

# Multi-Institutional Experience with Robotic Nephrectomy with Inferior Vena Cava Tumor Thrombectomy

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**Purpose:** Since the first report of robotic management of renal tumors with inferior vena cava tumor thrombi, few additional cases have been reported in the literature. We report our combined experience with this procedure, to our knowledge the first multi-institutional and largest series reported to date.

**Materials and Methods:** A retrospective, multi-institutional review of robotic nephrectomy with inferior vena cava tumor thrombectomy was performed with institutional review board approval.

**Results:** A total of 32 cases were performed among 9 surgeons at 9 institutions since the first known procedure in 2008. Of these cases 30 were level II and 2 were level III thrombi with no level I thrombi (renal vein only) included in the analysis. Each surgeon performed between 1 and 10 procedures. Mean patient age was 63 years (range 43 to 81) with a mean body mass index of 30 kg/m<sup>2</sup> (range 17 to 43) and mean maximal tumor diameter of 9.6 cm (range 5.4 to 20). The length of inferior vena cava tumor thrombi ranged from 1 to 11 cm (median 4.2) on preoperative imaging. The inferior vena cava required cross-clamping in 24 cases. One patient had 2 renal veins with 2 caval thrombi and 1 patient required synthetic patch cavoplasty. Mean operative time was 292 minutes (range 180 to 411) with a mean blood loss of 399 cc (range 25 to 2,000). There were no conversions to open surgery or aborted procedures and there were 3 transfusions of 1 to 3 units. All but 2 patients ambulated by postoperative day 1 and mean hospital stay was 3.2 days (range 1 to 7). Lymphadenectomy in 24 patients yielded a mean of 11 nodes and 8 patients had node positive disease. There were 7 patients who experienced distant recurrence at a mean followup of 15.4 months, including 4 who had node positive disease on postoperative pathological examination.

**Conclusions:** Robotic nephrectomy in the setting of inferior vena cava tumor thrombus is feasible and was performed safely in selected patients. Despite the complex and critical nature of these procedures, our series demonstrates favorable outcomes and reproducibility with adequate robotic experience.

**Key Words:** robotics; laparoscopy; nephrectomy; carcinoma, renal cell; vena cava, inferior

## Abbreviations and Acronyms

IVC = inferior vena cava  
RCC = renal cell carcinoma  
RNIT = robotic nephrectomy with IVC thrombectomy

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RENAL cell carcinoma can involve tumor thrombus into the renal vein or the inferior vena cava in 4% to 36% of cases.<sup>1</sup> While renal vein tumor thrombus can often be managed in a minimally invasive fashion, open surgery remains the standard surgical treatment for IVC thrombus as laparoscopy is considered contraindicated for this condition by most experts.<sup>1–3</sup>

The complexity of the operation and potentially fatal complications that can occur in the course of tumor thrombectomy and IVC reconstruction have limited the application of laparoscopy.<sup>4</sup> Minimally invasive nephrectomy for IVC thrombus requiring cross-clamping of the cava had not been reported until the first such robotic series published in 2011.<sup>5</sup> Before this time laparoscopy had only been used for short thrombi not requiring IVC clamping or before an open incision to manage the IVC.<sup>6</sup>

Since then, only 1 laparoscopic series<sup>7</sup> and individual cases or videos of robotic nephrectomy for RCC with IVC thrombi have been published.<sup>8–12</sup> The safety and reproducibility of minimally invasive surgery for such complex tumors remain uncertain due to the scarcity of cases reported. We report the first multi-institutional and the largest series to date to our knowledge of robotic nephrectomy with IVC thrombectomy.

## METHODS

A multi-institutional database of RNIT procedures at 9 institutions was compiled with institutional review board approval and inter-institutional data sharing agreements as required. Each institution collected data prospectively while compilation of the data among institutions was done retrospectively in a de-identified fashion. Procedures were performed between 2008 and 2014. All patients who underwent RNIT at these institutions were elicited regardless of whether the procedure was completed robotically or whether open conversion was necessary. Given the retrospective nature of the study, inclusion criteria were at the discretion of the operating surgeon and were not uniform.

Demographic and perioperative data were reviewed, including patient age, gender, body mass index, operative time, estimated blood loss, conversion rate, transfusion requirements, tumor histology and stage, thrombus length, margin status, nodal status, length of stay, complications and cancer recurrence. Due to the small number of patients, descriptive statistics only were analyzed (eg medians, means etc).

## RESULTS

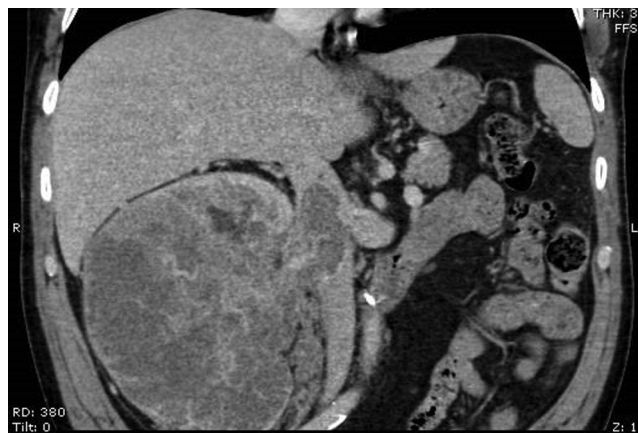
A total of 32 cases were performed among 9 surgeons at 9 institutions since the first known procedure in 2008, with each surgeon having performed between 1 and 10 RNIT procedures. Among the 9 surgeons previous robotic surgery experience before

performing RNIT averaged 1,100 robotic cases (range 600 to 2,500).

Right side tumors accounted for 27 of the 32 procedures. All patients underwent preoperative cross-sectional imaging with computerized tomography or magnetic resonance imaging and 1 surgeon performed a vena cavogram before his first procedure (fig. 1). Mean patient age was 63 years (range 43 to 81) and mean body mass index was 30 kg/m<sup>2</sup> (range 17 to 43). Overall 30 IVC thrombi were level II (below hepatic veins) and 2 were level III (above hepatic veins but below diaphragm) according to the Novick classification with no level I thrombi (renal vein only) included in the series. The maximal tumor diameter was 9.6 cm (range 5.4 to 20) with IVC tumor thrombus length ranging from 1 to 11 cm (median 4.2) on preoperative imaging. No patient underwent preoperative renal artery angioembolization.

There were no conversions to open surgery or aborted procedures. Among the 24 (75%) procedures with tumor thrombus length requiring cross-clamping of the IVC, clamping was performed with bulldog clamps or modified Rommel tourniquets using vessel loops. Shorter IVC thrombi were managed with tangential clamping of the IVC using a laparoscopic Satinsky clamp. Procedures were performed using a maximum of 8 port sites (4 assistant ports) to as few as 3 ports with a stab incision for the Satinsky clamp in less complex procedures (no assistant port).

All procedures were performed transperitoneally as previously described with minor variations among surgeons.<sup>5</sup> Cross-clamping of the IVC was accomplished after ligating the arterial supply and circumferentially dissecting the cava above and below the thrombus, placing modified Rommel tourniquets in the form of vessel loops doubly wrapped around



**Figure 1.** Representative preoperative computerized tomography of 20 cm primary right renal mass with level II IVC thrombus.

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