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# Mycotic Femoral Artery Aneurysms

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The term *mycotic aneurysm* is currently used to refer to any infected aneurysm. Mycotic aneurysms today are often a complication of parental drug abuse, but can follow arterial trauma of any form, including invasive diagnostic and therapeutic procedures. In the past, septic emboli from bacterial endocarditis were a major cause of mycotic aneurysmal degeneration, but this is less common today. With the advent of antibiotics, aneurysms secondary to syphilis or tuberculosis are rare. With this shift in etiology, the location of mycotic aneurysms has shifted from central (aorta) to peripheral arteries with the femoral artery being the most common site. Mycotic aneurysm has a propensity to rupture. Infection of the arterial wall often leads to disruption of the arterial wall and pseudoaneurysm formation.

## Case Report

*The patient is a 52-year-old gentleman with a history of intravenous drug abuse (IVDA) who presents with severe right groin pain and a pulsatile mass. Having run out of accessible veins, the patient has been using his groins as an access point for heroin injection and since an injection to the right groin a few days past, he has developed chills, significant pain and discomfort and redness over the right groin. He has had two abscess drainage procedures previously also related to IVDA on the abdomen and lower extremity. On physical examination, he had a pulsatile right groin with some erythema and tenderness over the area. A CTA was performed which showed a large pseudoaneurysm (PSA) with perivascular hematoma and aneurysmal degeneration of the common femoral artery (CFA) to include orifices of both the superficial femoral artery (SFA) and profumda femoris artery (PFA) (Figure 1A). He was taken to the operating room and exploration revealed aneurysmal degeneration of the CFA, perivascular hematoma, and PSA. Some purulence was also*

(Continued on page 2)

# Mycotic Femoral Artery Aneurysms (continued from page 1)

*noted and seen in the perivascular area as well. The aneurysm was resected and the hematoma and surrounding hematoma and purulence were evacuated. We reconstructed the vessels using a reversed greater saphenous vein (GSV) interposition graft between the CFA and SFA. Another interposition graft was sewn to this and anastomosed in an end-to-end fashion to the orifice of PFA (Figure 1B). The patient was discharged home on post-operative day three on oral antibiotics. Intrapoerative cultures grew Staphylococcus aureus.*

## Pathogenesis

The pathogenesis of mycotic aneurysms can be divided into four major categories, although other less common causes also exist:

1. Septic emboli from bacterial endocarditis may lodge in normal arteries, causing an infection that weakens the arterial wall, resulting in aneurysm formation. These lesions are often multiple.
2. During an episode of bacteremia, microorganisms may lodge in a preexisting atherosclerotic plaque or aneurysm and begin to multiply with the same result.
3. Mycotic aneurysms are formed by contiguous spread of bacteria from a local abscess. The inflammatory process destroys the arterial wall, causing pseudoaneurysm formation.
4. Trauma to the artery with concomitant contamination may result in formation of an infected pseudoaneurysm. This mechanism of mycotic aneurysm formation is currently the most common cause of mycotic artery aneurysm formation due to significant increase in number of endovascular procedures. Mycotic aneurysms accompanying drug abuse may be secondary to direct contamination of the arterial wall, or they may result from destruction of the vessel wall by a local abscess.

The bacteriology of arterial infections depends upon the cause of the lesion. Aneurysms secondary to bacterial endocarditis grew Pneumococcus, Streptococcus, and Enterococcus species most frequently in the past, but recently, organisms such as Staphylococci, Salmonella, Escherichia coli, and Proteus have also been cultured. Staphylococcus aureus is the most common pathogen in mycotic femoral artery aneurysm secondary to trauma and drug abuse, occurring in >65 percent of cases. In this population, at least 50 percent of the S. aureus organisms are resistant to methicillin.

## Clinical Manifestations

The typical patient with a mycotic femoral aneurysm presents with a history of chills and fever, and a tender, enlarging, pulsatile groin mass. The patient may have a history of intravenous drug use, recent arterial catheterization, penetrating trauma, or bacterial endocarditis. Local signs of infection, including tenderness, erythema, and warmth are noted on physical examination. Lower extremity edema may occur secondary to venous or lymphatic obstruction. Petechial skin lesions, splinter hemorrhages, cutaneous abscesses, and septic arthritis may occur as a result of emboli originating from a mycotic aneurysm. A "sentinel bleed" may occur and indicates risk of impending rupture and life-threatening hemorrhage. Emergency surgery is indicated.

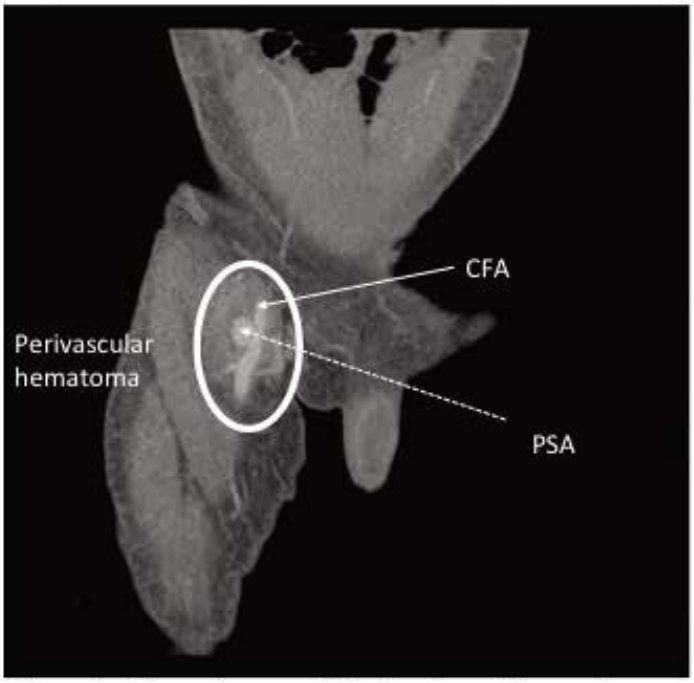


**Figure 1A:**
CTA of a patient with mycotic aneurysm and PSA that involves the common femoral artery involving the origin of the superficial femoral artery (SFA) and profunda femoris artery (PFA).

