**Table.** Outcome of thrombophilia testing in patients without strong provoking factors for venous thromboembolism (VTE)

| Thrombophilia type | Patients tested for thrombophilia (n = 138), No. (%) |
|---|---|
| Thrombophilia negative | 79 (57) |
| Inherited | 30 (22) |
| Factor V Leiden | 22 (16) |
| Prothrombin gene mutation | 0 (0) |
| Protein C | 2 (1) |
| Protein S | 2 (1) |
| Antithrombin | 4 (3) |
| Acquired (antiphospholipid antibody syndrome) | 29 (21) |

patency was assessed using duplex ultrasound 24 hours, 2 weeks, 6 weeks, 3 months, 6 months,1 year, and yearly after intervention. Reinterventions were performed when there was a reduction in stent diameter of >50% or occlusion.

**Results:** Of 205 patients treated, 138 (67%) were tested for thrombophilia, of which 59 of 138 (43%) had an inherited (30/59 [51%]) or acquired (29 [49%]) thrombophilia (Table). Cumulative patency was 88% in patients with thrombophilia and 89% in patients without (median follow-up, 1.7 years; range, 52-258 weeks). In addition, 64 of 138 (46%) patients required reintervention to maintain patency, of which 28 of 59 (47%) occurred in patients with thrombophilia and 36 of 79 (45%) in patients without. Inherited or acquired thrombophilia was not associated with cumulative patency loss ($P = .402$) or higher risk of reintervention ($P = .255$).

**Conclusions:** Thrombophilia assessment for APS should be performed in patients undergoing iliofemoral venous stenting without strong provoking factors for VTE as prolonged anticoagulation with VKAs is advised in this group of patients because of their increased risk of VTE recurrence. Furthermore, patients with inherited or acquired thrombophilia should not be excluded from iliofemoral venous stenting as patency outcomes are good in conjunction with appropriate postoperative anticoagulation therapy.

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## Single- Versus Multiple-Stage Catheter-Directed Thrombolysis Does not Affect Iliac Vein Stent Length or Patency Rates

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**Objective:** Incomplete venous thrombolysis and residual nonstented iliac vein disease are known predictors of recurrent deep venous thrombosis (DVT). Controversy exists as to whether the number of thrombolysis sessions affects total stent treatment length or stent patency. The goal of this study was to evaluate the outcomes of patients who underwent single vs multiple catheter-directed lysis sessions with regard to stent extent and patency.

**Methods:** Consecutive patients who underwent thrombolysis and stenting for acute iliofemoral DVT between 2007 and 2018 were identified and divided into two groups based on number of treatments performed (one vs multiple sessions). Operative notes and venograms were reviewed to determine the number of lytic sessions performed and stent information including size, location, total number, and length treated. End points include total stented length and 30-day and long-term outcomes. The $\chi^2$ comparisons, logistic regression, and survival analysis were used to determine outcomes.

**Results:** Seventy-nine patients underwent lysis and stenting (6 bilateral interventions; mean age, 45.9 ± 17 years; 48 female). Ten patients (12 limbs) underwent single-stage treatment with pharmacomechanical thrombolysis and the remaining 69 (73 limbs) two to four treatments combining pharmacomechanical thrombolysis and catheter-directed lysis. Patients who underwent a single-stage procedure were older and more likely to have a malignant neoplasm. These patients also received less tissue plasminogen activator compared with the multiple-stage group (17.2 ± 7.0 mg vs 27.3 ± 11.7 mg; $P = .010$). Average stent length was 8.8 ± 5.2 cm for the single-stage group vs 9.2 ± 4.6 cm for the multiple-stage group ($P = .764$). In dividing patients into one or two treatments (52 patients) vs three or four (27 patients), there was no significant difference in total stent length ($P = .489$). Patients who underwent a single-stage procedure had no difference in average length of stay than those who underwent multiple sessions (8.5 days vs 5.9 days; $P = .269$). The overall 30-day rethrombosis rate was 14.8%. Three-year patency was 72.2% and 74.8% for the single and multiple stages; respectively. The major predictor for loss of primary patency was incomplete lysis (hazard ratio, 7.69; $P < 0.01$) but not number of procedures (hazard ratio, 1.01; $P = .994$). The overall rate of post-thrombotic syndrome (Villalta score ≥5) was 9.3% at 5 years.

**Conclusions:** Single- vs multiple-stage thrombolysis for DVT is not associated with a difference in extent of stent coverage. Patency rates remain high for iliac stenting irrespective of the number of lytic sessions, provided lysis is complete and the diseased segments are appropriately stented. Preoperative factors including the patient's age and comorbidities may contribute to the decision to proceed with single vs multiple lysis sessions and deserve further investigation.

