Retrograde approach

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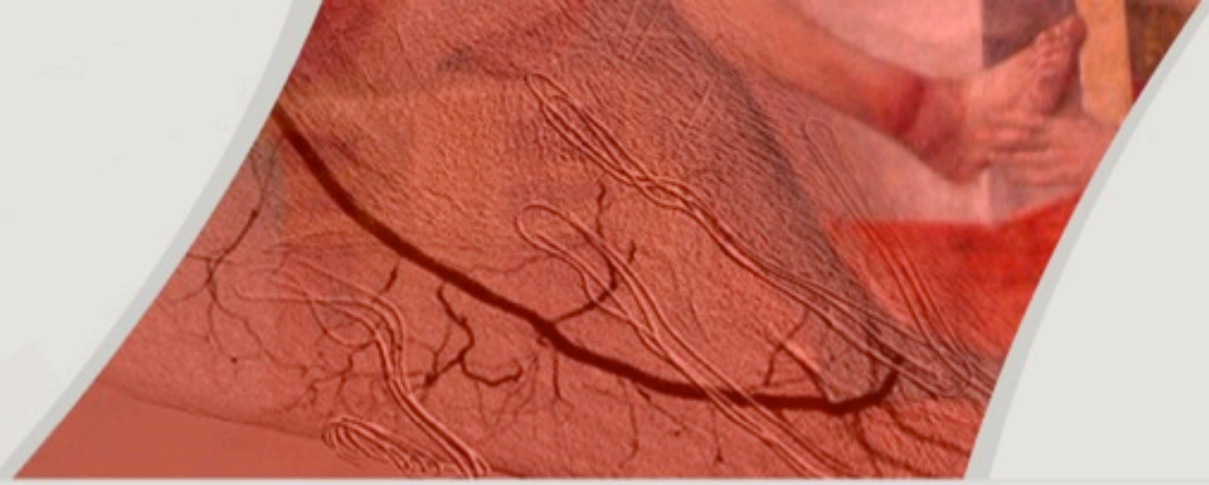
Retrograde approach



Rationale

Clinical Experience–Milan 2010-2014

Retrograde Puncture - Key Points

- Case 1
- Case 2
- Case 3
- Case 4
- Case 5
- Case 6
- Case 7
- Case 8

Transcollateral

The pedal-plantar loop technique

- Loop Case 1
- Loop Case 2
- Loop Case 3
- Transcoll Case 1
- Transcoll Case 2
- Transcoll Case 3

Retrograde approach: rationale

Reasons for unsuccessful antegrade approach:

1) Inability to correctly identify the origin of an occluded tibial artery.

2) Rupture or loss of the antegrade vessel pathway.

3) Inability to re-enter into the true distal patent lumen due to limited distal "landing" zone or vessel calcification.

4) High risk of damaging the distal target vessel when continuing the antegrade subintimal dissection, which could be the only landing zone for a distal bypass.

Retrograde approach: essential bibliography

1. Montero-Baker M, Schmidt A, Bräunlich S, Ulrich M, Thieme M, Biamino G et al. Retrograde approach for complex popliteal and tibioperoneal occlusions. J Endovasc Ther 2008;15:594-604.

2. Manzi M. Palena LM, Cester G. Endovascular techniques for limb salvage In diabetics with crural and pedal disease. J Cardiovasc Surg 2011;52:485-492.

3. Graziani L, Silvestro A. Alternative approaches in critical limb ischemia. Clin Vision 2006;17:2-7.

4. Spinosa DJ, Leung DA, Hathun NL, et al. Simultaneous antegrade and retrograde access for subintimal recanalization of peripheral arterial occlusion. J Vasc Interv Radiol 2003;14:1449-54.

5. Spinosa DJ, Harthun NL, Bissonette EA, Cage D, Leung DA, Angle JF et al. Subintimal arterial flossing with antegrade–retrograde intervention (SAFARI) for subintimal recanalization to treat chronic critical limb ischemia. J Vasc Interv Radiol 2005;16:37-44.

6. Gandini R, Pipitone V, Stefanini M, et al. The ''Safari'' technique to perform difficult subintimal infragenicular vessels. Cardiovasc Intervent Radiol 2007;30:469-73.

7. Fusaro M, Dalla Paola L, Biondi-Zoccai G. Pedal-plantar loop technique for a challenging below-the-knee chronic total occlusion: a novel approach to percutaneous revascularization in critical lower limb ischemia. J Invasive Cardiol 2007;19:34-7.

8. Manzi M, Fusaro M, Ceccacci T, Erente G, Dalla Paola L, Brocco E. Clinical results of below-the knee intervention using pedal-plantar loop technique for the revascularization of foot arteries. J Cardiovasc Surg (Torino) 2009;50:331-7.

9. Graziani L, Silvestro A, Monge L, Boffano GM, Kokaly F, Casadidio I et al. Transluminal angioplasty of peroneal artery branches in diabetics: initial technical experience. Cardiovasc Intervent Radiol 2008;31:49-55.

1. Fusaro M, Agostoni P, Biondi-Zoccai G. "Trans-collateral" angioplasty for a challenging chronic total occlusion of the tibial vessels: a novel approach to percutaneous revascularization in critical lower limb ischemia. Catheter Cardiovasc Interv 2008;71:268-72.

2. Graziani L, Morelli LG. Combined retrograde-antegrade arterial recanalization through collateral vessels: redefinition of the technique for below-the-knee arteries. Cardiovasc Intervent Radiol 2011;34(suppl 2):S78-82.

3. Fusaro M, Dalla Paola L, Biondi-Zoccai G. Retrograde posterior tibial artery access for below-the-knee percutaneous revascularization by means of sheathless approach and double wire technique. Minerva Cardioangiol 2006;54:773-7.

4. Fusaro M, Tashani A, Mollicheli N, et al. Retrograde pedal artery access for below-the-knee percutaneous revascularisation. J Cardiovasc Med 2007;8:216-8.

5. Fanelli F, Lucatelli P, Allegritti M, Corona M, Rossi P, Passariello R Retrograde popliteal access in the supine patient for recanalization of the superficial femoral artery: initial results. J Endovasc Ther 2011;18:503-9.

6. Manzi M, Palena LM. Retrograde percutaneous transmetatarsal artery access: new approach for extreme revascularization in challenging cases of critical limb ischemia. Cardiovasc Intervent Radiol 2013;36:554-7.

7. Palena LM, Manzi M. Extreme below-the-knee interventions: retrograde transmetatarsal or transplantar arch access for foot salvage in challenging cases of critical limb ischemia. J Endovasc Ther 2012;19:805-11.

8. Palena LM, Brocco E, Manzi M. The clinical utility of below-the-ankle angioplasty using "transmetatarsal artery access" in complex cases of CLI. Catheter Cardiovasc Interv 2013. doi: 10.1002/ccd.24992. [Epub ahead of print]

Retrograde approach: Milan experience 2010-2013

1,473 pts

- Rutherford 4-5-6
- 85% diabetes mellitus
- 19% ESRD-HD
- Mean age 71 ± 14.3 yrs
- Only below-the-groin vessels

2,063 PTA

3,351 succesfully treated lesions

1,943 (58%) stenosis
mean length
11,6 ± 10.9 cm
Standard endoluminal approach

1,408 (42%) CTOs
mean length
23.2 ± 11.7 cm

Retrograde approach: Milan experience 2010-2013

Step-by-step approach in CTOs

- **Antegrade approach**
  1. Endoluminal
  2. Subintimal

- **Retrograde puncture**
- **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

1,408 (42%) CTOs
mean length
23.2 ± 11.7 cm

Retrograde approach: Milan experience 2010-2013

Step-by-step approach in CTOs

- ❑ **Antegrade approach**
  1. Endoluminal
  2. Subintimal
- ❑ **Retrograde puncture**
- ❑ **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

ENDO successful
56% (792)

1,408 (42%) CTOs
mean length
23.2 ± 11.7 cm

Retrograde approach: Milan experience 2010-2013

Step-by-step approach in CTOs

- ❑ **Antegrade approach**
  1. Endoluminal
  2. Subintimal
- ❑ **Retrograde puncture**
- ❑ **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

ENDO successful
56% (792)

SUBI successful
34% (469)

1,408 (42%) CTOs
mean length
23.2 ± 11.7 cm

Retrograde approach: Milan experience 2010-2013

Step-by-step approach in CTOs

- ❑ **Antegrade approach**
  1. Endoluminal
  2. Subintimal
- ❑ **Retrograde puncture**
- ❑ **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

ENDO successful
56% (792)

SUBI successful
34% (469)

SUBI+RETRO successful
10% (147)

1,408 (42%) CTOs
mean length
23.2 ± 11.7 cm

Retrograde approach: the retrograde puncture

- ❑ **Retrograde puncture**
- ❑ **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

Retrograde approach: the retrograde puncture

KEY POINTS

- Direct percutaneous retrograde puncture of a distal patent vessel, followed by the insertion of wires and catheters to reach the proximal open lumen where the antegrade approach failed

- When both antegrade and retrograde devices are used, the procedure can continue with a standard antegrade angioplasty and hemostasis of the distal puncture site

- A retrograde puncture can be done in every segment of the below-the-groin (BTG) vessel, from the superficial femoral artery (SFA) to the foot vessels

Key points in retrograde puncture (1)

1. **Choice of the puncture site**

Accurate angiographic evaluation using different oblique views to identify the best target vessel.

2. **Vasodilators**

Especially for the distal vessels, the use of vasodilator (nitroglycerine, verapamil) to avoid spasm of the vessel. Vasodilators can be administered intra-arterially, as close as possible to the puncture site, and subcutaneously around the needle entry point.

3. **Puncture technique.**

- Puncture performed with a ***21 gauge needle***, under fluoroscopic guidance with contrast medium and maximum magnification. The length of the needle must be chosen according to the depth of the target vessel.
- ***Remember parallax technique***: the needle should be advanced by maintaining a perfect overlap with the target vessel.
- After the correct projection for the puncture has been chosen, a 90° angulated projection can be useful to check the distance from the needle to the target vessel.

Key points in retrograde puncture (2)

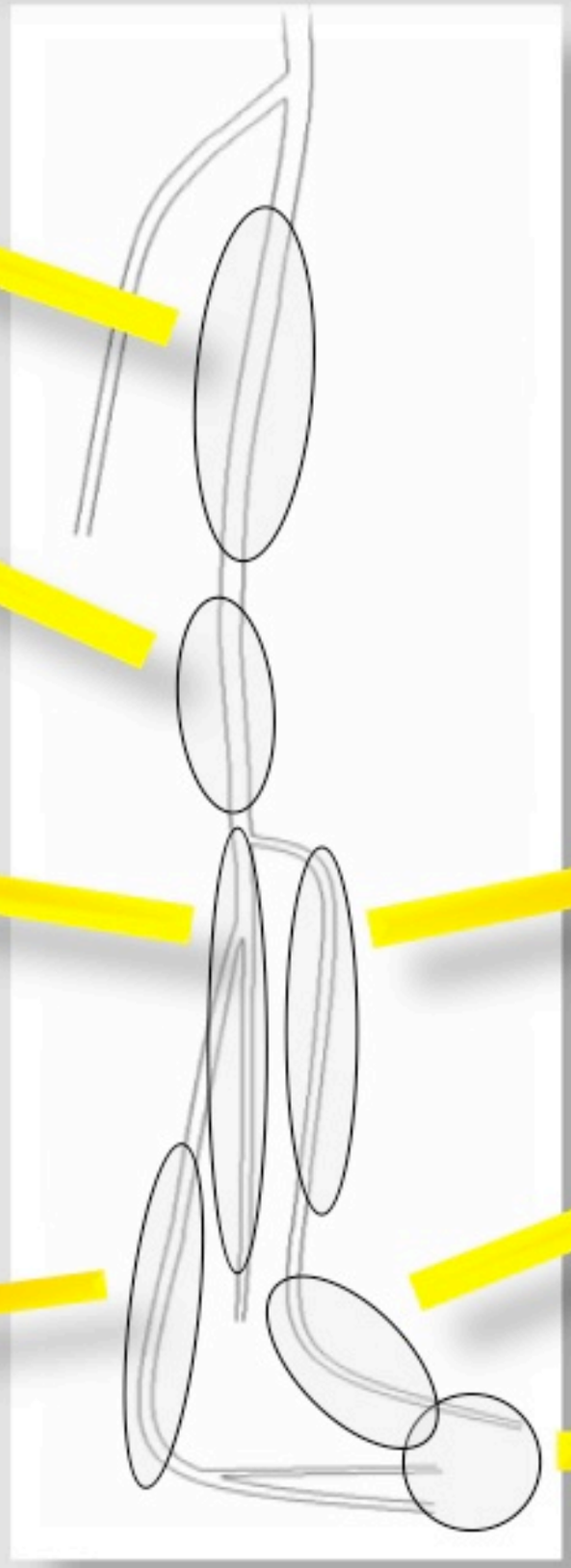
4. **Sheath**
   In the SFA and popliteal artery, a 4 Fr sheath is sometimes necessary to permit retrograde approach with the support of a 4 Fr catheter. In BTK vessels we prefer a sheathless approach or a microsheath.

5. **Retrograde crossing strategy**
   Every 0.014” and 0.018” wire can be used for retrograde crossing of the CTO. We prefer to start with a 0.018” wire, because of the enhanced support, but other types of wires can be selected. Low-profile, support catheters are very useful for wire support, orientation and exchange.

Key points in retrograde puncture (3)

Artery	Preferred oblique view	Preferred segment	Skin puncture site	Needle length
SFA	Controlateral, 30-45°	Distal	Medial aspect of the thigh at the level of the superior edge of the rotula	9-15 cm
Popliteal	Anteroposterior Maintain the supine position with the knee gently flexed and rotated	Medium-distal	Posterior aspect of the knee	7-9 cm
Anterior tibial	Homolateral 20°-40°	Every segment	Anterolateral aspect of the leg	4-7 cm
Posterior tibial	Lateral	Distal, retromalleolar segment, proximal plantar arteries	Medial aspect of the ankle	4-7 cm
Peroneal	Homolateral 20°-40°	Every segment	Anterolateral aspect of the leg; the needle crosses the interosseous membrane	7 cm
Dorsalis pedis	Anteroposterior	Every segment	Dorsum of the foot	4 cm
Foot arteries	Anteroposterior	First metatarsal artery Tarsal arteries Collaterals	Dorsum of the foot Plantar access is not practical because of skin thickness	4 cm

Retrograde approach: Milan experience 2010-2013



SFA 8% (12)

POP 5% (7)

TTP-PER 3% (5)

PT 15% (23)

OTHER 5% (7)

AT 13% (19)

PED 35% (51)

PED-PLANT LOOP 16% (23)

CASE 1 RETRO

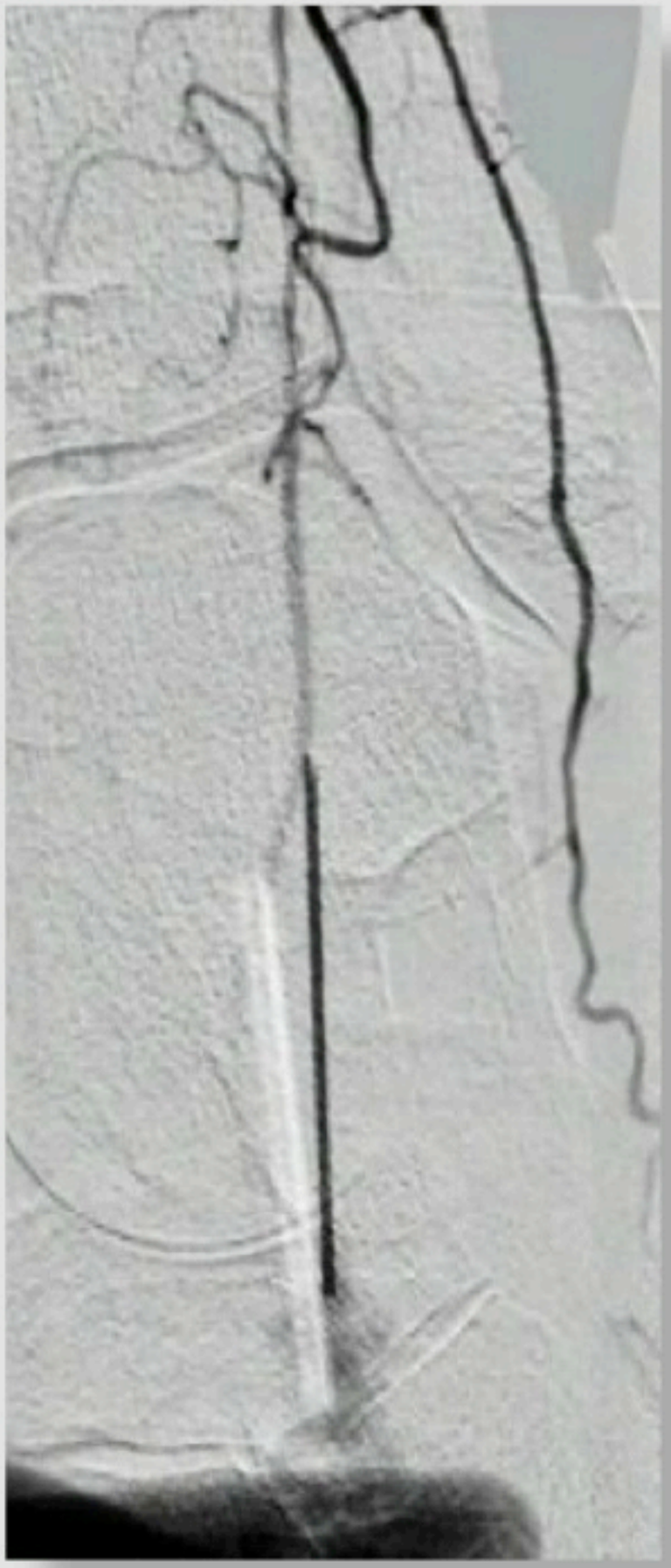
Why the retrograde approach?

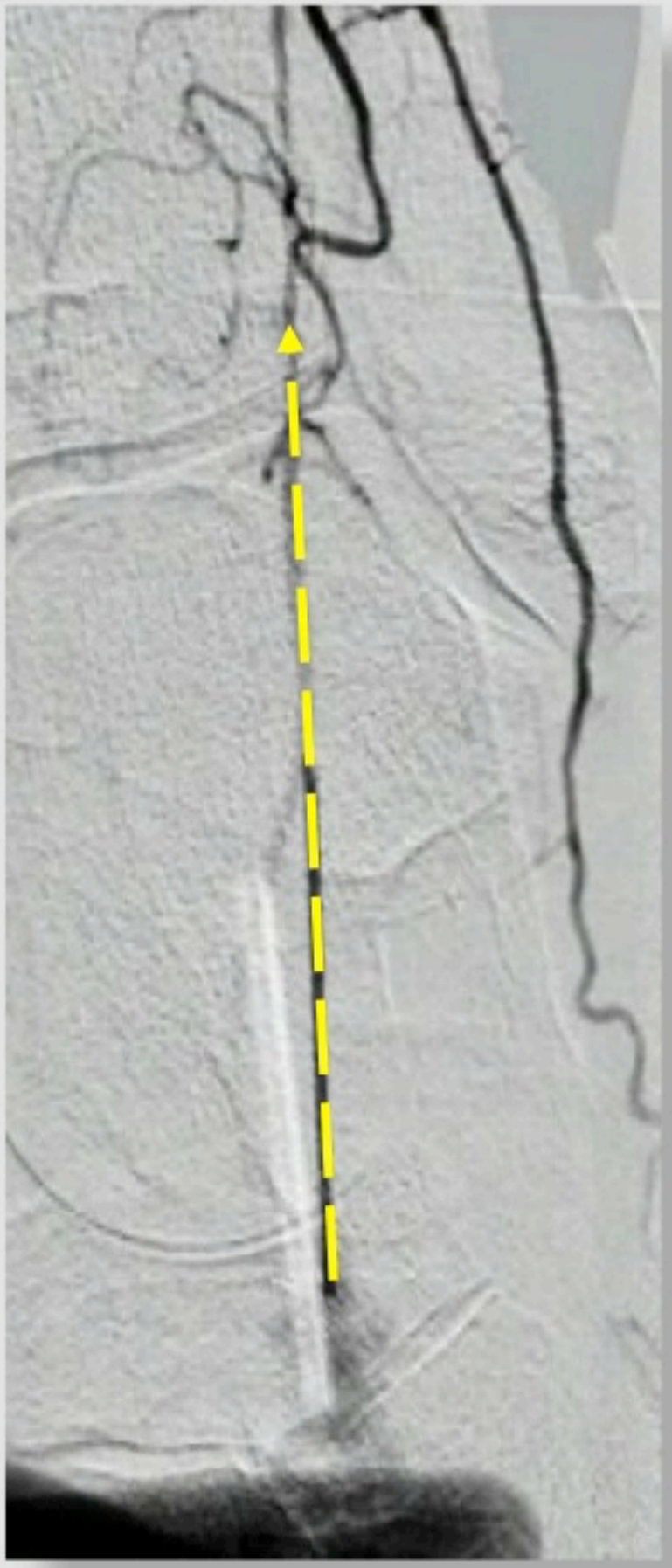
Failure of ATA antegrade approach due to perforation

Basal ANGIO

- Short occlusion of ATA
- Trying to cross the occlusion resulted in rupture of ATA with direct bleeding into the anterior muscular space of the leg
- A sphygmomanometer placed around the leg and inflated at the systolic pressure (4 minutes)

Dorsalis pedis puncture

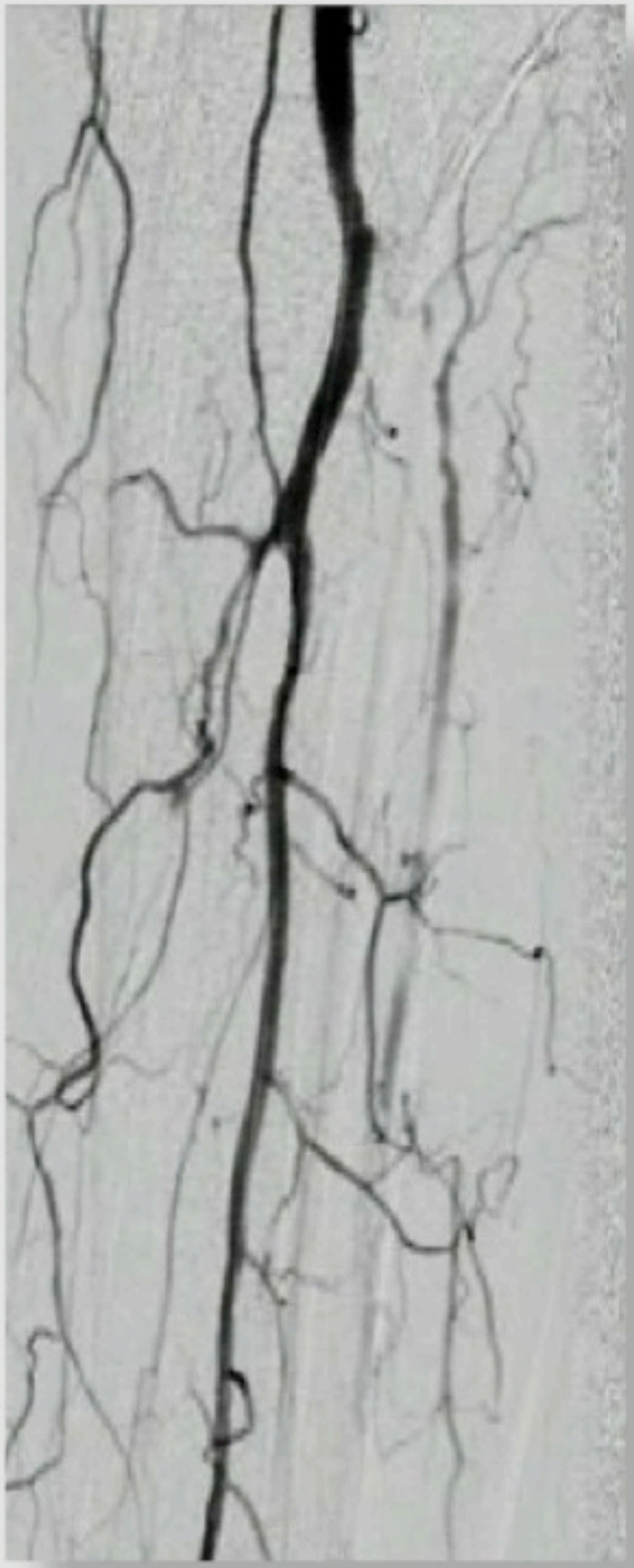




Parallax technique:

needle and artery perfectly aligned

Final result



CASE 2 RETRO

Why the retrograde approach?

