Robotic Partial Nephrectomy

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Craig A. Peters

Patient Selection

Robotic-assisted laparoscopic partial nephrectomy in children most commonly involves patients who have a nonfunctioning moiety in a duplex renal system. Specific indications that would lead to discussion with the patient and parents of intervention include recurrent urinary tract infections, flank pain, or nausea/vomiting suspected to be related to the nonfunctioning moiety. Asymptomatic patients raise the concern about the long-term risks of developing symptoms, generally related to infection.

When a duplicated renal moiety shows some level of function on a renal scan, a drainage procedure may be considered. This can be a proximal or distal ureteroureterostomy, or less often a ureteral reimplantation. Even in some nonfunctioning segments, a drainage procedure may be the most efficient with less risk of injury to the remnant moiety. The advantage of a partial nephrectomy includes avoiding prolonged follow-up, which is often appropriate for reconstructive procedures. In general, however, partial nephrectomy is somewhat more complex, includes the risk of a residual urinoma, and poses a small risk of devascularization of the remnant pole. Both upper and lower partial nephrectomies can be performed with equal success. Upper pole procedures are usually performed for ectopic ureters or ureteroceles with duplication, while lower ole procedures are for lower pole reflux or ureteropelvic junction obstruction associated with nonfunction. The author's practice has been to perform salvage procedures when there is function or when there is limited function but the upper pole is not markedly dilated. In the older child, often with marked dilation of the upper pole, a partial nephrectomy is preferred. Lower pole preservation is only offered when there is demonstrable function in the affected segment, although there are no guidelines as to the appropriate amount of function [1].

Preoperative Preparation

Bowel Preparation

All patients are asked to have a clear liquid (apple juice, Jell-O, ginger ale, water, broth) diet for 24 h before surgery to reduce the bulk of stool in the colon. They are also given one Dulcolax® suppository for the night before. They are then NPO for at least 3 h prior to the case. Specific to

Electronic supplementary material: The online version of this chapter (doi:10.1007/978-3-319-45060-5_30) contains supplementary material, which is available to authorized users.

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L.-M. Su (ed.), *Atlas of Robotic Urologic Surgery*, DOI 10.1007/978-3-319-45060-5_30

infants or young children is the use of milk of magnesia (cherry flavor, refrigerated) one to two teaspoons, daily for 2 days before surgery. For 3 days prior to surgery, older children are asked to use senna liquid, one to two teaspoons up to twice daily for 3 days before surgery or ex-lax® squares (chocolate covered senna): ½ to 1 square, repeating twice daily until cleaned out. Teenagers may use Dulcolax® tabs: 20 mg BID the day prior to surgery.

Informed Consent

All patients and family should understand that the surgeon, NOT the "robot", will perform the procedure. The da Vinci® is actually a "master–slave" micromanipulator where the operator is in total control. The robot is not in any way autonomous. Some families are concerned about this issue due to misinformation or misperceptions. The family and patient should always be made aware of the possibility of conversion to open surgery. This is emphasized to be used in cases where the ability to complete the procedure or safety are of concern. If a family is hesitant or unwilling to consent to this uncertainty, open surgery should be recommended so they know what to expect. The risks of general anesthesia must also be presented to the patient. Other risks that need to be relayed during informed consent include the possibility of continued flank pain, nausea, vomiting, recurrent urinary tracts infections, and reoperation.

Operative Setup

At our institution we use the da Vinci® S*i* with a three-armed technique. An assistant and the scrub technician are positioned on the side of the patient opposite the robot. Video monitors are placed for easy viewing by all team members. An overhead view of the room setup for right and left partial nephrectomies are shown, respectively, in Figs. 30.1 and 30.2.

Patient Positioning and Preparation

Place the patient in modified flank position with a 30° wedge under the ipsilateral side where the partial nephrectomy will be performed with padding and tape across chest and thighs. Also, place folded towels and tape over the patient's arms but under abdomen (Fig. 30.3). Rotate the table so that the patient's abdomen is flat while obtaining trocar access, then rotate to 60° (30° wedge plus 30° table rotation) just prior to docking the robot. The anesthesia team should place an NG or OG tube prior to access.

