Vascular Diseases in Athletes

Richard L. Hallett, MD

Chief, Cardiovascular Imaging – Northwest Radiology Network

Indianapolis, IN

Adjunct Assistant Professor, Stanford University

NASCI 2012 *15 October 2012* *08:00*

Disclosures: None

Handouts Available:

www.stanford.edu/~hallett

Choose folder “NASCI 2012”

Background…….

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

Diagnostic Evaluation of Athletes

- Vascular H & P; Clinical Testing
- Plain films
- Ultrasound
- CTA / MRA
- Catheter angiography

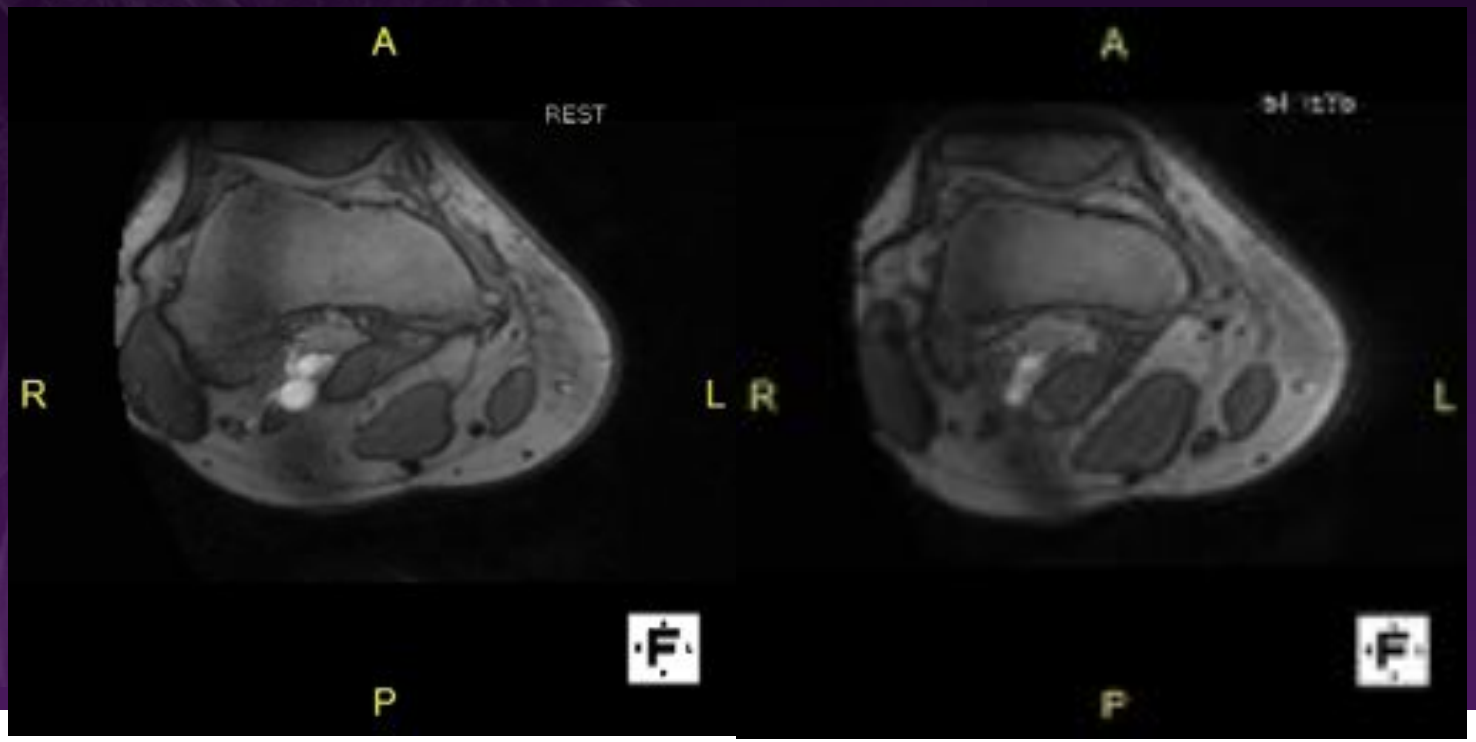
DYNAMIC EVALUATION IS IMPORTANT !!

Dynamic Cross-Sectional Imaging

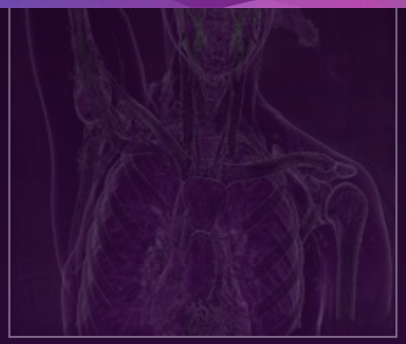
- **Principle:** simulate the predisposing motion / position and assess vascular response
  - "Stress" and "Relaxed" Imaging
  - Can vary timing to assess arteries / veins
- Think outside the box of "typical CTA"

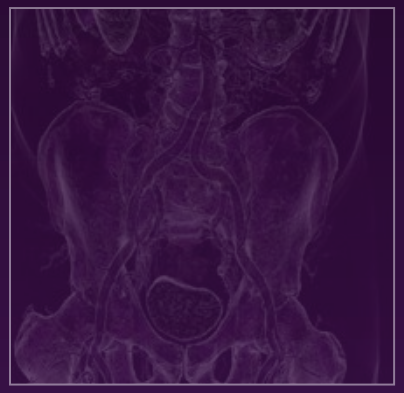
Caveats

- Don’t be afraid to think outside the box
- Use physiology to your advantage
- Blood pool agent for MRA → interesting



Vascular Diseases in Athletes

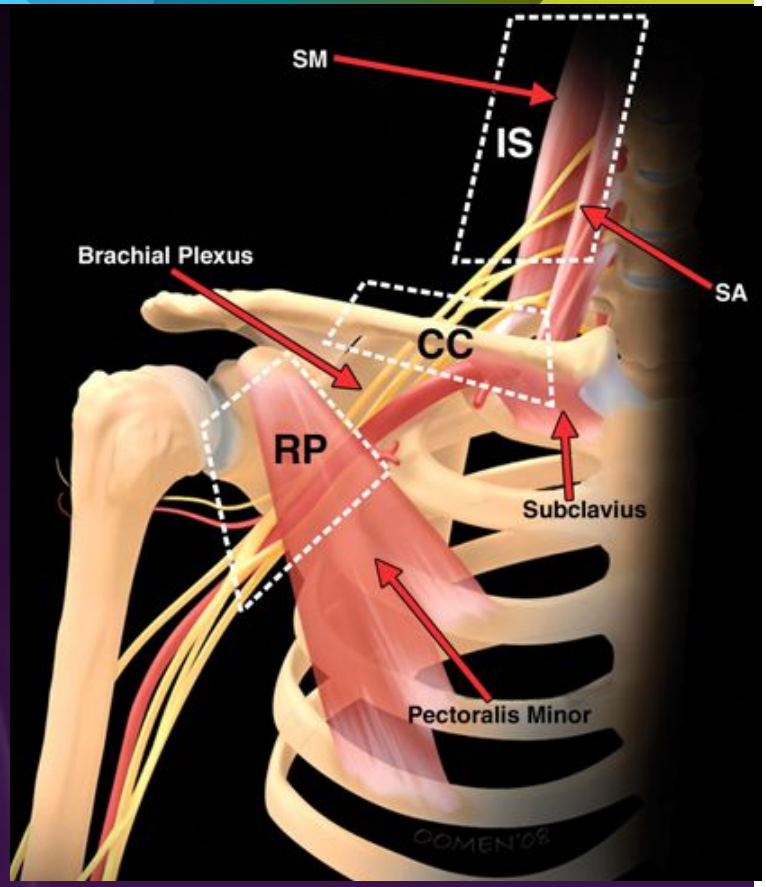




- Upper Extremity
  - Thoracic Outlet Syndrome (TOS)
- Pelvis
  - Iliac Endofibrosis
- Lower Extremity
  - Popliteal Entrapment Syndrome (PAES)