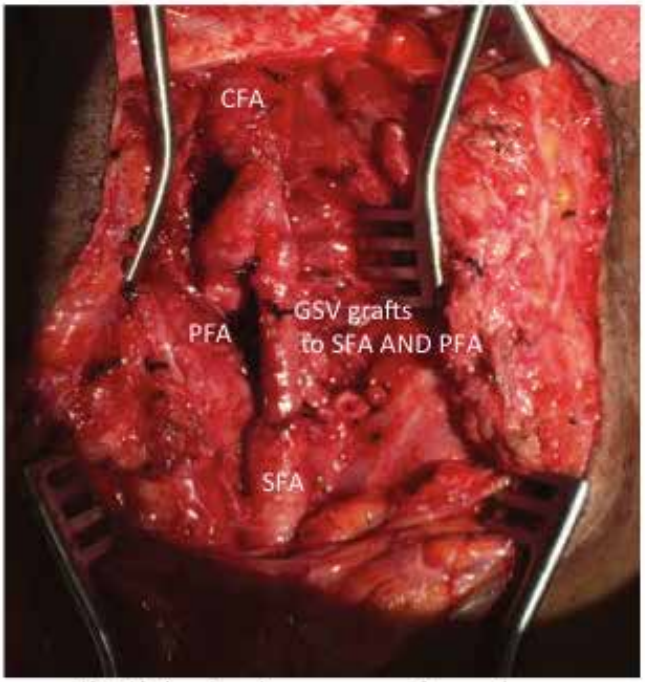


**Figure 1B:**
Post-repair. GSV = greater saphenous vein.

## Diagnosis

The diagnosis of a mycotic aneurysm is usually straightforward, but distinguishing an abscess adjacent to the femoral artery from a femoral mycotic aneurysm may be difficult. Ultrasonography and CT angiography are helpful in establishing the diagnosis of an aneurysm, but lack precision in distinguishing infected from bland aneurysms. The diagnosis of a mycotic aneurysm is confirmed at operation by the demonstration of organisms on Gram stain or by positive cultures of the aneurysm wall.

## Treatment

Mycotic aneurysms represent a serious life- and limb-threatening disease because their natural history is one of expansion and rupture. Therefore, mycotic aneurysms must be addressed surgically. Firstly, the goal of treatment is eradication of the infection by excision of the aneurysm and debridement of adjacent infected tissue as well as by long-term antibiotic therapy. Secondly, adequate distal circulation must be restored. Before operative intervention is performed, the patient is started on antibiotics that are modified based on sensitivity testing of intraoperative cultures. Stent grafts have been used in selected cases of mycotic aneurysms when other approaches were not feasible; however, concern about latent infection of the stent graft often renders this as a bridging technique rather than a long-term solution.

The complexity of the operative procedure varies with the location and extent of the mycotic aneurysm. Although a direct approach to the femoral artery may be taken, a retroperitoneal exposure of the distal external iliac artery for proximal control is sometimes preferred for large or proximal femoral lesions to avoid excessive hemorrhage. Proximal control can also be achieved using an angioplasty balloon. In > 50 percent of cases, the mycotic aneurysm involves the femoral artery bifurcation, and treatment requires resection of the femoral bifurcation and debridement to healthy arterial wall. The distal external iliac or proximal common femoral artery, as well as the superficial and deep femoral arteries, are oversewn with nonabsorbable monofilament suture. This results in significant ischemia in most patients, but with the patient heparinized, symptoms gradually improve as collateral circulation increases. The majority of patients will not need revascularization for limb salvage, but up to one-third of patients may have limb-threatening ischemia. In patients in whom sepsis can be adequately controlled at the initial procedure, aggressive debridement may be followed by immediate revascularization using an autogenous saphenous vein graft as the conduit and covering the graft with a sartorius muscle flap. Another option is to observe patients for four hours after arterial ligation and selectively revascularize only those patients in whom limb-threatening ischemia persists. Use of prosthetic material is avoided because of the high incidence of early and late septic complications, though can occasionally be necessary through uninfected tissue planes such as the obturator or lateral femoral route. Antibiotics are begun preoperatively and are continued for at least six weeks postoperatively. Endovascular interventions have no role in the therapy of mycotic aneurysm except for possibly obtaining proximal control when the aneurysm is too large.

## Further Reading Suggestions

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# An Innovative Technique for Treating Varicose Veins

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ClariVein® (Vascular Insights, Quincy, Mass.), is a new technology which utilizes mechananochemical ablation (MOCA) instead of the traditional thermal energy used in EVLA and radiofrequency ablation (RFA) to treat venous insufficiency and reflux. This technology uses an angulated, semi-rigid wire (Figure 1) that spins approximately 3,000 times per minute, inducing vasospasm and mechanically disrupting the endothelial cells within the vein. While the catheter is on, polidocanal is injected slowly to chemically ablate the vein. The combination of mechanical and chemical ablation results in thrombosis of the vein. Because no tumescent anesthesia is used, the procedure is relatively pain-free and faster than the thermal techniques currently in use.

## Case Report

*A 37-year-old female was seen in the office for evaluation of left lower extremity pain, swelling, and varicose veins. She experienced progressive symptoms since the birth of her eight-year-old daughter. She noted new skin discoloration over her medial shin which occurred after a minor trauma. She had no history of hypercoagulability, deep venous thrombosis (DVT), or arterial insufficiency. She had a family history of severe venous insufficiency with ulceration that required amputation.*

*By physical exam, the left leg had moderate edema below the knee. There were easily visible varicose veins along the medial aspect of the calf and thigh that were tender to palpation. She had mild hemosiderosis with no areas of ulceration. She had palpable pedal pulses and her legs were warm and well perfused. Her duplex exam revealed a large incompetent great saphenous vein (6.5 mm, 2.8 seconds of reflux), incompetent small saphenous vein (5.5 mm, 1.2 seconds of reflux), and multiple associated varicosities. There was normal venous phasicity in the femoral vein, suggesting no proximal venous stenosis or occlusion. She was placed in 20-30 mmHg knee-high compression stockings and told to follow up in three months as mandated by insurance.*