Trocar Configuration

Trocar configurations for left and right partial nephrectomies are shown in Figs. 30.4 and 30.5. One notable difference is the possibility of needing an extra trocar for liver retraction during a right partial nephrectomy. Again, we typically use the 5 mm trocars when the patient is younger than 8–10; otherwise, the 8 mm trocars are used.

Instrumentation and Equipment List

Equipment

- Da Vinci® Surgical System (3-arm system; Intuitive Surgical, Inc., Sunnyvale, CA)
- EndoWrist® Monopolar Hook Electrocautery, 5 or 8 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- EndoWrist® Maryland Dissector, 5 mm or Bipolar Maryland Dissector, 8 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- EndoWrist® Curved Monopolar Scissors, 8 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- EndoWrist® Round Tip Scissors, 5 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- EndoWrist® Needle Driver, 5 or 8 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- Articulated Suction device, 8 mm (Intuitive Surgical, Inc., Sunnyvale, CA)
- InSite® Vision System with 30° lens (Intuitive Surgical, Inc., Sunnyvale, CA)

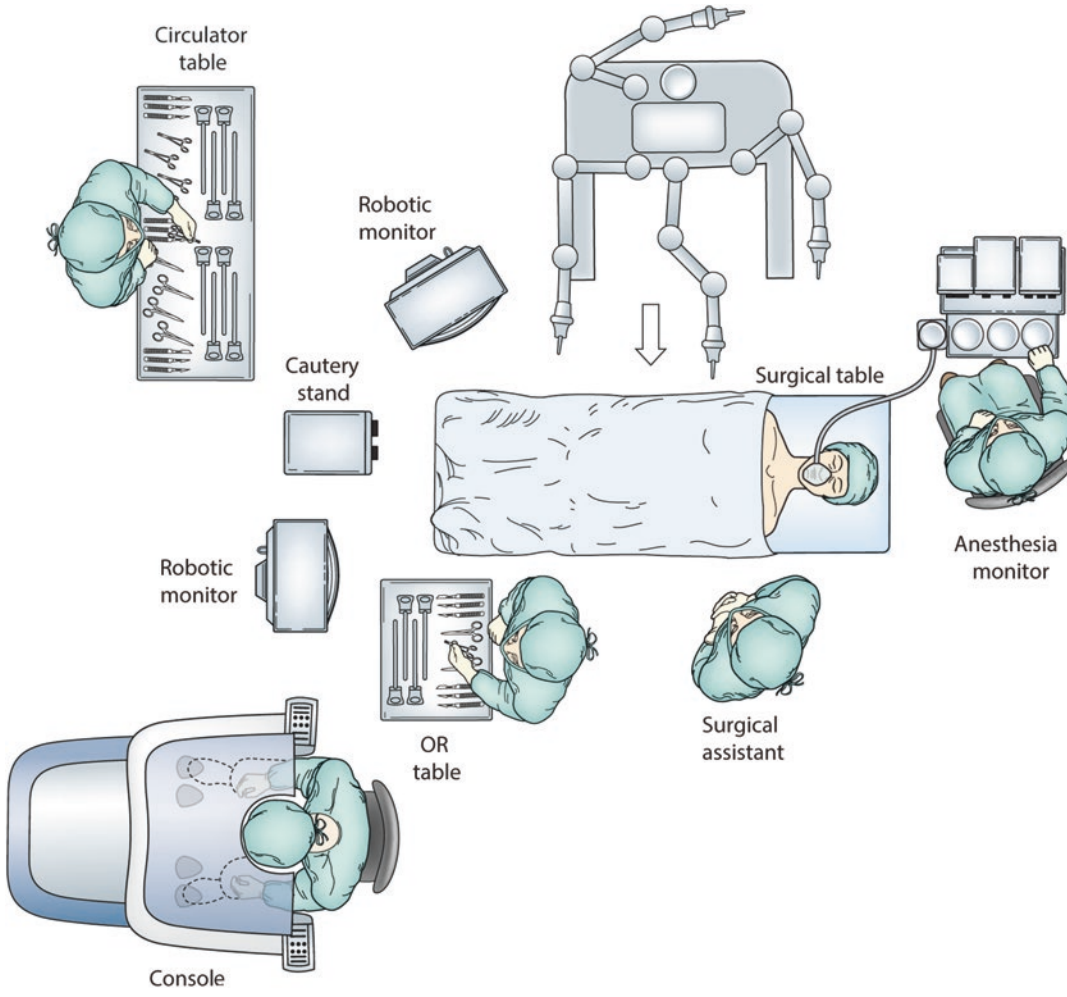

Fig. 30.1 Operating room setup for right partial nephrectomy demonstrating standard configuration of operating room personnel and equipment

Trocars

- 10 mm trocar—camera port
- 8 mm robotic trocars (2, if child is older than 8 years)
- 5 mm trocar (usually 2, if you need liver retraction during a right partial nephrectomy then you will need a 3 mm or 5 mm port for a lifting/retraction device)

Recommended Sutures

- Preplaced fascial box stitch: 2-0 or 3-0 polyglactin suture
- Vessel ligation and closure of renal defect: 3-0 and/or 4-0 polyglactin suture, length 12–14 cm by age
- Skin Closure: 4-0 or 5-0 monocryl suture

Instruments Used by the Surgical Assistant

- Laparoscopic needle driver
- Maryland grasper
- Suction irrigator device
- Laparoscopic Kittner
- 5 mm titanium clip applier, medium (two are always kept in room)

