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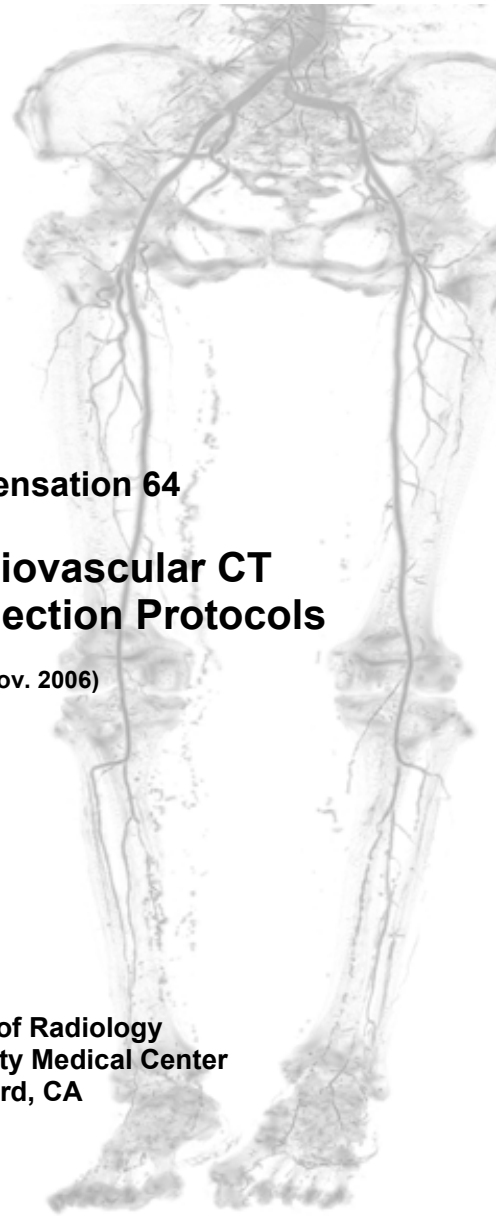

Siemens Sensation 64

Stanford Cardiovascular CT Scanning and Injection Protocols

(v2.04, Nov. 2006)

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Stanford Cardiovascular CT Scanning and Injection Protocols

Preface

Cardiovascular imaging is one of the most important and visible beneficiaries of the recent and dramatic evolution of comuted tomographic (CT) technology. CT–angiography (CTA) has evolved into a routine minimally-invasive vas and cardiac CT have evolved into widely available routine clinical applications

The quality of a CT angiogram or a cardiac CT strudy depends to a great extent on the appropriate selection of CT data acquisition and contrast medium injection parameters. Image quality (section thickness, noise), radiation exposure, and arterial opacification have all to be taken into account when planning a cardiovascular CT study. All user-selectable parameters have to be integrated with patient physiology as well.

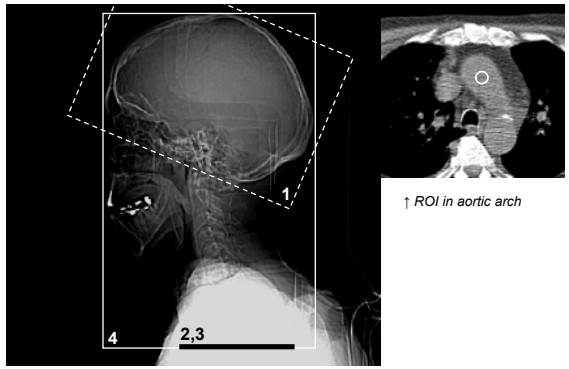
The following cardiovascular CT scanning and injection protocols have been developed with the goal to derive theoretically sound and at the same time practicable scanning and injections protocols for the Siemens Sensation 64 multi-slice scanner at Stanford.

The protocols provided in this text provide complete information regarding (i) patient positioning and scanning ranges, (ii) all scanning parameters for all parts of the respective CT study, and (iii) detailed injection protocols. While much attention to detail may limit easy readability, we feel that this is outweighted by completeness. Both radiologists and technologists benefit more from a detailed reference when facing less common CT examinations.

On behalf of the Cardiovascular Imaging Section we would like to thank all the radiological technologists at Stanford who's input and feedback has influenced this text. We are particularly greatful to Dominique Sandner and the support of Siements Medical Solutions, whithout whom this project would not have been possible.

Dominik Fleischmann, M.D. Geoffrey D Rubin, M.D.
November 2006

Head and Neck CTA



↑ *ROI in aortic arch*

Indication:
Cerebrovascular disease, intracranial aneurysms

Patient preparation:
20G IV cannula.

Patient positioning:

- Head first, supine, arms down by the side of the body;
- Remove any metal objects (e.g. ear-rings) out of the scanning range;

Comment:

- Instruct patient not to swallow during CT angiogram.

Notes:

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	vertex → aortic arch		insp	↓
1 Head Seq	base of skull → vertex		no	↑
2 premonitoring	ROI in aortic arch; Trigger level 100 HU		no	N/A
3 monitoring		10 s	no	N/A
4 HN CTA	aortic arch → vertex.	10 s	insp	↑

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	LAT, 512 mm
1 Head Seq	410	•	120	64x0.6	18mm	1.0 s	•	Gantry tilt
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 HN CTA	•	200	120	64×0.6	variable	0.37 s	10 s	

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 Head Seq	axial	4.8mm	4.8mm	H41f	80/40	skull
4a HN CTA	axial	1mm	0.7mm	B25f	600/80	neck
4b HN CTA	axial	3mm	3mm	B31f	600/80	same
4c HN CTA	MIPcor	3mm	1mm	B25f	700/200	same
4d HN CTA	MIPsag	3mm	1mm	B25f	700/200	same

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	10 s for everyone
Injection duration	12 s
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, minimum user delay (2 s)
Saline flushing	40 mL @ same flow rate as contrast

Body weight		Flow Rate	relaxed Volume
< 121 lbs	(<55kg)	4.0 mL/s	48 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	54 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	60 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	66 mL
> 209 lbs	(>95kg)	6.0 mL/s	72 mL

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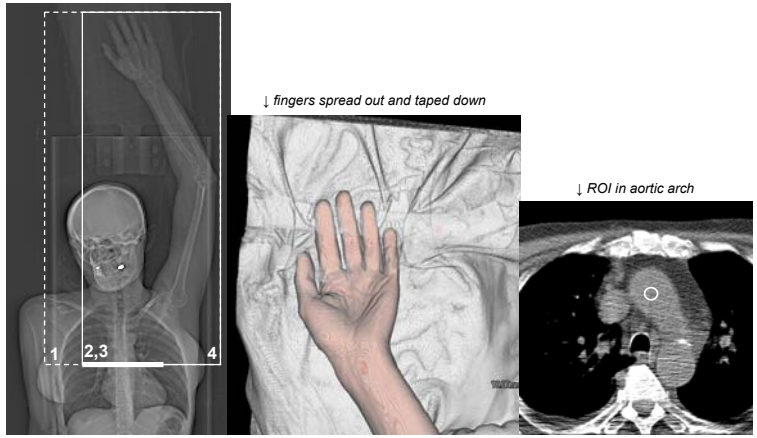
Upper Extremity Runoff



Indication:

upper extremity aneurysmal/embolic/occlusive disease, trauma, AVM, vasculitis, Hemodialysis shunt evaluation, anatomic mapping for free flap graft harvesting, hypothenar-hamate syndrome

Patient preparation:

20G IV cannula at contra lateral arm!
Hand and fingers should not be cold !

Patient positioning:

- head first, supine or prone (depending on patient's physical condition), arm to be scanned above head.
- Fingers spread out and taped down (see figure above)
- use laser light and adjust table height to align arm and fingers with center of scanner.