Failure of PTA antegrade approach due to loss of the correct subintimal pathway

Basal ANGIO

- Complete occlusion of BTK vessels
- Good distal PTA

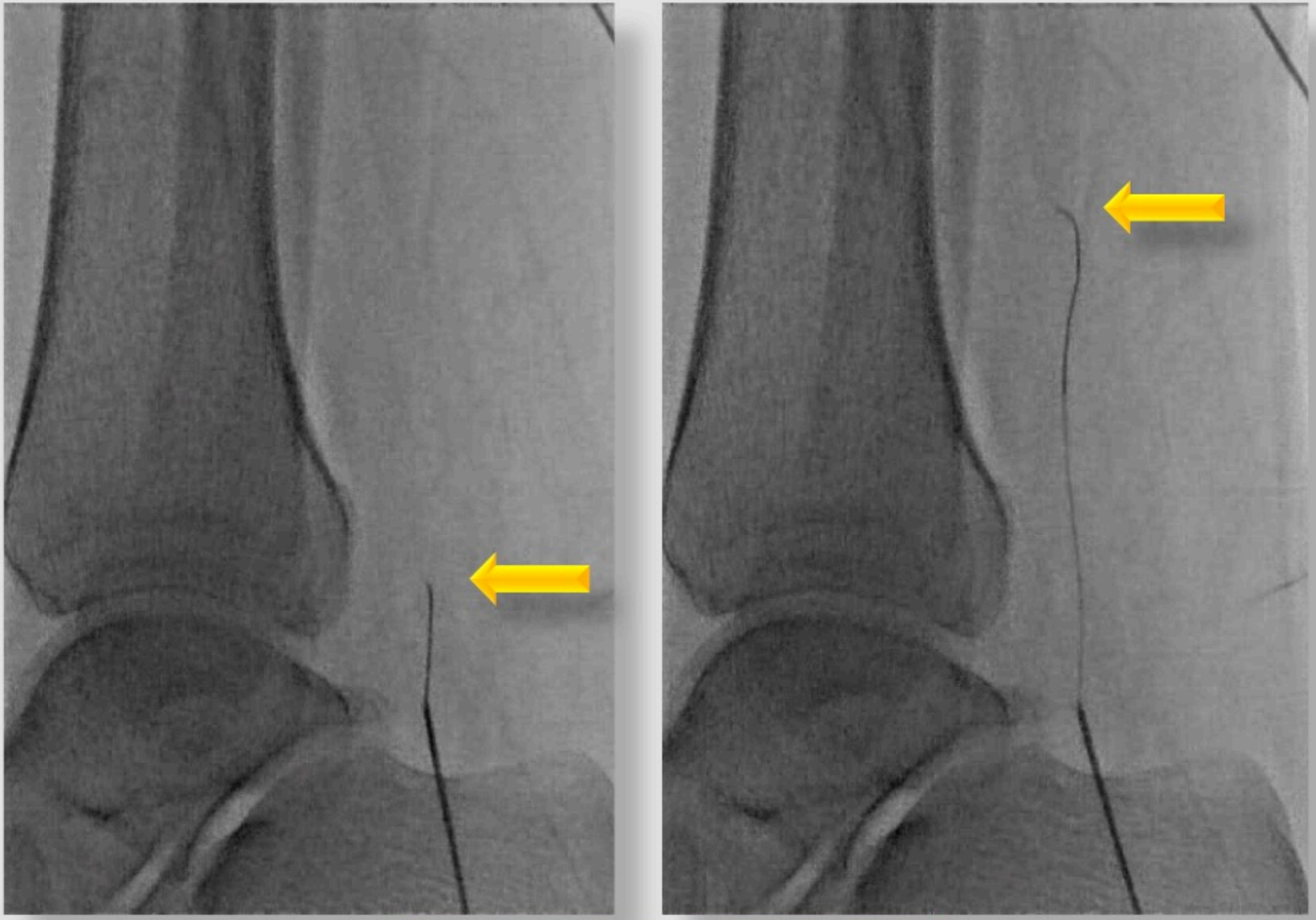
Subintimal approach to tibioperoneal trunk

- Not sure of my position.
- Clearly I was in the correct subintimal space, but…
- Decided to switch to a retrograde approach.

Retrograde puncture

PTA bifurcation very high. Puncture into the medial plantar artery.

Parallax technique: needle and artery perfectly aligned



Introduction of retrograde 0.014” wire

Catching the retrograde wire: 1° method

Catching the retrograde wire: 2° method

Final result

Spasm of the medial plantar artery at the puncture site

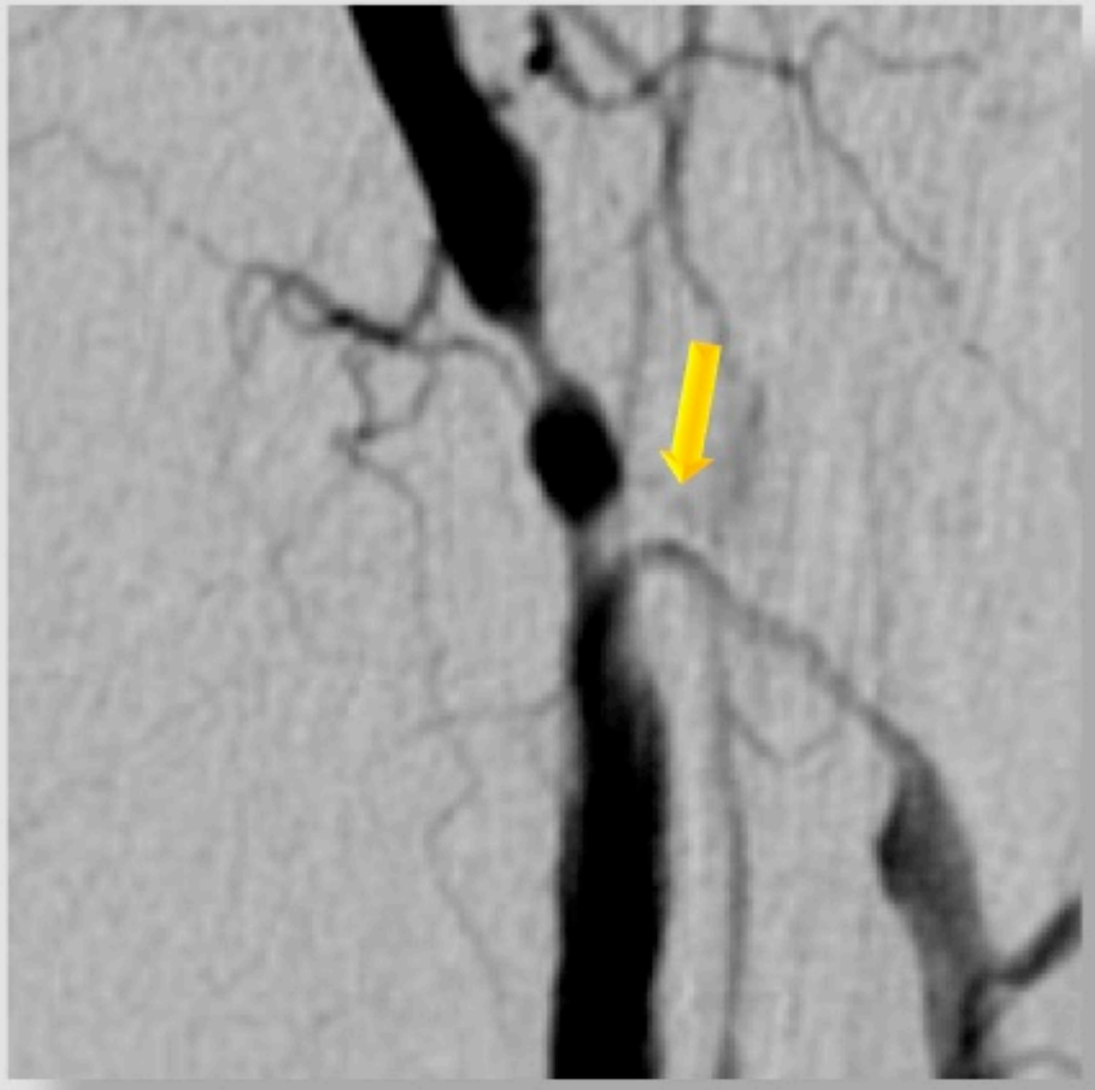
CASE 3 RETRO

Why the retrograde approach?

Failure of antegrade approach due to unfavorable ATA take off

Basal ANGIO

Basal ANGIO



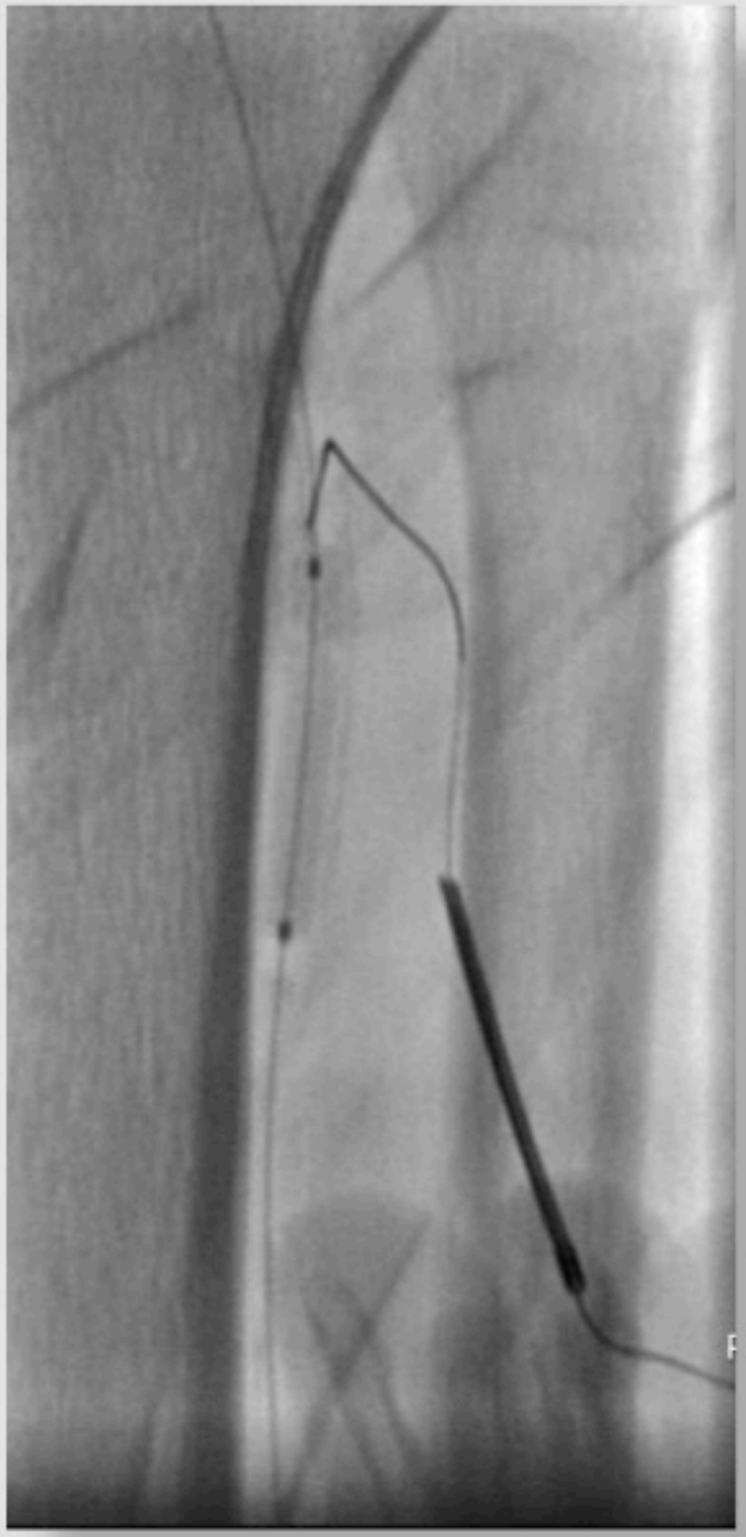
Failure to enter the ATA ostium

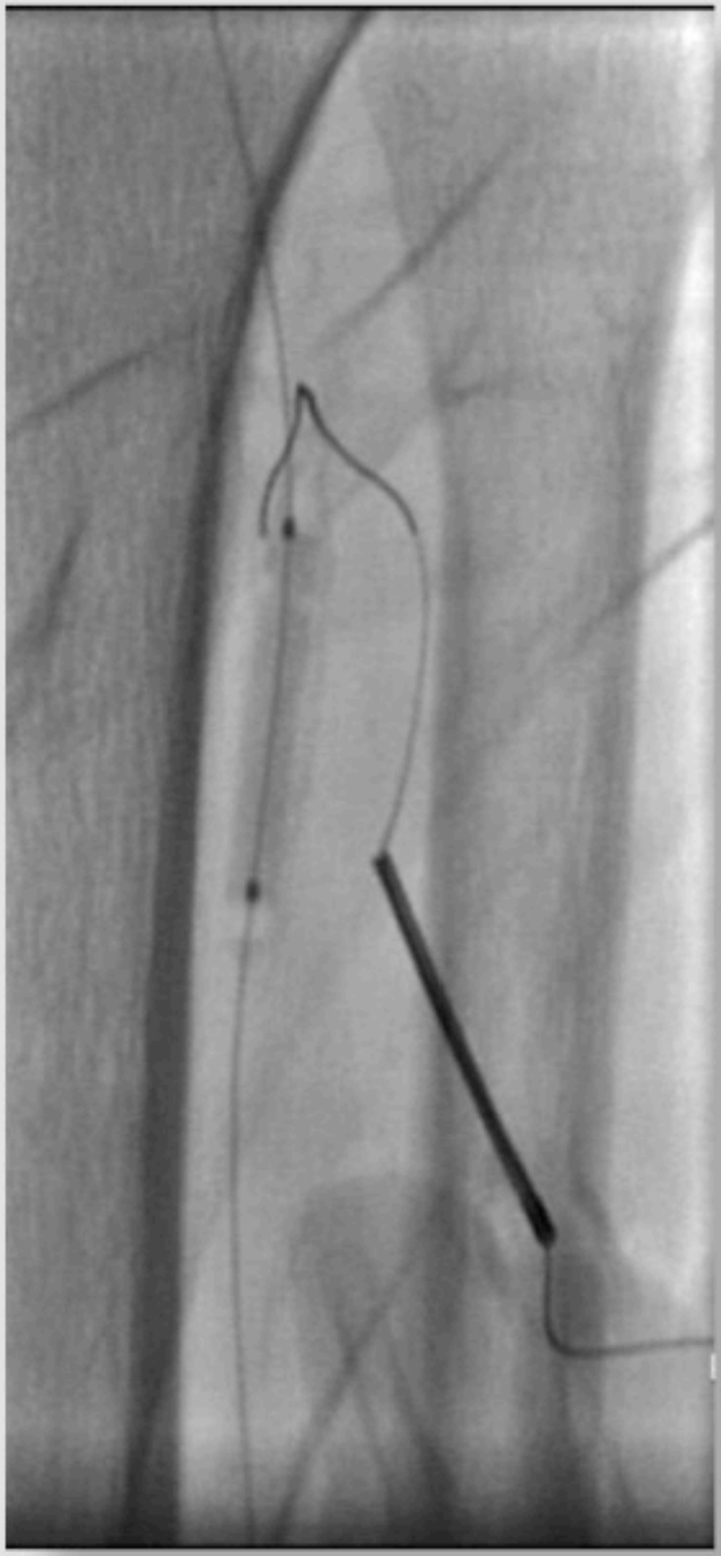
Failure to enter the ATA ostium

Retrograde ATA puncture

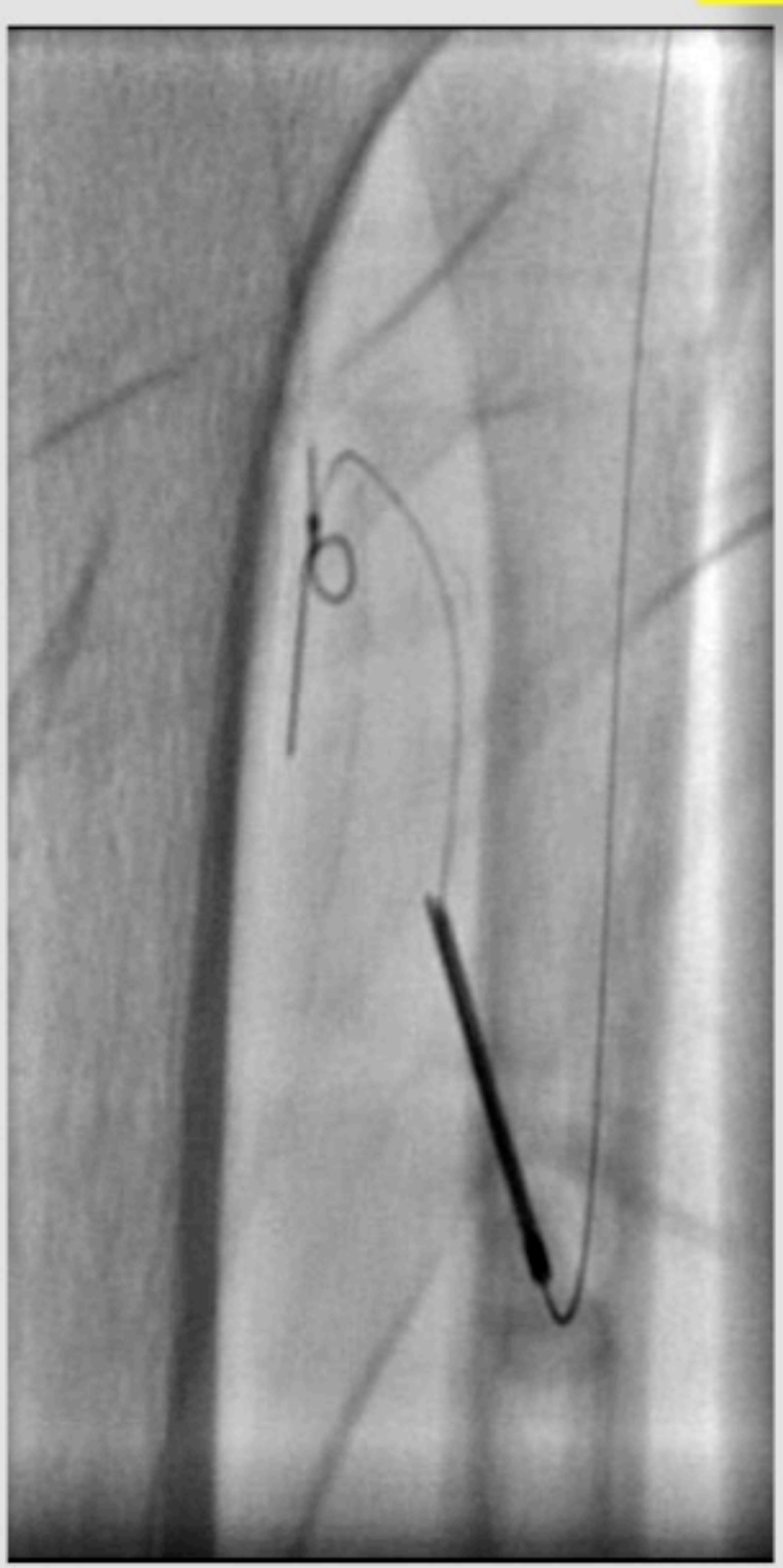
Retrograde puncture of proximal ATA

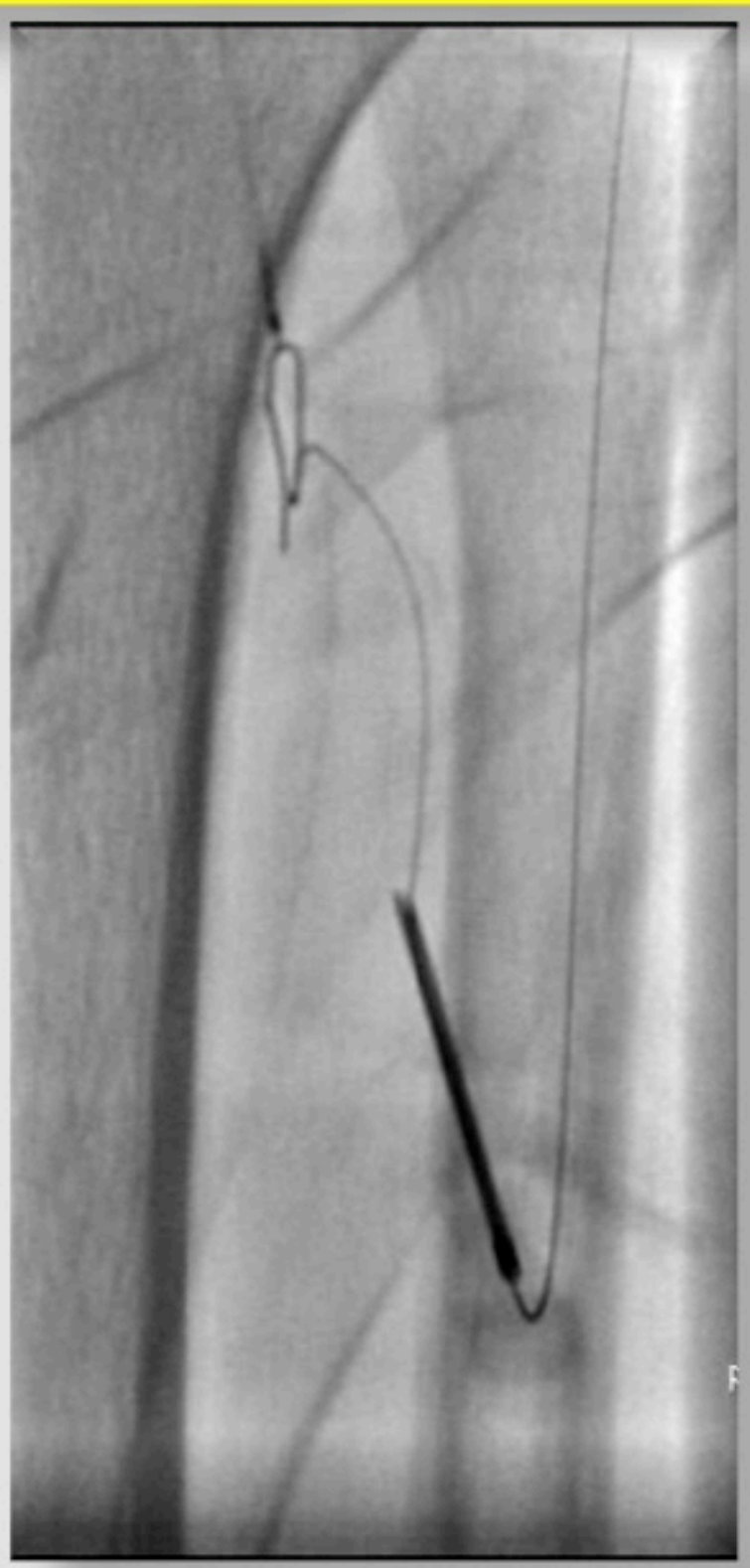
- **0.014” wire inserted through a 21 G needle**
- **Impossible via a retrograde approach into the POP artery despite a balloon inflated in the TPT to prevent wrong threading of the wire**

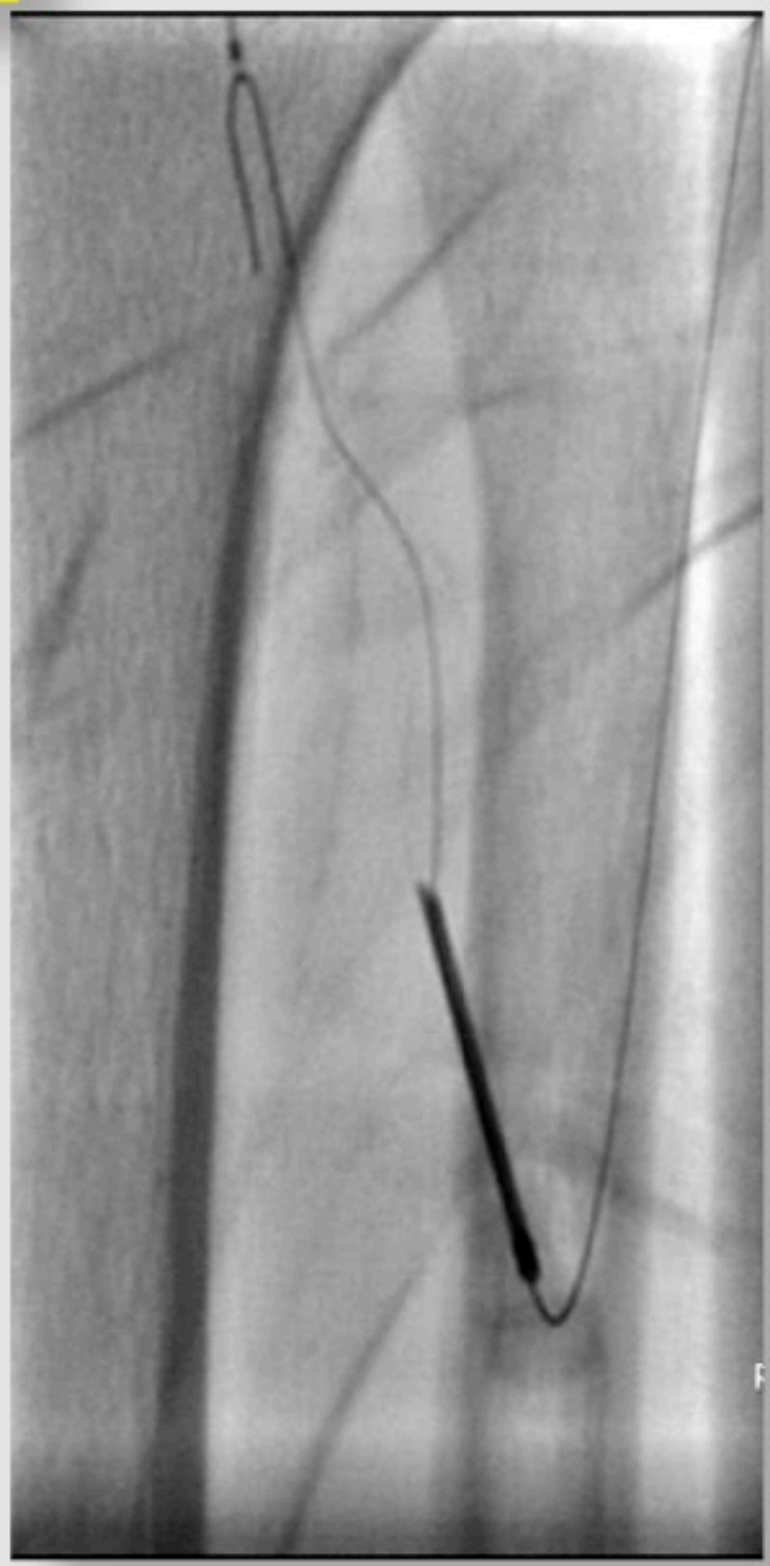




Retrograde ATA puncture







Snare kit capture of the retrograde wire

Kissing balloons

Final results

Basal angio

Final results

CASE 4 RETRO

Why the retrograde approach?