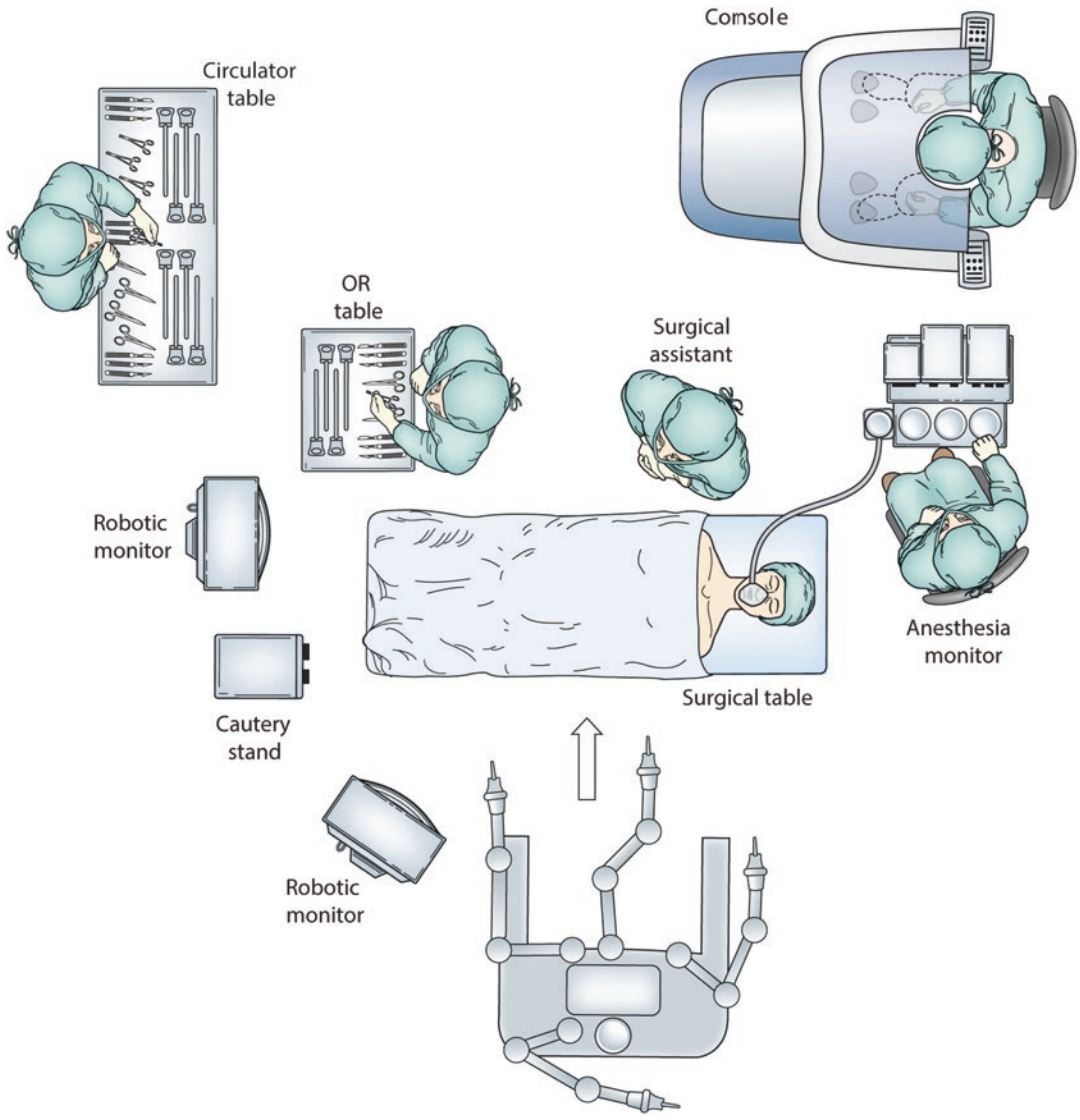

Fig. 30.2 Operating room setup for left partial nephrectomy demonstrating standard configuration of operating room personnel and equipment

Step-by-Step Technique (Video 30.1)

Step 1: Abdominal Access and Trocar Placement

For a right partial nephrectomy, reposition the patient in a right modified flank position as noted above then, for trocar placement, rotate the table so the patient's abdomen is 0°. The 12 mm camera trocar is placed in the area of the umbilicus, using the Hasson open technique with 2-0 polyglactin suture on a UR-6 needle or a 3-0 polyglactin suture on a CT-2 needle bent accordingly. These are pre-placed fascial box stitches (used later for closure). Working trocars are then placed sharply under direct vision after pre-placing the fascial box stitches. For right-sided operation, a fourth trocar is placed for liver retraction. This trocar is

Fig. 30.3 Patient positioning shown for a left partial nephrectomy

