Purpose and Summary

This protocol describes the guidelines for a CT and MRI scan intended for the creation of Ricoh 3D for Healthcare Cardiovascular Anatomic Models.

Important

Use of this scanning protocol as a guideline will result in a more anatomic accurate model.

Preparation of the Patient

- Remove any non-fixed metal prosthesis or jewelry that might interfere with the region to be scanned.
- Non-metal dentures may be worn during the scan.
- Make the patient comfortable and instruct not to move during the procedure, ideally holding their breath.
- Heartbeat should measure below 65.

Reconstruction of the Images

- Use a proper image reconstruction algorithm to get sharp reformatted images for locating internal structures.
- Reconstruct the images with a 512 × 512 matrix or 768 x 768 matrix.
- Only the axial images are required, no additional reformatting of the images must be done.
- Save the images in uncompressed standard DICOM format.
- Choose appropriate image modality during export of images. Non-corresponding modality can be a reason for rejection of images.

CT Scanning Instructions

- Use only primary axial images.
- Images scanned under a gantry tilt and oblique or reformatted images negatively influence the accuracy.
- All slices must have the same field of view, reconstruction center, and table height.
- Scan each slice in the same direction.
- Scan with the same slice spacing, less than or equal to the slice thickness. Non-overlapping axial slices may decrease the quality of reformatted images.

Patient Positioning

- Place the patient supine on the scanner table and move the patient into the gantry, head first. Adjust the table height in order to position the patient's heart in the field of view of the scanner.
- Stabilize the patient's chest.

In the Presence of Artifacts

- Check whether strategies of optimizing scan parameters to reduce metal artifacts seem beneficial, such as using thin slice collimation and reconstructing to slices of 1.25 mm, lowering pitch, and increasing kVp.
- Use a Metal Artifact Reducing algorithm/ filter, if available. Include this along with the standard scan.
- Increase the HU scan range by using a 16 bit or extended CT scale, if available.
- Artifacts from calcifications or plaque in the area of interest may hinder image quality. This may affect the output of the medical model. Site-specific artifact reduction protocols can be used to decrease the amount of artifact from the calcifications.

Dose Optimization

- Standard protocol for a specific structure that includes ECG-triggered end diastolic or end systolic imaging.
- The area of interest should be of optimal viewing for diagnostic imaging. Specific factors such as contrast agents, concentration, volume, injection rate, and timing should be determined by qualified facility staff performing the scanning. Contrast dosing should be determined by the facility's protocols in place for each patient, taking into account patient's age, kidney function, and medical history.
- Adjust parameters depending on patient body habitus (e.g. kVp, mAs).
- Dose information displayed at your scanner (such as CTDIvol) can be used to optimize scan parameters.
- Apply dose reduction techniques such as automatic tube current modulation and automatic voltage selection whenever possible and applicable (e.g. only apply automatic tube current modulation when your system can apply it correctly in the presence of metal in the scan region).
- For patients of standard body size without metal implants it is often possible to use a low-dose protocol for bone imaging and 3D applications.
- Tip: On some scanners, prospective selection of thin reconstructed slice thickness (e.g. 1mm) can lead to higher doses. Consider a retrospective reconstruction from thin acquisitions according to scan protocol parameters (Image Type needs to be ORIGINAL).

CT Scanning Parameters

Cardiovascular	
Scanner Type	Multi-detector row CT with number of detector rows ≥ 64
Scan Mode	Helical
Collimation	Slice thickness: 1.25 mm or smaller Slice increment: contiguous or overlapping slices (50% overlap): slice increment ≤ slice thickness
Gantry tilt/oblique angle	0°
kVp	100-120 (automatic voltage selection, if available)
mAs	Automatic tube current modulation
Rotation Time	Use 1-second or smaller
Pitch	Use 1 or smaller
Field of View (FOV)	Use smallest FOV that includes the complete anatomy of interest
Matrix	Use a 512 x 512 matrix
Reconstruction Algorithm	Use the following reconstruction algorithms and provide axial images: 1) Use a standard or soft tissue algorithm without edge enhancement. Always provide this reconstruction. 2) Provide multiple phases in the cardiac cycle to choose from. 3) Axial images must be provided. No reformatting, no oblique reconstructions; no MPRs. 4) If metal is present, provide additional reconstruction(s) with metal artifact reduction applied if available. (Always provide a reconstruction without metal artifact reduction applied.) Reconstructions should be obtained from one single acquisition.
HU Scale	If metal implants are present, us a HU scale of 16-bit.

MRI Scanning Parameters

Cardiovascular	
Scanner Type	T2 sequence EPI sequence (diffusion) T2 weighing SSFSE for biliary tract IP-OP according to the indication Non-Con TOF can be used if the indication is for vasculature. Multi-phase contrast-enhanced scans should be sent with all phases that correlate.
Scan Mode	Standard diastolic protocol with good contrast. For full heart: it is preferable to obtain 3D volume data (at least) three times and merge it into one file so that all cardiovascular structures contain contrast medium.
Collimation	Slice thickness: 1.25 mm or smaller Slices are incremental or (at least) equal to slice distance The higher the spatial resolution the better (as long as the signal-to-noise ratio permits)
Field of View (FOV)	Use smallest FOV that includes the complete anatomy of interest
Voxels	Nearly isotropic voxels (not standard)