



Published in final edited form as:

Ann Vasc Surg Brief Rep Innov. 2022 June ; 2(2): . doi:10.1016/j.av surg.2022.100070.

A single institutional experience with suction thrombectomy in acute mesenteric ischemia*

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Abstract

Acute mesenteric ischemia (AMI) is typically treated by open surgery or hybrid techniques. Catheter-based aspiration thrombectomy represents another minimally invasive alternative with a potential additional safety benefit of minimizing the bleeding risk associated with thrombolytics. In this institutional case series, we present five clinical cases of aspiration thrombectomy for high-risk AMI using the Penumbra aspiration system. All patients underwent technically successful endovascular thrombectomy as demonstrated by intraoperative angiography results. However, bowel necrosis and sepsis adversely affected postoperative outcomes. Lack of intraoperative bowel assessment is a limitation of endovascular methods, highlighting the importance of patient selection.

Introduction

Acute mesenteric ischemia (AMI) is a rare but life-threatening vascular syndrome characterized by inadequate intestinal blood flow through the mesenteric vessels. Left untreated, AMI has extremely high mortality rates, with its poor prognosis directly correlated to severity of intestinal necrosis¹. Timely diagnosis and treatment are therefore vital to minimize bowel damage. Unfortunately, early detection is difficult due to its vague presentation with nonspecific abdominal symptoms². The current standard of AMI treatment includes open surgery, mesenteric bypass, hybrid techniques such as retrograde open stenting, and less frequently catheter-directed thrombolysis³. Endovascular revascularization

*Presented at the 2021 Eastern Vascular Society Fellow, Resident & Student Case Report Contest, Friday, September 24, 2021 in Charleston, SC

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Author contributions

Conception and design (AM, EAA, RA, ME, EA), data collection (AM, EA, KR), writing of the manuscript (AM, EAA, KR, EA), critical revision (AM, EAA, KR, RC, MH, EA), approval of the manuscript (AM, EAA, KR, RC, MH, EA), accountability (AM, EAA, KR, RC, MH, EA).

Declaration of Competing Interest

The authors have no conflicts of interest.

is less invasive and may offer improved clinical outcomes, especially in elderly or particularly frail patient populations^{4, 5}; however, bleeding risk is a major concern. Novel aspiration thrombectomy limits the use of thrombolytics and has been increasingly used. This case series examines catheter-based suction thrombectomy as a novel approach to AMI revascularization.

Cases and clinical course

Between February 2019 and March 2021, 5 patients (mean age 62.2y, ranging from 44 to 76y; 3 male) presented with AMI symptoms. All patients were determined to be poor candidates for open surgery and underwent endovascular suction thrombectomy using the Penumbra aspiration catheter system (Indigo System CAT6 or CAT8). Three of the five cases were performed with brachial access, and two cases were performed with femoral access. Perioperative and postoperative outcomes are summarized below. Additional patient details are summarized in Table 1.

Case 1

A 76-year-old male with a history of congestive heart failure, status post SMA open thrombectomy without bowel resection in 2018, presented to the emergency room with abdominal symptoms for five days after being recently treated for *Clostridium difficile* colitis. On contrasted computed tomography (CT), he was found to have a short segment occlusion of the superior mesenteric artery (SMA) and thickened loops of small bowel without evidence of bowel necrosis. Given his age and extensive history of abdominal surgeries, the patient was deemed to be high-risk for redo laparotomy. The decision was made to revascularize with suction thrombectomy by brachial artery access using the Penumbra CAT6 aspiration catheter at the distal main trunk of the SMA. Two passes of Penumbra preceded by 4 mg of tissue plasminogen activator (tPA) infusion retrieved thrombus and achieved excellent angiographic result (Figs. 1A, 1B). Eight days later, the patient passed away from overwhelming sepsis after he was noted to have increased liver function tests and found to have a gangrenous gallbladder on laparoscopy. All bowel was deemed viable.

Case 2

A 61-year-old female with a history of mesenteric occlusion and coronary artery disease, status post SMA and celiac stenting in 2015 and 2017 respectively, presented with acute onset periumbilical pain, bloody diarrhea, nausea, dizziness and fever. CT angiogram revealed SMA thrombus and occluded stent. She also had concomitant significant GI bleeding for which she had been hospitalized recently and was therefore deemed too high-risk for open surgery. Suction thrombectomy was performed using the Penumbra CAT8 aspiration catheter via brachial artery access, with multiple passes through the existing SMA stent. Thrombus was retrieved (Fig. 2) and a new 7 × 29 VBX stent was placed with good angiographic result. At her one-month follow-up appointment, the patient reported good overall health and complete resolution of her symptoms.

