Upper and Lower Extremity CTA

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OUTLINE

- Lower Extremity CTA
  - Indications
  - Technique/Results
  - Cases
- Upper Extremity CTA
  - Indications
  - Technique
  - Cases

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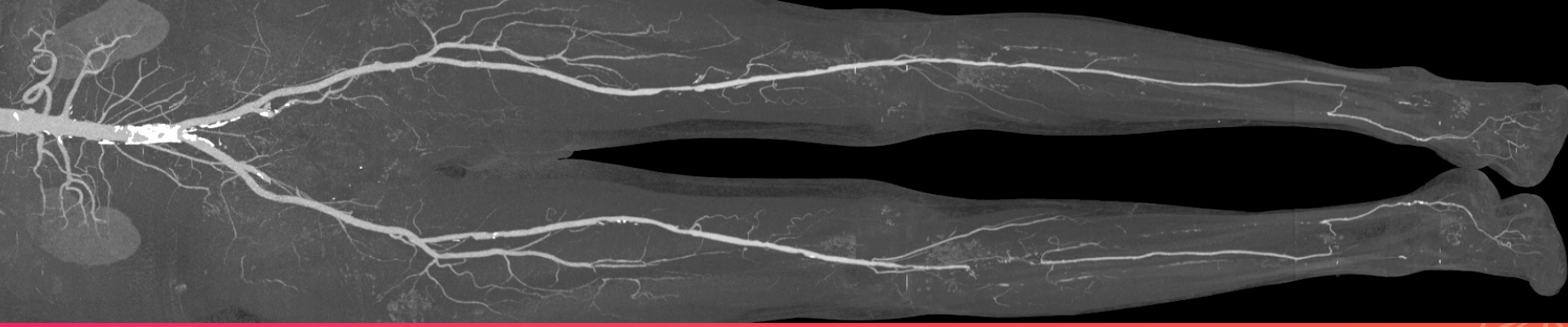


Lower Extremity CTA

Lower Extremity CTA - Indications

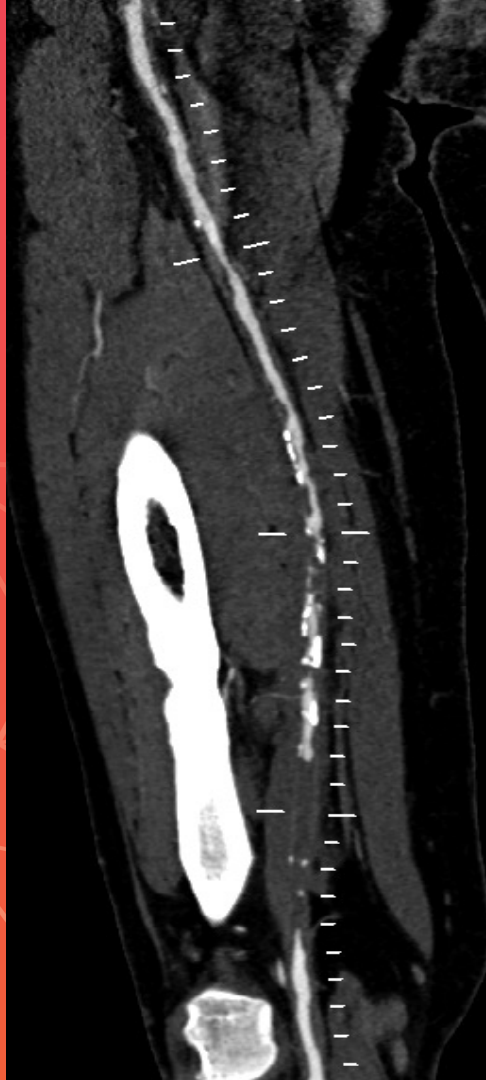
- PAD
  - IC
  - CLI
  - Acute ischemia
  - Response to Tx / complications
- Trauma
- Other
  - Vasculitis / CTD
  - Buerger's
  - AVF/AVM
  - Surgical planning (free flap)

Diagnosis and Staging of PAD

= symptoms + ABI

* poor correlation of symptoms and ABI with number, location and severity of lesions

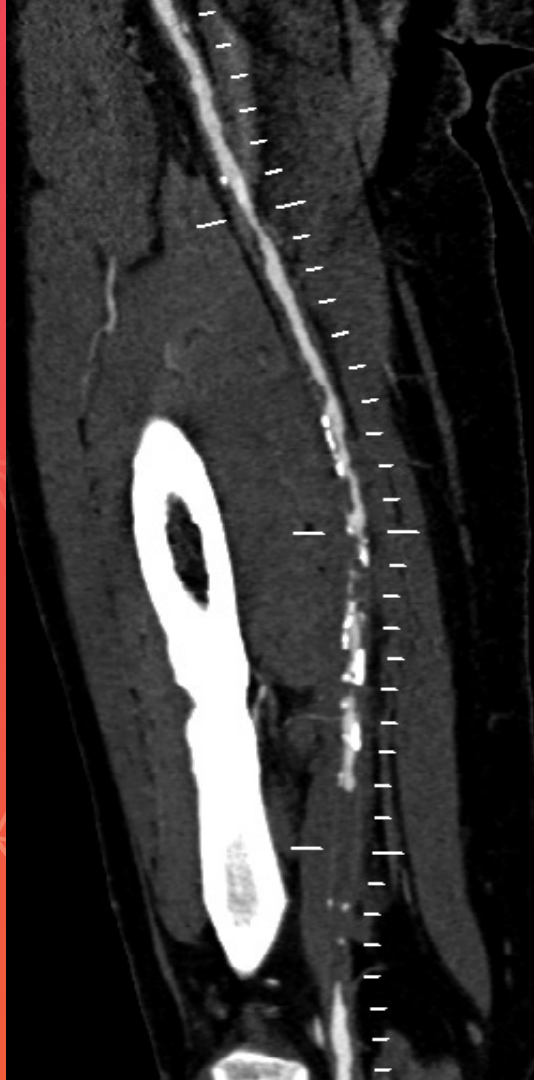
Example: calf claudication can be caused by isolated disease or combination of iliac and/or femoropopliteal lesions



Goal of CTA imaging in PAD

Goal of LE CTA Imaging is **NOT** diagnosis / staging

The role of CTA is to map lesions to patient symptoms
guide treatment planning



Technique - LE CTA

- Scan Acquisition
- Contrast Medium Injection

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Lower Extremity CTA: Scan Acquisition

Scanning Range 1

celiac artery (~T12) → toes

(105 – 130 cm)

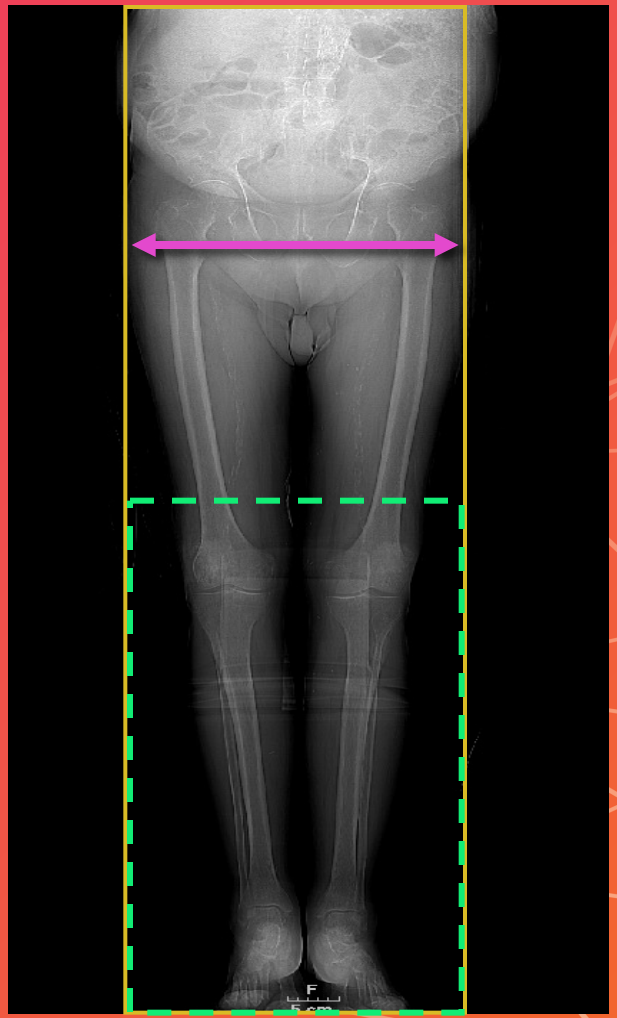
Optional Scanning Range 2

above the knees → toes

Always pre-programmed, but only initiated by RT if no contrast in pedal vessels

Recons:

FOV = greater trochanters



Contrast injection for peripheral CTA

- Aorto-popliteal transit time: 4-24 sec (10 sec)
  = Contrast (blood) speed: 29-177 mm/s
  →Slow scanner down, otherwise can overrun bolus

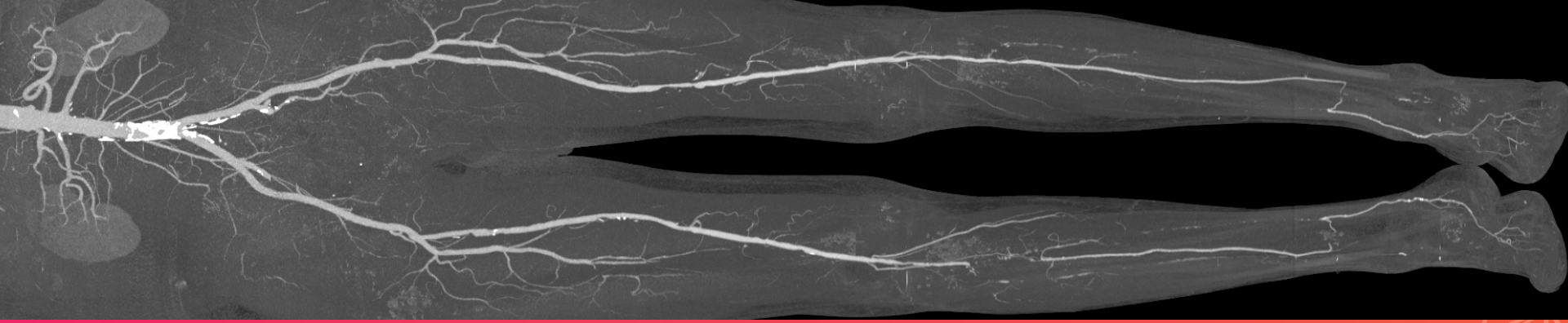
- Biphasic injections and weight-based CM dosing yield more consistent enhancement profile

Fleischmann et al. JVIR 2006, 17(1) 3-26.

