FFR$_{CT}$ Guidance for the Diagnosis and Treatment of Suspected CAD

The DECISION Trial

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Disclosures

Consultant to HeartFlow
Background: Most Patients with Suspected CAD Undergoing Cath Do Not Have Obstructive CAD

Cath performed in 398,978 pts at 663 US hospitals between 1/2004 - 4/2008 for suspected CAD; median age 61 yrs, 53% men, 26% diabetes, 79% HTN. Obstr. CAD (DS ≥50% in LM or ≥70% in non-LM) in 149,739 pts (37.6%). Non-invasive testing was performed in 83.9% of pts.

39.2% of pts had normal cors (DS <20% in all vessels)

Pts with a + NI test were moderately more likely to have obstr CAD than those who did not undergo any testing (41.0% vs. 35.0%; adj OR 1.28; 95% CI, 1.19 to 1.37), and more than those with equivocal neg test results (41.3%, vs. 27.1% vs. 28.3%, respectively)

Patel MR et al. *NEJM* 2010:362:886-95
More Background

- Heart Team decision-making is recommended for complex CAD
  - However, detailed angiographic anatomy and lesion-specific physiologic significance is not usually known until after invasive coronary angiography
  - Pts and docs prefer ad hoc PCI when feasible – it is difficult to “take pts off the table” to hold these discussions
- Since FFR/iFR is usually done at the time of PCI, stent decisions are usually made “on the fly”
  - Assessing serial lesions/diffuse disease can be particularly challenging – yes, mistakes can be made
## Identifying Anatomically and Functionally Significant CAD

<table>
<thead>
<tr>
<th>Non-Invasive</th>
<th>Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anatomy</strong></td>
<td><strong>Function</strong></td>
</tr>
<tr>
<td>Identify obstructive CAD</td>
<td>Identify vessel-specific ischemia</td>
</tr>
<tr>
<td><img src="image1" alt="Heart Anatomy" /></td>
<td><img src="image2" alt="Function" /></td>
</tr>
<tr>
<td><img src="image3" alt="CT Scan" /></td>
<td><img src="image4" alt="FFR Equation" /></td>
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</tbody>
</table>

### Function

**Identify lesion-specific ischemia**

\[
\text{FFR} = \frac{P_d}{P_a} \text{ at hyperemia}
\]

- **Adenosine**
- **Proximal Pressure (Pa)**
- **Distal Pressure (Pd)**
Identifying Anatomically Vessel-Specific and Lesion-Specific Functionally Significant CAD with a Single Non-invasive Test
Performance of coronary diagnostic tests vs. FFR

- Specificity: 86%
- Sensitivity: 84%
- Accuracy: 86%

Adapted from Nørgaard B et al. Euro Radiology 2015;25:2282-90
PACIFIC: 208 pts underwent CTA, SPECT, PET, and routine 3-vessel invasive FFR

FFR\textsubscript{CT} was analyzable in 180 pts (87%)

FFR ≤0.80 in 81 pts (45%); FFR\textsubscript{CT} ≤0.80 in 114 pts (63%)

Sensitivity, specificity and accuracy vs. invasive FFR

![ROC curve diagram]

- FFR\textsubscript{CT}: AUC 0.94 (0.92-0.96)
- PET: AUC 0.87 (0.83-0.90)
- CT: AUC 0.83 (0.80-0.86)
- SPECT: AUC 0.70 (0.65-0.74)

P<0.001

FFR\textsubscript{CT} vs. all others
584 pts with new onset CP were prospectively assigned to usual testing (n=287) or FFR_{CT}-guided testing (n=297) in different time periods. Local site decided ICA would be performed in 380 pts.

Primary endpoint was catheterization without obstructive CAD: 73.4% with Usual Care vs. 12.4% with FFR_{CT} Guidance, P<0.0001
# PLATFORM Invasive: 1-Year Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Usual Care (n=187)</th>
<th>FFR\textsubscript{CT} Guidance (n=193)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MACE</td>
<td>2 (1.1%)</td>
<td>2 (1.0%)*</td>
<td>0.99</td>
</tr>
<tr>
<td>- Death</td>
<td>1 (0.5%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>- Non-fatal MI</td>
<td>1 (0.5%)</td>
<td>1 (0.5%)</td>
<td></td>
</tr>
<tr>
<td>- Hosp w/urg revasc</td>
<td>0 (0%)</td>
<td>1 (0.5%)</td>
<td></td>
</tr>
<tr>
<td>Cum. Radiation, mSv</td>
<td>10.4 ± 6.7</td>
<td>10.7 ± 9.6</td>
<td>0.21</td>
</tr>
<tr>
<td>Total costs, mean</td>
<td>$12,145</td>
<td>$8,127</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>(FFR\textsubscript{CT} = $0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs, mean</td>
<td>$12,145</td>
<td>$8,975</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>(FFR\textsubscript{CT} = $1400**)</td>
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</tbody>
</table>

*Among 117 pts whose planned ICA was cancelled on the basis of FFR\textsubscript{CT}, only 4 underwent ICA during 1-year FU, and MACE = 0%. **Current ASP
Geometry of the diseased segment on the original computational model is virtually remodeled to enlarge the radius of the lumen according to the proximal and distal reference area to mimic the effects of a stent. Computational analysis of coronary pressure and flow is repeated to determine post-treatment FFR\textsubscript{CT} blinded to invasive FFR results.

