



## Case Series of the Month

# Initial Series of Robotic Radical Nephrectomy with Vena Caval Tumor Thrombectomy

Ronney Abaza \*

Robotic Urologic Surgery, Department of Urology, Ohio State University Medical Center & James Cancer Hospital, 503 Doan Hall, 410 W. 10th Avenue, Columbus, OH 43210, USA

### Article info

#### Article history:

Accepted August 25, 2010

Published online ahead of  
 print on September 3, 2010

#### Keywords:

Robotics  
 Laparoscopy  
 Nephrectomy  
 Renal cancer  
 Inferior vena cava  
 Thrombus

**EU\*ACME**  
[www.eu-acme.org/](http://www.eu-acme.org/)  
[europeanurology](http://europeanurology.com)

### Abstract

Laparoscopy has become a standard modality for most renal tumors but not as yet for renal cell carcinoma (RCC) involving the inferior vena cava (IVC). Robotic technology may facilitate such complex procedures. We report the first series of robotic nephrectomy with IVC tumor thrombectomy including the first cases requiring cross-clamping of the IVC in a minimally invasive fashion. Five patients underwent robotic nephrectomy with IVC tumor thrombectomy including one patient having two renal veins, each with an IVC thrombus, for a total of six IVC thrombi. The IVC was opened in all patients, and tumor thrombi were delivered intact, followed by sutured closure. The mean patient age was 64 yr (53–70 yr) with a mean body mass index of 36.6 kg/m<sup>2</sup> (22–43 kg/m<sup>2</sup>). Thrombi protruded 1 cm, 2 cm, 4 cm, and 5 cm into the IVC in five patients and 3 cm and 2 cm in the patient with two thrombi. The mean estimated blood loss was 170 ml (50–400 ml). Mean operative time was 327 min (240–411 min). Mean length of stay was 1.2 d. There were no complications, transfusions, or readmissions. This early series represents a limited experience by a single surgeon with a new procedure and may not be reproducible in larger numbers or by all surgeons. Further experience is necessary to validate this application.

© 2010 European Association of Urology. Published by Elsevier B.V. All rights reserved.

\* Tel. +1 614 293 0981.

E-mail address: [ronney.abaza@osumc.edu](mailto:ronney.abaza@osumc.edu).

## 1. Case series

Laparoscopic nephrectomy has become a standard approach in managing renal tumors, but open surgery remains the preferred approach for inferior vena caval (IVC) involvement [1]. Even in cytoreductive nephrectomy, IVC involvement is considered an exclusion criterion for a laparoscopic approach [2–4].

Laparoscopy has been reported for IVC tumor thrombi using open incisions for tumor thrombectomy after laparoscopic mobilization and dissection [5–7] or pure

laparoscopy with hand assistance for the thrombectomy only [8]. Single case reports have also been described using hand-assisted or pure laparoscopy for short thrombi [9,10]. To date, no reports of a minimally invasive approach have been described for more extensive tumor thrombi requiring cross-clamping of the vena cava.

Robotic instruments may improve the ability to treat such challenging tumors in a minimally invasive fashion. Robotic surgery has been applied for both partial nephrectomy and less commonly for radical nephrectomy but not with IVC thrombus.

We report the first series of robotic nephrectomy with IVC tumor thrombectomy, including the first cases of minimally invasive cross-clamping of the IVC.

Five patients underwent robotic nephrectomy with IVC thrombectomy by a single surgeon (RA) with one patient having two renal veins, each with an IVC thrombus, for a total of six IVC thrombi. All tumors were right sided. Four patients had clinically localized disease; one underwent cytoreductive nephrectomy and had limited lung metastasis. None underwent preoperative angioembolization. Perioperative data were collected with institutional review board approval.

Procedures were performed transperitoneally as follows. Patients were positioned in the left lateral decubitus position at 90°. A 12-mm optical port was placed either to the right of or in the midline just above the umbilicus. In the first case, two 8-mm robotic ports were used with no assistant port and the Satinsky placed percutaneously through a stab incision. In subsequent cases, one or two assistant ports were placed and a fourth 8-mm port was placed in three cases for the robotic fourth arm.

