

**CARDIO
RUN
2024**

16^{ème} CONGRÈS DE PATHOLOGIE CARDIO-VASCULAIRE

Hôtel Saint Alexis
ILE DE LA RÉUNION
France

18-19-20 SEPTEMBRE 2024

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La FFR angio c'est quoi ?

CardioRun, le Mercredi 18 Septembre 2024

Dr C. Pouillot, Clinique Sainte Clotilde, La Réunion

Quelques précisions



- Par FFR Angio, je désignerai **l'ensemble des logiciels** permettant de **calculer la FFR dérivée de l'angiographie coronaire** (il ne s'agit pas du logiciel dénommé FFR angio).
- La présentation **se limitera à la FFR Angio** (dérivée de l'angiographie coronaire), **sans parler de la FFR CT** (dérivée du scanner).

2012 : l'apparition de la FFR Angio...



2012, Premières publications :

Huo Y, Svendsen M, Choy JS, Zhang ZD, Kassab GS : A validated predictive model of coronary fractional flow reserve. J R Soc Interface. 2012 ; 9 ; 1325-1338.

Depuis : un intérêt considérable !

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angiography derived FFR

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RESULTS BY YEAR

1999 2023: 120

Angiography-Derived FFR as Novel Parameter in Assessing Flow-Limiting CAD?

1

Cite Schindler TH, Fearon WF.

Share JACC Cardiovasc Imaging. 2023 Oct;16(10):1332-1334. doi: 10.1016/j.jcmg.2023.03.004. Epub 2023 Apr 26.

PMID: 37115161 No abstract available.

FFR(CT) derived from computed tomography angiography: the experience in

La FFR Angio VS la FFR wire : quel intérêt ?



Functional coronary angiography for the assessment of the epicardial vessels and the microcirculation

Daniel Faria^{1,2}, MD; Breda Hennessey¹, MD; Asad Shabbir¹, MD; Hernán Mejía-Rentería¹, MD, PhD;
Lin Wang¹, MD; Joo Myung Lee³, MD, PhD; Hitoshi Matsuo⁴, MD, PhD; Simone Biscaglia⁵, MD;
Bon-Kwon Koo⁶, MD, PhD; Bo Xu⁷, MD, PhD; Sergio Bravo Baptista^{2,8}, MD, PhD;
Nieves Gonzalo¹, MD, PhD; Javier Escaned^{1*}, MD, PhD

Abstract

« Le nouveau domaine de la coronarographie fonctionnelle (FFR Angio) a attiré l'attention des cardiologues cliniciens & interventionnels, car il permet d'anticiper une nouvelle ère d'évaluation physiologique facilitée de la pathologie coronaire, sans nécessiter d'instrumentation coronaire ou de drogue vasodilatatrice et ainsi une meilleure adoption des revascularisations guidée par l'ischémie. »

Daniel Faria (Madrid)

La FFR Angio : comment ça marche ?



1. **Reconstruction 3D de l'arbre coronaire obtenu à partir d'une ou plusieurs projections d'angiographie invasive**
2. **Résolution des équations de la mécanique des fluides (solutions différentes selon les logiciels)**
 - Le plus souvent, **dynamique des fluides « computationnelle »** (calculs mathématiques permettant d'analyser le flux sanguin)
 - Peuvent s'y ajouter selon les logiciels :
 - TIMI Frame Count (apprécie la vitesse du flux) : QFR
 - Pression aortique (limite d'entrée du modèle dynamique) :v-FFR
 - Limites de sortie incluant :
 - Résistance de la micro-circulation
 - P veineuse centrale
 - ➔ Le plus souvent préétablies

Les différents logiciels de FFR Angio disponibles en France à ce jour..



EuroIntervention

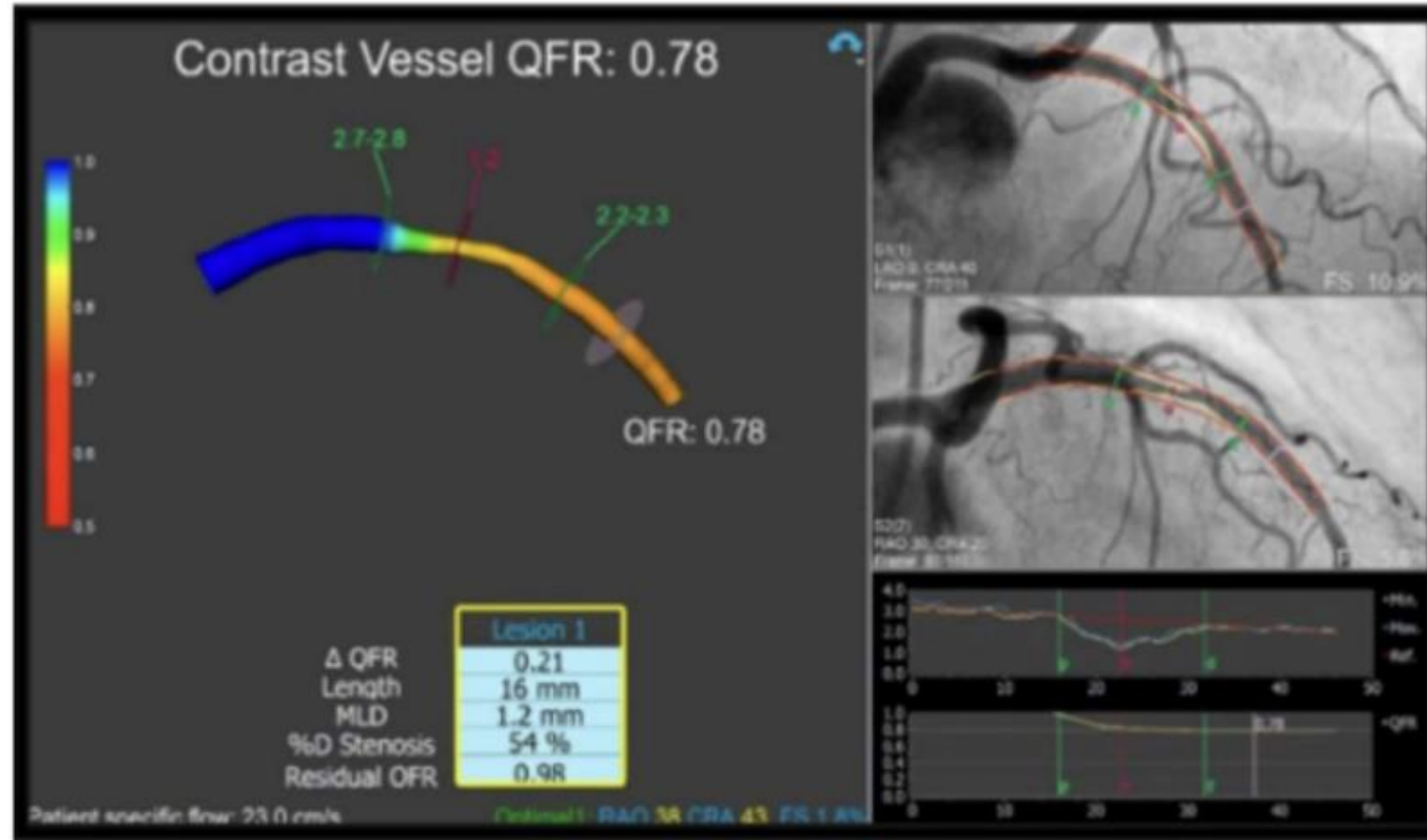
CENTRAL ILLUSTRATION Current commercially available functional indices based on invasive coronary angiography.

