

# FFR at the Diagnostic Angiogram

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# Nick Curzen – Conflicts of Interest

- I have received unrestricted research funding from St Jude Medical
- I have received speaker and consultancy fees from St Jude Medical
- I have received educational grant funding from Volcano

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

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



Prof N Curzen

7-May-14

Our current practice for assessment & management  
of angina is flawed & confused.....



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University Hospital Southampton **NHS**  
NHS Foundation Trust

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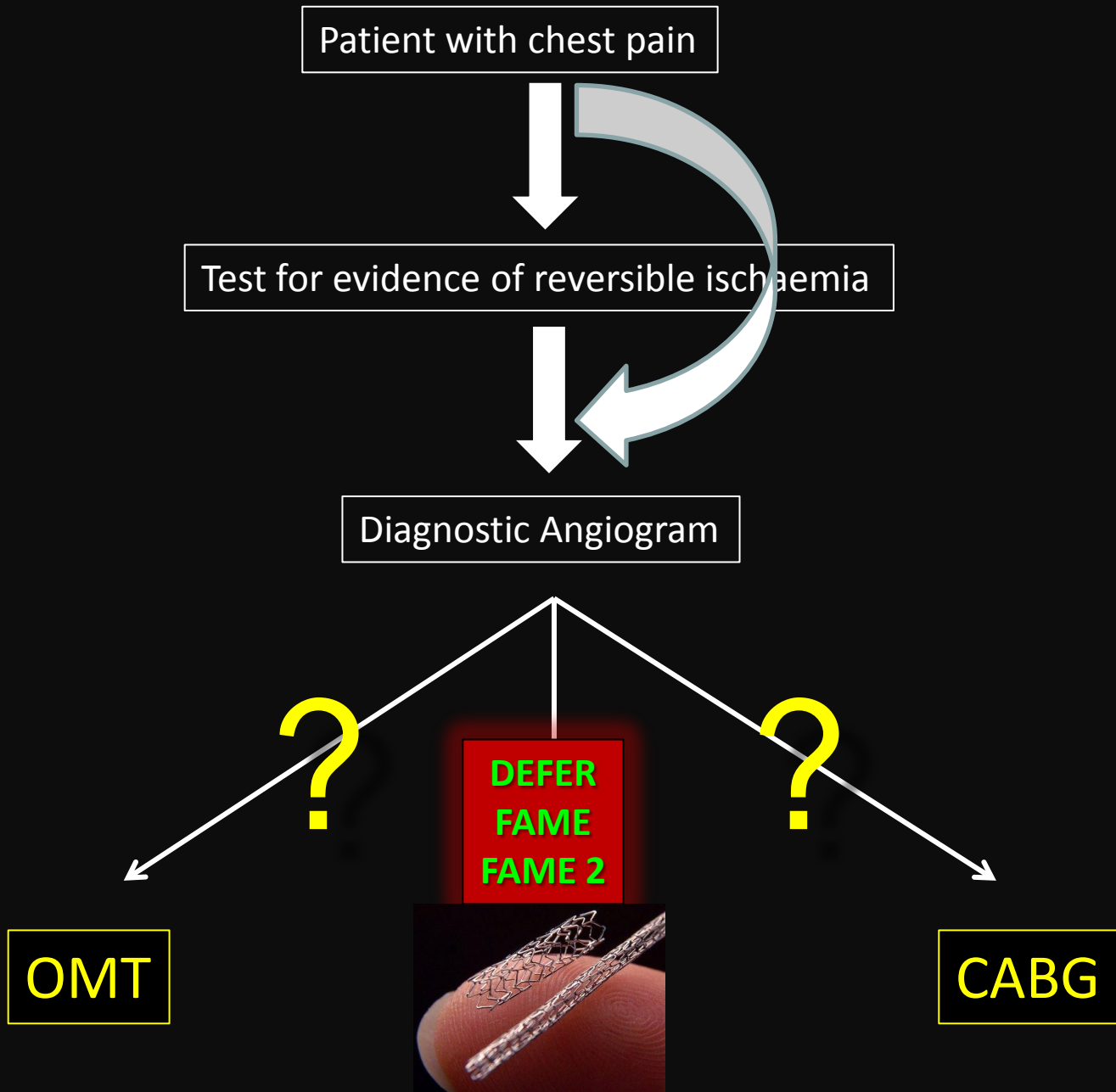
What is our current philosophy for the investigation & treatment of patients with stable angina?

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

*“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”*



Let's ask some questions about what we are trying to do....


*When someone presents with chest pain that we think is angina, what is it that we actually want to know?*

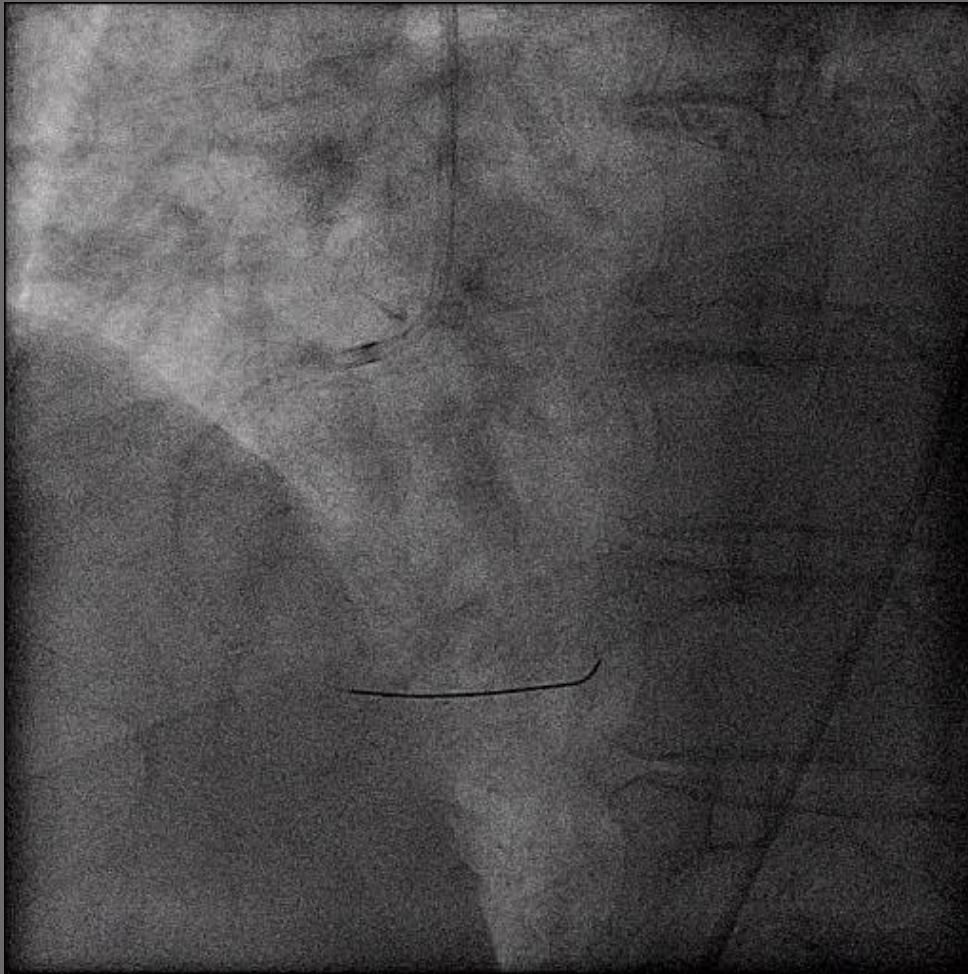
*Whether they have:*

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

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

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CAD present? ✓

Benefit from statin/ramipril? ✓

Symptoms due to this CAD? ?

Needs revasc? ?

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# Why is ischaemia so important?

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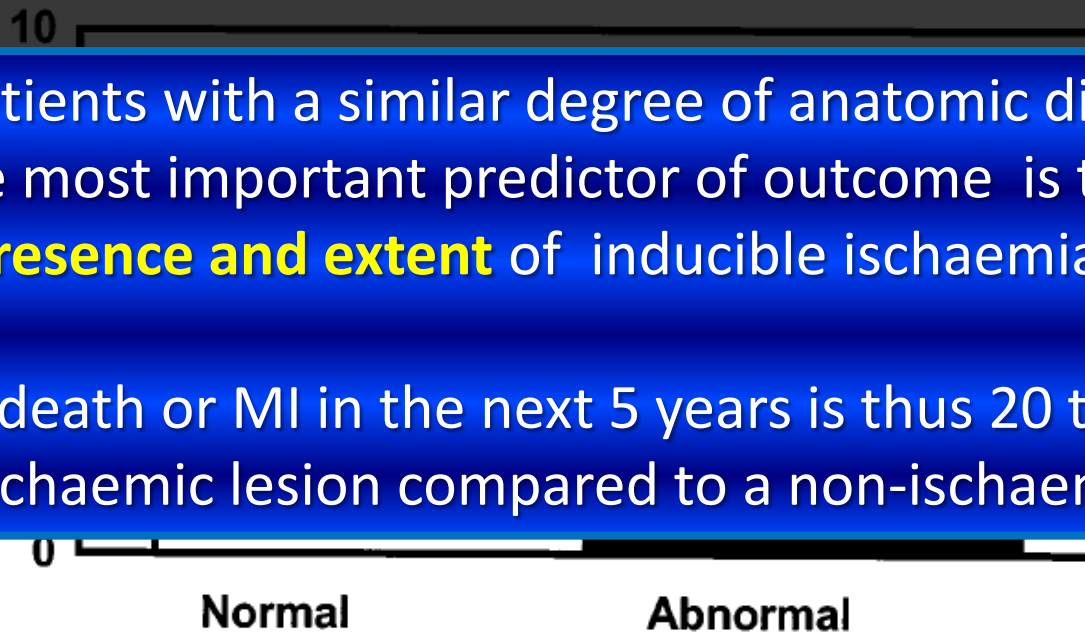
**Risk assessment using single-photon emission computed tomographic technetium-99m sestamibi imaging**

