Percutaneous thrombectomy of mural aortic thrombus using intravascular ultrasound guidance

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ABSTRACT

Mural aortic thrombus is a challenging clinical problem with significant potential complications. Particularly precarious are situations with involvement of the visceral segment of the aorta. We describe a technique for percutaneous thrombectomy of mural aortic thrombus using intravascular ultrasound to guide an angled mechanical thrombectomy catheter in conjunction with a continuous aspiration system (Indigo mechanical thrombectomy system; Penumbra, Alameda, Calif). Use of this technique in three patients with challenging cases of mural aortic thrombus is discussed. All patients were treated successfully and without complication using this technique. (J Vasc Surg Cases and Innovative Techniques 2019;5:472-6.)

Keywords: Mural aortic thrombus; Thrombectomy

Arterial embolic events remain a significant cause of morbidity and mortality.[1] Management of mural thrombus within the visceral aortic segment, in particular, remains a subject of debate, with treatment options including therapeutic anticoagulation, endovascular techniques, and open thrombectomy.[2] Endovascular treatment of a mural aortic thrombus has been performed with placement of a stent graft in the thoracic aorta when occlusion of visceral or extremity vasculature is of no concern.[3] In addition, endovascular mechanical thrombectomy has been established as an alternative to open thrombectomy and is primarily reported in the setting of visceral or extremity arterial embolic occlusion.[4,5] Herein, with publication consent obtained from each patient, we describe a technique used in three patients with symptomatic mural aortic thrombus involving percutaneous thrombectomy with an angled mechanical thrombectomy catheter in conjunction with a continuous aspiration system and real-time intravascular ultrasound (IVUS) guidance.

CASE REPORTS

Patient 1. A 53-year-old woman with a previous history of hypertension and stroke presented with recent-onset left-sided flank pain. Computed tomography (CT) scan of the chest, abdomen, and pelvis demonstrated focal mural aortic thrombus in the visceral segment of the aorta (Fig 1, *A*). It also showed celiac trunk and superior mesenteric artery occlusion that appeared to be chronic, with robust collateralization through the inferior mesenteric artery, best demonstrated on subsequent angiographic images (Fig 1, *B*). The right renal artery was occluded, with an atrophic right kidney. The left renal artery was patent; however, the left kidney demonstrated multiple areas of acute infarction, which was thought to be the cause of the patient's flank pain. The patient additionally underwent hypercoagulable workup and echocardiography; the findings of both were normal.

The patient was treated initially with therapeutic-dose heparin infusion. Given ongoing symptoms of flank pain with a single remaining functional kidney that was at high risk for further thromboembolic insult, the decision was made to intervene. The patient was taken to the angiography suite, where single Perclose ProGlide Suture-Mediated Closure devices (Abbott Vascular, Santa Clara, Calif) were placed in each common femoral artery using standard ultrasound-guided preclose technique with 8F sheaths left in place. The patient was systemically heparinized. Bentson wires were advanced carefully into the descending thoracic aorta from both femoral sheaths. Based on the position of the mural aortic thrombus on the right lateral wall of the aorta and the position of wires in the aorta, the decision was made to place the IVUS catheter (Visions PV .035 Digital IVUS catheter; Philips Volcano, San Diego, Calif) through the right femoral artery sheath and the 8F angled mechanical thrombectomy catheter (CAT8; Penumbra, Alameda, Calif) through the left femoral artery sheath. IVUS examination was then performed on the aorta, demonstrating a highly mobile mural aortic thrombus in the visceral segment of the aorta, just proximal to the left renal artery (Fig 1, *C*). Under IVUS guidance and with the wire removed, the thrombectomy catheter was positioned directly below the thrombus. The thrombectomy catheter was then connected to the continuous aspiration system (Indigo aspiration system; Penumbra), and thrombectomy was performed under real-time IVUS guidance by carefully manipulating the angled thrombectomy catheter to keep it

