بسم الله الرحمن الرحيم

CT Angiography Signs of Lower Extremity Vascular Trauma

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Values

CT Angiography (CTA) of L.L. is

the *initial imaging examination of choice* in the diagnosis of vascular injury after trauma.

- increased availability.
- Short acquisition time. and
- high diagnostic accuracy of MDCT
- Regarding *osseous and soft-tissue* injuries and their relationship to the injured vessel.

- A scanning time: of less than 1 minute → allows to the diagnostic imaging algorithm without delaying patient treatment

Comparing CTA with conventional Angiography

- More accuracy,
- more time-efficient,
- less invasive, and
- Less expensive
- High sensitivity and specificity

- Clinical findings of vascular injury calcified into:

soft signs

- Small stable *Hematoma,*
- unexplained *Hypotension*,
- Injury of related nerve,
- Proximity of an injury to a major vessel

Hard signs

- Absent or diminished *pulses*,
- Active *Hemorrhage*,
- Large expanding or pulsatile Hematoma,
- Bruit, thrill, or
- Distal *ischemia*.

Case Deal

- Presenting with *hard signs* →
  - ***proceed directly to operative management.***

  Or perform CTA in all patients who are sufficiently stable , *Because:*
- *It can be rapidly performed,*
- *Decreases diagnostic ambiguity,*
- *Provides valuable information to the vascular surgeon or interventionalist,→*
- *Avoids unnecessary intraoperative exploration,*
- *decreases procedure time.*

CTA Technique

- *IV Line*:
  - > 20-gauge and
  - preferably in the anticubital fossa,
  - or a central venous catheter that has been approved by the manufacturer for power injection,

- CTA protocols : *vary depending on*
  - the type of scanner, manufacturer, and institutional preferences;

we recommend working
with your scanner manufacturer
Applications specialist

64-MDCT protocol

parameters for lower extremity CTA trauma studies include :

- 120 kVp,
- 200–300 mAs,
- Collimation of 64 × 0.6 mm,
- gantry rotation speed of 0.37 second,
- pitch of 0.65,
- slice thicknes of 0.75–2 mm
- Reconstruction interval of 0.5–1 mm,
- B31 medium smooth reconstruction kernel.

Contrast

- 100 milliliters of iodinated IV contrast
- Rate of 3 mL/s,
- followed by a saline flush.
- Use contrast bolus tracking & trigger threshold of 100 HU,

The region of interest

- placed in the *upper abdominal aorta* ← if the abdomen and pelvis are also included.

Protocol Modifications

- The protocol can be modified for a specific site of injury.

For example,

if injury's *limited to the calf vessels*, → the region of interest for the bolus trigger could be placed in the *popliteal artery*, with scanning coverage limited to that level.

- *Un-enhanced*, *venous*, or *delayed phase* images → not routinely obtained in all patients, but do so in a selective manner.

CTA Image Analysis

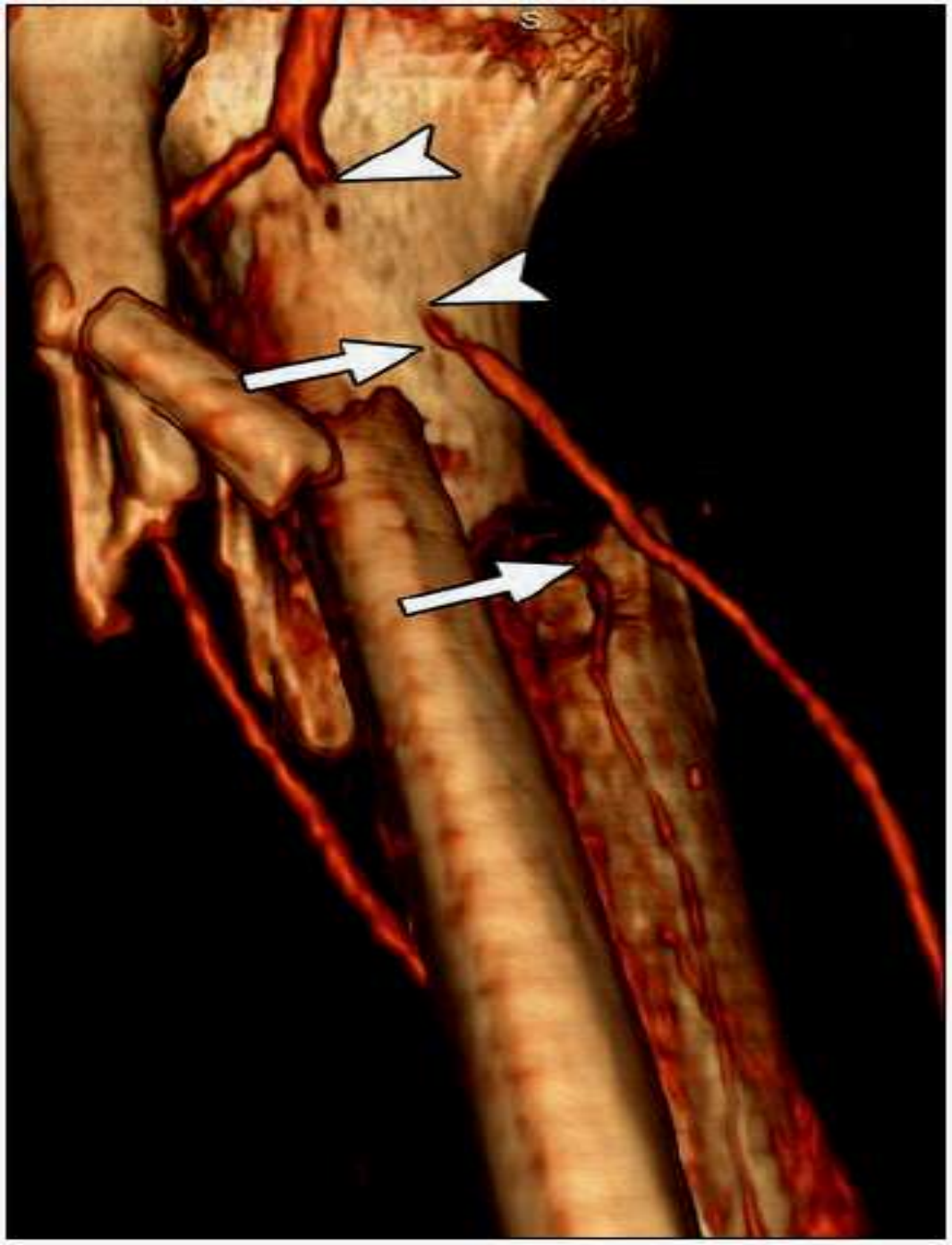
Depends mainly on:

1. careful analysis of the axial source images
2. interactive review of 2D multi planar reformations (MPRs).

is often necessary to
adequately discriminate between :
Contrast material, ***c***alcification,
Non-calcified plaque,
thrombus, a dissection flap,
& other vesselwall or lumen components.

