Transient arterial insufficiency and neurologic deficit following external iliac vein stent reconstruction for malignant compression

Aaron C. Daub, MD, PhD,[a] David S. Shin, MD,[a] Mark H. Meissner, MD,[b] Christopher R. Ingraham, MD,[a] Eric J. Monroe, MD,[c] *and* Jeffrey Forris Beecham Chick, MD, MPH, FCIRSE, FSVM,[a] *Seattle, Wash*

ABSTRACT

Acute iliofemoral deep vein thrombosis may present with pain and swelling or phlegmasia cerulea dolens. When thrombosis occurs in the setting of an underlying venous obstruction, stent reconstruction should be performed after thrombus clearance to prevent rethrombosis. Stent reconstruction after thrombus clearance is associated with high technical success rates and durable patency. This report describes transient lower extremity arterial insufficiency and neurologic deficit after external iliac vein stent expansion and reconstruction within a confined space resulting from a malignant obstruction. It serves as a cautionary tale that, in rare cases, aggressive venous stenting within a confined space can transfer clinically significant forces to adjacent arteries and nerves. (J Vasc Surg Cases Innov Tech 2021;7:469-73.)

Keywords: Malignant venous compression; Venous stent reconstruction; Venovo; Gianturco Z-stent; Arterial insufficiency

Acute iliofemoral deep venous thrombosis (DVT) presents with lower extremity pain and swelling or phlegmasia cerulea dolens. Thirty percent will develop post-thrombotic syndrome (PTS).[1] In patients with symptomatic iliofemoral DVT, catheter-directed thrombolysis, mechanical thrombectomy, or pharmacomechanical catheter-directed thrombolysis, compared with standard anticoagulation, may restore in-line patency more quickly, preserve valve function, improve quality of life, and decrease the severity of PTS.[2] Iliofemoral DVT is associated with preexisting obstructive lesions.

In one study, 84% of patients with iliofemoral DVT had iliac vein compression on computed tomographic venography.[3] For these patients, the use of self-expanding metallic venous stents to treat the obstructive lesion is a prerequisite for durable results.[4] Iliac venous stenting may be performed with minimal morbidity and is associated with acceptable long-term patency rates.[5,6]

This report describes a patient with acute iliofemoral and femoropopliteal DVT owing to malignant external iliac venous compression who developed arterial insufficiency from compression of the external iliac artery after venous stenting.

CASE REPORT

Institutional review board approval was not required. The patient's consent was obtained.

A 75-year-old woman with bladder cancer presented with 5 weeks of progressive right lower extremity pain and edema that had become debilitating. A computed tomography scan with contrast performed 3 weeks prior showed an enhancing mass along the right pelvic sidewall that resulted in extrinsic compression and occlusion of the right external iliac vein (Fig 1). Right lower extremity venous duplex ultrasound examination was obtained, showing occlusive acute thrombosis of the right external iliac, common femoral, and femoral veins. Apixaban 5 mg twice daily was initiated.

Two days later, after considering conservative therapy, the patient returned for venous recanalization, thrombectomy, and stent reconstruction (Fig 2). Ascending venography, performed from a right popliteal vein approach, demonstrated a transition from nonocclusive-to-occlusive thrombus in the common femoral vein and minimal venous collateralization. Mechanical thrombectomy of the common femoral and femoral veins was performed using the ClotTriever mechanical thrombectomy device (INARI Medical, Irvine, Calif). Post-thrombectomy venography demonstrated high-grade stenosis of the external iliac vein, corresponding with the site of malignant external compression on computed tomography scanning.

A 14-mm × 10-cm Venovo stent (Bard Peripheral Vascular; Tempe, Ariz) was deployed across the malignant stenosis and post-dilated with a 14-mm balloon. Repeat venography showed persistent stenosis at the site of compression, which was, therefore, buttressed with a 15-mm × 5-cm Gianturco Z-stent (Cook

From the Section of Vascular and Interventional Radiology, Department of Radiology,[a] Division of Vascular Surgery, Department of Surgery,[b] and the Section of Interventional Radiology, Department of Radiology, Seattle Children's Hospital,[c] University of Washington.

Author conflict of interest: none.

