

A Prime of Lower Extremity CTA: Part 1 and 2

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Disclosures

I do not have any relationships to report with ACCME defined ineligible companies.

I will not be discussing unlabeled/investigational uses of medical devices or pharmaceuticals during this presentation.

Who likes to read CTA of LE with run-off?

Residents: "Pain to read", "Time-consuming", "Hate it", "Avoid it when I see on the list", etc.

Why?

- *Thousands of images and reconstruction:*
 - CT abdomen, CT pelvis, CT LE
- *Elderly population: multiple chronic findings.*
- *Multiple comparisons: "Frequent fliers".*
- *Long reports.*

Objectives

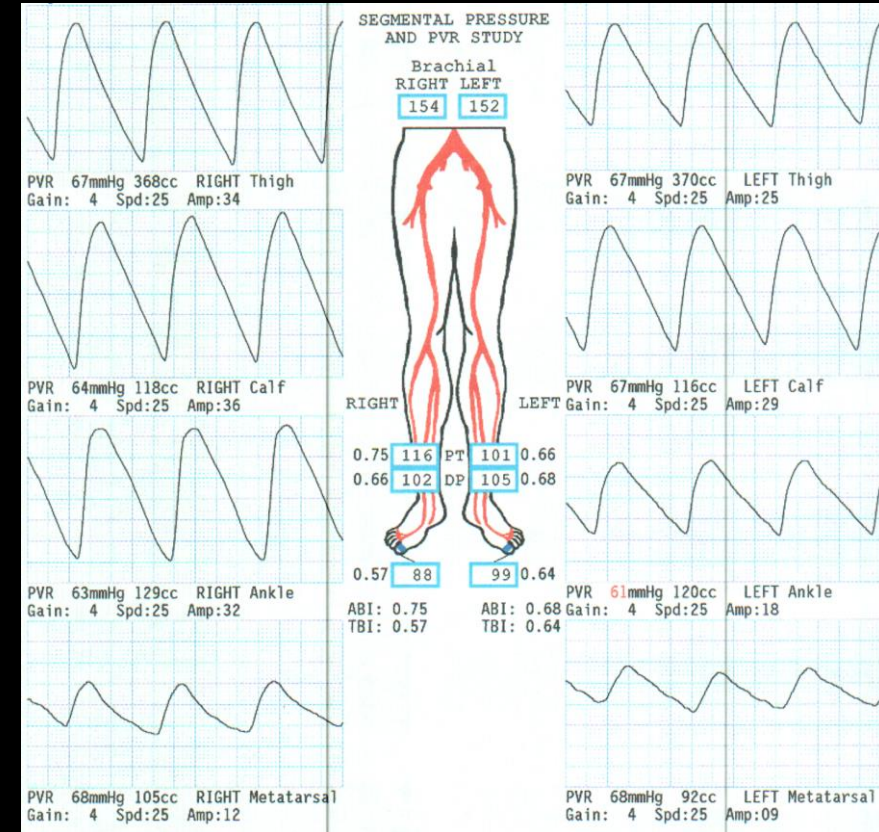
- Review the role of CTA imaging for PAD evaluation in the ER.
- Present the key CTA imaging anatomy and findings of LE arterial diseases.
- Discuss cases of LE arterial disease on CTA and strategies for efficient reading



Why CTA of Lower Extremity in the ER?

- **ER use:**
 - Intermittent Claudication
 - Acute Limb Ischemia
 - Chronic Limb Ischemia
 - Endovascular and Surgical complications
 - Trauma
- **Advantages:** Fast, Non-invasive, Accurate (>95%).
- **Disadvantages:** Contrast and Radiation
- **Used in combination** with US/Doppler and Plethysmography/PVR/ABI

} PAD



CTA LE Technique

U.Miami CTA run off - Protocol	
Coverage	Diaphragm to Feet.
Settings	120 kV (or lower), 250 mAs, dose-modulation, 0.5 mm slice thickness.
Contrast Injection	4-5 mL/s, 95-125 mL, *Optiray 350.
Trigger	Bolus tracking, 15s fixed delay trigger once 125 HU in the descending Aorta
*Delay Imaging	Immediate knee to toe repeat scan at 80 kV (if needed).



	Scan	kV	mAs	/ ref.
Patient Position F-SP				
Topogram	1	120	34 mA	
PreMonitoring	2	120	60	
Contrast Monitoring	3	120	60	
CTA	6	120	72	1250

Pitfalls on LE CTA

Bolus timing:

- **Too early:** outrun the contrast - poor opacification of the distal arterial bed - crural level (false positive)
- **Too late:** poor arterial enhancement and venous contamination (false negative)

Poor cardiac output:

- Same as too early scanning.

Dense vascular calcifications and hardware:

- Blooming artifact obscures lumen and lead to overestimation of stenosis.

Overlook extravascular findings:

- 15% of CTAs have clinically significant unexpected extravascular findings*.



*Naidu SG, et al. (2010) Incidence of highly important extravascular findings detected on CT angiography of the abdominal aorta and the lower extremities. *AJR Am J Roentgenol* 194(6):1630–1634

Arterial Anatomy

Inflow Arterial Circulation

Infrarenal Abdominal Aorta:

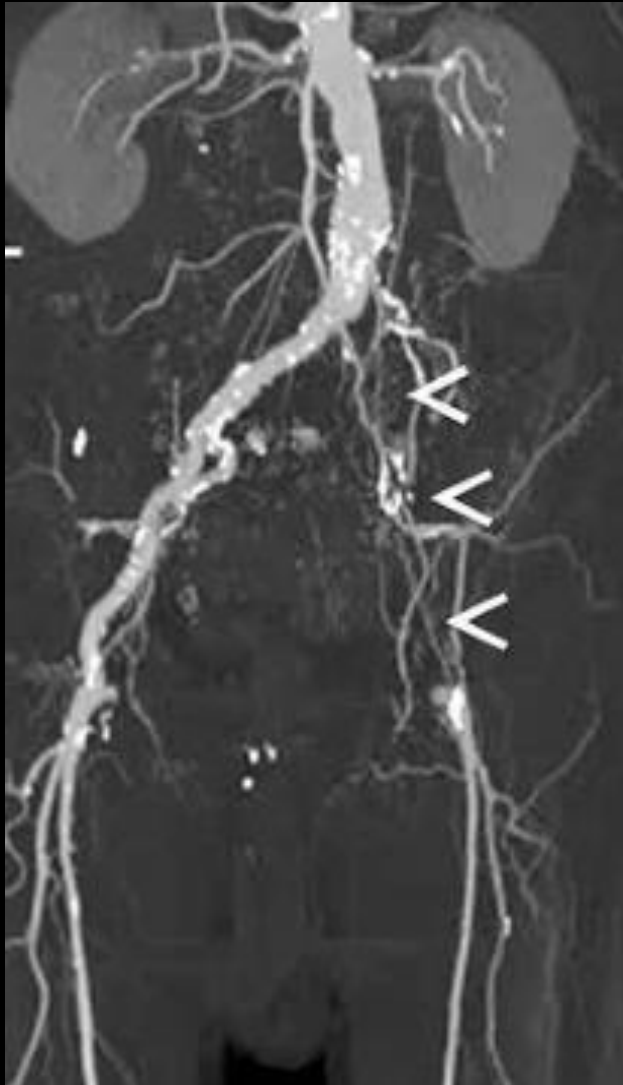
- *Inferior Mesenteric Artery*
- * *Lumbar and Intercostal Arteries*

Pelvis:

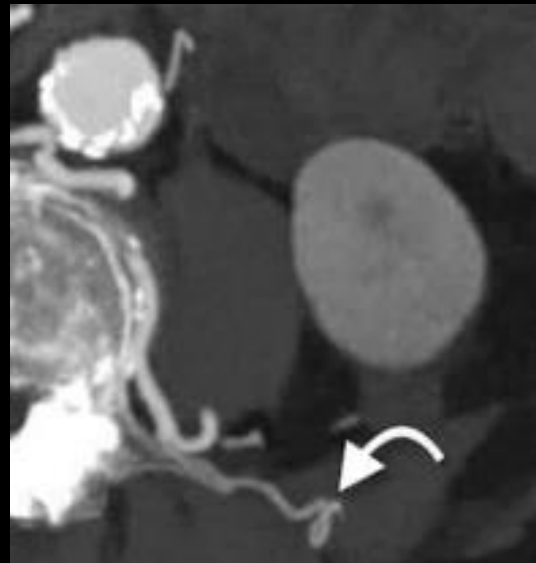
- *Common Iliac Arteries*
- *External Iliac Arteries*
 - * *Inferior Epigastric*
 - * *Circumflex Iliac*
- *Internal Iliac Arteries*
 - ** *Persistent Sciatic Artery*



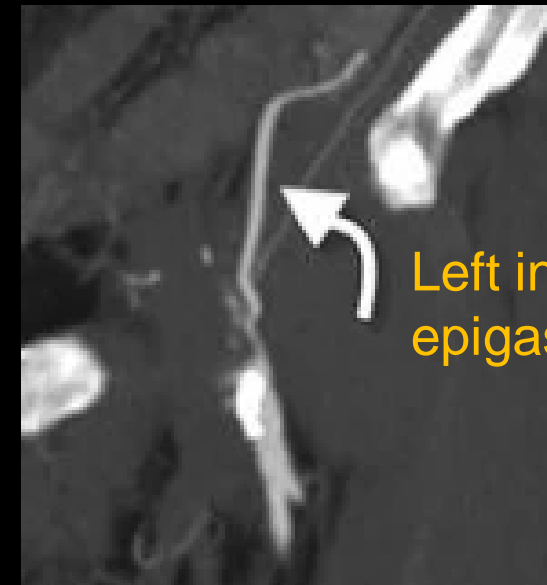
LCIA, LIIA and LEIA occlusion - Collateral flow to left SFA



Left subcostal art.

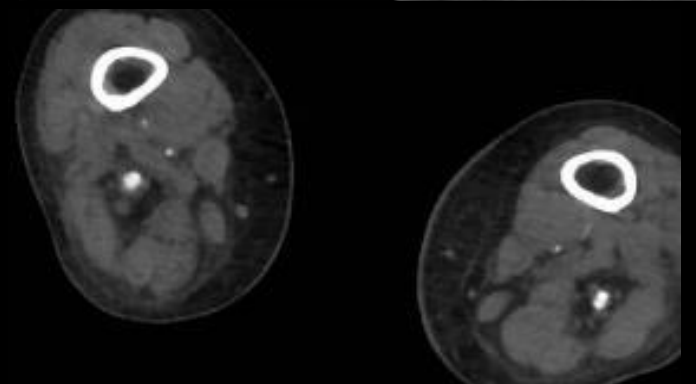
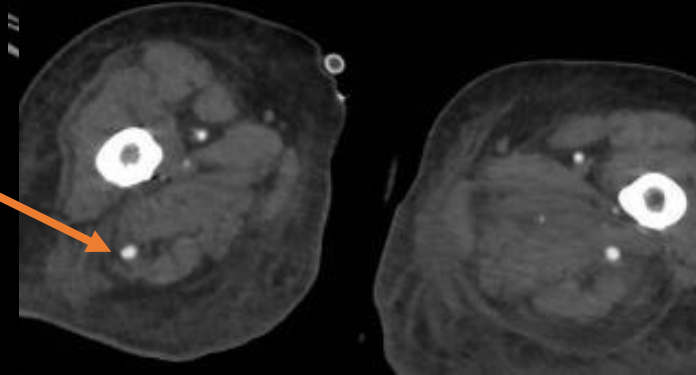
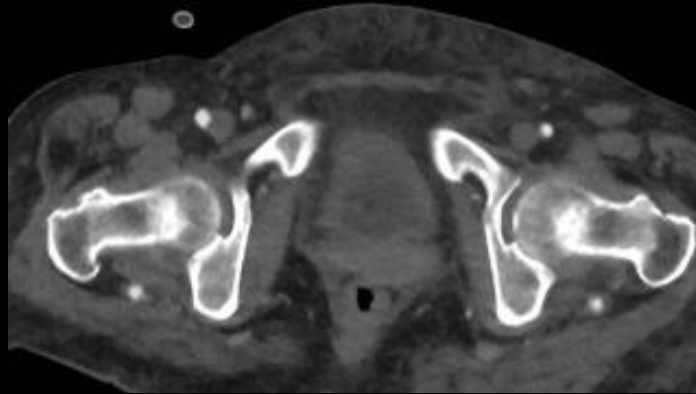


Left 3rd-4th lumbar art.



Left inferior epigastric art.

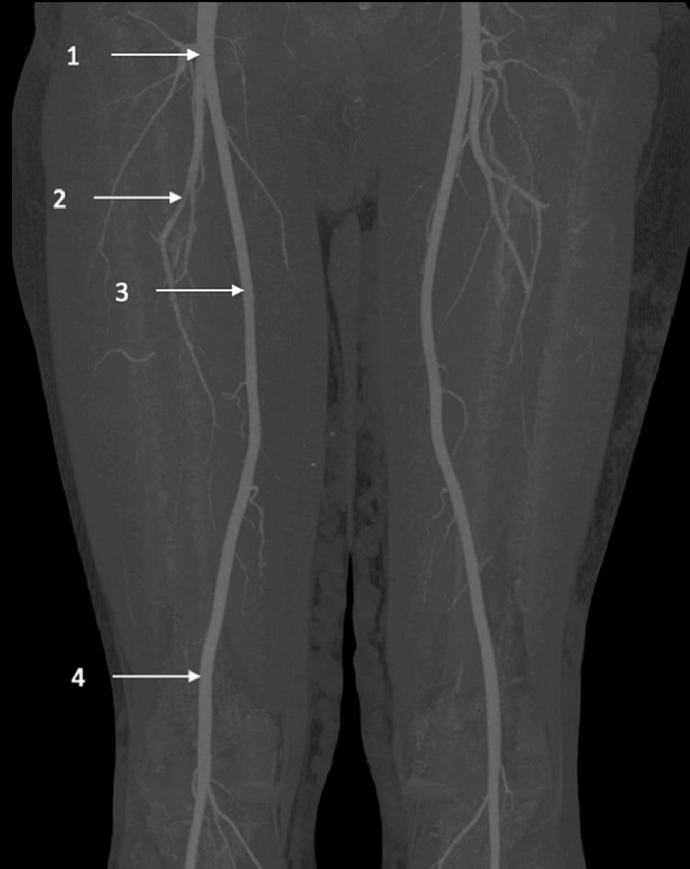
Persistent Sciatic Artery



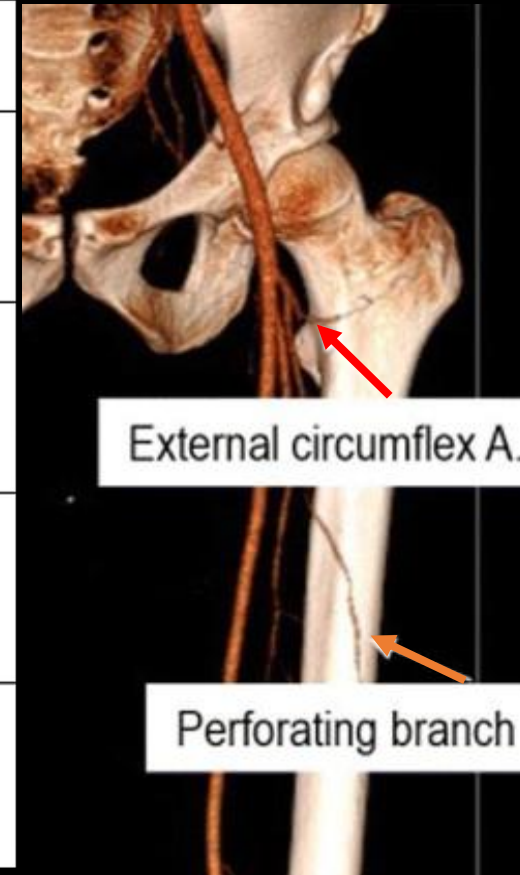
Arterial Anatomy

Outflow arterial circulation:

- *Common Femoral (8mm)*
- *Superficial Femoral (6mm)*
 - *Circumflex Femoral*
- *Deep Femoral*
 - *Muscular Perforators*
 - *40% variation of origin and branching pattern*



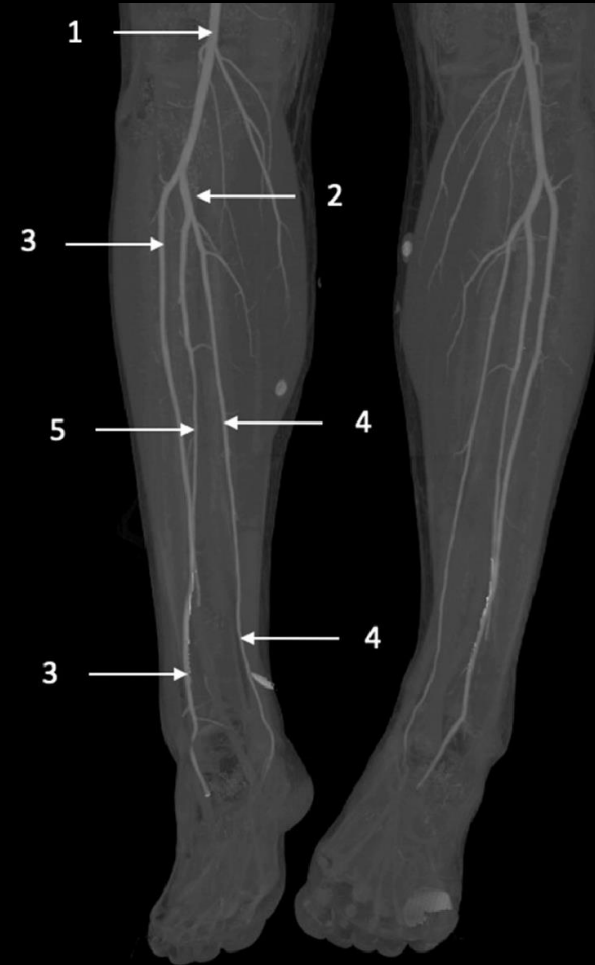
Legend	
1	Common femoral artery
2	Profunda femoris artery
3	Superficial femoral artery
4	Popliteal artery