*She was not interested in waiting for the definitive ablation and sought a second opinion at an outside facility. She was told to undergo ablation of left great and small saphenous vein which would improve her symptoms. She had an endovenous laser ablation (EVLA) of her small saphenous vein which resulted in significant parasthesias and post-procedure skin staining. When she returned to my office, she was quite dissatisfied with the outcome of the EVLA. We had a long discussion about ClariVein.*

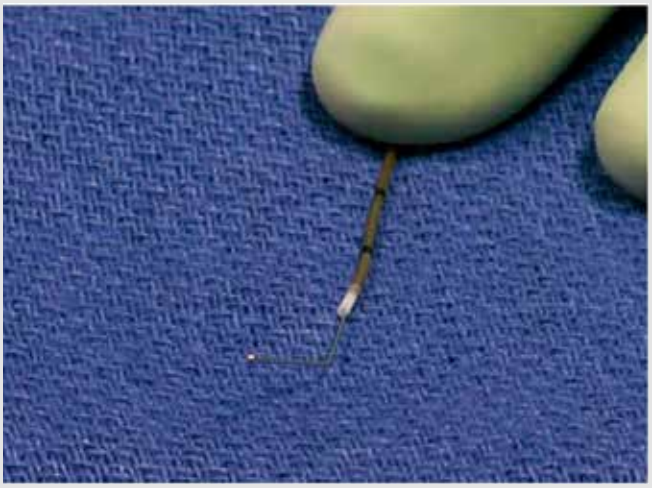

**Figure 1:**
Image of the angulated tip of the ClariVein catheter.

*After reviewing the literature and the technique, her left leg was prepared with a betadine scrub and she had a small injection of local anesthesia in her medial calf under ultrasound guidance. A micropuncture needle was inserted into the vein and the ClariVein catheter advanced under duplex and placed approximately 3 cm from the saphenofemoral junction. The catheter was slowly pulled back and polidocanal was injected. Completion duplex revealed immediate thrombosis of the vein (Figure 2). The procedure took approximately 10 minutes and she had no discomfort after the initial lidocaine injection. Her follow-up duplex revealed a thrombosed great saphenous vein with no parasthesias and only mild discomfort from the ablated vein.*

## Discussion

Thermal ablation of saphenous veins has supplanted open ligation and stripping with good long-term closure rates and minimal complications. The procedure itself is generally well tolerated although the tumescent anesthesia, delivered through multiple needle sticks with pressurized instillation of fluid, can be uncomfortable. This fact has led some patients to forgo treatment due to fear of the painful ablation. The thermal ablation has also been shown in a small subset of patients (approximately three to

five percent) to cause nerve damage due to heat dispersion during the procedure. In addition to the pain from the procedure and possible nerve damage, long-term studies have shown that the recanalization rate can approach 10 to 15 percent, which will prompt secondary procedures at a later date. In addition to recanalization, neovascularization can occur due to the remnant varicosities that are not directly treated with contemporary thermal techniques.

ClariVein is a new technology that has been successfully shown to ablate saphenous veins with similar closure rates to modern thermal techniques. Studies comparing ClariVein to RFA and EVLA have shown several advantages. One of the earliest studies conducted in the United States found a closure rate at one month and one year to be 100 percent. In 2012, Van Eekeren and colleagues reported outcomes of 92 patients treated with ClariVein. They found the six-month closure rate to be 93 percent and the one-year rate to be 88 percent. The average treatment time was 11 minutes with no major adverse events. The 14-day pain scale was 8.6/100 for ClariVein, compared to 14.8/100 for thermal ablations. In addition, there was faster return to normal activity (1.2 v. 2.8) and return to work (3.3 v. 5.6). After the two week time period, there were no differences in quality of life scores and the ablation rates were similar.

The next generation catheter utilizes mechanical and chemical energy to ablate saphenous veins. This technique is faster, less painful, and has similar outcomes when compared to traditional thermal techniques. The American Venous Forum (AVF) has supported the use of non-thermal ablation techniques in a recent publication saying "We find the clinical evidence to demonstrate comparable effectiveness to thermal-based ablation procedures, with similar venous closure rates at 3, 6, 12, and 24 months, and are pleased that patients can return quickly to normal activities. With minimal risk to surrounding tissue or nerves, MOCA is a clinically meaningful addition to the excellent treatment options patients and physicians have to manage vein disease.[1]"

Recently, the Food and Drug Administration has approved ClariVein for use in the United States, paving way for the widespread use of the new, innovative technology. Mechananochemical ablation of saphenous veins is an innovative new technique that avoids the use of thermal energy and therefore does not require tumescent anesthesia. This technique is now available at UPMC, and as a result, varicose veins can now be treated faster and with less pain than the traditional thermal ablation.

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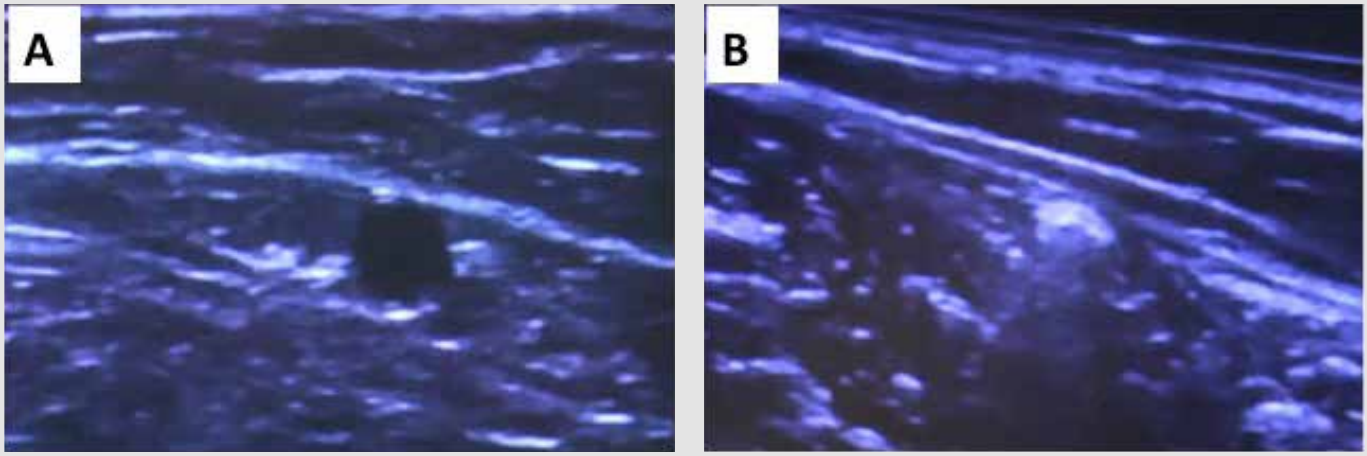


