10 Robotic Assisted Laparoscopic Complete and Partial Nephrectomy in Children

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10.1 Introduction

The current gold standard for pediatric complete and partial nephrectomy is the open surgical approach. Despite its short surgical times and excellent long-term outcomes, the open surgical approach has historically been associated with increased hospital stays and morbidity. The open approach often requires the patients to be on high doses of narcotics for postoperative pain management. This, in turn, has led to increased postoperative complications of refractory pain and constipation, which could potentially lead to readmission for their treatment. Laparoscopy provides an alternative approach in performing complete and partial nephrectomy. This approach is associated with less pain, shorter hospitalization, and more rapid recovery time compared to its open counterpart. However, laparoscopy is technically more demanding, leading to potentially higher rates of intraoperative complications, surgical time, and costs.

Approved by the Food and Drug Administration in 2000, the da Vinci surgical system provides a means of decreasing the technical demands of laparoscopy. The robotic system provides a three-dimensional, stable visualization of the surgical field, eliminates the counterintuitive movement associated with conventional laparoscopy, and provides fine control of the laparoscopic instruments. However, it is associated with significantly higher equipment/instrumentation costs compared to that of the open and conventional laparoscopic approach. Recognizing its advantages in reducing the technical complexities associated with laparoscopy, proponents of robotic assisted laparoscopic surgery (RALS) utilized this approach for more complex surgeries [1]. The application of robotic technologies to urologic procedures has been rapidly adopted in the management of adults, while in children its use has lagged behind. Currently, it is not known if in children RALS can become the gold standard for total nephrectomy due to its persistently higher cost. In contrast, for partial nephrectomy, which has a higher degree of technical complexity compared to the more straightforward complete nephrectomy, RALS could potentially become the gold standard of care [2].

10.2 Indications

In children, the indications for complete and partial nephrectomy are more commonly related to benign diseases rather than from malignancies. Obstruction (such as ureteropelvic junction or ureterovesicular junction), vesicoureteral reflux, multicystic dysplasia, and recurrent urinary tract infections (specifically from pyelonephritis) may result in a nonfunctioning or poorly functioning renal unit

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that in the long term may lead to hypertension and significant proteinuria [3]. It is generally recommended that kidneys with relative renal function less than 10% as measured on DMSA scan should be removed. In determining whether renal units associated with a duplicated collecting system should be removed or reconstructed, there is not a consensus on a threshold amount of renal function required. More often, a subjective decision is based on the amount of renal parenchyma seen on ultrasound (US) and the differential renal function between the upper and lower pole segments.

The decision as to whether to perform the procedure with an open versus conventional laparoscopic versus RALS approach is dependent on numerous factors such as the patient/parental preference, assessment of the relative risks versus benefits of each surgical approach, surgeon's experience and comfort with the various surgical modalities, availability of instruments and equipment, cost/insurance coverage, time available, and accessibility of trained assistants and operating room personnel. When a minimally invasive surgical approach is chosen, the advantages and disadvantages of conventional laparoscopy and RALS must be considered and compared. The principal advantages of RALS include simplification and precision of exposure and suturing; movements of the robotic arm in real time providing an increased degree of freedom in the movement of the laparoscopic instruments; and a magnified three-dimensional view [4]. Other advantages include computer elimination of tremor, increased range of motion at the distal end of the instruments, and improved surgeon ergonomics. As with the conventional laparoscopic approach, RALS epitomizes the idea of minimally invasive surgery with its miniaturized and precise movements that ultimately result in smaller incisions, less blood loss and pain, shorter hospital stays, and quicker convalescence [5].

10.3 Equipment and Instruments

With the da Vinci system, which evolved from the telepresence machines developed for NASA and the United States Army and is the most commonly used equipment, there are essentially three components: a vision cart that holds a dual-light source and two high-definition cameras, a master console where the operating surgeon sits, and a moveable cart, where three instrument arms and the camera arm are mounted [6]. The camera arm contains dual cameras and the image generated is three-dimensional. The master console consists of (1) an image-processing computer that generates a true three-dimensional image with depth of field; (2) the view port where the surgeon views the image; (3) foot pedals used to control electrocautery, camera focus, and instrument/camera arm clutches; and (4) master control grips that drive the servant robotic arms at the patient's side. The instruments are cable driven and provide seven degrees of freedom, mimicking the natural movements of the surgeon's hands, wrists, and arms. The system displays its three-dimensional image above the hands of the surgeon so that it gives the surgeon the illusion that the tips of the instruments are an extension of the control grips, thus giving the impression of being at the surgical site [7].