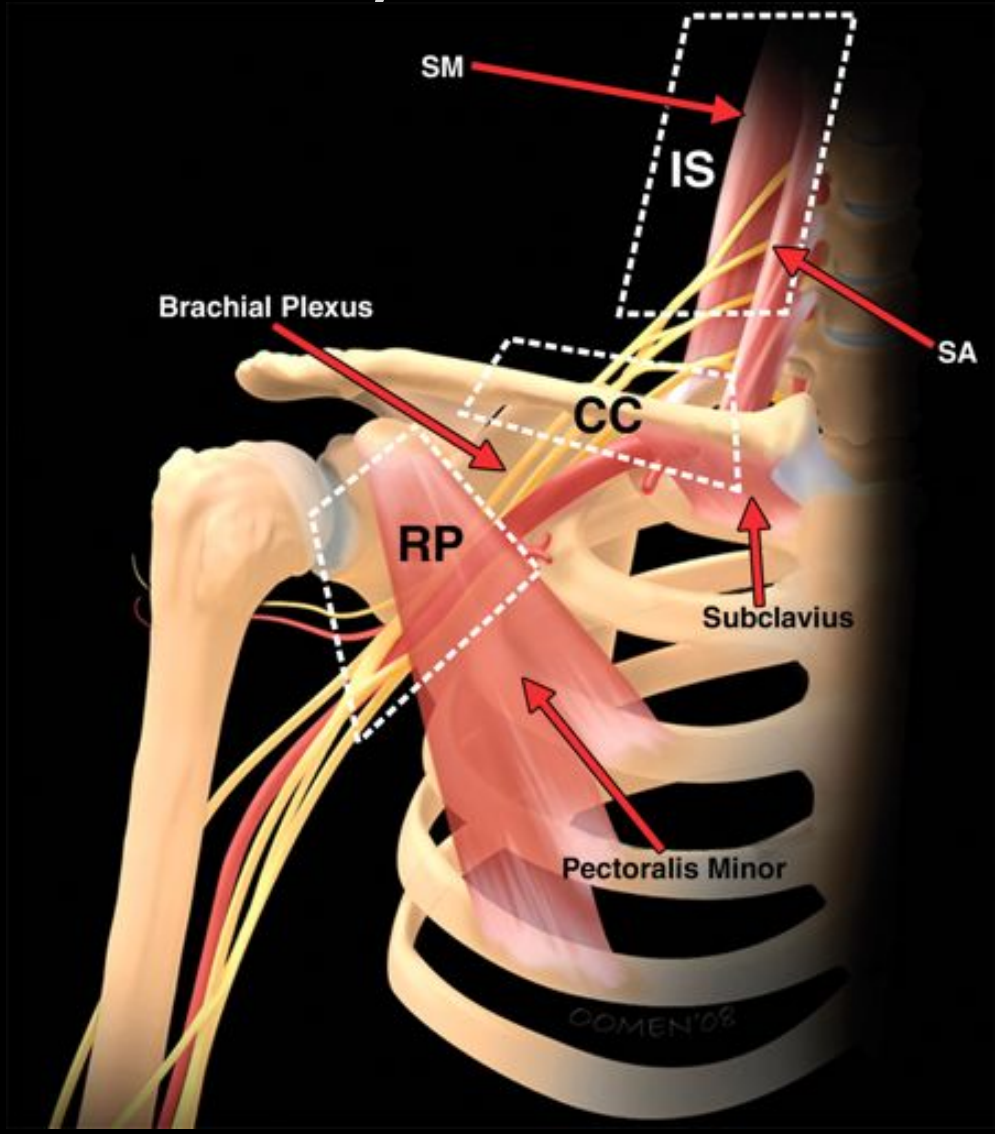
Thoracic Outlet Syndrome (TOS)

- Symptomatic compression/ entrapment of neurovascular structures by bone and/or soft tissue as they pass through the cervicoaxillary canal
- 90% Neurogenic
- 10% Vascular
  - Venous > Arterial



Components of Cervico-Axillary Canal

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



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

Venous TOS: “Effort Thrombosis”

- Paget-Schroetter syndrome (PSS)
- AKA axillo-subclavian venous thrombosis
- “Overhead” athletes
- PE in up to 1/3!! *
- Post-thrombotic syndrome (later)

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

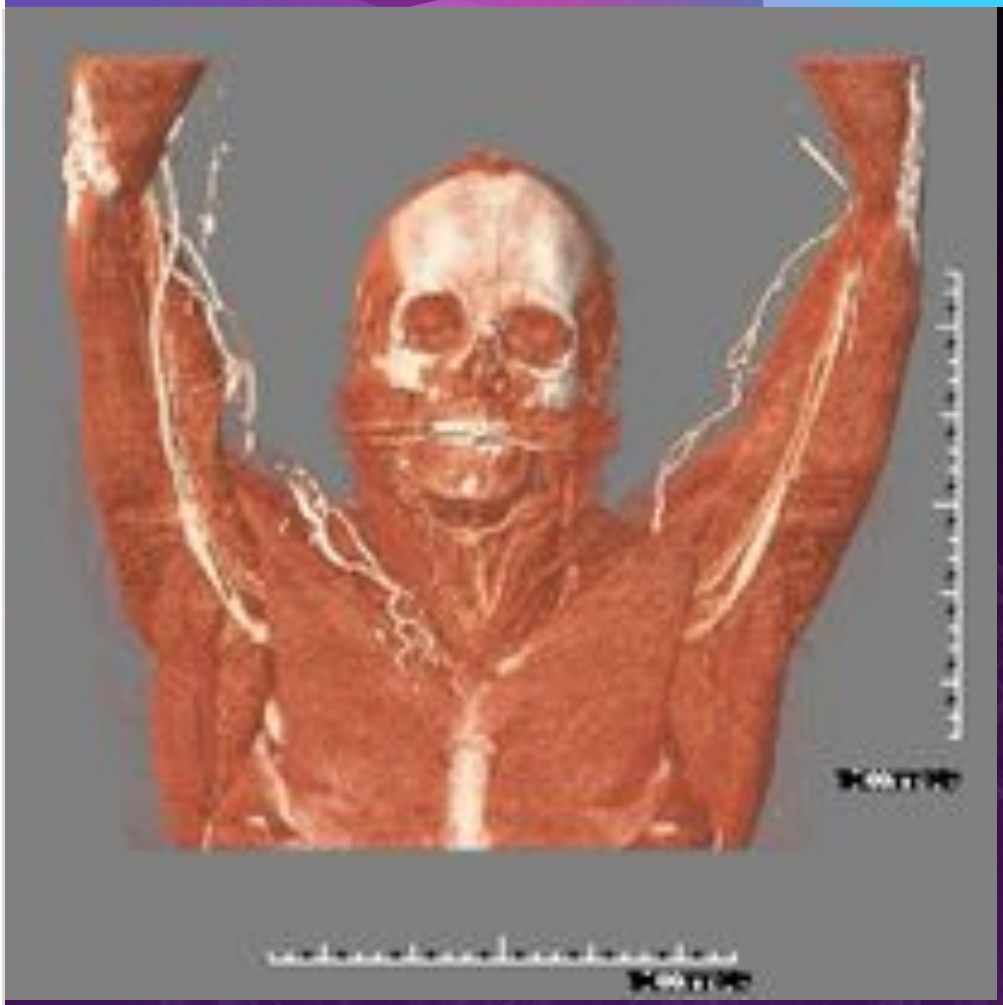
Arterial TOS

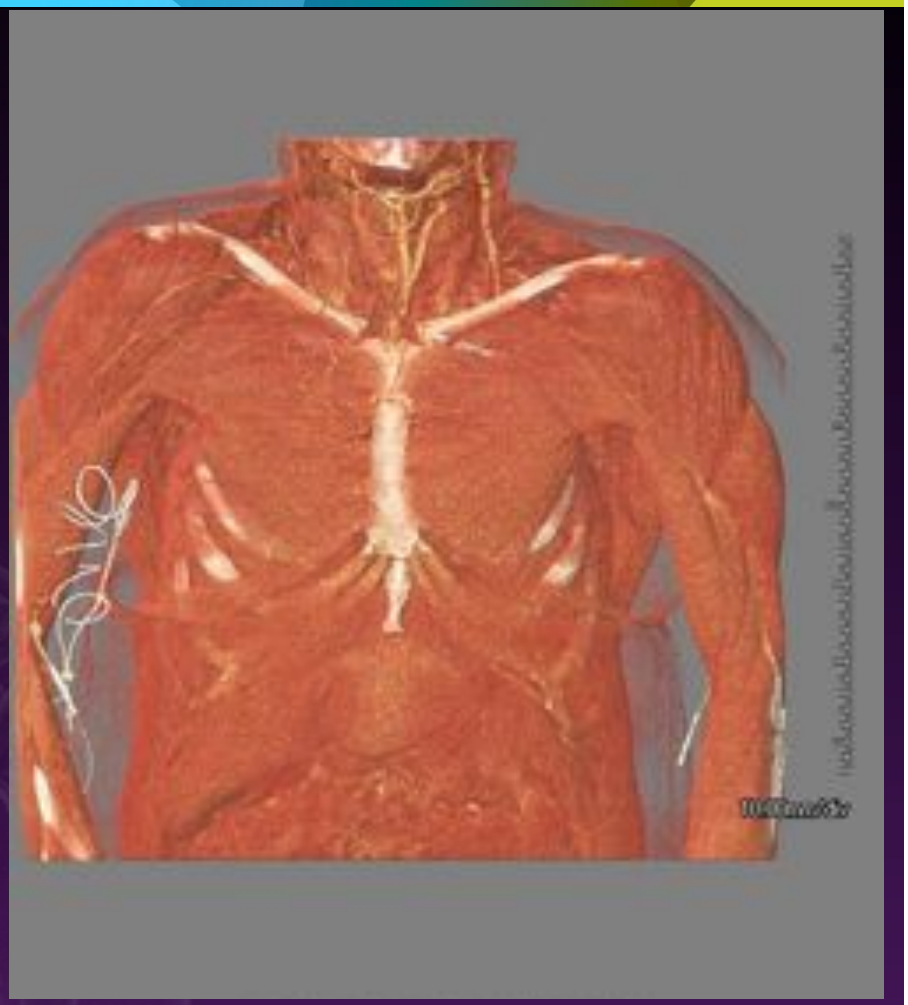
- Less common than venous TOS
- “Overhead athletes”
- Cause: Repetitive compression injury
  - Anatomic predisposition (tight CCS)
  - Post-traumatic, bony callus
  - Scalene hypertrophy

