Single-session inferior vena cava filter removal, recanalization, and endovenous reconstruction for chronic iliocaval thrombosis

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ABSTRACT

Objective: The objective of this study was to demonstrate the safety and efficacy of treatment of inferior vena cava filter (IVCF)-related chronic iliocaval thrombosis with single-session IVCF retrieval and iliocaval recanalization, thereby optimizing stent deployment and avoiding adverse events (AEs) related to stent placement across an obstructed filter.

Methods: From January 2015 to April 2018, a cohort of 25 consecutive patients presented for treatment of IVCF-related chronic iliocaval thrombosis with filter retrieval, followed by recanalization with stent placement and adjunctive iliofemoral thrombectomy as needed. Inclusion criteria included computed tomography (CT) imaging and clinical presentations consistent with chronic (>30 days) IVCF-related chronic thrombosis. A retrospective analysis of technical success, clinical success as measured with the Venous Clinical Severity Score, use of advanced filter retrieval techniques, and AEs was performed. Primary patency was evaluated with CT at 1 to 3 months and 1 year. Data analysis was performed using a paired *t*-test.

Results: There were 25 patients (median age, 58.0 years; standard deviation, 15.6 years) with eight types of IVCF encountered; all were treated in a single session. Technical success was achieved in all patients. Mean improvement in the Venous Clinical Severity Score was 1.4 (95% confidence interval, 1.0-1.7; $P < .01$) in the venous edema subscore and 0.6 (95% confidence interval, 0.2-1.0; $P < .01$) in the pain subscore. At 1 to 3 months, iliocaval stent patency was maintained in 96% of patients; unilateral iliac vein stent thrombus was seen in one patient. One-year follow-up was available in eight patients, with CT imaging demonstrating maintained patency. Median filter implantation time was 12.3 months (mean, 41.9 months; range, 0.8-245.1 months; standard deviation, 63.3 months). Advanced IVCF retrieval techniques were required for 17 procedures. One major AE and minor AE occurred; no patients died in the study period.

Conclusions: Single-session iliocaval recanalization with IVCF retrieval has high rates of technical and clinical success in patients with IVCF-related chronic iliocaval thrombosis. (J Vasc Surg: Venous and Lym Dis 2019;7:176-83.)

Keywords: Iliocaval thrombosis; IVC filters; Chronic venous occlusion

The substantial increase in placement of inferior vena cava filters (IVCFs) has placed a large population of patients at risk for development of IVCF-related thrombus.[1,2] Studies have demonstrated that up to 18.6% of patients with IVCFs may have filter-associated thrombus, with a reported total caval occlusion rate of 2%.[3] Chronic iliocaval thrombosis has been associated with significant morbidity as manifested by development of the post-thrombotic syndrome (PTS), with symptoms including lower extremity pain, edema, skin changes, and ulceration.[4-7]

A commonly described approach to chronic IVCF-related iliocaval thrombosis involves catheter-directed thrombolysis, mechanical thrombectomy, and stent placement across an obstructed filter.[4,8,9] Whereas previous studies have reported clinical outcomes and patency rates with this approach or in non-filter-bearing patients, only small cohorts of patients with obstructed IVCF undergoing simultaneous retrieval and recanalization have been studied. Placement of a stent across an obstructed filter may result in lower patency rates and suboptimal clinical improvement because of the in situ filter's impeding full stent deployment.[10,11] In some patients, the remnant device may also be directly responsible for clinical symptoms that are not relieved without retrieval. Furthermore, exclusion of an IVCF with a stent results in device displacement, disfigurement, or fracture and poses a theoretical risk of embolization or penetration of filter components.[4,10,12,13] We hypothesized that a single-session, simultaneous retrieval with recanalization may result in higher rates

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of clinical efficacy and stent patency while also avoiding potential adverse events (AEs) related to stenting across a filter.

This study aimed to evaluate the efficacy and safety of performing single-session, simultaneous inferior vena cava (IVC) recanalization with IVCF retrieval in treatment of chronic IVCF-related iliocaval thrombosis.

METHODS

The Institutional Review Board approved this retrospective study. Between June 2015 and April 2018, a consecutive 25 patients with demonstrated IVCF-related thrombosis on computed tomography (CT) imaging with correlation of clinical signs and symptoms presented for evaluation and intervention. Each patient's preprocedural clinical symptoms were quantified using the pain and venous edema components of the Venous Clinical Severity Score (VCSS).[14] Patients underwent preprocedural CT venography and lower extremity duplex ultrasound to evaluate for the presence of acute deep venous thrombosis (DVT) or chronic PTS changes to the infrainguinal veins. Chronic iliocaval thrombosis was defined per findings of an atretic IVC on preprocedure CT venography of the abdomen or pelvis (Fig 1) and the duration of symptoms (>30 days), the presence of mature collaterals on catheter venography (Fig 2), and the difficulty in obtaining wire access across occluded venous segments.

