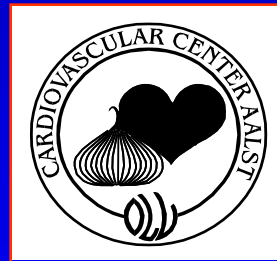


CORONARY PHYSIOLOGY IN THE CATH LAB

Educational Training Program ESC

European Heart House, Nice, April 24th – 26th, 2014



Course Directors:

Bernard De Bruyne, MD, PhD, Cardiovascular Center Aalst, Aalst, Belgium

William F. Fearon, MD, Stanford University School of Medicine, Stanford, USA

Nico H. J. Pijls, MD, PhD, Catharina Hospital, Eindhoven, The Netherlands

Andreas Gruentzig
NEJM 1979

The New England Journal of Medicine

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Volume 301

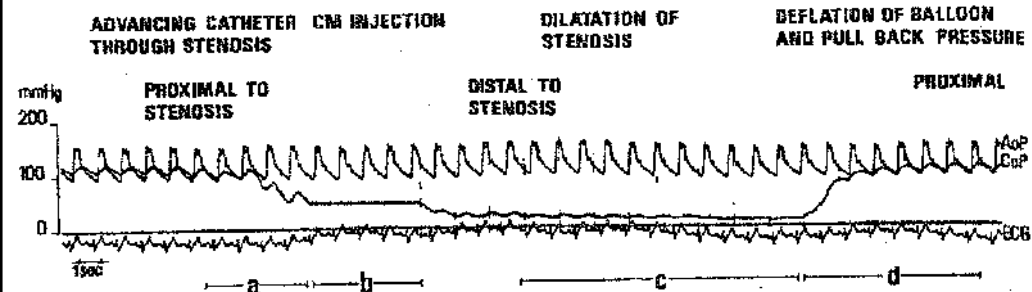
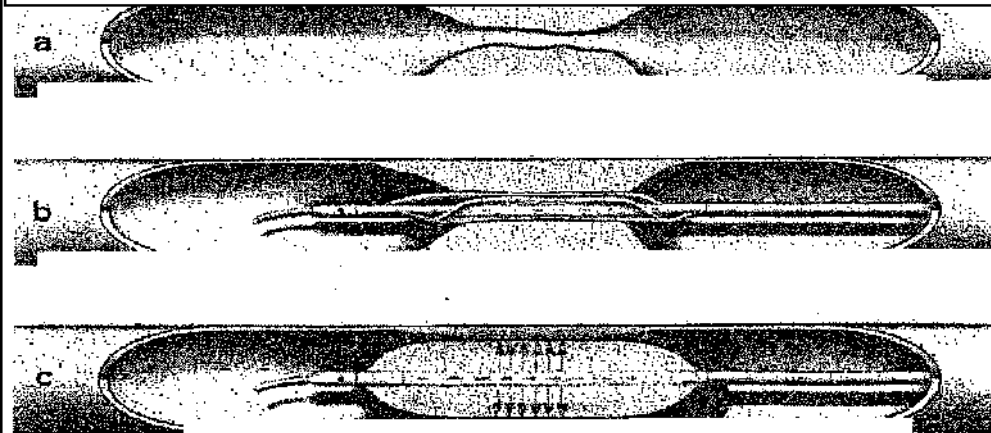
JULY 12, 1979

Number 2

NONOPERATIVE DILATATION OF CORONARY-ARTERY STENOSIS

Percutaneous Transluminal Coronary Angioplasty

ANDREAS R. GRÜNTZIG, M.D., ÅKE SENNING, M.D., AND WALTER E. SIEGENTHALER, M.D.



Even in the beginning Andreas Gruentzig strongly believed in the value of coronary pressure measurements, but investigators in those days were handicapped in 3 ways.....

- **no reliable device** to measure coronary pressure (only 3 F catheters instead of 0.014" pressure wires, resulting in gross overestimation of gradients)
- importance of **maximum hyperemia** was not yet recognized (baseline values are not very helpful for decision making)
- interpretation of gradients difficult and inconsistent, **FFR was not available yet**
(Pa = 100, Pd = 70 mmHg → FFR = 0.70
Pa = 70, Pd = 40 mmHg → FFR = 0.57)

2.8F infusion
catheter

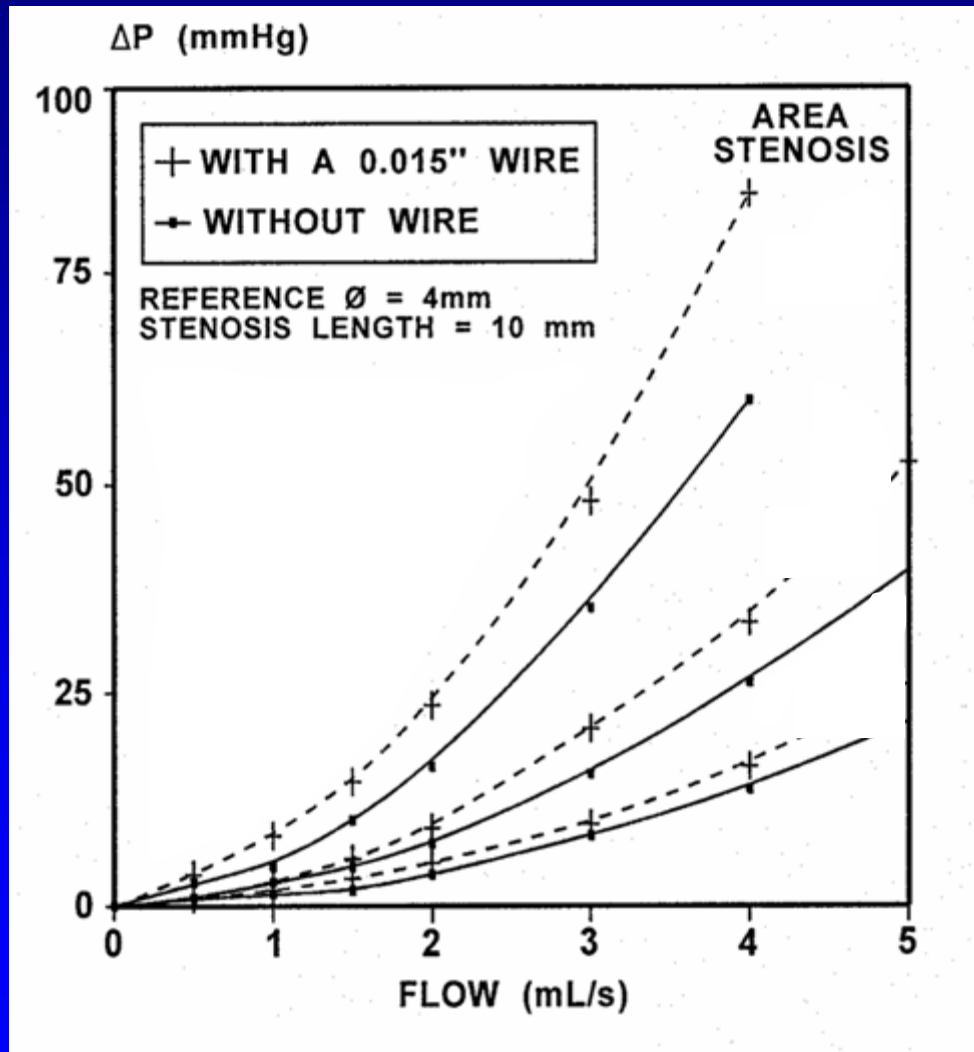
last 15 cm of
0.015 hollow guidewire

glued together at the
kitchen table and
sterilized by ethylene
oxide



Early 1990s: Development of FFR

Effect on the Pressure Gradient by the Presence of the Pressure Measuring Wire in the Stenosis



*The presence of a 0.014" pressure monitoring guide wire in the stenosis **does not** create any clinically significant additional resistance.*

Experimental basis of determining maximum coronary, myocardial, and collateral blood flow by pressure measurements for assessing functional stenosis severity before and after percutaneous transluminal coronary angioplasty.

