CT Acquisition and Reconstruction Techniques for Transcatheter Aortic Valve Procedure Planning Utilizing Canon Medical Systems

WRITTEN IN COLLABORATION WITH:



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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) is 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 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 that 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

- Position the patient, typically supine, on the scanner table to closely resemble catheterization table positioning. This is important for the prediction of C-arm angulation from the CT dataset.
- Place ECG-electrodes and IV access in accordance with institutional policies.
- Provide time for the patient to practice the breath hold prior to scan acquisition, as it may significantly improve patient compliance and thereby scan quality.
- Plan additional scanning and instruction time as needed, due to the advanced age and frailty of this patient population.

CT Scan – Scan Length and Scan Strategy

In general, three different approaches are used to combine the ECG–assisted data acquisition of the aortic root structures and the non-ECG-assisted computed tomography angiography (CTA) of the aorto/ilio/ femoral vasculature for evaluation of the transfemoral access route-

- 1) Systems without variable helical pitch (vHP). Cardiac ECG–assisted data acquisition of the heart and aortic root (usually beginning 2 cm below the carina) 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 is kept to a minimum to aid in limiting the contrast dose. Furthermore, limiting the ECG-assisted acquisition range also limits the radiation dose intensive component of the examination, although the cardiac scan range is covered twice. The proposed protocols for the Aquilion ONE Vision/Genesis/PRISM, the Aquilion PRIME SP, Aquilion PRIME and Aquilion 64/VeloCT 128 Families without variable helical pitch (vHP) use this approach.
- 2) Systems utilizing 2 phase variable helical pitch (vHP 2). ECG–assisted data acquisition of the thorax transitions to a non-ECG assisted CTA of the abdomen and pelvis. With this method, the thorax is ECGassisted. Limit the ECG-assisted range to the necessary anatomy to reduce breath hold time for the patient and likelihood of breathing artifact. The proposed protocols for the Aquilion ONE Vision/Genesis/ PRISM, the Aquilion PRIME SP, Aquilion PRIME and Aquilion 64/VeloCT 128 Families utilizing 2 phase variable helical pitch (vHP 2) use this approach.
- 3) Systems utilizing 3 phase variable helical pitch (vHP 3). Non-ECG-assisted CTA of the upper thorax to 2 cm below the carina, transitioning to ECG-assisted cardiac CTA, transitioning to a non-ECG assisted CTA of the abdomen and pelvis. With this method, limit the ECG-assisted range for the fastest acquisition time. Furthermore, limiting the ECG-assisted acquisition range also limits the radiation dose intensive component of the examination. The proposed protocols for the Aquilion ONE Vision/Genesis/PRISM, the Aquilion PRIME SP, and Aquilion PRIME utilizing 3 phase variable helical pitch (vHP 3) use this approach.

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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: Igorithms/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

Canon Medical Systems - Aquilion ONE 640/Aquilion ONE ViSION / GENESIS / PRISM without variable helical pitch (vHP)

1. Scanogram						
 General AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter 	 Data acquisition AP Scanogram – 120 kVp/50 mA LAT Scanogram – 120 kVp/100 mA 					
2. Non–enhanced scan (optional) – Calcium Score						
 General Can be used for quantification of annular calcification Can be used for planning of subsequent contrast – enhanced data acquisition Volume data can be acquired as a single–beat/one rotation scan 	 Data acquisition Acquisition mode – Ca Score Volume Mode Tube voltage – 120 kVp Tube current – ^{SURE}Exposure R–R Scanning Window – HR<71 bpm (75%); HR>71 bpm (40%) (determined by scanner) Slice/Collimation – 0.5/240 (120 mm) Rotation time – Aquilion ONE 640 / GENESIS 640 – 350 msec Aquilion ONE VISION / GENESIS / PRISM – 275 msec 	 Data reconstruction Field of View limited to the heart (220 mm) Thick Axial Reconstructions required Slice Thickness – 3 mm Slice Interval – 3 mm SUREIQ – Ca Score (FC 12) 				
3. S&V Scan and View						
 General Plan location of ^{SURE}Start on AP Scanogram view – center of volume Place region of interest (ROI) within the descending aorta 	Data acquisition (manufacturers' default settings) • Delay – 0 seconds • Tube current – 50 mA • Tube voltage – 100 kV • Slice/Collimation – 0.5 mm x4 • Rotation Time – Aquilion ONE 640 / GENESIS 640 – 350 msec Aquilion ONE VISION / GENESIS – 275 msec					
4. Bolus tracking – ^{SURE} Start						
 General Same location as #3 Threshold– 300 HU 	Data acquisition (manufacturers' default settings) Delay – 10 seconds Tube current – 50 mA Tube voltage – 100 kVp Slice/Collimation – 0.5 mm x4 Rotation Time – Aquilion ONE 640 / GENESIS 640 – 350 msec Aquilion ONE VISION / GENESIS – 275 msec					

