

CT-derived FFR vs. Invasive FFR for the Management of Moderate Coronary Artery Stenosis: A Case Study

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Introduction

Coronary artery disease (CAD) is the leading cause of heart disease, affecting 1 in 20 adults over the age of 20 in the United States. CAD occurs when atherosclerotic plaque builds up in the coronary arteries, narrowing the blood vessels and limiting blood flow to the heart muscle (myocardium). This reduced blood flow can lead to myocardial ischemia, significantly increasing the risk of myocardial infarction (heart attack) and acute coronary syndrome (ACS). Acute chest pain is a common presentation of coronary artery disease (CAD), requiring precise diagnostic evaluation to guide treatment. Computed Tomography-derived Fractional Flow Reserve (CT-FFR, often written FFRCT) is a non-invasive technique that computes fractional flow reserve from standard coronary CT angiography (CCTA) images. Computed tomography coronary angiography (CTCA) provides excellent visualization of the coronary artery structure. However, the anatomical severity of coronary artery disease (CAD) does not always correlate with its functional impact. To assess the functional effects of CAD, fractional flow reserve (FFR) is often calculated. FFR is defined as the ratio of blood pressure measurements taken proximal and distal to a coronary artery stenosis. This measurement is typically performed during invasive angiography. After inducing hyperemia with adenosine, a specialized coronary guide wire with built-in pressure sensors near its tip is used to measure the pressures on either side of the stenosis. While ICA is effective, it carries a risk of serious, though rare, complications. To mitigate this risk, international guidelines strongly advocate for risk-based decision-making when determining the necessity of testing. To date, Invasive FFR is considered the gold standard for assessing the physiological significance of coronary artery stenosis. This case study compares the results of CCTA, CT-FFR and invasive FFR in a 69-year-old female patient presenting with acute chest pain.

Case presentation

A 69-year-old female presented with substernal chest pain. She has a history of hypertension, hyperlipidemia, and a history of smoking (quit 20 years ago). Her family history is notable for her father having suffered a myocardial infarction at age 68. Initial workup revealed a sinus rhythm on electrocardiogram (ECG), with no ST-segment elevation or depression. Troponin levels were negative, and serial measurements were within normal limits. Baseline laboratory results showed an LDL of 110 mg/dL, HDL of 45 mg/dL, and an HbA1c of 5.6%.

Anatomical and Functional Assessment

1. Coronary Computed Tomography Angiography (CCTA):

Findings:

- Intermediate stenosis between (50-69%) in the mid left anterior descending (LAD).

2. CT-derived Fractional Flow Reserve (CT-FFR):

Findings:

- LAD: CT-FFR value of 0.83 (borderline ischemic).

3. Invasive Coronary Angiography (ICA) with FFR:

Findings:

- Mid-LAD: 60% stenosis with FFR 0.81 (borderline ischemic).

Comparison of Diagnostic Modalities

Parameter	CCTA	CT-FFR (DVFFR)	ICA with FFR
Left Main (LM)	No stenosis	0.97 (non-ischemic)	No stenosis
Mid-LAD	50-69% stenosis	0.83 (borderline)	60%, FFR 0.81
Distal LCX	25-49% stenosis	0.93 (non-ischemic)	30%, non-ischemic
RCA	No stenosis	0.90 (non-ischemic)	No stenosis

Critical Insights:

- CCTA successfully identified coronary lesions, providing a detailed anatomical overview.
- Both CT-FFR and invasive FFR provided consistent results, agreeing on the borderline hemodynamic significance of the mid-LAD stenosis. The CT-FFR value of 0.83 and FFR value of 0.81 suggest that the lesion may not be functionally significant enough to warrant intervention. This demonstrates the added value of CT-FFR in assessing functional impairment, particularly in cases of intermediate stenosis, where anatomical imaging alone may not provide sufficient guidance for treatment decisions.
- Both diagnostic modalities—CCTA and CT-FFR—confirmed non-ischemic findings in the LCX and RCA, with CT-FFR values of 0.93 and 0.90, respectively. These findings indicated that these lesions were not hemodynamically significant and were unlikely to cause ischemia. This highlights the importance of CT-FFR in ruling out functionally significant disease, potentially avoiding unnecessary interventions such as stenting or bypass surgery.

Discussion

In this case study, we aimed to compare the results of CCTA, CT-FFR and invasive FFR in a 69-year-old female patient presenting with chest pain. CCTA provided high-resolution anatomical imaging, clearly identifying coronary lesions, while CT-FFR offered valuable functional insight by assessing the impact of these lesions on blood flow. The mid-LAD lesion demonstrated borderline hemodynamic significance with a CT-FFR value of 0.83, which closely aligned with the invasive FFR measurement of 0.81, confirming the lesion's minimal functional impact.