Comment:

- It is critical to select the scanning range first, and then set the scan-time to 30 seconds in all patients.

Notes:

Blood flow to the upper extremity at rest is generally low. Opacification of small hand/finger arteries may be difficult, notably in a cold environment. This slow acquitision/scanning protocol allows for adequate filling of small peripheral arteries. Consider a one-minute exercising (squeezing a ball/object) before taping down the fingers, or use post-ischemic hyperemia (one minute blood-pressure cuff immediately released before the injection).
Scan time can be shorter / scanning range restricted for AVMs.

DRAFT

Cardiovascular Vascular01^ UPPER_EXTR_RUNOFF Upper Extremity Runoff

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → finger tips		insp	↑
1 non contrast	aortic arch → finger tips		insp	↑
2 premonitoring	ROI in aortic arch		no	N/A
3 monitoring		10 s	no	N/A
4 UE Runoff	aortic arch. → through finger tips	2-3 s	insp	↑

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 1500 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 UE Runoff	•	250	120	64×0.6	variable	0.5 s	30s	fixed 30s scan time!

C: Reconstruction Parameters

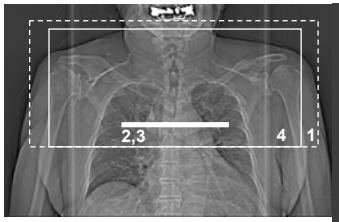
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4 UE Runoff	axial	1mm	0.7mm	B25f	600/80	Include aortic arch and elbow

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 30s for all patients !
Injection duration	30s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, minimum user delay (~2s)
Saline flushing	40 mL @ same flow rate as Phase II

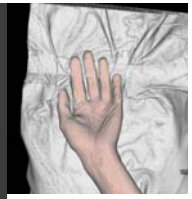
Body weight		Phase I	Phase II	Total CM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	80 mL @ 3.2 mL/s	100 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	90 mL @ 3.6 mL/s	113 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	100 mL @ 4.0 mL/s	125 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	110 mL @ 4.4 mL/s	138 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	120 mL @ 4.8 mL/s	150 mL

Thoracic Outlet



↑ *Scan 1: relaxed position, arms down by the side*

Scan 2: maneuver or provocative position with affected arm raised above head (prone position also possible) →



↑ *fingers taped down*

↑ *ROI in aortic arch*

Indication:

Thoracic Outlet Syndrome (TOS)

Patient preparation:

20G IV cannula, at contra lateral side
Hand and fingers should not be cold

Patient positioning:

- Scan 1: head first, supine, arms down;
- Scan 2: head first, supine or prone (depending on patients physical condition), arm to be scanned raised above head with finger tips spread out and taped down;
- Head turned away from elevated arm shoulder;
- use laser light and adjust table height to align arms and fingers with center of scanner

Comment:

- this protocol requires two arterial scans (one scan in a neutral arm position and one provocation-maneuver scan with elevated arm),
- position needs to be changed after first contrast scan and a second Topogram is required;
- It is critical to select the scanning range first, and then set the scan-time for the first scan to 10 seconds, for the second scan to 20 seconds in all patients.

Notes:

Blood flow to the upper extremity at rest is generally low. Opacification of small hand/finger arteries may be difficult, notably in a cold environment. Consider a one-minute exercising (e.b. squeezing a ball) before taping down the fingers for the provocation-maneuver scan.

DRAFT

Cardiovascular Vascular01^THORACIC_OUTLET_SYNDROM Thoracic Outlet

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 non contrast	mid chest → lower neck		insp	↑
2 premonitoring	ROI aortic arch; 100 HU trigger level;		no	N/A
3 monitoring		10 s	no	N/A
4 relaxed	mid chest → lower neck	2-3 s	insp	↑
0 Topogram	diaphragm → finger tips		insp	↑
5 premonitoring	ROI aortic arch; 100 HU trigger level;		no	N/A
6 monitoring		10 s	no	N/A
7 maneuver	aortic arch → through finger tips	2-3 s	insp	↑

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 relaxed	•	250	120	64×0.6	variable	0.5 s	10s	fixed 10s scan time!
0 Topogram	35	•	120	•	•	•	•	AP, 1500 mm
5 premonitoring	20	•	120	•	•	•	•	
6 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
7 maneuver	•	250	120	64×0.6	variable	0.5 s	30s	fixed 20s scan time!

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4 relaxed	axial	1mm	0.7mm	B25f	600/80	Include both sides
7 maneuver	axial	1mm	0.7mm	B25f	600/80	Include aortic arch and elbow

D: Contrast Medium Injection Parameters (monophasic and biphasic)

CM Concentration	≥ 350mgI/ml
Scantime	Relaxed 10 s, maneuver 20 s for all patients
Injection duration	Relaxed 10 s; maneuver 20 s for all patients
Bolus Timing	Autom. bolus trigger (Care-Bolus); 100HU trigger level; 2s and 2s user Delay, respectively
Saline flushing	40 mL @ at same flow rate (scan 2: same as phase II)

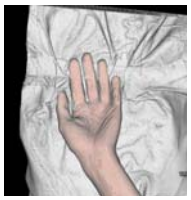
Body weight		relaxed Flow Rate	relaxed Volume
< 121 lbs	(<55kg)	4.0 mL/s	40 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	45 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	50 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	55 mL
> 209 lbs	(>95kg)	6.0 mL/s	60 mL

Body weight		maneuver Scan 2: Phase I	maneuver Scan 2: Phase II	Total CM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	48 mL @ 3.2 mL/s	108 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	54 mL @ 3.6 mL/s	122 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	60 mL @ 4.0 mL/s	135 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	66 mL @ 4.4 mL/s	149 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	72 mL @ 4.8 mL/s	162 mL

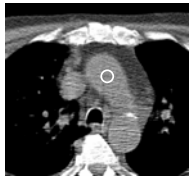
Bilateral Thoracic Outlet

↑ *Position 1: right arm maneuver, left arm relaxed*

↑ *Position 2: left arm maneuver, right arm relaxed*



↑ *fingers taped down*



↑ *ROI in aortic arch*

Indication:

Bilateral Thoracic Outlet syndrome
Hand and fingers should not be cold

Patient preparation:

20G IV cannula, in both arms, to use for each contra lateral side (left arm injection for rith arm maneuver, right arm injection for left arm maneuver)

Patient positioning:

- head first, supine or prone (depending on patient's physical condition), arm for maneuver scan raised above head with finger tips spread out and taped down;
- head turned to relaxed shoulder; second scan vise versa;
- use laser light and adjust table height to align arms and fingers with center of scanner

Comment:

- this protocol requires two arterial scans (one for right arm maneuver and left arm relaxed, and one for left arm maneuver and right arm relaxed),
- position needs to be changed after first contrast scan and a second Topogram is required;
- It is critical to select the scanning range first, and then set the scan-time to 20 seconds for each scan in all patients.

Notes:

This protocol uses a shorter (20s) scan time, in order to reduce the total amount of contrast medium for the two injections. Since blood flow to the upper extremity at rest is generally low, consider a one-minute exercise (e.b. squeezing a ball) of the elevated arm before taping down the fingers for the provocation-maneuver scan.

