

CONTRAST MEDIUM DYNAMICS, SCAN PROTOCOLS, AND TROUBLESHOOTING



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DISCLOSURES

- None

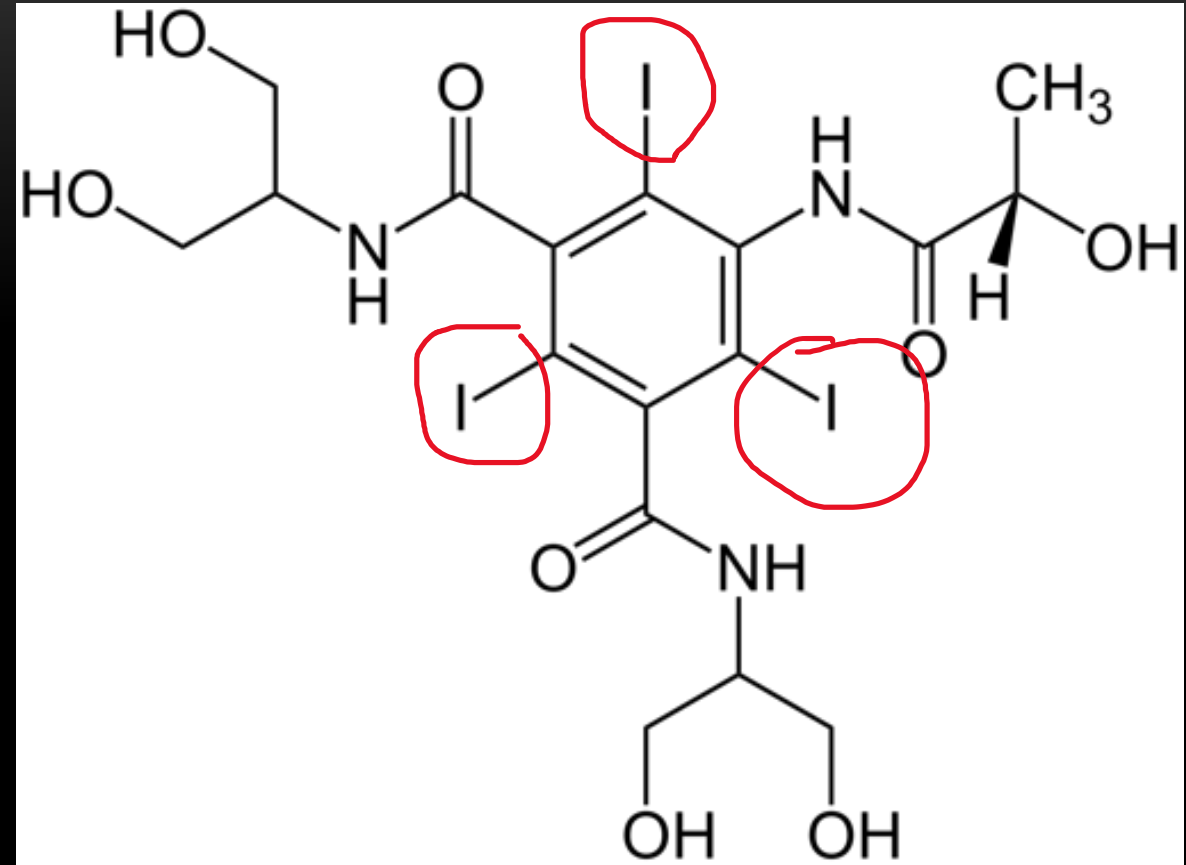
OVERVIEW

- Review of Early Contrast Medium Dynamics
 - Rational CTA Protocol Design
 - Routine cardiovascular imaging exams
 - Special exam considerations / Troubleshooting
 - Q & A
-

EARLY CONTRAST MEDIUM DYNAMICS

IOPAMIDOL (ISOVUE™)

- 3 Iodine atoms / molecule
 - Iodine k-edge = 33keV
- Iodine atoms attenuate (stop) x-rays, leads to “enhancement” on CT
- How contrast medium is delivered controls degree of arterial vascular enhancement



Why care about early contrast medium dynamics?

*.. to understand relationship between
IV CM delivery and
arterial enhancement
(time-attenuation response)*

EARLY CONTRAST DYNAMICS (~ 1 MIN.)

IV contrast medium injection

→ r. heart → lung* → l.heart → **arterial system**

→ organs* → brain

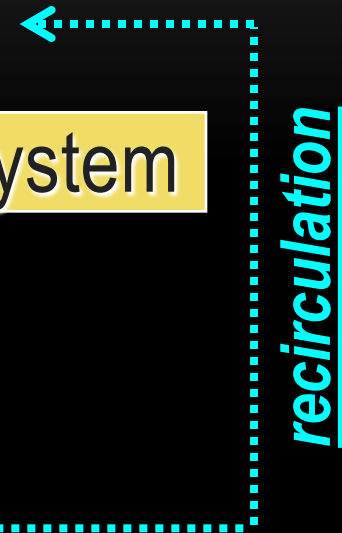
→ kidney

→ spleen, intestines ...

→ liver

→ myocardium, muscles

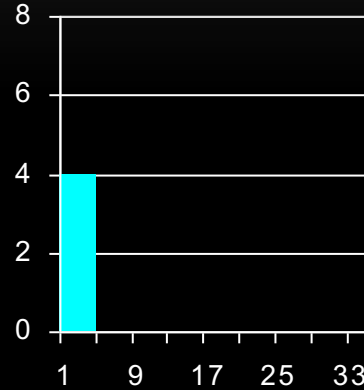
* intravascular/interstitial



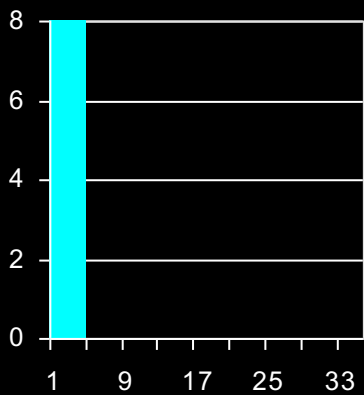
INPUT

intravenous
injection rate
(mL/s)

4 mL/s
(16 ml)

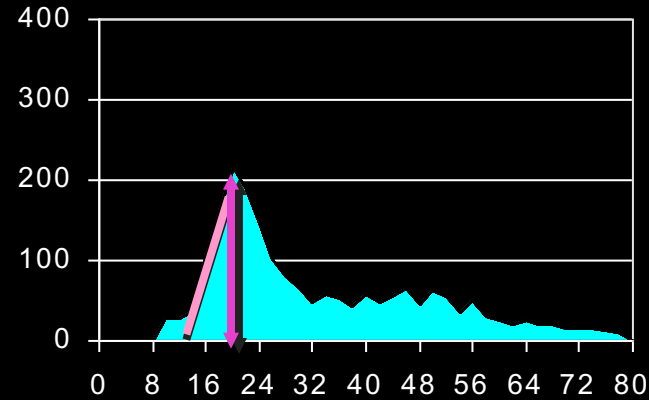
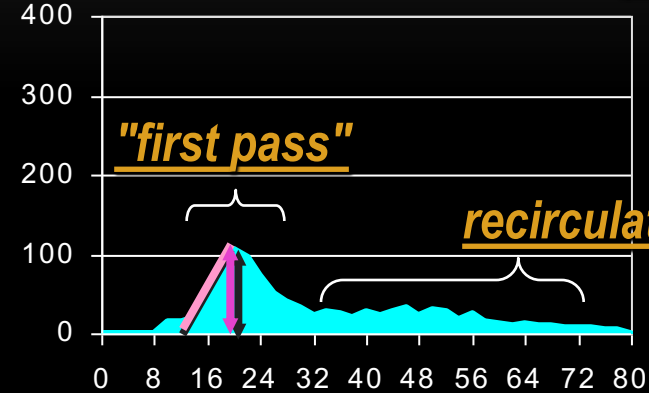


8 mL/s
(32 mL)



OUTPUT

arterial
enhancement
(change in HU)



→ time (s)

EARLY CONTRAST DYNAMICS

KEY RULES FOR CTA

- §1 arterial enhancement is proportional to Iodine administration (flow) rates
- §2 arterial enhancement increases ("cumulative") with longer injection duration

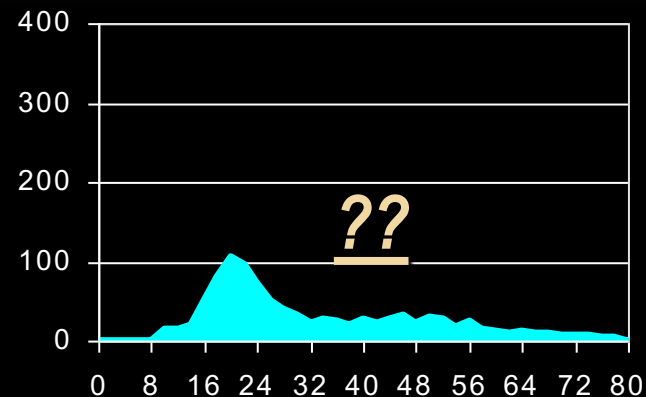
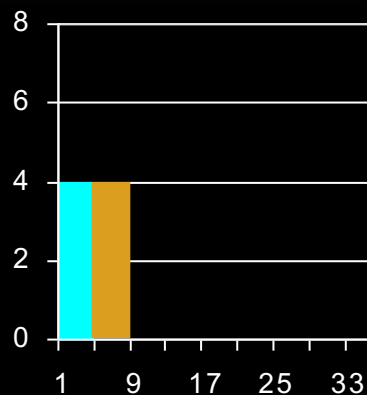
INPUT

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injection rate
(mL/s)

4 mL/s
~~(16 mL)~~
(32 mL)

OUTPUT

(change in HU)
arterial
enhancement



→ time (s)

INPUT

intravenous
injection rate
(mL/s)

(4 mL/s)

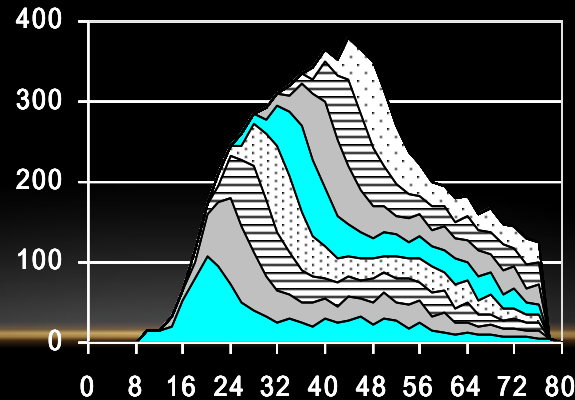
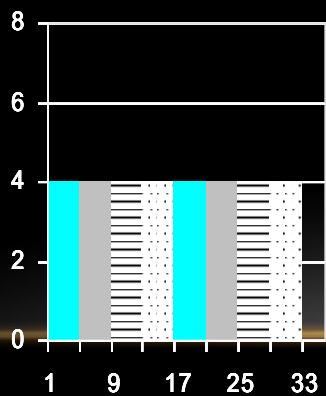
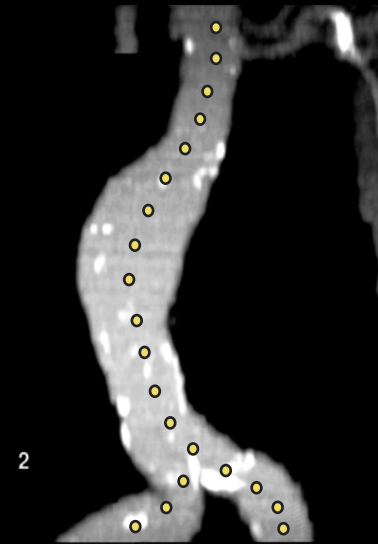
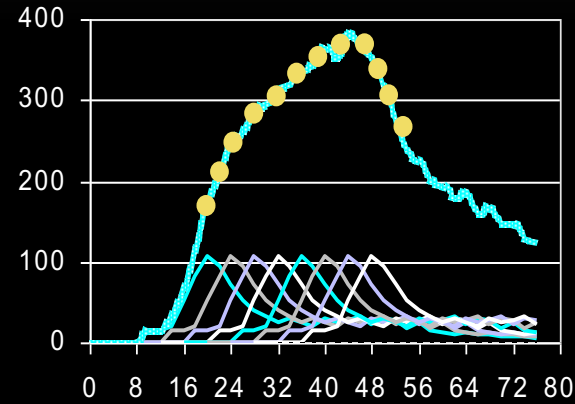
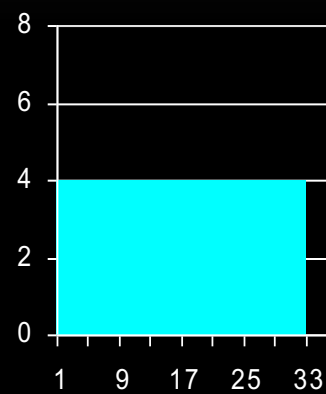
+16 mL

+16 mL

+16 mL

+.....