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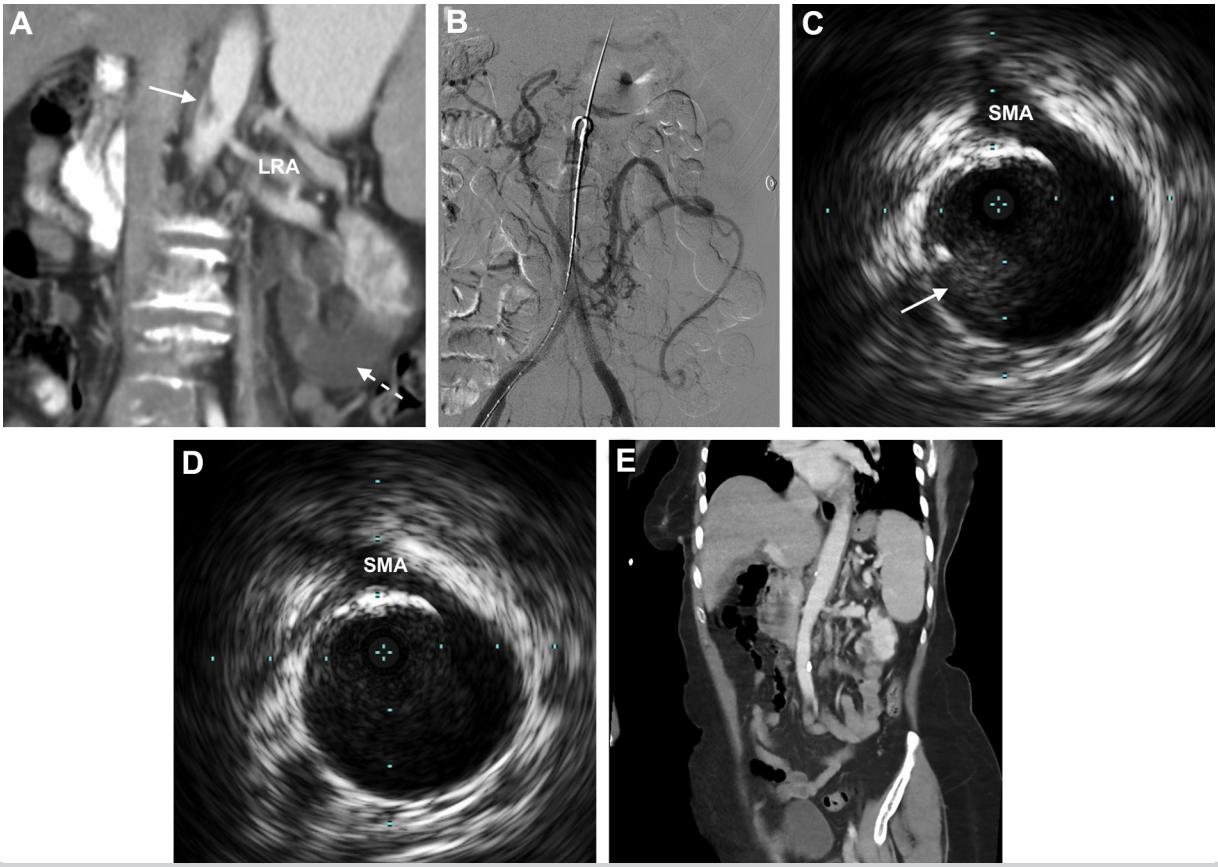

Fig 1. A, Coronal computed tomography (CT) image showing mural aortic thrombus (*arrow*) and proximity to left renal artery (*LRA*), with areas of infarction in left kidney (*dashed arrow*). **B,** Angiography image showing inferior mesenteric artery collateral system. **C,** Intravascular ultrasound (IVUS) image before thrombectomy showing mural aortic thrombus (*arrow*), with proximity to occluded superior mesenteric artery (*SMA*). **D,** IVUS image after thrombectomy with resolution of thrombus. **E,** Follow-up CT image showing no residual or recurrent mural aortic thrombus.

close to the thrombus, moving distal to proximal and central to peripheral in the aorta. A second operator manipulated the IVUS catheter proximally and distally as needed to optimize views. With only two or three passes, nearly all of the thrombus was removed, with no signs of embolic complication based on completion IVUS examination (Fig 1, *D*) and completion aortoiliofemoral angiography. Examination of material removed during thrombectomy showed fragments of thrombus and atheromatous debris. Postoperatively, the patient's flank pain improved, with resolution of inflammation associated with renal infarction, and she was discharged on apixaban. Notably, she was monitored closely, both during hospitalization and in outpatient follow-up, for symptoms or signs of mesenteric ischemia, but she did not and has not developed any of these. Her follow-up CT scan showed no residual or recurrent thrombus (Fig 1, *E*).