Arterial Anatomy

Crural vessels – Triple run-off

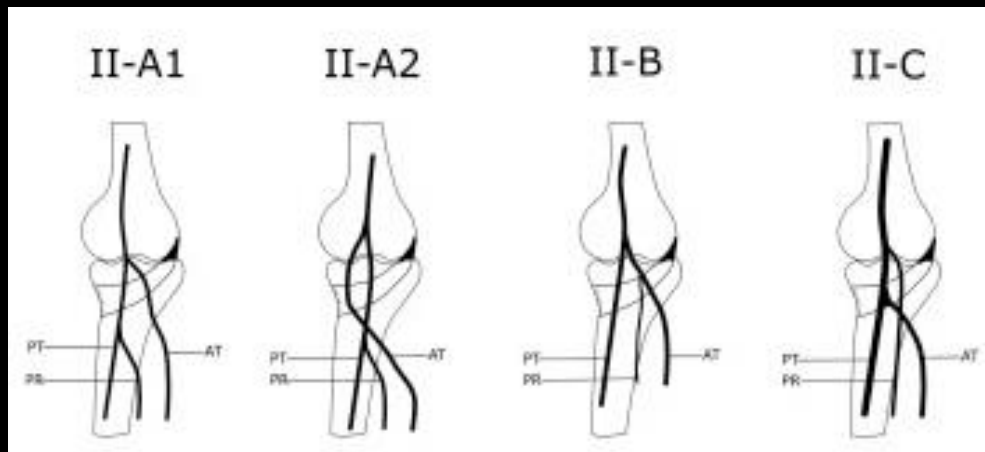
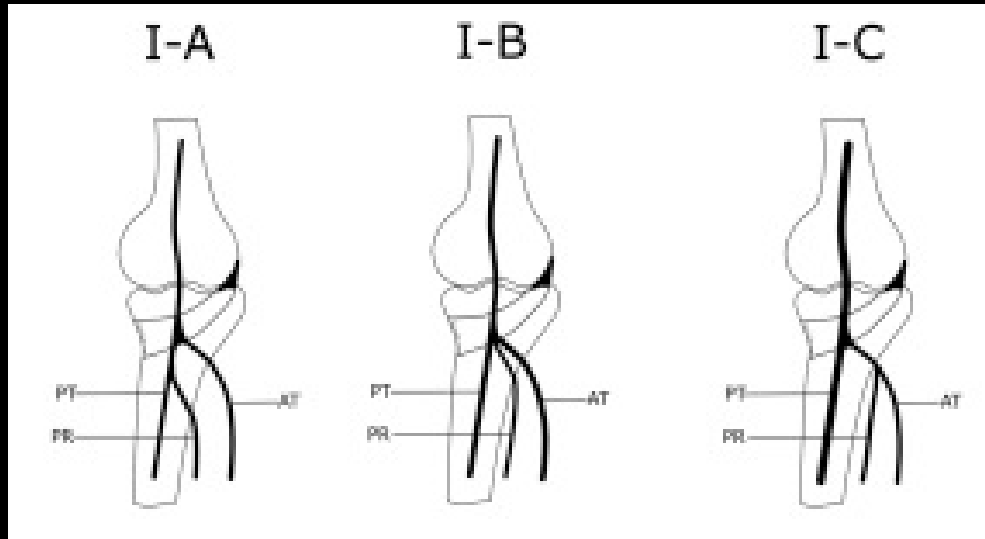
- *Popliteal (6 mm)*
- *Anterior Tibial*
 - *Dorsalis Pedis*
- *Tibioperoneal Trunk*
 - *Posterior Tibial*
 - *Medial Plantar*
 - *Lateral Plantar*
 - *Peroneal*



Legend	
1	Popliteal artery
2	Tibioperoneal trunk
3	Anterior tibial artery
4	Posterior tibial artery
5	Peroneal artery

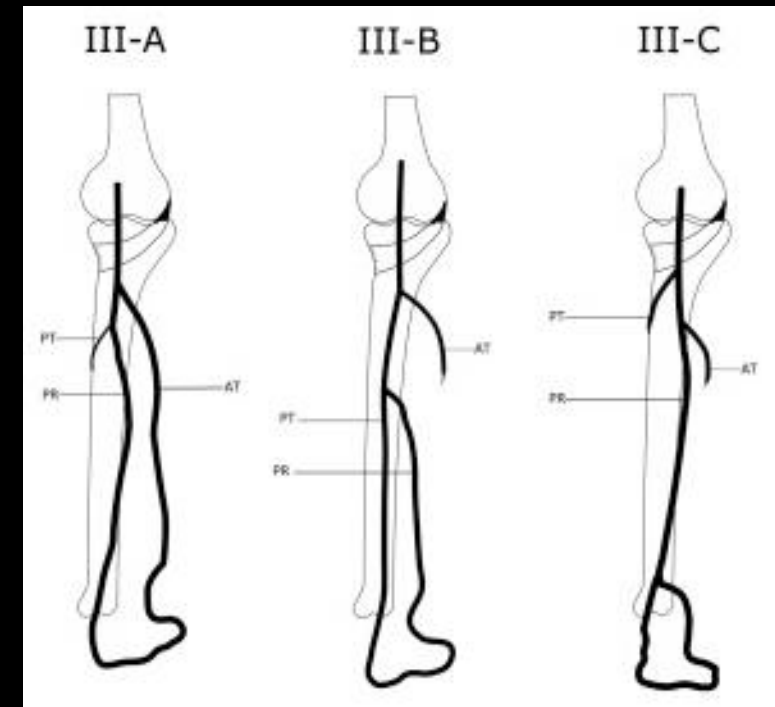
**Attention to Normal Variants*

Variations of Popliteal Branching



1-C: Common AT-PR origin

2-A1: High AT origin



Hypoplasia/Absence of one or two vessels

(Atherosclerotic) Peripheral Arterial Disease (PAD)

Clinical Presentation:

- **Intermittent Claudication:** pain or cramping with exertion
- **Chronic Limb Ischemia:** rest pain, ulceration and tissue necrosis.
- **Acute Limb Ischemia:** "6" Ps: pain, paralysis, paresthesia, pallor, pulselessness, and poikilothermia.

Diagnosis:

- Ankle-Brachial Index (**ABI**) **less than 0.90 is diagnostic for PAD** in patients with claudication or other signs of ischemia, with **95% sensitivity and 100% specificity**



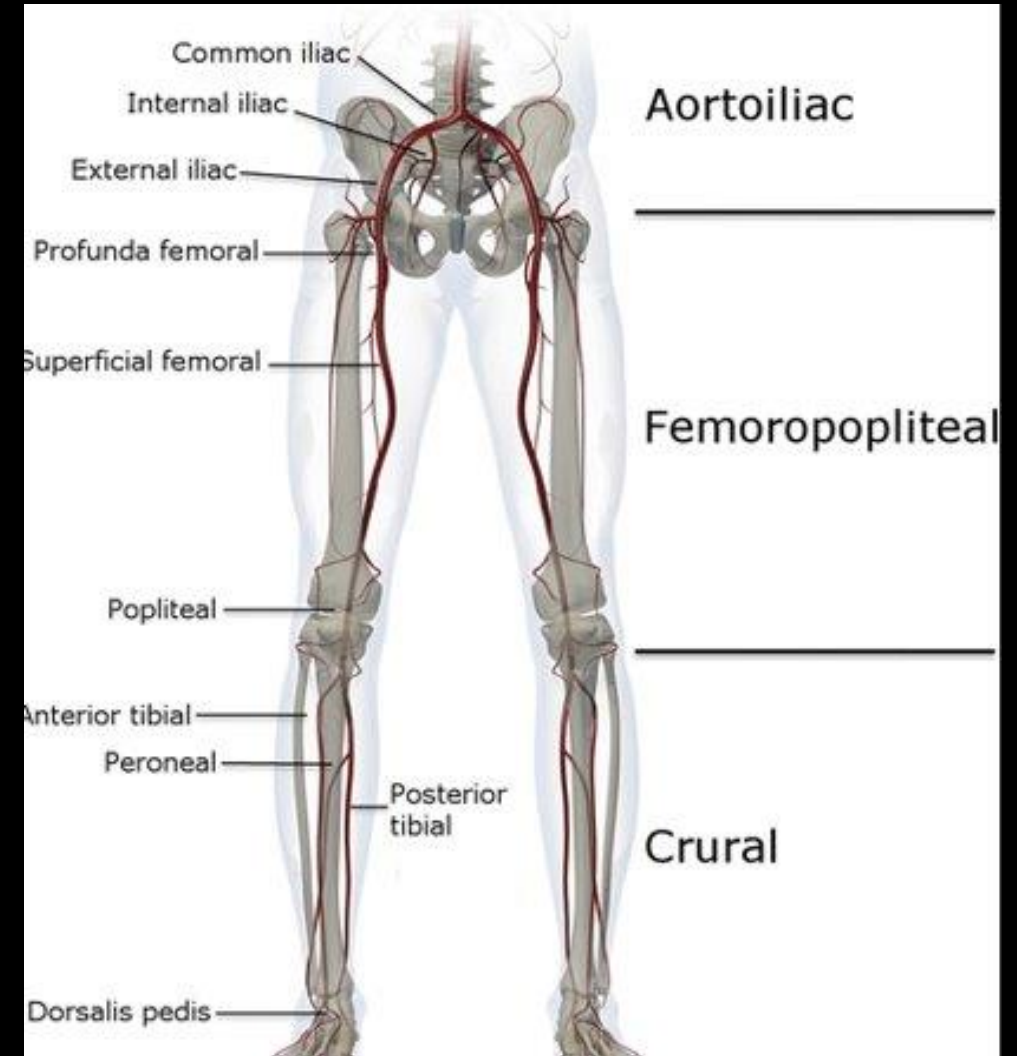
CTA Imaging in PAD

Goal of Imaging:

- Detect **clinically significant stenosis or occlusion**.
- Evaluate **level and severity**.
- Map the arterial inflow and outflow

Report:

- **Location:** inflow vs outflow circulation
- **Severity:** mild, moderate, severe
- ***Length:** stenotic or occluded segment.



Determine degree of stenosis

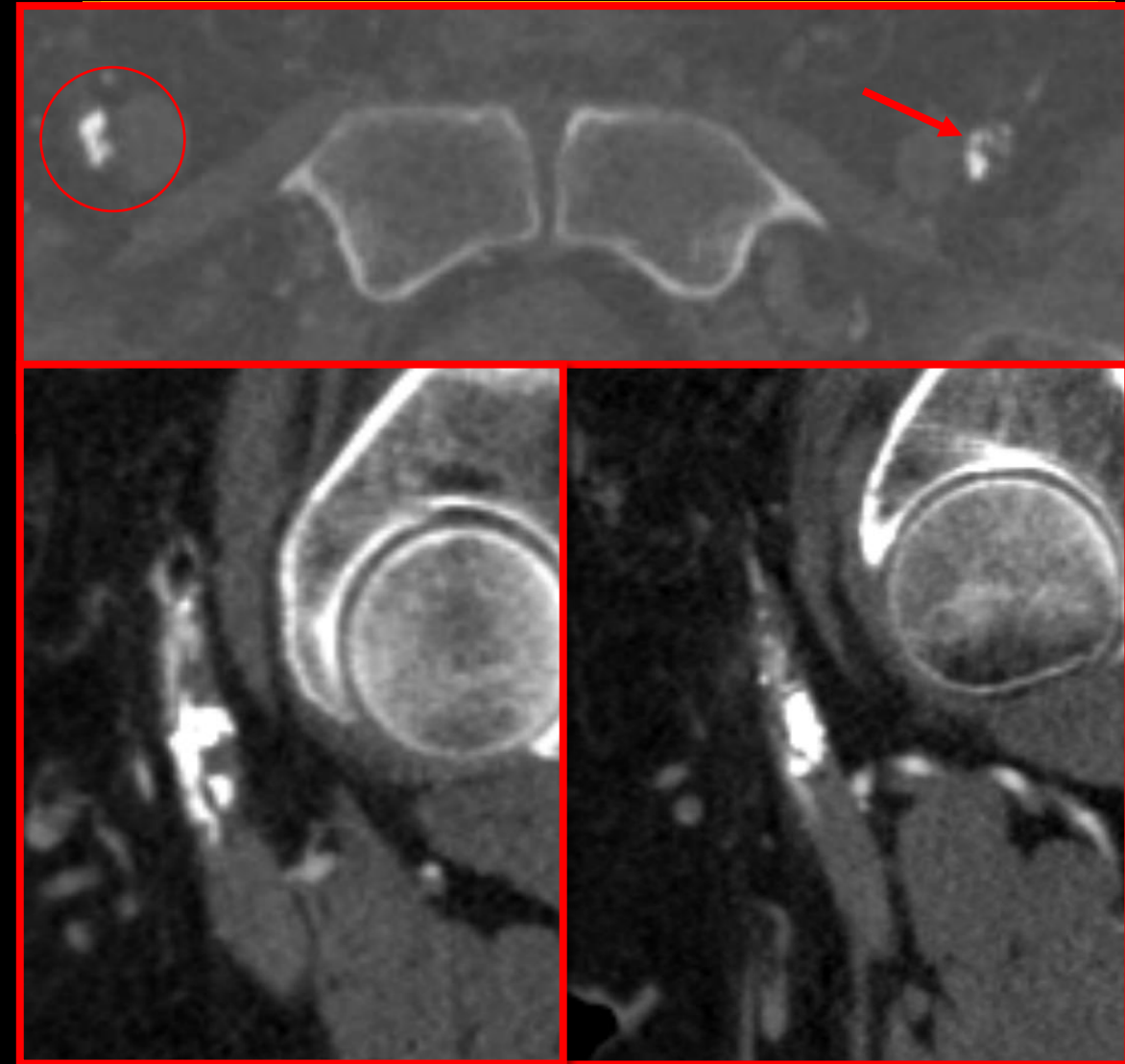
"Eyeballing" approach using axial plane, MIP, and MPR.

- **Mild: 0%-50%**
- **Moderate: 50%-70%**
- **Severe/High-grade: >70%**
- ***Critical: >90%**

*Length of stenosis or occlusion (variable):

- Short segment (<3-10cm)
- Long segment (>5-10cm)
- *Multifocal/Multisegmental

Pitfalls: calcified plaque burden, stents and foreign bodies.



Reporting

CTA run-off Template/Macro

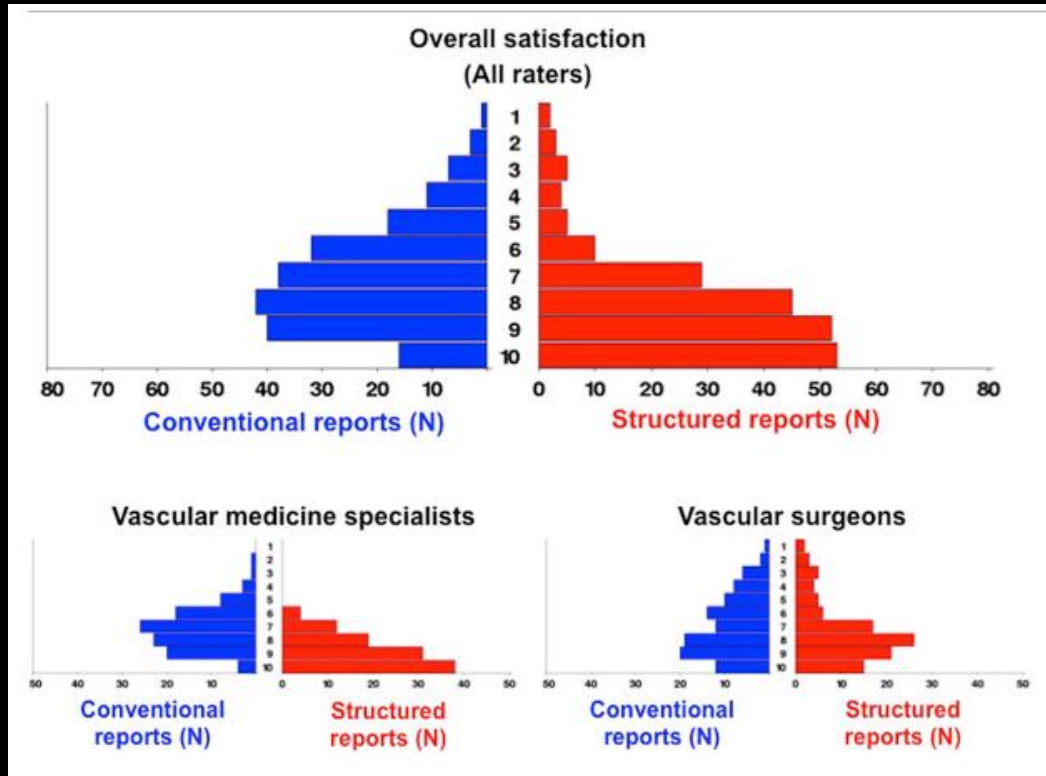
Abdominal Aorta: [Patent and normal caliber.] [No significant atherosclerotic disease.]

Right Lower Extremity:

- Bypass or stent: [None]
- Common Iliac artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Internal Iliac artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- External Iliac artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Common Femoral artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Profunda Femoris artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Superficial Femoral artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Popliteal artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Anterior Tibial Artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Posterior Tibial Artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]
- Peroneal Artery: [Patent and normal caliber.] [No significant atherosclerotic disease.]

Reporting

Structured Reporting of CT Angiography Runoff Examinations of the Lower Extremities. Bastian O. Sabel, Jessica L. Plum, Michael Czihal, Christian Lottspeich, Frank Schönleben, Gabor Gäbel, Regina Schinner, Franziska Schoeppe, Felix G. Meinel, *European Journal of Vascular and Endovascular Surgery*, Volume 55, Issue 5, 2018, Pages 679-687, ISSN 1078-5884, <https://doi.org/10.1016/j.ejvs.2018.01.026>.



Conclusion: Referring clinicians perceive SRs of CTA runoff examinations of the lower extremities as offering superior clarity, completeness, clinical relevance, and usefulness than CRs."

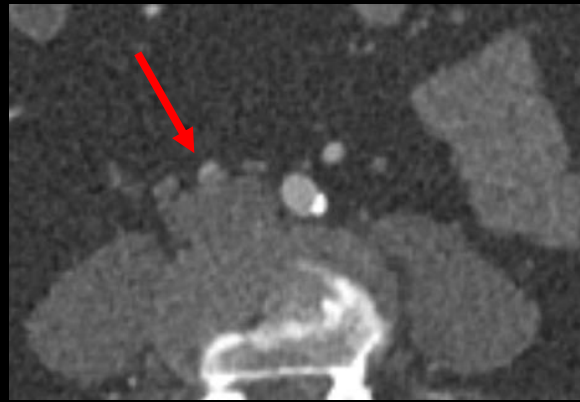
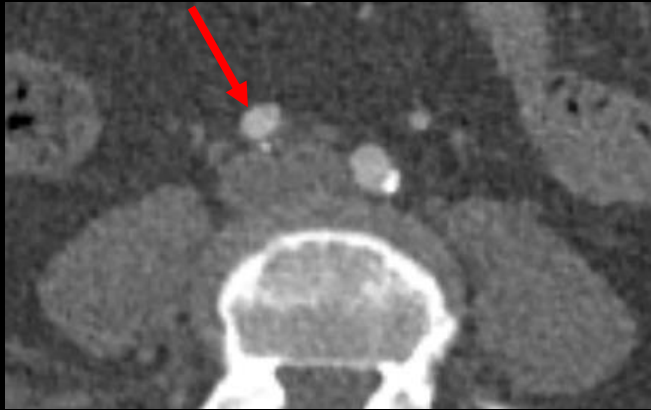
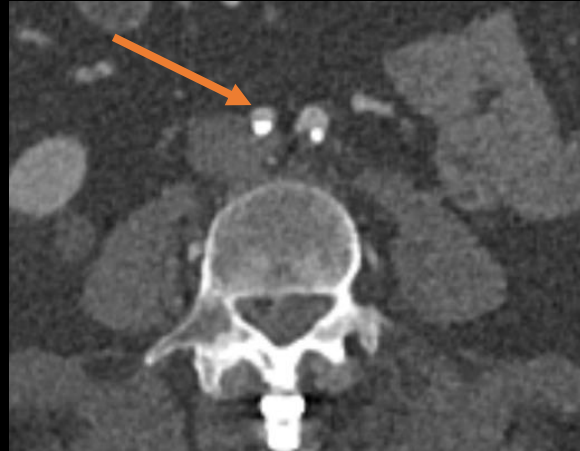
Table 2. Analysis of referring clinicians' free text comments on radiology reports.