	User display	Projections needed	Pressure sensor	Microcirculation	Side branches	Available data
QFR		2	No	Yes	No	
CAAS vFFR		2	No	No	No	
caFFR		2	Yes	Yes	No	
FFR angio		3	Yes	No	Yes	
μ QFR		1	No	Yes	Yes	

The columns from left to right show user interface display after index calculation; number of angiographic projections needed; need for mean aortic pressure input; capacity to provide microcirculatory resistance evaluation; simultaneous side branch physiological interrogation; and the quality and quantity of published evidence. Colour code: green=advantage; yellow=amenable; red=disadvantage.

CAAS vFFR: vessel fractional flow reserve; caFFR: computational pressure-flow dynamics derived FFR; FFR: fractional flow reserve; FFR_{angio}: angiography-derived FFR; QFR: quantitative flow ratio; μ QFR: Murray law-based QFR

Exemple logiciel QFR (MEDIS)

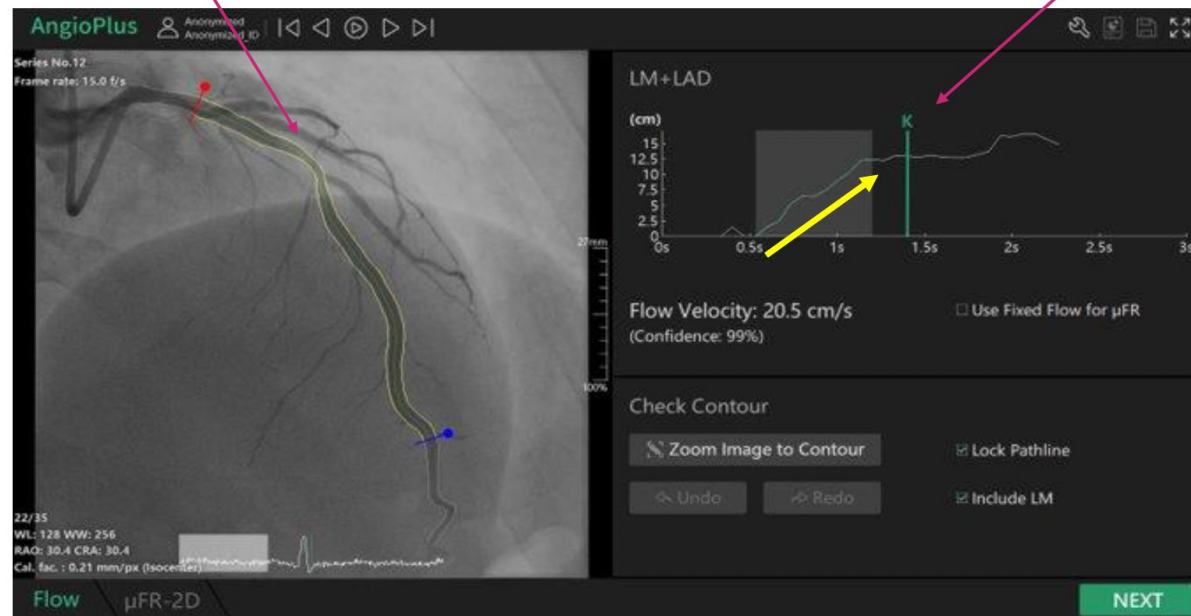


Exemple logiciel μ FR (MicroPort)



Contourage et délimitation de la zone d'intérêt

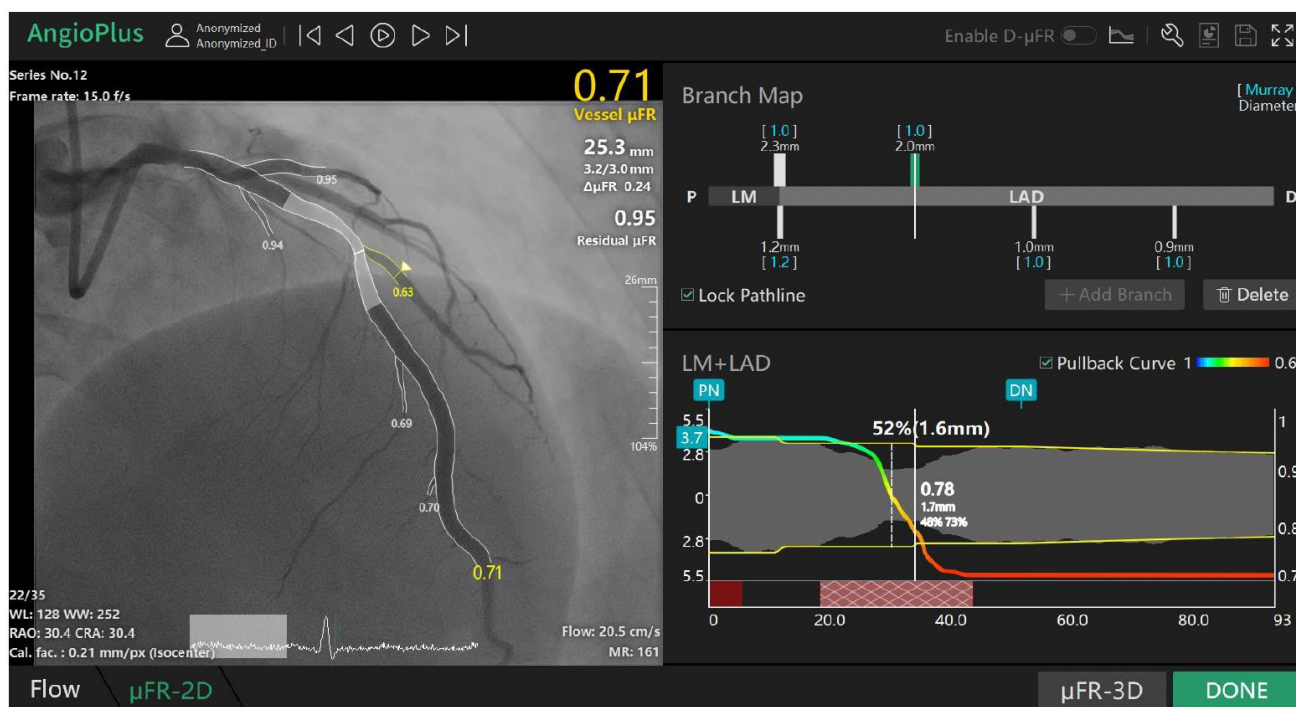
Choix de l'image
Calcul de la vitesse du flux





