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BƯỚC ĐẦU ỨNG DỤNG CT-FFR TẠI VIỆT NAM

(Initial Application of CT-FFR in Vietnam)

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ECHO ASIA 2025 | 3rd VSCI CONGRESS 2025 | SCIENTIFIC CONFERENCE ASIA PACIFIC SOCIETY OF ECHOCARRIOGRAPHY 2025 THE 3rd VIETNAM CARDIOGRAPHY IMAGING | Da Nang 10-12 October, 2025

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Introduction

- CCTA has emerged as the leading non invasive imaging modality for the assessment of CAD.
- The development of FFR-CT has further transformed the diagnostic landscape by enabling the simultaneous evaluation of both anatomical stenosis and lesion-specific ischemia.
- The combined use of CCTA and FFR-CT is now pivotal in a broad range of clinical scenarios, including the evaluation of stable and acute chest pain.
- CCTA and FFR-CT are positioned to become the primary gatekeepers to the cardiac catheterization laboratory, potentially reducing the number of unnecessary invasive procedures.

Benjamin Stark et al. *JACC* 2024; 83:2320-2320

S. Yang, B.-K. Koo / Journal of the Society for Cardiovascular Angiography & Interventions 3 (2024) 101304

Arta Kasaeian et al. Fractional Flow Reserve from Coronary CT: Evidence, Applications, and Future Directions. J. Cardiovasc. Dev. Dis. 2025, 12, 279

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FFR-CT analysis using computational fluid dynamics and machine learning for coronary stenosis assessment.

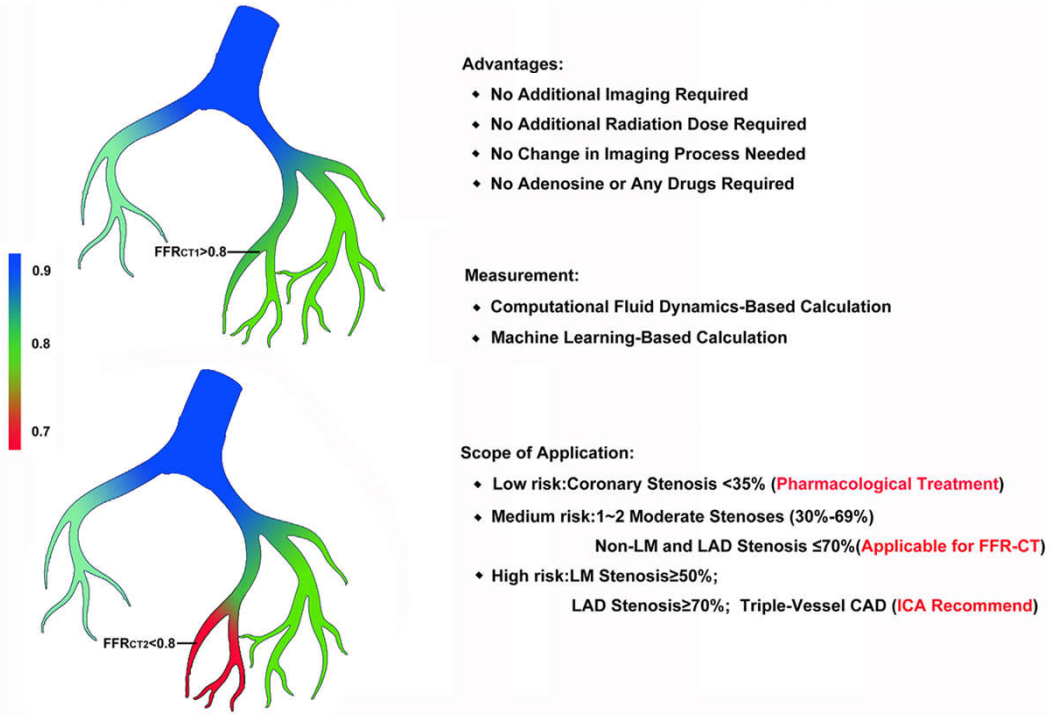

Fig. 1. FFR-CT analysis using computational fluid dynamics and machine learning for coronary stenosis assessment.

J. Wu et al. Journal of Cardiovascular Computed Tomography 19 (2025) 152–158

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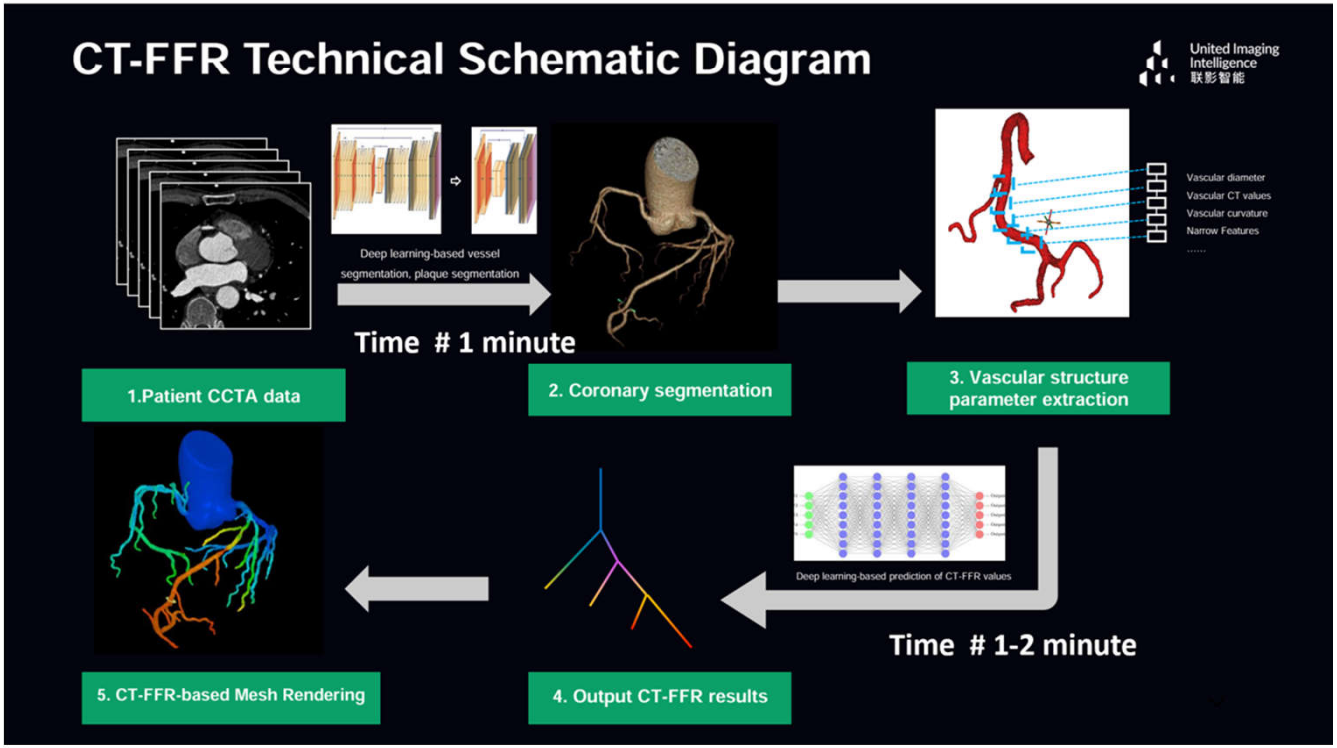
uAI Discover® – FFR$_{CT}$