CTA for TOS: Combo Direct / Indirect CTA

- Ipsilateral IV, arm over head w/ palm taped up
- Bolus: 120 mL full-strength @ 4ml/s
- Chase: 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**

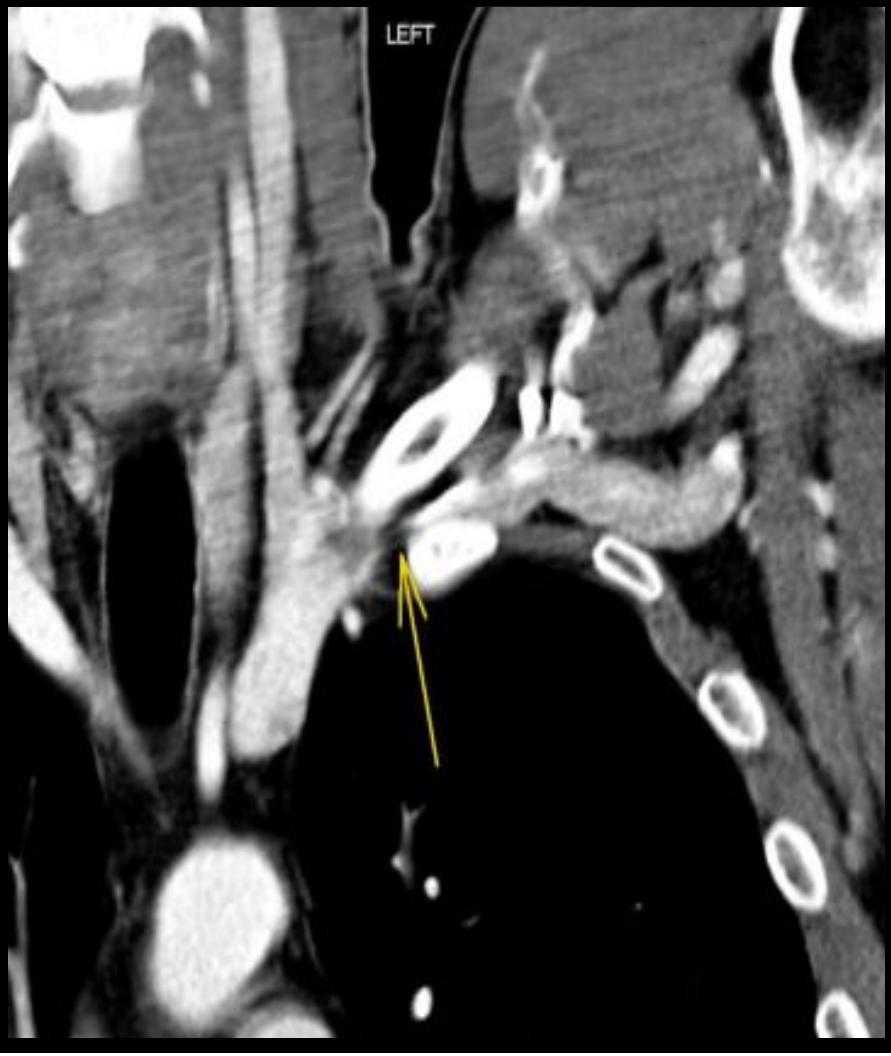
Bilateral Direct / Indirect CTA



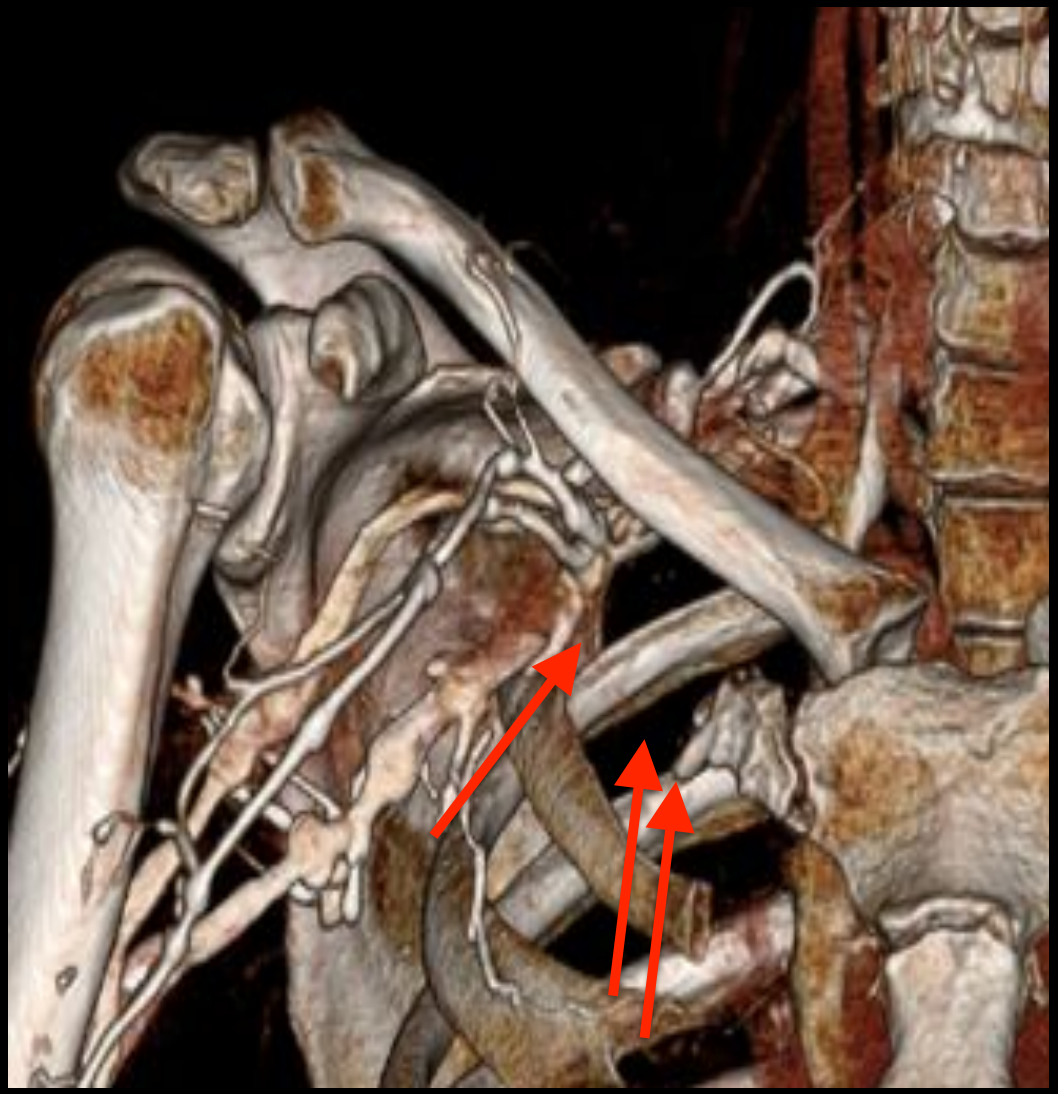


Combo Direct / Indirect CTA

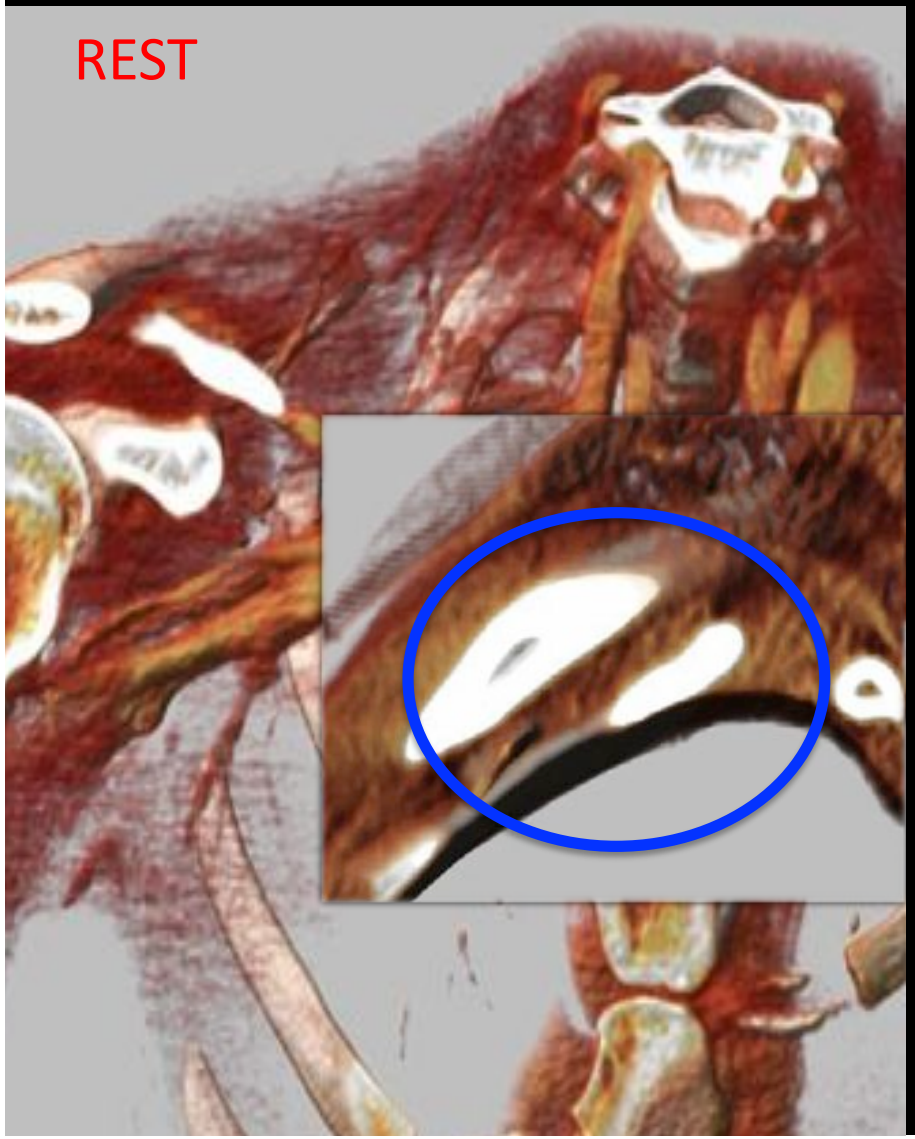
Effort Thrombosis:
36 YO weightlifter



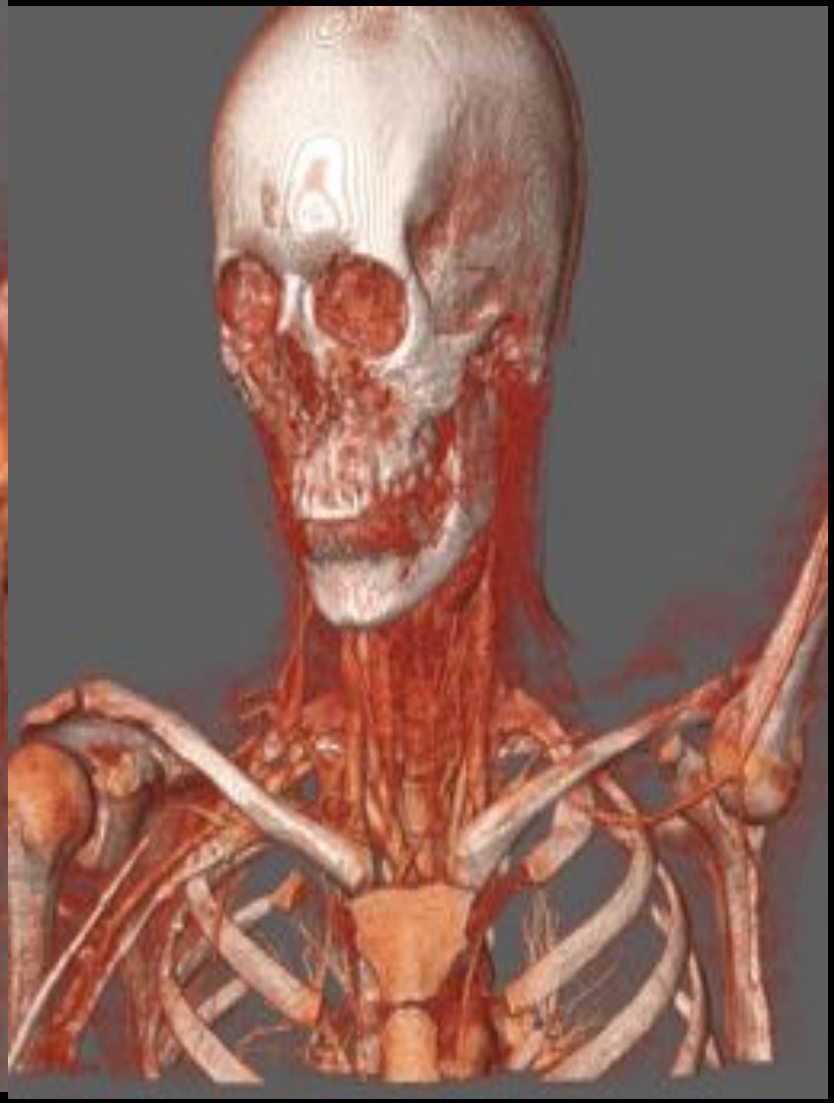
Post-Op 1st rib resection



Arterial and Venous TOS:
16 YO Volleyball Athlete



Arterial Compression



Vascular Diseases in Athletes

Iliac Endofibrosis

Handouts Available:

www.stanford.edu/~hallett

Choose folder “NASCI 2012”

Flow limitations in the athlete pelvis

- Dynamic:
  - Elongated / tortuous vessels
  - Kinking with or w/o stenosis (elongation/ tethering)
  - compression (psoas hypertrophy, ligaments)
- Static: Iliac endofibrosis

Lim CS, et al., Eur J Vasc Endovasc Surg 2009:38:180-6.

Iliac Endofibrosis

- 90% of pts are cyclists
  - 8000-35000 km/yr or 150,000 km lifetime
  - Also: speed skaters, runners, wt lifters, XC skiers, and rugby players
- 90% external iliac artery (EIE)
- Smooth, eccentric, non-calcified
- Pathology: intimal fibroplasia, medial hypertrophy, and adventitial hyperplasia.
  Involved segments universally free from atherosclerosis.

Lim CS, et al. Eur J Vasc Endovasc Surg 2009:38:180-6.

