Difficulties in Transperitoneal Laparoscopic Radical Nephrectomy

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Laparoscopic radical nephrectomy has gained widespread acceptance as the standard of care for localized renal cell carcinoma. Since its inception, the technique has continued to evolve and, therefore, it is not surprising that variations in technique exist.

Relative contraindications to laparoscopic radical nephrectomy include vena cava thrombus, bulky adenopathy, locally invasive tumors, and significant cardiopulmonary disease. Uncorrected coagulopathy is an absolute contraindication to laparoscopic nephrectomy.

Complications from laparoscopic transperitoneal nephrectomy (e.g., bowel injury, barotraumas) are discussed elsewhere in this book. The aim of the present chapter is to detail difficulties encountered intraoperatively and to provide practical methods on how they can be resolved. Each step of radical nephrectomy is described and potential difficulties dealt with.

Patient Positioning

The patient is positioned in a modified flank position with all pressure points padded. While the patient should be positioned over the break in the bed and the table flexed, excessive flexion is not required and may potentially increase the risk of rhabdomyolysis, especially in obese patients.

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A. Al-Kandari et al. (eds.), *Difficult Conditions in Laparoscopic Urologic Surgery*,
https://doi.org/10.1007/978-3-319-52581-5_7

Access

A number of different approaches with regard to radical nephrectomy have been devised. In general this includes between three and five ports: one camera port, two working ports, one assistant port for retraction/elevation, and one port for liver retraction. Access can be obtained either by using a Veress needle or an open Hassan technique. If using a Veress needle, prior to insufflation, a drop test, aspiration, and advancement test should be performed. Correct placement is confirmed under conditions of low flow of insufflant, low intraabdominal pressure (generally less than 8 mm Hg), and uniform abdominal distension.

If blood can be aspirated upon insertion of the Veress needle, raising concern of great vessel injury, the veress needle should be closed and left in place in order to identyfy the site of injury. A laparoscopic or open technique can be used to inspect the site of injury. Observation may be elected if there is a non-expanding henatomec. In general, if uncertainty exists with regard to Veress needle placement, an open Hassan technique should be performed.

In order to avoid injury to the epigastric artery, trocars should, in general, be placed either in the midline or lateral to the rectus muscle.

Bowel Mobilization

The line of Toldt is incised and the colon is mobilized medially to expose the kidney. On the right side, the duodenum is Kocherized and the liver is elevated and retracted cranially using a liver retractor or a grasper attached to the abdominal side wall. On the left side to provide optimal exposure, the pancreas and spleen must be mobilized medially. The lienorenal, phrenicocolic, and splenic attachments to the diaphragm should be divided so that the spleen is able to fall away medially with the aid of gravity.

When performing bowel mobilization, care should be taken to avoid injury to the duodenum or liver on the right side, and to the pancreas and spleen on the left side. Minor bleeding from the spleen or liver can be controlled by using argon beam coagulation or by applying compression with any of a number of hemostatic agaents. If an especially severe splenic laceration is noted, splenectomy can be considered with appropriate vaccinations administered prior to hospital discharge.

Difficulties with bowel mobilization consist initially of lysis of adhesions. Using a laparoscopic bowel grasper to provide gentle traction, adhesions are divided using cold scissors. Adhesions should be divided as close as possible to the peritoneal wall to avoid inadvertent bowel injury.

Attention is then turned to mobilization of the colon regardless of the side of nephrectomy. This is performed by identifying the lateral edge of the colon and dissecting this from the Gerota's overlying the kidney and ureter. A common mistake is to begin dissection lateral to the kidney. The lateral attachments of the kidney should be maintained until much later in the procedure in order to allow for optimal hilar exposure.

