Minimally Invasive Adrenalectomy

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KEYWORDS

• Minimally invasive • Laparoscopic adrenalectomy • Adrenal incidentaloma
• Posterior retroperitoneoscopic adrenalectomy • Adrenal metastases

KEY POINTS

- Minimally invasive adrenalectomy is the preferred method for benign, accessible adrenal masses.
- Adrenal imaging and biochemical evaluation are essential for characterization of adrenal lesions.
- Patient selection for laparoscopic transabdominal and posterior retroperitoneoscopic adrenalectomy (PRA) should be based on anthropometric parameters and characterization of the adrenal mass.
- Minimally invasive adrenalectomy has been shown to be safe and efficacious for adrenal metastases; however, open adrenalectomy is recommended in suspected or confirmed primary adrenal malignancy for best oncologic outcome.

INTRODUCTION

With the increased use of abdominal imaging, adrenal neoplasms are being identified more frequently.[1,2] Autopsy studies have evaluated the frequency of incidental adrenal masses and found that they are present in up to 6% of patients. There is an increasing prevalence with age, as adrenal masses are present in less than 1% of patients younger than 30 years and up to 7% of patients older than 70 years.[3–8] Minimally invasive adrenalectomy through a laparoscopic transabdominal approach was first introduced in the early 1990s and has transformed the management of adrenal tumors.[9] Since then, minimally invasive adrenalectomy has been shown to have less blood loss, earlier patient mobility, decreased length of stay, and faster return to regular

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activity.[10–12] These advantages have led to increased frequency of surgery and evolution of indications for adrenalectomy.[13–15]

Laparoscopic adrenalectomy has become the gold standard for removal of benign adrenal masses. This article discusses the management of incidentally discovered adrenal masses, indications for surgery, and surgical approaches, with a focus on the transabdominal and retroperitoneal methods.

PATIENT EVALUATION AND INDICATIONS FOR ADRENALECTOMY

The initial presentation of an adrenal mass is frequently an adrenal incidentaloma, defined as the identification of an unsuspected adrenal mass when imaging is performed for other indications. Adrenal incidentalomas have been reported in up to 5% of patients undergoing abdominal computed tomographic (CT) scans for other indications.[16–18] Most adrenal masses are benign, although biochemical evaluation is recommended in all patients with adrenal incidentalomas.[2,19,20] Indications for adrenalectomy include a hormonally active adrenal tumor or a suspected or confirmed malignancy.[2,20,21] Adrenal malignancies may be either a primary adrenocortical carcinoma (ACC) or metastases from another primary cancer.

Imaging of Adrenal Masses

The increased frequency and technological advances in abdominal imaging have led to the increased identification of adrenal masses. Most often the imaging is obtained for other indications and is not optimized for evaluating the adrenal glands.[17] However, some characteristics can be identified to broadly determine the nature of the lesion. Common characteristics attributed to benign adrenal neoplasms are size less than 4 cm, smooth contours with planes between organs intact, and a homogenous density; in contrast, malignant neoplasms are frequently greater than 6 cm in size, have irregular borders without clear planes, and are heterogeneous.[1]

Benign adrenal adenomas contain high amounts of intracytoplasmic fat; approximately 70% of adrenal adenomas are rich in lipids.[22] This high lipid content allows for the use of densitometry, measured as Hounsfield units (HU), to distinguish benign and malignant lesions on unenhanced CT.[1] Initial reports used an HU threshold of less than 0 to indicate a benign lesion, with high specificity (100%) but poor sensitivity (47%).[23] A meta-analysis of 10 studies that evaluated 495 adrenal lesions (272 benign and 223 malignant) by unenhanced CT found that an HU threshold of less than 10 had a sensitivity of 71% and specificity of 98% for the diagnosis of an adrenal adenoma, without further radiologic imaging.[24] This method has become the standard for initial evaluation of incidental adrenal lesions without intravenous contrast.[1]