Integrated Scanning-Injection Protocol: (Siemens)

- Scan time: 40s for ALL patients (pitch variable)
- Inj.duration: 35s for ALL patients
- Delay: bolus triggering

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



Efficacy of LE CTA in PAD

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CTA: Diagnostic Performance vs. DSA

Performance

CT Channels	Sens (95% CI)	Spec (95% CI)
2-4	92 (88-96)	98 (95-99)
16-64	97 (95-98)	98 (96-99)

Detection of ≥50% Stenosis or Occlusion By Anatomical Region

Vessels	Sens (95% CI)	Spec (95% CI)
Aortoiliac	96 (91-99)	98 (95-99)
Femoropopliteal	97 (95-99)	94 (85-99)
Trifurcation	95 (85-99)	91 (79-97)

Met R et al. JAMA 2009;301:415-424

Management of IC and CLI by CTA

- Treated using TASC II guidelines
  - 49 conservative TX
  - 87 Endovascular
  - 38 surgery
  - 17 hybrid
- Tx recommendations from CTA same as DSA in all but ONE

Napoli A. Radiology. 2011 Dec 1;261(3):976–86.

Recent Advance: Dual Energy/ Dual Detector CT

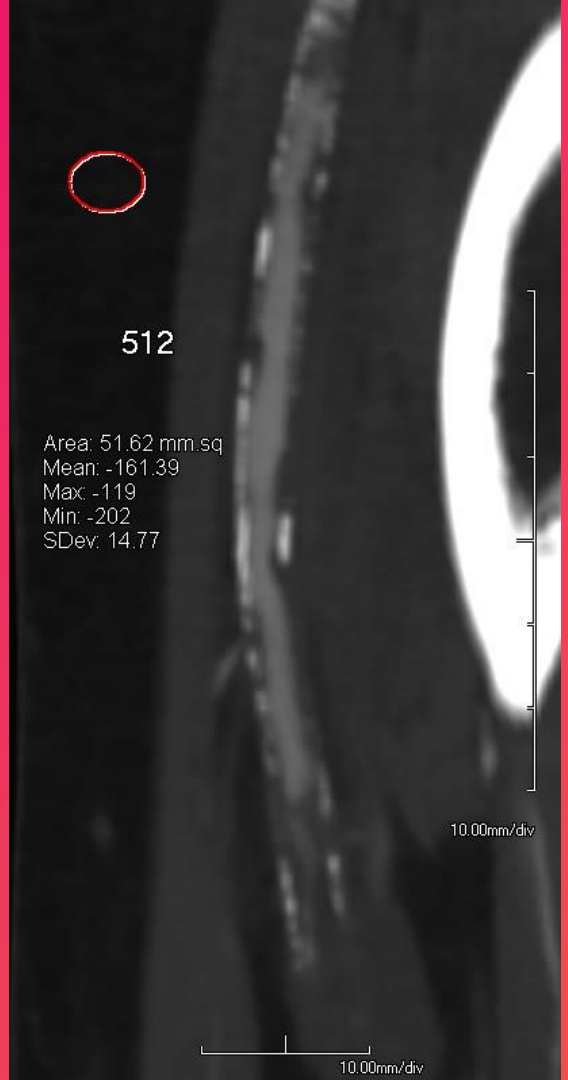
- Dual-Layer Spectral Detector CT[1]:
  - VMI best at 40 keV; 50% less CM outperforms standard CTA runoff
- PCCT:
  - VMI 40 – 60 keV – all better CNR/SNR/SEQ than standard 80-100 kVp[2]
- VMI also better for diabetic patient runoff [3]

[1] *Kristiansen CH, at al. Eur Radiol 2023; 33:6033-44.*
[2] *Ripple K, et al. Eur J Radiol 2023; 158: 110645*
[3] *Bucolo GM et al.Diagnostics 2023: 13, 1790*

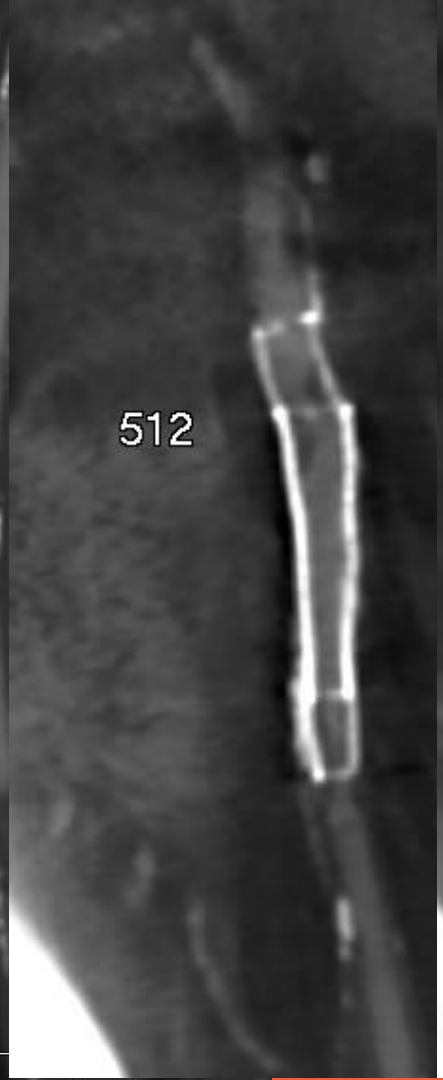
Recent Advance: High Spatial Resolution CT

- Better:
  - Wall definition
  - Noise
  - Diagnostic confidence
- More gains in calf vessels vs. fem-pop
- Maybe not better diagnostic accuracy for stenosis?[1]

[1]*Onishi H, et al. Radiology 2018 (289) 255-260*
Wang J, Fleischmann D. Radiology 2018 (289) 261-262
Schwartz FR, et al, Eur Radiol. 2023 Jun 29.doi: 10.1007/s00330-023-09841-4