128 mL



OUTPUT

(change in HU)
arterial
enhancement

EARLY CONTRAST DYNAMICS

KEY RULES FOR CTA

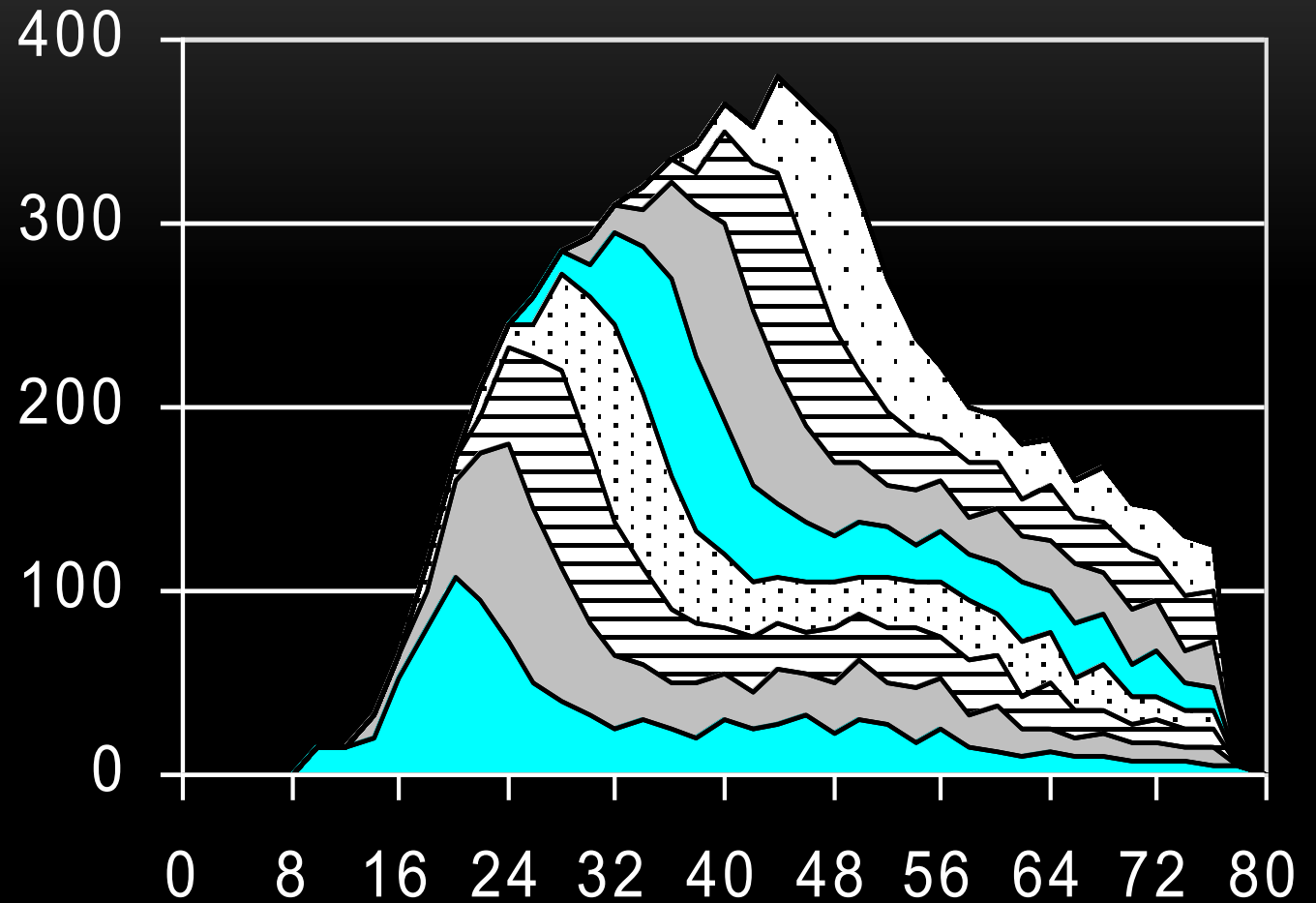
- §1 arterial enhancement is proportional to Iodine administration (flow) rates
 - §2 arterial enhancement increases ("cumulative") with longer injection duration
-

EARLY CONTRAST DYNAMICS

KEY RULES FOR CTA

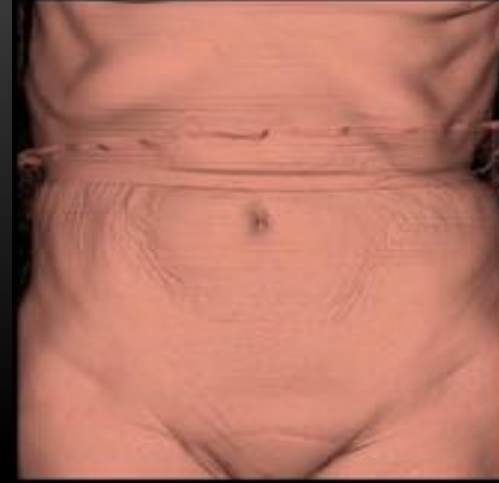
§1 arterial enhancement is proportional to iodine administration rates

§2 arterial enhancement increases ("cumulative") with longer injection duration



Are there other factors?

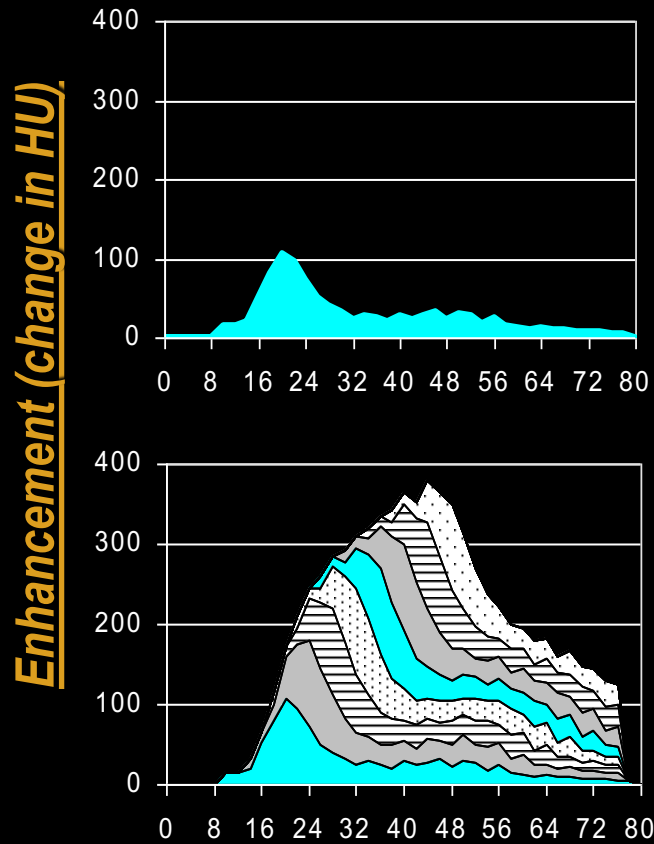
PATIENT FACTORS



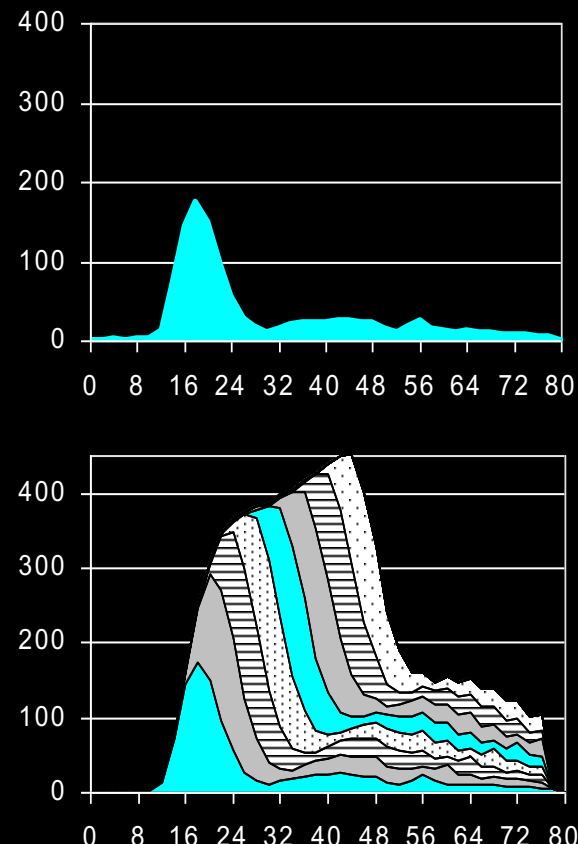
- Arterial enhancement is inversely related to:
 - Cardiac output (CO)
 - Central blood volume (CBV) } usually unknown
 - CO (and CBV) correlate with body weight
 - at least in pts. with ~ normal cardiac function
 - Weight-based dosing helps consistency

" PATIENT ATTENUATION FACTOR "

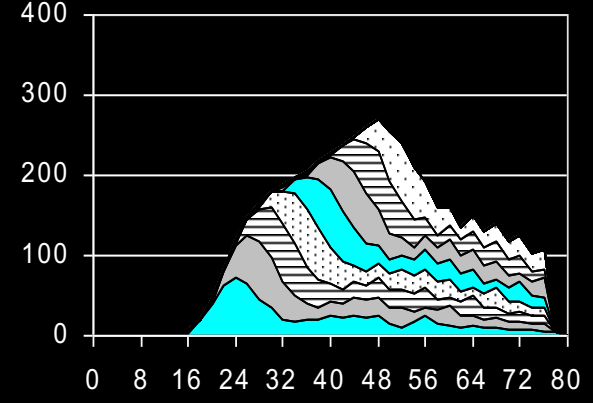
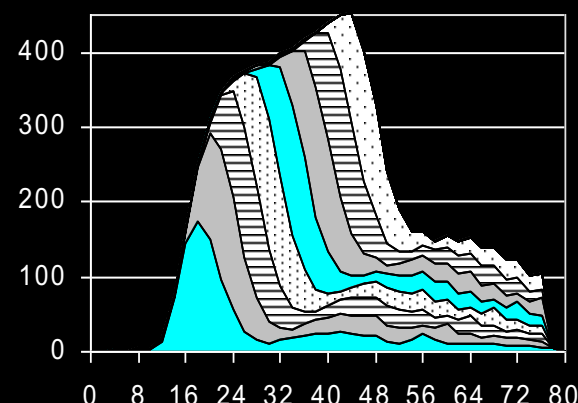
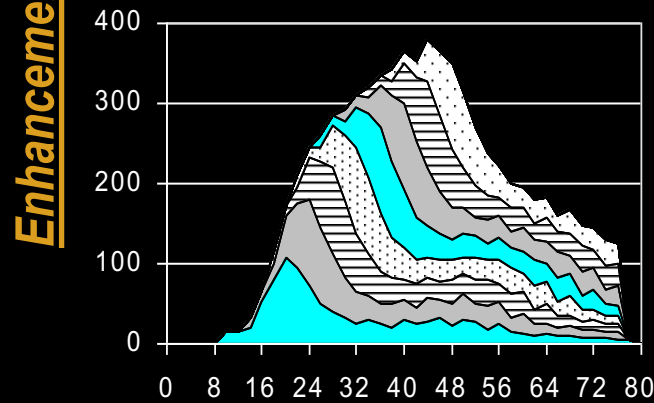
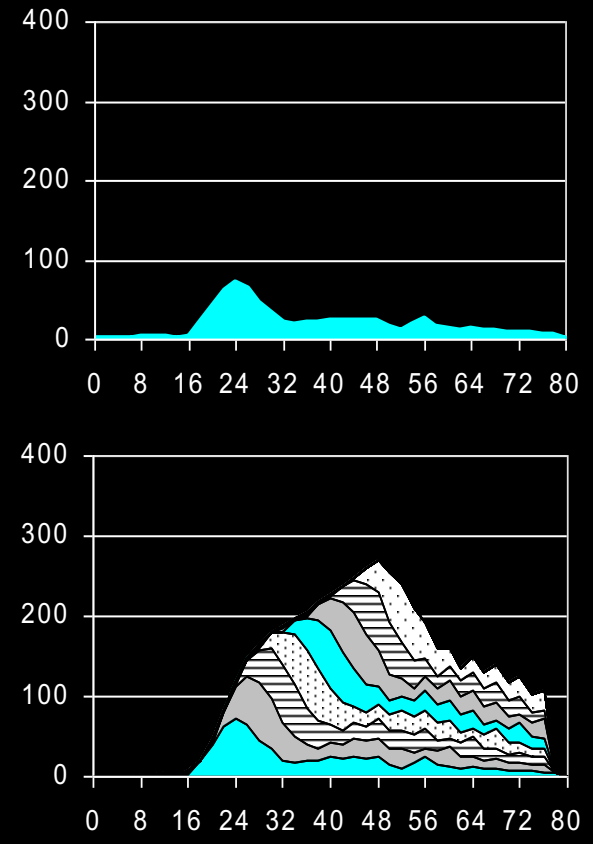
average
attenuation
response



high
attenuation
response



low
attenuation
response

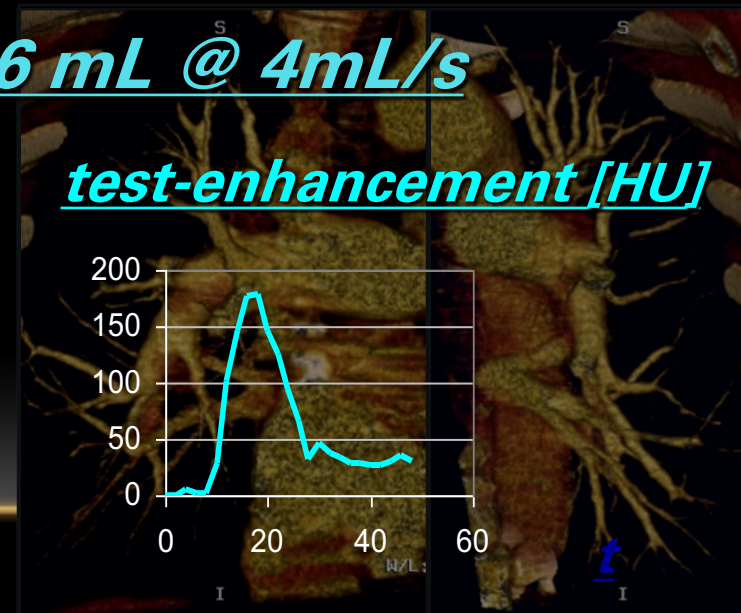
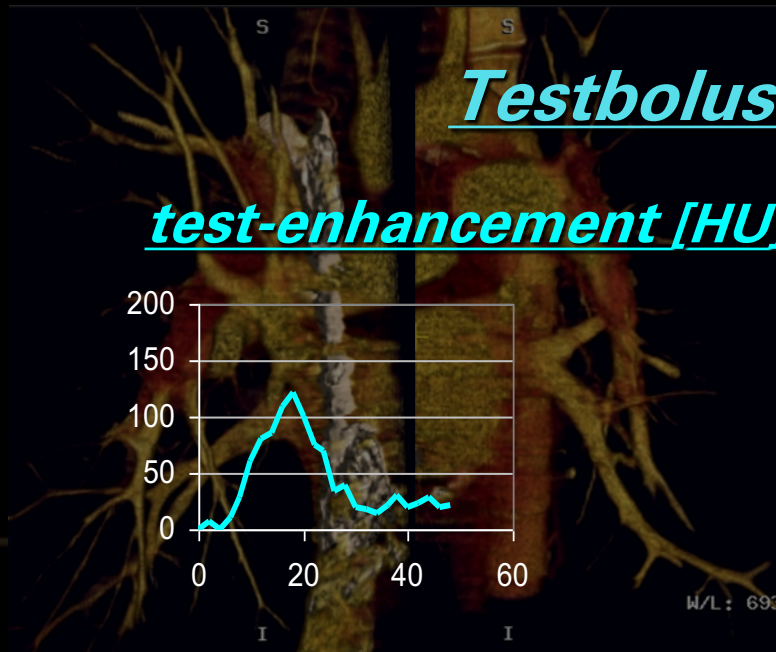