Exemple logiciel μ FR

Détection du vaisseau et des branches filles



Positionnement PN/DN

Nombre de centres français équipés FFR Angio

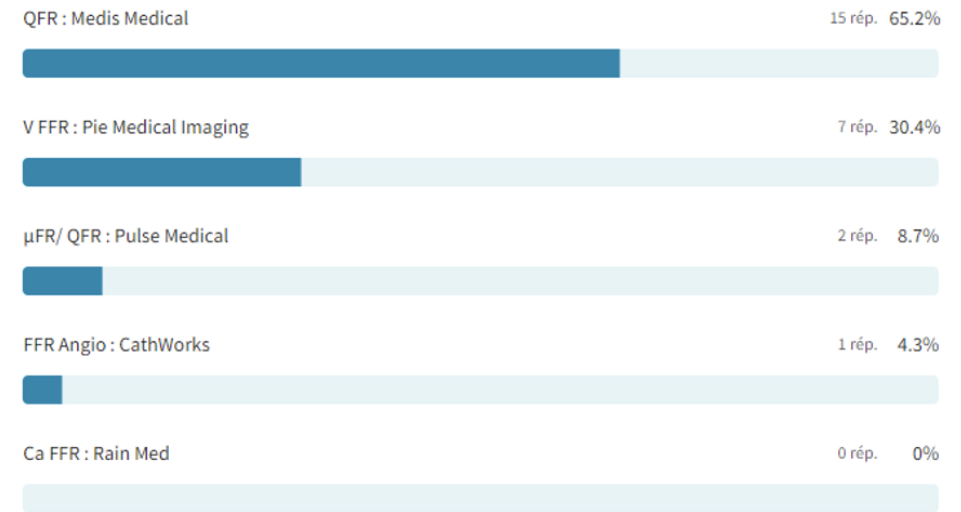


Q12- Êtes-vous équipé d'un logiciel de FFR-Angio ?



→ 1/4 centres français équipés FFR Angio en septembre 2023

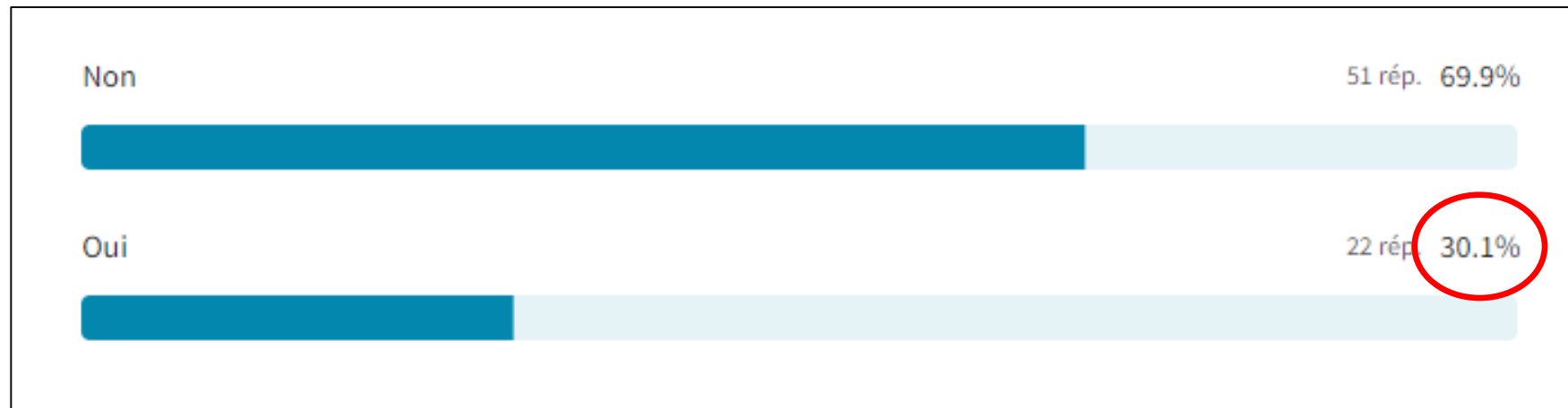
Q15- Vous êtes équipés du (des) logiciel(s) de FFR-Angio suivant(s) :



- 2/3 QFR : Médis médical.
- 1/3 V-FFR : Pie médical.
- Quelques μ FR : Pulse Médical.
- Quelques FFR Angio : Cath work

Source: Enquête Physio Abbott octobre 2023

Envisagez-vous prochainement l'achat d'un logiciel de FFR-Angio ?



→ Fin 2024 > **50% des centres** français seront équipés d'un logiciel de FFR Angio.

Les études



2012 : premières publications :

- *Huo Y, Svendsen M, Choy JS, Zhang ZD, Kassab GS : A validated predictive model of coronary fractional flow reserve. J R Soc Interface. 2012 ; 9 ; 1325-1338.*