N H Pijls, J A van Son, R L Kirkeeide, B De Bruyne and K L Gould

Circulation. 1993;87:1354-1367

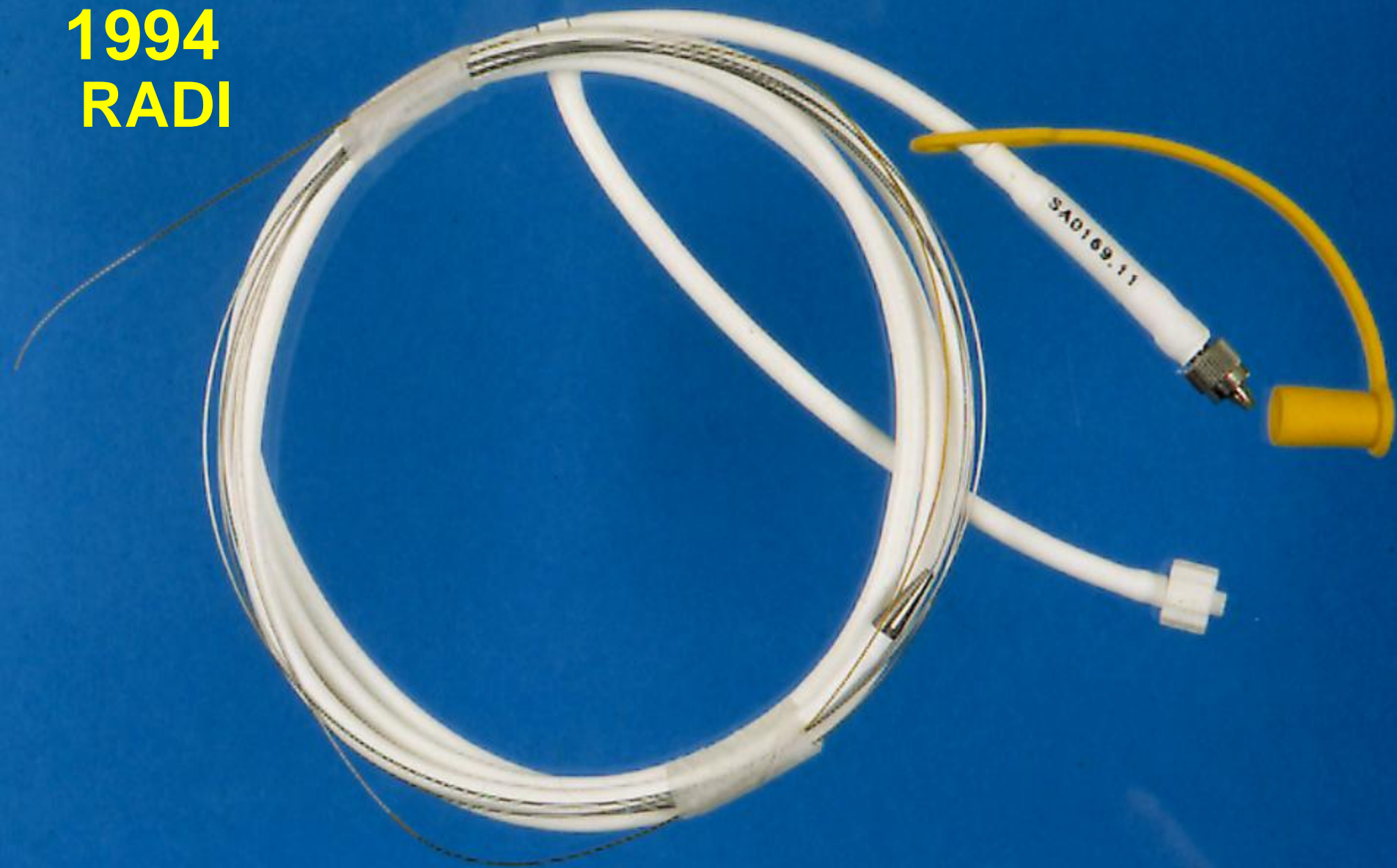
that same artery in the absence of that stenosis. Consequently, we express coronary flow reserve for a stenotic artery as a fraction of its normal expected value in that same artery in the absence of a stenosis. We therefore use the term “fractional flow reserve” (FFR).

