

Iatrogenic thrombosis of the deep inferior epigastric artery during diagnostic angiography—a rare complicating factor during rectus free flap harvest

Christopher G. Langhammer, MD, PhD,^a Nathan F. Miller, MD,^a Carl L. Herndon, MD,^b Allen P. Burke, MD,^c Rishi Kundi, MD,^d and Raymond A. Pency, MD,^a Baltimore, MD; and New York, NY

ABSTRACT

We describe a 28-year-old man who sustained an open IIIB left ankle fracture dislocation with heel pad avulsion. The patient underwent formal angiography of the left lower extremity, followed by free tissue transfer of a rectus abdominis flap several days later. Intraoperatively, a thrombus was identified in the deep inferior epigastric artery above the femoral artery access site requiring thrombectomy. Histologic analysis estimated the thrombus age at 12 to 72 hours, raising concern that the thrombus was induced during angiogram instrumentation. Donor and recipient site-specific risks of arterial instrumentation (including invasive diagnostics) should be considered when planning free tissue transfer. (*J Vasc Surg Cases Innov Tech* 2022;8:580-2.)

Keywords: Limb salvage; Rectus abdominis free flap; Angiogram; Pedicle thrombus; Flap salvage

Selective, catheter-based angiography (CBA) remains the gold standard for the assessment of arterial anatomy.¹ CBA is a well-tolerated procedure, with an acceptably low complication rate.^{2,3} Complications are related to hematoma and pseudoaneurysm, with common femoral arterial stenosis or occlusion rates reported at less than 0.5%.⁴

Less invasive imaging modalities like arterial duplex, computed tomography angiography,^{5,6} and magnetic resonance angiography⁷ have recently proven effective at imaging vascular anatomy at recipient and donor sites for preoperative planning.^{8,9} These advances have caused many to reconsider the need for invasive imaging. The adoption of these alternative imaging modalities has been slow, as the presence of post-traumatic soft tissue changes and the presence of orthopedic implants complicate their interpretation.

With the consent of the patient, we report a case where unknown injury to a vascular pedicle sustained during

preoperative angiography was discovered during free tissue transfer surgery and required thrombectomy before anastomosis.

CASE

A 28-year-old man sustained left leg injuries in a motorcycle collision including open talar extrusion, heel pad avulsion, and laceration of the posterior tibial artery. He underwent primary repair of the artery to maximize perfusion to the foot, but developed full thickness necrosis of the posteromedial heel pad. Debridement of the wound resulted in a soft tissue defect with exposed bone and joint. After a discussion regarding amputation vs limb salvage, the patient was indicated for free tissue transfer to address the soft tissue defect.

He underwent CBA of the left lower extremity performed through a contralateral retrograde approach, with ultrasound visualization of the right common femoral artery and cannulation with a 0.018 inch micropuncture system 5 to 10 mm proximal to the femoral bifurcation. The 0.018 inch wire was advanced into the external and common iliac arteries with fluoroscopic confirmation before the micropuncture sheath was advanced to minimize the probability of vessel injury. There was no difficulty with the approach, and no “J-loop” was seen at any point during cannulation or sheath placement. This contralateral approach is used in patients with a pre-existing contralateral computed tomography angiography (Fig 1) because it allows our team to cannulate the vessel and advance the catheter to the segment of interest without the use of contrast, reducing total contrast load. The inferior epigastric artery was not selected for imaging at the time of the original angiogram. Up-and-over access was followed by wire selection of the left external iliac and superficial femoral arteries. Infringuinal angiography was performed

From the Department of Orthopaedics, R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore^a; the Department of Orthopedic Surgery, Columbia University Irving Medical Center, New York^b; and the Department of Pathology,^c and Division of Vascular Surgery, R Adams Cowley Shock Trauma Center,^d University of Maryland Medical Center, Baltimore.

Author conflict of interest: none.

Correspondence: Christopher G. Langhammer, MD, PhD, Department of Orthopaedics, R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, 22 South Greene St, Baltimore, MD 21201 (e-mail: clanghammer@som.umaryland.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

© 2022 The Author(s). Published by Elsevier Inc. on behalf of Society for Vascular Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jvscit.2022.08.001>



Fig 1. A maximum intensity projection reconstruction from a post-injury computed tomography angiography demonstrating an intact inferior epigastric artery before instrumentation for catheter-based angiography (CBA), and its relationship with the external iliac artery.