La chronologie des études FFR-Angio

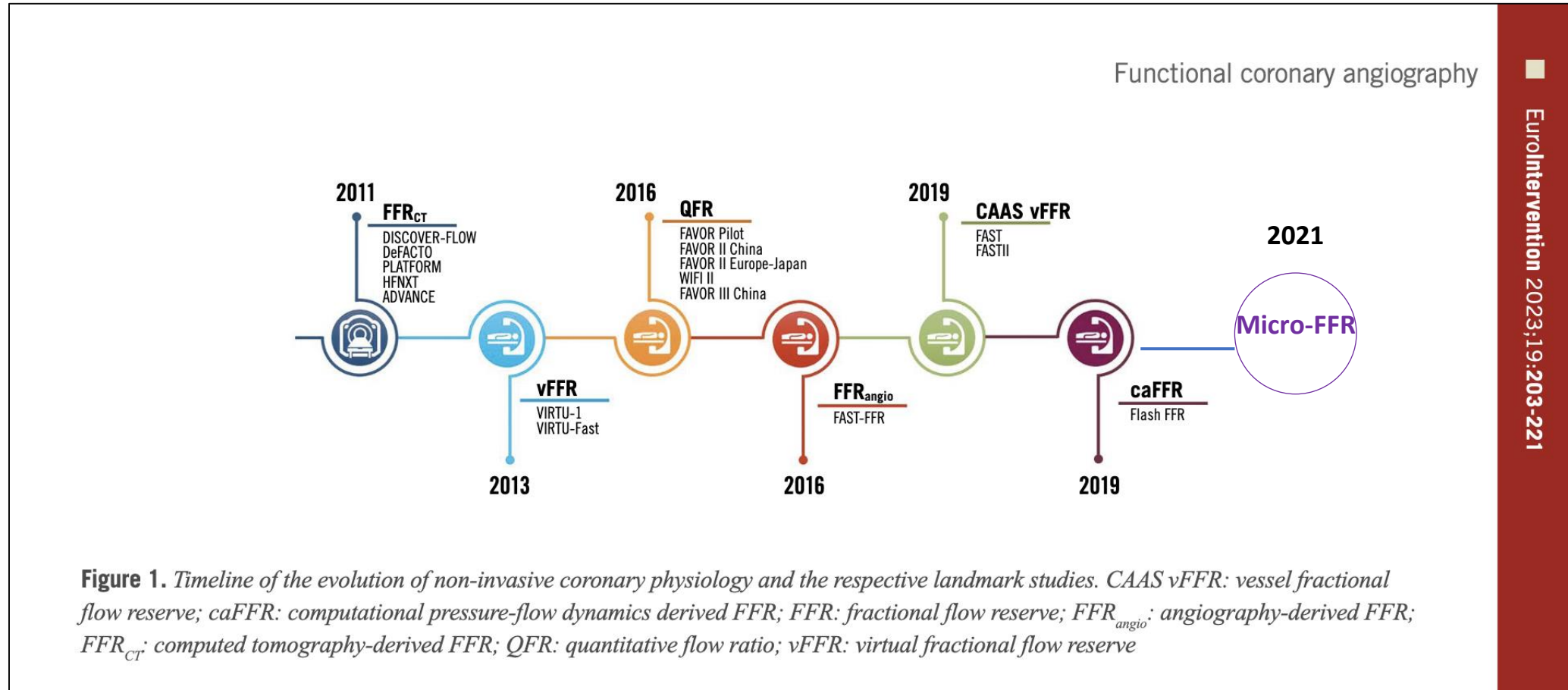


Figure 1. Timeline of the evolution of non-invasive coronary physiology and the respective landmark studies. CAAS vFFR: vessel fractional flow reserve; caFFR: computational pressure-flow dynamics derived FFR; FFR: fractional flow reserve; FFR_{Angio}: angiography-derived FFR; FFR_{CT}: computed tomography-derived FFR; QFR: quantitative flow ratio; vFFR: virtual fractional flow reserve

Différents types d'études



I. Etudes pré-stents

- Comparant la FFR angio vs FFR wire (gold standard).
- Sensibilité. Spécificité. Valeur prédictive positive. Valeur prédictive négative.

Accuracy : « la précision ou l'exactitude »

$$\text{Accuracy (patients ou lésions)} = \frac{\text{FFR angio} \leq \mathbf{0.80} \text{ ou } > \mathbf{0.80}}{\text{FFR wire} \leq \mathbf{0.80} \text{ ou } > \mathbf{0.80}}$$

Corrélation : définie par l'aire sous la courbe et son r

Différents types d'études



I. Etudes post-stents

- **Comparent le diagnostic accuracy des FFR Angio avant stenting pour prédire la FFR wire post-stenting**
- **Utilisent le « Virtual stenting » pour prédire la FFR wire post stenting**
- **Etudient la corrélation entre les résultats de la FFR Angio post-stent et les V.O.C.E (*Vessel Oriented Composite Endpoint*)**

Multiples autres domaines d'études



- **Corrélation FFR Angio / FFR Wire** dans études de la microcirculation
- **FFR Angio** et RAO / TAVI
- **Rares études comparatives de FFR Angio**

QFR : FAVOR Studies depuis 2016



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**Diagnostic Accuracy of Fast
Computational Approaches to
Derive Fractional Flow Reserve
From Diagnostic Coronary Angiography**

The International Multicenter FAVOR Pilot Study

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on behalf of the FAVOR Pilot Trial Study Group



FAVOR II China Study (2017)



Accepted Manuscript



Angiography-Based Quantitative Flow Ratio for Online Assessment of Coronary Stenosis: FAVOR II China Study

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PII: S0735-1097(17)41278-2

DOI: [10.1016/j.jacc.2017.10.035](https://doi.org/10.1016/j.jacc.2017.10.035)

Reference: JAC 24376

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FAVOR II Europe Japan Study (2018)



ORIGINAL RESEARCH



Diagnostic Performance of In-Procedure Angiography-Derived Quantitative Flow Reserve Compared to Pressure-Derived Fractional Flow Reserve: The FAVOR II Europe-Japan Study

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Background—Quantitative flow ratio (QFR) is a novel modality for physiological lesion assessment based on 3-dimensional vessel reconstructions and contrast flow velocity estimates. We evaluated the value of online QFR during routine invasive coronary angiography for procedural feasibility, diagnostic performance, and agreement with pressure-wire-derived fractional flow reserve (FFR) as a gold standard in an international multicenter study.

Methods and Results—FAVOR II E-J (Functional Assessment by Various Flow Reconstructions II Europe-Japan) was a prospective, observational, investigator-initiated study. Patients with stable angina pectoris were enrolled in 11 international centers. FFR and online QFR computation were performed in all eligible lesions. An independent core lab performed 2-dimensional quantitative coronary angiography (2D-QCA) analysis of all lesions assessed with QFR and FFR. The primary comparison was sensitivity and specificity of QFR compared with 2D-QCA using FFR as a reference standard. A total of 329 patients were enrolled. Paired assessment of FFR, QFR, and 2D-QCA was available for 317 lesions. Mean FFR, QFR, and percent diameter stenosis were 0.83 ± 0.09 , 0.82 ± 10 , and $45 \pm 10\%$, respectively. FFR was ≤ 0.80 in 104 (33%) lesions. Sensitivity and specificity by QFR was significantly higher than by 2D-QCA (sensitivity, 86.5% [78.4–92.4] versus 44.2% [34.5–54.3]; $P < 0.001$; specificity, 86.9% [81.6–91.1] versus 76.5% [70.3–82.0]; $P = 0.002$). Area under the receiver curve was significantly higher for QFR compared with 2D-QCA (area under the receiver curve, 0.92 [0.89–0.96] versus 0.64 [0.57–0.70]; $P < 0.001$). Median time to QFR was significantly lower than median time to FFR (time to QFR, 5.0 minutes [interquartile range, –6.1] versus time to FFR, 7.0 minutes [interquartile range, 5.0–10.0]; $P < 0.001$).

Conclusions—Online computation of QFR in the catheterization laboratory is clinically feasible and is superior to angiographic assessment for evaluation of intermediary coronary artery stenosis using FFR as a reference standard.

Clinical Trial Registration—URL: <https://www.clinicaltrials.gov>. Unique identifier: NCT02959814. (*J Am Heart Assoc.* 2018;7:e009603. DOI: 10.1161/JAHA.118.009603.)

- Etude multi centrique > 300 pts ..
- Montrait simplement que la FFR Angio était mieux corrélée à la FFR wire que le QCA ...

FAVOR III China



Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial



Bo Xu*, Shengxian Tu*, Lei Song*, Zening Jin, Bo Yu, Guasheng Fu, Yujie Zhou, Jian'an Wang, Yundai Chen, Jun Pu, Lianglong Chen, Xinkai Qu, Junqing Yang, Xuebo Liu, Lijun Guo, Chengxing Shen, Yaojun Zhang, Qi Zhang, Hongwei Pan, Xiaogang Fu, Jian Liu, Yanyan Zhao, Javier Escaned, Yang Wang, William F Fearon, Keifei Dou, Ajay J Kirtane, Yongjian Wu, Patrick W Serruys, Weixian Yang, William Wijns, Changdong Guan, Martin B Leon†, Shubin Qiao*†, Gregg W Stone†, and the FAVOR III China study group‡

Summary

Background Compared with visual angiographic assessment, pressure wire-based physiological measurement more accurately identifies flow-limiting lesions in patients with coronary artery disease. Nonetheless, angiography remains the most widely used method to guide percutaneous coronary intervention (PCI). In FAVOR III China, we aimed to establish whether clinical outcomes might be improved by lesion selection for PCI using the quantitative flow ratio (QFR), a novel angiography-based approach to estimate the fractional flow reserve.

