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Appropriateness of the Modality of Revascularization According to the SYNTAX Score II 2020 in the FASTTRACK CABG Study: An Interim Report on Patient Selection

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ABSTRACT

Background: Personalized long term vital prognosis plays a key role in deciding between percutaneous coronary intervention (PCI) and CABG in patients with complex coronary artery disease. The FASTTRACK CABG trial enrolls patients with the sole guidance of coronary computed tomographic angiography (CCTA) and fractional flow reserve CCTA (FFR_{CT}). The feasibility/non-feasibility of this approach is determined by the surgeon request to have access to the invasive coronary angiography.

Methods: This interim analysis, which was requested by the Data and Safety Monitoring Board (DSMB), compared the treatment decision of the "on site" Heart team to the recommended treatment as per the SYNTAX Score II 2020 (SS-2020), which was prospectively assessed by the central core laboratory in the first 57 consecutive patients (half of the planned population) enrolled in this First in Man study.

Results: The average anatomical SYTAX Score is 35.6 ± 11.5. The SS-2020 predicted 5-year MACE and 10-year all-cause mortality are 14.7 % and 21.6 % following CABG, and 23.0 % and 30.4 % following PCI. Among the enrolled patients the SS-2020 predicts long-term PCI outcomes similar to CABG (absolute risk difference ≤0 % in favor of PCI) in only two patients whilst the remaining 55 patients had a predicted survival benefit with CABG.

Conclusions: According to the SS-2020, the first 57 patients recruited into the FASTTRACK CABG trial received the appropriate modality of revascularization and the DSMB allowed the investigators to complete the study.

1. Introduction

Selecting the optimal modality of revascularization in patients with three-vessel disease (3VD) and/or left main coronary artery disease (LMCAD) remains a topic of debate for non-invasive cardiologists, interventional cardiologists and cardiac surgeons [1]. Ultimately deciding between percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) surgery should be made by consensus during a

Abbreviations: CABG, coronary artery bypass graft surgery; CAD, coronary artery disease; LMCAD, left main coronary artery disease; MACE, major adverse cardiovascular events; PCI, percutaneous coronary intervention; 3VD, three-vessel disease.

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Heart team consultation as endorsed by a Class I, Level C recommendation from the European Society of Cardiology (ESC) [2].

In 2009 the anatomical SYNTAX score (aSS) was incorporated into the ESC and ACC guidelines for revascularization [2]. In 2013 the aSS was combined with relevant clinical characteristics and comorbidities and renamed the SYNTAX score II (SS-II) [3]. Subsequently in 2020, the SS-II was redeveloped and recalibrated after integrating very long-term all-cause mortality from the SYNTAX trial (SYNTAXES trial; NCT03417050) [4]. This new score—SYNTAX score II 2020 (SS-2020)—has additional accuracy in predicting all-cause mortality and has been externally validated not only in other randomized trials with long-term follow-up of patients with 3VD, with or without LMCAD, but also in contemporary registries [4,5].

The present study is a comparison between the modality of revascularization chosen by the on-site local Heart team and the one recommended using the SS-2020, as assessed by the core laboratory (CL) during the screening of patients in the ongoing FASTTRACK CABG trial (NCT04142021) [6].

2. Materials and methods

2.1. Ethical statement

Ethical approvals from the ethics committee of the Centro Cardiologico Monzino (R1158/20-CCM 1220), University Hospital of Brussels (B1432020000236) and University Hospital of Jena (2020-1889-1-BO) have been obtained. Each patient has to provide written informed consent as approved by the ethical committee of the respective clinical site. Results will be submitted for publication in peer-reviewed journals and will be disseminated at scientific conferences.

2.2. Study population

The on-going FASTTRACK CABG study is an investigator-initiated single-arm, multicentre, prospective, proof-of-concept, first-in-man study in patients with 3VD, with or without LMCAD, referred for CABG. The surgical revascularization strategy and treatment plan was formulated solely using coronary CT angiography (CCTA) and fractional flow reserve, derived from CT angiography (FFR_{CT}), without any knowledge of the coronary anatomy from invasive coronary angiography (ICA) [6]. The ICA was only used for treatment decision-making by the regular "Conventional Heart Team," which was independent and separate from the "CCTA Planning and Operating Heart Team" which remained blinded to the findings of the ICA. One clinical follow-up visit including a CCTA was performed 30 days after surgery in order to assess graft patency, and the topographical adequacy of revascularization with respect to the documented surgical plan, which was based entirely on the initial non-invasive imaging (Fig. 1).

Clinical data are adjudicated by an independent Clinical Events Committee, with ongoing safety monitoring by a Data and Safety Monitoring Board (DSMB), which prospectively requested the present interim report on the appropriateness of treatment. The present study includes the first 57 consecutive enrolled patients and represents half of the planned study population. The appropriateness of selecting CABG in this trial population was reviewed by the DSMB at the time of their second predefined evaluation. The study complied with the Declaration of Helsinki and Good Clinical Practice.

2.3. The SYNTAX score family

Currently, a web-based and smartphone application facilitates the computation of the various SYNTAX scores (https://syntaxscore2020.com/).

The aSS assesses the complexity and extent of coronary disease according to a weighting score, related to the amount of subtended myocardium at risk. Additional scoring points related to the complexity of the anatomy (e.g., bifurcation, calcium, and tortuosity…) are incorporated into the score [7,8]. The aSS was converted into a functional SYNTAX score (fSS) by the CL (CORRIB Core Lab, Galway, Ireland) following physiological assessment using FFR_{CT} (HeartFlow, Redwood City, California, USA). Anatomic scoring points were subtracted if the stenotic vessel was not physiologically significant as indicated by an $FFR_{CT} > 0.8$.

