A novel approach to percutaneous aortic thrombectomy

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ABSTRACT

Aortic mural thrombus in the absence of underlying aortic disease is rare and results in a risk of distant arterial embolization that can result in limb loss or other end organ damage. Current management involves open surgery, anticoagulation, and systemic thrombolysis; however, each carries inherent risks. We report the case of aortic thrombus with distal emboli in two patients, a 56-year-old man and a 68-year-old man, neither with underlying aortic pathology and both presenting with limb threatening ischemia. We performed percutaneous mechanical thrombectomy using the FlowTriever System (Inari Medical, Irvine, Calif) with successful removal of the aortic thrombus in both patients. (J Vasc Surg Cases and Innovative Techniques 2021;7:123-7.)

Key words: Aortic mural thrombus; Percutaneous; Thrombectomy

Peripheral arterial emboli are most commonly cardiac in origin but can also originate from an atherosclerotic or aneurysmal aorta.[1] An aortic mural thrombus found in the absence of preexisting aortic disease is uncommon and can have devastating consequences, including end organ damage and acute limb ischemia, and can be associated with high mortality.[1] The best treatment for patients with aortic thrombus is not well established and is largely driven by the presenting clinical scenario. Anticoagulation is considered first-line therapy but has a 34.6% rate of persistent thrombus.[1] For good surgical risk patients with embolic events and a large clot burden, open aortic surgery can be performed but has a similar rate of persistent thrombus and the added risk of surgery.[1] In addition to open surgery and anticoagulation, systemic thrombolysis has been used to treat aortic thrombi but carries the risk of massive arterial embolization and bleeding.[2] We report two cases in which mechanical thrombectomy via the FlowTriever System (Inari Medical, Irvine, Calif), without any adjunctive pharmacolysis, was used to treat aortic thrombus in patients with no underlying aortic pathology. Both patients provided written informed consent.

CASE DESCRIPTIONS

Our first patient was a 56-year-old man who had presented with a 6-week history of left foot pain. Imaging revealed an aortic thrombus and occlusion of the popliteal artery with reconstitution of the distal tibial arteries. He was offered aortic thrombectomy and open popliteal artery and tibial thromboembolectomy. In the operating room, bilateral femoral artery access was obtained. In addition to an aortogram, intravascular ultrasonography (IVUS) was performed to visualize the thrombus. Using the preclose technique, two Perclose ProGlide devices (Abbott Vascular, Santa Clara, Calif) were deployed, and a 20F sheath was placed in the proximal left common iliac artery to deliver the FlowTriever catheter and disks (Inari Medical). An 8-mm × 40-mm balloon was placed in the right common iliac artery to protect against embolization down the right side. Next, the disk of the large FlowTriever catheter, which expands to 15 to 18 mm, was advanced, deployed within the distal aorta, and pulled back into the FlowTriever aspiration catheter (Fig 1). After removal from the sheath, the disk was examined and noted to contain the thrombus. IVUS confirmed no residual thrombus. The balloon on the right was deflated to restore flow to the leg. For the popliteal thrombus, open embolectomy was performed via a below-the-knee medial popliteal exposure, with return of palpable pulses. The patient had an uneventful hospital course and was discharged on postoperative day 3 with clopidogrel and anticoagulation therapy. Follow-up imaging studies demonstrated no residual thrombus (Fig 2).

The second patient was a 68-year-old man who had presented with a 2-week history of left leg pain and was found on imaging to have aortic and left femoropopliteal thrombi. Given the acute presentation, an endovascular approach was chosen, in contrast to the previous patient. Using ultrasound guidance, the bilateral common femoral arteries were accessed. The right side was used to place a balloon in the right common iliac artery to protect against emboli showering down the right leg. Next, angiography via the left side was performed, which demonstrated a near occlusive left common iliac artery thrombus and large aortic thrombus at the bifurcation (Fig 3, *A*). Using the preclose technique, the access was upsized to a 16F sheath, and a FlowTriever device (Inari Medical) was used to perform aspiration

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thrombectomy of the iliac and aortic segments (Fig 3, *B*). At this point, the balloon of the right common iliac artery was deflated, restoring flow to the leg. Aortography, followed by further confirmation with IVUS, demonstrated no residual thrombus in the aorta or left iliac artery. Next, percutaneous mechanical thrombectomy was performed on the left femoral and popliteal arteries. A completion angiogram demonstrated excellent results with good flow to the anterior tibial artery. The hospital course was unremarkable, and patient was discharged on postoperative 3 with clopidogrel and anticoagulation therapy. The follow-up imaging studies demonstrated complete thrombus resolution (Fig 4).