Methods FAVOR III China is a multicentre, blinded, randomised, sham-controlled trial done at 26 hospitals in China. Patients aged 18 years or older, with stable or unstable angina pectoris or patients who had a myocardial infarction at least 72 h before screening, who had at least one lesion with a diameter stenosis of 50–90% in a coronary artery with a reference vessel of at least 2.5 mm diameter by visual assessment were eligible. Patients were randomly assigned to a QFR-guided strategy (PCI performed only if $QFR \leq 0.80$) or an angiography-guided strategy (PCI based on standard visual angiographic assessment). Participants and clinical assessors were masked to treatment allocation. The primary endpoint was the 1-year rate of major adverse cardiac events, a composite of death from any cause, myocardial infarction, or ischaemia-driven revascularisation. The primary analysis was done in the intention-to-treat population. The trial was registered with ClinicalTrials.gov (NCT03656848).

Findings Between Dec 25, 2018, and Jan 19, 2020, 3847 patients were enrolled. After exclusion of 22 patients who elected not to undergo PCI or who were withdrawn by their physicians, 3825 participants were included in the intention-to-treat population (1913 in the QFR-guided group and 1912 in the angiography-guided group). The mean age was 62.7 years (SD 10.1), 2699 (70.6%) were men and 1126 (29.4%) were women, 1295 (33.9%) had diabetes, and 2428 (63.5%) presented with an acute coronary syndrome. The 1-year primary endpoint occurred in 110 (Kaplan-Meier estimated rate 5.8%) participants in the QFR-guided group and in 167 (8.8%) participants in the angiography-guided group (difference, -3.0% [95% CI -4.7 to -1.4]; hazard ratio 0.65 [95% CI 0.51 to 0.83]; $p=0.0004$), driven by fewer myocardial infarctions and ischaemia-driven revascularisations in the QFR-guided group than in the angiography-guided group.

Interpretation In FAVOR III China, among patients undergoing PCI, a QFR-guided strategy of lesion selection improved 1-year clinical outcomes compared with standard angiography guidance.

Lancet 2021; 398: 2149–59

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See Comment page 2130

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‡All investigators are listed in the appendix (pp 2–4)

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- Première étude FFR angio avec end points cliniques..
- Stratégie de guidage de l'angioplastie coronaire par QFR est meilleure que par angiographie .😊

FAVOR III Europe-Japan



QFR guided PCI strategy vs FFR wire guided PCI strategy :

- 2000 patients
- Clinical end points
- Résultats 2025 ?

Une stratégie de guidage de l'angioplastie coronaire par la QFR VS FFR wire est-elle équivalente en termes d'end points cliniques ?

V-FFR : FAST studies depuis 2019



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DOI: 10.1002/ccd.29311

ORIGINAL STUDIES

WILEY

Validation of novel 3-dimensional quantitative coronary angiography based software to calculate fractional flow reserve post stenting

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Abstract
Objectives: To validate novel dedicated 3D-QCA based on the software to calculate post PCI vessel-FFR (vFFR) in a consecutive series of patients, to assess the diagnostic accuracy, and to assess inter-observer variability.
Background: Low post percutaneous coronary intervention (PCI) fractional flow reserve (FFR) predicts future adverse cardiac events. However, FFR assessment requires the insertion of a pressure wire in combination with the use of a hyperemic agent.
Methods: FAST POST study is an observational, retrospective, single-center cohort study. One hundred patients presenting with stable angina or non ST-elevation myocardial infarction, who underwent post PCI FFR assessment using a dedicated microcatheter were included. Two orthogonal angiographic projections were acquired to create a 3D reconstruction of the coronary artery using the CAAS workstation 8.0. vFFR was subsequently calculated using the aortic root pressure.
Results: Mean age was 65±12 years and 70% were male. Mean microcatheter based FFR and vFFR were 0.91±0.07 and 0.91±0.06, respectively. A good linear correlation was found between FFR and vFFR ($r = 0.88$; $p < .001$). vFFR had a higher accuracy in the identification of patients with FFR values < 0.90 , AUC 0.98 (95% CI: 0.96-1.00) as compared with 3D-QCA AUC 0.62 (95% CI: 0.94-0.74). Assessment of vFFR had a low inter-observer variability ($r = 0.95$; $p < .001$).
Conclusion: 3D-QCA derived post PCI vFFR correlates well with invasively measured microcatheter based FFR and has a high diagnostic accuracy to detect FFR < 0.90 with low inter-observer variability.

KEYWORDS
coronary angiography, fractional flow reserve, quantitative coronary angiography

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Catheter Cardiovasc Interv. 2020;1-7 | wileyonlinelibrary.com/journal/ccd | 1


FAST STUDY (2020)



CORONARY INTERVENTIONS
CLINICAL RESEARCH

Special feature: Physiology indices

Validation of a three-dimensional quantitative coronary angiography-based software to calculate fractional flow reserve: the FAST study

 Kaneshka Masdjedji¹, MD; Laurens J.C. van Zandvoort¹, BSc; Matthew M. Balbi¹, MD; Frank J.H. Gijssen¹, PhD; Jurgen M.R. Ligthart¹, RT; Marcel C.M. Rutten², ir. PhD; Miguel E. Lemmert¹, MD, PhD; Jeroen Wilschut¹, MD; Roberto Diletti¹, MD, PhD; Peter de Jaegere², MD, PhD; Felix Zijlstra¹, MD, PhD; Nicolas M. Van Mieghem¹, MD, PhD; Joost Daemen^{1*}, MD, PhD

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KEYWORDS

- * fractional flow reserve
- * other technique
- * QCA
- * stable angina

Abstract

Aims: The aim of this study was to validate novel software to calculate vessel fractional flow reserve (vFFR) based on 3D-QCA and to assess inter-observer variability in patients who underwent routine pre-procedural FFR assessment for intermediate coronary artery stenosis.

Methods and results: *In vitro* validation was performed in an experimental model. Clinical validation was performed in an observational, retrospective, single-centre cohort study. A total of 100 patients presenting with stable angina or non-ST-segment elevation myocardial infarction and an indication to perform FFR between January 2016 and October 2016 were included. vFFR was calculated based on the aortic root pressure along with two angiographic projections and validated against pressure wire-derived FFR. Mean FFR and vFFR were 0.82±0.08 and 0.84±0.07, respectively. A good linear correlation was found between FFR and vFFR ($r=0.89$, $p<0.001$). Assessment of vFFR had a low inter-observer variability ($r=0.95$, $p<0.001$). The diagnostic accuracy of vFFR in identifying lesions with an FFR ≤ 0.80 was higher as compared with 3D-QCA: AUC 0.93 (95% CI: 0.88-0.97) vs 0.66 (95% CI: 0.55-0.77), respectively.

Conclusions: The 3D-QCA-derived vFFR has a high linear correlation to invasively measured FFR, a high diagnostic accuracy to detect FFR ≤ 0.80 and a low inter-observer variability.

