CORONARY PHYSIOLOGY IN THE CATHLAB

Educational Training Program ESC
European Heart House, Nice, April 25th – 27th, 2013

Course Directors:

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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
  
  \[
  \begin{align*}
  & ( Pa = 100, \ Pd = 70 \text{ mmHg} \quad \Rightarrow \quad FFR = 0.70 ) \\
  & ( Pa = 70, \ Pd = 40 \text{ mmHg} \quad \Rightarrow \quad FFR = 0.57 )
  \end{align*}
  \]
Early 1990s: Development of FFR

- 2.8F infusion catheter
- last 15 cm of 0.015 hollow guidewire
- glued together at the kitchen table and sterilized by ethylene oxide
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).
OPENING EUROPEAN HEART HOUSE, JANUARY 1994
First educational & training program: coronary physiology
(course directors: Patrick Serruys and Carlo di Mario)
First pressure “wire” Concept of FFR
1994 – 1997 validation studies of FFR
MEASUREMENT OF FRACTIONAL FLOW RESERVE TO ASSESS THE FUNCTIONAL SEVERITY OF CORONARY-ARTERY STENOSSES

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. Kooaren, 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.)

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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
CATHETERIZATION LABORATORY, ETP NICE, April 6-8, 2000
Coronary Pressure
Second Edition
by
Nico H.J. PIJLS
and
Bernard DE BRUYNE

Kluwer Academic
Publishers, 2000
RADI / SJM Pressure Wire
Volcano Wire

0.014 sensor-tipped PTCA guidewires
Pressure Pullback Recordings

LCX, hyperemia

pull-back
IMR = Pd x Tmn
absolute coronary blood flow

\[ Q_b = 25 \times \left( \frac{-7.1}{-0.97} \right) \times 1.08 = 198 \text{ ml/min} \]
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*
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.,
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Keith G. Oldroyd, M.D., Kretos 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…

2013 and Beyond…
An indispensable component of PCI validated and utilized in a multitude of complex situations…
How has FFR Evolved?

Number of PubMed papers each year with “fractional flow reserve” in the title or abstract
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
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And to St Jude Medical and Volcano Corp