Procedures were performed under intravenous moderate sedation, monitored anesthesia care, or general anesthesia. Filter retrieval was performed through internal jugular access, except for retrieval of OptEase (Cordis Corp, Fremont, Calif), which required either groin access or dual groin and jugular access. Recanalization (angioplasty, stent placement) was performed through the bilateral great saphenous, common femoral, or small saphenous veins. Initial iliocaval venography revealed chronic occlusions involving and extending caudally from the IVCF with mature collateral venous drainage pathways in all patients (Fig 2).

Thrombolysis was performed for acute infrainguinal DVT identified on preprocedure duplex ultrasound or acute in-stent thrombosis. Thrombolysis was not performed for chronic iliocaval thrombus. Acute DVT involving the femoral and common femoral veins was treated with pharmacomechanical thrombectomy using the AngioJet ZelanteDVT rheolytic thrombectomy system (Boston Scientific, Marlborough, Mass). Alteplase (Activase; Genentech, South San Francisco, Calif) was pulse sprayed through the acutely thrombosed segment at a dilution of 10 mg in 50 mL of sterile water. Simultaneously, unfractionated heparin was administered intravenously between 80 and 100 units/kg. In patients with heparin-induced thrombocytopenia, bivalirudin was administered intravenously at 1 mg/kg/h. Activated clotting time was not routinely measured. After a 25-minute alteplase dwell time, rheolytic thrombectomy was carried out with heparinized saline. In a single case of acute in-stent thrombosis, catheter-directed thrombolysis was carried out with alteplase through a multiple-side hole infusion catheter placed into each occluded iliac segment (UniFuse; AngioDynamics, Latham, NY) at a rate of 0.45 mg/h per catheter; the total infusion time was 8 hours. Technical success of thrombectomy was defined as >90% reduction in thrombus with no significant residual flow limitation.

Iliocaval occlusions were traversed from bilateral groin accesses using an angled-tip catheter (5F Kumpe or vertebral; Cook Medical, Bloomington, Ind) and stiff shaft angled-tip hydrophilic wire (0.035-inch stiff shaft Glidewire; Terumo, Tokyo, Japan). On each side, exchange was made for a 180-cm 0.035-inch Magic

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective single-institution cohort study
- **Key Findings:** This study reported successful single-session inferior vena cava filter (IVCF) retrieval followed by stent placement in 25 consecutive patients presenting with IVCF-related iliocaval thrombosis. Clinical and radiographic follow-up to 1 year suggested that this treatment approach is both safe and efficacious for treatment of IVCF-related chronic iliocaval thrombosis.
- **Take Home Message:** Single-session IVCF removal and stenting is safe and efficacious up to 1 year for treatment of IVCF-related chronic iliocaval thrombosis.

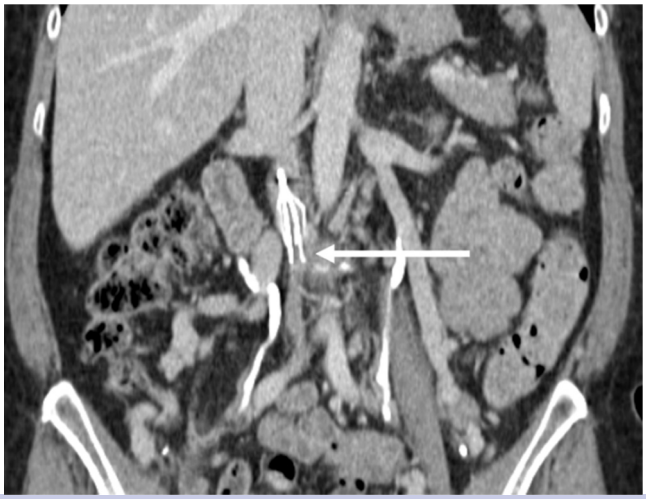

Fig 1. Computed tomography (CT) abdominal venography of chronic inferior vena cava filter (IVCF)-associated thrombosis. CT abdominal venography demonstrating chronic inferior vena cava (IVC) and iliac vein thrombosis extending caudally from the level of the IVCF (*arrow*).

Fig 2. Digital subtraction venography of chronic inferior vena cava filter (IVCF)-associated thrombosis. Digital subtraction venography demonstrating occlusion of the common iliac veins and the inferior vena cava (IVC) at the level of the IVCF (*arrow*). Mature lumbar and retroperitoneal collaterals are present.

Torque wire (Boston Scientific), and simultaneous, side-by-side 8-mm balloon angioplasty (Dorado; Bard Peripheral Vascular, Tempe, Ariz) was performed to permit subsequent stent delivery after filter retrieval.