AI-Based Analytics System of Fractional Flow Reserve Derived from CCTA

United Imaging Intelligence 联影智能



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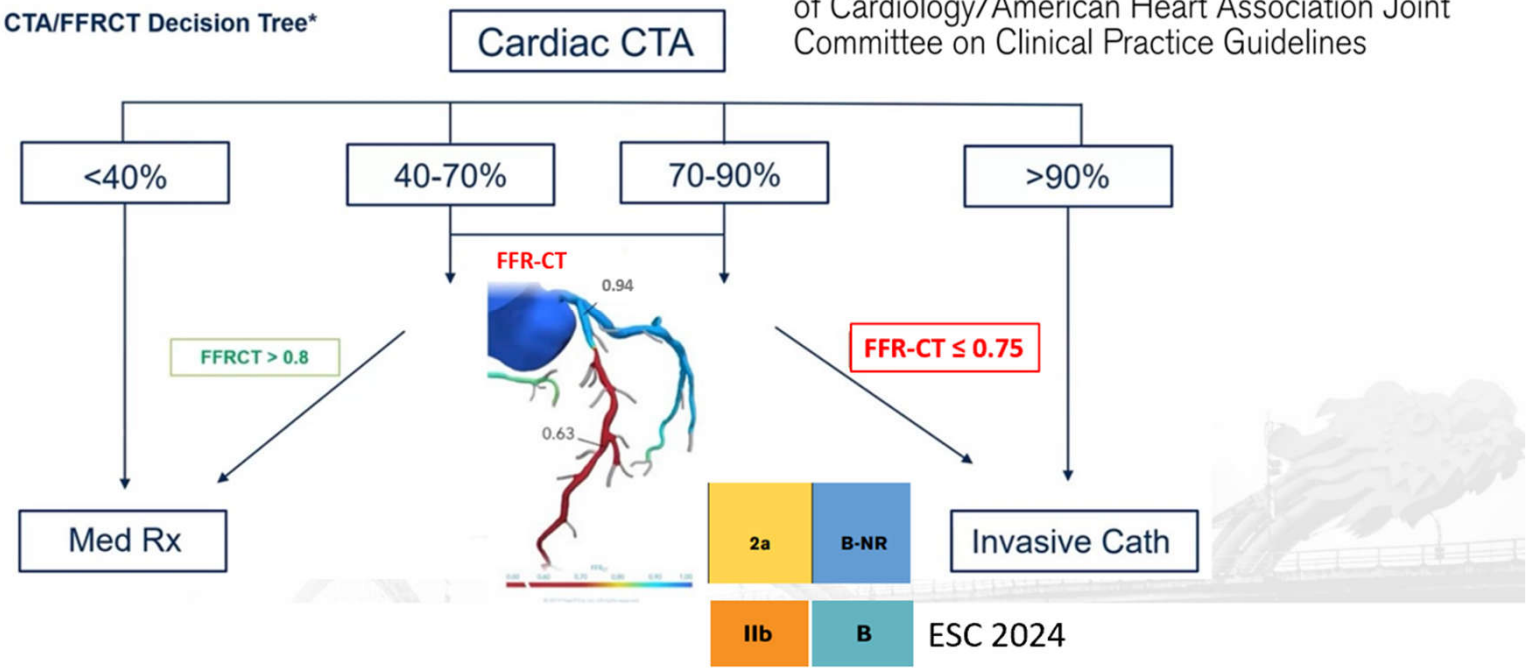
Cardiac CTA / FFR - CT

AHA/ACC CLINICAL PRACTICE GUIDELINE

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

CTA/FFRCT Decision Tree*



FFR-CT : 0.75-0.8 → Delta FFR-CT > 0.12 → Xem xét can thiệp mạch vành

(Cury RC et al. JCCT 2022.)

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Δ FFR-CT

Δ FFR-CT = FFR-CT proximal - FFR-CT distal

- $FFR\text{-}CT_{proximal}$: đo trước vị trí hẹp 2cm
- $FFR\text{-}CT_{distal}$: đo sau vị trí hẹp 2cm

- Assess the hemodynamic significance of stenosis more accurately by estimating the lesion-specific pressure loss
- Thus, utilizing ΔFFRCT is more effective in identifying patients needing early revascularization than the standard diagnostic approach using CCTA and FFRCT.
- Δ FFR-CT ≥ 0.12, show a significant impact on coronary hemodynamics.

Roozbeh Narimani Javid . **CT-derived Fractional Flow Reserve: How, When, and Where to use this Novel Cardiac Imaging Tool.**
Current Cardiology Reviews, 2024, Vol. 20, No. 6 :e040624230662

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(Initial Application of CT-FFR in MEDIC, HCMC, Vietnam)

OBJECTIVES:

1. To evaluate the diagnostic performance of CCTA, FFR-CT and delta CT-FFR using ICA -detected stenosis as the reference standard.
2. Model comparison in the diagnosis of suspected patient (CT-FFR : 0.76–0.80)
3. Evaluation of compatibility of CT-FFR values with clinical treatment decision (Revascularization vs medical treatment)
4. Description of the revascularization rate according to CT-FFR or Δ CT- FFR
5. Accuracy of AI for stenosis vs ICA

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Materials and Method

- Our retrospective study assessed 69 adult patients who underwent clinically indicated CCTA, FFR-CT and Delta CT-FFR at MEDIC Medical Center, HCMC.
- MSCT-640 slice Aquilion One,Canon,
- uAI Discover- CT- FFR , United Imaging , One- click reporting system,
- Patients with moderate or severe stenosis on CCTA or those exhibiting strong clinical indications were subsequently referred for ICA.
- Comparative analysis to evaluate the sensitivity and specificity of CCTA , FFR-CT and Delta CT-FFR using ICA-detected stenosis as the gold standard.

