Chapter 33
Laparoscopic Adrenalectomy

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33.1 Introduction

Laparoscopic adrenalectomy is a minimally invasive approach for resection of the adrenal gland that can be performed in one of two ways: transabdominally or via a posterior, retroperitoneal approach. In 1991, Snow et al. performed the first successful transabdominal laparoscopic adrenalectomy, which was soon followed by the first posterior, retroperitoneal laparoscopic adrenalectomy by Mercan et al. in 1995 [1, 2].

Since its introduction in the 1990s, laparoscopic adrenalectomy has since become the preferred approach for nonfunctional and functional benign lesions, as it has similar biochemical cure rates and fewer complications in comparison to open adrenalectomy [3, 4]. In cases of primary hyperaldosteronism, several single institutions studies have shown laparoscopic adrenalectomy to be associated with lower risk of postoperative complications and shorter hospital length of stay [5–7]. Nonfunctioning benign lesions with suspicious imaging findings or size between 4 to 10 cm should be considered for laparoscopic adrenalectomy. Because of the limited working space, the retroperitoneoscopic approach is typically not recommended for tumors larger than 7–8 cm [8]. Although there is no size limit to the laparoscopic transabdominal approach, tumors >10 cm may not be as amenable

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to laparoscopy due to technical difficulty or local invasion. However, the placement of a hand-assist port can help for resecting tumors >10 cm.

In addition to large tumor size, suspected adrenocortical carcinoma is considered a relative contraindication for laparoscopic resection. The use of laparoscopic adrenalectomy in adrenocortical carcinoma is controversial, as some studies have suggested that laparoscopic approach may increase risk of locoregional recurrence or mortality [9, 10].

33.2 Preoperative Management

Initial evaluation of an adrenal mass should rule out functional tumors: hyperaldosteronism, hypercortisolism, or pheochromocytoma. Initial laboratory studies therefore should include serum potassium levels, aldosterone, plasma renin activity, a low-dose dexamethasone test, and plasma fractionated metanephrines. If any of the initial biochemical evaluation is abnormal, consultation with an endocrinologist is recommended, and further confirmatory testing is necessary.

For patients with functional tumors, electrolyte or metabolic abnormalities should be corrected prior to surgery. Patients with primary hyperaldosteronism may need potassium supplementation, as they characteristically have hypokalemia. Patients with Cushing syndrome may require correction of hyperglycemia and electrolytes. Importantly, those with pheochromocytoma will need close preoperative management to manage their blood pressure. These patients first receive alpha blockade with doxazosin, prazosin, or phenoxybenzamine. Subsequent beta-blockade may be needed in patients with persistent tachycardia. Patients with pheochromocytoma also need volume repletion and increased salt intake to avoid postoperative hypotension [3].

Imaging evaluation of an adrenal mass may aid in distinguishing malignant and benign disease. If an adrenal mass with smooth borders measures less than 10 Hounsfield units (HU) on a noncontrast computed tomography (CT), it is likely to be a benign adenoma [3]. CT findings of a poorly defined tumor with high CT attenuation > 20 HU, delay in contrast washout, high standardized uptake value on FDG-PET, calcifications, necrosis and associated lymphadenopathy are suggestive of malignancy.

Troubleshooting: Pregnant patients merit special preoperative consideration. Ideally, surgery would be delayed until a few months after delivery, but if surgery is required during pregnancy, the second trimester is safest. Surgery during the first trimester carries risk of teratogenesis and spontaneous abortion, while the surgery in the third trimester poses greatest risk of preterm labor [12].