Correspondence: Jeffrey Forris Beecham Chick, MD, MPH, FCIRSE, FSVM, Section of Vascular and Interventional Radiology, Department of Radiology, University of Washington, 1959 Northeast Pacific St, Seattle, WA 98195 (e-mail: jeffreychick@gmail.com).

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

https://doi.org/10.1016/j.jvscit.2021.05.007

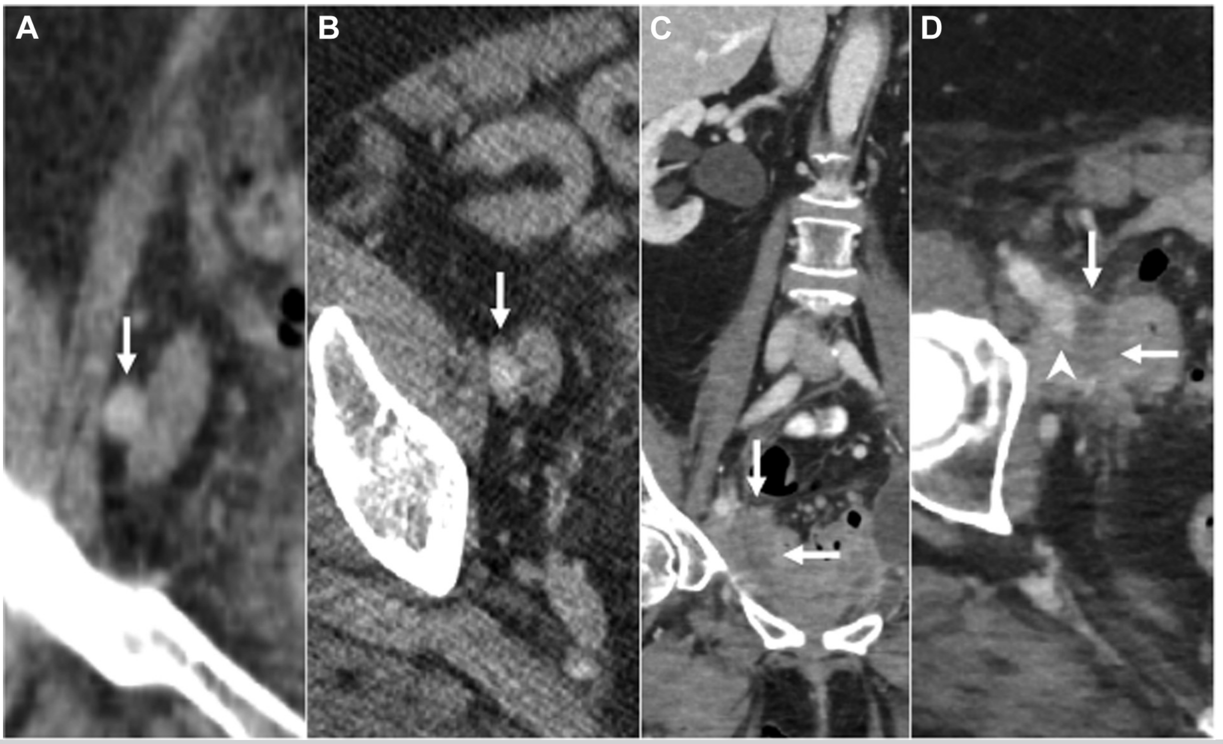

Fig 1. Computed tomography (CT) scan with administration of intravenous contrast 3 weeks before stent reconstruction. **A,** Coronal and **(B)** axial reformations showing a patent right external iliac artery (EIA) (*arrows*) traversing the site of metastatic recurrence along the right pelvic sidewall. **C,** Coronal and **(D)** axial reformations showing complete effacement of the right external iliac vein (EIV) at the site of metastasis (*arrows*). There is tumor encasement of the EIA and EIV and abutment of the iliac body creating a rigid confined space. At this time, there is normal opacification of the EIV immediately peripheral to the tumor (*arrowhead*) without evidence of thrombosis.