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## In-Stent Restenosis After Iliocaval Stenting—Characteristics and Outcomes

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**Objective:** With increasing use of iliocaval stenting, complications of such stenting have also become more common. In-stent restenosis (ISR), an outcome that is responsible for a majority of reinterventions, is one that has not been studied in detail. Characteristics of ISR in addition to outcomes after reintervention are evaluated.

**Methods:** A retrospective review of contemporaneously entered electronic medical record data on 372 limbs with initial unilateral iliocaval stents (247 left and 125 right) placed during a 3-year period from 2015 to 2017 was performed. ISR was estimated from stent and flow channel diameters measured using duplex ultrasound. Characteristics evaluated included onset of ISR after stent placement and progression over time. Regression analysis was performed to evaluate risk factors for development of ISR. Outcomes after reintervention for ISR were also appraised. Kaplan-Meier analysis was used to assess stent patency afater intervention; paired *t*-test was used to examine preintervention and postintervention outcomes.

**Results:** There were 361 limbs that underwent stenting for stenotic lesions, whereas 11 underwent stenting for chronic native vein occlusions. ISR was noted as early as postintervention day 1. It progressed to a maximal value by 6 months and stabilized thereafter. The overall median ISR across stented common femoral, external iliac, and common iliac segments at 12 months was 43.75%. The segment most commonly affected by ISR was the external iliac vein (77.5%). Up to 89% of stents can have some degree of ISR at 12 months. Variables evaluated as predictors for ISR included age, sex, thrombophilia, thrombotic or nonthrombotic lesion, inflow, stent compression, shear rate, and flow rate. Of these, only lack of stent compression was a significant predictor of ISR at 6 and 12 months. During a median follow-up of 13 months, 50 of 372 (13%) limbs underwent reintervention for ISR and 12 (3%) underwent reintervention for stent occlusion (8 acute [<30 days] and 4 chronic [>30 days]). After reintervention, the Venous Clinical Severity Score improved from 6 to 4 for the ISR cohort ($P < .001$). Median primary, primary assisted, and secondary patencies after reintervention for ISR were 37, 38, and 17 months, respectively.

**Conclusions:** ISR occurs early after iliocaval stenting but stabilizes around 6 months. Progression of ISR to stent occlusion is rare. No statistically significant, modifiable predictor for ISR was noted. After reintervention for ISR, good clinical outcomes and stent patencies can be expected.

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## Comparison of Open Versus Robotic Nephrectomy and Inferior Vena Cava Reconstruction for Renal Cell Carcinoma With Inferior Vena Cava Tumor Thrombus

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**Objective:** Vascular surgeons are frequently involved in inferior vena cava (IVC) reconstruction during nephrectomy for renal cell carcinoma (RCC) with tumor thrombus. Robotic nephrectomy for RCC claims shorter length of stay (LoS), faster return to work, and decreased pain medication requirements. Our goal was to compare our robotic nephrectomy with IVC reconstruction experience with our open experience.

**Methods:** We performed a single-institution retrospective review of patients undergoing open or robotic nephrectomy for RCC with IVC tumor thrombus between January 1998 and January 2018. Patients' characteristics, surgical records, and follow-up and survival data were recorded. Tumor level was classified according to the Mayo Clinic venous tumor thrombus (VTT) level.

**Results:** There were 57 patients (49 male) who underwent nephrectomy with tumor thrombectomy and IVC reconstruction; 38 (66%) had open procedures for RCC with level 1 (n = 6), level 2 (n = 21), and level 3 (n = 11) VTT. Average operative time was 251 minutes (range, 108-375 minutes), and average blood loss was 2482 mL (range, 50-10,950 mL). Average LoS was 10.79 days (range, 1-95 days). There were two (3.5%) deaths within 30 days. Short-term complications included atrial fibrillation (n = 2), ileus (n = 2), seroma (n = 1), sepsis (n = 1), pulmonary embolism (n = 1), urinary tract infection (n = 1), and pneumothorax (n = 1). Long-term complications included deep venous thrombosis (n = 1) and intra-abdominal abscess (n = 1).

Nineteen patients (33%) underwent robotic nephrectomy for RCC with level 1 (n = 1), level 2 (n = 17), and level 3 (n = 1) VTT. Average operative time was 283 minutes (range, 182-382 minutes), and average blood loss was 942 mL (range, 100-3000 mL). Average LoS was 3.11 days (range, 1-8 days). There were no deaths within 30 days. Short-term complications included pulmonary embolism (n = 1) and deep venous thrombosis (n = 1). Long-term complications included pleural effusion requiring thoracentesis (n = 1). All IVC reconstructions were performed by primary closure. Three (15.7%) cases required open conversion, two for control of the retrohepatic IVC and one for posterior lumbar venous bleeding unable to be controlled robotically.