512
Area: 51.62 mm.sq
Mean: -161.39
Max: -119
Min: -202
SDev: 14.77
10.00mm/div
10.00mm/div


1024
Area: 44.68 mm.sq
Mean: -148.41
Max: -128
Min: -166
SDev: 7.72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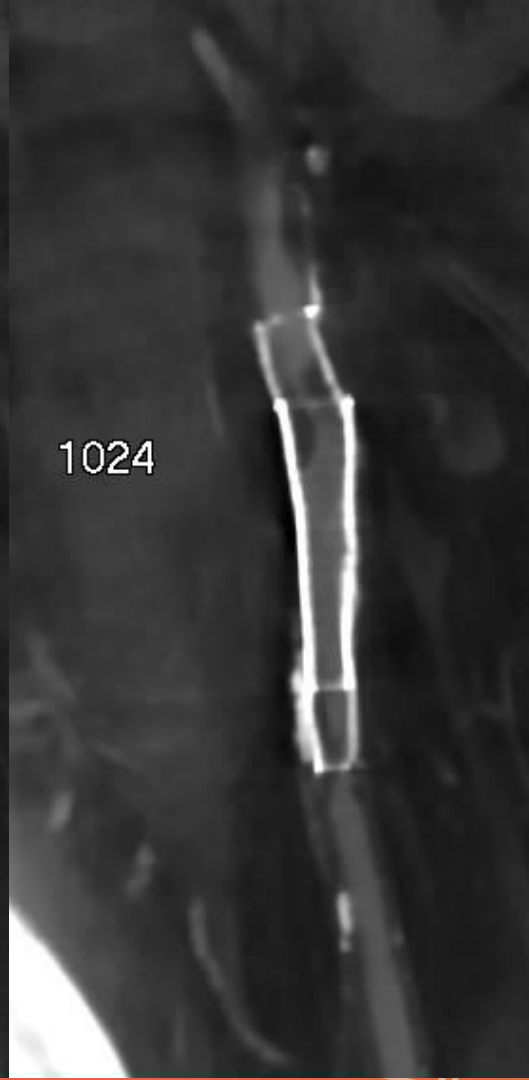
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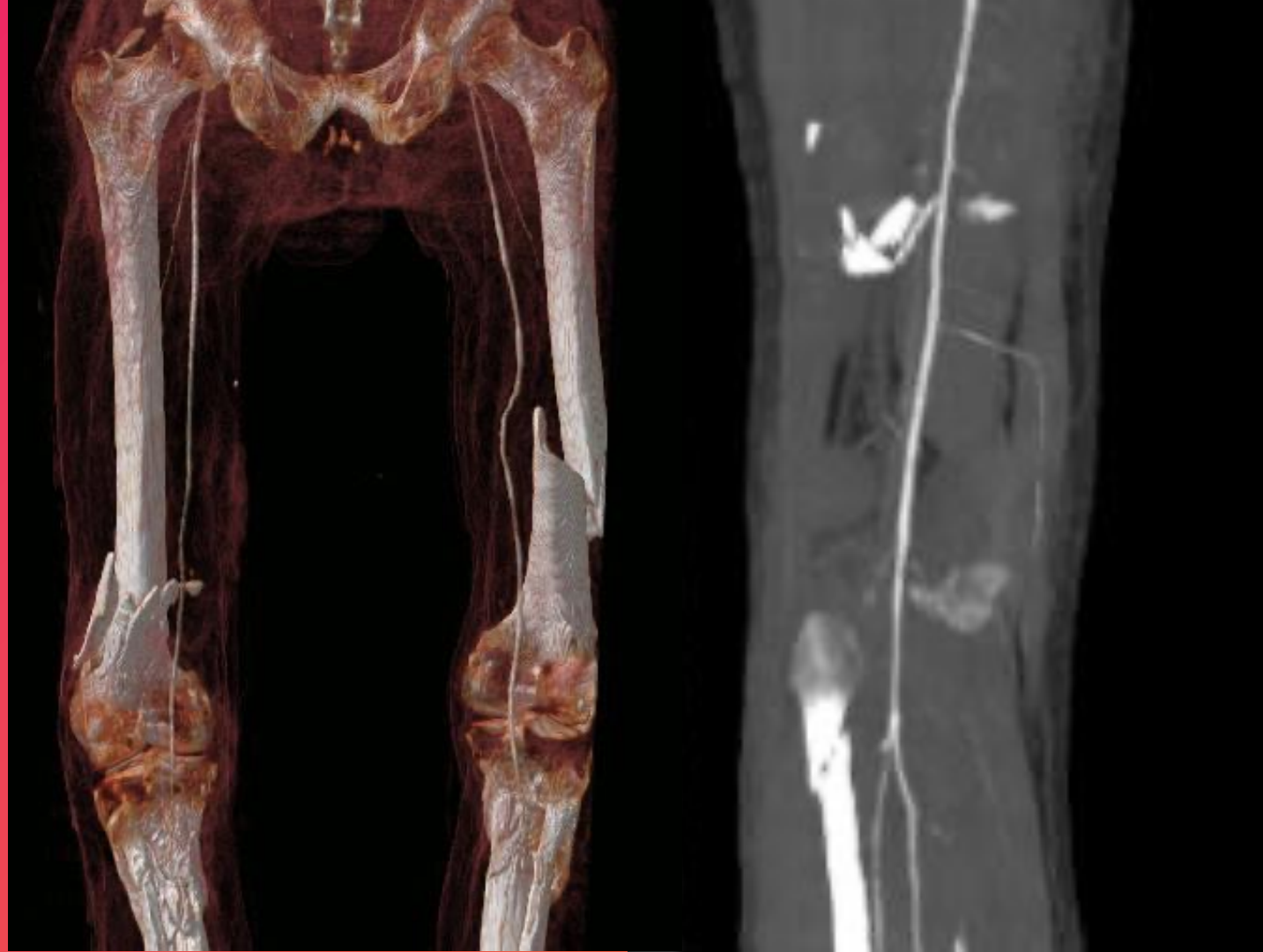
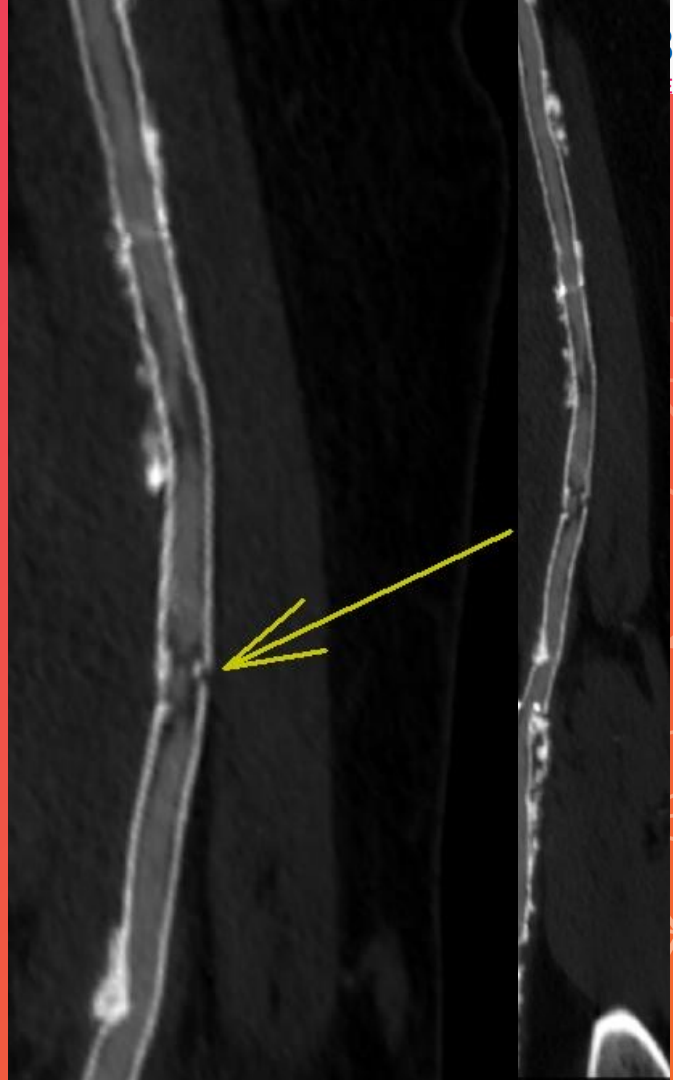
Cases – Lower Extremity

Trauma

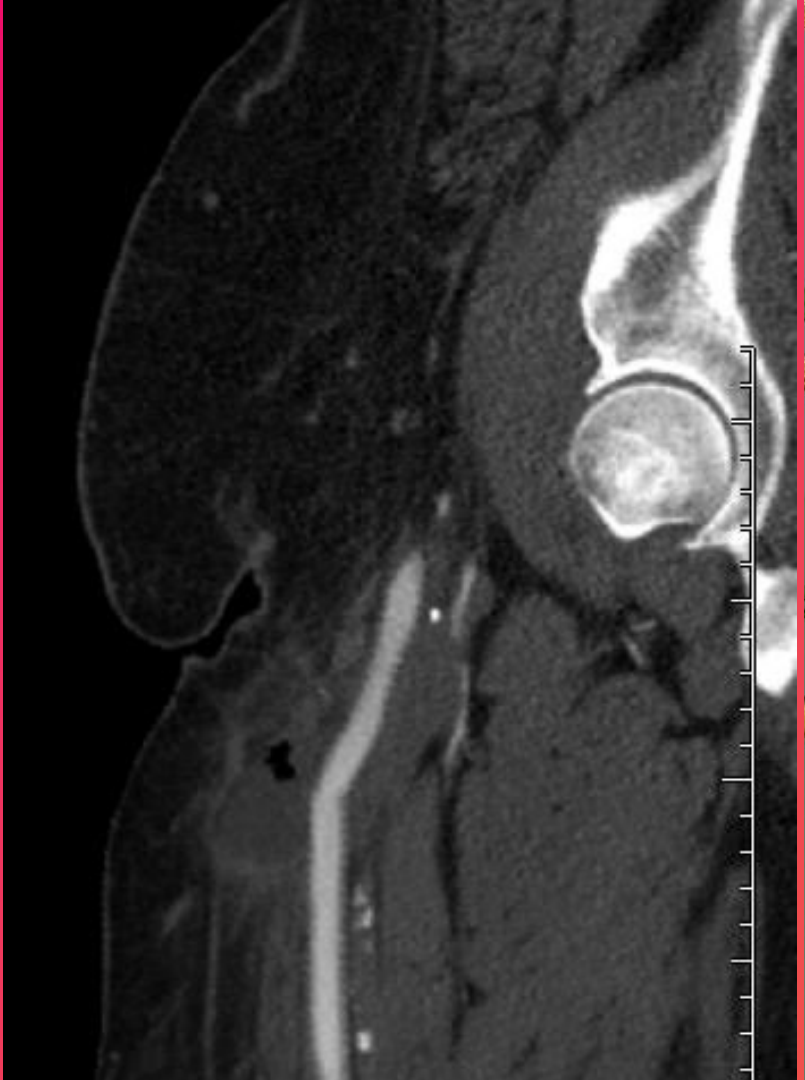


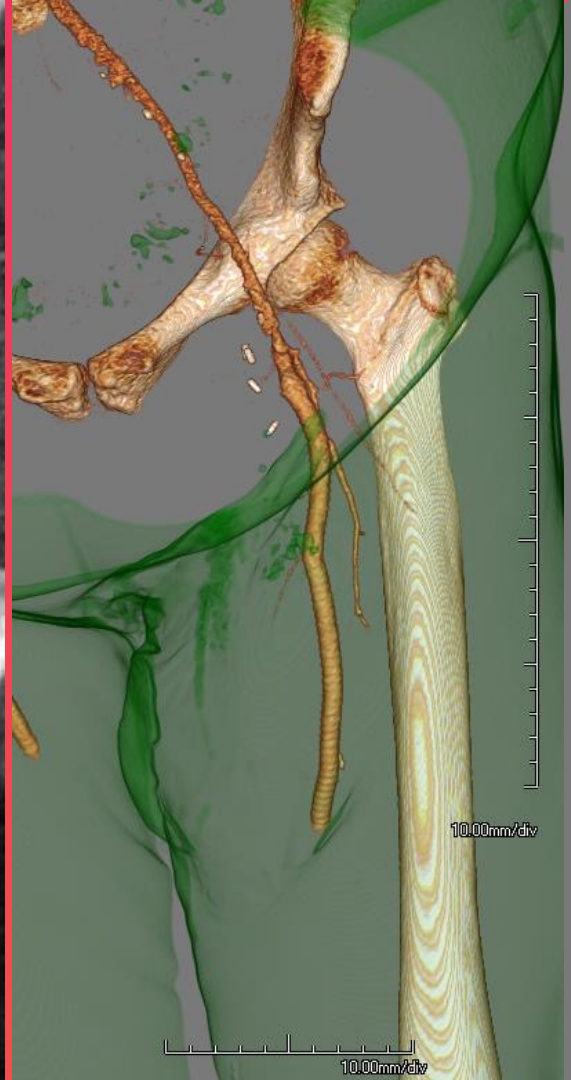
CTA for stent assessment

- Most stents assessable (76%) by CTA
  - Gold / platinum markers
  - Motion
  - Strecker stent (Tantalum): Increased luminal density [2]
- If evaluable, sens/spec ~ 95% for significant in-stent restenosis (vs. DSA)