In performing complete or partial nephrectomy, a very limited number of instruments are required. Dissection can be performed using a forceps, such as a DeBakey or ProGrasp, and a cautery instrument, such as a monopolar curved scissors or cautery hook. In performing a partial nephrectomy, the use of a Harmonic curved shears is very helpful in removing the nonfunctioning renal unit from the rest of the kidney without excessive bleeding. Since in most cases the vascular supply to the nonfunctional renal unit is diminished, a 5 mm vascular clip applier can be used to ligate the renal vessels. A vascular stapler or suture ligation is rarely required. To remove the specimen, it is useful to place the specimen in a laparoscopic bag so that it can be removed easily and intact through the umbilical port.

10.4 Surgical Approach

Much debate has centered on the best laparoscopic approach, transperitoneal versus retroperitoneal. The advantages and disadvantages of both

Table 10.1 Advantages and disadvantages of transperitoneal and retroperitoneal approach

Approach	Advantages	Disadvantages
Transperitoneal	Familiar anatomy	Theoretical risk of postoperative intraperitoneal adhesions
	More working space, especially in young children	
	Can perform concurrent procedures such as extravesical ureteral reimplantation	
Retroperitoneal	Short distance to the kidney	Limited working space and unfamiliar layout of anatomy
	Less risk of subjecting peritoneum to complications such as urine leak, infection, and tumor seeding	Inability to perform total ureterectomy without adjunct inguinal incision
	Less interference from surrounding organs such as the liver, spleen, and bowel	Risk of peritoneal tear and subsequent conversion to open surgery
	Easier exposure to the renal hilum (due to the kidney falling anteriorly with gravity)	Risk of balloon rupture used to develop the retroperitoneal space, which necessitates meticulous retrieval of fragments
	Ureter and pelvis are posterior for easier dissection	
	Theoretical reduction in postoperative intraperitoneal adhesions and easy conversion to lumbodorsal approach	

Modified from Freilich DA and Nguyen HT. Robotic-Assisted Laparoscopic heminephrectomy in Current Clinical Urology: Pediatric Robotic Urology. Editor Palmer JS. 2009. Chapter 10: page 137–172. Humana Press, NY

approaches are listed in Table 10.1. In most instances, the surgeon's preference and comfort with the surgical approach are the prime determinants of which approach is selected.

10.5 Preparation

All patients require a thorough clinical evaluation and a complete discussion of all surgical options, expected outcomes, and potential complications. Unless there is a history of coagulopathy, preoperative blood values are often not necessary. Further, there is no need for considering blood type and cross, but this should be left to the surgeon's preference, experience, and comfort. A complete bowel preparation is also not necessary under most circumstances. However, decompression of the colon with enemas done the evening prior to surgery is often helpful, especially in smaller children in which the abdominal space is limited. For anxious patients, an appropriate dose of anxiolytic may be prescribed prior to surgery. In cases of a duplicated collecting system, placement of a ureteral stent prior to the RALS procedure to identify the normal ureter in partial nephrectomy is often not necessary since the grossly dilated affected ureter sufficiently enables proper identification [8].

10.6 Patient Positioning

One of the most important aspects of the procedure is appropriate patient positioning to prevent inadvertent injury of the patient during the procedure and to allow the robotic equipment to be in the optimal location for proper functioning. Once the patient has been anesthetized and the endotracheal tube is secured in place, a Foley catheter should be inserted, and the patient should be moved into a lateral decubitus position. It is important to bring the patient toward the edge of the table and rotated off the vertical plane at approximately 45°. This will help to prevent the robotic arms from colliding with the table.

Some surgeons prefer to use a beanbag to support the patient's positioning, while others prefer

Fig. 10.1 Patient position for the transperitoneal approach. In this instance, a *left* partial nephrectomy was performed. The patient's *left side* was up, approximately 45° off the bed. The *left arm* was placed straight down the patient's side. Safety straps were placed over the head, shoulder, pelvis, and lower extremities to prevent the patient from moving when tilting the table

the use of gel rolls. The beanbag should be placed on the operative table prior to moving the patient from the transport gurney. The upper aspect of the beanbag or gel rolls should reach just below the patient's neck. The bottom arm should then be placed on an arm board and padded with egg crate foams or pressure point gels. The upper arm should then be secured along the side of the body with appropriate foam padding. Placing the upper arm crossed over the upper chest, as in the conventional lateral decubitus position, may impede the robotic equipment from properly coming over the shoulder and having adequate range of movements without hitting the body. The upper leg should be placed straight while the lower leg crossed with both being carefully padded to prevent pressure injury. This configuration of the lower extremities helps to stabilize the lower body while in the lateral decubitus position. Security straps or, preferably, large fabric tape are used to secure the shoulder, pelvis, and lower extremities to prevent movement when the table is tilted; if a beanbag is used, it should be deflated to fix the patient's position, and then inflated when the proper positioning has been achieved (Fig. 10.1).