Filter retrieval was initially attempted with an endovascular snare (12-20 mm EN Snare; Merit Medical, South Jordan, Utah) and endovascular sheaths (12F × 40-cm and 8F × 55-cm Flexor; Cook Medical). If unsuccessful, advanced filter retrieval techniques were employed through a larger sheath (16F × 45-cm Performer; Cook Medical) including rigid endobronchial forceps (model 4162; Lymol Medical, Woburn, Mass),[15] loop wire technique,[16] excimer laser sheath-assisted photothermal ablation (14F GlideLight; Philips/Spectranetics, Colorado Springs, Colo),[17] or a combination of techniques. Rigid endobronchial forceps were employed to facilitate access to tilted filters and were used to dissect fibrinous material from the filter apex (Fig 3, *A*). A loop wire technique was used to retrieve filters with a fibrinous capsule impeding access to the filter hook. In this technique, a reverse curve catheter was used to engage the elements of the device, and then a hydrophilic wire was advanced cranially and snared, forming a wire loop (Fig 3, *B*). Countertraction was then applied to collapse the filter in the sheath. In cases in which the filter was densely adherent to the caval wall and application of large traction-countertraction forces by previously described techniques was unable to dislodge the filter, a CVX-300 XeCl excimer laser system was used (Fig 3, *C*). The laser sheath was advanced over the implanted filter to the point of maximal resistance and sequentially activated to ablate the encasing tissue. A priori, if filter retrieval could not be successfully performed, balloon angioplasty and stent deployment across the filter would be attempted.

After IVCF retrieval, stent placement was performed in a double-barrel fashion from each great saphenous, common femoral, or small saphenous venous access using self-expanding nitinol stents (14- and 12-mm SMART stents; Cordis). If no thrombolysis or thrombectomy had taken place, 80 to 100 units/kg of unfractionated heparin was administered intravenously before stent deployment, with activated clotting time not routinely measured. In patients with heparin-induced thrombocytopenia, bivalirudin was administered intravenously at 1 mg/kg/h. Stents were placed in a side-by-side fashion across the previously occluded caval segments, trailing into each iliac vein, and postdilated with either 12-mm or 14-mm balloons (Atlas; Bard Peripheral Vascular) per the rated stent diameter (Fig 4). This double-stent approach was preferred to preserve laminar flow and to achieve an uninterrupted conduit diameter of 14 mm from each iliac limb into the IVC, where there is a summed diameter of 28 mm. If the thrombosed caval segment approximated or involved the ostia of the renal veins, an uncovered tracheobronchial stent was placed (30-mm Gianturco Z-stent; Cook Medical) to minimize the theoretical risk of renal vein thrombosis by placing a stent with wide interstices at the level of the renal vein inflow. Completion digital subtraction venography was performed to evaluate flow through the recanalized, stented segments and to document resolution of previously visualized collateral venous drainage pathways (Fig 5).

All patients received a loading dose of 300 mg of clopidogrel (Plavix; Sanofi, Paris, France) immediately after the procedure to minimize risk of in-stent thrombosis[18-21]; this was intended to be continued for 3 months at 75 mg daily. Patients were maintained on anticoagulation therapy if they received treatment before recanalization; the intended final length of treatment was at the discretion of the primary clinician. In addition to procedural technical success, clinical success was evaluated by changes in VCSS pain and edema subscores and stent patency on CT venography at 1 to 3 months of follow-up.[22] Procedure-related AEs were classified per previously published guidelines.[23] Use of advanced filter retrieval techniques, procedure time as measured by sedation or anesthesia time, and fluoroscopy time were