DRAFT

Cardiovascular Vascular01^BILAT_THORACIC_OUTLET_SYNDROM Bilateral Thoracic Outlet

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → finger tips		insp	↑
1 premonitoring	ROI aortic arch; 100 HU trigger level;		no	N/A
2 monitoring		10 s	no	N/A
3 right maneuver	aortic arch → through finger tips	2-3 s	insp	↑
0 Topogram	diaphragm → finger tips		insp	↑
4 premonitoring	ROI aortic arch; 100 HU trigger level;;		no	N/A
5 monitoring		10 s	no	N/A
6 left maneuver	aortic arch → through finger tips	2-3 s	insp	↑

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 1500 mm
1 premonitoring	20	•	120	•	•	•	•	
2 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
3 right maneuver	•	250	120	64×0.6	variable	0.5 s	30s	fixed 20s scan time!
0 Topogram	35	•	120	•	•	•	•	AP, 1500 mm
4 premonitoring	20	•	120	•	•	•	•	
5 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
6 left maneuver	•	250	120	64×0.6	variable	0.5 s	30s	fixed 20s scan time!

C: Reconstruction Parameters

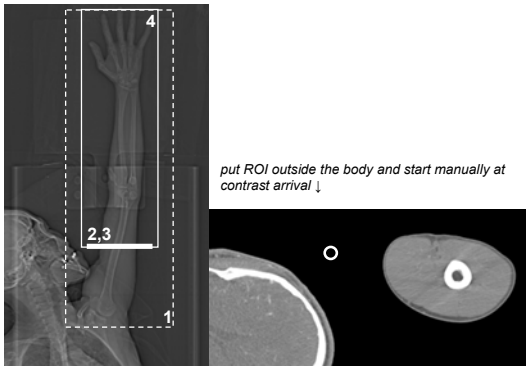
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
3 right maneuver	axial	1mm	0.7mm	B25f	600/80	both shoulders and maneuver arm
6 left maneuver	axial	1mm	0.7mm	B25f	600/80	both shoulders and maneuver arm

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 20s for all patients
Injection duration	20s for all patients
Bolus Timing	Automated bolus trigger (Care-Bolus); 100HU trigger level; 2s user delay
Saline flushing	40 mL @ same flow rate as contrast Phase II

Body weight		Phase I	Phase II	Total CM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	48 mL @ 3.2 mL/s	2 x 68 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	54 mL @ 3.6 mL/s	2 x 77 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	60 mL @ 4.0 mL/s	2 x 85 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	66 mL @ 4.4 mL/s	2 x 94 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	72 mL @ 4.8 mL/s	2 x 102 mL

Limited Upper Extremity Runoff (Trauma)



put ROI outside the body and start manually at contrast arrival ↓

Indication:

Blunt or penetrating trauma to arm, forearm or hand, suspected vascular injury;
hand AVM, hypothenar-hamate syndrome

Patient preparation:

20G IV cannula at contra lateral arm!

Patient positioning:

- head first, supine or prone (depending on patient's physical condition), arm to be scanned above head.
- Fixate arm to the middle of the table;
- use laser light and adjust table height to align arm and fingers with center of scanner.

Comment:

- It is critical to select the scanning range and then set the scan-time to 15 seconds in all patients.

Notes:

DRAFT

Cardiovascular Vascular01^LTD_UPPER_EXTR_RUNOFF Limited Upper Extremity Runoff

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	shoulder → finger tips		insp	↑
1 non contrast	shoulder → finger tips		insp	↑
2 premonitoring	ROI outside the body at beginning of scan range		no	N/A
3 monitoring		10 s	no	N/A
4 Ltd UE Runoff	proximal to elbow → through finger tips	2-3 s	insp	↑

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 Ltd UE Runoff	•	250	120	64×0.6	variable	0.5 s	15s	fixed 15s scan time!

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	3mm	3mm	B31f	400/40	
4 Ltd UE Runoff	axial	1mm	0.7mm	B25f	600/80	Arm, forearm, hand

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 15s for all patients !
Injection duration	15s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); manual start, minimum user delay (~2s)
Saline flushing	40 mL @ same flow rate as Contrast

Body weight		Flow Rate	Volume
< 121 lbs	(<55kg)	4.0 mL/s	60 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	68 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	75 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	83 mL
> 209 lbs	(>95kg)	6.0 mL/s	90 mL

Chest/Abdomen/Pelvis CTA

← to put ROI in ascending aorta is better than in the aortic arch (dissection flaps most likely occur in the arch ↓)

Indication:

Acute aortic syndromes (suspected dissection / IMH / penetrating ulcer) of the descending (thoracic or thoraco-abdominal) aorta, Evaluation of thoracic (arch, descending) and thoraco-abdominal aortic aneurysms. Large vessel vasculitis,
For ascending aortic and aortic root evaluation, 'Gated Chest + Abdomen/Pelvis' protocol is preferred.

Patient preparation:

20G IV cannula.

Patient positioning:

- Head first, supine, arms above head.

Comment:

- It is critical to select the scanning range first, and then set the scan-time to 20 seconds in all patients.

Notes:

Avoid placing the ROI for bolus-timing into the aortic arch since lumen cannot be distinguished from false lumen or mural thrombus.

DRAFT

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → lesser trochanter		insp	↓
1 non contrast	neck → lesser trochanter		insp	↓
2 premonitoring	ROI in ascending aorta; Trigger level 100 HU		no	N/A
3 monitoring		10 s	no	N/A
4 CAP Angio	above aortic arch. → lesser trochanter.	5 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 768 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 CAP Angio	•	250	120	64×0.6	variable	0.5 s	20s	fixed 20s scan time!

C: Reconstruction Parameters

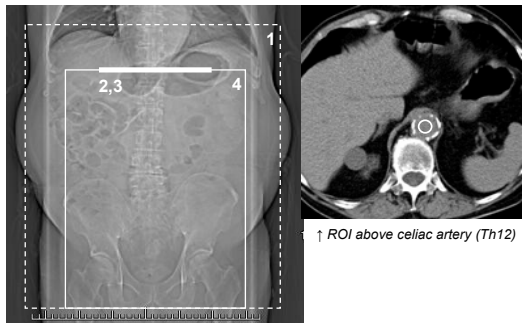
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4a CAP Angio	axial	1mm	0.7mm	B25f	600/80	use greater trochanter
4b CAP Angio	axial	5mm	5mm	B31f	600/80	same

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 20s for all patients
Injection duration	25s for all patients (scan time of 20s + 5s user delay)
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, 5s user delay
Saline flushing	40 mL @ same flow rate as Phase II

Body weight		Phase I	Phase II	Total CM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	64 mL @ 3.2 mL/s	84 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	70 mL @ 3.6 mL/s	93 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	80 mL @ 4.0 mL/s	105 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	88 mL @ 4.4 mL/s	116 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	96 mL @ 4.8 mL/s	126 mL

Abdomen/Pelvis CTA



↑ *ROI above celiac artery (Th12)*

Indication:

abdominal, iliac or mesenteric aneurysm evaluation and surveillance; atherosclerotic or inflammatory occlusive disease of the aorta and it's branches. Acute and chronic mesenteric ischemia.

Patient preparation:

20G IV cannula.

Patient positioning:

- Head first, supine, arms above head.

Comment:

- It is critical to select the scanning range first, and then set the scan-time to 10 seconds in all patients.

Notes:

add a portal venous phase for mesenteric ischemia (i.e. to see bowel wall / mesenteric veins)

DRAFT

Cardiovascular Vascular01^AP_CTA Abdomen Pelvis CTA

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → lesser trochanter		insp	↓
1 non contrast	diaphragm → lesser trochanter		insp	↓
2 premonitoring	ROI in aorta above celiac artery (Th12); Trigger level 100 HU		no	N/A
3 monitoring		10 s	no	N/A
4 AP Angio	above celiac artery. → lesser trochanter.	8 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 AP Angio	•	250	120	64×0.6	variable	0.5 s	20s	fixed 10s scan time!

