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Vascular Lesions of the Upper Extremity in Athletes

American Heart Association 2019 IM.CVS.366 1100 Philadelphia, PA

Learning Objectives

- Identify anatomic and functional lesions that predispose to vascular disease of the upper extremity in athletes.
- Describe methods to assess vascular entrapment using dynamic, functionally challenged CTA and MRA.
- Describe the imaging findings for diagnosis.

Backgr

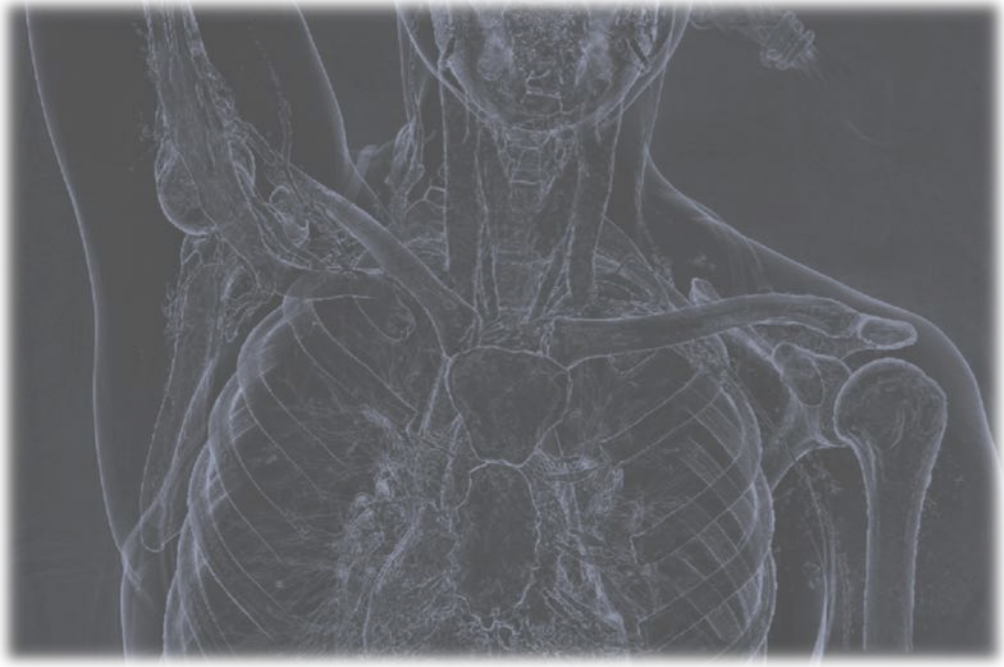
DYNAMIC EVALUATION IS IMPORTANT !!

- Vascular diseases are easily overlooked in athletes
- Thorough vascular H&P needed
- Deciding WHEN (or IF) to image vascular entrapment syndromes requires clinical judgment and multi-specialty coordination!!

Dynamic Cross-Sectional Imaging

- **Principle:** simulate the predisposing motion / position and assess vascular response
  - "Stress" and "Relaxed" Imaging
  - Vary timing to assess arteries / veins

UE Vascular Diseases in Athletes



- Thoracic Outlet Syndrome (TOS)
- Vascular Quadrilateral Space Syndrome (vQSS)

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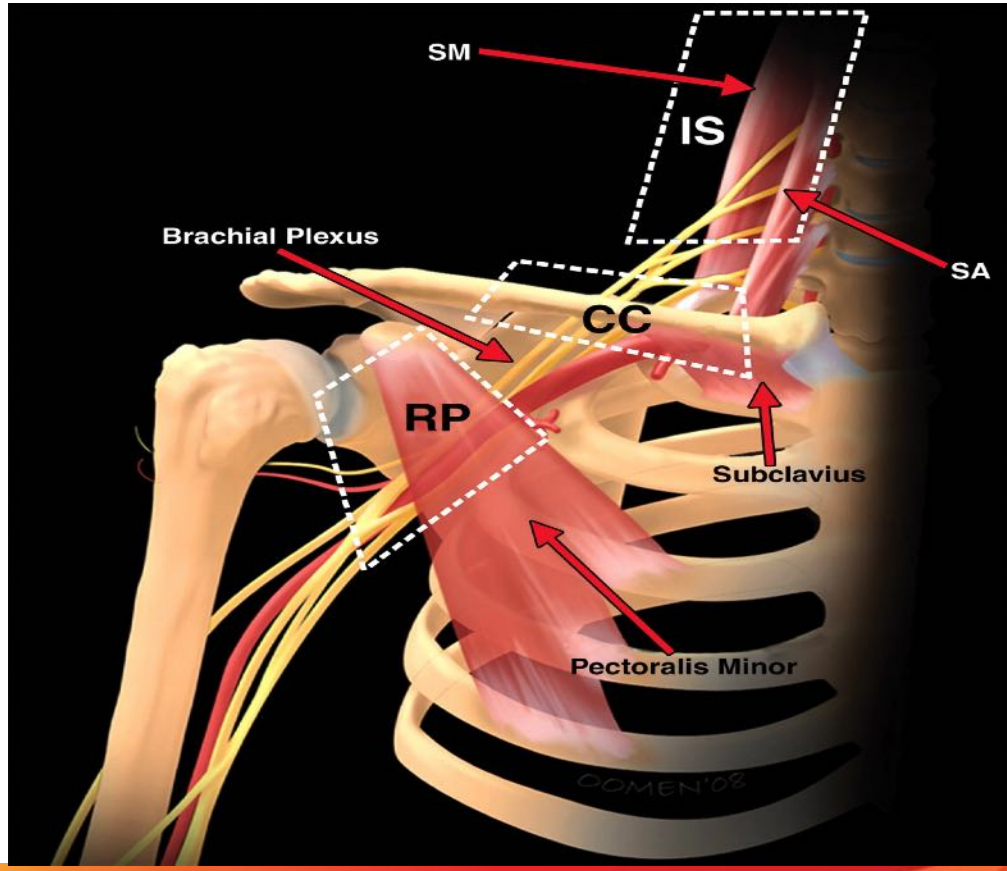
Thoracic Outlet Syndrome (TOS)

Thoracic Outlet Syndrome (TOS)

- Symptomatic compression/entrapment of neurovascular structures by bone and/or soft tissue as they pass through the cervicoaxillary canal
- 90% Neurogenic (PT, postural Tx, NSAIDs)
- **10% Vascular**
    - Venous > Arterial