- Cycle time/repetition 2 second intermittent interval
- Voice timing 18 seconds

Canon Medical Systems - Aquilion ONE 640/Aquilion ONE ViSION / GENESIS / PRISM without variable helical pitch (vHP) (continued)

5. ECG-assisted cardiac data acquisition - Contrast enh

General

- ECG–assisted data acquisition of the aortic root and heart as a single beat/one rotation scan
- Plan volume acquisition on scanogram view – Scan range beginning 1 cm below the carina to the apex of the heart
- Use unenhanced CaSc CT data for planning if available
- C-FOV must match helical CTA

starts immedia acquisition)

- Breath hold co Inspiration onl initiated with set in ^{SURE}Start beginning of c
- Tube voltage -• Tube current – (automatically current based
- Target mode se exposure wind msec will ensu exposure time based upon HF beat/one rotat
- Slice/Collimati based upon de (0.5x240/0.5x2
- Rotation time Aquilion ONE 6 – 350 msec
 - Aquilion ONE PRISM
 - 275 msec

6. CTA of the thorax/abdomen/pelvis - Contrast enhance

General

- Scan range Upper thoracic aperture to the proximal femoral (lesser trochanter)
- C-FOV must match volume scan
- Data acquisition • Delay – 6.4 sec delay needed t scanner table a non-gated acc
- No additional hold command manual instruc exhale
- Tube voltage -
- Tube current (automatically current based
- Slice/Collimati
- Scan direction
- Pitch Standar
- Rotation time
- Aquilion ONE – 350 msec
- Aquilion ONE
 - PRISM
 - 275 msec

on – Contrast enhanced	
 Data acquisition No delay after bolus monitoring has reached threshold (system starts immediately with data acquisition) Breath hold command – Inspiration only (Breath command initiated with Voice HU threshold set in ^{SURE}Start at 18 seconds after beginning of contrast injection) Tube voltage – 100 kVp Tube current – ^{SURE}Exposure (automatically selects the tube current based on the patient size) Target mode set to 50% and exposure window set to 1000 msec will ensure full R–R scan. The exposure time can be adjusted based upon HR. This is a single beat/one rotation scan Slice/Collimation – Configured based upon desired scan range (0.5x240/0.5x280/0.5x320) Rotation time – Aquilion ONE 640 / GENESIS 640 – 350 msec Aquilion ONE ViSION / GENESIS / PRISM – 275 msec 	
 - Contrast enhanced Data acquisition Delay – 6.4 seconds (minimum delay needed to reposition scanner table and continue with non–gated acquisition) No additional automated breath hold command; alternatively manual instruction to slowly exhale Tube voltage – 100 kVp Tube voltage – 100 kVp Tube current – ^{SURE}Exposure (automatically selects the tube current based on the patient size) Slice/Collimation – 0.5 mm x 100 Scan direction – Cranio–caudal Pitch – Standard Rotation time – Aquilion ONE 640 / Genesis 640 – 350 msec Aquilion ONE ViSION / GENESIS / PRISM – 275 msec 	Data reconstruction • Slice thickness – 1.0 mm • Increment – 0.8 mm • SUREIQ – CTA Body FC 08 • Iterative reconstruction – AIDR 3D

Canon Medical Systems - Aquilion ONE 640/Aquilion ONE ViSION / GENESIS / PRISM without variable helical pitch (vHP) (continued)