Postoperative imaging was completed in 12 (63.2%) of the patients undergoing a robotic procedure at a median of 340 days postoperatively. The vena cava was patent in all studies. The median percentage of postoperative to preoperative IVC diameter was 58% (axial) and 45% (sagittal). In comparing open vs robotic procedures, the robotic approach had a shorter LoS ($P < .05$), less intraoperative blood loss ($P < .01$), and similar operative times ($P$ = NS).

**Conclusions:** Robotic nephrectomy and IVC reconstruction for RCC with level 1 to level 3 VTT can be performed safely and effectively. The minimally invasive approach offers patients a shorter LoS, less intraoperative blood loss, and similar operative times compared with open surgery. Postoperative IVC diameter is maintained after robotic reconstruction. Proper selection of patients and robotic expertise are essential to optimize outcomes.

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## Operative Strategies for Inferior Vena Cava Reconstruction in Oncologic Surgery

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**Objective:** Tumor involvement of the inferior vena cava (IVC) can result from primary caval leiomyosarcoma, local invasion by retroperitoneal malignant disease, or metastases. Whereas ligation of the IVC may be well tolerated if collateral circulation can be adequately preserved, collaterals must often be ligated during oncologic resection. Reconstruction of the IVC may be performed by primary repair, patch angioplasty, or interposition graft. The purpose of our study was to describe different strategies of IVC reconstruction at our institution and to measure outcomes associated with IVC reconstruction among patients with retroperitoneal malignant disease.

**Methods:** All patients undergoing IVC reconstruction at our tertiary care hospital between November 2004 and February 2018 were identified using billing data (*Current Procedural Terminology* code 34502). Patients who underwent resection of the IVC for tumor involvement were enrolled in our study; data were collected on demographics, operative intervention, type of reconstruction, postoperative course, and 1-year outcomes. Patency rates were assessed by reviewing postoperative imaging including contrasted computed tomography, magnetic resonance imaging, ultrasound, and venography. One-year mortality and patency were calculated using Kaplan-Meier analysis methods.

**Results:** We identified 52 (46% female) patients who underwent IVC reconstruction for retroperitoneal malignant disease. Mean age was 53.6 years (range, 23-80 years). Procedures performed included primary repair (n = 17 [33%]), patch angioplasty (n = 18 [35%]), interposition grafting (n = 16 [31%]), and primary repair plus bypass (n = 1 [2%]). Mean length of stay was 16 days and did not vary significantly by group. Patients undergoing interposition graft were discharged on aspirin 81 mg daily.

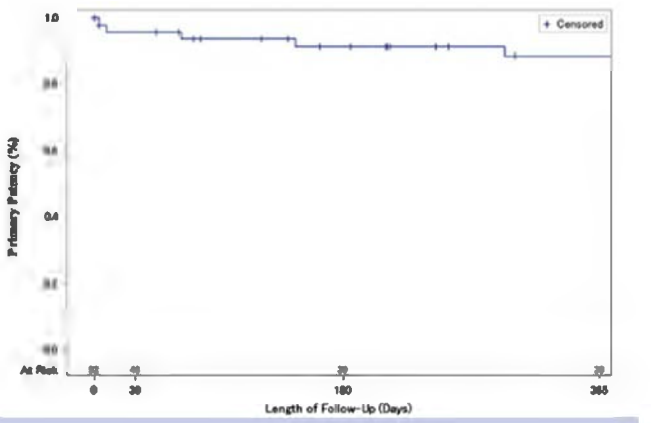


**Fig 1.** Primary patency after inferior vena cava (IVC) reconstruction (N = 52).

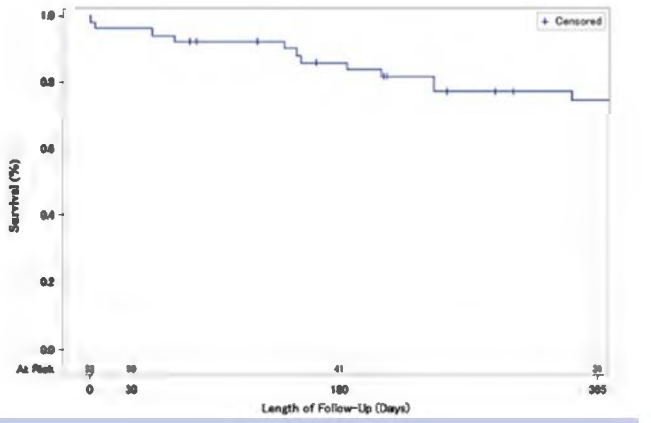


**Fig 2.** Survival after inferior vena cava (IVC) reconstruction (N = 52)..