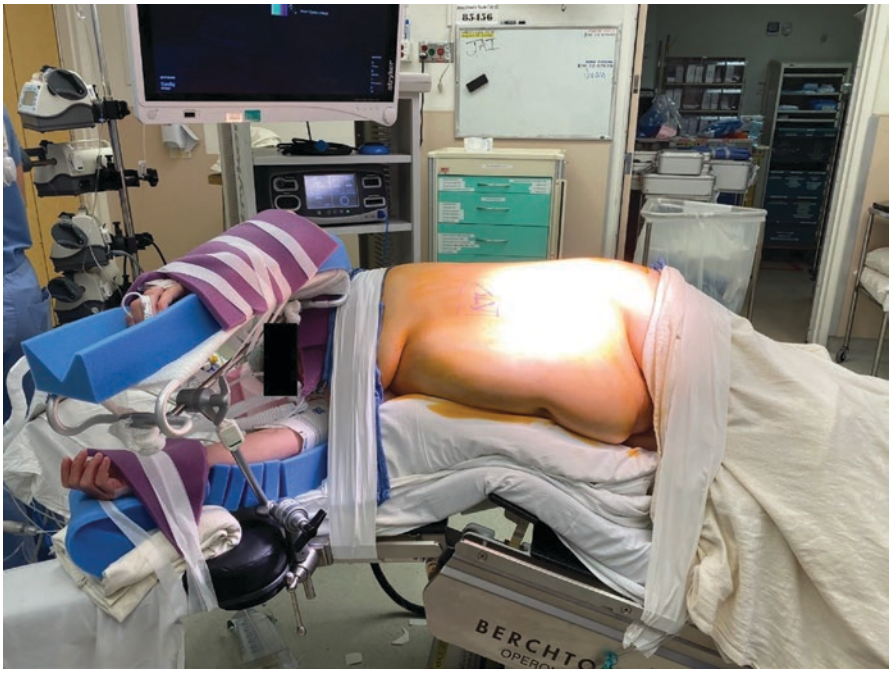

Fig. 33.1 Positioning for laparoscopic transabdominal left adrenalectomy

33.3 Left Adrenalectomy

33.3.1 Laparoscopic Transabdominal Left Adrenalectomy (TAA)

1. *Patient positioning*

   The patient is intubated, the urinary catheter placement and line placement are done in the supine position. An orograstric tube is indicated to keep the stomach decompressed during the procedure. Sequential compression devices are applied to the legs for venous thromboembolism prophylaxis. The patient is then placed on a padded bean bag in the right lateral decubitus position (left side up). The operating table is flexed at the waist with the kidney rest elevated to open up the area between the lower ribs and the iliac crest. The left arm should be secured forward, at the level of the patient's head using a padded armrest. The right leg is flexed while the left leg is left straightened, with padding between the legs and around them; this position opens the flank area more. The bean bag air is evacuated and hardened to secure this position. The surgeon and assistant both stand on the patient's right side. The laparoscopic tower and screen are placed on the patient's left, over the patient's left shoulder, for an in-line view (Fig. 33.1).

2. *Incisions/Trocar Placement*

Pneumoperitoneum to 12–15 mmHg can be achieved using a Veress needle. The Veress needle is inserted in the left anterior axillary line below the costal margin. Alternatives to the Veress needle are an optical trocar or muscle-splitting open technique with an 11mm Hasson cannula, by which the abdominal cavity can be entered with direct visualization.

Ports are placed along the left subcostal margin. Two additional 5 mm ports are placed: one in the mid-axillary line near the epigastrium, one in the mid-axillary line lateral to the 11 mm port. Most left TAA can be performed with three ports. If needed, a fourth 5 mm port can be placed slightly below the anterior axillary line port and the mid axillary line port in a triangular configuration. For patients who have thick abdominal walls, the lateral-most port in the mid axillary line can be converted to a 10 mm trocar.

Troubleshooting: A hand-assist port could be inserted in the medial most subcostal region by making a 6 cm incision in the subcostal area encompassing the medial-most 5 mm port site. A hand-assist port is valuable if an adrenal mass is large, friable, or concerning for malignancy and can avoid a full conversion to open surgery in most cases.

3. *Exposure*

A retractor is inserted through the medial-most port to retract the spleen. A 5 mm, 30-degree laparoscope is inserted through the lateral-most port. Dissecting instruments are placed in the middle (and the fourth, if needed) port. To expose the left adrenal gland, the splenic flexure of the colon is mobilized first by dividing the attachments to the spleen and pancreatic tail. This maneuver allows for the spleen and pancreatic tail to fall medially and the colon to be mobilized inferiorly (Fig. 33.2). The splenorenal ligament is then entered, and taken down circumferentially around the spleen all the way superiorly to the diaphragmatic crus and gastric cardia. This allows the spleen and pancreatic tail to be mobilized medially off the adrenal gland and kidney posteriorly, exposing the anterior aspect of the adrenal gland.

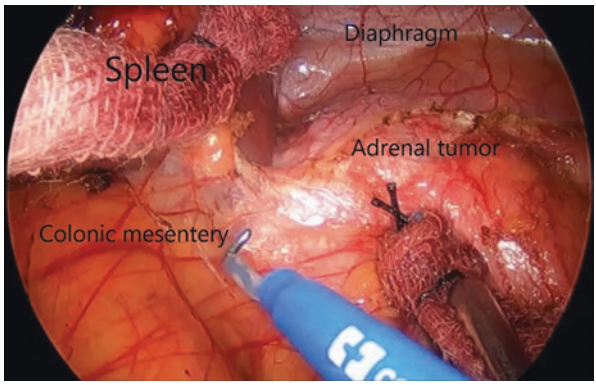

Fig. 33.2 Splenic flexure mobilization during laparoscopic transabdominal left adrenalectomy allows for the spleen and pancreatic tail to fall medially while the colon falls inferiorly

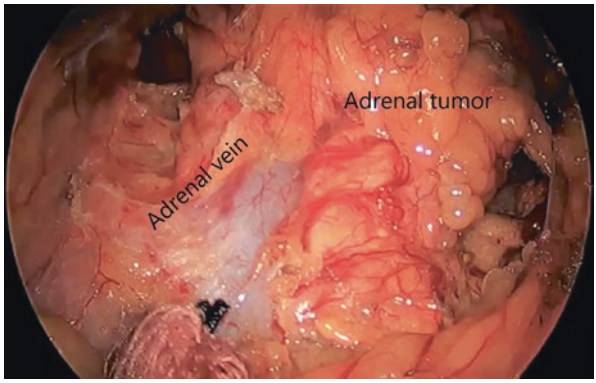

Fig. 33.3 Identification and dissection of the adrenal vein during laparoscopic transabdominal left adrenalectomy. If the left adrenal vein cannot be identified intraoperatively, the left phrenic vein can be used as a guide to track inferiorly to where it joins the adrenal vein

4. *Dissection of the adrenal gland*

   The avascular plane between the transverse mesocolon and Gerota's fascia is incised to expose the left renal vein. The left adrenal vein can be identified as it runs from the inferior aspect of the adrenal gland to the renal vein (Fig. 33.3). If the left adrenal vein cannot be identified, the left phrenic vein also can be used as a guide to track inferiorly where it joins the adrenal vein. The left adrenal vein is then dissected, ligated, and divided between clips. Arterial branches originating from the phrenic, aortic and renal areas can be coagulated or clipped and divided. The adrenal gland is dissected off the kidney inferolaterally. Superior and lateral dissection in the retroperitoneum can be delayed until later in the procedure, as these attachments help keep the adrenal suspended, facilitating medial and inferior dissection.