Approximately 30% of adrenal masses may have an indeterminate HU (between 10 and 30), necessitating contrast-enhanced CT with delayed washouts.[1] Because of neovascularization, malignancies tend to have increased contrast accumulation; as a result, intravenous contrast washes out from adenomas, both lipid rich and lipid poor, more quickly than from adrenal malignancies and pheochromocytomas.[25] Contrast washout can be calculated in 2 ways: absolute percentage washout (APW) requires both noncontrast and contrast scans ([(enhanced HU−delayed HU)÷(enhanced HU−noncontrast HU)] × 100), whereas relative percentage washout (RPW) can be calculated based on an initial CT scan with contrast and delayed scans only ([(enhanced HU−delayed HU)÷enhanced HU] × 100). In adrenal protocol CT scans, initial noncontrast imaging is followed by contrast imaging; a 15-minute delayed scan is then performed. Adrenal masses with initial noncontrast HU less than 10 do not warrant contrast imaging.[2,26] A 2002 prospective study of 166 adrenal

masses imaged using this protocol found that an APW threshold of greater than 60% had a sensitivity of 86% and specificity of 92% for distinguishing lipid-poor adenomas from nonadenomas and an RPW threshold of 40% had a sensitivity of 82% and specificity of 92%.[26,27] Other studies have confirmed these thresholds using 15-minute delayed imaging.[22,25,27–29]

MRI may also be used for the characterization of adrenal lesions. Malignant adrenal lesions tend to contain more water and less fat than benign lesions and therefore have higher signal on T2 images, although pheochromocytomas may also have a similar appearance.[1,20] When gadolinium contrast is used, adenomas appear more homogenous, whereas malignancies are heterogeneous. However, there is significant overlap in the characteristics of benign and malignant lesions; therefore, MRI may not definitively distinguish adenomas from malignant masses.[30]

Adrenal lesions not well characterized by CT or MRI may benefit from radionuclide adrenal imaging with specific radiolabeled compounds that target elements of adrenal function and help characterize lesions.[31,32] These radiotracers may include metaiodobenzylguanidine (MIBG) for medullary tissue lesions and fludeoxyglucose F 18 (^{18}F FDG) for malignant tumors.[33] MIBG imaging may identify both nonhypersecreting and hypersecreting adrenal medulla lesions with a positive predictive value of 83%.[32] ^{18}F FDG-PET/CT has a sensitivity 99% to 100% and specificity of 94% to 100% for identifying malignant lesions.[32,34,35]

Biochemical Evaluation of Adrenal Tumors

Initial evaluation of an adrenal mass should be to determine functional status.[5,36] A thorough history and physical examination should be obtained, with specific questions related to eliciting symptoms of excess production of aldosterone, cortisol, or catecholamines (**Table 1**).[2,5] Evaluation should include assessment of other constitutional symptoms, including weight loss, history of cancer, and smoking history, as a primary ACC or adrenal metastases must also be considered in the differential diagnosis.

METASTASES TO THE ADRENAL GLAND

Isolated adrenal metastases are most commonly from a primary lung cancer, but other sites of primary malignancy include breast, melanoma, kidney, colon, stomach, and lymphoma.[37–39] The benefits of surgery for metastatic disease are controversial, but studies have demonstrated improved survival in properly selected patients. Adrenal metastases should be suspected in patients with known history of cancer who are found to have an adrenal mass on initial workup or routine surveillance of the primary malignancy. Evaluation should include comparison to prior imaging and biochemical evaluation for a functional adrenal tumor.[2,40]

According to the American Association of Clinical Endocrinologists (AACE) and American Association of Endocrine Surgeons (AAES) guidelines on the management of adrenal incidentaloma, a thorough evaluation for locoregional recurrence and other metastatic sites is required if an adrenal metastasis is suspected.[2] Adrenalectomy can be considered to improve disease-free survival in appropriately selected patients without significant other sites of disease and good performance status. Given the safety of minimally invasive surgery, it should be considered as a first-line approach for isolated adrenal metastases.