Components of the Cervico-Axillary Canal

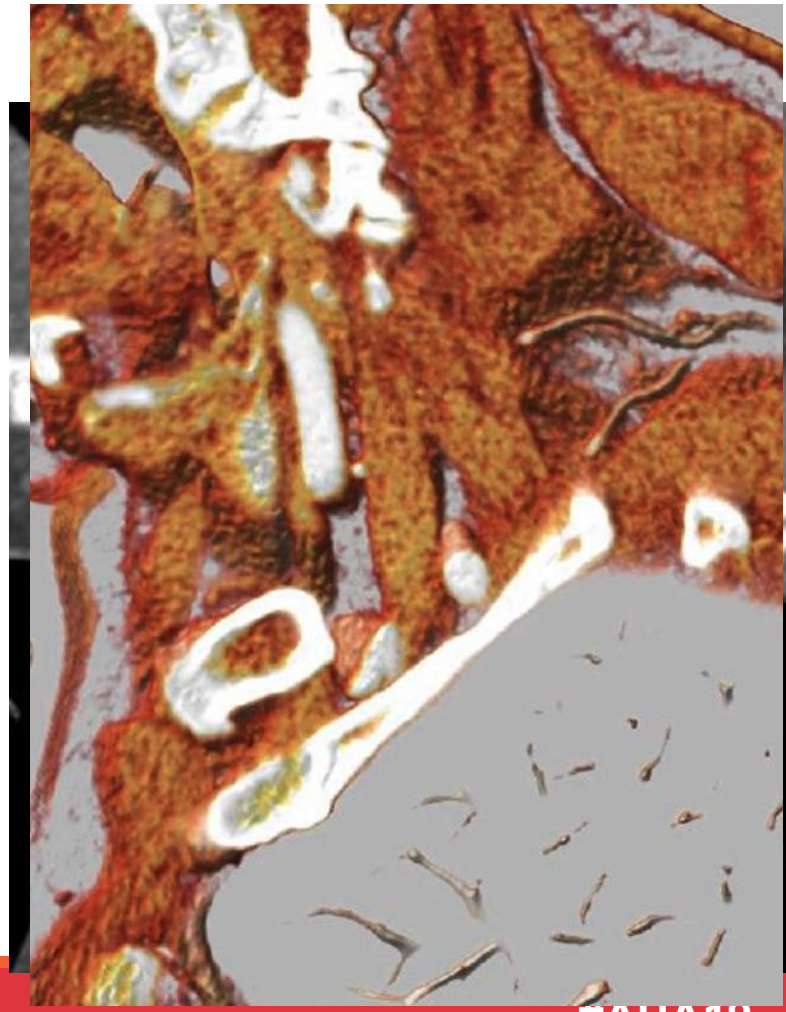
- Interscalene Triangle: #1 site of compression
- Costoclavicular Space: #1 site for vascular TOS
- Retro-pectoralis minor space: #1 site for masses



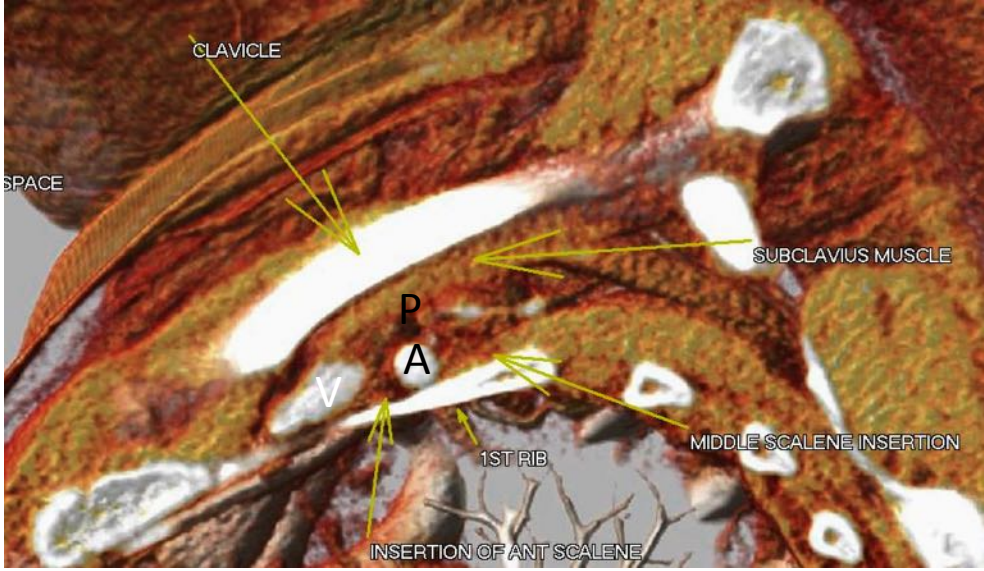
Linda D D et al. Radiographics 2010;30:1373-1400

Interscalene Triangle

- # 1 site of compression
- Borders:
  - Anterior: anterior scalene
  - Posterior: middle/post. scalenes
  - Inferior: 1st rib
- Contents:
  - Subclavian Artery
  - Brachial Plexus (3 trunks)
  - NOT subclavian vein



Costoclavicular Space

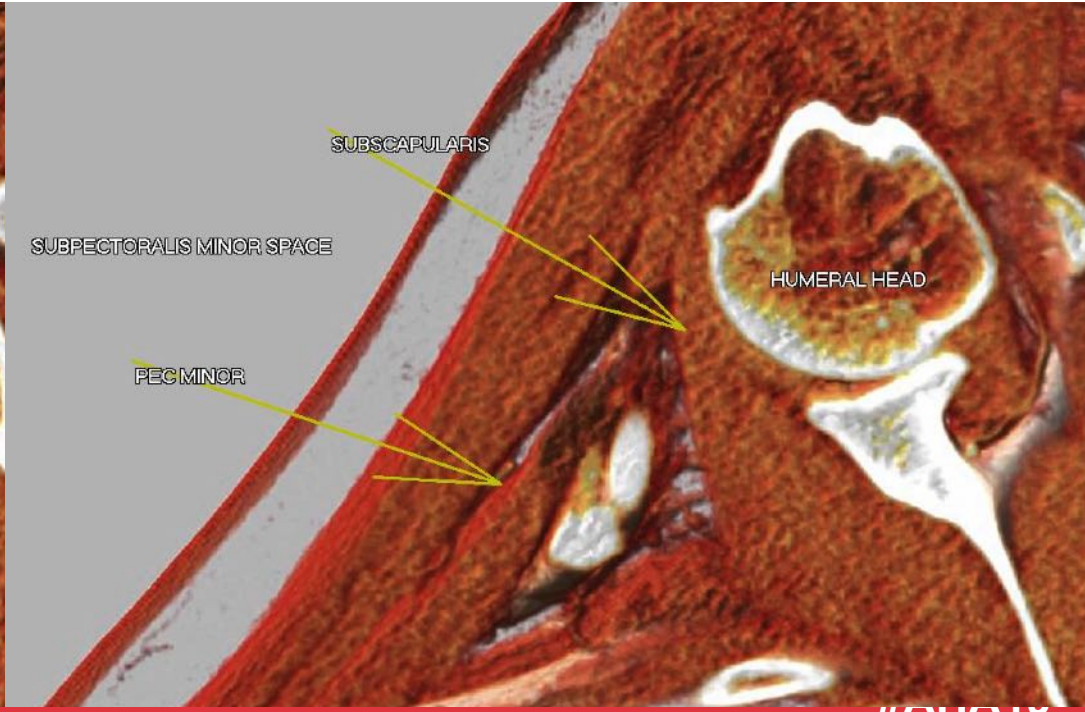


Borders:

- Inferior: 1st rib
- Superior: clavicle + subclavius ms.
- Anteromedial: Clavicopectoral fascia, rhomboid ligament & sternum
- Posterolateral: Middle scalene muscle
- Anterior scalene muscle divides space into anterior and posterior divisions

Retro-pectoralis Space

Borders:
Anterior: Pec Minor
Superior (anterior): Corocoid Process
Posterior: Subscapularis, humeral head



