Journal of Vascular Surgery: Venous and Lymphatic Disorders
March 2019

Author Disclosures: A. Jayaraj: Nothing to disclose; **W. Walker:** Nothing to disclose; **S. Raju:** stock Veniti, U.S. patent venous stent design, patent holder IVUS.

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

Victor Davila,[1] Kyle Rose,[2] Kate Peng,[3] Andrew Meltzer,[1] William Stone,[1] Samuel Money,[1] Erik Castle[2]. [1]Vascular Surgery, Mayo Clinic Arizona; [2]Urology, Mayo Clinic Arizona; [3]General Surgery, Mayo Clinic Arizona

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.

Author Disclosures: V. Davila: Nothing to disclose; **K. Rose:** Nothing to disclose; **K. Peng:** Nothing to disclose; **A. Meltzer:** Nothing to disclose; **W. Stone:** Nothing to disclose; **S. Money:** Nothing to disclose; **E. Castle:** Nothing to disclose.

Operative Strategies for Inferior Vena Cava Reconstruction in Oncologic Surgery

Colby Ruiz, MS4,[1] Corey Kalbaugh, PhD,[2] Sydney Browder,[2] Katharine McGinigle, MD,[2] Melina Kibbe, MD,[2] Mark Farber, MD,[2] Jason Crowner, MD,[2] William Marston, MD,[2] Luigi Pascarella, MD[2]. [1]School of Medicine, University of North Carolina at Chapel Hill; [2]Department of Vascular Surgery, University of North Carolina at Chapel Hill

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.

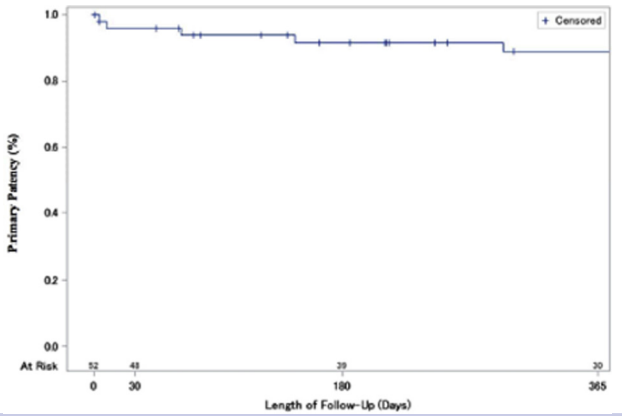

Fig 1. Primary patency after inferior vena cava (IVC) reconstruction (N = 52).

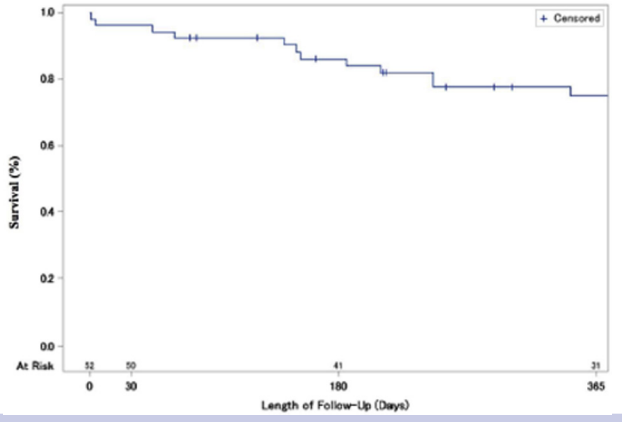

Fig 2. Survival after inferior vena cava (IVC) reconstruction (N = 52)..

Thirty-day survival rate was 96.2% (95% confidence interval [CI], 90.9-100), and 1-year survival rate was 75.1% (95% CI, 62.8-87.4) as seen in Fig 1. There were no intraoperative deaths. Thirty-day primary patency rate was 96% (95% CI, 90.7-100.0), and 1-year primary patency rate was 88.8% (95% CI, 79.4-98.2). Seven patients (14%) developed nonocclusive thrombus within the IVC. Mortality was known to be due to oncologic progression in 29% of deceased patients as seen in Fig 2.

Conclusions: IVC reconstruction is a safe option for patients requiring IVC resection during oncologic surgery as evidenced by 1-year survival of 75% and 1-year primary patency approaching 90%. Overall rate of postoperative thrombus development was low and similar across all groups. In the management of primary and secondary retroperitoneal malignant disease with IVC infiltration, IVC reconstruction should be considered to achieve appropriate oncologic resection while minimizing possible complications from caval interruption.

Author Disclosures: C. Ruiz: Nothing to disclose; **C. Kalbaugh:** Nothing to disclose; **S. Browder:** Nothing to disclose; **K. McGinigle:** Nothing to disclose; **M. Kibbe:** Nothing to disclose; **M. Farber:** Nothing to disclose; **J. Crowner:** Nothing to disclose; **W. Marston:** consultant Veniti; **L. Pascarella:** Nothing to disclose.

Effect of Etiology and Inflow on Outcomes of Endovascular Recanalization for Nonmalignant Inferior Vena Cava Occlusion

Aleem Mirza,[1] Manju Kalra,[1] Newton Neidert,[2] Melissa Neisen,[2] Young Erben,[1] Haraldur Bjarnason[2]. [1]Vascular and Endovascular Surgery, Mayo Clinic Rochester; [2]Division of Vascular and Interventional Radiology, Mayo Clinic Rochester

Objective: The aim of this study was to determine factors affecting outcomes of inferior vena cava (IVC) recanalization for nonmalignant obstruction, with focus on venous inflow and etiology of IVC occlusion.