$$\text{FFR}_{\text{myo}} = \frac{Q}{Q^N} = \frac{P_d - P_v}{P_a - P_v}$$



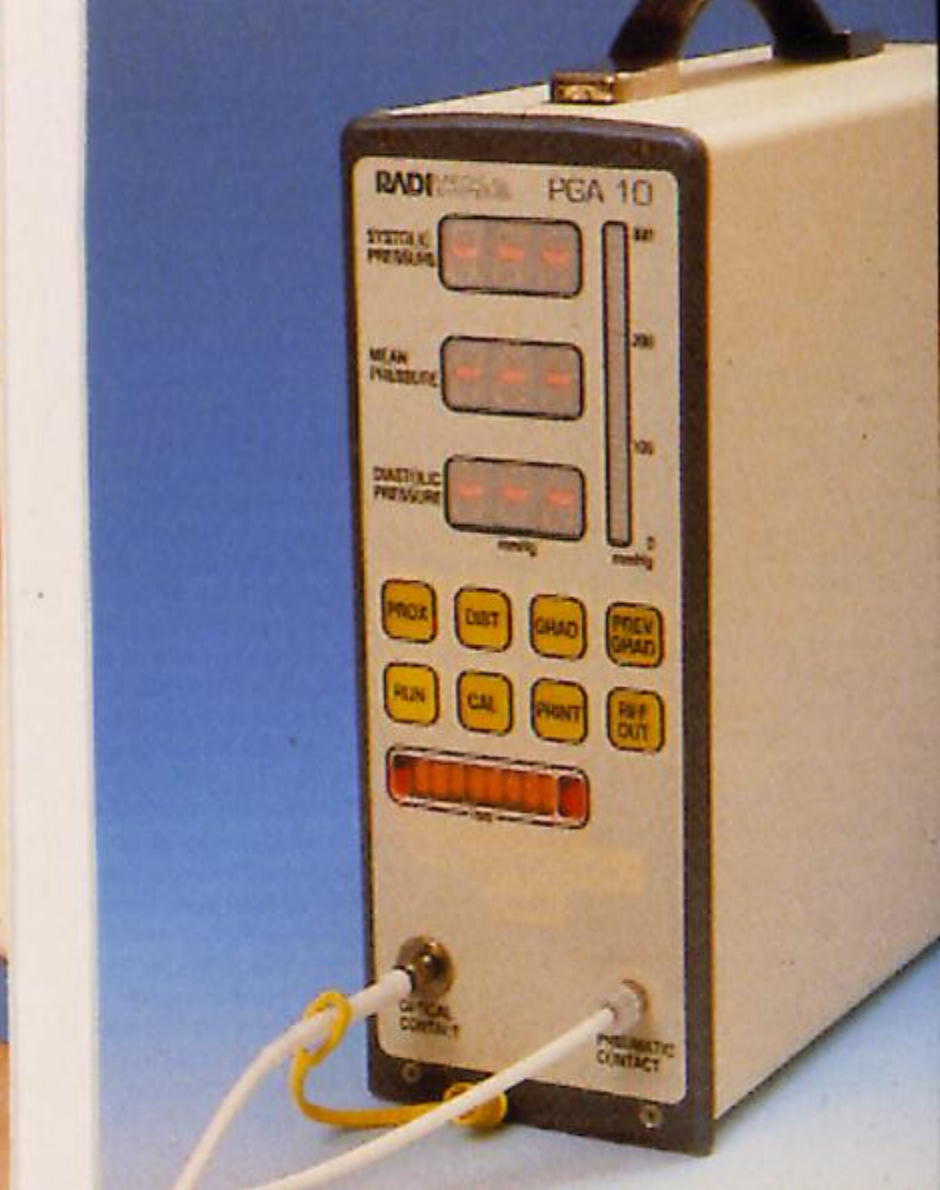
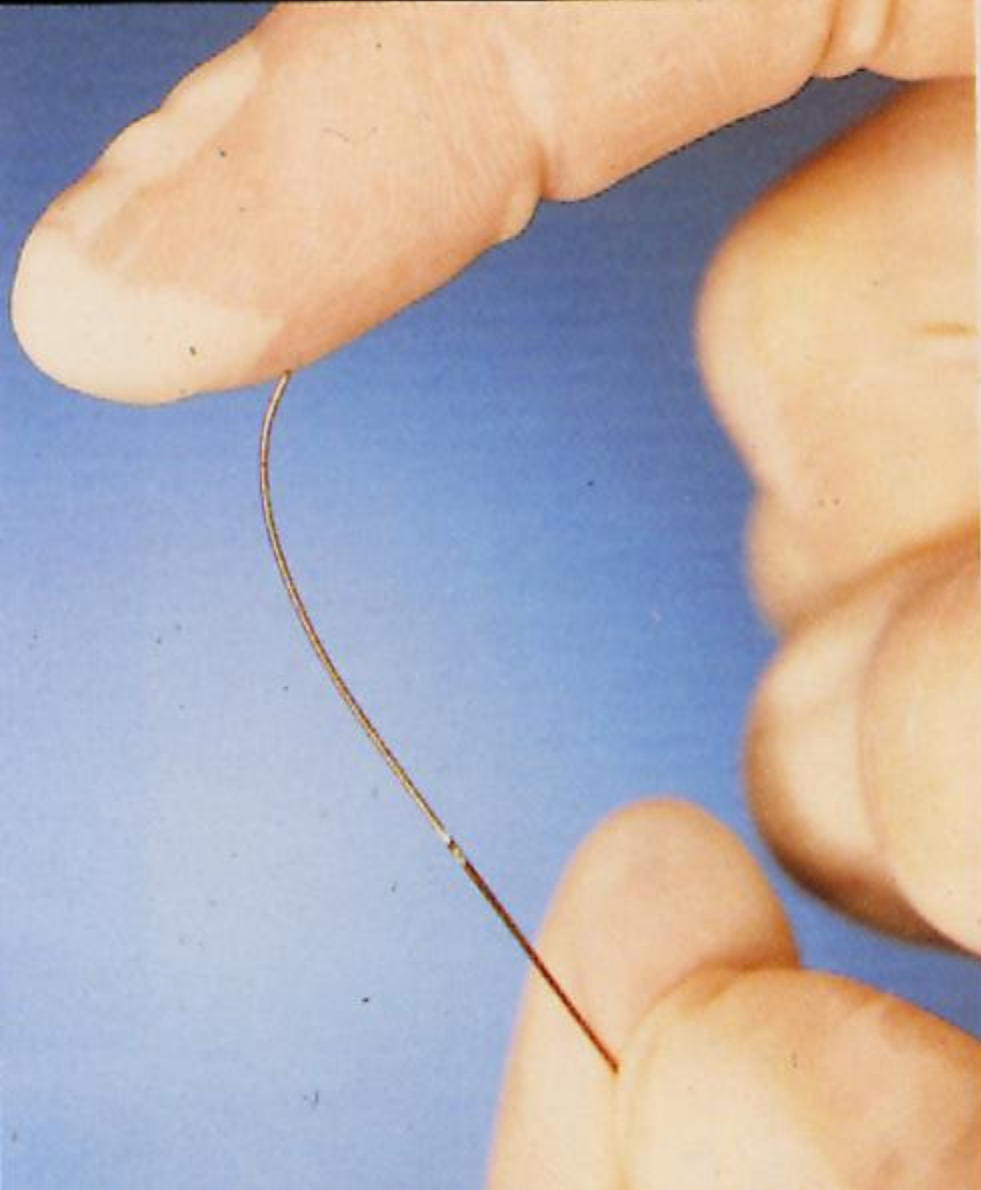
OPENING EUROPEAN HEART HOUSE, JANUARY 1994
First educational & training program: ***coronary physiology***
(course directors: Patrick Serruys and Carlo di Mario)

**1994
RADI**



First pressure “wire

Concept of FFR



1994 – 1997 validation studies of FFR

ORIGINAL ARTICLE

MEASUREMENT OF FRACTIONAL FLOW RESERVE TO ASSESS THE FUNCTIONAL SEVERITY OF CORONARY-ARTERY STENOSES

NICO H.J. PIJLS, M.D., PH.D., BERNARD DE BRUYNE, M.D., KATHINKA PEELS, M.D.,
PEPIJN H. VAN DER VOORT, M.D., HANS J.R.M. BONNIER, M.D., PH.D., JOZEF BARTUNEK, M.D.,
AND JACQUES J. KOOLEN, M.D., PH.D.

Abstract *Background.* The clinical significance of coronary-artery stenoses of moderate severity can be difficult to determine. Myocardial fractional flow reserve (FFR) is a new index of the functional severity of coronary stenoses that is calculated from pressure measurements made during coronary arteriography. We compared this index with the results of noninvasive tests commonly used to detect myocardial ischemia, to determine the usefulness of the index.