**Figure 2:**
**A) Duplex exam showing the patent saphenous vein. B) Thrombus seen within the saphenous vein after ClariVein ablation.**

# Intermittent Claudication in the Young Patient

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**Associate Professor of Surgery, UPMC Division of Vascular Surgery**
**Co-Director, Aortic Center**

Peripheral arterial occlusive disease is exceedingly rare in patients younger than 30 years of age. This young patient population rarely suffers from atherosclerosis, and an alternative spectrum of pathology is more likely the source of arterial occlusion which includes popliteal entrapment syndrome, traumatic arterial occlusion, adventitial cystic disease, exercise-induced compartment syndrome, chronic arterial injury from repetitive trauma (i.e. external iliac stenosis associated with competitive cycling), congenital anomalies, and pro-thrombotic states.

## Case Report

*A 15-year-old young man was referred to the UPMC Division of Vascular Surgery with a several year history of debilitating right thigh and calf claudication. The symptoms have progressively worsened especially with exertional activity on the basketball court. The left leg is without symptoms. The patient's medical history is extensive; he was born with a hypoplastic left heart, aortic atresia, and mitral stenosis and underwent a three stage Norwood procedure from the age of one week to one year. In review of his interventional procedures, the right femoral artery was utilized for access in 2001 and 2005 with a 7F sheath. Thereafter, the left femoral artery was used because the right femoral artery pulse was diminished. From a cardiac standpoint he has done remarkably well, requiring only one additional balloon dilation for restenosis of the aortic coarctation.*

*On examination, upper extremity blood pressures and lower extremity thigh pressures were equal at rest. The pulse exam revealed normal pulses throughout the bilateral upper extremities and left leg but all the pulses were missing on the right lower extremity. An exercise tolerance test was significantly abnormal showing a significant drop in the right leg ankle brachial index (0.98 to 0.74) while the patient complained of debilitating claudication in the right leg after 10 minutes of exercise. Thigh pressure on the left also dropped to 80 mmHg (baseline 98) which retuned to baseline within four minutes. CT angiogram (Figures 1 and 2) showed chronic occlusion of the right external iliac artery, patent right common iliac artery, and prominent collaterals from the right internal iliac artery with reconstitution of the distal right common femoral artery. In addition, the right leg run-off was widely patent.*

*Even though the patient had done extremely well from a cardiac standpoint, a comprehensive workup was preformed and pertinent findings included an echocardiogram which showed a dilated hypertrophied right ventricle with preserved systolic function and mild narrowing in the aortic arch. Since he was debilitated by the right leg claudication which prevented him for engaging in extramural activities and participating in activities with friends and family, the patient and family decided to proceed with right lower extremity revascularization. Through two small incisions (6 cm right flank and 3 cm right femoral), a right common iliac artery (CIA) to right common femoral artery (CFA) bypass was performed using an 8 mm PTFE graft which re-established inline flow to the right leg (Figures 3 and 4). The native CIA measured 6 mm in diameter and the CFA measured 4 mm in diameter. A slightly larger prosthetic graft was implanted in expectation of the patient's future growth and development. At the end of the procedure, a bounding pulse was present in the right dorsalis pedis and posterior tibial arteries. His postoperative course was unremarkable and the patient was discharged home on postoperative day four. In follow-up, the patient has returned to school, regularly plays basketball, and no longer lags behind his teammates. According to his family, the patient's quality of life has markedly improved with the resolution of his claudication.*

Claudication from vascular insufficiency is rare in patients under the age of 30 years. A population-based study indicated an incidence of 14.6/100,000 person years for patients under 40 years. Due to rarity of vascular insufficiency in this patient population, the exact diagnosis is often delayed and referral to vascular surgeons are made often after extensive musculoskeletal workup since claudication symptoms are attributed to musculoskeletal injuries, developmental growth pain, or other unknown causes. A keen awareness of this unique and diagnostically challenging problem in young active patients is crucial. The differential diagnosis for the astute clinician should include: premature atherosclerosis which often is isolated to the aortoiliac arteries, hypercoagulable states (< 15 percent) associated with acute arterial insufficiency, congenital developmental disorders (10 percent) such as hypoplasia of the aortoiliac system, coarctation and persistent sciatic artery, spontaneous arterial dissection with native vessel thrombosis, repetitive trauma (competitive cyclists develop external iliac fibrosis due to repetitive strenuous hip flexion), and ergotism. For patients with isolated calf claudication, additional diagnoses include popliteal artery entrapment syndrome, adventitial cystic disease, and exercise-induced compartment syndrome. In this specific case, repetitive endovascular interventions using right femoral artery access sites most likely caused access site trauma, proximal arterial spasm, and subsequent vessel occlusion which over time became well collateralized via the internal iliac artery. At rest, and with normal daily activity, the compensatory collateral flow was sufficient, however with exertion the patient was debilitated by right thigh and calf claudication.

In summary, claudication in the young adult has distinctly different differential diagnoses. A comprehensive history and physical examination are essential and are complemented with timely use of non-invasive imaging studies (ABI, exercise tolerance testing, duplex examination). Additional imaging modalities including MRA, CTA, and diagnostic angiography often confirm the diagnosis and provide critically important anatomic information that guides the optimal type of revascularization. The UPMC Heart and Vascular Institute's Division of Vascular Surgery continues to play an integral role in the diagnosis, management, and treatment of pediatric patients and young individuals with vascular related problems. Our comprehensive patient care approach combined with utilization of advanced imaging technology allows us to provide optimal care to patients with these atypical and infrequently seen complex pathologies.