Medical; Bloomington, Ind). Postdeployment angioplasty was performed with a 16-mm balloon. To completely cover all residual venous disease and ensure adequate inflow and outflow, the stent construct was extended peripherally across the inguinal ligament into the common femoral vein with a 12-mm × 6-cm Wallstent (Boston Scientific; Marlborough, Mass) and centrally into the common iliac vein with a 14-mm × 8-cm Venovo stent. Postdeployment angioplasty was performed with 14-mm and 12-mm balloons in the common iliac and common femoral veins, respectively. Completion venography showed in-line flow from the popliteal vein into the inferior vena cava. The patient was transitioned to enoxaparin 1 mg/kg twice daily and maintained on aspirin 81 mg daily.

The following morning, the patient described numbness and tingling involving the dorsal and lateral aspects of her right foot with foot drop. The right dorsalis pedis and posterior tibial pulses were newly nonpalpable. Right ankle dorsiflexion strength was 2/5 compared with 5/5 on the left. Right lower extremity arterial and venous duplex ultrasound studies were performed. The ankle-brachial index was 0.31 on the right compared with 1.16 on the left. The right iliofemoral venous stents were widely patent. There was no popliteal hematoma. Velocity within the midsegment of the right external iliac artery was markedly increased at 497 cm/s. There was poststenotic turbulence and monophasic flow within the right common femoral artery. The remainder of the right lower extremity arteries showed dampened monophasic waveforms. Computed tomography angiogram demonstrated a severe, focal, nearly occlusive, right external iliac artery stenosis at the site of the pelvic sidewall tumor, directly adjacent to the location of the buttressed venous stent placement (Fig 3).

A multidisciplinary discussion occurred. External iliac artery stent placement was feasible, but thought to be associated with a risk of thrombosis and stent fracture owing to crossing of the inguinal ligament. A left-to-right femorofemoral bypass graft was considered; however, the patient had edema from prior DVT, and it was thought that this factor would increase the risk for graft infection. Based on these considerations and because the patient could be monitored closely in the hospital for worsening symptoms, conservative management with anticoagulation alone was continued.

By the following day, the patient's right foot numbness and weakness improved, and she was able to ambulate. Over the next 2 days, she was able to walk independently for longer distances owing to decreased foot drop. On postprocedure day 4, the patient was discharged to home in stable condition.

The patient was seen at 1 month. Her right lower extremity edema and neurologic symptoms had resolved. Her right

Fig 2. Iliofemoral and femoropopliteal venous recanalization, mechanical thrombectomy, and stent reconstruction. **A,** Prone positioning and initial venography, from right popliteal access, showing multiple defects within the popliteal and femoral veins consistent with a nonocclusive thrombus with filling of venous collaterals. **B,** Ascending venography showing occlusive thrombus within the common femoral vein (CFV) and high-grade stenosis of the low external iliac vein at the site of malignant compression (*arrow*). **C,** The collection bag and coring (*arrow*) element of the Inari ClotTriever were deployed above the most central extent of the thrombus, and thrombectomy was performed. **D,** Completion femoropopliteal venography showing in-line flow. **E,** Residual waist (*arrow*), at the site of malignant extrinsic compression, after deployment of a 14-mm × 10-cm Venovo stent and angioplasty to 14-mm. **F,** Using a buttressing technique, a 15-mm × 5-cm Gianturco Z-stent was deployed within the Venovo stent (*double arrows*), centered at the waist, and angioplasty was performed to 16-mm resulting in near resolution of the waist. The stent construct was extended centrally into the common iliac vein (CIV) with a 14-mm × 8-cm Venovo stent and peripherally across the inguinal ligament with a 12-mm × 6-cm Wallstent. **G,** Completion iliofemoral venography showing in-line flow with no filling of venous collaterals.