   Troubleshooting: If conversion to an open procedure is required, a subcostal incision can be created by connecting the subcostal trocar incisions. The authors prefer to insert a hand-assist port as an intermediate step for a very difficult laparoscopic TAA before converting to a fully open procedure if possible.

5. *Specimen retrieval*

   Once the dissection and vein ligation is complete, the adrenal gland can be placed in a specimen bag and brought out through the 11 mm port. The authors do not recommend morcellating the adrenal gland. Taking out the port and applying surgical sterile lubricant in the port site can help slide the retrieval bag out. A large adrenal mass also can be extracted via a hand-assist port if used.

33.3.2 Posterior Retroperitoneoscopic Left Adrenalectomy (PRA)

1. *Patient Positioning*

Fig. 33.4 Empty surgical bed for prone positioning, with lateral vertical supports to allow the abdominal wall to drop ventrally with gravity

PRA requires special equipment for prone positioning. Endotracheal intubation, urinary catheter placement, and line placement are performed with the patient supine on a stretcher. The patient is then positioned prone, either on a dedicated prone bed or a standard bed with extenders that allows for flexion at the hip joints and a special bed padding that allows for abdominal support which should be empty in the middle to allow for gravity and insufflation to drop the abdominal wall ventrally, away from the retroperitoneum. This can be achieved either with vertical supports on a prone bed (Fig. 33.4), or with horizontal bolsters at the inferior rib cage and hip joint, placed at the leg break on a standard bed [13].

The bed is positioned so that the patient is flexed at the hips 90 degrees on a prone bed. The knees are bent, and the shins prevent caudal displacement. The bed should be tilted as needed, so that the patient's back is horizontal to the floor. The patient is positioned toward the left side of the bed to allow full range of motion with the laparoscopic instruments at the level of the left flank. The arms are placed toward the patient's head, bent at the elbow in the modified partial "superman" position (Fig. 33.5). The patient should be secured to the bed with tape and belts to prevent slippage during the procedure. Sequential compression devices are applied to the legs for venous thromboembolism prophylaxis.

Troubleshooting: If conversion to an open procedure is necessary, the conventional posterior technique can be undertaken, connecting the three trocar incisions, and may require resection of the 12th rib [14].

Fig. 33.5 Patient positioned prone. The patient's hips are flexed 90 degrees. Bent knees are supported with padding and taped in place to prevent rear slippage. The bed is tilted as needed

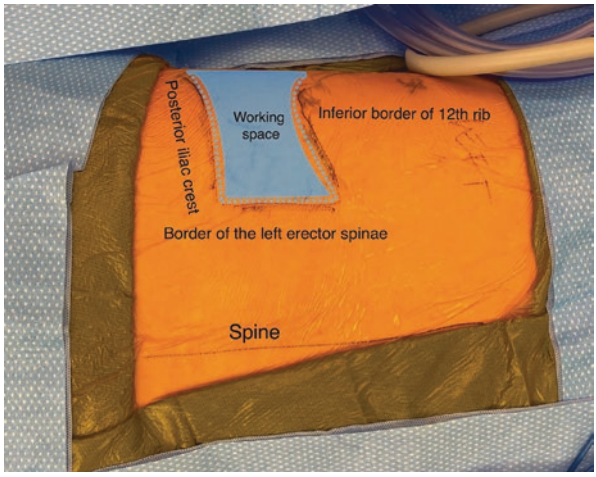

Fig. 33.6 The working space of the posterior retroperitoneoscopic adrenalectomy is bordered superiorly by the 12th rib, medially by the paraspinous muscle externally (psoas muscle internally), and the posterior iliac crest inferiorlyt

2. *Incisions/Trocar Placement*

The anatomic location of the 11th and 12th ribs, as well as the paraspinous muscles and the posterior iliac crest are palpated. The working space is bordered superiorly by the 12th rib, medially by the paraspinous muscle externally (psoas muscle internally), and the posterior iliac crest inferiorly (Fig. 33.6).

A space of at least two fingerbreadths should exist between the 12th rib and the iliac crest for optimization of this approach. The initial incision is made transversely 5 mm below the tip of the 12th rib, and the subcutaneous tissue is dissected. Using a closed Metzenbaum or Mayo scissor, the retroperitoneal space is bluntly entered through the posterior fascia. Palpation of the smooth underside of the rib confirms entry into the correct space. Blunt finger dissection creates a small space lateral, superior, and medial to the retroperitoneal entry site to allow for placement of the lateral and medial ports under direct palpation with an internal finger to ensure all ports enter the same space. The medial 5 mm trocar is placed just lateral to the sacrospinal muscles externally, and just lateral to the psoas muscle internally (this can be palpated digitally through the 12 mm port site), and the lateral 5 mm trocar is placed approximately 4–5 cm lateral to the initial incision, in approximately the midaxillary line in the flank area. A 12 mm balloon-tip trocar with adjustable sleeve is placed in the middle, initial incision site, the balloon inflated, and pulled snugly to the fascia to secure the trocar to the abdominal wall and avoid subcutaneous insufflation of CO_2.

Troubleshooting: Finger palpation is crucial to direct trocars into the same space. The index finger can be used to push the fatty tissue onto the distal end of the trocar to facilitate this, as well as to avoid scope smearing on entry and exit from the trocar. It can also palpate the kidney and protect it during trocar insertion.