Patient 2. A 43-year-old man, with no significant medical history, presented with acute onset of right leg pain with some sensory deficits in his right foot but no motor deficits. CT angiography (CTA) was performed, showing a partially occlusive thrombus in the infrarenal abdominal aorta (Fig 2, *A*). Additional thrombus was seen in the right tibioperoneal trunk, extending into the peroneal and posterior tibial arteries. Given the findings of acute limb ischemia, the patient was taken urgently to the angiography suite for intervention. Although preparations were made for possible open exploration, an endovascular-first approach was chosen because of the involvement of different anatomic regions and the potential need for thrombolysis, given tibial and possible microvasculature involvement, which would allow safer subsequent open surgery, if needed, rather than an open-first approach. During his hospital course, he also underwent hypercoagulable workup and echocardiography; the findings of both were normal.

By the same techniques as in patient 1, a mobile, partially occlusive thrombus was demonstrated slightly proximal to the aortic bifurcation using the IVUS catheter (Fig 2, *B*). The angled mechanical thrombectomy catheter was then advanced over a Bentson wire through the left femoral artery sheath, and thrombectomy was performed under IVUS guidance. The aortic thrombus was completely removed, as confirmed by IVUS and completion angiography (Fig 2, *C*). Percutaneous thrombectomy

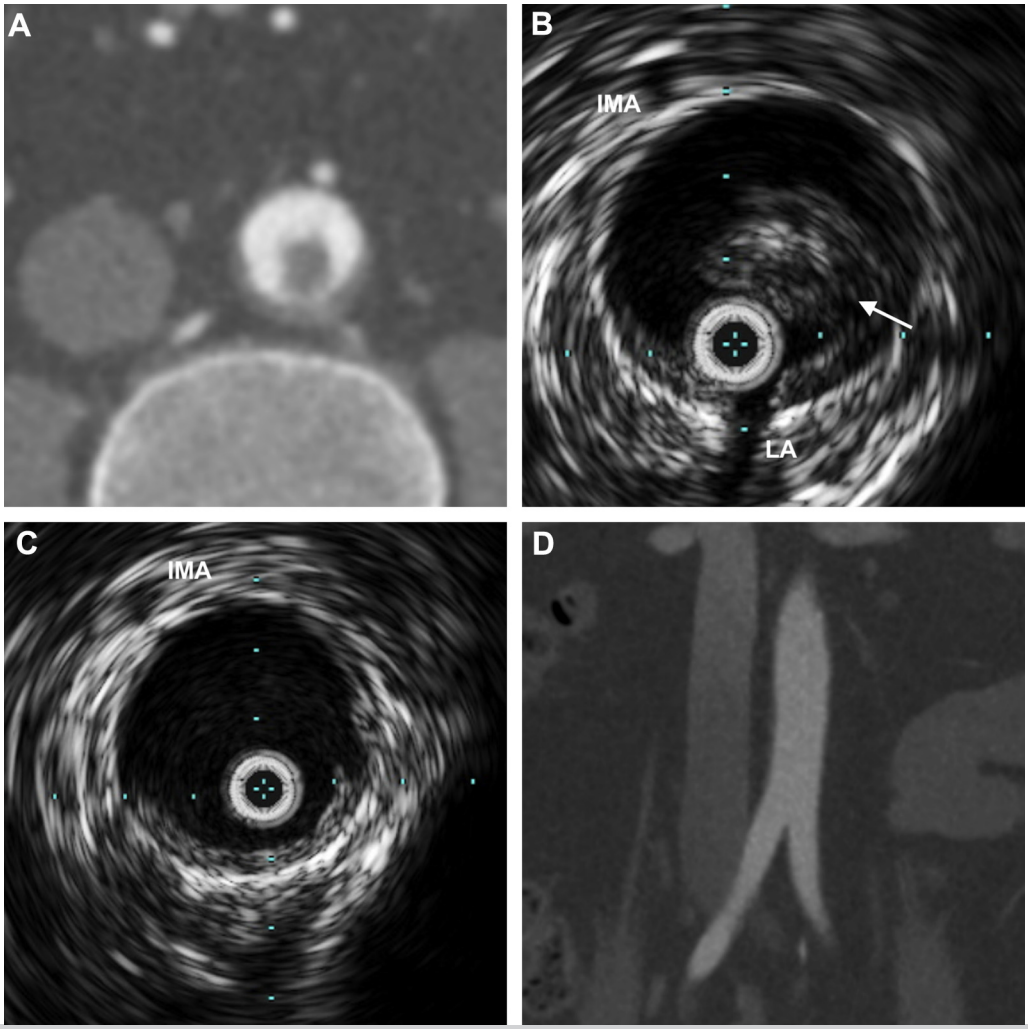

Fig 2. A, Axial computed tomography (CT) image showing mural aortic thrombus 2 to 3 cm proximal to aortic bifurcation. **B,** Intravascular ultrasound (IVUS) image before thrombectomy showing mural aortic thrombus (*arrow*), inferior mesenteric artery (*IMA*), and lumbar artery (*LA*). **C,** IVUS image after thrombectomy. **D,** Follow-up coronal CT image showing no residual or recurrent mural aortic thrombus.

