# Post-traumatic pseudoaneurysm of the medial plantar artery with arteriovenous fistula treated by coil embolization of the main feeding artery and percutaneous thrombin injection

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## ABSTRACT

Endovascular treatment for post-traumatic pseudoaneurysm (PsA) has been deemed effective and minimally invasive. However, embolization of all feeding and outflow vessels is difficult if multiple fine arteriovenous fistulas (AVFs) are present. In the present case, PsA of the medial plantar artery with AVF was diagnosed 1 month after injury by a rusty nail. Treatment using a combination of embolization of only the main feeding artery and percutaneous thrombin injection into PsA was successful. This approach can completely resolve PsA in narrow vessels, such as in the foot, particularly when AVF is present with numerous connected vessels. (J Vasc Surg Cases and Innovative Techniques 2021;7:51-5.)

**Keywords:** Pseudoaneurysm; AVF; Thrombin injection; Endovascular treatment; Trauma

Endovascular treatment (EVT) for post-traumatic pseudoaneurysm (PsA) has been deemed effective and minimally invasive; however, it is difficult to embolize all feeding and outflow vessels when vessels are narrow, such as in the plantar region, or multiple fine arteriovenous fistulas (AVFs) are present.[1-4] We report the successful treatment of a patient with PsA and AVFs in the plantar region by a combination of embolization only of the main feeding artery and percutaneous thrombin injection into the PsA.

## CASE REPORT

The present case is of a 77-year-old man with Hailey-Hailey disease and prostate cancer with no history of antithrombotic drugs. Approximately 1 month before his current presentation, he was treated in the emergency department after stepping on a rusty metal nail (length 6 cm, diameter 3 mm) while mowing his lawn. The nail was embedded in the inner sole of his right foot (Fig 1, *A* and *B*). An orthopedist removed the nail and cleaned, drained, and performed primary wound closure; the wound healed without infection. However, approximately 25 days after trauma, the wound site developed pain and swelling, and the patient sought evaluation on day 30 (Fig 1, *C*).

On presentation, the patient was afebrile. Physical examination showed a pulsatile mass in the plantar region, and shunt murmurs were also heard. The dorsalis pedis artery was patent and there were no symptoms of toe ischemia, right lower limb stasis, or heart failure. Blood tests showed no infectious reactions: white blood cell count was 4130/μL, C-reactive protein level was 0.13 mg/dL, and procalcitonin level was 0.02 ng/mL. Contrast-enhanced computed tomography scan and ultrasound imaging revealed a 3 cm × 2 cm PsA originating from the medial plantar artery (MPA), with early venous return to the posterior tibial vein and great saphenous vein (Fig 2).

The patient was diagnosed with PsA of the MPA with AVF, and EVT was performed. We placed a 4.5 F sheath into the right superficial femoral artery with a right common femoral artery antegrade puncture and performed digital subtraction angiography (Fig 3). We placed a 2F microcatheter in the proximal MPA, but we could not advance the guidewire to the periphery of the rupture site; therefore, we performed coil embolization only for the proximal MPA (AZUR CX18 3 mm × 8 cm; Interlock coil 2 mm × 4 cm and 2 mm × 6 cm). Although MPA-to-PsA blood flow disappeared and early venous return was attenuated, blood flow persisted in the PsA from small branches of the lateral plantar artery as well as the peripheral MPA retrogradely via the plantar arch (Fig 4). Once the blood flow to PsA decreased considerably, we completed the EVT, and then compressed the plantar region with a balled-up gauze and elastic bandage overnight.

PsA persisted the next day, and we percutaneously injected thrombin into the PsA using ultrasound guidance under avascularization at 200 mm Hg to the lower leg using a tourniquet to prevent venous thrombosis. After 0.5-mL thrombin injection (500 U), the PsA was completely thrombosed without venous thromboembolism or ischemia in the toes (Fig 5, *A* and *B*). Shunt murmurs and early venous return disappeared. In addition, PSA pulsation disappeared, and it became soft. The patient was discharged on postoperative day 3.