C: Reconstruction Parameters

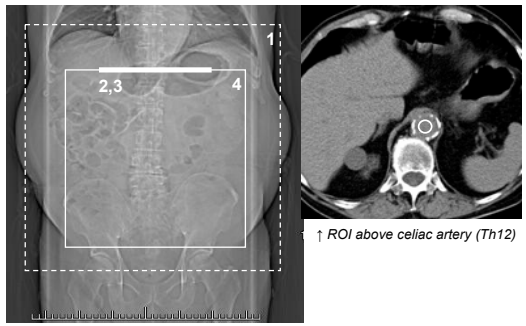
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4a AP Angio	axial	1mm	0.7mm	B25f	600/80	use greater trochanter
4b AP Angio	axial	5mm	5mm	B31f	600/80	same

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 10s for all patients
Injection duration	18s for all patients (scan time of 10s + 8s user delay)
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, 8s user delay
Saline flushing	40 mL @ same flow rate as contrast

Body weight		Flow Rate	Volume
< 121 lbs	(<55kg)	4.0 mL/s	72 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	81 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	90 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	99 mL
> 209 lbs	(>95kg)	6.0 mL/s	108 mL

Renal Arteries CTA



↑ *ROI above celiac artery (Th12)*

Indication:
Renal artery stenosis, renal artery aneurysm or AVM

Patient preparation:
20G IV cannula.

Patient positioning:

- Head first, supine, arms above head.

Comment:

- It is critical to select the scanning range first, and then set the scan-time to 10 seconds in all patients.

Notes:

DRAFT

Cardiovascular Vascular01^RENAL_ARTERIES_CTA Renal Arteries CTA

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → greater trochanter		insp	↓
1 non contrast	diaphragm → greater trochanter		insp	↓
2 premonitoring	ROI in aorta above celiac artery (Th12); Trigger level 100 HU		no	N/A
3 monitoring		10 s	no	N/A
4 Renal Angio	above celiac artery. → greater trochanter.	6 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 Renal Angio	•	250	120	64×0.6	variable	0.5 s	20s	fixed 10s scan time!

C: Reconstruction Parameters

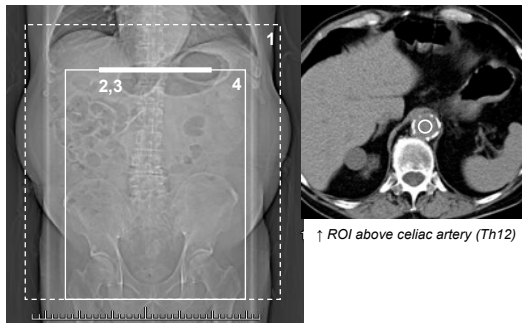
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4a Renal Angio	axial	1mm	0.7mm	B25f	600/80	use greater trochanter
4b Renal Angio	axial	5mm	5mm	B31f	600/80	same

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 10s for all patients
Injection duration	16s for all patients (scan time of 10s + 6s user delay)
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, 6s user delay
Saline flushing	40 mL @ same flow rate as contrast

Body weight		Flow Rate	Volume
< 121 lbs	(<55kg)	4.0 mL/s	64 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	72 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	80 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	88 mL
> 209 lbs	(>95kg)	6.0 mL/s	96 mL

Living Related Renal Donor



↑ *ROI above celiac artery (Th12)*

Indication:
Evaluation of living related kidney donor.

Patient preparation:
20G IV cannula.

Patient positioning:

- Head first, supine, arms above head;
- Patients should be advised to drink at least a liter of water prior to the exam;

Comment:

- It is critical to select the scanning range first, and then set the scan-time to 10 seconds in all patients.

Notes:

Cardiovascular Vascular01^LIVING_RELATED_RENAL_DONOR Living Related Renal Donor

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → symphysis		insp	↓
1 non contrast	diaphragm → symphysis		insp	↓
2 premonitoring	ROI in aorta above celiac artery (Th12); Trigger level 100 HU		no	N/A
3 monitoring		10 s	no	N/A
4 LRD	above celiac artery. → symphysis.	10 s	insp	↓
5 Topogram	diaphragm → symphysis	5 min	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 LRD	•	250	120	64×0.6	variable	0.5 s	10s	fixed 10s scan time!
5 Topogram	35	•	120	•	•	•	•	AP, 512 mm

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	3mm	3mm	B31f	400/40	body
4a LRD	axial	1mm	0.7mm	B25f	600/80	lateral kidney boundary
4b LRD	axial	5mm	5mm	B31f	600/80	same

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 10s for all patients
Injection duration	20s for all patients (scan time of 10s + 10s user delay)
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, 10s user delay
Saline flushing	40 mL @ same flow rate as contrast

Body weight		Flow Rate	Volume
< 121 lbs	(<55kg)	4.0 mL/s	80 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	90 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	100 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	110 mL
> 209 lbs	(>95kg)	6.0 mL/s	120 mL

DRAFT

Lower Extremity Runoff

use table extension

wrap tape around feet

ROI above celiac artery

Indication:

peripheral arterial occlusive disease (intermittent Claudication, chronic critical limb ischemia), pre- and post-interv./surgical evaluation. Protocol works also for anatomic mapping (fibula graft harvesting), and trauma.

Patient preparation:

20G IV cannula.

Patient positioning: IMPORTANT

- feet first, supine, arms above head; use table extension instead of head holder
- feet relaxed, use cushions, but do not bend (and elevate) knees, tape around forefoot.
- use laser light and adjust table height to align legs and feet with center of scanner.

Comment:

- this protocol deliberately uses a comparably slow acquisition speed for scanning the abdomen, pelvis ('inflow') and lower extremity ('runoff') arteries in order to prevent that the scanner outraces the bolus in patients with delayed filling of the peripheral arteries.
- It is critical to select the scanning range, and then set the scan-time to 40 seconds.

Notes:

DRAFT

Cardiovascular Vascular01^_RUNOFF (Adult) Lower Extremity Runoff

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	diaphragm → toes		insp	↓
1 non contrast	diaphragm → lesser trochanter		insp	↓
2 premonitoring	ROI in aorta above celiac artery (Th12)		no	N/A
3 monitoring		10 s	no	N/A
4 AngioRunoff	above celiac artery. → through toes.	minimal	insp	↓
5 Legs	above knee → through toes	minimal	no	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 1500 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 AngioRunoff	•	250	120	64×0.6	variable	0.5 s	40s	fixed 40s scan time!
5 Legs	•	250	120	64×0.6	1.0	0.5 s	•	

C: Reconstruction Parameters

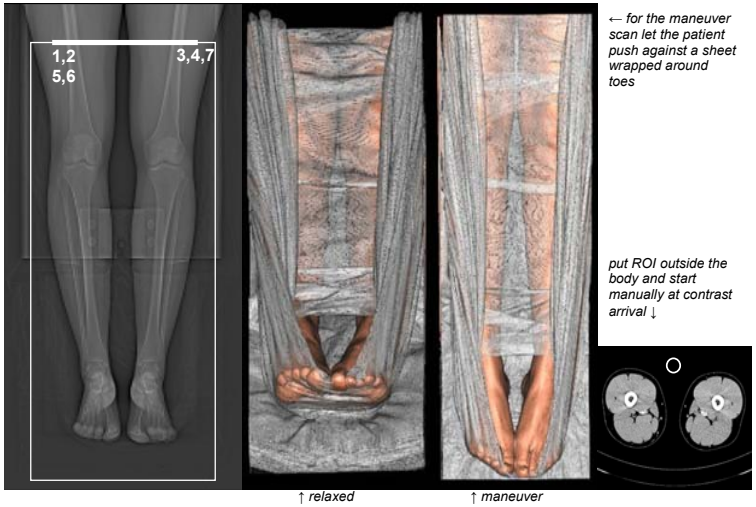
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	5mm	5mm	B31f	400/40	
4a AngioRunoff	axial	2mm	1mm	B25f	600/80	use greater trochanter
4b AngioRunoff	axial	5mm	5mm	B31f	600/80	same, but abd. and pelvis only
5 Legs	axial	1mm	0.7mm	B25f	600/80	same as 4a, knee to toes

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 40s for all patients !
Injection duration	calculated to equal 35s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level, minimum user delay (~2s)
Saline flushing	40 mL @ same flow rate as Phase II

Body weight		Phase I	Phase II	CM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	96 mL @ 3.2 mL/s	116 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	108 mL @ 3.6 mL/s	131 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	120 mL @ 4.0 mL/s	145 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	132 mL @ 4.4 mL/s	160 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	144 mL @ 4.8 mL/s	174 mL

Popliteal Entrapment CTA



Indication:

Popliteal entrapment syndrome

Patient preparation:

20G IV cannula.

