TCTAP 2023

Coronary CT angiography for Heart Team Decision-making in Multivessel Coronary Artery Disease

Yoshinobu Onuma, MD, PhD

Professor in Interventional Cardiology at University of Galway, Medical Director CORRIB Corelab research centre for coronary imaging and Atherosclerosis research

Nozomi Kotoku, MD

Patrick W. Serruys, MD, PhD

Monday, May 8
7:16 am-7:23 am
Coronary Theater, Walker Hall, Level 1

Disclosure

- I have no conflicts of interest

Guideline Recommendations for Coronary CTA

NICE National Institute for Health and Care Excellence

Clinical guideline
Published: 24 March 2010
nice.org.uk/guidance/cg95

NICE guideline

Chest pain of recent onset: assessment and diagnosis

Recommend CTA as first-line test

Using CTA with FFR_{CT} may lead to cost savings of £214 per patient avoiding invasive investigation and treatment (13 Feb 2017).

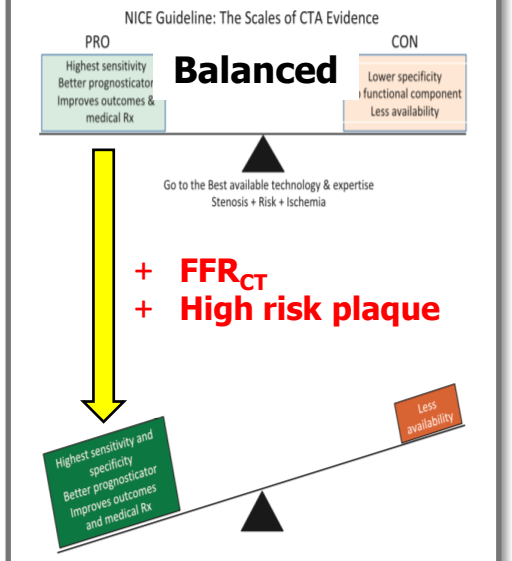
Projection…

CTA 400%

Invasive angiography 60%

Should NICE guidelines be universally accepted for the evaluation of stable coronary disease? A debate

Harvey S. Hecht[1]*, Leslee Shaw[2], Y.S. Chandrashekhar[3], Jeroen J. Bax[4], and Jagat Narula[1]



In favor of CTA as driven by NICE guidelines

Eur Heart J. 2019 May 7;40(18):1440-1453.

2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes

The Task Force for the diagnosis and management of chronic coronary syndromes of the European Society of Cardiology (ESC)

Class I Level B recommendation

Coronary CTA with Non-invasive functional imaging recommended as **the initial test to diagnose CAD** in symptomatic patients in whom obstructive CAD cannot be excluded by clinical assessment alone.

Knuuti J, Wijns W, et al. Eur Heart J. 2019 Aug 31. pii: ehz425.

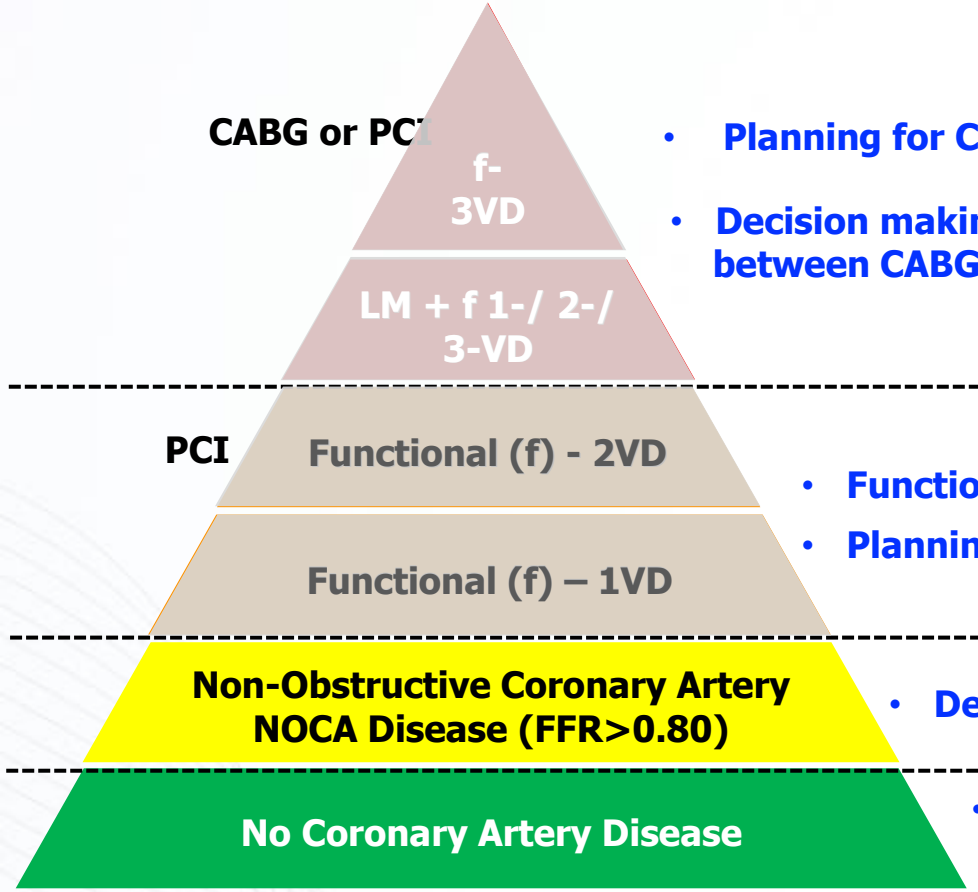
2021 AHA/ACC/ASE/CHEST/SAEM/ SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

1	A

For intermediate-risk patients with acute chest pain and no known CAD eligible for diagnostic testing after a negative or inconclusive evaluation for ACS, **CCTA is useful for exclusion of atherosclerotic plaque and obstructive CAD**

CORRIB CORE LAB:

The role of CCTA in CAD: a diagnostic tool, decision maker and treatment planner

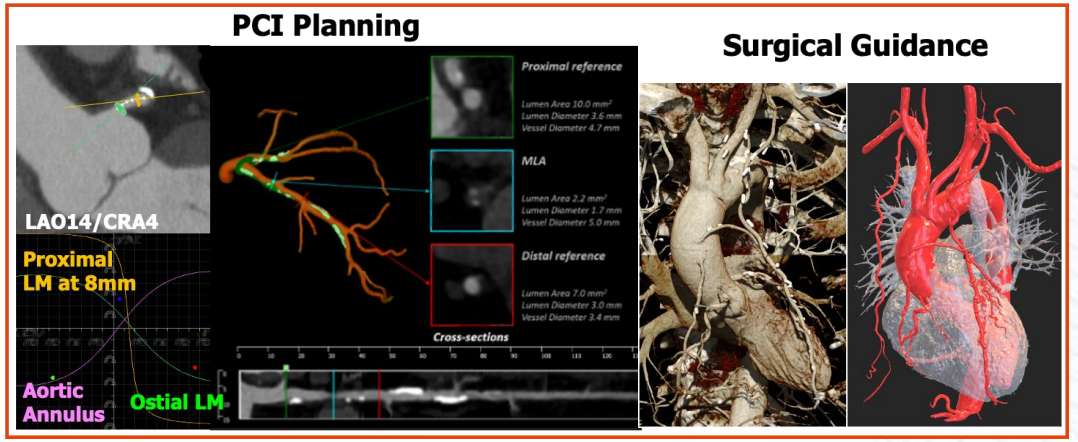


- Planning for CABG (FASTTRACK CABG)
- Decision making between CABG and PCI (SYNTAX III)
- Functional Severity Assessment
- Planning for PCI
- Detection of High-risk Plaque
- Rule-out of Epicardial and Microvascular Disease

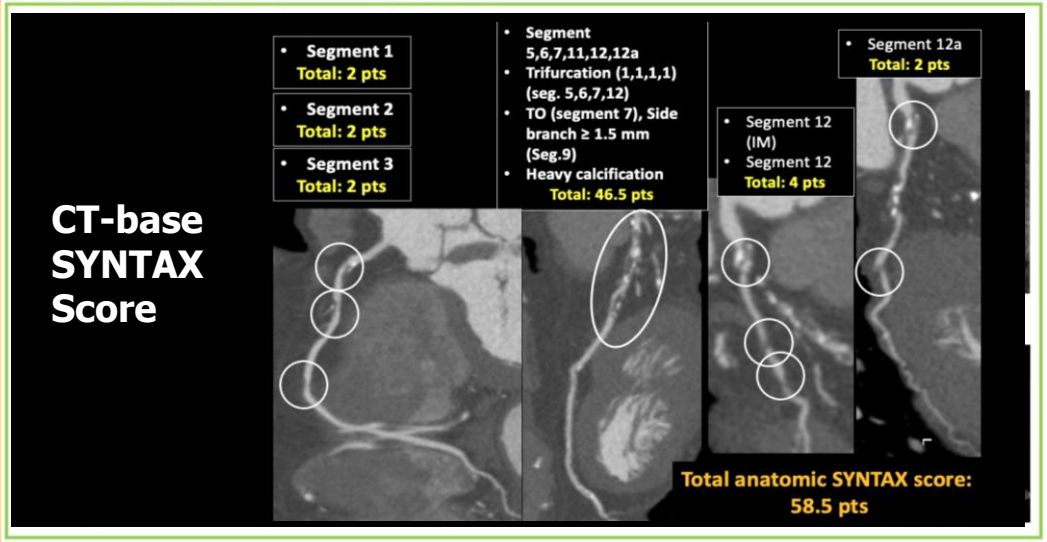
Serruys et.al. JACC State-of-the-Art Review CCTA vol.78:713-736.

Serruys et al. State-of-the-art EuroIntervention 2023;18(16):e1307-e1327.