Sherif Iskander, and Ami E. Iskandrian  
*J. Am. Coll. Cardiol.* 1998;32;57-62

12000 patients with similar coronary stenosis severity at angio

“In patients with a similar degree of anatomic disease the most important predictor of outcome is the **presence and extent** of inducible ischaemia”

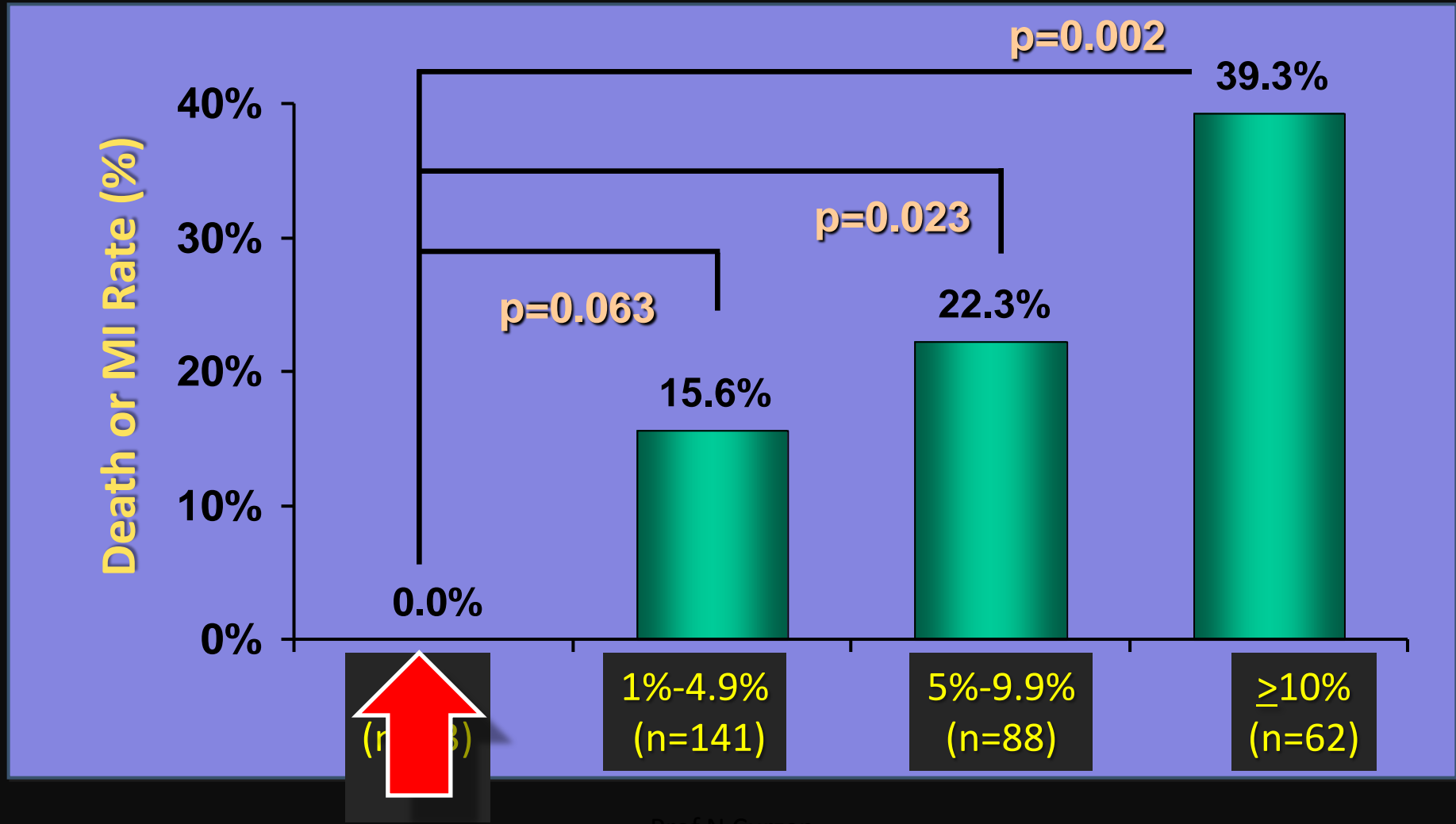
The risk for death or MI in the next 5 years is thus 20 times higher for an ischaemic lesion compared to a non-ischaemic one



**Figure 1.** Rate of hard cardiac events (death or nonfatal MI) in patients with normal and abnormal stress SPECT images.



# Rates of Death or MI by Residual Ischaemia on 6-18m MPS



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# Ischaemia is the dominant factor to determine clinical outcome



# How can we test for ischaemia?

Non-invasive tests have important limitations.....

- Poor diagnostic value (ETT!!)

- Limited access (stress MRI/echo/MPI)

Issue date: March 2014

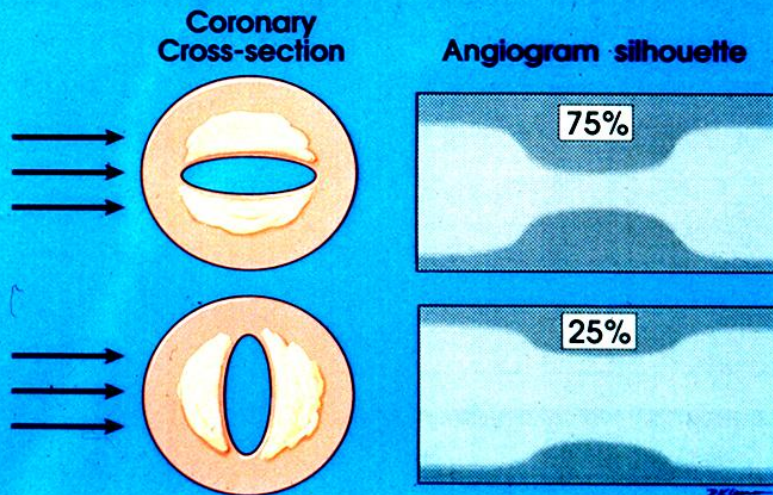
## Chest pain

Assessment of  
onset chest pain  
suspected

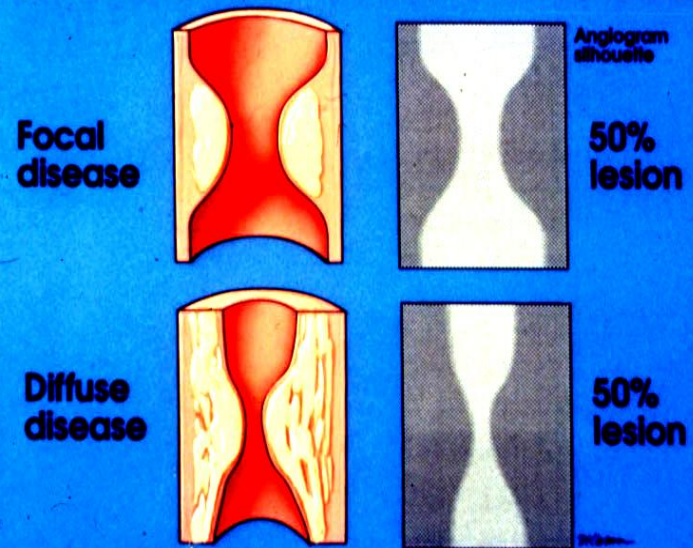
- In people without confirmed CAD, in whom stable angina cannot be diagnosed or excluded based on clinical assessment alone, estimate the likelihood of CAD (see table 1). Take the clinical assessment and the resting 12-lead ECG into account when making the estimate. Arrange further diagnostic testing as follows:
  - If the estimated likelihood of CAD is 61–90%, offer invasive coronary angiography as the first-line diagnostic investigation if appropriate (see recommendations 1.3.4.4 and 1.3.4.5).
  - If the estimated likelihood of CAD is 30–60%, offer functional imaging as the first-line diagnostic investigation (see recommendation 1.3.4.6).
  - If the estimated likelihood of CAD is 10–29%, offer CT calcium scoring as the first-line diagnostic investigation (see recommendation 1.3.4.7). **[1.3.3.16]**
- Do not use exercise ECG to diagnose or exclude stable angina for people without known CAD. **[1.3.6.5]**

So... Should everyone have an angiogram?