Especially in younger children, the head accounts for a significant portion of the body weight. Consequently, the head should also be padded and secured to the table with fabric tape to prevent movement during the procedure. Anesthesia and grounding cables should be placed in such a way to remain clear of the patient and to avoid resting on exposed skin. Finally, some surgeons prefer to raise the kidney rest to provide additional flexion to improve the exposure of the kidney. While this may be important in the open surgical approach to help bring the kidney into the surgical field, it is less important in transabdominal laparoscopic approach.

10.7 Port Placement for the Transperitoneal Approach

In most pediatric cases, RALS complete and partial nephrectomy can be performed with a camera port and two instrument ports. An additional 5 mm assistant port may be helpful for retraction and passing sutures and vascular clips. There are currently two sizes of laparoscopes on the market, 8.5 and 12 mm, and two sizes of robotic instruments, 5 and 8 mm. The previously available 5 mm laparoscope has been discontinued because of its inability to allow for three-dimensional binocular vision [9].

It is often assumed that the smaller laparoscope and instruments are preferable in the pediatric cases. However, it is actually more advantageous to use the 12 mm laparoscope and 8 mm instruments in these cases. The 12 mm laparoscope has much brighter lighting components compared to its 8 mm counterpart. The concern that a larger port is needed for the 12 mm laparoscope is ameliorated by the fact that the excised renal unit could be more easily and safely removed through the larger port site. Moreover, there is a greater variety of 8 mm instruments available compared to the 5 mm instruments, most importantly, the availability of those that provide hemostasis such as cauterizing scissors and Harmonic scalpel. In addition, due to the difference in joint configuration of the 8 and 5 mm instruments, the 5 mm instruments require more of the instrument to be in the abdominal cavity, which is a significant issue in smaller children. Based on personal experience, placement of the larger instrument port needed for 8 mm instruments has not been an issue even in small children.

Once the patient has been prepped and draped in the usual sterile fashion, a semilunar incision is made around the umbilicus. The table should be tilted so that the patient is leveled as much as possible (correcting for the 45° lateral decubitus position). This maneuver will aid in obtaining a 90°, straight access into the abdominal cavity. Some surgeons prefer to obtain access into the peritoneal cavity using the open Hasson technique, while others use a needle system to insufflate the abdomen and then place the port using a self-retracting bladed trocar. Once the camera port is in place and pneumoperitoneum is achieved (approximate pressure 12–14 mmHg in adolescents and 10–12 mmHg in younger children), the laparoscope is placed into the peritoneal cavity, and careful inspection of the abdominal cavity is performed to identify any bleeding or inadvertent vascular, bowel, or organ injuries. The instrument and assistant ports are then placed under direct vision. The robotic trocar ports are used to mark circular indentations in the skin at the preferred port sites; the 8 mm ports will be inserted for the robotic arms and a 5 mm port for the assistant. Local anesthesia is applied to the port insertion sites and then skin incisions are made within the circular indentations. The underlying fascia is widened with a blunt mosquito under direct vision; this method of obtaining port access allows for well-fitted ports and eliminates the need for mooring the ports with sutures to prevent dislodgement.

When placing the ports, the size of the patient is taken into consideration. For older children, the upper instrument port (closer to the head) is placed at midline, approximately 8 cm from the camera port (Fig. 10.2). The lower instrument port is placed in the midclavicular line at a 30° angle (rotated away from midline toward the affected kidney), 6 cm away from the camera port. Finally, a 5 mm assistant port can be placed either in between the upper instrument and the camera port or inferior to the camera port in the midline depending on the

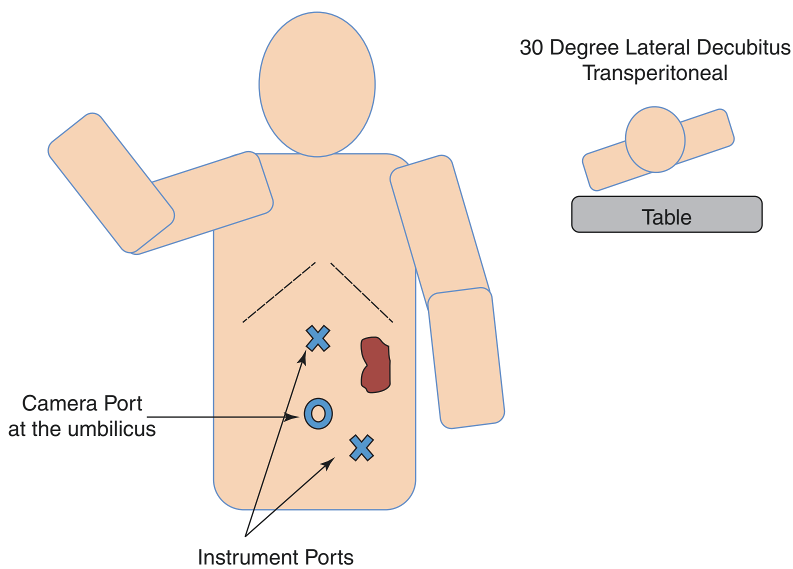

Fig. 10.2 Position of the camera and instrument ports when performing transperitoneal approach with the patient in a 45° lateral decubitus position