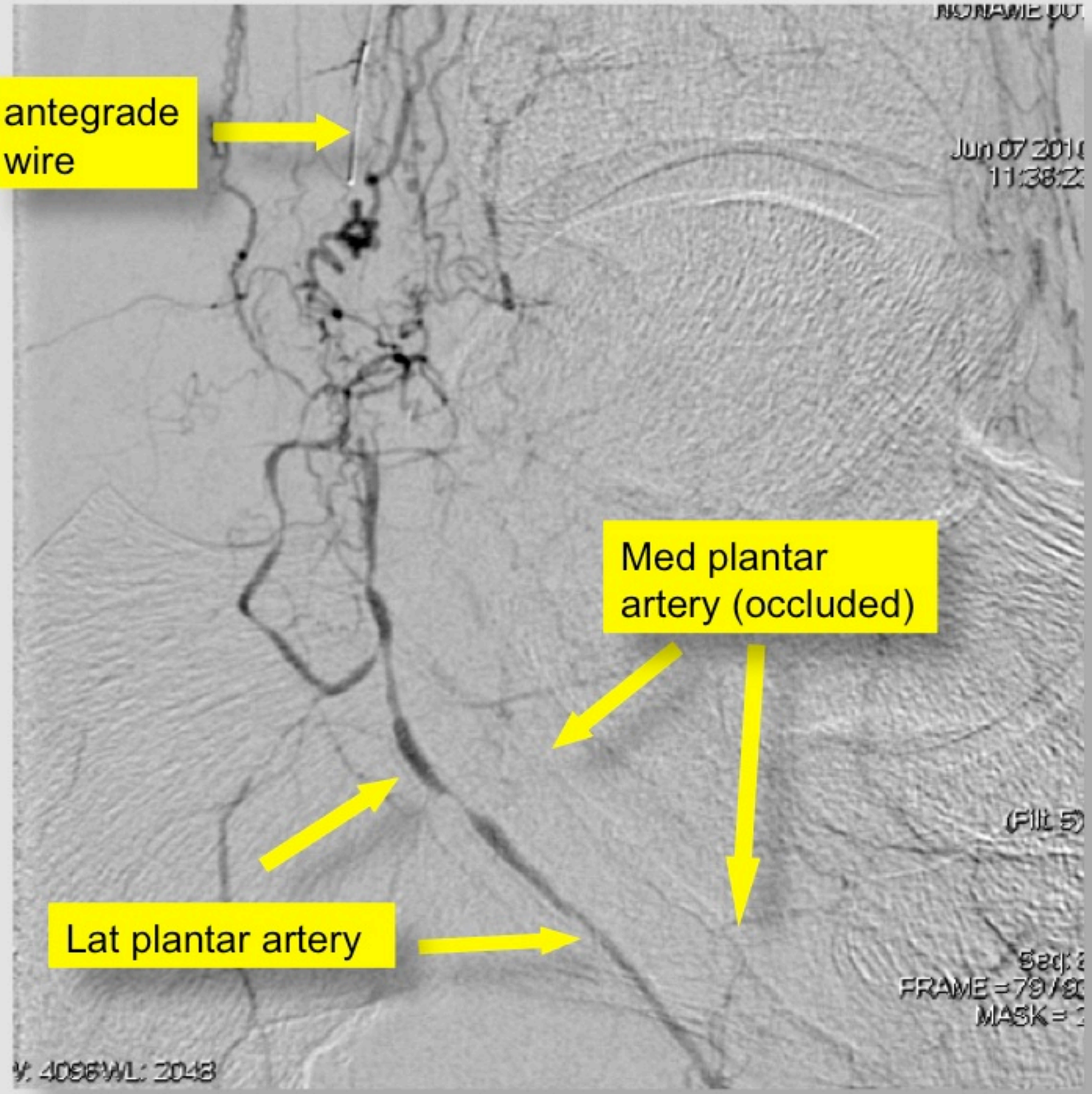
Failure of PTA antegrade approach due to heavy calcifications

- ***64-year-old male***
- ***type 2 DM***
- ***ESRD-HD***
- ***Forefoot plantar ulcer***

Basal ANGIO

“Desert” foot is typical of patients with a long history of diabetes and hemodialysis

Failure of antegrade approach


antegrade
wire
Med plantar
artery (occluded)
Lat plantar artery

Retrograde puncture of common plantar artery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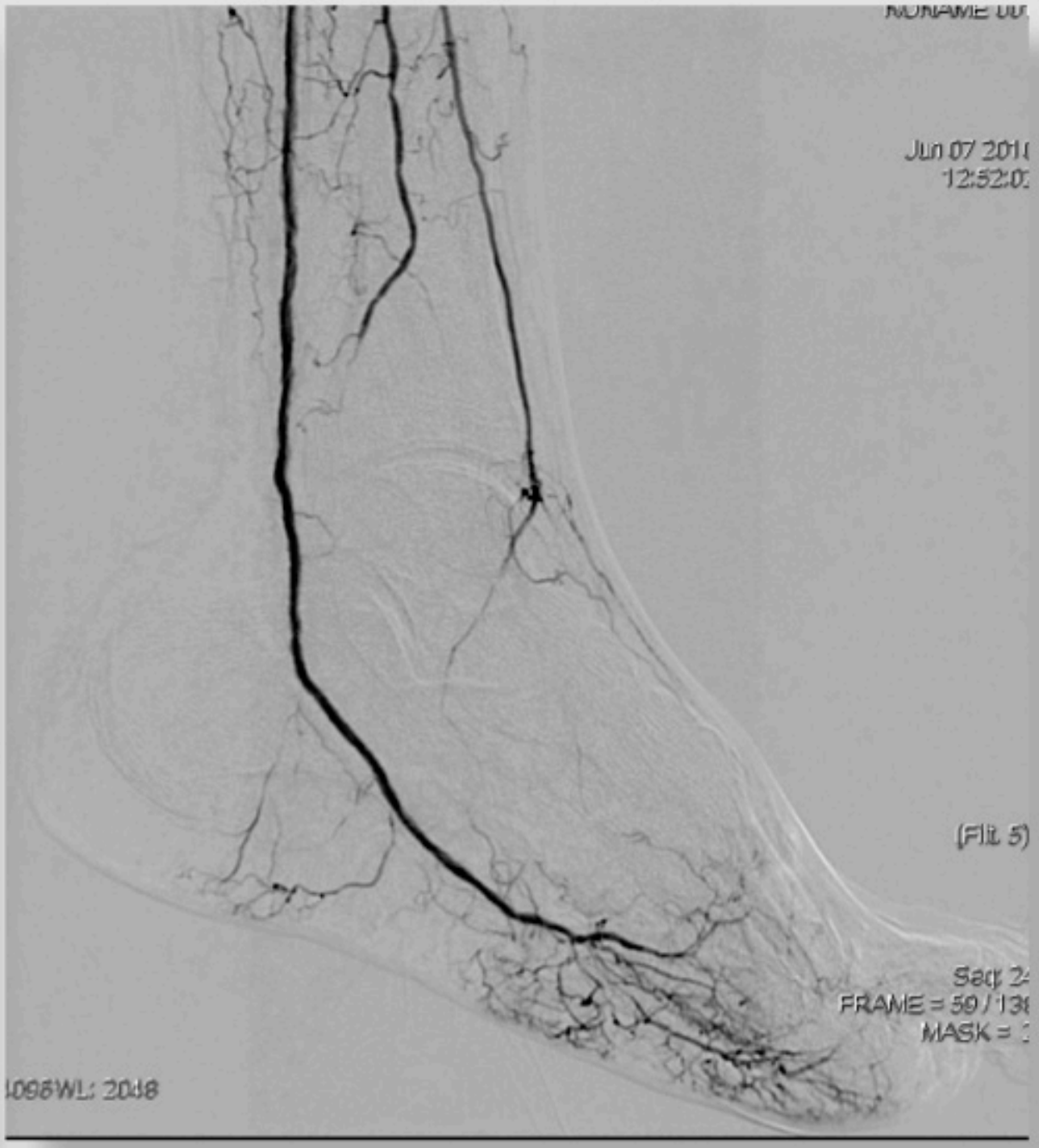
Final result

Basal angio

Final results



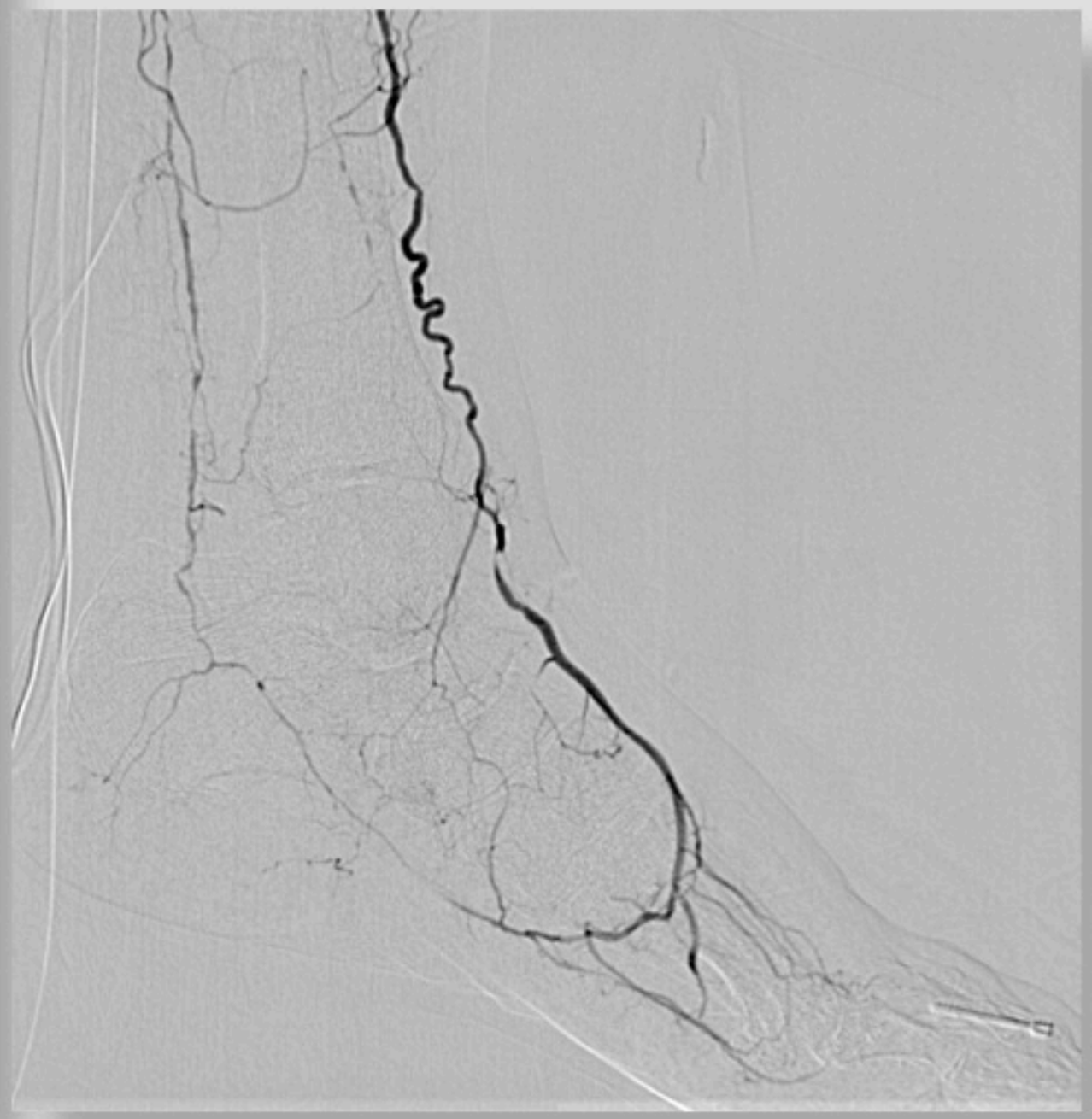
CASE 5 RETRO

Why the retrograde approach?

High risk of dissection of dorsalis pedis due to vessel calcification: respect the landing zone!

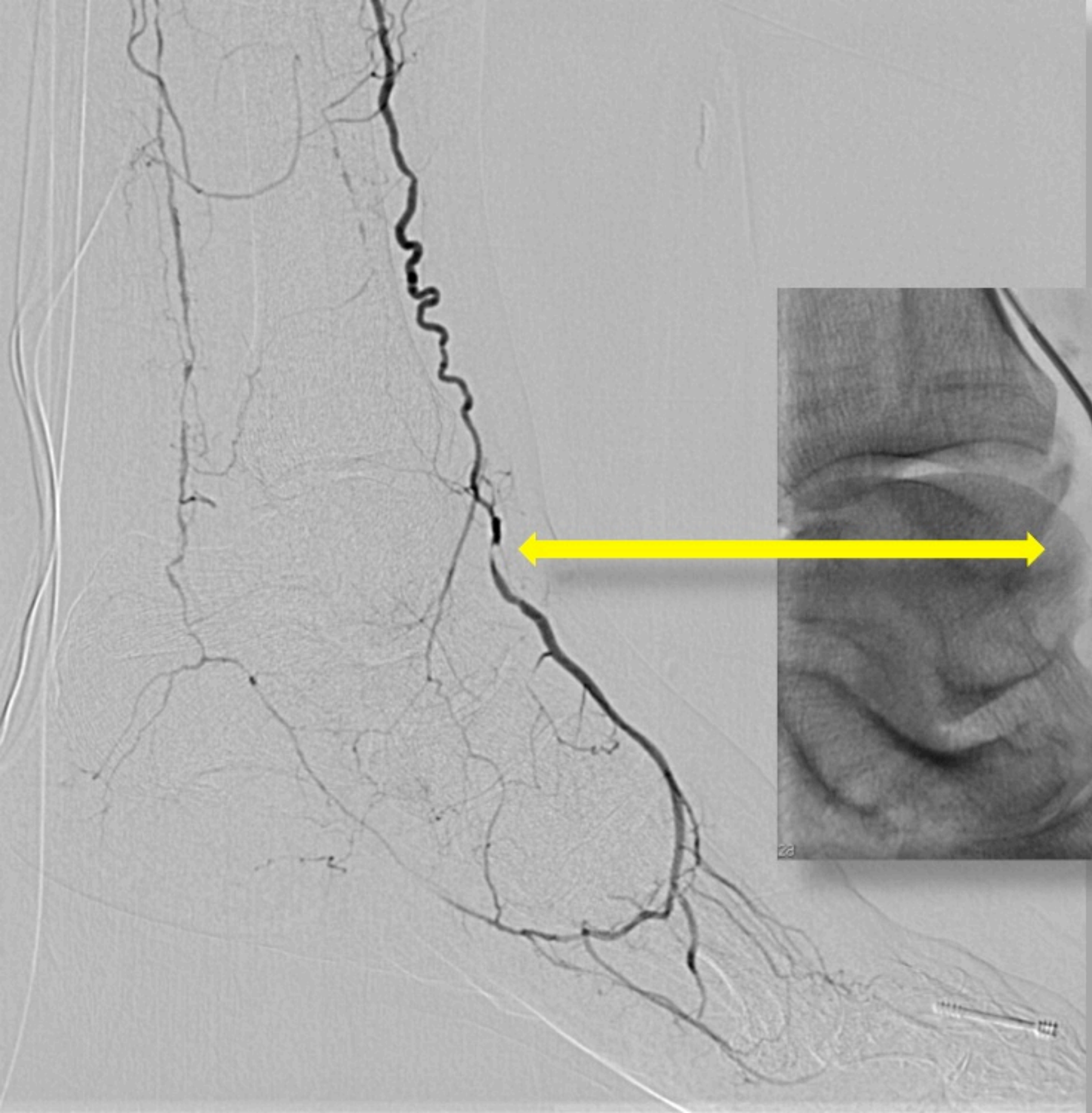
Basal ANGIO

- Hypoplastic ATA: suspect an anterior dominance of peroneal artery!
- Big and healthy dorsalis pedis



Subintimal approach in peroneal artery

Subintimal approach in peroneal artery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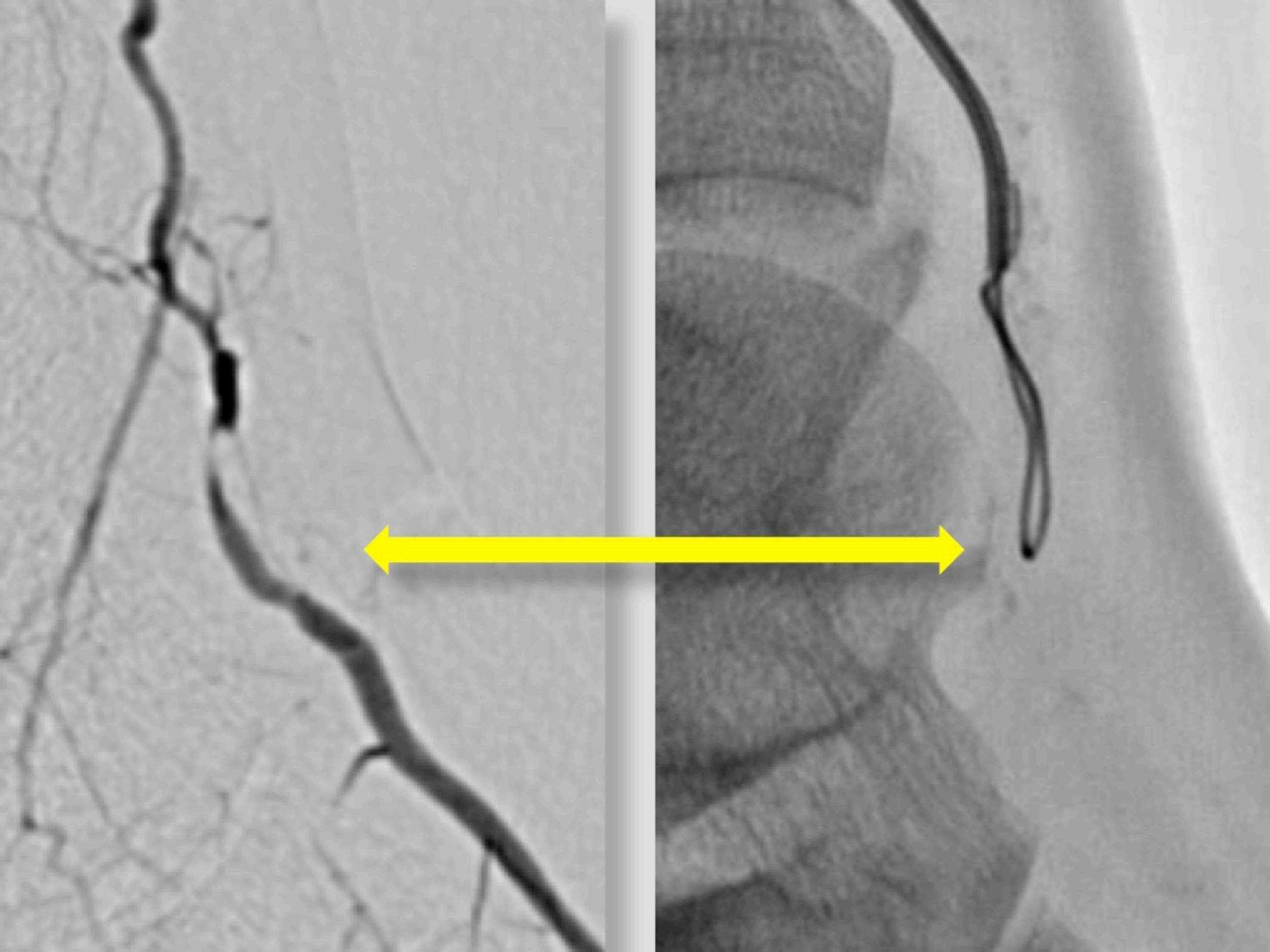
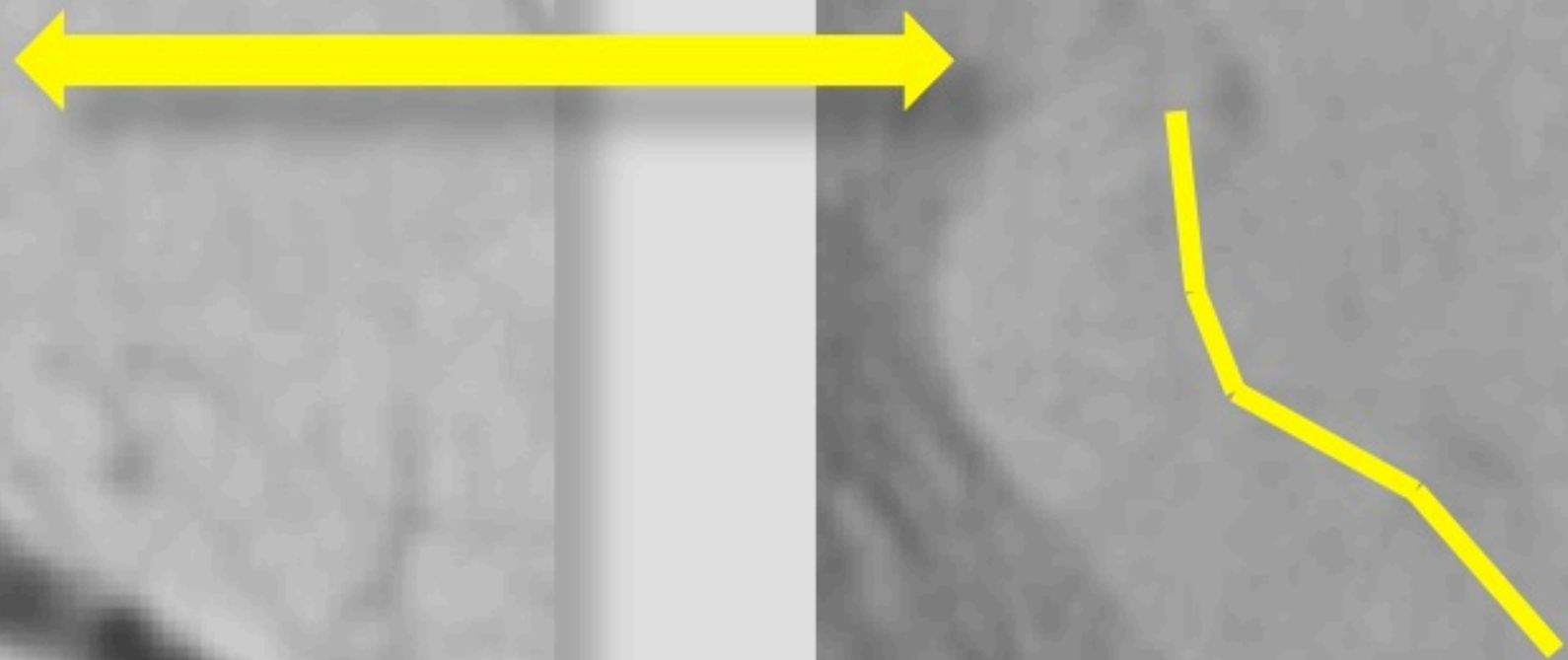


Stop! Due to calcification, the wire is very unlikely to re-enter the true distal lumen by the antegrade approach!