Vascular TOS: Workup

- Clinical Tests (Adson, Roos, etc)
- Plain films
- Ultrasound
- CTA / MRA
- Catheter angiography

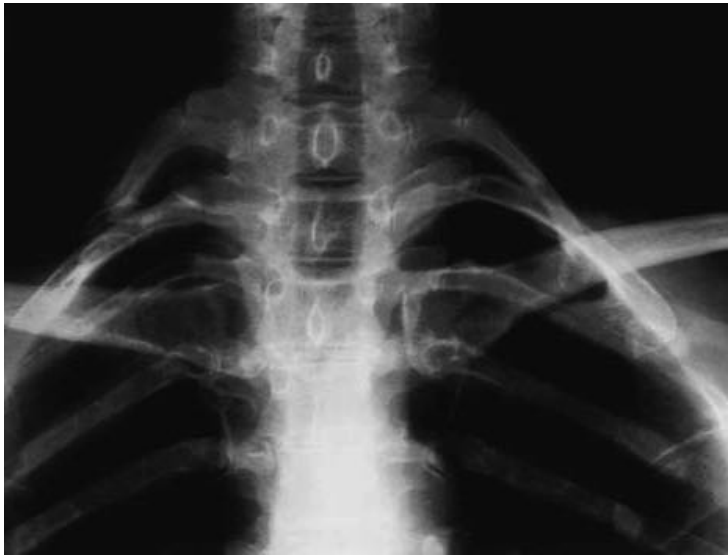
DYNAMIC EVALUATION IS IMPORTANT !!

Clinical Tests

- **Adson**: supination + 15^0 abduction, head turned to Sx side, lose radial pulse w/ deep inspiration
  - Most sensitive
- **Roos**: both arms abducted+XROT x3 min, open/close hands
- **Costoclavicular compression**
  - Examiner depresses shoulder and checks for Sx
- **Wright**:
  - Hyper-abducted+XROT, check Sx or pulse change

Vascular TOS: Imaging

- Radiography: Valuable 1st step
  - Cervical rib
  - Elongated C7 trans. process
  - Callus/Deformity of clavicle / 1st rib
  - Exostosis
- Ultrasound
  - Readily available, inexpensive, no radiation
  - Operator dependent, up to 30% false NEG



Cross-Sectional Imaging in TOS - Considerations

- Dynamic evaluation
- Image with arm at side and over head
- Which arm to inject?
- One injection or two ?
- Timing?

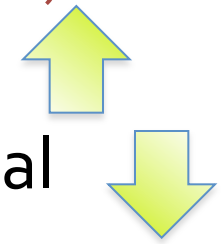
CTA for TOS: Combo Direct/Indirect CTA

- Ipsilateral IV, arm over head w/ palm taped up

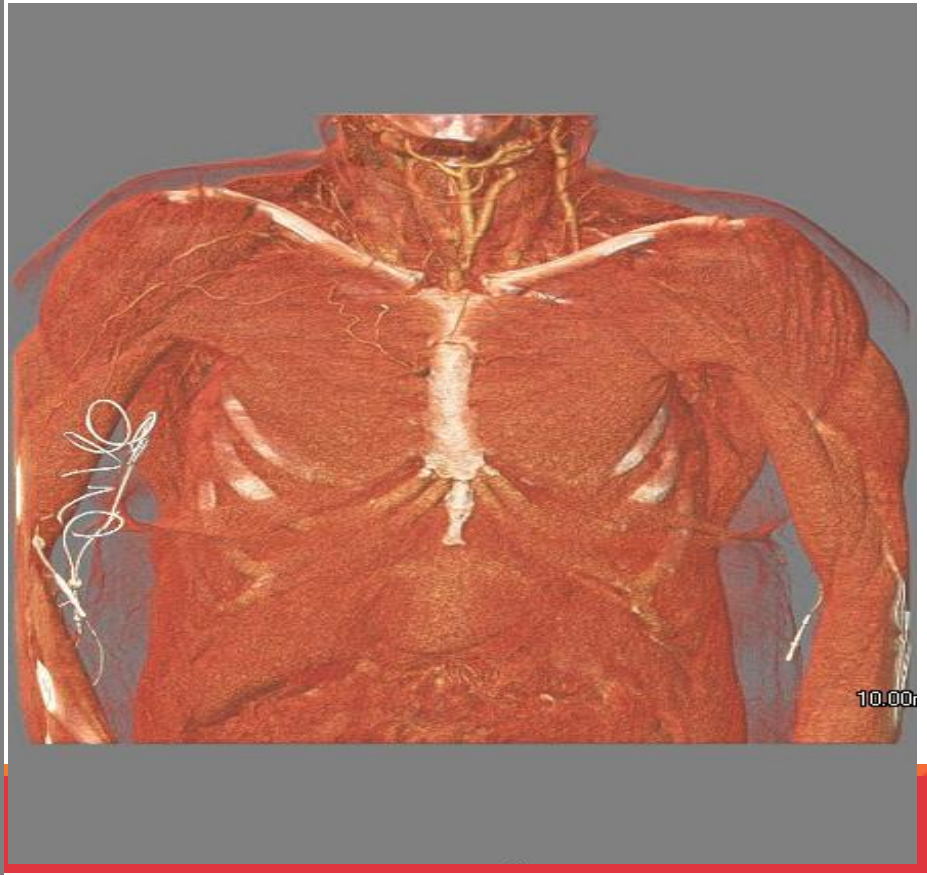
  120 mL full-strength @ 4ml/s

  100 mL dilute (10%) contrast @2.5 ml/s

  - Can inject contralateral arm at same time (dilute)
- 65 sec empiric delay, scan caudo-cranial
- Arm down, immediate re-scan cranio-caudal
- **Volumetric Review**