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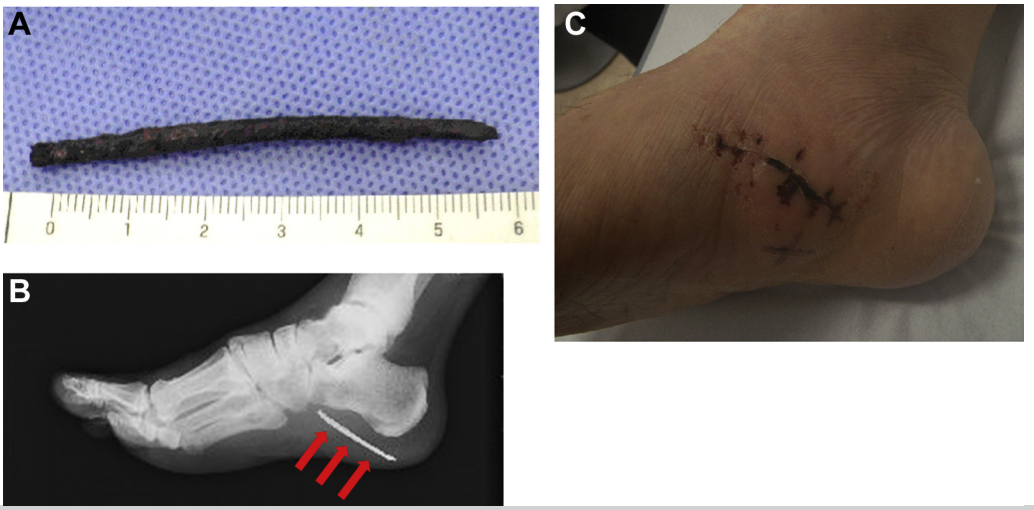


**Fig 1.** Photographs and radiograph of the trauma. **A,** Photograph of the rusty nail. **B,** Radiograph of the right foot in lateral view. *Red arrows*, shadow of the rusty metal nail. **C,** Photograph of the right foot on day 30 after the injury.