CTA Signs of Lower Extremity Vascular Injury

- Active contrast extra-vasation,
- an extra-vascular contrast material– containing collection,
- loss of opacification or occlusion of an arterial segment,
- Abrupt vessel narrowing,
- Intra-luminal filling defect,
- Early venous opacification,
- Abnormal change in vessel caliber, contour, or course



A

B

Fiig.1 MCA - Lt L.L. Trauma , (CTA) images show

comminuted fractures of tibia and fibula and *lack of opacification of tibioperoneal* trunk (between *arrowheads,* **A**)

and proximal 3.5 cm of *peroneal artery* (between *arrows,* **A**).

1. Active Extra-vasation of contrast-

- Indicative of ongoing hemorrhage.
- *Manifests as* : an irregular blush of extra-luminal contrast material near the focal arterial mural disruption.
- It insinuate into adjacent soft tissues and muscles

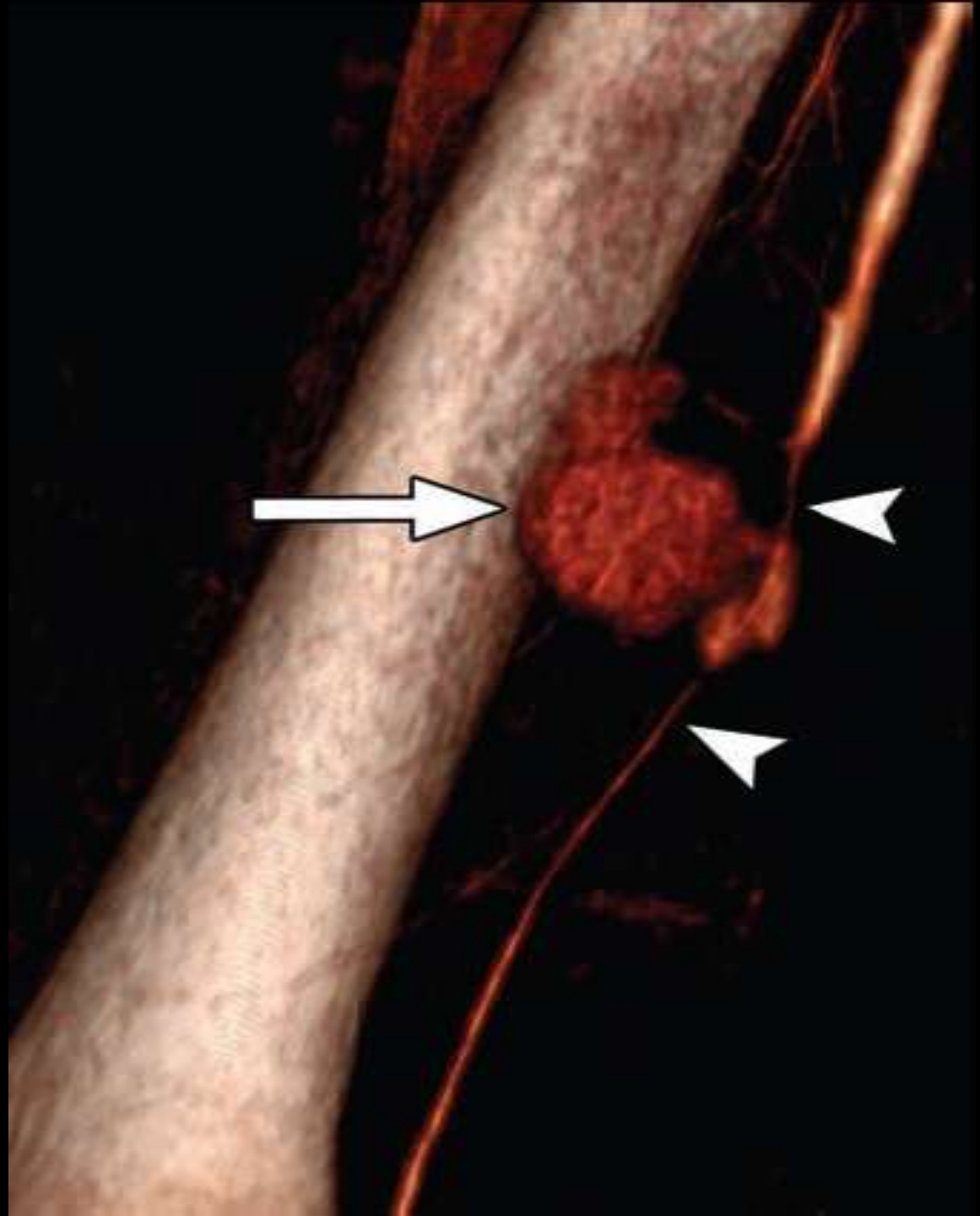


Fig. 3—15-year-old boy with gunshot injury to right thigh.

- ***At presentation:***, right popliteal, posterior tibial, and dorsalis pedis pulses were not palpable, and there were no Doppler signals.
- ***Volume-rendered CT angiogram*** at level of lower thigh shows: *segmental narrowing* (*arrowheads*) of superficial femoral artery and adjacent *active contrast extravasation*

(*arrow*).

- ***Surgical exploration*** found focal disruption of posterolateral aspect of *superficial femoral artery* just above adductor canal, spanning approximately 30% of vessel circumference and measuring 1.5 cm

in length.