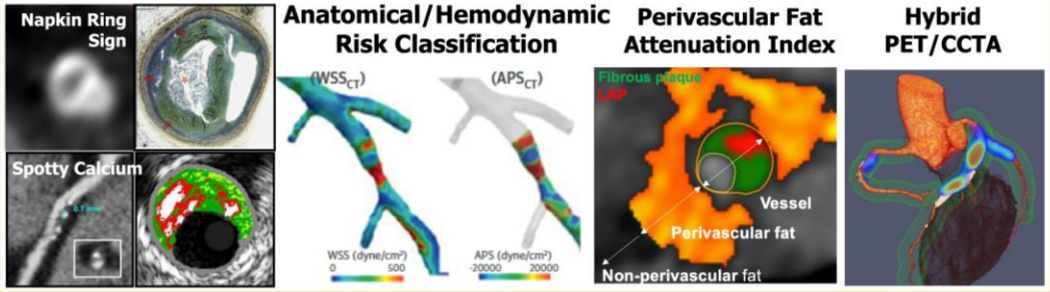
Treatment Planner



Decision Maker



Coronary Plaque Activity/Risk Assessment



CT-SYNTAX Score

Serruys PW, et al, JACC Cardiovasc Imaging. 2013 Mar;6(3):413-5.

A Feasibility and Reproducibility Study

Segments with disease

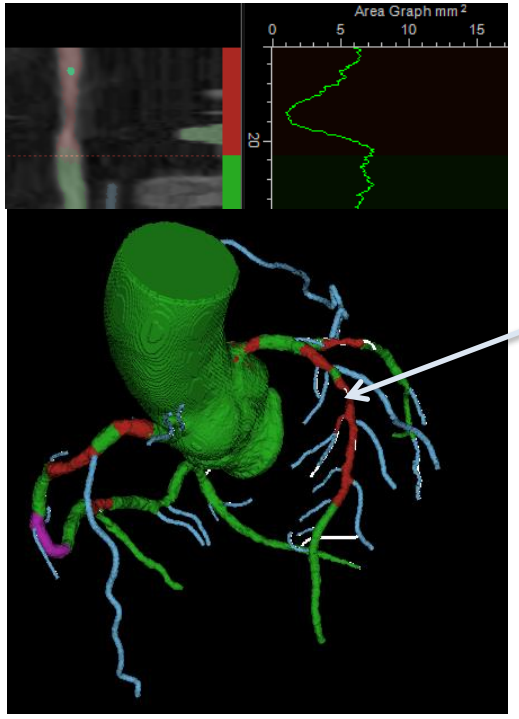
3. Specify which segments are diseased for lesion 1.

Click on the coronary tree image to select or unselect segments.

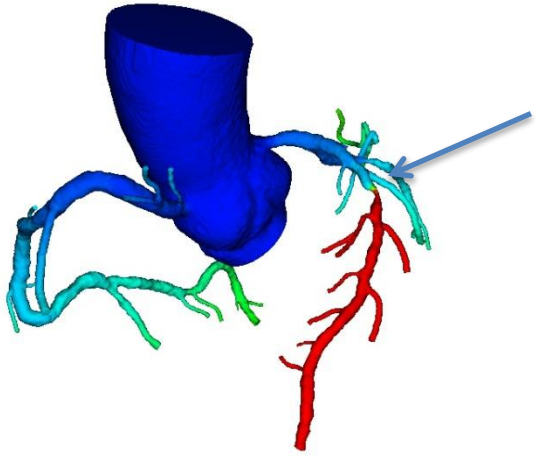
(Right dominance)

Total occlusion: x5
Significant lesion: x2

		Lesion:	1	
	Segments:			
RCA	RCA proximal	1	☐	1
	RCA mid	2	☐	1
	RCA distal	3	☐	1
LM	Left main	5	☐	5
LAD	LAD proximal	6	☐	3.5
	LAD mid	7	☐	2.5
	LAD apical	8	☐	1
	First diagonal	9	☐	1
	Add. first diagonal	9a	☐	1
	Second diagonal	10	☐	0.5
	Add. second diagonal	10a	☐	0.5
LCX	Proximal circumflex	11	☐	1.5
	Intermediate/anterolateral	12	☐	1
	Obtuse marginal	12a	☐	1
	Obtuse marginal	12b	☐	1
	Distal circumflex	13	☐	0.5
	Left posterolateral	14	☐	0.5
	Left posterolateral	14a	☐	0.5
	Left posterolateral	14b	☐	0.5
	Posterior descending	15	☐	n.a.



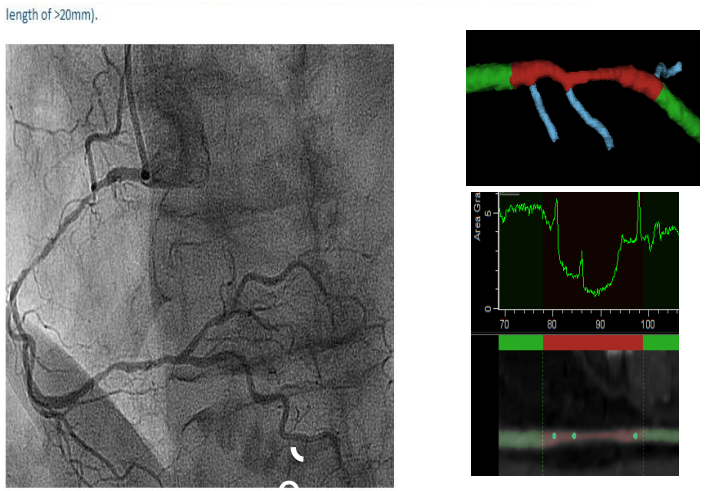
Anatomic calculation of >50% stenosis



Functional calculation stenosis with <0.80 FFR

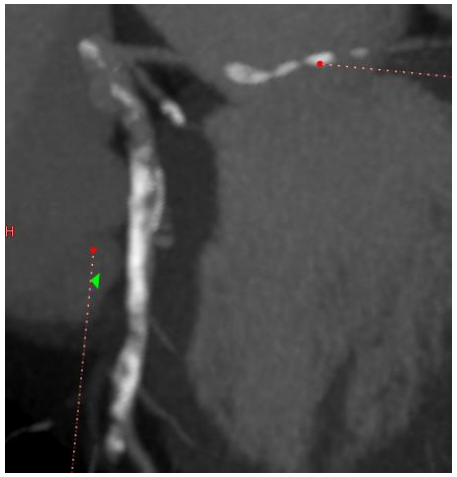
Length of lesion

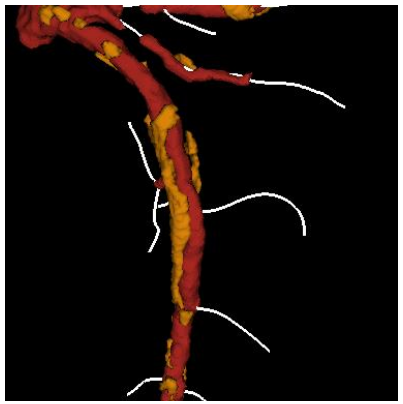
The length of a stenosis can be calculated from the 3D model.



Extent of calcification

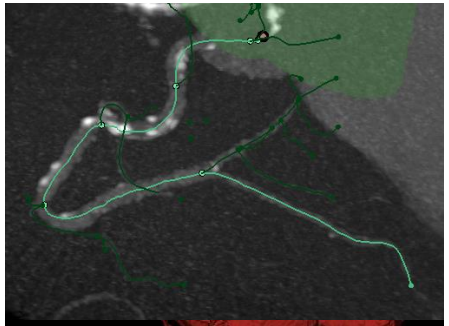
Calcified plaque is detected and classified in the 3D model.

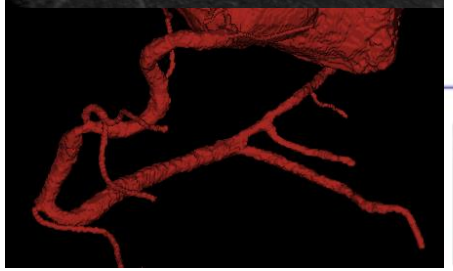


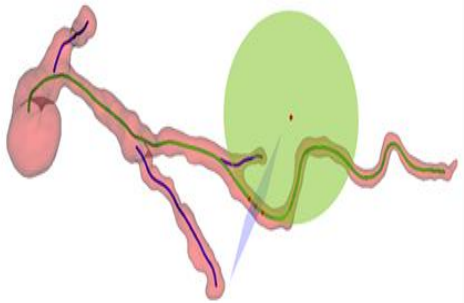


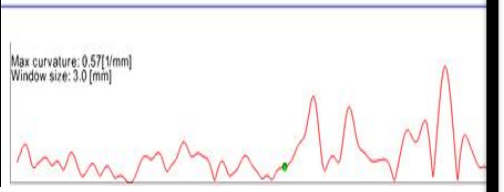
Cubic mm,circular

Tortuosity (index of curvature)





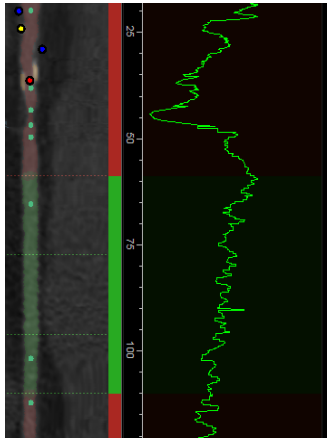




Diffuse disease(75% < 2mm)

The size and length of every vessel is quantified in the 3D model.

Less than 2 mm



Recommendation for the revascularization mode in patients with multivessel disease

CORRIB CORE LAB:

ESC Guideline 2018

Neumann FJ et al. Eur Heart J. 2019 Jan 7;40(2):87-165.