Several studies have examined the outcomes of patients undergoing adrenalectomy for adrenal metastases. A retrospective review from the Mayo clinic matched 166 patients who underwent adrenalectomy for adrenal metastases to Surveillance, Epidemiology, and End Results (SEER) data of similar patients who did not undergo

Table 1
Evaluating for hormonal excess in adrenal tumors

	Signs/Symptoms	Biochemical Evaluation
Cushing's syndrome	• Weight gain • Easy bruising • Acne • Proximal muscle weakness • Striae • Fatigue • Neuropyschological disturbances • Hypertension • Glucose intolerance • Hyperlipidemia • Menstrual abnormalities	• Overnight 1 mg dexamethasone suppression test • 24-h urine free cortisol • Late-night salivary cortisol (at least 2 tests)
Pheochromocytoma	• Severe headache • Weight loss • Anxiety • Sweating • Cardiac arrhythmia • Palpitations • Syncope	• Plasma free metanephrines • 24-h urine fractionated metanephrines and catecholamines
Primary aldosteronism	• Hypertension (often refractory) • Fluid retention • Hypokalemia • Muscle cramps • Polyuria • Palpitations	Plasma aldosterone/renin ratio

Data from Young WF Jr. Clinical practice. The incidentally discovered adrenal mass. N Engl J Med 2007;356(6):601–10; and Zeiger MA, Siegelman SS, Hamrahian AH. Medical and surgical evaluation and treatment of adrenal incidentalomas. J Clin Endocrinol Metab 2011;96(7):2004–15.

adrenalectomy.[41] Patients with primary soft-tissue, kidney, lung, and pancreatic tumors were found to have better overall survival at 3 years: sarcoma (86% vs 30%), kidney (72% vs 27%), lung (52% vs 25%), and pancreas (45% vs 12%). In this study, risk factors for death included shorter interval from primary diagnosis to adrenalectomy, other distant sites of disease, surgery for palliation, and persistent disease. A retrospective European multicenter review identified 317 patients who underwent adrenalectomy for adrenal metastases; the most common primary tumor was non–small cell lung cancer (47%), followed by colorectal (14%) and renal (12%) cancers.[39] Laparoscopic adrenalectomy was performed in 146 (46%) patients. Median overall survival was 29 months, with 3- and 5-year survival of 42% and 35%, respectively. Patients who underwent laparoscopic adrenalectomy had improved survival (hazard ratio, 0.65; 95% confidence interval, 0.47–0.90).

Laparoscopic adrenalectomy has been shown to be safe and oncologically appropriate for adrenal metastases. A retrospective review of 92 patients undergoing adrenalectomy (94 adrenalectomies: 63 open and 31 laparoscopic) for isolated adrenal metastases found a median overall survival of 30 months and 5-year estimated survival of 31%.[42] In comparing laparoscopic with open surgery, there was no difference in local recurrence, margin status, disease-free interval, or overall survival. Laparoscopic adrenalectomy was associated with decreased blood loss (106 vs 749 mL; $P<.0001$),

operative time (175 vs 208 minutes; $P = .04$), length of stay (2.8 vs 8.0 days; $P<.0001$), and complication rates (4% vs 34%; $P<.0001$). A more recent study of 90 patients who underwent adrenalectomy for adrenal metastases found that laparoscopic adrenalectomy, performed in 55 (61%) patients, was associated with smaller tumor size and reduced blood loss, operative time, and length of stay.[38] Median overall survival was 2.46 years (range, <1 month to 15 years) and 5-year survival was 38%, with no difference in overall survival between laparoscopic and open adrenalectomy.