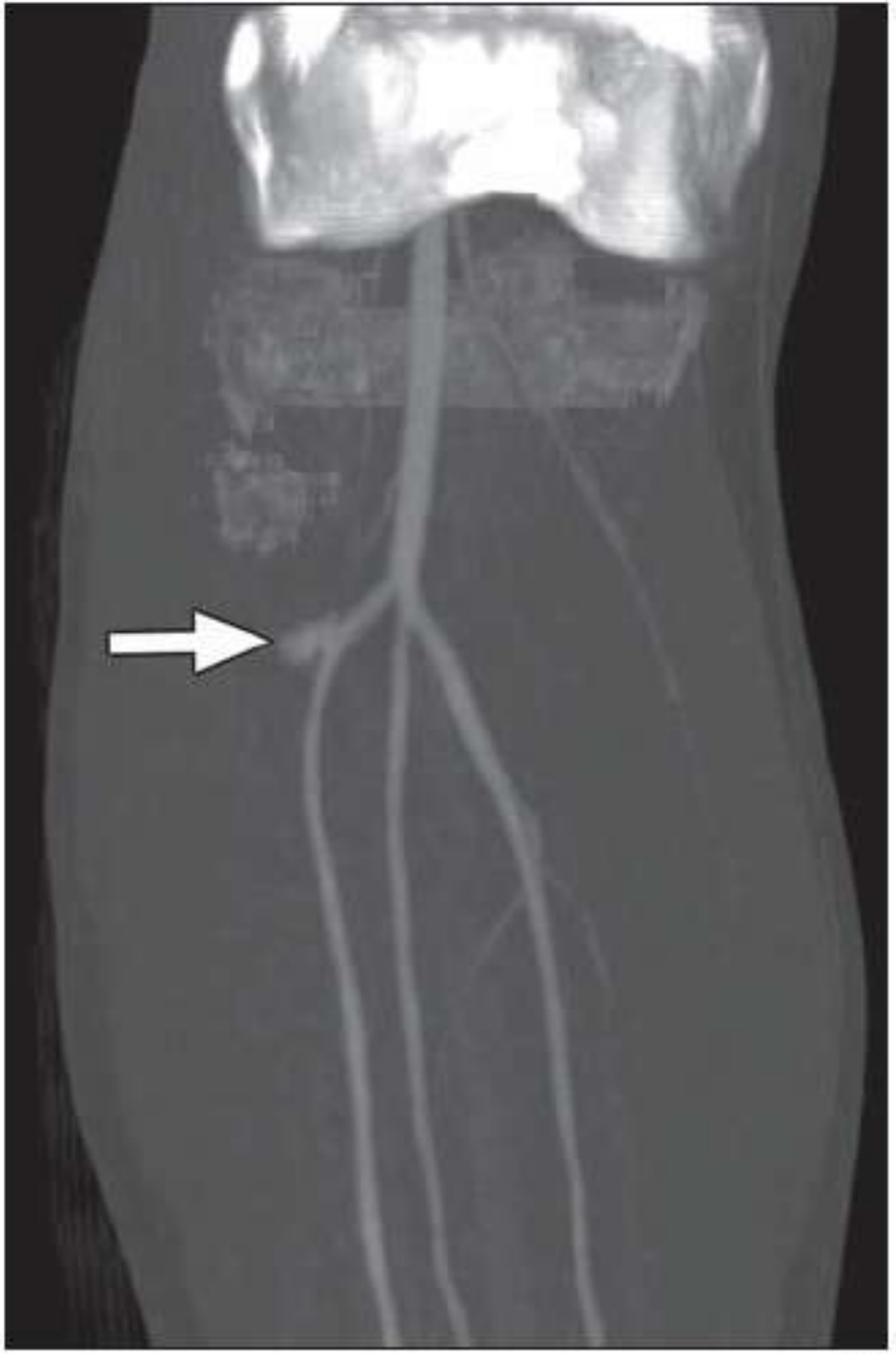
Small focal intimal injury at opposite side of vessel was also noted. Arterial débridement,

primary repair with sutures, saphenous vein patch, and thrombectomy were required. Large disruption of adjacent femoral vein was also surgically repaired, and four-compartment lower leg fasciotomies and thigh fasciotomy were performed because of high risk for compartment syndrome.

2. Pseudo-aneurysm formation

- A more organized extra-vascular contrast filled sac , connected to a vessel through a neck at a site of focal arterial wall discontinuity.

A



B

Fig. 4— 28-year-old man

- self-inflicted stab wound to right lower leg
- Pain and Bleeding but intact pulses.

and maximum-intensity-projection (**B**) CT (A) angiograms show :

➔ small pseudo-aneurysm (*arrow*) arising from (B) proximal anterior tibial artery.

- *Subsequent conventional arteriogram* : *confirmed pseudoaneurysm but also revealed arterio-venous fistula to anterior tibial vein.*
- *Endovascular repair was performed with placement of 6 × 25 mm covered stent in proximal anterior tibial artery.*

3. Vessel caliber Reduction

- It can indicate :
  - spasm,
  - Dissection, or
  - External compression.
- Lumen narrowing with irregular contour signifies a partial-thickness wall injury and thrombus.
- Caliber change can be subtle, especially

in the distal lower extremities, (*As native lumen normally tapers)*

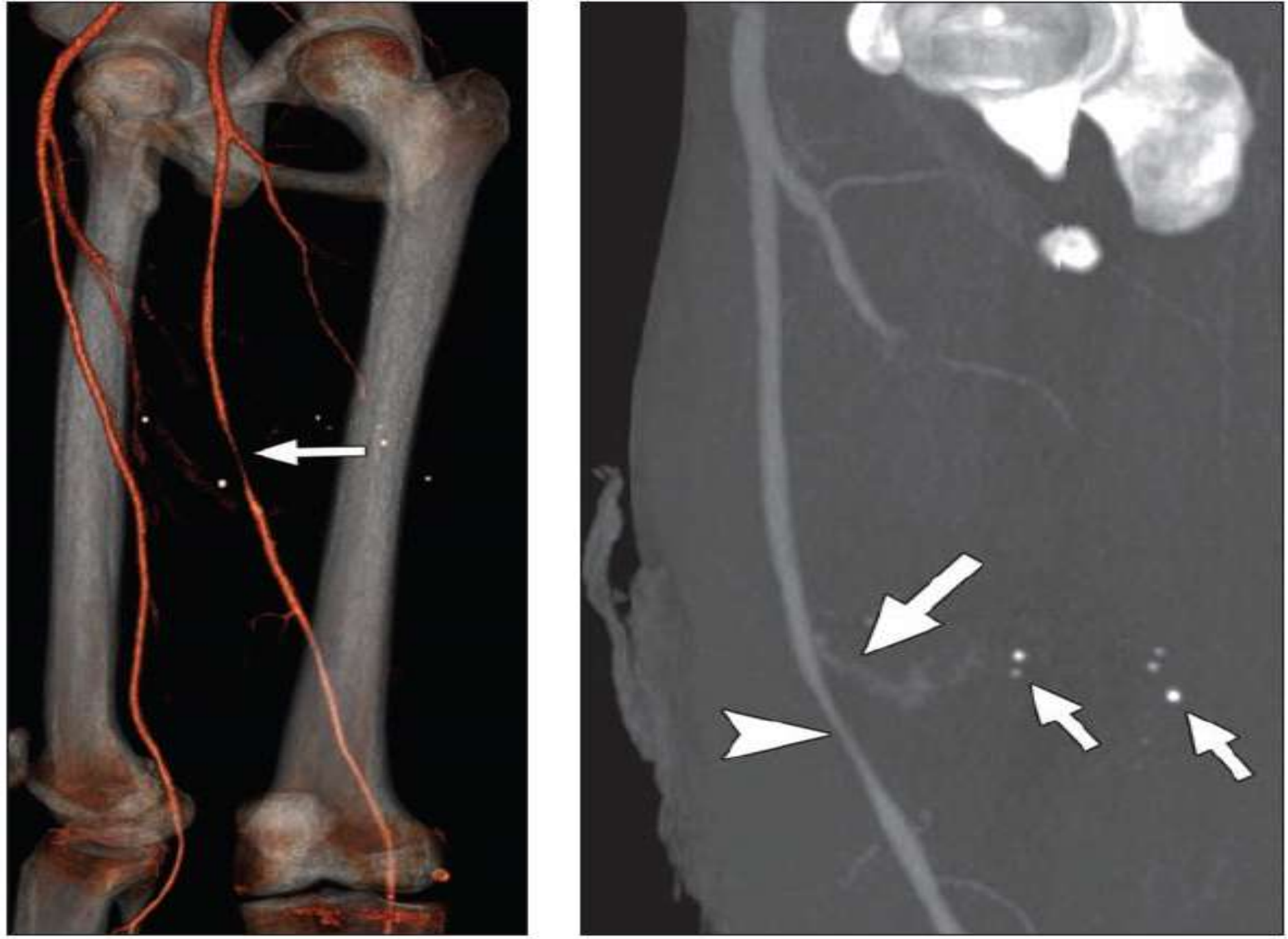

A
B

Fig. 2—18-year-old man , gunshot injury to left thigh,

- minimally palpable popliteal artery,
- and barely discernible Doppler signal in posterior tibial and dorsalis pedis arteries.