→ time (s)

EFFECT OF CARDIAC OUTPUT : CTEPH PATIENTS

- 34 y.o. man
- PAP: 63/12 (34)
- CO: 5.4 L/min
- CI: 2.5 L/min/m²

- 59 y.o. woman
- PAP: 67/23 (40)
- CO: 3.4 L/min
- CI: 1.7 L/min/m²



EARLY CONTRAST DYNAMICS

KEY RULES FOR CTA - **REVISED**

§1 arterial enhancement is proportional to Iodine administration rate (flow rate)

(inverse to CO)

§2 arterial enhancement increases ("cumulative") with longer injection duration

(inverse to CO and body-weight)

§3 *adjust inj. rate and CM volume ($\pm 20\%$)
for pts. $\leq 60\text{kg}$ and $\geq 90\text{kg}$*

*If injecting longer, scan LATER
(increase DELAY)*

"Inject longer,
scan later"

20-s scan

4 ml/s for 20s

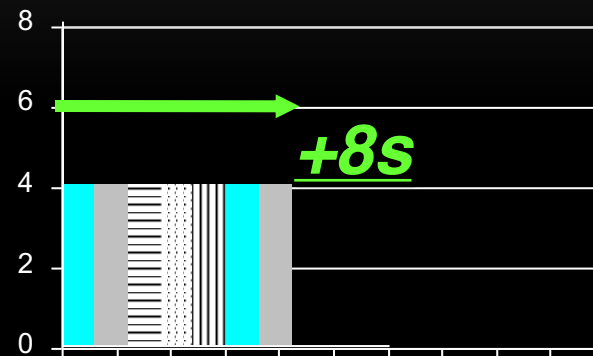
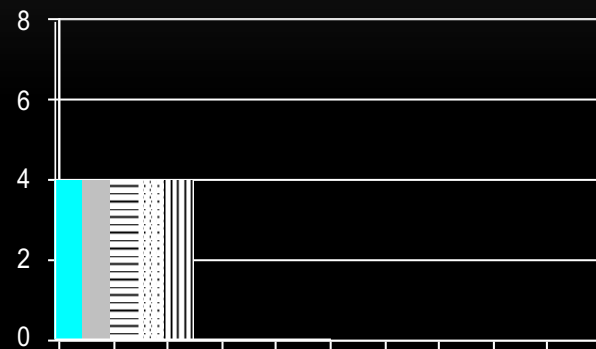
80 ml

28-s scan

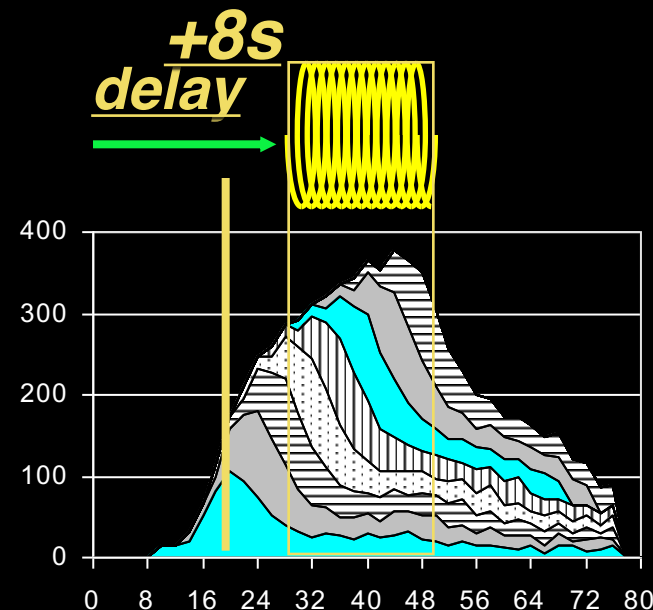
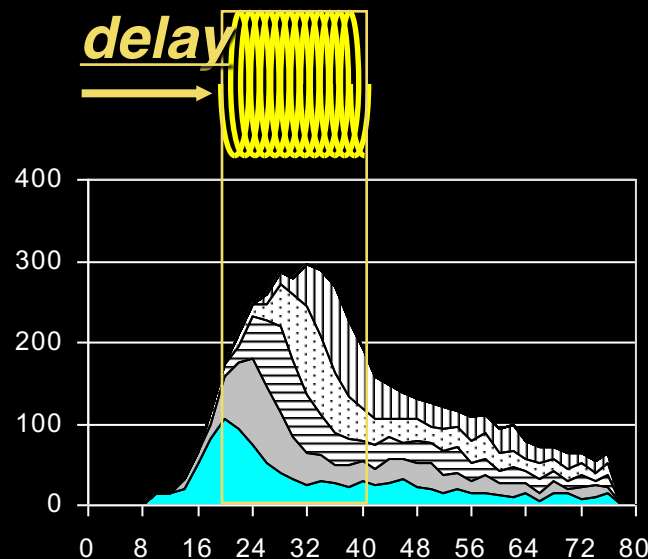
4 ml/s for 28s

112 ml

inj.rate (ml/s)



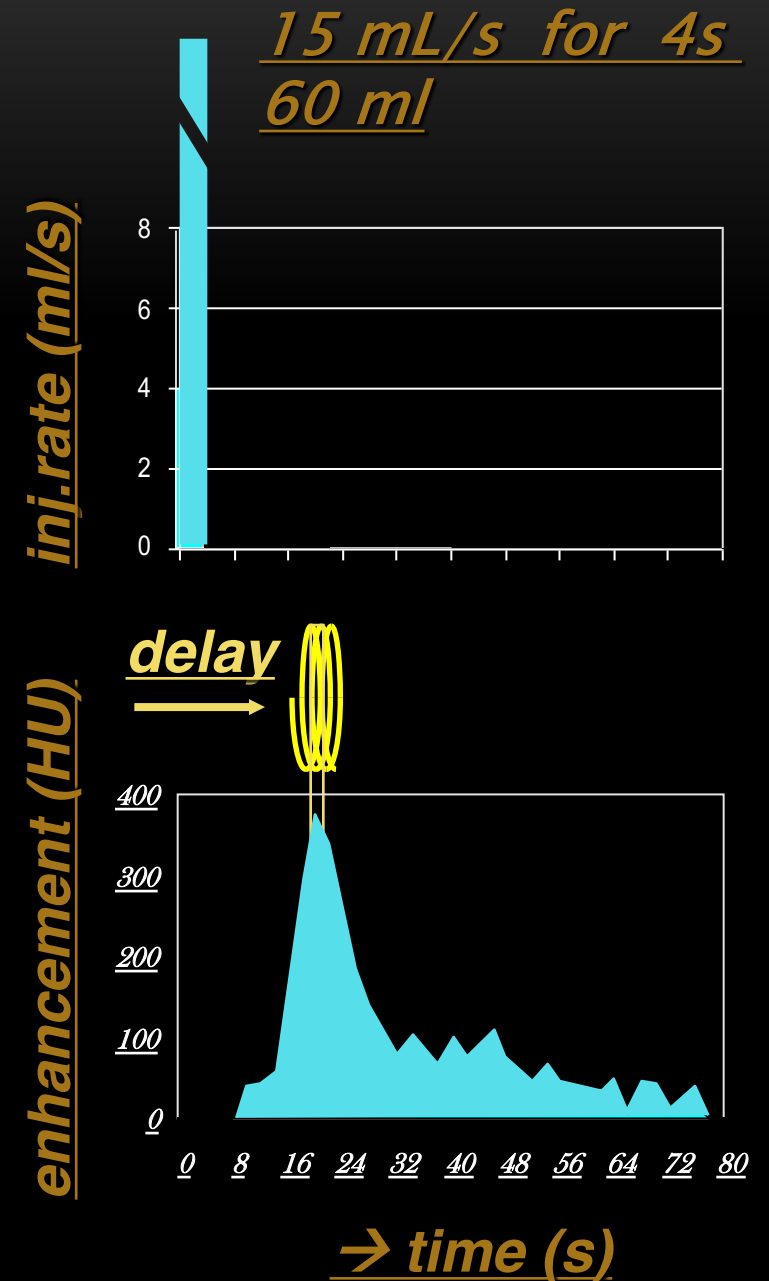
enhancement (HU)



→ time (s)

What about very fast CTA acquisition?

- *short acquisitions (injections) give lower enhancement*
- *Unable to increase the injection rate indefinitely*
- *increased risk of completely missing the bolus*
- *risk of outrunning the bolus (aneurysms, peripheral CTA ..)*



Summary: Rules of Early CM Dynamics

- **Arterial Enhancement is Proportional to Iodine Flow Rate (Flux)**
 - Increasing the injection flow rate and/or iodine concentration of CM will increase the arterial opacification.
- **Arterial enhancement increases over time as a cumulative effect**
 - Arterial enhancement increases with increasing injection duration.
 - Minimum injection duration of ~ 10 s needed to achieve adequate arterial enhancement.
- **Arterial enhancement is highly variable between individuals**
 - Cardiac output (CO) is inversely proportional to arterial enhancement
 - CO correlates proportionally to body weight / body surface area (BSA)
 - Revising the injection rate and CM volume upward for larger (>90 kg) and downward for smaller (<60 kg) patients will reduce inter-individual variability.
- **Arterial filling may be delayed physiologically and/or pathologically**
 - Even normal coronary arteries need several heartbeats to fully opacify
 - Mixing of opacified and unopacified blood in aneurysms delays peak enhancement

CTA PROTOCOL DESIGN



CTA PROTOCOL DESIGN: IMPORTANT FACTORS

- Early Contrast Medium Dynamics
 - Weight-based CM dosing
 - Scan time
 - Tube energy (kV), image noise considerations
 - Low kV scanning
 - Iterative Reconstruction
-

TIPS FOR BUILDING INJECTION/SCAN PROTOCOLS

- Scan times dependent on scanner, scan mode chosen
- Bolus track the area of interest
- It takes ~ 6 sec for image reconstruction, table movement, and breath hold instructions
 - I also add 2 sec “fudge factor”

Injection Duration = scan time + 8 + “delay”

EXAMPLE: INTEGRATED CT ACQUISITION / INJECTION PROTOCOL: CTA OF THE THORACIC / ABDOMINAL AORTA

Acquisition	64 x 0.6 mm (channels x channel width); automated tube current modulation (250 mAs reference mAs)
Pitch	Variable (depends on volume coverage, usually >1.0)
Scan time	Fixed to 10 s (all patients)
Injection duration	Fixed to 18 s (all patients)
Scanning delay	$t_{\text{CMT}} + 8 \text{ s}$ (scan starts 8s after CM arrival, as established by automated bolus triggering)
Contrast medium	High concentration (350-370 mg I/mL)

Injection flow rates /
volumes

Individualized to body weight:

Body Weight (kg)	CM Flow Rate (mL/s)	CM Volume (mL)
≤ 55	4.0	72
56-65	4.5	81
66-85	5.0	90
86-95	5.5	99
> 95	6.0	108

CONTRAST Q & A

SPECIAL SCENARIOS / EXAMS

- Peripheral CTA
- CCTA
- Structural Heart (TAVR, TMVR, etc)
- LAA mapping / Watchman
- Pediatric cardiac CT
 - “Routine” peds cardiac CT
 - Fontan Circulation



SPECIAL SCENARIO: PERIPHERAL CTA

Long scan time needed (variable speed of blood flow)