Contrast application protocol

General

- Single contrast administration for both the ECGassisted as a single beat/one rotation scan of the aortic root/heart and the CTA of the thorax/abdomen/pelvis
- Placement of IV access per institutional protocol (an 18-guage IV typically provides the highest safety)
- Automated contrast injection using a dual-cylinder injector

Specific

- Recommended contrast media application 50–90 cc iodinated contrast medium at 4 cc/sec
- Contrast bolus monitoring and timing of data acquisition by means of bolus tracking at the level of the descending aorta with an ROI placed within the descending aorta; threshold set at 250 HU

Data reconstruction

(220 mm)

required

• Field of View limited to the heart

Thick Axial Reconstructions

Slice Thickness – 3 mm

Slice Interval – 3 mm

• ^{SURE}IQ – Ca Score (FC 12)

Recommendations for a Low-Contrast Protocol

- Use lower range of total amount of contrast (50 cc) •
- Place ROI for bolus tracking (SUREStart) in descending aorta •
- A threshold of 250 HU ensures a contrast attenuation of at least 250 HU in the aortic root, however with 50 cc of • contrast, attenuation of the non-gated scan may be variable

Canon Medical Systems – Aquilion ONE 640/Aquilion ONE VISION / GENESIS /PRISM, Aquilion Prime SP and Prime with 2-Phase Variable Helical Pitch (vHP 2 Optional)

1. Scanogram

General

Data acquisition

- AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter
- AP Scanogram 120 kVp/50 mA
- LAT Scanogram 120 kVp/100 mA

2. Non-enhanced scan (optional) – Calcium Score

General

• Can be used for quantification of annular calcification

subsequent contrast-enhanced

• Can be used for planning of

Data acquisition

- Wide–Volume Scan mode
- Tube voltage 120 kVp
- Tube current ^{SURE}Exposure
- R-R Scanning Window -HR<71 bpm (75%)-HR>71 bpm (40%)
- Slice/Collimation (0.5 x 80)
- Rotation time 350 msec

3. S&V Scan and View

General • Plan location of SUREStart on AP Scanogram view – 1 cm below carina

 Place region of interest (ROI) within the descending aorta

Data acquisition (manufacturers' default settings) • Delay – 0 seconds

- Tube current 50 mA
- Tube voltage 100 kV
- Slice 0.5 mm x 4
- Rotation Time 350 msec

Canon Medical Systems – Aquilion ONE 640/Aquilion ONE VISION / GENESIS /PRISM, Aquilion Prime SP and Prime with 2-Phase Variable Helical Pitch (vHP 2 Optional) (continued)

4. Bolus tracking – ^{SURE} Sta	t		
General • Same location as #3 • Threshold – 180 HU	Data acquisition (manufacturers' d • Delay – 10 secon • Tube current – 5 • Tube voltage – 1 • Slice/Collimatio • Rotation Time – • Intermittent cyce interval	nds 50 mA 00 kVp n – 0.5 mm x 4 350 msec	
5. ECG–gated thoracic da Contrast enhanced	a acquisition and non-gated d	ata acquisition of th	e abdomen and pelvis –
 General Utilize vHP (optional sc on Aquilion ONE and P of CT scanners) Allows for one helical sc one breath hold combin gated thoracic and non abdominal/pelvic data a Plan helical scan from a of the lung to the femore trochanter The retrospectively ECC helical range can be set details. ECG-gated show above lung apices and t Non-ECG assisted acqui apex of the heart 	ME family n/ ng gated cquisition ove apices l lesser gated the scan d start ansition to	itoring has reached conds nmand – 00 kVp d anatomical dose REExposure XYZ ctively ECG gated n – 0.5 mm x 80 350 msec	 Data reconstruction Axial multiphasic reconstruction covering the entire cardiac cycle in 5% or 10% intervals Use ECG editing if necessary Field of View limited to the heart (220 mm) Slice thickness – 0.5 mm Increment – 0.3 mm ^{SURE}IQ – Cardiac CTA (FC 03) Iterative reconstruction – AIDR 3D
	 Abdominal/Pelvic Tube voltage– 1 Tube current an modulation – ^{SU} Modulation Slice/Collimatio Scan direction – Pitch – Standarc Rotation time – 	00 kVp d anatomical dose ^{RE} Exposure XYZ n – 0.5 mm x 80 Cranio–caudal	 Data reconstruction Slice thickness – 1.0 mm Increment – 0.8 mm ^{SURE}IQ – CTA Body FC 08 Iterative reconstruction – AIDR 3D CTA 75% Phase
Contrast application pro	ocol		
 ECG–gated CTA of the active the thorax/abdomen/pe Placement of IV access 18–gauge IV typically p 	n for both the retrospectively tic root/heart and the CTA of vis er institutional protocol (an ovides the highest safety) ction using a dual–cylinder	 iodinated contra- Contrast bolus r acquisition by m the descending 	contrast media application – 90 cc ast medium at 4 cc/sec nonitoring and timing of data neans of bolus tracking at the level of aorta with an ROI placed within the ta; threshold set at 180 HU