A, Oblique volume-rendered CT angiogram shows: ***segmental narrowing of lumen of*** left superficial femoral artery (*arrow*).

B, Sagittal maximum-intensity-projection CT angiogram reveals ***active contrast extravasation*** (*large arrow*) from posterior aspect of superficial femoral artery near upper margin of lumen narrowing (*arrowhead*).

- ***Small bullet fragments*** are also noted (*small arrows*).
- ***at surgery***: ***Small hole in superficial femoral*** artery wall measuring approximately 1 mm was discovered and repaired primarily with sutures.

Complete ***transection*** of adjacent ***femoral vein*** was also found, with 2.5-cm-long defect that was repaired with saphenous vein interposition graft.

4. Segmental vessel occlusion

- Due to Arterial trans-section and complete rupture.
- Injuries that result in vessel narrowing can also → cause or progress to

lack of lumen opacification and segmental occlusion

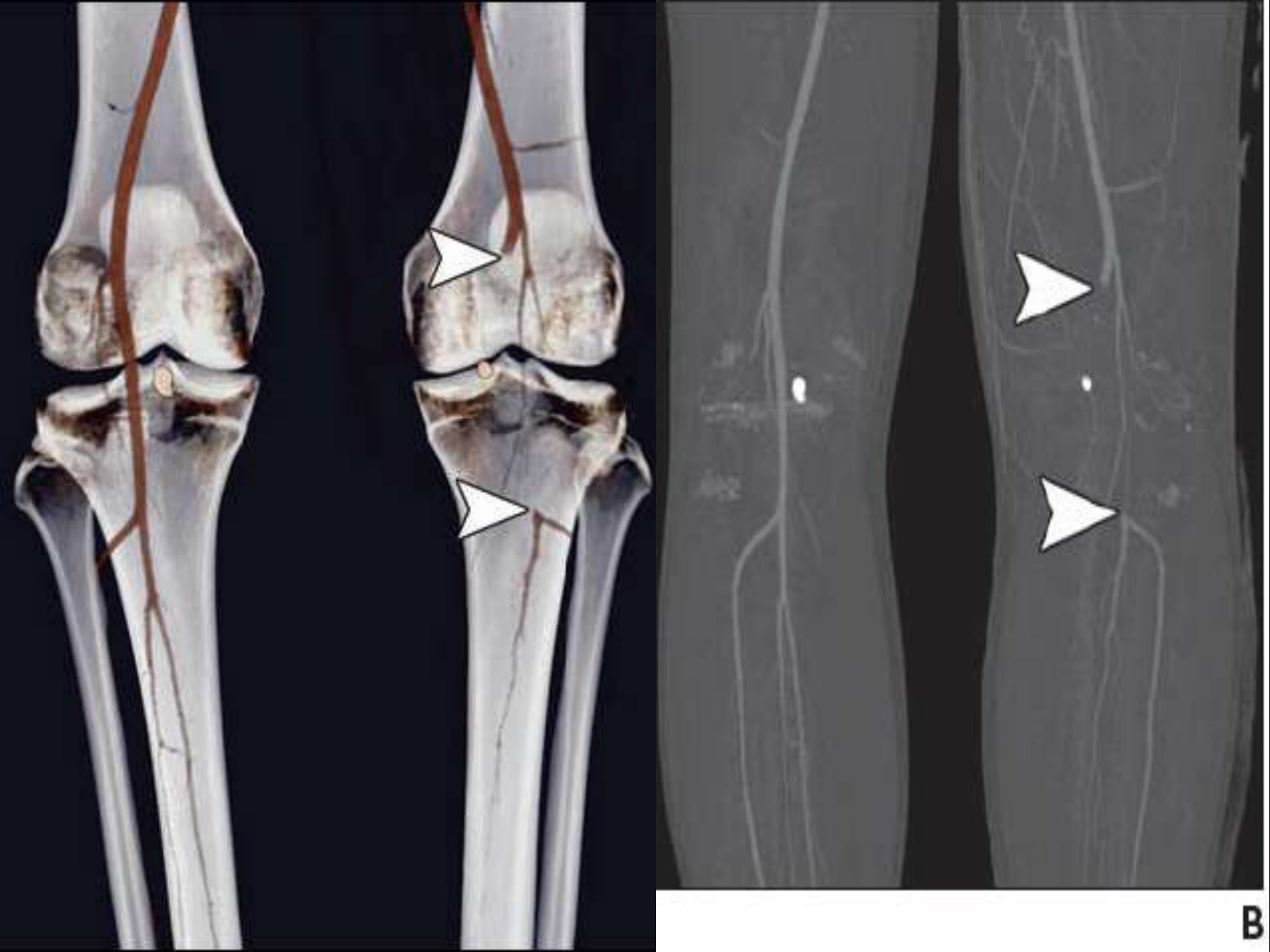

B

Fig. 7—39-year-old man who sustained posterior

right knee dislocation during fall from ladder.

CT angiograms show :

Abrupt segmental occlusion of right popliteal artery (between *arrowheads*).

- At surgery : *Complete transection* of popliteal artery was found.
- Repair was performed with saphenous vein interposition and two-compartment anterolateral fasciotomy.

5. Intra-luminal filling defect

- It can represent:

thrombus or *intimal flap*,

- Intimal Flap appears linear and denoting the presence of a localized dissection
- However, dissection can also appear as :
  - Semi-lunar lumen deformation,
  - Eccentric stenosis, or
  - Segmental thrombotic occlusion.