Pts without DM

Extent of CAD	CABG		PCI	
3VD with low SS (0-22)	I	A	I	A
3VD with intermediate or high SS (>22)	I	A	III	A

Pts with DM

Extent of CAD	CABG		PCI	
3VD with low SS (0-22)	I	A	IIb	A
3VD with intermediate or high SS (>22)	I	A	III	A

ACC/AHA/SCAI Guideline 2021

Jennifer S. Lawton et al. Circulation. 2021;144:00–00.

Recommendations for Revascularization to Improve Survival in SIHD Compared With Medical Therapy

	CABG		PCI	
Left ventricular dysfunction and multivessel CAD	I	B-R	No description for PCI	
Multivessel CAD	IIb	B-R	IIb	B-R
	In patients with SIHD, normal ejection fraction, significant stenosis in 3 major coronary arteries, and anatomy suitable for CABG, CABG may be reasonable to improve survival.		In patients with SIHD, normal ejection fraction, significant stenosis in 3 major coronary arteries, and anatomy suitable for PCI, the usefulness of PCI to improve survival is uncertain.	

Recommendation for the revascularization mode in patients with left main disease

CORRIB CORE LAB:

ESC Guideline 2018

Neumann FJ et al. Eur Heart J. 2019 Jan 7;40(2):87-165.

Extent of CAD	CABG		PCI	
Left main disease with low SS (0-22)	I	A	I	A
Left main disease with intermediate SS (23-32)	I	A	IIa	A
Left main disease with high SS (≥33)	I	A	III	B

ACC/AHA/SCAI Guideline 2021

Jennifer S. Lawton et al. Circulation. 2021;144:00–00.

Recommendations for Revascularization to Improve Survival in SIHD Compared With Medical Therapy

	CABG		PCI	
	I	B-R	IIa	B-NR
Left main CAD	In patients with SIHD and significant left main stenosis, CABG is recommended to improve survival.		In selected patients with SIHD and significant LM stenosis for whom PCI can provide equivalent revascularization compared with CABG, PCI is reasonable to improve survival.	

ESC European Society of Cardiology

European Heart Journal (2018) **39**, 3689–3698
doi:10.1093/eurheartj/ehy581

CORRIB CORE LAB:

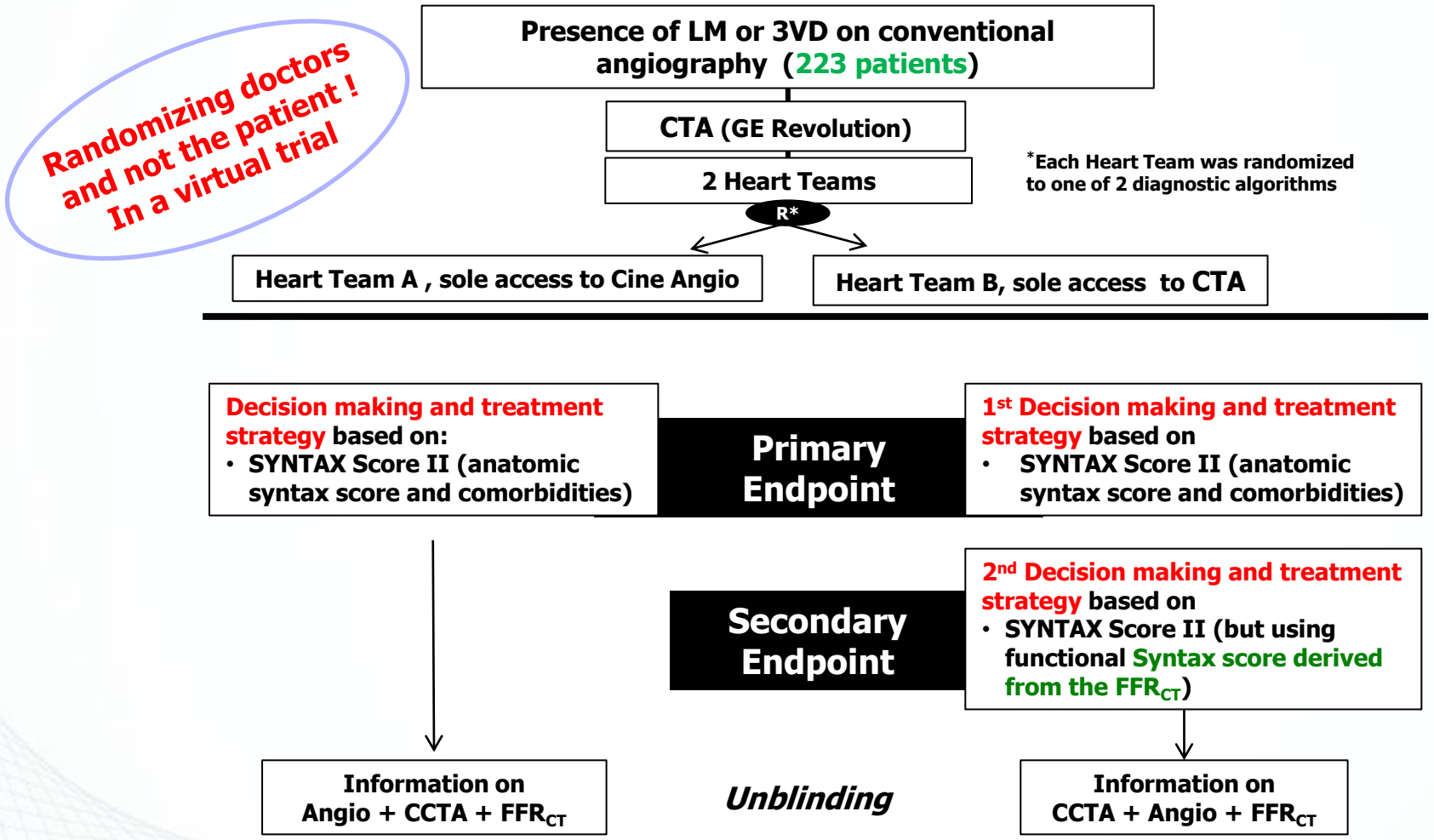
FASTTRACK CLINICAL RESEARCH

Imaging

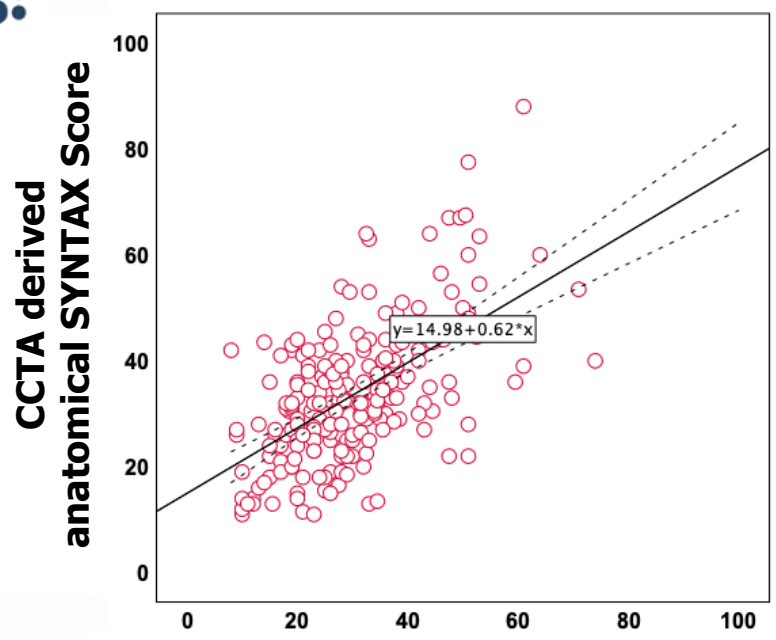
Coronary computed tomography angiography for heart team decision-making in multivessel coronary artery disease

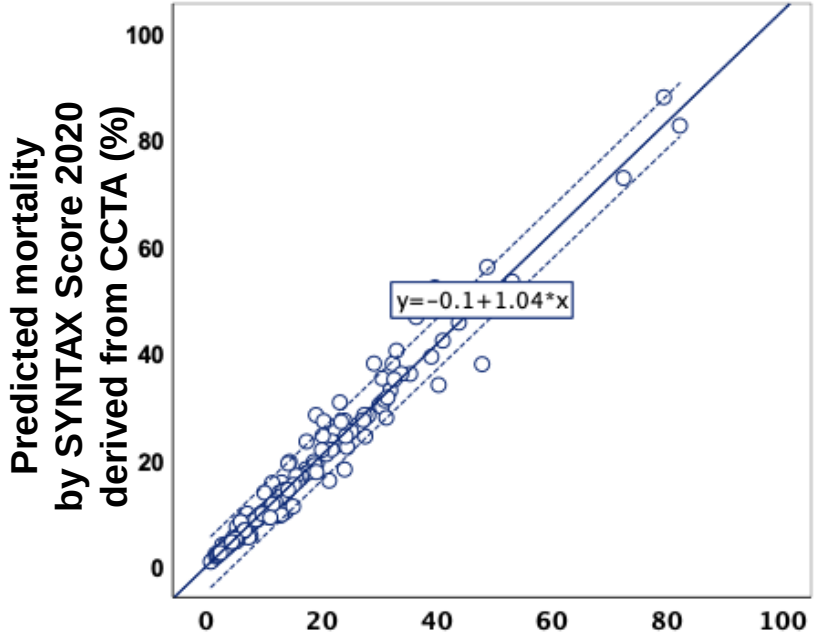
Carlos Collet[1,2†], Yoshinobu Onuma[3,4†], Daniele Andreini[5], Jeroen Sonck[2], Giulio Pompilio[5], Saima Mushtaq[5], Mark La Meir[6], Yosuke Miyazaki[3], Johan de Mey[7], Oliver Gaemperli[6], Ahmed Ouda[8], Juan Pablo Maureira[9], Damien Mandry[10], Edoardo Camenzind[11], Laurent Macron[12], Torsten Doenst[13], Ulf Teichgräber[14], Holger Sigusch[15], Taku Asano[1], Yuki Katagiri[1], Marie-angele Morel[3], Wietze Lindeboom[4], Gianluca Pontone[5], Thomas F. Lüscher[8,16], Antonio L. Bartorelli[5,17]*, and Patrick W. Serruys[16]*; for the SYNTAX III REVOLUTION investigators

