CT Acquisition and Reconstruction Techniques for Transcatheter Aortic Valve Procedure Planning Utilizing GE Healthcare CT Scanners

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WARNING: *Any reference to X–ray exposure, intravenous contrast dosage, and other medication is intended as a reference guideline only. The guidelines in this document do not substitute for the judgment of a health care provider. Each scan requires medical judgment by the health care provider about exposing the patient to ionizing radiation. Use the As Low As Reasonably Achievable (ALARA) radiation dose principle to balance factors such as the patient's condition, size, and age; region to be imaged; and diagnostic task.*

NOTE: *Algorithms/protocols included in this paper are for educational reference only. The authors do not endorse or support any one specific algorithm/protocol. It is up to each individual clinician and institution to select the treatment that is most appropriate.*

Philipp Blanke, MD is a paid consultant for Edwards Lifesciences

Introduction

Transcatheter aortic valve procedures have proven to be an effective alternative in the treatment of severe symptomatic aortic stenosis. Contrast-enhanced computed tomography (CT) has become an integral part of transcatheter aortic valve procedure planning by allowing for anatomical assessment of the aortic root and the aorto-iliofemoral vasculature within a single examination.

It is critical that artifact free image data is obtained to allow for reliable anatomical measurements. Data acquisition strategies and scanning protocols may vary depending on scanner manufacturer, system, and institutional preferences. This document provides some recommendations for reliable CT image acquisition for transcatheter aortic valve procedures.

Work–Flow Rationale

The key component of all approaches is an ECG-assisted data acquisition which covers at least the aortic root, while the remainder of the data acquisition may be performed without ECG-assistance. If employed properly, ECG-assistance allows for artifact-free depiction of the aortic root. The sequence of patient preparation and the relevant principles of CT data acquisition will be explained in brief below.

Patient Preparation

- Positioning of the patient on the scanner table, typically supine, should closely resemble positioning on the cath lab table.
- This is important for the prediction of c-arm angulation from the CT dataset.
- Placement of ECG-electrodes and IV access should follow institutional policies.
- Patient instruction on breath-holding prior to scanning may improve compliance with the breath-holding instructions during the scan.
  - Due to the advanced age and frailty of this patient population, additional time may be needed for patient instruction.

Providing time for the patient to practice the breath hold prior to scan acquisition may drastically improve patient compliance and thereby scan quality.

CT Scan – Scan Length and Scan Strategy

In general, there are two different approaches on how to combine the ECG-assisted data acquisition of the aortic root structures and the non-ECG assisted computed tomography angiography (CTA) of the aorta-iliofemoral vasculature for evaluation of the transfemoral access route:

1) ECG-assisted data acquisition of the heart and aortic root followed by a non-ECG assisted CTA of the thorax, abdomen and pelvis. Although this approach results in repeat data acquisition of the aortic root and cardiac structures, the time-intensive ECG-assisted data acquisition (in particular when using retrospective ECG-gating) is kept to a minimum which aids in limiting the contrast dose. Furthermore, limiting the ECG-assisted data acquisition also limits the radiation dose intensive component of the e examination; although the cardiac scan range is covered twice.

   The proposed protocols for all GE scanner Families use this approach. In 40mm detector coverage systems, cardiac data acquisition is performed with retrospective ECG-gating. With the Revolution CT system, with 160mm detector coverage, a one beat, gated whole heart volume scan is performed.

2) ECG-gated data acquisition of the thorax followed by a non-ECG gated CTA of the abdomen and pelvis. The disadvantage of this approach, when using 40 mm detector systems, is the relatively long acquisition time required for the entire thorax (depending on scanner model this will vary but in some cases it may exceed 15 seconds, in particular when using retrospective ECG-gating), which increases the risk of breathing artifacts at the level of the cardiac structures.