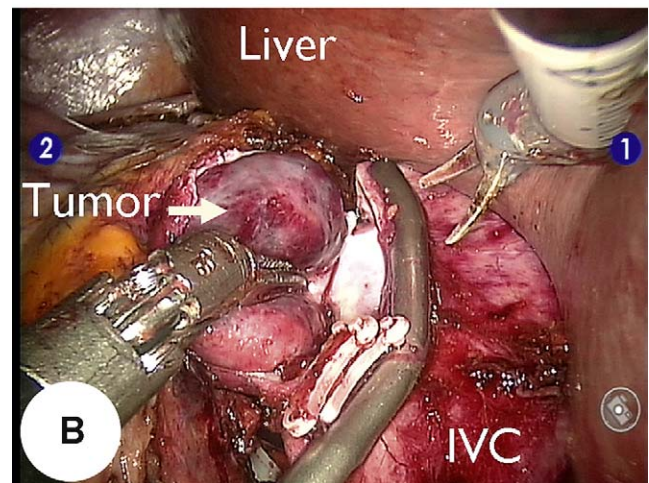
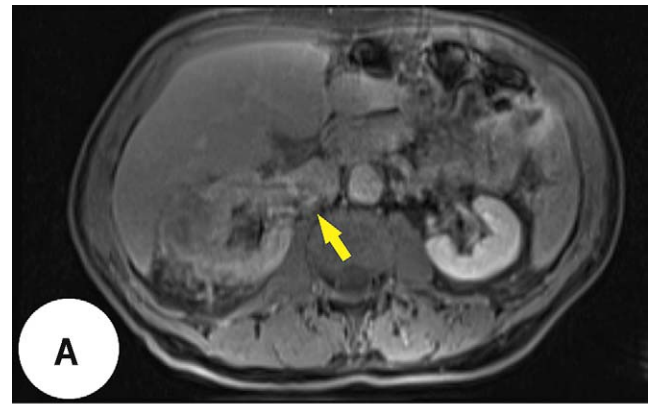
The colon is reflected medially and the duodenum Kocherized. The renal artery is clipped with the robotic Hem-o-Lok clip either at the renal hilum or in the interaortocaval space to minimize early IVC manipulation and for thrombi with bulkier portions in the renal vein. Interruption of arterial blood supply is performed first for anticipated partial retraction of the tumor thrombus.

The IVC is dissected circumferentially above and below the insertion of the right renal vein to the extent dictated by the length of the thrombus. The laparoscopic ultrasound probe was used selectively to identify the extent of the thrombus. All lumbar veins are controlled with bipolar cautery or clipped if larger. The left renal vein is dissected circumferentially.

For more extensive tumor thrombi, the robotic fourth arm instrument was used for lateral kidney retraction to shorten the tumor in the IVC lumen. This requires complete mobilization of the kidney excluding only the lateral attachments. Such mobilization was performed in all cases and believed necessary to ensure identification of all vessels and venous collaterals.

The first patient did not tolerate IVC cross-clamping due to severe aortic stenosis. Fortunately, this tumor thrombus was able to be gently milked further into the renal vein until it spanned only 50% of the way across the IVC lumen. This allowed tangential clamping of the IVC with a curved laparoscopic Satinsky clamp with preservation of flow through the remaining lumen. In this case and subsequent cases where tangential clamping was used, the clamp was always placed by the surgeon after returning to the bedside (Fig. 1).

The wall of the IVC is then incised along the inner curvature of the Satinsky clamp, and the tumor thrombus is delivered intact. The IVC is closed with 4-0 polypropylene beneath the clamp, after which it is removed, and then a second suture is run over the closure. The final reduction in size of the IVC lumen is planned to preserve at least 50% of the original caliber.