size of the patient (Fig. 10.3) [5]. For smaller and younger children, the distance between the camera ports and instruments can be reduced by 2–3 cm. In addition, the lower instrument port may be moved closer to the midline if the width of the abdomen is limited. It should be noted that with the abdomen fully insufflated, there should be ample space to accommodate all the robotic ports even in the smallest children. Once all the ports have been place, the table should be tilted in the opposite direction of the side of the surgery in order for the bowel to fall to a more dependent position in the abdomen, away from the kidney being operated on. The robotic system is then brought over the patient's shoulder, and the ports are clipped onto the robotic arm. It is crucial to line the center robotic arm up with the midportion of the kidney. This can be accomplished by leaving the laparoscope in the abdomen and directly visualizing the kidney while moving the robot into place (Fig. 10.4). This alignment

Fig. 10.3 Location of the accessory working port. In this instance, it is placed between the midline instrument port and the camera port

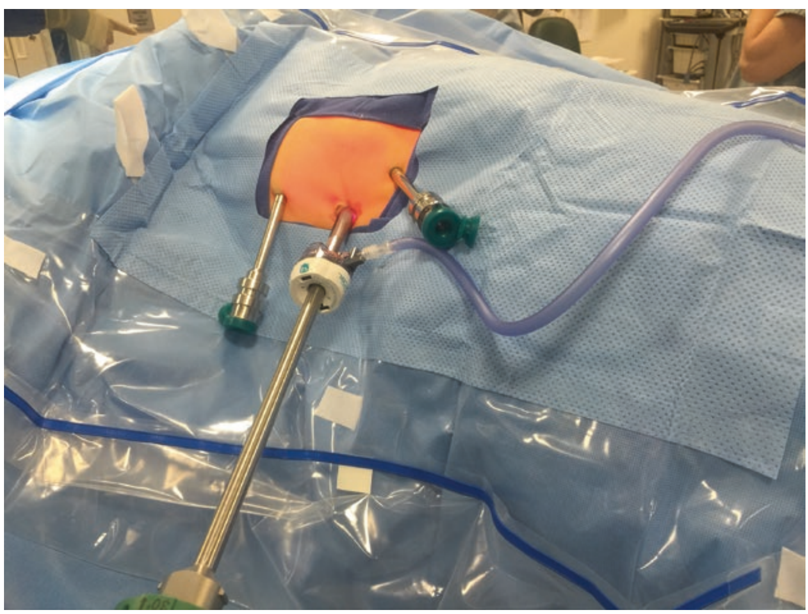

Fig. 10.4 To properly align the robotic system, the camera is *left* in place to visualize the kidney when the robotic system is moved into place. This allows the center robotic arm to be aligned up with the kidney

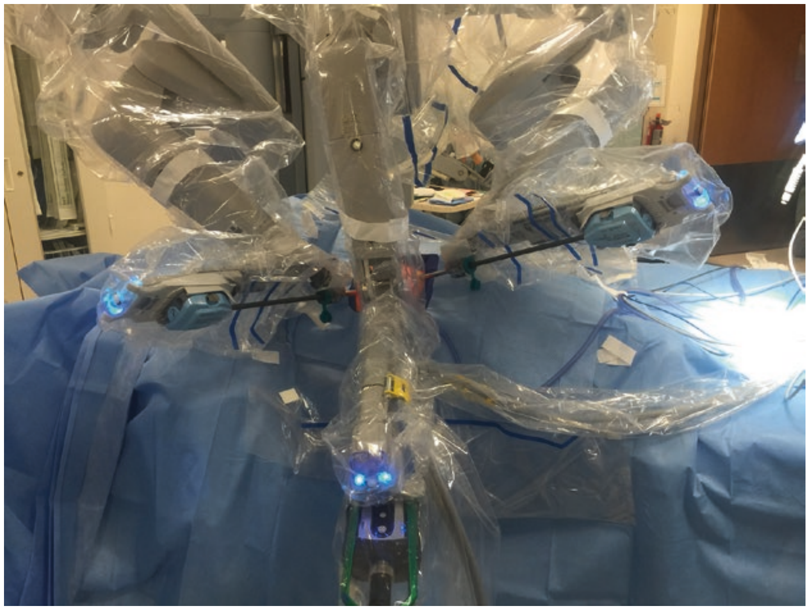

Fig. 10.5 Proper setup of the robotic system with maximal working space between the instrument and camera arms to prevent collision

allows the robotic arms to be in optimal location for proper functioning (Fig. 10.5). Especially in younger children, it is important to lift the ports and robotic arms upward and outward from the abdominal wall to maximize the space available inside the abdominal cavity for the instruments to maneuver (Fig. 10.6).