[1] *Li X, et al. Eur J Radiol 2010; 98-103*
[2] *Strotzer, Invest. Radiol. 2001:36(11)*

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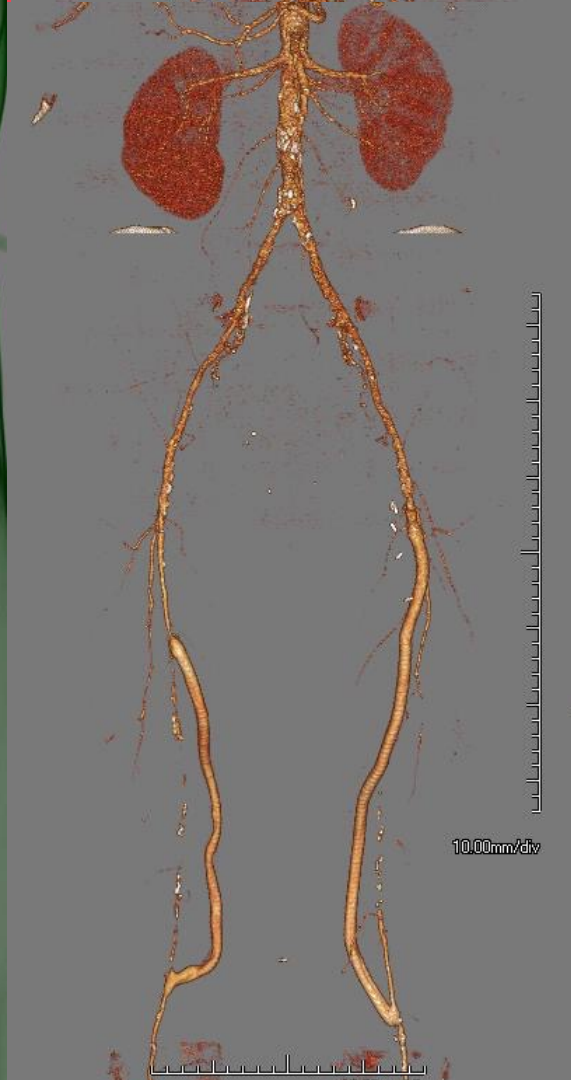
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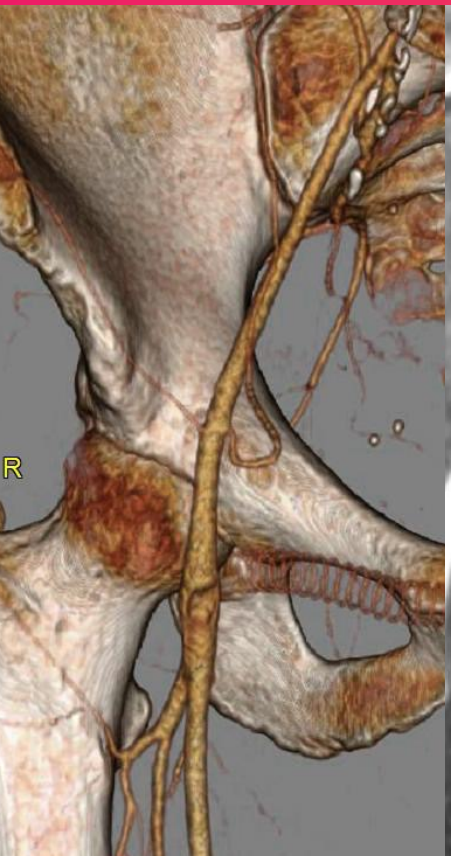
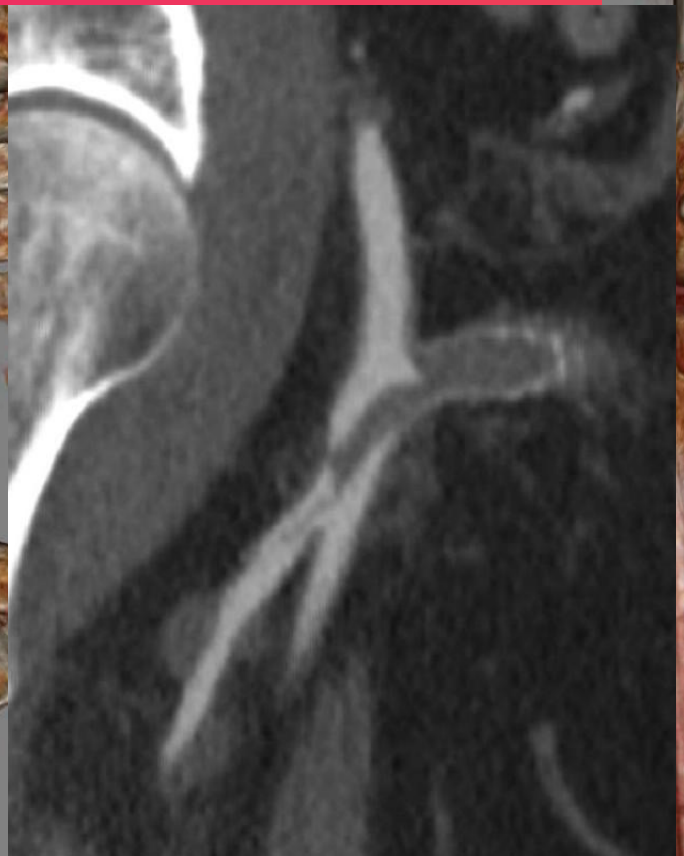
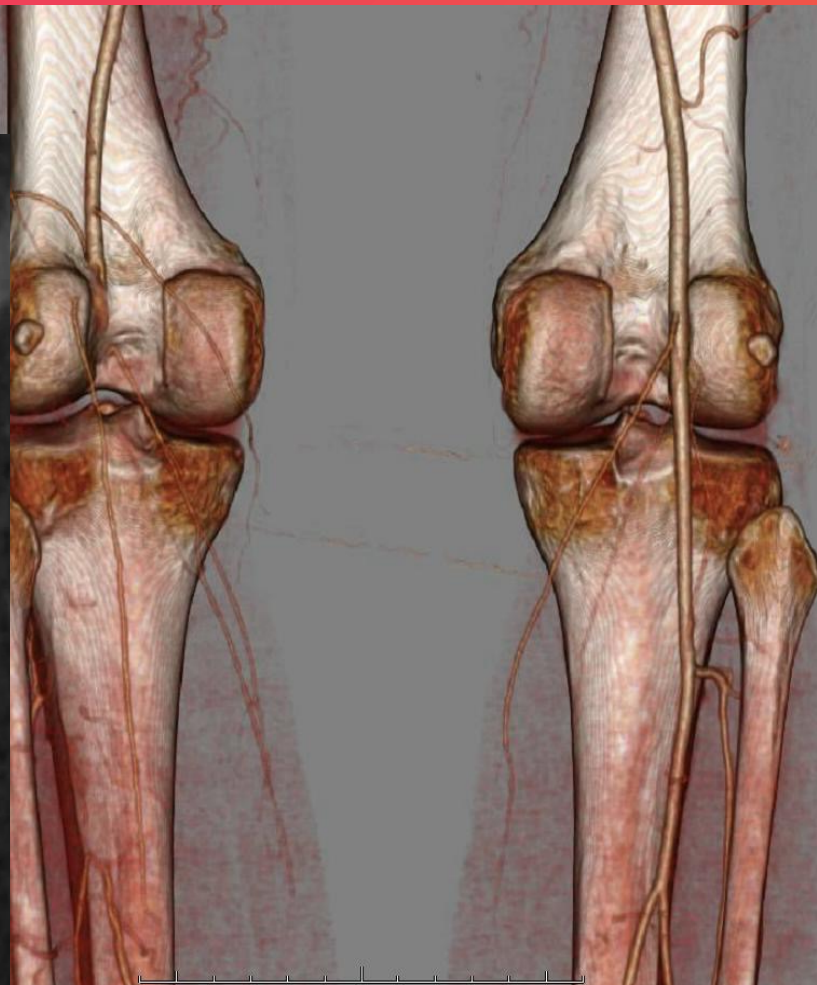
Acute R leg pain







UPPER EXTREMITY CTA

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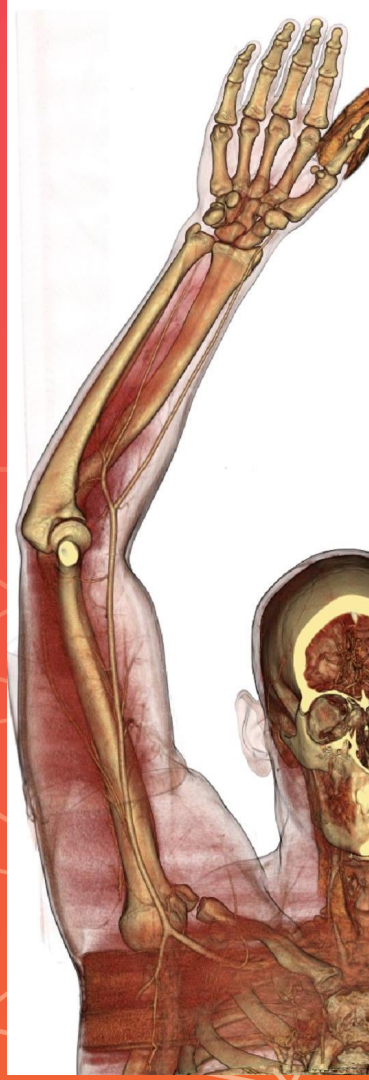
Upper Extremity Vascular Pathology

- Acute trauma (penetrating, crush, MVA, GSW)
- Ischemia, thromboembolic
- Aneurysms/PSA/AVM/vascular masses
- Vasculitis
- Hemodialysis fistulae/grafts
- Raynauds /connective tissue disease
- Anatomic mapping (radial flap)

UE CTA: Injection / Scan Technique

- Non-trauma: Supine, arm abducted and externally rotated, hand flat and fingers fanned (tape).
  - Trauma: arm at side, position near isocenter
- Inject contralateral arm, use saline flush
- Scan carina → fingertips
- Induce hyperemia:
  - BP cuff or squeeze ball x 1 min;
  - Warm compress
  - SL NTG



Ghouri MA, et al. Cardiovasc Diagn Ther. 2019 Aug; 9(Suppl 1): S152–S173.
Dave R, Fleischmann D. Rad Clin NA 2016 54(1):101-14.