Canon Medical Systems – Aquilion ONE 640/Aquilion ONE VISION / GENESIS /PRISM, Aquilion Prime SP and Prime with 3-Phase Variable Helical Pitch (vHP 3 Optional)

5. ECG-gated thoracic data acquisition and non-gated data acquisition of the abdomen and pelvis 1. Scanogram **Contrast enhanced** General Data acquisition General • AP/LAT Scanogram covering the • AP Scanogram – 120 kVp/50 mA • Utilize vHP (optional scan mode thorax, abdomen, and pelvis on Aquilion ONE and PRIME family LAT Scanogram – 120 kVp/100 mA including the proximal femoral to of CT scanners) the lesser trochanter • Allows for one helical scan/one breath hold combining non-gated upper thoracic, gated cardiac and 2. Non-enhanced scan (optional) - Calcium Score non-gated abdominal/pelvic data acquisition Data acquisition Data reconstruction General Plan helical scan from above apices of the lung to the femoral lesser • Can be used for quantification of • Wide–Volume Scan mode • Field of View limited to the heart trochanter annular calcification • Tube voltage – 120 kVp (220 mm) Set a non-ECG-assisted range from • Can be used for planning of • Tube current – ^{SURE}Exposure Thick Axial Reconstructions the apices of the lungs to 1cm subsequent contrast-enhanced required • R-R Scanning Window below the carina, transitioning HR<71 bpm (75%) – Slice Thickness – 3 mm there to a retrospectively ECG-HR>71 bpm (40%) Slice Interval – 3 mm gated cardiac. ECG-gated range • Slice/Collimation – (0.5 x 80) • ^{SURE}IQ – Ca Score (FC 12) can be set to transition at the apex Rotation time – 350 msec of the heart to a non-ECG assisted acquisition of the abdomen and pelvis 3. S&V Scan and View General Data acquisition (manufacturers' default settings) • Plan location of ^{SURE}Start on AP Scanogram view – 1 cm below • Delay – 0 seconds carina • Tube current – 50 mA Place region of interest (ROI) • Tube voltage – 100 kV within the descending aorta • Slice/Collimation – 0.5 mm x 4 • Rotation Time – 350 msec **Contrast application protocol** 4. Bolus tracking – ^{SURE}Start General • Single contrast application for both the retrospectively General Data acquisition ECG-gated CTA of the aortic root/heart and the CTA of (manufacturers' default settings) • Same location as #3 the thorax/abdomen/pelvis • Delay – 10 seconds Threshold – 180 HU Placement of IV access per institutional protocol (an • Tube current – 50 mA 18–gauge IV typically provides the highest safety) • Tube voltage – 100 kVp Automated contrast injection using a dual-cylinder • Slice/Collimation – 0.5 mm x 4 injector • Rotation Time – 350 msec

Intermittent cycle – 2 second

interval

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Canon Medical Systems – Aquilion ONE 640/Aquilion ONE VISION / GENESIS /PRISM, Aquilion Prime SP and Prime with 3-Phase Variable Helical Pitch (vHP 3 Optional) (continued)