Endofibrosis CTA: Imaging technique

- Two phases: relaxation and hip flexion
- Coverage ~ 40 cm
- Relaxation – 100 kVp, flexion – 120 kVp
- ~ 80 mL of IV contrast at 4 -5 mL/s for each phase (20 sec injection)
- Saline flush at same rate
- Scan time 10 - 12 sec
- Volumetric Review

CTA: Positioning

- Simulate cycling position as closely as possible considering space within CT gantry (almost 90 deg)

Case I

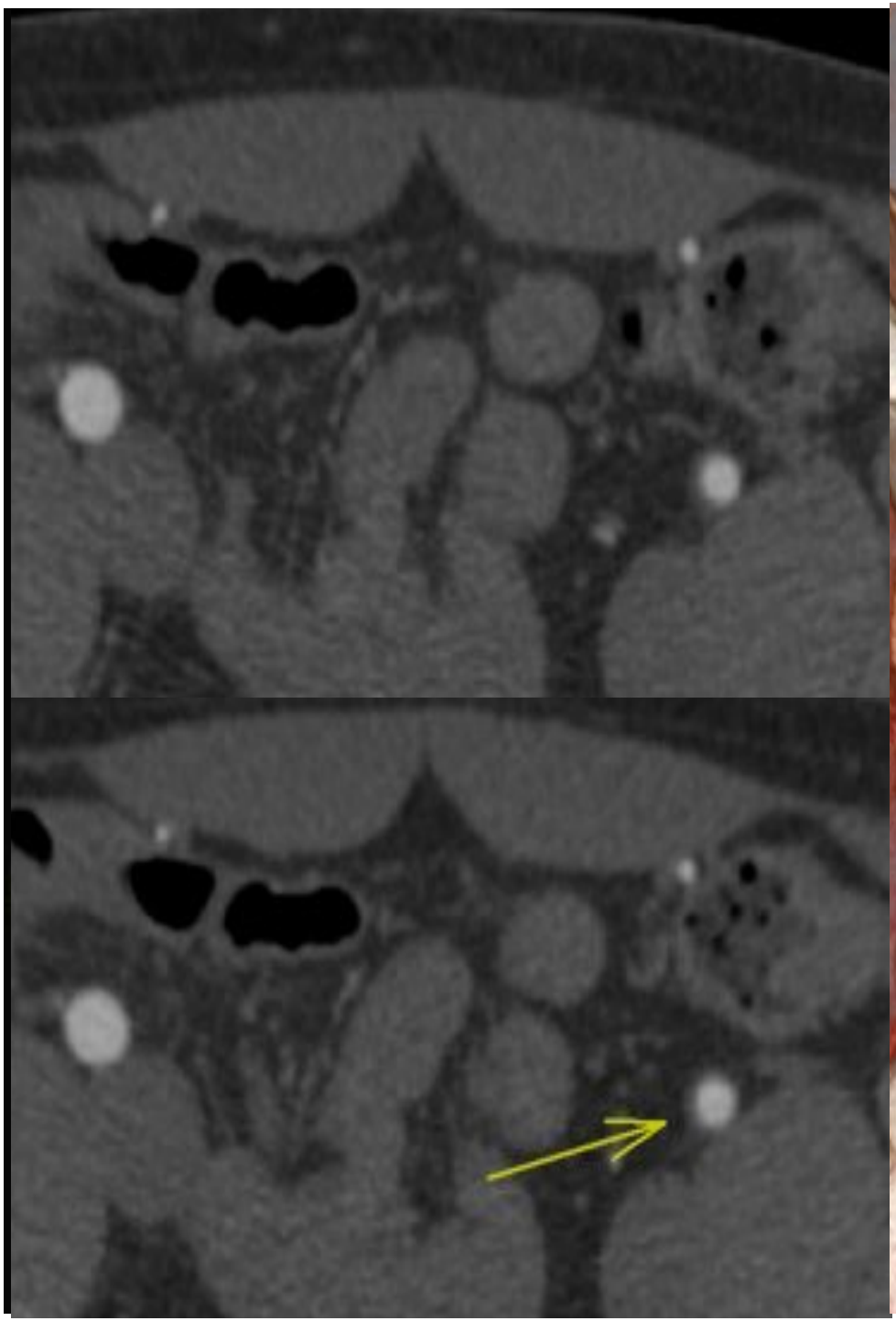
- 45 yo avid cyclist
- Proximal thigh pain, cramping with exertion
- ABI drops with exertion

Supine, legs extended

Dynamic Flow Restriction

Case 2

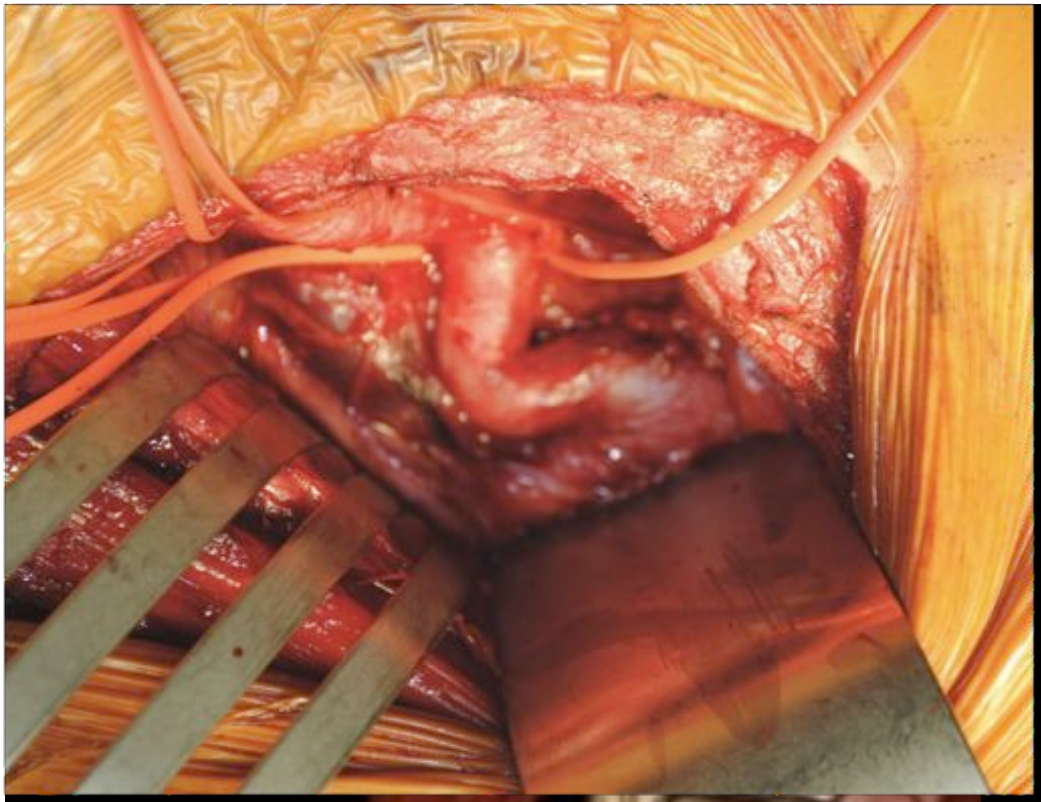
- 43 yo elite male cyclist
- left thigh and buttock pain at high performance levels.
- Exercise ABI drop on left



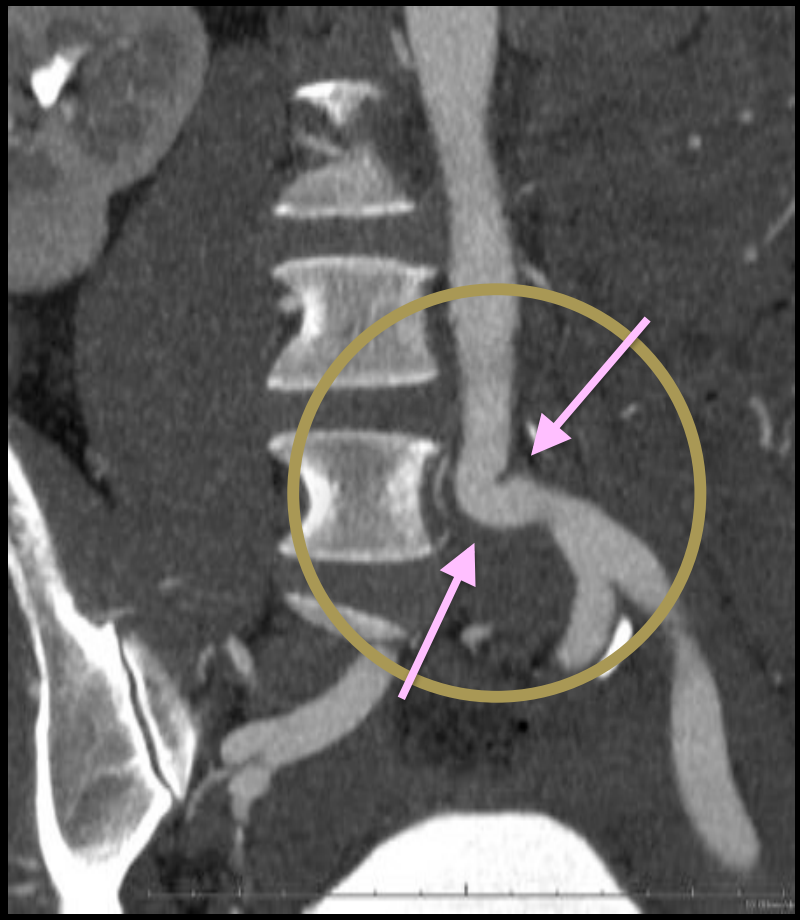
Case 3

- 49 yo avid cyclist x 30 yrs
- left thigh and buttock pain at high performance levels.
- Pain described as a “deep burn”