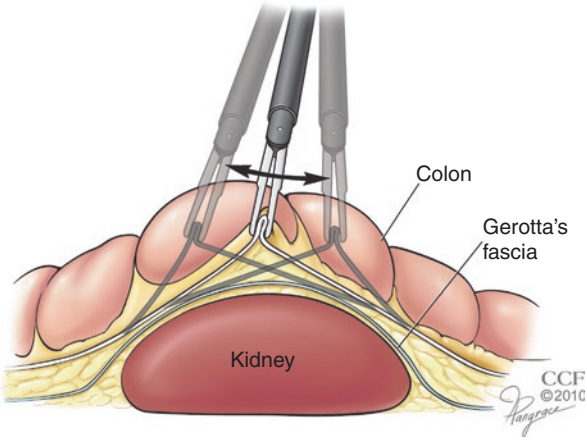

Fig. 7.1 Identifying the correct plane between the mesentery of the bowel and Gerota's fascia. This is performed by recognizing a difference in color and texture between the perirenal fat and the bowel mesentery. This is easier to appreciate by grasping the bowel mesentery using laparoscopic graspers and pulling the mesentery in an anteromedial direction (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2010. All Rights Reserved)

Identifying the correct plane between the mesentery of the bowel and Gerota's fascia can be difficult (Fig. 7.1). This is performed, however, by recognizing a difference in color and texture between the perirenal fat and the bowel mesentery. Additionally, the correct plane should be relatively avascular. Using a laparoscopic grasper, the bowel mesentery is grasped and pulled anteromedially in order to expose the plane of dissection. If significant bleeding is encountered, this is usually indicative that one is dissecting within an improper plane and one is within the bowel mesentery.

Identification of full-thickness bowel injury is critical. If this is noted, consideration can be given to primary repair in two layers with permanent sutures. It is the authors' standard practice to ask for an intraoperative general surgery consultation in this event. If there is only an injury in the serosal layer, oversewing with permanent suture should be performed.

Identification of the Ureter

The ureter is located anterior to the psoas muscle within the lower pole cone of Gerota's fat. The identification of the gonadal vein is a reliable landmark as the ureter will lie posterior and lateral to this vein. The ureter is isolated and traced superiorly to the renal hilum.

At times, especially when a lot of retroperitoneal fat is present, isolation of the ureter can be difficult. In such instances one should proceed by first identifying the psoas muscle and then the gonadal vein. The ureter will lie anterior to the psoas muscle and posterior to the gonadal vein. If uncertain, the ureter can be

differentiated from the gonadal vein by recognizing that the ureter will often peristalse after manipulation.

On the right side, the insertion of the gonadal vein into the inferior vena cava can be a source of significant bleeding if avulsed. This can be avoided by dissecting the gonadal vein medially away from the ureter. Otherwise the gonadal vein can be clipped and divided. If bleeding is encountered secondary to an avulsed gonadal vein, the area of bleeding should be grasped using a laparoscopic grasper or vascular clamp. This can then be controlled either by applying a clip or by suture ligation. Application of a Hem-o-lok® clip (Teleflex Medical, Research Triangle Park, NC) partially on the renal vein should not be attempted as the distal locking portion of the clip can severely injure the vessel. Instead, titanium clips can be attempted in this situation.

A critical point for left-sided nephrectomy is that the aortic pulse should be identified and all dissection carried out lateral to this. Dissection medial to the aorta increases the risk of inadvertent injury or transection of the superior mesenteric artery.

Hilar Dissection

A thorough review of preoperative imaging should be undertaken to provide an idea of: (1) relative position of artery and vein, (2) the number of arteries and veins, and (3) the possibility of renal vein thrombus. If a renal vein thrombus is suspected, intraoperative ultrasound must be available.

It must be stressed that the key to hilar dissection is to proceed in a meticulous fashion. In this respect, the authors prefer to use hook electrocautery, as opposed to scissors or the harmonic scalpel, as this provides for a more accurate dissection.

Hilar dissection requires that the kidney be retracted anterolaterally in order to place the hilum on gentle tension and that the bowel be fully mobilized medially in order to have optimal exposure.

Intraoperatively, the key to hilar dissection begins by first identifying the gonadal vein as on the left side it will lead to the left renal vein. The renal vein will usually be anterior to the renal artery. As one approaches the renal vein on the left side, often a posterior lumbar vein will be present. Care must be taken as significant bleeding can occur if this vein is disrupted. Often by clipping and dividing the lumbar vein, greater exposure will be achieved for identification and dissection of the renal artery. Furthermore, if the gonadal vein is to be ligated, this should not be done too close to the renal vein as clips may interfere with stapler firing and if hemorrhage occurs from the gonadal vein, a greater length of vein is available for control.