ii and non-gated data acquisition of th	e abdomen and peivis –
 Thoracic Data acquisition Delay after monitoring has reached threshold – 4 seconds Breath hold command – Inspiration only Tube voltage – 100 kVp Tube current and anatomical dose modulation – ^{SURE}Exposure XYZ Modulation Helical retrospectively ECG gated mode using vHP Slice/Collimation – 0.5 mm x 80 Rotation time – 350 msec Pitch– Cardiac (automatically set by ^{SURE}Cardio) 	 Data reconstruction Axial multiphasic reconstruction covering the entire cardiac cycle in 5% or 10% intervals Use ECG editing if necessary Field of View limited to the heart (220 mm) Slice thickness – 0.5 mm Increment – 0.3 mm ^{SURE}IQ – Cardiac CTA (FC 03) Iterative reconstruction – AIDR 3D
 Abdominal/Pelvic Data acquisition Tube voltage- 100 kVp Tube current and anatomical dose modulation - ^{SURE}Exposure XYZ Modulation Slice/Collimation - 0.5 mm x 80 Scan direction - Cranio-caudal Pitch - Standard Rotation time - 350 msec 	Data reconstruction • Slice thickness – 1.0 mm • Increment – 0.8 mm • SUREIQ – CTA Body FC 08 • Iterative reconstruction – AIDR 3D • CTA 75% Phase

Specific

- Recommended contrast media application 90 cc iodinated contrast medium at 4 cc/sec
- Contrast bolus monitoring and timing of data acquisition by means of bolus tracking at the level of the descending aorta with an ROI placed within the descending aorta; threshold set at 180 HU

Canon Medical Systems – Aquilion Prime without variable Helical Pitch (vHP)

anon Medical Systems – Aquilion Pri	me without variable Helical Pitch (vHP)		Canon Medical Systems – Aquilion F	rime without variabl	e Helical Pitch (vHP)(continued)
1. Scanogram			5. ECG-gated data acquisition of th	e aortic root/heart		
 General AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter 	 Data acquisition AP Scanogram – 120 kVp/50 mA LAT Scanogram – 100 kVp/20 mA 		 General Retrospectively ECG–gated helical acquisition of the aortic root and heart. 	 ECG-gated Data a aortic root and he Delay after mon threshold – 4 se Breath hold cor Inspiration only 	eart itoring has reached econds nmand –	 Data reconstruction Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhythm Use ECG editing if necessary Field of View limited to the heart
2. Non–enhanced scan (optional) – Calcium Score			• Tube voltage – 1	 Tube voltage – 100 kVp Tube current and anatomical dose 	(220 mm)	
 General Can be used for quantification of annular calcification Can be used for planning of subsequent contrast–enhanced data acquisition 	 Data acquisition Acquisition mode – Wide – Volume Scan Mode Tube voltage – 120 kVp Tube current – ^{SURE}Exposure R–R Scanning Window– HR<71 bpm (75%); HR>71 bpm (40%) 	 Data reconstruction Field of View limited to the heart (220 mm) Thick Axial Reconstructions required. Slice Thickness – 3.0 mm Slice Interval – 3.0 mm SUREIQ – Ca Score (FC12) 		 Hube current and modulation – ^{su} Modulation Helical retrospetence mode Slice/Collimation Rotation time – Pitch – Cardiaction 	REExposure XYZ ective ECG Gated on – 0.5 mm x 80 - 350 msec	 Slice thickness – 0.5 mm Increment – 0.3 mm ^{SURE}IQ – Cardiac CTA (FC 03) Iterative reconstruction – AIDR 3D
	 Slice/Collimation – (0.5 x 80) Rotation time– 350 msec 		6. CTA of the thorax/abdomen/pelv	ris – Contrast enhance	ed	
	· Kotation time 550 misee		 General Non–gated data acquisition of the thorax, abdomen, and pelvis 	Delay prior to see	can scans –	 Data reconstruction Slice thickness – 1.0mm Increment – 0.8 mm
3. S&V Scan and View			immediately following the prior data acquisition		imum delay needed anner and continue	 SUREIQ – CTA Body (FC 08) Iterative reconstruction – AIDR 3D
 General Plan location of ^{SURE}Start on AP Scanogram view – 1 cm below carina Place ROI within the descending aorta 	Data acquisition (manufacturers' default settings) • Delay – 0 seconds • Tube current – 50 mA • Tube voltage – 100 kV • Slice/Collimation – 0.5 mm x 4 • Rotation Time – 350 msec			 No additional a hold command manual instruct Tube voltage – 1 Tube current an modulation – ^{su} Modulation 	utomated breath ; alternatively tion to slowly exhale 100 kVp d Anatomical dose REExposure XYZ	
4. Bolus tracking – ^{SURE} Start				 Pitch – Standard Rotation time – 		
General Same location as #3 	Data acquisition (manufacturers' default settings)		Contrast application protocol			
• Threshold – 180 HU	 Delay– 10 seconds Tube current – 50 mA Tube voltage – 100 kVp Slice/Collimation – 0.5 mm x 4 Rotation Time – 350 msec Cycle time/repetition – 2 second intermittent interval 		 General Single contrast application for bot ECG–gated CTA of the aortic root/ the thorax/abdomen/pelvis Placement of IV access per institut (an 18–guage IV typically provides) Automated contrast injection using injector 	neart and the CTA of ional protocol the highest safety)	 iodinated contra- Contrast bolus r acquisition by m the descending 	contrast media application – 80 – 100 co ast medium at 4 cc/sec nonitoring and timing of data leans of bolus tracking at the level of aorta with an ROI placed within the a; threshold set at 180 HU