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Published online: 10 May 2019



FAST II study (2021)

CORONARY INTERVENTIONS
CLINICAL RESEARCH

Vessel fractional flow reserve (vFFR) for the assessment of stenosis severity: the FAST II study

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KEYWORDS

- fractional flow reserve
- other technique
- QCA

Abstract

Background: Fractional flow reserve (FFR)-guided percutaneous coronary intervention (PCI) is superior to angiography-guided PCI. The clinical uptake of FFR has been limited, however, by the need to advance a wire in the coronary artery, the additional time required and the need for hyperaemic agents which can cause patient discomfort. FFR derived from routine coronary angiography eliminates these issues.

Aims: The aim of this study was to assess the diagnostic performance and accuracy of three-dimensional quantitative coronary angiography (3D-QCA)-based vessel FFR (vFFR) compared to pressure wire-based FFR (≤ 0.80).

Methods: The FAST II (Fast Assessment of STenosis severity) study was a prospective observational multicentre study designed to evaluate the diagnostic accuracy of vFFR compared to the reference standard (pressure wire-based FFR ≤ 0.80). A total of 334 patients from six centres were enrolled. Both site-determined and blinded independent core lab vFFR measurements were compared to FFR.

Results: The core lab vFFR was 0.83 ± 0.09 and pressure wire-based FFR 0.83 ± 0.08 . A good correlation was found between core lab vFFR and pressure wire-based FFR ($R=0.74$; $p<0.001$; mean bias 0.0029 ± 0.0642). vFFR had an excellent diagnostic accuracy in identifying lesions with an invasive wire-based FFR ≤ 0.80 (area under the curve [AUC] 0.93; 95% confidence interval [CI]: 0.90-0.96; $p<0.001$). Positive predictive value, negative predictive value, diagnostic accuracy, sensitivity and specificity of vFFR were 90%, 90%, 90%, 81% and 95%, respectively.

Conclusions: 3D-QCA-based vFFR has excellent diagnostic performance to detect FFR ≤ 0.80 . The study was registered on clinicaltrials.gov under identifier NCT03791320.

- Etude X centrique > 300 pts..
- V FFR bonne corrélation avec la FFR wire



FAST III trial

Fractional flow reserve or 3D-quantitative-coronary-angiography based vessel-FFR guided revascularization. Rationale and study design of the prospective randomized fast III trial

Alessandra Scoccia ¹, Robert A Byrne ², Adrian P Banning ³, Ulf Landmesser ⁴, Eric Van Belle ⁵, Ignacio J Amat-Santos ⁶, Manel Sabaté ⁷, Jan G P Tijssen ⁸, Ernest Spitzer ⁹, Joost Daemen ¹⁰

Study design and objectives: The FAST III is an investigator-initiated, open label, multicenter randomized trial comparing vFFR guided versus FFR guided coronary revascularization in approximately 2228 patients with intermediate coronary lesions (defined as 30%-80% stenosis by visual assessment or QCA).

Résultats en 2025 ?

Première étude comparant stratégie d'angioplastie coronaire guidée par la V FFR VS FFR wire avec end points cliniques

FFR angio : études depuis 2017



Circulation

Volume 139, Issue 4, 22 January 2019; Pages 477-484
<https://doi.org/10.1161/CIRCULATIONAHA.118.037350>



ORIGINAL RESEARCH ARTICLE

Accuracy of Fractional Flow Reserve Derived From Coronary Angiography

Editorial, see p 485

William F. Fearon, MD, S
Abid Assali, MD, Richar
Ajay J. Kirtane, MD, Ran
Daniel M. Kolansky, MD
MD, Mitsuaki Matsumur
the FAST-FFR Study Inv

Conclusions:

FFRangio measured from the coronary angiogram alone has a high sensitivity, specificity, and accuracy compared with pressure wire–derived FFR. FFRangio has the promise to substantially increase physiological coronary lesion assessment in the catheterization laboratory, thereby potentially leading to improved patient outcomes.

Une des rares études comparant les FFR angio : logiciel FFR Angio vs QFR



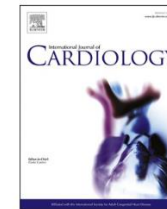
International Journal of Cardiology 399 (2024) 131663



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International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard



Head-to-head comparison of two angiography-derived fractional flow reserve techniques in patients with high-risk acute coronary syndrome: A multicenter prospective study



Ioannis Skalidis^{a,b,1}, Nathalie Noirclerc^{a,1}, David Meier^a, Wongsakorn Luangphiphat^a, Aurelien Cagnina^a, Sarah Mauler-Wittwer^a, Thabo Mahendiran^a, Bernard De Bruyne^{a,c}, Alessandro Candreva^d, Carlos Collet^c, Jeroen Sonck^c, Olivier Muller^a, Stephane Fournier^{a,*}

^a Department of Cardiology, Lausanne University Hospital and University of Lausanne

^b School of Medicine, University of Crete, Greece

^c Cardiovascular Center Aalst, Aalst, Belgium

^d Department of Cardiology, University Hospital of Zurich, Zurich, Switzerland

Conclusion: In patients with high-risk ACS, FFRangio and QFR demonstrated excellent diagnostic performance. FFRangio seems to have better correlation to invasive FFR compared to QFR but further larger validation studies are required.

μ FFR : études depuis 2021



- Logiciel basé sur la loi fractale « Murray Law » simplifiée par G. Finet « Loi de Finet ».
- Autorise **la reconstruction 3D avec une seule projection angiographique.**



Received: 8 January 2021

Revised: 16 February 2021

Accepted: 19 February 2021

DOI: 10.1002/ccd.29592

ORIGINAL STUDIES

WILEY

Diagnostic accuracy of quantitative flow ratio for assessment of coronary stenosis significance from a single angiographic view: A novel method based on bifurcation fractal law

Shengxian Tu PhD^{1,2}  | Daixin Ding MSc^{1,3} | Yunxiao Chang MSc⁴ |
Chunming Li BSc¹ | William Wijns MD, PhD³ | Bo Xu MBBS⁵

Objectives: We aimed to evaluate the diagnostic accuracy of computation of fractional flow reserve (FFR) from a single angiographic view in patients with intermediate coronary stenosis.

Results: The μ QFR was successfully computed in all 330 vessels of 306 patients. There was excellent correlation ($r = 0.90$, $p < .001$) and agreement (mean difference = 0.00 ± 0.05 , $p = .378$) between μ QFR and FFR. The vessel-level diagnostic accuracy for μ QFR to identify hemodynamically significant stenosis was 93.0% [...].

Certaines FFR Angio sont-elles meilleures que les autres ?



ESC

European Society
of Cardiology

European Heart Journal (2018) 39, 3314–3321
doi:10.1093/eurheartj/ehy445

META-ANALYSIS

Diagnostic performance of angiography-derived fractional flow reserve: a systematic review and Bayesian meta-analysis

Carlos Collet^{1,2}, Yoshinobu Onuma^{3,4}, Jeroen Sonck², Taku Asano¹, Bert Vandeloo²,
Ran Kornowski⁵, Shengxian Tu⁶, Jelmer Westra⁷, Niels R. Holm⁷, Bo Xu⁸,

Robbert J. de Winter¹, Jan C.
Erhan Tenekecioglu⁴, Rodrig
Daniel Schoors², Bram Roos
Alexandre van Rosendael⁹, J
Bernard De Bruyne¹³, Willia

Conclusion:

The accuracy of angiography-derived FFR was good to detect haemodynamically significant lesions with pressure-wire measured FFR as a reference. **Computational approaches and software packages did not influence the diagnostic accuracy of angiography-derived FFR.** A diagnostic strategy trial with angiography-derived FFR evaluating clinical endpoints is warranted.