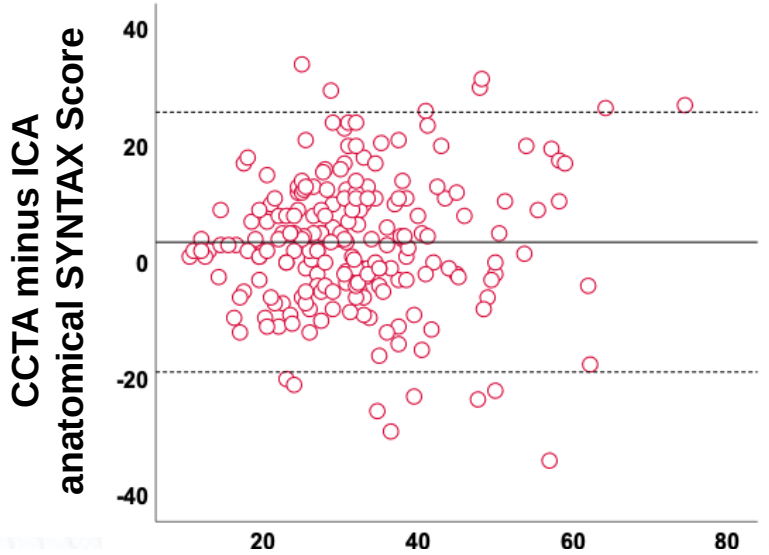
CCTA combined with FFR_{CT} for Heart Team Decision-making in Multivessel Coronary Disease

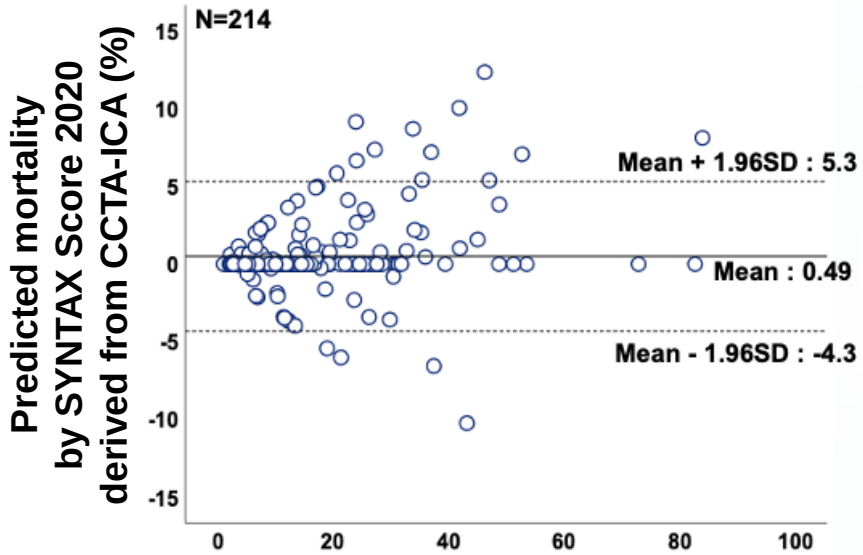


Correlation and Agreement between ICA and CCTA Anatomical SYNTAX Score and SYNTAX Score 2020









Primary Endpoint

	Heart team treatment recommendation based on coronary computed tomography angiography		
Heart team treatment recommendation based on conventional angiography	**CABG**	**PCI/Equipoise CABG and PCI**	
CABG	**23.4% (52/222)**	**2.7% (6/222)**	**26.1% (58/222)**
PCI/Equipoise CABG and PCI	**4.5% (10/222)**	**69.4% (154/222)**	**73.9% (164/222)**
	27.9% (62/222)	**72.1 (160/222)**	**92.8%(206/222)**
Cohen's kappa 0.82 (95% CI 0.73 to 0.91)			

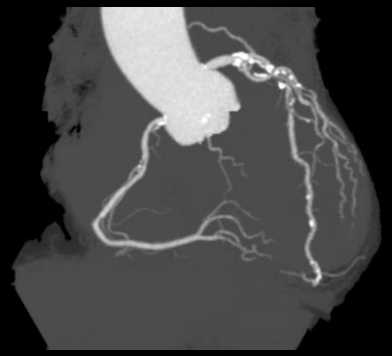
- The heart team **changed the treatment recommendation in 7%** of the cases and modified the selection of **vessel to be revascularization in 12%** when **functional evaluation with FFR_{CT}** was added to an anatomical assessment with CCTA.

- **SYNYAX III demonstrated that CT could be used for decision-making of the selection of revascularization mode between CABG or PCI.**

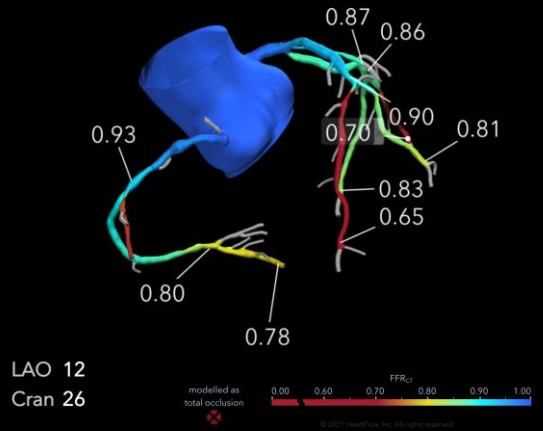
- **The question remains whether surgeons can operate CABG solely based on CCTA?**

FASTTRACK CABG Trial

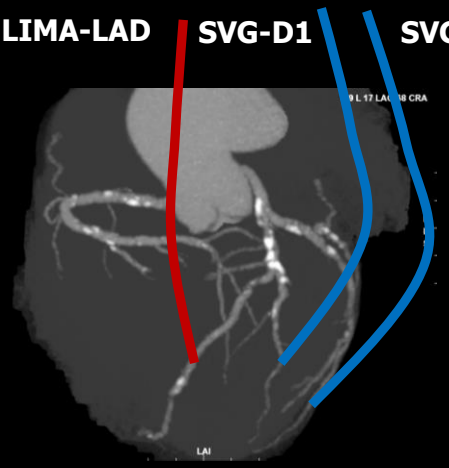
CABG plan in "CCTA Planning and Operating Heart Team"

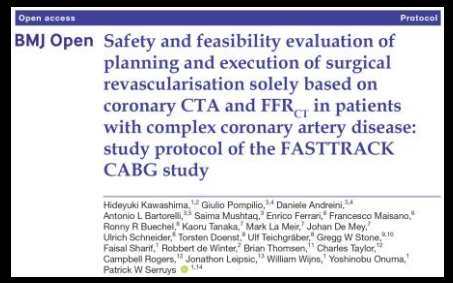


Pre CABG
MIP



Functional assessment
FFR_{CT}





Open access Protocol

BMJ Open

Safety and feasibility evaluation of planning and execution of surgical revascularisation solely based on coronary CTA and FFR_{CT} in patients with complex coronary artery disease: study protocol of the FASTTRACK CABG study

Hideyuki Kawashima,[1,2] Giulio Pompilio,[3,4] Daniele Andreini,[3,4] Antonio L Bartorelli,[3,5] Saima Mushtaq,[3] Enrico Ferrari,[6] Francesco Maisano,[6] Ronny R Buechel,[7] Kaoru Tanaka,[7] Mark La Meir,[7] Johan De Mey,[7] Ulrich Schneider,[8] Torsten Doenst,[8] Ulf Teichgräber,[9] Gregg W Stone,[9,10] Faisal Sharif,[1] Robbert de Winter,[2] Brian Thomsen,[11] Charles Taylor,[12] Campbell Rogers,[12] Jonathon Leipsic,[13] William Wijns,[1] Yoshinobu Onuma,[1] Patrick W Serruys [1,14]

Post CABG
Volume rendering

The FASTTRACK CABG study evaluates the feasibility and safety of planning and execution of CABG solely based on CCTA combined with FFR_{CT} without knowledge of the anatomy defined by invasive coronary angiography. At 30 days after CABG, postsurgical CCTA is performed to evaluate the patency of bypass grafts.

CABG Planning solely based on CCTA combined with FFR_{CT}

FASTTRACK CABG trial

The real thing has started ! Ongoing trial

Kawashima, Onuma, Serruys et al. BMJ2020;10:e038152.