3. *Creating the Retroperitoneal Space*

The retroperitoneal space is insufflated with CO_2 to approximately 20–25 mmHg, and a 30 degree laparoscope, angled toward the ceiling, inserted in the medial-most trocar. Higher pressures may be necessary for large patients or those with a significant amount of retroperitoneal adipose. Laparoscopic graspers are inserted into the lateral port and diathermy or sealing/cutting dissection instruments are placed in the middle port. The avascular plane between the retroperitoneal fatty tissue and Gerota's fascia is bluntly dissected, taking down the posterior attachments and sweeping them ventrally. Keeping the psoas muscle in view on the right side of the screen allows dissection to proceed in the correct plane.

This dissection continues cranially, working towards the superior border of the space, often visualizing the renal hilum inferiorly. The newly-developed space is bordered by the psoas muscle medially, the kidney laterally, the chest wall superiorly, and the renal hilum and the peritoneum inferiorly.

Troubleshooting: If the patient becomes hypercarbic during the procedure, temporary desufflation of the retroperitoneum and hyperventilation of the patient by the anesthesiologist may be necessary. Subcutaneous inspissation of CO_2 can occur in a prolonged procedure under high pressure; this is not dangerous to the patient and will resolve within a few hours

4. *Mobilization of the Upper Pole of the Kidney and Initial Dissection*

The perirenal fat is then gently bluntly dissected to identify the superior border of the kidney. The perirenal fat is separated from the kidney along the supe-

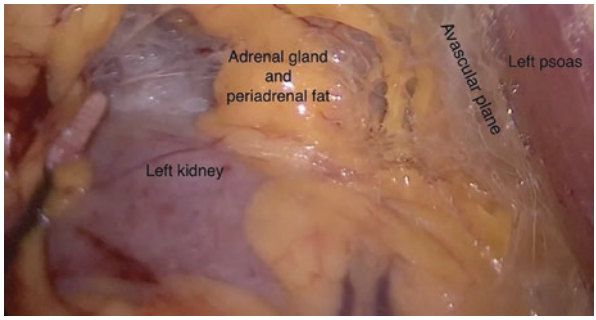

Fig. 33.7 Keeping the psoas muscle in view on the right, the avascular plane is dissected, proceeding cranially. The perirenal fat is separated from the kidney, which is retracted ventrally, laterally, and inferiorly away from the inferior border of the adrenal gland

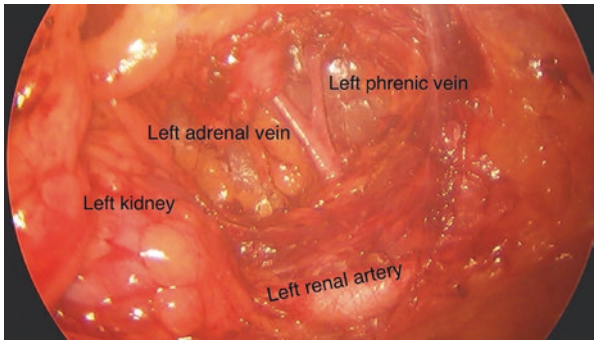

Fig. 33.8 View of the major vasculature of the retroperitoneal dissection

rior and lateral borders of the kidney using a sealer/divider device. This dissection allows for lateral and inferior retraction of the kidney away from the inferior border of the adrenal gland (Fig. 33.7). The inferior border of the adrenal gland may become visible during this point in the dissection.

After mobilizing the superior pole of the kidney, dissection of the adrenal gland often begins inferiorly and medially, sealing the small vessels between the adrenal gland and the psoas and diaphragm.

Troubleshooting: Of note, polar renal arterioles can often be seen here traversing across this area; care should be taken to follow these to the kidney and preserve them intact if they prove to be polar vessels. Transecting such vessels will make segments of the kidney ischemic, which is problematic. The adrenal gland often is just cranial to such vessels. In this infero-medial space, one usually can identify and divide the adrenal vein early (see next section). Dissection of the adrenal gland should always be performed with gentle dissection to avoid violation of the capsule.

5. *Identification and Division of the Adrenal Vein*

The left adrenal gland typically lies more caudal than the right gland, anterior to (i.e., "behind") the upper pole of the kidney. With the kidney retracted inferiorly and medially, the anterior surface of the kidney is freed from the periadrenal fat, and the junction of the adrenal vein and the phrenic vein can be

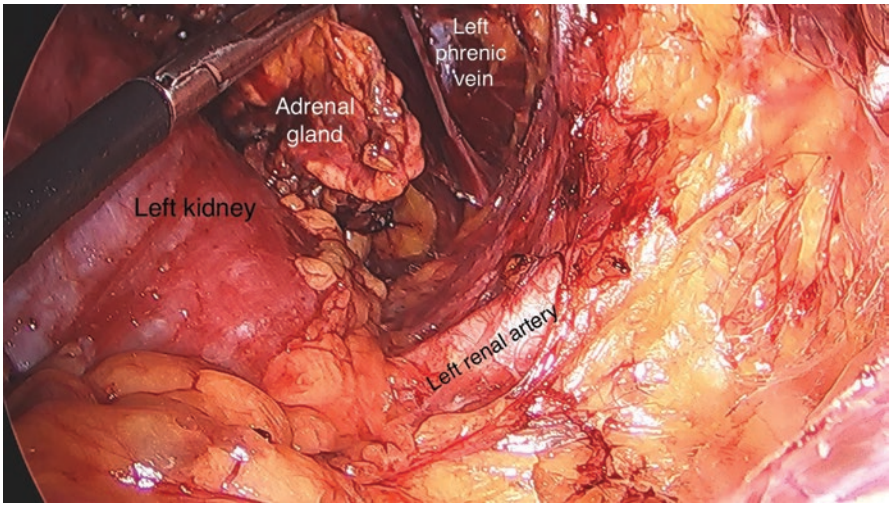

Fig. 33.9 The adrenal gland is freed from the remainder of its attachments, resting on the superior left kidney, ready for extraction

identified medially. There is often a finger of adrenal tissue extending up to this convergence. The adrenal vein is carefully dissected and divided with a vessel sealer or surgical clips (Fig. 33.8). The phrenic vein is typically left intact, though the vein may be taken distal to the confluence of the adrenal vein and phrenic vein, if necessary.