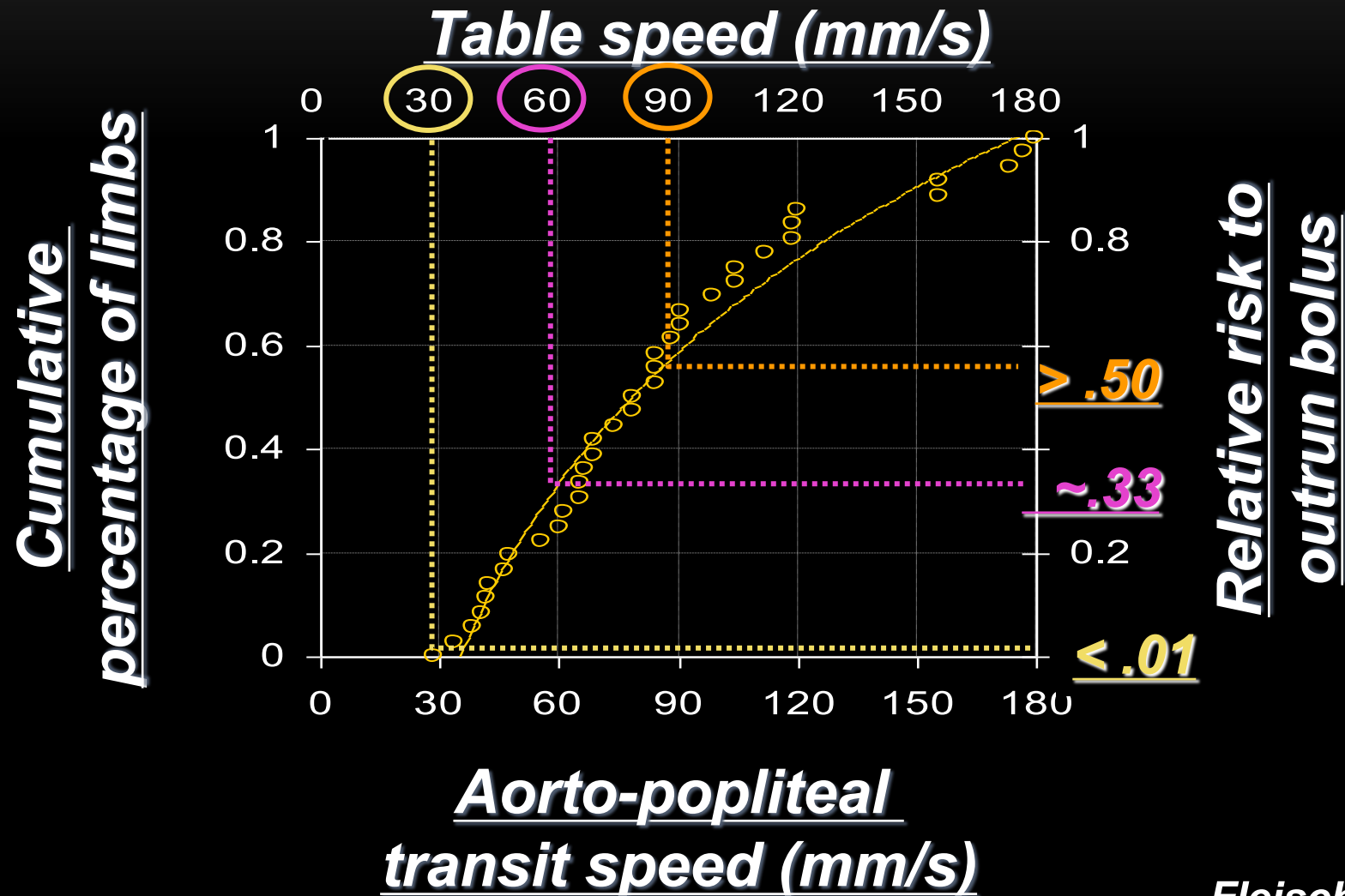
Contrast medium volume is a limiting factor



CONTRAST CONSIDERATIONS FOR PERIPHERAL CTA

- Aorto-popliteal transit time: 4-24 sec (10 sec)
 - Contrast speed: 29-177 mm/s
- Biphasic injections yield more consistent enhancement profile

PERIPHERAL ARTERIAL BOLUS PROPAGATION



Fleischmann D and Rubin GD.
Radiology 2005, 1076-1082

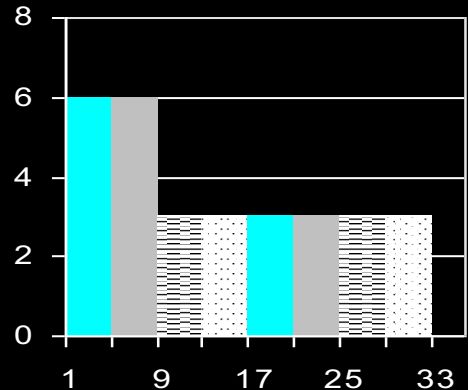
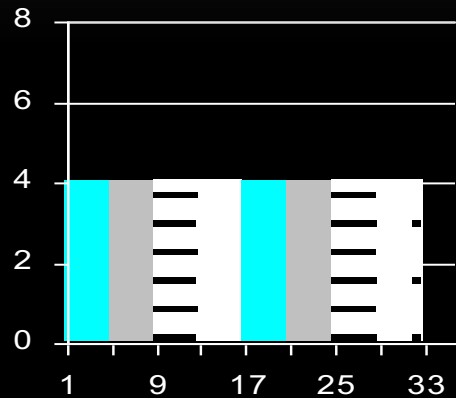
Biphasic Injection for Peripheral CTA

INPUT

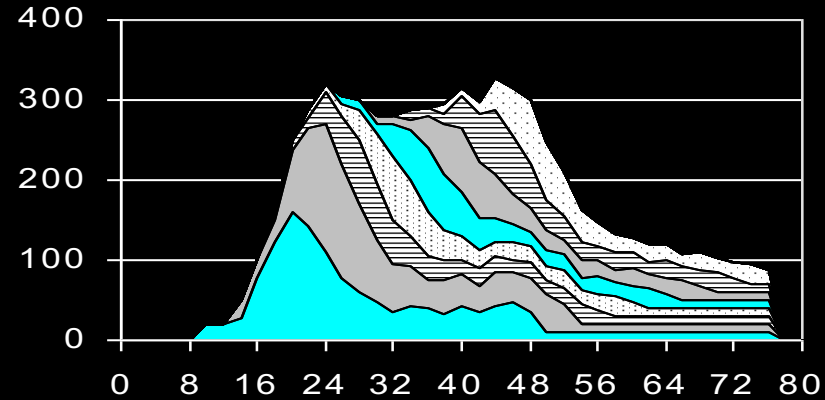
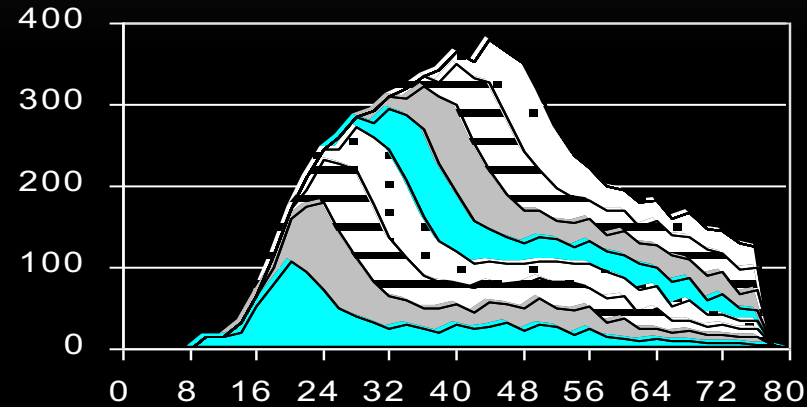
intravenous
injection rate
(mL/s)

Biphasic Injection

Phase I
(surge phase)



Phase II
(continuing phase)



OUTPUT

arterial
enhancement
(Δ HU)

INTEGRATED SCANNING-INJECTION PROTOCOL: (SIEMENS)

- Scan time: 40s for ALL patients (pitch variable)
- Inj.duration: 35s for ALL patients
- Delay: bolus triggering 5 sec FAST + 30 sec SLOWER

<u>Weight</u>	<u>Biphasic Injection</u>
<u><55kg</u>	<u>20 mL (4.0mL/s) + 96 mL (3.2mL/s)</u>
<u><65kg</u>	<u>23 mL (4.5mL/s) + 108 mL (3.6mL/s)</u>
<u>75kg</u>	<u>25 mL (5.0mL/s) + 120 mL (4.0mL/s)</u>
<u>>85kg</u>	<u>28 mL (5.5mL/s) + 132 mL (4.4mL/s)</u>
<u>>95kg</u>	<u>30 mL (6.0mL/s) + 144 mL (4.8mL/s)</u>

SPECIAL SCENARIO: CORONARY CTA (CCTA)

- Requires HR control (beta-blockers) and vasodilation (NTG)
- ? R heart opacification – is split contrast chaser needed?

CCTA: PROTOCOL CHOICES

- Helical, retrospective ECG-synchronized
 - Can do function (LVEF)
- Prospective, ECG synchronized
- High speed helical (Flash, turbo flash)

CCTA PROTOCOL:



FLASH_CARDIO_ROUTINE (Adult)

Indications- coronary vessel disease
SOMOTOM DEFINITION FLASH

POSITIONING		Feet first, arms above head			
CARDIAC GATING		Yes			
		FLASH CA SCORE HR under 65 bpm	FLASH COR CTA HR under 65 bpm; pt wt under 220 lbs	DS CorAdSeq HR over 65 bpm; pt wt over 220 lbs	
INJECTION RATE / VOLUME		n/a	Weight based	Weight based	
SCAN TYPE/ ROTATION TIME		Helical / 0.28 sec	Helical / 0.28 sec	Helical / Flex 0.28 sec	
START LOCATION		Carina	Carina	Carina	
END LOCATION		Diaphragm	Diaphragm	Diaphragm	
ACQUISTION	DETECTOR CONFIGURATION	128 x 0.6 mm	128 x 0.6 mm	128 x 0.6 mm	
	DETECTOR COVERAGE	76.8 mm	76.8 mm	76.8 mm	
GANTRY ANGLE		n/a	n/a	n/a	
PITCH/FEED(mm/rotation)		3.45 mm	3.4 mm	34.5 mm FEED	
KVP		120 Reference kV	100 Reference kV	100 Reference kV	
MA		Quality Ref mAs 80	Quality Ref mAs 240	Quality Ref mAs 240	
SAFIRE (NOISE REDUCTION)		OFF	OFF	OFF	
BOLUS TRACK (LOCATION) MAS / MONITORING DELAY BOLUS TRIGGER (HU)		n/a	ROI Ascending Aorta 30 / 8 sec n/a / 15 scans	ROI Ascending Aorta 30 / 8 sec n/a / 15 scans	
PREP GROUP (seconds)		n/a	9 sec	9 sec	
BREATHING INSTRUCTIONS		Suspended inspiration			
SERIES	FOV	ALGORITHM	WINDOW	THICKNESS	INTERVAL
FL CA SCORE	200 mm	B20f Smooth	Mediastinum	3.0 mm	1.5 mm
Cardiac 1mm 60%	200 mm	B20f Smooth	CT Angio	1.0 mm	0.6 mm
Cardiac 1.0	200 mm	B20f Smooth	CT Angio	1.0 mm	0.6 mm
Lungs 60%	330 mm	L50f Med Sharp ASA	Lung	2.0 mm	2.0 mm
Cardiac 1mm 60%	200 mm	B20f Smooth	CT Angio	1.0 mm	0.6 mm
Cardiac 0-90%	200 mm	B20f Smooth	CT Angio	1.0 mm	0.6 mm
Lungs	340 mm	B60f Med Sharp	Lung	2.0 mm	2.0 mm
DOSE INDEX (CTDIvol) (mGy)					
PACS		Blank and lined scouts; all series			
WORKSTATION (AQNET & TERA WORKSTATION)		Blank and lined scouts; all series			

SHIELD PATIENT APPROPRIATELY FOR EXAM.

ADJUST DFOV FOR PATIENTS BODY HABITUS. DFOV SHOULD BE LARGE ENOUGH TO INCLUDE ALL SOFT TISSUES

CARE Dose 4D and CARE kV ARE UTILIZED TO DECREASE PATIENT DOSE.

WHAT ABOUT THE DILUTE CONTRAST CHASER?