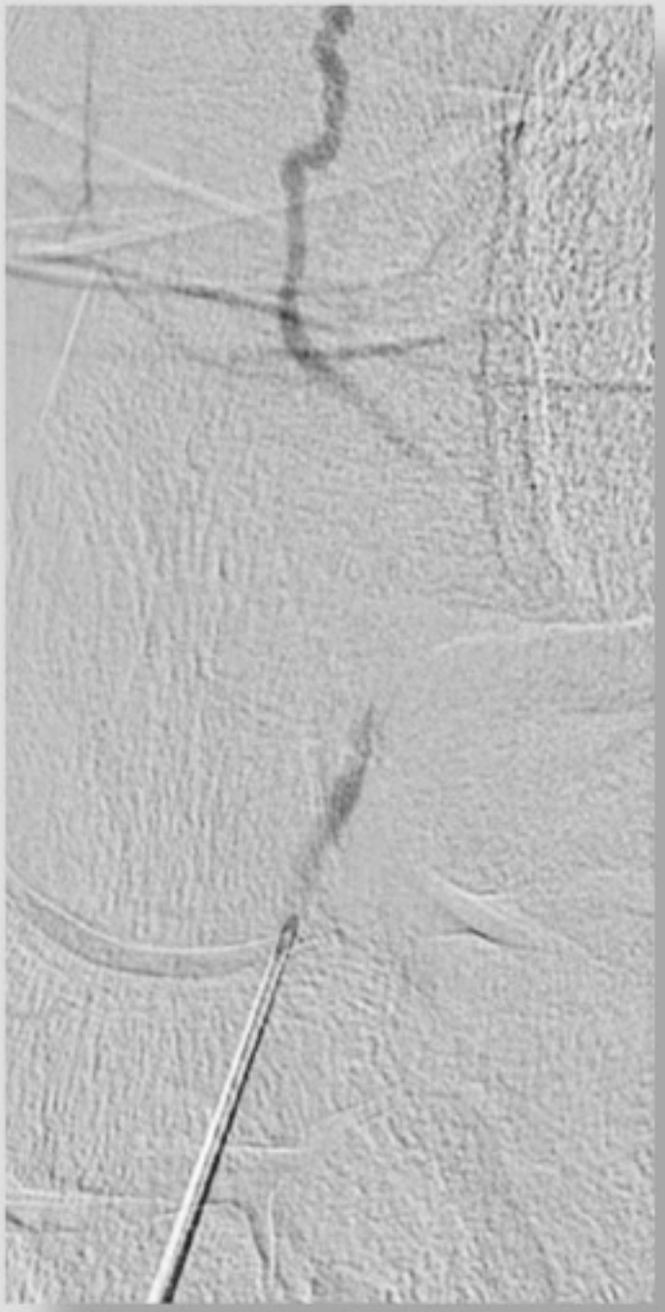
You could dissect the dorsalis pedis artery, damaging the only good artery of the foot and jeopardizing the possibility of a good distal bypass!

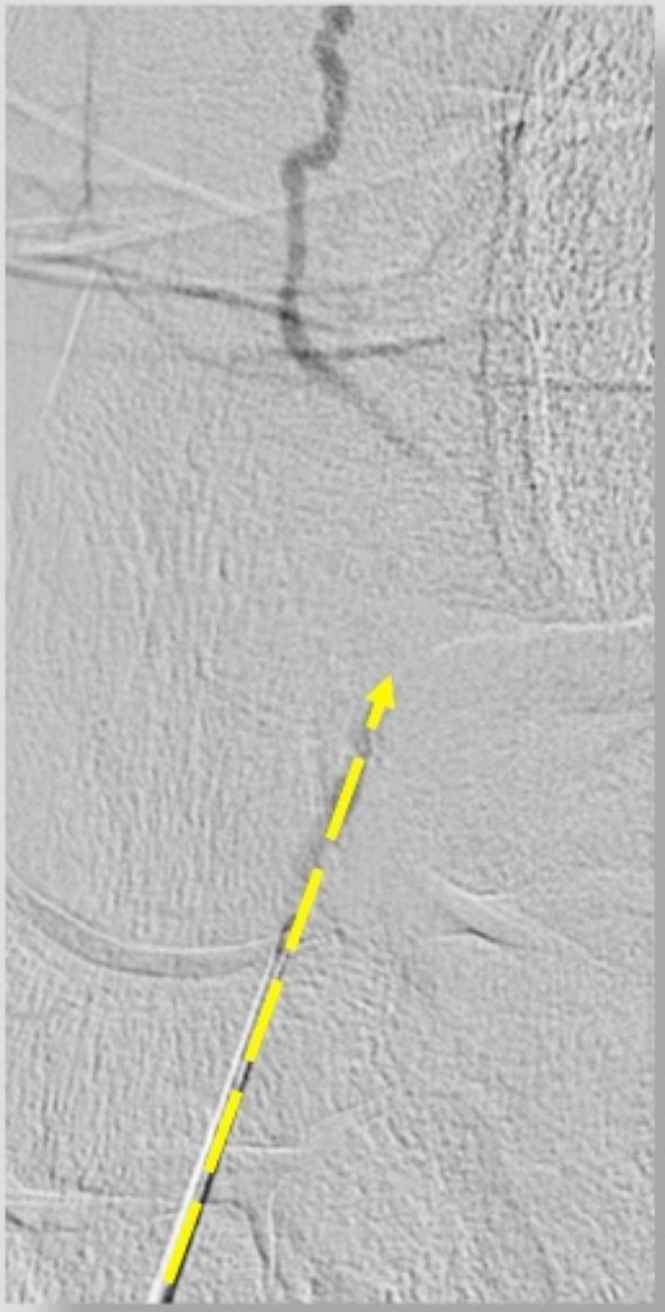


Retrograde dorsalis pedis puncture

Retrograde dorsalis pedis puncture

Retrograde dorsalis pedis puncture





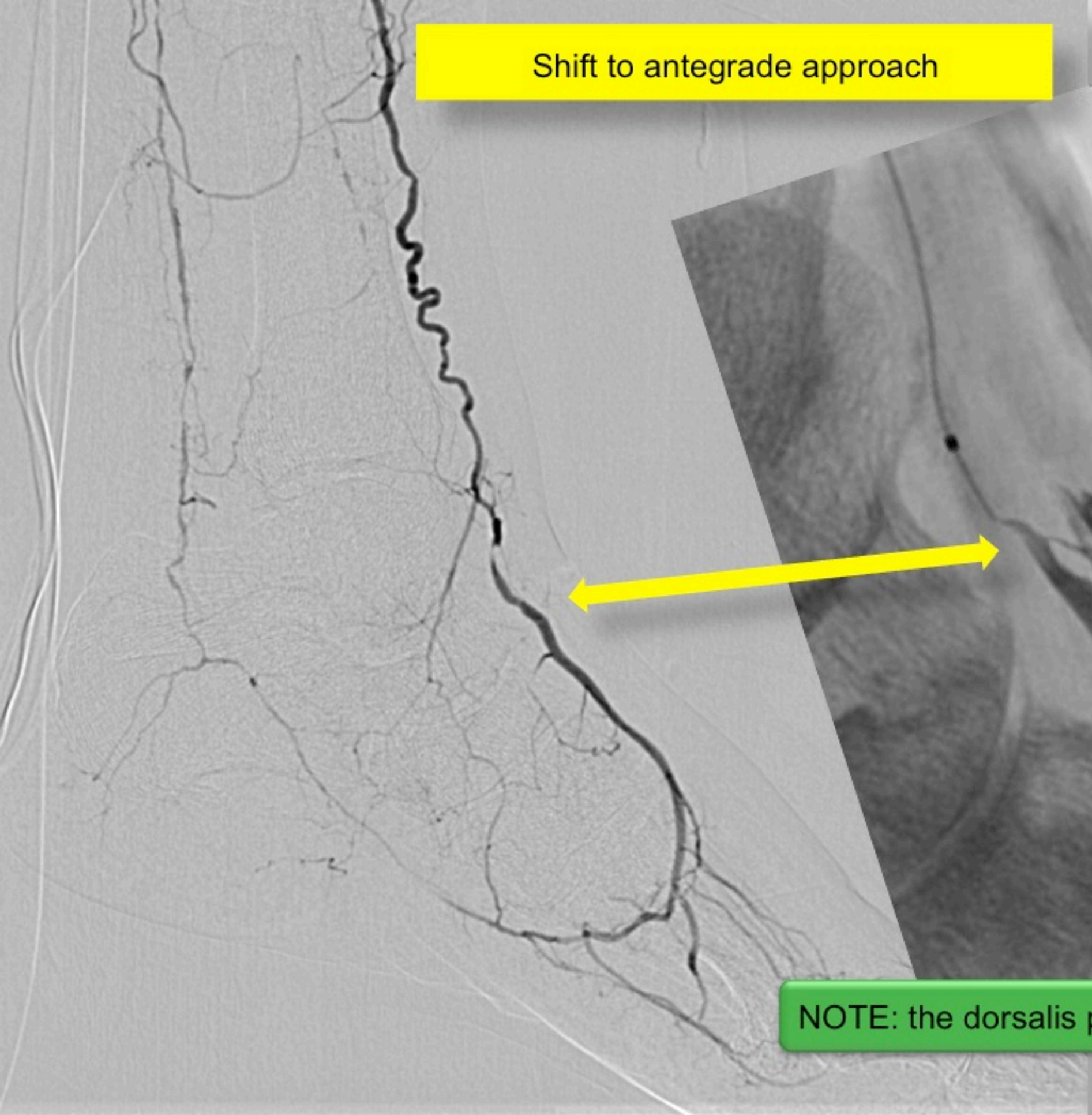
Parallax technique: needle and artery perfectly aligned

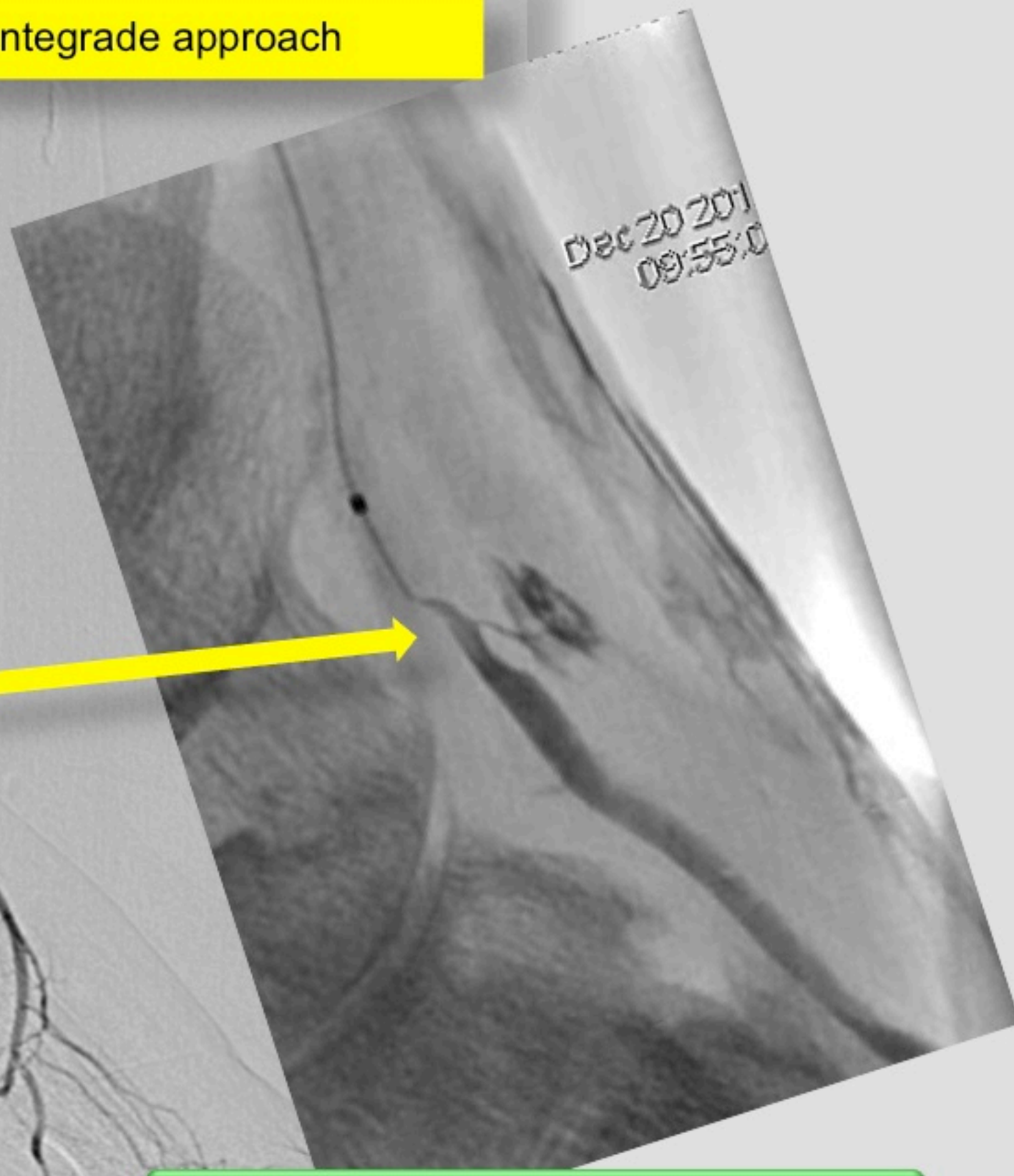
Retrograde dorsalis pedis puncture

Retrograde dorsalis pedis puncture

Shift to antegrade approach

Shift to antegrade approach

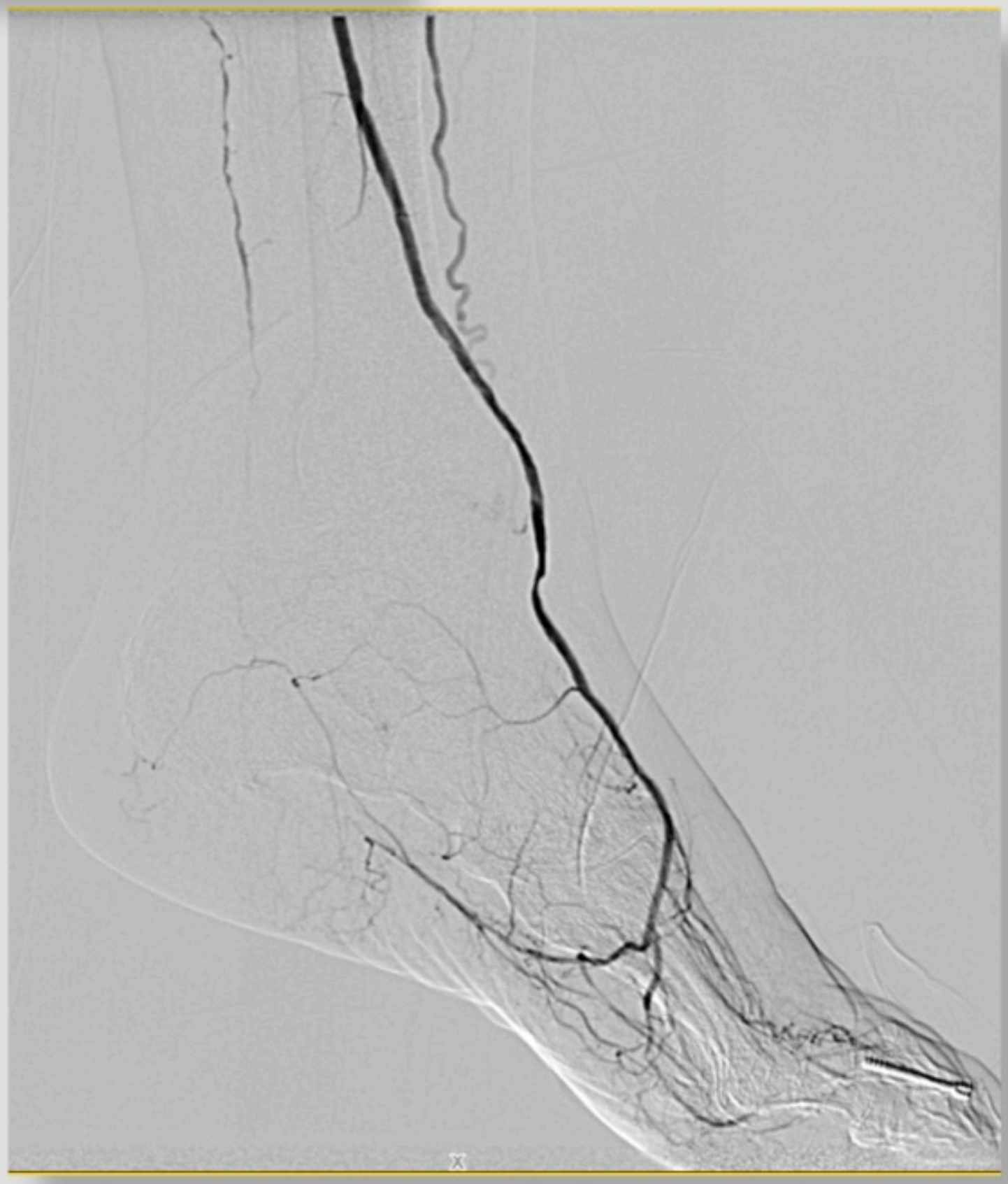




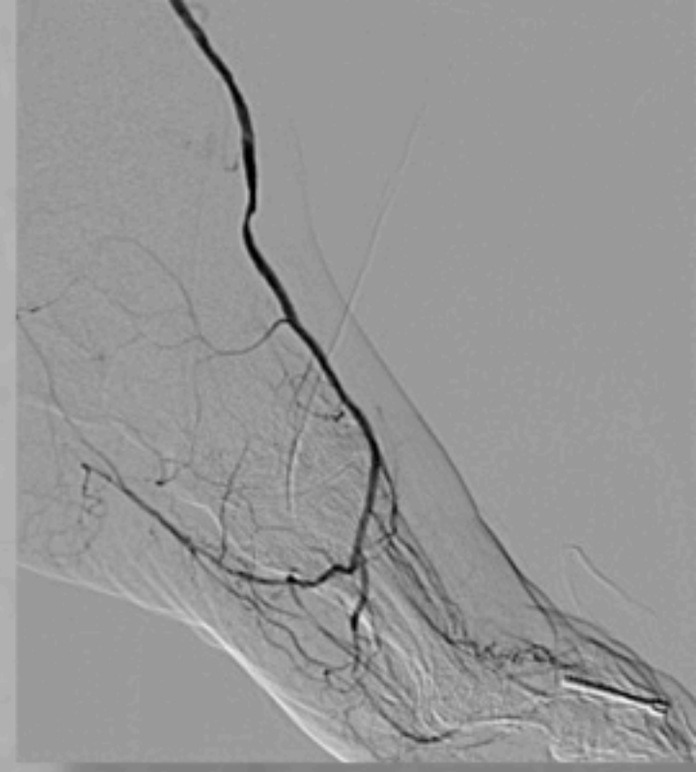
NOTE: the dorsalis pedis is untouched!

Final result

Final result



Final result after the inflation of a 2.5 mm non-compliant coronary balloon at 26 atm!!!



CASE 6 RETRO

Why the retrograde approach?

Failure to find the ostium of the PTA

Basal ANGIO

Impossible to identify the ostium of PTA

Retrograde puncture of PTA

Shift to antegrade approach

Shift to antegrade approach

Kissing balloon on TPT bifurcation

Final result

CASE 7 RETRO

Why the retrograde approach?

High risk of dissection of dorsalis pedis: respect the landing zone!

