FFR in the diagnostic phase

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Diagnostic angiography without pressure wire assessment can no longer be considered to be an optimal standard of care for patients with chest pain.
This talk contains 2 challenges to your conventional way of thinking
Current practice for assessment & management of angina is fundamentally flawed......
Patient with chest pain

Test for evidence of reversible ischaemia

Diagnostic Angiogram

OMT

CABG
What is our current philosophy for the investigation & treatment of patients with stable angina?

“Everyone with chest pain should have an angiogram”

“Only patients with objective evidence of ischaemia should have an angiogram”

“A significant stenosis is better off being treated”
When someone presents with chest pain that we think is angina, what is it that we actually want to know?

**Whether they have:**

- Atheroma?
- “Significant” coronary artery disease?
- Impaired prognosis?

How much of this can we address by doing a coronary angiogram?
CAD present?

Benefit from aspirin/statin/ramipril?

Symptoms due to this CAD?

Needs revasc?
✔ Ischaemia is the dominant factor to determine clinical outcome
✔ There are problems with all our NI tests for ischaemia

So... Should everyone have an angiogram?

R Swallow, I Court, A Calver, N Curzen

Int J Cardiol 2006;106:123-5
Pressure Wire: diagnostic precision in an ischaemia-directed strategy

FFR has a high accuracy for detecting myocardial ischaemia. More specifically, FFR < 0.75 has 100% specificity for indication inducible ischaemia, whereas a FFR > 0.80 has a sensitivity of >90% for excluding inducible ischaemia.
RCA:
Min FFR = 0.96

LAD:
Min FFR = 0.84

Intermediate:
Min FFR = 0.84

Diagonal
Min FFR = 0.82

Multivessel Disease
Stents or Surgery?

No.... MEDICAL!
What does this mean for routine angiogram-guided practice??

- How many patients have PCI who didn’t need it?
- How many patients have CABG when they didn’t need it?
- How many patients are reassured or given OMT when they need revasc?
Our current practice for assessment & management of angina is flawed & confused........

You cannot rely on what you see at angiography if your currency is “significance”
Patient with chest pain

Test for evidence of reversible ischaemia

Diagnostic Angiogram

OMT

PCI

CABG

DEFER

FAME

FAME 2

OMT

CABG
Does Routine Pressure Wire Assessment Influence Management Strategy at Coronary Angiography for Diagnosis of Chest Pain?
The RIPCord Study

Hypothesis

That, in patients with coronary artery disease, routine assessment of FFR could lead to different management strategy derived from diagnostic angiography.

Or, in other words......

“How different is our management with FFR compared with angio alone?”
Patient being investigated for chest pain

Diagnostic Coronary Angiogram by Cardiologist 1

FFR* of all patent vessels of stentable (>2.25mm) diameter by Cardiologist 2

Primary endpoint based upon the difference between **Plan 1** and **Plan 2**

**Method**

n=200

**TREATMENT PLAN 1**
Medical/PCI/CABG/more info

**Cardiologist 1 shown FFR results**

**TREATMENT PLAN 2**
Medical/PCI/CABG/more info

*FFR<0.8

18-May-15
18/05/2015

The RIPCORD Study
Summary

In a total of 64 cases (32%), FFR leads to a change in the judgement as to whether a coronary artery has a “significant” lesion compared to angiogram alone.
Results: PRIMARY ENDPOINT

Management of population by angiogram versus FFR

<table>
<thead>
<tr>
<th>PLAN 1</th>
<th>FFR</th>
<th>PLAN 2</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>Medical</td>
<td>PCI</td>
<td>CABG</td>
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<tr>
<td>Total</td>
<td>89</td>
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<td>30</td>
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</table>

Fishers exact test  p<0.0001

Summary
- Agreement about category of management in 147 out of 200 (74%)
- ie after FFR management change in 26% of cases

The RIPCORD Study
No matter how experienced you are...
No matter how “tight” the lesion looks...

You will be wrong about “significance” on the angio in about 30% of lesions!

And it’s NOT just Intermediate lesions!!!!
IMPLICATIONS

These results have potentially important implications for clinical practice:
- management of patients with stable angina by angiogram alone is flawed
- management of patients would be improved by routine use of FFR at the diagnostic stage

A large scale randomised trial of angiographic- versus FFR-guided assessment & management of patients undergoing diagnostic angiography with stable angina is now warranted

RIPCORD 2

1100 patient randomised trial of angio-guided versus FFR-guided management in patients with chest pain
- n=1075 consecutive patients undergoing diagnostic angiography including an FFR Investigation

- Patients had to have at least 1 angiographically ambiguous lesion

- Primary objective was to describe the rate of reclassification of the patient’s coronary revascularisation strategy by an intention to use FFR in patients referred for coronary angiography
Change of Revascularization strategy in 43% of patients

- Overall: 43%
- Medical: 34%
- PCI: 56%
- CABG: 51%

« A priori » strategy

- Overall: n=1075
- Medical: n=587
- PCI: n=409
- CABG: n=79

- Changed
- Unchanged
Final Revascularization strategy according to the initial strategy group

- **Medical**
  - Initial strategy: 587
  - Final strategy: 26 (Medical: 67)

- **PCI**
  - Initial strategy: 409
  - Final strategy: 44 (PCI: 48)

- **CABG**
  - Initial strategy: 79
  - Final strategy: 49 (CABG: 38)

- **Final strategy**
  - CABG: 49
  - PCI: 44
  - Medical: 26

« A priori » strategy
“SAME TIME, SAME PLACE”

Angiogram with FFR:

(a) definitive diagnosis & (b) ischaemia-directed management
Current strategies for diagnosis & management of chest pain are confused.

