Supplemental file

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1. **Supplemental Table 1**. Comparing early graft patency by ICA and CCTA.

	Timing	IMA	Radial	Vein
ICA				
Kobayashi et al [1]	3 weeks	94%[#], 93%*	99%[#], 95%*	100%[#], 94%*
Bourassa et al [2]	1 month	NA	NA	90%
Mehta et al [3]	1 month	NA	NA	85%
CCTA				
Balkhy et al [4]	1 month	100%	NA	NA
Doi et al [5]	3 weeks	96%	NA	92%
Tochii et al [6]	2 months	100%	100%	83%

[#] on-pump, * off-pump

ICA: invasive coronary angiography, CCTA: coronary computed tomography angiography, IMA: internal mammary artery, NA: not applicable.

2. **Supplemental Table 2**. Procedural complications.

• Death
• Stroke
• Myocardial infarction
• Any revascularization
• Bleeding complications -BARC scale -TIMI scale
• Transfusion ≥2 units of blood
• Major arrhythmia (supraventricular tachycardia requiring cardioversion, ventricular tachycardia or fibrillation requiring treatment, or bradyarrhythmia requiring temporary or permanent pacemaker)
• Any unplanned surgery or therapeutic radiologic procedure
• Renal failure (serum creatinine increases by ≥0.5 mg/dL from baseline or need for dialysis)
• Sternal wound dehiscence

• Infection requiring antibiotics
• Prolonged intubation (>48 hours)
• Post-pericardiotomy syndrome

Modified from Kappetein AP, Serruys PW, Sabik JF, Stone GW et al. Design and Rationale for a Randomized Comparison of Everolimus-eluting Stents and Coronary Artery Bypass Graft Surgery in Selected Patients with Left Main Coronary Artery Disease: The EXCEL trial [7].

BARC scale: Bleeding Academic Research Consortium scale, TIMI scale: Thrombolysis in Myocardial Infarction scale.

3. CCTA acquisition guideline before CABG

CCTA acquisition guidelines prior to CABG

Introduction

- Before CABG procedure, CCTA is performed to assess the native coronary arteries. According to the local practice, mammary arteries may be assessed with additional imaging.
- Utilize 256-slice GE Revolution CT Scanner.
- Imaging the entire coronary tree allows for the most accurate FFR_{CT} computation.
- These guidelines also including imaging of the mammary arteries and implications on image reconstruction.
- The full set of image data as well as raw scan data should be saved for each examination.

Preparation

- Assess heart rate and rhythm. Heart rate control (below 65 beats per minute) reduces motion artifacts.

- Heart rate modulation for heart rates >60/min during breath holding.
  - Oral: metoprolol tartrate 100 mg, one hour before the exam.

    atenolol 50 mg, one hour before the exam.
  - Intravenous: metoprolol 5 mg, repeated up to 5 times.
    - Contraindications: conduction delays, hypotension, severe asthma, allergy to beta-blockers, reduced left ventricle ejection fraction
    - Consider ivabradin for patients with contra-indications to beta-blockers (in case of ivabradine the dosage suggested is 5 mg twice a day for at least 3-4 days before the scan)

- Provide full explanation of exam, and practice breath hold. Ensure breath hold time will be sufficient for scan time. Evaluate impact of breath holds on heart rate.

- Nitrates and FFR_{CT}.
  - use NTG preferably 3 minutes prior to CTA image acquisition;
  - use 1-2 sprays (0.4mg-0.8mg).
  - use beta-blocker with it to avoid reflex tachycardia/vasoconstriction.
  - additional beta-blockade may be given after nitroglycerin to counteract the reflex tachycardia.

- Confirm absence of allergy to contrast media (consider prophylaxis for patients with doubtful or mild reactions to contrast in the past).

Patient installation

- Attach ECG leads, avoid respiratory muscles, check signal stability during breath hold.
- Placement of an intravenous catheter that allows a flow of at least 5 ml/sec.