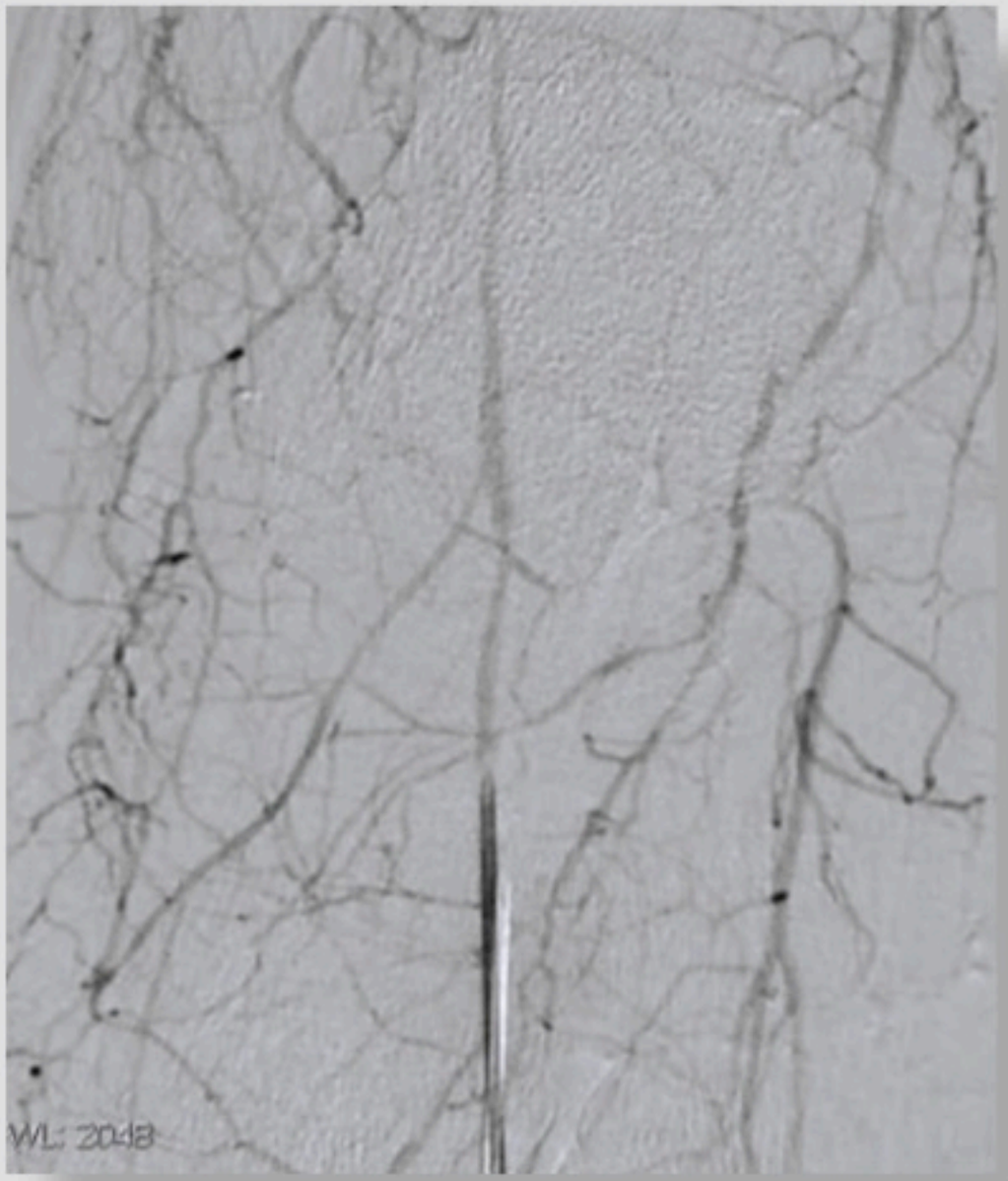
Basal ANGIO

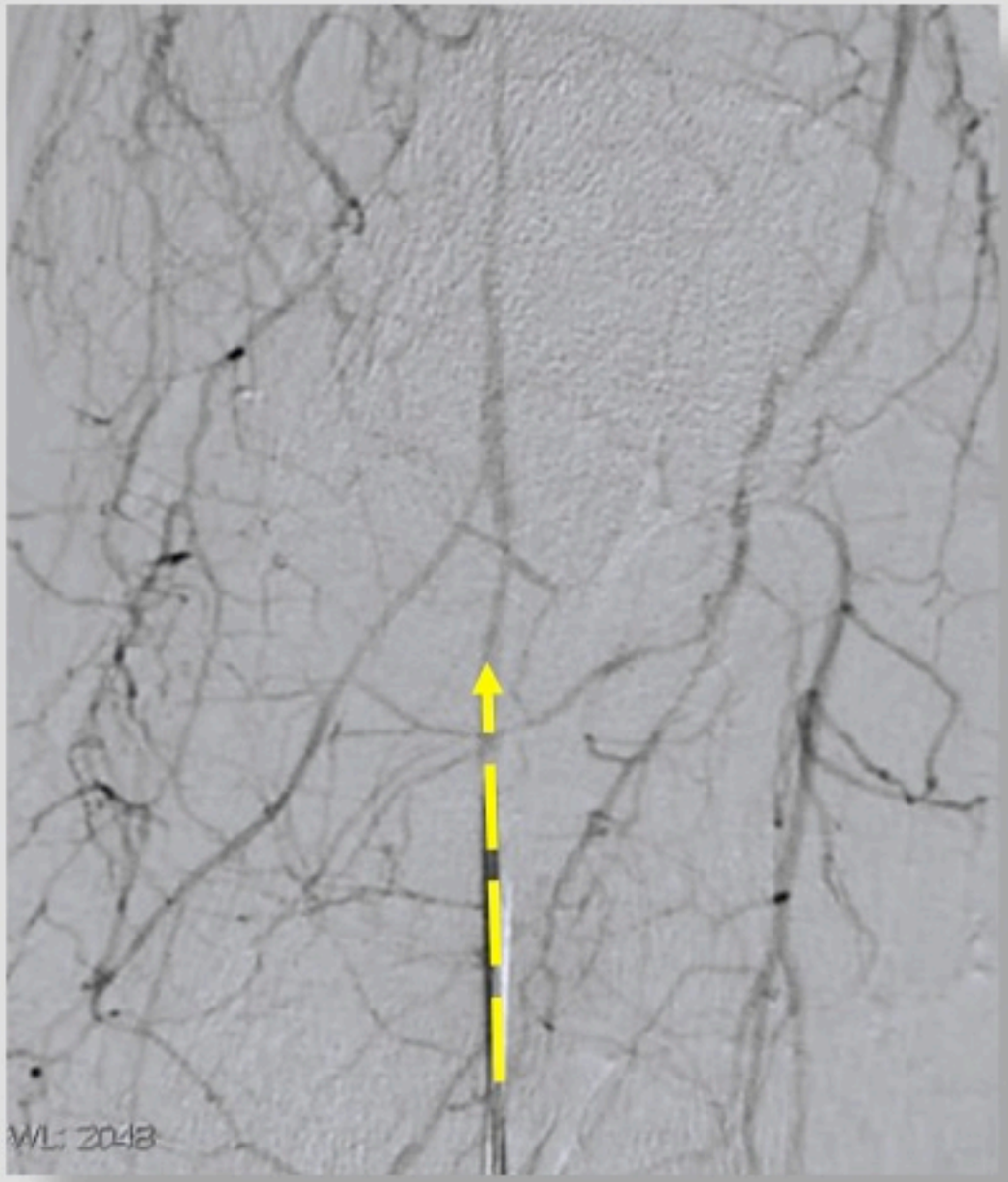
Failure of ATA approach

Retrograde puncture of ATA

Shift to antegrade approach and sealing

Parallax technique: needle and artery perfectly aligned





Final result

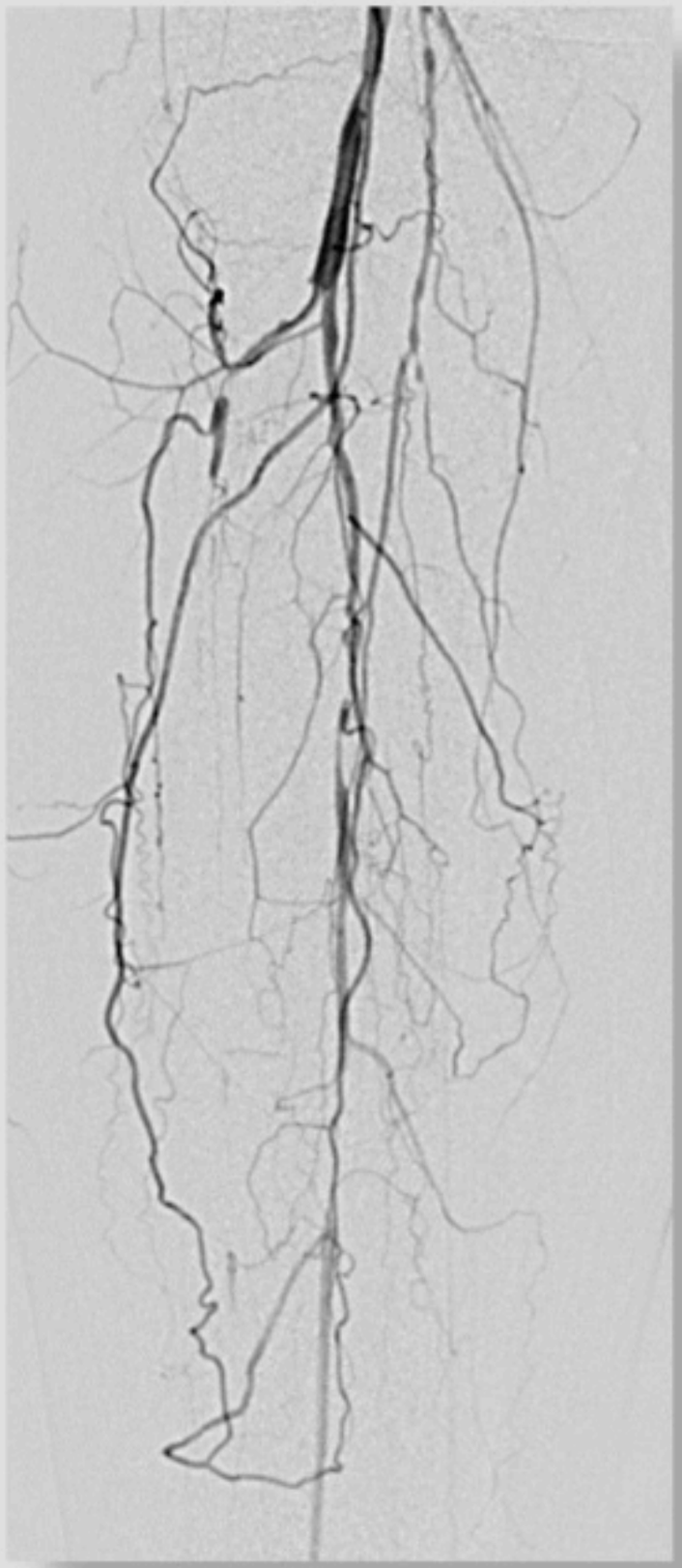
CASE 8 RETRO

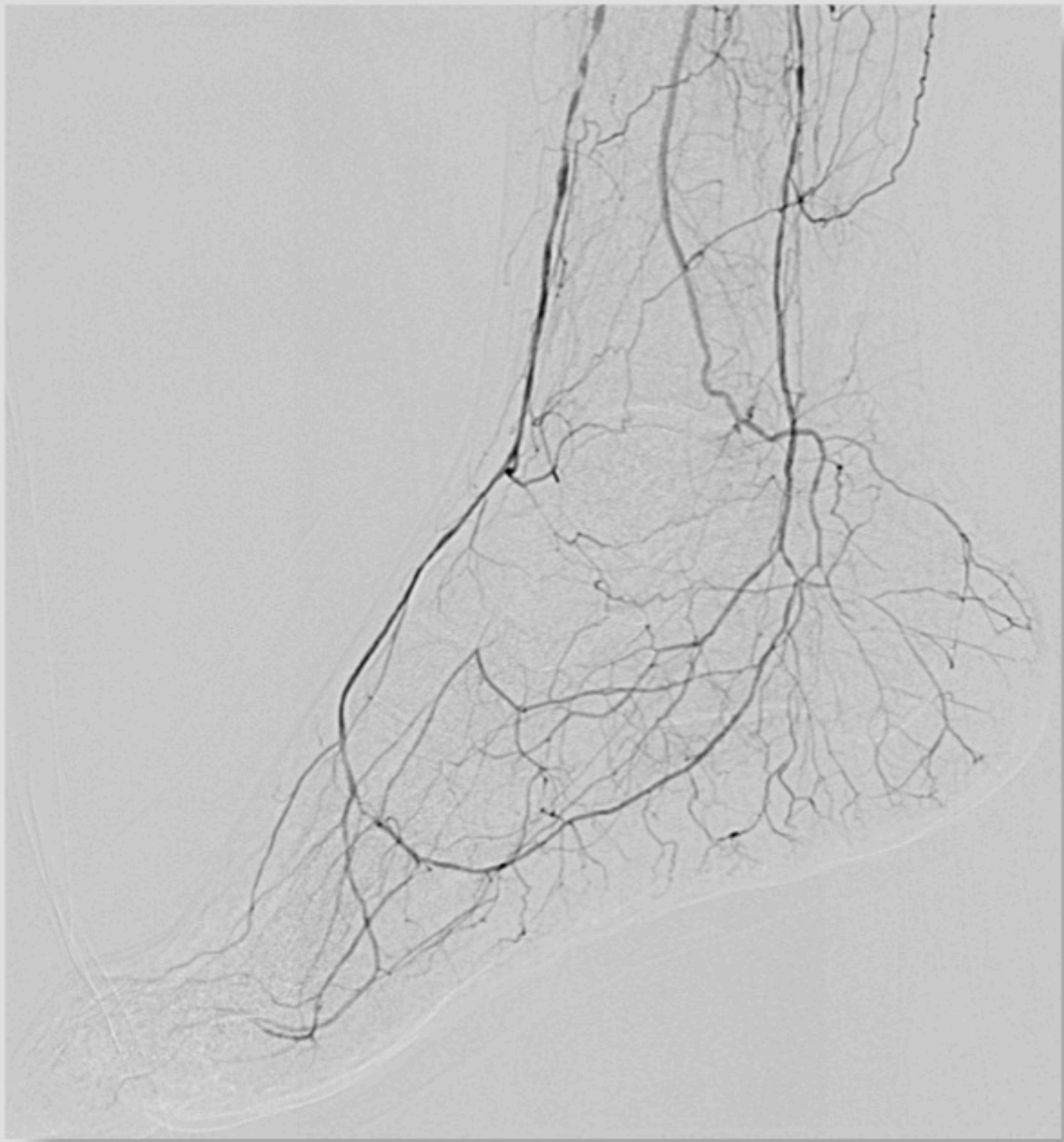
Why the retrograde approach?

Diffuse calcification of dorsalis pedis makes it impossible to enter the true distal lumen and there is a high risk of damaging the distal target vessel

Basal ANGIO

Basal ANGIO





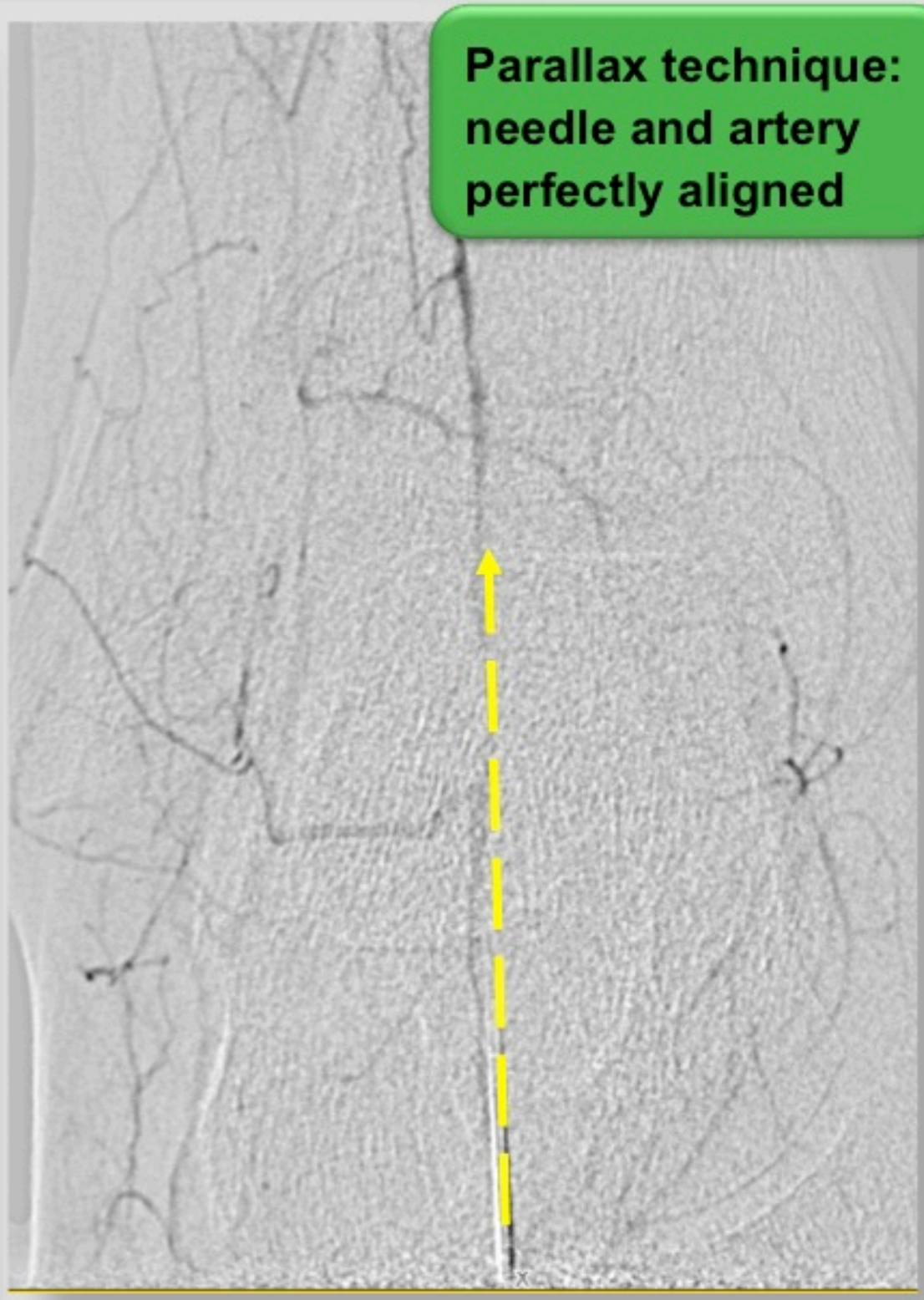
Failure of ATA approach

Failure of ATA approach

- **Subintimal space is outside of the calcifications**
- **True distal lumen very thin due to diffuse disease**
- **Quite impossible to re-enter the distal target vessel by an antegrade approach due to high risk of damaging the last foot vessel!**

Retrograde puncture of ATA

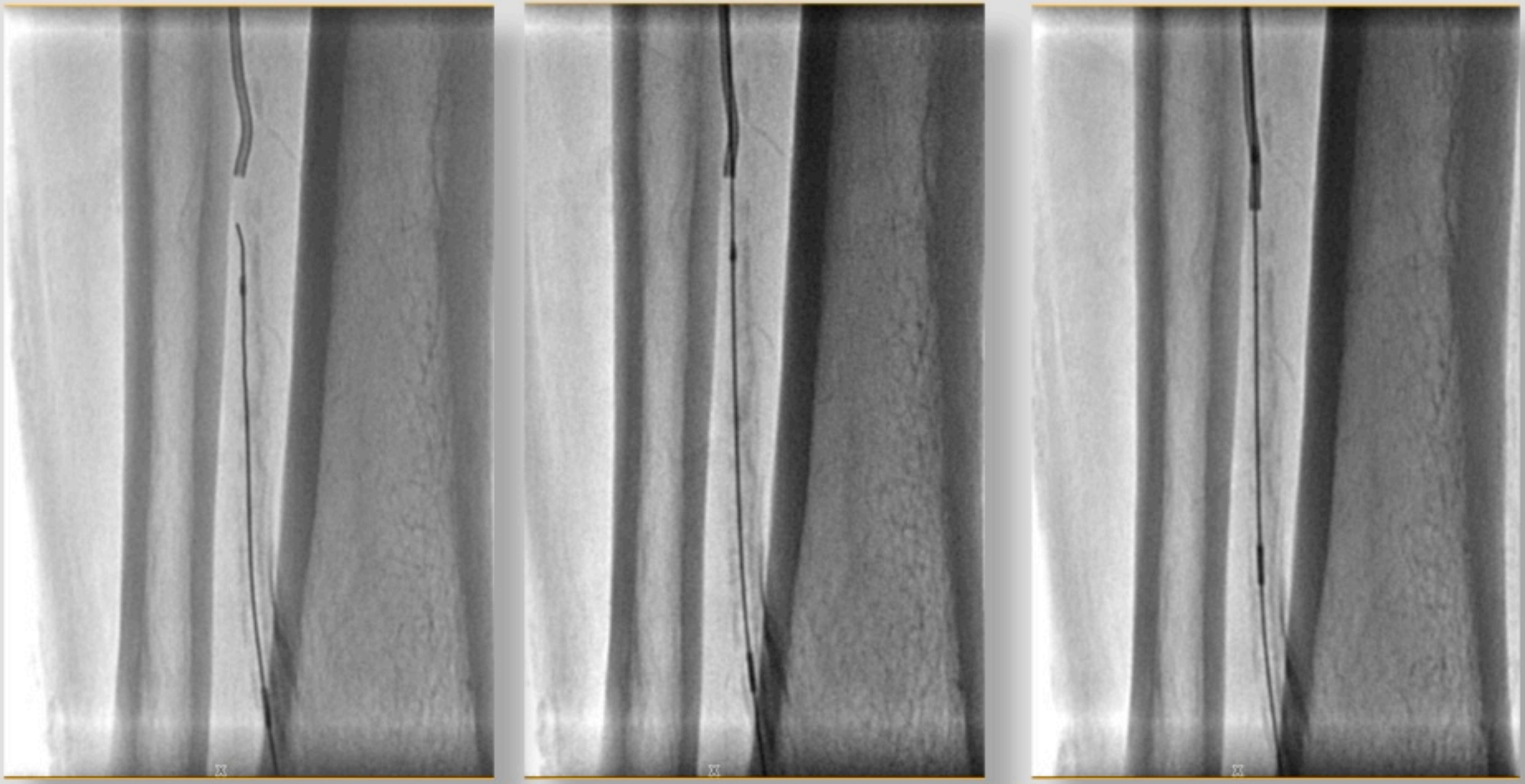
Retrograde puncture of ATA



Parallax technique: needle and artery perfectly aligned

Retrograde advancement of a support catheter

Retrograde advancement of a support catheter

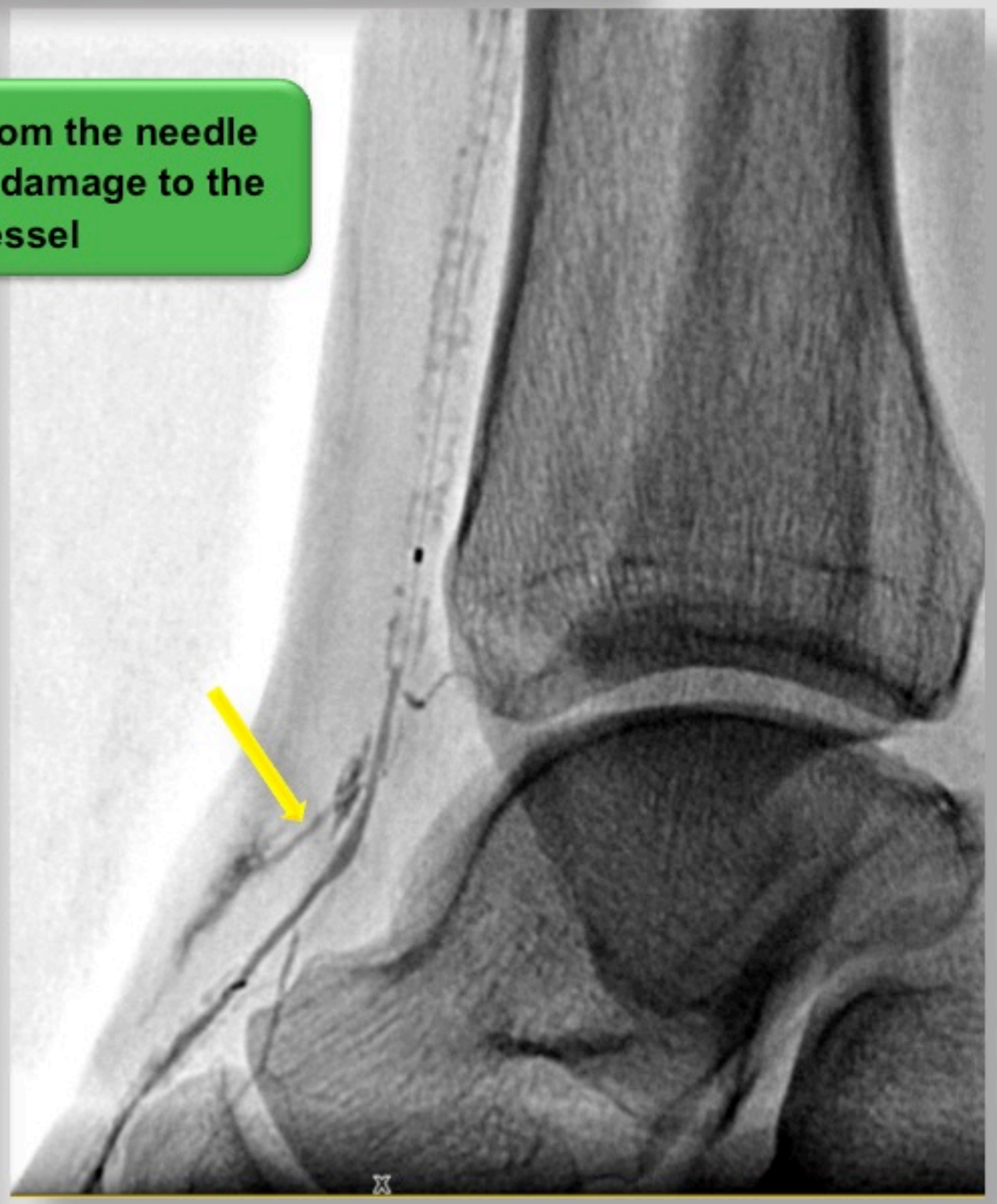


Support catheter (65 cm long, 2.6 Fr, 0.018”, angulated tip) easily advanced on the 0.018” retrograde wire and enters into the antegrade Berenstein catheter. the 0.018” wire exchanged for a 0.014” antegrade wire.

