ABSTRACT
Robot assisted partial nephrectomy (RAPN) is an intriguing alternative surgical approach to traditional open and conventional laparoscopic partial nephrectomy to treat small renal masses in terms of surgical, oncological, and functional results. Recently, a built-in near-infrared technology was introduced with the currently available robotic systems. With the use of appropriate fluorescent dyes such as indocyanine green, the near-infrared technology may help in differentiation of cancer cells from healthy kidney cells. In this video, we demonstrated a patient with a 4-cm renal mass who underwent RAPN with near-infrared fluorescence imaging.

Key Words: Kidney cancer, Robotics, Partial nephrectomy, Nephron sparing surgery

INTRODUCTION
Incidence of small renal masses has increased due to widespread use of cross sectional imaging systems. Because of this, renal tumors usually have been diagnosed at early clinical stages. Though multiple treatment options are available, such as radical and partial nephrectomy (PN), thermal ablation and active surveillance, PN is now considered as standard of care in patients with clinical stage T1 and T2 renal tumors which are amenable to nephron sparing surgery given the importance of preservation of renal parenchyma and avoidance of chronic kidney disease. [1] Even though, open partial nephrectomy is seen as the most preferred technique among nephron sparing surgical options, robot assisted partial nephrectomy (RAPN) has gained acceptance especially in developed countries. Although transition from open to laparoscopic partial nephrectomy had been challenging for many urologist, robotic surgical system provides some advantages over traditional laparoscopy in order to facilitate this transition. These advantages include tremor filtering, motion scaling, and magnified three-dimensional vision with fully articulating instruments. These advantages facilitate excision of the tumor even with “difficult” tumor locations. In this study, we aim to describe surgical technique of RAPN in a step by step fashion and review of current literature.

DESCRIPTION OF THE SURGICAL TECHNIQUE OF RAPN
1. Trocar Placement
An informed consent and a permission to record and publish the surgical procedure anonymously was obtained from the patient. We prefer 5 port transperitoneal setting with 3 robotic ports and 2
assistant ports. Following the endotracheal intubation under general anesthesia, the patient was placed in a 60 degree modified flank position and the pneumoperitoneum was achieved with a Veress needle. A 12 mm camera port was placed 4 cm lateral and 2 cm cranial to the umbilicus. An 8 mm robotic port was placed 3 cm medial to anterior superior iliac spine, and another 8 mm robotic port was placed 2 cm below the costal margin in the mid-clavicular line. A 12 mm assistant port was placed between the camera port and the caudal robotic port and a 5 mm assistant port was placed between the camera port and the cranial robotic port in order to assist hilar dissection and place the Bulldog clamps.

2. Mobilization of the Colon and Identification of the Ureter

The line of Toldt is incised by using monopolar scissors and the bowel is mobilized using the Prograsp forceps. Care should be taken to minimize the thermal injury and dissection is carried out at least 2 cm away from the bowel. After the reflection of the bowel, psoas muscle is visualized. The ureter is identified medial to the psoas muscle. (Figure 1) The assistant surgeon helps in elevating the lower pole of the kidney and the cephalad dissection is carried out towards the renal hilum.

3. Dissection of the Hilum and Delineation of the Excision Line

First of all, anterior and medial surface of the renal vein is exposed and the renal artery is located by looking for transmitted pulsations. Posterolateral tissue of the renal artery should be dissected sufficiently. Primary goal at this point is to obtain sufficient length on the skeletonized artery to have enough space for Bulldog clamps. (Figure 2) We do not routinely clamp the renal vein during the procedure. After the hilar dissection, Gerato’s fascia is opened and the renal tumor is exposed. At this point, 10 mg furosemide and 12.5 mg mannitol should be administered intravenously in order to prevent renal tubular damage. Laparoscopic ultrasound probe is used by the bedside assistant to determine localization of the mass and its depth as well as to assess the delineation of margins and proximity to the collecting system.