1. Scout

General	Data acquisition	*Comment*
• Lateral and AP scout covering the thorax, abdomen and pelvis including the proximal femoral to the lesser trochanter	• Start: Superior 60 • End: Inferior 800 • Tube current 10 mA, Tube voltage 120 kV, or SmartScout • ECG trace: On • Scout Plane: 90 and 0 degrees • Auto Voice (Breath hold command): Inspiration	*Take note of the iso-center indicator line on the first scout to ensure that the patient is positioned within 2 cm of isocenter to allow for best image quality. Adjust table height to indicated iso-center location if more than 2 cm off before acquiring the 2nd scout.*

2. ECG-gated axial data acquisition of the aortic root/heart (Group 1) followed by non-gated CTA of the thorax, abdomen, and pelvis (Group 2).

Smart Prep

General	Data acquisition	*Comment*
• Bolus tracking to automatically trigger the diagnostic scan acquisition based on the HU reading in the ROI reaching the prescribed enhancement threshold • Slice location: approx 2 cm below the carina • ROI location: Ascending aorta or descending aorta	• Monitoring Delay: 12 sec • Monitoring Inter Scan Delay: 1 sec • Tube voltage: 120 kV • Tube current: 100 mA • Diagnostic Delay: Auto Minimum • Enhancement Threshold: ~ Ascending aorta 200 HU ~ Descending aorta 100 HU	*The effective ('diagnostic') delay between reaching the threshold and the start of the subsequent data acquisition (Group 1) is the combined time comprising the length of the breath hold command (autovoice), the time needed for table movement and the subsequent pre-scan delay (pre-set delay time in Group 1)*

Group 1 scan parameters - ECG-gated axial data acquisition of the aortic root/heart

General	Data acquisition	Data reconstruction
• ECG-gated axial data acquisition of the aortic root and heart • Scan range beginning 2 cm below the carina to the base of the heart • Dose modulation is not recommended to ensure optimal image quality throughout the entire cardiac cycle • Smart mA automatically sets the tube current to achieve the targeted Noise Index within the range defined by the min and max values • For Revolution ES: when imaging the entire heart 2 or more slabs may be required. The user should ensure that the rotation boundary between the slabs does not occur at the level of the aortic root. Use the Split and Link function to adjust the transition between the rotations to avoid having the transition at the aortic root.	• Auto voice (Breath hold command): On (#1 – Suspension) Playback option: Group 1 Pre Only • Pre-set Delay Time: 2 seconds (Together with the auto voice command and table movement, this results in a diagnostic delay of 4-5sec) • Scan Type: Cardiac • Rotation Speed: 0.28 seconds • SFOV: Cardiac Large • DFOV: 25 cm • Slice thickness: 0.625 mm • Collimation: 160 mm (Smart Collimation will automatically select the appropriate collimation for the planned scan range • Tube voltage: 120 kV • Tube current: Smart mA: Min: 50 mA Max: ~ Apex: 900 mA ~ Revolution CT & ES: 600 mA	• Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhythm • Slice Thickness: 0.625 mm • Increment: 0.625 mm • Iterative Reconstruction ASiR-V™: 50% • Recon: Std • Use ECG editing if necessary

• Smart Arrhythmia Management is an additional option which can be used when covering the gated acquisition within a single volume. It may be useful in patients with atrial fibrillation, frequent premature contractions or extremely variable heart rates. See section on ECG Editing to learn how to select the desired heart beat for reconstruction.	• Noise Index: 30 • Auto Gating: Off (Dose modulation is not recommended, alternatively ensure max mA during systole • Targeted Phase reconstruction: When scanning entire heart cycle, reconstruction Phase Type should be set to Earliest to Latest and Phases, Interval One Heart Cycle enabled. • HR Variation Allowance: 4 bpm • Acquisition Window Part 1 1 Beat	***Comment*** *Within the "Phases, Interval" selection menu, select "One Heart Cycle to ensure x-ray for the full R to R interval. If "One Heart Cycle" option is not present, enter 5-95%*