Case 3

A 55-year-old male presented with abdominal pain to an outlying community hospital where he was diagnosed with chronic mesenteric ischemia and treated with an SMA stent. After initial improvement, he had recurrence of his abdominal pain and CT demonstrated thrombosis of the SMA stent on postoperative day four, prompting transfer to our facility. Upon arrival, an attempt was first made to cannulate the thrombosed SMA stent, but this proved unsuccessful. An obtuse sheath was introduced and with some effort, a stiff Glidewire and glide catheter were able to cross the area of occlusion. Following 2 mg of tPA infusion, a Penumbra CAT8 aspiration catheter was used by brachial artery access to clear the thrombosed stent and some embolus at the distal main trunk of the SMA. Stent patency was verified via arteriogram. Despite optimal angiography and continuous administration of heparin and bivalirudin during his postoperative course, the patient progressed to severe bowel necrosis a few days later and underwent several urgent bowel resections, after which he developed septic shock and respiratory failure. The patient continued to decompensate and passed away 16 days following suction thrombectomy.

Case 4

A 44-year-old female presented to an outside emergency room with a four-month history of abdominal and back pain. She suffered from a ventricular fibrillation cardiac arrest in the emergency department but had return of circulation after 10 min of care. Post-arrest abdominal and pelvic CT scans revealed an SMA occlusion, and she was placed on heparin and transferred to our facility for further evaluation. The decision was made to revascularize her with suction thrombectomy. Accessing the SMA via the right common femoral artery, a CAT6 Penumbra device was used to retrieve thrombus, which resolved the filling defect. A residual area of proximal stenosis was treated by balloon angioplasty and 7 × 29 VBX stent and excellent results were verified by angiogram. One month postoperatively, the patient reported complete resolution of her symptoms.

Case 5

A 75-year-old male with a history of morbid obesity, atrial fibrillation non-compliant with Xarelto and aortic stenosis, status post transcatheter aortic valve replacement (TAVR) in February 2021 and permanent pacemaker (PPM) placement in 2018, presented to emergency room with a two-day history of shortness of breath, wheezing, lower extremity edema and back pain. On exam, he was noted to have a left-sided facial droop. CT angiogram revealed an acute SMA occlusion and concurrent right inferior occipital lobe mycotic aneurysm. Given his frail state, the decision was made to forgo open surgery. Suction thrombectomy was performed from a right common femoral artery access point with a CAT6 Penumbra aspiration catheter which improved angiography results. Remaining stenosis of the SMA orifice was treated by balloon angioplasty and 7 × 39 VBX stent. Postoperatively, the patient developed a large mesenteric hematoma, likely from wire perforation and injury, requiring a small bowel resection. Despite these efforts, the patient continued to decline and passed away seven days following suction thrombectomy.

Results & discussion

Endovascular methods such as suction thrombectomy are quickly emerging as a minimally invasive alternative to current treatments of acute vascular disease in high-risk populations^{6, 7}. Existing literature demonstrates variable success rates in both arterial and venous disease, with technical success ranging from 38.5%–100% (mean 84.3%) and clinical success ranging from 46.2%–100% (mean 84.3%) for use in the superior mesenteric artery and vein^{8–13}. These disparate results may be attributable to differences in patient selection between institutions and overall small study population sizes.

In this case series, we presented five cases of patients who were not candidates for open surgery due to frailty and other risk factors that already predisposed them to poor clinical outcomes.

In all patients, thrombectomy by aspiration catheterization was technically successful as demonstrated by improved blood flow on intraoperative angiography (Figs. 1, 2). Despite this, some patients developed (or already had) bowel necrosis ($n = 2$) and sepsis ($n = 2$) that affected postoperative mortality outcomes. An adjunctive stent was placed in 4 patients. Overall, the 30-day mortality rate was 60% ($n = 3$). The two surviving patients reported complete resolution of symptoms.

While technique for this intervention is guided largely by physician experience and preference, the majority of patients at our institution are treated via brachial access with open brachial cutdown. Generally, we use the CAT8 device for proximal thrombus and CAT6 for more distal thrombus. Suction thrombectomy can then be performed with and without a wire. We have used the separator wire that comes with the device but other wires – e.g. a floppy glide wire – work well too to unclog the catheter but not as a true over the wire aspiration. To go wireless, the sheath must be secured inside the SMA.

The main disadvantage of any endovascular intervention remains the inability to directly assess and address bowel viability. For patients who have clinical suspicion for bowel necrosis, preoperative or post-intervention laparoscopy or open surgery are indicated. There is emerging evidence that early endovascular intervention may reduce the length of necessary bowel resection.¹⁰ Additionally, aspiration thrombectomy cannot address ischemia of distal branches. However, these are not accessible with open thrombectomy either, thus combining an endovascular approach with local infusion of thrombolytics in selected cases might add some benefit. Overall, this is a disease process with high risk for mortality and an endovascular approach may not completely mitigate that risk. If a patient is high risk for open surgery, while endovascular is an option, palliative care is also an important alternative to discuss with patients at high risk for complications. In addition to complications related to the disease process, technical complications can occur as well, such as wire perforation. Therefore, careful patient selection and technical dexterity are critical for optimal outcomes.