UE CTE Contrast Injection

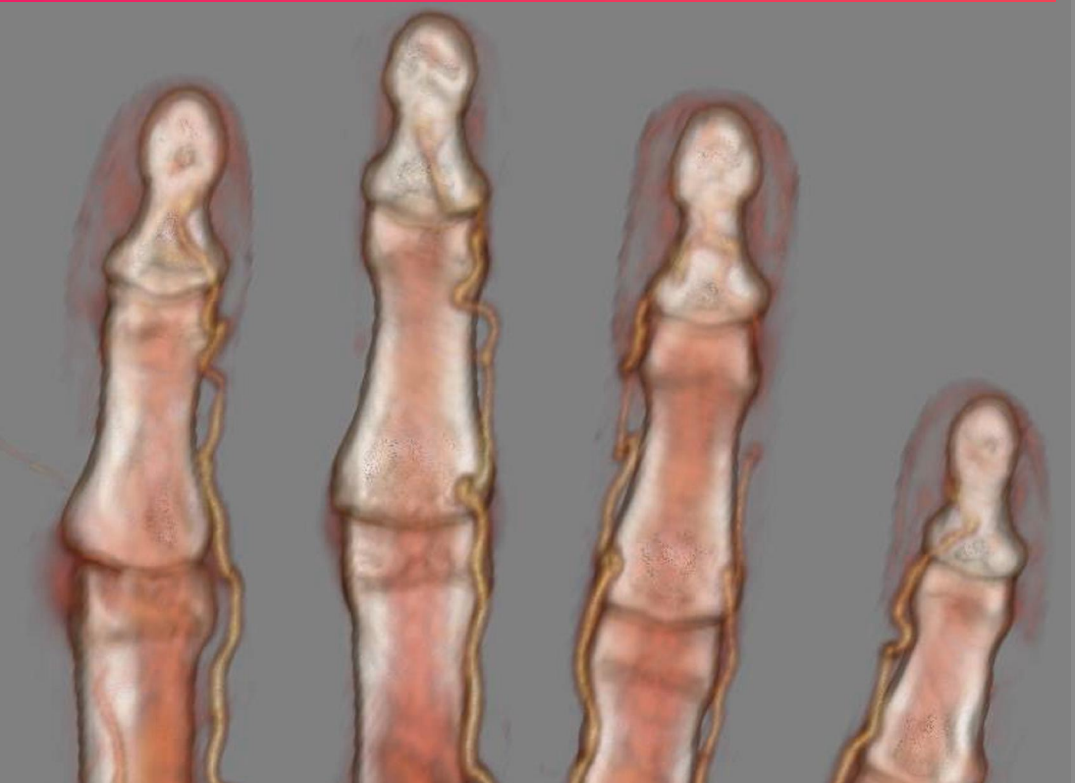
(5 SEC LESS THAN LE)

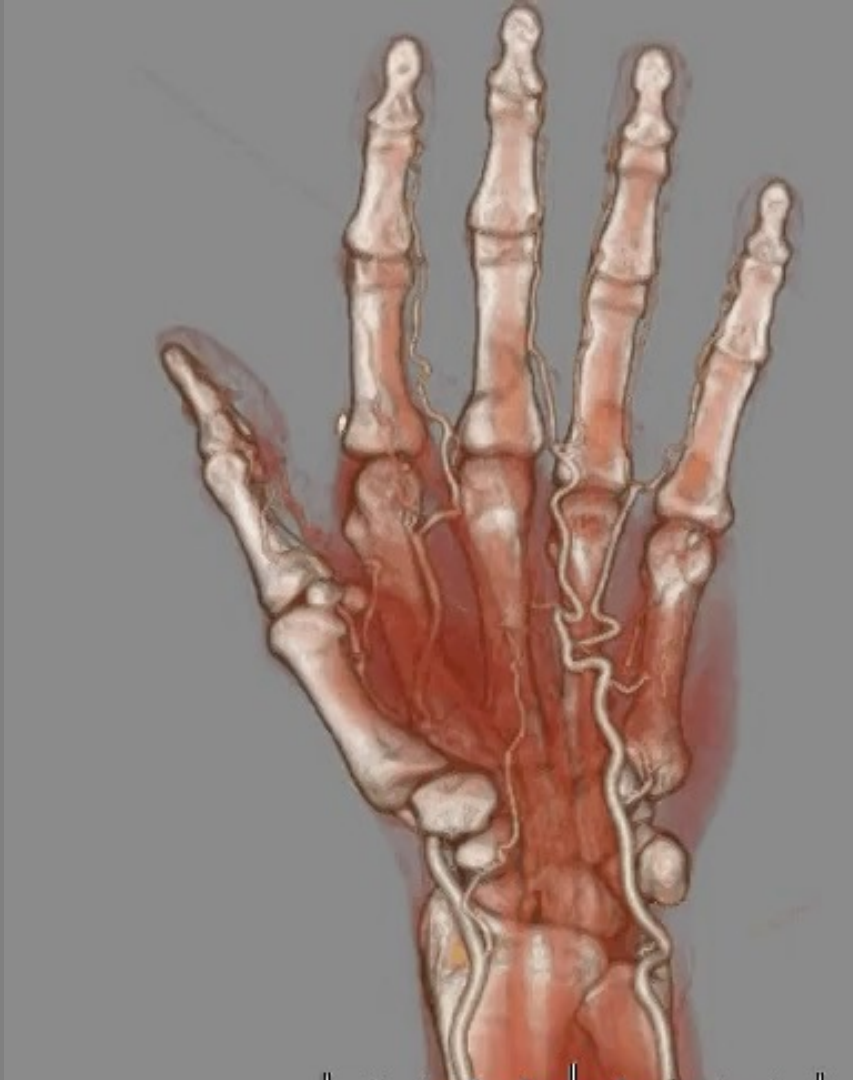
Body Weight (kg)	Phase I	Phase II	Total Contrast Medium Volume (mL)
<55	20 mL @ 4.0 mL/s	80 mL @ 3.2 mL/s	100
<65	23 mL @ 4.5 mL/s	90 mL @ 3.6 mL/s	113
~75	**25 mL @ 5.0 mL/s**	**100 mL @ 4.0 mL/s**	**125**
>85	28 mL @ 5.5 mL/s	110 mL @ 4.4 mL/s	138
>95	30 mL @ 6.0 mL/s	120 mL @ 4.8 mL/s	150

Dave R, Fleischmann D. Rad Clin NA 2016 54(1):101-14.