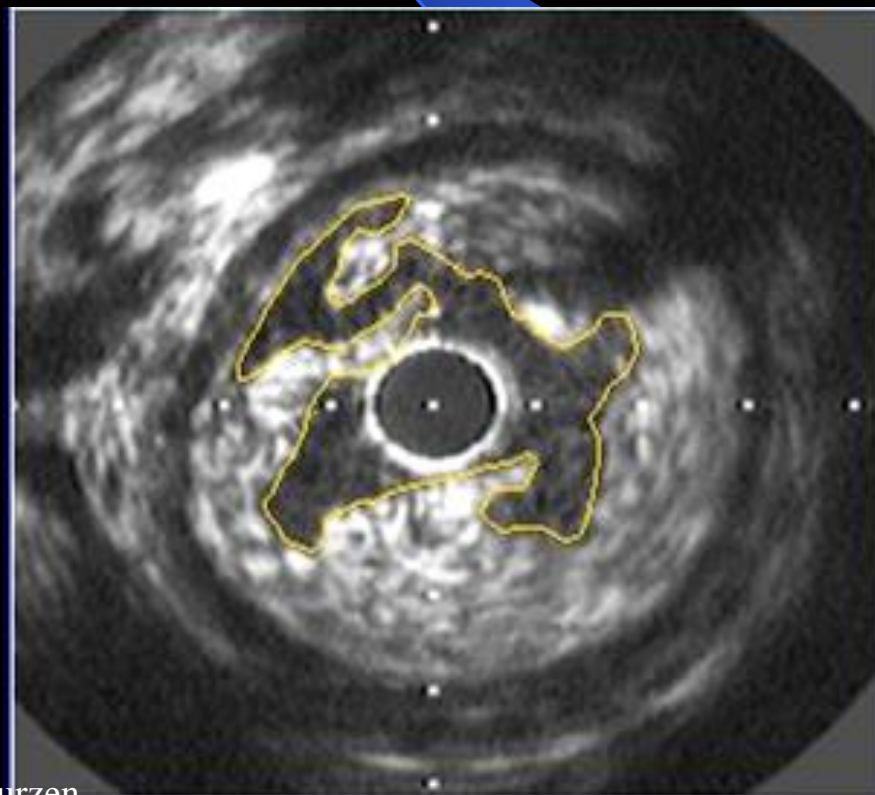
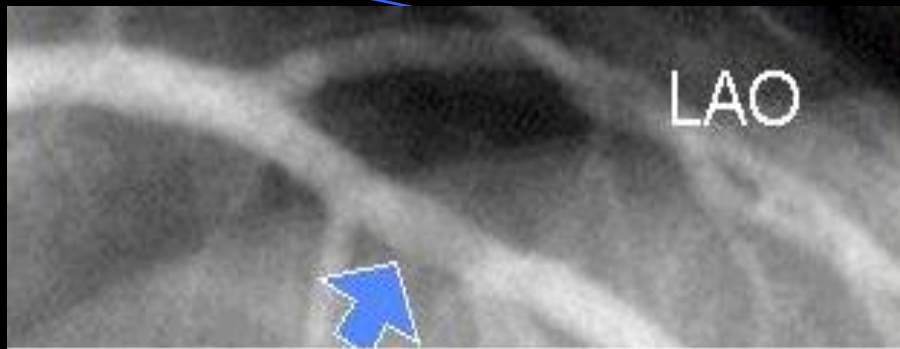
# LIMITATIONS OF CORONARY ANGIOGRAPHY



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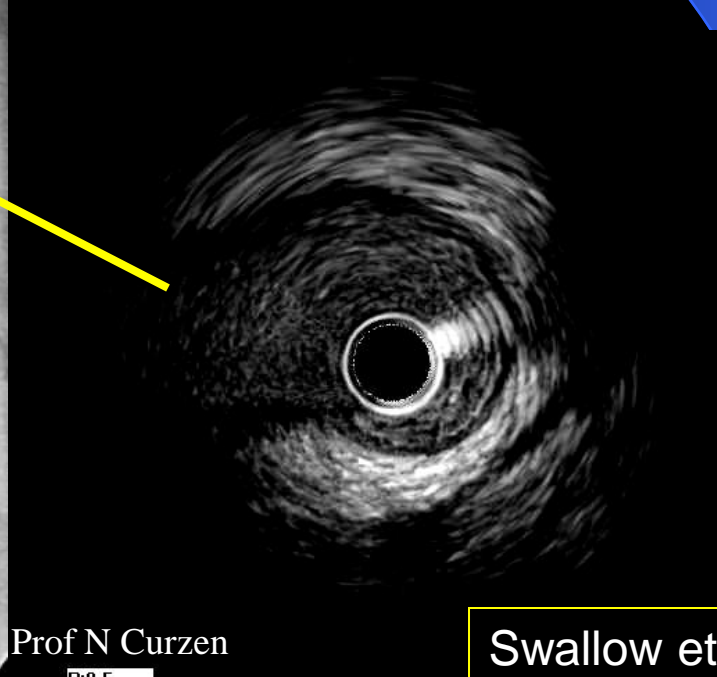
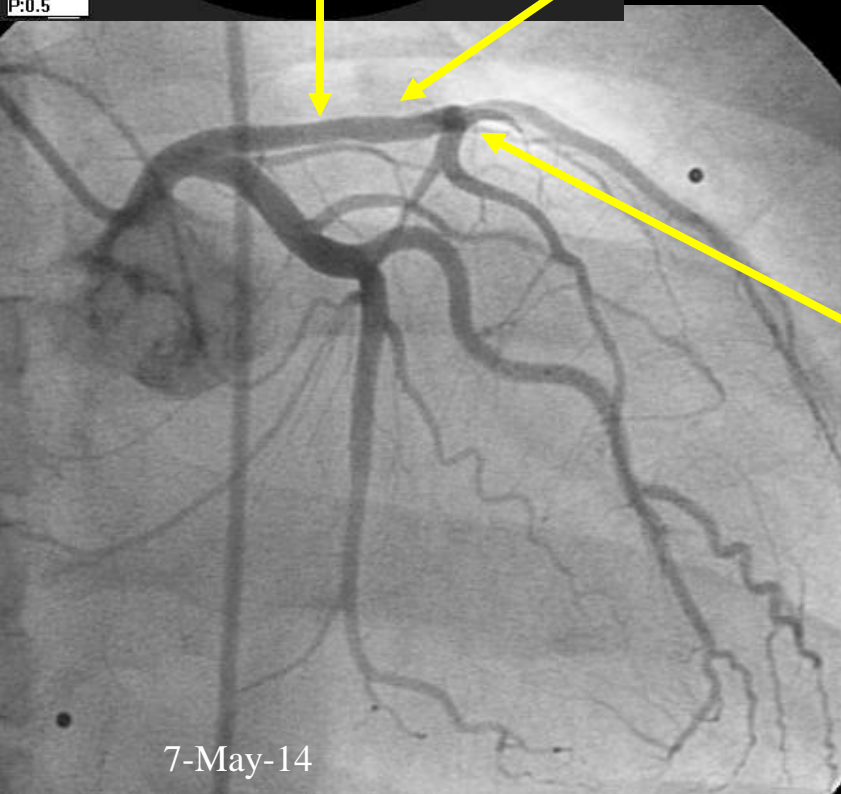
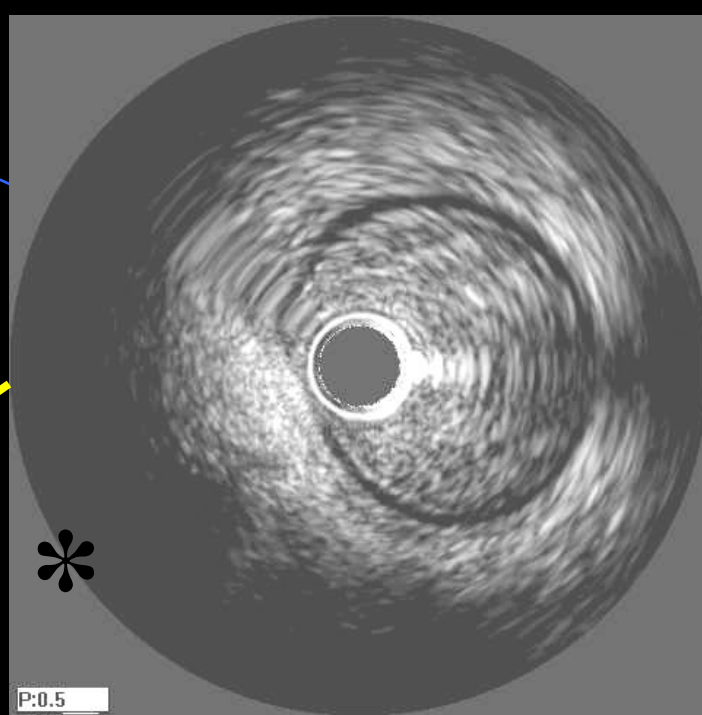
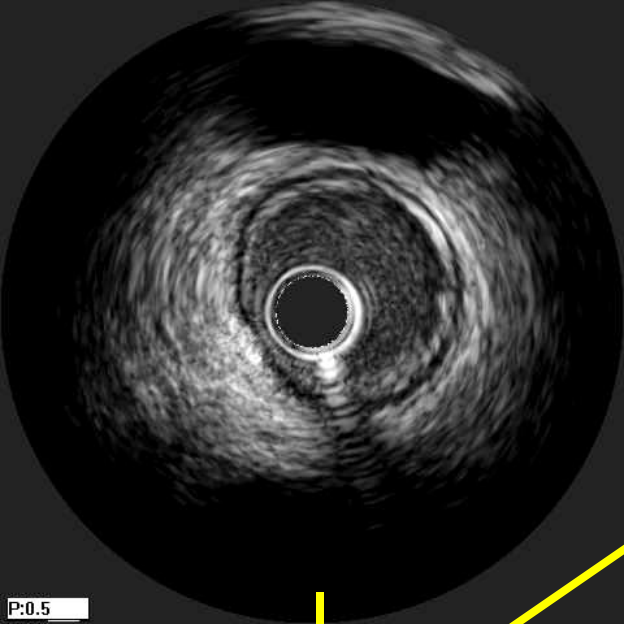
# The Limitations of Coronary Angiography: Identification of a Critical Coronary Stenosis using Intravascular Ultrasound.