Patient positioning:

- feet first, supine, arms at the side holding the ends of a bed-sheet looped under the forefoot and toes; use table extension;
- use laser light and adjust table height to align legs and feet with center of scanner

Comment:

- this protocol requires two injections, and three scans. The first injection is for an arterial and venous phase acquisition in relaxed position, the second injection is acquired in an arterial phase only during the provocation maneuver (gastrognemius muscle contraction); for the provocation maneuver the patient is instructed to push the toes against the resistance of the loop of bed-sheet while pulling back the sheet with his/her hands; this position needs to be hold for the length of the scan (15 s long); It is important to practice the provocation maneuver with the patient.
- the scan range of the maneuver scan needs to be long enough to cover the tipped down toes;
- It is critical to select the scanning range first, and then set the scan-time to 15 seconds.

Notes:

DRAFT

Cardiovascular Vascular01^POPL_ENTRAPMENT_CTA Popliteal Entrapment CTA

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	mid thigh → below toes		no	↓
1 premonitoring	ROI outside the body; start manually at contrast arrival;		no	N/A
2 monitoring		10 s	no	N/A
3 relaxed	mid thigh → below toes	2 s	no	↓
4 venous	mid thigh → below toes	20 s	no	↓
5 premonitoring	ROI outside the body; start manually at contrast arrival;		no	N/A
6 monitoring		10 s	no	N/A
7 maneuver	mid thigh → below toes (longer than shown in Topogram)	2 s	no	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 768 mm
1 premonitoring	20	•	120	•	•	•	•	
2 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
3 relaxed	•	250	120	64×0.6	variable	0.5 s	15 s	fixed 15s scan time!
4 venous	•	250	120	64×0.6	variable	0.5 s	15 s	fixed 15 s scan time
5 premonitoring	20	•	120	•	•	•	•	
6 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
7 maneuver	•	250	120	64×0.6	variable	0.5 s	15s	fixed 15s scan time!

C: Reconstruction Parameters

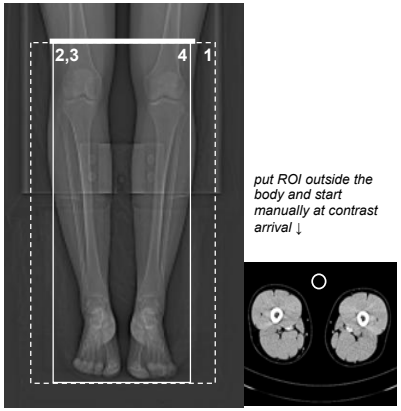
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
3 relaxed	axial	1mm	0.7mm	B25f	600/80	use greater trochanter
4 venous	axial	1mm	0.7mm	B25f	600/80	same
7 maneuver	axial	1mm	0.7mm	B25f	600/80	same

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 15s for all patients
Injection duration	15s for all patients
Bolus Timing	Automated bolus trigger (Care-Bolus); start manually; 2s user delay
Saline flushing	40 mL @ same flow rate as contrast Phase

Body weight		Flow Rate	Volume	Total CM Vol.
< 121 lbs	(<55kg)	4.0 mL/s	60 mL	2x60=120 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	68 mL	2x68=136 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	75 mL	2x75=150 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	83 mL	2x83=166 mL
> 209 lbs	(>95kg)	6.0 mL/s	90 mL	2x90=180 mL

Limited Lower Extremity Runoff (Trauma)



put ROI outside the body and start manually at contrast arrival ↓

Indication:

Trauma, suspected vascular injury

Patient preparation:

20G IV cannula !

Patient positioning:

- head first, supine
- position leg(s) to the center of the table;
- it is also possible to scan one leg only, with the other leg pulled up.
- use laser light and adjust table height to align legs with center of scanner.

Comment:

- It is critical to select the scanning range and then set the scan-time to 15 seconds in all patients.

Notes:

DRAFT

Cardiovascular Vascular01^LTD_LOWER_EXTR_RUNOFF Limited Lower Extremity Runoff

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	mid thigh → toes		insp	↓
1 non contrast	mid thigh → toes		insp	↓
2 premonitoring	ROI outside the body at beginning of scan range		no	N/A
3 monitoring		10 s	no	N/A
4 Ltd LE Runoff	above knees → through toes	2-3 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 768 mm
1 non contrast	•	140	120	24×1.2	1.0	0.5 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 Ltd LE Runoff	•	250	120	64×0.6	variable	0.5 s	15s	fixed 15s scan time!

C: Reconstruction Parameters

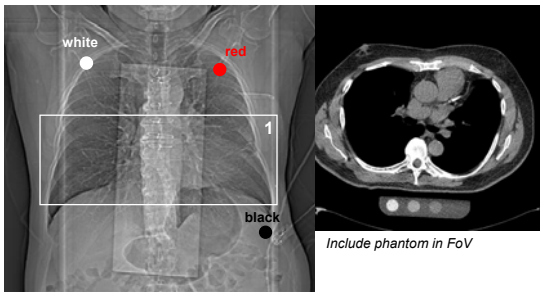
#	Type/ orient	STh	RI	Filter	Window WW / WL	Field of View / Comment
1 non contrast	axial	3mm	3mm	B31f	400/40	
4 Ltd LE Runoff	axial	1mm	0.7mm	B25f	600/80	Leg of interest

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	needs to be 15s for all patients !
Injection duration	15s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); manual start, minimum user delay (~2s)
Saline flushing	40 mL @ same flow rate as contrast

Body weight		Flow Rate	Volume
< 121 lbs	(<55kg)	4.0 mL/s	60 mL
121 – 143 lbs	(<65kg)	4.5 mL/s	68 mL
143 – 187 lbs	(~75kg)	5.0 mL/s	75 mL
187 – 209 lbs	(>85kg)	5.5 mL/s	83 mL
> 209 lbs	(>95kg)	6.0 mL/s	90 mL

CaScoring Sequence



Include phantom in FoV

Indication:

Quantification of coronary artery calcified plaque

Patient preparation:

None

Patient positioning:

- head first, supine, arms above head
- CaScoring phantom underneath heart
- ECG-leads

Comment:

- This protocol requires a prospective ECG-triggered scan
- make sure the ECG-display shows a clear signal with well identifiable R-peaks; target heart-rate is 55-62 bpm
- make sure the breath hold time which you can configure in the options/configuration panel is longer than the total scan time

Notes:

DRAFT

Cardiovascular Cardiac01^CASCORING_SEQ CaScoring Sequence

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 CaScoreSeq	carina → diaphragm		insp	↓