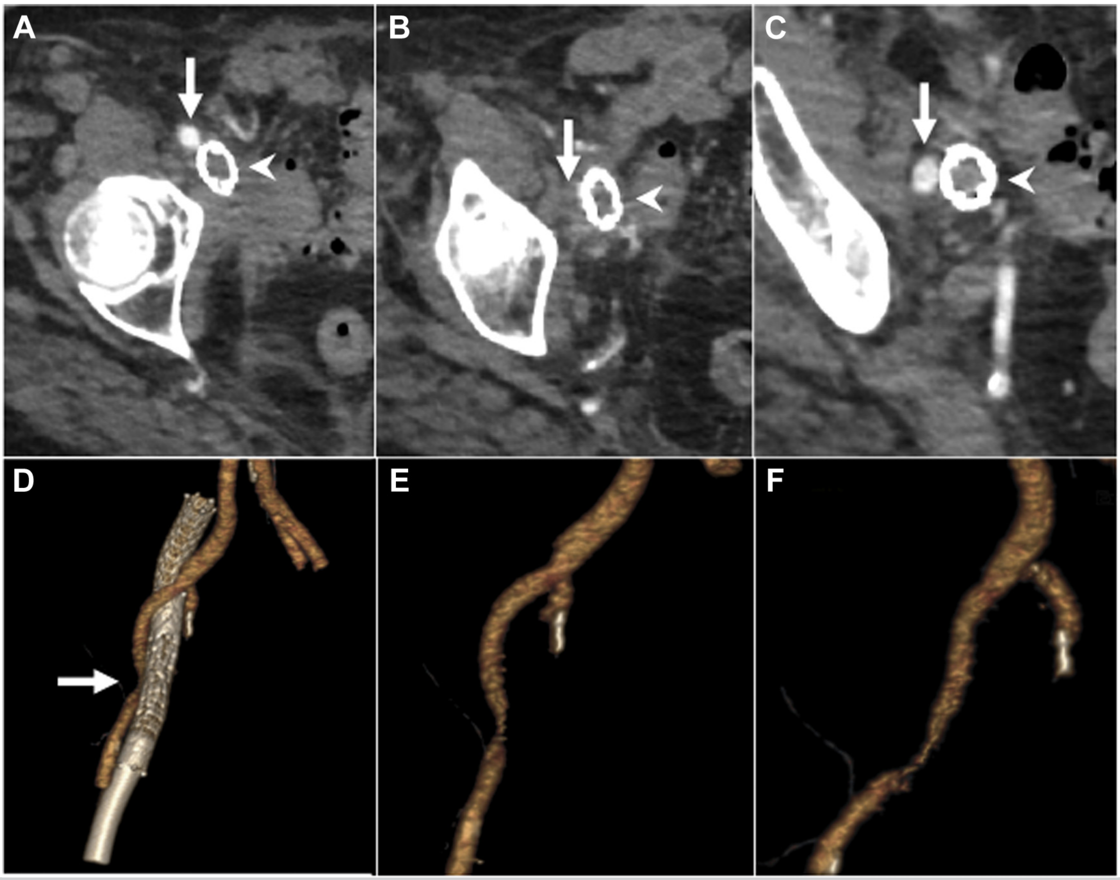

Fig 3. High-grade arterial stenosis after iliofemoral venous stent reconstruction. **A-C,** Sequential axial images from a pelvic computed tomographic angiography (CTA) through the site of pelvic side wall metastasis and venous Gianturco Z-stent buttressing show focal obliteration of the external iliac artery (EIA) (*arrows*) owing to extrinsic compression from both the venous stent construct (*arrowheads*) and tumor. There is normal opacification of the EIA immediately distal to the obstruction. The level of obliteration corresponds with the adjacent Venovo and Gianturco Z-stent (**B**; *arrowhead*). **D,** Three-dimensional reconstruction from pelvic CTA showing high-grade EIA stenosis (*arrow*). **E,** Anteroposterior and **(F)** 30° left anterior oblique views, with stent subtracted, showing concentric, near-occlusive, EIA stenosis.

ankle-brachial index had improved to 0.74 from 0.31. The external iliac vein velocity was 443 mL/min, and computed tomographic venography confirmed patency of the right iliofemoral stent reconstruction. At 2 months, patency of the stented iliofemoral vein was noted on a nondedicated computed tomography, along with persistent severe stenosis of the external iliac artery at the site of aggressive venous stenting. The patient was placed on hospice care and deceased 4 months later.