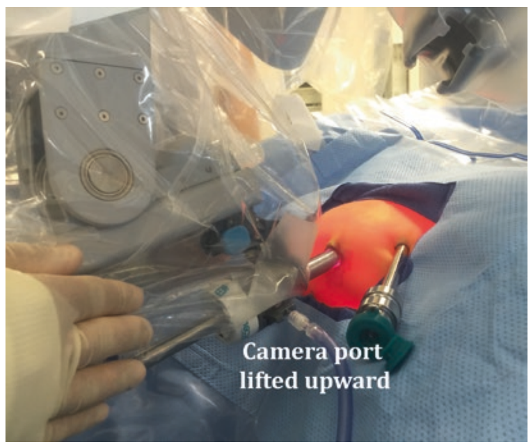

Fig. 10.6 All ports should be lifted up and away from the abdominal wall to maximize intra-abdominal working space

10.8 Positioning and Port Placement for Lateral and Prone Retroperitoneal Approach

For the lateral retroperitoneal (RP) approach, the patient is positioned on the operating table laterally with flexion to facilitate trocar placement between the last rib and iliac crest (Fig. 10.7). The camera port is placed 3 cm below the 12th rib. The Gerota fascia is approached with a muscle-splitting technique via blunt dissection along the lumbodorsal fascia. An anchoring suture is placed to secure the port, allowing it to pull back and tent the skin in order to increase the retroperitoneal working space. The working space is developed either with gas insufflation, balloon dilator, or blunt finger dissection. The first instrument port is placed posteriorly in the costovertebral angle and the second along the anterior axillary line 10 mm superior to the iliac crest.

For the prone RP approach, the patient is placed in the prone position (Fig. 10.8). The camera port is inserted laterally along the posterior clavicular line, just above the iliac crest. The first instrument port is placed at the costovertebral angle at the edge of the paraspinous muscles and the 12th rib, and the second port is placed medial to the paraspinous muscles, just above the iliac crest.

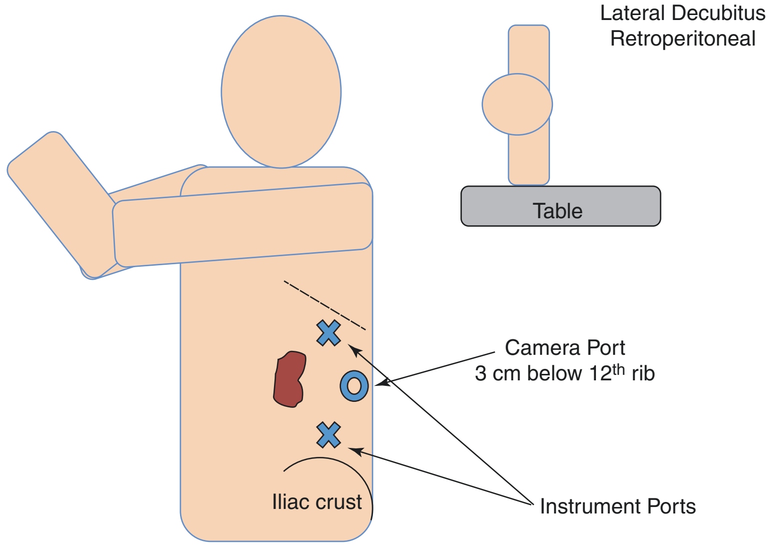

Fig. 10.7 Position of the camera and instrument ports when performing retroperitoneal approach with the patient in a lateral decubitus position

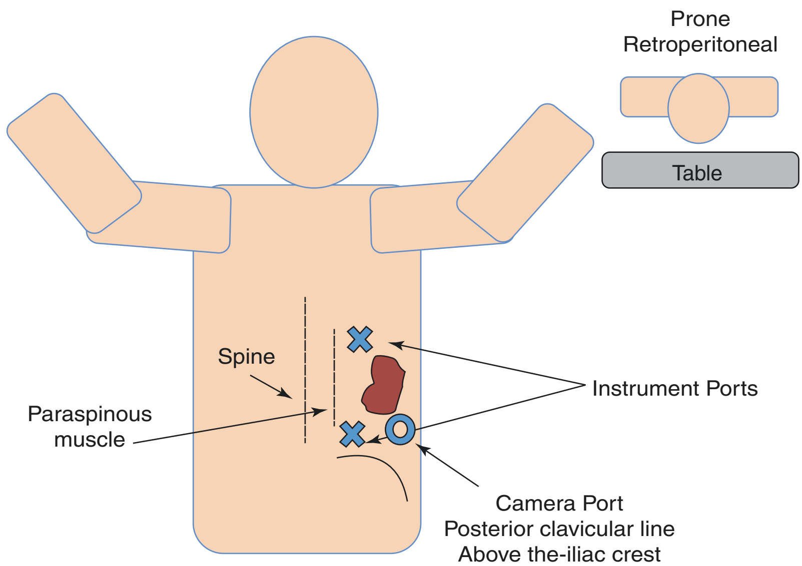

Fig. 10.8 Position of the camera and instrument ports when performing retroperitoneal approach with the patient in a prone position