Bilateral Direct / Indirect CTA



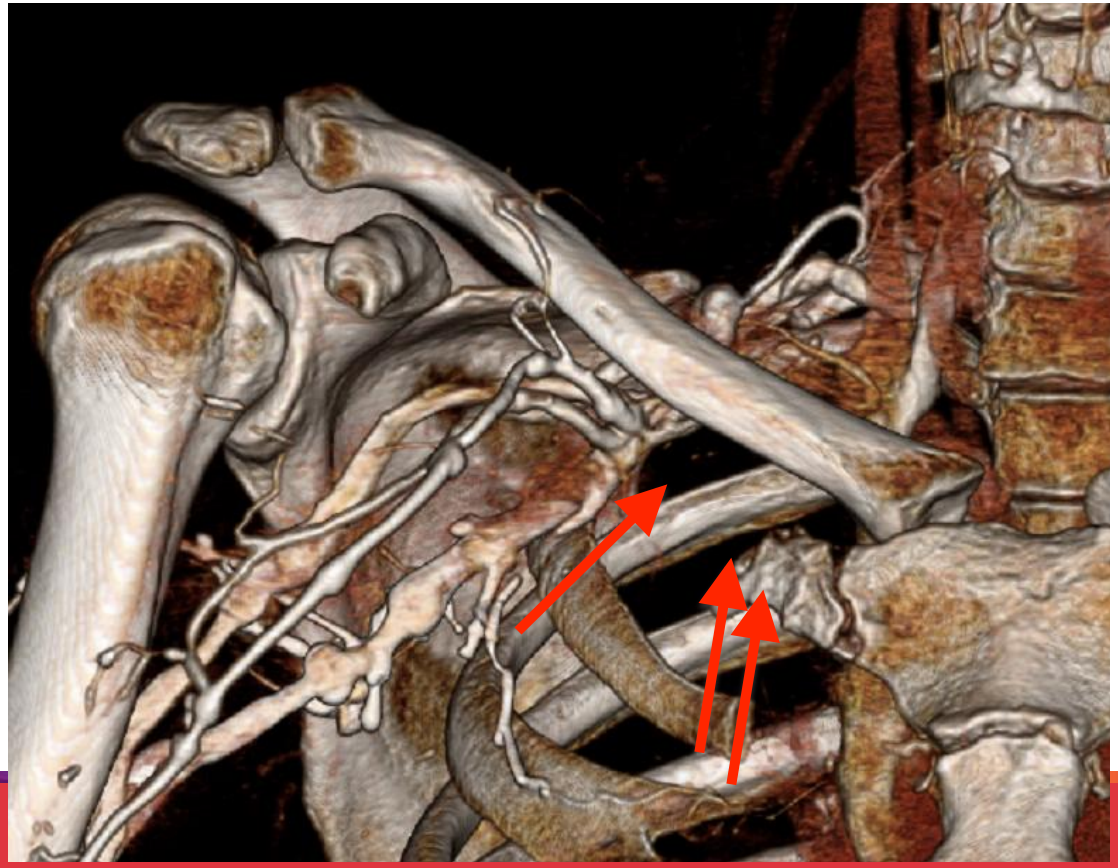
Venous TOS: "Effort Thrombosis"

- Paget-Schroetter syndrome (PSS)
- AKA axillo-subclavian venous thrombosis
- "Overhead" athletes
- Heaviness, purple discoloration
- PE in up to 1/3!! *
- Post-thrombotic syndrome (later)

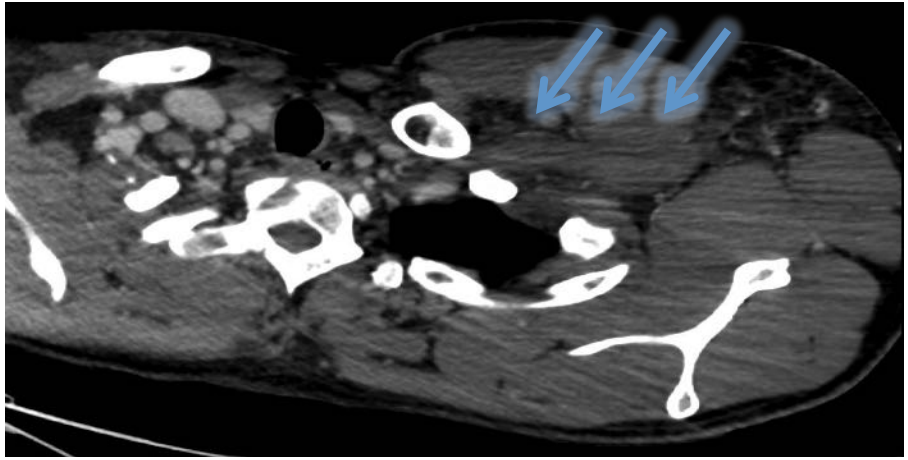
* Perlowski AA. Vasc Med (2010) vol. 15 (6) pp. 469-79