Data acquisition

1) Overview/scout of the entire chest.
2) Contrast enhancement:
    - ≥300 g/L iodine contrast medium.
    - Injection rate: 5-6 ml/s.
    - Total amount depends on the patient size, the scan mode and the scan duration.
    - Contrast-scan timing:
        - Test/Timing Bolus: 15-20 ml of contrast is injected, preferably followed by a bolus chaser. Place the localizer line one centimeter below the carina and just above the base of the heart, which is the optimal location to find the ascending aorta for a timed contrast injection. The time of (maximum) enhancement is used as the delay of the data acquisition after start of contrast injection.

- Bolus tracking/Smart Prep: arrival of the (entire) bolus is monitored in the ascending aorta. To avoid premature triggering of the scan, the ROI should be sufficiently large and placed away from the superior vena cava.

- A saline bolus of 50 ml is injected after the contrast medium at the same rate.

3) Gating and phase acquisition:

ECG-triggered one-beat scan mode should be used. For HR <65, 75% of the R-R cycle is appropriate. For HR>65 or variable heart rates, 40-80% of the R-R cycle is appropriate with ECG mA modulation. Consider use of Auto-Gating functionality on the system.

4) Acquisition parameters:

- Thinnest detector collimation.

- Noise Index (NI) of 30 at ASIR-V 50%. May be adjusted depending on the size of the patient. If fixed tube current (mA) is used, it should be >500 mA. For patients acquired in standard mode, we suggest 100 kVp for BMI<25 and 120 kVp for BMI>25; for HD mode, we suggest 100 kVp for BMI<20 and 120 kVp for BMI>20. Do not use a kVp less than 100 kVp.

- For patients with BMI >25, the x-large focal spot should be preferentially used. This can be achieved by either increasing the NI until the focal spot size change is reflected on the screen, or by switching to a fixed tube current scan mode.

- Additionally, if heart rate is well controlled (HR<65) in these large patients, gantry rotation time of 0.35sec should be considered. This is pre-configured in the nominal Auto Gating profiles if Auto Gating is being utilized on the system.

- Scan range: from the apex of the lung to the caudal border of the heart. If more than one slab is required, the acquisition should be performed such that first the entire heart is captured in one axial slab, and then the table is moved to capture the remaining range in the cranial direction.

- High Definition Mode should be preferably used except in patients with BMI >25

Image reconstruction:

Two sets of reconstructions will be provided – one for assessing the heart and one for assessing the mammary arteries.

For assessment of the heart:

- 0.625mm slice thickness.

- ASIR-V 50% in all cases should be provided. Additional ASIR-V levels may be provided if ASIR-V 50% is inadequate.

- Field-of-view enclosing the entire heart (cover inferior carina to lower heart border) (approx. 18 x 18 cm).

- Standard kernel reconstructions. Depending on the scan protocol both diastolic and systolic reconstructions should be performed.

- Reconstructions should be optimized for the segments of interest (ROI). In case of suboptimal image quality, other phases should be explored.

- Additional high-definition or sharp kernel reconstructions should be provided at the optimal phase(s). If High Definition mode was not performed, then Detail kernel reconstructions should be provided.
- If motion artifacts persist in the optimal phase images, the standard and high definition (or detail) reconstructions should be done with "Temporal Enhanced" enabled, and SnapShot Freeze processing should be performed.

For assessment of the mammary arteries:

- 0.625mm slice thickness.
- ASIR-V 50% in all cases should be provided. Additional ASIR-V levels may be provided if ASIR-V 50% is inadequate.
- Field-of-view enclosing the entire chest cavity.
- The optimal phase as what was reconstructed for the coronary assessment should be reconstructed.
- Standard kernel reconstruction.

The above acquisition and reconstruction guidelines are subject to revision by the steering committee based on new software and hardware capabilities that may become available on the CT system during the course of this study.