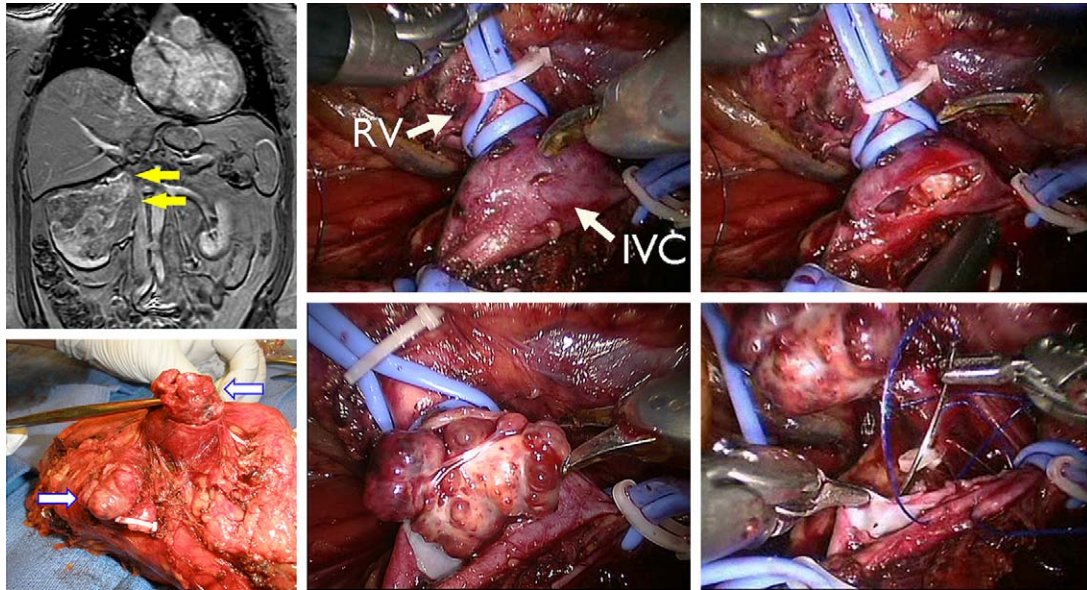


**Fig. 1** – Representative images from the first patient. (A) Limited inferior vena cava (IVC) thrombus is visible on magnetic resonance imaging scan; (B) tangential clamping is medial to the clipped gonadal vein for caval incision and intact tumor thrombus delivery.

Cross-clamping of the IVC was necessary due to two tumor thrombi in one patient (Fig. 2) and a bulky tumor thrombus in another that filled and distended the IVC up to the level of the liver (Fig. 3). In these cases, a modified Rommel tourniquet was fashioned with vessel loops placed twice around the IVC above and below the tumor thrombus and around the left renal vein as needed and then cinched and secured with a robotic clip for surgeon control.

In such cases, a small incision is made in the IVC to ensure that all lumbar veins have been controlled for a completely bloodless field before opening the IVC. The IVC is closed after tumor extraction and the lumen irrigated with heparinized saline before completion. The closure is tested by loosening one vessel loop before complete removal.

The specimen is extracted in an endoscopic extraction bag through a suprapubic incision, by extension of the periumbilical port site around the umbilicus, or through previous surgical scars (Fig. 4). A subcutaneous catheter delivering local anesthetic for 3 d (ON-Q, I-Flow, Lake Forest, CA, USA) was placed at the extraction incision in four patients and omitted in one with a lidocaine allergy. Discharge planning was targeted for postoperative day (POD) 1 per our routine for robotic nephrectomy (95% success rate).



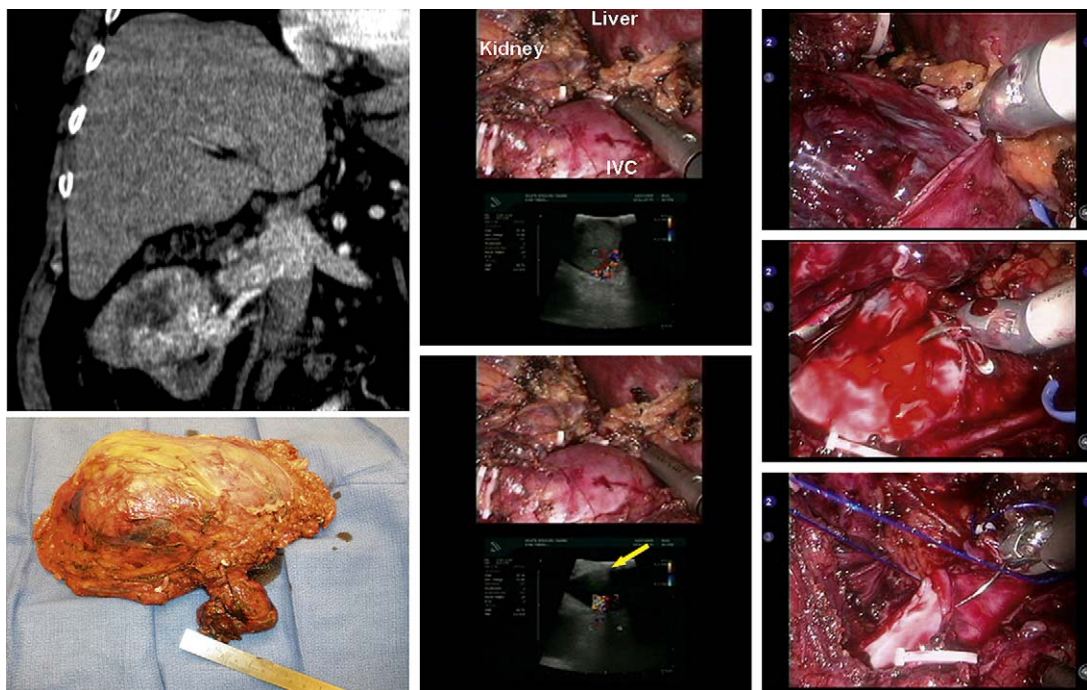
**Fig. 2** – Patient with two renal veins each with caval tumor thrombus, as seen on magnetic resonance imaging (upper left), after extraction (lower left) and intraoperatively with modified Rommel tourniquets for cross-clamping of the inferior vena cava (IVC) and lightly applied to prevent back bleeding from the right renal vein (RV) to open and deliver lower thrombus in a bloodless field (right).