R Swallow, I Court, A Calver, N Curzen



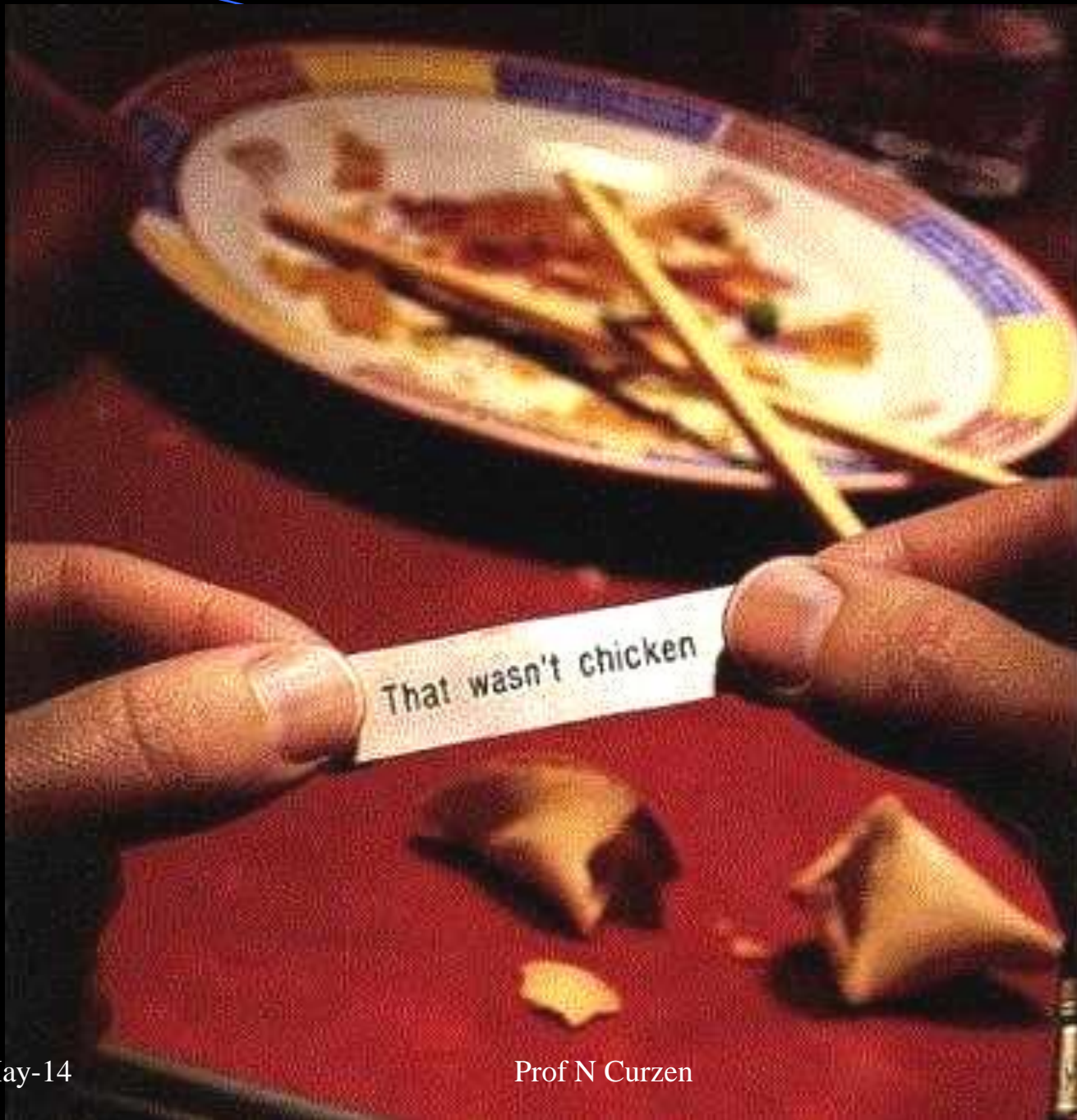
7-May-14

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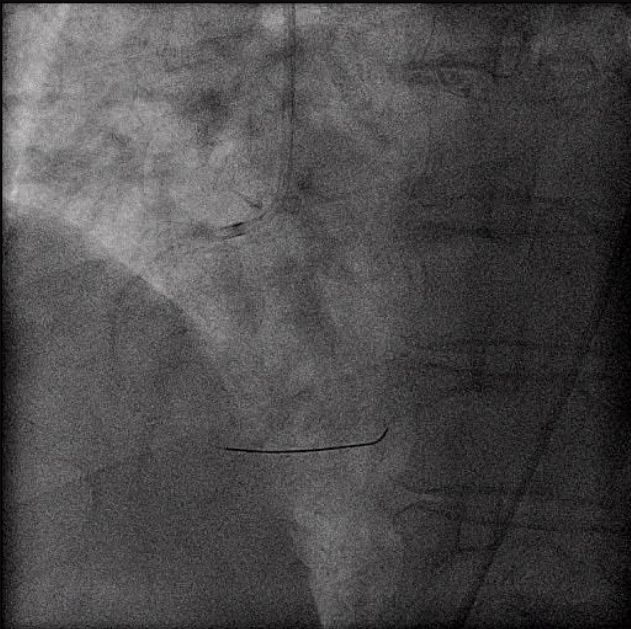
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P:0.5

Swallow et al Int J Cardiol



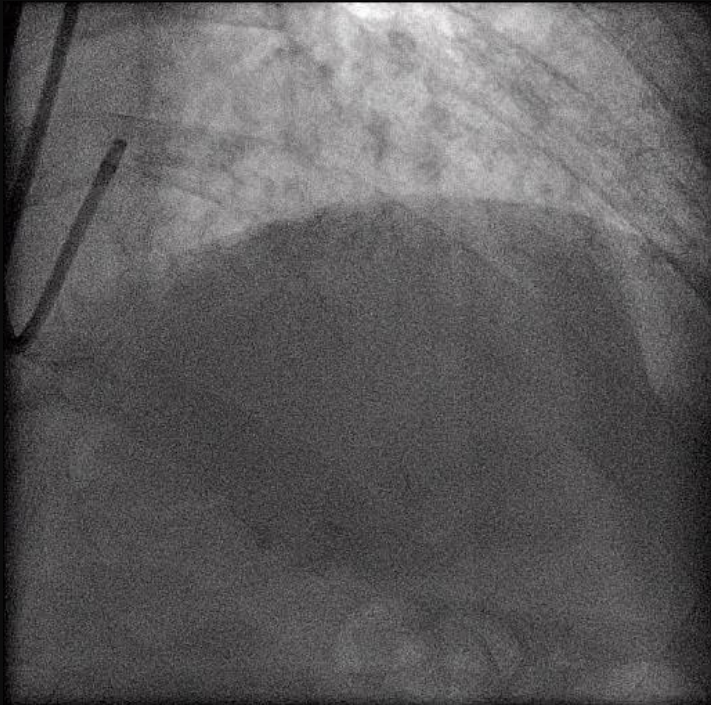
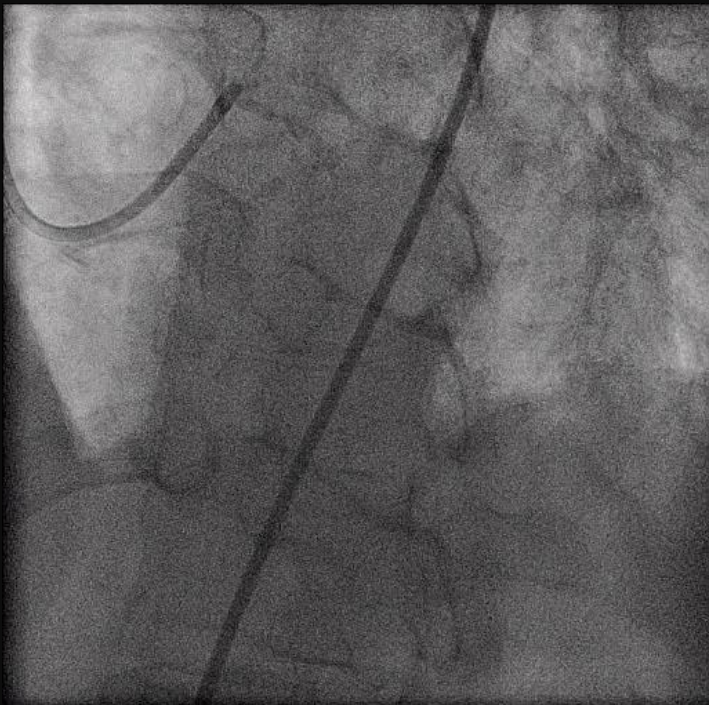
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Multivessel Disease.....  
Stents or Surgery?

stents or surgery?  
Multivessel Disease.....