Group 2 scan parameters – non-gated CTA of the thorax, abdomen, and pelvis

General	Data acquisition	Data reconstruction
• Helical, non-gated acquisition • Scan range: lung apices to the lesser trochanters of the femoral bone • The Prep/Group Delay is needed to allow for the contrast opacified blood to reach the iliofemoral arteries	• Prep/Group Delay 2s • Auto voice (Breath hold command): On (#1 – Suspension) Playback option: Group 2 Post Only • Scan type: Helical • SFOV: Large Body • Detector coverage: 80 mm • Pitch: 0.992 • Table Speed: 283 mm/sec • Rotation Speed: 0.28 seconds • Slice Thickness: 0.625 mm • Tube voltage: ~ 70 kV for BMI 9-16 kg/m2 ~ 80 kV for BMI 16-23 kg/m2 - ~ 100 kV for BMI 23-31 kg/m2 ~ 120 kV for BMI >31 kg/m2 • Tube current: Smart mA: Min: 10 mA Max: ~ Apex: 900 mA ~ Revolution CT & ES: 530 mA • Noise Index: 18 • Scan direction: cranio-caudal	• Slice Thickness: 0.625 mm • Increment: 0.625 mm • Iterative Reconstruction ASiR-V 50% • Recon: Std
		Comment *When DLIR is available it may be desirable to reconstruct the exam or a subset of the exam with DLIR -H and Edge 1 (E1) filter*

GE REVOLUTION APEX™, REVOLUTION™ CT, REVOLUTION ES (CONT)

Contrast application protocol	
General • Single contrast application for both the ECG-gated axial CTA of the aortic root/heart and the CTA of the thorax/abdomen/pelvis • Triphasic administration protocol with pure contrast, followed by a contrast/saline mixture, followed by a saline chaser • Placement of IV access per hospital protocol (an 18-guage IV typically provides the highest safety) • Automated contrast injection using a dual-cylinder injector	**Specific** • For normal weighted patients and an iodinated contrast agent with 300 mg/ml apply 30 ml contrast at 3.5 ml/sec, followed by 60 ml of 70% contrast/30% saline at 3.5 ml/sec, followed by 30 ml saline at 3.5 ml/sec; this results in a total amount of 72 ml total contrast agent (adjust for contrast agents with differing iodine concentrations) • For large patients and an iodinated contrast agent with 300 mg/ml apply 40 ml contrast at 4.0 ml/sec, followed by 80 ml of 70% contrast/30% saline at 4.0 ml/sec, followed by 30 ml saline at 4.0 ml/sec; this results in a total amount of 96 ml total contrast agent (adjust for contrast agents with differing iodine concentrations) • Bolus monitoring and timing of data acquisition by means of bolus tracking at the level of the ascending aorta with a region of interest placed either in the ascending aorta (200 HU) or descending aorta (100 HU).

REVOLUTION HD, REVOLUTION EVO, OPTIMA™ 660, DISCOVERY™ CT750 HD and LIGHTSPEED™ VCT™ SCANNER PLATFORMS

1. Scout		
General • Lateral and AP scout covering the thorax, abdomen and pelvis including the proximal femoral to the lesser trochanter	**Data acquisition** • Start: Superior 60 • End: Inferior 800 mA: 10 mA • ECG trace: On • Scout Plane: 90 and 0 degrees • Auto Voice (Breath hold command): Inspiration	