Shift to antegrade approach and sealing

Shift to antegrade approach and sealing

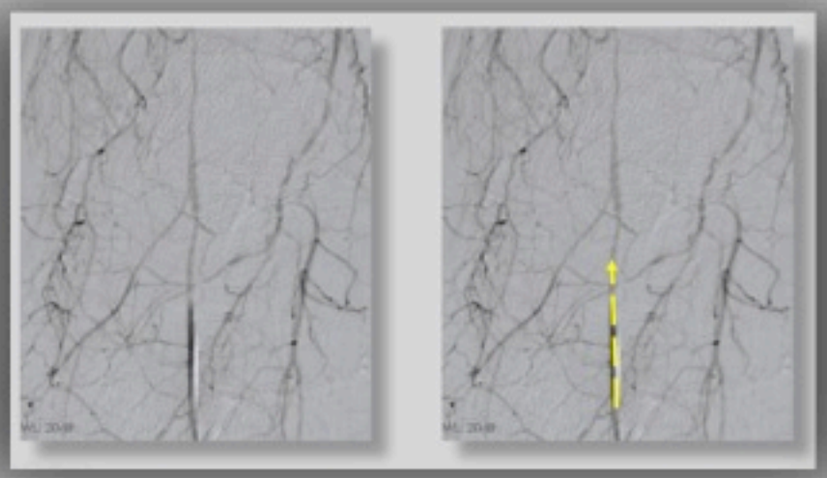
Thin leaking from the needle hole: no other damage to the distal target vessel



Final result

Final result

Retrograde approach: the retrograde puncture



- ❑ **Retrograde puncture**
- ❑ **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

Parallax technique: needle and artery must be perfectly aligned

Retrograde approach: the pedal-plantar loop technique

- **Retrograde puncture**
- **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

Retrograde approach: the pedal-plantar loop technique

- Creation of a loop between dorsal and plantar circulation with a wire and balloon tracking through the pedal arch of the foot
- The technique aims at restoring arterial flow from both tibial arteries
- Direct blood flow through one tibial artery with a good distal distribution system into the foot vessels can be a good and conclusive result
- The benefit of opening the opposite tibial vessel must be balanced with the risk of damaging the forefoot distribution system
- In “desert foot”, opening the distal distribution system, if possible, becomes essential for wound healing

Retrograde approach: the pedal-plantar loop technique

1. **Antegrade recanalization of the anterior tibial artery** and the pedal artery, including the pedal arch, followed by retrograde recanalization of the lateral plantar artery and then of the posterior tibial artery

2. **Antegrade recanalization of the posterior tibial artery** and the lateral plantar artery, including the pedal arch, followed by retrograde recanalization of the pedal artery and then of the anterior tibial artery

3. **Combination techniques**, such as antegrade subintimal recanalization of the tibial artery followed by a re-entry on the foot artery, or a retrograde subintimal recanalization of the foot and tibial arteries, followed by a re-entry at the origin of the tibial vessel

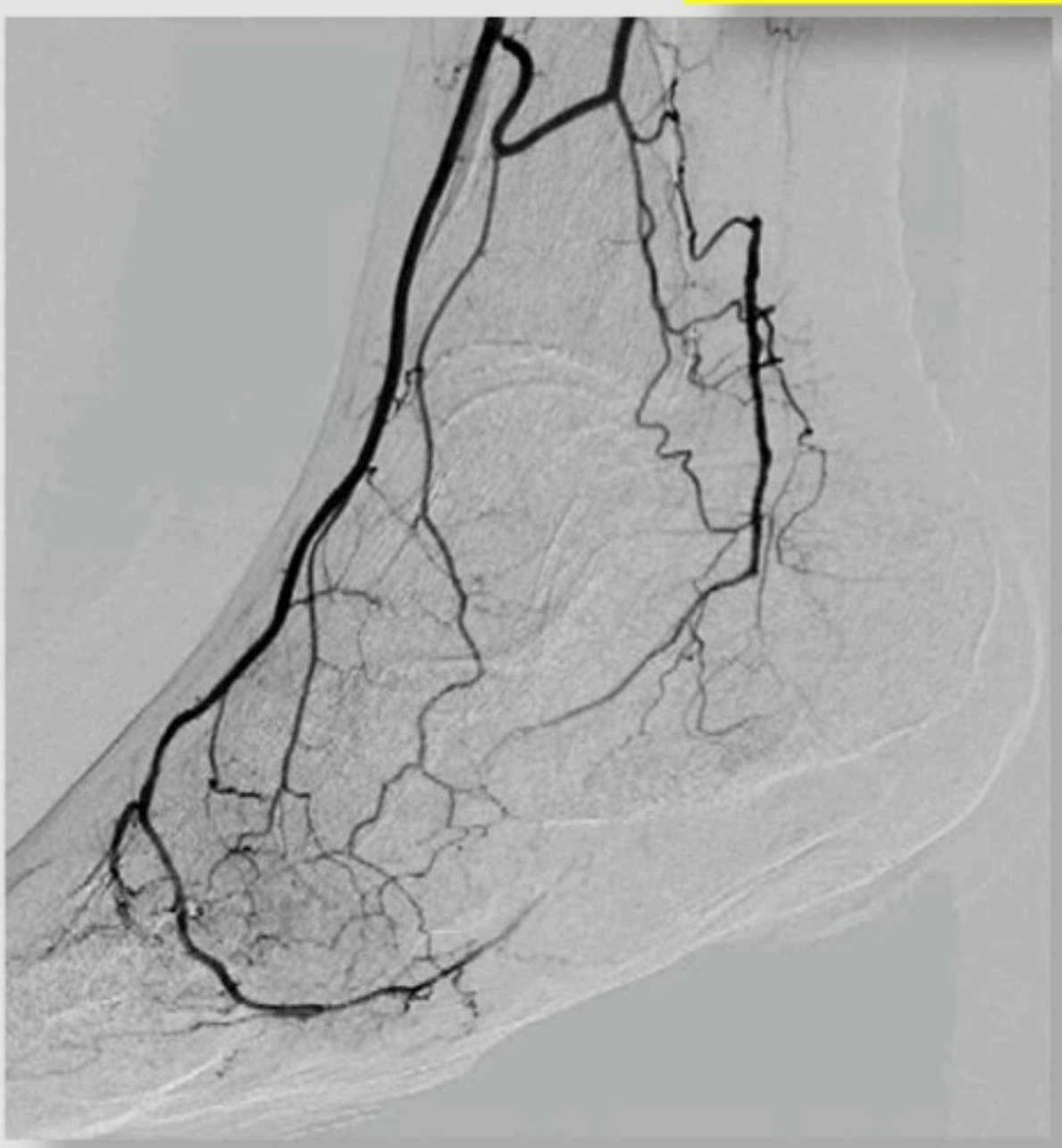
CASE 1 LOOP

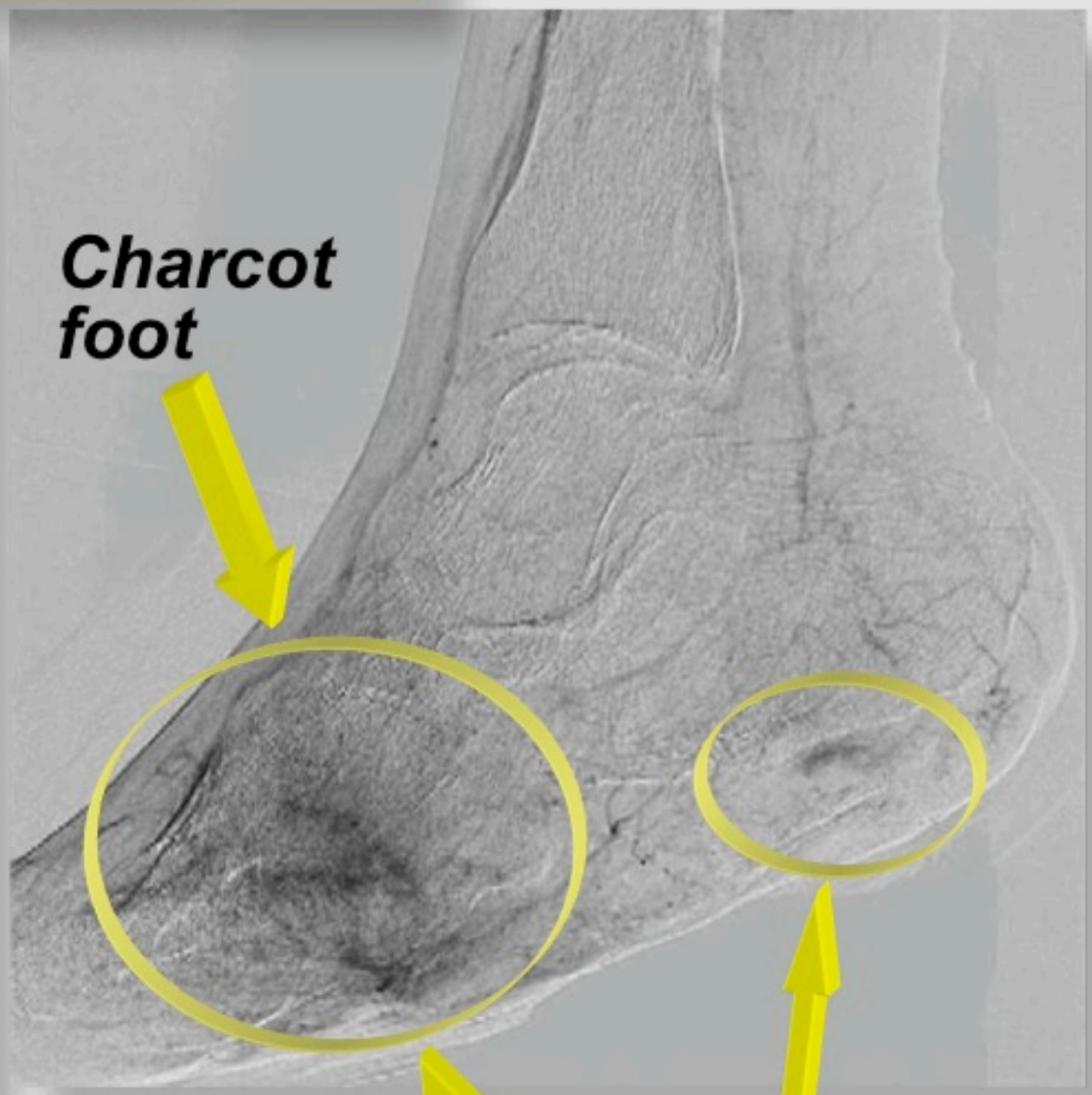
Why the pedal-plantar loop technique?

Failure of the subintimal approach in lateral plantar artery

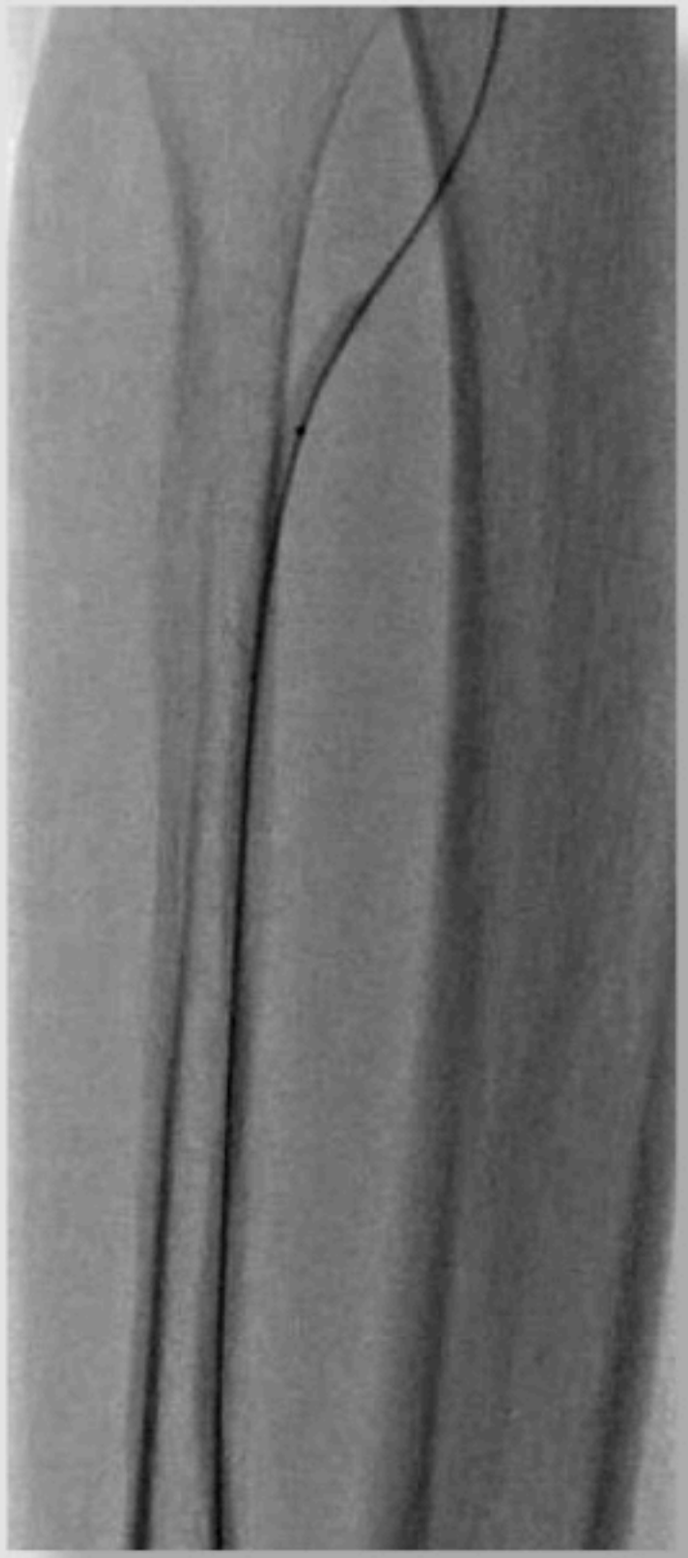
Basal ANGIO

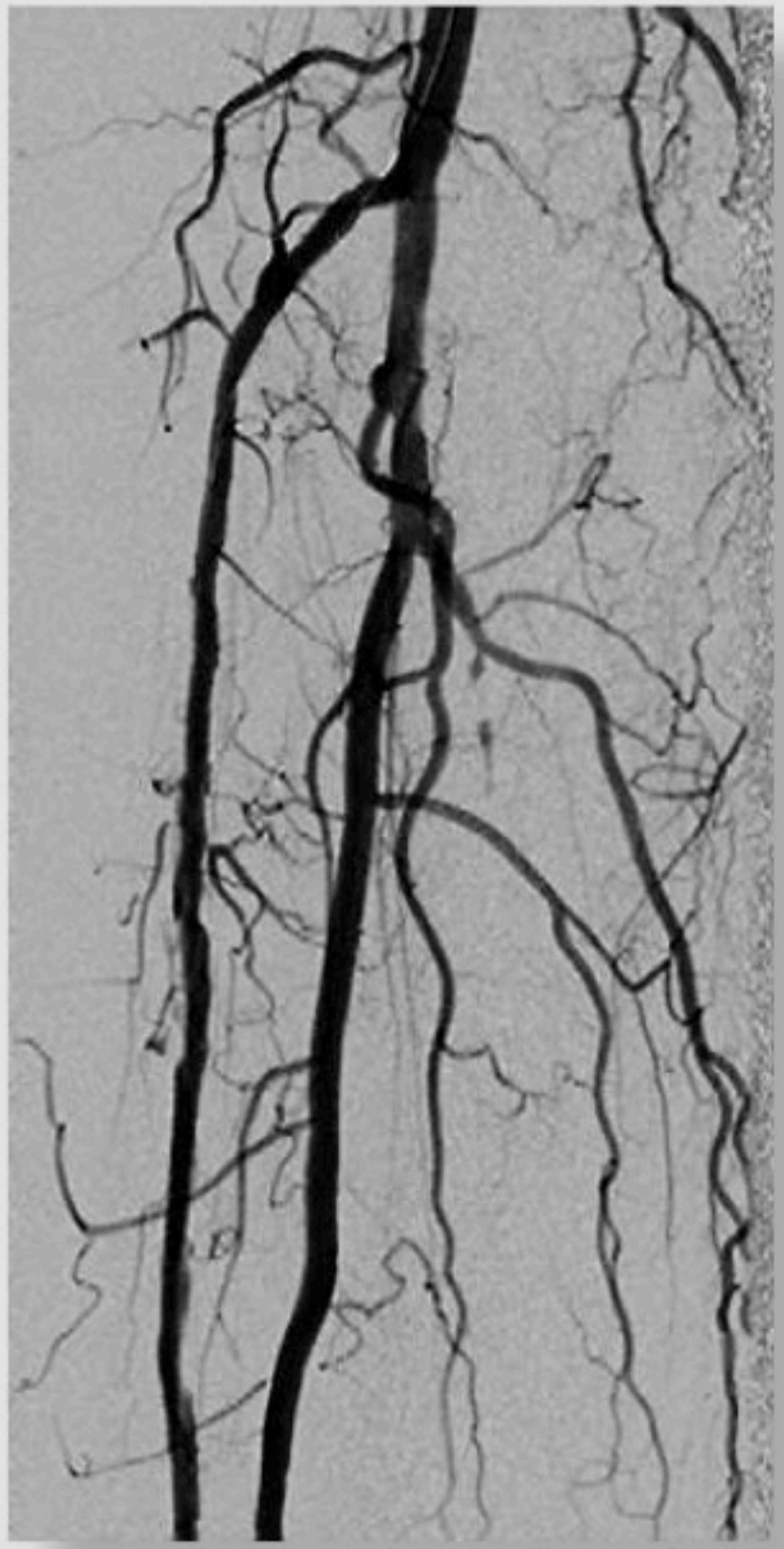
Basal ANGIO





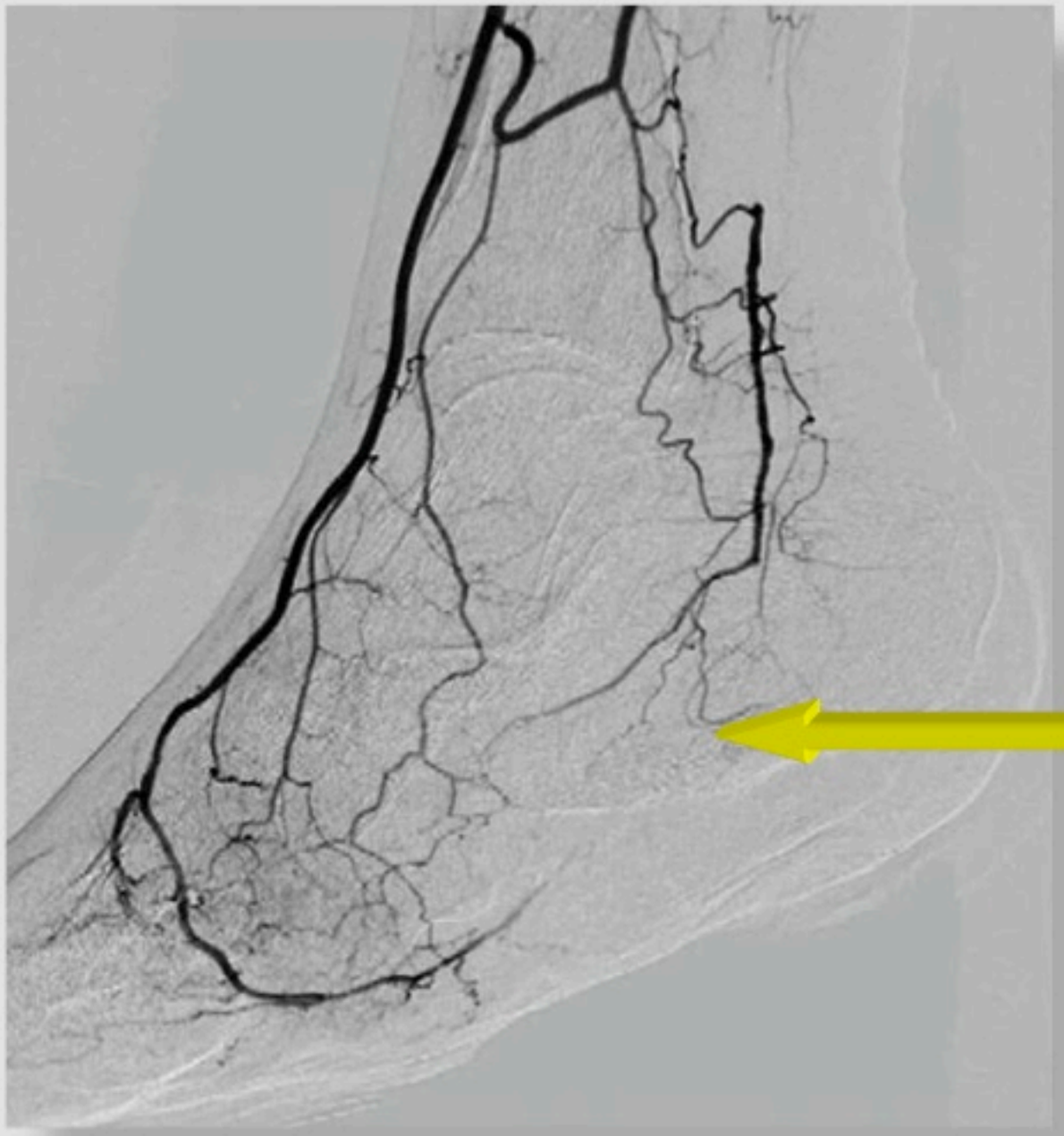
Proximal ATA treatment

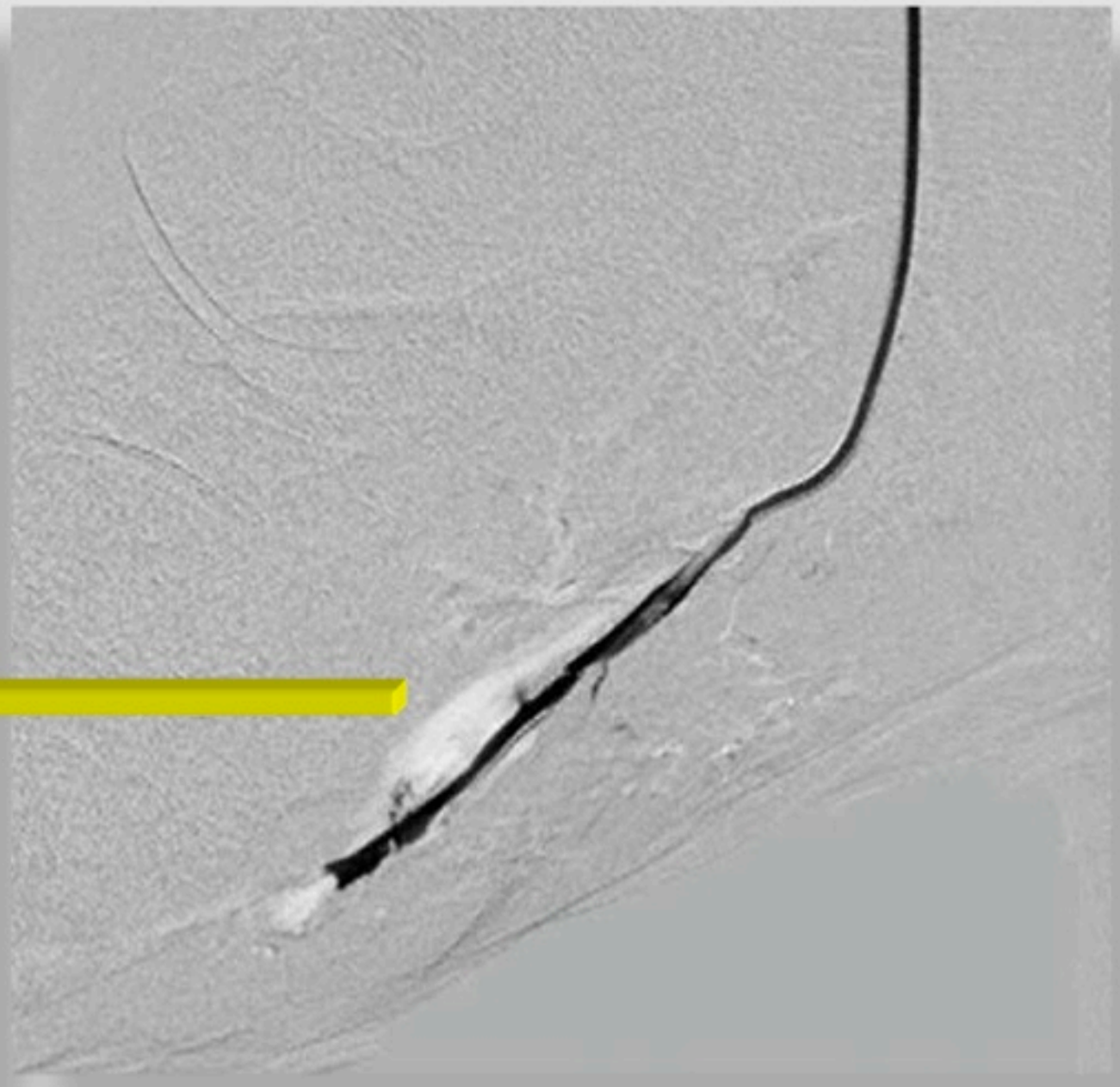




PTA subintimal approach

Failure!