10.9 General Technique for Transperitoneal Approach

In performing the complete or partial nephrectomy, it is important to maximally tilt the table away from the side of the affected kidney. This allows the bowel to fall into a more dependent position on the downside of the abdomen, thus increasing the available abdominal space for unrestricted movement of the robotic instruments. It is important to first take down the splenic (for left-sided surgery) or the hepatic flexure (for right-sided surgery), and then carry the dissection along the white line of Toldt to the pelvic brim in order to efficiently mobilize the large bowel away from the kidney. Some surgeons prefer to avoid this step and operate through a mesenteric window. Since the hilum is often difficult to directly visualize due to the surrounding fat tissue, it is often easier to identify the ureter near the pelvic brim and, using the ureter as a landmark, to advance the dissection superiorly toward the renal hilum. Of note, it is helpful to avoid initially dissecting laterally to the kidney and releasing the kidney from the lateral abdominal wall. Instead, this should be done last, in order to prevent the kidney from flopping over the hilum and obscuring it.

Dividing the ureter and using it as a handle will provide traction and facilitate the dissection around the hilum as well as the identification of the renal artery and vein. When performing a partial nephrectomy, it is important to trace the ureters to their corresponding renal units. For a nonfunctioning upper pole system, the upper pole ureter should be dissected free from the surrounding tissues and then divided. The ureteral stump is then passed below the lower pole renal hilum and then re-grabbed from above. It can then be used to facilitate the dissection of the upper pole hilum. After ligating its vasculature, the upper pole parenchyma can be removed with a Harmonic curved shear. Using this instrument will help to reduce bleeding. Careful attention should be paid to avoiding the collecting system of the lower pole. If the collecting system is violated, suture closure with absorbable sutures such as Chromic or Vicryl can be performed, which can be expediently done using the robotic system.

Cauterizing the bed that remains following the excision of the upper pole will help to destroy any residual functioning renal tissue. In addition, perinephric fat should be placed into this area. These maneuvers, in addition to the application of a sealing agent such as fibrin glue (from personal experience), can help to reduce the chance of developing a urinoma in this area postoperatively. After carrying out the complete or partial nephrectomy, the hilum should be observed at a low abdominal pressure (approximately 5 mmHg) to make sure that there is no venous bleeding. In dealing with the remaining distal ureteral stump, if the pathology is from an obstructive process then the remnant ureter should be left open; if the pathology is from vesicoureteral reflux then the remnant ureter should be ligated.

10.10 Removal of Specimen

Once the nonfunctioning renal unit is removed from the functional portion of the kidney, or, in the case of total nephrectomy, the kidney is isolated from the renal hilum and hemostasis is obtained, the robotic telescope is removed from the 12 mm port and a smaller laparoscope is introduced through one of the 8 mm ports. The pneumoperitoneum tubing is then attached to one of the smaller ports. Under direct visualization, the laparoscopic specimen bag is placed through the 12 mm port and into the surgical field (Fig. 10.9). The specimen is maneuvered into the

Fig. 10.9 The laparoscopic specimen bag was placed through the 12 mm camera port. The string is *left* outside in order to retrieve the bag