was also performed in the right tibioperoneal trunk using a smaller continuous aspiration mechanical thrombectomy catheter (CAT6; Penumbra). The patient did require approximately 48 hours of arterial thrombolysis for some distal residual thrombus and microemboli in the right foot, which were present on angiography before intervention. He recovered uneventfully and was discharged on apixaban. Follow-up CTA at 1 month after discharge showed no residual or recurrent aortic thrombus and continued patency of right lower extremity runoff vessels (Fig 2, *D*).

Patient 3. A 57-year-old woman with hypertension presented with acute-onset right flank pain. CTA demonstrated multiple areas of infarction in the right kidney. There was a large thrombus in the visceral segment of the aorta and a smaller mural aortic thrombus just inferior to the left renal artery (Fig 3, *A*). A therapeutic-dose heparin infusion was started, and the patient was taken urgently to a hybrid operating room for intervention. Findings of echocardiography and hypercoagulable workup performed during hospitalization were normal.

By the same initial techniques, a large, mobile thrombus was visualized in the visceral segment of the aorta using the IVUS catheter (Fig 3, *B*; Video 1). Additional mobile thrombus was visualized just inferior to the left renal artery. Based on the right lateral aortic wall location of the larger visceral segment thrombus, the angled mechanical thrombectomy catheter was initially placed through the left femoral artery sheath, and thrombectomy was performed under IVUS guidance (Fig 3, *C* and *D*; Video 2). The thrombectomy catheter and IVUS catheter were then switched to perform thrombectomy on the other mural thrombus just below the left renal artery. Thrombus at both locations was nearly completely removed, as confirmed by IVUS and completion aortoiliofemoral angiography (Fig 3, *E*). She