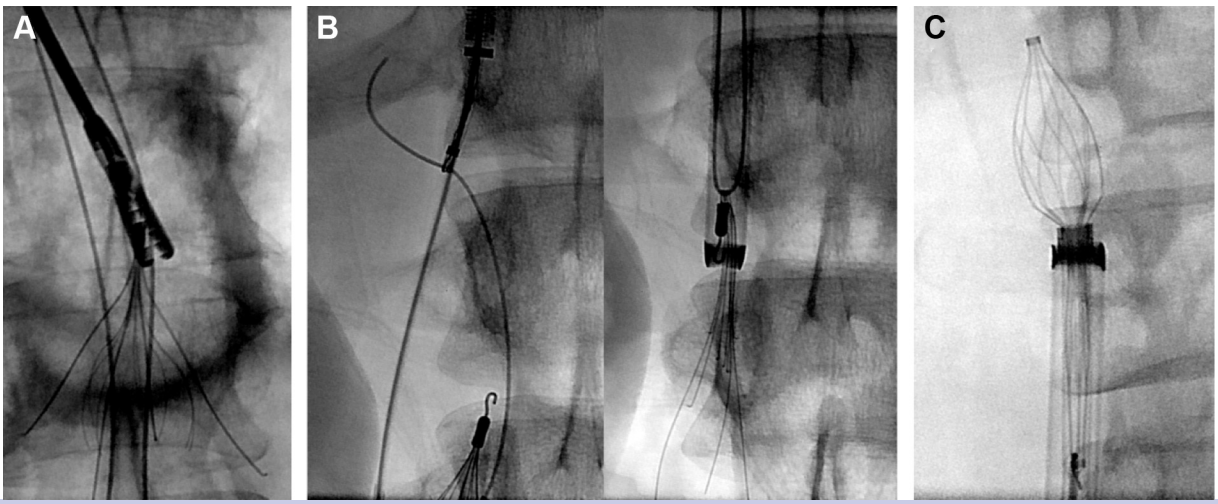

Fig 3. Complex retrieval techniques. **A,** Endobronchial forceps. Fluoroscopic spot image demonstrating retrieval of inferior vena cava filter (IVCF) with endobronchial forceps. The jaws of the forceps are angled toward the filter apex and firmly engaged onto the device. **B,** Loop wire technique. Reverse curve catheter is passed through the filter elements caudally and hydrophilic wire is advanced cranially and captured with snare device, forming the loop wire (*left*). The device is then folded and collapsed into the sheath (*right*). **C,** Excimer laser sheath-assisted retrieval. The laser sheath is sequentially activated and advanced coaxially, ablating the encasing fibrous tissue at the caudal end.

also assessed. Pairwise comparisons of VCSS scores between preprocedural and postprocedural groups were performed using a paired *t*-test analysis. Statistical significance was determined at $P < .05$.

RESULTS

Twenty-five consecutive patients were encountered during the study period (Table). Median IVCF dwell time was 12.3 months (mean, 41.9 months; range, 0.8-245.1 months; standard deviation [SD], 63.3 months). The mean time from diagnosis of filter-related thrombosis to intervention was 8.9 months (median, 1.4 months; SD, 13.9 months). All patients presented with bilateral lower extremity edema, and 12 patients experienced lower extremity pain. One paraplegic patient with sensory loss was excluded from VCSS scoring. Mean preprocedural edema and pain subscores were 2.5 (median, 2.5; SD, 0.5) and 0.9 (median, 0; SD, 1.29), respectively. A 1- to 3-month clinical follow-up was available for all patients, and clinical success was defined as an improvement in the VCSS.[14] Mean improvement in the VCSS was 1.4 in the venous edema subscore (95% confidence interval [CI], 1.0-1.7; $P < .01$) and 0.6 (95% CI, 0.2-1.0; $P < .01$) in the pain subscore (Fig 6). In patients presenting with venous edema without pain, mean baseline edema score was 2.3 (median, 2; SD, 0.13), with an improvement of 1.6 (95% CI, 1.3-1.9; $P < .01$) after the procedure. In 12 patients presenting with pain, the mean improvement in the pain subscore was 1.6 (95% CI, 1.0-2.2; $P < .01$) from a mean baseline of 2.3 (median, 2; SD, 0.7).

Eight types of IVCFs were encountered: Denali and Eclipse (Bard Peripheral Vascular), Option (Argon Medical Devices, Plano, Tex), Gunther Tulip and Celect (Cook Medical), Greenfield (Boston Scientific), OptEase (Cordis), and ALN (ALN Implants Chirurgicaux, Ghisonaccia, France). At the time of filter retrieval and iliocaval recanalization, no patients had contraindications to anticoagulation or persistent indications for mechanical IVCF caval prophylaxis. Advanced filter retrieval techniques were required in 17 procedures (Table). Twenty-three patients' IVCFs were removed intact. On CT and venography before filter retrieval, one patient's IVCF was noted to have a fractured strut fragment in the paraspinal soft tissues and was completely extracaval; the remainder of the IVCF was removed. A second patient was found to have a fractured IVCF with embedded struts within the caval wall; the bulk of the filter was retrieved using rigid endobronchial forceps, with a single small fragment remaining embedded in the caval wall.

Technical success of filter retrieval and iliocaval recanalization was achieved in all 25 patients. Median fluoroscopy time was 40.9 minutes (mean, 41.9 minutes; range, 21.8.2-77.4 minutes; SD, 14.8 minutes), and mean procedure time was 206.7 minutes (median, 181.5 minutes; range, 103.0-456.0 minutes; SD, 83.8 minutes).

Seven patients required thrombolytic therapy. Six patients underwent rheolytic thrombectomy for acute DVT in the common femoral and femoral veins, and one patient underwent 8 hours of catheter-directed lysis for acute in-stent thrombosis. All patients achieved >90% reduction in thrombus, with no significant residual flow limitation.

Follow-up CT imaging was available for all 25 patients between 1 and 3 months after the procedure. Twenty-four