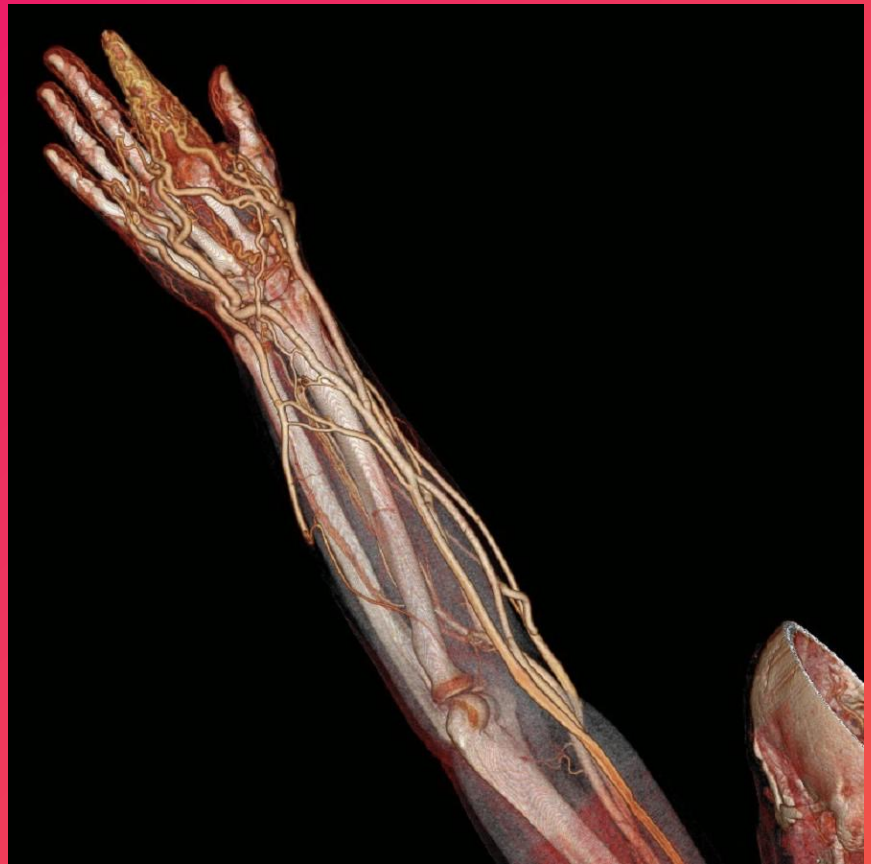
Cases – Upper Extremity

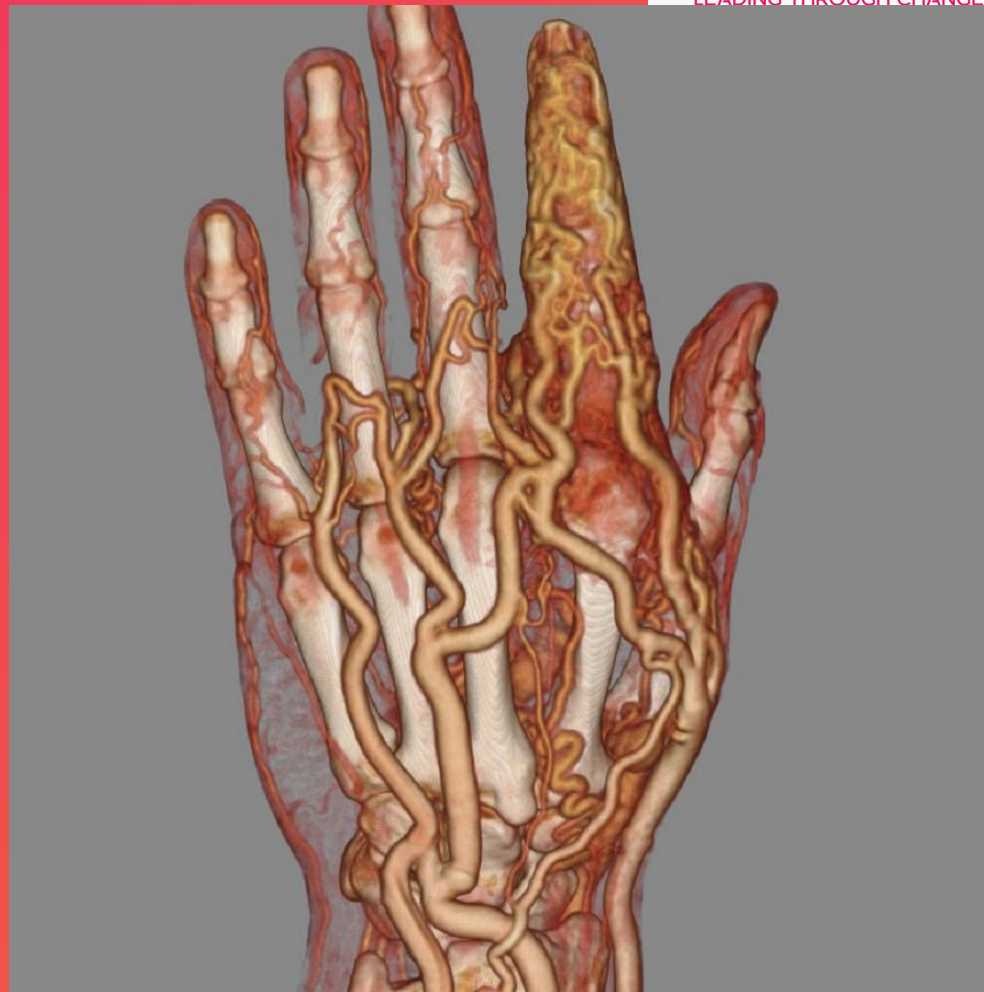
Prior crush injuries, cool fingers



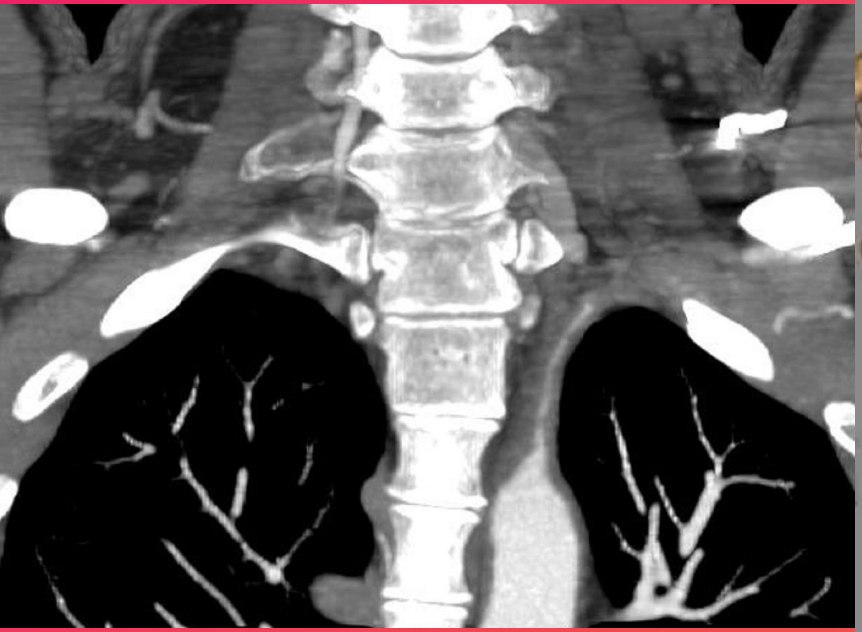


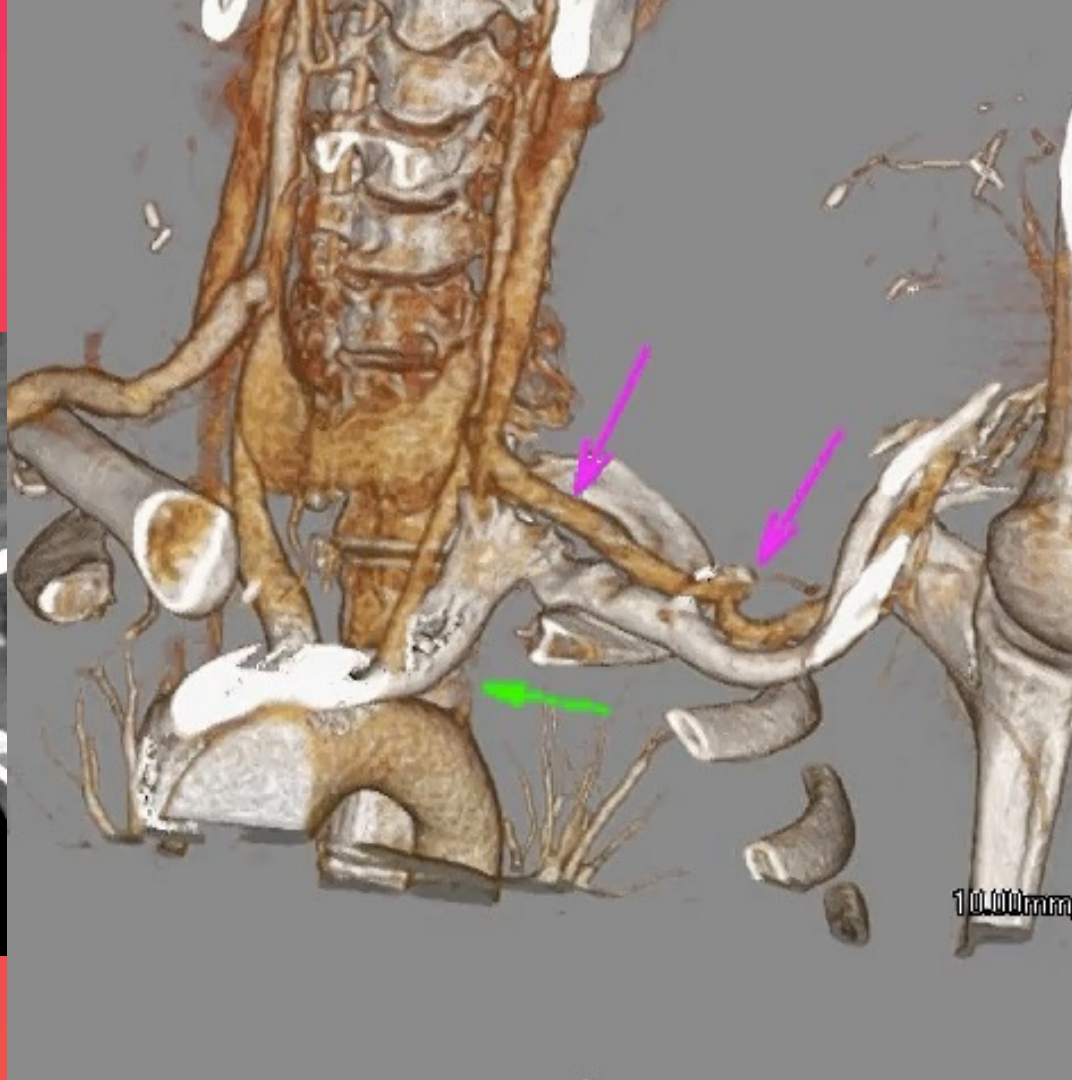
Hand/ Finger AVM



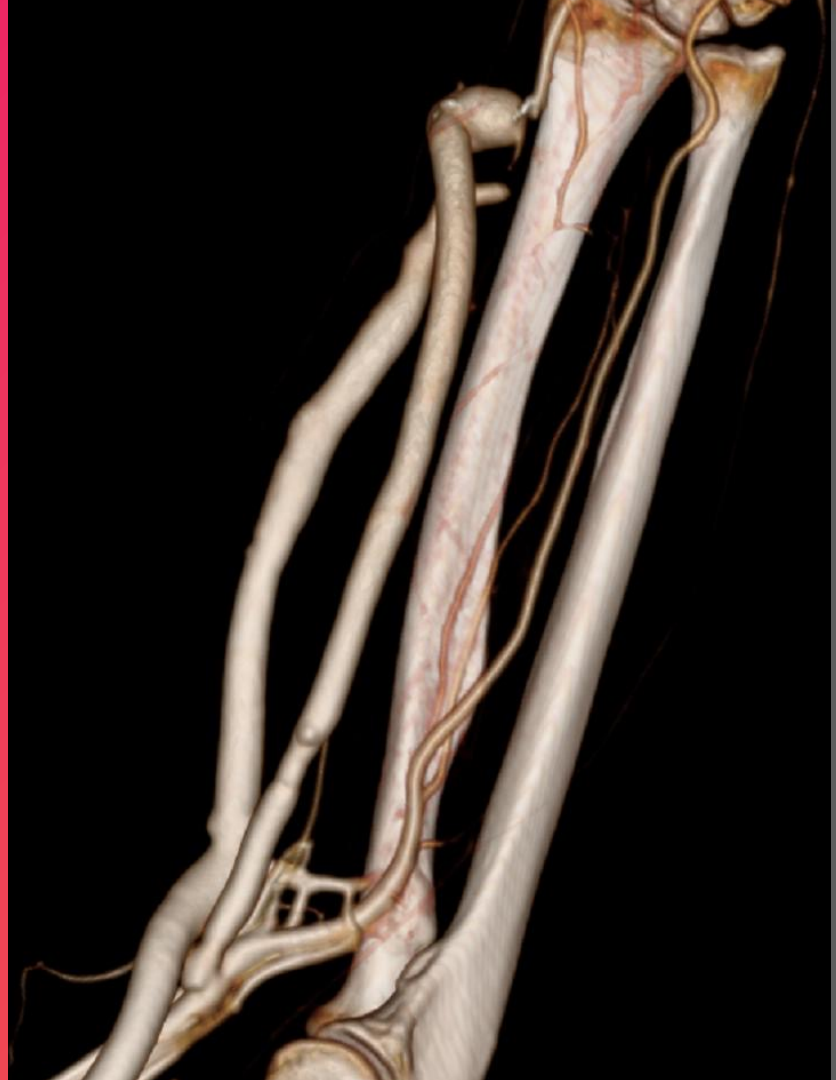


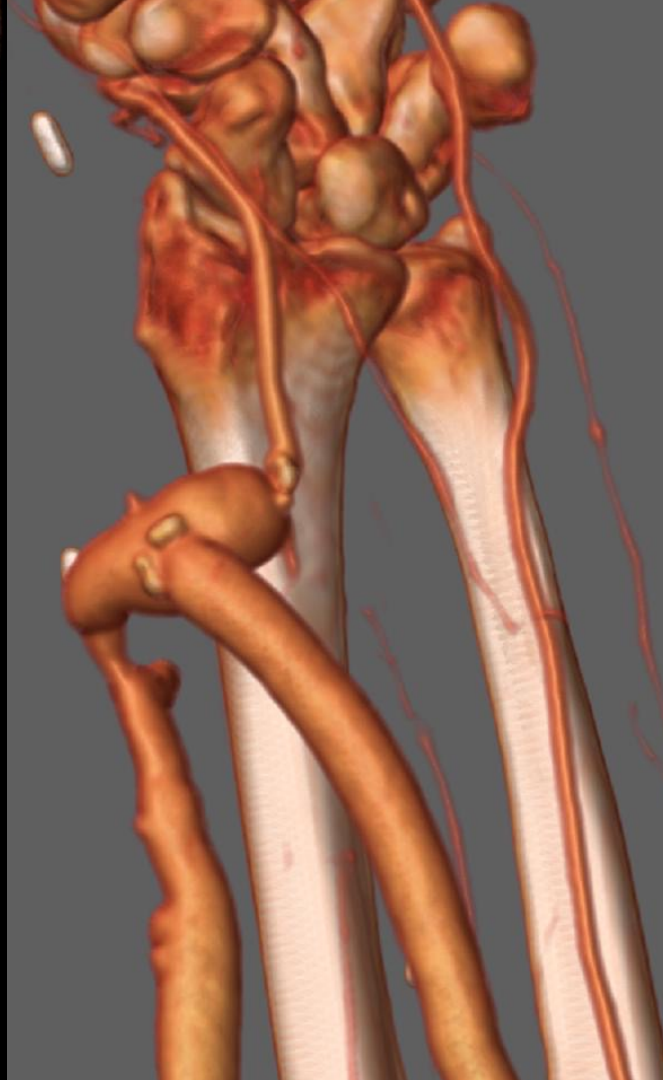
Takaysu Arteritis



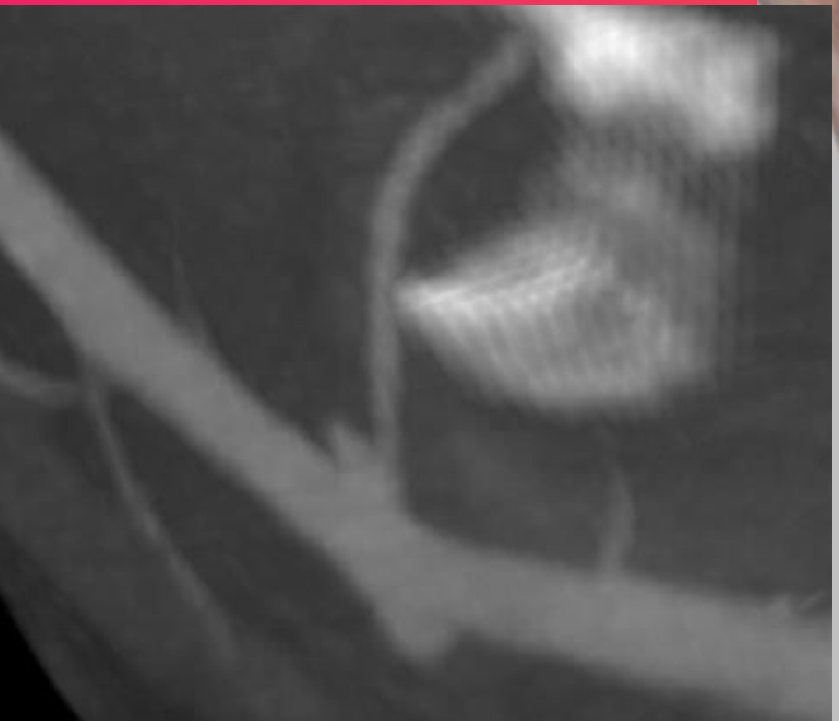