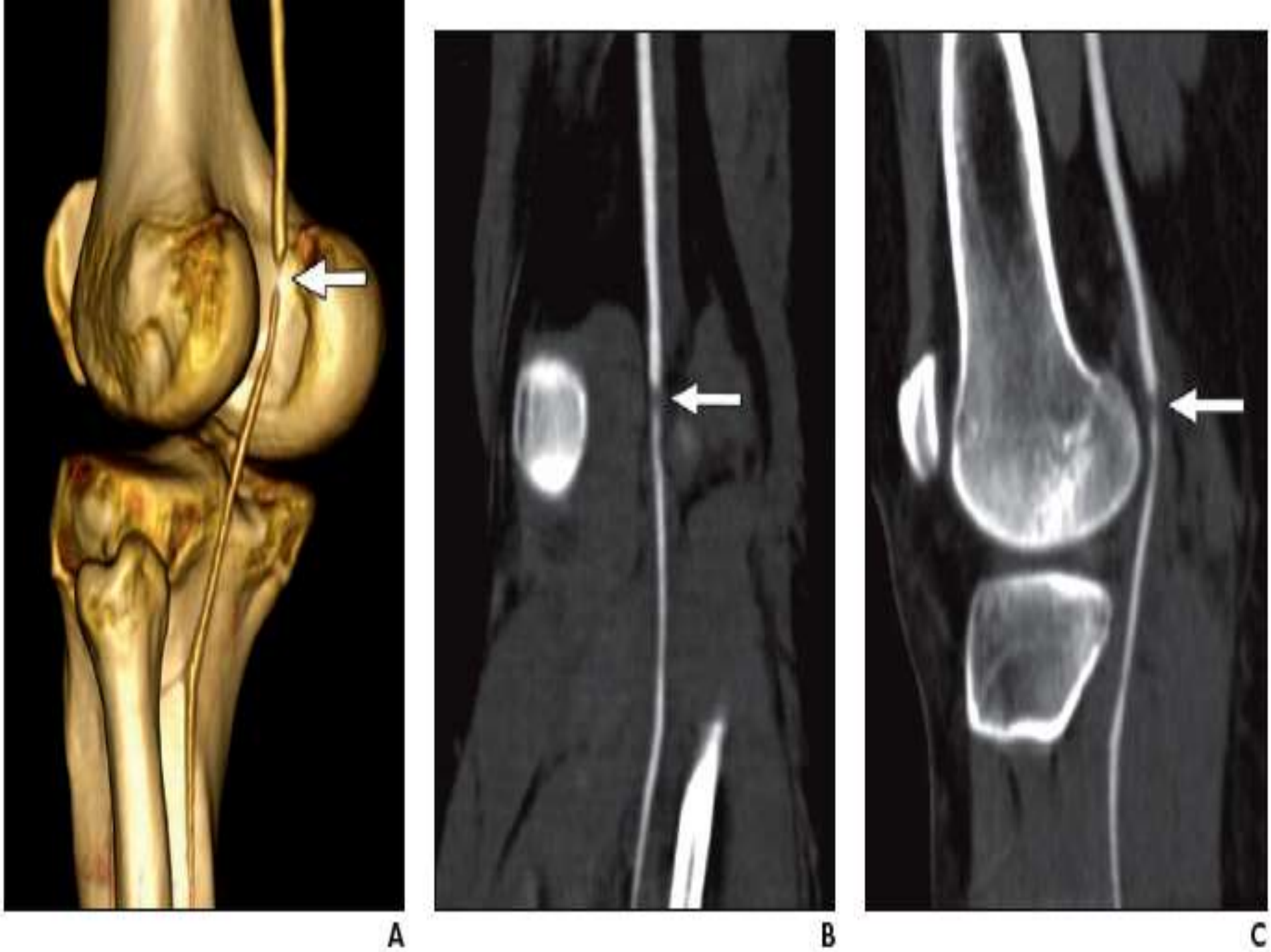

A
B
C

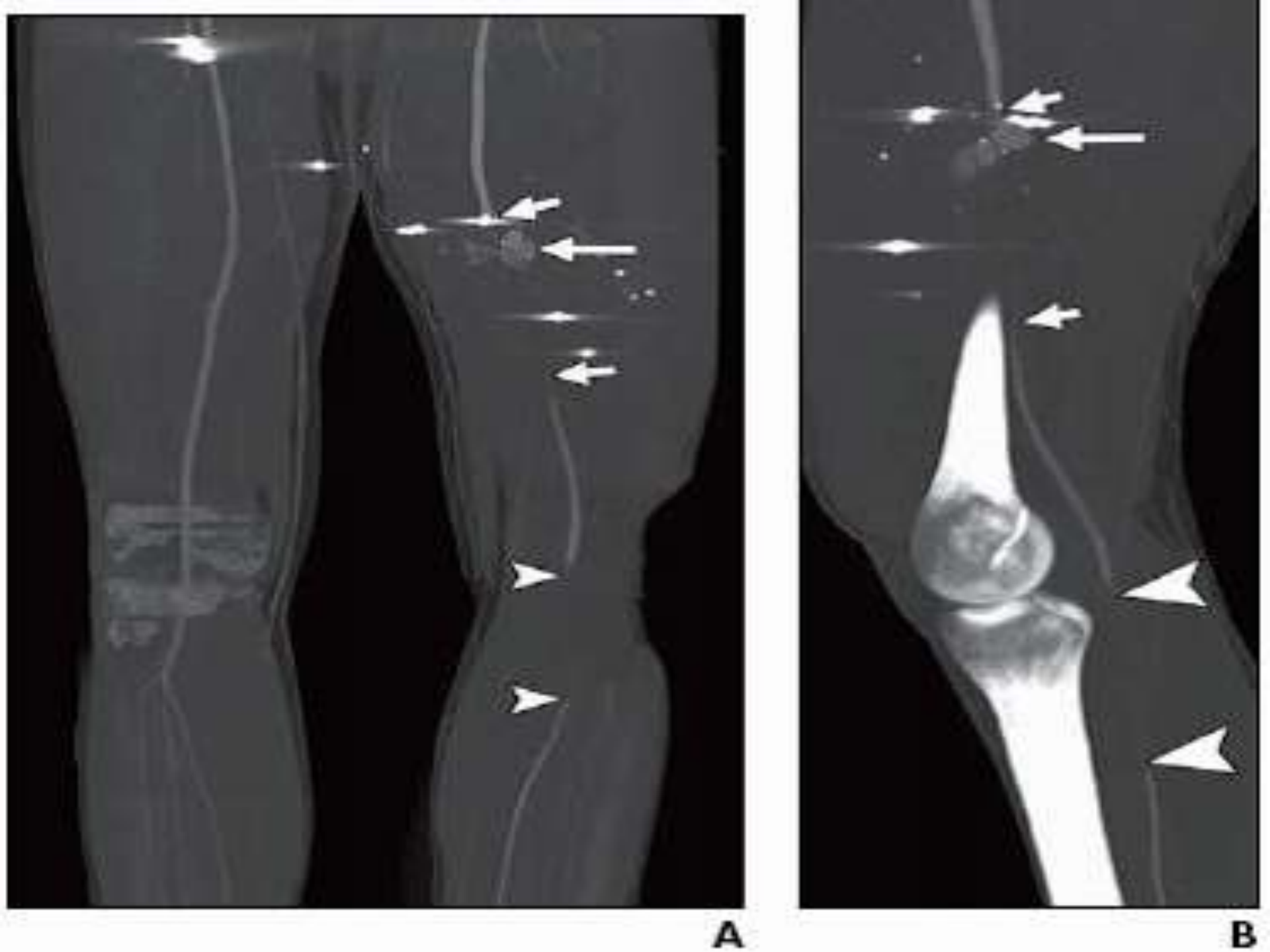
Fig. 8— 24-year-old woman , FFH, and sustained fractures to pelvis and left foot as well as left posterior knee dislocation.