4. CCTA acquisition guidelines at 30 days after CABG

Introduction

- At 30-day follow-up, CCTA is performed to assess the native coronary arteries and bypass grafts. Therefore, in addition of triggered acquisition of CTA for coronary artery, a second non-gating acquisition is performed.

- Utilize 256-slice GE Revolution CT Scanner.
  - Imaging the entire coronary tree and grafts allows for the most accurate FFR_{CT} computation.
  - These guidelines also include imaging of the mammary arteries and implications on image reconstruction.
- The full set of image data as well as raw scan data should be saved for each exam.

Preparation

- Assess heart rate and rhythm. Heart rate control (below 65 beats per minute) reduces motion artifacts.

- Heart rate modulation for heart rates >60/min during breath holding.
  - Oral: metoprolol tartrate 100 mg, one hour before the exam.

    atenolol 50 mg, one hour before the exam.
  - Intravenous: metoprolol 5 mg, repeated up to 5 times.
  - Contraindications: conduction delays, hypotension, severe asthma, allergy to beta-blockers, reduced left ventricle ejection fraction

- o Consider ivabradin for patients with contra-indications to beta-blockers (in case of ivabradine the dosage suggested is 5 mg twice a day for at least 3-4 days before the scan)
- Provide full explanation of exam, and practice breath hold. Ensure breath hold time will be sufficient for scan time. Evaluate impact of breath holds on heart rate.

- Nitrates and FFR_{CT}.
  - use NTG preferably 3 minutes prior to CT image acquisition;
  - use 1-2 sprays (0.4mg-0.8mg)
  - use beta-blocker with it to avoid reflex tachycardia/vasoconstriction
  - additional beta-blockade may be given after nitroglycerin to counteract the reflex tachycardia

- Confirm absence of allergy to contrast media (consider prophylaxis for patients with ` doubtful or mild reactions to contrast in the past).

Patient installation

- Attach ECG leads, avoid respiratory muscles, check signal stability during breath hold.
- Placement of an IV catheter that allows a flow of at least 5 ml/sec

Data acquisition

5) Overview/scout of the entire chest.

6) Contrast enhancement:

- ≥300 g/L iodine contrast medium.
- Injection rate: 5-6 ml/s.
- Total amount depends on the patient size, the scan mode and the scan duration.
- Contrast-scan timing:
    - Test/Timing Bolus: 15-20 ml of contrast is injected, preferably followed by a bolus chaser. Place the localizer line one centimeter below the carina and just above the base of the heart, which is the optimal location to find the ascending aorta for a timed contrast injection. The time of (maximum) enhancement is used as the delay of the data acquisition after start of contrast injection.
    - Bolus tracking/Smart Prep: arrival of the (entire) bolus is monitored in the ascending aorta. To avoid premature triggering of the scan, the ROI should be sufficiently large and placed away from the superior vena cava.
- A saline bolus of 50 ml is injected after the contrast medium at the same rate.

7) Gating and phase acquisition:

ECG-triggered one-beat scan mode should be used. For HR <65, 75% of the R-R cycle is appropriate. For HR>65 or variable heart rates, 40-80% of the R-R cycle is appropriate with ECG mA modulation. Consider use of Auto-Gating functionality on the system.

8) Non-gating acquisition:

In presence of mammary grafts, additional non-gating acquisition is performed to cover the proximal origin of mammary arteries (from the subclavian arteries) to the upper limit of the first gated acquisition. In case that there are only venous grafts, non-gating acquisition should be performed from the proximal aortic origin of most cranially inserted venous grafts to the upper boundary of the first gated volume.

9) Acquisition parameters:

- Thinnest detector collimation.
- Noise Index (NI) of 30 at ASIR-V 50%. May be adjusted depending on the size of the patient. If fixed tube current (mA) is used, it should be >500 mA. For patients acquired in standard mode, we suggest 100 kVp for BMI<25 and 120 kVp for BMI>25; for HD mode, we suggest 100 kVp for BMI<20 and 120 kVp for BMI>20. Do not use a kVp less than 100 kVp.
- For patients with BMI > 25, the x-large focal spot should be preferentially used. This can be achieved by either increasing the NI until the focal spot size change is reflected on the screen, or by switching to a fixed tube current scan mode.