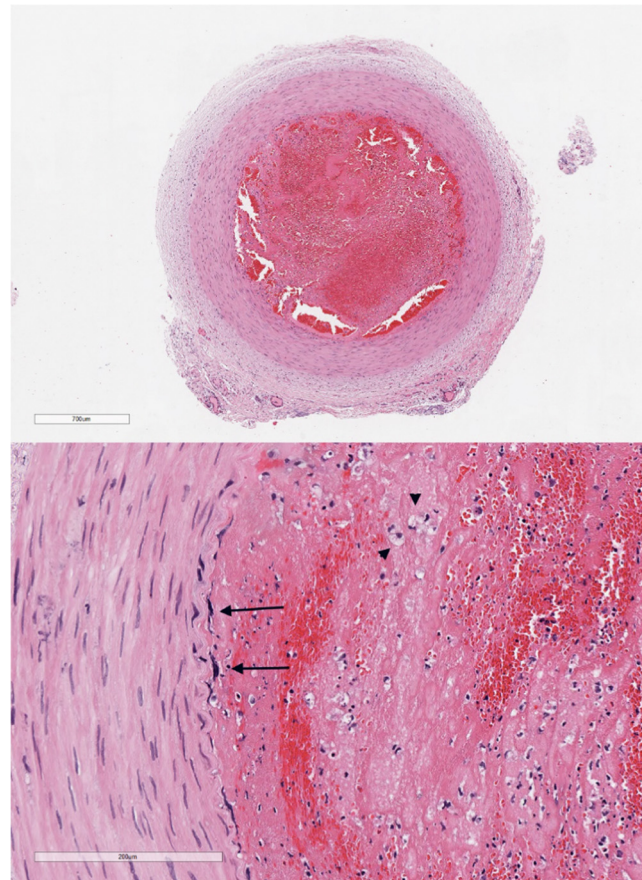


Fig 2. Artery occluded by a thrombus (above). Endothelial swelling (*long arrows*) and perinuclear haloes (*short arrows*) around pyknotic leukocytes in the thrombus. These changes are most compatible with the thrombus duration of 3 to 8 days.

through a 5F Glide catheter (Terumo) positioned first in the external iliac artery and then at the adductor hiatus. A crossover working sheath was not used. Images confirmed patency of the arterial tree from the aortoiliac system to the popliteal trifurcation demonstrating two-vessel runoff into the left foot. The posterior tibial artery flow became severely attenuated in the proximal calf, and the flow was clearly inadequate to support free tissue transfer. The dynamic view of arterial flow provided by CBA guided the surgical decision to use the peroneal system as the recipient vessel.

Four days later the patient was taken to the operating room for free tissue transfer of the right rectus abdominis to the left calcaneal defect with primary anastomosis to the peroneal vessels. The rectus abdominis muscle was harvested in the standard fashion.¹⁰ The superior and inferior epigastric vessels were identified. The superior epigastric vessel was ligated, and the muscle was elevated in a cephalad to caudal direction. Care was taken not to place the pedicle on traction while the deep inferior epigastric vessels were skeletonized at their takeoff from the external iliac artery (Fig 1).

There was concern for ischemia during flap elevation due to color change in the muscle tissue. Doppler probe examination demonstrated strong flow in the external iliac vessel and the absence of flow in the inferior epigastric artery. The vessel was noted to appear darker than expected and have reduced compressibility. On division of the pedicle, an organized thrombus was noted within the pedicle artery. A portion of this clot was removed and was sent for histologic analysis. The total length of the clot was 3 cm.

The pedicle was shortened incrementally until the proximal level of the clot could be reached. Direct thrombectomy was performed using a 2-mm Fogarty catheter (Edwards Lifesciences Corporation). The intima was examined visually and thought to be uninjured at this level. Arterial inflow of the flap was flushed with heparin saline (100 units/cc) resulting in clear drainage from the venae comitantes.

Vessel anastomoses were performed into the peroneal system using interrupted 8-0 nylon sutures placed under an operating microscope. The patient was administered a bolus of 5000u heparin at the time of anastomosis and

was placed on a maintenance regimen of 500 units per hour heparin infusion because of the concern for thrombosis and missed intimal injury. He was additionally maintained on the facility standard anticoagulation regimen of 81 mg of aspirin twice a day. There were no postoperative complications. The patient was taken off the heparin infusion 1-week postoperatively.

Histologic analysis of the thrombus (Fig 2) placed the age of the clot between 3 and 8 days based on the findings of leukocyte pyknosis and presence of endothelial budding.¹¹⁻¹³ This timing corresponded more closely with the angiogram than the surgery and is suggestive that the pedicle thrombus was an iatrogenic consequence of the diagnostic angiogram.

DISCUSSION

There is unavoidable intimal injury during arterial cannulation and locally altered hemodynamics during diagnostic angiography. Flow can be temporarily stopped in vessels close to the access site, whereas the origin is occluded by the catheter during the procedure or during manual compression for hemostasis after decannulation. In a prothrombotic post-trauma patient, this could be enough to facilitate clot propagation. Because the inferior epigastric artery was not selected for imaging at the time of the original angiogram, there is a probability that there was unappreciated dissection at the origin of the vessel. This dissection is unlikely given the use of a micropuncture system and continuous ultrasound visualization during cannulation. However, even without intimal injury from technical error, vessels can thrombose during instrumentation. Local vessel thrombosis may be well tolerated in the overwhelming majority of patients. In free tissue transfer patients, however, this unobserved complication may become clinically significant.