Table 1 lists patient characteristics and outcomes. Thrombi protruded 1 cm, 2 cm, 4 cm, and 5 cm into the IVC and 3 cm and 2 cm in the patient with two thrombi on gross examination of specimens. Two patients had positive nodes in 1 of 24 nodes and 1 of 9 nodes, respectively. Extraction incisions ranged from 4 to 6 cm in length (Fig. 4).

No patients required intravenous narcotics, and all were managed with oral pain control and ketorolac. All patients

ambulated the evening of surgery and tolerated a regular diet on the first POD. Four were discharged on POD 1 and one on POD 2 due to an oxygen requirement for chronic obstructive pulmonary disease. There were no complications, transfusions, or readmissions.

Histology revealed renal cell carcinoma in all patients with negative surgical margins. With a mean follow-up of 15.4 mo, all patients have had no evidence of recurrence,



**Fig. 3** – Tumor thrombus of 5 cm with computed tomography scan image and final specimen (left top and bottom), laparoscopic ultrasound used to identify inferior vena cava (IVC) tumor at liver (center top), uppermost tip of thrombus (center bottom), robotic view of IVC incision (right top), tumor thrombus extraction (right center), and closure of IVC (right bottom).



Fig. 4 – Extraction incisions including 4 cm in patient with two thrombi through a portion of the previous hysterectomy incision (left), suprapubic location (center), and periumbilical location (right).

and the patient who underwent cytoreductive nephrectomy has had stable metastatic disease on systemic medical therapy.

## 2. Discussion

Although IVC tumor thrombus occurs in up to 10% of renal tumors, laparoscopic management is uncommon despite nearly 20 yr of laparoscopic nephrectomy with only one case report of pure laparoscopic management for a short thrombus not requiring IVC cross-clamping [10]. The few related series have typically involved an open incision for IVC control or hand assistance when thrombi are short [5–9]. Robotic management has not previously been reported nor has cross-clamping of the IVC by any minimally invasive technique.

Open surgery remains the predominant method for addressing RCC involving the IVC [2]. This is not surprising despite the benefits of minimally invasive surgery because these are short-term benefits compared with cancer control. Even more critical, safe handling of the IVC is paramount to avert potentially fatal bleeding or embolism. Only if minimally invasive surgery can achieve these two goals of safety and long-term cancer control can the short-term benefits of reduced pain, hospital stay, and recovery justify the approach for such a complex condition.

Although the first series is reported here, robotic IVC tumor thrombectomy remains a challenging procedure and should not be embarked on lightly. The favorable results reported here represent a limited experience by a single surgeon in selected cases. Because serious and potentially fatal complications can occur even with open management, the absence of such events in a small series does not establish whether a robotic approach is more or less safe than the open technique. Nevertheless, the benefit of robotic instrumentation has allowed a successful minimally invasive approach in our experience thus far.

