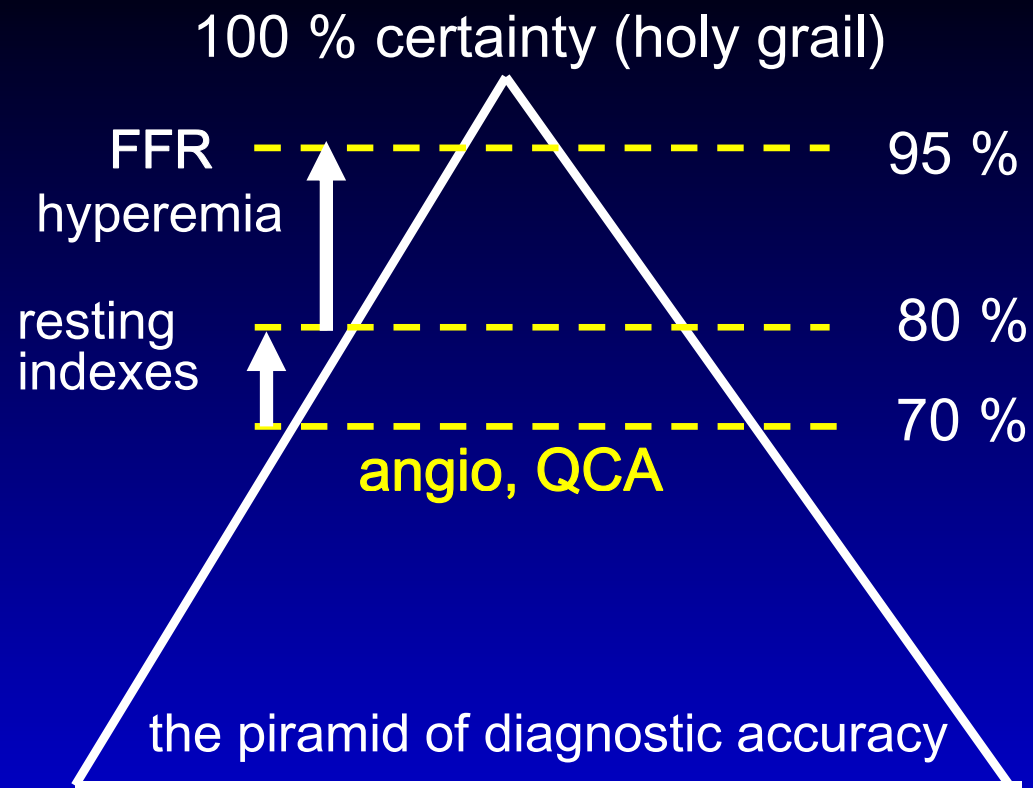
→ *further discussed tomorrow 10 AM*

HYPEREMIC STIMULI: SUMMARY:

- number of reliable and safe hyperemic stimuli
- adenosine: 1- or 2-vessel focal disease without diffuse disease
(*i.c. bolus*)
- regadenoson: 1- or 2-vessel disease with diffuse disease,
(*i.v. bolus*) tandem lesions, straightforward bifurcations
papaverine with necessity of 1 or 2 pullback recordings;
(*i.c. bolus*) “*ad hoc*” FFR during radial procedure
- central i.v. adenosine: more complex disease with multiple
lesions, diffuse disease, necessity of
repeated pullback recordings