Category of comment/criticism	All reports	Structured reports	Conventional reports
Information on specific native vessel missing or insufficient	43	13	30
Information on bypass graft/stent missing or insufficient	33	24	9
Report does not (sufficiently) address clinical question	6	5	1
Medical or anatomical errors/inaccuracies	14	7	7
Affected side at some point not (sufficiently) clear	5	2	3
Information on extravascular structures missing or insufficient	4	4	0
Radiological assessment too vague (e.g., degree of stenosis; atherosclerotic vs. embolic occlusion)	14	4	10
Essential information in findings but not in summary of report	4	4	0
Other	2	0	2
Total	125	63	62

Case Review

Peripheral Arterial Disease - (PAD)

Common iliac disease (PAD)



4/2021

11/2023



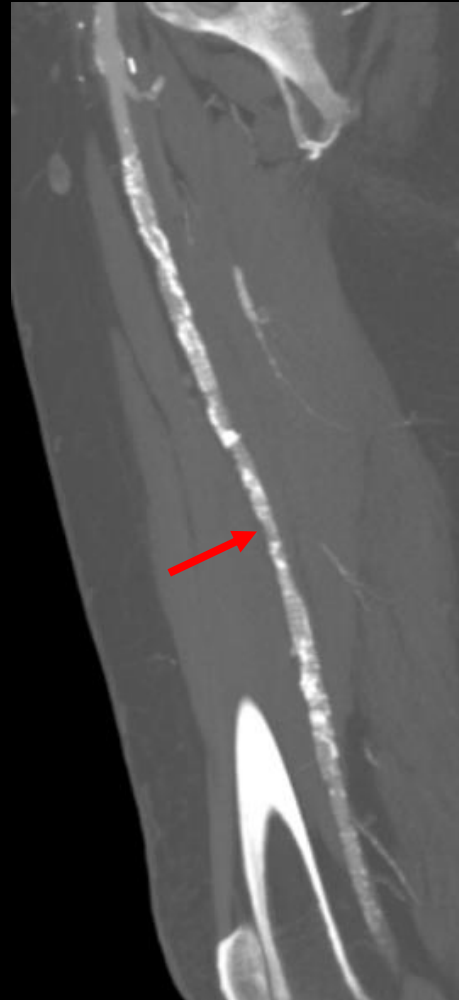
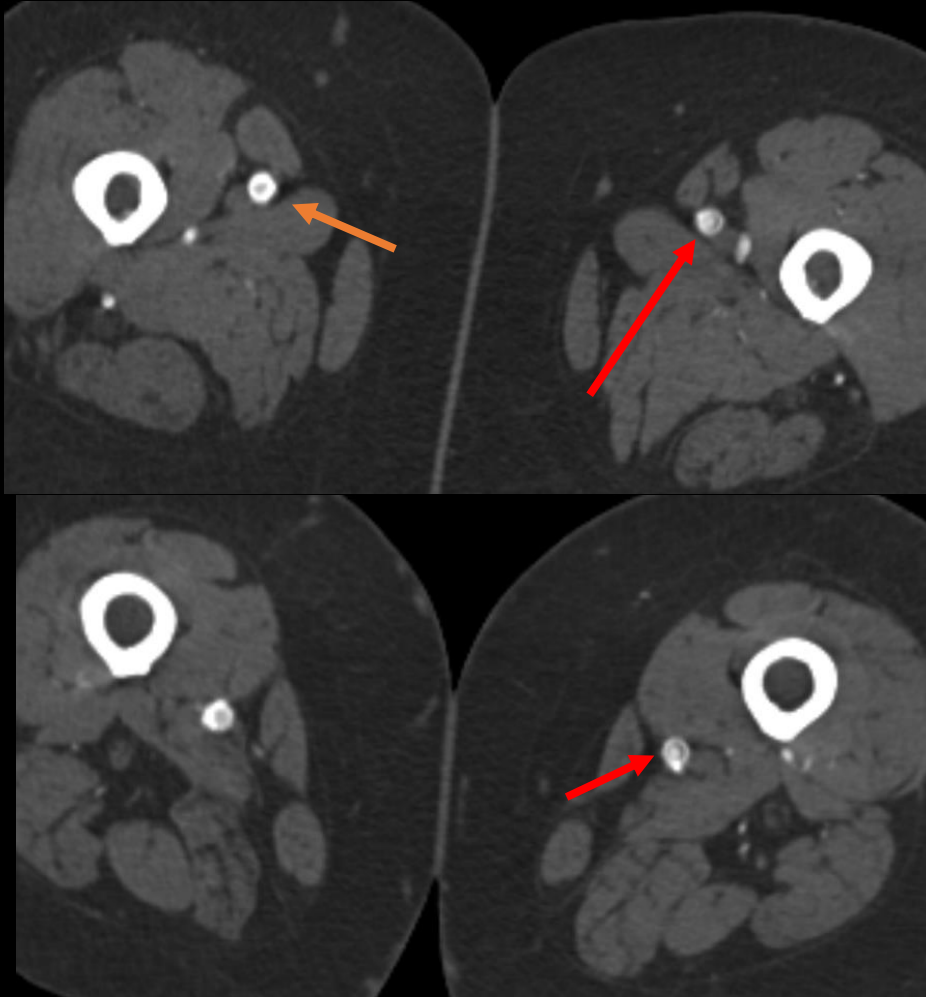
4/2021



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72 y/o F with h/o DM and HTN with progressive right gluteal and thigh claudication.

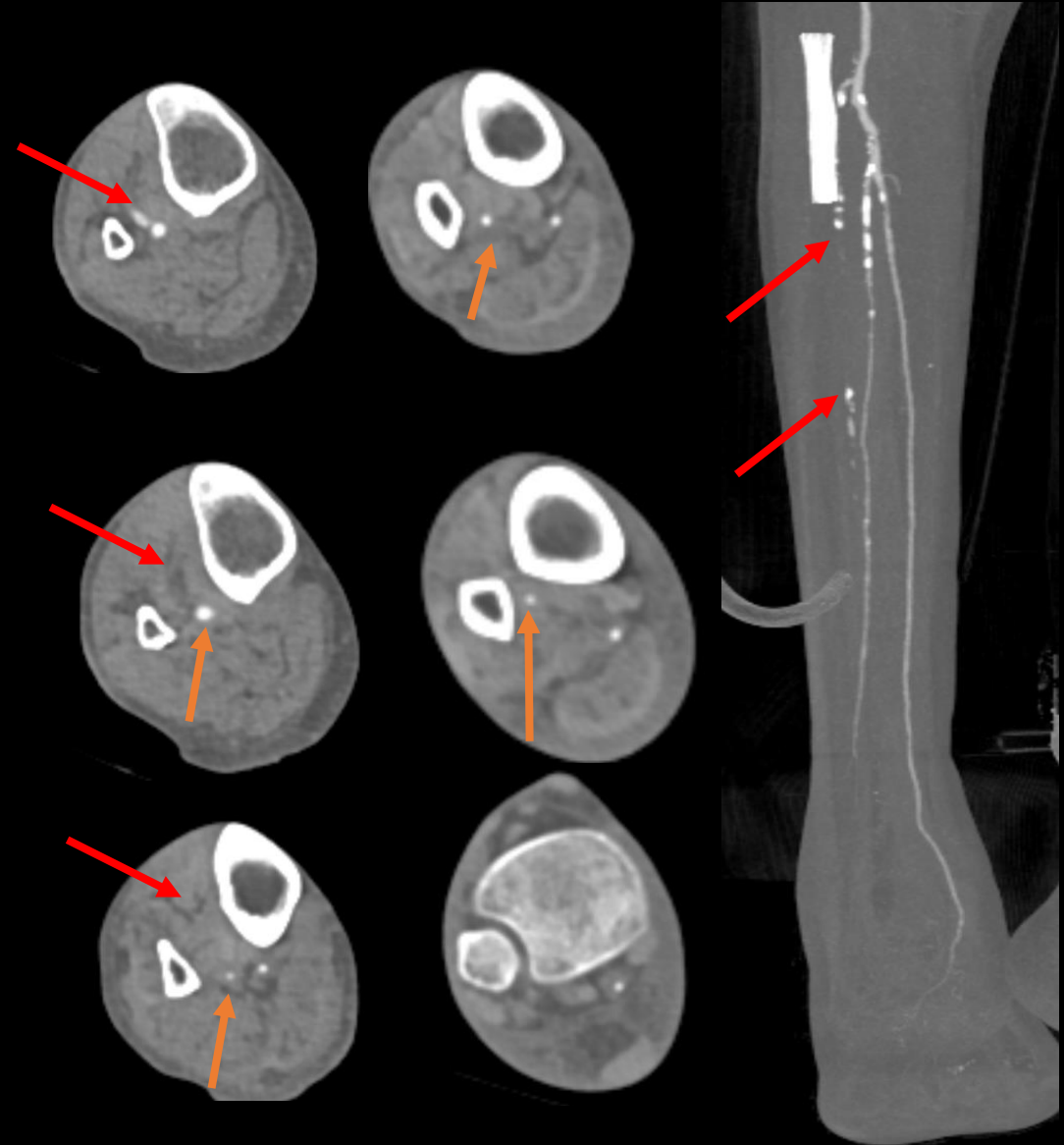
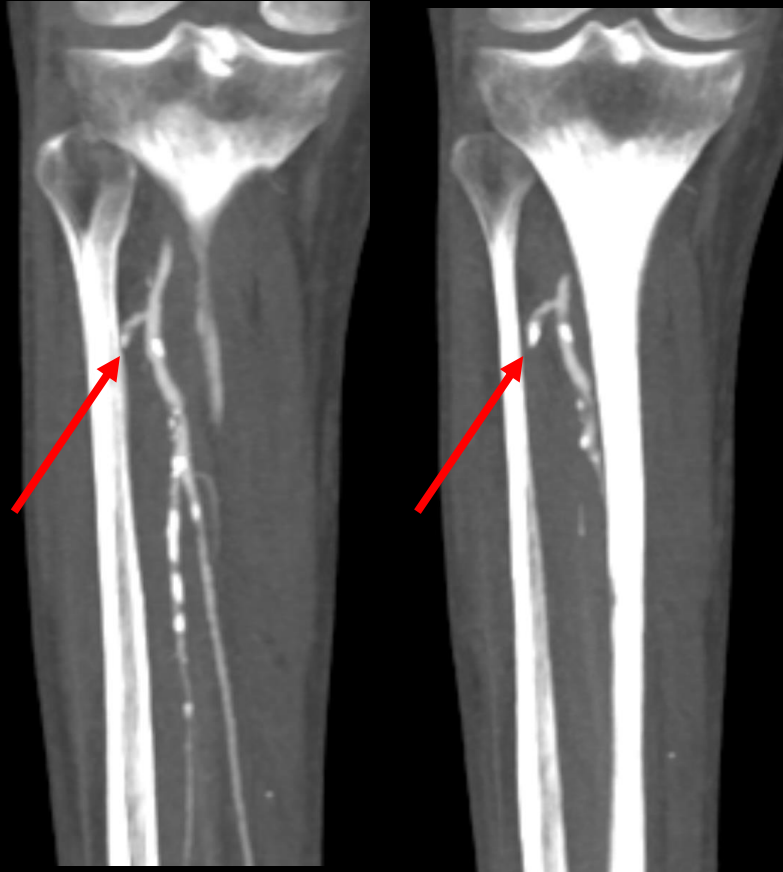
Femoropopliteal Disease (PAD)



"Left SFA: Diffuse atherosclerotic plaques with multiple short segments of moderate stenosis. No segmental occlusion"

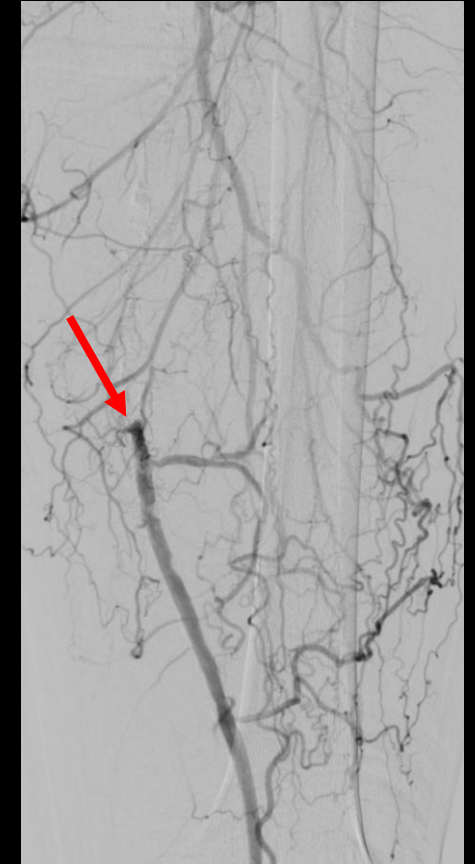
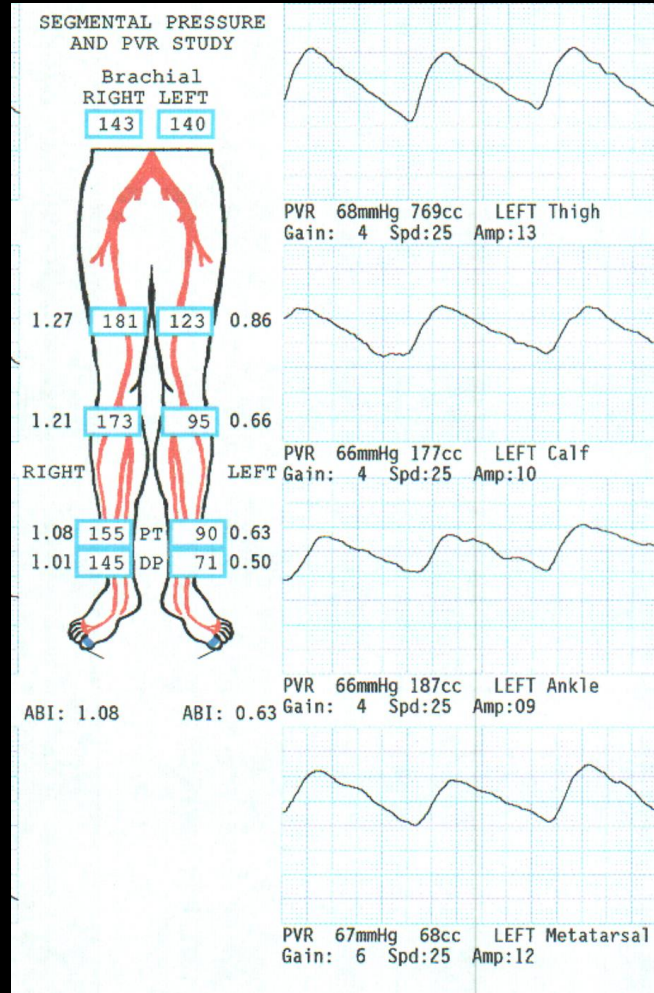
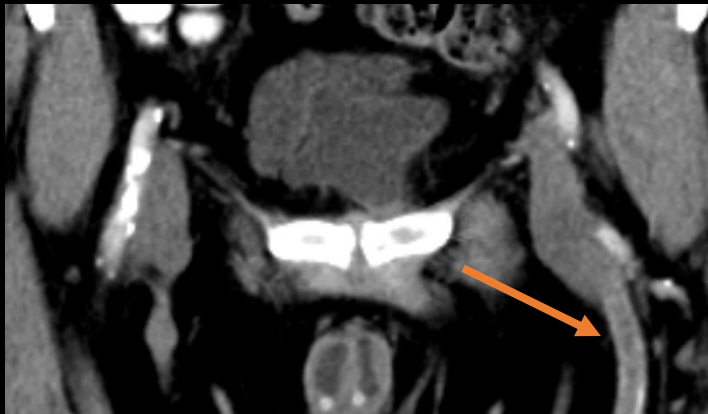
75 y/o with progressive LLE claudication, now pain at rest.

Anterior Tibial Chronic Occlusion



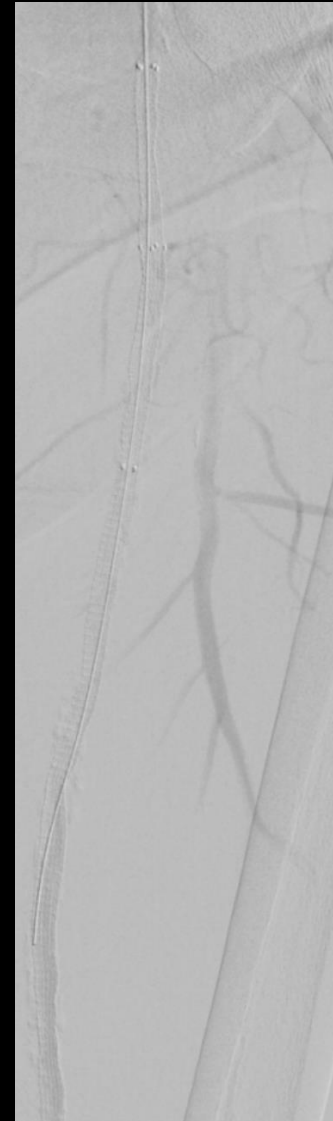
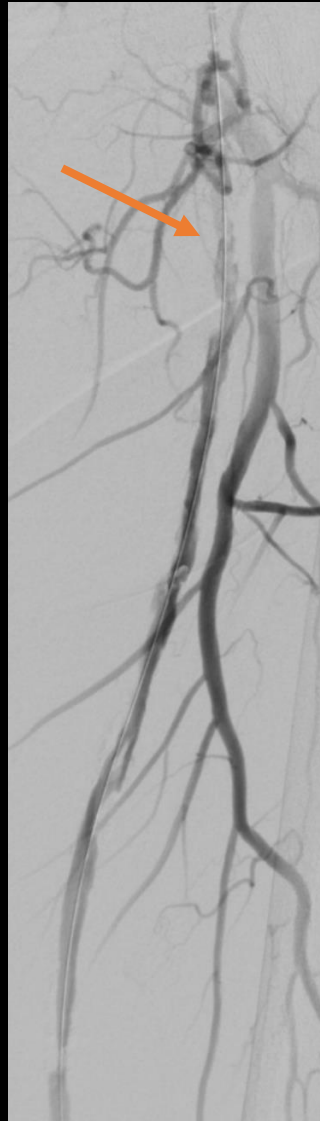
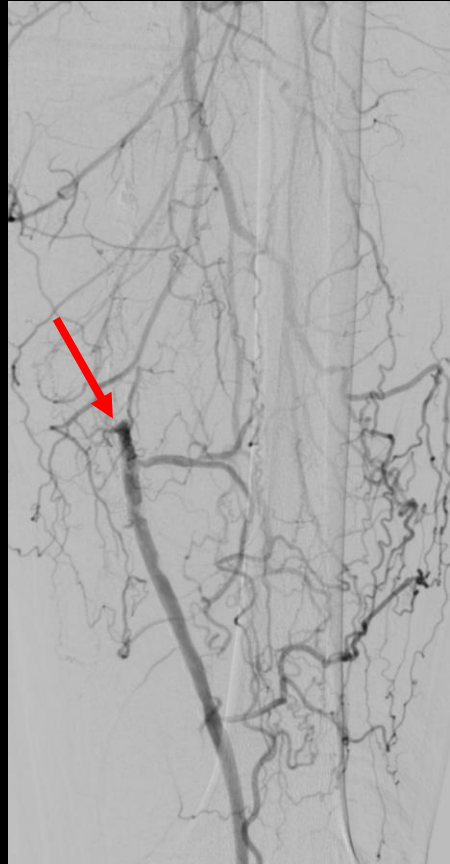
82 y/o female with hx of Ulcerative Colitis, HTN, and DM presenting with progressive 3rd toe pain, and now with a blister/ulcer at the tip.