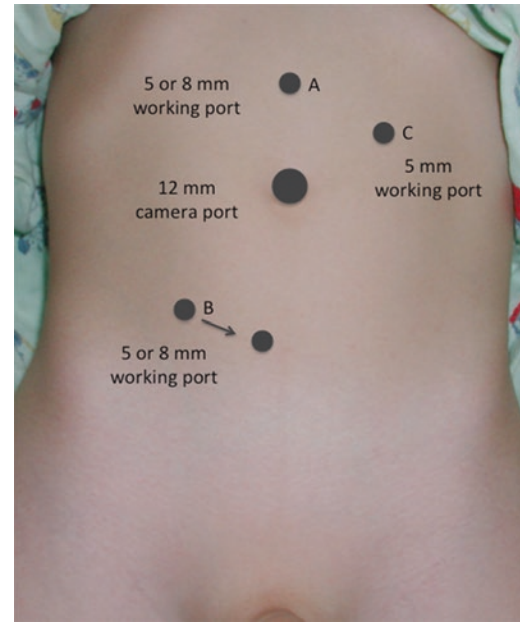

Fig. 30.4 Trocar configuration for right partial nephrectomy. (*A*) Working port is roughly half the distance between the umbilicus and the xiphoid. (*B*) Working port is roughly 2/3 the distance between the umbilicus and the anterior superior iliac spine (ASIS), but if the area of interest is in the lower retroperitoneum or the child is small, may be adjusted medially and inferiorly. (*C*) Working port is for retraction of the liver

placed in the left upper quadrant to permit passing between the camera and upper working trocar without interference and to lift the liver for exposure. Either a blunt Kittner dissector or a grasping tool is passed under the liver edge, lifted and pushed against the opposite abdominal sidewall to stabilize the instrument and liver. Rotate the patient to approximately 60° (30° from table rotation and 30° from the wedge placed earlier) and dock the robot.