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Materials and Method

- Hemodynamically significant coronary stenosis was characterized by ≥50% stenosis on CCTA, ≥ 70% stenosis on ICA
- FFR-CT (+) was determined when FFR-CT ≤ 0.8; Delta CT-FFR (+) : ≥ 0.12
- The analysis was performed at both the patient and vessel level.
- All inferential and descriptive analyses were performed at the 0.05 significance level for a 2-sided test by using R. (t-test, Wilcoxon)

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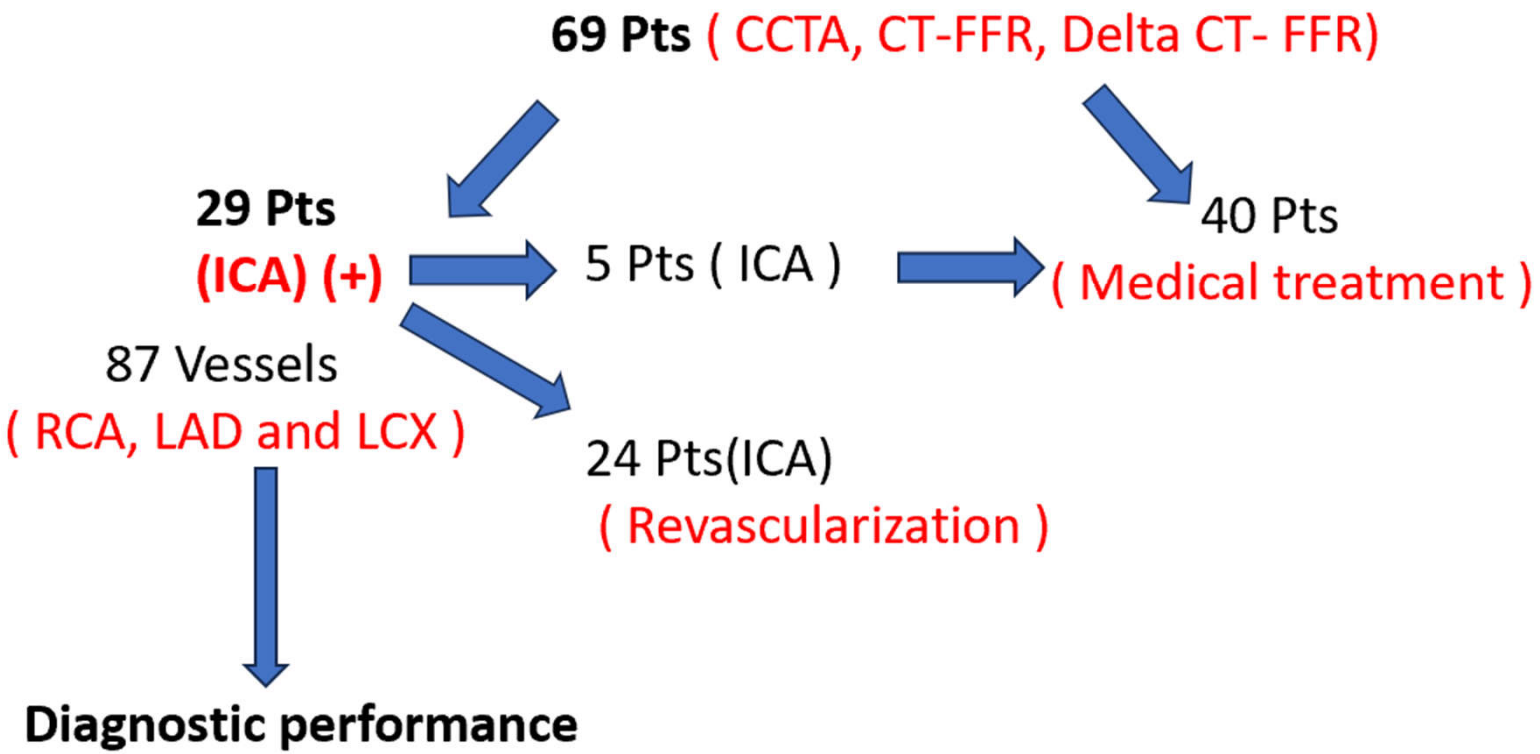
Study Flow diagram



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Models:

- pred_A: CCTA only: Diameter Stenosis ≥50%
- pred_B: CCTA + CT-FFR ≤ 0.80
- pred_C: CT-FFR + Delta FFR: CT-FFR ≤ 0.80 **hoặc** (0.76–0.80 và Δ FFR ≥0.12)
- pred_D: CT-FFR ≤ 0.75 hoặc Δ FFR ≥ 0.13

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INITIAL RESULTS AND DISCUSSION

DIAGNOSTIC PERFORMANCE

Model	Sensitivity(%)	Specificity (%)	PPV (%)	NPV(%)	Accuracy(%)
pred_A: CCTA only	76	90.3	76	90.3	86.2
pred_B: CT-FFR	96	45.2	41.4	96.6	59.8
pred_C: Delta FFR	92	59.7	47.9	94.9	69
pred_D: FFR ≤ 0.75 or Delta FFR ≥ 0.13	92	58.1	46.9	94.7	67.8

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Screening Function (Gatekeeper):

- FFR-CT shows very high diagnostic performance at the vessels level, with sensitivity (96%) and NPV (96.6%) , particularly impressive, making it a very reliable hemodynamically significant CAD rule-out tool.
- If the FFRct (-), the patient can avoid ICA because the risk of severe ischemia is extremely low. These are the patients who account for the majority of unnecessary ICA cases.
- If the FFRct (+), the patient will be assigned an ICA for confirmation and intervention.

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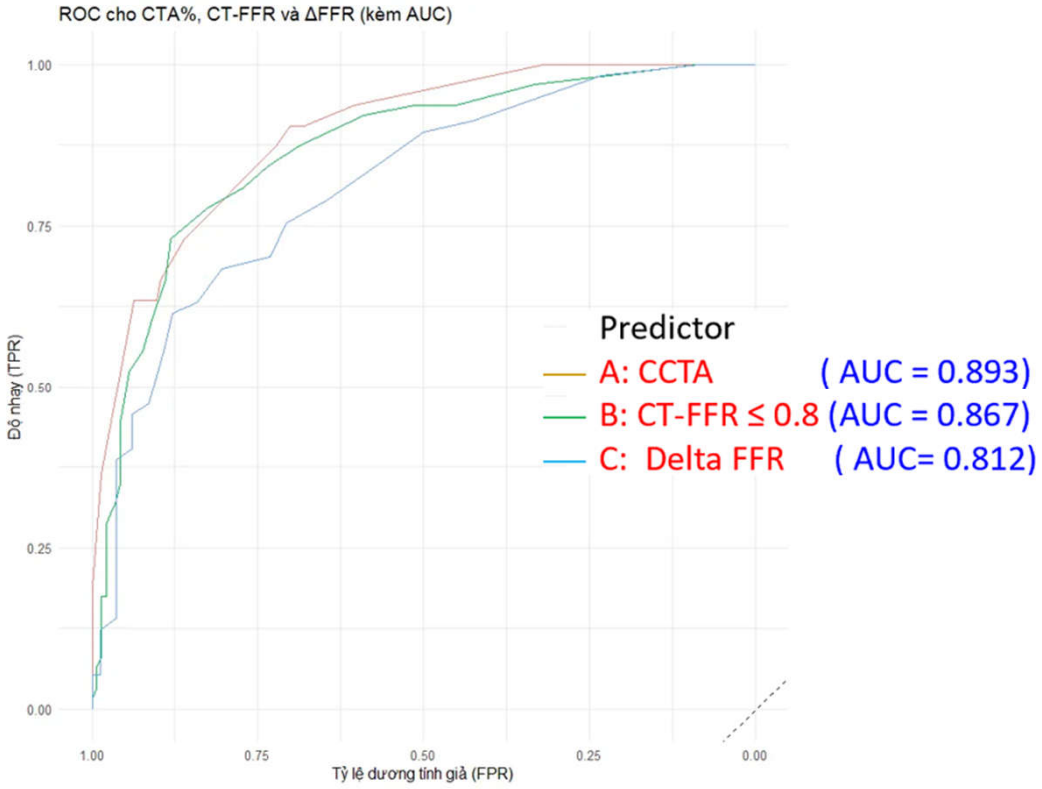
ROC/AUC Chart Analysis