The SS-2020 was redeveloped from the 10-year follow-up of the SYNTAXES trial and externally validated in four randomized trials (FREEDOM, BEST, PRECOMBAT, and EXCEL) and a large contemporary registry of patients with 3VD, with or without LMCAD, treated with PCI or CABG [4,5]. The score, which uses two anatomical effect modifiers (the aSS and the presence of 3VD or LMCAD) and 7 clinical prognostic factors (age, medically treated diabetes mellitus with or without insulin, chronic obstructive pulmonary disease (COPD), peripheral vascular disease (PVD), current smoking, creatinine clearance, and LVEF), predicts 5-year MACCE defined as all-cause mortality, stroke, or myocardial infarction, as well as 5- and 10- year all-cause mortality.

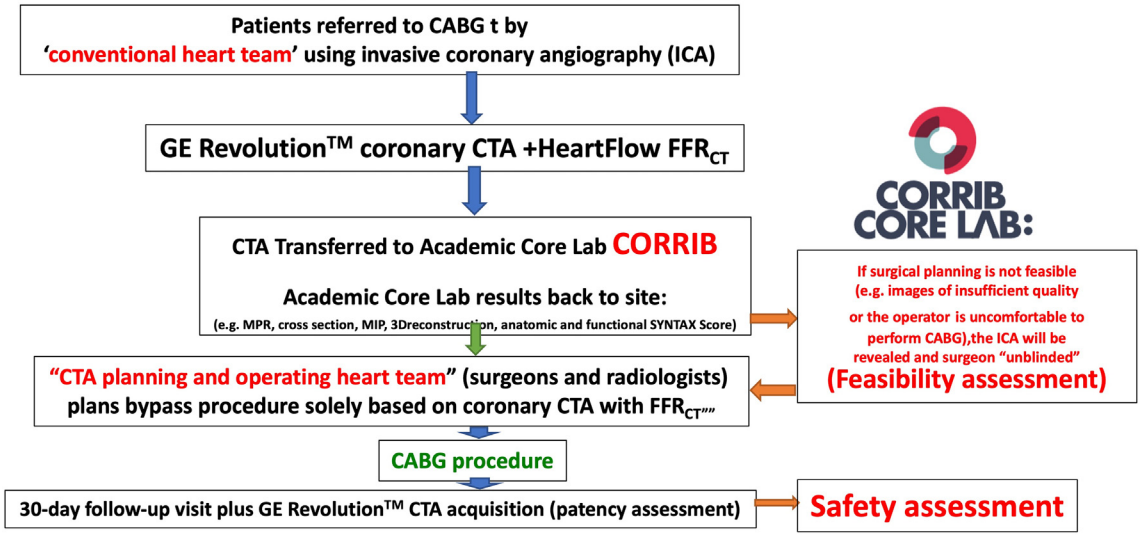

Fig. 1. Study flow chart of the FASTTRACK CABG trial.
CABG, coronary artery bypass graft; CCTA, coronary CT angiography; FFRCT, fractional flow reserve derived from CT angiography; ICA, invasive coronary angiography; MIP, maximum intensity projection; MPR, multiplanar reconstruction; SYNTAX Score, Synergy Between percutaneous coronary intervention With Taxus and Cardiac Surgery Score.

2.4. Image acquisition and analysis

CCTA was performed with the GE Revolution CT scanner that has a nominal spatial resolution of 230 μm along the X–Y planes, a rotational speed of 0.28 s, and a Z-plane coverage of 16 cm enabling imaging of the heart in one heartbeat [9]. The protocol mandated the use of nitrates prior to CT acquisition and beta-blockers in cases of heart rates >65 b.p.m. Image quality was measured using the five-point Likert scale at the patient and segment level. The severity and extent of coronary artery disease was assessed using the aSS with all coronary segments with a visual diameter stenosis >50 % using CCTA or ICA evaluated and included in the calculation [10,11].

2.5. Fractional flow reserve derived from CT angiography (FFR_{CT})

The reconstructed CCTA images were transferred electronically from the surgical sites to the independent CL for anatomic analysis and to HeartFlow (Redwood City, California, USA) for FFR_{CT} assessment. CCTA imaging data were also provided to GE Healthcare for general assessment of CT exams. The results of FFR_{CT} analyses of each stenotic vessel were subsequently provided to the investigators (Fig. 2).

2.6. Academic core laboratory

The anatomical SYNTAX Score and functional SYNTAX score based on CCTA were assessed by the Academic Core Laboratory. The intraclass correlation coefficient (ICC) of interobserver reproducibility for the CT based aSS score and fSS in the present study were 0.59 (95 % CI: 0.39–0.74) and 0.76 (0.63–0.85) (Supplementary Fig. 1). The agreement on the classic aSS and fSS tertiles based on Fleiss Kappa statistics was moderate (0.42 and 0.52, respectively) (Supplementary Fig. 2).

2.7. Statistical analysis

Continuous variables are expressed as mean ± standard deviation and were compared using Student's *t*-test or Mann–Whitney *U* test. Categorical variables are reported as numbers and percentages and were compared using the Chi square or Fisher's exact test as appropriate. A two-sided p-value <0.05 was considered statistically significant.