TRI-PHASE

Fluid Source ml

A 100 ml
B 100 ml

Add 4 ml

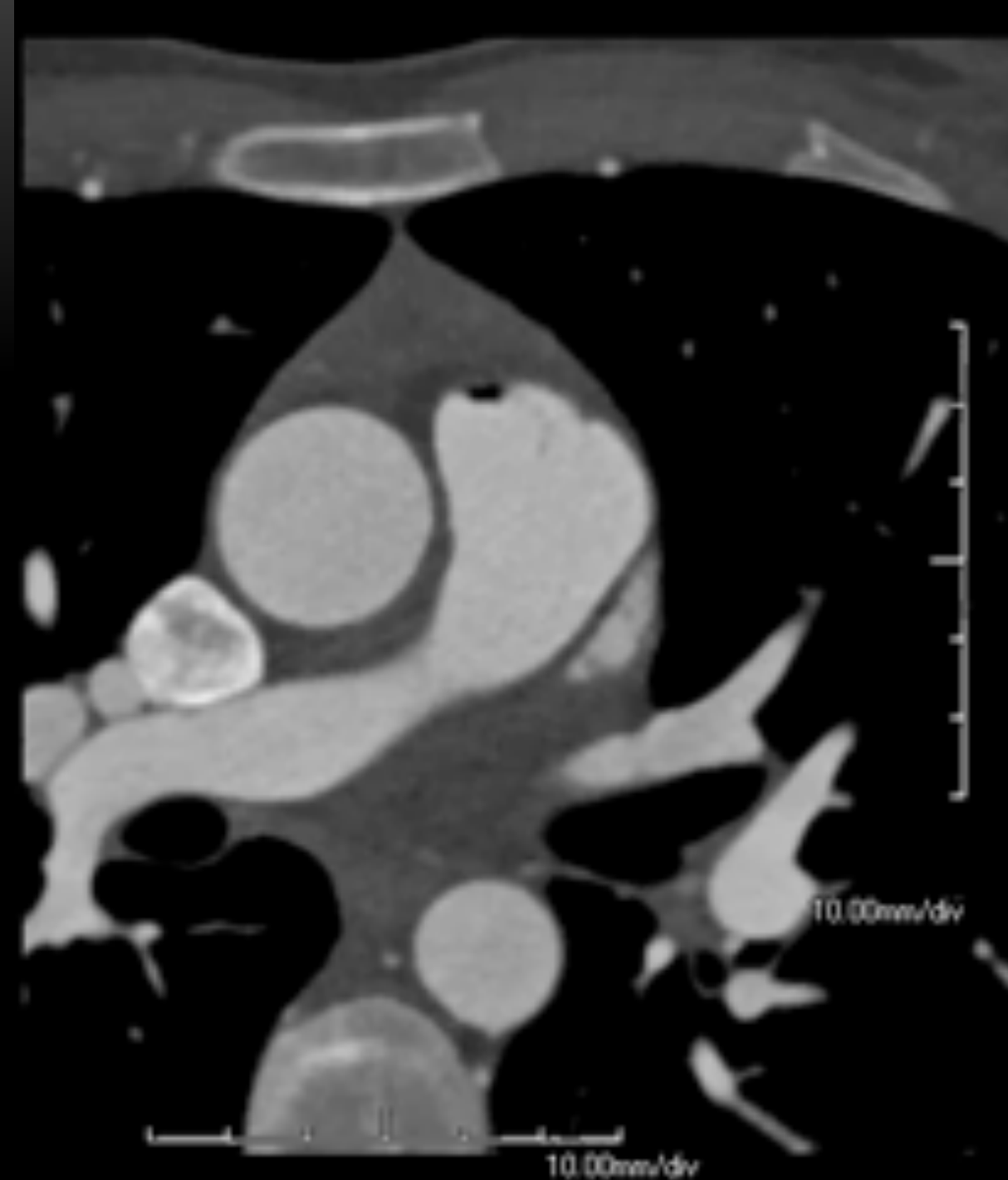
04/20/2020 10:41:48

	Flow Rate ml/s	Volume ml	Duration min:ss
B	5.0	50	00:10
Test Injection			
A	5.0	60	00:12
%	5.0	60% 35 40%	00:07
B	5.0	40	00:08
?			
(R)	Total A ml	81	Total B ml 104

1	C	5.0	45	9
2	C	2.5	12	5
3	S	5.0	40	8

RIGHT HEART OPACIFICATION

- We do NOT use dilute contrast chaser routinely
- We use longer injection than 9 sec (allow full filling of coronaries)
- R heart opacification is almost always enough to allow quantification
- If question, could add 5 more sec CM injection



STRUCTURAL HEART THERAPY

- TAVR
 - TMVR
 - LAA mapping / Watchman
-

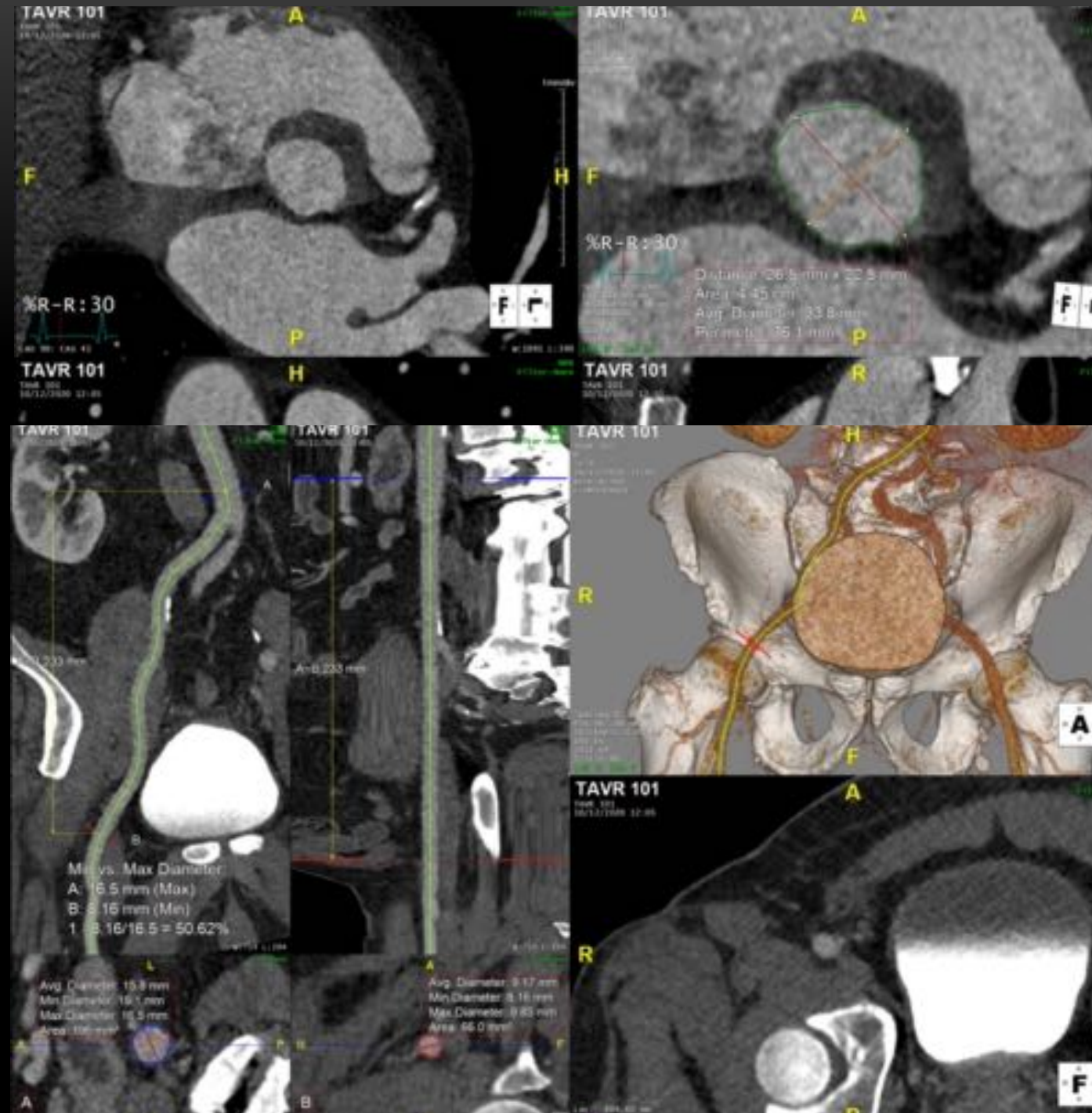
TAVR

- “Transcatheter **A**ortic **V**alve **R**eplacement”
- Typically performed for valvular aortic stenosis, bioprosthesis dysfunction
- Percutaneous placement means CT planning is important
 - Device sizing
 - Arterial Access vessel route and sizes (≥ 6.0 mm)



TAVR

- “Transcatheter **A**ortic **V**alve **R**eplacement”
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- Percutaneous placement means CT planning is important
 - Device sizing
 - Arterial Access vessel route and sizes (≥ 6.0 mm)



TAVR

- “Transcatheter Aortic Valve Replacement”
- ECG-synchronized CTA of heart
 - Bolus track ascending aorta
 - 30-70% RR = systole and diastole
 - Annulus largest at 30%
- Non-gated Flash CTA neck, chest, abdomen, pelvis
- Weight-based, single injection

GATED_FLASH_TAVR_RETRO (Adult)

Indications- Evaluate aorta size
SOMOTOM DEFINITION FORCE

POSITIONING/LANDMARK		Supine feet first, arms above head			
CARDIAC GATING		Yes			
INJECTION RATE / VOLUME		Weight based			
		GATED HEART 30, 40, 60 70	CORBODY 3.0 (FLASH)		
SCAN TYPE/ ROTATION TIME		Helical / 0.25 sec /	Helical / 0.25 sec /		
START LOCATION		Aortic Arch	Apices		
END LOCATION		Diaphragm	Lesser Trochanters		
ACQUISITION	DETECTOR CONFIGURATION	192 x 0.6 mm	192 x 0.6 mm		
	DETECTOR COVERAGE	57.6 mm	57.6 mm		
GANTRY ANGLE		n/a	n/a		
PITCH (mm/rotation)		0.2 mm	1.9 mm		
KVP		100 Reference kV	80 Reference kV		
MA		Quality Reference mAs 288	Quality Reference mAs 174		
ADMIRE (NOISE REDUCTION)		ON	ON		
BOLUS TRACK (LOCATION)		ROI Ascending Aorta	n/a		
MAS / MONITORING DELAY		23 mAs / 10 sec			
BOLUS TRIGGER (HU)		150 HU			
PREP GROUP (seconds)		7 sec	9 sec		
BREATHING INSTRUCTIONS		Suspended inspiration	Suspended inspiration		
SERIES	FOV	ALGORITHM	WINDOW	THICKNESS	INTERVAL
HEART 30-70	200 mm	BR40	CT Angio	0.6 mm	0.55 mm
FL CAP 3.0	300 mm	BR40	Mediastinum	3.0 mm	3.0 mm
FL CAP 1.0	300 mm	BR40	CT Angio	1.0 mm	0.7 mm
COR MIP	300 mm	BR40	Mediastinum	5.0 mm	3.0 mm
COR MPR	300 mm	BR40	Mediastinum	3.0 mm	2.0 mm
SAG MPR	300 mm	BR40	Mediastinum	3.0 mm	2.0 mm
LUNG	300 mm	BR64	Lung	2.0 mm	2.0 mm
DOSE INDEX (CTDIvol) (mGy)					
PACS		Blank and lined scouts; all series			
WORKSTATION (AQNET)		Blank and lined scouts; all series			

SHIELD PATIENT APPROPRIATELY FOR EXAM.

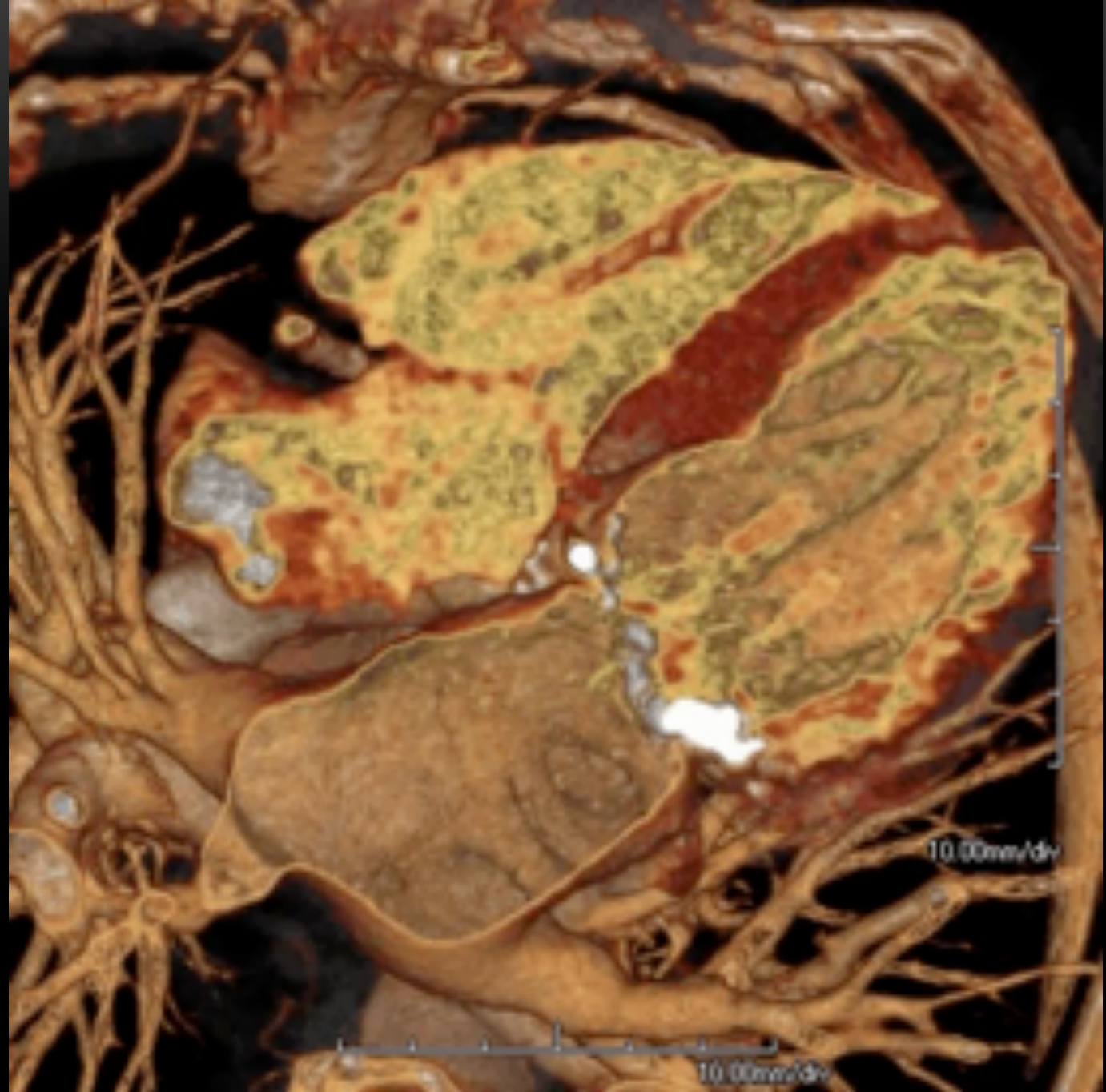
ADJUST DFOV FOR PATIENTS BODY HABITUS. DFOV SHOULD BE LARGE ENOUGH TO INCLUDE ALL SOFT TISSUES

CARE Dose 4D and CARE kV ARE UTILIZED TO DECREASE PATIENT DOSE.