ATP ~ adenosine

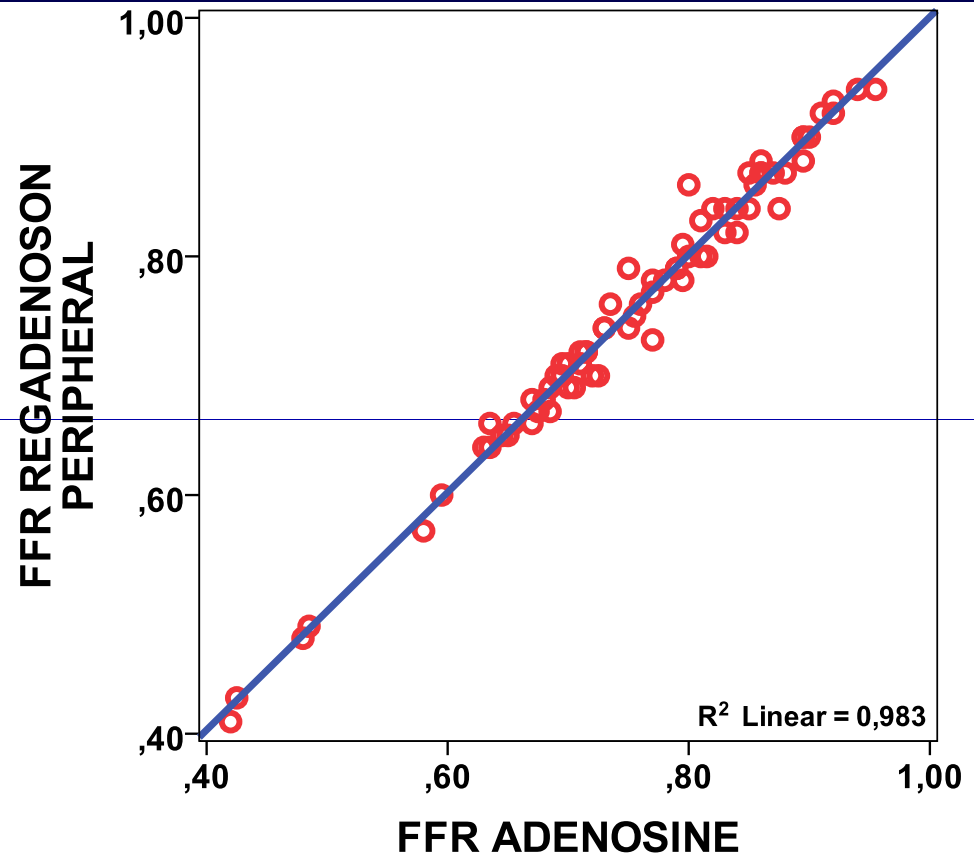
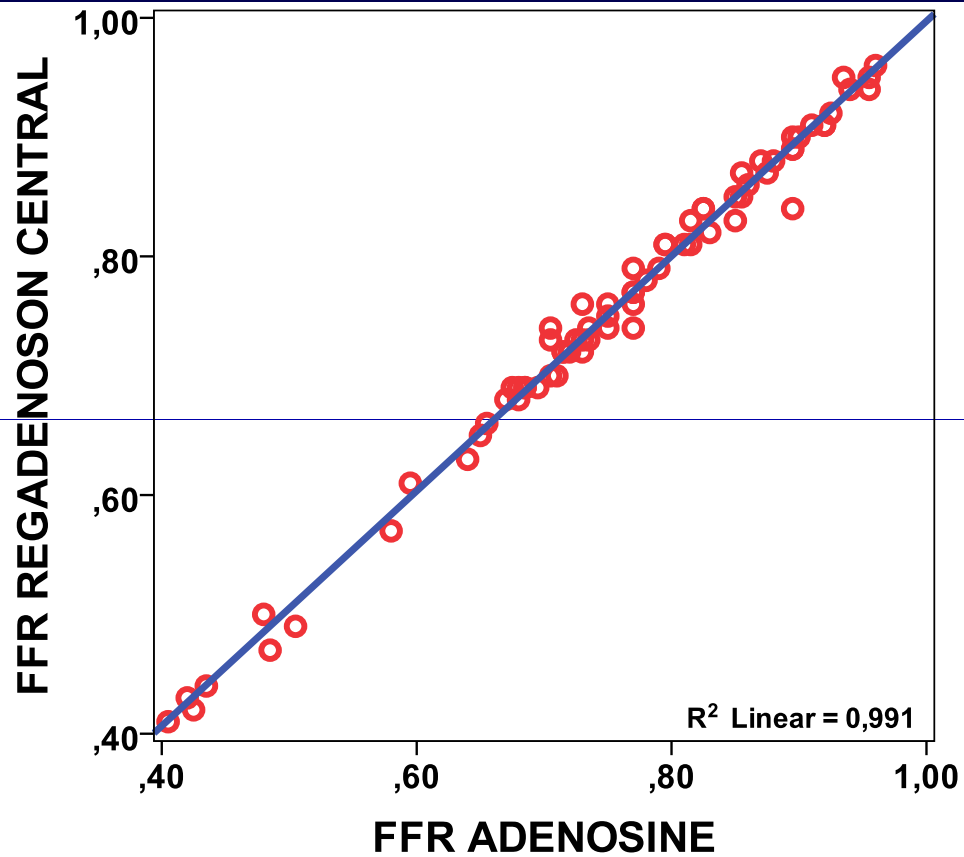




***Why to go for less than 95 % certainty ?
Just to avoid adenosine ?***

Is it so cumbersome to create maximum hyperemia ?