The individual predicted absolute risk differences (ARD) in all-cause mortality between CABG and PCI for each patient were ranked in order of magnitude according to the predicted PCI mortality minus the predicted CABG mortality and shown in a scatter plot of predicted mortality with either PCI or CABG. The dots in the scatter plot were connected with the use of locally estimated scatterplot smoothing (LOESS) curves.

Analyses were performed using R version 3.6.0 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

Patient characteristics are shown in Table 1. The Likert scale was available in 689 segments and mean value was 3.25 ± 0.59. The patient's mean age was 66.6 ± 9.1 and 89.5 % were men. Mean EuroSCORE II was 1.05 ± 0.49. A history of medically treated diabetes was observed in 26.3 %.

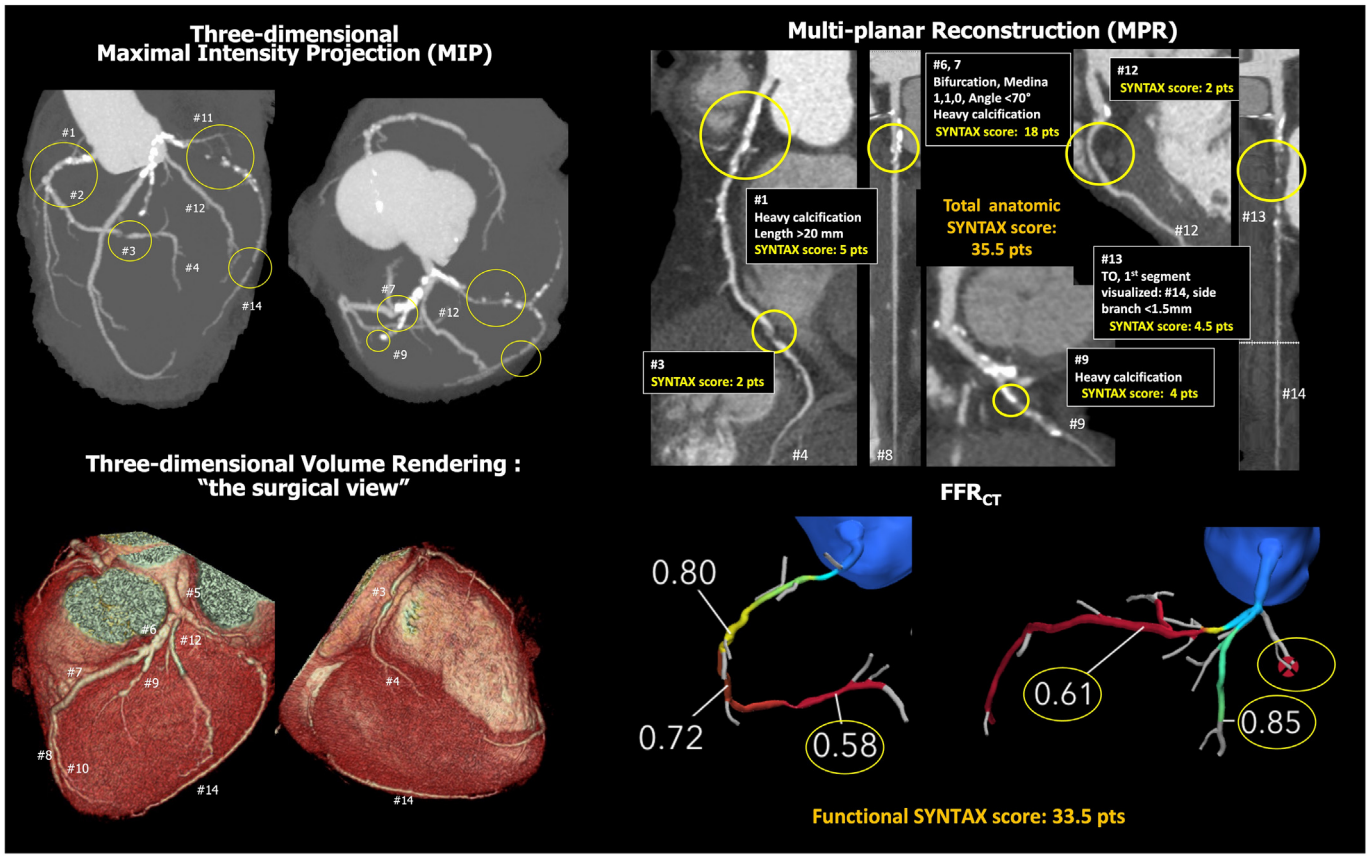

Fig. 2. Calculation of anatomical and functional SYNTAX Score by CCTA.
The anatomical SYNTAX Score by CCTA will be performed by the Academic Core Laboratory (upper right). The functional SYNTAX Score uses the principle of the functional assessment of coronary lesions derived from FFRCT, as is undertaken in conventional anatomical SYNTAX Score calculation (lower right). The heart team will consult the Academic Core Laboratory SYNTAX Score during the 'CCTA Planning and Operating Heart Team' meeting whenever deemed necessary. SYNTAX Score: Synergy Between percutaneous coronary intervention With Taxus and Cardiac Surgery Score, FFRCT: fractional flow reserve derived from CT angiography; LAD, left anterior descending; LCX, left circumflex artery; RCA, right coronary artery.

Table 1
Baseline characteristics for the SYNTAX score family.