Ihdayhid AR et al. JACC Int 2017
FFR$_{CT}$ Planner Application: Virtual Stenting

Before Stenting (A)

Angiography

Invasive FFR

FFR 0.68

After Stenting (B)

Angiography

Invasive FFR

FFR 0.90

Kim KH et al. JACC Intv 2014;7:72-8
**FFR\textsubscript{CT} Planner Application: Virtual Stenting**

**Angiography**

**Before Stenting (A)**

**Invasive FFR**

**CT-derived computed FFR (FFR\textsubscript{CT})**

**After Stenting (B)**
Interactive $\text{FFR}_{\text{CT}}$ Planner to Guide Stenting

Baseline $\text{FFR}_{\text{CT}}$ highly positive
4 stenting strategies evaluated
Interactive $\text{FFR}_{\text{CT}}$ Planner to Guide Stenting

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Interactive $\text{FFR}_{CT}$ Planner to Guide Stenting

Baseline $\text{FFR}_{CT}$ highly positive
4 stenting strategies evaluated

Bl 1 2 – Stent PRCA and MRCA

Sonck J et al. EuroIntervention 2018;14:924-925
Interactive $\text{FFR}_{\text{CT}}$ Planner to Guide Stenting

Baseline $\text{FFR}_{\text{CT}}$ highly positive
4 stenting strategies evaluated

Bl 1 2 3 – Stent PRCA, MRCA and DRCA
Interactive FFR$_{CT}$ Planner to Guide Stenting

Baseline FFR$_{CT}$ highly positive
4 stenting strategies evaluated

1 – 3: Stent PRCA
4 – Stent PRCA and DRCA
Interactive FFR$_{CT}$ Planner to Guide Stenting

Baseline FFR$_{CT}$ highly positive
4 stenting strategies evaluated

Recommended

Sonck J et al. EuroIntervention 2018;14:924-925
FFR\textsubscript{CT} Planner Superior to FFR? Case report

Baseline

After stent lesion B

After stent lesion A
FFR$_{CT}$ Planner Superior to FFR?
Better strategy:
Stent lesion A only

Baseline

Ihdayhid AR et al. JACC Int 2017
FFR$_{CT}$ Planner Superior to FFR?

Better strategy:
Stent lesion A only

Baseline

Baseline

After virtually stenting lesion A
DECISION Trial
A multicenter randomized trial of FFR<sub>CT</sub>-guided selective angiography and FFR<sub>CT</sub>-guided revascularization compared with routine angiography and FFR/iFR-guided revascularization in pts with suspected CAD in whom angiography is intended

~5000 troponin negative pts in whom angiography is planned for suspected CAD

Study FFR<sub>CT</sub>
(blinded, w/o incidental findings)

1:1

Angiography
(FFR<sub>CT</sub> stays blinded)
(n=2500)

FFR<sub>CT</sub> guidance
(FFR<sub>CT</sub> is unblinded)
(n=2500)

PI: Gregg W. Stone
AROs: CRF and DCRI; Sponsor: HeartFlow
NHPR = Non-Hyperemic Pressure Ratio: iFR, RFR, dPR, dFR
DECISION Trial

Primary endpoints (sequentially tested):

1) 2-year MACE\(_1\): all-cause death, MI, or ischemia-driven revascularization (time-to-first event, powered for noninferiority)

2) 2-year MACE\(_2\): all-cause death, MI, all revascularization, cardiac catheterization without actionable cardiac pathology (requiring transcatheter or surgical cardiac intervention within 30 days) (Finkelstein-Schoenfeld hierarchical testing, powered for superiority)

Secondary powered endpoints (sequentially tested):

1) 2-year rate of cardiac catheterization without actionable cardiac pathology (time-to-first event, powered for superiority)

2) 2-year total costs (powered for superiority)
Conclusions

- CTA w/FFR$_{CT}$ provides data on coronary anatomy and physiology which more strongly correlates with invasive FFR than any other non-invasive diagnostic test

- Non-randomized studies suggest deferral of ICA in pts with negative FFR$_{CT}$ may safely obviate unnecessary ICA

- The FFR$_{CT}$ Planner has been developed to allow the local heart team to reach revascularization decisions prior to ICA, and provide interventional guidance for PCI procedures w/o the need for invasive physiology

- The DECISION Trial is a large-scale randomized study which will determine whether FFR$_{CT}$-guidance with use of the FFR$_{CT}$ Planner in pts in whom ICA is otherwise planned may safely defer unnecessary cardiac catheterization procedures while improving overall clinical outcomes and reducing costs