Step 2: Accessing the Nonfunctioning Moiety (Table 30.1)

Reflect the colon away from the renal hilum and upper pole to permit full exposure of the upper aspect of the kidney (for upper pole partial) A hitch stitch can be placed through the abdominal wall to the upper pole for better exposure and retraction (Fig. 30.6). Expose the affected ureter at the lower pole of the kidney and separate it from the lower pole ureter carefully (Fig. 30.7).

The dilated upper pole ureter is then dissected upward and under the hilar vessels with care. It must be sufficiently mobilized to permit being passed under the vessels.

Step 3: Transection of Ureter and Vessels to Nonfunctioning Pole (Table 30.2)

Once mobilized, the ureter is ligated with polyglactin suture unless markedly dilated. If maintained somewhat distended, future dissection will be easier. The affected ureter is then transected between sutures and mobilized under the vessels and used to expose the upper pole. This permits better identification of the upper pole vessels and subsequent control. Vessels supplying the upper pole may be clipped or ligated with silk suture (Fig. 30.8). It is important to assess the effect of vessel ligation each time and make sure there are no lower pole

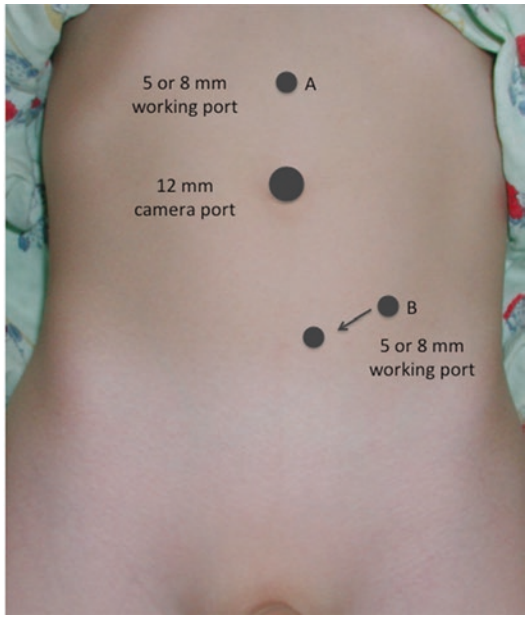

Fig. 30.5 Trocar configuration for left partial nephrectomy. (*A*) Working port is roughly half the distance between the umbilicus and the xiphoid. (*B*) Working port is roughly 2/3 the distance between the umbilicus and the anterior superior iliac spine (ASIS), but if the area of interest is in the lower retroperitoneum or the child is small, may be adjusted medially and inferiorly

Table 30.1 Accessing the nonfunctioning moiety: surgeon and assistant instrumentation

Surgeon instrumentation		Assistant instrumentation
Right arm	Left arm	• Suction-irrigator • Laparoscopic Kittner
• Monopolar hook electrocautery	• Maryland dissector	
Endoscope lens: 30° down		

collaterals being clipped. If multiple vessels are encountered, individual suture ligation may be preferable to avoid dislodging clips.

Step 4: Dissection of Nonfunctioning Moiety (Table 30.3)

Once the vessels and ureter are controlled, the affected upper pole is dissected free by establishing

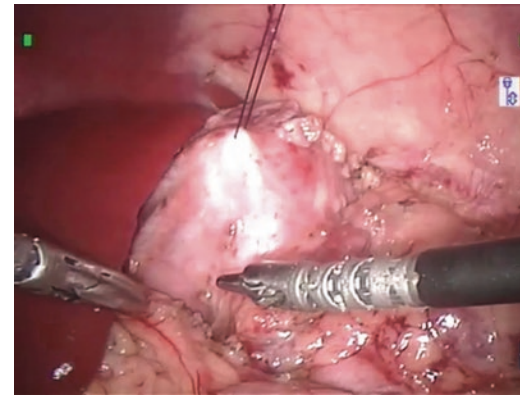

Fig. 30.6 Exposure of the upper pole collecting system using a hitch stitch to lift and stabilize the upper pole