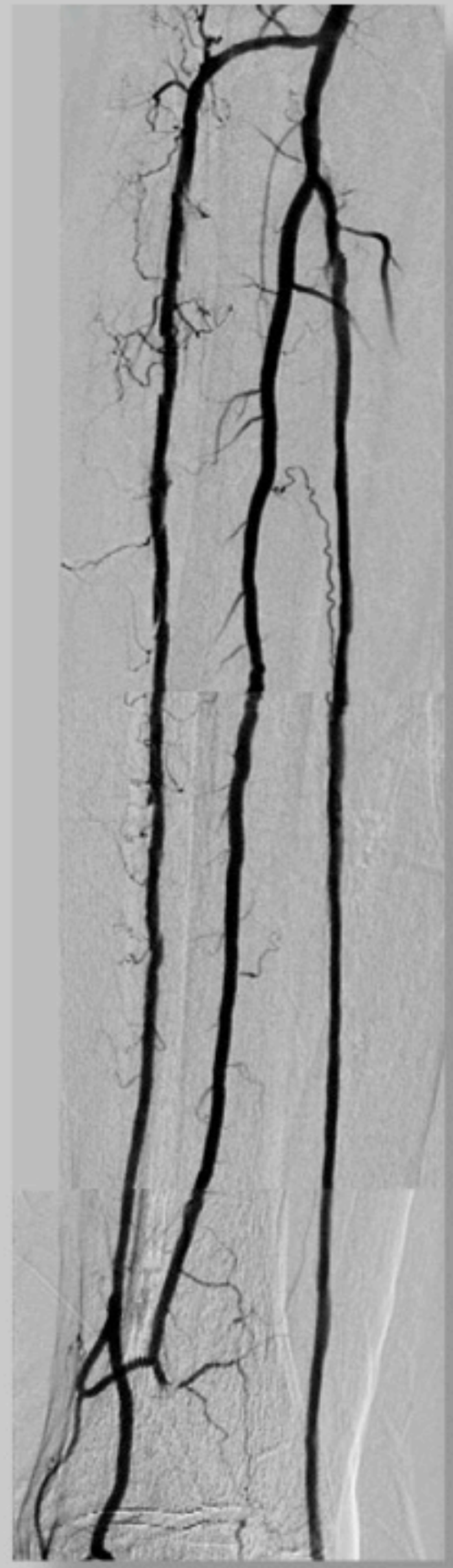


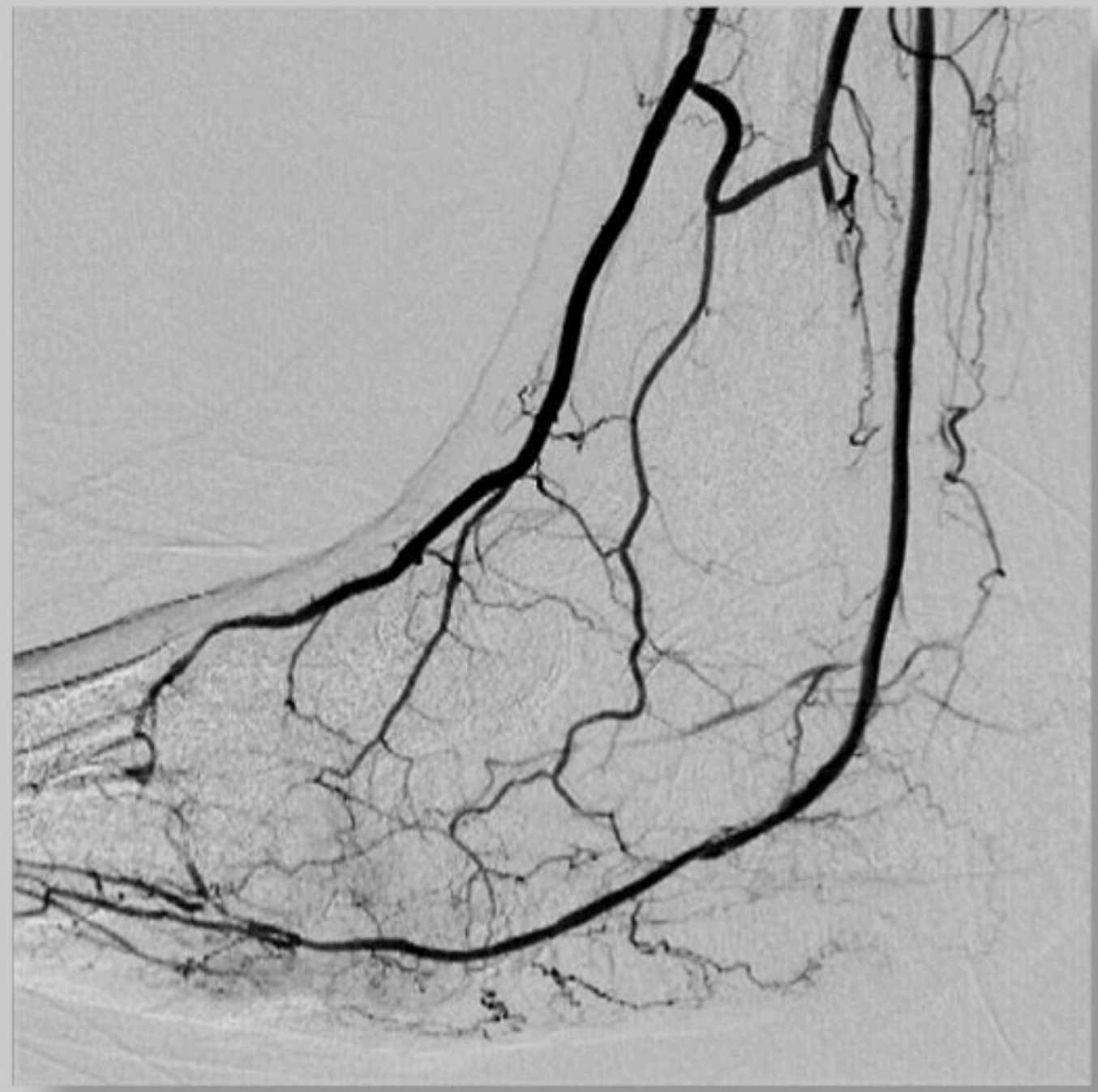


Pedal-plantar loop

Final result

Final result





CASE 2 LOOP

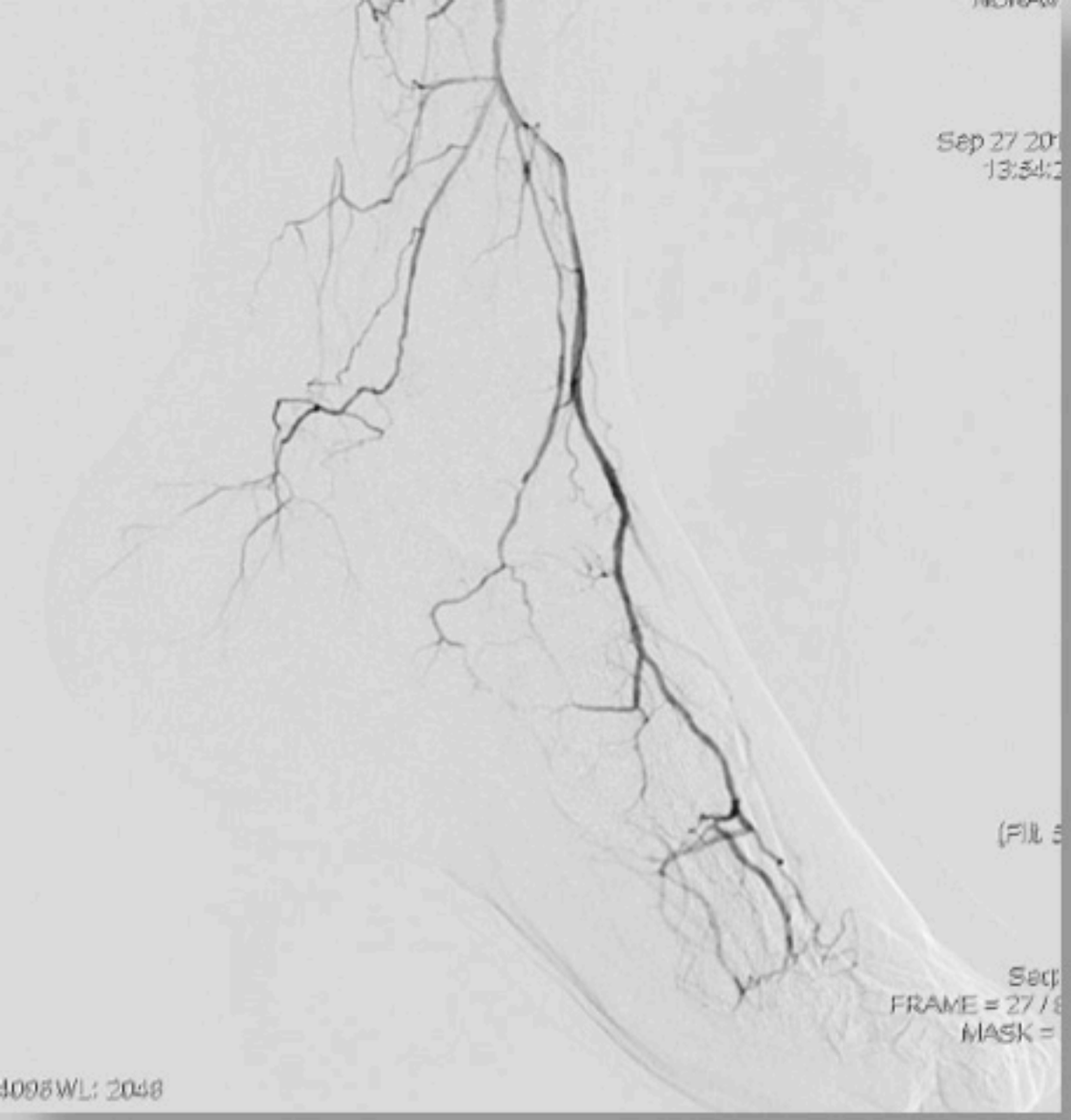
Why the pedal-plantar loop technique?

Failure of the subintimal approach in the lateral plantar artery

Basal ANGIO

- Occlusion of ATA and PTA
- Anterior dominance of peroneal artery
- Occlusion of dorsalis pedis and plantar arteries

Failure of lateral plantar artery subintimal angioplasty



The catheter is in a deep vein of the plantar region!

Pedal-plantar loop technique

Key point: 0.014”, hydrophilic wire, very soft tip. The last 1 mm must be 45-60° angulated.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Seq
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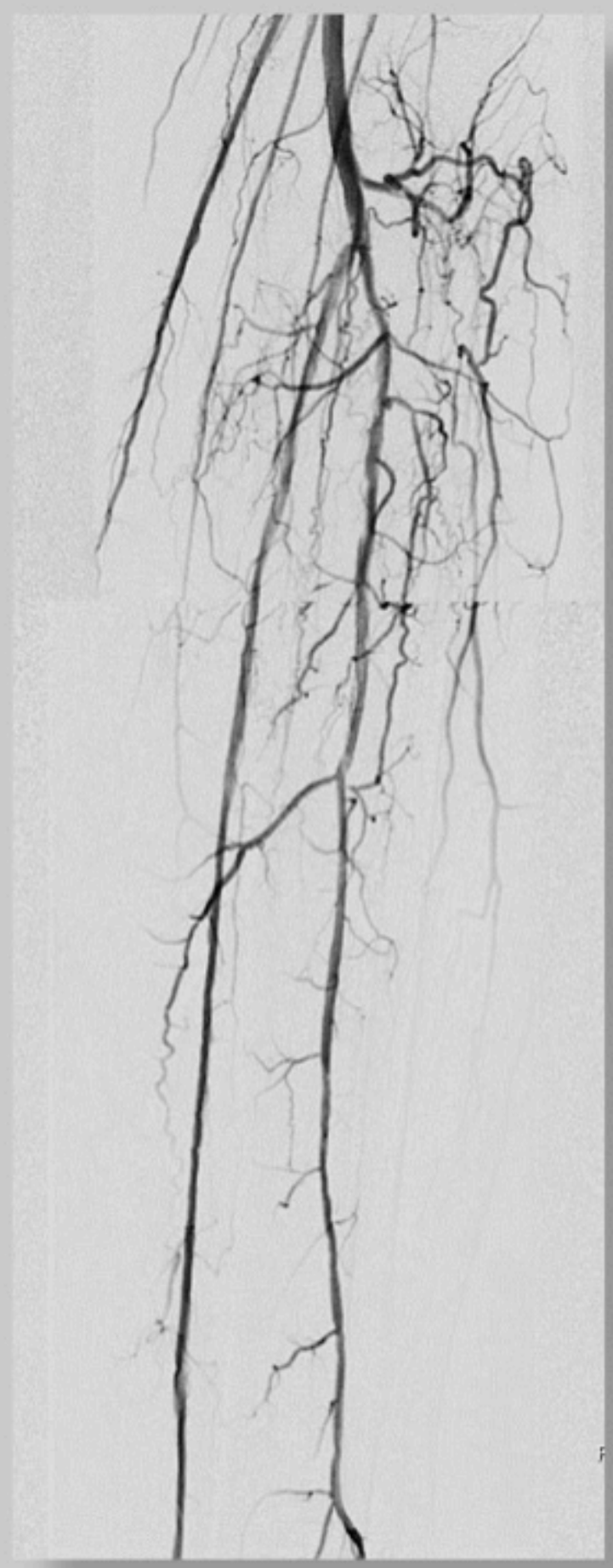
Balloon dilatation

Final result

Final result



CASE 3 LOOP

Why the pedal-plantar loop technique?

Diffuse disease of the foot vessels

Basal angio

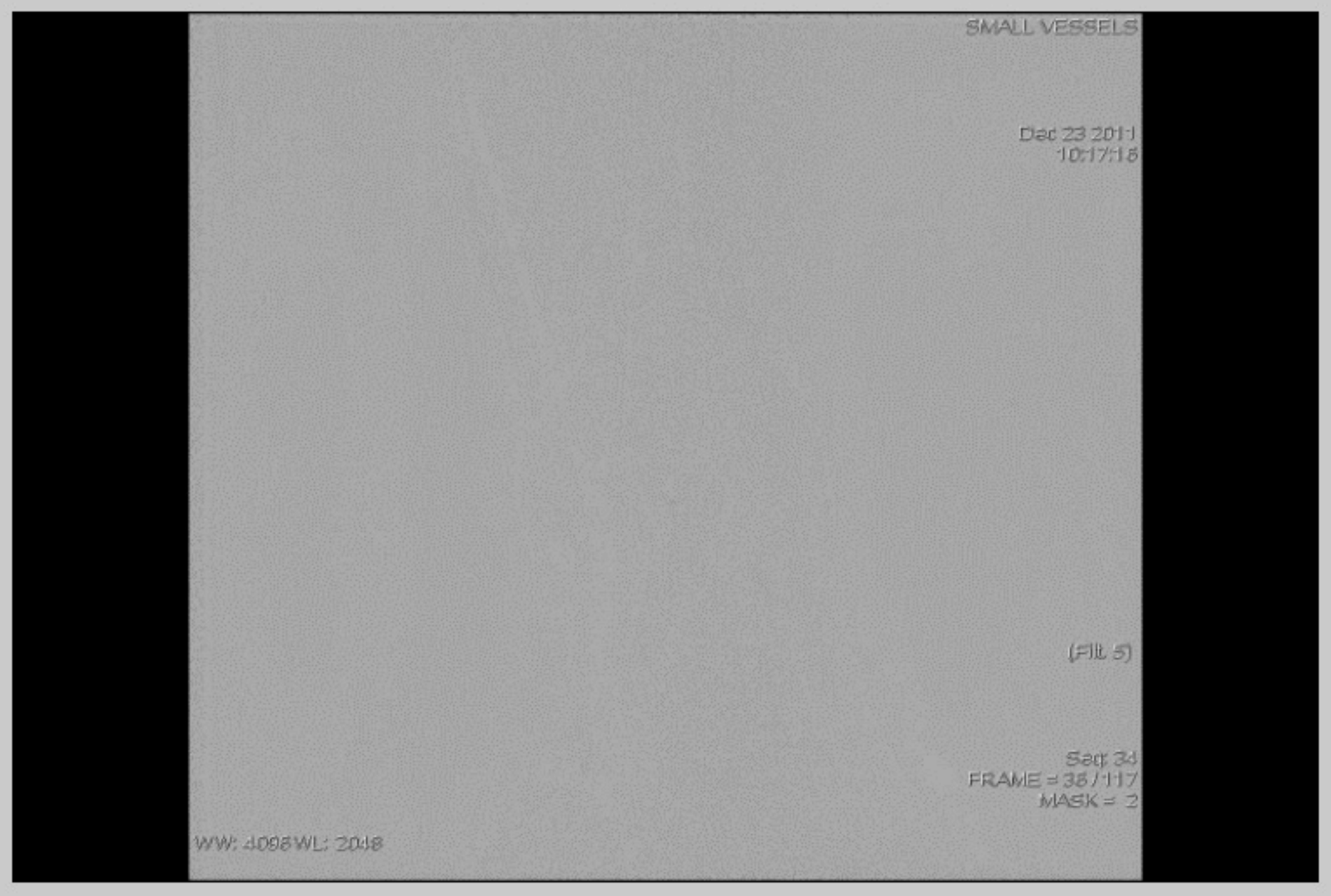
Basal angio

Diffuse disease of the foot vessels

Pedal-plantar loop

Final DEB treatment

Final result



Final result

Retrograde approach: the transcollateral approach

- **Retrograde puncture**
- **Transcollateral**
  1. Pedal-plantar loop technique
  2. Peroneal artery branches PTA

Retrograde approach: the transcollateral approach

Uses the natural vessel anastomoses to recanalize tibial or foot arteries

1. **“Deep arch”** of the foot can be used to recanalize the dorsal or plantar circulation or the pedal arch, through the tarsal branches.

2. **Distal peroneal artery branches** can be used to reach tibial and foot arteries. Angioplasty of a distal perforating peroneal branch can be sufficient alone to give a new direct blood flow line to an open foot vessel.

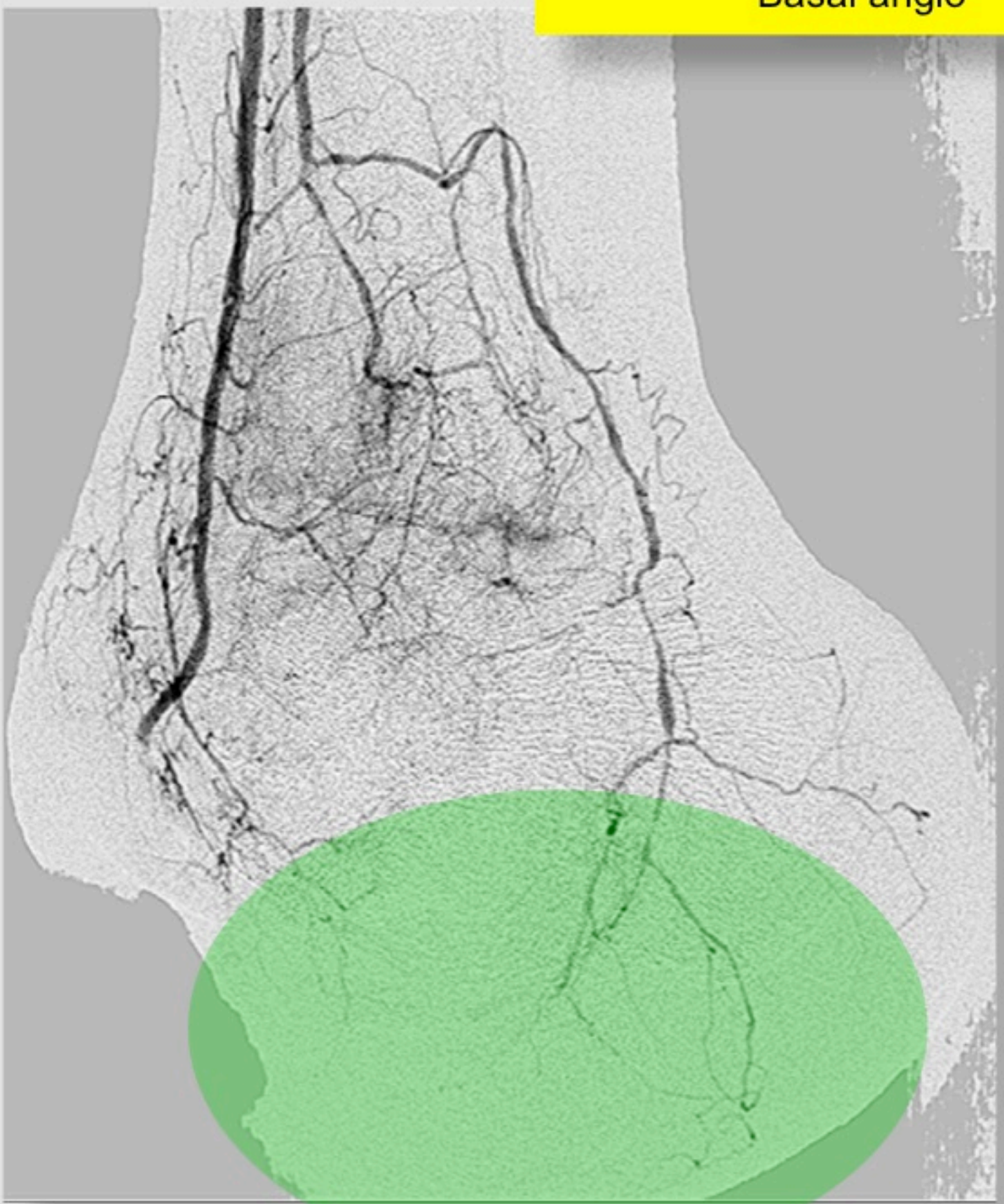
CASE 1 TRANSCOLL

Why the trans-collateral approach?

Impossible to open PTA; ischemia of the plantar flap of a Chopart amputation

Basal angio

Basal angio



Ischemia of the plantar flap of the amputation without healing

Treatment

Treatment

Final result

Basal angio

Final results

CASE 2 TRANSCOLL

Why the transcollateral approach?