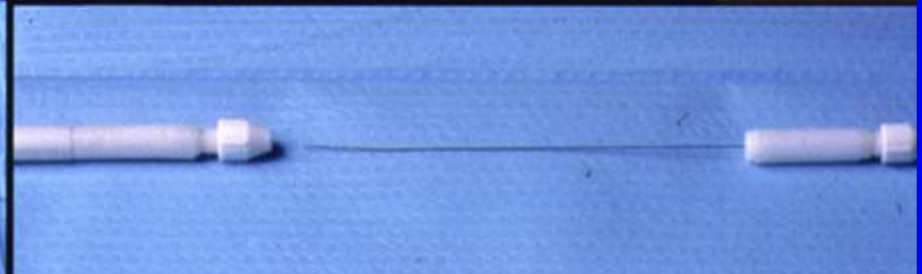
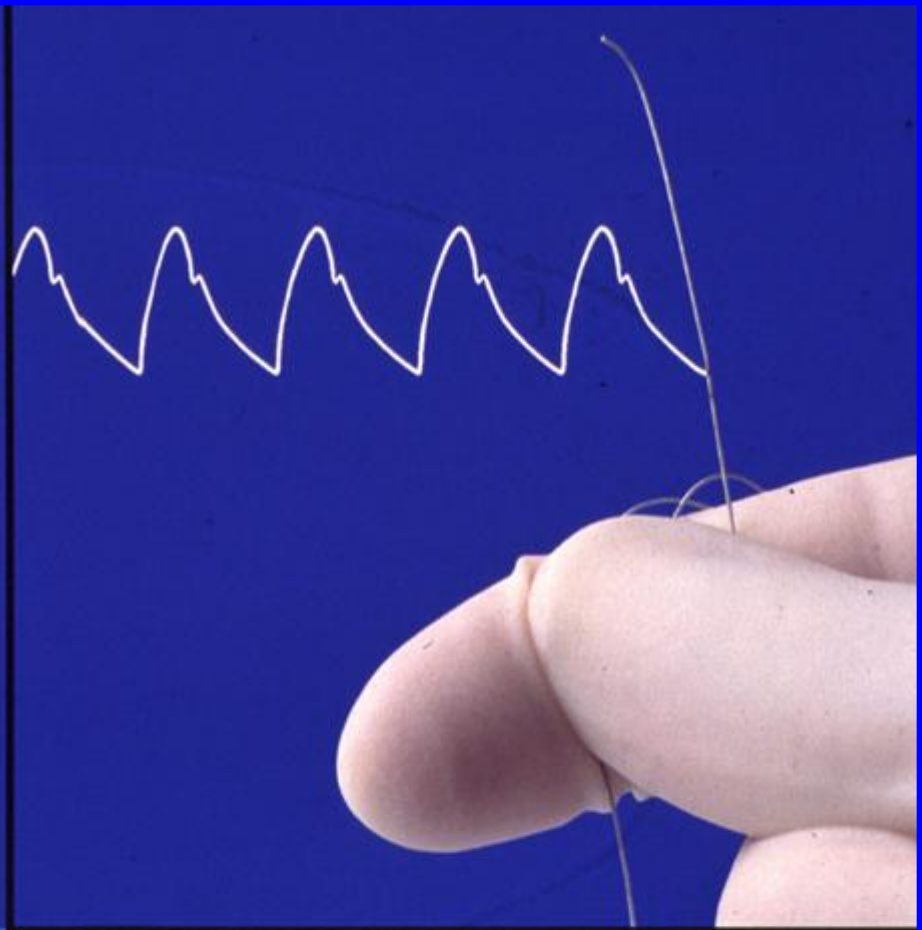
Methods. In 45 consecutive patients with moderate coronary stenosis and chest pain of uncertain origin, we performed bicycle exercise testing, thallium scintigraphy, stress echocardiography with dobutamine, and quantitative coronary arteriography and compared the results with measurements of FFR.

Results. In all 21 patients with an FFR of less than 0.75, reversible myocardial ischemia was demonstrated

unequivocally on at least one noninvasive test. After coronary angioplasty or bypass surgery was performed, all the positive test results reverted to normal. In contrast, 21 of the 24 patients with an FFR of 0.75 or higher tested negative for reversible myocardial ischemia on all the noninvasive tests. No revascularization procedures were performed in these patients, and none were required during 14 months of follow-up. The sensitivity of FFR in the identification of reversible ischemia was 88 percent, the specificity 100 percent, the positive predictive value 100 percent, the negative predictive value 88 percent, and the accuracy 93 percent.

Conclusions. In patients with coronary stenosis of moderate severity, FFR appears to be a useful index of the functional severity of the stenoses and the need for coronary revascularization. (N Engl J Med 1996;334:1703-8.)

©1996, Massachusetts Medical Society.