## Further Reading Suggestions

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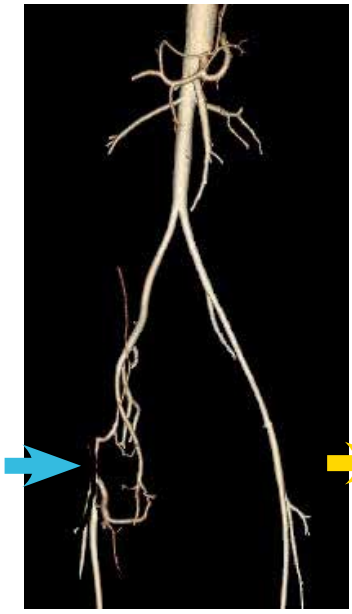

**Figure 1:**
CT angiogram with 3-D reconstruction; note the occluded right external iliac artery (blue arrow).

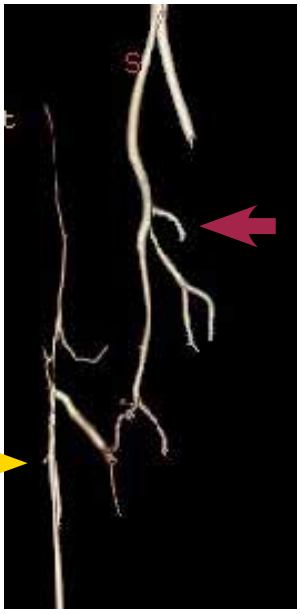

**Figure 2:**
CT angiogram with 3-D reconstruction; note the prominent collaterals from the right internal iliac artery (red arrow) connecting to the right common femoral artery (yellow arrow).

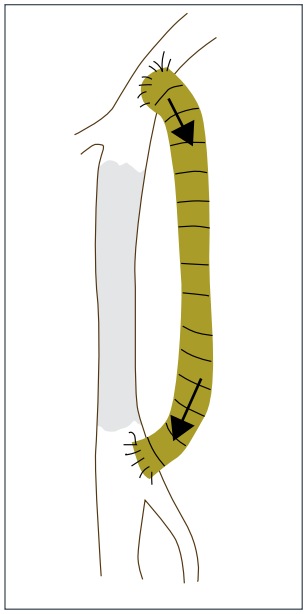

**Figure 3:**
Diagram of right common iliac to common femoral artery bypass.

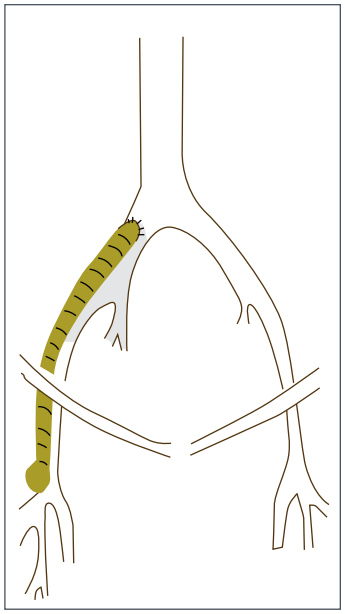

**Figure 4:**
Anatomic image of right common iliac to common femoral artery bypass.

# Novel Catheter Interventions for Acute Iliofemoral Deep Venous Thrombosis

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Venous thromboembolism (VTE) is relatively common and has been categorized by the United States Surgeon General as a major public health problem. Traditionally, cases with iliofemoral DVT (IFDVT) were treated by anticoagulation alone but catheter-directed thrombolysis (CDT) with or without pharmacomechanical thrombolysis (PMT) has shown promise in improving outcomes. The benefits of CDT and PMT include thrombus removal, valvular competence, and, therefore, prevention of post-thrombotic sequelae often seen in patients with IFDVT. We present a challenging case of a symptomatic IFDVT that was successfully managed using novel pharmacomechanical endovascular technologies.

## Case Report

*A 29-year-old female on oral contraceptives presented to her primary care physician (PCP) with complaints of worsening right thigh and leg pain and swelling. The symptoms started after several long car rides over a three-day period. Worsening leg edema led to a PCP visit where a venous duplex revealed iliofemoral DVT prompting an emergency room visit, admission, and vascular surgery consultation. She had extensive swelling and pain. Due to her severe symptoms and extensive thrombus burden she was offered an endovascular intervention to alleviate her pain and prevent the long-term sequelae of post-thrombotic syndrome (PTS). Preoperatively she was noted to have thrombocytopenia with a platelet count of 55,000, so we opted to attempt completion within a single session and minimize the use of thrombolytic agents to reduce her bleeding risk.*

*She was taken to the operating room for venogram through the right popliteal vein. Occlusive thrombus was noted in the popliteal, femoral, and iliac veins with protrusion into the vena cava (Figures 1A and 1B). Pharmacomechanical thrombolysis was initiated first using the AngioJet® Peripheral Thrombectomy System (Boston Scientific, Marlborough, Mass.) device in Power Pulse™ mode forcefully spraying the clot with thrombolytics. Eight mg of alteplase were used and allowed to dwell for 30 minutes after which the AngioJet device was turned to thrombectomy mode macerating and aspirating thrombus from the affected venous segments (Figure 1C). The common and external iliac veins remained occluded indicating some thrombus chronicity. Suction thrombectomy using the larger Indigo® (Penumbra, Inc., Alameda, Calif.) device was used subsequently clearing out significantly the iliac segments (Figure 2A). As some residual chronic thrombus and scarring remained we proceeded with balloon venoplasty using 12 and 14mm balloons (Figure 2B). A 16mm x 90mm WALLSTENT™ (Boston Scientific, Marlborough, Mass.) was placed in the iliac vein allowing brisk unobstructed flow throughout the right lower extremity into the vena cava (Figures 2C and 2D).*

*One month postoperatively her leg pain and swelling had resolved. At three-month follow-up her iliac vein stent remained widely patent.*