FFR Angio : certaines limitations existent cependant



- \approx **15 à 20 %** des angiogrammes non utilisables pour FFR angio (qualité technique insuffisante, tortuosités, superpositions...)
- La FFR angio ne s'applique pas :
 - **Lésions ostiales** – Tronc commun ou CD ;
 - **Lésions de bifurcations ; Vaisseaux pontés ; CTO ; RIS ; lésions diffuses ;**
 - Le plus souvent, la FFR angio **ignore la micro circulation.**



Excellente accuracy des logiciels FFR Angio vs FFR Wire dans les études des constructeurs (AUC 0.92 à 0.97)

Angio-derived FFR- reported correlation with FFR




TABLE 1. THREE CORONARY ANGIOGRAPHY-DERIVED PHYSIOLOGIC INDICES AND THEIR DIAGNOSTIC PERFORMANCE AGAINST WIRE-BASED FFR

Index	Company	Clinical Studies	Year	Correlation With FFR	Sensitivity	Specificity	Accuracy	AUC (95% CI)	
FFR _{Angio}	CathWorks	Kornowski et al ¹	2016	0.90-0.93	0.88	0.98	0.94	-	
		Pellicano et al ²	2017	0.88	0.88	0.95	0.93	0.97 (N/A)	
		FAST-FFR ³	2019	0.80	0.94	0.91	0.92	0.94 (0.92-0.97)	
		Kobayashi et al ⁴							
		- LAD	2020	-	0.93	0.99	-	-	
		- LCX		-	1.00	0.86	-	-	
		- RCA		-	0.92	0.84	-	-	
		Witberg et al ⁵							
		- FFR (range, 0.75-0.85)	2020	-	0.82	0.89	0.86	-	
		Omori et al ⁶							
- MVD	2019	0.83	0.92	0.92	0.92	0.92 (0.84-0.97)			
QFR	Medis Medical Imaging/Pulse Medical Imaging Technology	FAVOR Pilot ⁴	2016	0.77	0.74	0.91	0.85	0.92 (0.94-0.98)	
		FAVOR II China ⁵	2017	0.86	0.95	0.92	0.92	0.96 (0.94-0.98)	
		FAVOR II Europe-Japan ⁷	2018	0.80	0.87	0.87	0.87	0.92 (0.89-0.96)	
		- FFR (range, 0.75-0.84)		-	-	-	0.71	-	
vFFR	Pie Medical Imaging	FAST ⁸	2020	0.89	-	-	-	0.93 (0.88-0.97)	


Abbreviations: AUC, area under the curve; FFR, fractional flow reserve; LAD, left anterior descending artery; LCX, left circumflex artery; MVD, multivessel disease; N/A, not available; QFR, quantitative flow ratio; RCA, right coronary artery; vFFR, vessel fractional flow reserve.

Mais quelle corrélation FFR Angio vs FFR wire dans la « vraie vie » ?



ELSEVIER



JACC: Cardiovascular Interventions
Volume 16, Issue 14, 24 July 2023, Pages 1778-1790



JACC
Cardiovascular
Interventions

New Research Paper
Coronary

Anonymous Comparison of Various Angiography-Derived Fractional Flow Reserve Software With Pressure-Derived Physiological Assessment

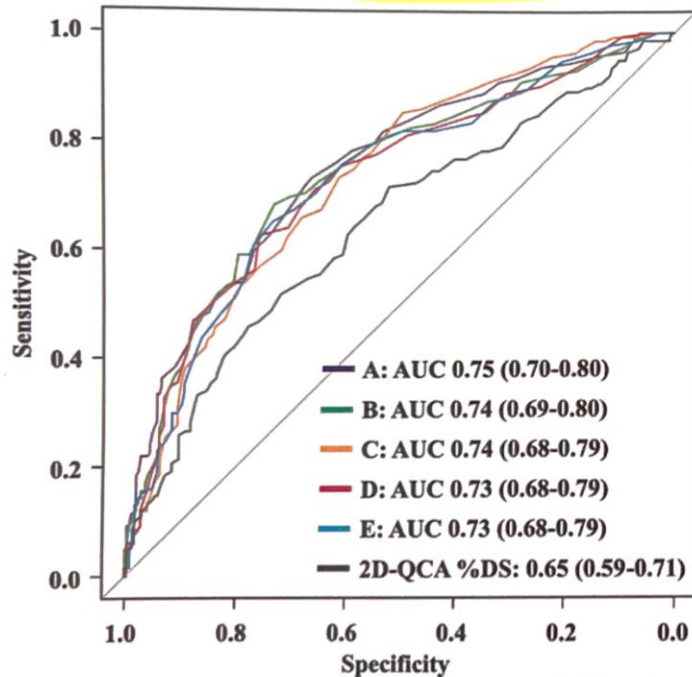
Kai Ninomiya MD^a*, Patrick W. Serruys MD, PhD^{a b *}  , Nozomi Kotoku MD^a,
Jinying Zhou MD^a, Shigetaka Kageyama MD^a, Shinichiro Masuda MD^a, Pruthvi C. Revaiah MD^a,
Bo Wang MD^a, Xingqiang He MD^a, Tsung-Ying Tsai MD^a, Momoko Kageyama MD^a,
Emelyne Sevestre BA^a, Faisal Sharif MD, PhD^a, Scot Garg MD, PhD^c, Takashi Akasaka MD, PhD^d,
Javier Escaned MD, PhD^e, Manesh R. Patel MD, PhD^f, Yoshinobu Onuma MD, PhD^a

Moins bonne corrélation FFR angio vs FFR wire (AUC 0.68-0.74)



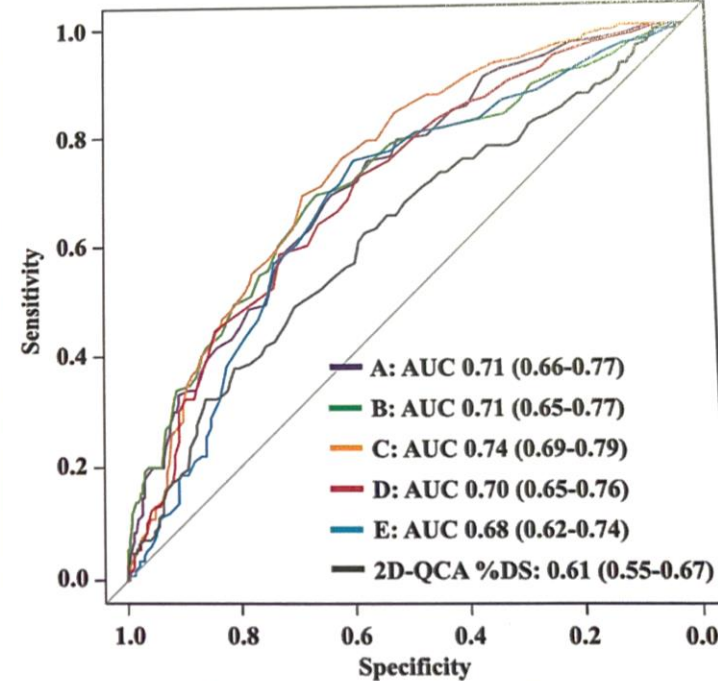
FIGURE 4 ROC Curves for Each Angiography-Derived FFR Against Wire FFR and IFR

A ROC curves for each angiography derived FFR to detect an FFR of ≤ 0.80



Threshold of A, B, C, D, E, and 2D-QCA %DS was 0.82, 0.81, 0.82, 0.81, 0.80, and 47%

B ROC curves for each angiography derived FFR to detect an iFR of ≤ 0.89



Threshold of A, B, C, D, E, and 2D-QCA %DS was 0.82, 0.83, 0.75, 0.81, 0.84, and 44%

En synthèse..