Canon Medical Systems – Aquilion Prime without variable Helical Pitch (vHP) (continued)

Canon Medical Systems - Aquilion 64 and Aquilion VeloCT 128 with vHP

General	Data acquisition	
• AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter	 AP Scanogram – 120 kVp/50 mA LAT Scanogram – 120 kVp/100 mA 	
2. Non–enhanced scan (optional) – C	alcium Score	
General	Data acquisition	Data reconstruction
 Can be used for quantification of annular calcification Can be used for planning of subsequent contrast–enhanced data acquisition 	 Acquisition mode – Scan & Scan (sequential mode) Tube voltage – 120 kVp Tube current – 300 mA (Aquilion 64), ^{SURE}Exposure (VeloCT 128) R–R Scanning Window – HR<71 bpm (75%); HR>71 bpm (40%) Slice/Collimation – 3.0 mm x 4 Rotation time – 400 msec, 350 msec (optional) 	 Field of View limited to the heart (220mm) Thick Axial Reconstructions required. Slice Thickness – 3.0 mm Slice Interval – 3.0 mm ^{SURE}IQ – Ca Score (FC12)
3. S&V Scan and View		
 General Plan location of ^{SURE}Start on AP Scanogram view – 1 cm below carina Place region of interest (ROI) within the descending aorta 	 Data acquisition (manufacturers' default settings) Delay – 0 seconds Tube current – 50 mA Tube voltage – 100 kV Slice/Collimation – 0.5 mm x 4 Rotation time – 400 msec (350 msec optional) 	
4. Bolus tracking – ^{sure} Start		
 General Same location as #3 Threshold – 180 HU 	 Data acquisition (manufacturers' default settings) Delay – 10 seconds Tube current– 50 mA Tube voltage – 100 kVp Slice/Collimation – 0.5 mm x 4 Rotation time – 400 msec (350 msec optional) Cycle time/repetition – 2 second intermittent interval 	

Canon Medical Systems – Aquilion 64 and Aquilion VeloCT 128 with vHP (continued)

5. ECG-gated thoracic data acquisition and non-gated of Contrast enhanced

General

- Utilize Variable Helical Pitch (vHP) vHP is an optional scan mode on Aquillion 64 and Aquilion VeloCT 128 CT scanners.
- Allows for one helical scan/one breath hold combining gated/ non-gated data acquisition.
- Plan helical scan from above apices to below ischium. The retrospectively ECG-gated helical acquisition should be set to start above lung apices to below apex of the heart
- Modulation (V Helical retrosp
- mode using vH
 - Slice/Collimati
 - Rotation time 350 msec (opt
 - Pitch Cardiac

6. Contrast enhanced ECG–assisted cardiac data acquisi

General

Abdominal/Pelvi

- Non–gated data acquisition of the • Tube voltage – thorax, abdomen, and pelvis • Tube current a dose modulati XYZ Modulatio Slice/Collimati • Scan direction • Pitch – Standar
 - Rotation time