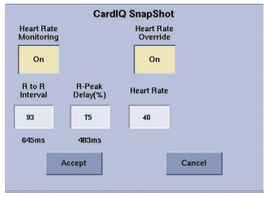
2. Retrospectively ECG-gated data acquisition of the aortic root/heart (Group 1) followed by non-gated CTA of the thorax, abdomen, and pelvis (Group 2).		
Smart Prep		
General • Bolus tracking to automatically trigger the diagnostic scan acquisition based on the HU reading in the ROI reaching the prescribed enhancement threshold. • Slice location: approximately 2 cm below the carina • ROI location: Ascending aorta	**Data acquisition** • Monitoring Delay: 7 sec • Tube current: 60 mA • Tube voltage: system sets it to be same as Group 1 • Slice/Collimation: 5 mm • ISD: 1.4 • Diagnostic Delay: Auto Minimum • Pre-set delay time: 3 seconds (this results in a 'diagnostic delay' of approximately 5-6sec, if rotation time is kept identical between both groups, i.e. 0.4sec) • Enhancement Threshold: 150 HU	***Comment*** *The effective ('diagnostic') delay between reaching the threshold and the start of the subsequent data acquisition (Group 1) is the combined time comprising the length of the breath hold command, (auto voice), the time needed for table movement and the subsequent pre-scan delay.*

REVOLUTION HD, REVOLUTION EVO, OPTIMA™ 660, DISCOVERY™ CT750 HD and LIGHTSPEED™ VCT™ SCANNER PLATFORMS (CONT)

Group 1 scan parameters – Retrospectively ECG-gated data acquisition of the aortic root/heart

General

- ECG-gated data acquisition of the aortic root and heart
- Scan range: beginning 2 cm below the carina to the base of the heart
- Irregular heart rates (HRs) are frequent within the TAVR population. Using the HR override capability with manually setting the HR to a lower value yields a lower pitch value which results in redundant CT data acquisition and thus provides the greatest flexibility in image reconstruction (e.g. utilization of SnapShot™ Segment, SnapShot Burst or SnapShot Burst Plus)



- Keeping as many parameters the same in Group 1 and Group 2 will result in a faster transition between the gated and non-gated groups
- In particular the rotation time needs to be consistent. The non-gated Group 2 is limited to a rotation speed of 0.40 seconds. Thus for heartrates <80 bpm, both groups should employ 0.40 seconds. For heart rates >80 bpm, a rotation speed of 0.35 seconds should be used, however this leads to a longer transition time

Data acquisition

- Scan Mode: Cardiac Helical
- Scan Parameter:
- <80 bpm: SnapShot Segment
- >80 bpm: SnapShot Burst
- DFOV: 25 cm
- HR Override: On (manually enter min HR present on the ECG trace)
- Rotation speed:
- HR < 80 bpm: 0.40 seconds
- HR > 80 bpm: 0.35 seconds
- Tube voltage:
  - ~ 120 kVp for BMI > 25 kg/m2
  - ~ 100 kVp for BMI < 25 kg/m2
- Tube current (manual): 450/600/700 mA for small, average and large patients
- ECG Dose modulation is not recommended, alternatively ensure maximum mA in systole (e.g. 25 to 45%, R-peak delay 35%)
- TargetPhase reconstruction: 5-95%
- Slice/Collimation: 0.625mm
- Scan direction: cranio-caudal
- Pitch: Autopitch (determined by HR)
- Auto voice (Breath hold command): Inspiration only

Data reconstruction

- Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhythm
- Use ECG editing if necessary
- Slice Thickness: 0.625 mm
- Increment: 0.62 mm
- Recon: Std
- Iterative reconstruction: ASiR (if available) 50%

Group 2 scan parameter – non-gated CTA of the thorax, abdomen, and pelvis

General

- Scan range: Lung apices/upper thoracic inlet to the proximal femoral (lesser trochanter)
- Max mA values will vary between scanner models

Data acquisition

- Scan type: Helical
- Pitch: 0.984
- Table Speed: 39.76 mm
- Rotation Speed: 0.4 seconds
- Slice Thickness: 1.25 mm
- Collimation: 40 mm
- Tube Voltage:
  - ~ 100 kV for BMI < 25 kg/m2
  - ~ 120 kV for BMI > 25 kg/m2,
- Tube current: Smart mA
  Min: 10 mA
  Max: 700 mA (may vary among scanner systems)
- Noise Index: 18.4
- Scan direction: cranio-caudal
- No additional automated breath hold command (no AutoVoice); alternatively manually instruct patient to slowly exhale

