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Robot-assisted Laparoscopic Partial Nephrectomy

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ABSTRACT

The indications for nephron-sparing surgery and for minimally invasive surgery are continually expanding. Nephron-sparing surgery, also known as partial nephrectomy, presents a challenge to the minimally invasive surgeon. Herein, we describe our technique of robot-assisted laparoscopic partial nephrectomy. This approach may have potential advantages of including easier excision and suturing. Moderate training is required.

Key Words: Laparoscopy, Nephrectomy, Robotic surgery.

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INTRODUCTION

The da Vinci surgical system was approved by the Food and Drud Administration in 2000. In urology, it has since been used clinically to perform radical prostatectomies, pyeloplasties, simple nephrectomies, donor nephrectomies, and recipient renal hilar anastomoses.[1–3] Purported advantages include 3-dimensional stereoscopic optics, computer elimination of tremor, 6 degrees of motion at the distal end of the instruments, and improved surgeon ergonomics.

As a pilot study, we set out to look at the feasibility of performing da Vinci robotic laparoscopic partial nephrectomies. Prior to embarking on this study, the authors performed approximately 50 standard laparoscopic or hand-assisted laparoscopic (HAL) partial nephrectomies, and several other urologic procedures using the da Vinci system. These included 4 dismembered pyeloplasties, 2 cyst marsupializations, and 2 radical nephrectomies. Both surgeons participated in a 3-day animal training laboratory with the da Vinci system prior to undertaking procedures in humans. Our first patient for partial nephrectomy was chosen based on the relatively small and exophytic nature of his renal tumor. Herein, we describe our technique of robotic-assisted laparoscopic partial nephrectomy.

METHODS

The patient was a 69-year-old male with a 2-cm, left, upper pole enhancing renal mass **(Figure 1)**. He was American Society of Anesthesiologists (ASA) class III with mild obesity and stable coronary artery disease, as well as a remote past surgical history of open cholecystectomy. He consented to robotic-assisted laparoscopic partial nephrectomy, possible open. He was typed and cross-matched for 4 units of packed red blood cells and received bowel preparation prior to surgery. He was placed in the semilateral, flexed position, padded, and strapped to the table with 3-inch cloth tape. A Hassan technique was used to gain access. In an effort to expedite the robotic set up, allow flexibility for the surgeon, and ease placement of the robotic arms, we utilized four 12-mm Ethicon Endo-surgical nondilating trocars **(Figure 2)**. During the robotic aspect of the operation the 2 robotic arms were attached

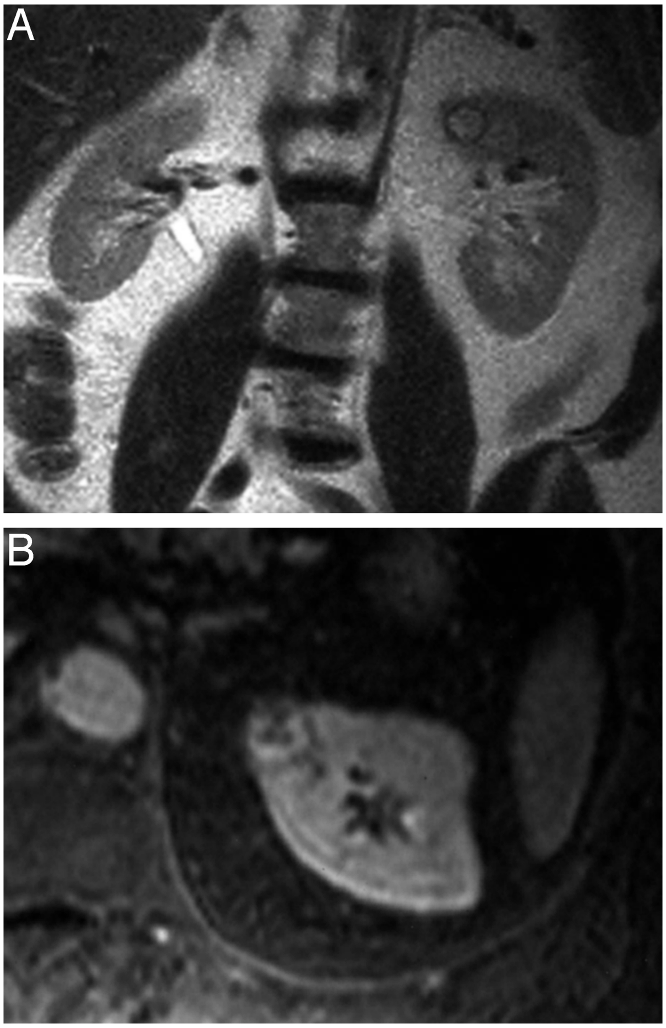

Figure 1. Coronal T1 MRI of left renal lesion (A); transverse T2 MRI of same lesion (B).

to their specialized trocars and then placed through the Ethicon trocar **(Figure 3)**.