Canon Medical Systems - Aquilion 64 AND Aquilion VeloCT 128 without vHP

1. Scanogram	
 General AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter 	 Data acquisition AP Scanogram – 120 kVp/50 mA LAT Scanogram – 120 kVp/100 mA

n and non–gated data acquisition of th	e abdomen and pelvis –
 Thoracic Data acquisition Delay after monitoring has reached threshold – 4 seconds. Breath hold command – Inspiration only Tube voltage – 100 kVp Tube current – fixed tube current adjusted to BMI, e.g 400 mA (Aquilion 64), ^{SURE}Exposure XYZ Modulation (VeloCT 128) Helical retrospective ECG Gated mode using vHP Slice/Collimation – 0.5 x 64 Rotation time – 400 msec, 350 msec (optional) Pitch – Cardiac (Set by ^{SURE}Cardio) 	 Data reconstruction Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhythm Use ECG editing if necessary Field of View limited to the heart Slice thickness – 0.5 mm Increment – 0.25 mm ^{SURE}IQ-Cardiac CTA FC 03 (VeloCT 128), FC 43 (Aquilion 64) Quantum De–noising Software (QDS +) (Aquilion 64) Boost 3D (Aquilion 64) Iterative reconstruction – AIDR 3D (VeloCT 128)
 Abdominal/Pelvic Data acquisition Tube voltage – 100 kVp Tube current and Anatomical dose modulation – ^{SURE}Exposure XYZ Modulation Slice/Collimation – 0.5x64 Scan direction – Cranio–caudal Pitch – Standard Rotation time – 350 msec 	 Data reconstruction Slice thickness thin – 1.0 mm Increment – 0.8 mm ^{SURE}IQ – CTA Body FC 08 Quantum De–noising Software (QDS +) (Aquilion 64) Boost 3D (Aquilion 64) Iterative reconstruction – AIDR 3D (VeloCT 128) 75% phase

Canon Medical Systems – Aquilion 64 AND Aquilion VeloCT 128 without vHP

1. Scanogram			5. ECG–gated data acquisition of the	aortic root/heart –	Contrast enhanced		
 General AP/LAT Scanogram covering the thorax, abdomen, and pelvis including the proximal femoral to the lesser trochanter 	 Data acquisition AP Scanogram – 120 kVp/50 mA LAT Scanogram – 120 kVp/100 mA 		 General Retrospectively ECG–gated helical acquisition of the aortic root and hear 	 Thoracic Data acq Delay after mon threshold – 0 se Breath hold con Inspiration only Tube voltage 10 	nitoring has reached conds nmand –	 Data reconstruction Axial multiphasic reconstruction covering the entire cardiac cycle, 5% or 10% intervals in sinus rhyth Use ECG editing if necessary Field of View limited to the heart 	
2. Non–enhanced scan (optional) – Calcium Score		•	adjusted to BMI	• Tube current – fixed tube current adjusted to BMI, e.g. 400mA	 Slice thickness – 0.5 mm Increment – 0.5 mm 		
 General Can be used for quantification of annular calcification Can be used for planning of subsequent contrast–enhanced data acquisition 	calcification used for planning of ent contrast-enhanced uisition(sequential mode) • Tube voltage – 120 kVp • Tube current – 300 mA Aquilion 64), SUREExposure (VeloCT 128) • R-R Scanning Window –(220 mm) • Thick Axial Reconstructions required. Slice Thickness – 3.0 mm	 Field of View limited to the heart (220 mm) Thick Axial Reconstructions required. Slice Thickness – 3.0 mm Slice Interval – 3.0 mm 		 (Aquilion 64), ^{SURE}Exposure XYZ Modulation (VeloCT 128) Helical retrospective ECG-gated mode Slice/Collimation – 0.5 mm x 64 Rotation time – 400 msec (350 msec optional) Pitch – Cardiac (set by ^{SURE}Cardio) 		SUREIQ – Cardiac CTA FC 43 (Aquilion 64), FC 03 (VeloCT 128) • Quantum De–Noising Software	
	 HR>71 bpm (40%) Slice/Collimation – 3.0 mm x 4 	• ^{SURE} IQ – Ca Score (FC 12)	6. Contrast enhanced ECG–assisted of	ardiac data acquisit	ion		
	 Rotation time – 400 msec (350 msec optional) 		 General Non–gated data acquisition of the thorax, abdomen, and pelvis 	 Abdominal/Pelvic Delay between as possible 	•	 Data reconstruction Slice thickness – 1.0 mm Increment – 0.8 mm 	
 3. S&V Scan and View General Plan location of ^{SURE}Start on AP Scanogram view – 1 cm below carina Place ROI within the descending aorta 	Data acquisition (manufacturers' default settings) • Delay – 0 seconds • Tube current – 50 mA • Tube voltage – 100 kV • Slice/Collimation – 0.5 mm x 4 • Rotation time – 400 msec			 Tube voltage – 1 Tube current an dose modulation XYZ Modulation Slice/Collimation Scan direction – Pitch– Standard Rotation time – (350 msec option) 	d Anatomical on – ^{SURE} Exposure on – 0.5 mm x 64 - Cranio–caudal l 400 msec	 SUREIQ – CTA Body FC 08 Quantum De–Noising Software (QDS +) Boost 3D Iterative reconstruction – AIDR 3 (VeloCT 128) 	
	(350 msec optional)		Contrast application protocol				
 4. Bolus tracking – ^{SURE}Start General Same location as #3 Threshold – 180 HU 	Data acquisition (manufacturers' default settings) • Delay – 0 seconds • Tube current – 50 mA • Tube voltage – 100 kV • Slice/Collimation – 0.5 mm x 4 • Rotation time – 400 msec (350 msec optional)		 ECG–gated CTA of the aortic root/he the thorax/abdomen/pelvis Placement of IV access per institution 18–guage IV typically provides the literation of the second secon	 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 institutional protocol (an 18–guage IV typically provides the highest safety) Automated contrast injection using a dual–cylinder Recommended contrast media iodinated contr		monitoring and timing of data neans of bolus tracking at the level of aorta with an ROI placed within the	

