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Surgery in Motion

Robotic Partial Nephrectomy for Complex Renal Tumors: Surgical Technique

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Abstract

Objectives: Laparoscopic partial nephrectomy requires advanced training to accomplish tumor resection and renal reconstruction while minimizing warm ischemia times. Complex renal tumors add an additional challenge to a minimally invasive approach to nephron-sparing surgery. We describe our technique, illustrated with video, of robotic partial nephrectomy for complex renal tumors, including hilar, endophytic, and multiple tumors.
Methods: Robotic assistance was used to resect 14 tumors in eight patients (mean age: 50.3 yr; range: 30–68 yr). Three patients had hereditary kidney cancer. All patients had complex tumor features, including hilar tumors ($n = 5$), endophytic tumors ($n = 4$), and/or multiple tumors ($n = 3$).
Results: Robotic partial nephrectomy procedures were performed successfully without complications. Hilar clamping was used with a mean warm ischemia time of 31 min (range: 24–45 min). Mean blood loss was 230 ml (range: 100–450 ml). Histopathology confirmed clear-cell renal cell carcinoma ($n = 3$), hybrid oncocytic tumor ($n = 2$), chromophobe renal cell carcinoma ($n = 2$), and oncocytoma ($n = 1$). All patients had negative surgical margins. Mean index tumor size was 3.6 cm (range: 2.6–6.4 cm). Mean hospital stay was 2.6 d. At 3-mo follow-up, no patients experienced a statistically significant change in serum creatinine or estimated glomerular filtration rate and there was no evidence of tumor recurrence.
Conclusions: Robotic partial nephrectomy is safe and feasible for select patients with complex renal tumors, including hilar, endophytic, and multiple tumors. Robotic assistance may facilitate a minimally invasive, nephron-sparing approach for select patients with complex renal tumors who might otherwise require open surgery or total nephrectomy.

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1. Introduction

Minimally invasive nephron-sparing surgery has become increasingly popular as expertise in laparoscopy has increased and has demonstrated excellent long-term renal functional and oncologic outcomes [1,2]. Laparoscopic partial nephrectomy is a technically challenging procedure, requiring advanced laparoscopic skills to accomplish tumor resection, hemostasis, and renal reconstruction with sufficient speed of intracorporeal suturing to minimize warm ischemia times. Complex renal tumors, such as hilar, endophytic, and multiple tumors, present additional challenges to a nephron-sparing approach using conventional laparoscopy.

The da Vinci® surgical system may facilitate performance of these complex renal tumors using the minimally invasive surgical approach. Potential advantages include three-dimensional stereoscopic vision, articulating instruments, and scaled-down movements reducing tremor. The articulating instruments and increased freedom of movement may also allow the surgeon to replicate well-established open surgical maneuvers more readily. Robotic assistance is well-established in radical prostate surgery and has also become more common for renal procedures, including pyeloplasty [3], radical nephrectomy [4], and donor nephrectomy [5]. Preliminary reports have demonstrated the safety and feasibility of robotic partial nephrectomy [6–9].

We describe our technique of robotic partial nephrectomy in the setting of complex renal tumors, including hilar, endophytic, and multiple tumors. We include a detailed outline of the procedure with corresponding video segments illustrating how robotic assistance can facilitate the challenges of tumor excision and renal reconstruction for complex renal masses.

2. Methods

2.1. *Introduction and imaging (video clip no. 1)*

At the National Cancer Institute, 28 patients underwent partial nephrectomy between March 2007 and July 2007. Robotic partial nephrectomy was offered to eight consecutive patients with complex renal tumors, defined as hilar (tumor abutting hilar vessels), endophytic (complete), or multiple tumors. Other surgical approaches to partial nephrectomy performed during that time included open (n = 16), laparoscopic intraperitoneal (n = 2), and laparoscopic retroperitoneal (n = 2). Selection criteria for a robotic approach was based on complex tumor features and patient preference rather than by randomization. Within our cohort of robotic patients, no patients had a solitary kidney or prior renal surgery. Both the console surgeon and assistant were fellowship trained with experience in laparoscopic and robotic surgery.

Table 1 – Patient demographic data

No. of patients	8
No. of tumors resected	14
Mean age, yr (range)	50.3 (30–61)
Sex (n)	
Male	2
Female	6
Mean preoperative serum creatinine, mg/dl (range)	0.9 (0.7–1.2)
Mean preoperative estimated GFR	84.9 (67–122)
Side of involvement (n)	
Right	3
Left	5

GFR = glomerular filtration rate (ml/min/1.73 m^2).

Patient demographic data for those who underwent robotic partial nephrectomy are summarized in Table 1. Mean patient age was 50.3 yr (range: 30–61 yr) and all patients had normal preoperative creatinine levels and were without major medical comorbidities. We present a brief clinical description of four patients mentioned in our accompanying video or figures.

A 30-year-old woman presented with an incidental left renal hilar mass. A computed tomography (CT) scan demonstrated a 2.6-cm solid, enhancing mass located near the renal hilum adjacent to the posterior renal pelvis and major branches of the renal hilar vessels (Fig. 1). A percutaneous renal biopsy had been performed at another facility, demonstrating clear-cell renal cell carcinoma, Fuhrman grade 2. The accompanying video demonstrates resection of this renal hilar mass.

A 60-year-old woman with Birt-Hogg Dube syndrome presented with a 2.6-cm solid, enhancing renal mass in the left upper pole that was completely endophytic as well as smaller masses in the midpole measuring 1.1 cm and 0.8 cm. The accompanying video demonstrates resection of the endophytic and multiple tumors.

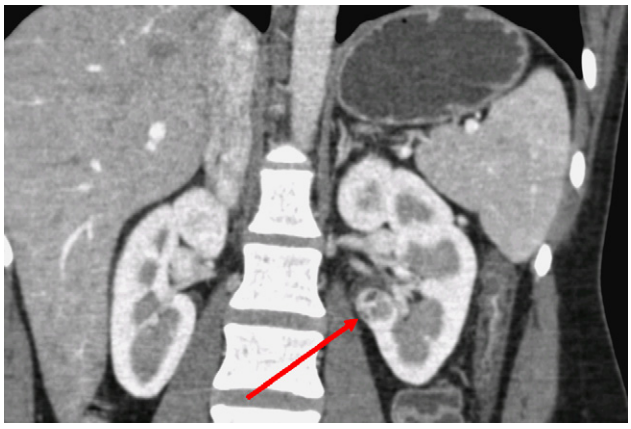

Fig. 1 – Hilar tumor. Computed tomography demonstrates a 2.6-cm solid tumor located near the left renal vessels and abutting the renal pelvis.