Variables used in the SYNTAX score family	Overall patients (n = 57)
Age, years	66.6 ± 9.1
Male %	89.5 (51)
Body mass index (kg/m^2)	27.5 ± 4.4
Diabetes %	26.3 (15)
Medically treated diabetes%	26.3 (15)
Insulin%	1.8 (1)
Creatinine clearance (mL/min)	79.9 ± 17.5
LVEF (%)	55.9 ± 7.8
COPD %	8.8 (5)
PVD %	8.8 (5)
Previous stroke %	3.5 (2)
Current smoker %	17.5 (10)
Hemoglobin (g/dL)	14.2 ± 1.5
WBC (10^9 cells/L)	7.3 ± 2.2
Left main disease %	15.8 (9)
Anatomic SYNTAX score	35.6 ± 11.5
Functional SYNTAX score	32.9 ± 13.2
EuroSCORE II	1.05 ± 0.49

Data are presented as mean ± standard deviation, or percentage (number). CABG: coronary artery bypass grafting; COPD: chronic obstructive pulmonary disease, LVEF: left ventricular ejection fraction; PCI: percutaneous coronary intervention; PVD: peripheral vascular disease.

Of the 57 patients, 30 (52.6 %) had a high aSS (>32), 20 (35.1 %) an intermediate aSS (23–32), and 7 (12.3 %) a low aSS score (<23). Among the low aSS patients, one had diabetes, and therefore in the remaining 6 patients, PCI could achieve similar long-term outcomes compared to CABG, justifying a class I recommendation for PCI as per the ESC guidelines.

In all patients FFR_{CT} values were measured in all three main coronary arteries and used to generate the fSS from the aSS. In only 2 vessels, FFR_{CT} were not available because of motion artifact (Supplementary Fig. 3).

Fig. 3 shows the cumulative frequency curves of both scores, together with demonstrating the left shift from the aSS to the fSS, and the significant difference between the medians of each score (aSS 35.6 ± 11.5 vs. fSS 32.9 ± 13.2, $p < 0.001$, Fig. 3).

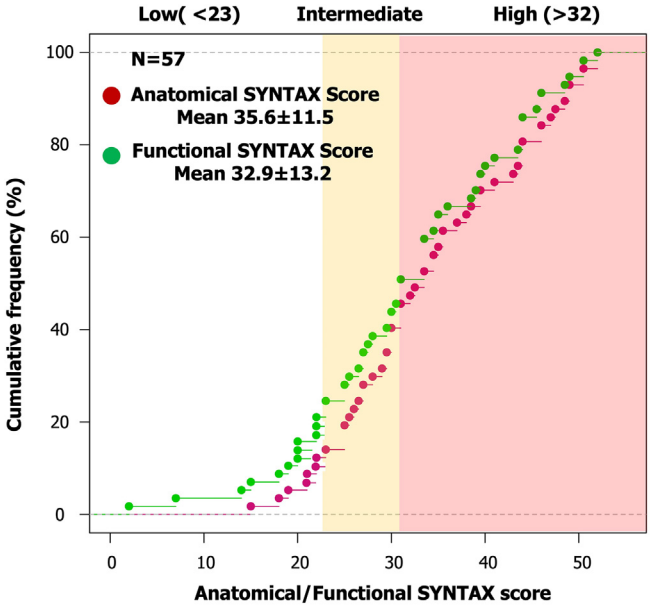

Fig. 3. Cumulative frequency curve of anatomical and functional SYNTAX Score.
Based on FFRCT functional assessment, the cumulative frequency curve of the anatomical SYNTAX score after functional adjustment showed a significant leftwards shift with reduction of the median value.

Table 2 shows the predicted event rates based on the SS-2020, if the patient had been theoretically allocated to either PCI or CABG. The predicted events rates would have been systematically and significantly higher after being virtually allocated to PCI compared to CABG. Of note, as an average treatment effect the aggregated predicted ARD in mortality between the virtual PCI and CABG population increased with the duration of follow up, from 4.9 ± 4.1 % at 5 years to 8.9 ± 6.0 % at 10 years.

The predicted mortality with PCI or CABG according to the SS-2020, as well as the predicted individual ARD in all-cause mortality at 5-years, ranked in order of magnitude, is shown in a scatter plot (Fig. 4). Based on SS-2020, only 2 patients would have had a predicted mortality at 5-years which was higher after CABG than PCI.

4. Discussion

This study confirms that CABG was selected appropriately in those patients enrolled thus far in the ongoing FASTTRACK CABG study, based on individual predictions using the SS-2020. The current interim report included the first 57 consecutive patients with 3VD or LMCAD screened for the FASTTRACK CABG trial –a trial that only relies on CCTA and FFR_{CT} for the planning and execution of CABG.

The SS-2020 is derived from 10-year follow-up of the SYNTAXES study and uses calibration plots to predict 5-year MACCE as well as 5- and 10-year all-cause death. The individual vital prognosis provided by this score can help the Heart team make informed treatment decisions between percutaneous and surgical revascularization, with the objective information provided possibly helping the surgeon, interventional cardiologist, non-invasive cardiologist, and the patient accept the treatment decision more readily [4,12]. Based on the SS-2020, only 2 patients in the ongoing FASTTRACK CABG trial had a higher predicted mortality at 5-years after CABG than PCI.