Journal of Hospital Medicine® Presented by shm®

IS FRACTIONAL FLOW RESERVE-COMPUTED TOMOGRAPHY EFFECTIVE IN THE REAL WORLD?

Anita Li, MD[1], Hinduja Nallamala, DO[2], Folake Ishola, MD[1], Michael Walls, MD[3], [1]Ascension St. Vincent Indianapolis Hospital, ; [2]Aurora Health Care, ; [3]Ascension Medical Group,

Meeting: SHM Converge 2024

Abstract Number: 301

Category: Research

Sub-Category: Translating Research into Practice

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- FFR-CT remained sensitive (90%) with much lower specificity (56%) using < 0.75 as the cutoff.
- The elevated false positive rate may stem from potential over-diagnosis of diffuse coronary narrowing via FFR-CT and the absence of invasive iFR measurements during catheterizations to validate true flow limitations.
- Despite this, FFR-CT outperformed CCTA alone, indicating its ability to enhance diagnostic accuracy and reduce the necessity for invasive procedures in evaluating suspected CAD.

Anita Li et al. Is Fractional Flow Reserve-Computed Tomography effective in the real world ?. Abstract published at shm converge 2024.

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Clin Imaging. 2022 Nov:91:32-36. doi: 10.1016/j.clinimag.2022.08.009. Epub 2022 Aug 13.

Real-world validation of fractional flow reserve computed tomography in patients with stable angina: Results from the prospective AFFECTS trial

Allison T Lanfear [1], Talia G Meidan [2], Allison I Aldrich [2], Nicholson Brant [2], John J Squiers [3], Emily Shih [2], Gurjaspreet Bhattal [4], Jasjit K Banwait [2], Julie McCracken [2], Steve Kindsvater [4], David Brown [5], J Michael DiMaio [3]

Affiliations + expand

PMID: 35986975 DOI: 10.1016/j.clinimag.2022.08.009

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Table 2
Performance metrics of FFRct compared to gold-standard invasive coronary angiography (ICA) in predicting hemodynamically-significant coronary artery disease (CAD).

	Agreement (%)	Krippendorff's alpha	Accuracy [95%CI]	Sensitivity	Specificity	PPV	NPV
Physician intuition vs ICA							
Per-patient (n = 56)	59.3	0.19	0.59 [0.45–0.72]	0.84	0.46	0.46	0.84
FFRct vs ICA							
Per-patient (n = 56)	87.5	0.74	0.88 [0.76–0.95]	0.95	0.83	0.76	0.97
All vessels (n = 166)	86.7	0.61	0.87 [0.81–0.92]	0.78	0.89	0.63	0.94
LCx (n = 56)	91.1	0.62	0.91 [0.80–0.97]	0.83	0.92	0.56	0.98
RCA (n = 54)	90.7	0.71	0.90 [0.80–0.97]	0.73	0.95	0.8	0.93
LAD (n = 56)	78.6	0.51	0.79 [0.66–0.88]	0.8	0.78	0.57	0.91

FFRct, fractional flow reserve computed tomography; ICA, invasive coronary angiography; LAD, left anterior descending artery; LCx, left circumflex artery; NPV, negative predictive value; PPV, positive predictive value; RCA, right coronary artery.

- FFRct identified hemodynamically significant CAD more accurately than physician intuition
- ICA may have been avoided in up to 53% of patients.
- PLATFORM study, there was a 61% reduction in invasive angiography

Allison T Lanfear et al. clinimag.2022 Nov:91:32-36

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TABLE 3 Diagnostic Accuracy of FFR-CT Compared to the 2 Gold Standards

	PPV	NPV
Accuracy of FFR-CT ≤0.80 compared to composite stress imaging and ICA gold standard (n = 652)		
For any CCTA stenosis	60 (59-62)	76 (69-81)
For CCTA stenosis of 50%-69%	44 (41-47)	84 (76-90)
For CCTA stenosis of 25%-69%	41 (38-44)	81 (73-86)
For CCTA stenosis of 50%-99%	61 (60-63)	79 (72-85)
Accuracy of FFR-CT ≤0.80 compared to invasive FFR gold standard (n = 213)		
For any CCTA stenosis	49 (46-52)	76 (62-87)
For CCTA stenosis of 50%-69%	35 (30-41)	75 (59-86)
For CCTA stenosis of 25%-69%	33 (28-39)	75 (60-86)
For CCTA stenosis of 50%-99%	50 (47-53)	76 (61-87)

Values are % (95% CI).

NPV = negative predictive value; PPV = positive predictive value; other abbreviations as in Table 1.