Protocol examined and approved by:

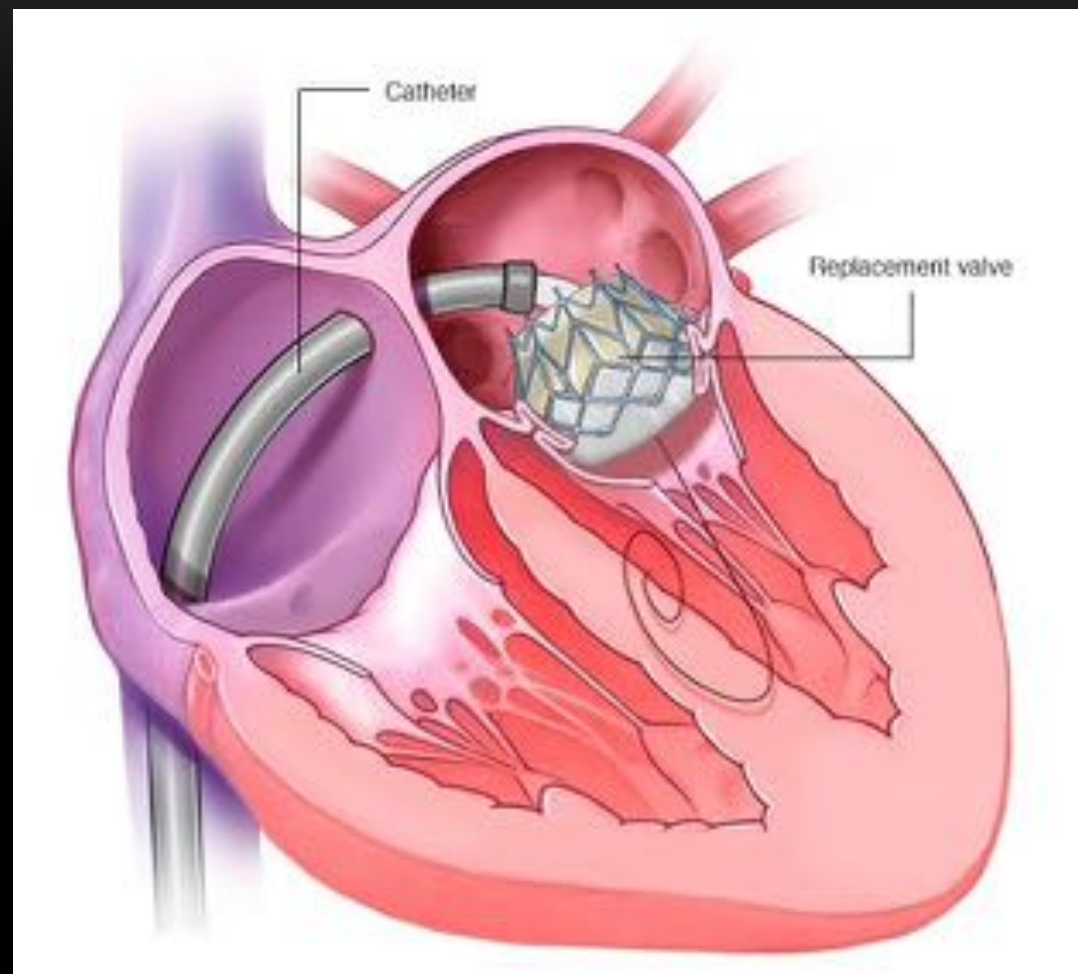
Body Weight	Phase 1	Phase 2	Total Volume
121 lbs(<55Kg)	20mL@4.0mL/s	48mL@3.2mL/s	68mL
121-143 lb(<65kg)	23mL@4.5mL/s	55mL@3.6mL/s	78mL
143-187lbs(-75kg)	25mL@5.0mL/s	61mL@4.0mL/s	86mL
187-209lbs(>85kg)	28mL@5.5mL/s	68mL@4.4mL/s	96mL
>209(>95kg)	30mL@6mL/s	74mL@4.8mL/s	104mL

TRANSCATHETER MITRAL VALVE REPLACEMENT (TMVR)



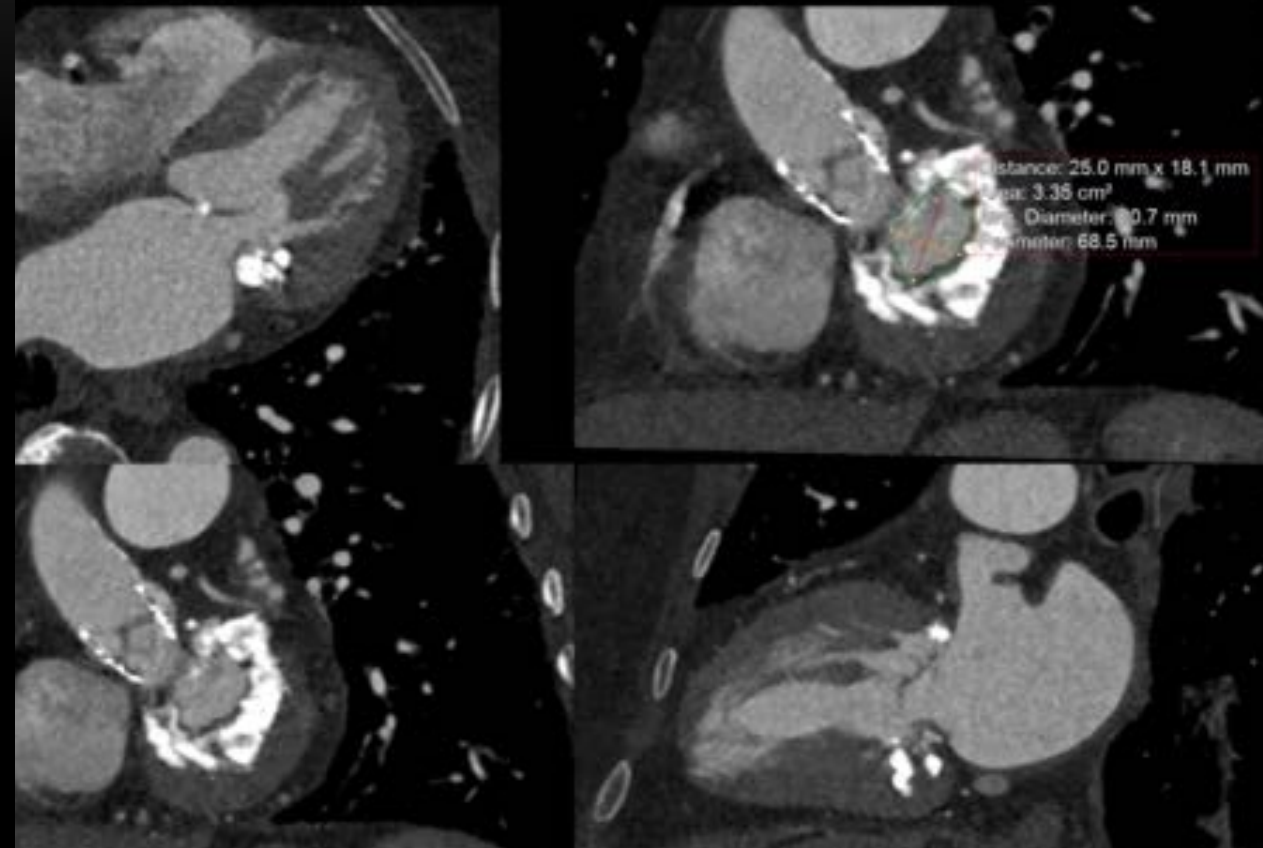
TMVR

- Transcatheter **Mitral Valve Replacement**
- For mitral insufficiency, stenosis
- Imaging goals: Device (annular) sizing, evaluation of LVOT, venous access diameters (≥ 6.0 mm)



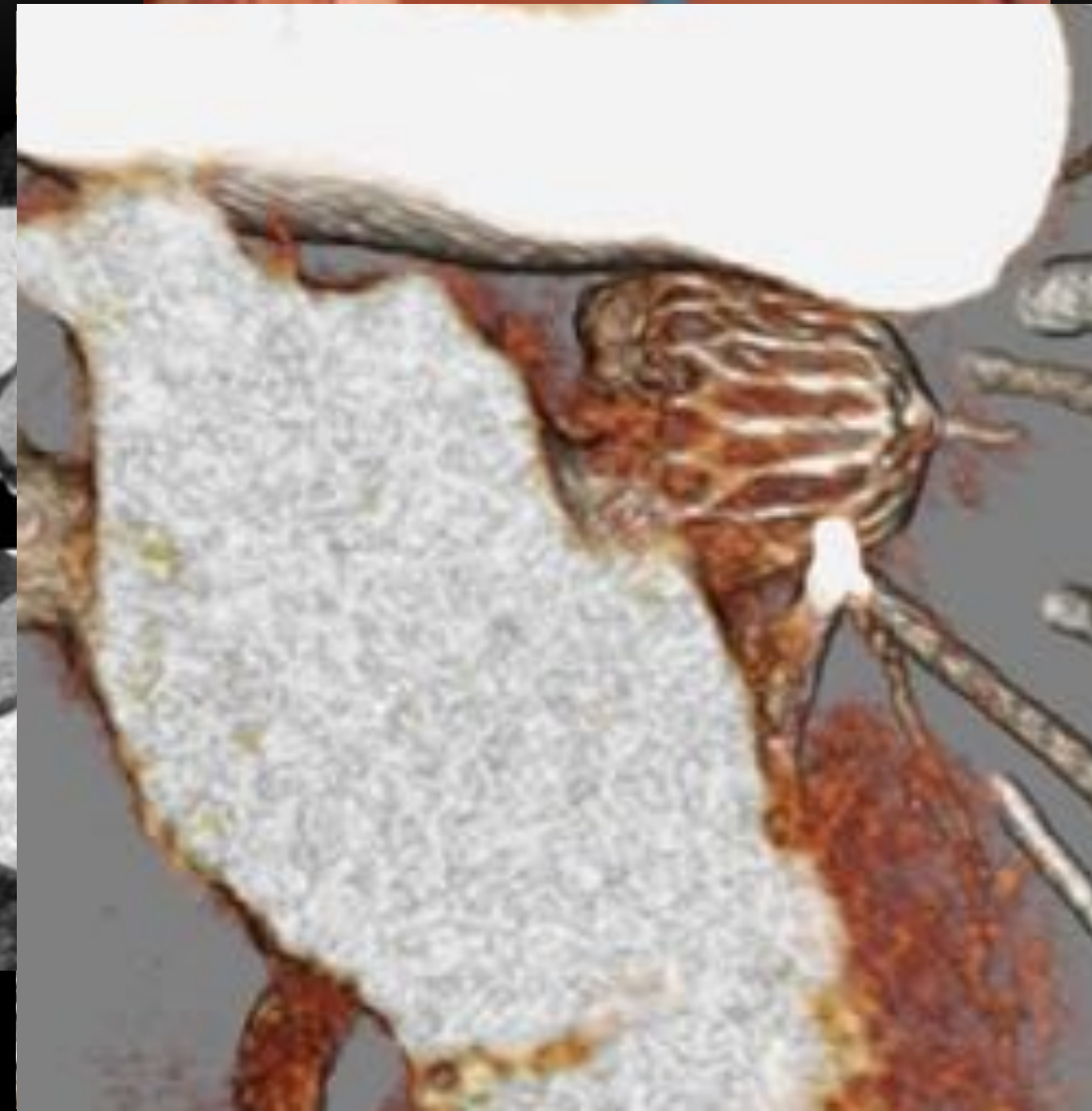
TMVR

- Transcatheter Mitral Valve Replacement
- ECG-synchronized CTA of heart
 - Bolus track left atrium
 - Annulus largest at 70% R-R
- Non-gated Flash CTA neck, chest, abdomen, pelvis – 90 sec delay (venous phase)
- Weight-based, single injection



LEFT ATRIAL APPENDAGE MAPPING / WATCHMAN

- LAA develops clot, especially w/ Afib; can lead to stroke
- Watchman device is LAA occluder
- Sizing done by CT and TEE
- Post-placement surveillance by CT



LAA / WATCHMAN PROTOCOL

- 18 sec injection w/ saline chaser
- Bolus track LA
 - Dx delay = 12
- Initial scan then **40 second delay scan**
 - Sluggish flow in LAA can simulate clots, need delay to allow full contrast mixing

WATCHMAN_LAA_GATED_RETRO (Adult)

Indications-
SOMOTOM DEFINITION FORCE

POSITIONING/LANDMARK		Feet first, arms above head			
CARDIAC GATING		Yes			
INJECTION RATE / VOLUME		5 ml/sec / 90 ml			
		PULMONARY FLASH		PULMONARY FLASH DELAY	
SCAN TYPE/ ROTATION TIME		Helical / Full 0.25 sec		Helical / Full 0.25 sec	
START LOCATION		Carina		Carina	
END LOCATION		Diaphragm		Mid Heart	
ACQUISITION	DETECTOR CONFIGURATION	192 x 0.6 mm		192 x 0.6 mm	
	DETECTOR COVERAGE	57.6 mm		57.6 mm	
GANTRY ANGLE		n/a		n/a	
PITCH/FEED (mm/rotation)		3.2 mm Pitch		3.2 mm Pitch	
KVP		100 Reference kV		100 Reference kV	
MA		Quality Reference mAs 288		Quality Reference mAs 288	
ADMIRE		ON		ON	
BOLUS TRACK (LOCATION)		ROI Left atrium			
MAS / MONITORING DELAY		23 mAs / 10 sec			
BOLUS TRIGGER (HU)		150 HU			
PREP GROUP (seconds)		12 sec		40 sec	
BREATHING INSTRUCTIONS		Suspended inspiration			
SERIES 1	FOV	ALGORITHM	WINDOW	THICKNESS	INTERVAL
PULM FLASH	200 mm	BV40	Cardiac	0.6 mm	0.6 mm
PULM FLASH LUNG	330 mm	BR64	Lung	2.0 mm	2.0 mm
SERIES 2					
PULM FLASH DELAY	200 mm	BV40	Cardiac	0.6 mm	0.6 mm
DOSE INDEX (CTDIvol) (mGy)		50 mGy		50 mGy	
PACS		Blank and lined scouts; all series			
WORKSTATION (AQNET & TERA WORKSTATION)		Blank and lined scouts; all series			

SHIELD PATIENT APPROPRIATELY FOR EXAM.