4.1. Legitimacy of including 3VD or LMCAD in the FASTTRACK CABG trial

In a clinical trial involving a population with 3VD or LMCAD, it is vital to legitimize PCI or CABG and ensure compliance with the ESC guidelines for revascularization and functional testing. Theoretically, only non-diabetic patients with an anatomic SYNTAX score <23 are eligible for PCI according to recommendations from the ESC. Moreover, the operator has the obligation, even in the presence of an ischemic non-invasive test, to identify in the epicardial vessels and their branches the flow limiting lesions that must be treated, and conversely the stenotic lesions for which treatment can be deferred [2,13].

Guidelines rely on evidence-based medicine derived from past trials, whilst trialists try to envision new ways to practice medicine and test new concepts. The legitimate choice of CABG as the modality of revascularization, as decided by a multidisciplinary Heart team is not actually part of the trial, however it is mandated by the ESC/ACC guidelines as a pre-requisite step prior to specific informed consent related to the trial's inclusion and exclusion criteria. The central CL and the on-site "scanning and operating Heart team" had access to the same software applications used for computation of the SS-2020 (https://syntaxscore2020.com/) during screening of the first 57 CABG patients in the trial.

Notably in the randomized cohorts of the EXCEL trial, deviation from the treatment recommended by the score (i.e. PCI instead of CABG) due to the imposed randomized trial allocation (allocation to PCI) led to an excess of death [14]. An uncontrolled observational study from a PCI centre without on-site surgery in Serbia has previously reported similar findings [15].

As per the ESC guidelines, in the present study only 6 patients (aSS<23 and non-diabetic) could achieve similar long-term outcomes with PCI compared to CABG, justifying a class I recommendation for PCI. Furthermore, there were only two deviations from the

Table 2
Predicted event rates derived from SYNTAX Score 2020.

	Overall patients (n = 57)			p value
	Event after PCI	Event after CABG	ARD	
5-year MACE(%) based on SS2020	23.8 ± 12.0	15.4 ± 8.4	8.4 ± 5.9	<0.001
5-year mortality (%) based on SS2020	15.4 ± 11.0	10.5 ± 8.0	4.9 ± 4.1	<0.001
10-year mortality (%) based on SS2020	31.4 ± 18.5	22.4 ± 15.0	8.9 ± 6.0	<0.001

Data are presented as mean ± standard deviation. ARD: absolute risk difference (PCI rate – CABG rate); CABG: coronary artery bypass grafting; MACE: major adverse cardiovascular events; PCI: percutaneous coronary intervention.

recommendation based on individual predictions using the SS-2020, with a possible better vital prognosis with PCI (Fig. 4).

4.2. Can we rely on the Heart team decision?

Detailed recommendations for implementing a Heart team are not provided in the current guidelines, potentially limiting their utilization in clinical practice and leading to reduced quality of care. In contemporary practice the Heart team discussion continues to be a vital part of the decision-making process for patients with complex coronary disease and retains a Class IC recommendation (C level, without randomized approach) [2], despite the encouraging report of the first virtual attempt to randomize Heart teams in the SYNTAX III trial [12].

Recently, Ma et al. reported the level of agreement between Heart teams for revascularization decisions in patients with complex coronary artery disease and the potential factors behind discrepancies [16]. Despite the fact that the Heart teams were in possession of the key factors for selecting the mode of revascularization (e.g. anatomic SYNTAX score, STS score etc.…), the primary outcome kappa for the level of agreement for inter-team decision-making was moderate (kappa = 0.58), at variance with the randomized SYNTAX III trial in which the kappa for agreement for inter-team decision-making based on ICA or