DISCUSSION

Residual venous obstruction and post-thrombotic reflux after iliofemoral DVT may be associated with chronic symptoms that decrease quality of life. If thrombus is not cleared adequately, patients may experience recurrence, valvular reflux, and PTS.[7-9] Endovascular treatment in iliofemoral DVT is focused on facilitated thrombus removal, relief of outflow obstruction, and restoration of flow sufficient to maintain long-term patency. When an anatomic abnormality is identified, the culprit lesion typically requires stent placement to prevent rethrombosis.[10,11]

Iliocaval and iliofemoral stent reconstruction have proven successful in treating acute and chronic DVT resulting from extrinsic compression. Studies have shown favorable technical successes, long-term patency rates, and low complication rates.[12-16] In one large study including both thrombotic and nonthrombotic iliac obstructions, the technical success rate was 83% and the 4-year primary and secondary patency rates were 35% and 72%, respectively.[17] Stent patency rates for nonthrombotic lesions associated with iliac venous compression are more favorable, with primary patency rates ranging from 74% to 92% at 1 year and secondary patency rates over 90% reported at up to 5 years.[15,16,18,19]

In this patient, a Gianturco Z-stent modification technique was used to provide greater radial force at the site of malignant venous compression.[20] The technique, as initially described, used a self-expanding Gianturco Z-stent to buttress the upper end of an iliac vein Wallstent stack, which increased radial force at the typical choke point near the iliocaval confluence to prevent compression, ostial coning, and migration. The authors showed primary and secondary patency rates at 2 years of 69% and 93%, respectively.[20] Venovo stents may be less prone to migration associated with compression than Wallstents. This case, however, was felt to require buttressing with a Gianturco Z-stent as a means to increase radial force.

Recent improvements in stent technology have resulted in dedicated venous stents that achieve higher radial forces.[21] The Venovo stent is a self-expanding nitinol stent with open cell design. It has the highest chronic outward force (4.83 N/cm) compared with similar self-expanding stents including Vici (1.39 N/cm) (Boston Scientific), Zilver Vena (2.02 N/cm) (Cook Medical), and Wallstent (0.85 N/cm).[22] The Gianturco Z-stent radial forces depend on design. The six-point double body Z-stent produces radial forces up to 16 N with pinching force resistance owing to stainless steel construction.[23,24]

This report describes transient arterial insufficiency and neurologic compromise resulting from adjacent venous stent reconstruction. In retrospect, the arterial compression likely resulted from (1) the stent expansion into a confined space flanked laterally by the external iliac artery, tumor, and ilium, (2) the high radial force of the overlapping Venovo stent and Gianturco Z-stent construct, and (3) the length of the iliofemoral stent construct (common iliac to common femoral vein) that resulted in stiffening and straightening of the associated venous segment. The rapid resolution of symptoms was not surprising; acute occlusion of the proximal arteries in patients without significant peripheral arterial disease may be tolerated, depending on individual clinical circumstances.[25] This finding may reflect robust autoregulation of existing collaterals.

In rare instances, standard venous stents do not provide sufficient radial force to overcome the compressive extrinsic force of the culprit lesion. This report serves as a cautionary tale that aggressive venous stenting within a confined space may transfer high radial forces to adjacent structures including arteries and nerves.