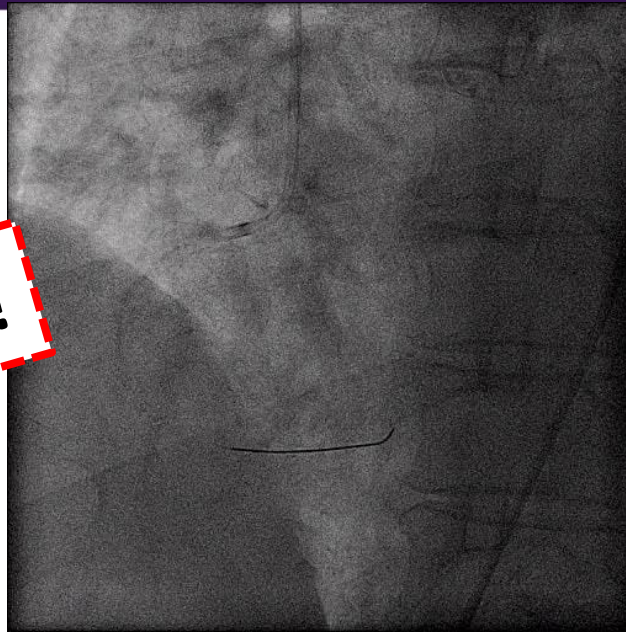
## Pressure Wire: Our perfect “let out” device



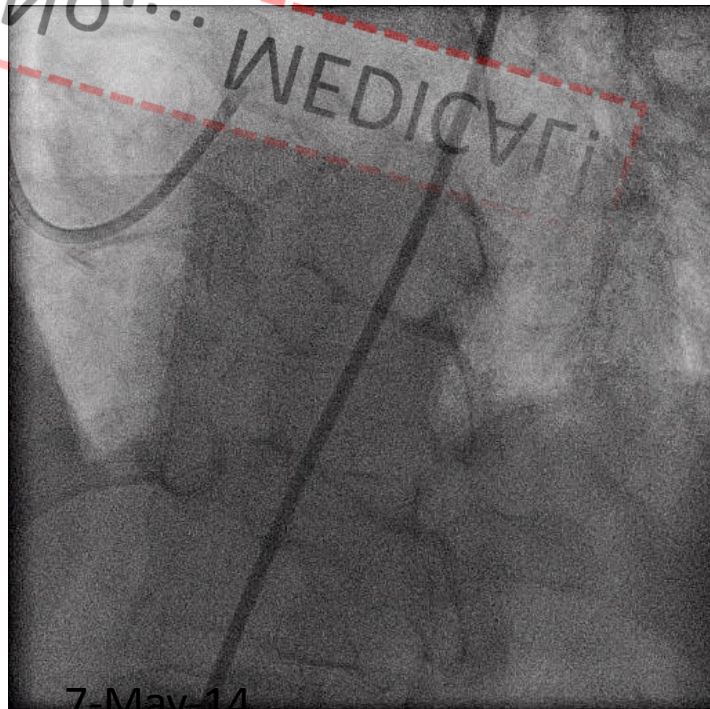
Multivessel Disease

Stents

**No.... MEDICAL!**



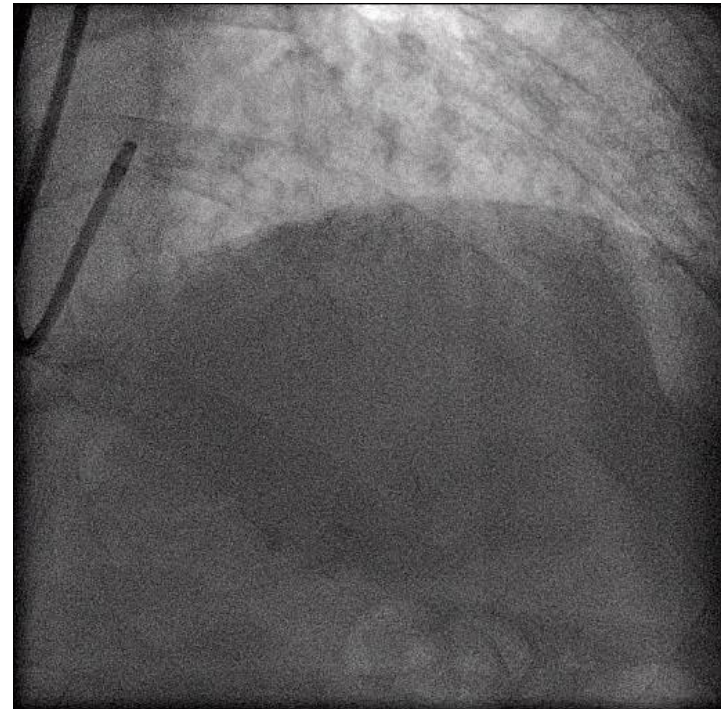
RCA:  
Min FFR = 0.96



LAD:  
Min FFR = 0.84

Intermediate:  
Min FFR = 0.84

Diagonal  
Min FFR = 0.82



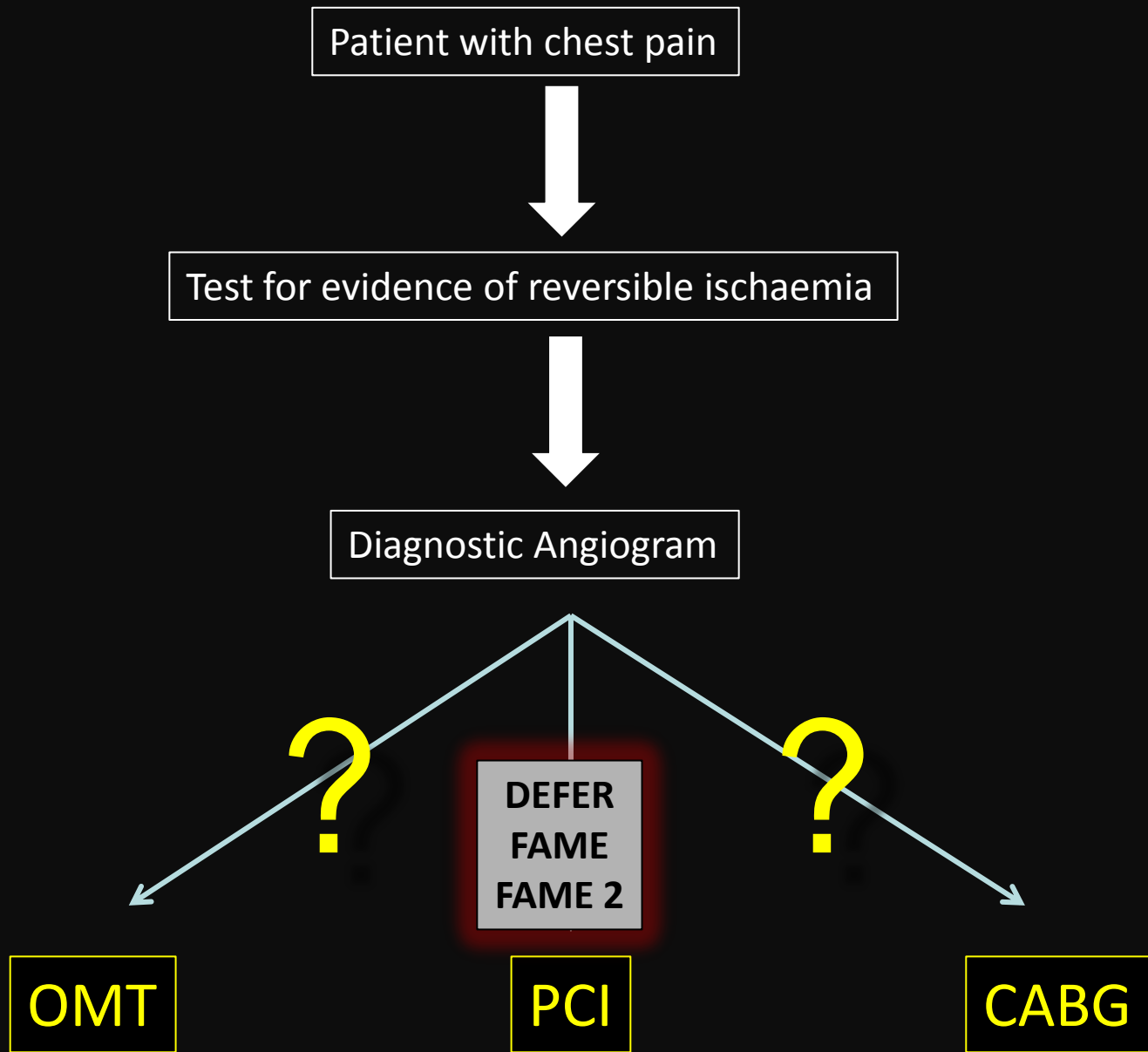
7 May 14

## 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?

What does the literature tell us about the FFR at the stage of the angiogram?