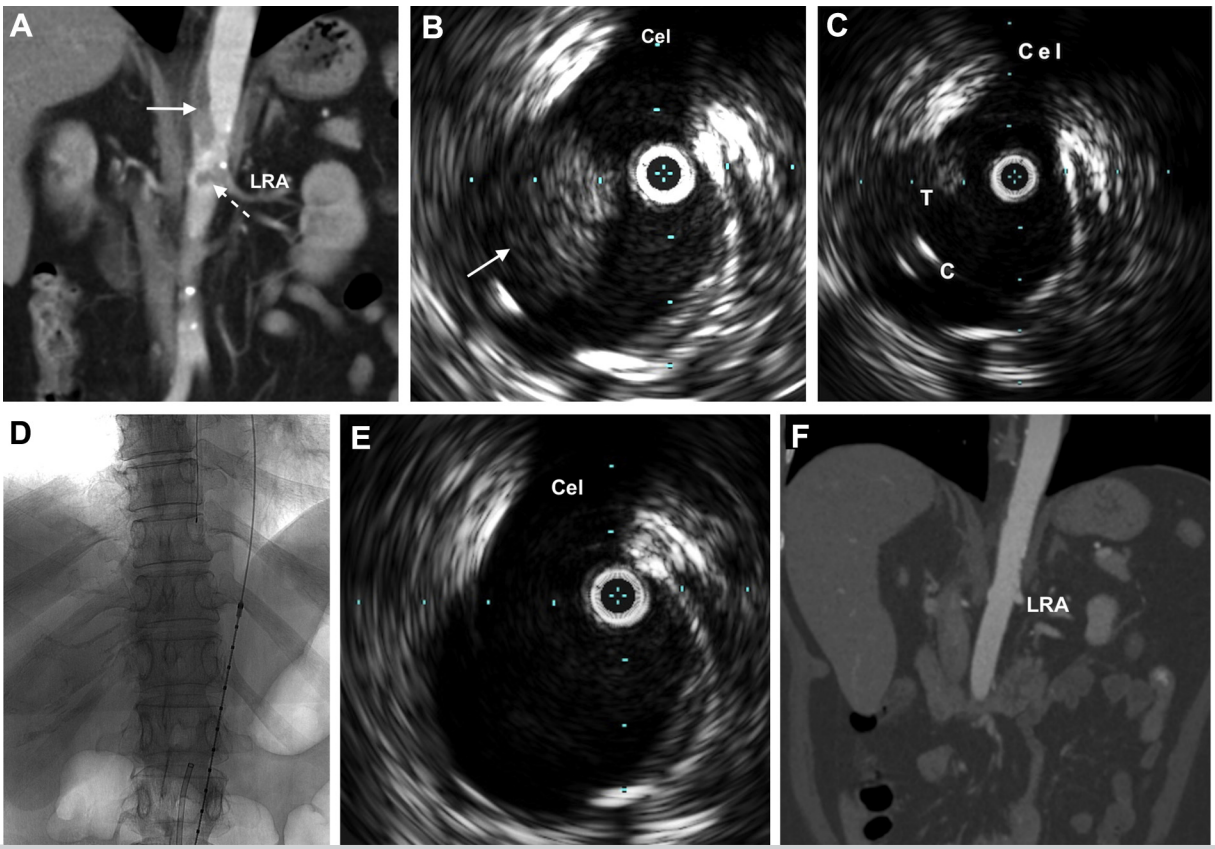

Fig 3. A, Coronal computed tomography (CT) image showing visceral segment aortic thrombus (*arrow*) and mural thrombus (*dashed arrow*) just below left renal artery (*LRA*). **B,** IVUS image before thrombectomy with large mural aortic thrombus (*arrow*), in proximity to celiac artery (*Cel*). **C,** IVUS image from Video 2 showing celiac artery (*Cel*), aortic thrombus (*T*), and thrombectomy catheter (*C*). **D,** Fluoroscopy image showing IVUS catheter on wire and angled thrombectomy catheter after completion of thrombectomy. **E,** IVUS image after thrombectomy, with celiac artery (*Cel*). **F,** Follow-up coronal CT image showing no residual or recurrent mural aortic thrombus, with left renal artery (*LRA*).

recovered uneventfully and was discharged on apixaban. Her follow-up CT scan showed no evidence of recurrent thrombus (Fig 3, *F*).

DISCUSSION

Percutaneous thrombectomy using IVUS to guide an angled continuous aspiration mechanical thrombectomy catheter provides another treatment option for symptomatic mural aortic thrombus, particularly in patients with thromboembolic complications who cannot wait for autogenous thrombolytic processes to occur while undergoing treatment with therapeutic anticoagulation only. One advantage of this technique is its minimally invasive approach, especially compared with open aortic thrombectomy, particularly of the visceral aorta. Another advantage is elimination of the need for extensive aortic coverage with stent graft placement, again, particularly in the visceral aorta. This technique provides excellent real-time visualization, with minimal radiation dose and contrast material use. Thromboembolic complications in other vascular beds can be treated endovascularly with thrombectomy or thrombolysis. Limitations of the technique include possibility of distal embolization and injury to the aortic wall. None of the patients treated thus far suffered any of these complications. Another consideration with this technique is the use of embolic protection. This was considered in all cases, with the arms accessible, but was not used because of fear of disrupting the mobile aortic thrombi with the process of catheter manipulation for selective cannulation. A case-specific approach is advised. Regarding blood loss, the estimated blood loss in all cases was <500 mL. This is easily monitored in the aspiration canister and can be minimized by careful catheter positioning and judicious aspiration.

CONCLUSIONS

Percutaneous thrombectomy using an angled continuous aspiration mechanical thrombectomy catheter under IVUS guidance provides a useful, minimally invasive treatment option in patients with challenging cases of mural aortic thrombus.

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