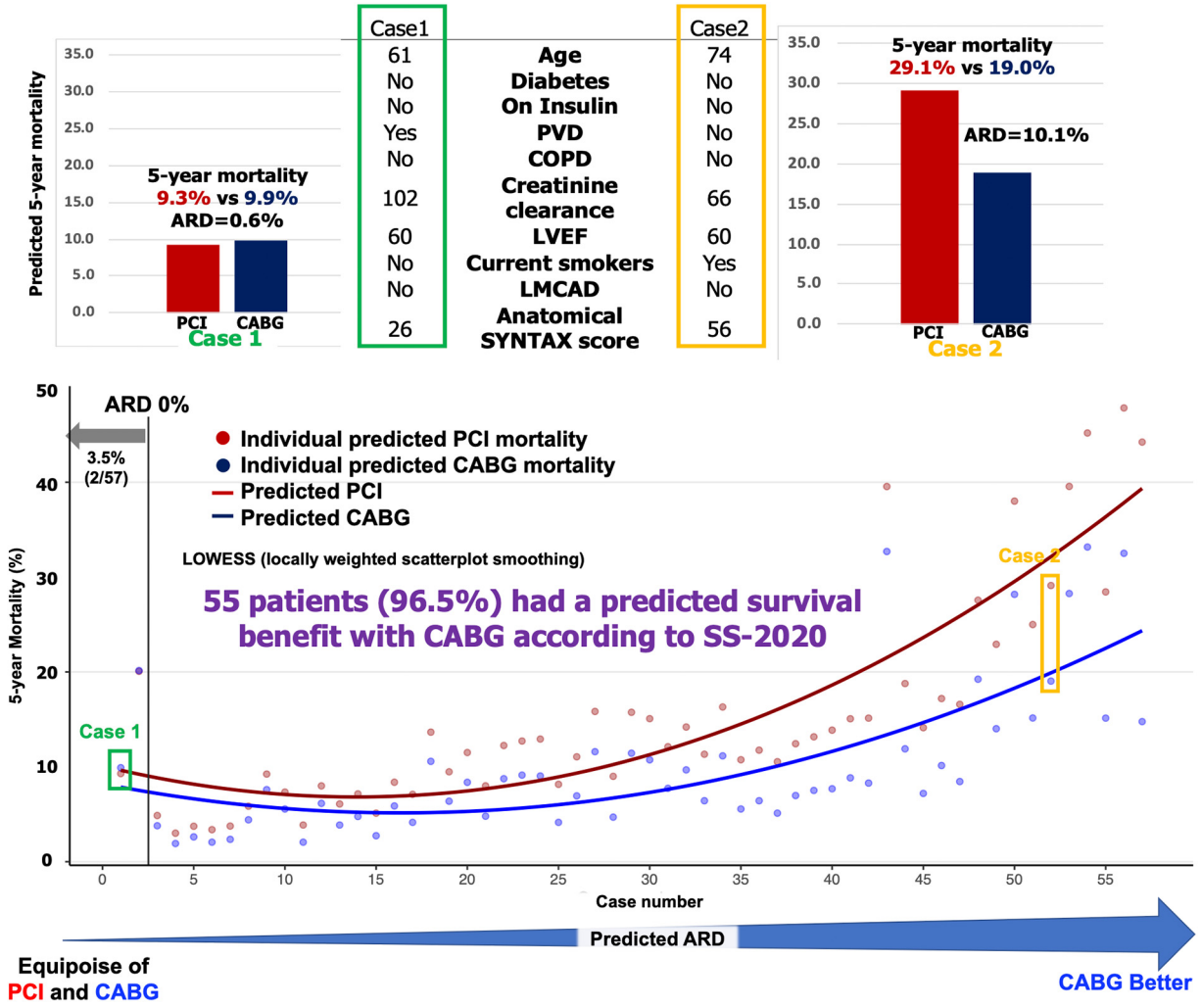

Fig. 4. Treatment recommendation according to the predicted absolute risk difference for 5-year mortality.
(Upper) In case 1, the patient has predicted 5-year mortality rates of 9.3 % after PCI and 9.9 % after CABG. The predicted ARD is 0.6 % with a possible better vital prognosis with PCI. In case 2, the patient has predicted 5-year mortality rates of 29.1 % after PCI and 10.1 % after CABG. The predicted ARD is 10.1 %, hence CABG should be recommended.
(Bottom) Predicted mortality after either PCI (red dots) or CABG (blue dots) for each individual patient (individual scatterplots). The dots in the scatter plot were connected with the use of locally estimated scatterplot smoothing (LOESS) curves.

CCTA was "almost perfect" (kappa = 0.82) [12]. In the present study, the Heart team consultation was not standardized, nevertheless, there was strict compliance to the recommendation for CABG in the first 57 consecutive patients with 3VD or LMCAD, screened on site.

4.3. Reproducibility of anatomical SYNTAX Score (aSS)

The aSS is a major component of the SS-2020, however, its calculation is subject to intra-and inter-observer variability and the variability could potentially affects the results of this ongoing clinical trial. Serruys et al. reported weighted kappa values for inter- and intra-observer reproducibility of the aSS of 0.45 and 0.59, respectively; notably the aSS as calculated by investigators consistently underscored the corelab by 3.4 points [17]. Collet et al. reported that the agreement on the aSS tertiles based on Kappa statistics was slight for the anatomic SS (Kappa = 0.19) and fair for the FSS (Kappa = 0.32) [18].

In the present study, the agreement of the proportion of patients classified in aSS tertiles (low<23, intermediate 23–32, and high>32) was moderate (weighted Kappa = 0.42). However, the variability of reproducibility between the observers is mainly due to the stratification between intermediate (aSS 23–32) and high aSS (>32). When patients are stratified into two groups, low aSS (aSS<23) and intermediate to high aSS (aSS≥23), based on ESC guidelines [2], there were only 2 discordant between 2 observers and the agreement was almost perfect with Kappa coefficient of 0.81.

Whilst it is evident from numerous clinical trials that stratification by aSS is helpful in determining treatment decisions [2], we have to concede that the aSS calculation is subject to intra-and inter-observer variability. The objective and automated assessment by machine learning of fluoroscopic or CTA would promote fast, accurate and reproducible aSS [8].

4.4. Current actuality of the SYNTAX score 2020 (SS-2020)

Improvements in devices and the techniques for stent implantation with intravascular imaging guidance, combined with better antiplatelet regimens and secondary prevention have reduced all-cause mortality following PCI over the last 10-years. In the SYNTAX II trial, there was a significant reduction in 5-year all-cause mortality compared to the SYNTAX I PCI cohort (8.1 % vs 13.8 %, p = 0.013) [19]. This is probably the reason why the threshold of equipoise in ARD for mortality moved to 4.5 % in the external validation of the CREDO KYOTO cohort [5]; below that threshold criterion the Kaplan Meier estimates show equipoise for mortality. Today, the use of an individual predicted ARD >0 % with the SS-2020, which is derived from outdated technology and techniques, might be too restrictive since it leads to the mandatory recommendation of CABG in almost all patients with 3VD without LMCAD.

4.5. Can we rely solely on non-invasive coronary imaging prior to revascularization?

Invasive assessment of coronary anatomy, functionality, high risk lesion characteristics and plaque composition could all be obtained by CCTA in a one-stop-shop providing diagnosis, risk management of patients undergoing either cardiac revascularization or non-cardiac surgery, as well as decision-making on percutaneous or surgical treatment [20,21].