After the vein has been identified, focus is turned towards the renal artery. On the left side, before transecting an artery, it must be established that the artery is not the superior mesenteric artery. This can be established by ensuring that the artery travels to the kidney and that all dissection is being carried out lateral to the aorta.

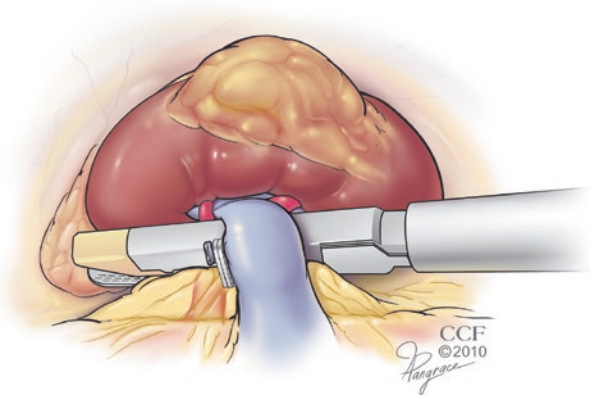

Fig. 7.2 Difficult access to the renal artery. If unable to access the renal artery, dissection may proceed by staying directly on the posterior aspect of the renal vein. The tissue posterior to the renal vein will contain the renal artery and can be taken with the endovascular stapler (Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2010. All Rights Reserved)

Difficulties with this part of the procedure include (1) being unable to dissect the vein and artery separately, (2) dealing with a complex hilum (i.e., multiple arteries and veins), (3) the presence of a renal vein thrombus, (4) being unable to dissect the hilum secondary to hilar adenopathy, and (5) bleeding.

If access to the renal artery is difficult secondary to the presence of the renal vein, dissection may proceed by staying directly on the posterior aspect of the renal vein. Two tissue packets are created. The posterior packet will contain the artery and can be taken with the endovascular stapler followed by another firing on the anterior packet containing the renal vein (Fig. 7.2). When firing the stapler, one must stay lateral to the great vessels. In addition, before firing the endovascular stapler, one must ensure that the endovascular stapler is free of any clips and that the tissue packets are thin as these situations can cause misfiring. Otherwise, if partial arterial exposure can be achieved, a clip can be applied across the artery but not divided. Subsequently, the vein is stapled and divided to fully expose the renal artery. Additional clips to the artery can then be applied and the artery divided. Lastly, if the renal artery and vein packet cannot be separated, but can be thinned, consideration can be given to en bloc transection of the hilum using the endovascular stapler. An increased incidence of arteriovenous fistula formation has not been reported. However, if this is being performed and the stapler is being fired from a medial to lateral direction, the psoas muscle both superior and inferior to the renal vein should be visualized to ensure that the entire renal hilum has been taken.

If the artery and vein are taken separately, after division of the artery, a laparoscopic bowel grasper can be placed across the renal vein. If the renal vein remains collapsed, there is unlikely to be any additional arterial supply. However, if the renal vein fills, a search for accessory arteries should be performed.

In cases in which a renal vein thrombus is suspected, this can be confirmed by intraoperative ultrasound. Tumor thrombus will often retract after ligation of the renal artery. In right sided nephrectomies, one may isolate and clip the renal artery early in the procedure in the interaortocaval location. This not only may cause tumor thrombus retraction, and therefore provide a greater area in which the endovascular stapler may be fired, but will also aid in decreasing bleeding that may arise from large collateral vessels. After ligation of the renal artery, Doppler ultrasound of the renal vein is performed. The vascular stapler must be applied distal to the area of the thrombus. If unsure about stapler positioning, consideration should be given to performing an open procedure.

At times dissection of the hilum will be impossible (i.e., secondary to large adenopathy). In this circumstance, application of the stapler across the hilum and nodal tissue is not advised as a large tissue packet can result in stapler misfiring. In such a situation, if unable to perform a nodal dissection, strong consideration should be given to open conversion.