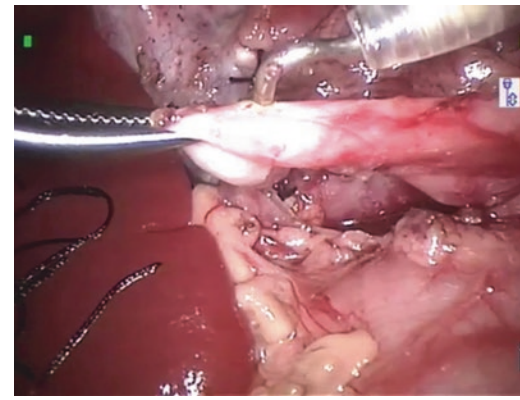

Fig. 30.7 Dissection of upper pole (UP) ureter at the level of the lower pole and moving superiorly to the hilum and under the renal vessels

the plane between the upper pole collecting system and the lower pole parenchyma. This usually leaves a rim of tissue that is easily transected with electrocautery (Fig. 30.9). The collecting system should be removed as completely as possible to avoid a post-operative urinoma (Fig. 30.10).

Step 5: Closure of Defect (Table 30.4)

Once the affected pole is removed, the defect is closed using 2–3 polyglactin mattress sutures over a bolster of local fat (Figs. 30.11 and 30.12). If the lower pole collecting system is violated, it

Table 30.2 Transection of ureter and vessels to nonfunctioning pole: surgeon and assistant instrumentation

Surgeon instrumentation		Assistant instrumentation
Right arm	Left arm	• Suction-irrigator • Laparoscopic Kittner • Laparoscopic needle driver
• Needle driver • Round tip scissors	• Maryland dissector	
Endoscope lens: 30° down		

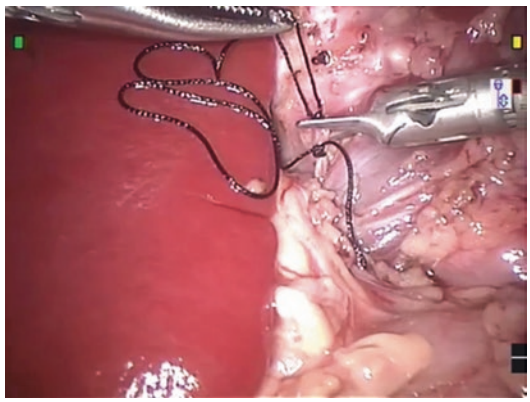

Fig. 30.8 Ligation of the upper pole vessels. Silk sutures are being used with these multiple small vessels to avoid dislodging vascular clips

Table 30.3 Dissection of nonfunctioning moiety: surgeon and assistant instrumentation

Surgeon instrumentation		Assistant instrumentation
Right arm	Left arm	• Suction-irrigator • Laparoscopic Kittner
• Monopolar hook electrocautery	• Maryland dissector	
Endoscope lens: 30° down		

is closed and a drain is left in place; otherwise, there is no drain used. While it may be acceptable to leave the defect open, there seems to be a relationship with developing post-operative urinomas when the defect has not been closed. These may not cause clinical problems, but are always of concern to families. Whenever possible, the defect is closed in a manner similar to what was performed with open procedures.