Chronic SFA occlusion + Bypass occlusion



75 y/o with severe claudication in the LLL – hx of prior SFA bypass

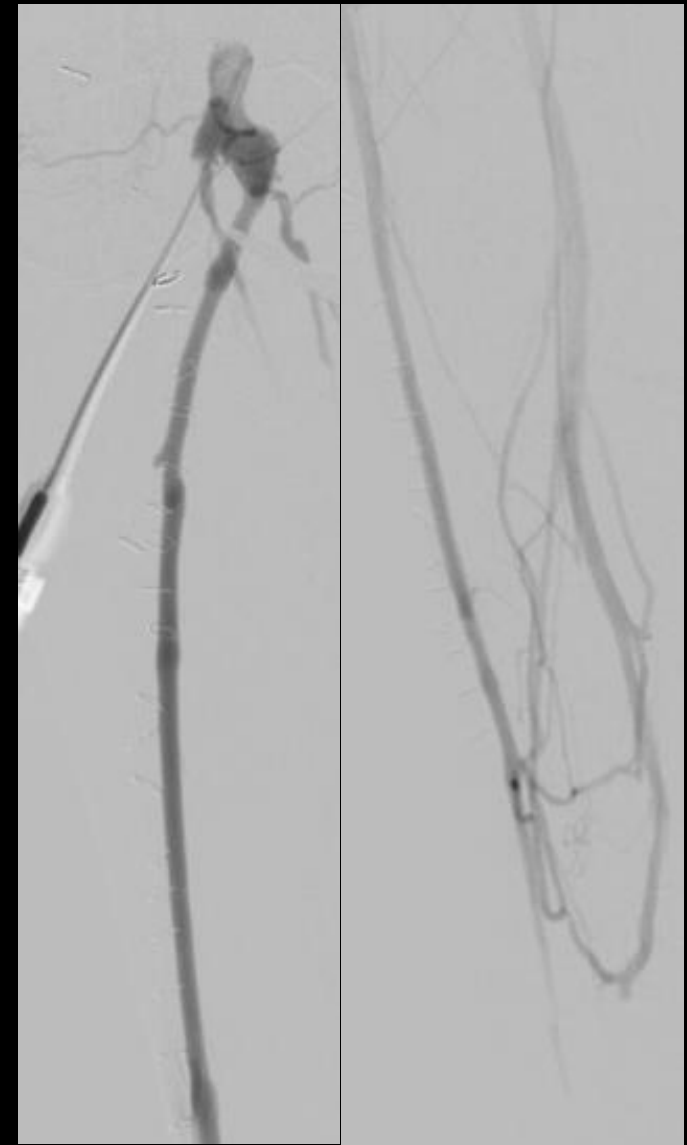
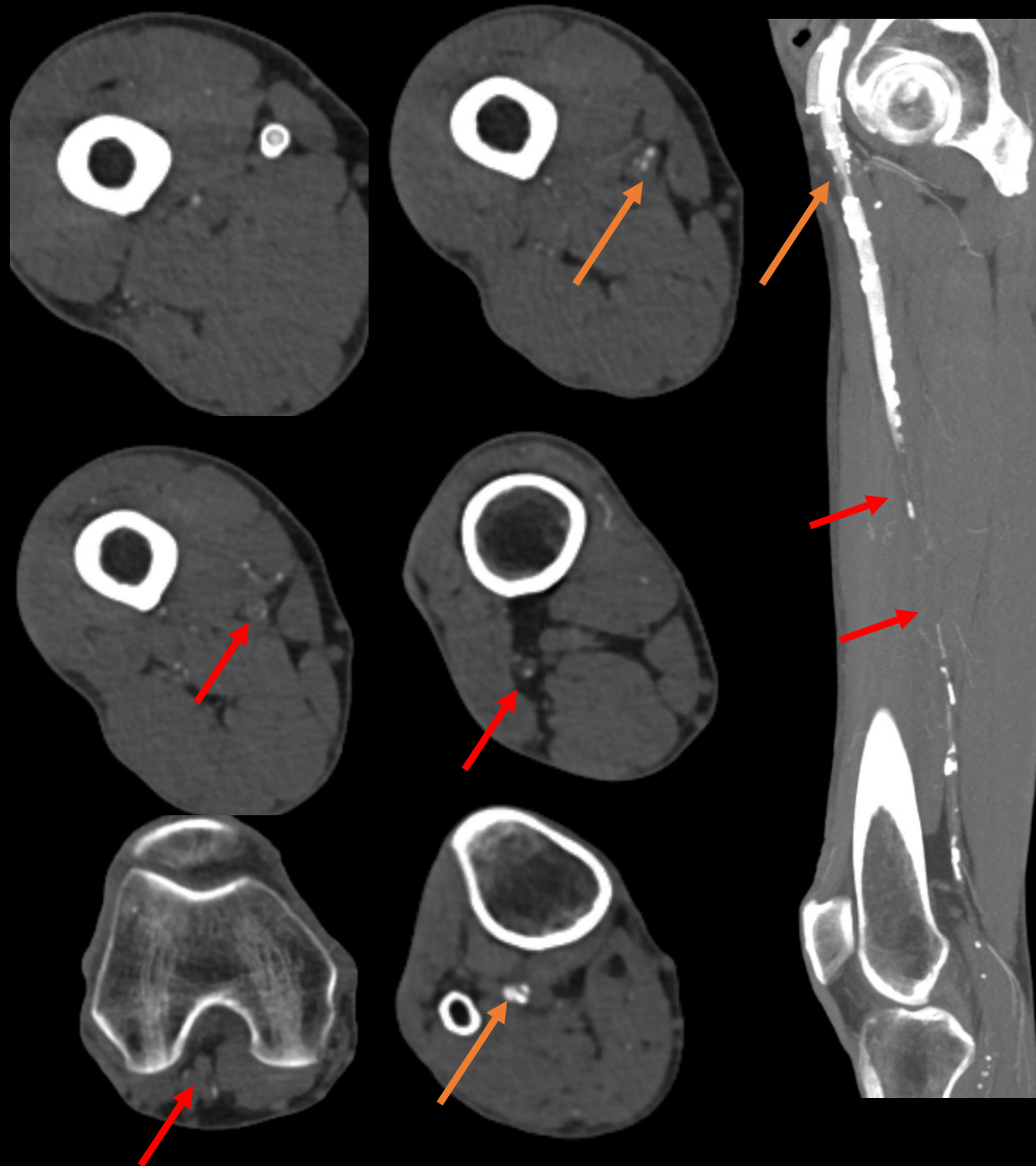
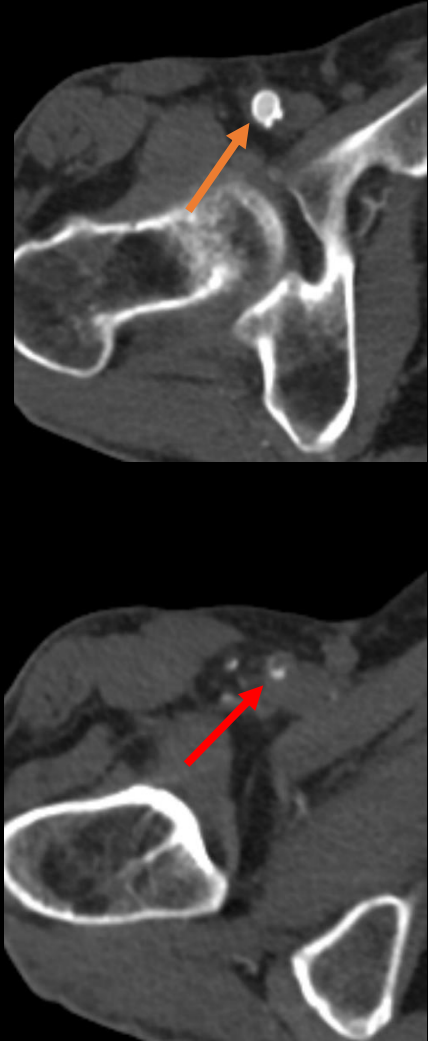
SFA bypass occlusion



75 y/o with severe claudication in the LLL
– hx of prior SFA bypass

Angioplasty and Stenting

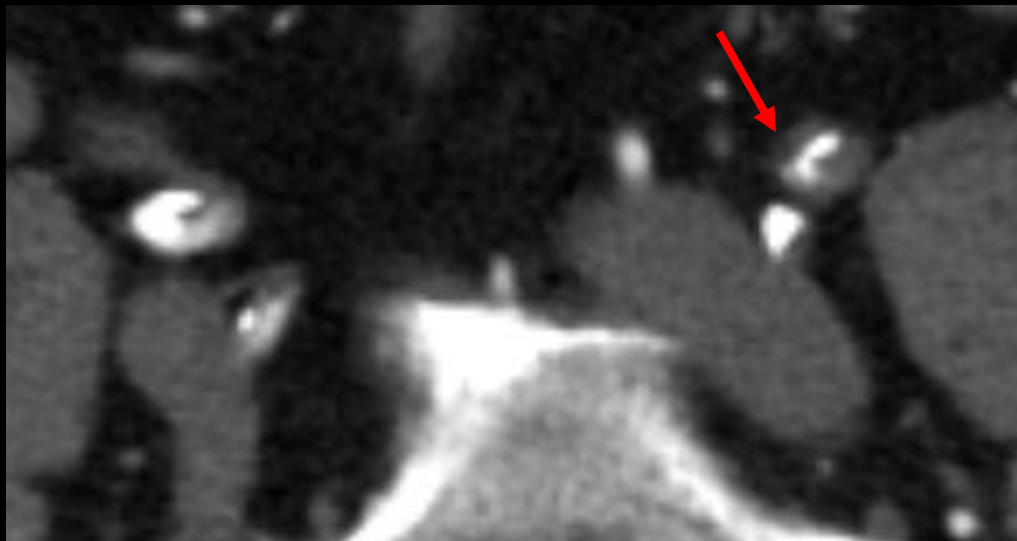
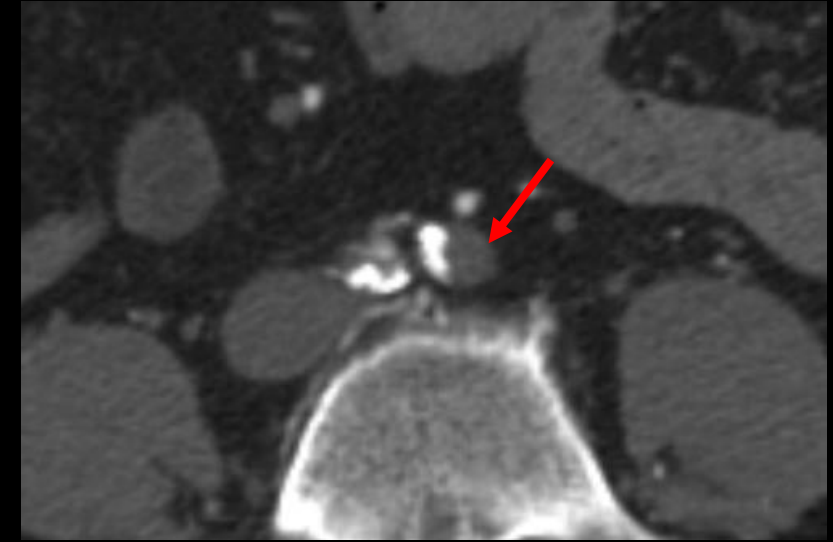
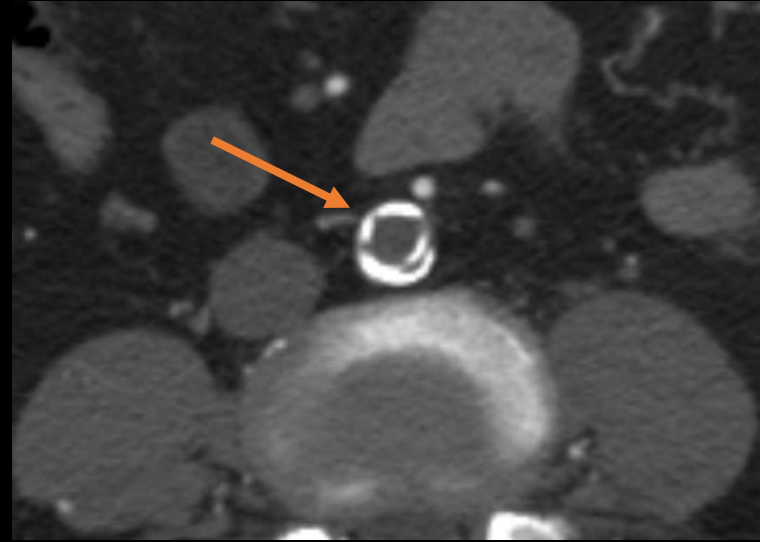
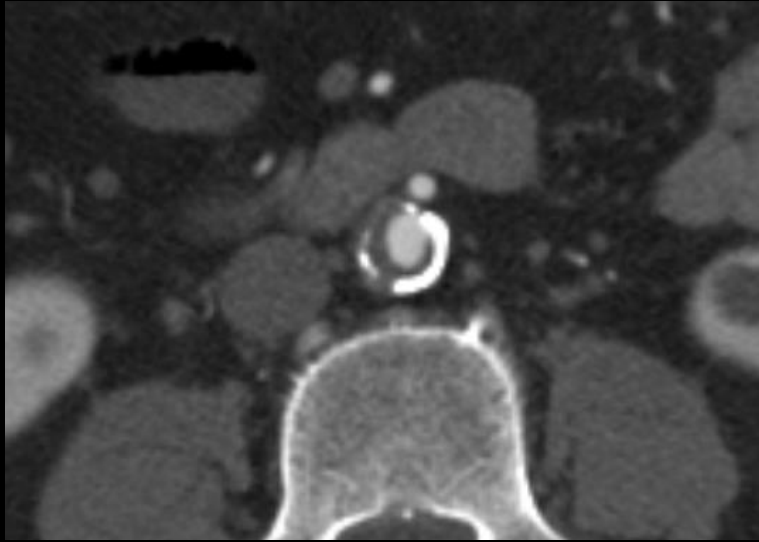
SFA occlusion post stent



Bypass graft

70 y/o with severe claudication in the RLL – hx of prior SFA stent

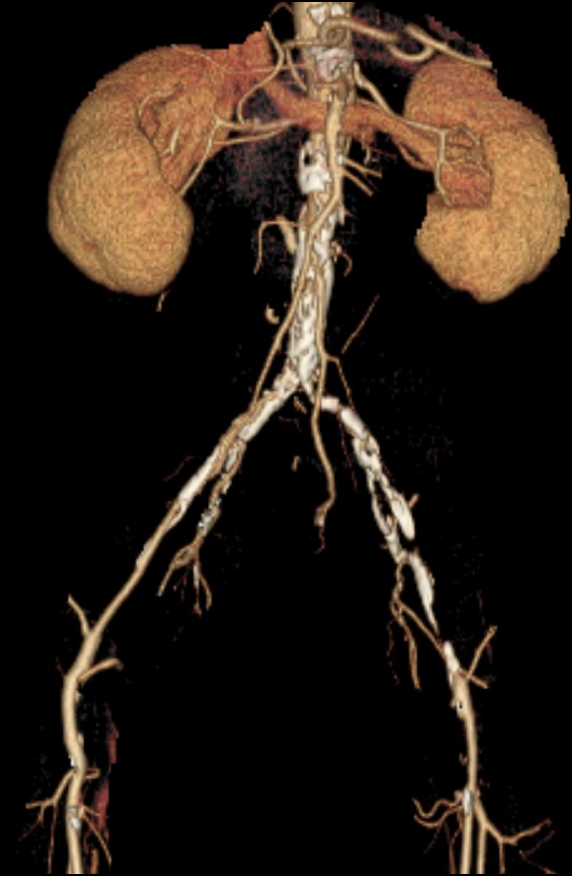
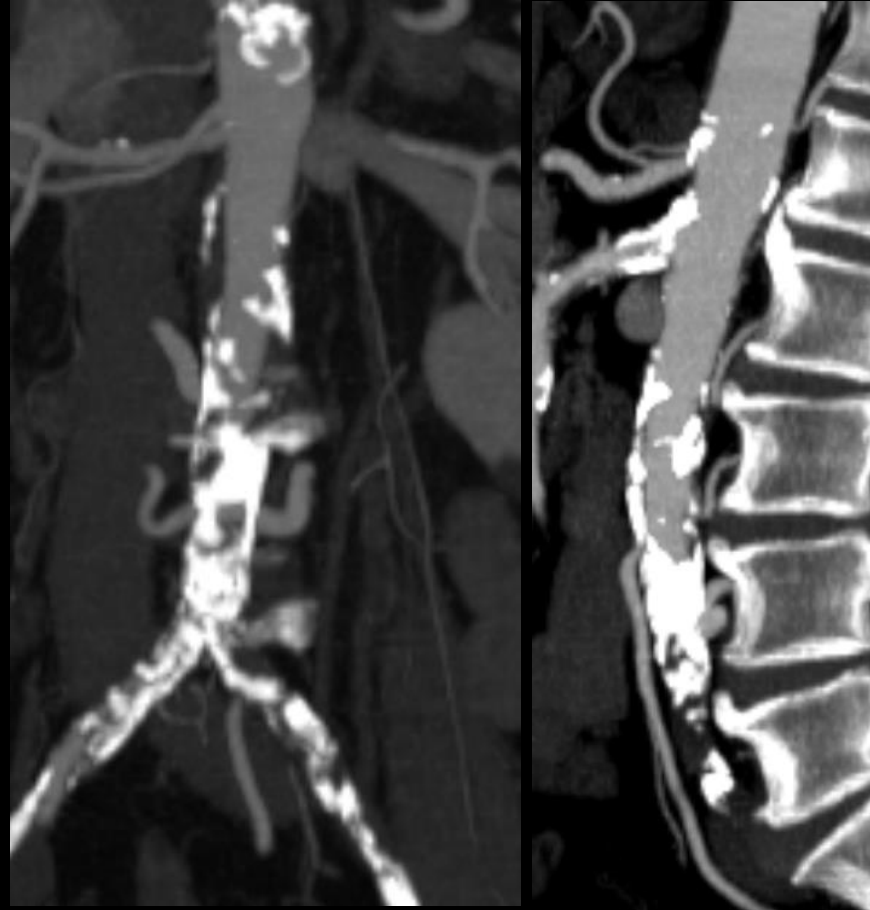
Chronic Aortic Occlusion - Leriche Syndrome