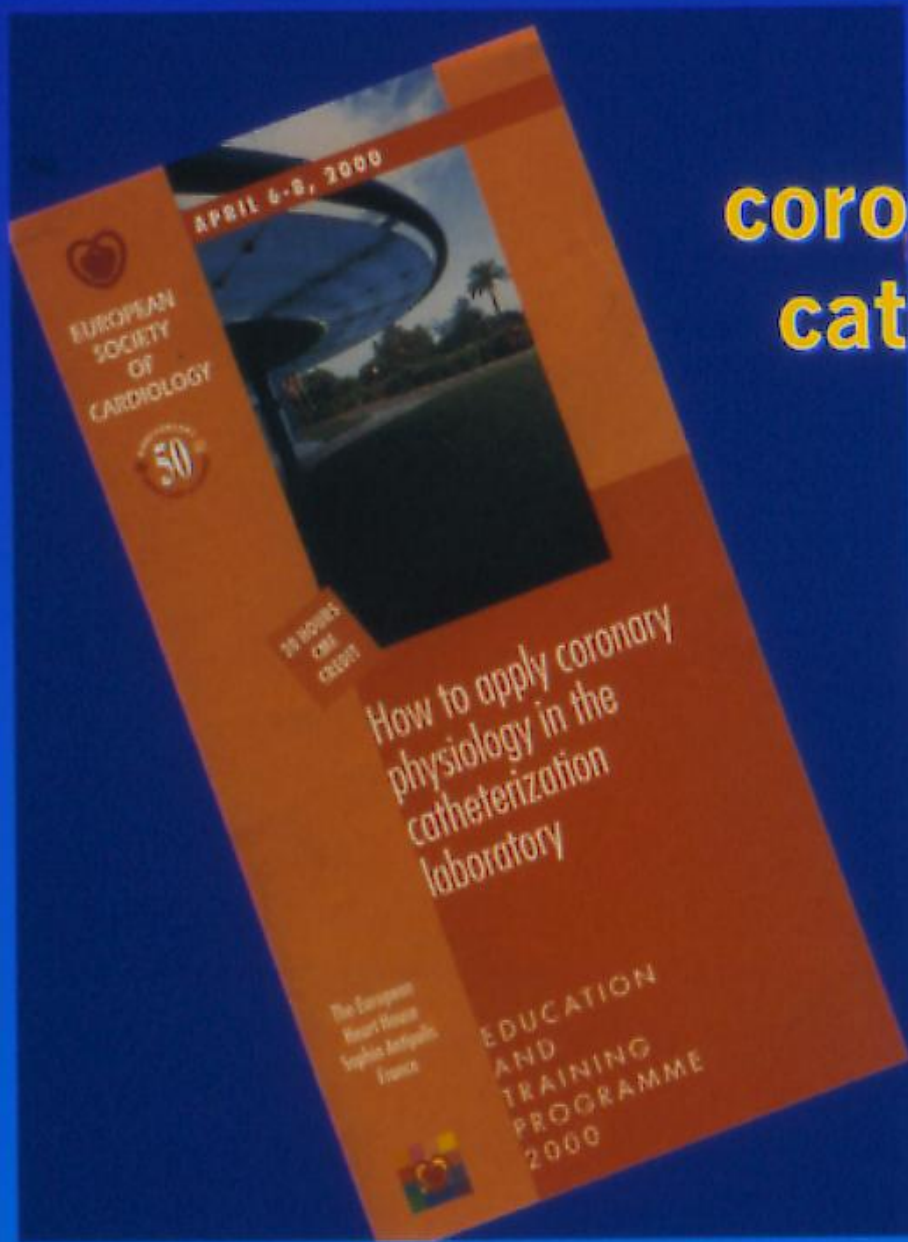
1997-2000 : clinical trials on FFR

How to apply coronary physiology in the catherization laboratory

**Education and Training
Program 2000**

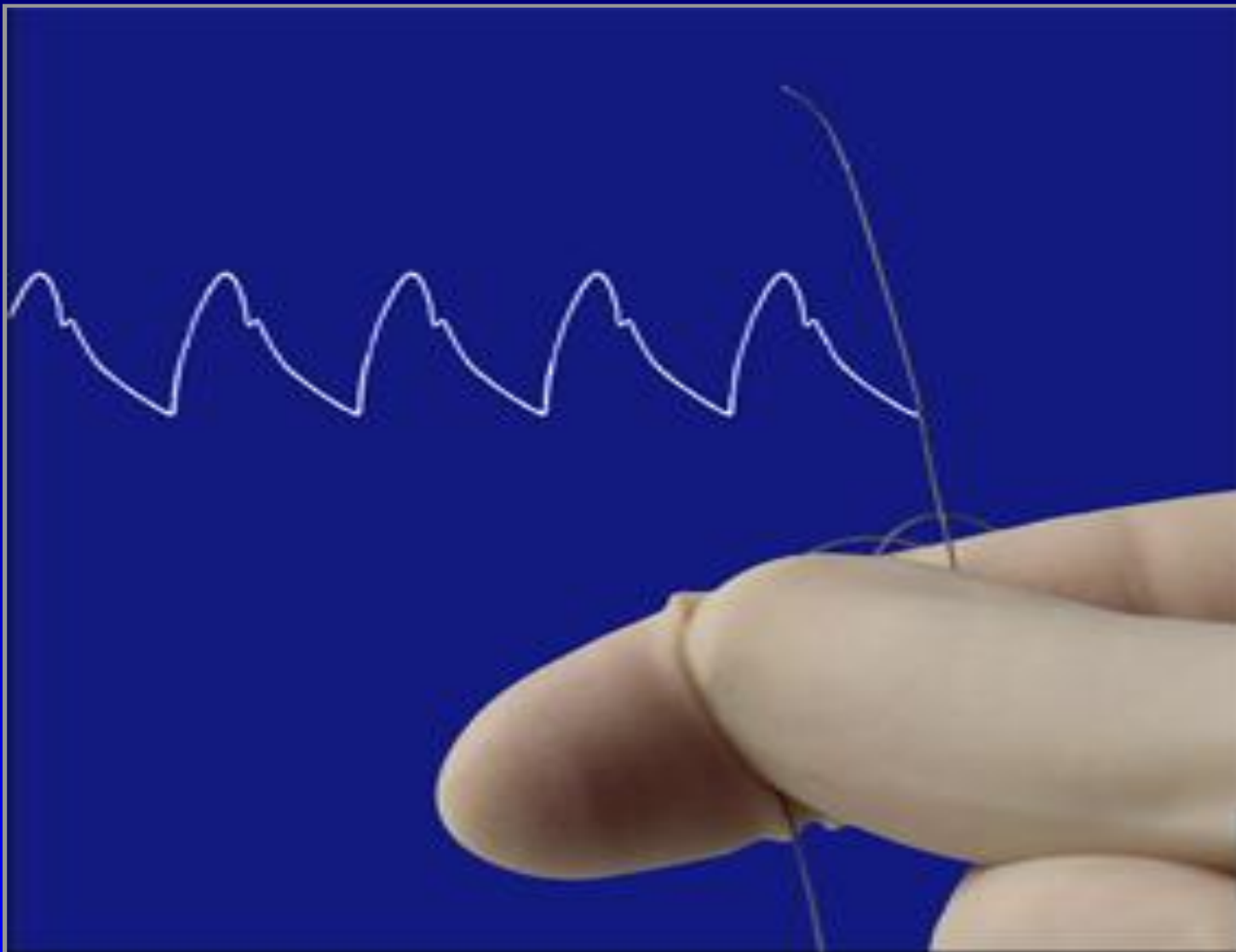
**Nice
European Heart House**

april 6 - 8, 2000





**HOW TO APPLY CORONARY PHYSIOLOGY IN THE
CATHERIZATION LABORATORY, ETP NICE , April 6-8, 2000**



RADI / SJM Pressure Wire
Volcano Wire

**0.014 sensor-tipped
PTCA guidewires**

PRESSUREWIRE[®]