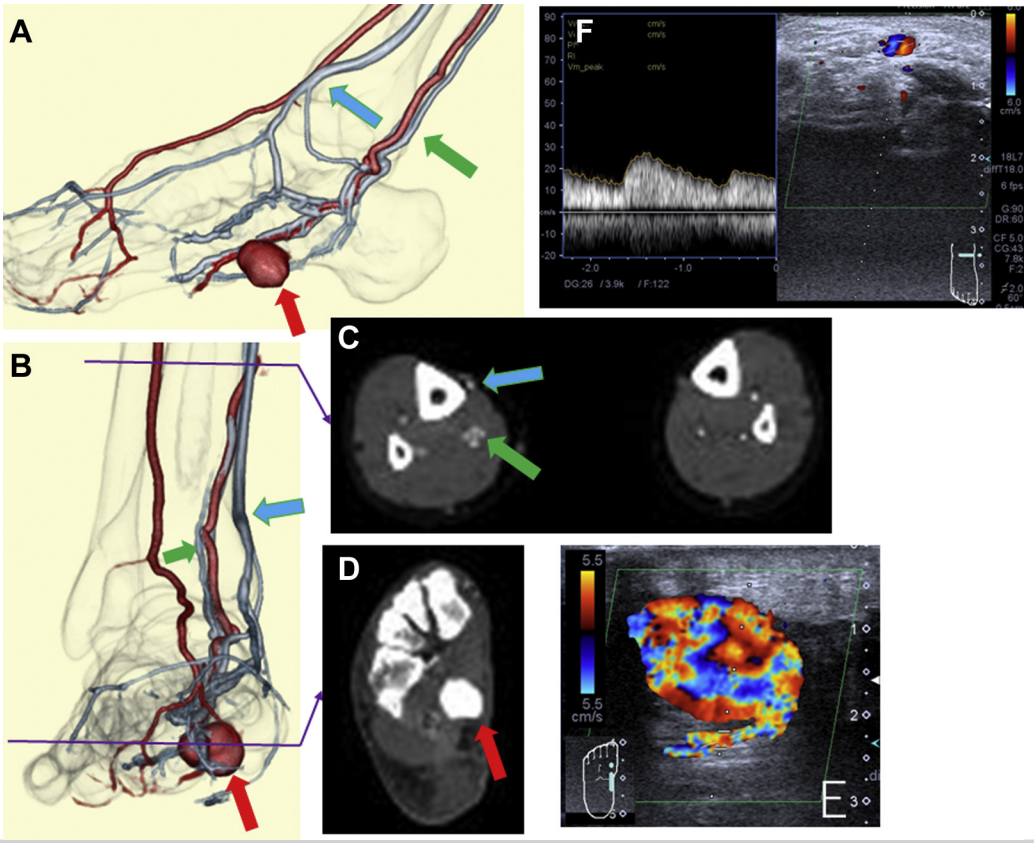


**Fig 2.** Computed tomography and ultrasound images on day 30 after the injury. *Red arrow*, pseudoaneurysm. *Green arrow*, early venous return to the posterior tibial vein. *Blue arrow*, early venous return to great saphenous vein. **A,** Volume-rendered lateral view of the right foot. **B,** Volume-rendered frontal view of the right foot. **C,** Axial view of the right lower leg. **D,** Axial view of the right foot and the pseudoaneurysm. **E,** Color Doppler image of pseudoaneurysm. **F,** Color Doppler image of great saphenous vein at the ankle that reveals arterial flow in the great saphenous vein.

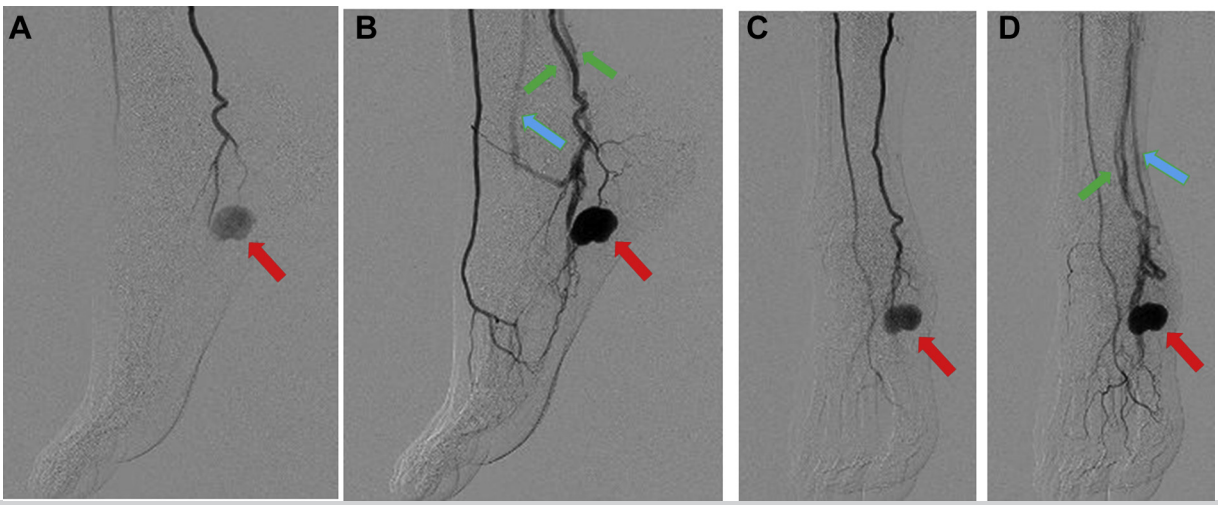


**Fig 3.** Digital subtraction angiography before embolization. *Red arrow*, pseudoaneurysm. *Green arrow*:, early venous return to the posterior tibial vein. *Blue arrow*, early venous return to great saphenous vein. **A,** Very early phase in lateral view. **B,** Early phase in lateral view. **C,** Very early phase in frontal view. **D,** Early phase in frontal view.