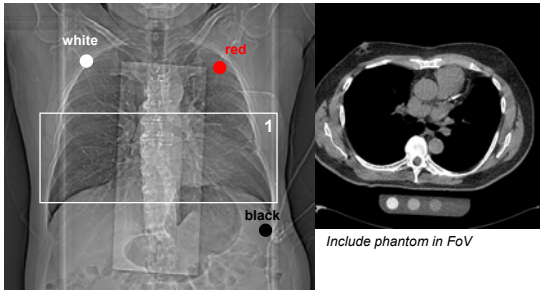
B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 CaScoreSeq	100	•	120	30x0.6	feed 18mm	0.33 s	Quick 0.24	

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1 CaScoreSeq	axial	3mm	1.5mm	B35f	400/40	65%	Include phantom

CaScoring Spiral



Include phantom in FoV

Indication:

Quantification of coronary artery calcified plaque

Patient preparation:

none

Patient positioning:

- head first, supine, arms above head
- CaScoring phantom underneath heart
- ECG-leads

Comment:

- make sure the ECG-display shows a clear signal with well identifiable R-peaks; target heart-rate is 55-62 bpm; Use ECG-Pulsing in low and stable heart-rates especially in younger patients;

Notes:

DRAFT

Cardiovascular Cardiac01^CaScoring Spiral CaScoring Spiral

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 CaScoring	carina → diaphragm		insp	↓

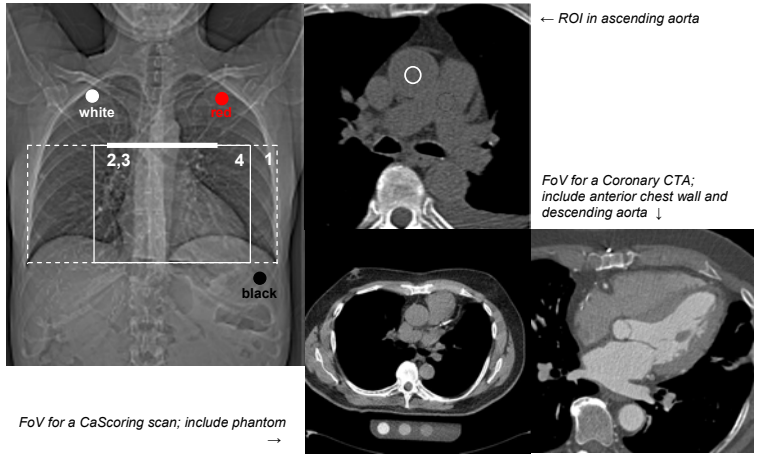
B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 CaScoring	220	•	120	24×1.2	0.2	0.33 s	•	

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1 CaScoring	axial	3mm	1.5mm	B35f	400/40	65%	Include phantom

CaScoring and Coronary CTA



FoV for a CaScoring scan; include phantom →

← ROI in ascending aorta

FoV for a Coronary CTA; include anterior chest wall and descending aorta ↓

Indication:

rule out Coronary Artery Disease

Patient preparation:

20G IV cannula; oral or I.V. β-Blocker and sublingual nitroglycerine as per protocol

Patient positioning:

- head first, supine, arms above head
- CaScoring phantom underneath heart
- ECG-leads
- Practice breath-holding

Comment:

- make sure the ECG-display shows a clear signal with well identifiable R-peaks; target heart-rate is 55-62 bpm; Use ECG-Pulsing in low and stable heart-rates especially in younger patients;

Notes:

DRAFT

Cardiovascular Cardiac01^CaScoring and Coronary CTA Coronary CTA

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 CaScoring	carina → diaphragm		insp	↓
2 premonitoring	At carina, ROI in ascending aorta		no	N/A
3 monitoring		10 s	no	N/A
4 CoronaryCTA	carina → diaphragm	8 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 CaScoring	220	•	120	24×1.2	0.2	0.33 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 CoronaryCTA	850	•	120	64×0.6	0.2	0.33 s	10-19s	As short as possible

C: Reconstruction Parameters

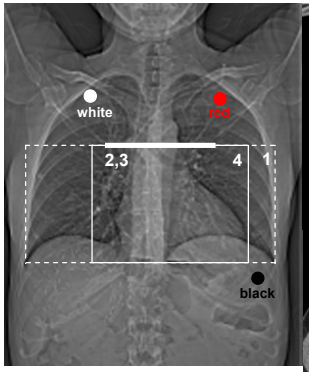
#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1a CaScoring	axial	3mm	3mm	B35f	400/40	65%	Include phantom
1b CaScoring	axial	1.5mm	1.5mm	B35f	400/40	65%	Include phantom
4a CoronaryCTA	axial	0.75mm	0.5mm	B25f	600/80	65%	Include Aorta and IMA
4b CoronaryCTA	axial	0.75mm	0.5mm	B25f	600/80	0-90%	Same as 4a

D: Contrast Medium Injection Parameters

CM Concentration	≥ 370mgI/ml
Scantime	As short as possible for maximum dose utilization
Injection duration	calculated to equal (scantime+8s) for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 120 HU trigger level; 8s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

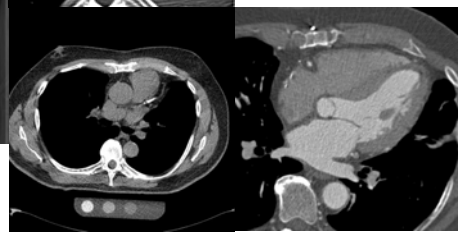
Body weight		Flow Rate	Calculate Volume
< 121 lbs	(<55kg)	4.0 mL/s	(Scan time + 8) * 4
121 – 143 lbs	(<65kg)	4.5 mL/s	(Scan time + 8) * 4.5
143 – 187 lbs	(~75kg)	5.0 mL/s	(Scan time + 8) * 5
187 – 209 lbs	(>85kg)	5.5 mL/s	(Scan time + 8) * 5.5
> 209 lbs	(>95kg)	6.0 mL/s	(Scan time + 8) * 6

CaScoring and Coronary CTA below 50 bpm HR



← *ROI in ascending aorta*

FoV for a Coronary CTA; include anterior chest wall and descending aorta ↓



FoV for a CaScoring scan; include phantom →

Indication:

rule out Coronary Artery Disease

Patient preparation:

20G IV cannula; oral or I.V. β-Blocker and sublingual nitroglycerine as per protocol

Patient positioning:

- head first, supine, arms above head
- CaScoring phantom underneath heart
- ECG-leads
- Practice breath-holding

Comment:

- make sure the ECG-display shows a clear signal with well identifiable R-peaks; this protocol should be used for heart rates clearly below 50 bpm; Use ECG-Pulsing especially in younger patients;

Notes:

DRAFT

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 CaScoring	carina → diaphragm		insp	↓
2 premonitoring	At carina, ROI in ascending aorta		no	N/A
3 monitoring		10 s	no	N/A
4 CoronaryCTA	carina → diaphragm	8 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 CaScoring	220	•	120	24×1.2	0.2	0.33 s	•	
2 premonitoring	20	•	120	•	•	•	•	
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 CoronaryCTA	850	•	120	64×0.6	0.24	0.37 s	10-19s	As short as possible

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1a CaScoring	axial	3mm	3mm	B35f	400/40	65%	Include phantom
1b CaScoring	axial	1.5mm	1.5mm	B35f	400/40	65%	Include phantom
4a CoronaryCTA	axial	0.75mm	0.5mm	B25f	600/80	65%	Include Aorta and IMA
4b CoronaryCTA	axial	0.75mm	0.5mm	B25f	600/80	0-90%	Same as 4a