Data reconstruction

- Slice Thickness: 1.25 mm
- Increment: 0.8 mm
- Recon: Std
- Iterative reconstruction: ASiR (if available) 50%

Contrast application protocol

General

- Single contrast application for both the retrospectively ECG-gated CTA of the aortic root/heart and the CTA of the thorax/abdomen/pelvis
- Placement of IV access per hospital protocol (an 18-guage IV typically provides the highest safety)
- Automated contrast injection using a dual-cylinder injector

Specific

- Recommended contrast media application: 90 cc iodinated contrast medium at 3.5 to 4 cc/sec (300mg/ml iodine contrast agent)
- Contrast bolus monitoring and timing of data acquisition by means of bolus tracking at the level of the ascending aorta with a region of interest placed within the ascending aorta; threshold set at 150 HU.

GE CARDIOGRAPHE CT

1. Scout

General

- Lateral and AP scout covering the thorax, abdomen and pelvis including the proximal femoral to the lesser trochanter

Data acquisition

- Start: Superior 2.5
- End: Inferior -627.5
- Tube current 50 mA
- Tube voltage: 80 kV
- ECG trace: On
- Scout Plane: Both Acquired Simultaneously
- Auto Voice (Breath hold command): Inspiration

Comment

Take note of the iso-centering. Table can be adjusted laterally to ensure all anatomy is in the 25FOV.

2. ECG-gated axial data acquisition of the aortic root/heart (Collection 1) followed by non-gated CTA of the thorax, abdomen, and pelvis (Collection 2).

Smart Prep

General

- Bolus tracking to automatically trigger the diagnostic scan acquisition based on the HU reading in the ROI reaching the prescribed enhancement threshold
- Slice location: approx 2 cm below the carina
- ROI location: Ascending aorta

Data acquisition

- Monitoring Delay: 07 sec
- Monitoring Inter Scan Delay: 1 sec
- Tube voltage: 100 kV
- Tube current: 60 mA
- Diagnostic Delay: Auto Minimum
- Enhancement Threshold: 150 HU

Comment

The effective ('diagnostic') delay between reaching the threshold and the start of the subsequent data acquisition (Collection 1) is the combined time comprising the length of the breath hold command (autovoice), the time needed for table movement and the subsequent pre-scan delay (pre-set delay time in Collection 1)

Collection 1 scan parameters - ECG-gated axial data acquisition of the aortic root/heart

General

- ECG-gated axial data acquisition of the aortic root and heart
- Scan range beginning 2 cm below the carina to the base of the heart
- Utilizing Arrhythmia Retriggering would be recommended to allow for irregular heart rate

Data acquisition

- Auto voice (Breath hold command): On (#1 – Suspension)
- Pre-set Delay Time: Set to Min Scan Delay.
- Post Voice Delay: Set to 7 sec to allow heartrate to lower.
- Scan Type: Cardiac
- Rotation Speed: 0.24 seconds
- SFOV: 25 cm
- DFOV: 25 cm
- Slice thickness: 0.5 mm
- Collimation: 140 mm
- Tube voltage: 100 kV
- Tube current: 500 mA
- Phase From 40% to 80%
- Recon Phase 75%
- ASiR-CV: 70%
- Widen for SSF

Data reconstruction

- Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhythm
- Slice Thickness: 0.5 mm
- Increment: 0.5 mm
- Iterative Reconstruction ASiR-CV: 70%
- Recon: CV Standard

GE CARDIOGRAPHE CT (CONT)

Collection 2 scan parameters – non-gated CTA of the thorax, abdomen, and pelvis

General

- Helical, non-gated acquisition
- Scan range: lung apices to the lesser trochanters of the femoral bone