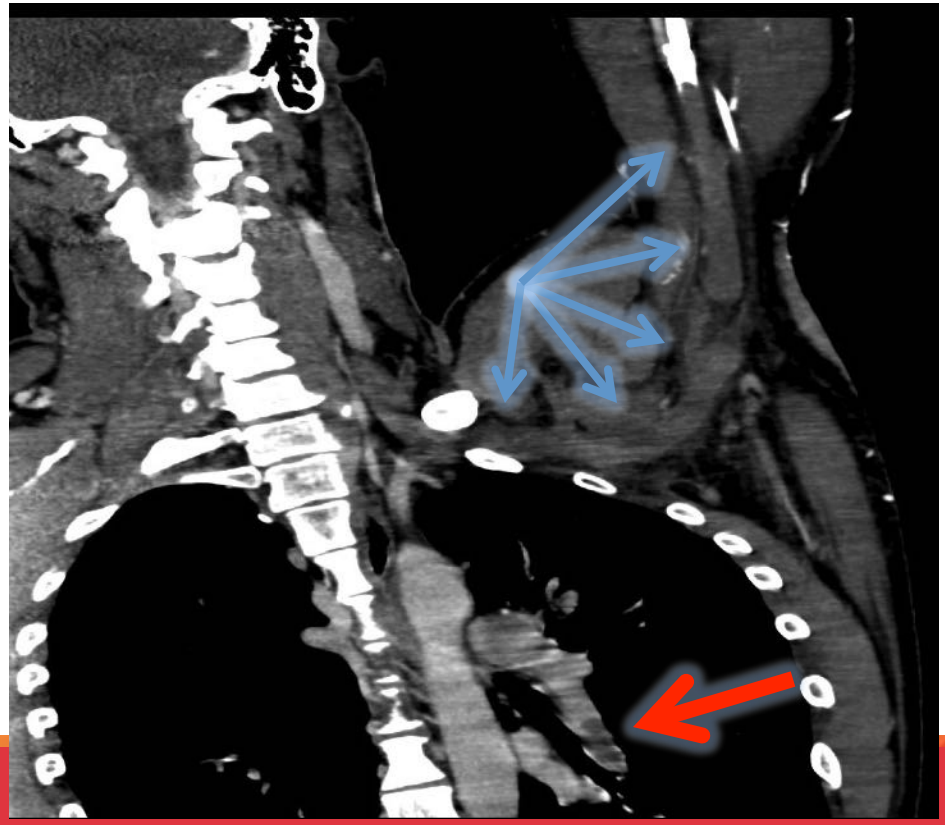
Effort Thrombosis:
36 YO weightlifter

Post-Op 1st rib resection



Effort Thrombosis – 26 year old pitcher





Courtesy Lt.Cmdr Scott Alexander, MD

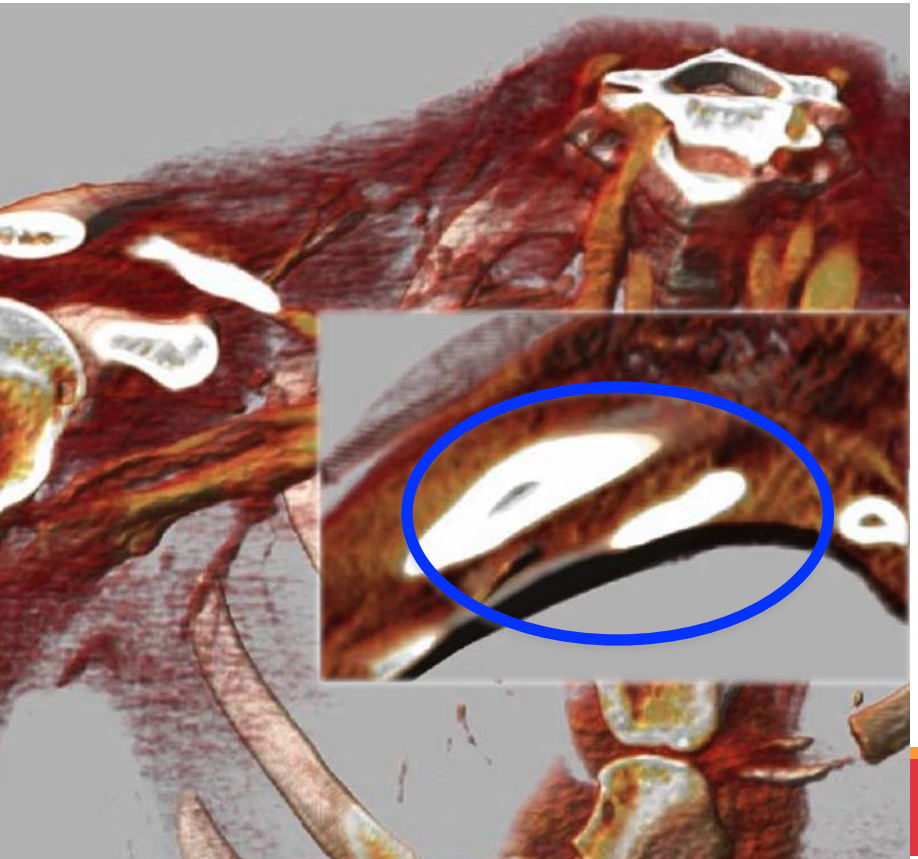
Arterial TOS

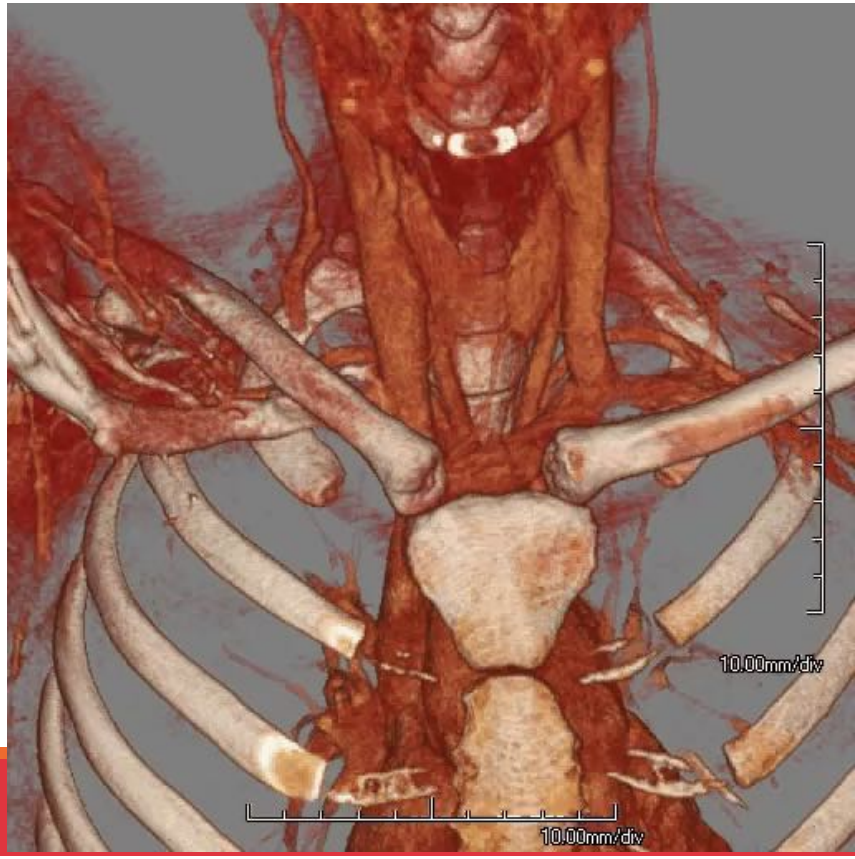
- "Overhead athletes"
- SX: Coolness, weakness, diffuse arm pain (ischemic neuritis)
- Cause: Repetitive compression injury
  - Anatomic predisposition (tight CCS)
  - Post-traumatic, bony callus
  - Scalene hypertrophy
  - Compression beneath pec minor when humeral head moves forward (tethered by humeral circumflex a.)