Tarun K. Mittal et al. The use and efficacy of FFR-CT: real-world multicenter audit of clinical data with cost analysis. JACC: cardiovascular imaging. Volume 16, issue 8, august 2023, pages 1056-1065

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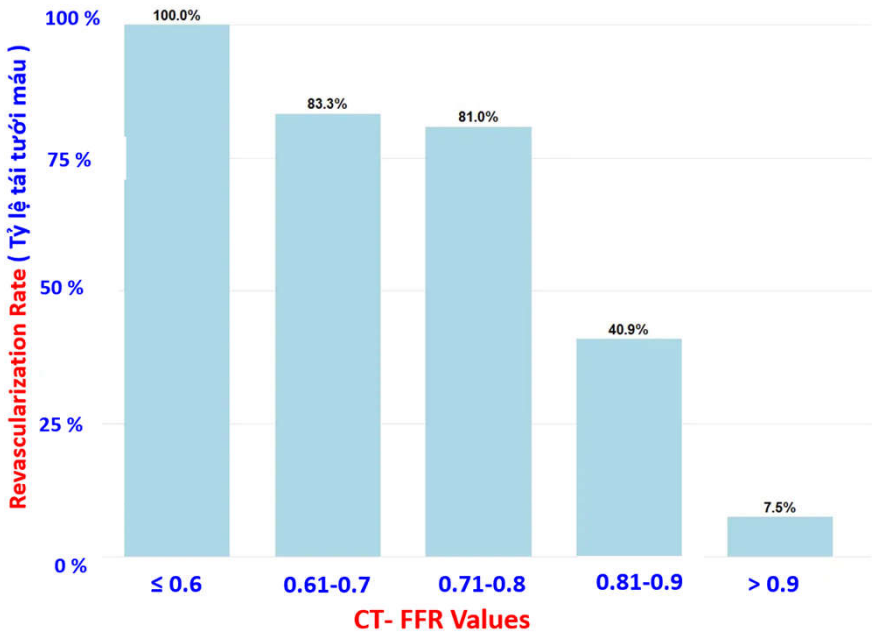
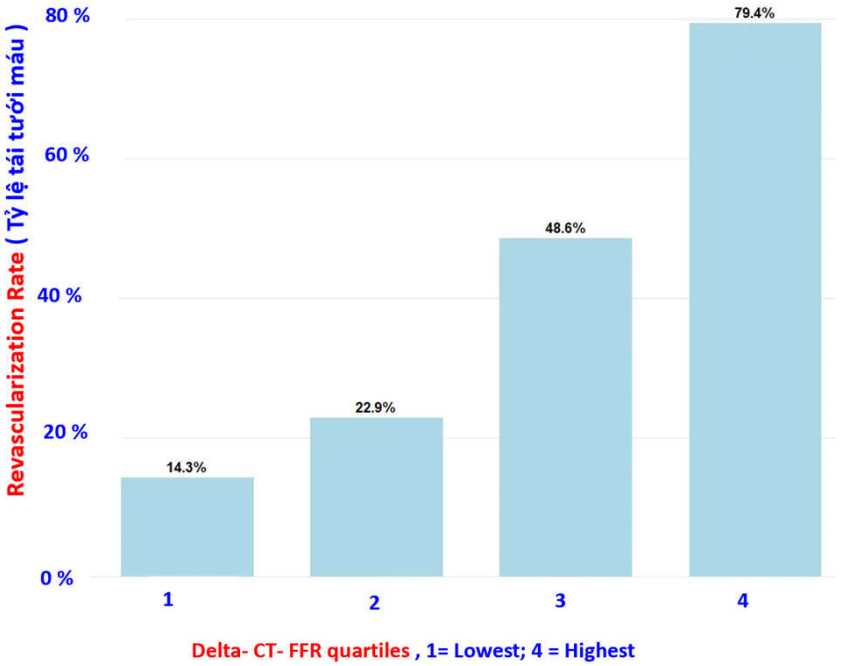
Revascularization Rate According to CT- FFR Values

Hemodynamically significant stenosis : CT-FFR ≤ 0.75



Revascularization Rate According to Delta CT- FFR quartile



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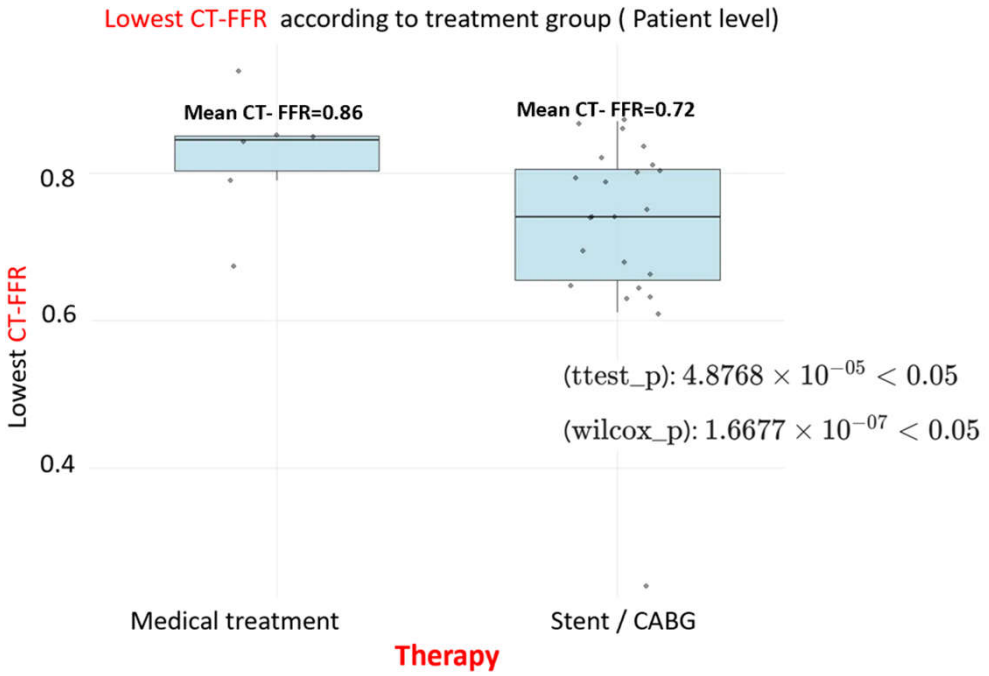
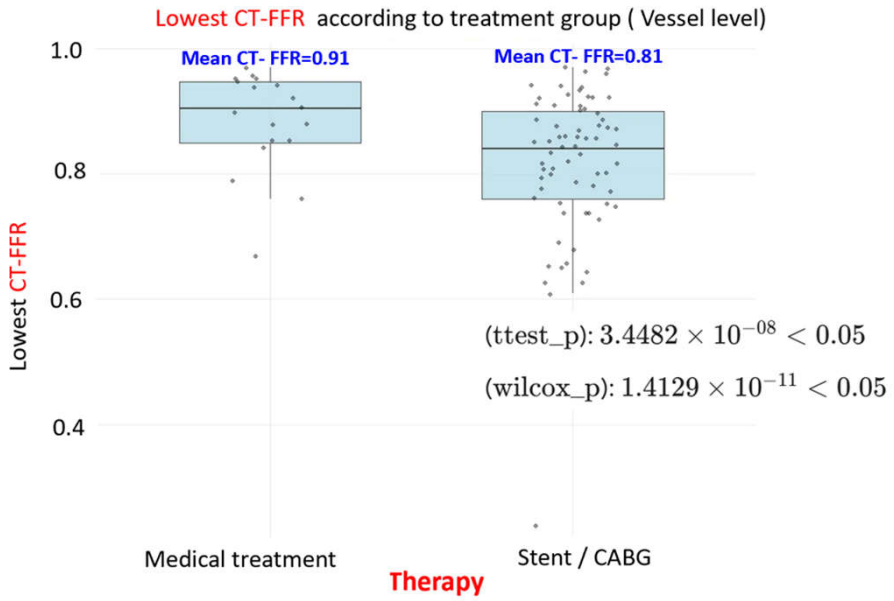
Compatibility of CT-FFR with clinical treatment decision