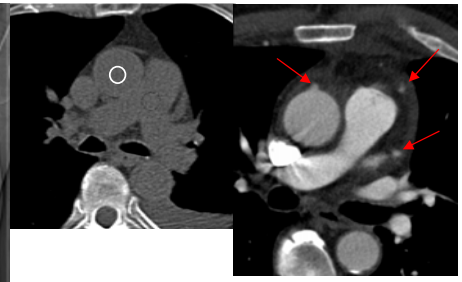
D: Contrast Medium Injection Parameters

CM Concentration	≥ 370mgI/ml
Scantime	As short as possible for maximum dose utilization
Injection duration	calculated to equal (scantime+8s) for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 120 HU trigger level; 8s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight		Flow Rate	Calculate Volume
< 121 lbs	(<55kg)	4.0 mL/s	(Scan time + 8) * 4
121 – 143 lbs	(<65kg)	4.5 mL/s	(Scan time + 8) * 4.5
143 – 187 lbs	(~75kg)	5.0 mL/s	(Scan time + 8) * 5
187 – 209 lbs	(>85kg)	5.5 mL/s	(Scan time + 8) * 5.5
> 209 lbs	(>95kg)	6.0 mL/s	(Scan time + 8) * 6

Coronary Bypass Graft CTA

↑ ROI in ascending aorta



↑ FoV for a Coronary Graft CTA; include anterior chest wall (LIMA, RIMA) and descending aorta

Indication:

Graft patency, distal anastomosis

Patient preparation:

20G IV cannula; oral or I.V. β-Blocker and sublingual nitroglycerine as per protocol

Patient positioning:

- head first, supine, arms above head
- ECG-leads
- Practice breath-holding

Comment:

- make sure the ECG-display shows a clear signal with well identifiable R-peaks; target heart-rate is 55-62 bpm; Use ECG-Pulsing in low and stable heart-rates especially in younger patients;
- no CaScoring needed;

Notes:

DRAFT

Cardiovascular Cardiac01^CORONARY GRAFT Coronary Graft CTA

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 premonitoring	At carina, ROI in ascending aorta		no	N/A
2 monitoring		10 s	no	N/A
3 CorGraftCTA	mid clavicle → diaphragm	5 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 premonitoring	20	•	120	•	•	•	•	
2 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
3 CorGraftCTA	850	•	120	64×0.6	0.2	0.33 s	15-20s	As short as possible

C: Reconstruction Parameters

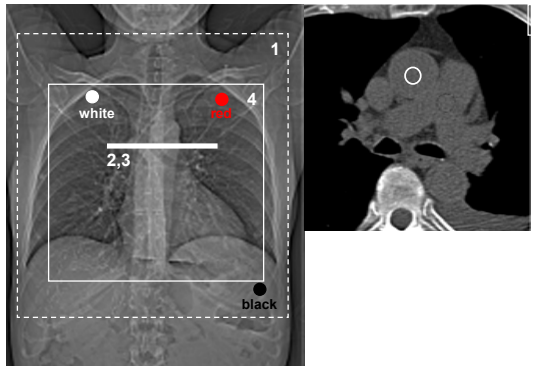
#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
4a CorGraftCTA	axial	0.75mm	0.5mm	B25f	600/80	65%	Include Aorta and IMA
4b CorGraftCTA	axial	0.75mm	0.5mm	B25f	600/80	0-90%	Same as 4a

D: Contrast Medium Injection Parameters

CM Concentration	≥ 370mgI/ml
Scantime	As short as possible for maximum dose utilization
Injection duration	calculated to equal (scantime+5s) for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 120 HU trigger level; 5s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight		Flow Rate	Calculate Volume
< 121 lbs	(<55kg)	4.0 mL/s	(Scan time + 5) * 4
121 – 143 lbs	(<65kg)	4.5 mL/s	(Scan time + 5) * 4.5
143 – 187 lbs	(~75kg)	5.0 mL/s	(Scan time + 5) * 5
187 – 209 lbs	(>85kg)	5.5 mL/s	(Scan time + 5) * 5.5
> 209 lbs	(>95kg)	6.0 mL/s	(Scan time + 5) * 6

Gated Chest



← put ROI in ascending aorta

Indication:

Aortic root and ascending aortic aneurysm and dissection; acute aortic syndrome with chest pain

Patient preparation:

20G IV cannula; NO β-blocker medication

Patient positioning:

- head first, supine, arms above head.
- ECG-leads
- Practice breath-holding

Comment:

- Make sure the ECG-display shows a clear signal with well identifiable R-peaks; Use ECG-Pulsing in low and stable heart-rates especially in younger patients;

Notes:

DRAFT

Cardiovascular Cardiac01^GATED_CHEST Gated Chest

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 non-cons	neck → diaphragm		insp	↓
2 premonitoring	At carina, ROI in ascending aorta		no	N/A
3 monitoring		10 s	no	N/A
4 gated Chest	well above arch → diaphragm	5 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•		AP, 512 mm
1 non-cons	220	•	120	24×1.2	1.2	0.5 s		
2 premonitoring	20	•	120	•	•	•		
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 gated Chest	700	•	120	64×0.6	0.2	0.33 s	≤25s	As short as possible

C: Reconstruction Parameters

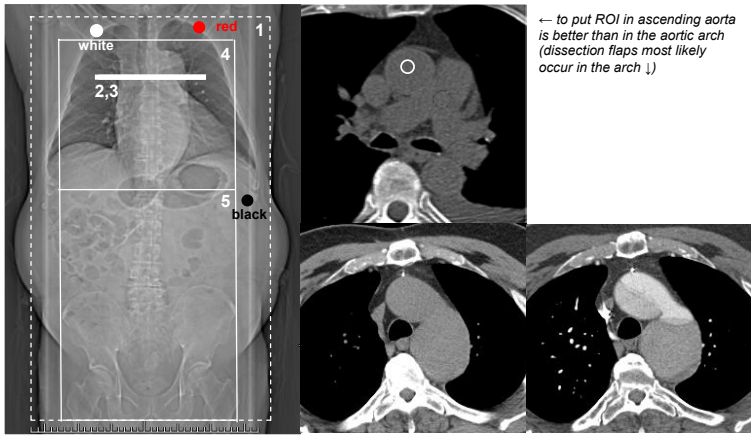
#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1 non-cons	axial	5mm	5mm	B31f	400/40		
4a gated Chest	axial	1mm	0.7mm	B25f	600/80	65%	chest wall
4b gated Chest	axial	1mm	0.7mm	B25f	600/80	0-90%	to heart and aorta

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 370mgI/ml
Scantime	as short as possible for maximum dose utilization;
Injection duration	Fixed phase I; calculated second volume to equal scan time -5s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level; 5s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight		Phase I	Phase II (Calculate Volume)
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	(Scan time - 5) * 3.2
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	(Scan time - 5) * 3.6
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	(Scan time - 5) * 4.0
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	(Scan time - 5) * 4.4
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	(Scan time - 5) * 4.8

Gated Chest/Abdomen/Pelvis CTA (gated Chest, non-gated Abdomen)



← to put ROI in ascending aorta is better than in the aortic arch (dissection flaps most likely occur in the arch ↓)

Indication:

acute dissection, preoperative chronic dissection, thoracic aneurysm, pre-interventional planning

Patient preparation:

20G IV cannula; NO β-blocker medication

Patient positioning:

- head first, supine, arms above head.
- ECG-leads
- Practice breath-holding

Comment:

- This protocol consists of two separate scans in auto-range mode with 4s interscandelay. The Start-button has to be pushed only once. Breathing instruction needs to be given by the technologist.
- The chest part should not exceed 25 s in scan time and the abdomen part should be scanned in 10 s.
- Make sure the ECG-display shows a clear signal with well identifiable R-peaks; Use ECG-Pulsing in low and stable heart-rates especially in younger patients;
- FoV and x/y coordinates should be the same for both contrast scans and merged after reconstruction. The merged dataset should be sent to PACS.