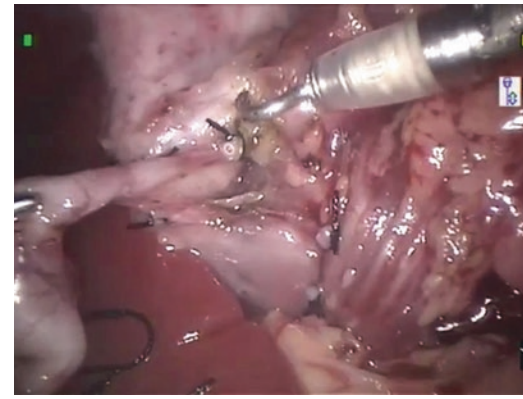

Fig. 30.9 Dissection of upper pole collecting system. The hook cautery or hot shears can be used to incise the rim of renal parenchyma of the upper pole

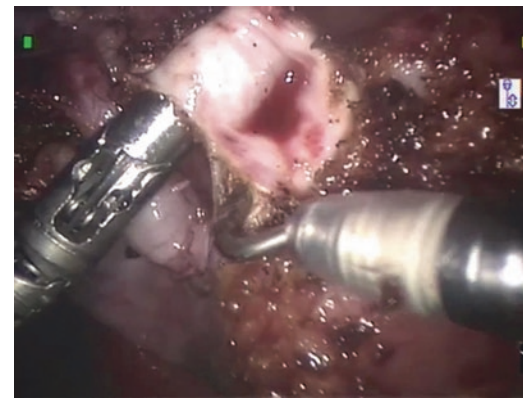

Fig. 30.10 Removal of the upper pole collecting system sitting on top of the lower pole

Table 30.4 Closure of defect: surgeon and assistant instrumentation

Surgeon instrumentation		Assistant instrumentation
Right arm	Left arm	• Suction-irrigator
• Needle driver • Round tip scissors	• Maryland dissector	• Laparoscopic Kittner • Laparoscopic needle driver
Endoscope lens: 30° down		

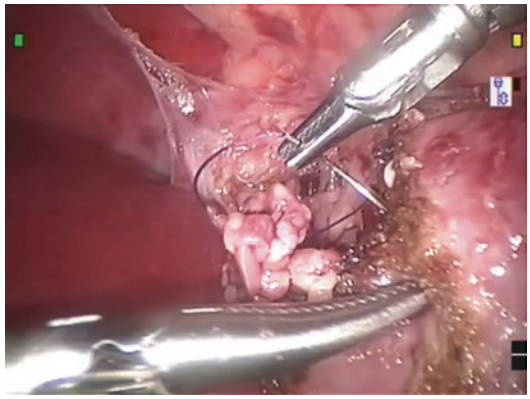

Fig. 30.11 Closure of renal defect by suturing a bolster of retroperitoneal fat into the defect and secured using mattress sutures of PDS

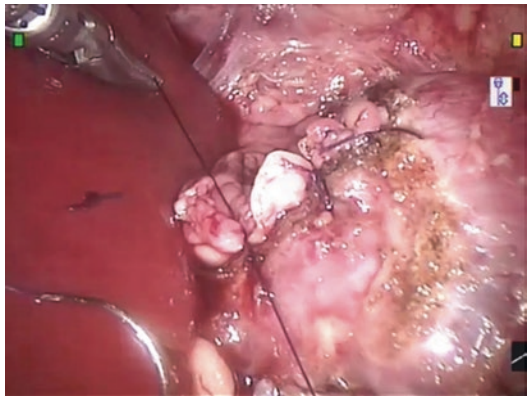

Fig. 30.12 Appearance of the closed defect on the upper aspect of the lower pole of the kidney

Step 6: Further Dissection and Removal of Affected Ureter (Table 30.5)

The affected ureter is resected as low as convenient, which is usually to the iliac vessels. It is tied off with polyglactin suture if refluxing (clips are not secure), or left open if obstructed without reflux (Fig. 30.13). If refluxing and obstructed, it should be ligated as close to the bladder neck as possible. This may require re-positioning the robot.