PREOPERATIVE PREPARATION

Preoperative preparation depends on the functional status of the mass. For patients with a pheochromocytoma, preoperative α-adrenergic blockade is necessary to decrease risk of perioperative cardiovascular complications.[43] Medication should be started 7 to 14 days before planned surgery for adequate time to correct blood pressure and heart rate. β-Adrenergic blockade should be initiated for reflexive tachycardia only after appropriate α-blockade. Patients should also be encouraged to increase sodium and fluid intake to counteract the catecholamine-induced volume contraction. It is important that preoperative consultation and discussion is arranged with the anesthesia team so they are prepared to manage hemodynamic changes during the procedure. For patients with cortisol production, patients may require perioperative steroids with outpatient follow-up for monitoring and tapering of steroids.

APPROACHES TO SURGERY: LAPAROSCOPIC TRANSABDOMINAL VERSUS POSTERIOR RETROPERITONEOSCOPIC ADRENALECTOMY

The laparoscopic transabdominal and posterior retroperitoneoscopic approaches to adrenalectomy both afford specific advantages and disadvantages (**Table 2**).[44]

Table 2
Advantages and disadvantages of laparoscopic transabdominal and posterior retroperitoneoscopic adrenalectomy

	Advantages	Disadvantages/Contraindications
Retroperitoneoscopic	• Do not have to mobilize other organs • Not affected by prior abdominal surgery • No intraperitoneal insufflation (for patients with potential cardiovascular or respiratory compromise) • Same position for bilateral adrenalectomy	• Not suitable for obese patients • Short distance between 12th rib and iliac crest (<4 cm) • Not suitable for known or highly suspected malignant tumor (ACC or pheochromocytoma); evidence of invasion into adjacent structures
Laparoscopic transabdominal	• Can be combined with other transabdominal procedure • Easier access for conversion to open procedure • More suitable in obese patients	• Need to change position for bilateral adrenalectomy • Need to mobilize abdominal structures • Not suitable for known or highly suspected malignant tumor (ACC or pheochromocytoma); evidence of invasion into adjacent structures

Data from Callender GG, Kennamer DL, Grubbs EG, et al. Posterior retroperitoneoscopic adrenalectomy. Adv Surg 2009;43:147–57.

Proper patient selection is essential, with minimally invasive adrenalectomy not recommended for suspected or known ACC.[45] The transabdominal approach was initially widely adopted as the view is more familiar to most surgeons and allows for combination with other abdominal procedures.[20] This approach requires mobilization of the colon, spleen, and pancreas (left) and liver (right), and intra-abdominal adhesions from prior surgical procedures may be present. Retrospective review of laparoscopic transabdominal adrenalectomy in patients with prior abdominal surgery has shown it to be safe, without significantly increasing operative time, complication rates, conversion to open surgery, or length of stay.[46,47]

PRA provides direct access to the adrenal gland without requiring mobilization and retraction of other organs.[48] A retrospective review suggested a selection algorithm for the 2 procedures by comparing anthropometric parameters between 52 patients who underwent laparoscopic transabdominal adrenalectomy and 30 patients who underwent PRA.[49] They recommended selection for PRA if distance from Gerota's fascia to the skin was less than 5 cm and the 12th rib was at or rostral to the level of the renal hilum. The transabdominal approach was recommended in obese patients with thick perinephric fat, a long distance from Gerota's fascia to skin, and tumors greater than 6 cm, as the limited space in PRA makes this dissection especially challenging. In a retrospective review of 118 PRAs comparing the authors' initial experience with PRA to their more recent experience, the authors noted a decrease in rates of complications (15.9% vs 7.7%, $P = .29$) and conversion to an open procedure (9.5% vs 1.9%, $P = .19$), although neither reached statistical significance.[50] However, the authors did gain increasing comfort with patients with higher body mass index (BMI), successfully performing PRA on 55 patients with BMI 30 or more and 17 patients with BMI 35 or more, despite longer operative times than in patients with BMI less than 30 (106 vs 125 minutes, $P = .01$).