Certainly not all surgeons will be comfortable with the exploration and development of this robotic procedure. The techniques presented were not initiated casually, and they represent the culmination of extensive experience with robotic renal surgery, including radical nephrectomy specifically, as well as robotic pelvic and retroperitoneal lymph node dissections involving major vascular structures where complete mobilization of vessels is required (including the aorta and IVC). More extensive thrombi were only tackled after shorter thrombi had been successfully managed, demonstrating that the IVC could be safely mobilized and controlled. Additionally, a strong background in open urologic vascular surgery, including the open equivalent and renal transplantation, contributed to the comfort level required to begin developing these techniques.

We prefer the precision of robotic instruments to standard laparoscopy, but laparoscopic or open surgeons might be concerned that the robotic surgeon is at a console away from the bedside during such a critical procedure. Although fatal errors can occur even with the open procedure, careful replication of all safety measures practiced in open surgery can be achieved robotically.

Preparations should always be made for any possible crises, but theoretical concerns over potential complications should not dissuade our specialty from exploring new techniques because without such explorations progress cannot occur. We believe that our discretion allowed us to achieve favorable results in our initial series and are optimistic that others will be able to duplicate our results as we extend our experience.

Table 1 – Patient characteristics and outcomes

	Mean value (range)
Patient age, yr	64 (53–70)
Body mass index, kg/m <sup>2</sup>	36.6 (22–43)
Follow-up, mo	15.4 (8–23)
Tumor size, cm	10.4 (7.8–15.5)
Estimated blood loss, ml	170 (50–400)
Operative time, min	327 (240–411)
Lymphadenectomy yield*	12.5 (7–24)
Transfusions	0
Complications	0
Length of stay, d	1.2 (1–2)

\* Performed in four of five patients.

**Conflicts of interest:** The author has nothing to disclose.

### EU-ACME question

Please visit [www.eu-acme.org/europeanurology](http://www.eu-acme.org/europeanurology) to answer the following EU-ACME question online (the EU-ACME credits will be attributed automatically).

Question:

Which of the following steps is not required before extraction of a large vena caval tumor thrombus associated with a right renal tumor?

- A. Ligation of the right renal artery
- B. Control of lumbar veins
- C. Cross-clamping of the right renal vein
- D. Cross-clamping of the vena cava above and below tumor thrombus

### References

- [1] Novick AC. Laparoscopic and partial nephrectomy. *Clin Cancer Res* 2004;10:6322S–7S.
- [2] Eisenberg MS, Meng MV, Master VA, et al. Laparoscopic versus open cytoreductive nephrectomy in advanced renal-cell carcinoma. *J Endourol* 2006;20:504–8.
- [3] Rabets J, Kaouk J, Fergany A, et al. Laparoscopic versus open cytoreductive nephrectomy for metastatic renal cell carcinoma. *Urology* 2004;64:930–4.
- [4] Matin S, Madsen L, Wood C. Laparoscopic cytoreductive nephrectomy: the M. D. Anderson Cancer Center experience. *Urology* 2006;68:528–32.
- [5] Disanto V, Pansadoro V, Portoghese F, et al. Retroperitoneal laparoscopic radical nephrectomy for renal cell carcinoma with infrahepatic vena caval thrombus. *Eur Urol* 2005;47:352–6.
- [6] Varkarakis IM, Bhayani SB, Allaf ME, et al. Laparoscopic-assisted nephrectomy with inferior vena cava tumor thrombectomy: preliminary results. *Urology* 2004;64:925–9.
- [7] Hoang AN, Vaporcyian AA, Matin SF. Laparoscopy-assisted radical nephrectomy with inferior vena caval thrombectomy for level II to III tumor thrombus: a single institution experience and review of the literature. *J Endourol* 2010;24:1005–12.
- [8] Martin GL, Castle EP, Martin AD, et al. Outcomes of laparoscopic radical nephrectomy in the setting of vena caval and renal vein thrombus: seven-year experience. *J Endourol* 2008;22:1681–6.
- [9] Sundaram CP, Rehman J, Landman J, et al. Hand assisted laparoscopic radical nephrectomy for renal cell carcinoma with inferior vena caval thrombus. *J Urol* 2002;168:176–9.
- [10] Romero FR, Muntener M, Bagga HS, et al. Pure laparoscopic radical nephrectomy with level II vena caval thrombectomy. *Urology* 2006;68:1112–4.