- Additionally, if heart rate is well controlled (HR<65) in these large patients, gantry rotation time of 0.35 sec should be considered. This is pre-configured in the nominal Auto Gating profiles if Auto Gating is being utilized on the system.
- Scan range: from the apex of the lung to the caudal border of the heart. If more than one slab is required, the acquisition should be performed so that first the entire heart is captured in one axial slab, and then the table is moved to capture the remaining range in the cranial direction.

- High Definition Mode should be preferably used except in patients with BMI >25.

Image reconstruction:

Two sets of reconstructions will be provided – one for assessing the heart and one for assessing the mammary arteries.

For assessment of the heart:

- 0.625mm slice thickness.
- ASIR-V 50% in all cases should be provided. Additional ASIR-V levels may be provided if ASIR-V 50% is inadequate.
- Field-of-view enclosing the entire heart (cover inferior carina to lower heart border) (approx. 18 x 18 cm).

- Standard kernel reconstructions. Depending on the scan protocol both diastolic and systolic reconstructions should be performed.
- Reconstructions should be optimized for the segments of interest (ROI). In case of suboptimal image quality, other phases should be explored.
- Additional high-definition or sharp kernel reconstructions should be provided at the optimal phase(s). If High Definition mode was not performed, then Detail kernel reconstructions should be provided.
- If motion artifacts persist in the optimal phase images, the standard and high definition (or detail) reconstructions should be done with "Temporal Enhanced" enabled and SnapShot Freeze processing should be performed.

For assessment of the mammary arteries:

- 0.625mm slice thickness.
- ASIR-V 50% in all cases should be provided. Additional ASIR-V levels may be provided if ASIR-V 50% is inadequate.
- Field-of-view enclosing the entire chest cavity.
- The optimal phase as what was reconstructed for the coronary assessment should be reconstructed.
- Standard kernel reconstruction.

The above acquisition and reconstruction guidelines are subject to revision by the steering committee based on new software and hardware capabilities that may become available on the CT system during the course of this study.

5. Pharmacologic therapy

It is strongly recommended that subjects are treated with aspirin and statins. Aspirin (≥75 mg) must be given within six hours after surgery intravenously, orally, rectally, or via a nasogastric tube if there is no important bleeding (≤50 cc/hr), and daily for the duration of the trial. If the patient is taking an adenosine-diphosphate receptor antagonist, it should be discontinued prior to surgery (at least five days prior for clopidogrel and ticagrelor and at least seven days prior for prasugrel). Post CABG, clopidogrel is not required but may be administered as per local standard of care in subjects with saphenous vein grafts or in those who underwent off-pump surgery. Subjects receiving amiodarone prophylaxis should be loaded prior to surgery, and have their treatment continued for a minimum of five days after surgery. Angiotensin-converting enzyme inhibitors are to be stopped before CABG to ensure they are no longer effective at the time of surgery. After the CABG procedure, all subjects should be started on a high dose “statin” based on low-density lipoprotein level according to the recommended regimens. Otherwise, optimal medical therapy is prescribed.

6. Video 1. Planning for CABG based on CCTA and FFR_{CT}

In this case, despite equipoise risk between surgical and PCI, the CCTA planning and operating decide to opt for surgery with a left internal mammary artery on the left anterior descending artery (recommendation equal risk of mortality at 4 years) and a saphenous vein

graft on the left marginal artery. The bifurcation (medina classification 1, 1, 1) with acute 3-dimentional angulation was probably perceived as a deterrent argument for PCI.

CABG: coronary artery bypass graft, CCTA: coronary computed tomography angiography, FFR_{CT}: fractional flow reserve derived from coronary computed tomography angiography, PCI: percutaneous coronary intervention.

7. Reference

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