Both patients had follow-up imaging studies showing excellent results and complete resolution of the aortic thrombus. Pathologic analysis of the thrombus from the second patient identified acute and chronic components. The acute component of thrombus was composed primarily of platelets, seen as eosinophilic amorphous material with hematoxylin and eosin staining (Fig 5, *A*) and confirmed by immunostaining with CD61 (Fig 5, *B*), which will be positive in the presence of platelets. Other areas of the thrombus (Fig 5, *C*; trichrome stain) showed intermingled fibrin and red blood cells, in addition to platelets. The chronic portion of the thrombus showed collagen deposition, seen as blue areas (Fig 5, *D*). Residual platelets were revealed by immunostaining with CD61 (Fig 5, *E*) and the ingrowth of endothelial cells is highlighted by immunostaining for CD34 (Fig 5, *F*).

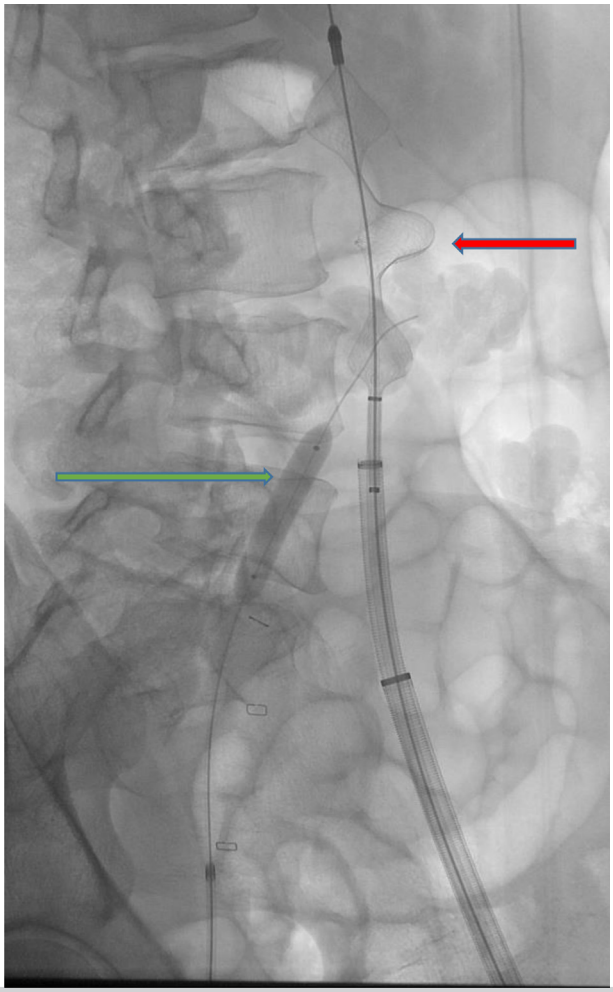

Fig 1. View showing the balloon protecting the right common iliac artery (*green arrow*) and the disk of the FlowTriever catheter and disks (*red arrow*) deployed within the distal aorta.

DISCUSSION

We safely and effectively treated two patients who had presented with aortic thrombus using mechanical thrombectomy with the FlowTriever System (Inari Medical), thereby mitigating the need for open aortic surgery and avoiding pharmacolysis. No intraoperative distal emboli occurred, nor were any emboli identified on the postoperative imaging studies. Patients presenting with aortic thrombus will typically be treated via anticoagulation or thrombolytic agents, which can result in high rates of persistent thrombus. Anticoagulation therapy, in particular, might not be ideal for patients with a large clot burden and, in particular, those with associated embolic events, which is how both of our patients had presented. Aortic thrombi have also been treated with systemic thrombolysis, which has shown some success. However, thrombolysis can lyse the pedicle of the thrombus faster than the corpus, causing massive arterial embolization.[2] Additionally, by avoiding the use of thrombolytic agents as either the primary treatment or after open surgery, we eliminated the need for intensive care unit monitoring, allowing for a shorter hospital stay of 3 days for each patient and an earlier return to activity.