4. Placement of the Bulldog Clamps

In preparation for the partial nephrectomy, the assistant introduces a 3-0 barbed (V-loc, Covidien, Ireland) suture (15 cm in length) through the 12 mm assistant port. Indocyanine green was administered intravenously and near-infrared camera (Firefly, Intuitive, USA) was activated to observe the fluorescence dye passing through the renal artery. Following the observation of the green dye in the renal artery, the renal artery is occluded with Bulldog clamps introduced by the 12 mm assistant port. (Figure 3-4) We usually place two clamps on the renal artery and do not routinely clamp the renal vein.

5. Excision of the Tumor and Renorraphy

Cold excision of the tumor is performed with robotic shears. (Figure 5-6) Perirenal fat tissue overlying the tumor is left in place and included as part of the pathologic specimen. The excised mass is temporarily placed close to the kidney, and the assistant changes to two large-needle drivers on the robotic arms. Tumor bed is then sutured continuously with the previously placed 3/0 barbed suture. (Figure 7) The renal parenchyma is further approximated using several running 0-0 polyglactin sutures with polymer clip at the tail using the sliding renorraphy technique. (Figure 8) The defect is covered with hemostatic agent (Floseal, Baxter, Inc., Irvine, CA, USA) (Figure 9)
Figure 3: ICG in the renal artery under near-infrared vision

Figure 4: Placement of the Bulldog clamp on the renal artery

Figure 5: Cold excision of the tumor under near-infrared vision.

Figure 6: Cold excision of the tumor under normal vision.

Figure 7: Renorrhaphy with 3/0 barbed suture.

Figure 8: Sliding renorrhaphy technique with 0-0 sutures with polymer clips at the tail.
After closure of the renal defect, the bulldog clamps are removed and the excised tumor is placed into a retrieval bag. The kidney is retroperitonealized. A Jackson-Pratt drain is placed and the tumor is then retrieved. All trocars are removed under direct vision, and trocar sites are closed in standard fashion.

DISCUSSION

Minimally invasive nephron sparing surgical approaches have been gaining acceptance since the last two decades due to technological advances in digital imaging systems and laparoscopic equipment. These surgical techniques include laparoscopic partial nephrectomy (LPN) and RAPN. LPN has comparable surgical and oncologic outcomes when compared to traditional open surgery. It is a challenging procedure requiring higher surgical skills and expertise. One of the most important disadvantages of laparoscopy is the steep learning curve. [2] On the contrary, robotic surgery facilitates intracorporeal suturing which results in a faster renorrhaphy. By this means, RAPN is increasingly preferred as the nephron sparing approach even in the challenging cases. Most recently, Choie et al has reported a meta-analyses comparing perioperative outcomes of RAPN and LPN. In this study, the authors concluded that RAPN has favorable results in terms of conversion to open surgery or radical nephrectomy, hospital stay, warm ischemia time and renal function. [3] In addition to this, Rogers et al reported a multi-institutional analysis associated with feasibility of RAPN in patients with renal hilar tumors. In this study, the authors declared that RAPN can be safely performed in selected patients with renal hilar tumors. [4]

The main goal of RAPN is tumor resection with negative surgical margins with minimum ischemia time to preserve maximal renal unit. However, current literature is unable to define the optimal ischemia time. Presently, warm ischemia time (WIT) is suggested to be less than 20-25 minutes. In addition to this, several techniques to reduce WIT has been reported in several papers. These techniques include zero ischemia with the controlled hypotension, off-clamp and early unclamping, segmental and super selective clamping of renal vasculature. Aboumarzouk et al published a meta analyses comparing seven RAPN and LPN series. Compared to LPN, RAPN has similar outcomes in terms of operation time, estimated blood loss, length of stay and complication rates. However, longer WIT was observed in LPN. In conclusion, the authors stated that RAPN compared to LPN may be a better option in order to preserve maximal renal function. [5] More recently, near-infrared technology (Firefly) technology has been introduced. Indocyanine green (ICG) is a water soluble fluorescence dye injected intravenously. With Firefly and ICG, normal parenchyma can be differentiated from the tumor cells because ICG is retained by normal renal parenchyma since renal proximal tubule cells has its own membrane protein bilitranslocase, but not retained in renal cell carcinoma. However, consistency of near-infrared technology in providing this differentiation from normal renal parenchyma to cancer cells is unclear and its usefulness in RPN has not been established, yet.

REFERENCES