Arterial and Venous TOS:
16 YO Volleyball Athlete

REST

STRESS



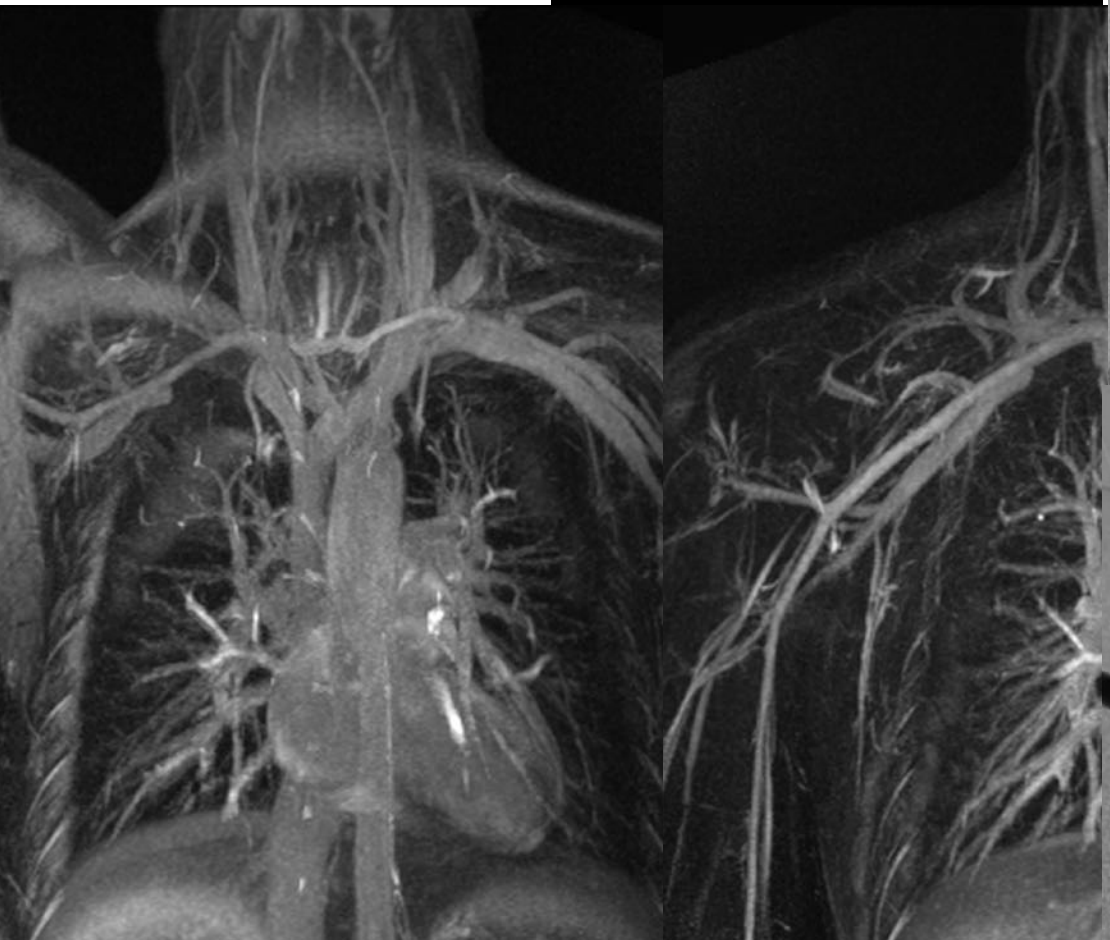


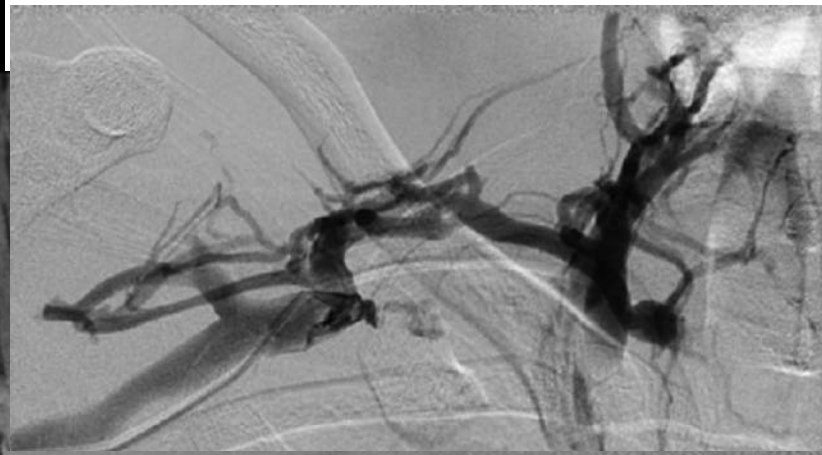
MRA for TOS: Blood Pool MRA

- Anatomic imaging: Oblique sag and cor T1/T2
- Relaxed and Challenged imaging:
  - 2 injections (previously: Gadofosveset (blood pool agent)
  - Breath-hold FSPGR, ECG-gated, high resolution (1.8 mm ST, 448 x 448 matrix) CORONAL acquisition
    - Challenged: Arm Abducted
    - Relaxed: Arm Down

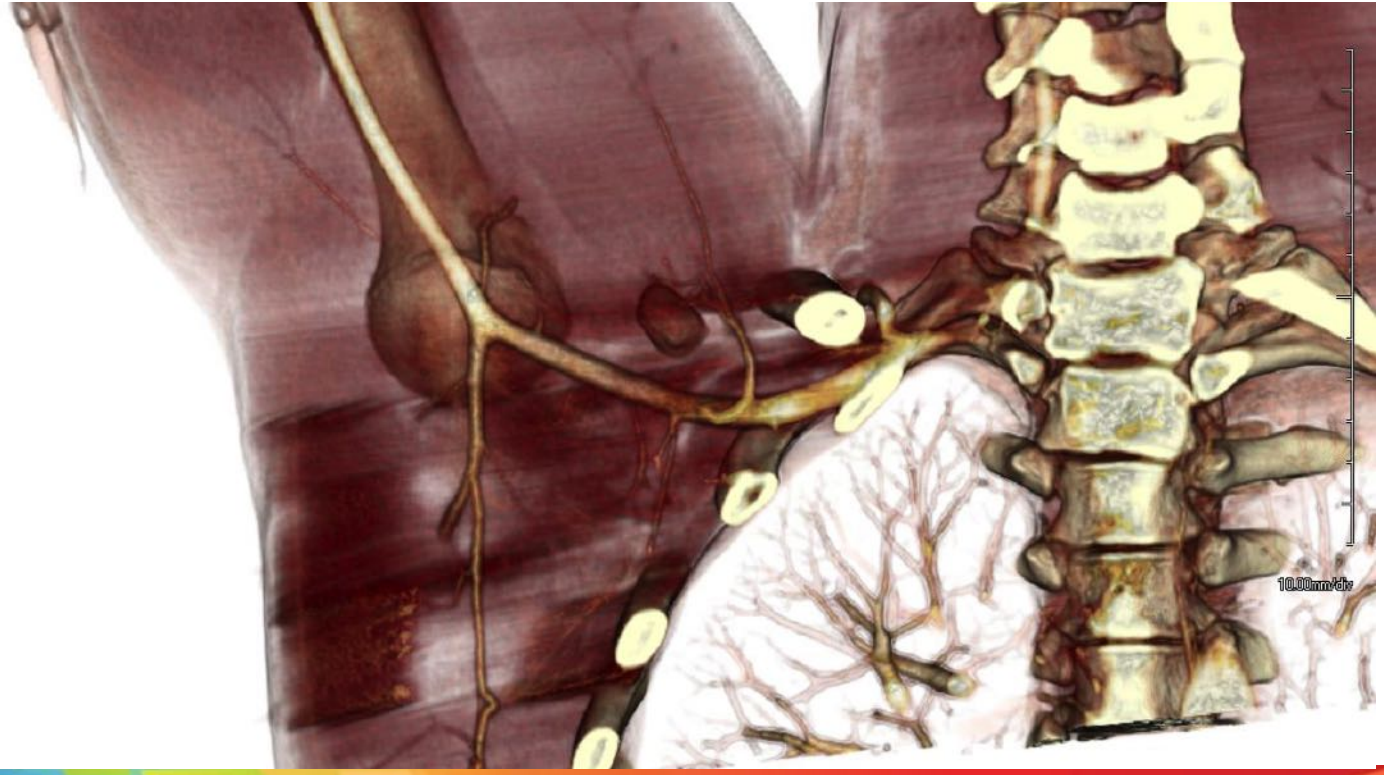
Arm UP

MRA: 17 yo baseball pitcher





Vascular Quadrilateral Space Syndrome



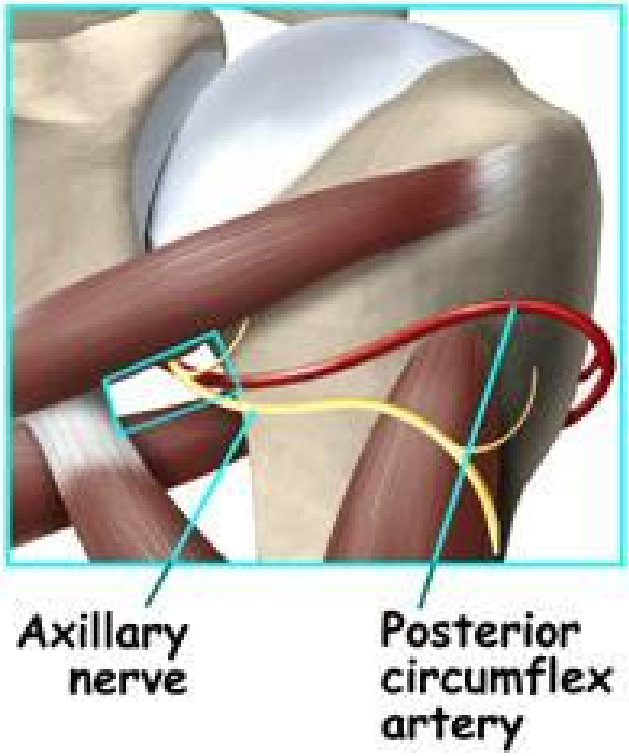
Causes of Hand Ischemia in Athletes

- Digital artery occlusions / forearm vessel aneurysms in handball players and karateists
- **VQSS:** Positional compression of the axillary artery
  - Embolic Occlusion from Aneurysms of Axillary Artery Branches
  - Posterior Circumflex Humeral a (PCHA).
  - Volleyball players, baseball pitchers, football QBs, tennis players