We believe that this case highlights important points to be considered in limb salvage surgery:

1. It is best practice to check the patency of the primary vascular pedicle before dividing secondary pedicles when elevating a free flap. Had the insufficiency of the deep inferior epigastric system been known, the flap could have been based off the superior system and would not have incurred the prolonged period of ischemia and increased risk of flap failure.¹⁴
2. Direct thrombectomy is an option when acute changes in perfusion to a flap are secondary to pedicle thrombus. We recommend excising the portion of the pedicle with the thrombus present, performing direct thrombectomy via passage of a small Fogarty catheter, and flushing the flap with a heparinized saline solution. If there is concern for substantial intimal damage, consider using an alternative flap.
3. If CBA is used for assessing recipient vessel availability, we recommend heparinization during the angiogram. In addition, we recommend considering an angiogram of the donor pedicle at the completion of the CBA if the donor vessel is at all in the field of

activity during angiography. This procedure can be performed through the short sheath before removing it.

CONCLUSIONS

This case report describes an iatrogenic deep inferior epigastric pedicle thrombus resulting from CBA performed through femoral artery access. The rectus abdominis flap was salvaged by transection of the pedicle more proximally, removal of the thrombus, and flushing with a heparinized saline solution. This case highlights the risks of using a rectus abdominis flap after previous femoral artery instrumentation in the setting of multitrauma and provides a proposed treatment algorithm when attempting to salvage a flap with chronic clot propagation. The risk of this complication can be mitigated through anticoagulation during CBA, by donor vessel angiography before sheath removal, or by considering alternatives to the rectus flap after any femoral artery access.

REFERENCES

1. May JW Jr, Athanasoulis CA, Donelan MB. Preoperative magnification angiography of donor and recipient sites for clinical free transfer of flaps or digits. *Plast Reconstr Surg* 1979;64:483-90.
2. Adnan SM, Romagnoli AN, Madurska MJ, Dubose JJ, Scalea TM, Morrison JJ. Safety and efficacy of radial access in trauma in 65 trauma endovascular cases. *J Vasc Surg* 2020;71:1564-71.
3. Hessel SJ, Adams DF, Abrams HL. Complications of angiography. *Radiology* 1981;138:273-81.
4. Siracuse JJ, Farber A, Cheng TW, Raulli SJ, Jones DW, Kalish JA, et al. Common femoral artery antegrade and retrograde approaches have similar access site complications. *J Vasc Surg* 2019;69:1160-6.e2.
5. Garvey PB, Chang EI, Selber JC, Skoracki RJ, Madewell JE, Liu J, et al. A prospective study of preoperative computed tomographic angiographic mapping of free fibula osteocutaneous flaps for head and neck reconstruction. *Plast Reconstr Surg* 2012;130:541e-9e.
6. Lee GK, Fox PM, Riboh J, Hsu C, Saber S, Rubin GD, et al. Computed tomography angiography in microsurgery: indications, clinical utility, and pitfalls. *Eplasty* 2013;13:e42. eCollection 2013.
7. Akashi M, Nomura T, Sakakibara S, Sakakibara A, Hashikawa K. Preoperative MR angiography for free fibula osteocutaneous flap transfer. *Microsurgery* 2013;33:454-9.
8. Chow LC, Napoli A, Klein MB, Chang J, Rubin GD. Vascular mapping of the leg with multi-detector row CT angiography prior to free-flap transplantation. *Radiology* 2005;237:353-60.
9. Mathes DW, Neligan PC. Preoperative imaging techniques for perforator selection in abdomen-based microsurgical breast reconstruction. *Clin Plast Surg* 2010;37:581-91. xi.
10. Pennington DG, Pelly AD. The rectus abdominis myocutaneous free flap. *Br J Plast Surg* 1980;33:277-82.
11. Mansueto G, Costa D, Capasso E, Varavallo F, Brunitto C, Caserta R, et al. The dating of thrombus organization in cases of pulmonary embolism: an autopsy study. *BMC Cardiovasc Disord* 2019;19:250.
12. Di Fazio N, Delogu G, Ciallella C, Padovano M, Spadazzi F, Frati P, et al. State-of-Art in the age determination of venous thromboembolism: a systematic review. *Diagnostics (Basel)* 2021;11:2397.
13. Irniger W. Histologische altersbestimmung von thrombosen und embolien. *Virchows Arch Path Anat* 1963;336:220-37.
14. Nyame TT, Holzer PW, Helm DL, Maman DY, Winograd JM, Cetrulo CL Jr. SPLIT rectus abdominis myocutaneous double free flap for extremity reconstruction. *Microsurgery* 2014;34:54-7.