Recently the Discharge trial has provided the first randomized comparison between an invasive and non-invasive diagnostic assessment prior to surgical or percutaneous revascularization [22]. Among patients referred for ICA because of stable chest pain and intermediate pre-test probability of CAD, the risk of major adverse cardiovascular events at medium term follow up was similar between the CCTA and the ICA group. The frequency of major procedure-related complications was nevertheless lower with an initial CCTA strategy.

The present trial addresses this issue specifically in the clinical setting of the most complex coronary artery disease, with LMCAD and 3VD. Thirty-day outcomes in terms of feasibility and safety are not part of this interim report, which was requested by the DSMB to ascertain whether patients included in this pilot study were truly legitimate surgical candidates and not suitable for PCI; in that regard there were only two patients that could have legitimately received PCI.

4.6. Patient's information and perspective

From a patient's perspective, PCI is less invasive, and this remains a very attractive and persuasive factor in favor of PCI, even though the individual predicted fatal outcome based on objective evidence, may formally contradict the patient's preference; of note, probabilistic outcome predictions are seldom shared with patients [23,24]. Therefore, it is mandatory to use validated models that estimate an individual's long term vital prognosis when deciding between modalities of revascularization [24].

Only accurate personalized predictions of vital prognosis, validated by observed all-cause mortality from very long-term follow up of randomized trials, will ultimately convince practitioners and scientific societies that personalized treatment recommendations should be rigorously implemented.

4.7. Limitation

First, this cohort of 57 patients is definitely not sufficient to draw any conclusion related to the safety and feasibility but the purpose of the present interim report was to reassure the DSMB that the surgeon had so far enrolled "surgical" cases. The current study is ongoing, and we intend to investigate the appropriateness of the selection of revascularization modality in all patients once the study is complete.

Second, the present study investigates predicted event rates based solely on pre-procedural angiographic anatomy and physiology, as well as clinical characteristics. However, operator proficiency, technical improvements in devices and the impact of novel pharmacological strategies may subsequently modulate the accuracy of these predictions based on preprocedural determinants. Equipoise in all-cause mortality, though an unbiased end point for trialists, is not ultimately the most relevant measure of a treatment's benefit from a patient's perspective, and quality adjusted life year (QALY) of survival remains the ultimate goal in the holistic approach to medicine [25].

5. Conclusion

The first 57 patients recruited into the FASTTRACK CABG trial received the appropriate modality of revascularization according to the SS2020. Scientific endorsement, logistic implementation, regulatory enforcement and prospective deep learning evaluations are the challenges for future decision-making scores, which should ultimately be openly shared with patients.

CRediT authorship contribution statement

Patrick W. Serruys, Yoshinobu Onuma, Marie Angele Morel: Conceptualization, Methodology.
Brian Thomsen; Charles Taylor: Software
Shinichiro Masuda, Shigetaka Kageyama, Nozomi Kotoku: Data curation
Kai Ninomiya, Patrick W. Serruys, Scot Garg: Writing - Original draft preparation.
John D. Puskas, Jagat Narula, Ulrich Schneider, Torsten Doenst, Kaoru Tanaka, Johan De Mey, Mark La Meir, Saima Mushtaq, Antonio L Bartorelli, Giulio Pompilio, Daniele Andreini: Patients recruitment, Investigation.
Patrick W. Serruys, Yoshinobu Onuma: Supervision

Data availability statement

All relevant data are stored on a secure private server; it is accessible with relevant limitations per IRB.

Conflict of interest

P.W. Serruys reports personal institutional grant from SMT Sahajanand Medical Technological, Sinomedical Sciences Technology, Novartis, Xeltis, Phillips, and Merilife outside the submitted work. All other authors have no conflict of interest to declare. Taylor C is shareholder and employee of HeartFlow, Inc. All other authors have no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.carrev.2023.01.001.