SURGICAL TECHNIQUE: LAPAROSCOPIC TRANSABDOMINAL ADRENALECTOMY

Patient Positioning

Patients should be placed in a supine position on the operating table; a bean bag should be placed below the patient. After the induction of general anesthesia, an orogastric tube and Foley catheter are usually placed, both of which may be removed at the end of the procedure. The patient is turned to a lateral decubitus position with the affected side up. An axillary roll is placed, and the elevated arm is secured on an elevated arm board. Pillows are placed between the legs, with the lower leg flexed and the upper leg straight. The superior iliac spine should be positioned at the break point in the operating table and the bed is flexed to increase working space.

The patient should be prepared and draped down to the midline of the abdomen (**Fig. 1**). Landmarks that should be noted, the costal margin and the midline, are marked. The Veress needle or Hasson technique may be used for access into the abdomen. The initial entry is made at the anterior axillary line, 2 cm below the costal margin. The authors prefer to use the Hasson technique with a balloon-tip adjustable 10- to 12-mm trocar and a 10-mm 30° laparoscope. The abdominal space should be insufflated to 15 mm Hg, and after inspection for intra-abdominal adhesions, additional 5-mm ports are placed medial and lateral to the initial port, making sure that port sites are greater than 5 cm apart to allow for mobility of the laparoscopic instruments.

Right Laparoscopic Transabdominal Adrenalectomy

For a right adrenalectomy, the patient is positioned with the right side up, and after placement of the ports, dissection is begun by incising the right triangular ligament.

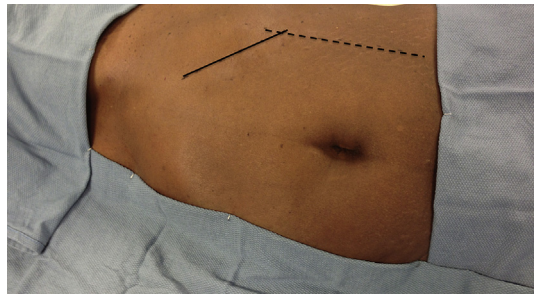

Fig. 1. Positioning for left laparoscopic transabdominal adrenalectomy. Solid line marks the costal margin and dotted line marks the anterior midaxillary line.

Most of the dissection should be performed with an ultrasonic or bipolar device. This incision should be carried up to the level of the diaphragm. A fourth port is often used (placed through the falciform ligament, in the midline of the abdomen), to allow use of a gentle liver retractor. Once the liver is completely mobilized, it should be retracted medially, allowing for visualization of the adrenal gland and the inferior vena cava (IVC). The right adrenal vein empties directly into the IVC and is identified by gentle dissection of the gland on its medial border. The plane between the adrenal gland and IVC should be gently created, using blunt dissection and electrocautery. The adrenal vein should be carefully delineated and be doubly ligated with clips. If the adrenal vein cannot be safely ligated with clips alone, a vascular stapler may be used. After the vein has been secured, the rest of the medial and inferomedial attachments are divided. The gland is then elevated, and the remainder of the avascular posterior and lateral attachments are ligated. The gland is placed in a retrieval bag and removed from the 12-mm port site, which may need to be increased in size to allow for safe removal of larger adrenal glands. The fascia for the 12-mm trocar site should be closed at the end of the procedure.

Throughout the procedure and dissection, it is important to avoid undue pressure, retraction, or grasping of the adrenal gland, as this may cause fracture or tearing of the gland. If surgery is being performed for a pheochromocytoma, constant communication with the anesthesia team is essential, including notifying the team when the adrenal vein is being ligated. The anesthesia and surgical teams must be ready for significant alterations in blood pressure and may need to pause dissection for addressing these needs.