Rollo, et al Ann Vasc Surg 2017, 42:63
Kee, et al. JVIR 1995; 6:979–982

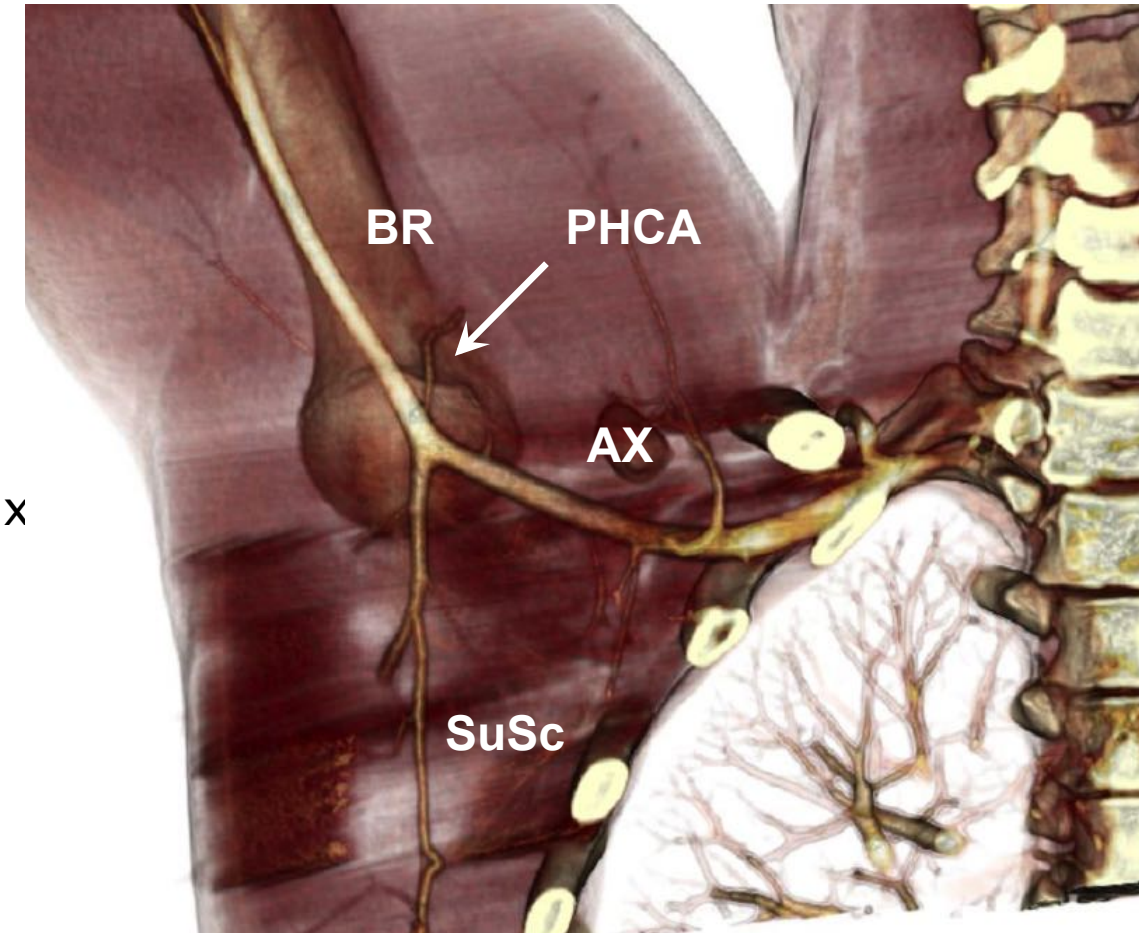
ANATOMY:
Quadrilateral Space

Borders
Medial: long head triceps
Lateral: humerus
Superior: teres minor
Inferior: teres major



ANATOMY:

AX: Axillary artery
BR: Brachial a.
SuSc: Subscapular a.
PHCA: Post. humeral circumflex