23/06/2004 08:20



(91)
Pa

(65)
Pd

0.71
FFR



ENTER

ESC

F1

REC

STOP
VIEW

FORGET

WARRANTY

o/o

MAIN
VIEW



LIBRARY



CURSOR



ZOOM +



ZOOM -



SCALE

Length 00:28
Cursor 00:22
Rec no 45/45

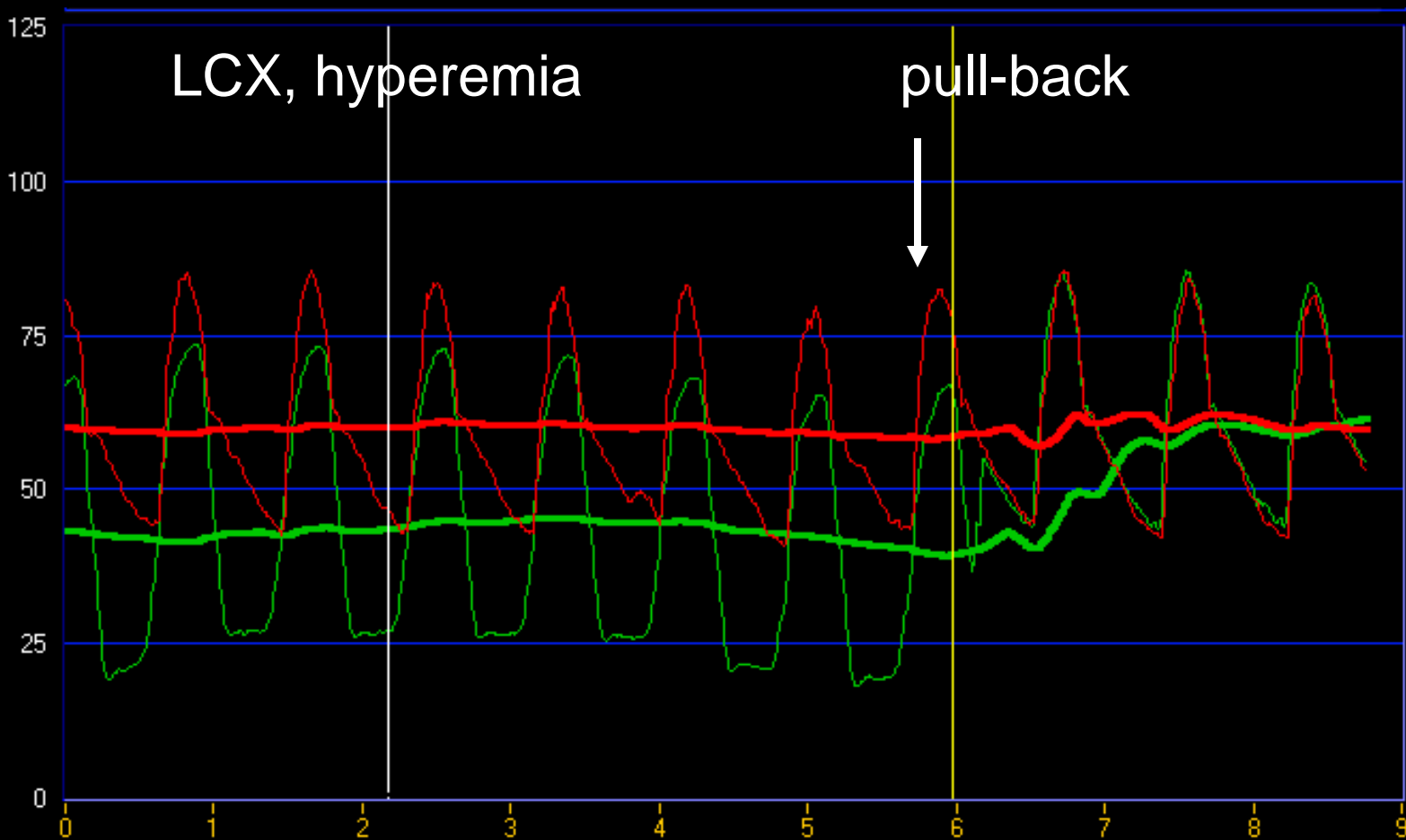
RADI

RADIANALYZER[®]X
PRECISE

PRESSUREWIRE[®] IN



Pressure Pullback Recordings



59
Pa mean

39
Pd mean

0,67
FFR

6,0
Cursor

$$\text{IMR} = \text{Pd} \times \text{Tmn}$$