- ABI R/L: 1.3/1.2
- Exercise ABI R/L: 1.5/1.2



CTA at Rest



- Pathology: intimal thickening and fibrosis
- No inflammatory change

Vascular Diseases in Athletes

- Lower Extremity

  Popliteal Entrapment Syndrome (PAES)

Popliteal Space - Embryology

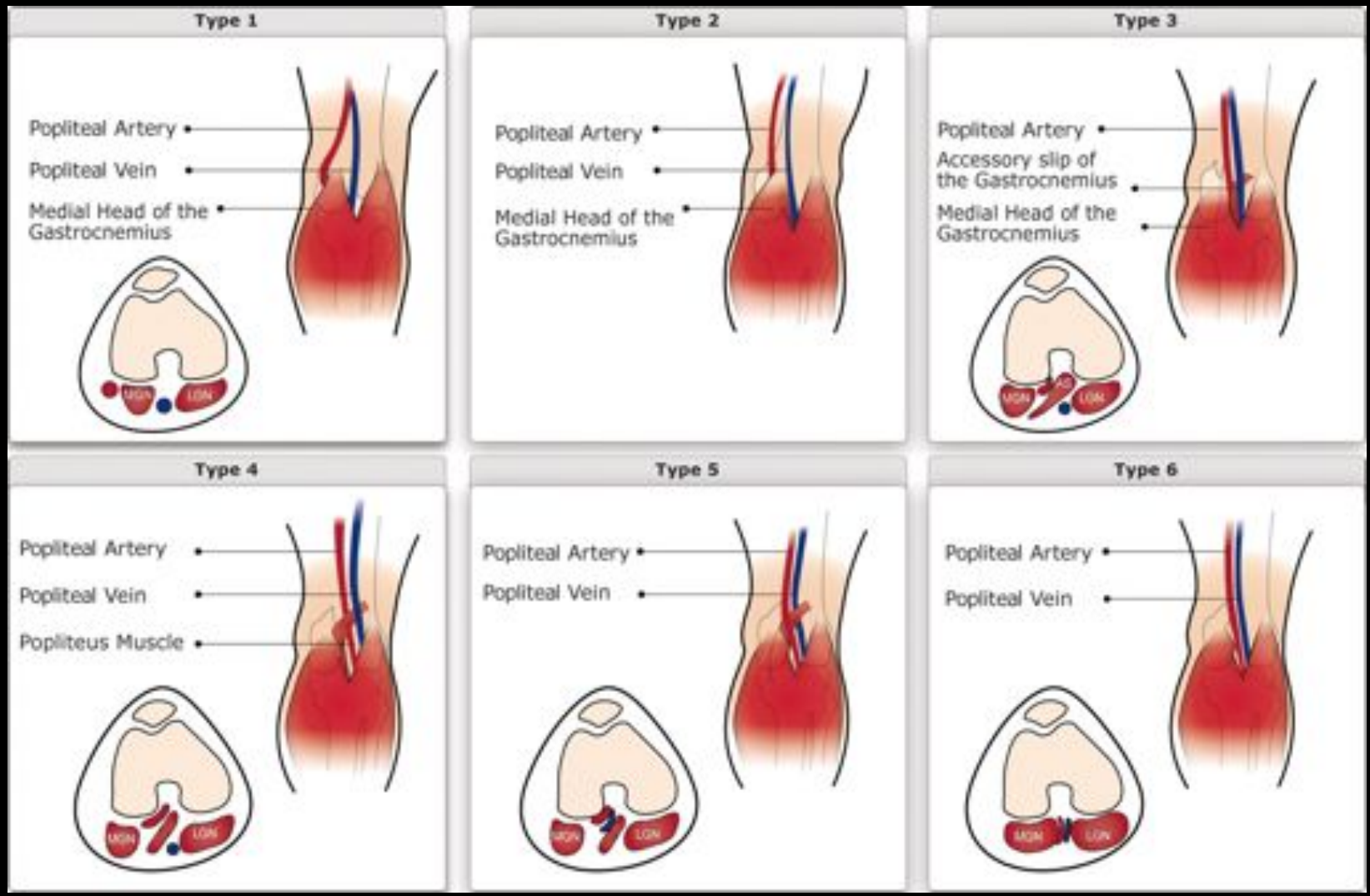
- *In utero*, competition between popliteal neurovascular bundle and migrating muscles (medial head gastrocnemius) for space
- If delayed or abnormal migration → **MHG too far lateral**
  - space is limited, thus compression can result

Causes of Popliteal Entrapment

- Anatomic Compression
  - Abnormal popliteal artery
  - Abnormal muscle
  - Both
- "Functional" compression

* Love and Whelan: in Haimovici H, Ed. Vascular surgery: principles and techniques. New York: McGraw-Hill, 1984

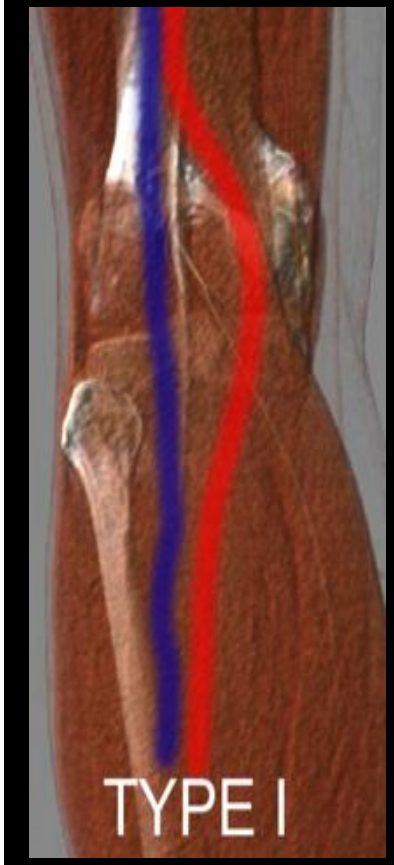
Classification of Popliteal Entrapment *



Eliahou R et al. Radiographics 2012;32:E33-E49

* Love and Whelan: in Haimovici H, Ed. Vascular surgery: principles and techniques. New York: McGraw-Hill, 1984

Classification of PAES

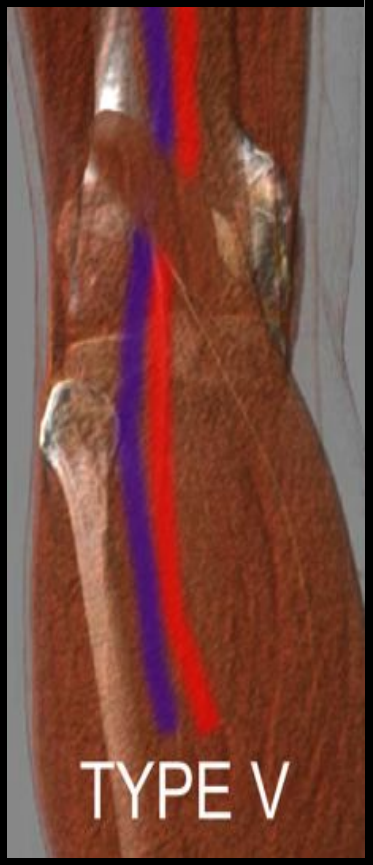


PA travels aberrantly, medial to normally positioned MHG

Anomalous lateral and inferior origin of MHG, PA displaced medially

Normal PA compressed by muscular slip or aberrant band from MHG

PA deep in popliteal fossa, entrapment from aberrant band or popliteus muscle



Any type of entrapment **involving popliteal vein**

* Whelan TJ. In: Haimovici H, Ed. Vascular surgery: principles and techniques. New York: McGraw-Hill, 1984: 557-67

Functional Popliteal Entrapment (Type VI)