REFERENCES

1. Kahn SR, Shrier I, Julian JA, Ducruet T, Arsenault L, Miron M-J, et al. Determinants and time course of the postthrombotic syndrome after acute deep venous thrombosis. Ann Intern Med 2008;149:698-707.
2. Comerota AJ, Kearon C, Gu C-S, Julian JA, Goldhaber SZ, Kahn SR, et al. Endovascular thrombus removal for acute iliofemoral deep vein thrombosis. Circulation 2019;139:1162-73.
3. Chung JW, Yoon CJ, Jung SI, Kim H-C, Lee W, Kim YI, et al. Acute iliofemoral deep vein thrombosis: evaluation of underlying anatomic abnormalities by spiral CT venography. J Vasc Interv Radiol 2004;15:249-56.
4. Meissner MH, Gloviczki P, Comerota AJ, Dalsing MC, Eklof BG, Gillespie DL, et al. Early thrombus removal strategies for acute deep venous thrombosis: Clinical Practice Guidelines of the Society for Vascular Surgery and the American Venous Forum. J Vasc Surg 2012;55:1449-62.
5. Raju S, Owen S, Neglen P. The clinical impact of iliac venous stents in the management of chronic venous insufficiency. J Vasc Surg 2002;35:8-15.
6. Neglén P, Hollis KC, Olivier J, Raju S. Stenting of the venous outflow in chronic venous disease: Long-term stent-related outcome, clinical, and hemodynamic result. J Vasc Surg 2007;46:979-90.e1.
7. Comerota AJ, Grewal N, Martinez JT, Chen JT, DiSalle R, Andrews L, et al. Postthrombotic morbidity correlates with residual thrombus following catheter-directed thrombolysis for iliofemoral deep vein thrombosis. J Vasc Surg 2012;55:768-73.
8. Aziz F, Comerota AJ. Quantity of residual thrombus after successful catheter-directed thrombolysis for iliofemoral deep venous thrombosis correlates with recurrence. Eur J Vasc Endovasc Surg 2012;44:210-3.
9. Haig Y, Enden T, Slagsvold C-E, Sandvik L, Sandset PM, Kløw NE. Determinants of early and long-term efficacy of catheter-directed thrombolysis in proximal deep vein thrombosis. J Vasc Interv Radiol 2013;24:17-24.
10. Mickley V, Schwagierek R, Rilinger N, Görich J, Sunder-Plassmann L. Left iliac venous thrombosis caused by venous spur: treatment with thrombectomy and stent implantation. J Vasc Surg 1998;28:492-7.
11. Patel NH, Stookey KR, Ketcham DB, Cragg AH. Endovascular management of acute extensive iliofemoral deep venous thrombosis caused by May-Thurner syndrome. J Vasc Interv Radiol 2000;11:1297-302.
12. Neglén P, Raju S. Balloon dilation and stenting of chronic iliac vein obstruction: technical aspects and early clinical outcome. J Endovasc Ther 2000;7:79-91.
13. Hartung O, Loundou AD, Barthelemy P, Arnoux D, Boufi M, Alimi YS. Endovascular management of chronic disabling ilio-caval obstructive lesions: long-term results. Eur J Vasc Endovasc Surg 2009;38:118-24.
14. de Graaf R, de Wolf M, Sailer AM, van Laanen J, Wittens C, Jalaie H. Iliocaval confluence stenting for chronic venous obstructions. Cardiovasc Intervent Radiol 2015;38:1198-204.
15. O'Sullivan GJ, Semba CP, Bittner CA, Kee ST, Razavi MK, Sze DY, et al. Endovascular management of iliac vein compression (May-Thurner) syndrome. J Vasc Interv Radiol 2000;11:823-36.
16. Knipp BS, Ferguson E, Williams DM, Dasika NJ, Cwikiel W, Henke PK, et al. Factors associated with outcome after interventional treatment of symptomatic iliac vein compression syndrome. J Vasc Surg 2007;46:743-9.e1.
17. Raju S, Neglén P. Percutaneous recanalization of total occlusions of the iliac vein. J Vasc Surg 2009;50:360-8.
18. Hager ES, Yuo T, Tahara R, Dillavou E, Al-Khoury G, Marone L, et al. Outcomes of endovascular intervention for May-Thurner syndrome. J Vasc Surg Venous Lymphat Disord 2013;1:270-5.
19. Hurst DR, Forauer AR, Bloom JR, Greenfield LJ, Wakefield TW, Williams DM. Diagnosis and endovascular treatment of iliocaval compression syndrome. J Vasc Surg 2001;34:106-13.
20. Raju S, Ward M, Kirk O. A modification of iliac vein stent technique. Ann Vasc Surg 2014;28:1485-92.
21. Shamimi-Noori SM, Clark TWI. Venous stents: current status and future directions. Tech Vasc Interv Radiol 2018;21:113-6.
22. Dabir D, Feisst A, Thomas D, Luetkens JA, Meyer C, Kardulovic A, et al. Physical properties of venous stents: an experimental comparison. Cardiovasc Intervent Radiol 2018;41:942-50.
23. Snowhill PB, Nosher JL, Siegel RL, Silver FH. Characterization of radial forces in Z stents. Invest Radiol 2001;36:521-30.
24. Hejazi M, Phani AS, Gagnon J, Hsiang Y, Sassani F. Deformation characteristics of venous stents: a comparative assessment. J Vasc Surg 2018;68:e84-5.
25. Quiroga E, Shalhub S, Tran NT, Starnes BW, Singh N. Outcomes of femoral artery ligation for treatment of infected femoral pseudoaneurysms owing to drug injection. J Vasc Surg 2021;73:635-40.

Submitted Jan 25, 2021; accepted May 7, 2021.