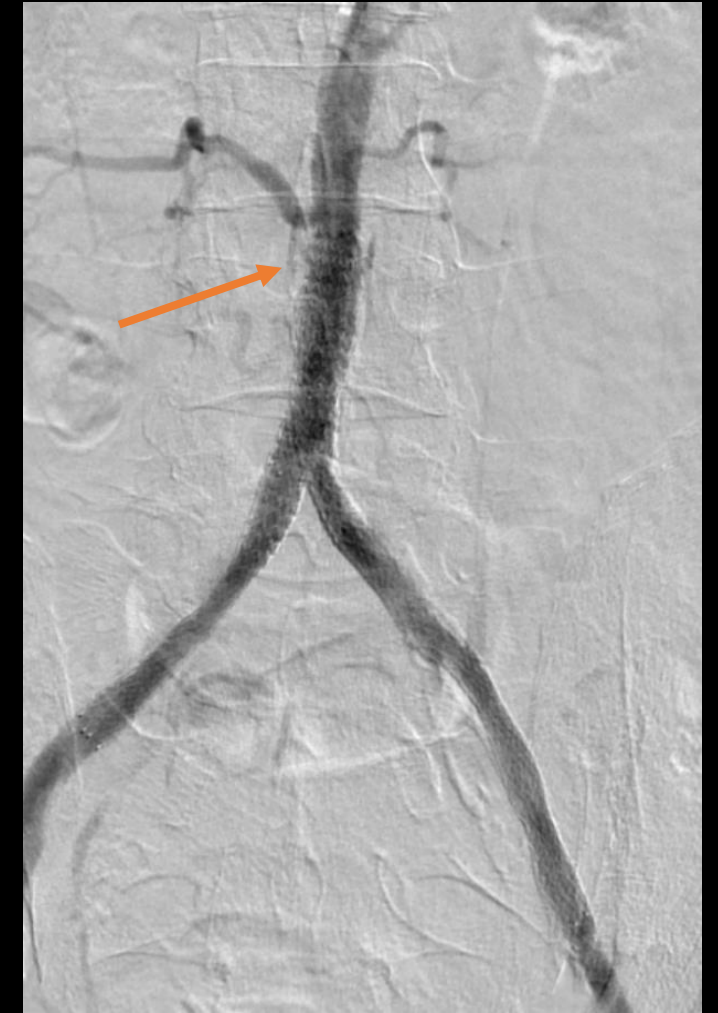
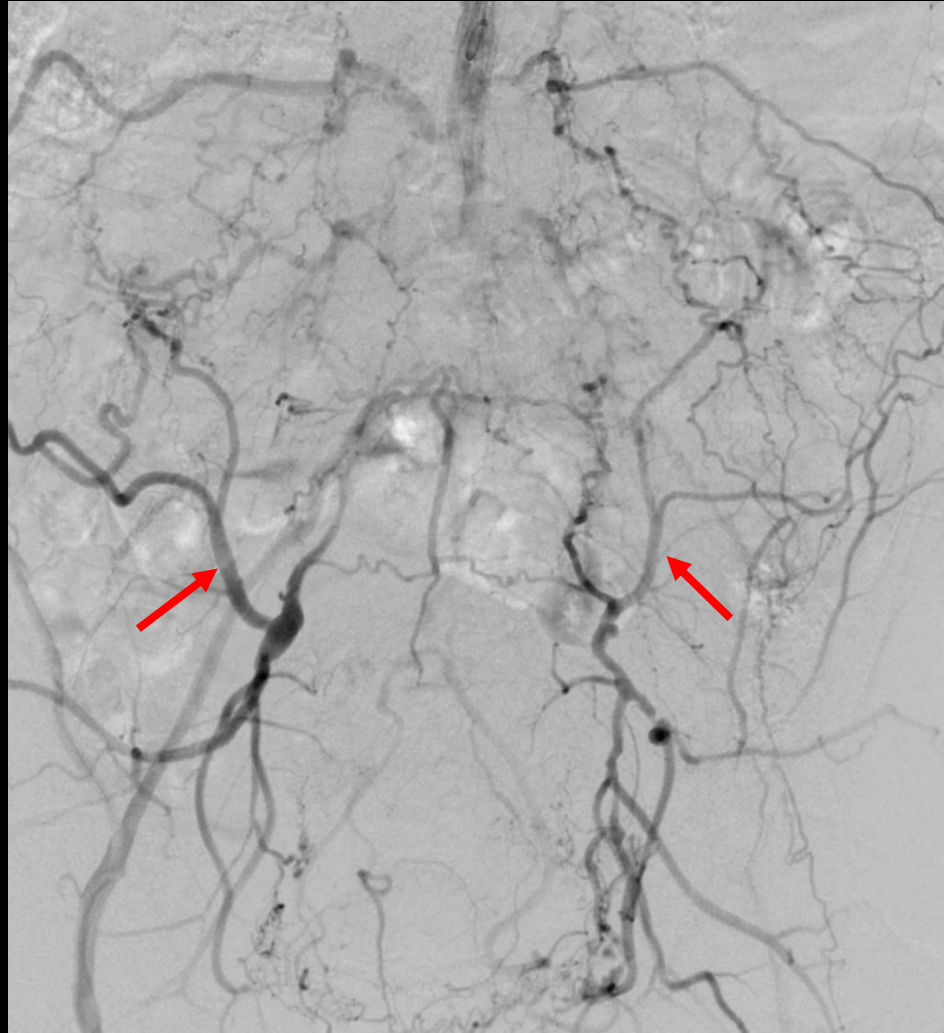
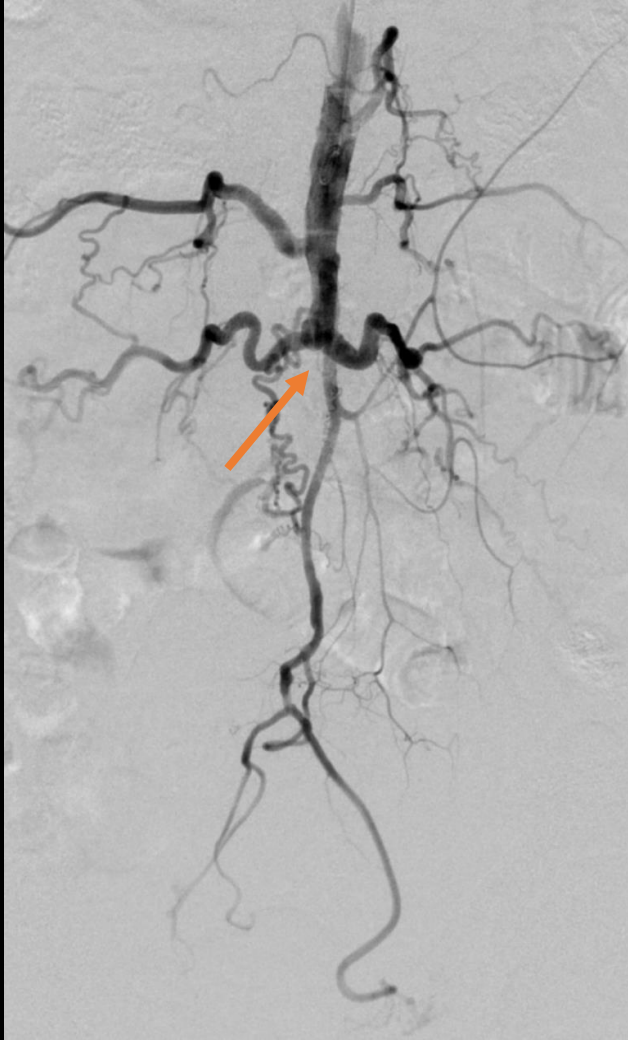
73 y/o with BL hip cramping while walking for 1-2 years. Initial work-up.

Chronic Aortic Occlusion - Leriche Syndrome

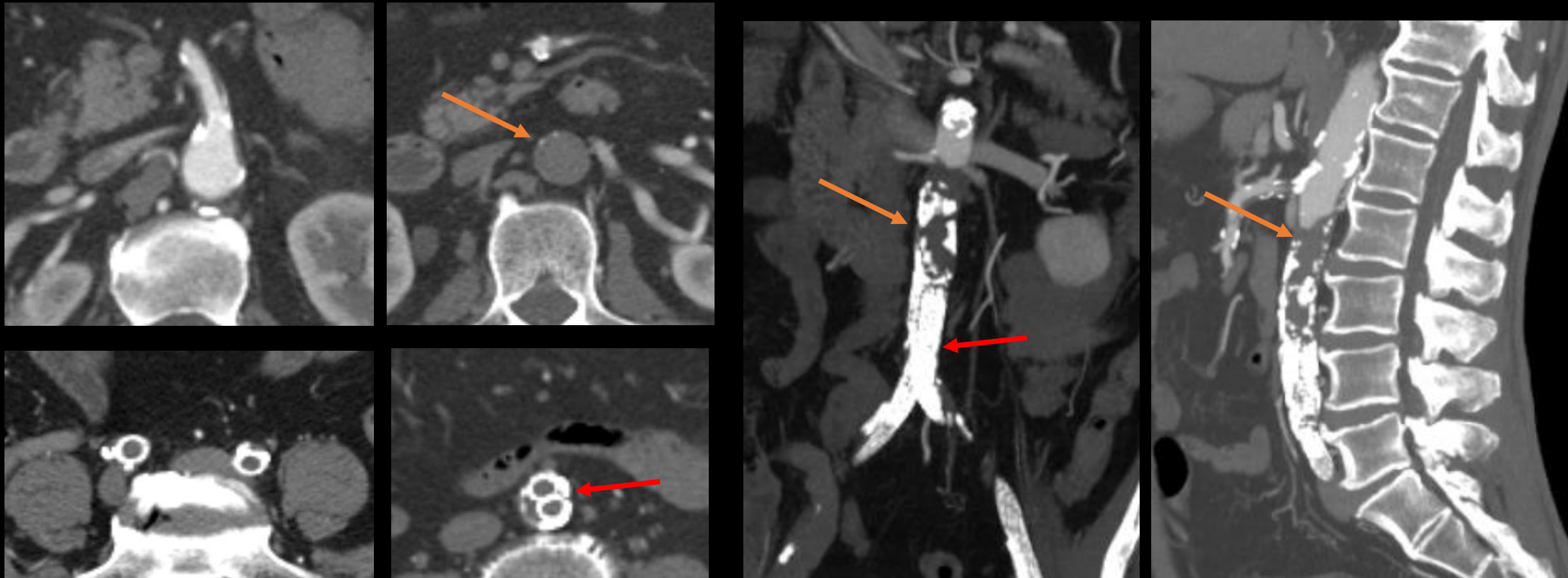
- More common than acute aortic occlusion.
- Disease of elderly. Deposition of atherosclerotic plaque in the distal AA, **usually at the aortic bifurcation**.
- **Classic triad**: buttock or thigh claudication, erectile dysfunction, and decreased or absent femoral.
- French surgeon **René Leriche** in 1923.



Chronic Aortic Occlusion - Leriche Syndrome

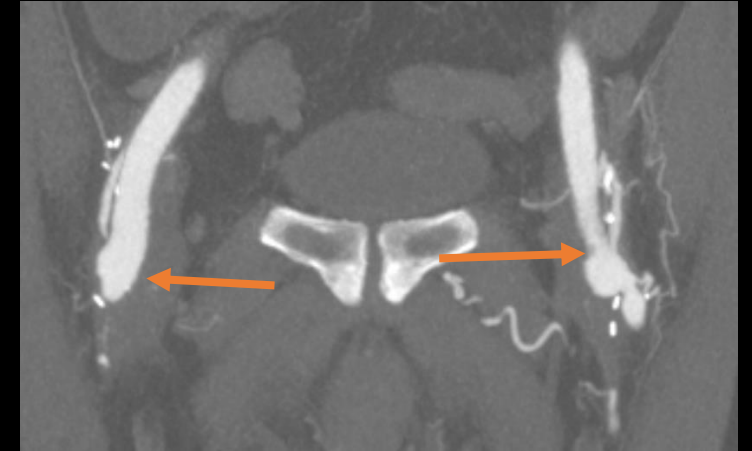


Aortic Thrombosis after endovascular graft



73 y/o male with hx of HTN, HLD, and PAD with double-barrel aortoiliac endovascular graft and bilateral iliac stent, presenting with BL thigh claudication.

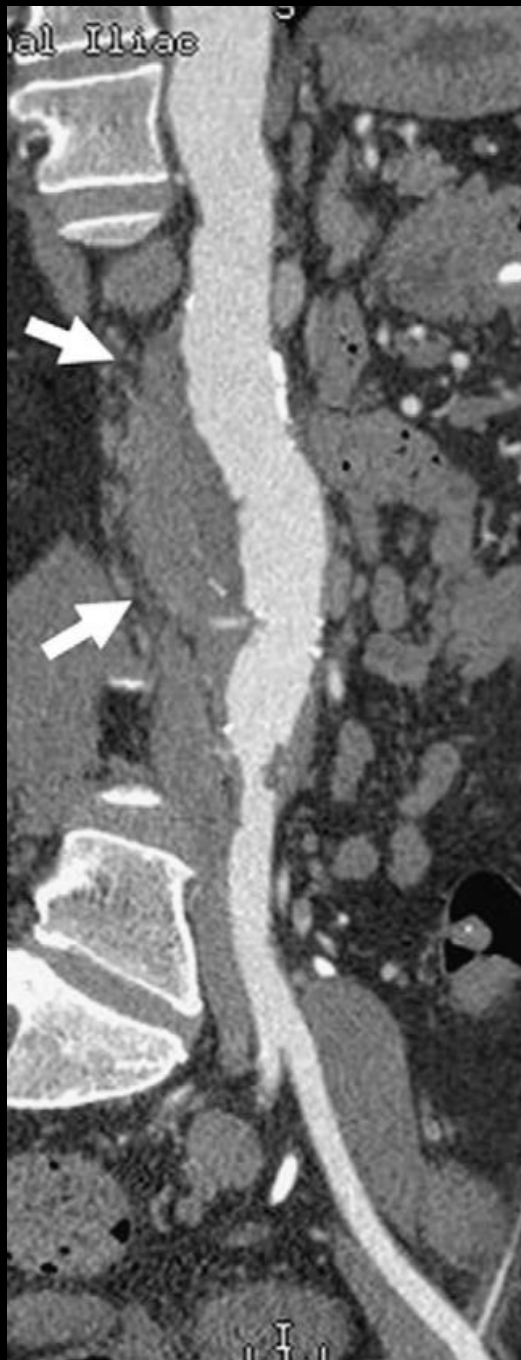
Aorto-bifemoral bypass graft for Aortic Thrombosis



73 y/o male with hx of HTN, HLD, and PAD with double-barrel aortoiliac endovascular graft and bilateral iliac stent, presenting with BL thigh claudication.

Case Review

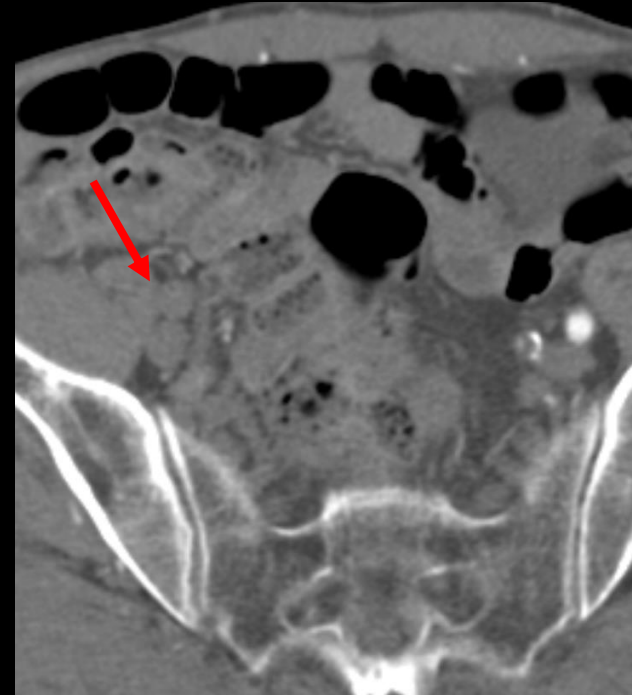
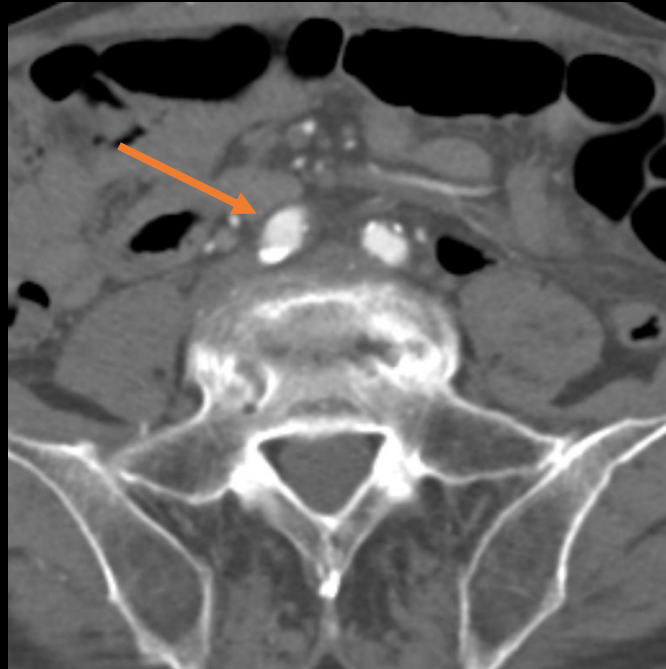
Arterial Embolism & Miscellaneous



50 y/o male with hx of AAA presenting with acute-on-chronic left lower extremity pain.