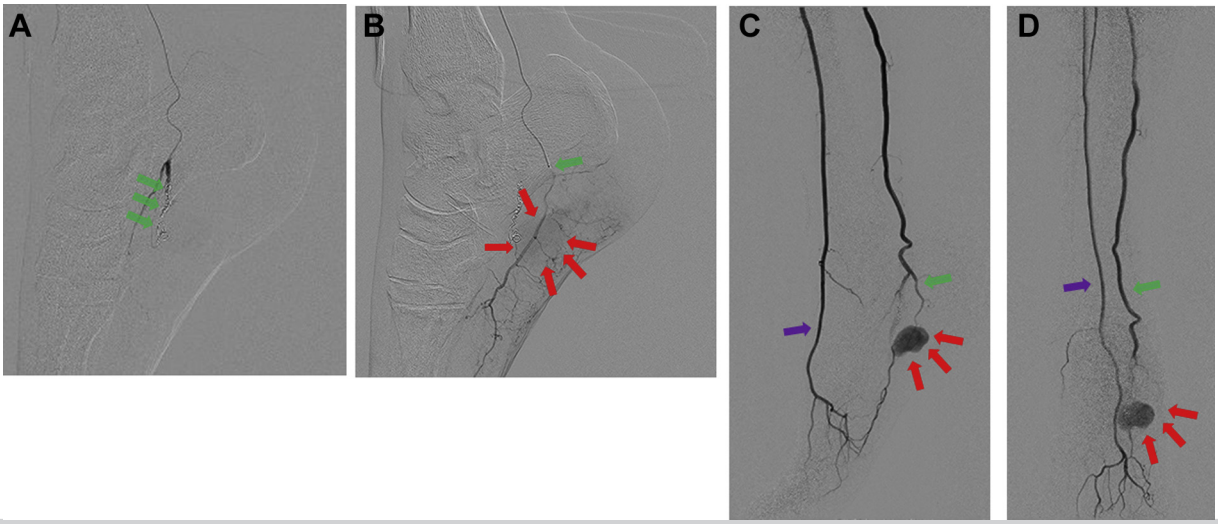


**Fig 4.** Digital subtraction angiography after embolization of medial lateral artery. *Red arrow*, pseudoaneurysm. *Purple arrow*, dorsalis pedis artery. **A,** Lateral view when contrast medium was injected from medial plantar artery (MPA). Pseudoaneurysm was not projected. *Green arrow*, embolization coils in MPA. **B,** Lateral view when contrast medium was injected from lateral plantar artery (*green arrow*). Pseudoaneurysm was projected in blood flow from the small branches of the lateral plantar artery. **C,** Lateral view when contrast medium was injected from superficial femoral artery. Pseudoaneurysm was projected in blood flow from the peripheral MPA retrogradely via the plantar arch. *Green arrow*, lateral plantar artery. **D,** Frontal view when contrast medium was injected from superficial femoral artery. Pseudoaneurysm was projected in blood flow from the peripheral MPA retrogradely via the plantar arch. *Green arrow*:, post-tibial artery.

The PsA had disappeared completely 1 month after treatment (Fig 5, *C*). Within 6 months, persistent numbness of the plantar region improved. At 2 years, the patient remains free from PsA recurrence and has no symptoms.

## DISCUSSION

In the extremities, PsA is often considered traumatic or iatrogenic, and the diagnosis is often delayed.[3] Most of these PsA cases occur in the thighs and lower legs, with a few reports in the foot, particularly with AVF.[1,5] Trauma to the MPA causes tarsal tunnel syndrome because of direct damage or compression by PsA to the accompanying posterior tibial nerve.[2,6]

Our patient had acute damage to the MPA resulting in PsA. Furthermore, branches of the surrounding veins and arteries were bluntly damaged, resulting in AVF connected to multiple blood vessels and tarsal tunnel syndrome.