Notes:

DRAFT

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → lesser trochanter		insp	↓
1 non-cons	neck → lesser trochanter		insp	↓
2 premonitoring	At carina, ROI in ascending aorta		no	N/A
3 monitoring		10 s	no	N/A
4 gated Chest	Above arch → diaphragm (≤ 25s scan time)	5 s	insp	↓
5 Abdomen	End of series 4 → lesser trochanter (10 s scan time)		↓	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•		AP, 768 mm
1 non-cons	220	•	120	24×1.2	1.2	0.5 s		
2 premonitoring	20	•	120	•	•	•		
3 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
4 gated Chest	700	•	120	64×0.6	0.2	0.33 s	≤25s	As short as possible
5 Abdomen		250	120	64x0.6	1	0.33	10s	

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
1a non-cons	axial	5mm	5mm	B31f	400/40		
4a gated Chest	axial	1mm	0.7mm	B25f	600/80	65%	
4b gated Chest	axial	1mm	0.7mm	B25f	600/80	0-90%	Same as abdomen
5a Abdomen	axial	1mm	0.7mm	B25f	600/80		Same as chest
5b Abdomen	axial	5mm	5mm	B31f	600/80		Body wall

D: Contrast Medium Injection Parameters (biphasic)

CM Concentration	≥ 370mgI/ml
Scantime	Chest: as short as possible for maximum dose utilization; Abdomen: 10s
Injection duration	calculated to equal 35s scantime for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 100 HU trigger level; 5s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight		Phase I	Phase II	TotalCM Vol.
< 121 lbs	(<55kg)	20 mL @ 4.0 mL/s	96 mL @ 3.2 mL/s	116 mL
121 – 143 lbs	(<65kg)	23 mL @ 4.5 mL/s	108 mL @ 3.6 mL/s	131 mL
143 – 187 lbs	(~75kg)	25 mL @ 5.0 mL/s	120 mL @ 4.0 mL/s	145 mL
187 – 209 lbs	(>85kg)	28 mL @ 5.5 mL/s	132 mL @ 4.4 mL/s	160 mL
> 209 lbs	(>95kg)	30 mL @ 6.0 mL/s	144 mL @ 4.8 mL/s	174 mL

Left Atrial Mapping

ROI in the left atrium

Indication:

Pre and post EP ablation in patients with atrial fibrillation

Patient preparation:

20G IV cannula; NO β-blocker medication

Patient positioning:

- head first, supine, arms above head
- ECG-leads
- Rehears breath-holding

Comment:

- This scan protocol utilizes CD4D on a level of 800 ref mAs; spatial resolution is not as important as in Coronary CTAs since primarily pulmonary veins are to evaluate; therefore the axial slice thickness is increased to 1.0mm
- The scan range should include the aortic arch to allow an evaluation of upper lobe veins.
- Make sure the ECG-display shows a clear signal with well identifiable R-peaks and T-waves; Systole reconstructions are necessary, so ECG-Pulsing is not recommended;
- FoV fit to aorta and heart;
- If the patient is in atrial fibrillation, T-wave reconstruction may improve image quality;

Notes:

DRAFT

Cardiovascular Cardiac01^LAM Left Atrial Mapping

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 premonitoring	~ 4cm below carina, ROI in left atrium		no	N/A
2 monitoring		10 s	no	N/A
3 LAM	above arch → diaphragm (≤ 25s scan time)	5 s	mid insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
1 premonitoring	20	•	120	•	•	•	•	
2 monitoring	20	•	120	•	•	30 scans, 1.2s cycle time		
3 LAM	•	800	120	64×0.6	0.2	0.33 s	≤25s	As short as possible

C: Reconstruction Parameters

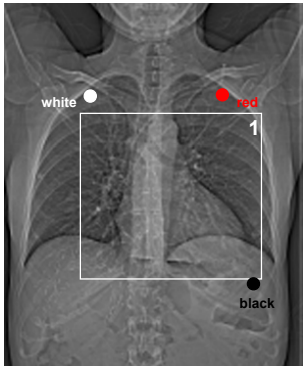
#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
3a LAM	axial	1mm	0.7mm	B25f	600/80	30%	Aorta and heart
3b LAM	axial	1mm	0.7mm	B25f	600/80	0-90%	Aorta and heart

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	as short as possible
Injection duration	scan time + 5 s for all patients !
Bolus Timing	Automated bolus trigger (Care-Bolus); 150 HU trigger level; 5 s user delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight		Flow Rate	Calculate Volume
< 121 lbs	(<55kg)	3.5 mL/s	(Scan time + 5) * 3.5
121 – 143 lbs	(<65kg)	4.0 mL/s	(Scan time + 5) * 4.0
143 – 187 lbs	(~75kg)	4.5 mL/s	(Scan time + 5) * 4.5
187 – 209 lbs	(>85kg)	5.0 mL/s	(Scan time + 5) * 5.0
> 209 lbs	(>95kg)	5.5 mL/s	(Scan time + 5) * 5.5

Coronary Vein Mapping



Indication:

Planning of left ventricular (coronary sinus) pacemaker lead placement

Patient preparation:

20G IV cannula; NO β-blocker medication

Patient positioning:

- head first, supine, arms above head
- ECG-leads
- Practice breath-holding

Comment:

- This scan protocol utilizes CD4D on a level of 800 ref mAs;
- Automated Bolus Timing is not necessary; use a delay of 50s;
- The aortic arch should be included in the scan range
- Make sure the ECG-display shows a clear signal with well identifiable R-peaks and T-waves; Systole reconstructions are necessary, so ECG-Pulsing is not recommended;
- FoV fit to aorta and heart;

Notes:

DRAFT

A: Chronologic Prescription and Scanning Range

#	Scanning Range	Delay	BH	Dir.
0 Topogram	neck → diaphragm		insp	↓
1 CVM	above arch → diaphragm (≤ 25s scan time)	50 s	insp	↓

B: Scanning Parameters

#	Eff mAs	Ref mAs	kV	Detector config.	Pitch	Rot. time	Scan time	Comment
0 Topogram	35	•	120	•	•	•	•	AP, 512 mm
3 CVM	•	800	120	64×0.6	0.2	0.33 s	≤25s	As short as possible

C: Reconstruction Parameters

#	Type/ orient	STh	RI	Kernel	Window WW / WL	ECG-Trigger	Field of View / Comment
3 CVM	axial	1mm	0.7mm	B25f	600/80	0-90%	Aorta and heart

D: Contrast Medium Injection Parameters

CM Concentration	≥ 350mgI/ml
Scantime	as short as possible
Injection duration	45s for all patients !
Bolus Timing	50s scan delay
Saline flushing	40 mL @ same flow rate as Contrast Phase

Body weight	Flow Rate	Volume
All patients	3.0 mL/s	135 mL

Abbreviations

AP	anterior-posterior
BH	breath-hold
Bpm	beats per minute
CM	contrast media
config	detector configuration
cor	coronal
CTA	Computed Tomography Angiography
Dir	scanning direction
ECG	electro cardiogram
Eff mAs	effective milli ampere seconds
FoV	Field of View
HN	head and neck
HU	hounsfield unite
IMA	internal mammarian artery
Insp	inspiration
IV	intra venous
Kg	kilogram
kV	kilo voltage
LAT	lateral
Lbs	pounds (libra)
LE	lower extremity
Ltd	limited
Mgl	milligram Iodine
mL	milli liter
mm	milli meter
N/A	not applicable
Orient	orientation
Ref mAs	reference milli ampere seconds
RI	reconstruction interval
ROI	region of interest
Rot time	rotation time
s	second
sag	sagittal
Seq	Sequence
STh	slice thickness
UE	upper extremity
Vol	volume
WL	window level
WW	window width