Difficulties and tips & tricks in measurement of FFR.

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I, Robert J. Gil DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.
Invasive Translesion Pressure Measurements

\[ FFR = \frac{P_{\text{dista}} \text{ (hyper)}}{P_{\text{aortic}} \text{ (hyper)}} \]

\[ iFR = \frac{P_{\text{dista}} \text{ (rest, wfp)}}{P_{\text{aortic}} \text{ (rest, wfp)}} \]

\[ \frac{P_{\text{dista}} \text{ (rest)}}{P_{\text{aortic}} \text{ (rest)}} \]
Know your data...

**DEFINE FLAIR**

Hazard Ratio, 0.95 (95% CI: 0.68 to 1.33); p=0.78

**FFR (7.02%)**

**iFR (6.79%)**

<table>
<thead>
<tr>
<th></th>
<th>Define Flair</th>
<th>Swede Heart</th>
<th>FAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event rates (%)</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Syntax Score</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>&gt;15-28</td>
</tr>
<tr>
<td>Ave. FFR</td>
<td>0.83</td>
<td>0.83</td>
<td>0.71</td>
</tr>
<tr>
<td>3V CAD</td>
<td>40%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>PCI Risk</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
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Physiological Lesion Assessment: A continuum

Angiography

> 80%

Left Main?

> 80%

iFR or Rest Pd/Pa

iFR < 0.89
Pd/Pa < 0.91

< 40%

< 40%

< 0.91

≥ 0.91

cFFR

≤ 0.82

Adenosine FFR

≤ 0.80

> 0.80

Revascularization

No revascularization

Know your wire options...

2017 Technology: New Pressure Sensor Wires and Microcatheter

Pressure Wire

Micro-Catheter

Optical Fiber

3 electrical cables

Optical fiber

Electrical sensor
Example of accordion effect on the mid-segment of RCA (arrow) and its complete resolution after removing the wire (right image).

Be careful with wires...
The figure illustrates the example of whipping. When the sensor hits the vessel wall an easily recognizable and correctable artifact may occur.

Be careful with wires...
The high of the transducer
Watch your patient position...

Reverse pressure gradient
Watch your guide position...

Wedging

Guiding catheter

60% area stenosis

Engagement of guiding into ostium

Normal

20% DS

30% DS

5-F

17%

27%

39%

6-F

25%

39%

56%

7-F

34%

52%

76%
Example of the effect of the presence of a 6F guide catheter in a minimally diseased left main on the FFR value of an LAD stenosis.
Illustration of the influence of the introducer needle in the ‘Y-connector.’ Left panel: a thin needle induces a pressure difference of only 2–3 mm Hg. After equalization of the pressures, the needle may be left in the ‘Y-connector’ for the rest of the procedure. A larger needle induces a difference of 10 mm Hg.

Do not forget about introducer needle…
Illustration of electronic equalization of both pressure signals that should be performed when the guidewire’s sensor is just outside the tip of the guiding catheter.
Be careful with LM stenosis assessment…

There is a hope for non-hyperemic indices (e.g., iFR)
iFR

A  Multiple lesions in LAD

Three discrete lesions with diffuse disease; the hemodynamic impact of the lesions can be detected using an iFR manual pullback

B  Manual iFR Pullback

[Graph showing pressure index and time with markers 0.04, 0.12, 0.15]
iFR®
0.93

List of Runs | iFR | FFR |
-------------|-----|-----|
09:35:07 AM  | 0.92|     |
09:35:20 AM  | 0.91|     |
09:35:36 AM  | 0.91|     |
09:35:47 AM  | 0.91|     |
09:35:59 AM  | 0.90|     |
09:37:58 AM  | 0.83|     |
09:39:06 AM  | 0.82|     |
09:51:38 AM  | 0.94|     |
09:51:47 AM  | 0.93|     |
09:51:56 AM  | 0.94|     |
09:52:05 AM  | 0.93|     |
09:52:13 AM  | 0.94|     |
09:53:14 AM  | 0.81|     |
09:54:16 AM  | 0.79|     |

iFR needs good ECG
Physiologic pressure gradient

Resting gradient is diastolic

Different shape of pressure curves
No dicrotic notch in distal pressure curve
When electronic drift occurs, the levels of aortic and coronary pressure are different but the morphology of the tracings is identical. When the levels of aortic and coronary pressure are different but the morphology of the tracings is different, a true pressure gradient is present.
 Congruent shape of pressure curves
 Dicrotic notch present in distal pressure curve

 Drift (2)
Hyperemia – pivotal in FFR

- Insufficient hyperemia
- Under estimation of gradient
- Over estimation of FFR
- Under estimation of stenosis severity
Different Vasodilators Available for Measuring FFR

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
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<tbody>
<tr>
<td>Adenosine</td>
<td>100 μg in RCA/200 μg in LCA as intracoronary bolus</td>
</tr>
<tr>
<td>Nitroprusside</td>
<td>140 μg/kg/min as intravenous infusion</td>
</tr>
<tr>
<td></td>
<td>0.6 μg/kg as intracoronary bolus</td>
</tr>
<tr>
<td>Nicorandil</td>
<td>2 mg as intracoronary bolus</td>
</tr>
<tr>
<td>Regadenoson</td>
<td>400 μg as intravenous slow bolus over 10 s</td>
</tr>
<tr>
<td>Papaverine</td>
<td>8 mg in RCA/12 mg in LCA as intracoronary bolus</td>
</tr>
</tbody>
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ATP, adenosine triphosphate; ic, intracoronary; iv, intravenously; RCA, right coronary artery; LCA, left coronary artery.
if intracoronary injection, FFR should be reproduced by repeated administrations
Intravenous adenosine infusion 140/ug/kg/min

Femoral or Hand vein?

P Scott et al J Am Coll Cardiol Intv 2015 on line
Intravenous adenosine infusion 140 µg/kg/min

Preferred route when a pressure pull-back is wanted

It is almost always associated with a burning sensation

Small fluctuations in Pd/Pa can be observed in some cases

A-V block is seen frequently but are always transient
Contrast FFR (cFFR) = Poor man`s FFR

Contrast gives app. 60% of maximal hyperemia

Optimal binary cutoff = \( cFFR \leq 0.83 \)

- Easy, inexpensive, and safe
- Reproducible
- Available immediately
- Does not depend on specific software platform or ECG
For your clinical decision making remember about...

Perfusion area

![Heart with circled perfusion area and diagrams showing FFR values]

- FFR=0.60: Normal Myocardium
- FFR=0.80: Scar, Normal Myocardium
For your clinical decision making remember about...
For your clinical decision making remember about…

Serial stenosis – cross talk
For your clinical decision making remember about...

Serial stenosis – cross talk

FFR = 0.74
Pressure-derived FFR is a simple, fast, and safe method to achieve functional information about the coronary artery stenosis in the catheterization laboratory.

FFR in fact should be considered as a perfusion imaging tool. The coronary artery pressure pressure measurement allows the operator to determine whether or not a lesion (or several lesions) detected by the coronary angiogram are able to induce myocardial ischemia and also assist in monitoring of the coronary interventions.

There are no major technical adaptations for pressure measurements as compared with a regular diagnostic procedure. The implementation of FFR program in the catheterization laboratory is simple, and the staff can be trained within a few cases. The application of the above-mentioned tips and tricks ascertain the accuracy of FFR measurements allowing appropriate clinical decision making regarding myocardial revascularization in the catheterization laboratory.