Conclusions

While suction thrombectomy is a clinically effective method of revascularization for acute mesenteric ischemia, laparotomy or laparoscopy may still be indicated in some patients

to assess bowel viability. Future studies will contribute more data towards the comparison of endovascular and open surgical techniques. Currently, it is our recommendation that thromboaspiration be reserved for frail patients for open surgery and who lack substantiated clinical or laboratory evidence of bowel necrosis.

Funding sources

This research was supported in part by grant 5T32HL0098036 from the National Heart, Lung, and Blood Institute (Andraska, Reitz) and L30 AG064730 from the National Institute on Aging (Reitz). The University of Pittsburgh holds a Physician-Scientist Institutional Award from the Burroughs Wellcome Fund (Andraska).

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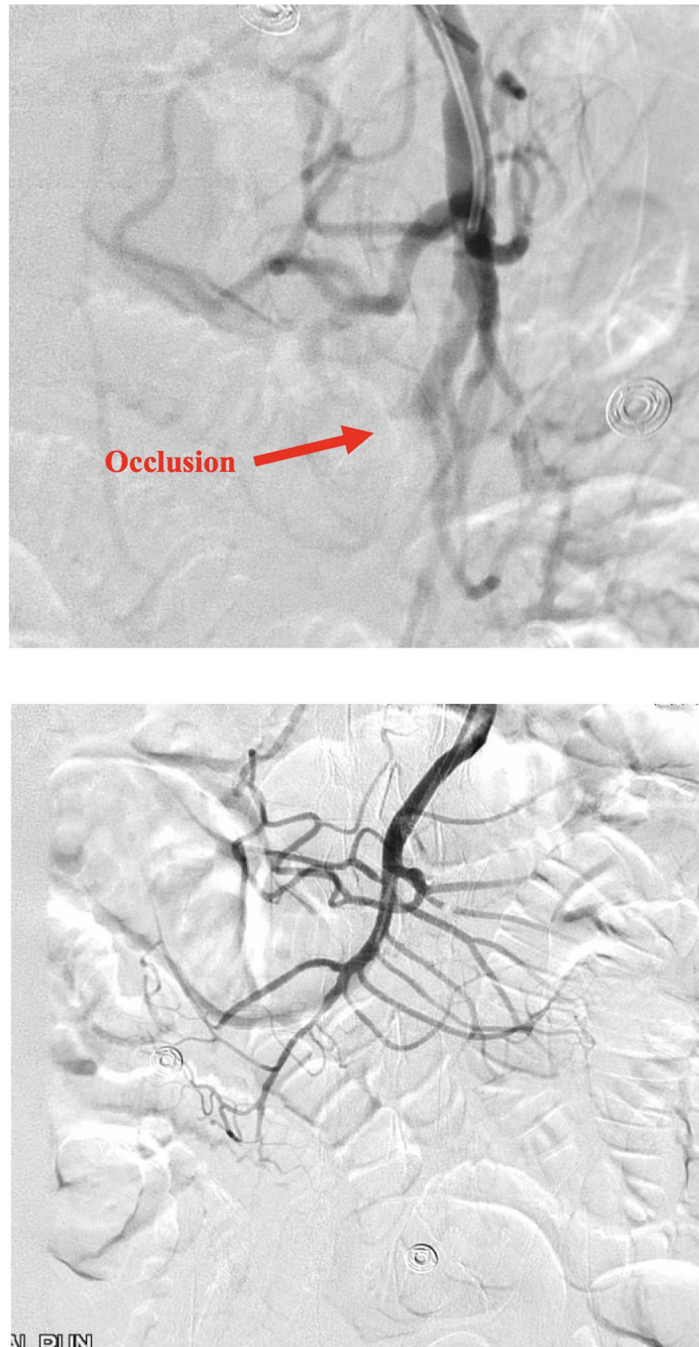


Fig. 1. (A). Intraoperative angiogram before suction thrombectomy. (B). Excellent angiographic result following suction thrombectomy.



Fig. 2.
Clot volume removed via Penumbra CAT6 aspiration catheter.

Table 1

Summary of acute mesenteric ischemia patients and procedural details.

Patient	Age	Etiology	Duration of symptoms	Catheter used	Stent placed	30d survival	1 year survival
1	76	Acute on chronic mesenteric ischemia	7 days	Penumbra CAT6	No	No	No
2	61	Acute on chronic mesenteric ischemia	<1 day	Penumbra CAT8	Yes	Yes	Yes
3	55	Acute on chronic mesenteric ischemia	9 days	Penumbra CAT8	Yes	No	No
4	44	Hypoperfusion	4 months	Penumbra CAT6	Yes	Yes	N/A
5	75	Acute on chronic mesenteric ischemia, atrial fibrillation	22 days	Penumbra CAT6	Yes	No	No