ADJUST DFOV FOR PATIENTS BODY HABITUS. DFOV SHOULD BE LARGE ENOUGH TO INCLUDE ALL SOFT TISSUES

CARE Dose 4D and CARE kV ARE UTILIZED TO DECREASE PATIENT DOSE.

Protocol examined and approved by:

IMPORTANCE OF DELAYED PHASE ACQUISITION

INITIAL

40 SEC DELAY



EXAMPLE CASE: WATCHMAN LEAK

INITIAL

40 SEC DELAY



SPECIAL SCENARIO: PEDIATRIC CARDIAC CT

- “Routine” cardiac CTA protocol
- “Special” cases: Fontan circulation

PEDIATRIC CARDIAC CT: “ROUTINE” SCANNING GUIDELINES

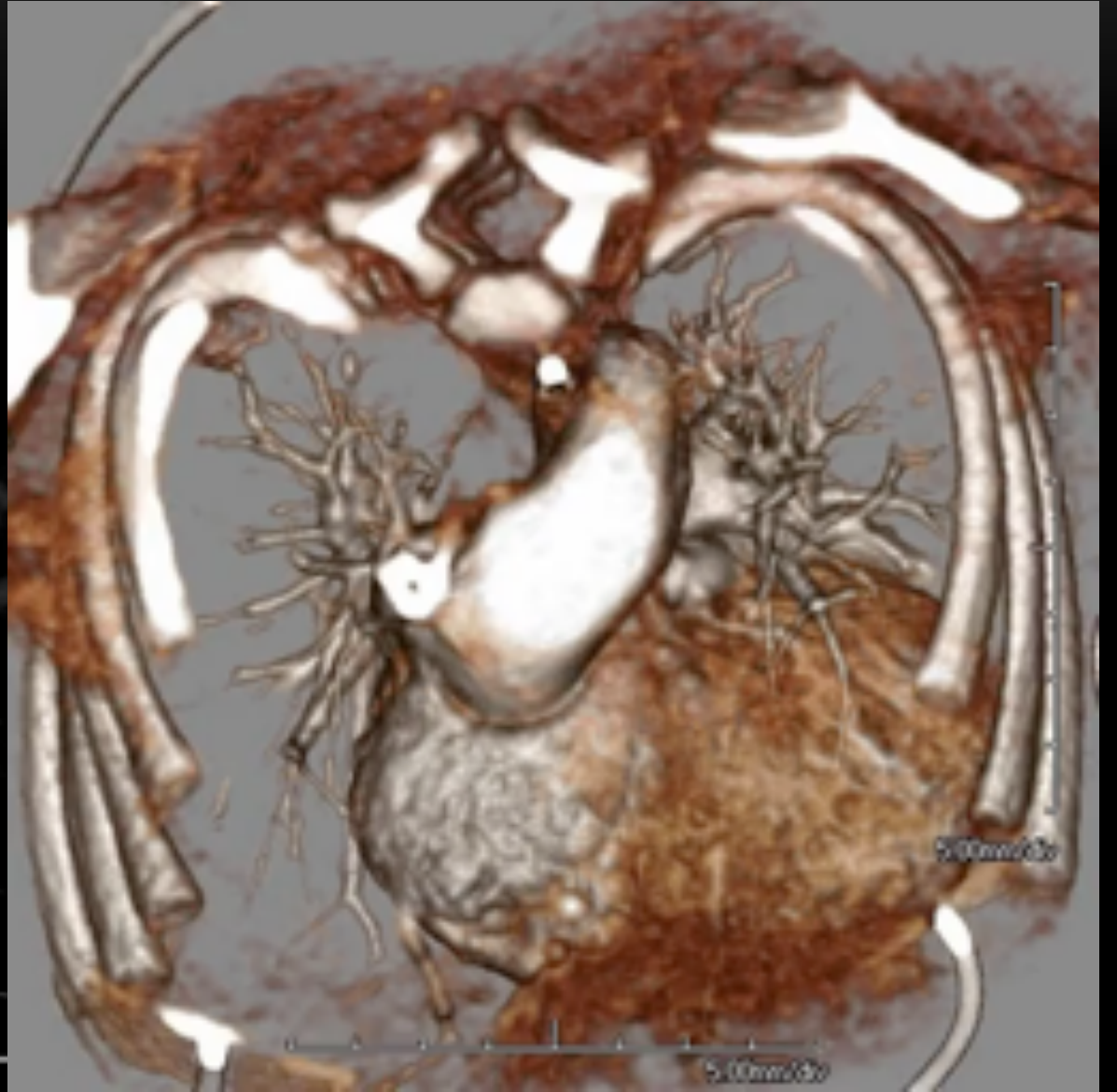
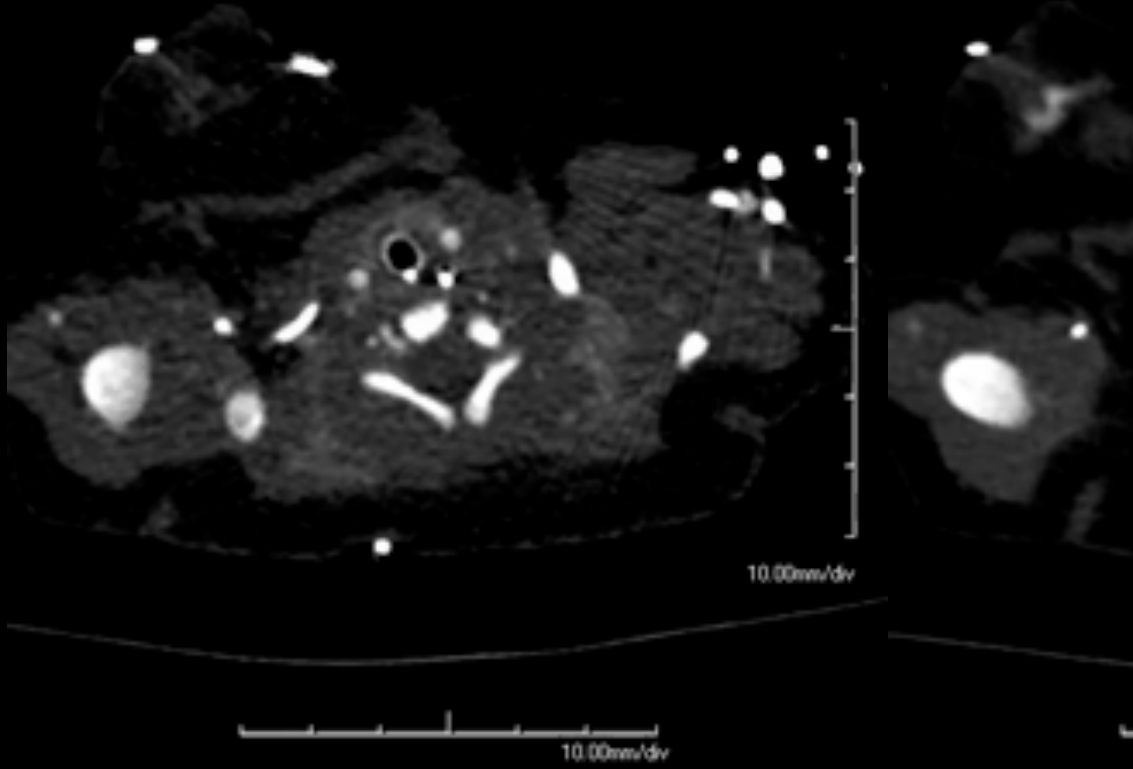
- GE Revolution CT (volume acquisition CT)
- Weight-based dosing: 2 mL 350 or 2.5 ml 300 per kg
- Use low kV CT when possible (noise index ~18)
- Low-dose noncontrast series (planning, grafts, postop changes)
- Inject CM over 15 sec, bolus track area of interest, Delay = 5 sec
 - use saline flush (1/4 CM volume) at same rate (NO BUBBLES!)
- Pre-programmed 2nd acquisition - low neck to upper abdomen

EXAMPLE: NEWBORN WITH TETRALOGY OF FALLOT, SEVERE PA STENOSIS, PDA

- 2.4 kg
- 6 mL 300 contrast over 15 sec
- 2 mL saline flush
- Bolus track PA, "Routine" scans

EXAMPLE: NEWBORN WITH TETRALOGY OF FALLOT, SEVERE PA STENOSIS, PDA

- 2.4 kg
- 6 mL 300 contrast over 15 sec
- 2 mL saline flush
- Bolus track PA, "Routine" scans

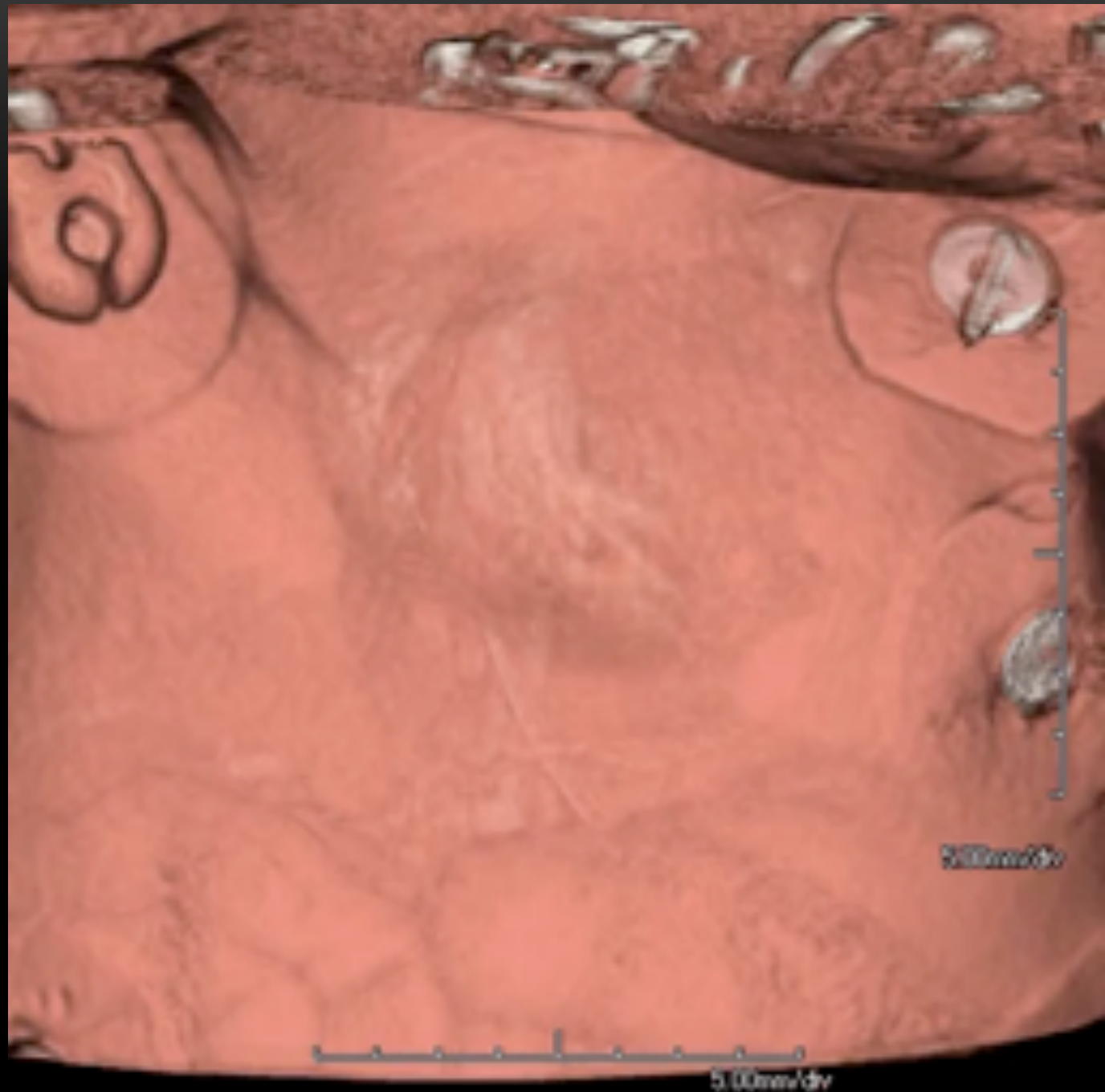


EXAMPLE: STERNAL CLEFT

- 2.0 kg newborn, pre-op anatomy for repair
- Hand injection: 5 mL 300 over 15 sec + 1.5 mL saline flush