The operation was performed initially using standard laparoscopic techniques. The goals include isolating the renal hilum and exposing the renal capsule surrounding the tumor. During the standard laparoscopic dissection, a circulation nurse and an Intuitive clinical specialist draped, set up, and calibrated the robot in an attempt to minimize operative setup time. The second stage of the procedure was performed utilizing the da Vinci surgical system. During this period, it is imperative that an experienced table-side surgeon (assistant) be present. The console surgeon (primary surgeon) is not scrubbed and is away from the operative table. The table-side surgeon must know and understand all the steps, be able to aid in dissection with a suction irrigator, exchange robotic instruments, pass sutures, retrieve sutures, be capable of suturing laparoscopically and/or of converting if an emergent operative situation occurs. The console surgeon utilized a flat cautery blade on the left robotic arm for retraction and dissection and a hook electrode on the right arm for electro-dissection. The console surgeon scored the capsule and then retracted the kidney, placing the hilum on stretch while the table-side surgeon placed a laparoscopic bulldog on the left renal artery. (For a right-sided lesion, we clamped both artery and vein.)

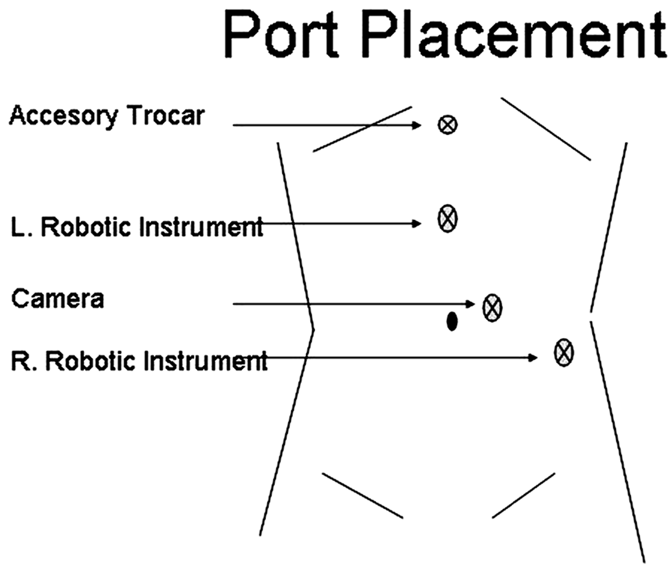

Figure 2. Schematic diagram of port placement.

Immediately after clamping, we switched out the hook electrode for scissors in the right robotic arm. The tumor was excised with the robotic Endoshears while the cautery/dissector (flat blade) in the left arm retracted the lesion and helped to elevate it during resection **(Figure 4)**. The table-side surgeon utilized a suction/irrigator to help expose the bed and remove any blood from the field. The depth of excision was based on 3D preoperative imaging and visual cues. Once excised, the deep margin of the specimen was visually inspected to assess completeness of excision. We took biopsies of the deep renal bed with the robotic Endoshears for pathologic confirmation. These specimens were collected by the table-side surgeon and sent for frozen section immediately.

At this stage, the right and left robotic arms were exchanged for needle drivers. The 3D stereoscopic laparoscope was used to identify large perforating vessels. A 3–0 Vicryl suture on a CT-1 needle was introduced by the side surgeon through the accessory port, and a large perforat-

Figure 3. Robotic torcar in laparoscopic trocar setup.

ing vessel was suture ligated. The argon beam coagulator was then introduced through the accessory port by the side surgeon, and the base of the renal defect was cauterized. Attention was paid not to coagulate any sutures. The side surgeon then introduced Fibrin (Haemacure, Montreal, Canada) soaked Gelfoam (Pharmacia, Peapack, NJ), and the console surgeon laid it into the defect using

Figure 4. Renal lesion excision with robotic articulating instruments.

the robotic needle drivers. A percutaneously placed spinal needle was guided by both the table-side surgeon and console surgeon into the Fibrin soaked Gelfoam, and Thrombin (Haemacure, Montreal, Canada) was injected to create a Gelfoam/Fibrin-Glue plug. Two mattress sutures were placed over the plug through the renal capsule by using 2.0 Vicryl suture on a CT-1 needle. The kidney was placed back on stretch, and the table-side surgeon released and retrieved the vascular bulldog.