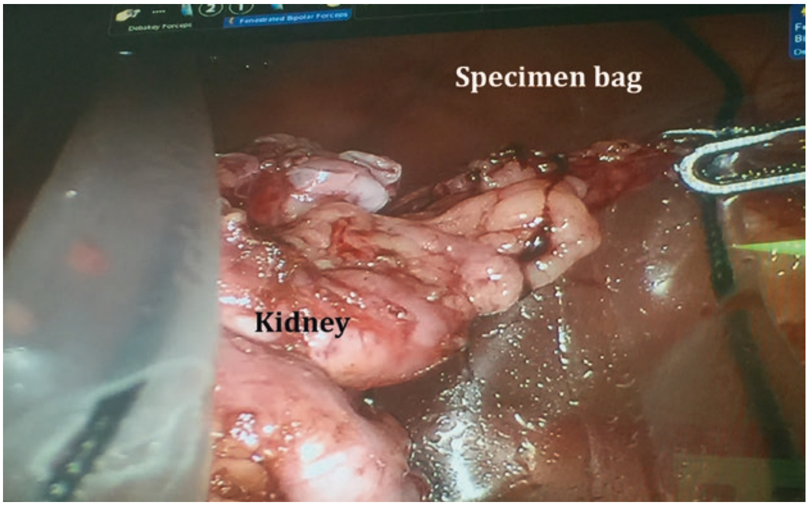

Fig. 10.10 The specimen is maneuvered into the specimen bag

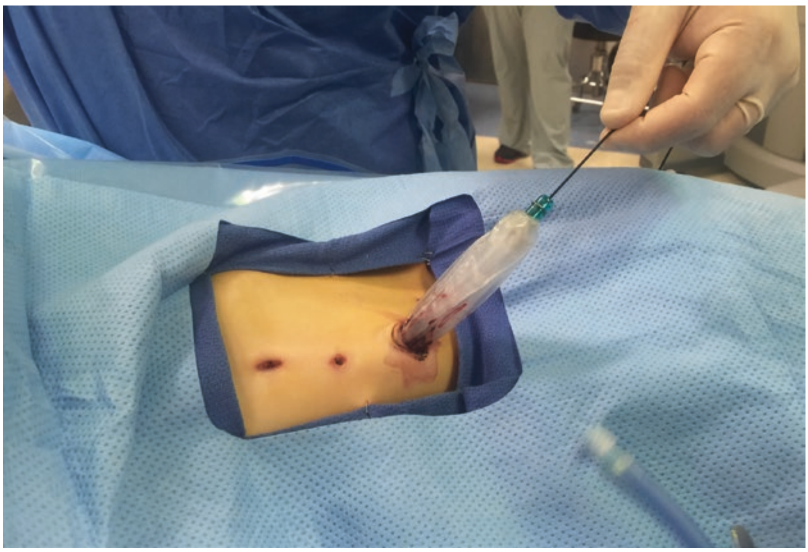

Fig. 10.11 The laparoscopic specimen bag is removed through the umbilical incision after removing the camera port

specimen bag with the forceps (Fig. 10.10). The laparoscopic bag is closed and removed through the 12 mm port site (Fig. 10.11).

The surgical field should be surveyed one last time to ensure that no damage has been caused to surrounding viscera and proper hemostasis has been obtained. Irrigation may be used to check for small areas of bleeding and for better visualization of sutures and staples that were applied. Once the field has been assessed and there are no other concerns to address, the robotic arm is disengaged from the 12 mm port site and the robot is pushed away from the field. The smaller laparoscope is returned and the remaining trocars are removed under direct visualization to ensure that there is no other bleeding from the port sites. When all ports have been safely removed, the field is prepared for closure of the port sites and completing the procedure.

10.11 General Technique for Retroperitoneal Approach

Since there are no overlying bowel or organs, the kidney and ureter are easily identified in this approach. The renal hilum can be identified anterior to the renal pelvis. The ureter should be transected to help manipulate the kidney. After ligation of the hilum and isolation of the nonfunctioning segment of kidney, the specimen can be removed through the larger 12 mm camera port. A Penrose drain in the surgical bed is recommend since there is limited fluid absorptive ability of the retroperitoneum as compared to the transperitoneal approach.

10.12 Postoperative Care

In most cases, a regular diet can be resumed, usually within 4 hours, despite the transperitoneal approach. In the management of pain, narcotics should be avoided in order to decrease the risk of an ileus. Instead, nonsteroidal anti-inflammatory drugs such as ketorolac, acetaminophen, and ibuprofen should be encouraged. Removing the Foley catheter early (either later in the evening following the completion of the procedure or the next morning) will help to decrease bladder spasms and encourage early ambulation. Obtaining a follow-up CBC the next day is left to the discretion of the surgeon, but is not mandatory. The patients are discharged on post-op day one when tolerating a diet, afebrile with no signs of wound infection, and are able to void. In some cases, such as simple nephrectomy, same-day discharge may be considered. A follow-up ultrasound is performed at 1 month postoperatively to assess for complications such as a hematoma or urinoma and evaluation of the remnant renal units.

10.13 Complications

There are few complications specific to performing RALS. Technical problems such as non-overridable fault and instrument failure may require conversion to conventional laparoscopy or open surgery. When performing any type of laparoscopic intraperitoneal procedure, there is a low risk of serious complications such as bowel perforation, trocar or needle trauma to major blood vessels, thermal injury from coagulation elements, splenic or liver injuries, and pneumothorax. Specific to partial nephrectomy, hematoma or urinoma and their potential for infection may occur postoperatively. In the majority of the cases, these complications are self-limiting and do not require intervention. However, urinoma may require an extensive amount of time before resolving. Inadvertent injury of the remnant renal unit may occur but this complication is uncommon.