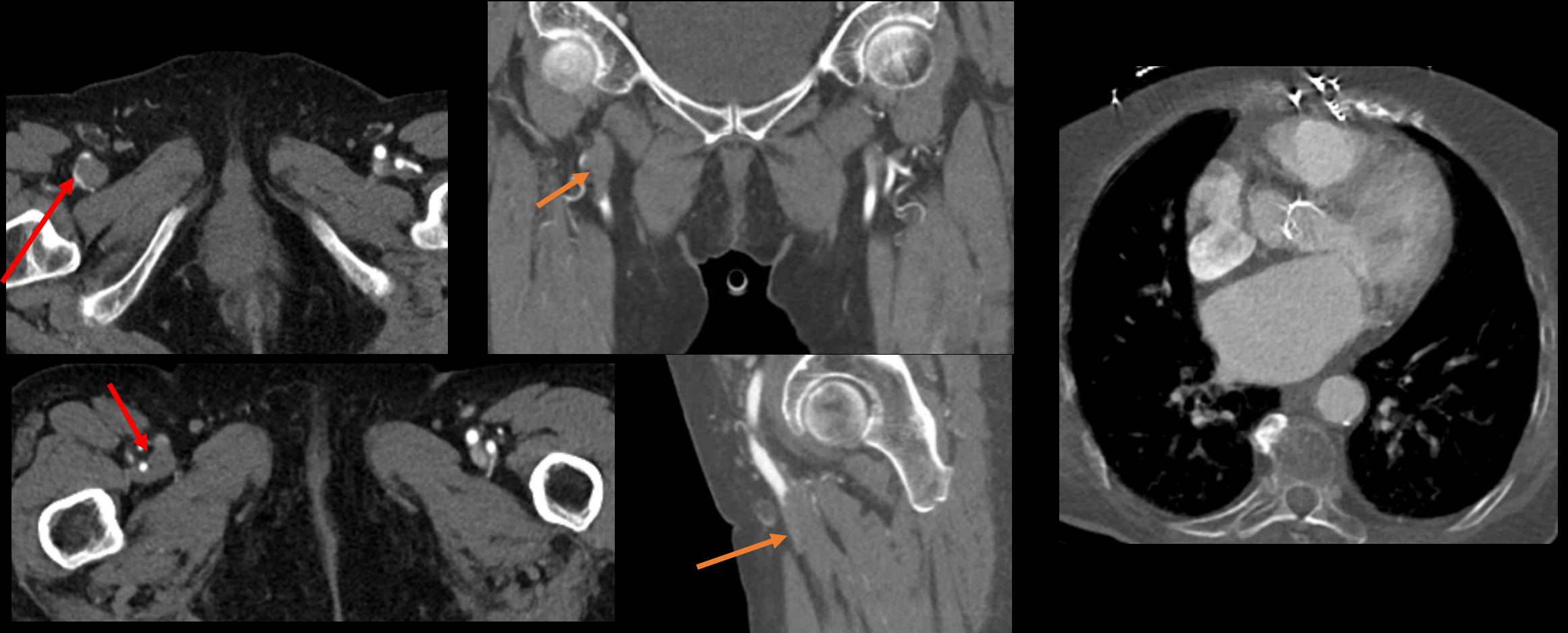
Popliteal Arterial Thromboembolism

Acute thromboembolic occlusion of the right EIA



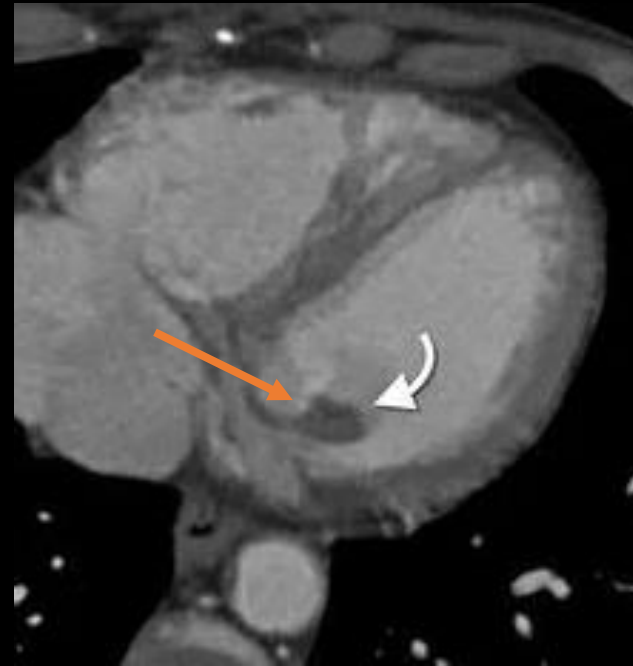
72 y/o with hx of HTN presented with severe right leg pain for two days and pallor of the right foot

Acute thromboembolic occlusion of the right CFA



92 y/o. w/ hx of aortic valve replacement and persistent A-Fib developing sudden loss of strength and sensation below the right knee.

Acute thromboembolic occlusion of aorta bifurcation and tibioperoneal trunk



54 y/o with rheumatic heart disease status post mitral valve replacement nine months prior to presenting with dry gangrene to the toes of both feet.

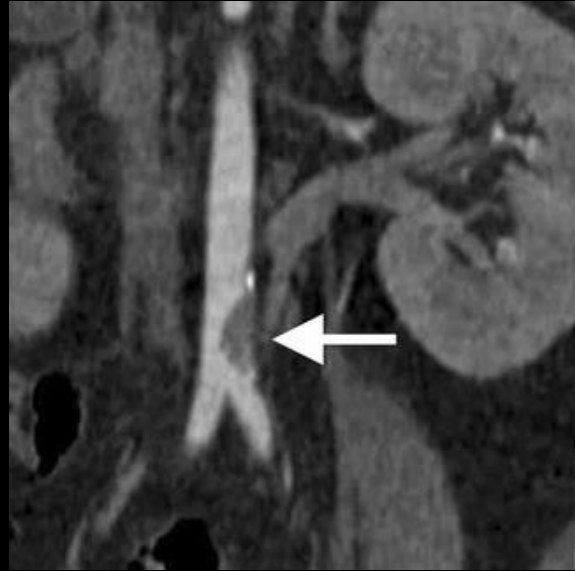
"Blue Toe Syndrome" - embolism from ulcerated atherosclerotic plaque



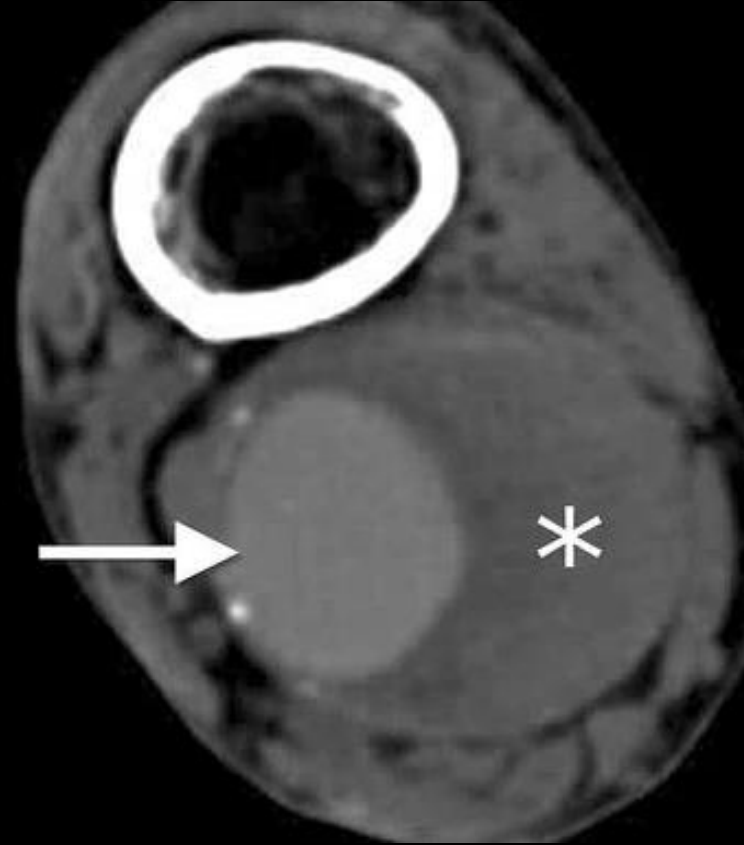
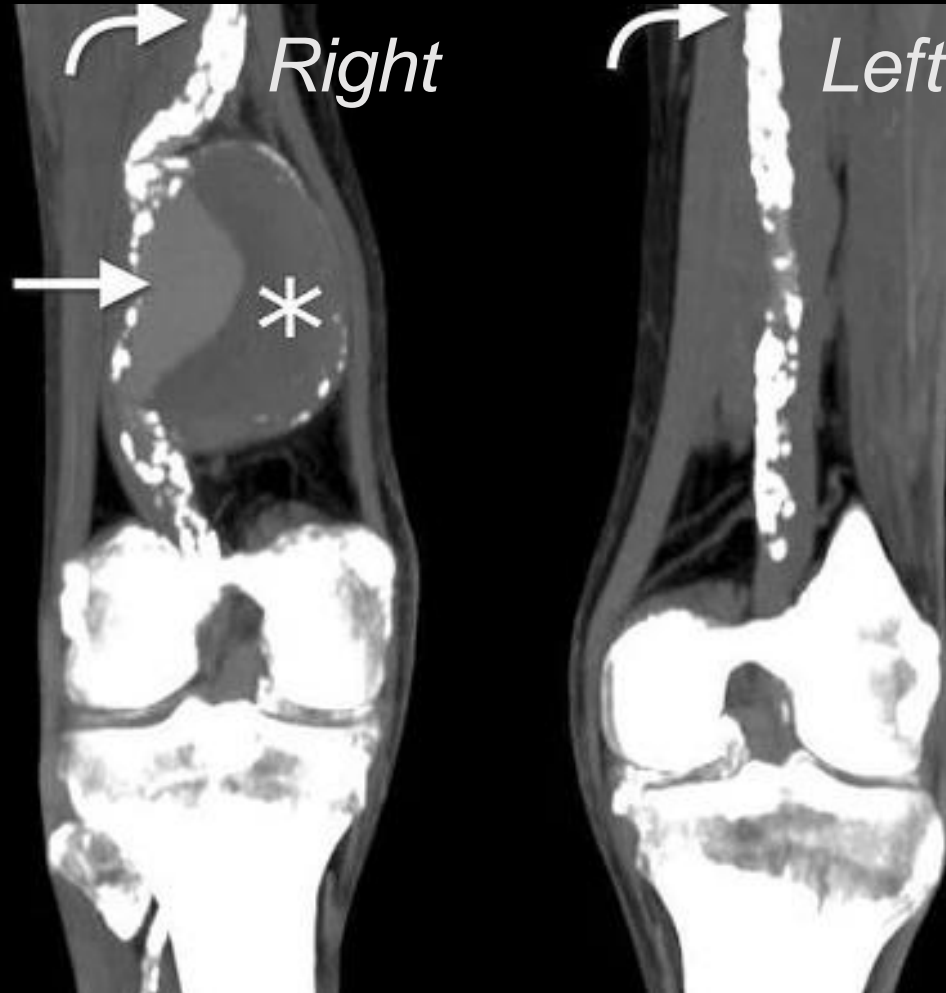
35 y/o patient presenting with acute pain, swelling and purple discoloration of the left 3rd and 4th toes.

Arterial Thromboembolism

- 15% of cases of acute limb ischemia.
- **Origin:** commonly from cardiac or aortic aneurysm origin.
- Larger embolic burden = more proximal arterial occlusion (i.e., SFA and popliteal).
- **Symptoms:** "acute limb pain and pallor", "blue toe syndrome"
- Worse prognosis than arterial thrombosis (less collaterals).

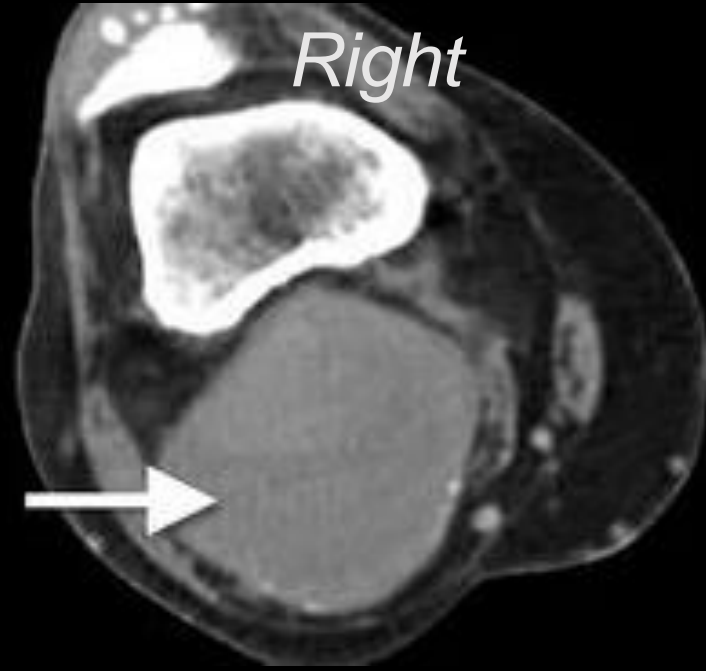


Popliteal Artery Aneurysm (PAA)



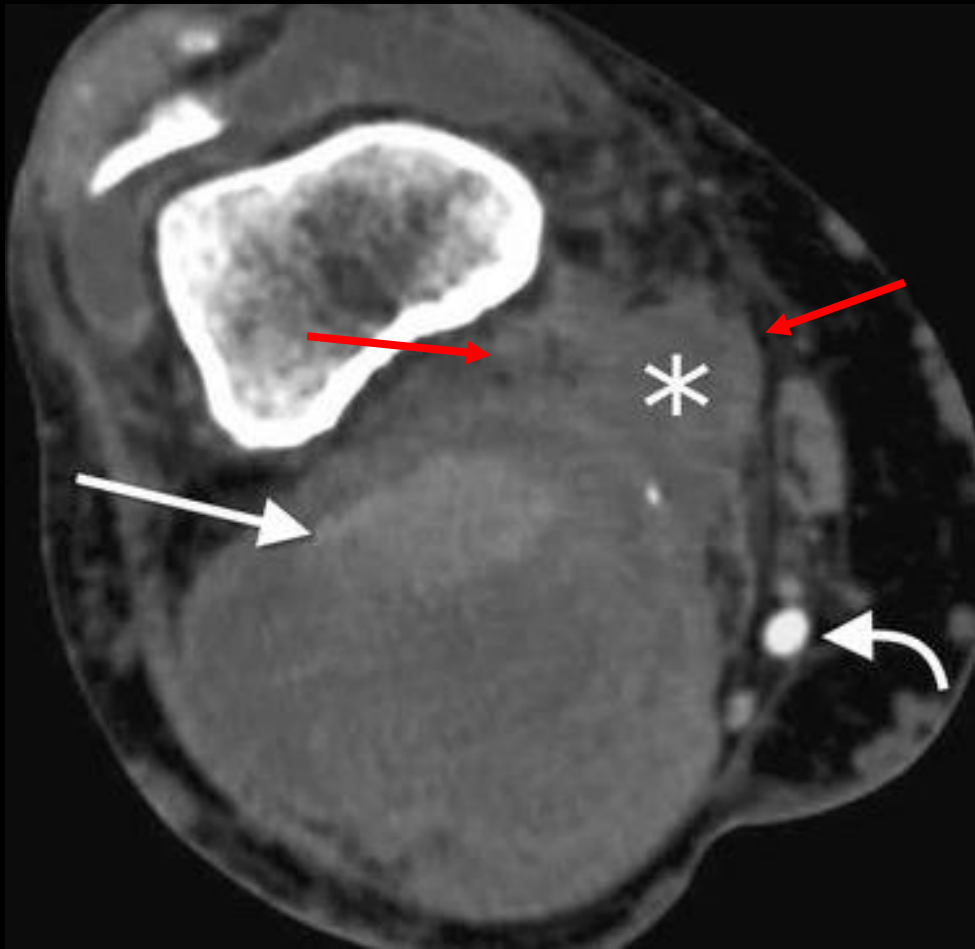
85 y/o man with known AAA sent for further evaluation of "popliteal cystic mass" noted on lower extremity sonographic exam

Popliteal Artery Aneurysm (PAA) + SFA thrombosis



77-year-old man presenting with a cold, blue right lower extremity for over 24 hours.

Popliteal Artery Aneurysm (PAA) + Bypass + Rupture



The same 77 y/o with right popliteal artery aneurysm previously treated by bypass graft presented with worsening right posterior knee pain.

Popliteal Artery Aneurysm (PAA)

- High association with AAA: ~ 40% have a AAA, (only 10-15% with AAA have PAA)
- **BL** in 50 to 70% of cases.
 - True aneurysms (commonest).
 - Pseudoaneurysms: result from trauma, surgery/intervention, or infection
- **Complications**
 - Distal thromboembolism (commonest, increased risk when > 2cm)
 - Rupture (rare)
 - Pressure effects if large enough



Nonatherosclerotic and Miscellaneous arterial disease

- Systemic Arteritis:

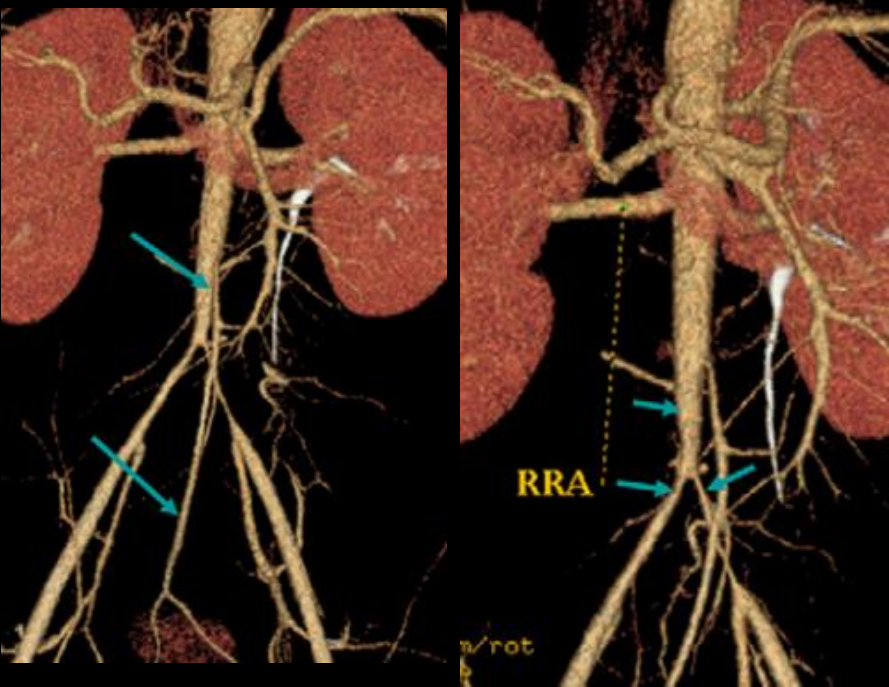
- Inflammatory/collagen-vascular diseases:

- **Takayasu arteritis:** most commonly affects the aortoiliac inflow circulation
 - **Buerger disease:** affects the femoropopliteal or tibioperoneal outflow circulation, smoking association.
 - **Giant Cell arteritis, Polyarteritis Nodosa, Behcet disease, etc.**

- Popliteal artery entrapment syndrome
- Adventitial cystic disease of the popliteal artery
- Thrombosis of a persistent sciatic artery
- Fibrodysplasia of the iliac vessel