Canon Medical Systems – Aquilion 64 AND Aquilion VeloCT 128 without vHP (continued)

Recommendations for a Low–Contrast Protocol

- Use reduced amount of contrast material (e.g. 50 60 cc)
- Place ROI for bolus tracking (SUREStart) in ascending aorta as this decreases the delay between contrast administration/arrival to the start of the data acquisition
- Reduce threshold for bolus tracking to 160 HU
- Limit the Z axis coverage of the ECG–gated data acquisition to the aortic root, as this is the time–intensive part of the examination (due to the low pitch value for ECG–gated data acquisition)
- This approach should allow for sufficient contrast attenuation of the aortic root, however contrast attenuation of the non–gated scan may be variable

Reconstruction of Multiphasic Data Set

Multiphasic ('dynamic', 'cine') data sets can be reconstructed using a relative approach (percentage intervals [% between two R–peaks) or an absolute approach (fixed distance of the reconstruction window form the R–peak, reported as [msec]).

For retrospectively ECG–gated CT data, the relative approach (e.g. 5% or 10% intervals) performs well in regular sinus rhythm. In case of increased heart rate variability, atrial fibrillation, or ectopic beats, absolute reconstruction should be employed in combination with ECG – editing if necessary.

Cardiac	Slice Thickness	Slice Interval	Start Position	End Position	Application Type
Stent	0.5	0.3	41.5	601.0	CARDIAC CFA
			(41.5)	(601.1) Center	Series
Gating ON		Recon Mode	D-FOV	X,Y	Description
		Segment	320.3 (L)	252,256	
Transfer OFF	Cardiac Phase From 0	CTA ()	CFA Phas	eXact	# of Images 37320
		10 95	Step 5		51520



Relative Reconstruction settings in 5% intervals

Absolute Reconstruction settings in 50 ms intervals

Review of Data Reconstruction and ECG-Editing

- Image reconstructions of the aortic root and heart should be reviewed immediately after the scan when raw data is still available
- The ECG–gating should be reviewed to ensure that the automated algorithms correctly identified the R–peaks
- If R-peaks were not correctly identified, manual correction should be performed (e.g. add an R-peak if an R-peak was not identified, or delete an R- peak if an R-peak was placed on anything other than the R-peak; alternatively R-peaks can be shifted manually)
- In case of ectopic contractions, absolute reconstruction should be used and the R-peak of the ectopic beat should be deleted



ECG-editing screen showing correctly identified R-peaks.

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