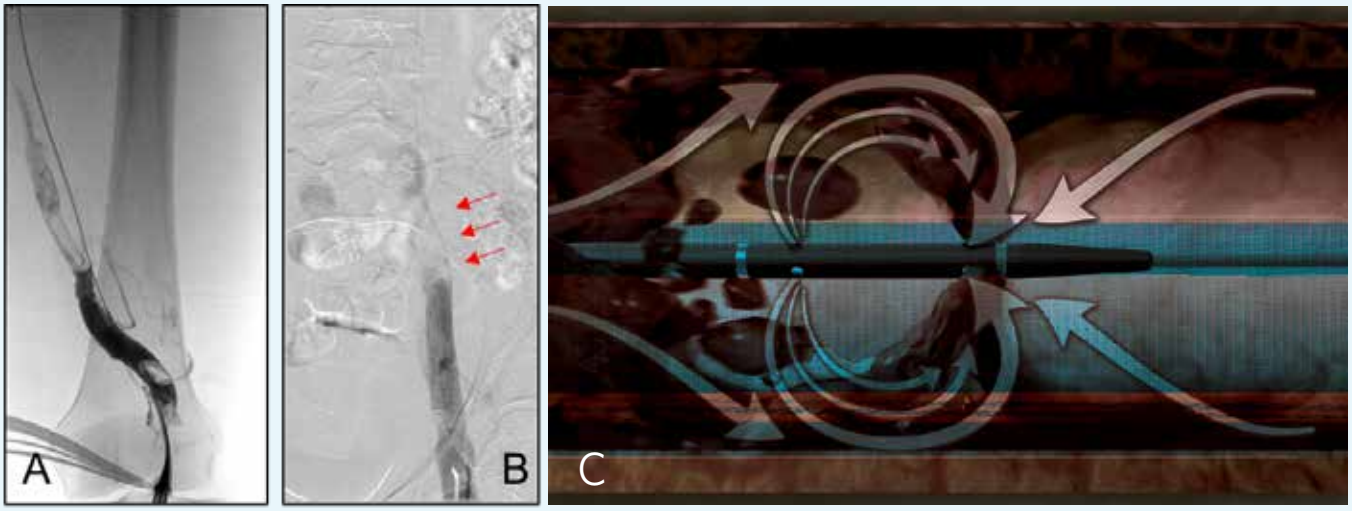


**Figure 1:**
A) Femoral vein occlusion. B) Iliac vein occlusion (arrows point to thrombus). C) AngioJet catheter.

## Overview

The precise incidence of venous thromboembolism is not known but annually 900,000 cases (one to two per 1,000) are reported in the United States. Two-thirds of symptomatic VTE present as deep venous thrombosis, while one-third present as pulmonary embolism. Apart from inherited hypercoagulable disorders, predisposing conditions for thrombosis include a prior thrombotic event, recent major surgery, trauma, immobilization, malignancy, pregnancy, and the use of oral contraceptives. Patients with an episode of VTE are more likely to have multiple acquired risk factors.

Post-thrombotic syndrome (PTS) is a common complication after acute IFDVT and has been associated with a reduced quality of life. Up to 50 percent of patients with acute DVT experience symptoms of PTS, and can occur at two or more years after IFDVT. Common symptoms include chronic leg pain, swelling, redness, and ulcers. Patients with IFDVT are more likely to develop this syndrome, and rapid removal of venous thrombus may reduce the frequency of PTS in these patients. Randomized controlled trials (e.g.CaVenT study, which is complete, and the ATTRACT trial, which is ongoing) were designed to evaluate the efficacy and safety of catheter-directed interventions over anticoagulation alone in this patient population. At five-year follow-up of the CaVenT study, patients who underwent CDT had a 14.4 percent absolute risk reduction of PTS. Twenty out of 90 patients who received CDT had bleeding complications, with three major bleeds and five clinically relevant bleeds; compared to standard therapy with anticoagulation alone which had no bleeding events. The ATTRACT trial is a multicenter, randomized, open-label, parallel two-arm, controlled trial which is similarly comparing CDT plus standard therapy to standard therapy with anticoagulation alone in patients with acute IFDVT. With a larger sample size of 692 patients (compared to only 189 in the CaVenT trial), this trial will help further determine whether CDT will aid in preventing PTS in this patient population. The results will be available later this year.

## Summary

The gold standard treatment of acute DVT is anticoagulation, however, patients with iliofemoral DVT may benefit from catheter-directed interventions to immediately alleviate severe acute symptomatology and prevent PTS. This potential benefit must be weighed against the risk of bleeding associated with CDT compared to standard therapy alone, thus making patient selection essential for this therapy. Novel treatments allow minimal use of lytics and may lead to better outcomes. The UPMC Division of Vascular Surgery is leading research projects on these novel treatments. Our vascular team offers the entire spectrum of contemporary endovascular and open surgical therapies for those patients who present with symptomatic IFDVT, targeting to relieve their symptoms and reduce the risk of PTS, with the goal of improving their quality of life.