Open surgery is often required for patients who present with aortic thrombus that has embolized because of the risk of further embolization; however, surgery has its own inherent risks. Although data on the surgical outcomes of open aortic thrombectomy are limited, a review of 34 open surgical procedures to treat nonaneurysmal aortic arch lesions in patients with systemic embolization documented a 2.6% mortality rate and 28.9% morbidity rate, including neurologic complications and recurrent embolic events.[3] Open surgery also results in longer recovery periods for patients, longer hospital stays, and, often, the need for intensive care unit monitoring. By removing the thrombus via percutaneous methods, we removed the nidus of the embolic source in each patient that otherwise could have embolized again, causing potential further complications. The risk of continued embolization has been reported in ≤73% of patients with a mobile thrombus, leading to mortality in ≤52% of patients.[4] Percutaneous mechanical thrombectomy via the FlowTriever device (Inari Medical) avoided the risks associated with open surgery and successfully and completely cleared the thrombus, eliminating the risk of future embolization.

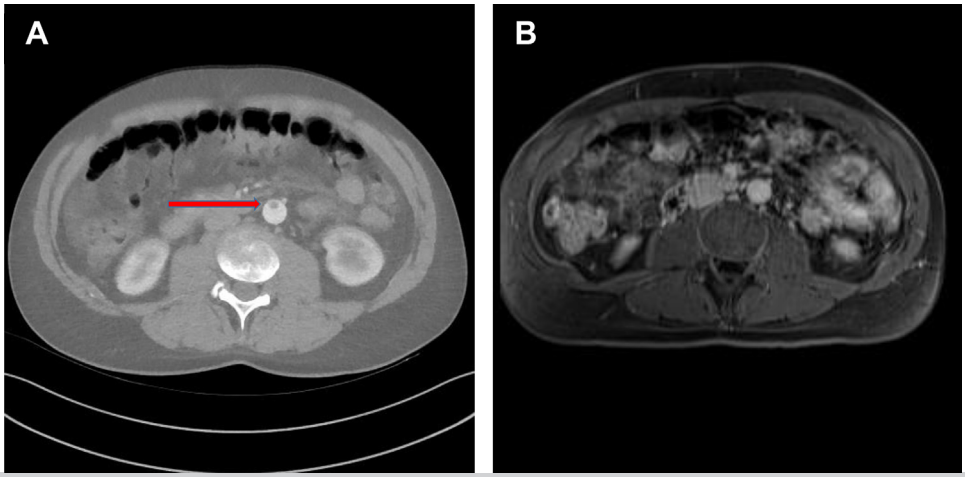

Fig 2. A, Preoperative computed tomography scan demonstrating the presence of aortic thrombus (*red arrow*). **B,** Postoperative magnetic resonance angiogram demonstrating no residual thrombus.