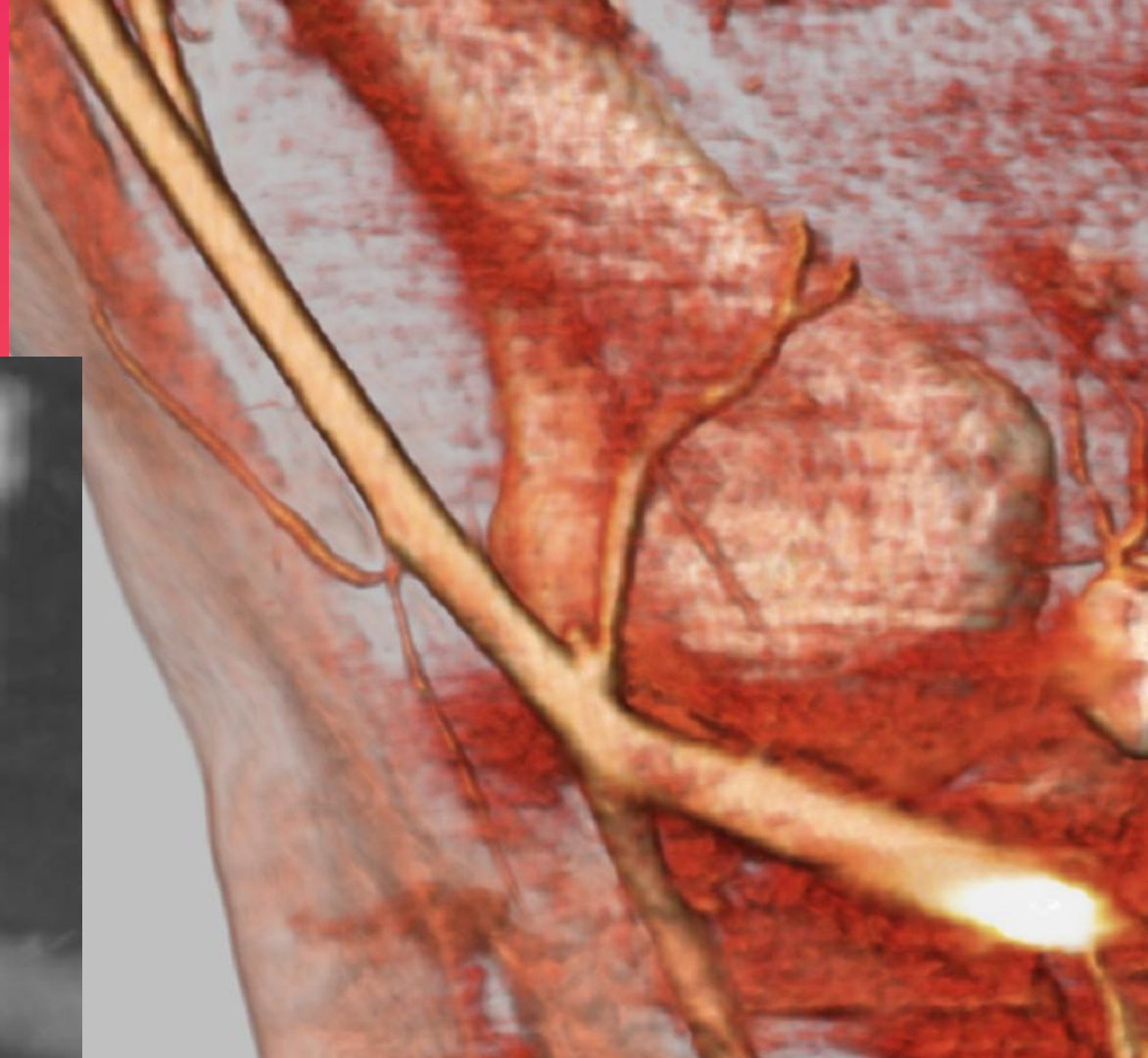
Re-do HD fistula



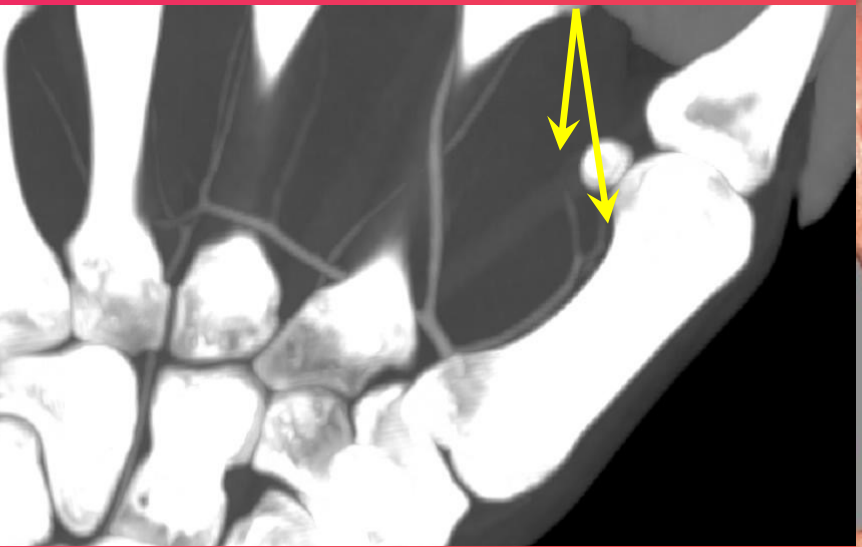


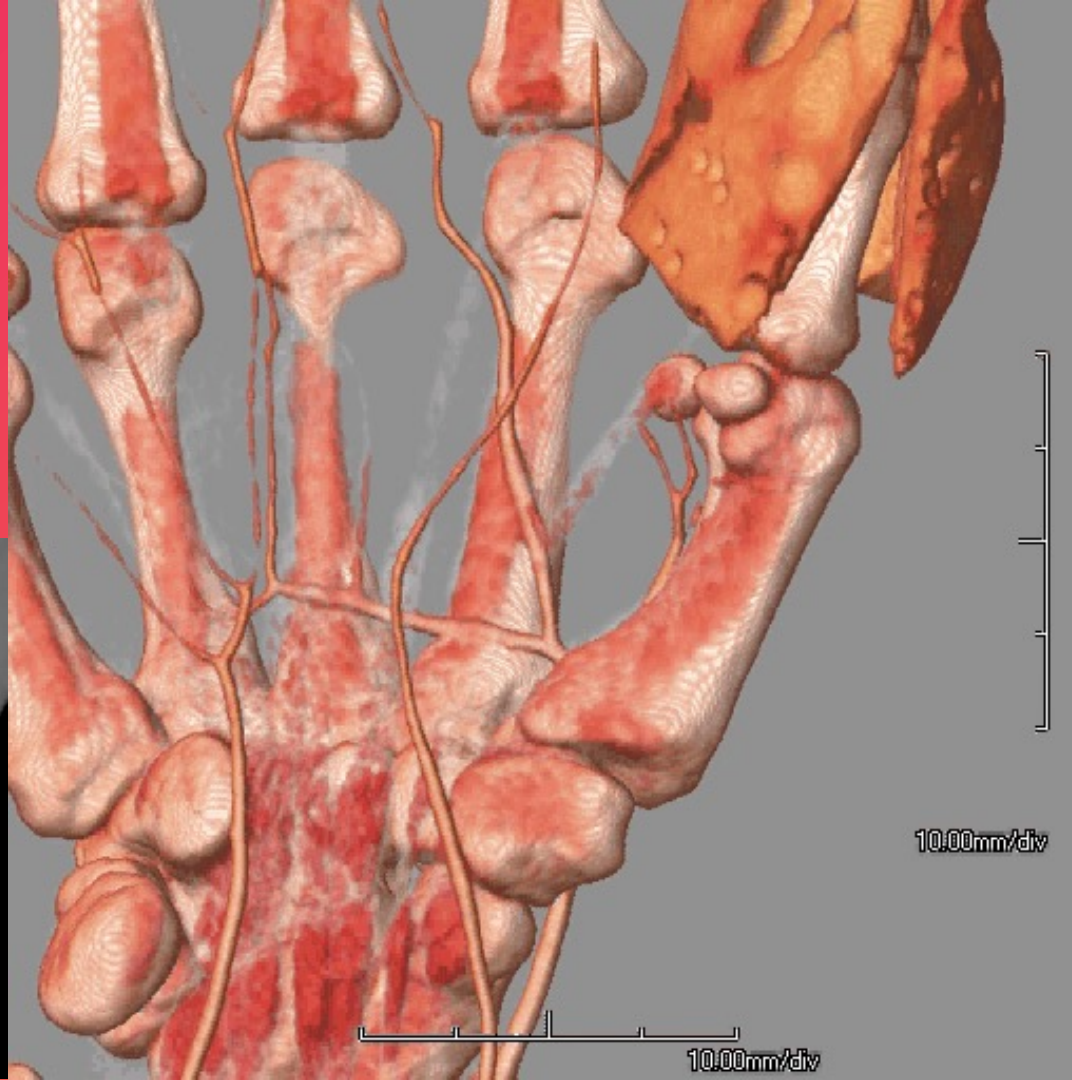
- vQSS: PHCA injury w/ aneurysm and thrombus



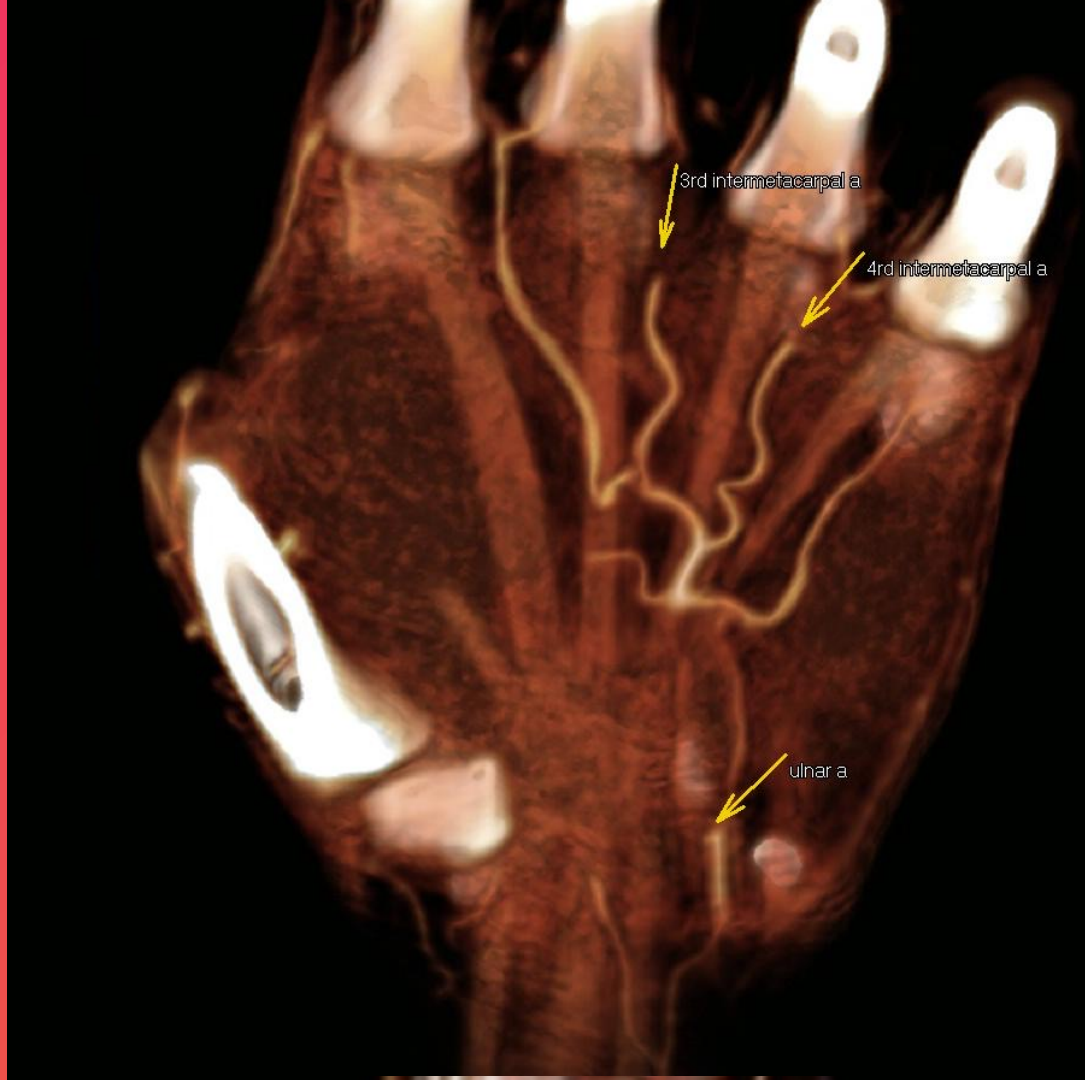


- vQSS: Distal embolic disease to princeps pollicis a. and PDAs





Hypothenar Hammer Syndrome



Courtesy Minhaj Khaja MD, MBA
Univ. of Michigan

Conclusions: Peripheral CTA

- Goal of LE CTA:

  map lesions to symptoms to direct therapy

- Goal of UE CTA:

  Answer the clinical questions

- Integrated CM/scan protocol improves consistency
  - Inject long, scan slow
  - Weight-based CM dosing w/ biphasic injection

Thanks for your Attention!

- Special thanks to…..

  Dominik Fleischmann, MD

  Kate Hanneman, MD

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