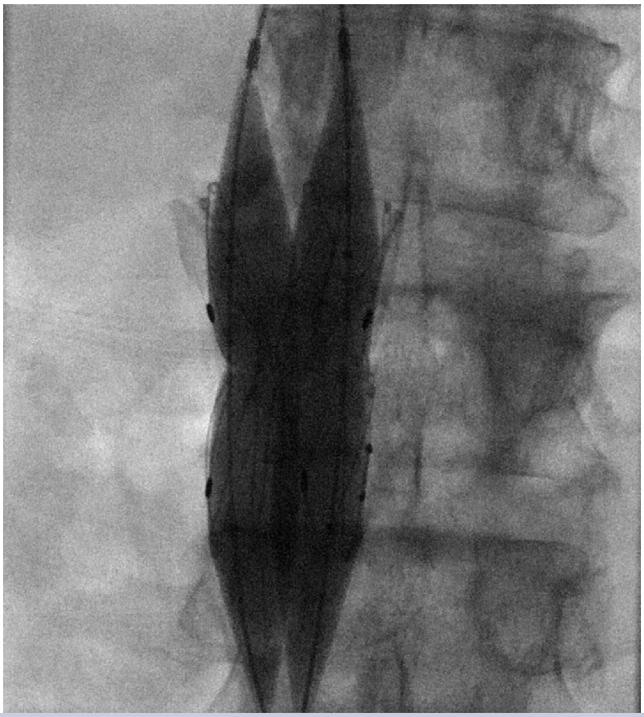

Fig 4. Stent placement subsequent to inferior vena cava filter (IVCF) retrieval. Fluoroscopic image demonstrating postdilation of a Gianturco tracheobronchial Z-stent using two 14-mm × 40-mm balloons.

Fig 5. Post single-session treatment venography. Venographic image demonstrating patent inferior vena cava (IVC) and iliac veins after 14-mm stent placement.

patients were evaluated with CT venography (Fig 7); one patient received a non-contrast-enhanced study. Twenty-three patients demonstrated conclusive primary patency on 1-month follow-up imaging. In one patient, CT venography could not definitively evaluate the right iliac stent. This patient had resolution of left lower extremity edema and marked improvement in right lower extremity edema, with only occasional swelling. Given symptom resolution, additional imaging studies were deferred. CT venography in a second patient revealed left iliac vein stent occlusion by low-density thrombus at 1-month follow-up; the right iliac stent remained patent. This patient developed down-trending hemoglobin levels postprocedurally, and anticoagulation was held for concerns of acute hemorrhage. No bleeding was appreciated on follow-up CT. Despite demonstrated stent occlusion, this patient had resolution of lower extremity edema. The occlusion was treated successfully with rheolytic thrombectomy. Repeated CT venography at 3 months after the procedure revealed stent patency. No other patients required reintervention. Eleven patients receiving interventions between June 2015 and May 2017 were due for 1-year CT follow-up, and imaging was successfully obtained on eight patients, all of which revealed maintained stent patency.

After the procedure, 12 patients were maintained on warfarin (Coumadin; Bristol-Myers Squibb, New York, NY), 2 patients on enoxaparin (Lovenox; Sanofi), 4 patients on rivaroxaban (Xarelto; Janssen Pharmaceutica, Raritan, NJ), 1 patient on fondaparinux (Arixtra; GlaxoSmithKline plc, London, United Kingdom), and 1 patient on apixaban (Eliquis; Bristol-Myers Squibb and Pfizer, New York, NY; Table).

One major AE and one minor AE occurred during the study period. The major AE occurred in a patient with chronic thromboembolic pulmonary hypertension who presented with hypoxia immediately after the procedure. Further workup demonstrated acute pulmonary edema that was thought to have been precipitated by a dramatic increase in venous return after the intervention. Following diuresis and supportive care for 3 days in the intensive care unit, this patient recovered completely and was discharged 4 days after the procedure. The minor AE occurred in a patient with asymptomatic caval perforation after retrieval of an adherent, 12-year-old Greenfield filter. Contained extravasation at the prior filter implantation site was noted on venography that persisted despite balloon tamponade with a 27-mm occlusion balloon (Equalizer; Boston Scientific) for 5 minutes. This perforation occurred in a previously occluded caval segment, and stents were placed across this lesion. The patient remained hemodynamically stable and asymptomatic during a 23-hour observation admission. At 1-month follow-up, the perforation had completely resolved on CT venography.

Table. Procedural details for 25 patients undergoing single-session inferior vena cava filter (IVCF) retrieval and endovenous reconstruction for IVCF-related chronic iliocaval thrombosis

Total No. of patients	25
Male	20
Female	5
Age, years	
Mean (SD)	56 (15.6)
Range	20-79
Filter dwell time, months	
Mean (SD)	41.9 (63.3)
Range	0.8-245.1
Time from thrombosis diagnosis to intervention, months	
Mean (SD)	8.9 (13.9)
Range	0.4-43.1
Fluoroscopy time, minutes	
Mean (SD)	43.5 (14.8)
Range	21.8-77.4
Fluoroscopy dose, mGy	
Mean (SD)	2308 (2041)
Range	398-8026
Filter type	
ALN	5
Celect	5
Denali	4
Eclipse	1
Greenfield	2
OptEase	1
Option	1
Tulip	6
Retrieval techniques	
Endobronchial forceps	12
Laser sheath	8
Loop wire	3
Endovascular snare only	8
Multiple advanced retrieval techniques used	5
Stents	
SMART	24
Gianturco Z-stent	5
Protégé stent	1
Postprocedure anticoagulation	
Warfarin	12
Rivaroxaban	4
Enoxaparin	2
Fondaparinux	1
Apixaban	1
None	5

SD, Standard deviation.