6. *Completion of Dissection and Extraction of Specimen*

After division of the adrenal vein, the adrenal gland can be mobilized, and freed from the remainder of its attachments medially, laterally, and cranially. The posterior attachments of the adrenal gland to the retroperitoneum (the ribcage) should be kept until the end to provide a natural suspension and avoid letting the adrenal gland fall anteriorly toward the abdomen. It is often useful to use the stump of the adrenal vein as a handle to manipulate the gland atraumatically. Blunt dissection is typically all that is necessary to release these attachments (Fig. 33.9).

Care should be taken to avoid traumatizing the peritoneum to the cranial end of the dissection in order to avoid injury of structures just beyond it, such as the splenic vessels, pancreatic tail and spleen. Once the adrenal gland is mobilized completely from all attachments, a specimen retrieval bag is placed through the center port and the specimen is extracted. Depending on the tumor size and type, the incision may need to be extended slightly [15], and sterile surgical lubricant can be placed in the incision to facilitate extraction. The authors do

not recommend morcellation of the adrenal specimen. The fascia of the extraction port site is closed with an absorbable suture. Closed suction drainage is not necessary.

Troubleshooting: If the peritoneum is inadvertently torn during ventral dissection, the subsequent pneumoperitoneum may decrease the retroperitoneal working space. However, repair is unnecessary. If the patient has a thick abdominal wall, the 5 mm medial-most camera port can be enlarged into a 10 mm port to allow placement of a 10 mm scope, which will be stronger and resist inadvertent bending and destruction of the thinner scope.

33.4 Right Adrenalectomy

33.4.1 Laparoscopic Transabdominal Right Adrenalectomy (TAA)

1. *Patient positioning*

The patient is intubated, the urinary catheter placement and line placement are done in the supine position. An orograstric tube is indicated to keep the stomach

Fig. 33.10 Patient positioning for laparoscopic transabdominal right adrenalectomy

decompressed during the procedure. Sequential compression devices are applied to the legs for venous thromboembolism prophylaxis. The patient is then placed on a padded bean bag in the left lateral decubitus position (right side up). The operating table is flexed at the waist with the kidney rest elevated to open up the area between the lower ribs and the iliac crest. The right arm should be secured forward, at the level of the patient's head using a padded armrest. The left leg is flexed while the right leg is left straightened, with padding between the legs and around them; this position opens the flank area more. The bean bag air is evacuated and hardened to secure this position. The surgeon and assistant both stand on the patient's anterior/left side. The laparoscopic tower and screen are placed on the patient's right, over the patient's right shoulder, for an in-line view (Fig. 33.10).

2. *Incisions/Trocar Placement*

The authors generally use four trocars aligned along the costal edge. The initial trocar site is where the pneumoperitoneum to 12–15 mmHg is achieved using a Veress needle, an optical trocar, or open technique with a Hasson cannula placed at the anterior axillary line just below the ribs. The liver edge often extends to this area, so care should be taken to avoid injury to the liver. This initial site is ultimately a 10–12 mm trocar. Additional ports are then placed

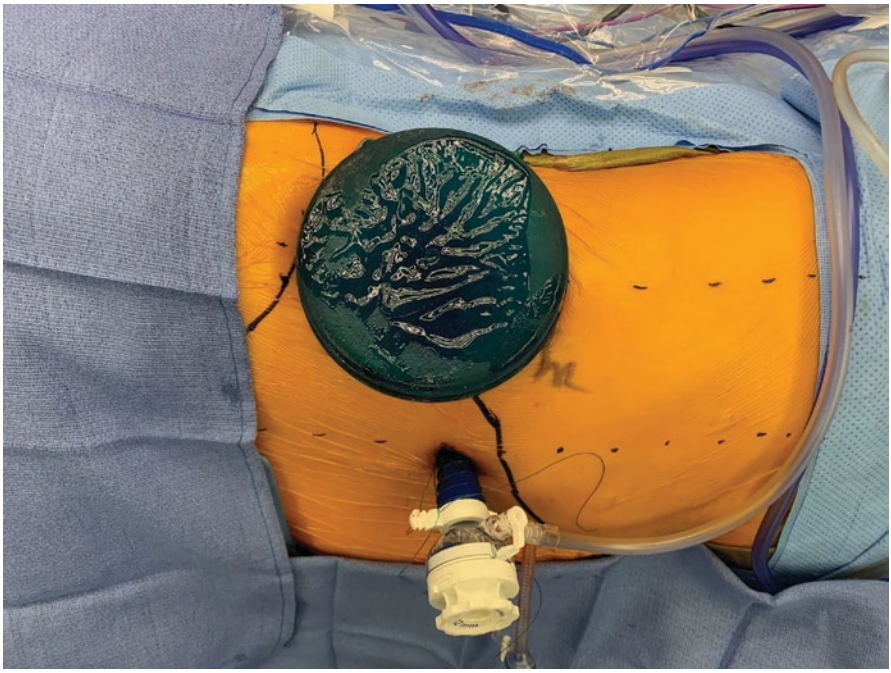

Fig. 33.11 Location of the hand-assist port, if used, during laparoscopic transabdominal right adrenalectomy