If bleeding is encountered, the first step is to remain composed. Grasping the lacerated vessel, pressure, packing with a surgical sponge, and application of a hemostatic matrix may be attempted. Furthermore, intra-abdominal pneumoperitoneum can be increased to 20 mmHg. A clip can be placed but only if safe placement is assured. As stated previously, placement of a Hem-o-lok® clip only partially across a vessel should not be done as the distal locking end will cause severe vascular injury. If unsure of safe placement of a Hem-o-lok® clip, a titanium clip can be attempted. If this results in control of bleeding, attention can be turned to another part of the case and this area can be reassessed at a later time. Otherwise, depending on one's level of expertise, intracorporeal suture ligation may be attempted. Application of a Hem-o-lok® clip to the distal suture end will aid in suturing by cinching down tissues and obviating the need for intracorporeal knot tying initially. Once a figure-of eight suture is placed, the Hem-o-lok® clip can be loosened and the clip cut from the suture and knots tied to secure the suture. In addition, another alternative includes insertion of an additional trocar. A laparoscopic Satinsky clamp may be placed through this trocar to obtain control. Definitive management can then be obtained, whether by clips, stapling, or suture ligature, under controlled conditions. On the right side, a laparoscopic vascular clamp must always be available in case emergency clamping of the vena cava is required. One must always keep in mind patient safety and if required one should not hesitate to convert to an open surgery. At least partial control of the hemorrhage with a laparoscopic instrument is optimal during open conversion in order to limit blood loss and also provide a landmark for rapid identification of site of hemorrhage once open exposure is established.

Upper Pole Mobilization

After hilar dissection, the remaining attachments of the kidney include the adrenal gland and the upper pole. The upper margin of dissection will depend on whether the adrenal gland is to be preserved.

Difficulties with this part of the procedure include dissecting within the correct plane between the adrenal gland and kidney (if the adrenal is to be preserved) or being unable to reach the upper part of the kidney secondary to a large tumor mass.

If the adrenal is to be removed en bloc with the kidney on the right side, the adrenal vein must be divided. Care must be taken as the adrenal vein on the right side drains directly into the inferior vena cava, is of short length, and can easily be avulsed. On the left side the medial edge of the adrenal gland should be identified and dissection should proceed superiorly and posteriorly.

Usually at this point in the procedure the kidney is freely mobile. Using a grasper, caudal traction can be placed on the kidney and the remaining attachments divided. If significant attachments remain, a stapler can be applied to fully mobilize the upper pole of the kidney. In situations with a large upper pole tumor, superior access can be difficult. Yet in nearly all cases a dissection plane exists between the mass and liver or spleen.

During upper pole dissection, care should be taken to avoid diaphragmatic injury. This should be suspected in the presence of increasing ventilatory difficulty or paradoxical diaphragmatic movements intraoperatively (the "bellows sign"). This can be closed using a figure-of-eight suture after a 14-F red rubber catheter is placed through one of the ports into the pleural space. The distal end of the catheter is placed under water. Pneumoperitoneum is reduced to 5 mmHg and the anesthesiologist is instructed to give the patient a large inspiration to expel the pleural air. After the air has been evacuated, the catheter is removed and the figure-of-eight suture tied down simultaneously.

Specimen Removal

After the upper pole has been mobilized, the ureter is divided and the specimen placed in an entrapment sac. It is the authors' practice not to morcellate the specimen when a radical nephrectomy is performed for tumor. The specimen may be removed though one of the port sites or a Gibson or Pfannensteil incision.

After specimen retrieval, hemostasis is verified with an intra-abdominal pneumoperitoneum of 5 mmHg. The trocars are removed under direct vision to ensure that no port site bleeding is present.

Conclusion

Though present for many years, laparoscopic transperitoneal nephrectomy remains a challenging technique. Patient safety and oncological control must not be compromised. However, it is hoped that after reading this chapter, the reader will have learned additional maneuvers to help perform this procedure.

Suggested Reading

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