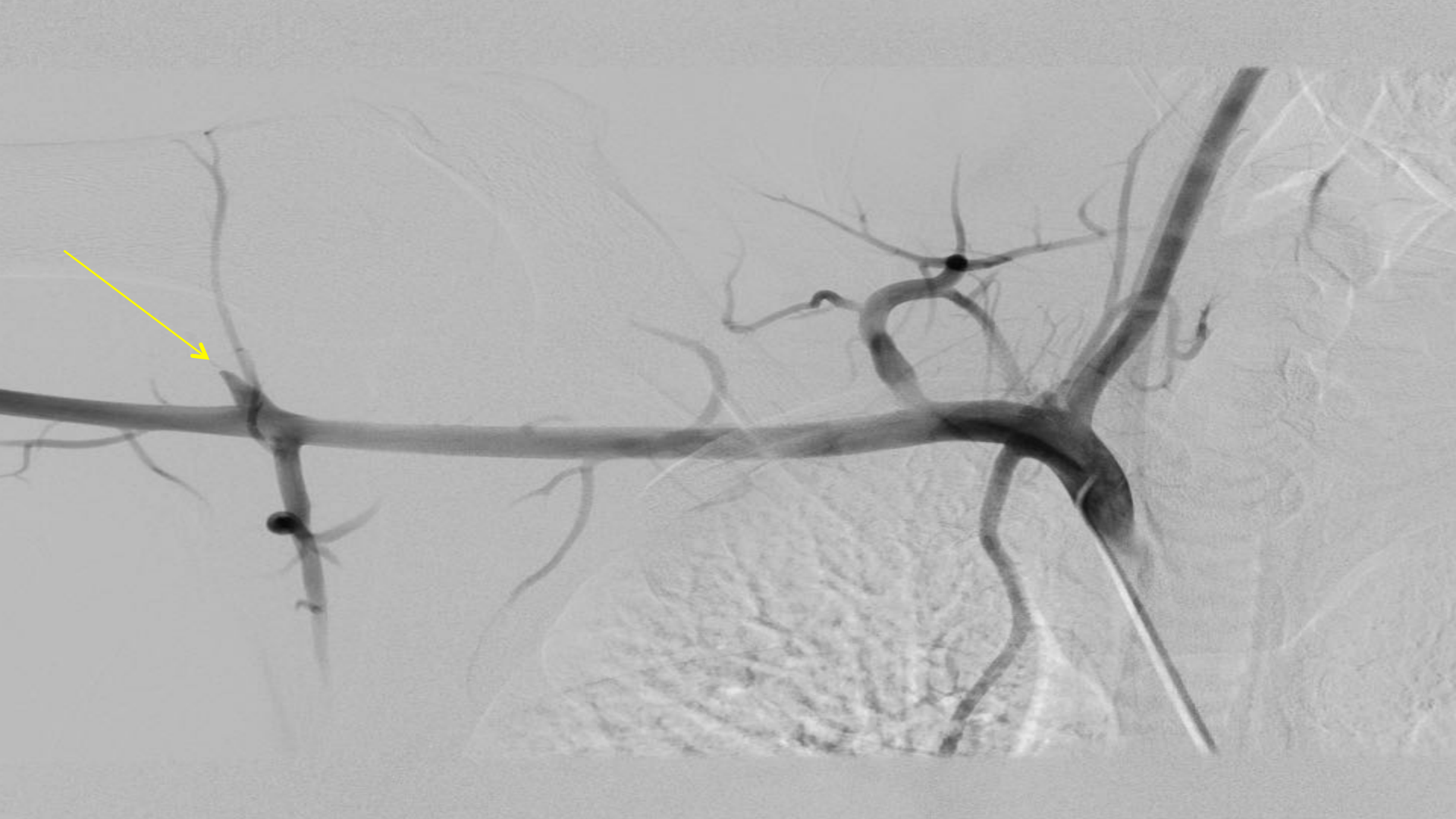
VQSS: Axillary Artery branch aneurysms

- Chronic repetitive trauma: Abduction + external rotation (AER) → rapid flexion + internal rotation
  - Compression of axillary a. branches against humerus, then stretched with flexion/IntRot → sheer forces → aneurysm / dissection +thrombus → embolic disease
- Sx: Hand ischemia
  - Digital pain, weakness, ulceration, arm fatigue, Raynaud's

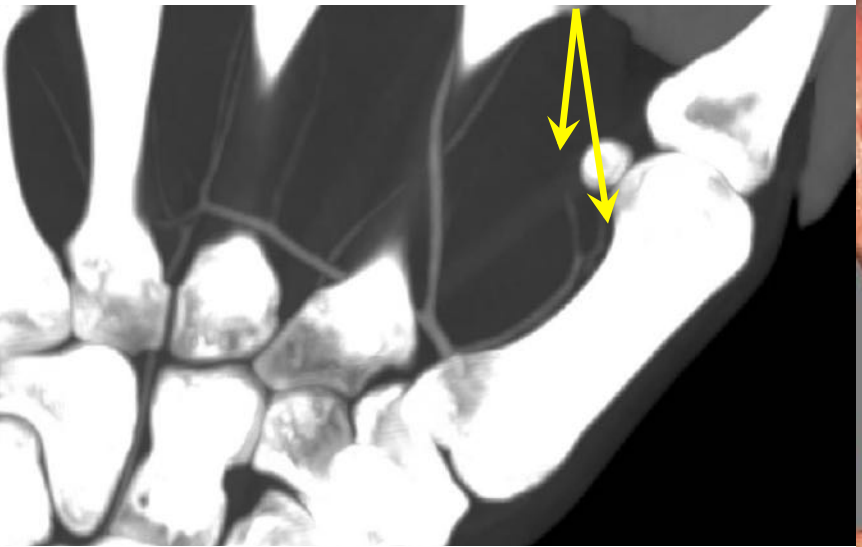
VQSS: Example Case

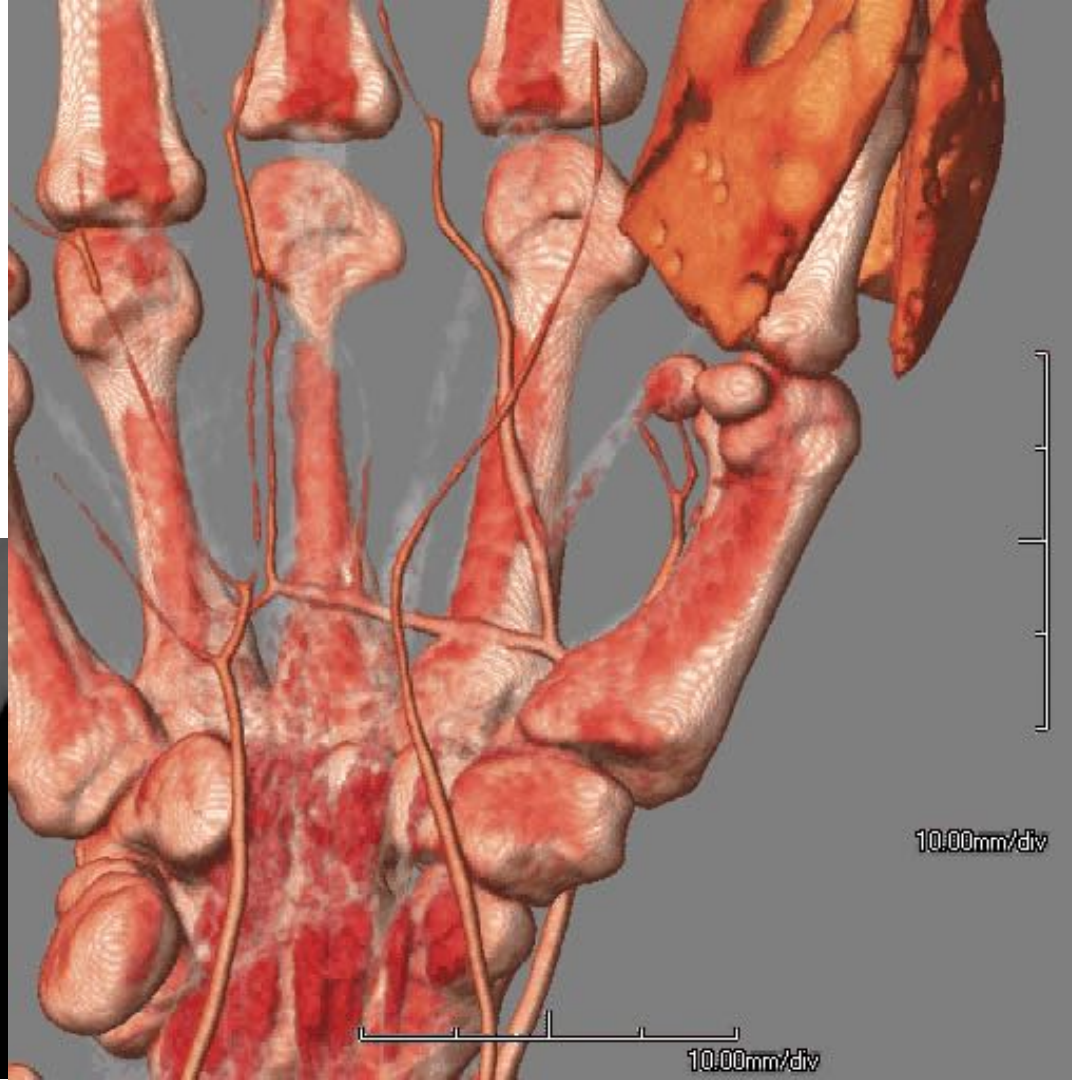
- 19 year old quarterback
- abrupt onset of right fingertip discoloration and pain /numbness over the thumb and first digit
- healing wound with scab on the tip of the thumb.

- PHCA injury w/ aneurysm and thrombus



- Distal embolic disease to princeps pollicis a. and CPDAs
- Vasc Surg. repair





Conclusions

- Although uncommon, upper extremity vascular diseases in athletes can be a significant source of disability and performance loss
- Functional imaging is important for accurate detection and characterization of vascular entrapment / aneurysmal disease
- CTA and MRA with functional techniques allow robust non-invasive assessment

Thank you!

Special Thanks to:
Dominik Fleischmann, MD

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