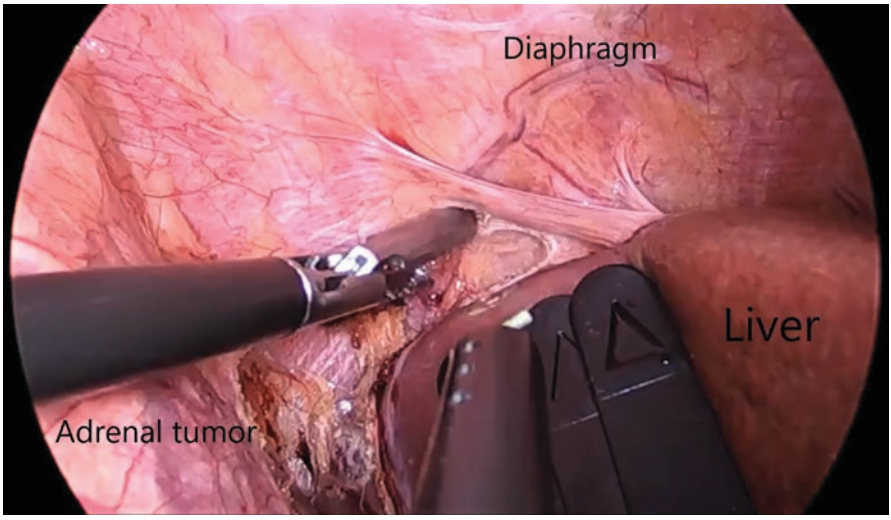

Fig. 33.12 The right triangular ligament is divided and the liver retracted during laparoscopic transabdominal right adrenalectomy

under direct vision with the help of the laparoscope as follows: one 5 mm port is placed medial to the initial trocar in the subcostal region and one 5 mm port is lateral in the subcostal region at the mid-axillary line. A fourth 10 mm port is placed in the subcostal region near the epigastrium through which a fan liver retractor can be placed.

If a hand-assist port is planned to be placed up front, then the 10 mm liver retractor port is not absolutely necessary. The hand-assist port can be placed in the flank/midaxillary line and the inserted left hand can hold the liver edge up with its dorsum, while the fingers manipulate the area below the liver. The authors then use the hand-assist port most laterally, the 10–12 mm port in the middle, and a 5 mm port in the midclavicular line, subcostally (Fig. 33.11). The port position is strategic for maximal visualization and manipulation, and for facilitating conversion to an open procedure by connecting all the incisions into one subcostal incision.

3. *Exposure*

The 30-degree laparoscope is inserted through the lateral-most port. Energy dissecting instruments are placed in the middle two ports. To expose the right adrenal gland, the right triangular ligament of the liver is divided to allow rotation of the right lobe of the liver medially. The retroperitoneum is incised and taken under the liver onto the right kidney and adrenal gland superiorly toward the inferior vena cava (IVC) medially. A fan retractor is inserted through the most medial port to retract/lift the liver upward (Fig. 33.12). The second portion of the duodenum will often need to be mobilized to better expose the right adrenal gland and the IVC.

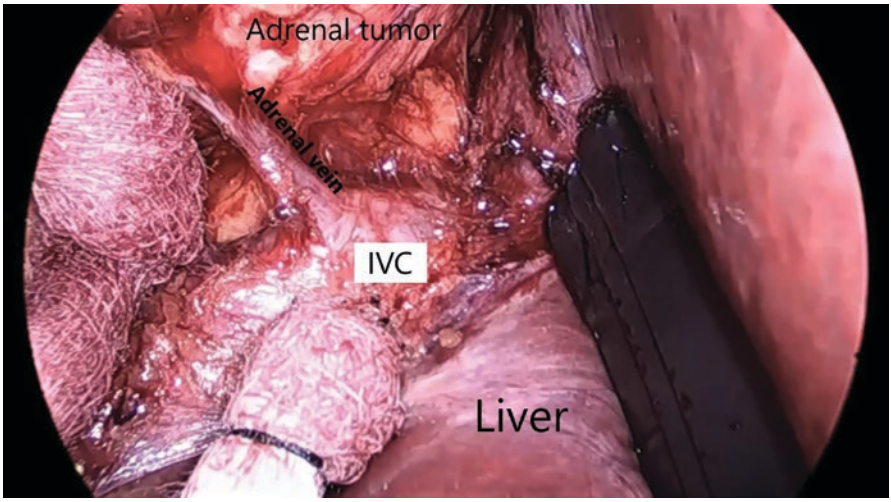

Fig. 33.13 The right adrenal vein, which is often short, is identified as it joins the IVC in laparoscopic transabdominal right adrenalectomy

Troubleshooting: Care should be taken to avoid traumatizing the gallbladder, as traumatic cholecystitis can occur postoperatively if this happens. Any prior surgery, such as the patient having had a laparoscopic cholecystectomy in the past, or prior perihepatic infection can cause adhesions, which will need to be carefully taken down. Avoid traction or trauma of the liver capsule, as this can cause liver bleeding or occult subcapsular liver hematoma. Liver tears can be controlled with manual pressure or use of the argon beam coagulator for superficial tears.

4. *Dissection of the adrenal gland*

Gerota's fascia, which covers the kidney and adrenal gland, is incised anteriorly and extended toward the diaphragm. The IVC is separated from the right superior aspect of the kidney, which is gently retracted downward and laterally. This opens the space between the lateral retroperitoneal structures and the IVC. Blunt and diathermic dissection can be carried craniad, between the IVC and the adrenal gland. The right adrenal vein can then be identified where it joins with the inferior vena cava (Fig. 33.13). It is often short, and can insert slightly onto the posterior aspect of the IVC. It should be dissected circumferentially, clipped and divided. Arterial branches can be coagulated, clipped and divided. The adrenal gland is dissected superiorly free from under the liver, and then inferiorly off the kidney. As mentioned for the left adrenalectomy, lateral dissection can be delayed until later in the procedure, as these attachments help keep the adrenal suspended, facilitating medial dissection.