Impossible to open ATA

Basal angio

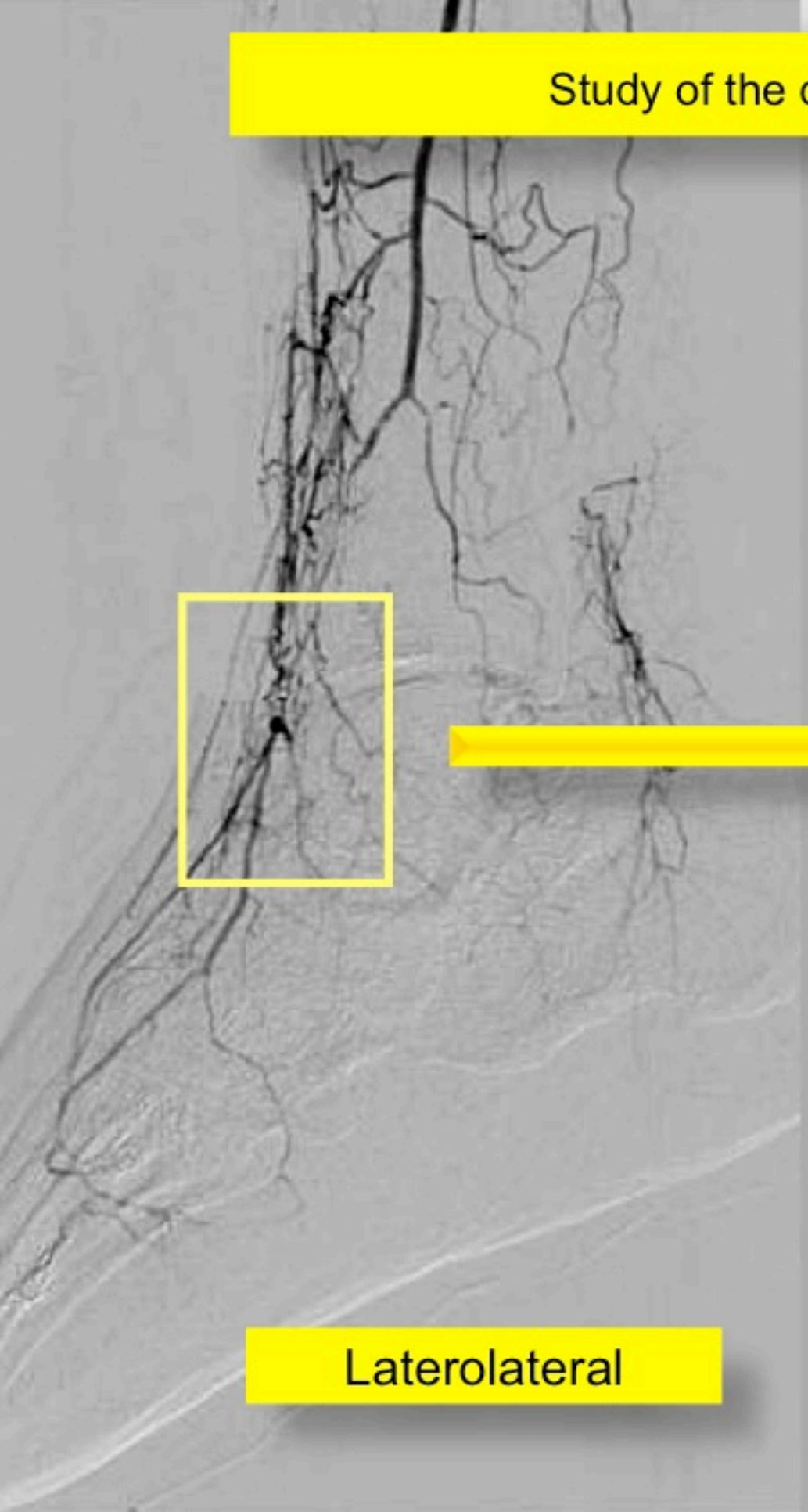
Basal angio

Failure of ATA treatment

Study of the distal peroneal artery distribution

Study of the distal peroneal artery distribution

Study of the distal peroneal artery distribution

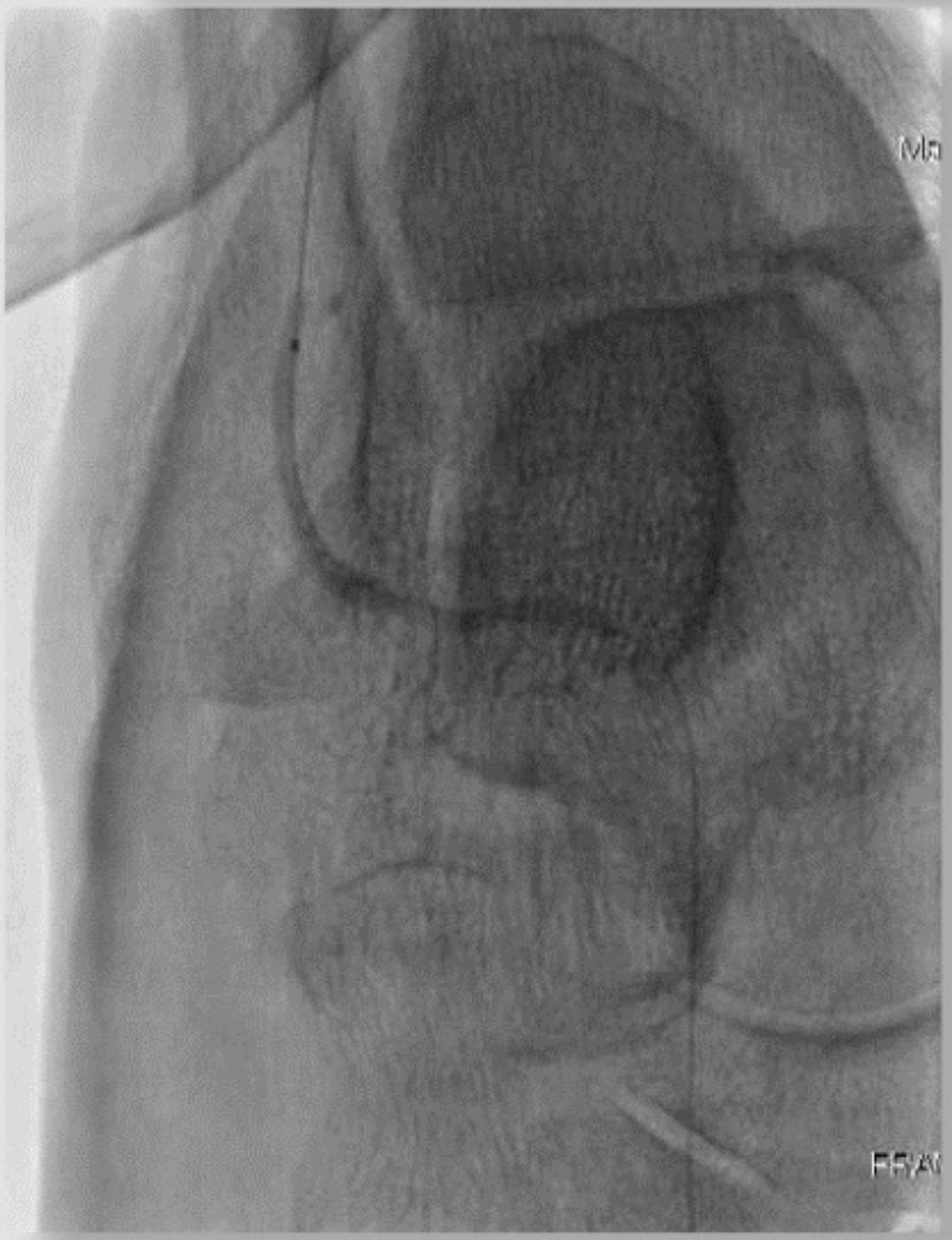


Laterolateral

Anteroposterior

Predilatation: 1.5 x 20 mm, 0.014", low-profile balloon

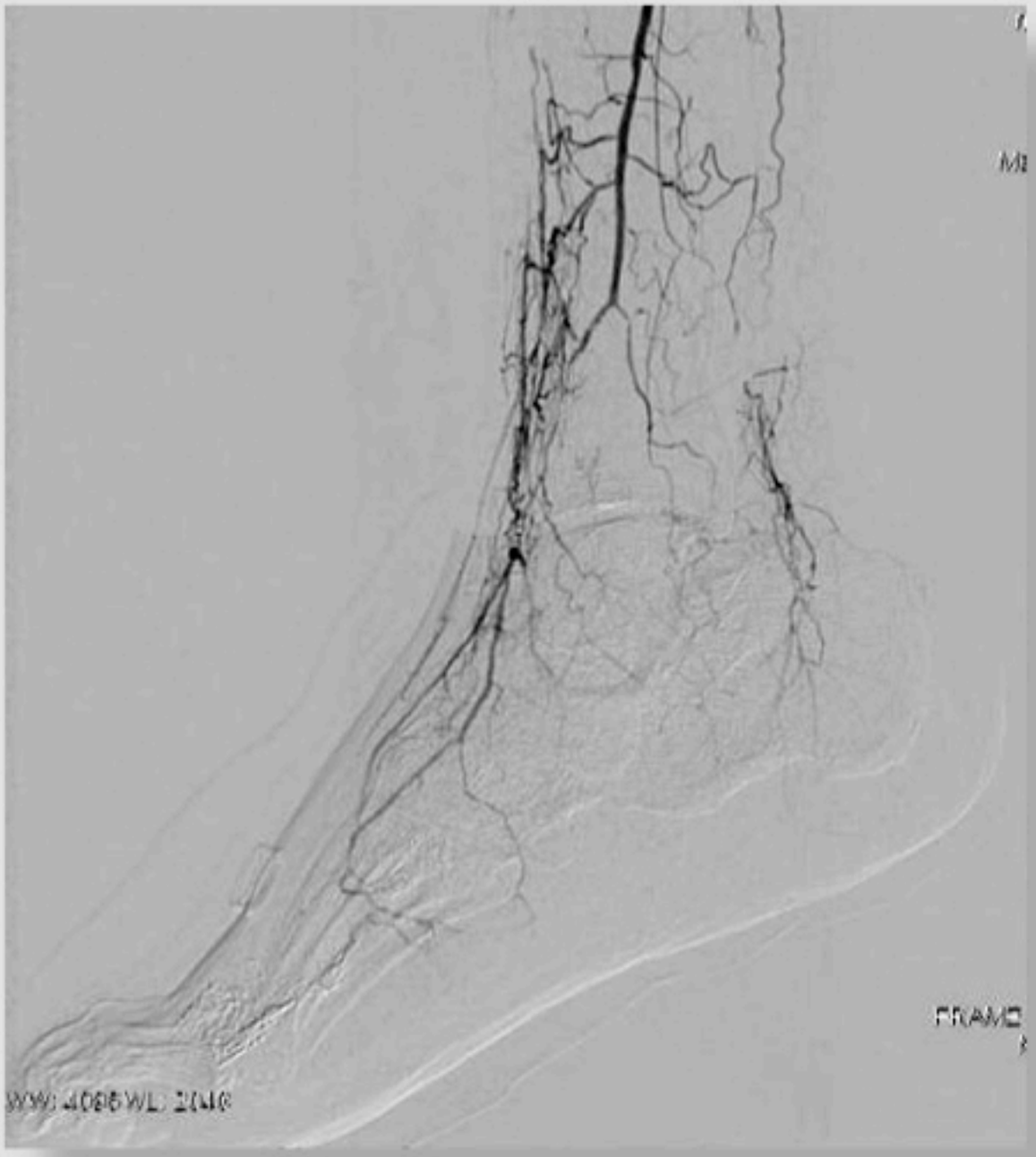
Final dilatation: 2.0 x 40 mm, 0.014", low-profile balloon



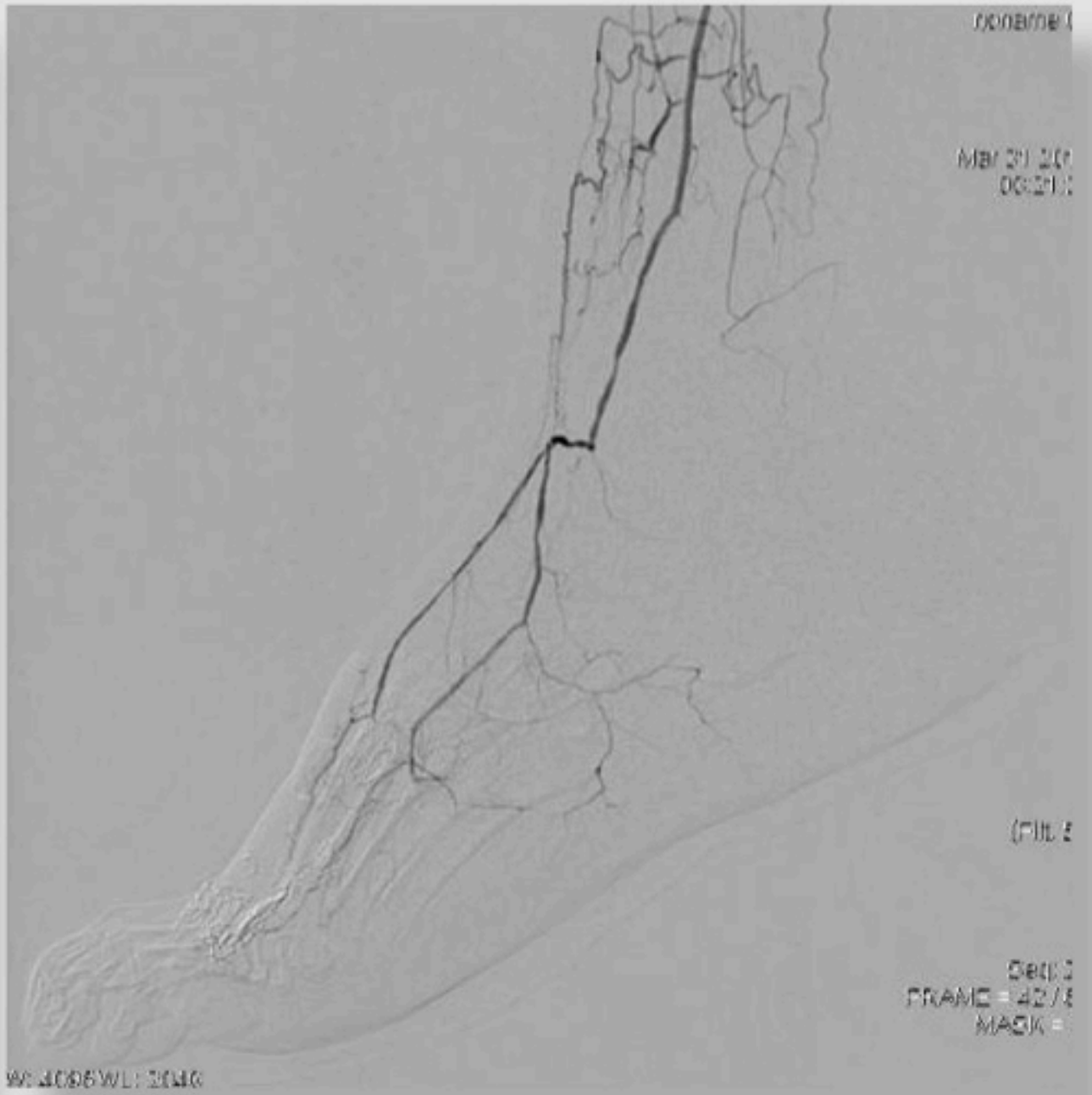
Final DEB treatment: 2.0 x 80 mm

Final result

Basal angio



Final results



CASE 3 TRANSCOLL

Why the transcollateral approach?

Easy to use a collateral peroneal branch to solve a failure of PTA subintimal approach

Basal angio

- Occlusion of ATA and PTA.
- Good distal lateral plantar artery

PTA subintimal angioplasty

Problem 1: PTA subintimal angioplasty

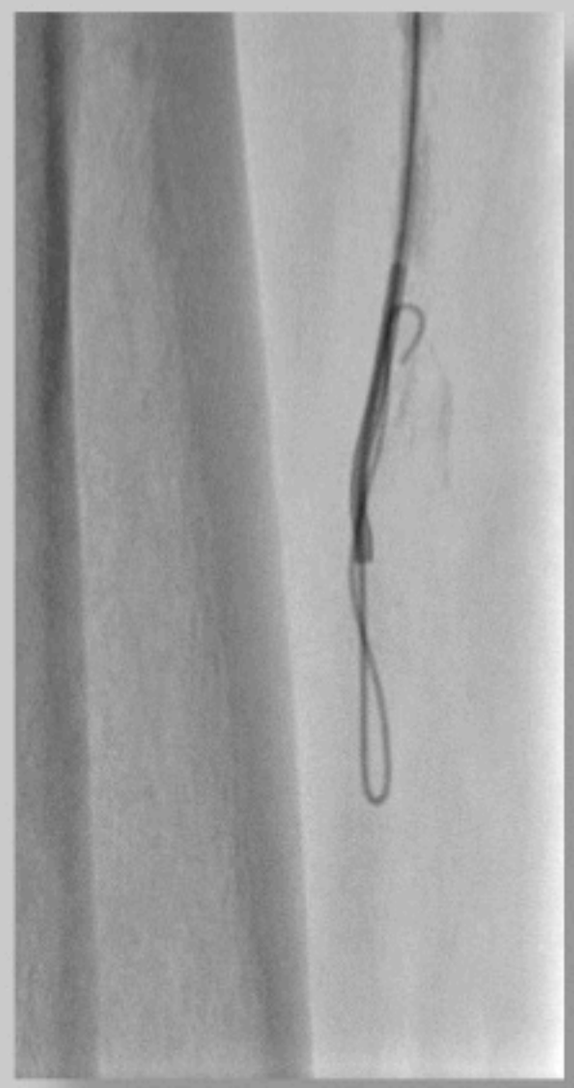
- **Impossible to continue because the subintimal lumen is too hard to cross**

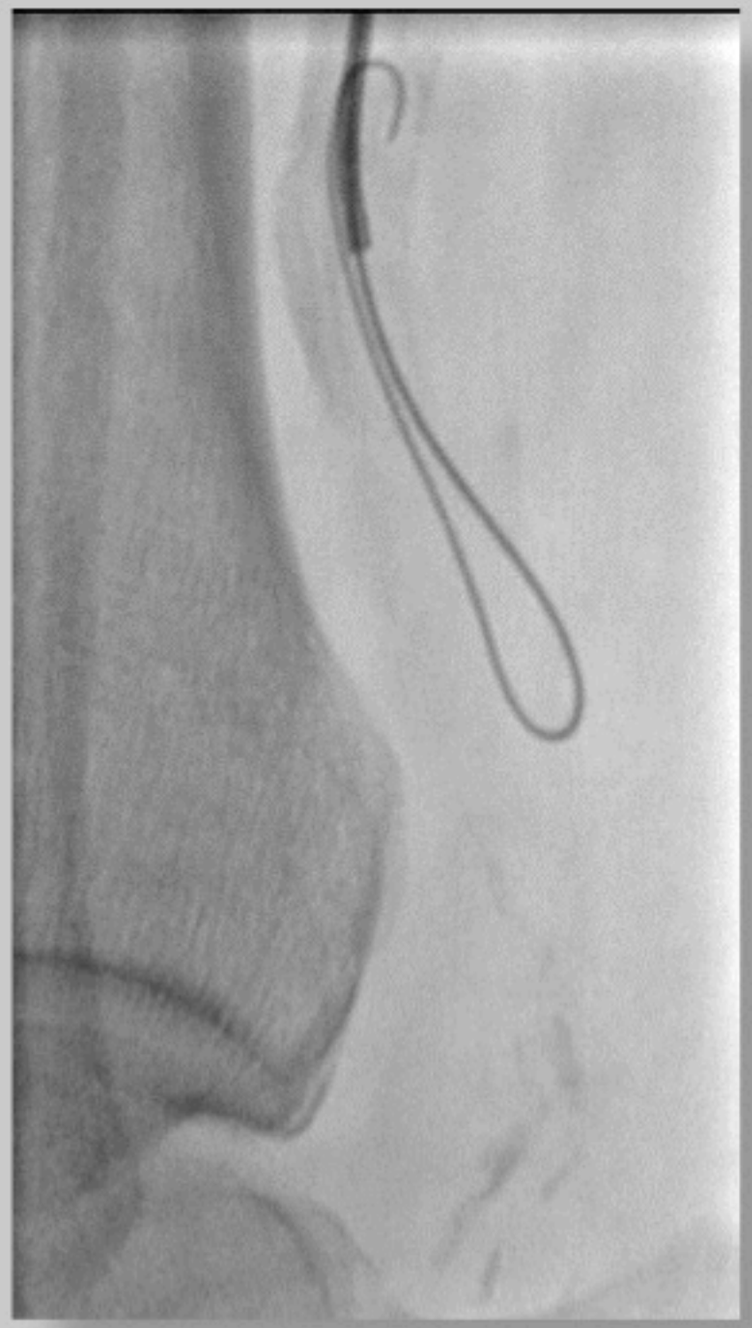
- **Solve by shifting from a sliding to puncturing strategy**

Bach tip, 0.035" wire

Shift back to the sliding strategy

Problem 2: The loop enlarges, failure of the subintimal approach





Observe this collateral vessel going from peroneal to distal PTA

Transcollateral approach

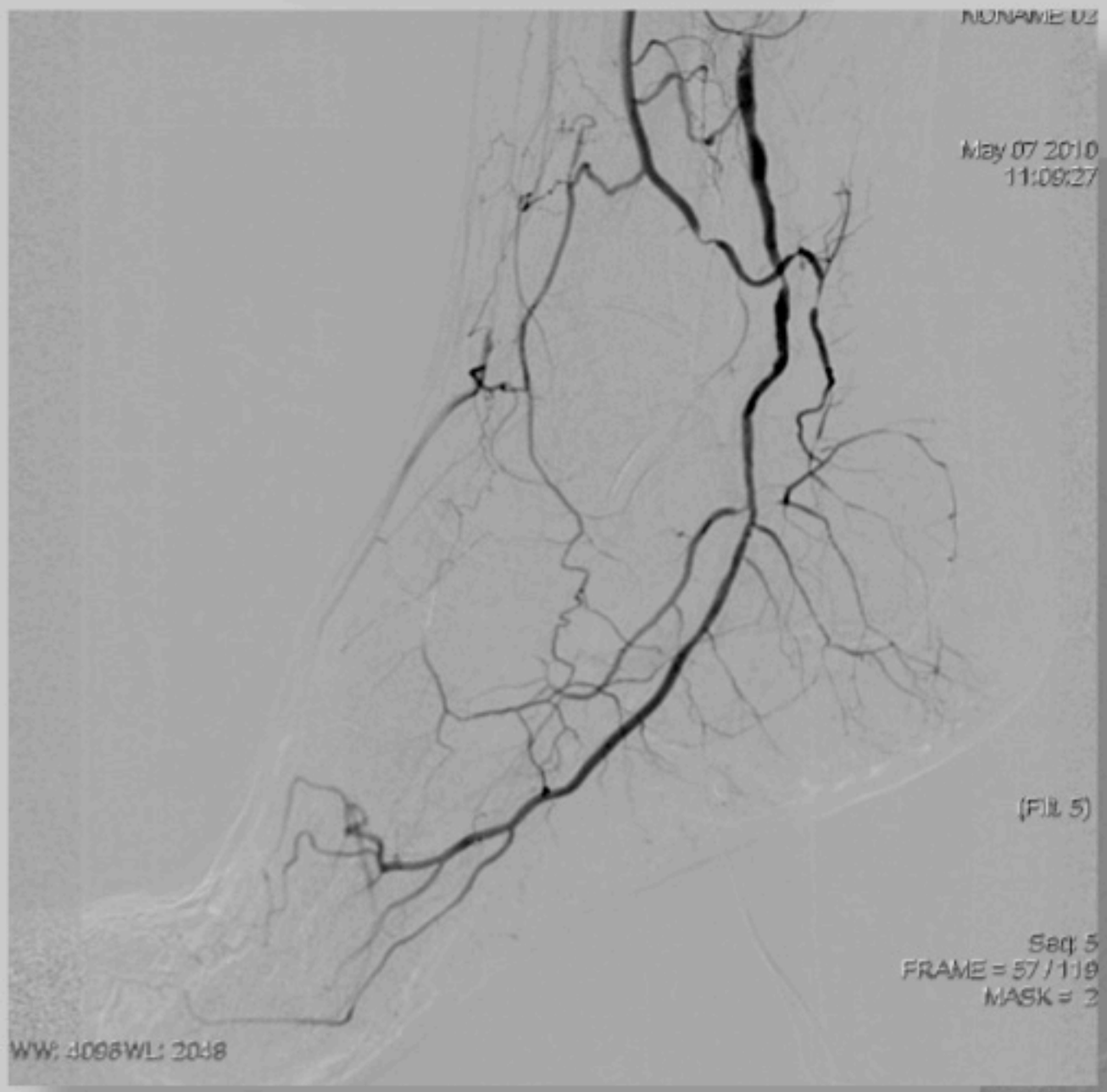
0.014” wire, low-profile, over-the-wire balloon

Final result

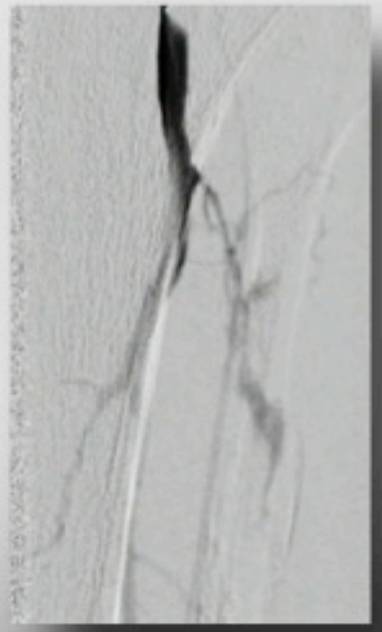
Basal angio

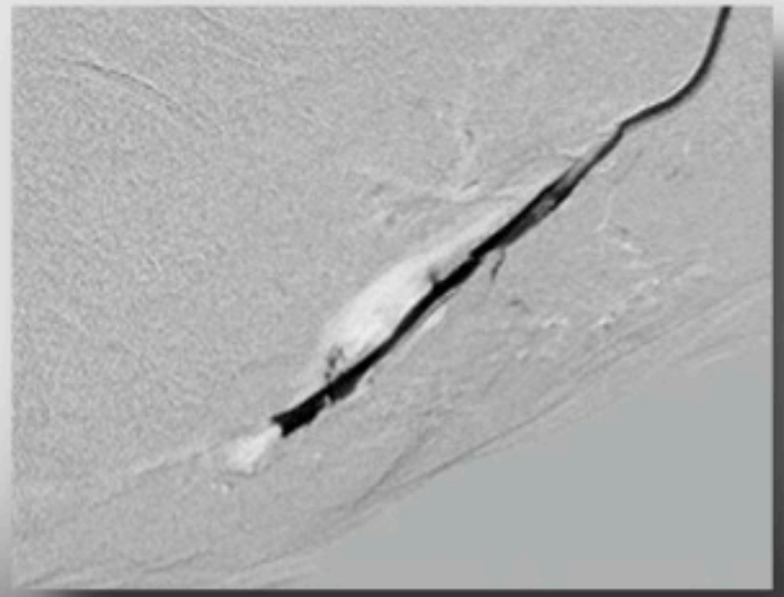
Final result

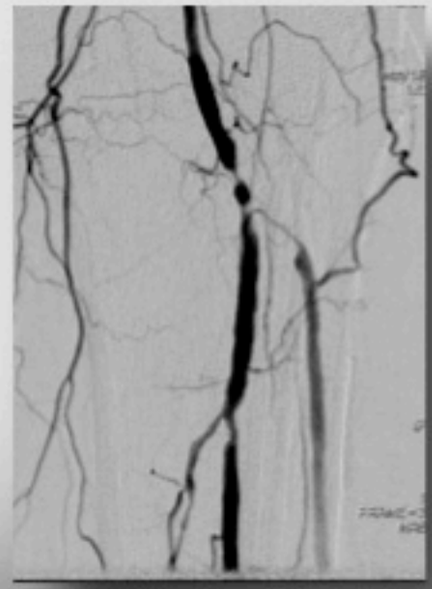
Basal angio



Final result







Retrograde approaches are essential in saving varied and complex situations…

With only a needle, a wire, your will, and extreme patience.