DISCUSSION

Chronic iliocaval thrombosis secondary to an obstructed IVCF presents a unique and complex clinical challenge. The literature to date has centered on placement of stents across an obstructed IVCF, which theoretically results in lower rates of stent patency and suboptimal clinical outcomes because of incomplete stent deployment and the presence of a residual device.

In this study, single-session IVCF retrieval and iliocaval recanalization was performed successfully in 25 (100%) consecutive patients with chronic IVCF-associated iliocaval thrombosis. A recent study of balloon crushing and stenting across the filter in patients with caval thrombosis reported a successful recanalization rate of 87%.[24]

Significant symptom improvement was observed in all patients at 1- to 3-month follow-up. Previous studies evaluating iliocaval reconstruction when an IVCF is present have reported at least partial symptom relief in 60% to 91% of patients.[11,12,24-27] The methods described in these studies have largely not attempted to remove the filters from the occluded cava. In the few reports in which filter retrieval was attempted, successful retrieval rates were only as high as 25%.[24,26] Several new advanced retrieval techniques have been developed and were used in this study, permitting successful retrieval in all patients. Accordingly, complex retrieval techniques were needed in the majority of cases and have been shown to be safe in centers with expertise in IVCF retrieval.[17,28-32]

One study reported clinical improvement in 84% and 97% of patients at 2 weeks and 6 months after the procedure, respectively, with no difference at 6 months with respect to retrieved vs excluded IVCF during reconstruction.[26] In this study, patients with edema alone and those with comorbid pain achieved clinical improvement, suggesting that the technique described here should be offered as a therapeutic option to patients suffering from various symptoms and severities of chronic IVCF-related thrombosis.

This study demonstrates that the iliocaval stent patency rate at 1 to 3 months is 96% for patients treated with filter retrieval and subsequent iliocaval stent; 1-year follow-up is available in eight patients, all of whom demonstrate persistent symptomatic improvement and stent patency on imaging. Neglen et al[10] described a cumulative IVC patency rate of 75% in patients with occlusive disease who underwent iliocaval stent placement across an obstructed filter. In the same study, early (<30-day) stent occlusion was higher in cases in which the filter was traversed by a stent vs those in which it was not (12% and 4%, respectively) with a trend toward significance ($P = .08$). In comparing patients with excluded filters with those receiving recanalization in the absence of a filter, patency rates were significantly lower in filter-bearing patients (75% vs 86%; $P = .045$), suggesting that crossing

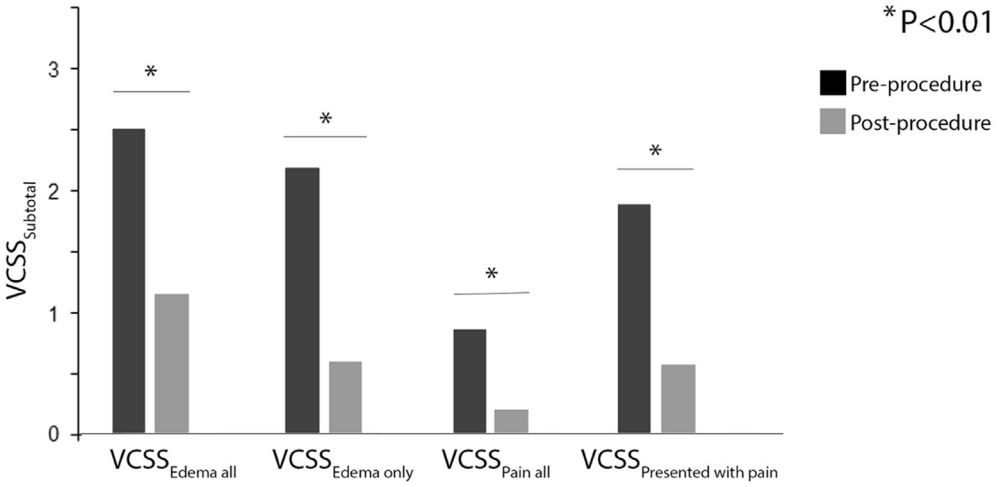

Fig 6. Venous Clinical Severity Score (*VCSS*) improvements at 1- to 3-month follow-up. Preprocedure and postprocedure mean VCSS subscores in edema and pain in patients presenting with only venous edema and in patients presenting with pain.

of the remnant filter was a risk factor for reduced patency. The 1- to 3-month patency rate of 96% in this study is concordant with the 4% rate of in-stent occlusion reported before, in which a filter was not traversed by a stent. Additional studies have reported primary and secondary patency rates of 30% and 71%, respectively, in patients in whom the IVCF was crushed and stented across.[24,27] Together, these data suggest that simultaneous removal of the IVCF may result in higher short-term patency rates by permitting full stent deployment as an adjacent embedded filter may preclude full opening of a stent.