Systemic Arteritis

Takayasu Arteritis



Buerger Disease

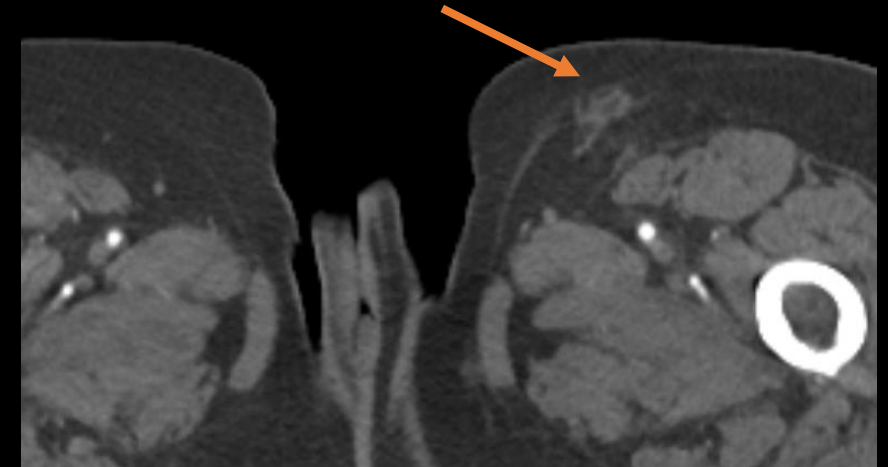
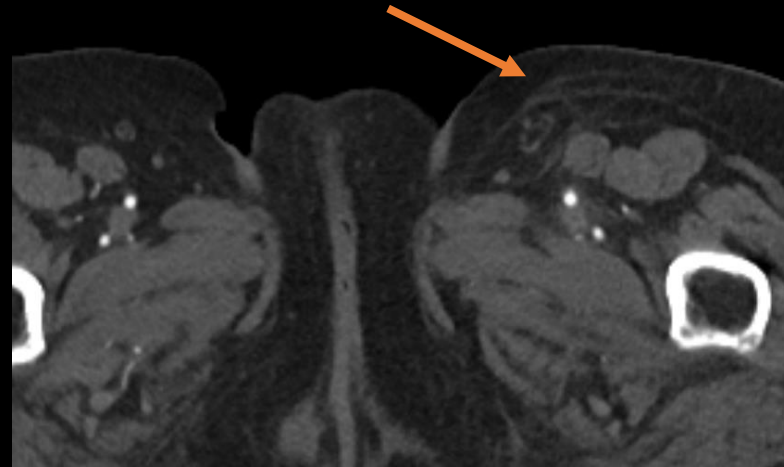
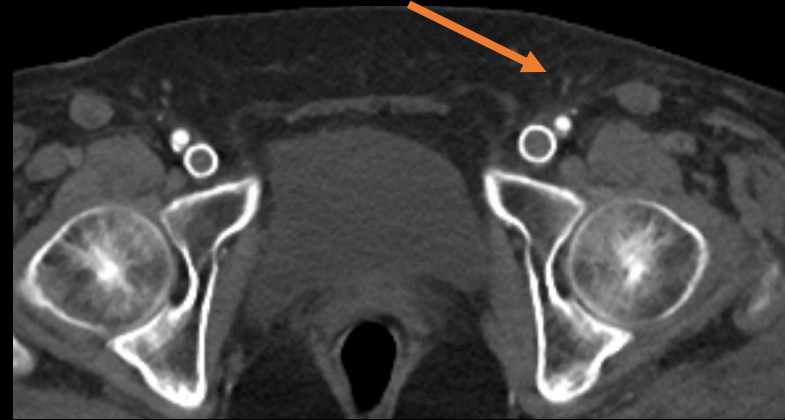


Endovascular Treatment Complications

Puncture site
Hemorrhage Pseudoaneurysm Arteriovenous fistula
Intervention site
Thrombosis Vascular rupture
Distal vessel
Thromboembolism Dissection
Systemic
Acute kidney injury Myocardial infarction Cerebrovascular accident

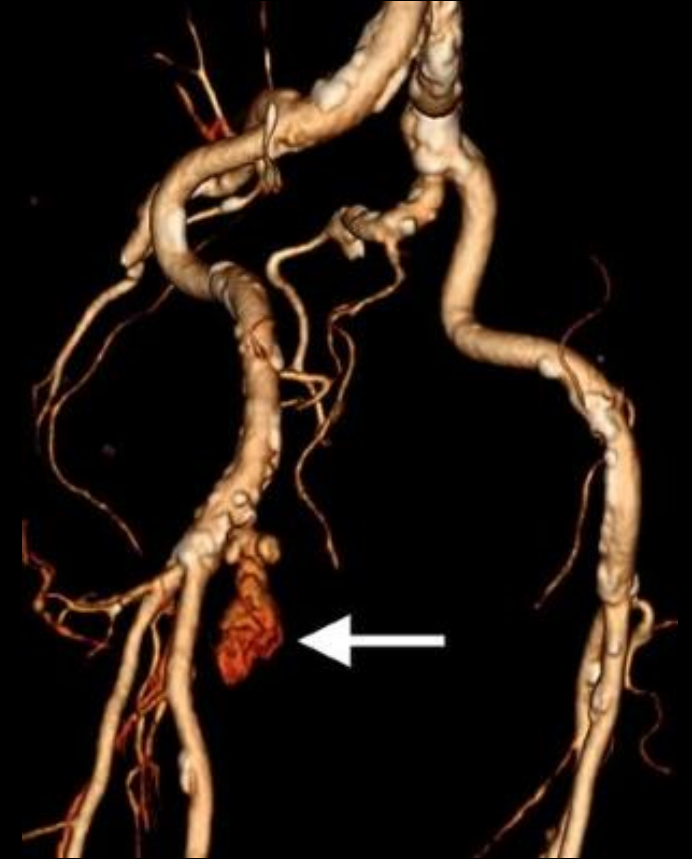
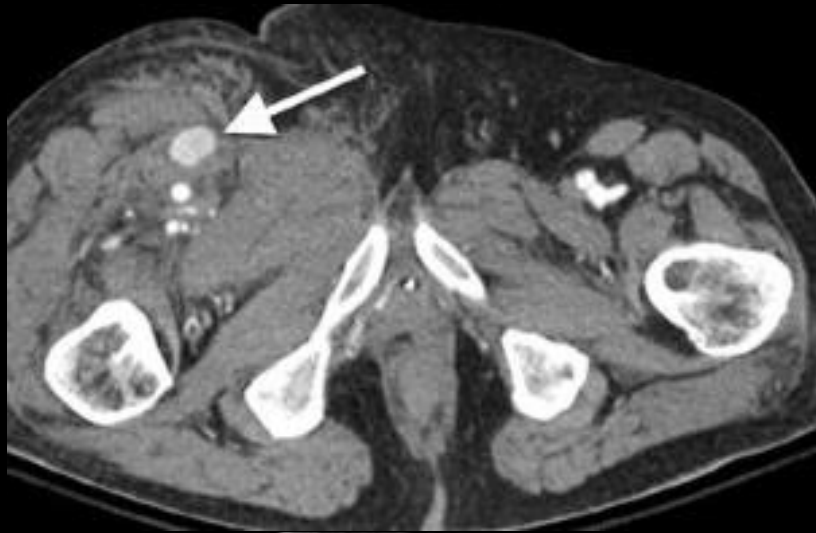


Puncture Bleeding – No Pseudoaneurysm



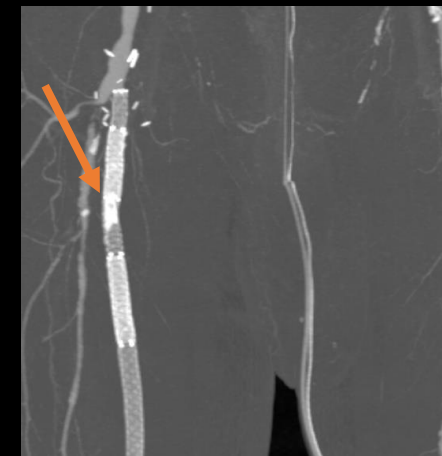
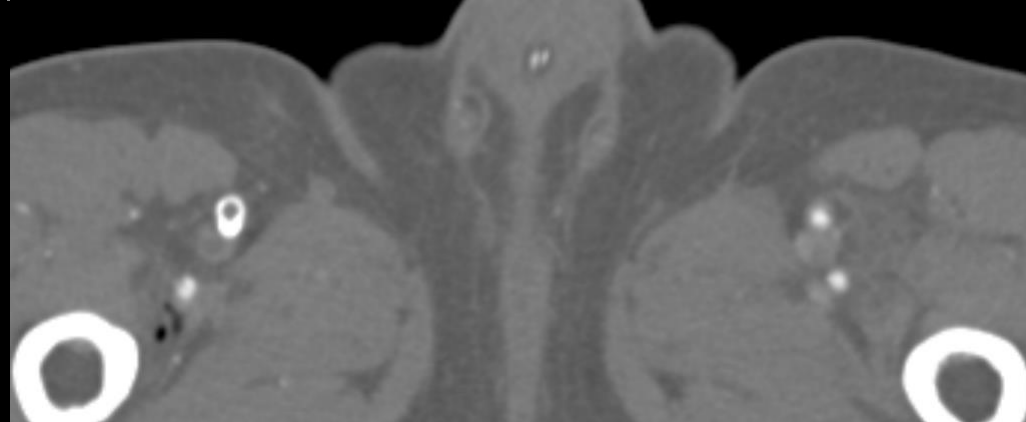
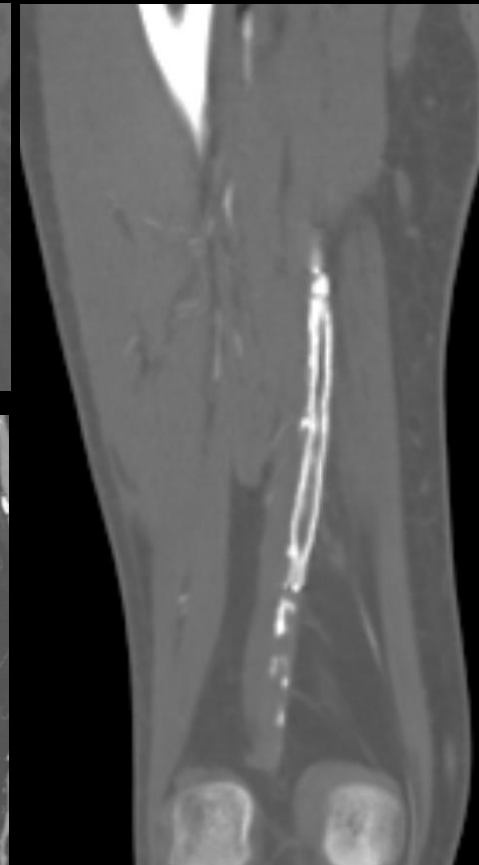
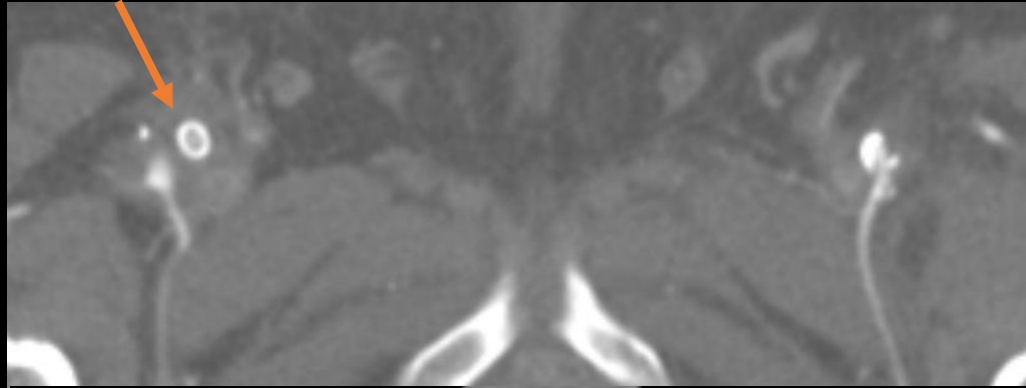
60 y/o on warfarin, post L FV access attempt with active puncture bleeding and hematoma.

Pseudoaneurysm + SFA narrowing



80 y/o with left MCA stroke status post mechanical thrombectomy, with expanding right groin hematoma and lower extremity pulselessness.

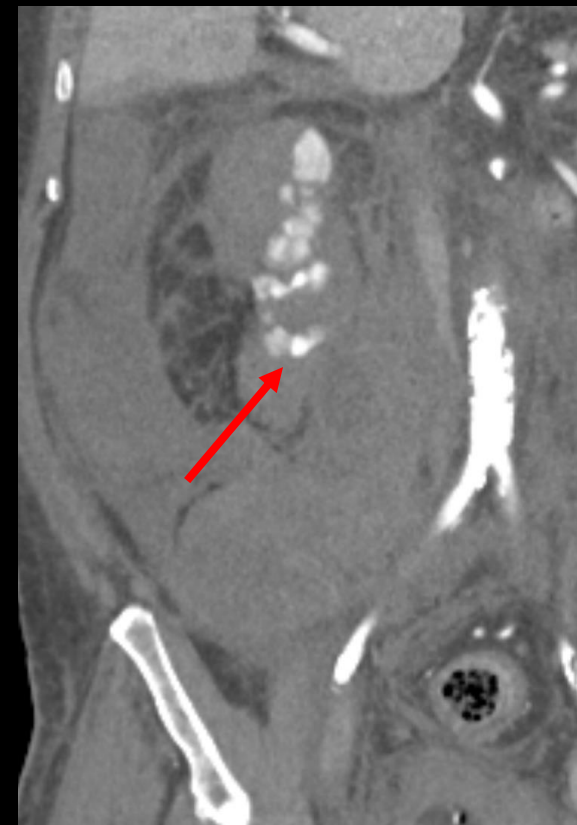
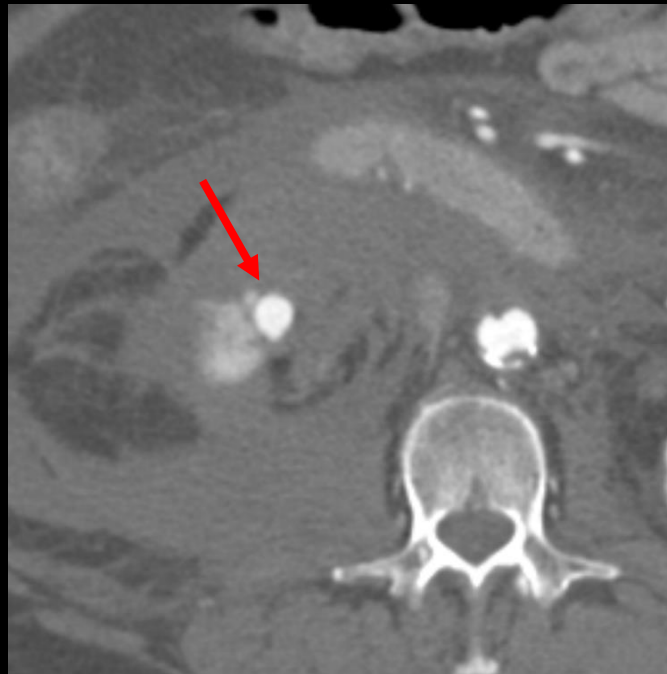
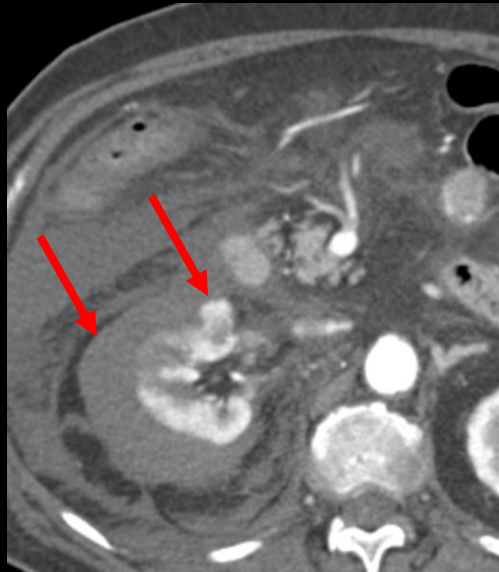
Superficial femoral artery stent occlusion (Thrombosis)



69 y/o post R SFA stenting presents with acute RLE pain and discoloration.

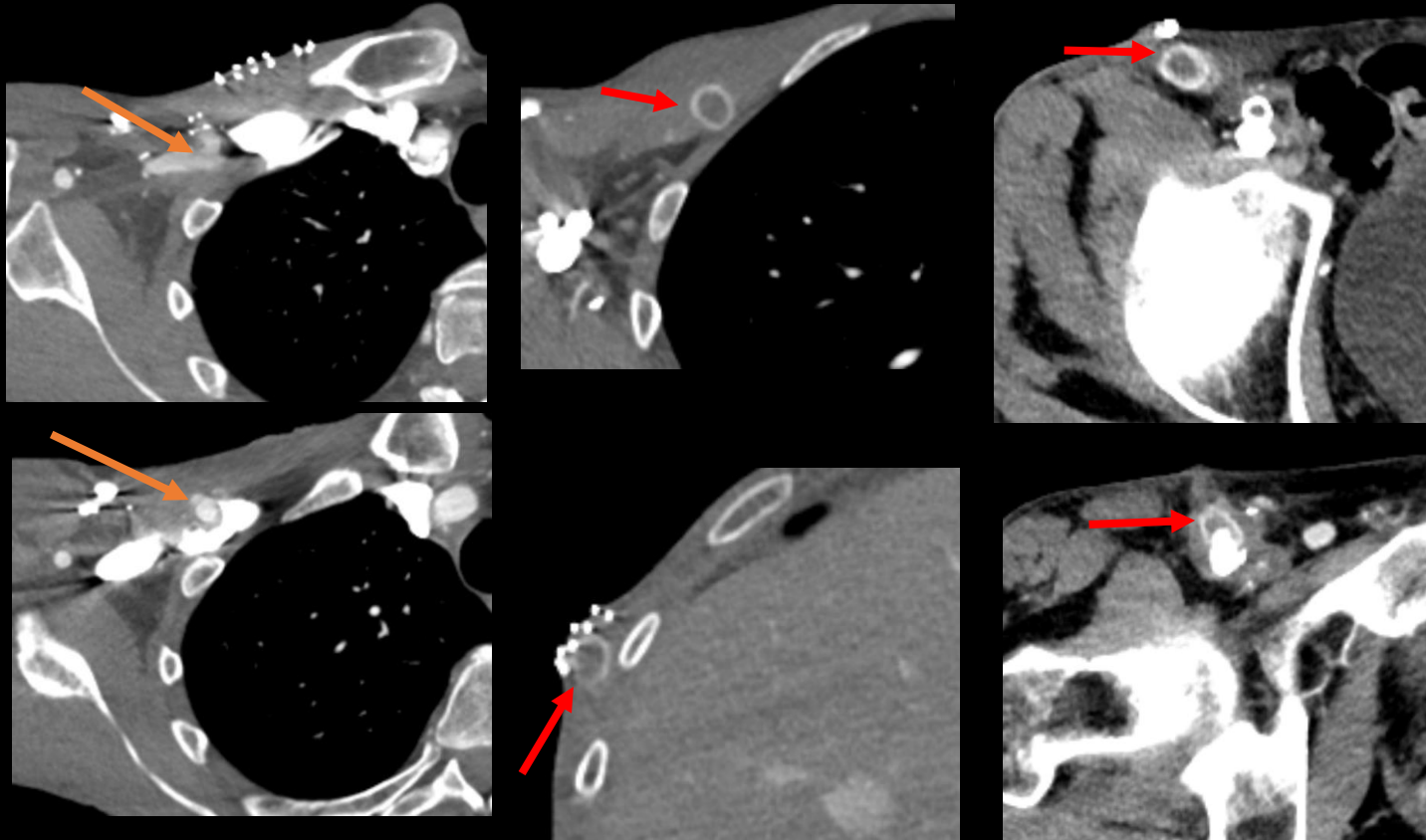
9/2023 – Percutaneous lysis

Rupture subcapsular hematoma with retroperitoneal bleeding



69 y/o POD#1 post R SFA stent percutaneous lysis developed acute abdominal pain and distention in the SICU.

SCA-Femoral Bypass Thrombosis



75 y/o s/p recent right SCA-femoral bypass presenting with pulseless and painful RLE.