Patients referred to CABG by "conventional heart team" using invasive coronary angiography (ICA)

↓

GE Revolution™ coronary CTA +HeartFlow FFR_{CT}

↓

CTA Transferred to Academic Core Lab CORRIB

Academic Core Lab results back to site:

(e.g., MPR, cross section, MIP, 3D reconstruction, anatomic and functional SYNTAX Score)

→ If surgical planning is not feasible (e.g., images of insufficient quality or the operator is uncomfortable to perform CABG), the ICA will be revealed and surgeon "unblinded"

(Feasibility assessment)

↓

"CTA planning and operating heart team" (surgeons and radiologists) plans bypass procedure solely based on coronary CTA with FFR_{CT}

↓

CABG procedure

↓

30-day follow-up visit plus GE Revolution™ CTA acquisition (patency assessment)

→ Safety assessment

- Segment 1
  Total: 2 pts
- Segment 2
  Total: 2 pts
- Segment 3
  Total: 2 pts

- Segment 5,6,7,11,12,12a
- Trifurcation (1,1,1,1) (seg. 5,6,7,12)
- TO (segment 7), Side branch ≥ 1.5 mm (Seg.9)
- Heavy calcification

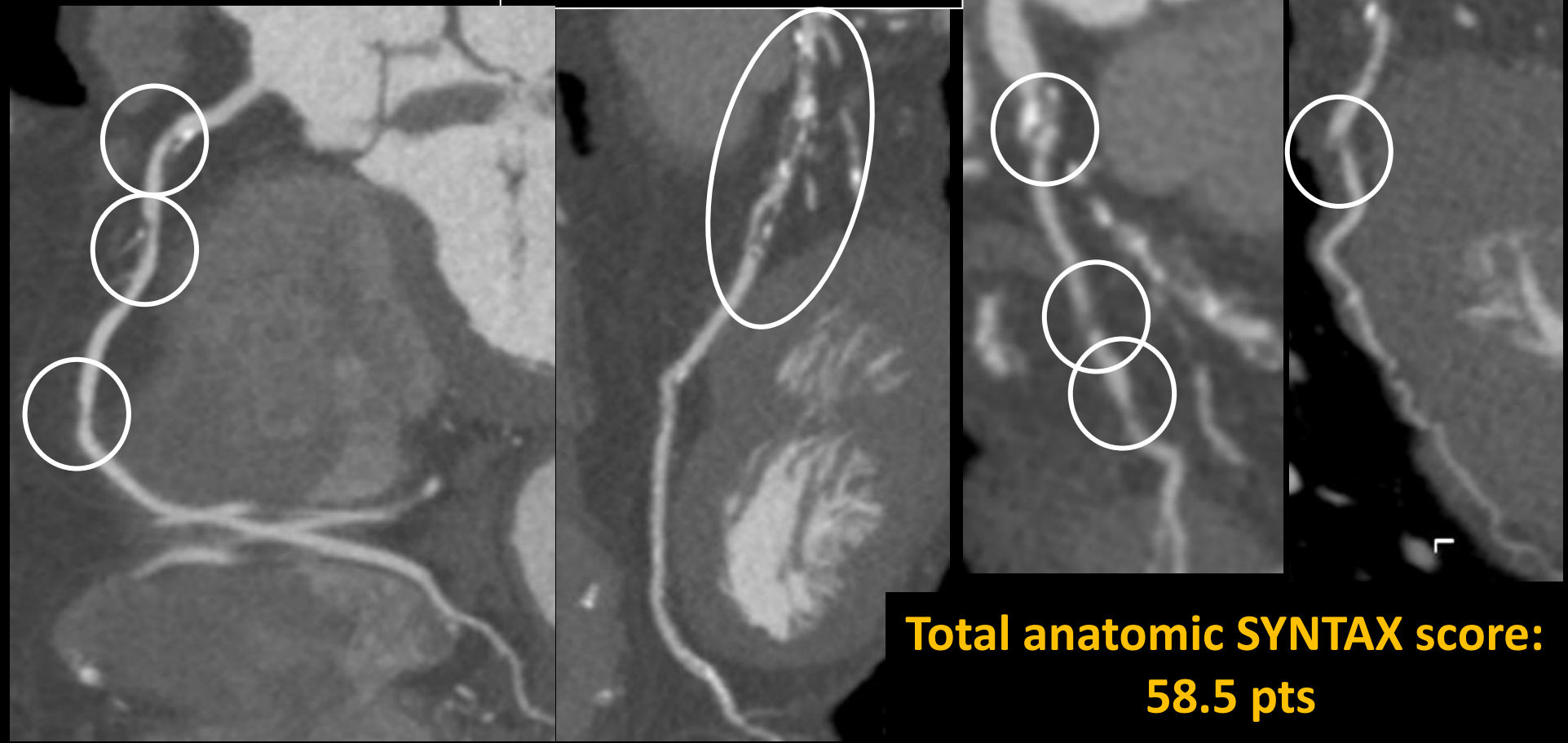
  Total: 46.5 pts

- Segment 12 (IM)
- Segment 12

  Total: 4 pts

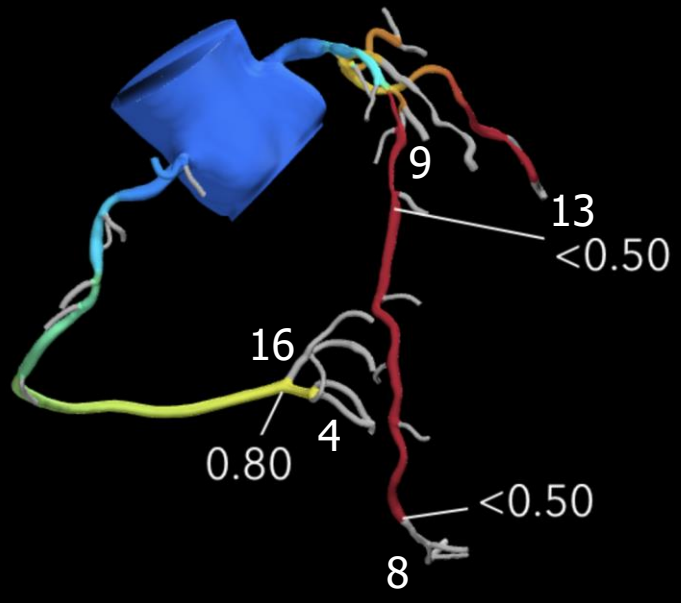
- Segment 12a

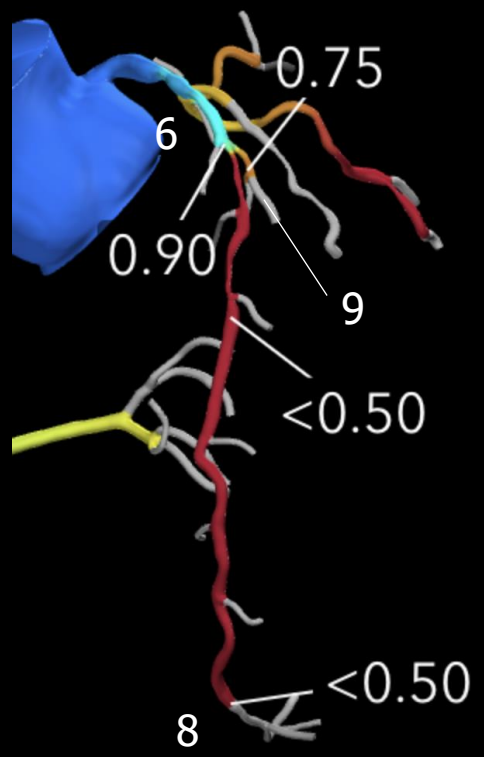
  Total: 2 pts

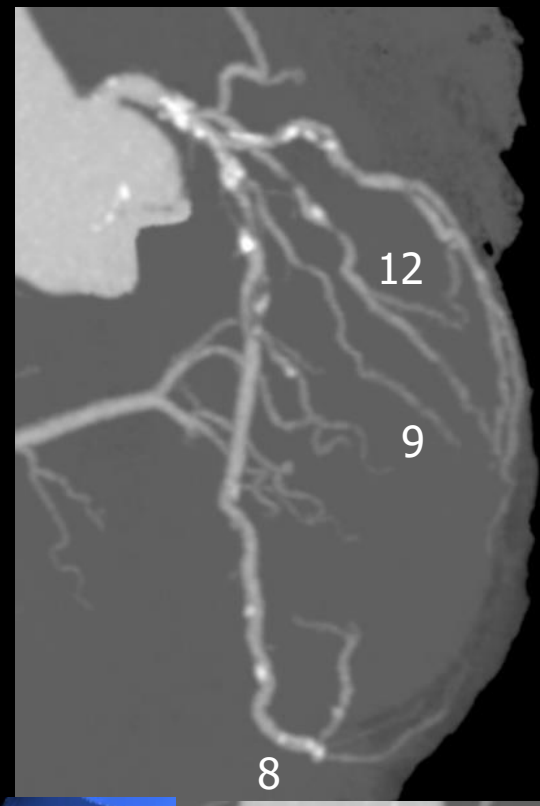


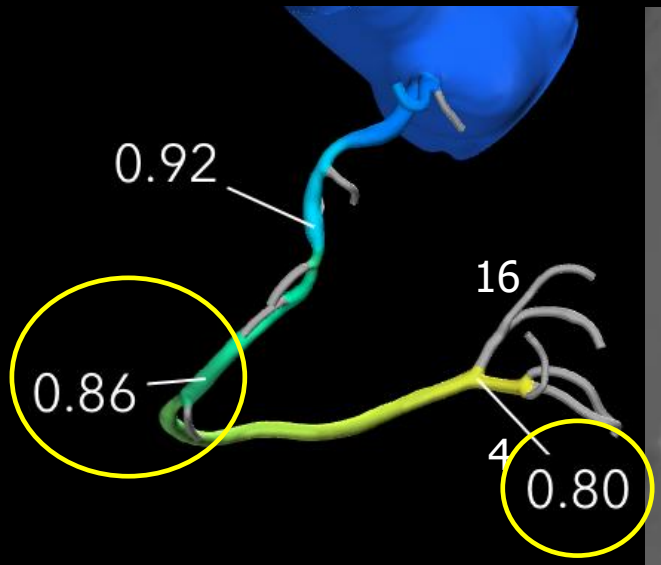
Total anatomic SYNTAX score: 58.5 pts