Table 30.5 Further dissection and removal of affected ureter: surgeon and assistant instrumentation

Surgeon instrumentation		Assistant instrumentation
Right arm	Left arm	• Suction-irrigator • Laparoscopic Kittner • Laparoscopic needle driver
• Monopolar hook electrocautery • Needle driver • Round tip scissors	• Maryland dissector	
Endoscope lens: 30° down		

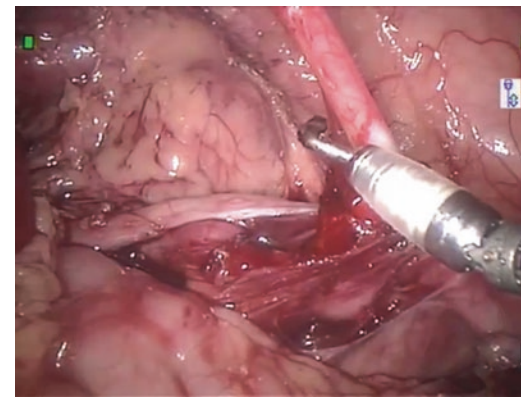

Fig. 30.13 Resection of affected ureter. Resection is performed by lifting ureter as shown here, and progressively releasing attachments with hook electrocautery. The ureter can usually be taken to just below the iliac vessels without difficulty

Step 7: Exiting the Abdomen

The operative area is irrigated, cleared, and inspected. The robot is undocked. Trocars are removed under direct vision. The two specimens (nonfunctioning moiety and ureter) are removed through the umbilical trocar. Preplaced fascial box stitches are tied, and a subcuticular Monocryl suture is used for skin closure.

Post-operative Management

Post-operatively, the patient is placed on 1.5× maintenance fluids, usually D5 ½ NS. A clear liquid diet is started on the operative day with

orders to advance as tolerated. Perioperative antibiotic (usually cefazolin) is continued for 24 h. Pain control includes morphine (0.1 mg/kg IV) every 3–4 h p.r.n. pain as well as Tylenol® with codeine elixir (0.5–1 mg/kg po) every 4 h p.r.n. pain. The urethral catheter is removed prior to leaving the operating room. If a drain is placed, it is monitored to ensure low output and is then usually removed on the morning of post-op day 1. Most patients are ready for discharge by midday on post-op day 1.

Special Considerations

Lower pole partial nephrectomy is performed in a similar manner, usually for lower pole reflux with nonfunction. The ureter is more easily controlled, but similar care must be taken to avoid upper pole vessel injury. Some authors use a ureteral catheter in the remnant pole to inject blue dye to identify collecting system leaks, but we have not found this to be necessary. The ability to efficiently close the polar defect has eliminated the occurrence of urinomas that have been reported in laparoscopic partial nephrectomy when the polar defect is not closed [2].

Handling of the distal ureter is based on practicality in terms of the extent of resection. Some authors claim it is important to remove as much as possible, but there are few reports to indicate a real risk of complications with the exception of a refluxing and obstructed segment. If it is felt that entire removal of the ureter is needed, or if it is necessary to perform a contralateral anti-reflux operation, the robotic system is re-docked in the lower position for bladder access and the dissection performed.

Post-operative follow-up involves a renal ultrasound at 4–6 weeks to ensure that the remnant pole is not obstructed in any way and that there is no urinoma. The vascular integrity of the lower pole can be assessed using Doppler flow and there is no need for a renal scan unless there is specific concern for injury. In the few reports where remnant pole injury has been demonstrated, patients presented with clear clinical symptoms of pain or fever.

The presence of a urinoma is best managed with reassurance and monitoring [3]. There is little chance it will become symptomatic. In one instance, a post-operative urinoma was aspirated to calm the family but it rapidly recurred, only to eventually resolve spontaneously.

Steps to Avoid Complications

The most significant complication for partial nephrectomy in children with duplication anomalies is injury to the lower pole, usually through vascular injury or spasm [4]. Great care must be taken to minimize manipulation of the hilar vessels and to carefully identify the vessels associated with the affected pole. They may be small and branched or a single vessel. Observation of the color of the remnant pole is useful to avoid inadvertent clamping of the remnant vessels. Vessels can be tied or clipped. Papaverine solution can be instilled through a long laparoscopic needle if spasm is evident.

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