# Thirty-Month Outcome After Fractional Flow Reserve–Guided Versus Conventional Multivessel Percutaneous Coronary Intervention

Am J Cardiol 2005;96:877-884

- Non-randomised..... “prospectively allocated”
- 137 patients (312 vessels)
- FFR-PCI 57 patients, 128 vessels..... 48 patients, 53 vessels
- Conventional PCI: 80 patients, 184 vessels

# Angio

# FFR

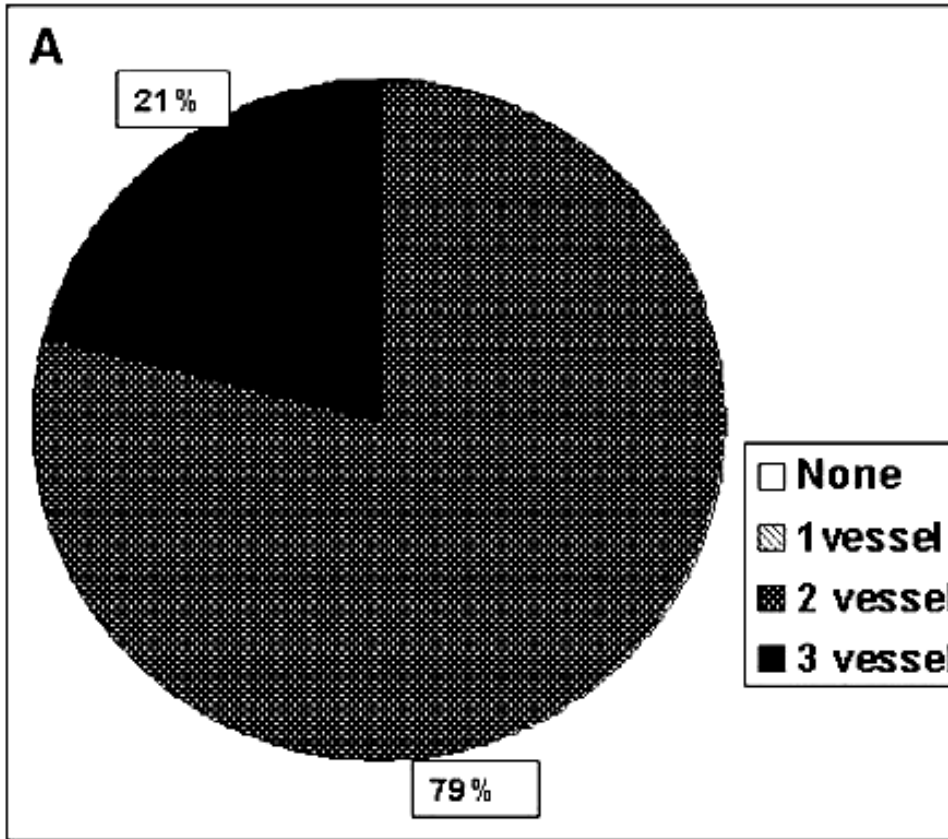


Figure 2. (A) Percentage of patients with 2- and 3-vessel disease outlined before FFR measurements. (B) Percentage of patients with significant 1-vessel or 2-vessel stenosis or no significant coronary artery stenosis depicted after FFR measurements.

# Does Routine Pressure Wire Assessment Influence Management Strategy at Coronary Angiography for Diagnosis of Chest Pain?

## The RIPCORDER Study

Nick Curzen, BM, PhD; Omar Rana, MD; Zoe Nicholas, BSc; Peter Golledge, MD; Azfar Zaman, MD; Keith Oldroyd, MD; Colm Hanratty, MD; Adrian Banning, MD; Stephen Wheatcroft, MD; Alex Hobson, MD; Kam Chitkara, MBBS; David Hildick-Smith, MD; Dan McKenzie, MBBS; Alison Calver, MD; Borislav D. Dimitrov, MD, PhD; Simon Corbett, MB BChir, PhD

*Circulation: Cardiovasc Interven* 2014

### Hypothesis

That, in patients with chest pain, the management strategy derived from diagnostic coronary angiography alone is different to the management strategy derived from diagnostic coronary angiography with simultaneous assessment of FFR

Or, in other words.....  
"How different is our management with FFR compared with angio alone?"

# Method

n=200

Patient being investigated  
for chest pain

Diagnostic Coronary Angiogram  
by Cardiologist 1

FFR\* of all patent vessels  
of stentable ( $\geq 2.25\text{mm}$ ) diameter  
by Cardiologist 2

\*FFR $\leq 0.8$

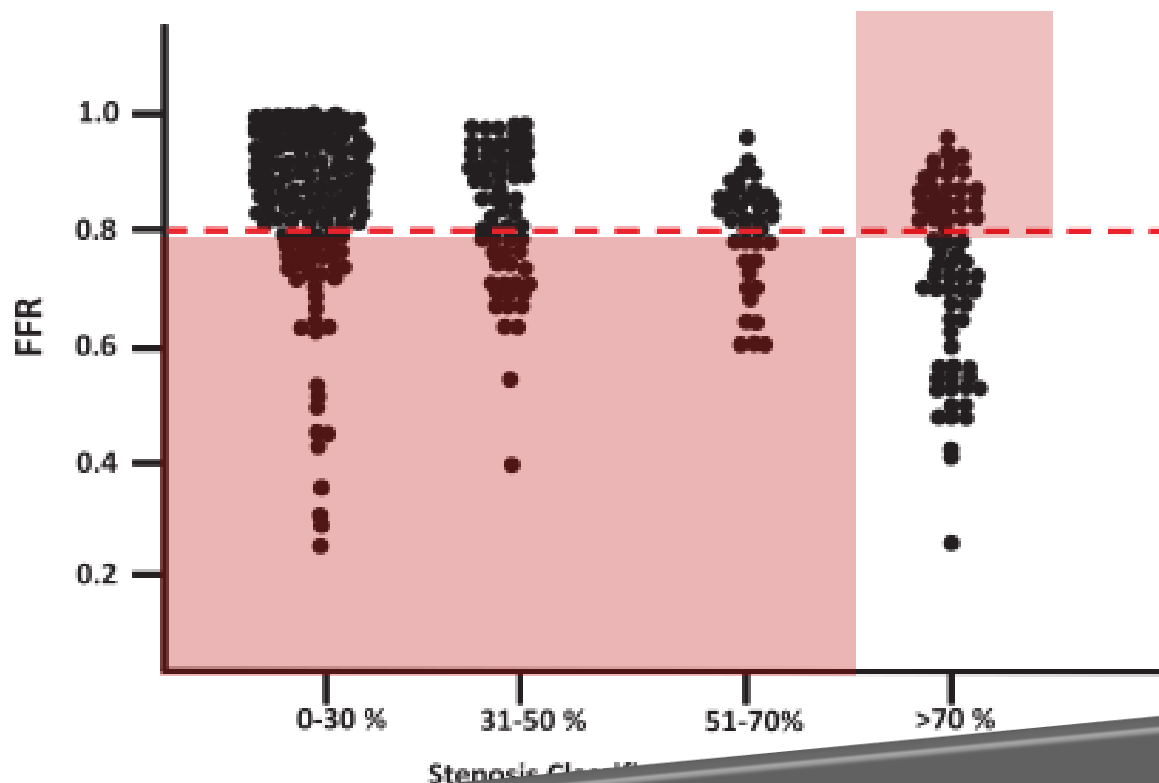
**TREATMENT PLAN 1**  
Medical/PCI/CABG/more info

Cardiologist 1 shown FFR results

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

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

# RESULTS



### 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

0-30%, n=33; >70%, n=68. In lesions graded >70% diameter stenosis, the FFR reading was <0.8 in 53%. Thus, in 47% of stenoses graded >70%, the FFR indicated that there was no physiologically significant lesion. In lesions graded between 51% and 70%, 31% and 50%, and 0% and 30% diameter stenosis, the FFR value was <0.8 in 33%, 33%, and 13%, respectively.

## Management of population by angiogram versus FFR

		FFR			PLAN 2	Total
		Medical	PCI	CABG	Further Info	
<b>PLAN 1</b>	Medical	63	6	3	0	72
<b>ANGIO</b>	PCI	24	64	2	0	90
	CABG	1	3	19	0	23
	Further info	1	7	6	1	15
<b>Total</b>		89	80	30	1	200

Fishers exact test  $p < 0.0001$

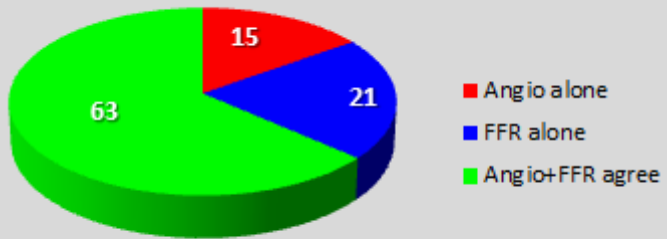
### Summary

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



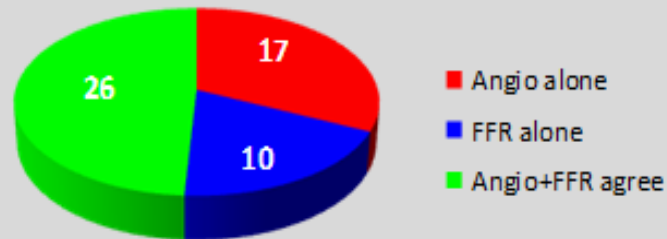
# Results: Indication for revascularisation of individual coronaries by angiogram & FFR

## Left Anterior Descending



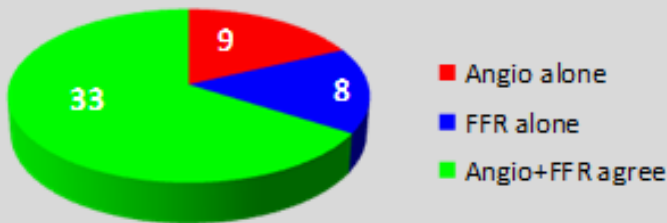
➤ In a total of 36 (ie 18%) cases the angiogram would have got indication for left anterior descending revascularisation wrong according to FFR...