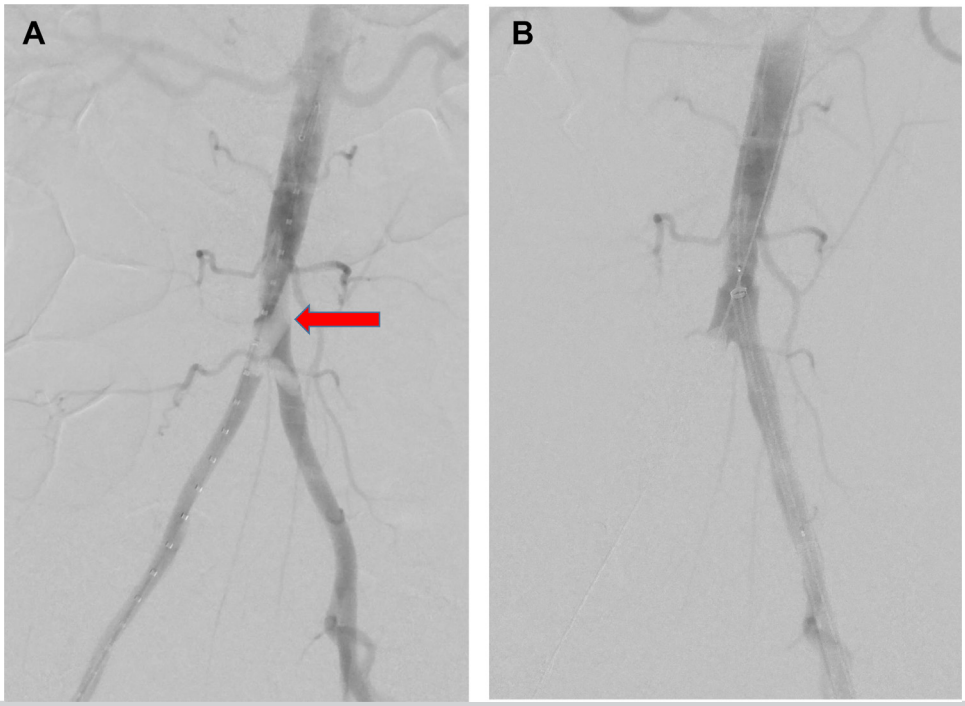

Fig 3. A, Angiogram demonstrating a near occlusive left common iliac artery thrombus and aortic thrombus (*red arrow*) at the bifurcation. **B,** Completion angiogram demonstrating balloon protecting the right arterial bed, and the FlowTriever device in place after aspiration thrombectomy.

Arterial thrombi are composed primarily of platelets and fibrin with a lower content of red blood cells owing to the high shear forces. As shown by scanning electron microscopy, old arterial thrombi become denser and contain more fibrin fibers and fewer intervening pores. This reduction in permeability might increase the resistance to fibrinolytic agents over time and necessitate mechanical removal.[5] Furthermore, the presence of platelets stresses the importance of using an aggressive antiplatelet regimen, in addition to anticoagulation therapy, to prevent clot propagation and embolization. Both of our patients will continue with antiplatelet therapy indefinitely and receive anticoagulation therapy for 1 year. At present, no guidelines are available regarding the appropriate medical therapy, and this regimen was based on our best judgment.

The FlowTriever System (Inari Medical), indicated for use in the peripheral vasculature and pulmonary arteries, is typically introduced via venous access. In both of our patients, arterial access was achieved percutaneously. Although the large-bore design allows for an increased

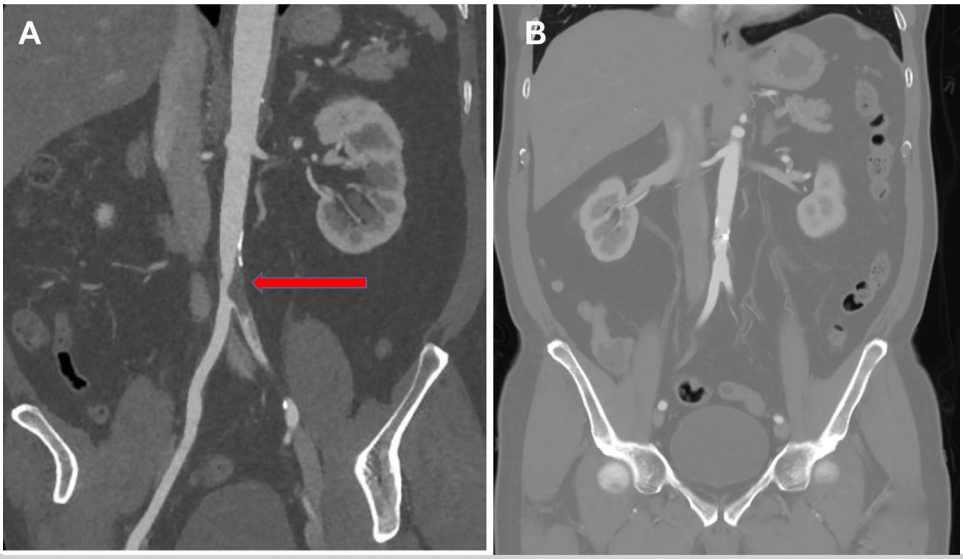

Fig 4. A, Preoperative computed tomography scan demonstrating the presence of aortic thrombus (*red arrow*). **B,** Postoperative computed tomography angiogram demonstrating no residual thrombus.