Left Laparoscopic Transabdominal Adrenalectomy

Left adrenalectomy may be performed with 3 ports, although an additional medial port may be used to aid in retraction (**Fig. 2**). The first step is mobilization of the splenic flexure of the colon. This step may need to be performed before the most lateral port can be placed. The splenorenal ligaments are then divided up to the diaphragm to allow the spleen to be retracted medially. Caution must be taken at this point to create a proper plane between the pancreas and the left kidney; Gerota's fascia should not be accessed. With the spleen and tail of the pancreas mobilized medially, an additional medial port may be placed to aid in retraction. The adrenal gland should now be seen adjacent to the superior pole of the kidney. The medial border of the adrenal gland should be dissected free with a combination of blunt dissection and electrocautery, again using the ultrasonic device. On the left, the adrenal vein drains into the renal vein and may be seen inferomedial to the adrenal gland (**Fig. 3**). Once it is

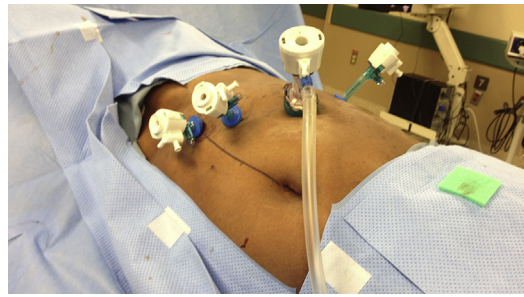

Fig. 2. Port placement for left laparoscopic transabdominal adrenalectomy.

properly dissected free, it should be ligated with a clip applier. The inferior phrenic vein may also enter into the adrenal vein and may require ligation. After the adrenal vein is ligated, the remaining attachments of the gland can be divided. The inferior portion of the gland is elevated to aid in division of the posterior attachments and small arterial branches. Once the gland is completely free, it may be placed into a retrieval bag for removal.

SURGICAL TECHNIQUE: POSTERIOR RETROPERITONEOSCOPIC ADRENALECTOMY

The technique for PRA has been extensively described by Walz and colleagues[51] and is summarized here.[52,53] Patients are intubated in the supine position after placement of sequential compression devices and a Foley catheter. The patient is then turned to the prone, jackknife position on a Cloward table (Surgical Equipment International, Honolulu, HI), which has an open space for the abdomen between the hip support to allow contents to fall forward, being careful to place appropriate padding for the patient's face (**Fig. 4**A). The arms are positioned on arm boards, with elbows bent at 90° angle. The hips and knees are also bent at a 90° angle, ensuring that the knee rest is low enough to limit pressure on knees and prevent the hips from being elevated, which can narrow working space.

The landmarks that should be noted in this position are the 12th rib and iliac crest. The initial incision is made just below the tip of the 12th rib. Using sharp dissection with Metzenbaum scissors, the underlying soft tissue is incised and the retroperitoneum is accessed. The index finger is used to create space, and under direct palpation, a 5-mm port is placed medially, just lateral to the paraspinous musculature. The lateral

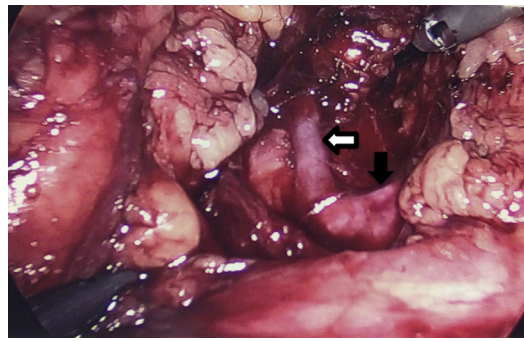

Fig. 3. Left adrenal vein (*no fill arrow*) entering into left renal vein (*solid arrow*).