101

Pa mean

82

Pd mean

0,82

FFR

1.7

CFR

-0,04

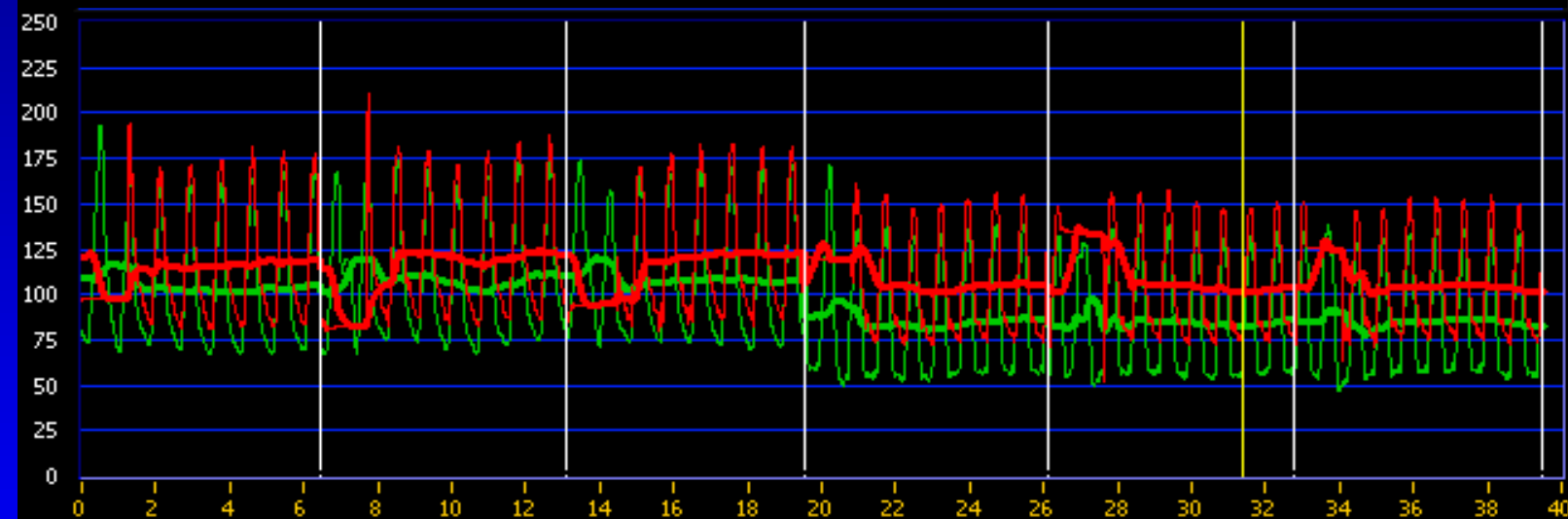
dT

4,2

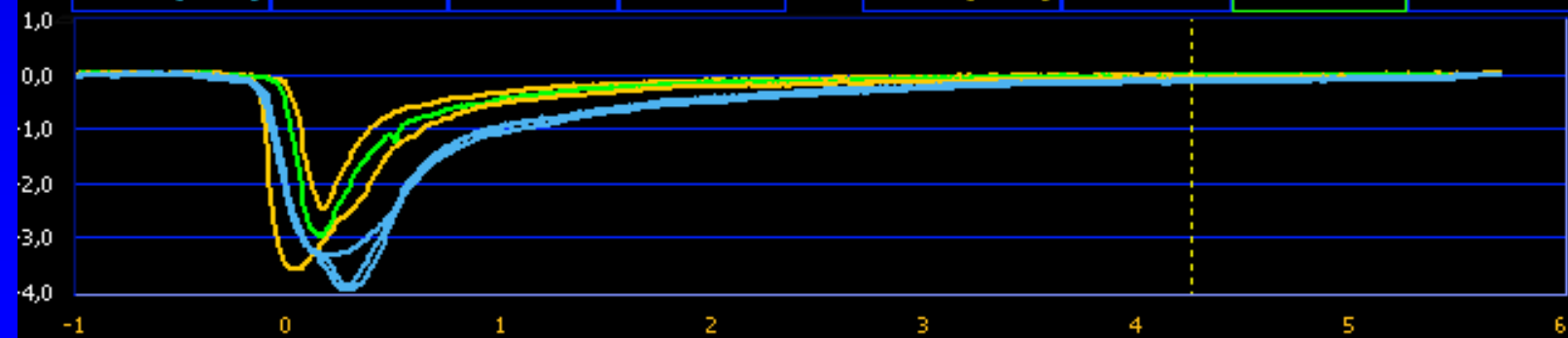
CURSOR



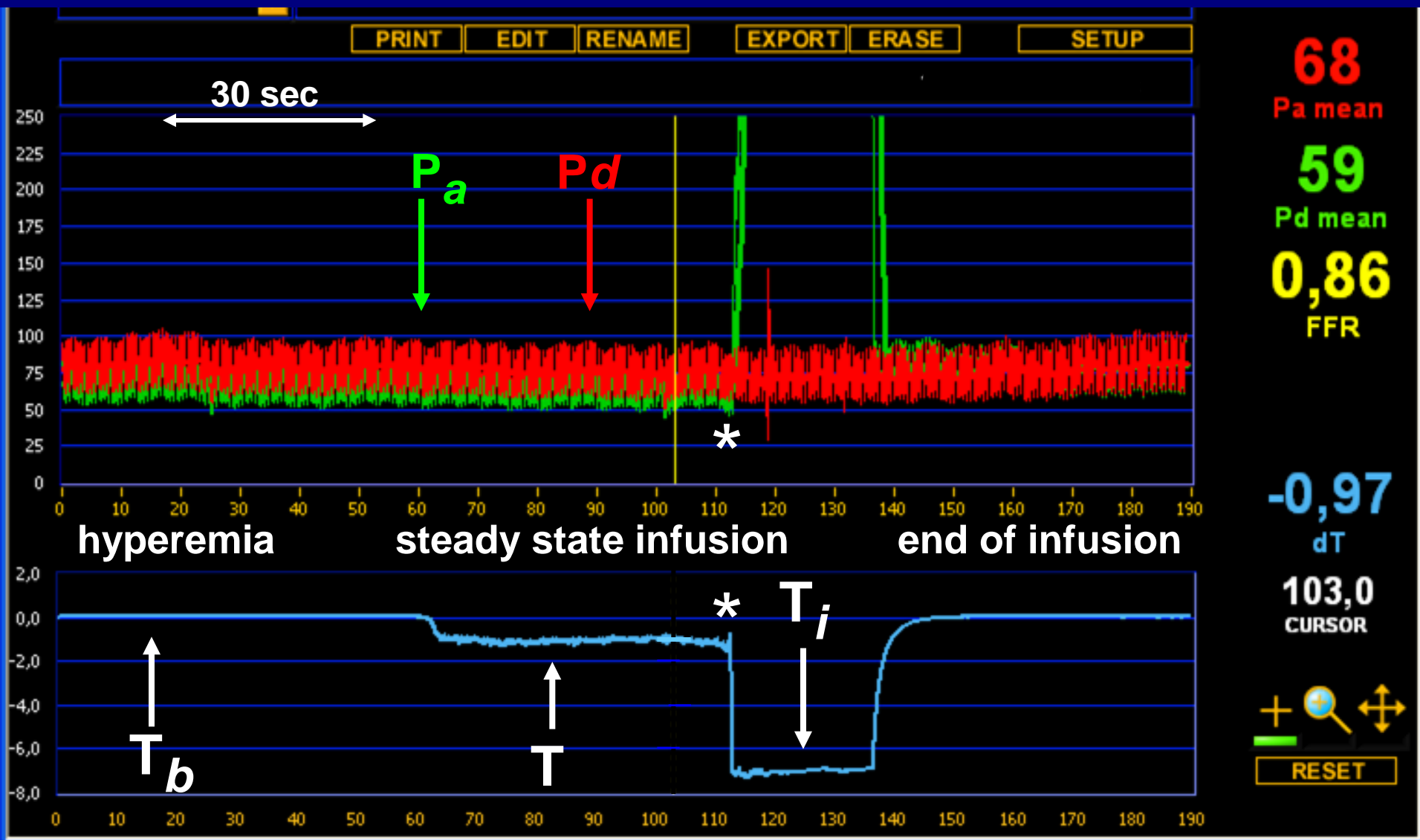
RESET



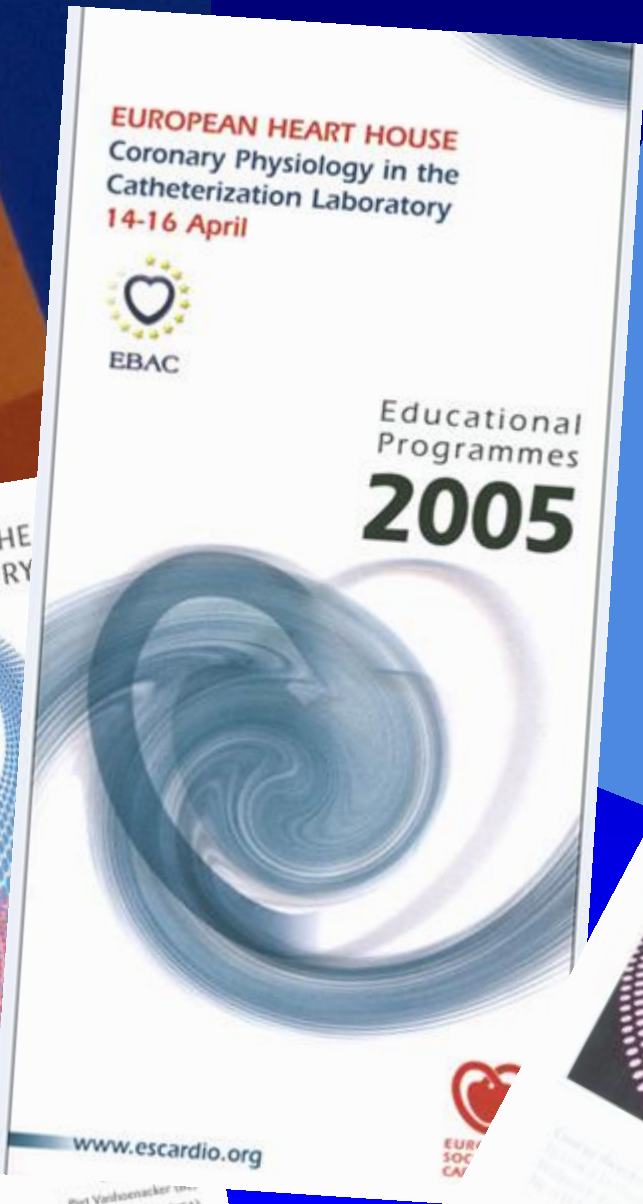
Bas (0.70)	0.74	0.66	0.72	Hyp (0.42)	0.42	0.43	0.42
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absolute coronary blood flow