(Revascularization vs medical treatment)





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ACCURACY OF AI FOR STENOSIS

Model	Sensitivity(%)	Specificity (%)	PPV (%)	NPV(%)	Accuracy(%)
Physician-CCTA	76	90.3	76	90.3	86.2
AI-CCTA	73.9	83.9	63	89.7	81.2

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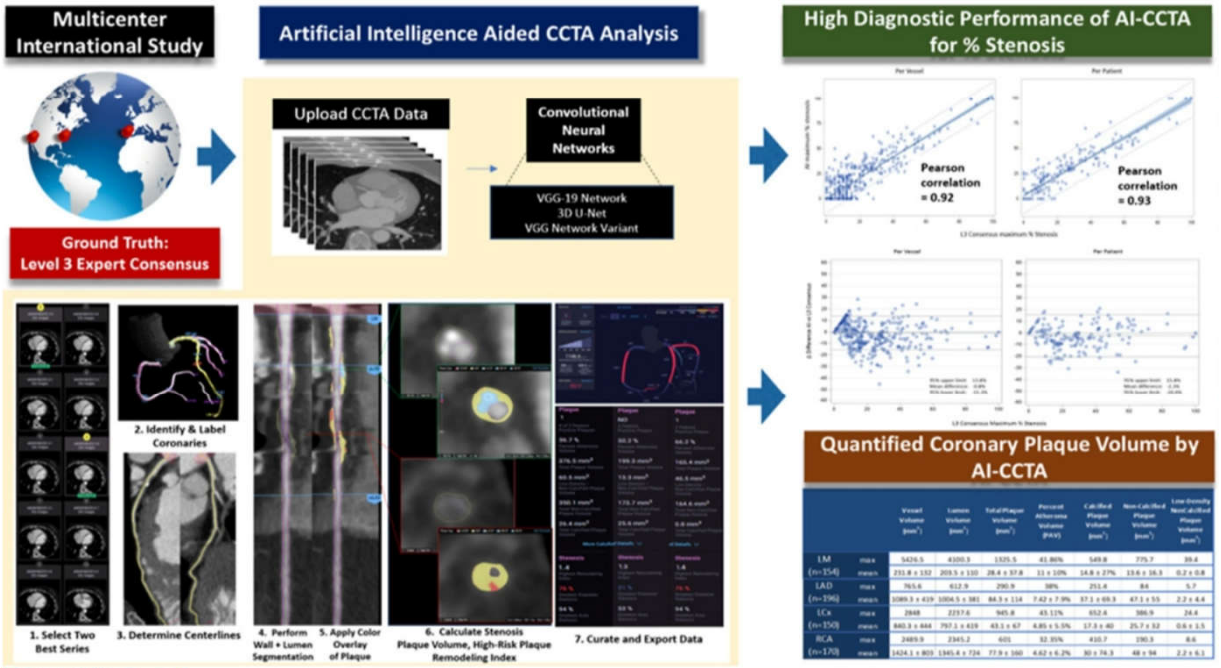
ACCURACY OF AI FOR STENOSIS



- N = 232 patients
- AI-driven coronary artery segmentation and labeling, lumen and vessel wall determination, plaque quantification and characterization
- Comparison to three Level 3 readers
- 98% per-patient agreement within one CAD-RADS category
- 99.9%) per-vessel agreement within one CAD-RADS category

Choi AD et al . CLARIFY. J Cardiovasc Comput Tomogr. 2021

SCCT2023 Boston | July 27 - 30

CT-FFR Analysis Report-MEDIC-United Imaging

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UNITED IMAGING

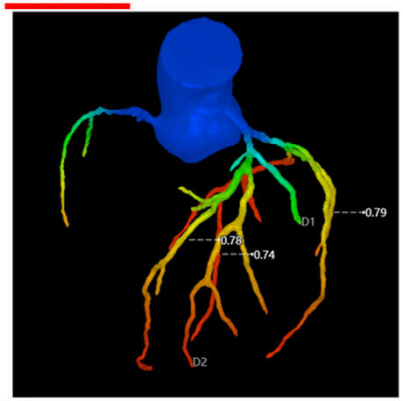
CASE 1

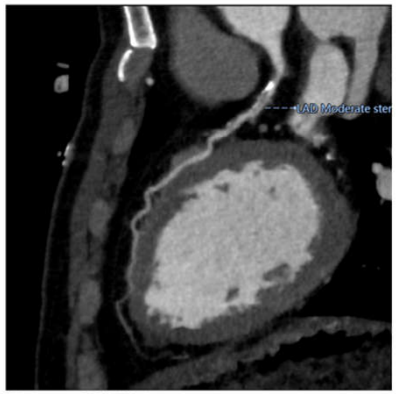
- 43M
- Chest pain
- Left dominance
- CT- FFR LAD = 0.78,

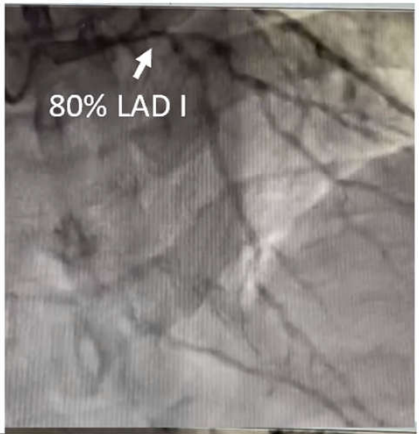
  Delta FFR= 0.19
- CT – FFR LCX= 0.63,

  Delta FFR= 0.27

Left anterior descending artery(LAD): The FFR measurement value is 0.78. The first stenosis is located at mLAD with Moderate stenosis and Mixed plaque visible. The ΔFFR is 0.19.