Troubleshooting: Timing of vein ligation can be variable based on the disease process as well as intraoperative findings. In cases of pheochromocytoma, early venous ligation may reduce intraoperative hemodynamic instability. If the vein

cannot be identified or is adherent to the IVC, the vein can be ligated after lateral and inferior mobilization.
Under the liver, small direct draining veins from the hepatic lobe into the IVC can be encountered. These should be either avoided or carefully clipped to avoid tearing the IVC in a deep space, which would be difficult to control.

5. *Specimen retrieval*
   Once the circumferential dissection and vein ligation is complete, the adrenal gland can be placed in a specimen bag and brought out through the 12 mm port. The authors do not recommend specimen morcellation, but placement of a sterile surgical lubricant into the trocar site can facilitate bag removal. Closed suction drainage is not necessary. The extraction port may have to be enlarged slightly, and then it will need to be closed by approximating the transverse/oblique muscle layers with absorbable sutures.

33.4.2 Posterior Retroperitoneoscopic Right Adrenalectomy (PRA)

1. *Patient Positioning*
   The patient is positioned as discussed above for left PRA, with the exception that the patient is positioned toward the right side of the bed to allow free access to the right flank.
2. *Incisions/Trocar Placement*
   Please refer to the segment of the left PRA for complete description of trocar placement. Briefly, the initial 12 mm incision is made transversely just below the tip of the 12th rib, and the retroperitoneal space is bluntly accessed. Blunt finger dissection creates a small space lateral, superior, and medial to the retroperitoneal entry site to allow for placement of the medial 5 mm trocar just lateral to the paraspinous and psoas muscles and the lateral 5 mm trocar in approximately the posterior axillary line, both under direct palpation, directing all trocars into the posteriorly created space. A 12 mm balloon-tip trocar with adjustable sleeve is placed in the middle, initial incision site, the balloon inflated, pulled snugly to the fascia, and secured in place. Insufflation to a pressure of 20–25 mm Hg is achieved. For patients who have significant retroperitoneal adipose or musculature, higher pressures may be indicated.
   Troubleshooting: If the patient becomes hypercarbic during the procedure, temporary desufflation of the retroperitoneum and hyperventilation of the patient by the anesthesiologist may be necessary. Subcutaneous inspissation of CO_2 can occur in a prolonged procedure under high pressure; this is not dangerous to the patient and will resolve within a few hours.
3. *Creating the Retroperitoneal Space*
   The 30 degree scope is placed in the medial port, and the dissecting instruments in the lateral ports. The psoas muscle should be kept in view on the left

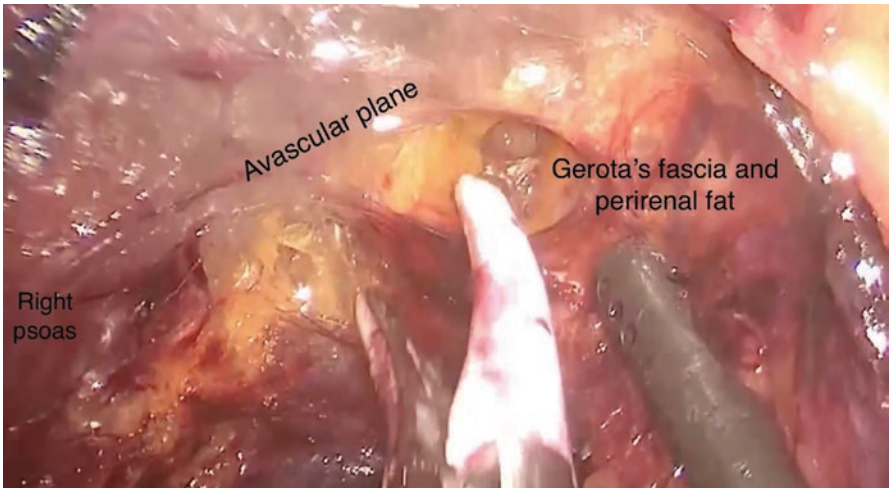

Fig. 33.14 Upon entry, the avascular plane between the psoas muscle medially (left of image) and the retroperitoneal fatty tissue and Gerota's fascia laterally (right of image) is bluntly dissected, sweeping the posterior attachments ventrally

side of the screen. The kidney should be identified and kept on the right side of the screen. The avascular plane between the psoas muscle medially and the retroperitoneal fatty tissue and Gerota's fascia laterally is bluntly dissected, sweeping the posterior attachments ventrally (Fig. 33.14). This dissection continues cranially, often identifying the renal hilum below, continuing working towards the superior border of the kidney, and until the adrenal gland is encountered.

4. *Mobilization of the Upper Pole of the Kidney and Identification of the IVC*

   The perirenal fat is bluntly dissected to identify the superior border of the kidney. The perirenal fat is then separated from the kidney along the superior and lateral borders of the kidney using a sealer/divider device, and the kidney is retracted laterally and ventrally, away from the inferior border of the adrenal gland. After mobilizing the superior pole of the kidney, the adrenal gland is identified medially. Dissection may begin inferiorly and medially, using blunt dissection to identify the IVC ventrally and medially, under the adrenal gland. The IVC is flattened by the high insufflating pressures and will appear like a broad flat bluish band. Once the IVC is identified, dissection of the adrenal gland can be undertaken medially and cranially along the IVC. Blunt dissection and diathermy can be used to clear the medial aspect of the adrenal gland toward the liver dome and diaphragm. Medially and ventrally, the duodenum is located, but this will not be visible; its location should be expected and respected. Dissection of the adrenal gland should always be performed with gentle, blunt or diathermic dissection to avoid violation of the capsule.