References

[1] Serruys PW, Ono M, Garg S, et al. Percutaneous coronary revascularization. J Am Coll Cardiol. 2021;78:384–407. https://doi.org/10.1016/j.jacc.2021.05.024.
[2] Task Force on Myocardial Revascularization of the European Society of Cardiologycollab, Surgery the European Association for Cardio-Thoracic, Interventions European Association for Percutaneous Cardiovascular, Neumann FJ, Sousa-Uva M, Ahlsson A. 2018 ESC/EACTS Guidelines on myocardial revascularization. Eur Heart J. 2019;40:87–165. https://doi.org/10.1093/eurheartj/ehy394.
[3] Farooq V, Klaveren DV, Ewout WS, et al. Anatomical and clinical characteristics to guide decision making between coronary artery bypass surgery and percutaneous coronary intervention for individual patients: development and validation of SYNTAX score II. Lancet. 2013;381:639–50. https://doi.org/10.1016/S0140-6736(13)60108-7.
[4] Takahashi K, Serruys PW, Valentin F, et al. Redevelopment and validation of the SYNTAX score II to individualise decision making between percutaneous and surgical revascularisation in patients with complex coronary artery disease: secondary analysis of the multicentre randomised controlled SYNTAXES trial with external cohort validation. Lancet. 2020;396:1399–412. https://doi.org/10.1016/S0140-6736(20)32114-0.
[5] Hara H, Shiomi H, Klaveren DV. External validation of the SYNTAX Score II 2020. J Am Coll Cardiol. 2021;78:1227–38. https://doi.org/10.1016/j.jacc.2021.07.027.
[6] Kawashima H, Pompilio G, Andreini D, et al. Safety and feasibility evaluation of planning and execution of surgical revascularisation solely based on coronary CTA and FFRCT in patients with complex coronary artery disease: study protocol of the FASTTRACK CABG study. BMJ Open. 2020;10:e038152.
[7] Sianos G, Morel MA, Kappetein AP, et al. The SYNTAX score: an angiographic tool grading the complexity of coronary artery disease. EuroIntervention. 2005;1:219–27.
[8] Serruys PW, Chichareon P, Modolo R, et al. The SYNTAX score on its way out or … towards artificial intelligence: part I and part II. EuroIntervention. 2020;16:44–59. https://doi.org/10.4244/EIJ-D-19-00543A.
[9] Andreini D, Pontone G, Mushtaq S, et al. Image quality and radiation dose of coronary CT angiography performed with whole-heart coverage CT scanner with intracycle motion correction algorithm in patients with atrial fibrillation. Eur Radiol. 2018;28:1383–92. https://doi.org/10.1007/s00330-017-5131-2.
[10] Leaman DM, Brower RW, Meester GT, et al. Coronary artery atherosclerosis: severity of the disease, severity of angina pectoris and compromised left ventricular function. Circulation. 1981;63:285–99. https://doi.org/10.1161/01.cir.63.2.285.
[11] Mushtaq S, Goncalves PDA, Garcia-Garcia HM, et al. Long-term prognostic effect of coronary atherosclerotic burden: validation of the computed tomography-leaman score. Circ Cardiovasc Imaging. 2015;8:e002332. https://doi.org/10.1161/CIRCIMAGING.114.002332.
[12] Collet C, Onuma Y, Andreini D, et al. Coronary computed tomography angiography for heart team decision-making in multivessel coronary artery disease. Eur Heart J. 2018;39:3689–98. https://doi.org/10.1093/eurheartj/ehy581.
[13] Jennifer S, Jacqueline ETH, Sripal B, et al. ACC/AHA/SCAI guideline for coronary artery revascularization: a report of the american College of Cardiology/American Heart Association joint committee on clinical practice guidelines. Circulation. 2021;2022(145):e18-114. https://doi.org/10.1161/CIR.0000000000001038.
[14] Modolo R, Chichareon P, Klaveren DV, et al. Impact of non-respect of SYNTAX score II recommendation for surgery in patients with left main coronary artery disease treated by percutaneous coronary intervention: an EXCEL substudy european journal of cardio-thoracic surgery. Eur J Cardiothorac Surg. 2020;57:676–83. https://doi.org/10.1093/ejcts/ezz274.
[15] Stanetic BM, Ostojic M, Campos CM. ApPropriateness of myocaRdial RevascularizatiOn assessed by the SYNTAX score II in a coUntry without cardiac Surgery faciliTies; PROUST study. Int J Cardiol. 2017;227:478–84. https://doi.org/10.1016/j.ijcard.2016.11.001.
[16] Ma H, Lin S, Li X, et al. Exploring optimal heart team protocol to improve decision-making stability for complex coronary artery disease: a sequential explanatory mixed method study. Eur Heart J Qual Care Clin Outcomes. 2021. https://doi.org/10.1093/ehjqcco/qcab074.
[17] Serruys PW, Onuma Y, Garg S, et al. Assessment of the SYNTAX score in the Syntax study. EuroIntervention. 2009;5:50–6.
[18] Collet C, Miyazaki Y, Ryan N, et al. Fractional flow reserve derived from computed tomographic angiography in patients with multivessel CAD. J Am Coll Cardiol. 2018;71:2756–69.
[19] Banning AP, Serruys PW, De Maria GL, et al. Five-year outcomes after state-of-the-art percutaneous coronary revascularization in patients with de novo three-vessel disease: final results of the SYNTAX II study. Eur Heart J. 2021. https://doi.org/10.1093/eurheartj/ehab703.
[20] Serruys PW, Hara H, Garg S, et al. Coronary computed tomographic angiography for complete assessment of coronary artery disease JACC state of-the-art review. J Am Coll Cardiol. 2021;78:713–36. https://doi.org/10.1016/j.jacc.2021.06.019.
[21] Hwang, et al. Assessment of perioperative cardiac risk of patients undergoing non-cardiac surgery using coronary computed tomographic angiography. Circ Cardiovasc Imaging. 2015;8:e002582.
[22] The DISCHARGE Trial Group. CT or invasive coronary angiography in stable chest pain. N Engl J Med. 2022. https://doi.org/10.1056/NEJMoa2200963.
[23] Taggart DP. Surgery is the best intervention for severe coronary artery disease. BMJ. 2005;330:785–6. https://doi.org/10.1136/bmj.330.7494.785.
[24] Ninomiya K, Serruys PW, Garg S, et al. The utility of the SYNTAX score II and SYNTAX score 2020 for identifying patients with three-vessel disease eligible for percutaneous coronary intervention in the multivessel TALENT trial: a prospective pilot experience. Rev Cardiovasc Med. 2022;23:133. https://doi.org/10.31083/j.rcm2304133.
[25] Abdallah MS, Wang K, Magnuson EA, et al. Quality of life after surgery or DES in patients with 3-vessel or left Main disease. J Am Coll Cardiol. 2017;69:2039–50. https://doi.org/10.1016/j.jacc.2017.02.031.