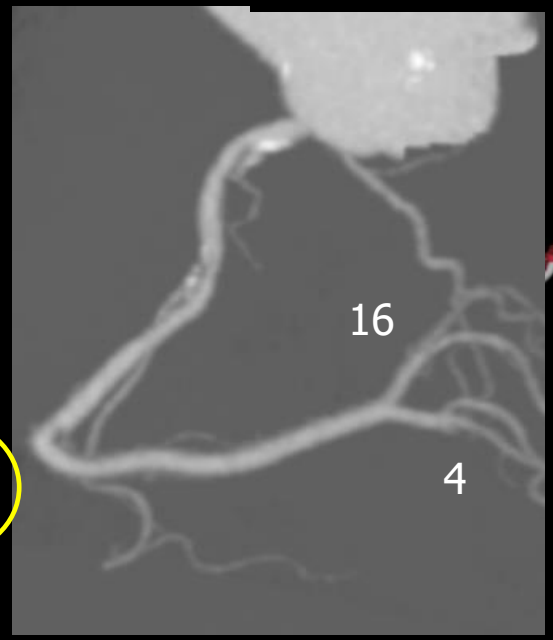
Pre CABG FFR_{CT}

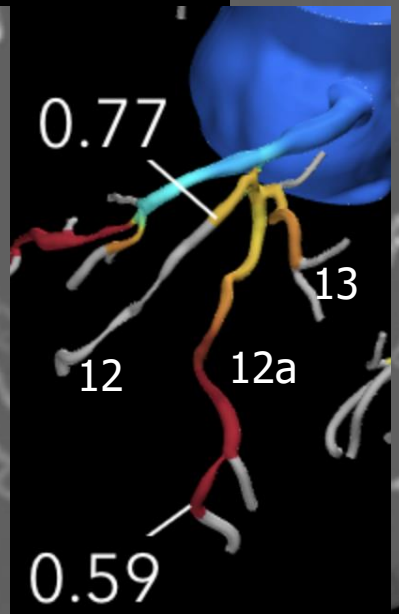


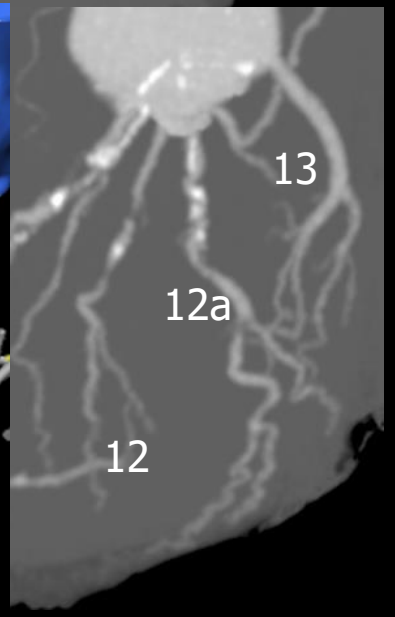




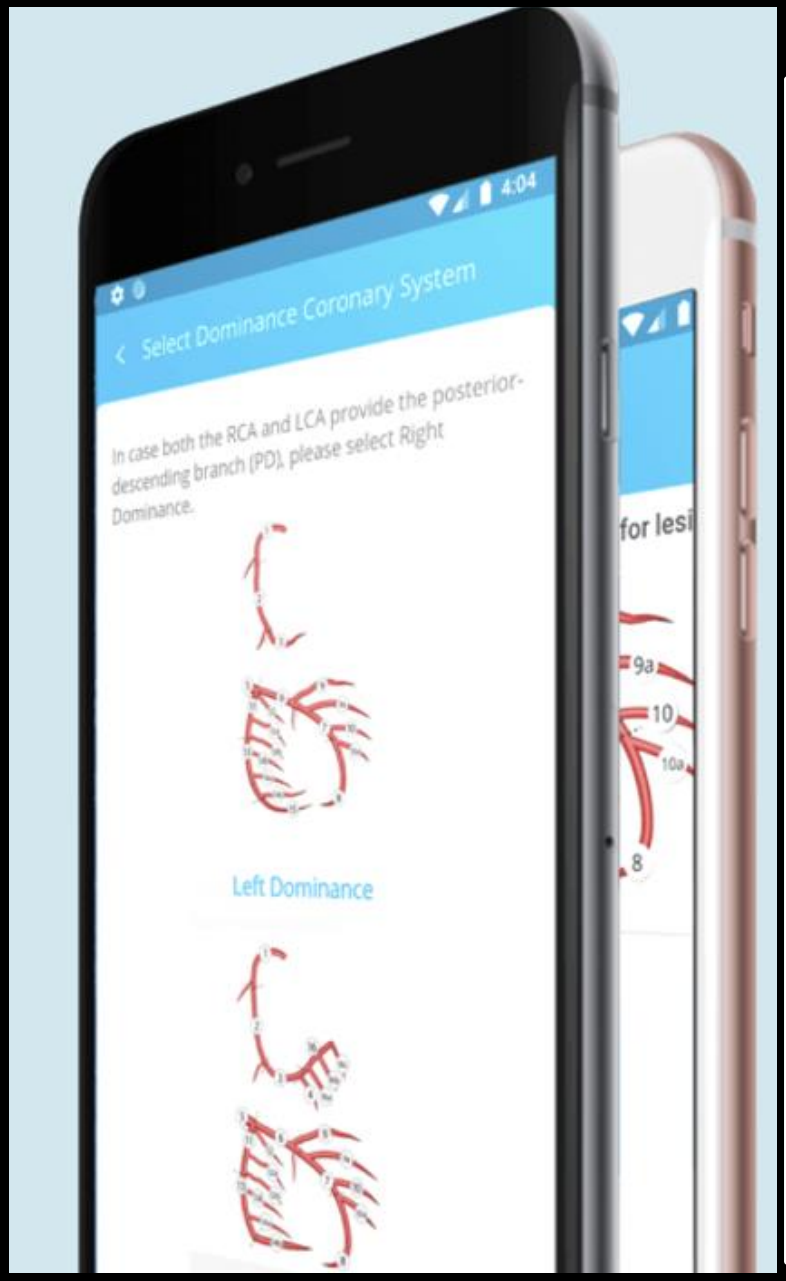




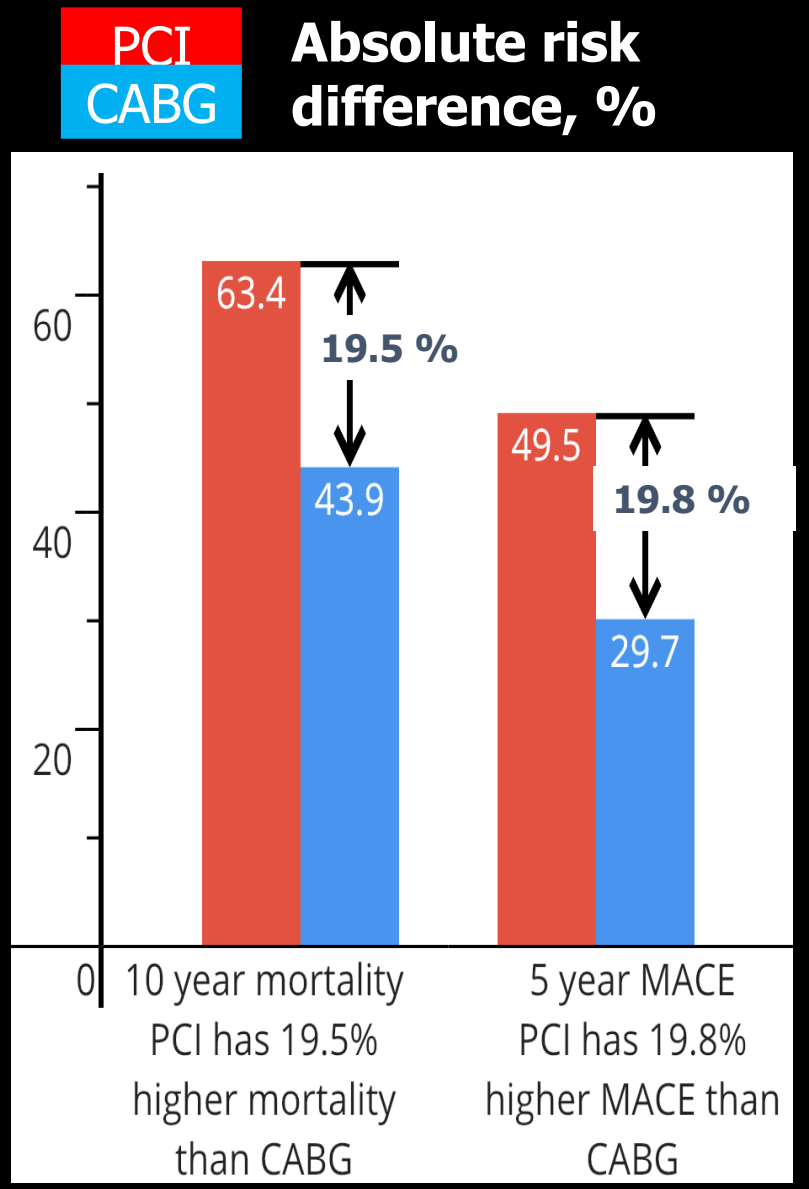




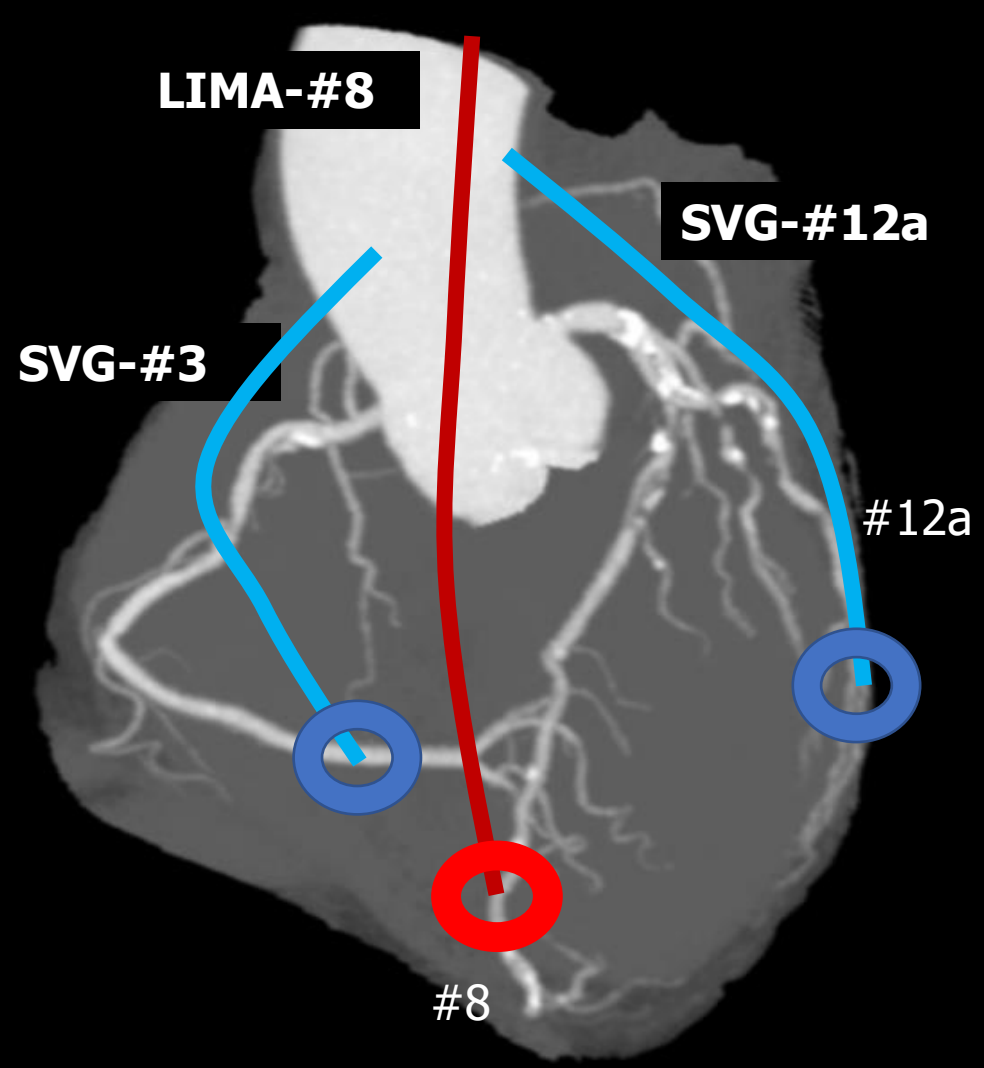
SYNTAX Score 2020 Predicts 5-year MACE and 10-year mortality



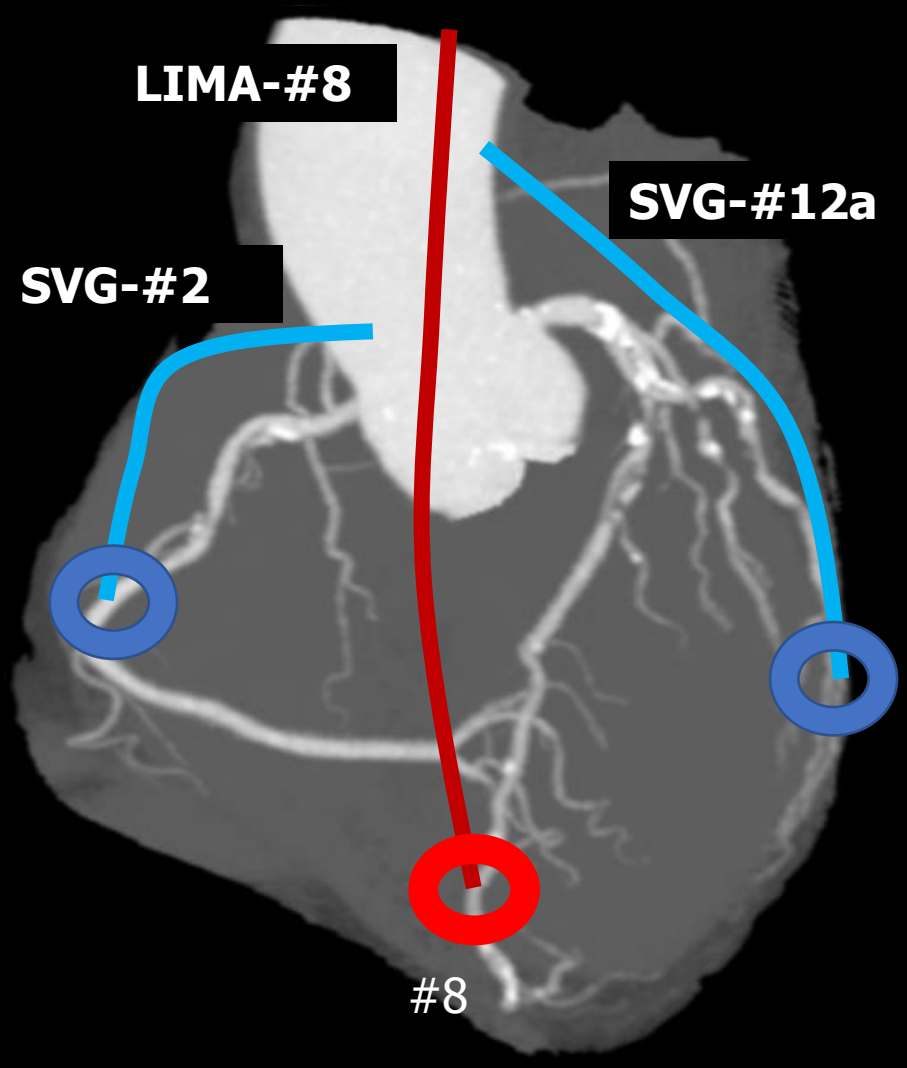
- **Anatomical SYNTAX score**
  58.5
- **Age (years)**
  81
- **CrCl (ml/min)**
  71.0
- **LVEF**
  65.0%
- **Left main disease**
  Yes
- **Gender**
  Male
- **COPD**
  No
- **Peripheral vessel disease**
  No
- **DM**
  No
- **Current Smoking**
  No



CABG plan in "CCTA Planning and Operating Heart Team"