   Troubleshooting: The renal artery often has significant anatomic variations. An upper pole renal artery may enter superiorly, outside of the hilum, and should be avoided as the upper pole of the kidney is mobilized. Any arteriolar

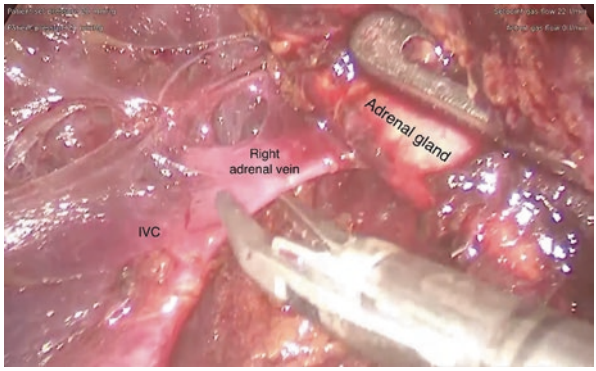

Fig. 33.15 The right adrenal vein originates from the lower medial adrenal gland and enters directly into IVC. The adrenal vein is bluntly dissected and clipped

appearing structure should be traced distally, to assure it is a true adrenal feeding artery (which can be taken) and not a renal polar artery (which should be preserved). The attachment of the adrenal gland to the superior aspect, the liver dome, and the sacrospinous muscles should be kept intact to allow natural suspension of the gland, which will aid dissection in the ventral portion, onto the IVC.

5. *Identification and Division of the Adrenal Vein*

   The adrenal gland is freed medially away from the psoas muscle, inferiorly away from the kidney and laterally away from the right hepatic lobe. Small adrenal arteries crossing the IVC posteriorly entering directly into the adrenal gland are divided with a vessel sealer or clips, allowing the gland to be gently lifted posteriorly to visualize the IVC. The adrenal vein typically enters the lower medial adrenal gland anteriorly (deep to the dissection) into the IVC. Once identified, the adrenal vein is bluntly circumferentially dissected free from the periadrenal fat in order to cleanly clip/seal with a vessel sealer and divide (Fig. 33.15).

   Troubleshooting: If significant bleeding is encountered while mobilizing the adrenal gland in the retroperitoneum, assess the surgical plane to ensure dissection is not entering the gland itself. If the IVC is torn by traction of the adrenal vein, bleeding can be controlled by compressing the IVC further with increased retroperitoneal pressure and direct pressure to the IVC with a blunt, non-traumatic instrument. This can allow control of the hemorrhage until it can be examined and controlled permanently adequately either by clip or suture. CO_2 embolization is very rare, but the pressure should be dropped once the IVC tear is clearly identified, examined, understood, controlled, and a repair plan put forth. If the hemorrhage is not controllable, performing an open retroperitoneal PRAprocedure may be necessary.

6. *Completion of Dissection and Extraction of Specimen*

   The adrenal gland is then mobilized and bluntly freed from the remainder of its attachments medially, laterally, and cranially. At this point, the adrenal gland is fully under the dome of the right lobe of the liver, so care must be taken to avoid injury to the liver. Once the adrenal gland is mobilized completely from all

attachments, a specimen retrieval bag is placed through the center port, and the specimen is extracted. The authors do not recommend morcellation of the specimen. The fascia of the medial port site is closed with an absorbable suture. Closed suction drainage is not necessary.

33.5 Postoperative Management

Post-operative care for patients who undergo TAA or PRA is similar, and nuances in management are dictated by the preoperative diagnosis. Patients can receive a regular diet postoperatively, and their urinary catheters are removed right after surgery. Electrolytes should be measured especially for patients with Cushing syndrome or primary hyperaldosteronism.

Most patients are discharged within 8–30 hours after surgery, except for those with Cushing syndrome who may require steroid replacement postoperatively. To assess subclinical hypoadrenalism, a morning serum cortisol level can be obtained on postoperative day 1. Depressed levels of cortisol will denote hypothalamic-pituitary-adrenal axis suppression and supplemental steroids will be necessary. Steroid taper schedules vary depending on the severity of the adrenal insufficiency; they typically start with one or two intravenous doses, then transition to oral doses once the patient is tolerating adequate oral intake. Patients who undergo unilateral adrenalectomy for Cushing syndrome may require steroids for many months, while those who undergo bilateral adrenalectomy will require lifelong steroid replacement with hydrocortisone or prednisone and fludrocortisone. Follow up with a medical endocrinologist is indicated on an outpatient basis. Acute adrenal insufficiency can manifest with nonspecific symptoms such as fever, nausea, hypotension and lethargy. Laboratory studies will often demonstrate hyponatremia, hyperkalemia and hypoglycemia. Acute adrenal insufficiency is diagnosed with an ACTH stimulation test, but treatment should be started based on clinical suspicion, especially after adrenalectomy [3].

For patients who are post-pheochomocytoma excision, continuous immediate postoperative measurement of vital signs and telemetry is indicated, but most patients can be weaned off any pressors in the operating room or recovery room, and will be able to be admitted overnight to a regular inpatient floor. Telemetry can be continued overnight if necessary. All preoperative alpha blockade should be stopped; any beta-blockade that was started specifically for the purpose of controlling heart rate preoperatively should be weaned over a medically determined time.

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