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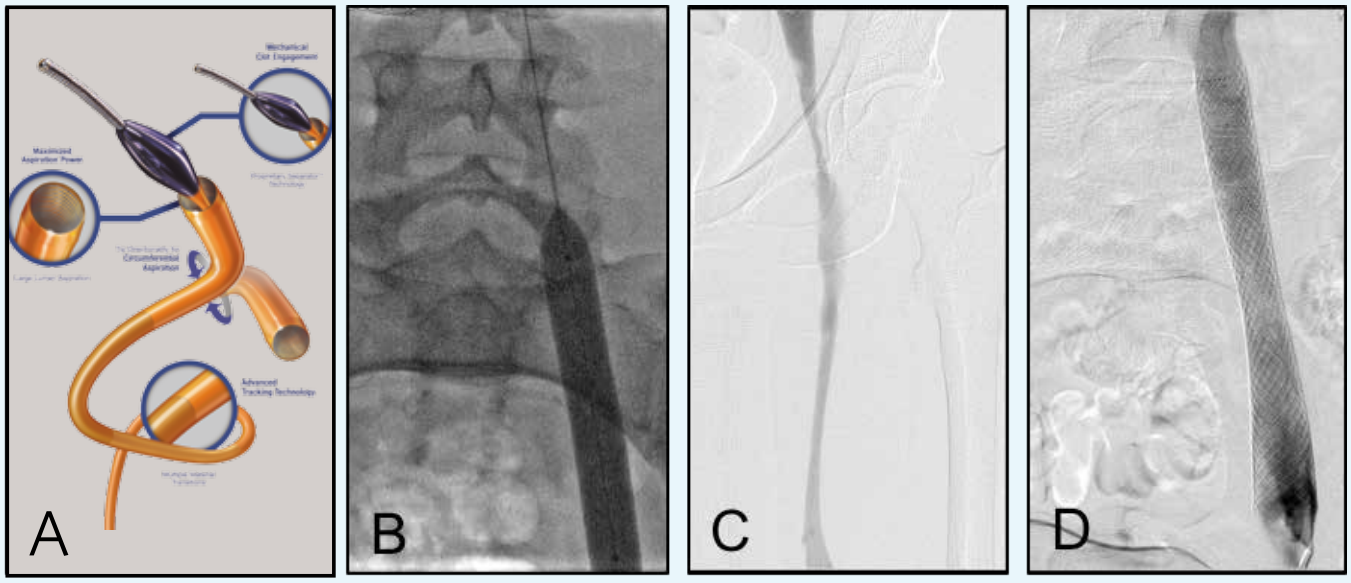


**Figure 2:**
**A) Indigo® Cat 8 catheter.** **B) Iliac vein balloon angioplasty.** **C) Cleared iliac segment.** **D) Iliac vein stent.**

# A Hybrid Approach to Acute Mesenteric Thrombosis: Retrograde Open Mesenteric Stenting (ROMS)

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Acute mesenteric ischemia (AMI) is one of the most catastrophic pathologies treated by vascular surgeons associated with significant mortality (50 to 80 percent) and morbidity despite successful revascularization. Despite many advances in the field of vascular surgery, the mortality and morbidity of AMI have remained unchanged for years mainly due to the delay in diagnosis and institution of therapy. A delay in diagnosis is the primary predictor of death in patients with AMI. Delays stem from similar symptomatology of AMI and other common gastrointestinal diseases, making the correct diagnosis of AMI—which is an uncommon abdominal malady—very challenging. Delays in diagnosis lead to worsening of intestinal ischemia, bowel necrosis and perforation, systemic shock, and cardiovascular collapse.

**Case Report:**

*A 73-year-old male presented to the emergency room for diffuse abdominal pain of one week duration. His past medical history is significant for coronary artery disease (CAD), s/p coronary artery bypass graft, hypertension, and diabetes mellitus. The patient also has a history of atrial fibrillation on anticoagulation and is on hemodialysis for ESRD. He was treated with antibiotics for presumed diagnosis of diverticulitis and was discharged home. He returned four days later complaining of chest pain, worsening abdominal pain, diarrhea, leukocytosis, and evidence of superior mesenteric artery (SMA) thrombosis on the CT scan (Figure 1). He improved clinically with hydration, antibiotics, and pain management. He refused revascularization of the SMA at that time and wanted a second opinion. Two days after discharge, he returned with severe abdominal pain, hypotension, signs of peritonitis, WBC of 28,000, lactate of 10, and evidence of pneumatosis on the CT scan (Figure 2). He was transferred to our institution and was urgently taken for exploratory laparotomy, resection of necrotic jejunum (40 cm), and successful retrograde open mesenteric stenting (ROMS) (Figures 3 and 4). A second-look laparotomy was performed two days later with primary intestinal anastomosis; the remainder of the bowel was viable with good SMA pulse. After a challenging postoperative course, he was discharged to rehab on postoperative day 25, tolerating diet with normal GI function.*

Acute mesenteric thrombosis (acute or chronic atherosclerotic disease) is a common occurrence in patients with AMI, with arterial embolization being the other frequent etiology. In these cases, the superior mesenteric artery (SMA) typically occludes at its origin, leading to an extensive bowel ischemia compared to a slightly distal SMA occlusion in the embolic cases, where the proximal jejunum is usually spared. Patients often report a history of postprandial abdominal pain and weight loss (symptoms of chronic mesenteric ischemia) prior to the acute thrombosis. Classical presentation of pain out of proportion to the physical exam is absent in more than 25 percent of these cases; these patients, therefore, are diagnosed later in the disease process, with peritoneal signs, leading to emergent surgical exploration.

The treatment of patients with AMI includes expeditious reperfusion of the ischemic bowel and resection of the necrotic intestine. For patients with AMI due to acute mesenteric thrombosis, the standard open