Hemostasis was confirmed while a mean arterial pressure above 90 mm Hg was documented, an intraperitoneal pressure of 6 mm Hg of CO_2 was documented and a Valsalva maneuver was performed. Finally, Gerota's fascia overlying the excision site was reapproximated with a running 2.0 Vicryl suture on a CT-1 needle. The robot was then removed from the patient, the specimen was retrieved with a 10-mm Endobag (Ethicon Endosurgical, Cincinnati, OH) via the Hassan trocar, and the abdomen was reinspected. Finally, a Jackson-Pratt drain was placed through a port site, and all trocars were removed and closed.

Demographics, lesion size, location of tumor, depth of penetration, and indication for surgery were recorded. Intraoperative parameters included blood loss, complications, need for open conversion, and operative time. Operative time was defined as time of first incision to closure of all trocar sites and was subdivided into standard laparoscopic time, robotic docking time, and robotic surgery time. Pathology, including specimen size, cell variant, and margin status was recorded. Length of stay and postoperative complications were also evaluated.

RESULTS

The operative time, including da Vinci setup (14 minutes), was 230 minutes. Warm ischemia time was 32 minutes, and robotic docking time performed prior to clamping was 4 minutes. Estimated blood loss was 150 mL, and no intraoperative or postoperative complications occurred. The patient was managed with intravenous patient-controlled analgesia for 24 hours after the procedure. A regular diet and ambulation were successfully resumed by postoperative day 1, and the patient was discharged home on postoperative day 2 with a hematocrit of 40.0% and a creatinine of 1.3 mg/dL. By postoperative day 10, the patient had resumed normal activities. Pathologic evaluation of the lesion revealed an oncocytoma with negative surgical margins.

DISCUSSION

This case report details our initial robot-assisted laparoscopic partial nephrectomy. We chose a small, exophytic lesion in this case to assess feasibility. We did not perform a collecting system reconstruction; however, suturing was necessary to control hemorrhage from a terminal artery and close the renal capsule and Gerota's fascia. Two urologic surgeons with approximately 2 to 3 years of laparoscopic experience (approximately 150 and 60 cases each) participated in this procedure. Both surgeons had been previously trained on the da Vinci in a 3-day animal laboratory.

We chose to perform this complex laparoscopic procedure using the da Vinci because of its several purported advantages, mentioned earlier, over standard laparoscopy. It is unclear whether these purported advantages will result in an improved learning curve. Even so, those with extensive laparoscopic experience at a limited number of centers may feel more facile with a straight laparoscopic approach to partial nephrectomies.[4] Regardless, the indications for partial nephrectomies and for minimally invasive surgery are both expanding, and the above described approach offers another tool in the armamentarium.

In this case, we found the da Vinci to aid us in wedge excision by allowing for perpendicular scoring and cutting through renal parenchyma. This is not always feasible with standard laparoscopic instruments secondary to the limited ability to angle the instrumentation. Suturing was felt to be easier to perform secondary to 3-dimensional vision, improved angulation, dexterity, loss of tremor, and precise control of the robotic needle driver due to the endowrist technology.

Potential disadvantages of the da Vinci include cost, training, setup time, and lack of tactile sensation or haptics. Another potential disadvantage, should conversion be required, is having the surgeon unscrubed and away from the patient. It is for this reason we used an experienced table-side surgeon assistant. We also placed the robotic trocar ports through standard laparoscopic trocars to decrease docking time and, potentially, conversion time to standard or hand-assisted laparoscopy if it were necessary. The time required for robotic preparation can be minimized by having an experienced nursing staff set up the device, while the surgeon enters the abdomen using standard laparoscopic trocars.

CONCLUSION

We report the first robot-assisted laparoscopic partial nephrectomy. Potential benefits of the da Vinci system may include a more accurate means of lesion resection and easier reconstruction of the renal defect. It is yet to be proven whether this technology can decrease ischemia time, expand the indications for laparoscopic partial nephrectomy, and/or decrease complications like bleeding and collecting system leak. As we continue to utilize this technique, our hypothesis of whether the potential advantages translate into improved outcome parameters will be tested.

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