Methods: Data from consecutive patients undergoing IVC recanalization between January 2001 and December 2017 were retrospectively reviewed. Patients were grouped by etiology of IVC obstruction, including post-thrombotic (PT), retroperitoneal fibrosis (RPF), and hypoplasia (HP). Patency of the femoral, deep femoral, and great saphenous veins was evaluated; the venous inflow was graded, assigning a point to each for stenosis or occlusion, for a total possible unilateral score of 3 and a composite score of 6. A score of 6 indicated no inflow stenosis or occlusion, whereas a score of 0 indicated disease of all 6 inflow veins. Primary outcomes included primary, primary assisted, and secondary patency rates.

Results: There were 114 patients during the 18-year period (64% male; mean age, 42 ± 15 years). Etiology was PT in 96 (84%), RPF in 5 (5%), and HP in 13 (11%) patients. Clinical, Etiology, Anatomy, and Pathophysiology classes included 3, 4a, 4b, 5, and 6 in 23, 17, 3, 11, and 23 patients, respectively. Forty-four (38%) patients had an IVC filter, all of whom had PT etiology, and 33 (29%) had a thrombophilia. Inflow grading was 6 in 20 (18%), indicating no disease; 4 in 36 (32%); and 3 or less in 32 (30%). There was no mortality related to the procedure. Periprocedural complications occurred in 11% of patients. Median follow-up was 15.2 months (interquartile range, 6.4-35.8 months; maximum, 141.6 months). Kaplan-Meier analysis of primary, primary assisted, and secondary patency in the entire cohort at 1 year and 5 years was 78%, 85%, and 95% and 66%, 85%, and 95%, respectively. Early failures occurred in 12 PT, 2 HP, and 0 RPF patients ($P = .94$) No factors studied, including female sex, etiology of IVC occlusion, or thrombophilia, affected patency ($P > .05$). Median venous inflow in PT, RPF, and HP was 4, 5.5, and 5, respectively. Patients with grade 0 to 3 had patency rates similar to those of patients with grade 4 to 6 ($P > .05$). Presence of an IVC filter crushed aside during IVC stenting did not adversely affect stent patency.

Conclusions: Midterm results of endovascular recanalization are excellent regardless of the etiology of IVC occlusion. This cohort was predominantly PT with small numbers of RPF and HP, resulting in insufficient statistical power to demonstrate the effect of venous inflow on patency.

Author Disclosures: A. Mirza: Nothing to disclose; **M. Kalra:** Nothing to disclose; **N. Neidert:** Nothing to disclose; **M. Neisen:** Nothing to disclose; **Y. Erben:** Nothing to disclose; **H. Bjarnason:** Nothing to disclose.

Clinical Response to Combination Therapy in the Treatment of Varicose Veins

R. Gregory Conway,[1] Jose I. Almeida,[2] Lowell Kabnick,[3] Thomas W. Wakefield,[4] Andrea G. Buchwald,[5] Brajesh K. Lal[1]. [1]University of Maryland School of Medicine; [2]Miami Vein Center; [3]Division of Vascular and Endovascular Surgery, New York University Langone Medical Center; [4]Section of Vascular Surgery, University of Michigan Medical School; [5]University of Colorado School of Public Health

Objective: Varicose vein ablation procedures are being performed with increasing frequency; however, there is a lack of consensus on the relative efficacy of combined treatment of saphenous incompetence and symptomatic varicosities vs a staged approach. In this study, we examined the impact on symptom severity when a procedure to eliminate varicosities is added to standard endovenous saphenous ablation.

Methods: The American Venous Registry Varicose Vein Module was established by the American Venous Forum in 2010 and collected data from 53 physicians from 37 clinical centers during a 2-year period. Our analysis includes patients with Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) class $C2_S$ disease severity and without prior treatment. Combination therapy (CT) is defined as the use of a varicosity-treating secondary procedure (stab phlebectomy or injection of sclerosant into varicosity) in combination with endovenous saphenous vein ablation. Unimodal therapy (UT) is defined as endovenous saphenous vein ablation

Table. Compared with unimodal therapy (*UT*), combination therapy (*CT*) is associated with an additional 1-point reduction in Venous Clinical Severity Score (*VCSS*) on bivariate analysis

	Total (N = 1031)	UT (n = 478)	CT (n = 553)	*P* value
Day of follow-up	29.7 (8.23)	25.9 (0.40)	32.9 (6.20)	<.001[b]
Age, years				<.001[a]
<45	253 (24.6)	85 (17.9)	168 (30.4)	
45-55	221 (21.5)	103 (21.6)	118 (21.4)	
55-64	269 (26.2)	117 (24.6)	152 (27.5)	
>64	285 (27.7)	171 (35.9)	114 (20.7)	
Female	733 (71.1)	342 (71.6)	391 (70.7)	.766[a]
White	741 (71.9)	379 (79.3)	362 (65.5)	<.001[a]
Initial VCSS	6.68 (3.87)	7.28 (4.52)	6.15(3.10)	<.001[b]
VCSS change	−4.06 (3.27)	−3.50 (3.95)	−4.54 (2.46)	<.001[b]

Categorical variables are presented as number (%). Continuous variables are presented as mean (standard deviation).
[a]Pearson χ^2.
[b]Student *t*-test.