10.14 Current Literature

It has been well demonstrated that RALS procedure in general is safe in children [10–12] and has greater efficiency and safety over standard laparoscopic approach [13]. A review of the most up-to-date published literature on RALS complete and partial nephrectomy reveals that there are a limited number of studies in the pediatric population compared to the more extensive body of literature in adults. Currently, there are no studies available to support the notion that RALS is a superior modality to laparoscopic or open surgical procedures in children. However, RALS and conventional laparoscopic approach are associated with shorter hospital stay with RALS (decreased by approximately 1 day), less blood loss, and decreased use of narcotics for postoperative pain control. On the other hand, these approaches are associated with an initial increase in operative time, which decreases with experience, and a significant increase in operative cost (especially with RALS).

When comparing conventional laparoscopy with RALS, the role of RALS has been more clearly established in reconstructive procedures such as pyeloplasty and ureteral reimplantation, while its role in extirpative surgery such as nephrectomy remains unclear. However, the use of RALS may serve as a learning procedure in preparation for performing more complicated reconstructive cases. Inarguably, performing a laparoscopic partial nephrectomy is technically more demanding than performing a complete nephrectomy. Consequently, the application of RALS in accomplishing this procedure has been more widely adopted and hence more reported in the literature.

In review of the over 30 articles with information on pediatric partial nephrectomy, some common observations can be identified. Comparing transperitoneal (TP) versus retroperitoneal (RP) approach, most surgeons preferred TP to RP approach due to more working space and the ability to excise the ureter completely [9]. TP was the best approach when a total ureterectomy was needed or when the child was less than a year old [14] or in small children because it provided greater working space and hence less risk of damage to the functional renal unit when performing a partial nephrectomy [15]. Some surgeons have noted that the RP approach was limited in space to properly visualize the hilum and distal ureter in infants [16]. RP approach may be best utilized for complete nephrectomy in children greater than 2 years of age [17].

In a study of 48 children who underwent RAL partial nephrectomy, Castellan et al. observed three complications out of 32 patients with the TP approach and three out of 16 with the RP approach; 80% of complications involved children less than 1 year of age [14]. In the TP approach, these complications included pneumothorax secondary to diaphragm perforation, postoperative hypertension requiring pharmacological treatment, and recurrent UTI requiring excision of a remnant ureteral stump left after RALS partial nephrectomy. In the RP approach, there was a peritoneal tear, which necessitated conversion to TP, conversion to open surgery due to scarring of the affected pole and anterior pole vasculature, postoperative urine leak, and postoperative urinoma. In another study of 22 children who underwent RP upper (18) versus lower (4) pole heminephrectomy, Wallis observed associated complications including converting to open due to peritoneal tears, the inability to develop adequate pneumoperitoneal space with which to work, postoperative urine leakage, aspiration of seroma, and fever [15]. The author suggested that the RP approach is preferable to the TP approach because it more closely resembles the open surgical technique. However, the TP approach may be more appropriate in smaller children because it offers more working space and potentially decreased risk of damage to the residual moiety.

In a randomized study of 19 children, Borzi examined posterior RP versus lateral RP approach in performing RALS partial nephrectomy [18]. The authors found that in children 5 years of age and older, the posterior RP was less favorable when compared to lateral RP since posterior RP approach did not provide for a more complete ureteral excision. However, the posterior RP provides superior vascular control.

There are many disadvantages associated with RALS. The use of the daVinci robot system is limited by its cost for many institutions. While most fellowship trained pediatric urologists are comfortable in the utilization of the robotic assisted technique, the modality remains a daunting task for more seasoned pediatric urologists to undertake. Additionally, when compared to RALS, the argument can be made that the open technique takes less time, has fewer complications, and can have the patient discharged from the hospital in little more than an extra day of recovery. However, with time, experience, increased comfort, and improved technique in using the robotic system, patient outcomes can be improved. RALS partial nephrectomy is superior to traditional open surgery in regard to cosmesis, postoperative length of hospitalization, and narcotic utilization [8]. Ultimately, many factors will have significant impacts on the future of RALS, namely, cost of the robotic system and the comfort level of the hands and eyes performing the surgery behind the console and not at the operative field. However, additional clinical experience is required to determine the long-term efficacy of this method. As there are many surgical techniques available that do not offer a conclusive endorsement, the best modality is that which the specialist is most comfortable.

Conclusion

Although it is not yet possible to demonstrate the superiority of one single surgical modality over another, RALS has been shown to be feasible, well tolerated, and advantageous in reconstructive urological procedures [19]. With increased experience, the surgeon utilizing the robotic approach will significantly decrease the operative time for RALS; this will, in turn, decrease the overall cost involved in using the robot. Furthermore, with the added benefits of precision of exposure and suturing in a magnified three-dimensional view and improved cosmesis, RALS may become the modality of choice for pediatric partial and, potentially, complete nephrectomy.

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