A, Volume-rendered CT angiogram shows:

focal lumen narrowing of left popliteal artery (*arrow*).

B and **C,** Coronal (**B**) and sagittal (**C**) curved planar reformations reveal *focal lumen narrowing* and *filling defect* in popliteal artery (*arrow*).

➔ ***Intimal flap*** was found in *popliteal artery* at site of CT angiography abnormality during surgical exploration and was repaired with sutures and saphenous vein patch.


A
B

- **Fig. 9—**31-year-old man with gunshot wound to left lateral thigh,
- Cool lower leg, and no palpable distal pulses or Doppler signals.
- CT angiograms show :
  - active contrast extra-vasation (*long arrow*)
  - Segmental lack of opacification of *left superficial femoral artery* (between *short arrows*) at site of gunshot injury.
  - note *segmental lack of opacification* of ***popliteal artery*** (between *arrowheads*) further distal due to ← downstream "***thrombo-embolism"*** from superiorly located superficial femoral artery injury, followed by opacification of ***posterior tibial artery*** only.

6- Embolism

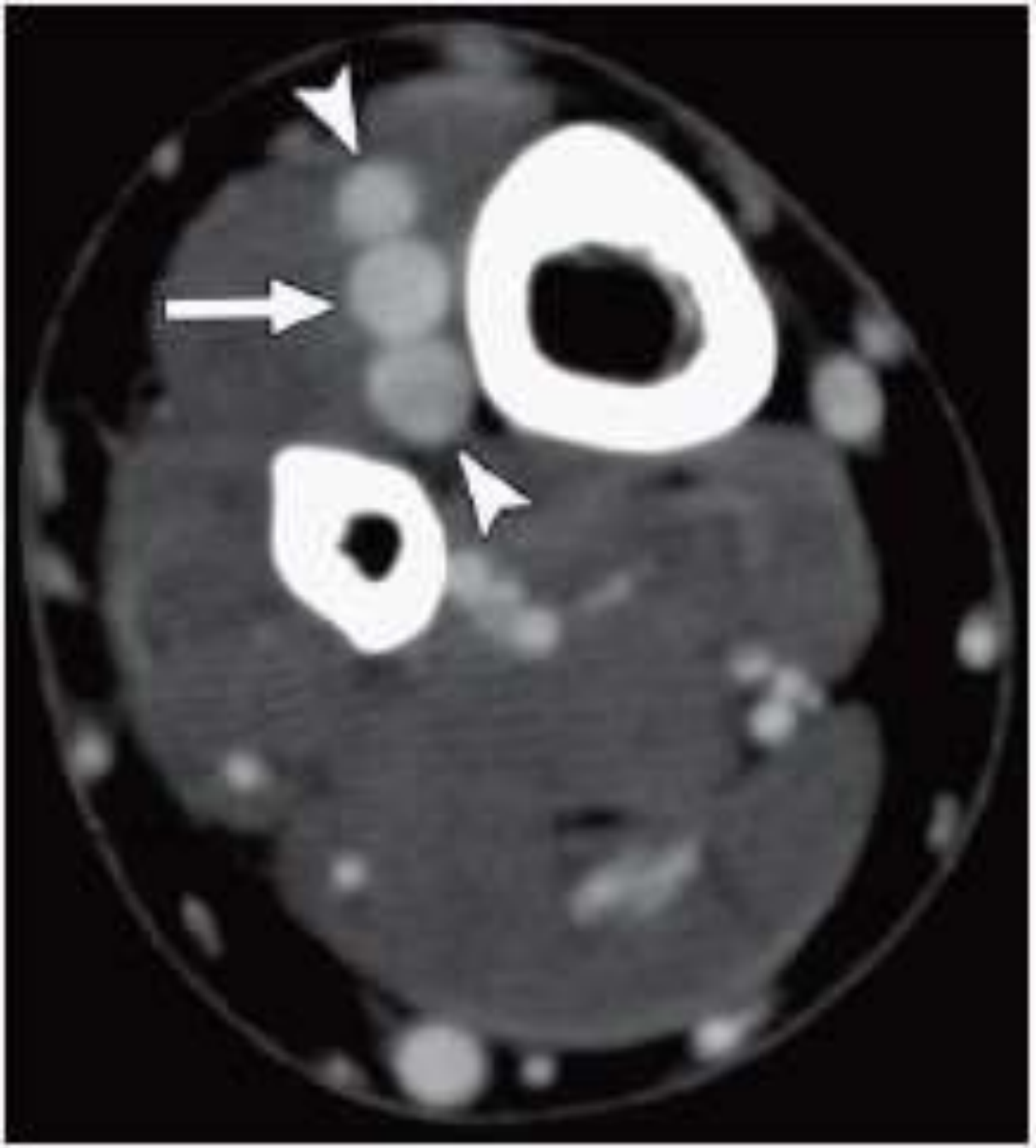
Arterial injury not only can result in *thrombus at the site* of injury

but also can cause *thrombo-embolism*

further downstream

7- AV Fistula

- *Early venous enhancement* on properly timed arterial phase CTA → should prompt evaluation for posttraumatic *arteriovenous fistula*.
- It may be accompanied e :
  - increase in size or caliber of the veins esp. if the fistula is sub-acute to chronic.