$$Q_b = 25 \times (-7.1 / -0.97) \times 1.08 = 198 \text{ ml/min}$$



Course directors:
 Piet Vanhooacker (---)
 Peter Verlee (USA)
 Michael Lindstaedt (DE)
 Petr Kala (CZ)

www.escardio.org

EUROPEAN SOCIETY OF CARDIOLOGY

2009

FAME

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

Pim A.L. Tonino, M.D., Bernard De Bruyne, M.D., Ph.D., Nico H.J. Pijls, M.D., Ph.D.,
Uwe Siebert, M.D., M.P.H., Sc.D., Fumiaki Ikeno, M.D., Marcel van 't Veer, M.Sc., Volker Klauss, M.D., Ph.D.,
Ganesh Manoharan, M.D., Thomas Engstrøm, M.D., Ph.D., Keith G. Oldroyd, M.D., Peter N. Ver Lee, M.D.,
Philip A. MacCarthy, M.D., Ph.D., and William F. Fearon, M.D., for the FAME Study Investigators*



Coronary Physiology in the Catheterization Laboratory

07 Apr 2011 - 09 Apr 2011 , Sophia Antipolis - France

ESC Educational
Courses



Coronary Physiology in the Catheterization Laboratory
07 Apr 2011 - 09 Apr 2011 , Sophia Antipolis - France

FAME 2

The NEW ENGLAND JOURNAL *of* MEDICINE

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SEPTEMBER 13, 2012

VOL. 367 NO. 11

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

Bernard De Bruyne, M.D., Ph.D., Nico H.J. Pijls, M.D., Ph.D., Bindu Kalesan, M.P.H., Emanuele Barbato, M.D., Ph.D., Pim A.L. Tonino, M.D., Ph.D., Zsolt Piroth, M.D., Nikola Jagic, M.D., Sven Möbius-Winkler, M.D., Gilles Rioufol, M.D., Ph.D., Nils Witt, M.D., Ph.D., Petr Kala, M.D., Philip MacCarthy, M.D., Thomas Engström, M.D., Keith G. Oldroyd, M.D., Kreton Mavromatis, M.D., Ganesh Manoharan, M.D., Peter Verlee, M.D., Ole Frobert, M.D., Nick Curzen, B.M., Ph.D., Jane B. Johnson, R.N., B.S.N., Peter Jüni, M.D., and William F. Fearon, M.D., for the FAME 2 Trial Investigators*



How has FFR Evolved?

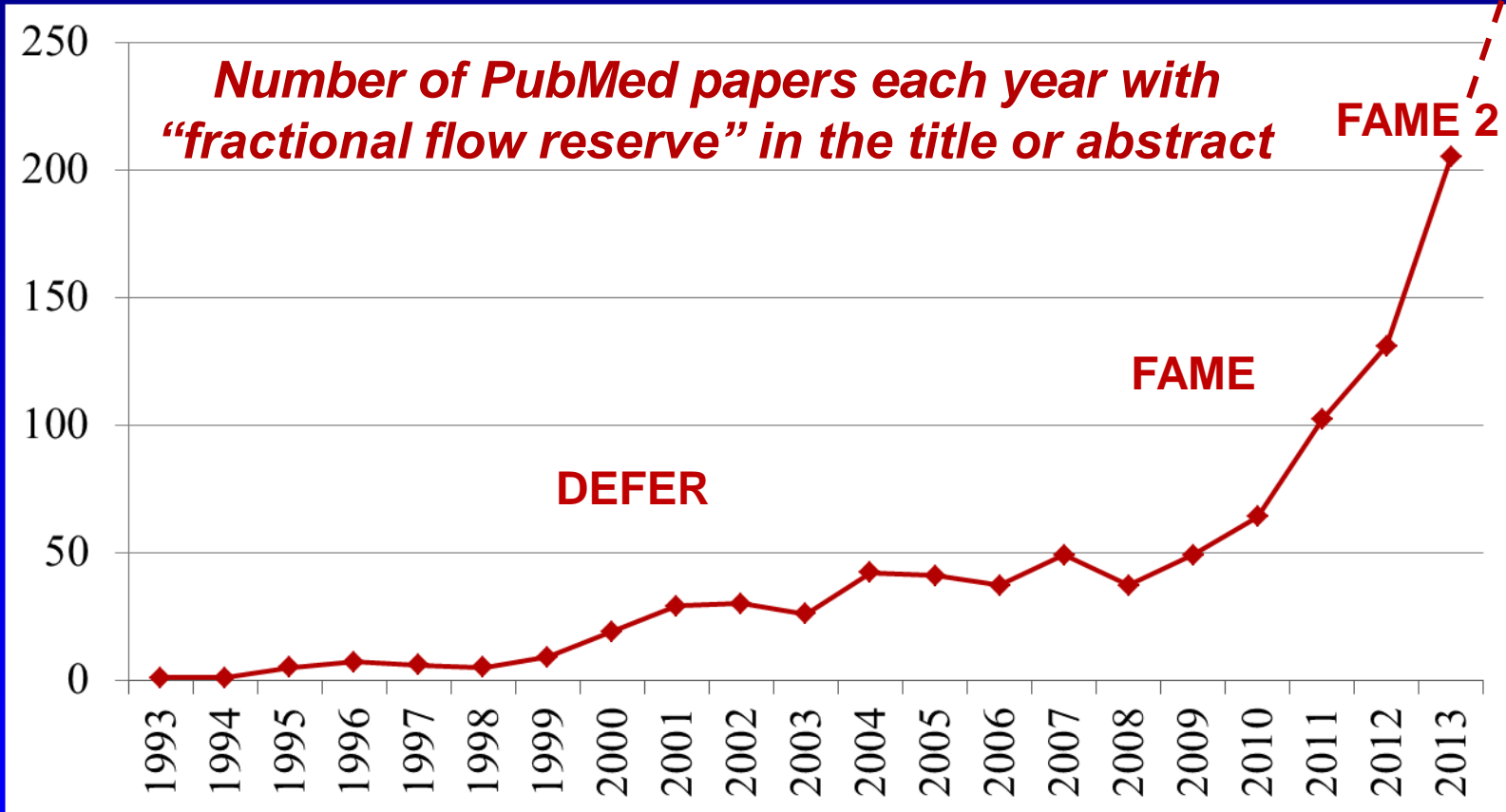
1990s

A tool occasionally (rarely) used for deferring PCI on an intermediate lesion...

2014 and Beyond...

An indispensable component of PCI validated and utilized in a multitude of complex situations...

How has FFR Evolved?



A few announcements & rules of this meeting:

- Stupid questions do not exist
- Be as open and frank as you can, take part in the discussion
- Approach the speakers whenever you like and ask everything you ever wanted to ask about coronary physiology



20th Anniversary of the European Heart House!!