Data acquisition

- Prep/Group Delay: Min Scan Delay
- Auto voice (Breath hold command): On (#1 – Suspension)
- Scan type: Axial
- SFOV: 25 cm
- Detector coverage: 140 mm
- Rotation Speed: 0.27 seconds
- Slice Thickness: 0.5 mm
- Tube voltage:
  ~ 100 kV for BMI <25 kg/m² -
  ~ 120 kV for BMI >25 kg/m²
- Tube current:
- 500 for BMI <25 kg/m
- 600 for BMI >25 kg/m
- Scan direction: cranio-caudal

Data reconstruction

- Slice Thickness: 1.0 mm
- Increment: 1.0 mm
- Iterative Reconstruction ASiR-CV 70%
- Recon: CV Standard
- Recon FOV 25 cm

Contrast application protocol

General

- Single contrast application for both the ECG-gated axial CTA of the aortic root/heart and the CTA of the thorax/abdomen/pelvis
- Triphasic administration protocol with pure contrast, followed by a contrast/saline mixture, followed by a saline chaser
- Placement of IV access per hospital protocol (an 18-guage IV typically provides the highest safety)
- Automated contrast injection using a dual-cylinder injector

Specific

- For normal weighted patients and an iodinated contrast agent with 300 mg/ml apply 30 ml contrast at 4.0 ml/sec, followed by 60 ml of 70% contrast/30% saline at 4.0 ml/sec, followed by 30 ml saline at 4.0 ml/sec; this results in a total amount of 72 ml total contrast agent (adjust for contrast agents with differing iodine concentrations)
- For large patients and an iodinated contrast agent with 300 mg/ml apply 40 ml contrast at 5.0 ml/ sec, followed by 80 ml of 70% contrast/30% saline at 5.0 ml/sec, followed by 30 ml saline at 5.0 ml/ sec; this results in a total amount of 96 ml total contrast agent (adjust for contrast agents with differing iodine concentrations)
- Bolus monitoring and timing of data acquisition by means of bolus tracking at the level of the ascending aorta with a region of interest placed within the ascending aorta; threshold set at 150 HU.

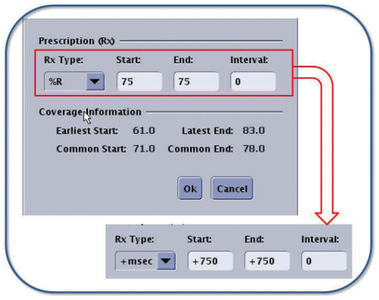
LOW CONTRAST DOSE PROTOCOL FOR 40mm DETECTOR FAMILY OF SCANNERS:

Options for consideration to optimize scan parameters when contrast volumes need to be minimized.

- Same scanner settings as listed above, except reduce threshold setting for bolus tracking (e.g. 80 HU)
- Reduce scan length of the retrospectively ECG-gated CTA to a minimum to cover only the aortic root as opposed to the entire heart, as this is the time-expensive part in regard to data acquisition
- Reduce total amount of contrast to 50-60 cc
- Injection rate should be lowered, but should at least be 3.5 cc/sec
- Threshold to trigger initiation of the retrospective ECG-gated spiral data acquisition can be lowered to 80 HU
- Use a lower kV such as 80 kV in thin patients
- These alterations should allow for a sufficiently contrast enhanced CT dataset of the aortic root. Contrast attenuation of the iliofemoral acquisition may be variable. Lowering kVp may help to maintain adequate opacification of the peripheral vessels

RECONSTRUCTION OF MULTIPHASIC DATA SET

Multiphase data should be reconstructed to enable evaluation of the aortic valve and aortic root throughout the entire cardiac cycle (e.g. in 10% intervals throughout the cardiac cycle). Although aortic root measurements are recommended in systole multiphase data sets allow for interrogation of other phases if systolic phases have degraded image quality (e.g. motion artifacts). Multiphase reconstruction: From the Prescription (Rx) screen, select the prescription type from the menu. Enter the Start phase/msec, End phase/msec, and Interval to reconstruct.