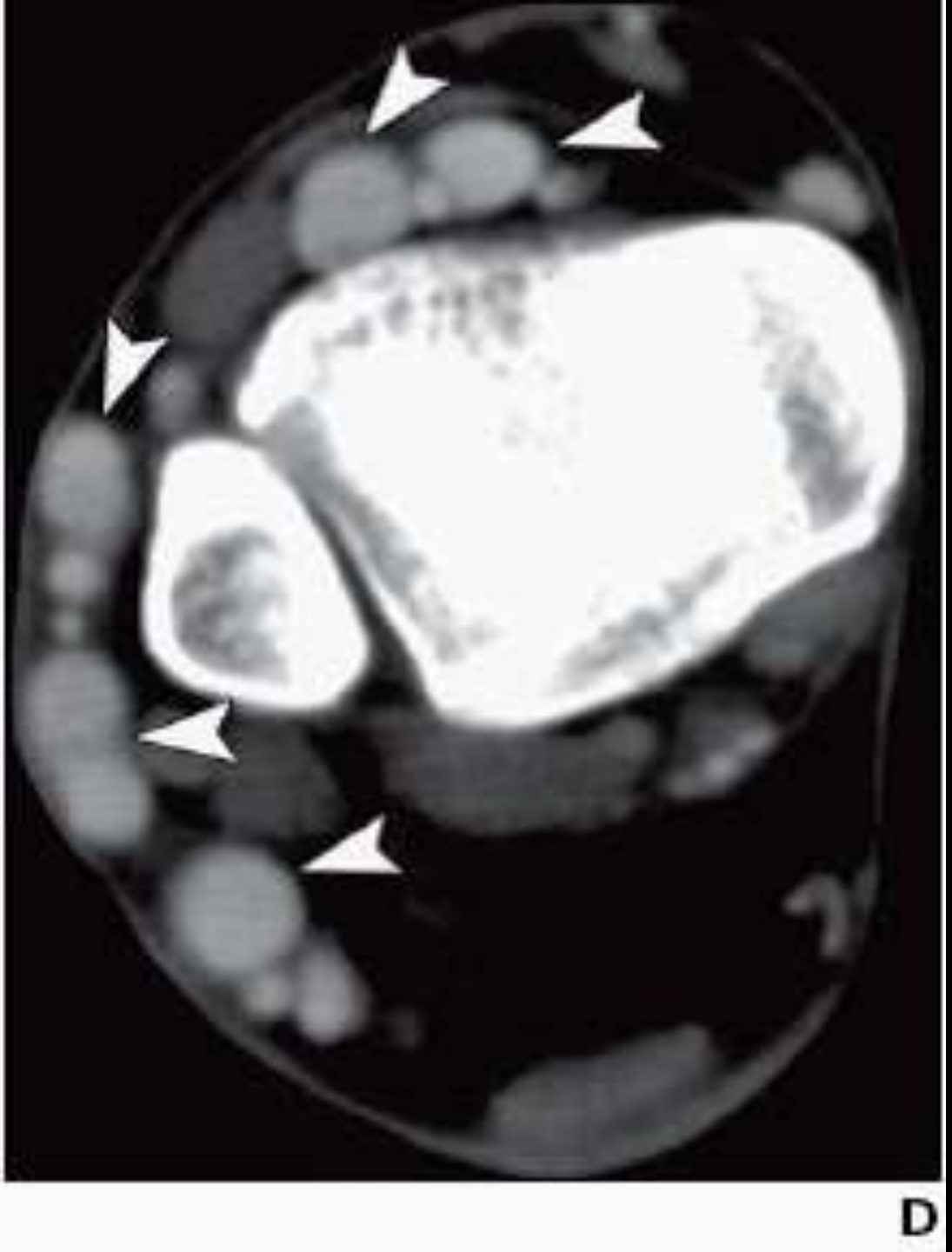
A, Transverse CT angiogram reveals: enlarged anterior tibial artery (*arrow*) and enlarged anterior tibial veins (*arrowheads*).

B

B, *Arteriovenous fistula* is shown: direct communication between anterior tibial artery and vein (*arrow*). Note adjacent retained BB pellet (*arrowhead*).

C

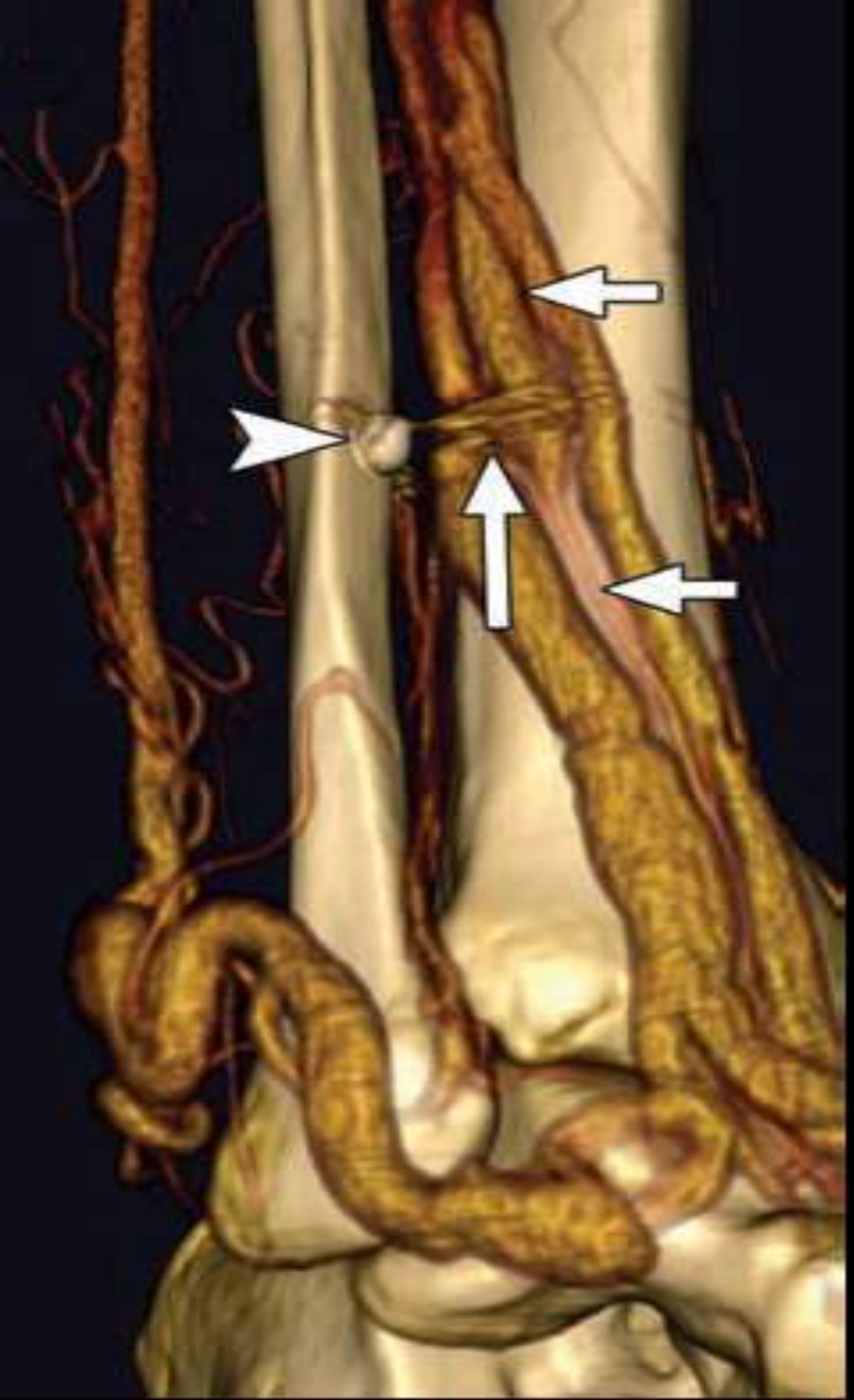
C, Transverse CT angiogram reveals anterior tibial artery (*arrow*) to be much smaller distal to level of arterio-venous fistula and dilation of anterior tibial veins (*arrowheads*).