## Circumflex



➤ In a total of 27 (ie 13.5%) cases the angiogram would have got indication for circumflex revascularisation wrong according to FFR

## Right Coronary



➤ In a total of 17 (ie 8.5%) cases the angiogram would have got indication for right coronary artery revascularisation wrong according to FFR

# Limitations

- No clinical outcome
- High denominator... selection of cases...
- CTOs not part of this trial
- Already VERY unpopular with non-interventional cardiologists!

# 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

- Could we ***really*** see FFR as part of angio routinely?
- Would diagnostic angio only be done by interventionists?
- Or... can non-interventional cardiologists do FFR without PCI training/back up?
- Will the surgeons accept FFR-guided practice?



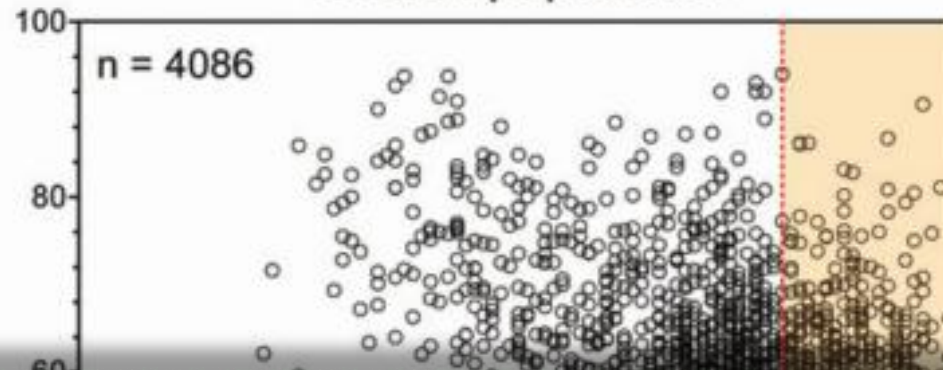
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reserv

Gabor Tot  
Frederic D  
Guy R. Hey  
William W

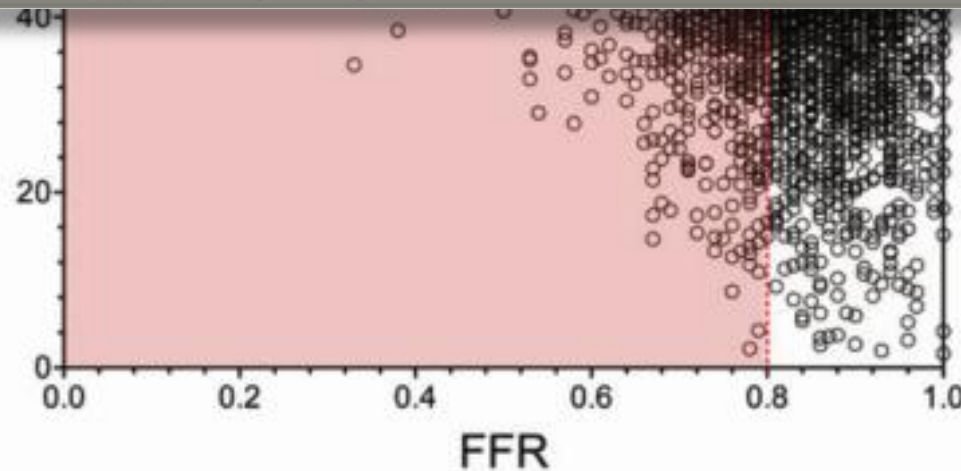
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### Overall population



The data confirm that one-third of a large patient population shows discordance between angiogram  $\geq 50\%DS$  and  $FFR \leq 0.8$  thresholds of stenosis severity. Left main stenoses are often underestimated by the classical 50% DS cut-off compared with FFR. This discordance offers physiologic insights for future trials. It is hypothesized that the discordance



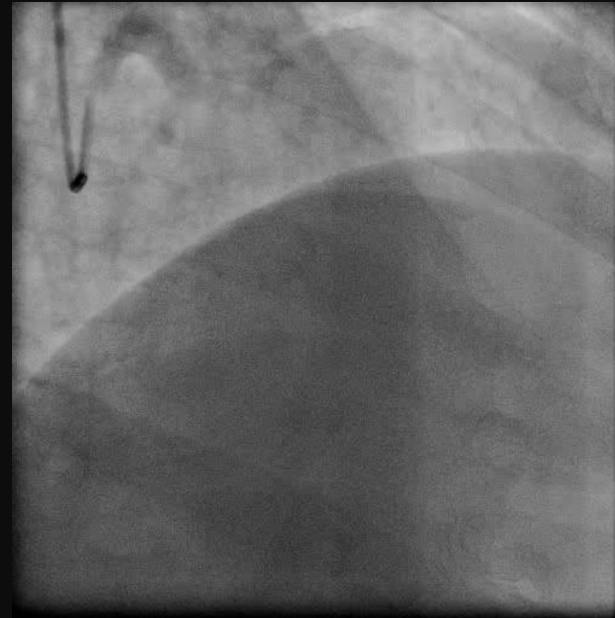
- 54 yr Asian male
- Hypercholesterolaemia; HT
- Developed angina with +ve ETT 2005
- Sept 05 Angiogram showed
  - 30% LMS
  - 90% mid LAD
  - 60% mid RCA
- Proceeded to stent LAD: Taxus 3x16
- Good symptomatic relief until March 06
- Recurrent exertional symptoms and +ve ETT
- 14/2/07 Further standby angiogram

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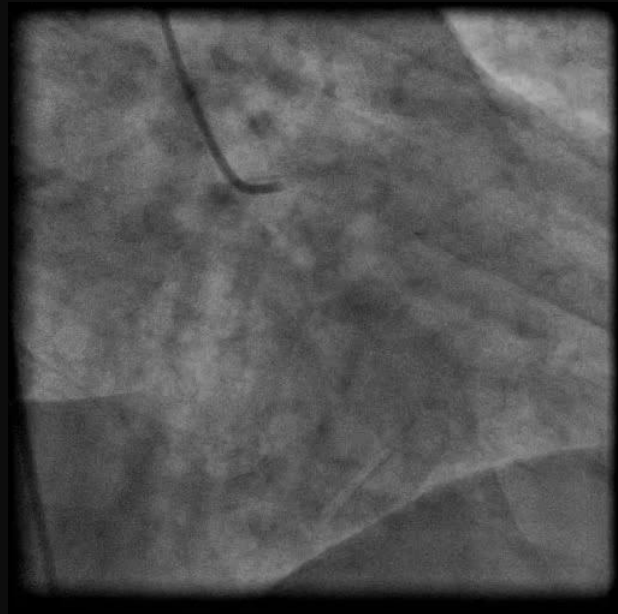
**FFR**  
50mcg adenosine

LAD 0.54  
OM 0.99  
CX 0.89



**FFR**  
50mcg adenosine

RCA 0.90



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# **Outcome Impact of Coronary Revascularization Strategy Reclassification With Fractional Flow Reserve at Time of Diagnostic Angiography**