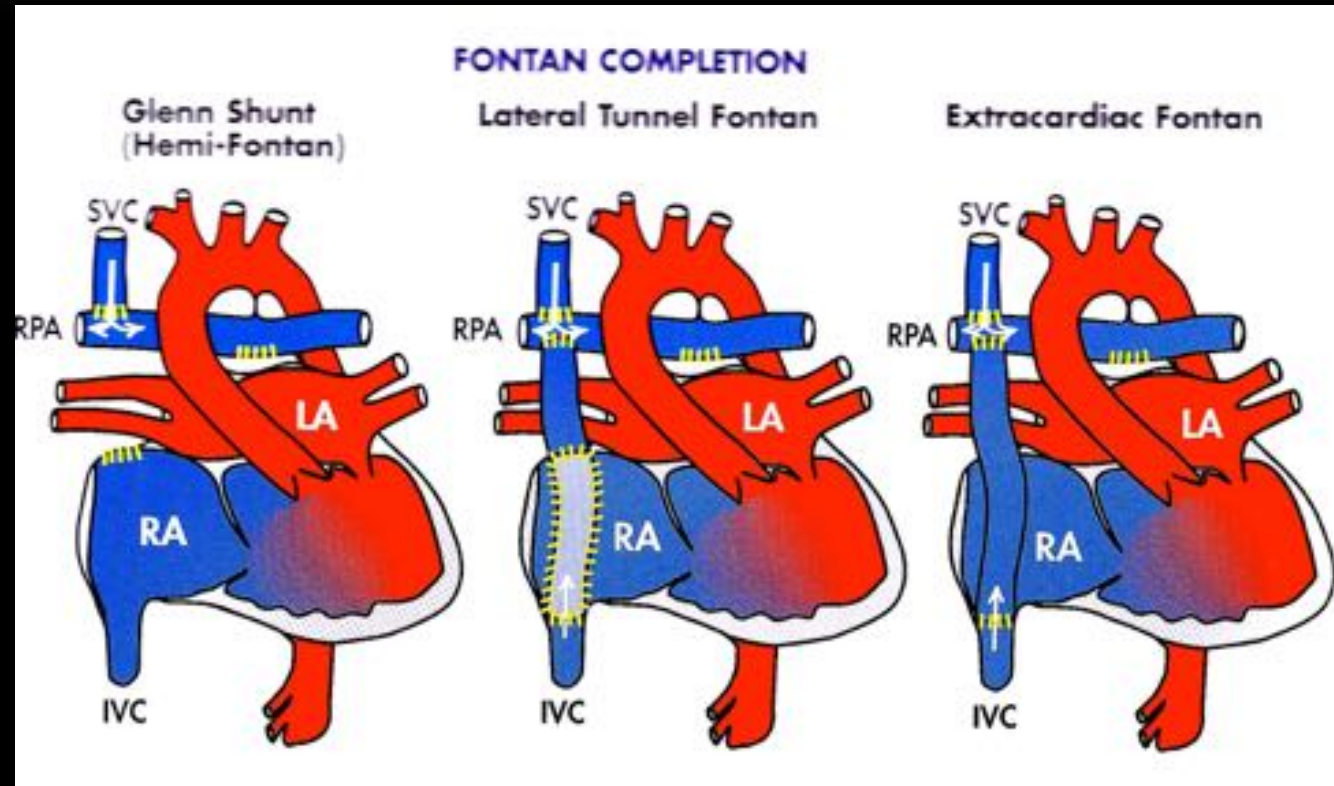
EXAMPLE: STERNAL CLEFT

- 2.0 kg newborn, preop anatomy for repair
- Hand injection: 5 mL 300 over 15 sec + 1.5 mL saline flush



COMPLEX PEDIATRIC CARDIAC CT: FONTAN CIRCULATION

- Aka “total cavopulmonary circulation”
- The end result of treatment of single ventricle physiology (HLHS, HRHS, etc)



IMAGING OF FONTAN CIRCULATION

- Need clinical information: is question coronary arteries, PAs, and/or Fontan circuit itself (thrombus)?
- Timing of contrast reaching R PA vs LPA is very different
 - Glenn: SVC to RPA
 - Lateral tunnel / IVC to LPA
- If performed for evaluation of PE, can give false positive results from lack of LPA opacification

FONTAN INJECTIONS: OPTIONS

- Inject from arm and leg simultaneously
 - 2/3 from leg, 1/3 from arm starting 5 sec after leg
 - Bolus track LPA if scanning for PE
 - Single arm injection
 - Single arm injection + drip phase contrast
-

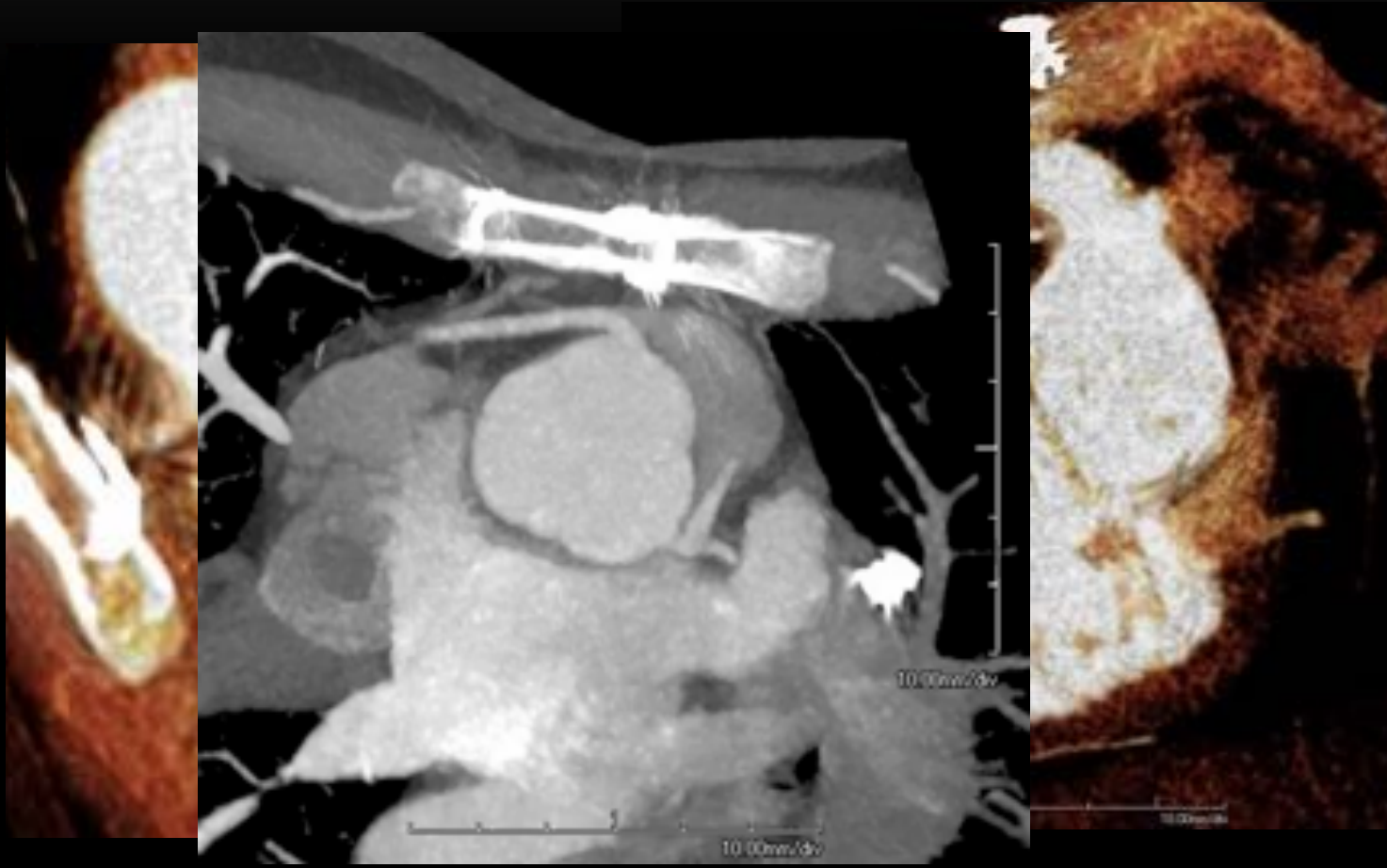
CURRENT FONTAN INJECTION PARAMETERS

- Weight based dosing
 - 2mL/kg of 350, 2.5 mL/kg of 300
- Inject 20 sec fast rate, then 45 sec slow (0.5 – 1.0 mL/sec)
- Image empirically at 75 sec
- If R/O PE: bolus track LPA, do PE CTA, then re-scan after 50 sec for Fontan
- If CCTA: bolus track ascending aorta if CCTA wanted + re-scan after 45 sec for Fontan

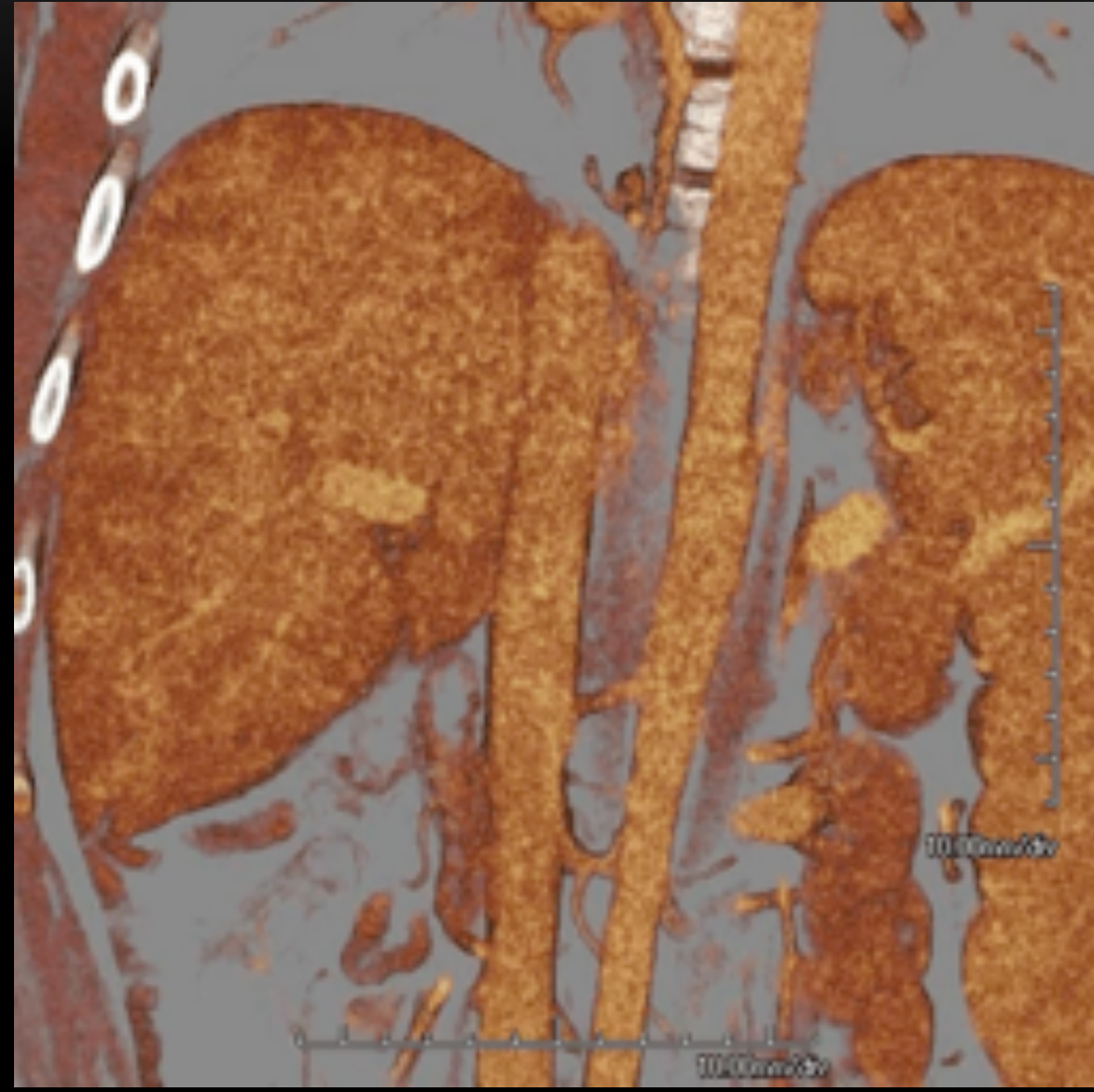
CASE: EXTRACARDIAC FONTAN

- 17 yo F
- 110 lb (50 kg)
- Clinical questions: evaluate for anomalous coronary artery, also evaluate Fontan for thrombus
- Injection: 3.5 mL/sec x 20 sec, then 1.0 mL/sec x 40 sec
- Bolus tracked aorta, scanned cors, re-scan Fontan 40 sec later

RESULTS: EXTRACARDIAC FONTAN



EXTRACARDIAC FONTAN – DELAYED IMAGING



CONCLUSIONS

- Development and implementation of rational CTA protocols improves consistency / quality and decreases operator dependence.
 - Knowledge of early contrast medium dynamics allows rational CTA protocol design
 - Special case scenarios in CV imaging require dedicated specific protocols that leverage physiology and CM dynamics
-

QUESTIONS.....

THANK YOU FOR YOUR ATTENTION!!

- Thanks to:
 - Dominik Fleischmann, MD
 - Brad Dixon
 - Ken Bodle

HANDOUT:

<http://stanford.edu/~hallett/BRACCO%202021/>