D

D, Numerous other dilated veins are shown near ankle (*arrowheads*) as result of **arteriovenous fistula.**

E, Volume-rendered CT angiogram shows dilated superficial veins (*arrowheads*).



G, Volume-rendered CT angiogram shows :

•arteriovenous fistula between anterior tibial artery and vein (*long arrow*)

•as well as adjacent retained BB pellet (*arrowhead*).

Some linear striations at site of fistula are due to streak artifact from BB pellet.

• **Anterior tibial artery** is enlarged above level of arteriovenous fistula and much smaller
distal to fistula (*short arrows*).

•**Dilated veins** are shown alongside anterior tibial artery and elsewhere.

•***Arteriovenous fistula*** was confirmed at surgery and repaired using minimally invasive procedure with CT angiography guiding surgical approach.

In some instances,

the exact site and nature of communication between the *artery and vein* are incompletely defined by CTA → require conventional catheter angiography.

Primary venous abnormalities and ***I***nfection
should be excluded
as potential causes for
dilated veins or asymmetric avid venous enhancement
in the lower extremities
before
Attributing their presence to an arterio-venous
fistula.

N.B.

venous injury adjacent to an abnormal artery *is occult on CTA* when only arterial phase images are obtained,

so venous injuries are often discovered at the time of surgical exploration.

Collaterals

The occlusion can vary in length, with reconstitution further distally via *collaterals.*

- The collateral difficult to identify in the *acute trauma,*
- unlike *atherosclerosis*, in which

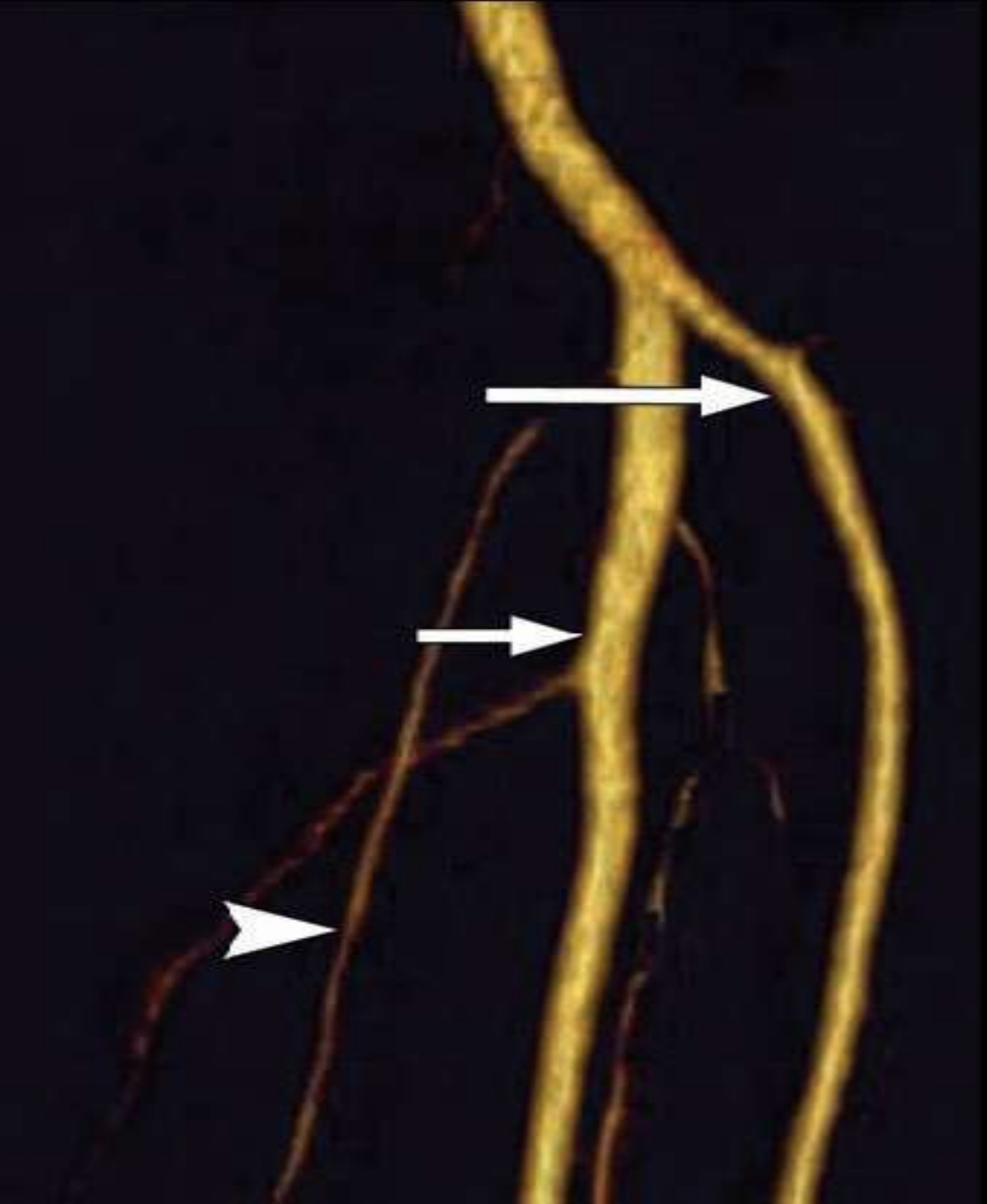
they are typically **larger** and **more** readily **visible**.

CTA Pitfalls

1. suboptimal contrast attenuation in the vessel lumen,
2. incomplete vessel opacification because of discrepancy between transit of the contrast bolus and timing of the image acquisition, and
3. vessel under-filling from slow flow as a result of injury further upstream.

Other variables that can confound or hinder accurate interpretation

1. Vessel spasm,
2. Anatomic variants,
3. Underlying atherosclerosis,
4. Displaced fracture fragments,
5. Artifacts from metal, foreign bodies
6. Patient motion or positioning constraints



show
•normal Anterior tibial artery (*long arrow*),
•Small-caliber posterior tibial artery (*arrowhead*),
and
•Enlarged peroneal artery (*short arrow*)
based on *developmental normal anatomic variant* rather than vascular injury.

Artifact from calcified plaque

- may obscure the vessel lumen.
- Result in stenosis over-estimation.
- Can be minimized by :
  - reducing partial volume averaging,
  - Selecting the *thinnest possible slice* thickness for reconstructing the initial transverse images .
  - Using wide window and level settings.

CONCLUSION

- CTA is efficient and accurate in the evaluation of clinically significant lower extremity arterial injuries after trauma.
- Additional information regarding osseous and soft-tissue injuries can also be routinely obtained.

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THANK YOU