Stenting across an IVCF results in device displacement, crush, and possibly fracture.[4,10-12] Whereas previous studies reporting on IVCF exclusion have not reported major complications related to device damage, there is a hypothetical concern of strut penetration and migration. One study reported a caval penetration due to IVCF exclusion during stenting, resulting in clinically significant chest pain due to IVCF struts penetrating the posteromedial wall and irritating periaortic nerve bundles.[13] The feasibility and safety of antecedent filter retrieval demonstrated in this study mitigate entirely the risk of these AEs.[10,26]

There are limitations to this study. The presented findings are a cohort from a single center, limiting assessment of outcomes relating to different IVCF types, choice of stents, and varying stent insertion methods. In addition, follow-up of these patients is ongoing and necessary to demonstrate long-term efficacy of the intervention. Whereas this study describes the potential to perform single-session IVCF retrieval and recanalization for patients with chronic iliocaval thrombus, the analysis of this intervention in comparison to staged recanalization procedures or stent placement across the filter is limited by the lack of a control comparison cohort.

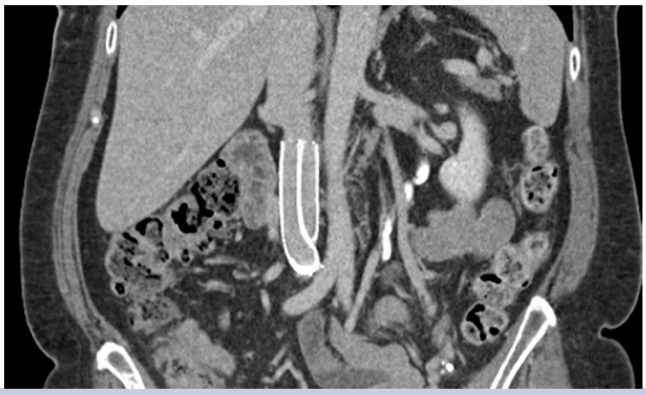

Fig 7. Postprocedure computed tomography (CT) venography at 1 month. Follow-up CT venography demonstrating patent stents without thrombus, coronal reconstruction.

CONCLUSIONS

Single-session IVCF retrieval and iliocaval stenting is safe and effective in the management of chronic IVCF-related iliocaval thrombosis. Possible advantages include increased short-term stent patency, prompt relief of PTS-related symptoms, and potential reduction of device-related AEs associated with a retained IVCF.

AUTHOR CONTRIBUTIONS

Conception and design: KD, NX, RS, HR, ME, RL
Analysis and interpretation: KD, NX, RS, RL
Data collection: KD, NX, JK, OU, RL
Writing the article: KD, NX, JK, OU
Critical revision of the article: KD, NX, RS, HR, ME, RL
Final approval of the article: KD, NX, JK, RS, HR, ME, OU, RL
Statistical analysis: NX
Obtained funding: Not applicable
Overall responsibility: KD