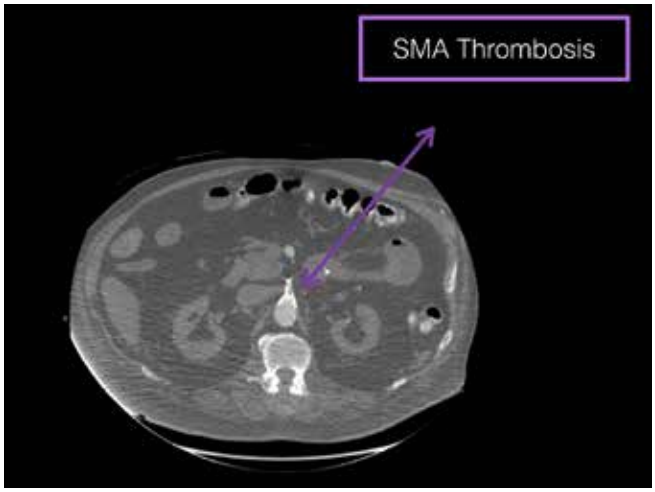


**Figure 1:**
CT scan showing thrombosed SMA.

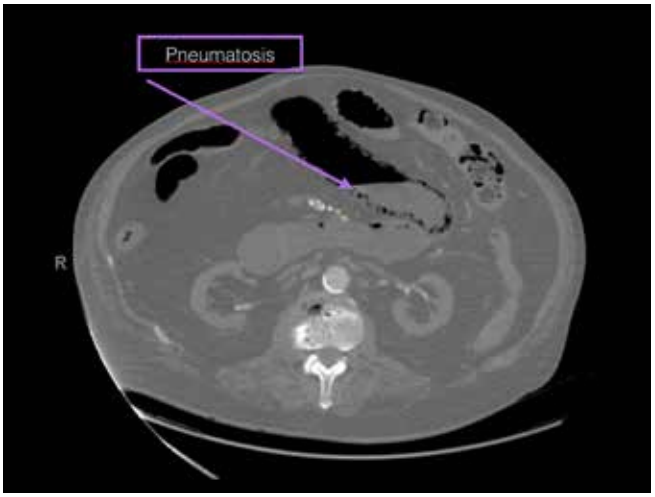


**Figure 2:**
CT scan showing pneumatosis of the small bowel concerning for bowel necrosis.

revascularization surgical option is an SMA bypass which can be performed using either iliac (retrograde bypass) or supraceliac artery (antegrade bypass) as the inflow vessel using either vein or prosthetic grafts. The choice of the conduit is determined by the degree of intraperitoneal contamination; vein grafts are preferred in contaminated cases and prosthetic grafts are used when the GI tract is not violated.

Mesenteric angioplasty and stenting has been accepted as a first-line treatment in patients with chronic mesenteric occlusive disease. However, in acute ischemia, the endovascular approach is not as widely adopted, despite the reported improved mortality from selective centers. Standard percutaneous techniques may not be feasible all of the time, especially in patients who require abdominal exploration often in operating room not equipped with fixed radiologic imagery. Additionally, mesenteric interventions can be challenging and time consuming, resulting in prolonged ischemic time and delay in reperfusion. In patients with atherosclerosis, the visceral vessels are commonly heavily calcified and occluded at their origin rendering antegrade endovascular recanalization difficult, if not impossible.

A hybrid approach to mesenteric thrombosis or retrograde open mesenteric stenting (ROMS) is an appealing technique in the treatment of AMI, particularly in contaminated cases and inaccessible donor vessels for a bypass. The procedure involves exposure of the SMA in a standard fashion; sheath access is obtained and the occluded vessel is crossed from the distal SMA end towards the aorta. Retrograde crossing the occlusion is often technically successful due to a better pushability and to a softer distal end of the plaque. Subsequently the occluded vessel is dilated and stented, which can be performed from either the SMA sheath or from a remote arterial access (brachial or femoral after snaring the wire). This technique will allow faster reperfusion without the need for aortic clamping. The utility of this technique is demonstrated above, in a high-risk patient with bowel necrosis and frank contamination, limited conduits, and limited donor vessels for a mesenteric bypass.

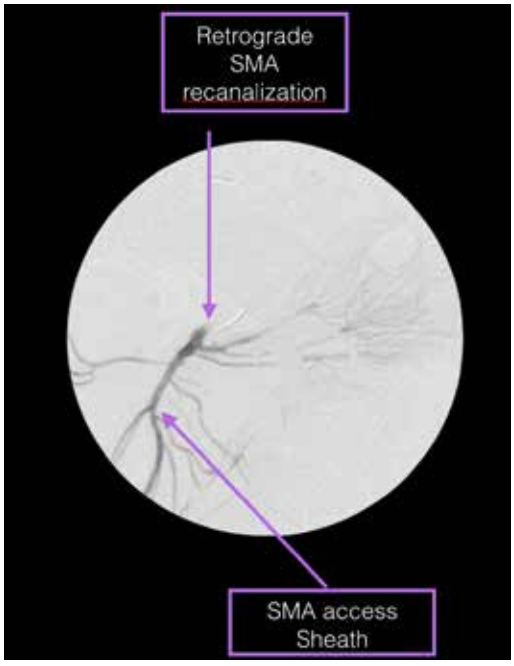


**Figure 3:**
Retrograde access to the SMA, placement of 6 Fr sheath and retrograde recanalization of the occluded SMA.

## Conclusion

AMI is a lethal disease if not recognized early and treated promptly. It is associated with very high mortality and morbidity especially in the presence of bowel necrosis. Early diagnosis and treatment are key to improving a patient's chance of survival. Not uncommonly, vascular surgeons are consulted for the intraoperative discovery of ischemic bowel; ROMS is a useful technique for rapid reperfusion without the need for aortic or iliac clamping, sophisticated fixed radiologic imagery, and without the risk of prosthetic graft infection in contaminated cases. However, very close follow-up and monitoring are recommended due to a relatively higher incidence of in-stent stenosis and potential re-thrombosis.

The greatest challenge in the management of patients with mesenteric ischemia remains the delay in diagnosis leading to worsening ischemia and poor outcomes, as shown in the case report above. Symptomatic patients with mesenteric vascular disease should be treated promptly to avoid the high mortality associated with AMI.

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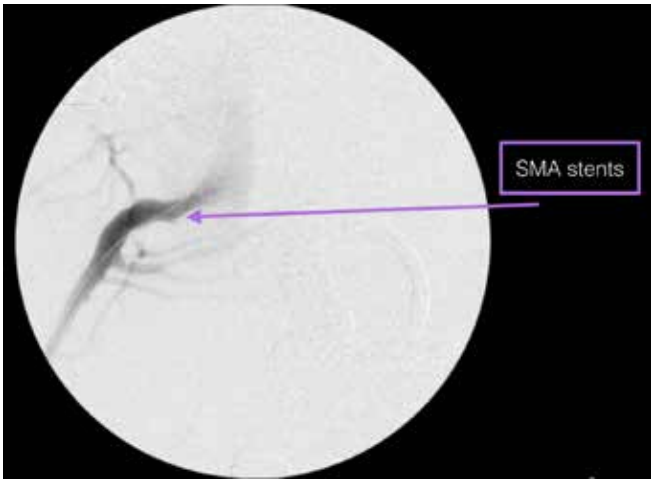


**Figure 4:**
Retrograde angiogram through the SMA sheath showing patent SMA stents without any residual stenosis.

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