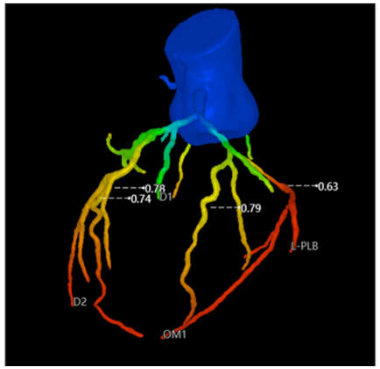


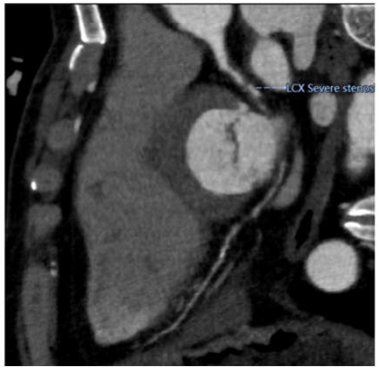


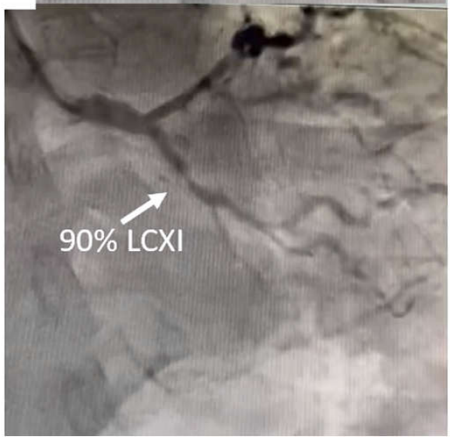


4/7/25, 8:15 AM CT-FFR-Report_8196670_1

Left circumflex artery(LCX): The FFR measurement value is 0.63. The first stenosis is located at pLCX with Severe stenosis and Noncalcified plaque visible. The ΔFFR is 0.27.







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CT-FFR Analysis Report-MEDIC-United Imaging

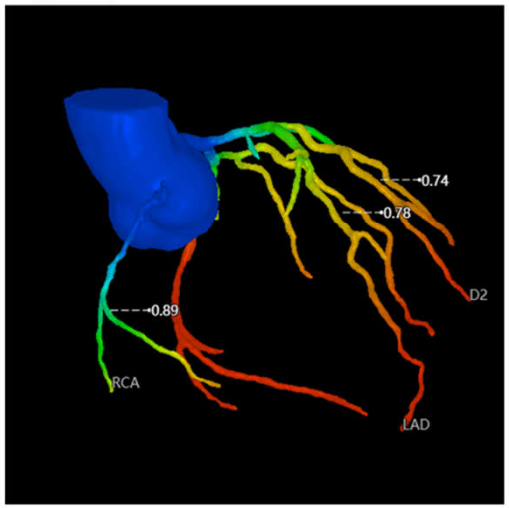
UNITED IMAGING

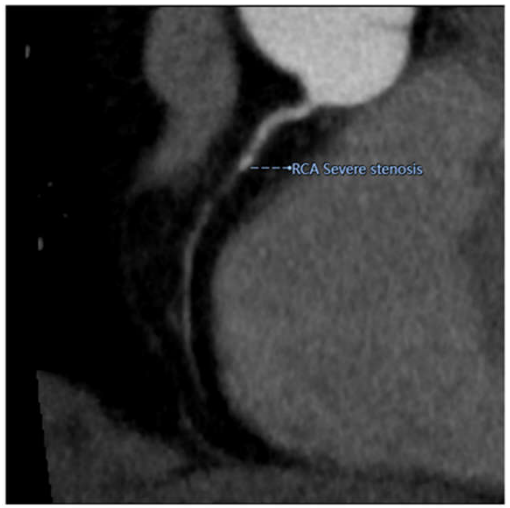
CASE 1

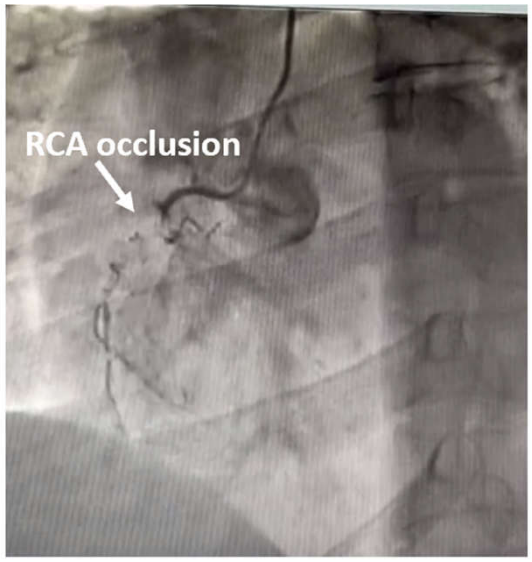
- 43M
- Chest pain
- CT- FFR RCA = 0.89,

  Delta FFR= 0.08

Right coronary artery(RCA): The FFR measurement value is 0.89. The first stenosis is located at pRCA with Severe stenosis and Noncalcified plaque visible. The ΔFFR is 0.08.