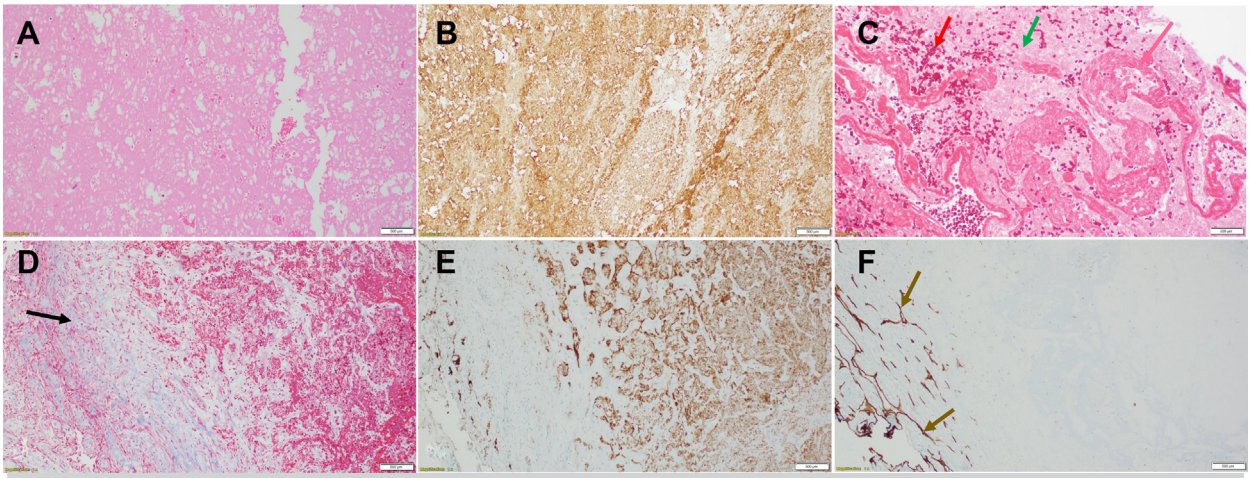

Fig 5. The acute component of the thrombus was composed primarily of platelets, seen as eosinophilic amorphous material on hematoxylin and eosin staining **(A)** and confirmed by immunostaining with CD61 **(B)**. **C,** Trichrome staining of the thrombus demonstrated intermingled fibrin (*pink arrow*) and red blood cells (*red arrow*), in addition to platelets (*green arrow*). **D,** The chronic portion of the thrombus shows collagen deposition, seen as blue areas (*black arrow*). **E,** Residual platelets can be seen by immunostaining with CD61. **F,** Ingrowth of endothelial cells is (*arrows*) highlighted by immunostaining for CD34. Original magnification, A, B, D to F, ×100; and C, ×200.

ability to capture large and chronic thrombi, it also introduces the risk of bleeding and vascular access complications, especially when used in the high pressure arterial system.[6] We used the Perclose ProGlide device (Abbott Vascular) to achieve hemostasis, which allowed for reversible downsizing of the arteriotomy using a rail suture until bleeding control was achieved.[7] Despite the large-bore arterial access, we were able to successfully upsize and downsize the arteriotomy with no access site issues in either patient.

CONCLUSION

We successfully performed mechanical thrombectomy of aortic thrombi in our two patients. The patients experienced no postoperative complications, and we successfully mitigated the need for open surgery. Both thrombi had embolized distally; as such, removal was deemed best, given the potential for recurrent embolization. In select cases, removal of an aortic thrombus could be feasible with use of the FlowTriever System (Inari Medical).

REFERENCES

1. Meyermann K, Trani J, Caputo FJ, Lombardi JV. Descending thoracic aortic mural thrombus presentation and treatment strategies. J Vasc Surg 2017;66:931-6.
2. Krüger T, Liske B, Ziemer S, Lindemann S, Ziemer G. Thrombolysis to treat thrombi of the aortic arch. Clin Appl Thromb Hemost 2011;17:340-5.
3. Safi HJ, Miller CC III, Estrera AL. Regarding "surgical treatment of nonaneurysmal aortic arch lesions in patients with systemic embolizations. J Vasc Surg 2002;36:1274-5.
4. Celikyay F, Yuksekkaya R, Yilmaz A, Beyhan M, Sivqin H, Almus F. A fatal condition in the thoracic aorta. What's your diagnosis? Floating aortic thrombus. Ann Saudi Med 2013;33:508-11.
5. Chernysh IN, Nagaswami C, Kosolapova S, Peshkova AD, Cuker A, Cines DS, et al. The distinctive structure and composition of arterial and venous thrombi and pulmonary emboli. Sci Rep 2020;10:5112.
6. Kaki A, Blank N, Alraies MC, Kajy M, Grines CL, Hasan R, et al. Access and closure management of large bore femoral arterial access. J Interv Cardiol 2018;31:969-77.
7. Baldino G, Persi F, Mortola P, Gori A. An alternative technique to achieve haemostasis during PEVAR using Perclose ProGlide. EJVES Short Rep 2018;41:8-9.

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