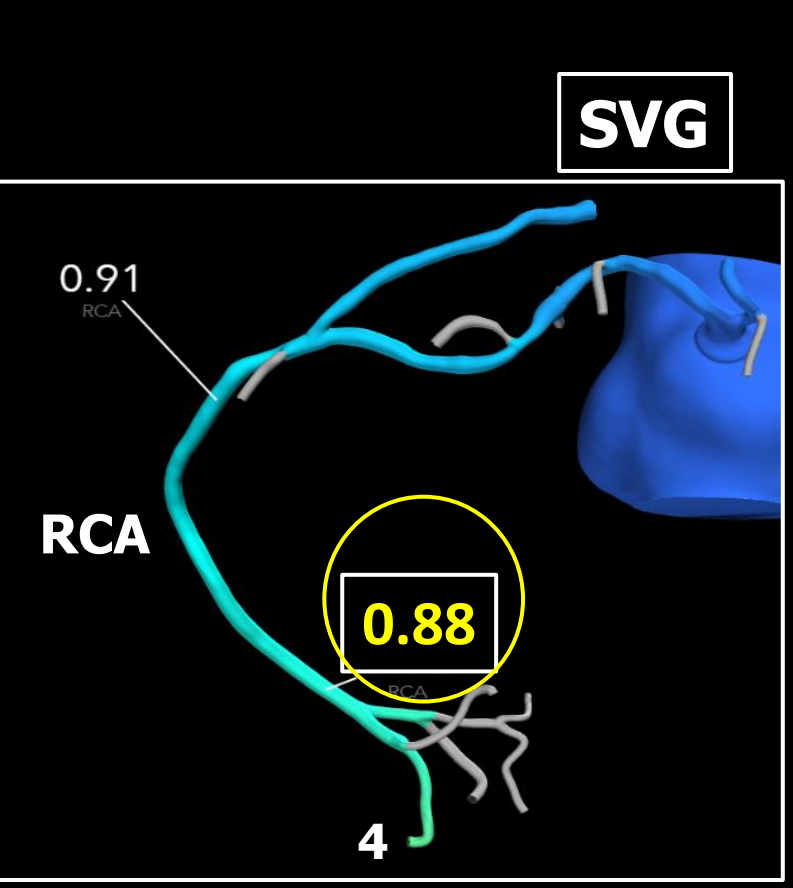


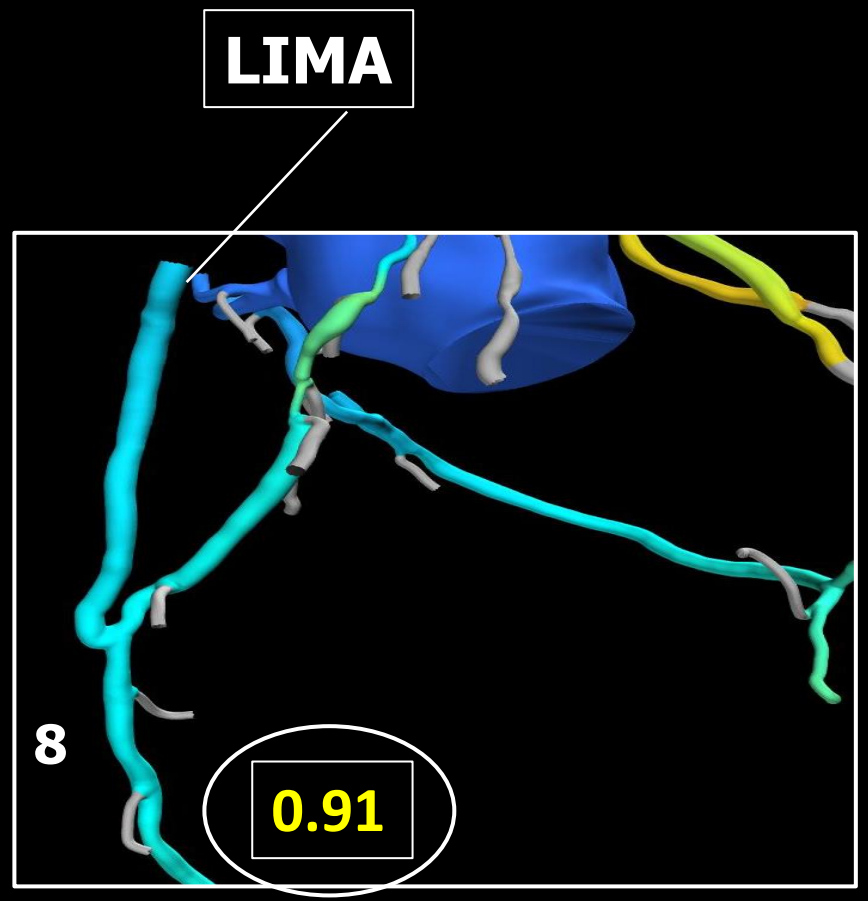
Actual treatment of CABG

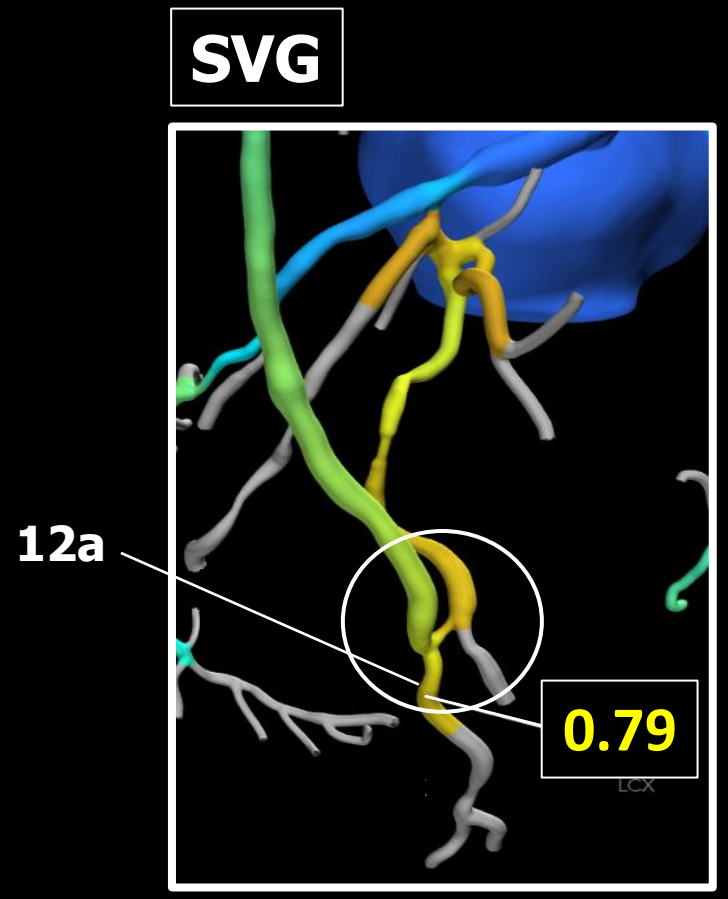


Hologram post-CABG

Post CABG FFR_{CT} 30 days safety assessment





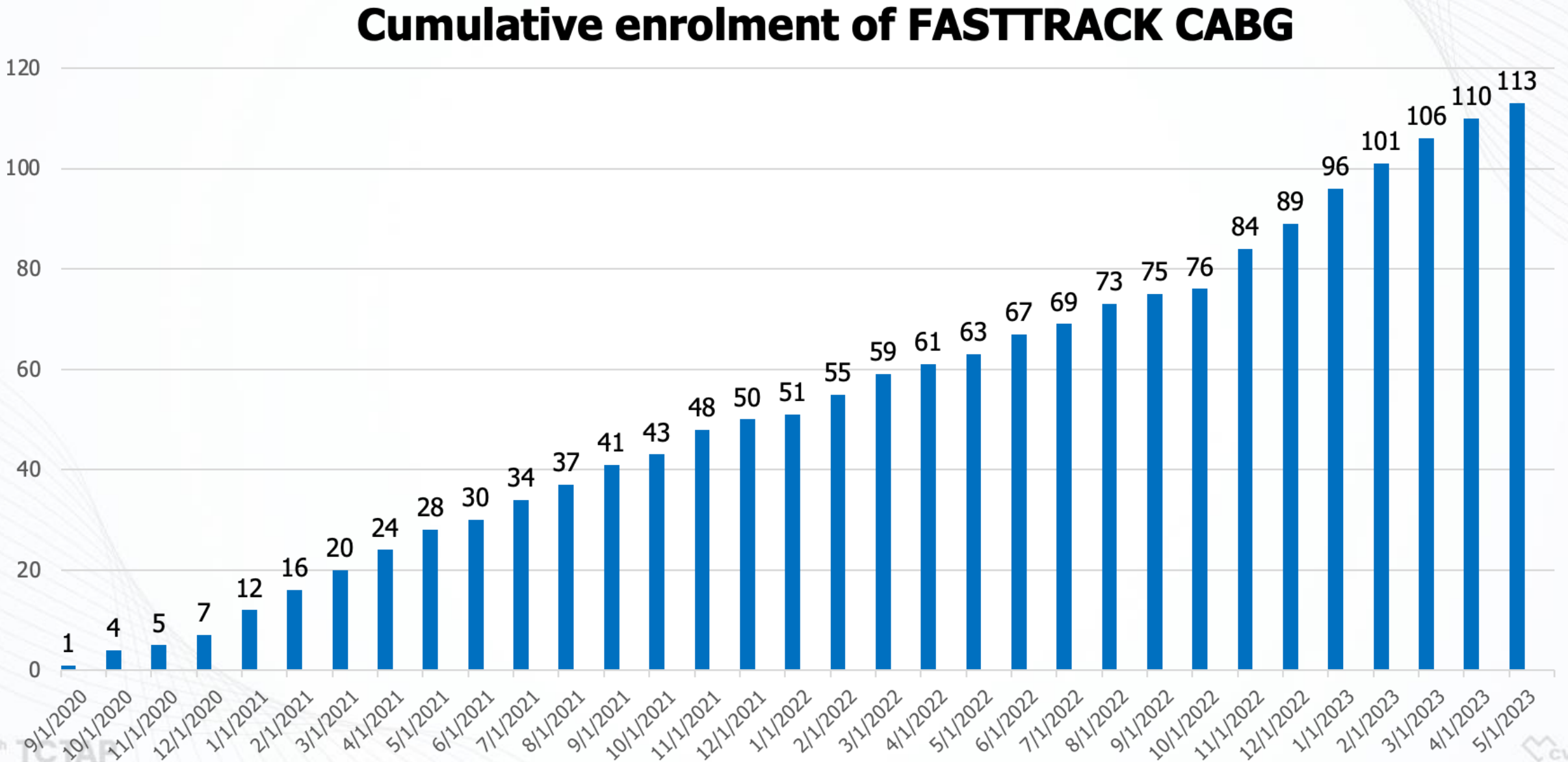


Ollscoil na Gaillimhe
University of Galway

Enrolment is almost completed
Sample size = 114 patients

LMCAD 16%

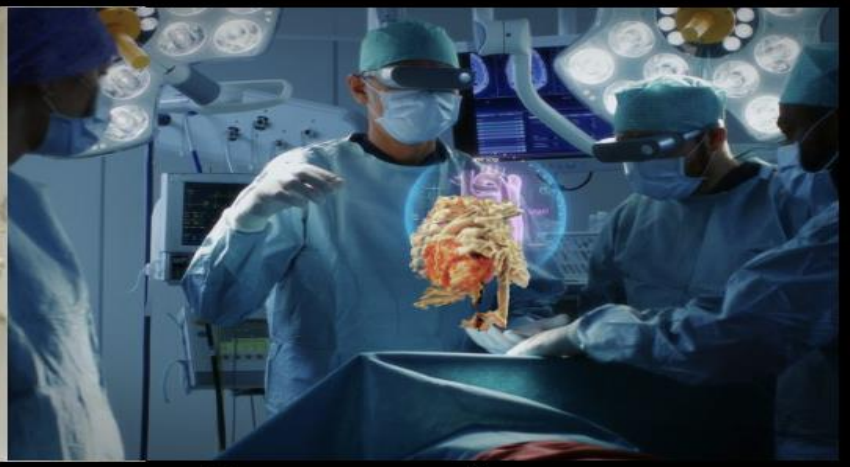
CORRIB CORE LAB:



In Galway, we have entered into the era of Mixed Reality:
"Heart team new style"…with Hologram

Heart Team

Surgeon on his way to operator room



Surgery theatre

OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

CORRIB CORE LAB:

Conclusion

- In the 2019 ESC guidelines, CCTA with non-invasive functional imaging was given a Class I Level B recommendation as the initial test to diagnose CAD in symptomatic patients.
- In complex CAD, CCTA can evaluate the total burden and severity of coronary artery disease (e.g., SYNTAX Score, Leaman Score).
- CCTA could be used as a "one-stop shop" diagnostic tool and decision-making between pharmacological treatment, PCI, and CABG.
- SYNTAX III REVOLUTION trial demonstrated that clinical decision-making between CABG and PCI based on CCTA had a high agreement with the treatment decision derived from ICA in patients with 3VD with or without left main disease.
- The ongoing FASTTRACK CABG trial investigates the feasibility and the safety of planning and executing CABG based solely on CCTA combined with FFR_{CT} without knowledge of anatomy defined by ICA.