ABSOLUTE RECONSTRUCTIONS

Millisecond prescription for data reconstruction, i.e. reconstruction windows in fixed msec distances from the R-peak,may improve image quality in patients with irregular heart rates. An end-systolic target millisecond reconstruction range is +250 to +300 milliseconds at 25 msec intervals. Hovering the mouse on the ECG trace will indicate phase % and +/- millisecond location.

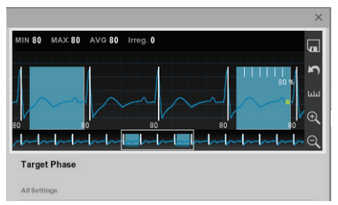
REVIEW OF DATA RECONSTRUCTION AND ECG-EDITING

- Image reconstructions of the aortic root and heart should be reviewed immediately after the scan when the raw data is still available
- The ECG-gating should be reviewed to ensure that the automated algorithms correctly identified the R-peaks

ECG EDITING ON REVOLUTION CT

It may be helpful to insert, remove, or move a trigger to normalize a heart cycle when a trigger occurs at an incorrect location. This may occur when abnormal ECG waveform patterns or excessive background noise are present during scan acquisition.

- Open the ECG-gated scan series in the Reconstruction and Image Processing area on the image monitor
- To [insert] a trigger, place the cursor at the intended position on the ECG trace (right-click to “Insert R-peak Trigger”). An additional trigger will display on the ECG trace
- To [delete] a trigger point on the ECG trace, place the cursor on the trigger and right-click “Delete R-peak Trigger”.
- To [move] a trigger, place the cursor over the trigger and click and drag it to the new location
- To switch to a second heartbeat when repeat acquisition is used; place the cursor in the ECG Editor, right-click and select “Switch Scan”. The reconstruction window toggles to the other scan

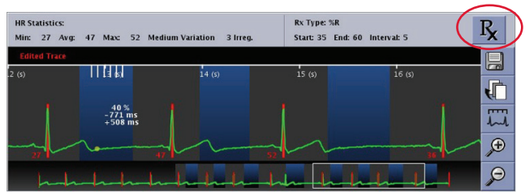


ECG EDITING ON REVOLUTION HD, REVOLUTION EVO, OPTIMA 660, DISCOVERY CT750 HD and LIGHTSPEED VCT SCANNER PLATFORMS

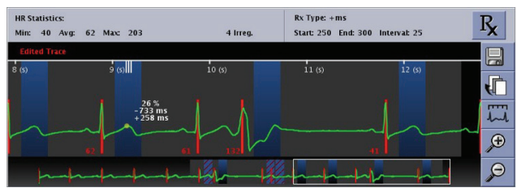
Cardiac Helical exams allow for image reconstruction at any point in the RR-interval as image data was acquired throughout the entire cardiac cycle using retrospective ECG-gating. The ECG editor provides the ability to move or reposition the reconstruction window.

In the ECG Editor click the "Rx" icon for the global phase prescription method, i.e. the entered phase values are applied to all available heart cycles.

Global phase prescription allows selecting the phases of the cardiac cycle from which images are created. The blue highlighted areas represent the recon windows for each available RR-interval. The example below displays a reconstruction window ranging from 35 to 60% of the RR-interval. Gray areas represents x-ray exposure/available image data within the exam.



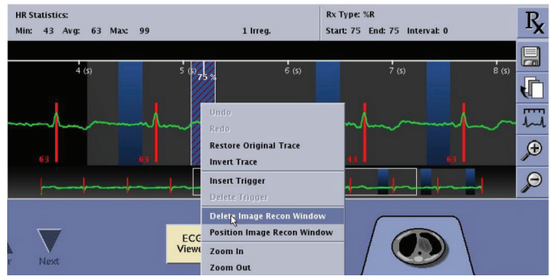
ECG-editing: If R-peaks of the ECG trace were not correctly identified by the trigger points, the trigger points need to be corrected along the ECG trace: Insert, remove, or move a trigger to normalize a heart cycle when a trigger occurs at an undesirable location.