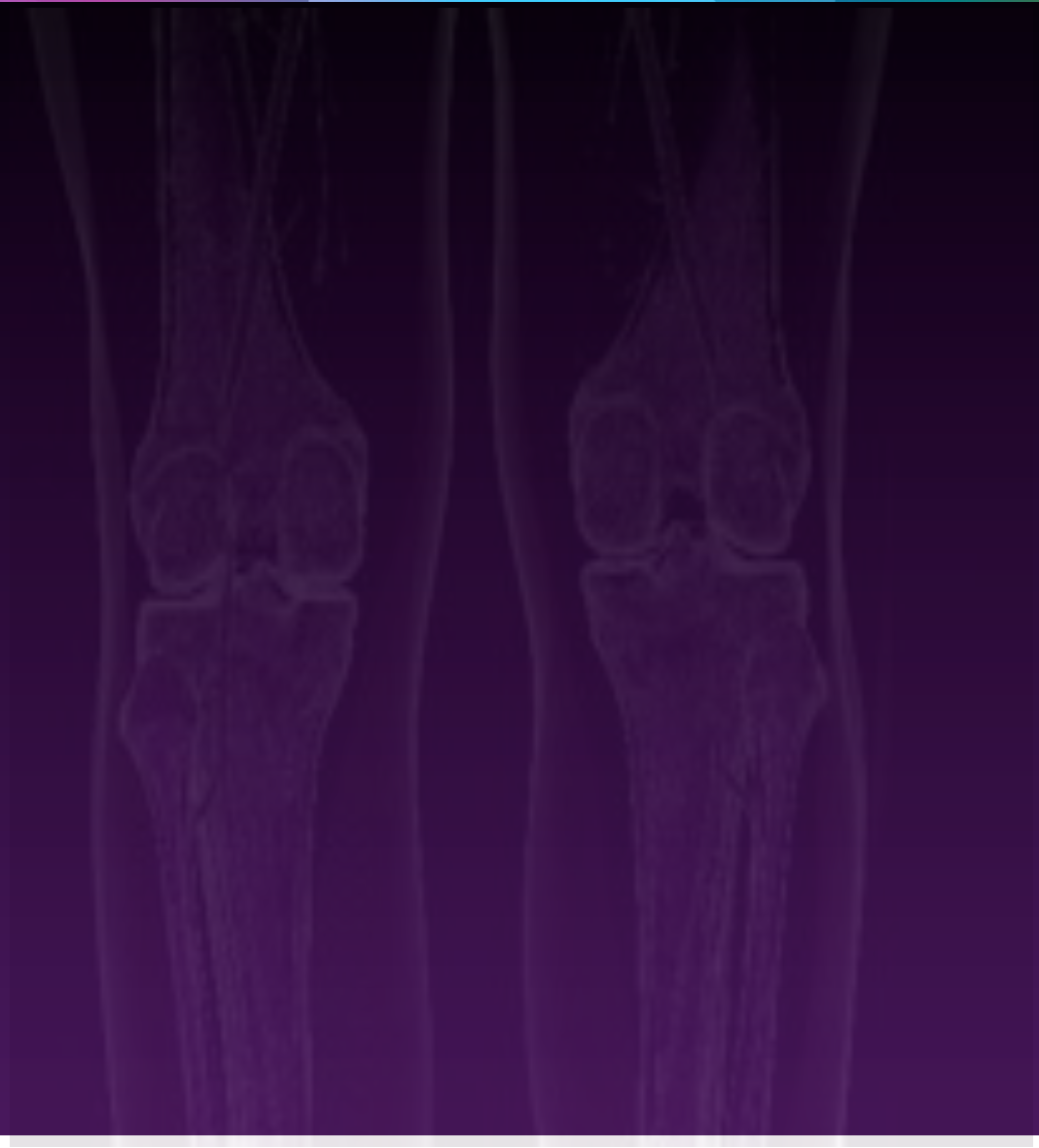
- Younger population, highly conditioned athletes)
- Neurovascular compression by hypertrophic gastrocnemius +/- soleal sling
- Longer segment involvement (vs. anatomic PAES)

PAES: CTA Imaging Technique

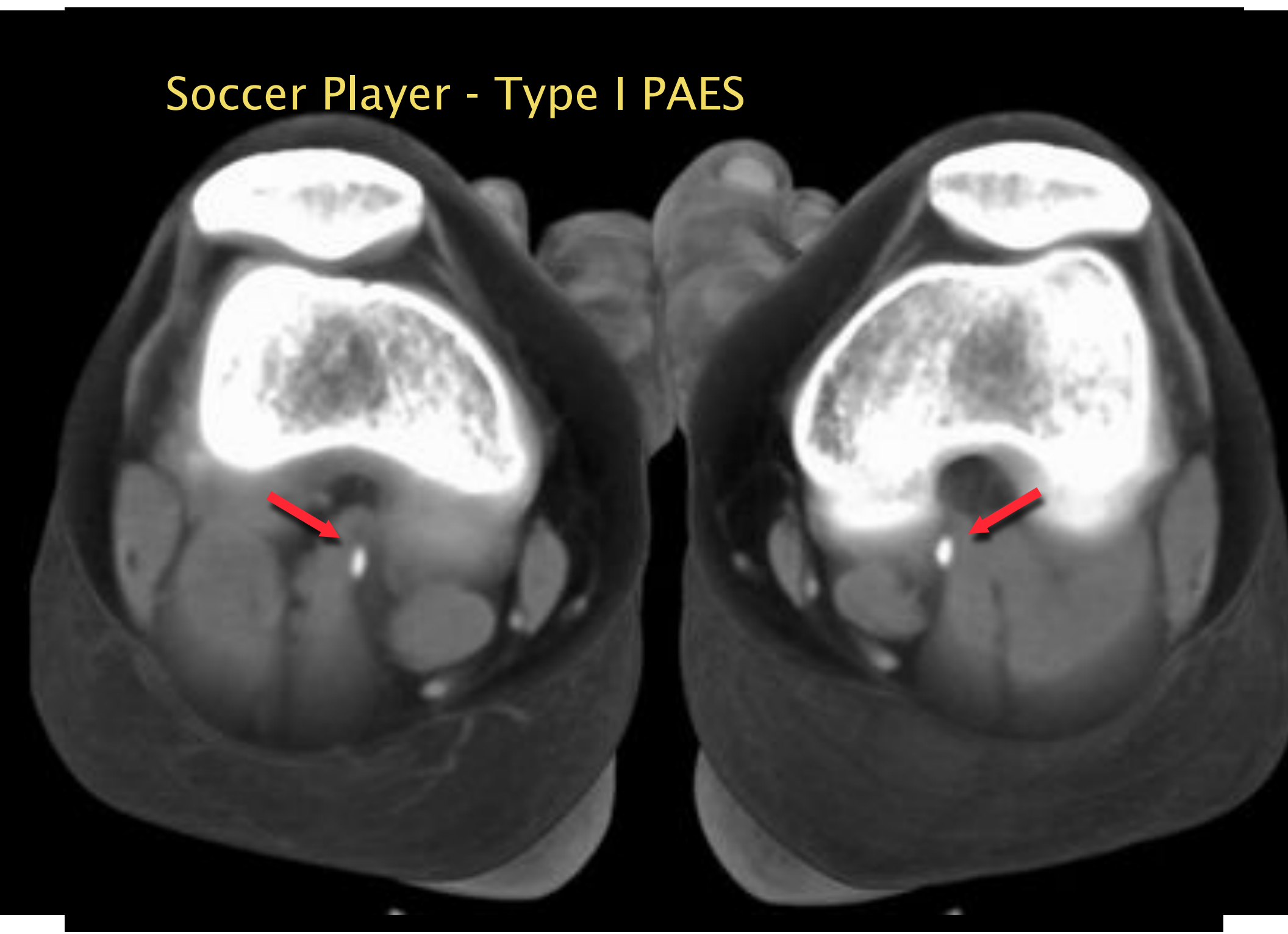
- 3 phases – relaxed and active plantar flexion
  - Active plantar-flexion without bearing down (straps)
  - Venous phase (caudo-cranial)
- ~ 80 mL of contrast (4mL/s) for each phase followed by saline flush at same rate
- Bolus track distal SFA
- Scan time: 12-15 sec
- Pulse oximeter on symptomatic large toe