A CT-FFR-guided approach reduced the need for invasive coronary angiography (ICA), particularly in patients without obstructive coronary artery disease, but resulted in a higher rate of revascularization procedures. However, there was no significant difference between the CT-FFR strategy and the control group regarding major adverse cardiovascular events (MACE), all-cause mortality, nonfatal myocardial infarction, or unplanned revascularization due to unstable angina. This case emphasizes the importance of CT-FFR in distinguishing between anatomically significant and functionally relevant lesions, helping guide clinical decisions, especially in cases of intermediate stenosis where the need for intervention can be unclear based solely on anatomical imaging. Initially, functional assessment was primarily used for intermediate coronary plaques, but it has now been expanded to include a broader range of patient subsets, such as those with left main coronary artery disease, diabetes mellitus, extensive coronary artery disease, and ostial lesions. As per the new European Society of Cardiology guidelines, coronary CT angiography (CCTA) is now the preferred initial non-invasive test for patients with suspected chronic coronary syndrome (CCS), especially those with low to moderate pre-test likelihood of obstructive CAD. CT-derived FFR (CT-FFR) is strongly endorsed as a non-invasive method to assess the physiological significance of intermediate stenosis detected on CCTA, reducing unnecessary invasive angiography

Conclusion

This case highlights the complementary roles of CCTA, CT-FFR, and invasive FFR in the evaluation of coronary artery disease (CAD). CT-FFR provided a precise non-invasive functional assessment, which closely matched the results with invasive FFR. Incorporating CT-FFR into clinical practice can enhance patient selection for invasive procedures, leading to better outcomes. In this case, medical management alone was considered sufficient, thereby preventing unnecessary stent implantation.

References

1. Meijboom WB, Meijs MF, Schuijf JD, et al. Diagnostic accuracy of 64-slice computed tomography coronary angiography: a prospective, multicenter, multivendor study. *J Am Coll Cardiol*. 2008;52:2135–2144. [\[1\]](#)
2. Zimmermann FM, Ding VY, Pijls NHJ, et al. FAME 3 investigators. Fractional flow reserve-guided PCI or coronary bypass surgery for 3-vessel coronary artery disease: 3-year follow-up of the FAME 3 trial. *Circulation*. 2023;148(12):950–958. [\[2\]](#)
3. Fractional flow reserve to determine the appropriateness of angioplasty in moderate coronary stenosis: a randomized trial. *Circulation*. 2001;103:2928–2934. [\[3\]](#)
4. Tonino PAL, De Bruyne B, Pijls NHJ, et al. Fractional Flow Reserve versus angiography for guiding PCI in patients with multivessel coronary disease (FAME study). *N Engl J Med*. 2009;360:213–224. [\[4\]](#)
5. Clinical impact of CCT-FFR as first-strategy in patients with symptomatic stable coronary artery disease: A systematic review and meta-analysis. Di Pietro, Gianluca et al. *Journal of Cardiovascular Computed Tomography*, Volume 19, Issue 2, 174 – 182
6. Koo BK, Erglis A, Doh JH, et al. Diagnosis of ischemia-causing coronary stenoses by noninvasive fractional flow reserve computed from coronary computed tomographic angiograms. *J Am Coll Cardiol*. 2011;58(19):1989–1997. (DISCOVER-FLOW Study)
7. Min JK, Leipsic J, Pencina MJ, et al. Diagnostic accuracy of fractional flow reserve from anatomic CT angiography. *JAMA*. 2012;308(12):1237–1245. (DeFACTO Study)
8. Nørgaard BL, Leipsic J, Gaur S, et al. Diagnostic performance of noninvasive fractional flow reserve derived from coronary computed tomography angiography in suspected coronary artery disease: the NXT trial. *J Am Coll Cardiol*. 2014;63(12):1145–1155. (NXT Trial)
9. Faulder, T. I., Prematunga, K., Moloi, S. B., Faulder, L. E., Jones, R., & Moxon, J. V. (2024). Agreement of Fractional Flow Reserve Estimated by Computed Tomography with Invasively Measured Fractional Flow Reserve: A Systematic

Review and Meta-Analysis. *Journal of the American Heart Association*, 13(10).
<https://doi.org/10.1161/jaha.124.034552>

10. KeyaMedical. (2024, September 10). *2024 ESC guidelines for the management of chronic coronary syndromes*. https://www.keyamedical.com/2024-esc-guidelines-ccs/?utm_source=chatgpt.com