Current patient-level treatment is not ischaemia-driven in most cases.

Current lesion-level treatment is not ischaemia-driven or targeted.

Routine FFR at the coronary angiogram stage would facilitate patient-level & lesion-level tailored therapy in the same manner as in FAME 1 & 2, but at an earlier stage of the care pathway.

If treatment was ischaemia-tailored the results of COURAGE & SYNTAX may have been very different.

RIPCORD 2 will help us understand this....

**USE FFR LIBERALLY IN YOUR PRACTICE: FOR THE SAKE OF YOUR PATIENTS!!**
I do not think diagnostic angiography **without FFR** can any longer be considered to be an optimal standard of care for patients with chest pain.....

What if we could do all this non-invasively one day?
Noninvasive Fractional Flow Reserve Derived From Computed Tomography Angiography for Coronary Lesions of Intermediate Stenosis Severity
Results From the DeFACTO Study

Circ Cardiovasc Imaging 2013
Figure 2: Comparison of (A) multiplanar reformat of CTA, (B) invasive coronary angiography with FFR value, and (C) FFR\textsubscript{CT} showing a hemodynamically significant stenosis of the left anterior descending artery. Reproduced with permission from Elsevier and Dr. Bon-Kwon Koo, Seoul National University Hospital.
Clinical Validation Data

- **DISCOVER-FLOW**
  - Completed 2011
  - N=104 patients
  - First in man pilot

- **DeFACTO**
  - Completed 2012
  - N=252 patients
  - 17 US/OUS sites

- **NXT**
  - Completed 2013
  - Focus on intermediate lesions
  - N=254 patients
Noninvasive Fractional Flow Reserve Derived From Computed Tomography Angiography for Coronary Lesions of Intermediate Stenosis Severity
Results From the DeFACTO Study

- N=407 vessels from 252 vessels
- All had invasive angio + FFR

![Bar chart showing accuracy, sensitivity, specificity, PPV, and NPV for FFR$_{CT}$ ≤ 0.80 and CT ≥ 50%]

Figure 2. Per-vessel diagnostic performance of fractional flow reserve derived from computed tomography angiography (FFR$_{CT}$) and CT stenosis among intermediate stenosis severity (30%–69%). NPV indicates negative predictive value; and PPV, positive predictive value.
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Circ Cardiovasc Imaging 2013
Diagnostic Performance of Noninvasive Fractional Flow Reserve Derived From Coronary Computed Tomography Angiography in Suspected Coronary Artery Disease

The NXT Trial (Analysis of Coronary Blood Flow Using CT Angiography: Next Steps)

N=254

CTA + FFRCT versus invasive angio + FFR

**Figure 5**

AUC of \( \text{FFR}_{\text{CT}} \) Versus Coronary CTA for Demonstration of Ischemia (\( \text{FFR} \leq 0.80 \)) on a Per-Patient and Per-Vessel Basis

(A) Per-patient; (B) per-vessel. In the per-patient analysis, a \( \text{FFR}_{\text{CT}} \leq 0.80 \) was diagnostic of ischemia, and stenosis >50% at coronary CTA was anatomically obstructive. \( N = 251 \) for subjects and 484 for vessels. AUC = area under the receiver-operating characteristic curve; other abbreviations as in Figures 2 and 3.
• 51 yr old male
• ↑BP; ↑cholesterol; brother MI in 50s
• 4 year history of SOBE... BMI 35...
• Exercise tolerance poor due to SOBE & takes little exercise
• 2 months: additional dull pain across upper chest & sharp pain R neck
• Usually exertional, occasionally at rest

What is my usual management of him?

⇒Test for reversible ischaemia... ? Stress echo  ?stress MRI

Enrolled into Cohort 2 PLATFORM Trial....
- 2 areas of calcification within the LAD
- Mild stenosis in the proximal LAD and a further mild plaque in the mid vessel
- Neither stenosis looks significant
- Step artefact in distal portion of the mid LAD
Diagnostic Performance of Noninvasive Fractional Flow Reserve Derived From Coronary Computed Tomography Angiography in Suspected Coronary Artery Disease

The NXT Trial (Analysis of Coronary Blood Flow Using CT Angiography: Next Steps)

JACC 2014

- N=254
- CTA + FFRCT versus invasive angio + FFR

Negative predictive value for lesions with CTFFR >0.9 was 100%

(206 out of 206 vessels)
What’s coming up... FFR CT?

PLATFORM Study

Hotline @ PCR

The FFRCT RIPCORD study

3D Solution of FFR_{CT} Throughout Coronary Tree
“The times, they are a’changin…”

Bob Dylan