Central & Peripheral Regadenoson

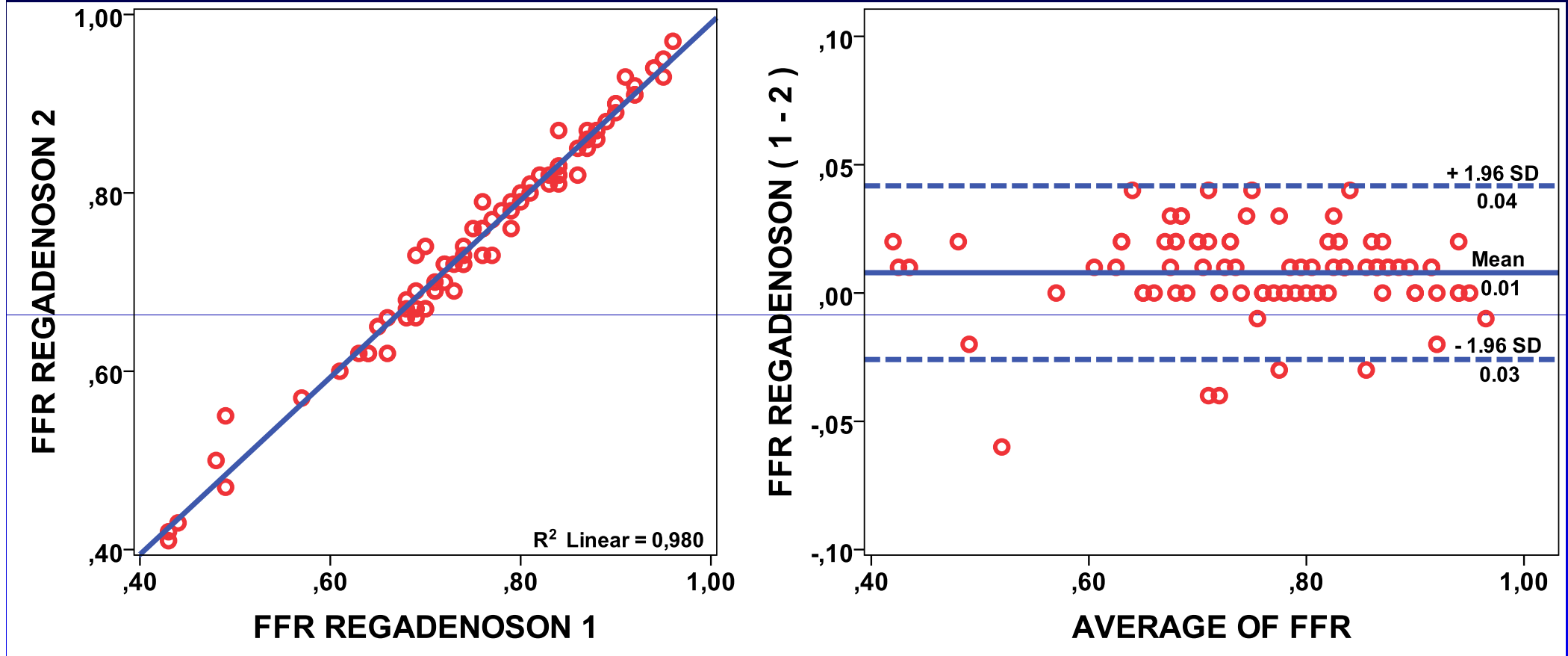


- Mean Difference 0.00 ± 0.01

- Mean Difference 0.00 ± 0.02

Presentation of this study: tomorrow morning at 09.40 a.m.

Reproducibility of Regadenoson



- Mean Difference 0.01 ± 0.02

Presentation of this study: tomorrow morning at 09.40 a.m.

Adenosine (central venous infusion) vs Regadenoson for maximum hyperemia (100 patients)