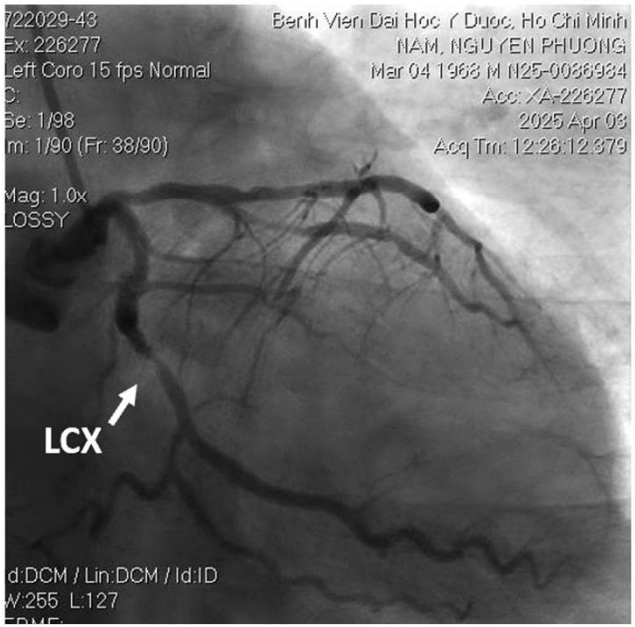


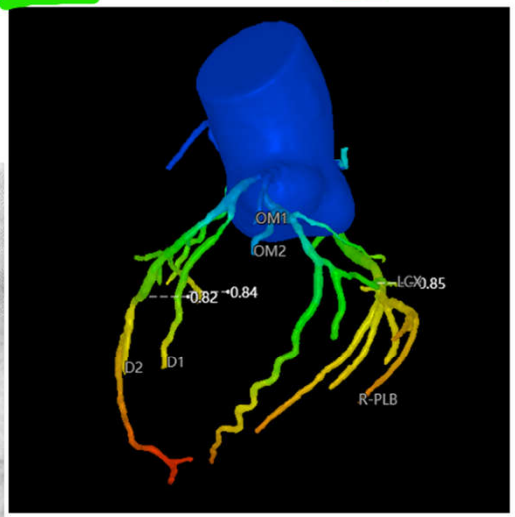


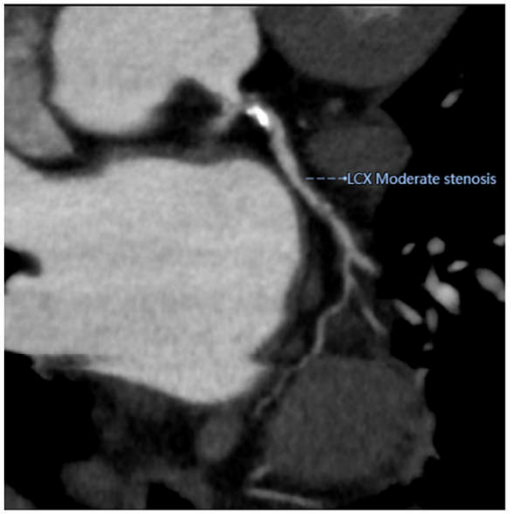


CT-FFR Analysis Report-MEDIC-United Imaging

Left circumflex artery(LCX): The FFR measurement value is 0.85. The first stenosis is located at pLCX with Moderate stenosis and Mixed p...
visible. The ΔFFR is 0.14.







CASE 2

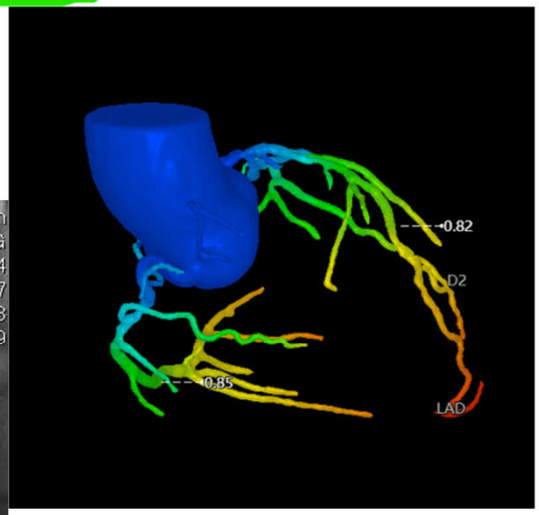
- 57M, Chest pain
- Agatston Score= 794 (A 3/N4) (CAC-DRS)
- CT – FFR LCX= 0.85,

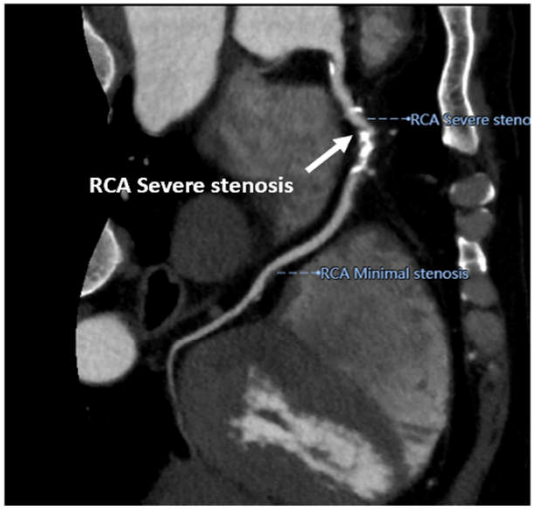
  Delta FFR= 0.14

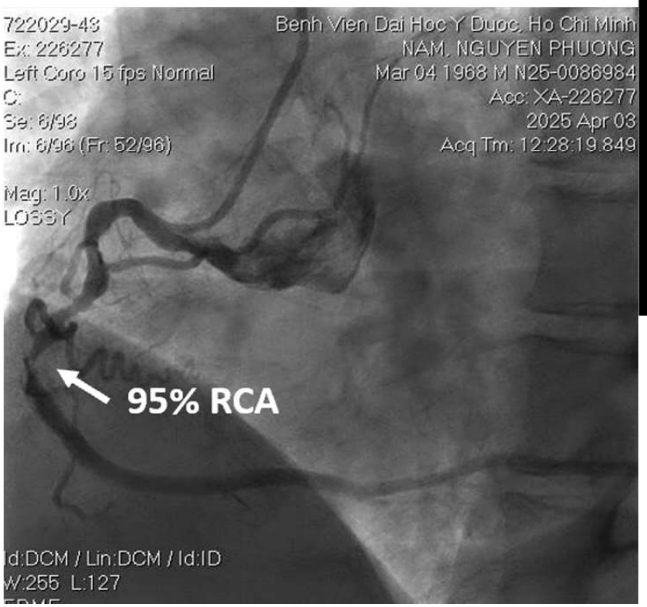
CT-FFR Analysis Report-MEDIC-United Imaging

CT-FFR Analysis Result

Right coronary artery(RCA): The FFR measurement value is 0.85. The first stenosis is located at pRCA with Severe stenosis and Mixed plaque visible. The ΔFFR is 0.14. The second stenosis is located at dRCA with Minimal stenosis and Noncalcified plaque visible. The ΔFFR is 0.05.







CASE 2

- 57M, Chest pain
- Agatston Score= 794 (A 3/N4) (CAC-DRS)
- CT– FFR RCA = 0.85,

  Delta FFR= 0.14

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STUDY LIMITATIONS

- Small study sample
- The patient’s vital signs:.
  - Systolic pressure: 120 mmhg
  - Diastolic pressure: 90 mmhg
  - cardiac output:
- Did not use invasive FFR as a gold standard
- Image analysis by AI only , No repairing by physician

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Limitations of the FFR-CT Technology

- Accurate FFR-CT analysis relies on high-quality coronary CTA, requiring precise lumen segmentation and myocardial mass estimation
- Image-degrading factors such as motion artifacts, calcium blooming, misalignment, noise, and poor contrast can obscure lumen boundaries or exclude sections of the myocardium from the field of view.
- Additionally, FFR-CT is currently not feasible in patients who have coronary stent or CABG.
- Coronary artery calcification (Agatston score >400) significantly affects the diagnostic accuracy of both CCTA FFR-CT

Arta Kasaeian et al. Fractional Flow Reserve from Coronary CT: Evidence, Applications, and Future Directions. J. Cardiovasc. Dev. Dis. 2025, 12, 279

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CONCLUSIONS

Initial Application of CT-FFR in MEDIC, Vietnam

- A real-world study to validate the diagnostic performance of CT-FFR ≤0.80, ΔFFR ≥0.12, CT-FFR <0.75 or ΔFFR ≥0.13 against ICA .
- FFR-ct shows **high diagnostic performance** for the diagnosis of hemodynamically significant CAD , with high sensitivity (96%) and NPV (96.6%)
- Making it a reliable hemodynamically significant CAD rule-out tool. → Screening Function (Gatekeeper).
- Compatibility of CT-FFR with clinical treatment decision (Revascularization vs medical treatment) .
- Lower specificity and PPV of FFR-CT in real world practice were lower than values obtained from published trials.

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Thank You