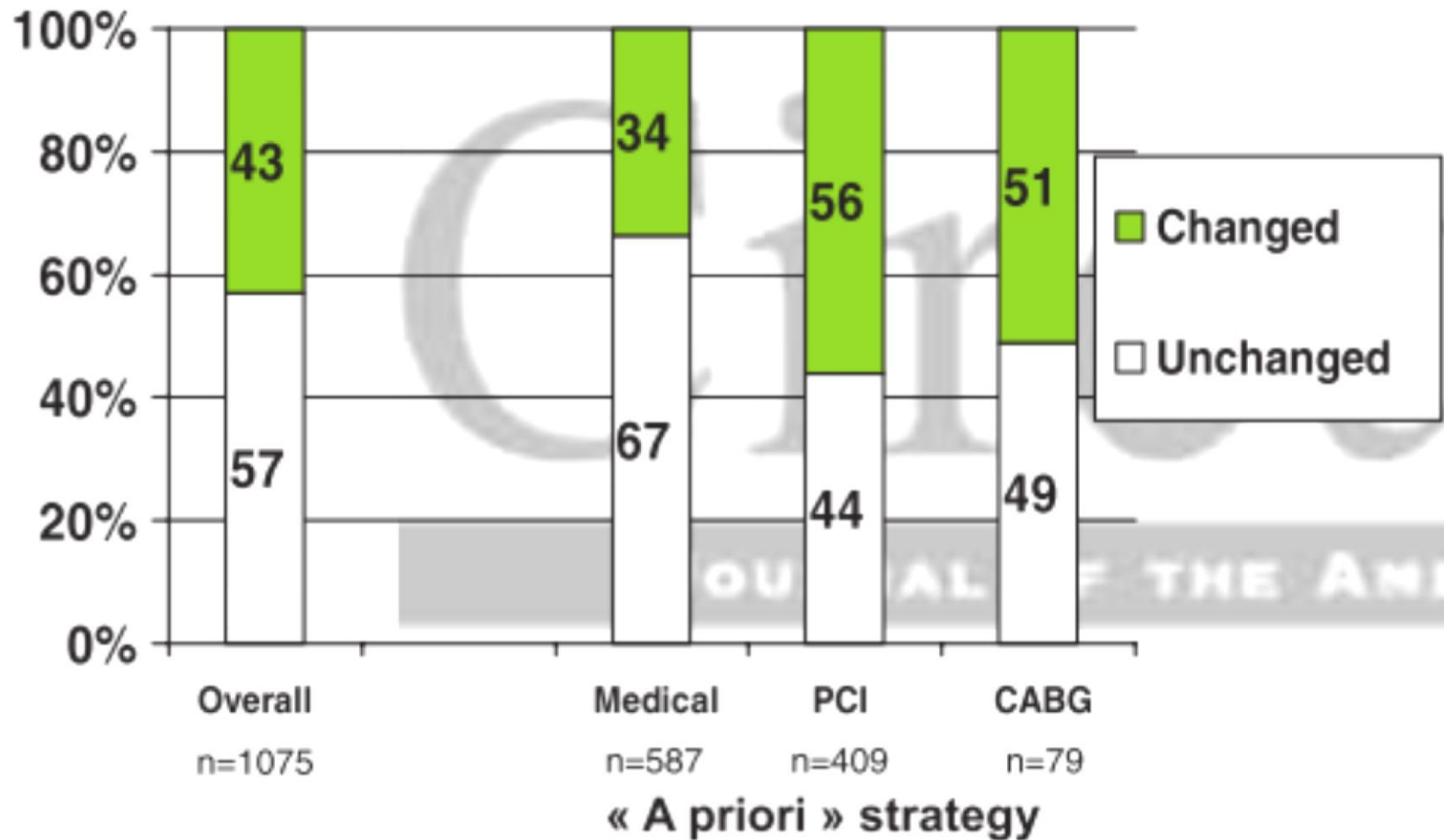
**Insights From a Large French Multicenter Fractional Flow  
Reserve Registry**

*Circulation 2014*

- 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

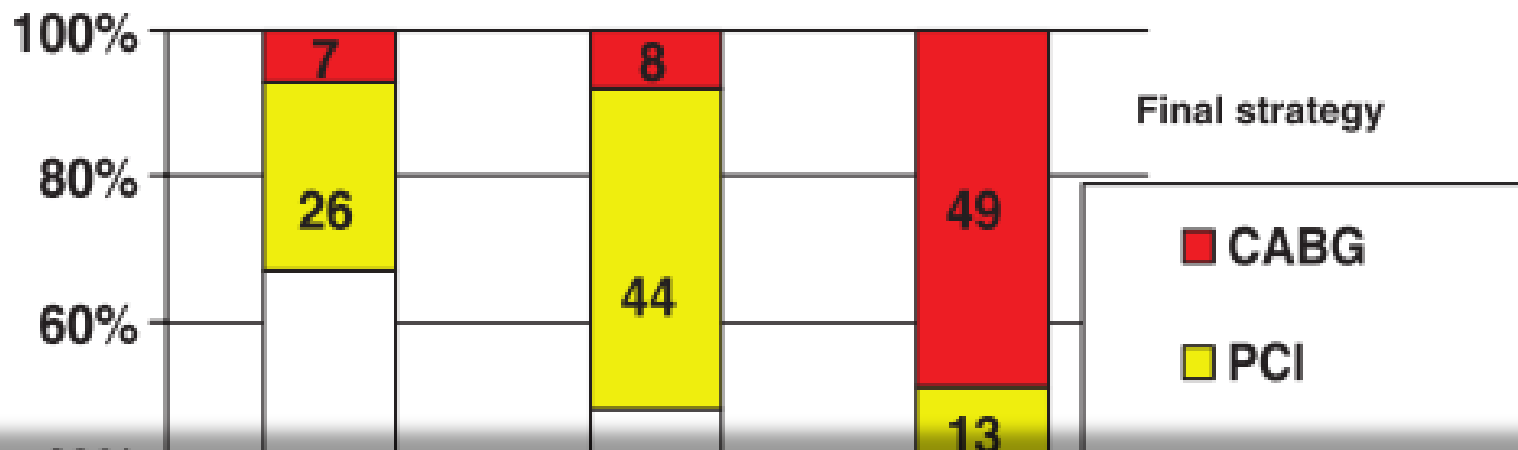
**A**

### Change of Revascularization strategy in 43% of patients

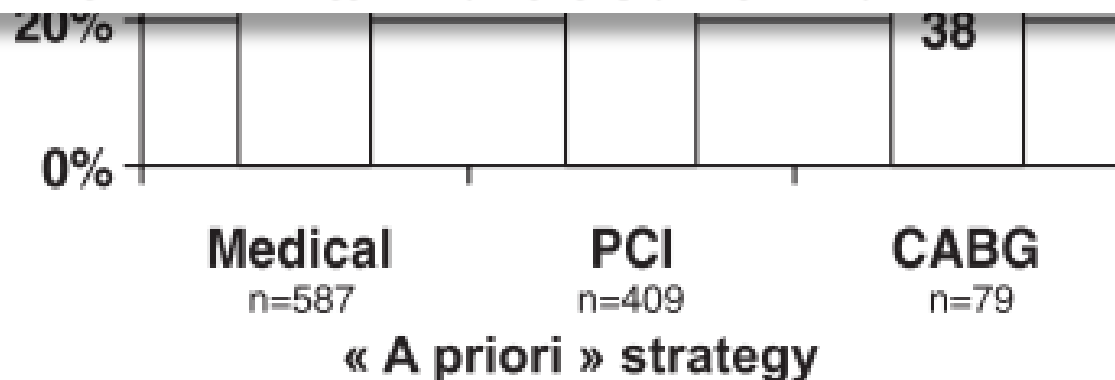




## B Final Revascularization strategy according to the initial strategy group



**Conclusion**—This study shows that performing FFR during diagnostic angiography is associated with reclassification of the revascularization decision in about half of the patients. It further demonstrates that it is safe to pursue a revascularization strategy divergent from that suggested by angiography but guided by FFR. (*Circulation*. 2014;129:00-00.)



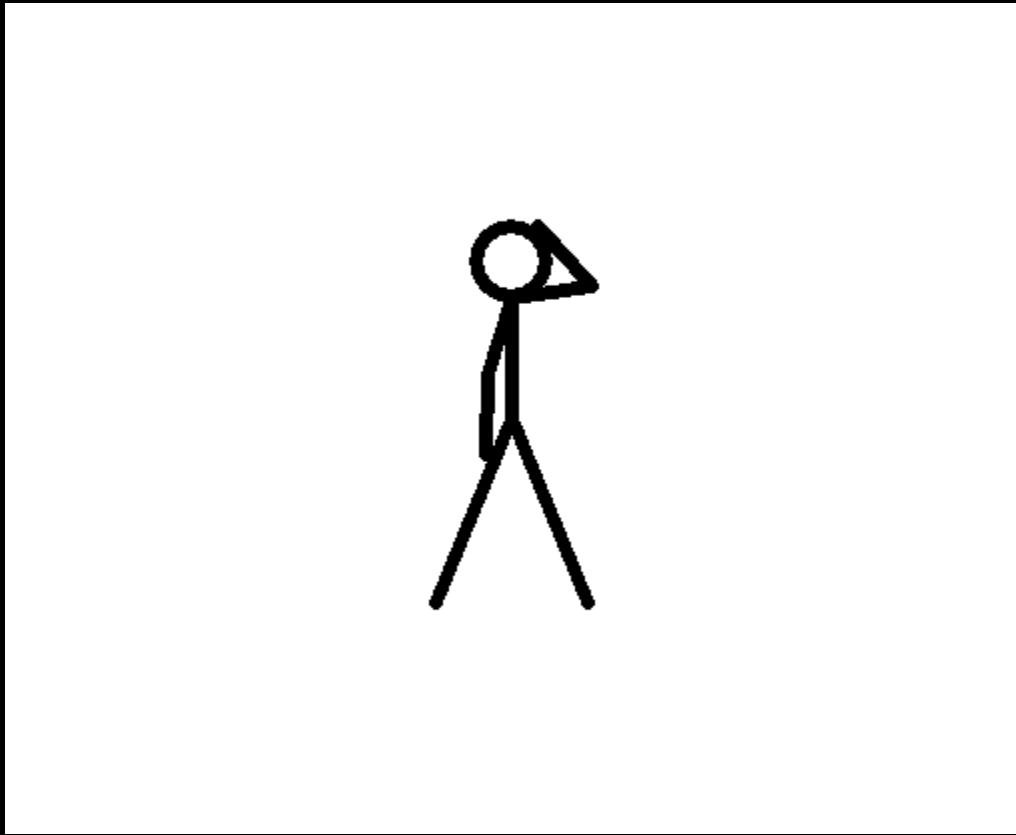
**"SAME TIME, SAME PLACE"**

**Angiogram with FFR:**

**(a) definitive diagnosis & (b) ischaemia-directed PCI**

## Conclusion:

- 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?
- RIPCORDER 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.....

DO YOU???????