- **Excellente Accuracy** des études FAVOR et FAST des constructeurs (AUC **0.92 à 0.97**)
- **Plus modeste Accuracy** dans la « vraie vie » ANONYMOUS (AUC **0.73 à 0.75**)

De plus pour certains sous-groupes de lésions:

- IVA : FFR angio + positifs / CX ou CD vs FFR Wire.
- Lésions coronaires en **zone grise** $0.75 < \text{FFR angio} < 0.85$: **AUC 0.63.**



FFR Angio vs FFR Wire ?

Il nous faudra encore attendre **1an environ** pour pouvoir trancher cette question avec les résultats **FAVOR III Europe – Japan et FAST III** (*comparant le guidage de l'angioplastie coronaire par la FFR Angio vs FFR_w ; > 2000 pts, end points cliniques*).

Que faire en attendant ?



Votre propre registre FFR angio VS Pressure wire FFR !

Registre Réunion CSC v-FFR vs Pressure wire FFR :

- > 120 pts, > 140 lésions,
- Soumis à publication, en attente..

Registre CSC V FFR / Pressure wire FFR	
Prénom:	
Nom:(1ere lettre):	
DDN:	Age:
IPP:	
No examen:	
Opérateur	
FFR wire	
V FFR	
Antécédents	
PCI	
Pontages	
facteurs de risque	
Diabète	
Hypercholestérolémie	
Hypertension	
Tabac	
Insuffisance rénale : 0 / modérée	
Obésité	
Présentation clinique	
Angor stable	
Asymptomatique à test d'ischémie +	
Asymptomatique et pas de test d'ischémie	
SCA ST -	
SCA ST + (artère non coupable)	
Coro systématique, bilan pré op vasc/valvulaire	
FEVG	
Normale	
40-50%	
30-40%	
< 30%	
Coronarographie	
1 TC	
2 TC	
3 TC	

Segment d'artère Interrogée (lésion 1)																													
<table border="1"> <tr><td>1 CD I</td><td>5 TC G</td></tr> <tr><td>2 CD II</td><td>6 IVA I</td></tr> <tr><td>3 CD III</td><td>7 IVA II</td></tr> <tr><td>4 IVP</td><td>8 IVA III</td></tr> <tr><td>16 RVP</td><td>9 DIAG 1</td></tr> <tr><td></td><td>10 DIAG 2</td></tr> <tr><td></td><td>11 CX I</td></tr> <tr><td></td><td>12 MG 1</td></tr> <tr><td></td><td>13 CX II</td></tr> <tr><td></td><td>14 MG 2</td></tr> <tr><td></td><td>14 MG 2 (Postéro latérale)</td></tr> <tr><td></td><td>15 RVP - CX</td></tr> <tr><td></td><td>17</td></tr> <tr><td></td><td>Bissectrice</td></tr> </table>		1 CD I	5 TC G	2 CD II	6 IVA I	3 CD III	7 IVA II	4 IVP	8 IVA III	16 RVP	9 DIAG 1		10 DIAG 2		11 CX I		12 MG 1		13 CX II		14 MG 2		14 MG 2 (Postéro latérale)		15 RVP - CX		17		Bissectrice
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Lésions/QCA																													
Diamètre référence (mm)																													
Longueur (mm)																													
% Sténose																													
MLD (mm)																													
Résultats:																													
V FFR																													
Pressure Wire FFR																													
Indications Contrôle FFR wire/ V FFR : registre CSC																													
PA au début de la FFR angio																													
Technique																													
KT diagnostique 5F																													
KT guide																													
Traitement																													
TNT 3mg																													
Héparine IV z 50 U/Kg																													
Aspegic IV 250 mg																													
Adénosine IV 180 gamma/Kg/min																													
Décision thérapeutique																													
OMT																													
PCI																													
Pontages																													
Signature consentement par le patient et le médecin en 2 exemplaires :																													
Signature cardiologue v FFR																													
signature cardiologue Pressure Wire FFR																													

La réalisation de votre « registre Home-made »



Avec votre propre logiciel, piloté par votre propre équipe médicale ou paramédicale :

→ Votre propre accuracy (vs FFRw)

→ Votre propre corrélation

→ Quels cas nécessiteraient encore une validation par la FFR invasive (grey zone)... ?

Take Home message



Attendez encore un peu avant de remettre
vos Pressure wires au placard..



Et voici le mot de la fin



Le dernier mot au Pr Patrick SERRUYS



La FFR Angio
durera 5 ans



PCR Mai 2023



Dans un avenir proche

Dans 5 ans, la FFR Angio sera probablement remplacée par la FFR CT (scanner coronaire avec étude fonctionnelle: réellement non invasif..).

Patients seront donc plus référés aux radiologues et non plus aux cardiologues interventionnels pour ex diagnostiques...

Seuls les patients pour intervention leur seront référés.

Mais alors qui sera le prochain Gate Keeper ?

- cardiologue correspondant ?
- Le radiologue ?
- MG demandant FFR CT ?

Merci





Concentrons-nous maintenant sur le choix des
différentes FFR Angio entre elles



Choix des FFR Angiographiques

Tout d'abord lever l'ambiguïté du titre :

- Le choix des FFR Angio vs FFR wire ?
- Le choix entre les différentes FFR Angio ?

Remarquable attractivité de la FFR Angio



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angiography derived FFR

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RESULTS BY YEAR

Year	Number of Results
1999	~1
2000	~2
2001	~3
2002	~4
2003	~5
2004	~6
2005	~8
2006	~10
2007	~12
2008	~15
2009	~18
2010	~22
2011	~28
2012	~35
2013	~45
2014	~55
2015	~65
2016	~75
2017	~85
2018	~95
2019	~105
2020	~115
2021	~120
2022	~120
2023	120

1 **Angiography-Derived FFR as Novel Parameter in Assessing Flow-Limiting CAD?**
1
Cite Schindler TH, Fearon WF.
Share JACC Cardiovasc Imaging. 2023 Oct;16(10):1332-1334. doi: 10.1016/j.jcmg.2023.03.004. Epub 2023 Apr 26.
PMID: 37115161 No abstract available.

FFR(CT) derived from computed tomography angiography: the experience in