PAES: CTA Imaging Technique

Examples - PAES



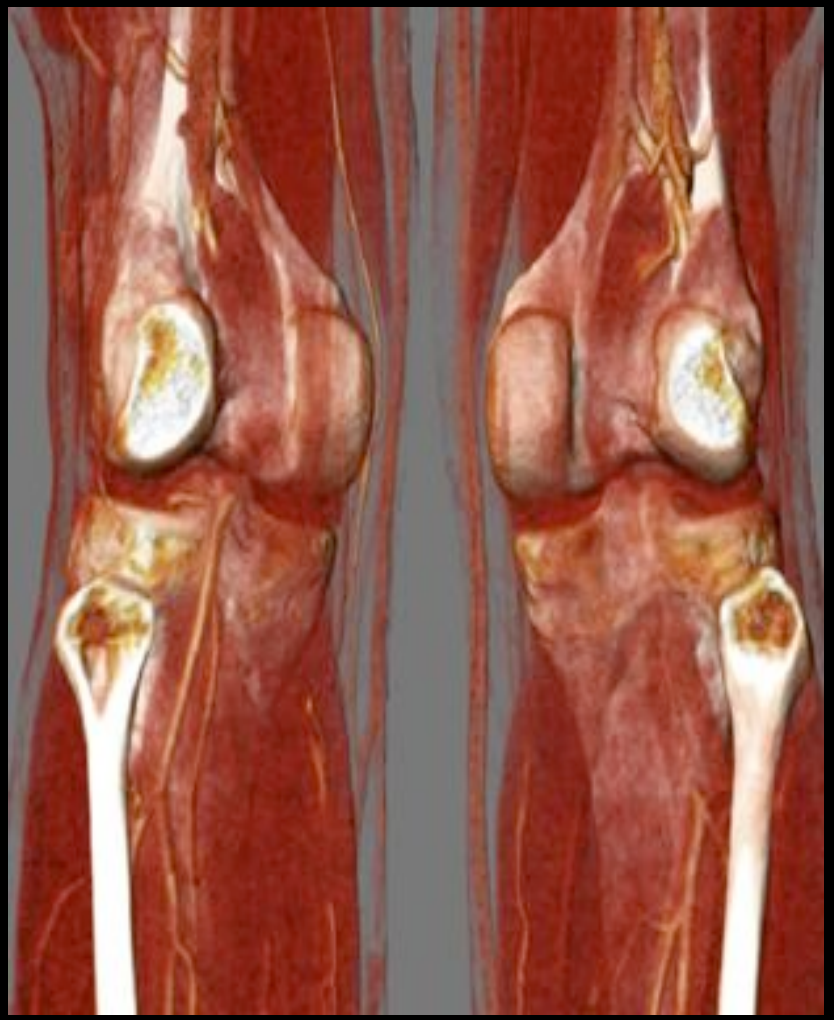
Soccer Player - Type I PAES



Type III PAES
Thrombosis of Left popliteal a.

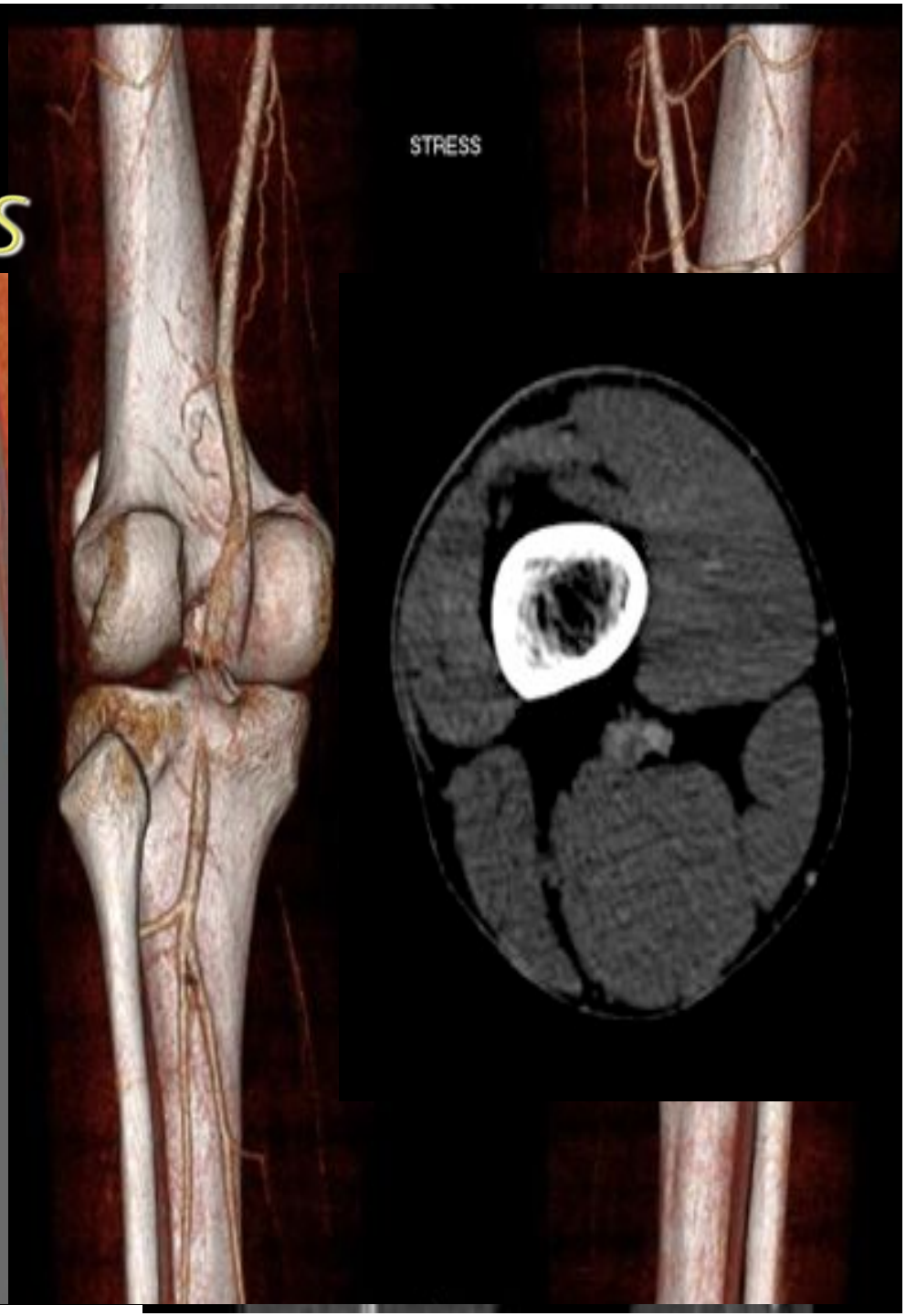
Relaxed –posterior view

provocation

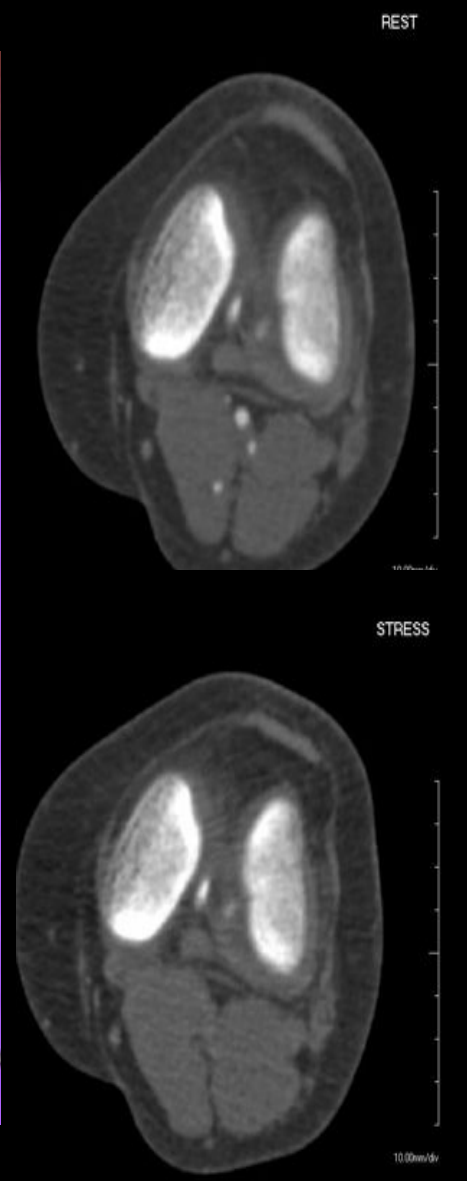


23 M Water Polo Athlete: Type V PAES

- Bilateral accessory slip MHG (type III)
- L popliteal a. occlusion @ rest
- Bilateral Popliteal v. thrombosis (Type V)



Functional (Type VI) PAES



Conclusions

- Vascular diseases in athletes can be a significant source of disability and performance loss
- Functional imaging is paramount for accurate detection and characterization of vascular entrapment / stenotic syndromes
- CTA (MRA) allows rapid, functional evaluation

Thanks for Your Attention !!

Special Thanks to:
Dominik Fleischmann, MD
Frandics Chan MD, PhD
Scott Alexander, MD
Deirdre Sheahan, MD
Russ Dilley, MD

www.stanford.edu/~hallett

Choose folder “NASCI 2012”