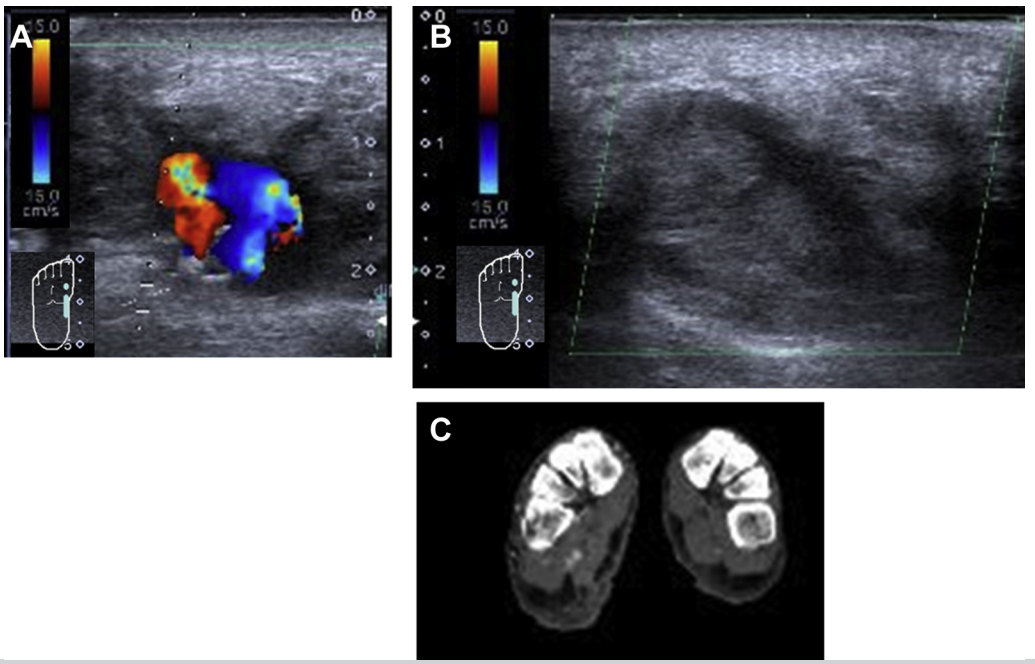


**Fig 5.** Ultrasound and computed tomography images before and after thrombin injection. **A,** Ultrasound image before thrombin injection. The pseudoaneurysm reportedly decreased in size compared with the size before embolization of main feeder. **B,** Ultrasound image just after thrombin injection. The pseudoaneurysm was completely thrombosed. **C,** Computed tomography image conducted 1 month after the treatment. The pseudoaneurysm disappeared completely.

Methods of PsA treatment include open surgery, EVT, and thrombin injection.[1-10] Peripheral blood flow is often sacrificed during the treatment of PsA in the lower legs because the blood vessels, particularly in the foot, are so narrow that revascularization is difficult while multiple major arteries are present.[1,3] Open surgery for PsA after trauma is inexpensive and radical; the compression for surrounding tissue may disappear immediately. However, open surgery has the risks of anesthesia, wound infection, bleeding, and collateral damage, particularly in the presence of detrition, scars, tissue adhesions, and numerous AVFs.[3,4] Although EVT is minimally invasive, embolization of all PsA feeding and outflow blood vessels, which is the preferred approach, is often difficult when the vessels are narrow or AVF with connection to numerous blood vessels is present.[1,4,5]

In another approach, numerous coils are inserted into the PsA. However, this method is expensive, may cause plantar discomfort when walking, and may introduce the risk for tarsal tunnel syndrome owing to a mass effect.[2,5] Percutaneous thrombin injection is often effective for PsA in EVT puncture site, with advantages such as being inexpensive and the absence of residual foreign matter after absorption and elimination of the thrombosed PsA.[8] However, injection is often ineffective when the ruptured hole in the artery is large. Furthermore, when no blind end is present, as in AVF with continuous high-speed blood flow, injection is not only ineffective, but also creates a risk for venous thromboembolism.[5,8,11] Selecting the appropriate treatment depends on the patient's general condition, the rupture hole site and size, and the need to maintain peripheral blood flow.

Our patient was ineligible for thrombin injections based on the large size of the artery rupture hole and the presence of an AVF. Considering the nonessentiality of MPA blood flow preservation and risk of open surgery, particularly the collateral damage of nerves, we first selected EVT. We attempted the embolization of both inflow and outflow of PsA; however, MPA cannulation in the periphery of the rupture site was difficult. Based on a report that PsA in MPA was completely resolved with only the embolization of the inflow artery, we embolized only the inflow artery first; however, although blood flow to the PsA was considerably decreased, it remained.[2] Moreover, because the main inflow artery was embolized and numerous connected vessels, such as the small branches of the lateral plantar artery, were revealed, we determined that embolization of all connected blood vessels was infeasible. Intra-aneurysmal embolization was also ineligible based on the possible sequelae of discomfort and tarsal tunnel syndrome. Because blood flow to PsA was considerably decreased, we initially selected percutaneous thrombin injection, and the treatment was successful. The nerve compression by PsA decreased immediately after thrombin injection without relief incision, and PsA disappeared without permanent tarsal

tunnel syndrome. Avascularization was considered to have prevented thrombin from flowing into the vein and facilitated creating blind ends and thrombus formation in PsA; hence, the patient was cured without venous thromboembolism.

## CONCLUSIONS

The combination of embolization involving only the main inflow artery and percutaneous thrombin injection may completely resolve PsA in narrow vessels, such as in the foot, particularly in cases with numerous connected vessels and AVF. This procedure is minimally invasive and inexpensive and results in minimal residual foreign matter.

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