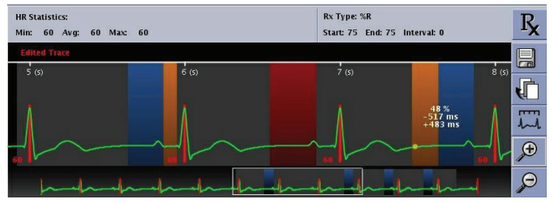


- To [insert] a trigger, place the cursor at the intended location along the ECG trace (right-click "Insert Trigger"). An additional trigger point (red line) appears on the ECG trace
- Following insertion of a trigger point, a recon window needs to be added (right-click "Add Recon Window"). Confirm that the recon window is in the desired location before confirming image reconstruction
- To [delete] a trigger point on the ECG trace, place the cursor on the trigger (red line), right-click "Delete Trigger"
- To [move] a trigger, place the cursor over the trigger and click and drag it to the desired location

Deleting a trigger affects the position of reconstruction windows in adjacent RR-intervals, when relative reconstructions (%) are employed. In contrast "Delete Image Recon Window" retains the trigger point while image data following the selected trigger point does not contribute to image reconstruction, thus not affecting adjacent RR-intervals. This approach may be employed to improve image quality, e.g. in cases of premature contractions or atrial fibrillation with extremely variable heart rates.

- Place the cursor in the blue image reconstruction window in the ECG editor, right click "Delete Image Recon Window"





- An orange (relaxed phase) or red (ungated) area appears on the trace if reconstruction window removal results in insufficient z-axis overlap to create gated images in order to compensate for the removed recon window. Relaxed phase reconstruction windows indicate where relaxed phase reconstruction images will be created. The images are reconstructed as close to the requested phase as possible, with a maximum of a 20% phase offset

In contrast to the global phase prescription across all RR-intervals, reconstruction windows can also be moved manually. Manually move or adjust recon window of one or more heart cycles, e.g. in setting of varying heart rates.

Always review the images created from the edit ECG Trace process. Editing the trace changes the reconstruction using the original scan data.

References

1. Achenbach S, Delgado V, Hausleiter J, et al. SCCT expert consensus document on computed tomography imaging before transcatheter aortic valve implantation (TAVI)/transcatheter aortic valve replacement (TAVR). J Cardiovasc Comput Tomogr 2012;6(6)366-380.
2. Blanke P, Bulla S, Baumann T, et al. Thoracic Aorta: Prospective Electrocardiographically Triggered CT Angiography with Dual-Source CT--Feasibility, Image Quality, and Dose Reduction. Radiology 2010;255(1):207-217.
3. Blanke P, Russe M, Leipsic J, et al. Conformational Pulsatile Changes of the Aortic Annulus. JACC Cardiovasc Imaging 2012;5(9):984-994.
4. Blanke P, Schoepf UJ, Leipsic J. CT in Transcatheter Aortic Valve Replacement. Radiology 2013;269(3):650-669.
5. Gurvitch R, Wood DA, Leipsic J, et al. Multislice Computed Tomography for Prediction of Optimal Angiographic Deployment Projections During Transcatheter Aortic Valve Implantation. JACC Cardiovasc Imaging 2010;3(11):1157-1165.
6. Leipsic J, Gurvitch R, LaBounty TM, et al. Multidetector Computed Tomography in Transcatheter Aortic Valve Implantation. JACC Cardiovasc Imaging 2011;4(4):416-429.
7. Litmanovich DE, Ghersin E, Burke DA, et al. Imaging in Transcatheter Aortic Valve Replacement (TAVR): role of the radiologist. Insights Imaging 2014; 5:123-145.

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