Technical approach in (true) bifurcation lesions:

“What have we learned from FFR?”

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Please remind….

• I have **NO** intention to say that FFR should be used in all bifurcation intervention.

• All FFR data of this presentation came from relatively short side branch ostial lesions.

• Side branch IVUS images from main branch catheter pull-back are not true SB ostial images.
What have we learned from “FFR”?

• What is FFR?

  • “What you see” is NOT “what it is”.

• Why?

• Functional outcome of jailed SB lesions
Fractional Flow Reserve

\[
FFR = \frac{Q_{\text{max}}^S}{Q_{\text{max}}^N} = \frac{(P_d-P_v)/R}{(P_a-P_v)/R} = \frac{P_d}{P_a}
\]

- Easily obtained, Stenosis specific, Simple(<0.75→ischemia)
- Reflects both degree of stenosis and myocardial territory

![Significant Stenosis Diagram]
“Are these stenoses significant?”

FFR<0.75 → functionally significant
What have we learned from “FFR”?

• What is FFR?
• “What you see” is NOT “What it is”.

• Why?
• Functional outcome of jailed SB lesions
Angiographic severity vs. Functional significance

SNUH SB-FFR registry, N=153

$r = -0.464$
$p < 0.001$

Koo BK, et al JACC 2005
Angiographic severity vs. Functional significance

N=153

<table>
<thead>
<tr>
<th>Percent stenosis</th>
<th>50% ~ 75%</th>
<th>≥75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFR &lt;0.75</td>
<td>5 (10%)</td>
<td>35 (34%)</td>
</tr>
<tr>
<td>FFR ≥0.75</td>
<td>46</td>
<td>67</td>
</tr>
</tbody>
</table>

False Bifurcation (N=62)

- <75% stenosis: 4%
- ≥75% stenosis: 26%

True Bifurcation (N=91)

- <75% stenosis: 14%
- ≥75% stenosis: 40%
**Angiographic severity vs. Functional significance**

<table>
<thead>
<tr>
<th>FFR</th>
<th>( \geq 70% ) Angiographic Stenosis</th>
<th>50%-70% Angiographic Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \geq 0.75 )</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>&lt;0.75</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Sensitivity 100\%, specificity 55\%, and test accuracy 60\%.

Ziaee A, et al. AJC 2004
Angiographic severity vs. Functional significance

What have we learned from “FFR”?

- What is FFR?
- “What you see” is NOT “what it is”.
- Why?
- Functional outcome of jailed SB lesions
Why the discrepancy?

- Side branch is usually small vessel
  → Myocardium supplied by SB is also small.
IVUS vs CFR/FFR

Vessel diameter: 2.9mm

- Abizaid, et al. AJC 1998

Vessel diameter: 4.2 ± 2.0mm


Vessel diameter: 2.1 ± 0.4mm

**Pearson’s correlation coefficients**

- MLA vs. FFR: r = -0.04
- Max %Obst vs. FFR: r = -0.06
- Lumen Volume vs. FFR: r = 0.01
- MLD vs. FFR: r = 0.27
- %DS vs. FFR: r = 0.01

*All p values: not significant*

Costa, et al. AHJ 2007
Why the discrepancy in large vessels?

3rd EBC

5 months Follow Up

FFR=0.67

FFR=0.93

FFR=0.92

2nd BEC

3rd EBC

5 months Follow Up

Courtesy of Dr Colombo and Dr Airoldi
Why the discrepancy?

• Side branch is small vessel
  → Supplies smaller myocardial territory

• SB ostial lesions are almost always eccentric
Bifurcation, Flow and Shear

Asakura & Karino Circulation Res 1990

Weydahl & Moore J Biomech 2001
Side branch ostial lesion

Eccentric plaque with disease free wall at carina
Why discrepancy????
Why the discrepancy?

- Side branch is small vessel
  → Supplies smaller myocardial territory
- SB ostial lesions are almost always eccentric
- Side branch jail occurs due to both plaque and carina shift
Bifurcation Model

**Finet’s law**

\[ D_1 = 0.678(D_2 + D_3) \]
Why discrepancy????

Before PCI

After Main branch stenting

Main Branch

Side Branch

Stent

Angiographic View
Lumen Area loss << Angiographic diameter loss
“Gentle kiss” to relocate the carina

Pre-intervention  MB stenting  Kissing balloon

* Gentle kiss: Balloon/Artery < 1
Changes of side branch FFR after “gentle kiss”

What have we learned from “FFR”? 

• What is FFR?

• “What you see” is NOT “what it is”.

• Why?

• Functional outcome of jailed SB lesions
6 Month Follow-up Post-PCI

FFR: 0.84

FFR: 0.93

FFR-guided SB intervention

FFR: 0.94

FFR: 0.86

6 Month Follow-up
Functional outcome of Jailed side branches

**Not-treated jailed side branches**

Fractional Flow Reserve

- **Post-PCI**
  - $0.87 \pm 0.06$

- **Follow-up**
  - $0.89 \pm 0.07$

$P=0.1$

*Koo BK, et al. Eur Heart J 2008*
Functional outcome of Jailed side branches

**True bifurcation**

- Post-PCI: 0.87 ± 0.06
- Follow-up: 0.88 ± 0.07

**False bifurcation**

- Post-PCI: 0.88 ± 0.05
- Follow-up: 0.89 ± 0.06

P = 0.5

P = 0.07

**FFR-guided SB intervention**
What have we learned from “FFR”?

• Jailed SB lesion is different from usual MB lesion.
• Angiography overestimates the severity of jailed SB lesion.
• Outcome of functionally non-significant SB lesions is good despite the angiographic severe stenosis.
• More comprehensive anatomical, physiological and rheological insight of bifurcation lesions is still needed.