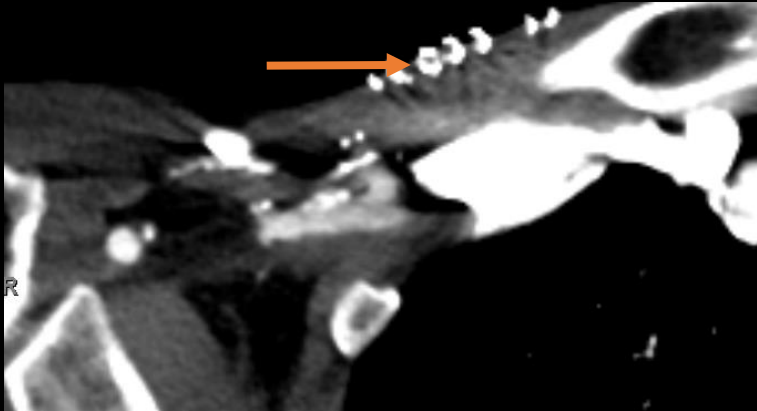
Thrombolysis

Pseudoaneurysm After Vascular Access

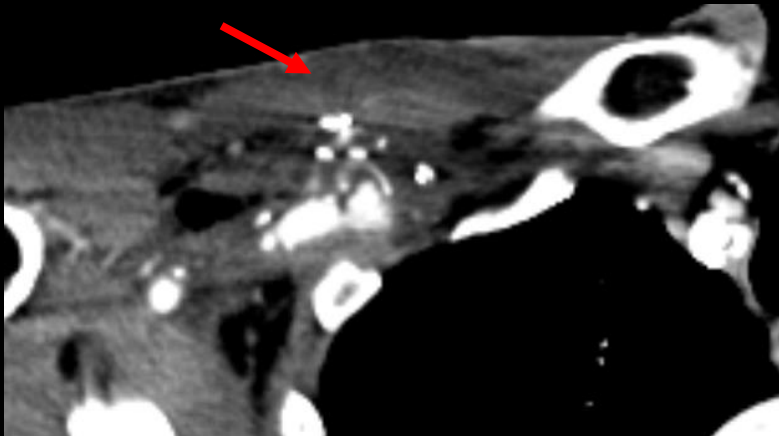


75 y/o POD#2 after thrombolysis of the recent right SCA-femoral bypass with painful R groin, fever and R infraclavicular swelling and redness.

Axilla-Femoral Bypass - Infection



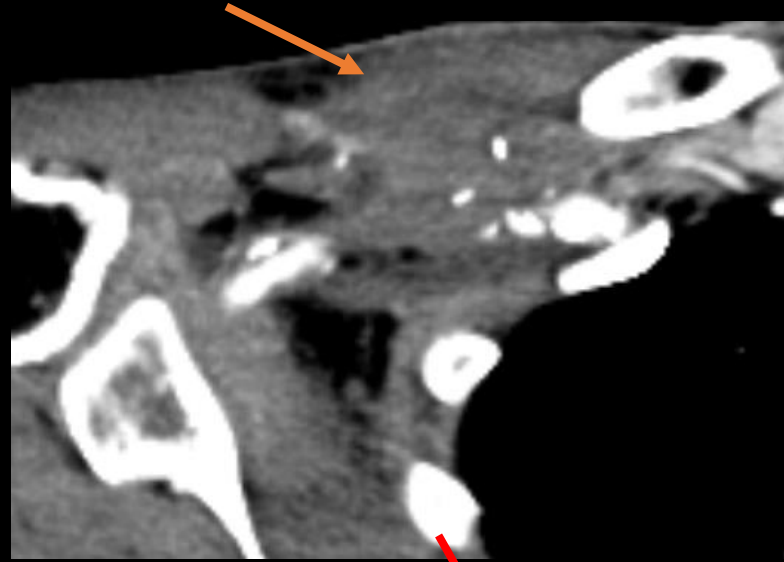
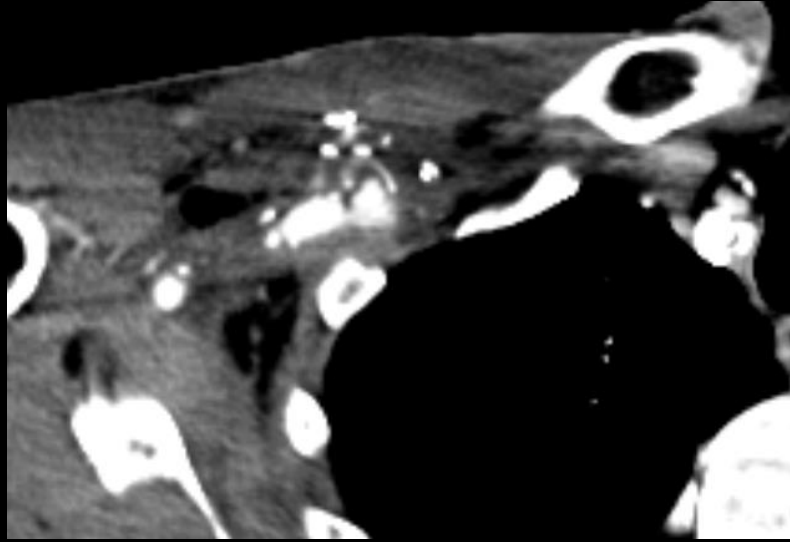
12/2022



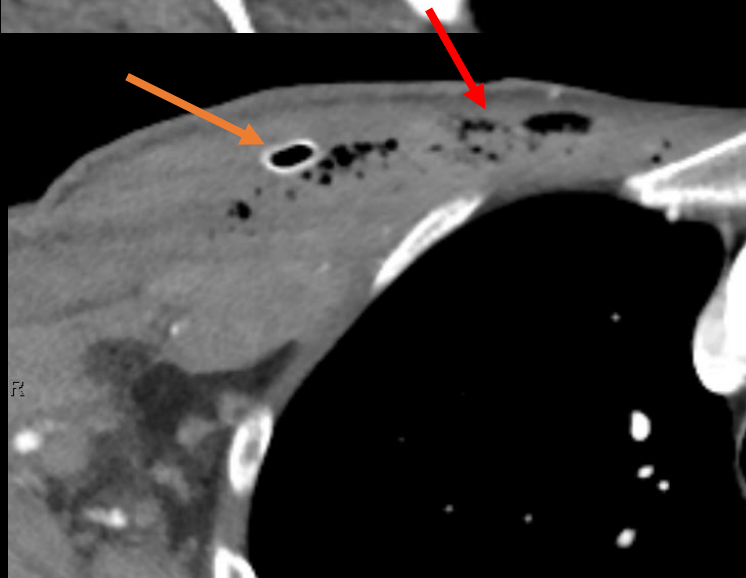
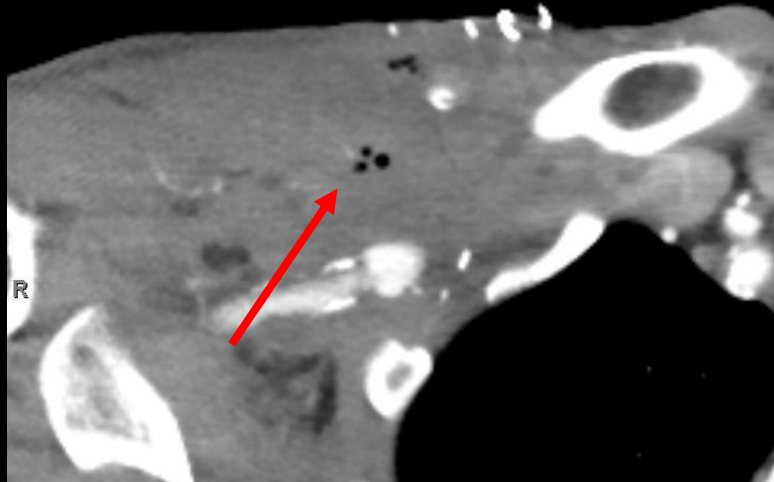
1/2023

75 y/o POD#3 after thrombolysis of the recent right SCA-femoral bypass with painful R groin, fever and R infraclavicular swelling and redness.

Axilla-Femoral Bypass Removal - Infection

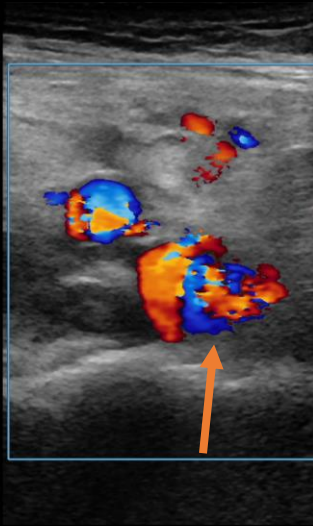
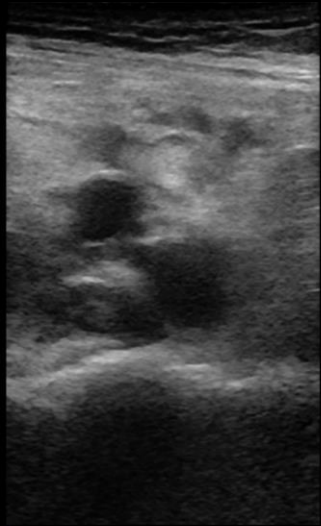


1/2023

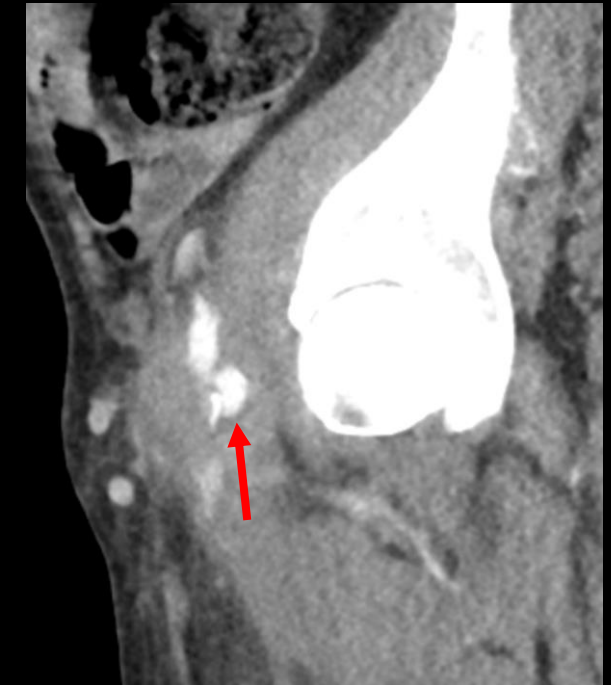
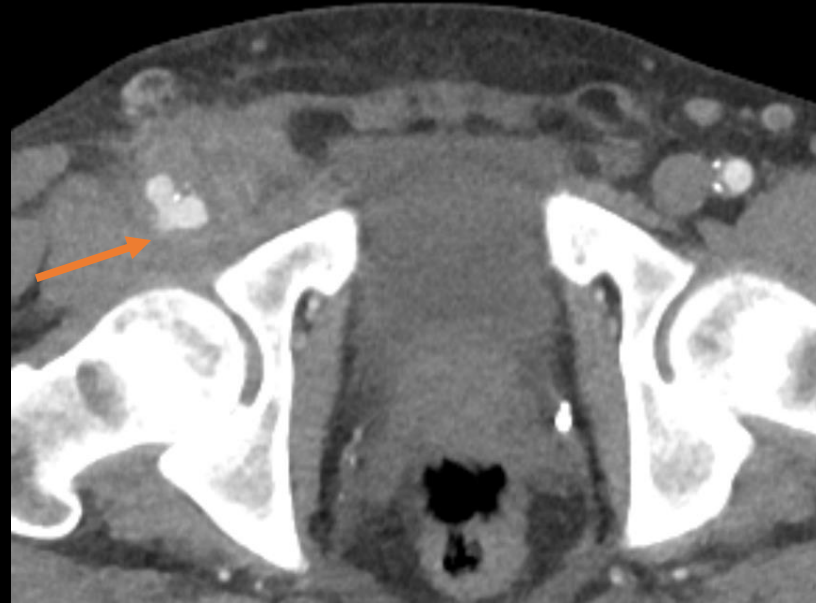


2/2023

CFA Pseudoaneurysm



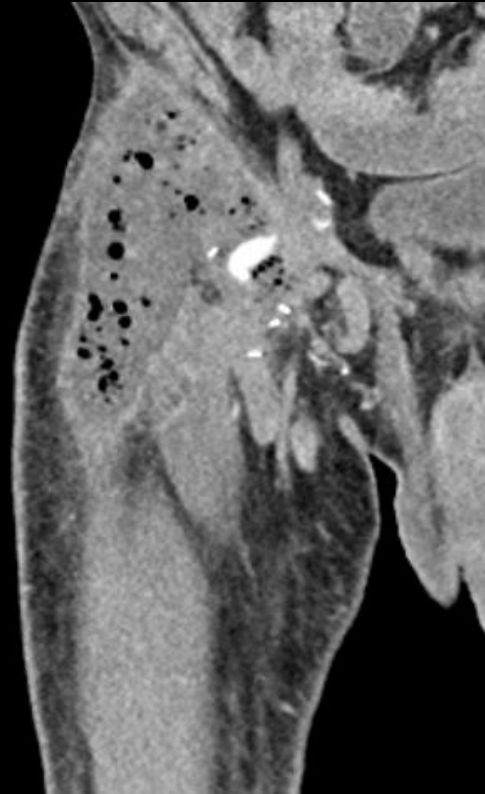
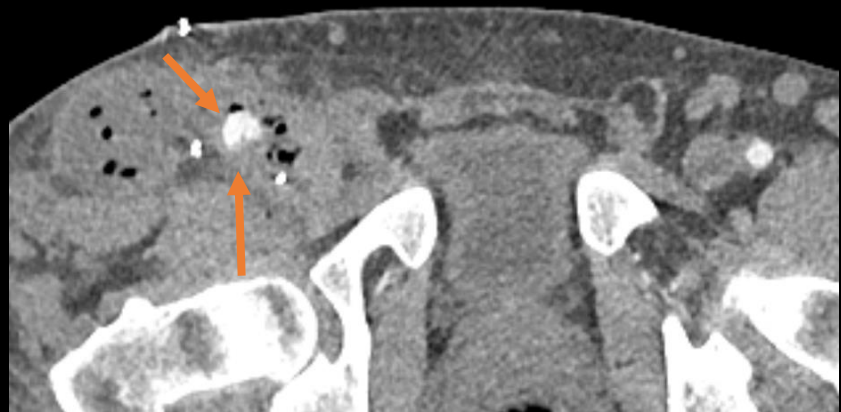
RT EIV



49 y/o w/ hx of bipolar disorder and drug abuse with a painful pulsatile R groin mass.

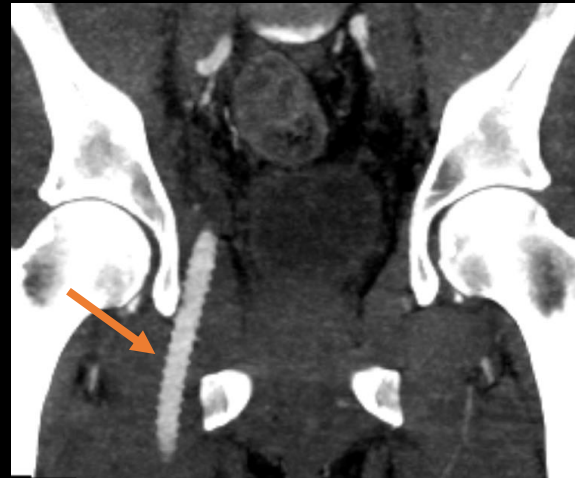
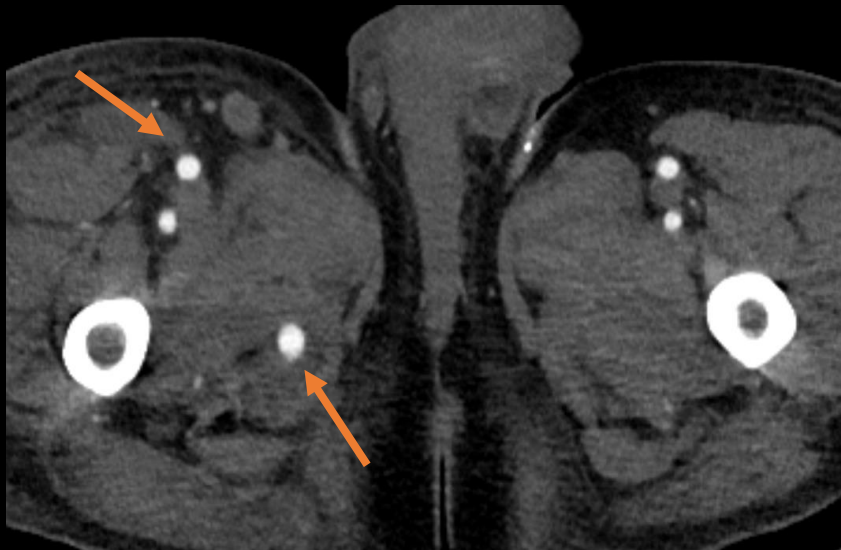
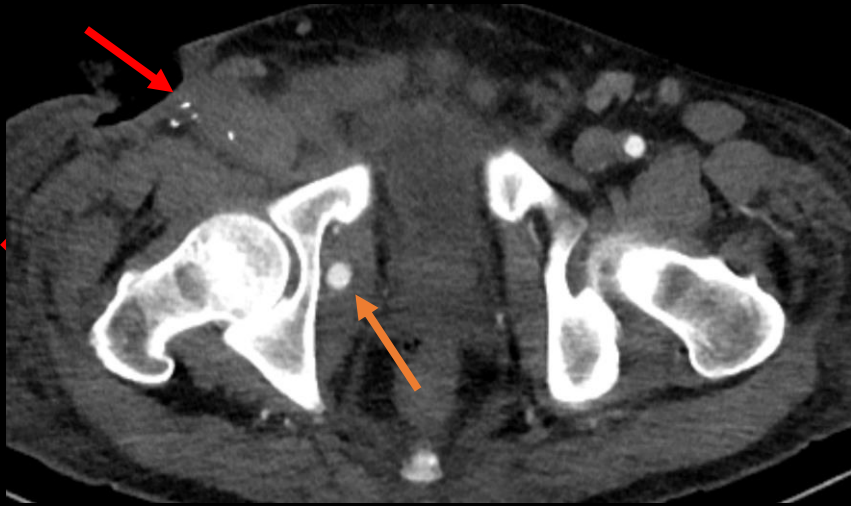
Treated with open repair and Dacron graft

Dacron Graft Infection - Abscess



49 y/o returns two weeks after discharge with a painful R groin mass and fever.

Debridement + CFA ligation and SFA bypass



Take Home Points

- CTA of the LE is the study of choice for the evaluation of **claudication, acute limb ischemia, chronic limb ischemia, vascular trauma and vascular treatment complications** in the ER setting.
- Knowledge of the **vascular anatomy, imaging findings, prior treatment history** are key for accurate diagnosis and adequate characterization of LE arterial diseases.
- The use of structured reports for CTA of LE should be encouraged. It offers superior clarity, completeness, clinical relevance, and usefulness for the treatment team.

Thank You!