REFERENCES

1. PREPIC Study Group. Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism: the PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) randomized study. Circulation 2005;112:416-22.
2. Grewal S, Chamarthy MR, Kalva SP. Complications of inferior vena cava filters. Cardiovasc Diagn Ther 2016;6:632-41.
3. Ahmad I, Yeddula K, Wicky S, Kalva SP. Clinical sequelae of thrombus in an inferior vena cava filter. Cardiovasc Intervent Radiol 2010;33:285-9.
4. Meltzer AJ, Connolly PH, Kabutey NK, Jones DW, Schneider DB. Endovascular recanalization of iliocaval and inferior vena cava filter chronic total occlusions. J Vasc Surg Venous Lymphat Disord 2015;3:86-9.
5. Raju S, Hollis K, Neglen P. Obstructive lesions of the inferior vena cava: clinical features and endovenous treatment. J Vasc Surg 2006;44:820-7.
6. Kolbel T, Lindh M, Akesson M, Wasselius J, Gottsater A, Ivancev K. Chronic iliac vein occlusion: midterm results of endovascular recanalization. J Endovasc Ther 2009;16:483-91.
7. Marston W, Fish D, Unger J, Keagy B. Incidence of and risk factors for iliocaval venous obstruction in patients with active or healed venous leg ulcers. J Vasc Surg 2011;53:1303-8.
8. Karageorgiou J, Fowler K, Vedantham S, Saad N. Endovascular intervention for deep venous thrombosis in patients with inferior vena cava filters. Vasc Med 2016;21:459-66.
9. Sildiroglu O, Ozer H, Turba UC. Management of the thrombosed filter-bearing inferior vena cava. Semin Intervent Radiol 2012;29:57-63.
10. Neglen P, Oglesbee M, Olivier J, Raju S. Stenting of chronically obstructed inferior vena cava filters. J Vasc Surg 2011;54:153-61.
11. Arabi M, Krishnamurthy V, Cwikiel W, Vellody R, Wakefield TW, Rectenwald J, et al. Endovascular treatment of thrombosed inferior vena cava filters: techniques and short-term outcomes. Indian J Radiol Imaging 2015;25:233-8.
12. Vedantham S, Vesely TM, Parti N, Darcy MD, Pilgram TK, Sicard GA, et al. Endovascular recanalization of the thrombosed filter-bearing inferior vena cava. J Vasc Interv Radiol 2003;14:893-903.
13. Johnston WF, Jain A, Saad WE, Upchurch GR Jr. Chest pain from excluded inferior vena cava filter after stent placement. J Vasc Surg Venous Lymphat Disord 2014;2:70-3.
14. Rutherford RB, Padberg FT Jr, Comerota AJ, Kistner RL, Meissner MH, Moneta GL. Venous severity scoring: an adjunct to venous outcome assessment. J Vasc Surg 2000;31:1307-12.
15. Stavropoulos SW, Dixon RG, Burke CT, Stavas JM, Shah A, Shlansky-Goldberg RD, et al. Embedded inferior vena cava filter removal: use of endobronchial forceps. J Vasc Interv Radiol 2008;19:1297-301.
16. Esparaz AM, Ryu RK, Gupta R, Resnick SA, Salem R, Lewandowski RJ. Fibrin cap disruption: an adjunctive technique for inferior vena cava filter retrieval. J Vasc Interv Radiol 2012;23:1233-5.
17. Kuo WT, Tong RT, Hwang GL, Louie JD, Lebowitz EA, Sze DY, et al. High-risk retrieval of adherent and chronically implanted IVC filters: techniques for removal and management of thrombotic complications. J Vasc Interv Radiol 2009;20:1548-56.
18. Bertrand ME, Rupprecht HJ, Urban P, Gershlick AH. Double-blind study of the safety of clopidogrel with and without a loading dose in combination with aspirin compared with ticlopidine in combination with aspirin after coronary stenting : the clopidogrel aspirin stent international cooperative study (CLASSICS). Circulation 2000;102:624-9.
19. Juergens CP, Wong AM, Leung DY, Lowe HC, Lo S, Fernandes C, et al. A randomized comparison of clopidogrel and aspirin versus ticlopidine and aspirin after coronary stent implantation. Am Heart J 2004;147:E15.
20. Navarese EP, Andreotti F, Schulze V, Kolodziejczak M, Buffon A, Brouwer M, et al. Optimal duration of dual antiplatelet therapy after percutaneous coronary intervention with drug eluting stents: meta-analysis of randomised controlled trials. BMJ 2015;350:h1618.
21. Pandit A, Giri S, Hakim FA, Fortuin FD. Shorter (≤6 months) versus longer (≥12 months) duration dual antiplatelet therapy after drug eluting stents: a meta-analysis of randomized clinical trials. Catheter Cardiovasc Interv 2015;85:34-40.
22. Jayaraj A, Meissner MH. A comparison of Villalta-Prandoni scale and Venous Clinical Severity Score in the assessment of post thrombotic syndrome. Ann Vasc Surg 2014;28:313-7.
23. Omary RA, Bettmann MA, Cardella JF, Bakal CW, Schwartzberg MS, Sacks D, et al. Quality improvement guidelines for the reporting and archiving of interventional radiology procedures. J Vasc Interv Radiol 2003;14(Pt 2):S293-5.
24. Murphy EH, Johns B, Varney E, Raju S. Endovascular management of chronic total occlusions of the inferior vena cava and iliac veins. J Vasc Surg Venous Lymphat Disord 2017;5:47-59.
25. Neglen 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.
26. Chick JF, Jo A, Meadows JM, Abramowitz SD, Khaja MS, Cooper KJ, et al. Endovascular iliocaval stent reconstruction for inferior vena cava filter-associated iliocaval thrombosis: approach, technical success, safety, and two-year outcomes in 120 patients. J Vasc Interv Radiol 2017;28:933-9.
27. Raju S, Neglen P. Percutaneous recanalization of total occlusions of the iliac vein. J Vasc Surg 2009;50:360-8.
28. Desai KR, Lewandowski RJ, Salem R, Mouli SK, Karp JK, Laws JL, et al. Retrieval of inferior vena cava filters with prolonged dwell time: a single-center experience in 648 retrieval procedures. JAMA Intern Med 2015;175:1572-4.
29. Laws JL, Lewandowski RJ, Ryu RK, Desai KR. Retrieval of inferior vena cava filters: technical considerations. Semin Intervent Radiol 2016;33:144-8.
30. Stavropoulos SW, Ge BH, Mondschein JI, Shlansky-Goldberg RD, Sudheendra D, Trerotola SO. Retrieval of tip-embedded inferior vena cava filters by using the endobronchial forceps technique: experience at a single institution. Radiology 2015;275:900-7.
31. Tamrazi A, Wadhwa V, Holly B, Bhagat N, Marx JK, Streiff M, et al. Percutaneous retrieval of permanent inferior vena cava filters. Cardiovasc Intervent Radiol 2016;39:538-46.
32. Van Ha TG, Vinokur O, Lorenz J, Regalado S, Zangan S, Piano G, et al. Techniques used for difficult retrievals of the Gunther Tulip inferior vena cava filter: experience in 32 patients. J Vasc Interv Radiol 2009;20:92-9.

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