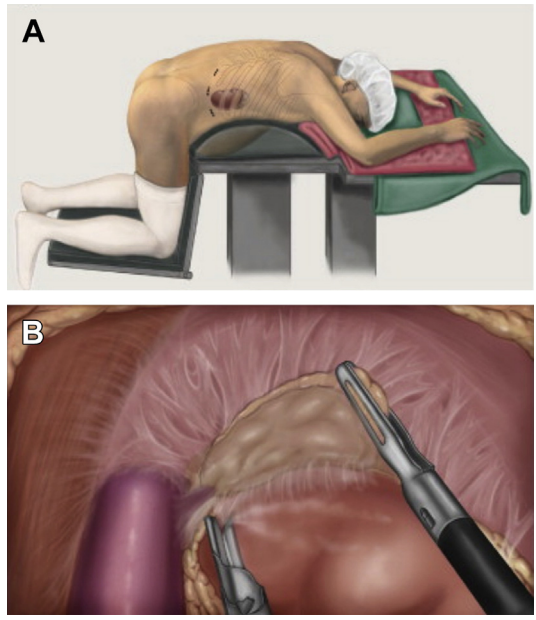

Fig. 4. Right posterior retroperitoneoscopic adrenalectomy. Patient positioning on Cloward table (*A*). After working space is created in the retroperitoneum, dissection begins by separating the lower aspect of the adrenal gland from the superior pole of the kidney (*B*). (*From* Dickson PV, Jimenez C, Chisholm GB, et al. Posterior retroperitoneoscopic adrenalectomy: a contemporary American experience. J Am Coll Surg 2011;212(4):660; [discussion: 665–7]; with permission.)

5-mm port is also placed under direct palpation, 5 cm lateral to the initial incision. A blunt 12-mm trocar with inflatable balloon and adjustable sleeve is then placed through the initial (middle) incision. The retroperitoneal space is then insufflated with high flow to a pressure of 20 to 24 mm Hg. This high insufflation pressure allows the retroperitoneal space to be adequately opened and helps prevent bleeding from smaller veins to aid in dissection. A 10-mm 30° laparoscope is placed in the middle trocar, with the surgeon working through the medial and lateral trocars to ligate the tissues of the retroperitoneum. Once the retroperitoneal space has been developed, a 5-mm 30° laparoscope is used, via the most medial port, and the lateral 2 ports are used by the operating surgeon.

The first landmark to be identified with careful blunt dissection is the superior pole of the kidney. During a right adrenalectomy, the IVC is seen medially, although it may be significantly decompressed because of the high insufflation pressure (see **Fig. 4**B). Mobilization of the adrenal gland should always begin inferiorly; this is done by gently pushing down on the kidney with a laparoscopic peanut and lifting the adrenal superiorly. The tissue along the superior border of the kidney is gently divided using an ultrasonic coagulator or bipolar device. This plane should be created first, as it is easier to accomplish with the other attachments in place with minimal manipulation of the adrenal gland. The adrenal vein should then be identified, medial to the adrenal gland. After it has been carefully dissected free, the vein is grasped on its distal side (closest to the adrenal) with a grasper, clips are doubly placed on the proximal side, and the vein is divided using electrocautery. The rest of the adrenal attachments are then

ligated. A retrieval bag is then inserted through the middle port, and the gland is removed. The trocar is then replaced, and the retroperitoneal space is inspected for hemostasis. To visualize any venous bleeding that may have been masked by the high insufflation pressure, the pressure is lowered to 8 to 12 mm Hg. Once hemostasis has been confirmed, the ports are removed, the larger port is closed in layers, and the skin is closed at all sites with absorbable suture. Occasionally, a tear may occur in the peritoneum, which may result in pneumoperitoneum as well. These tears do not have to be closed and usually do not interfere with the procedure.

OTHER APPROACHES TO ADRENALECTOMY

With the continued advances in minimally invasive procedures, there is the drive to identify ways to expand current methods. The first robotic adrenalectomy was reported in 2001.[54] Since then, the robotic approach has been used for both transabdominal adrenalectomy and PRA. Multiple studies have shown no significant difference in rates of conversion to open adrenalectomy, complications, or blood loss between robotic and laparoscopic adrenalectomy, and although operative times may be initially longer, this seems to improve with increasing experience.[55–58] However, use of the robot requires availability of the instrument, specific training, and a learning curve separate from laparoscopy alone. The advantages of robotic adrenalectomy may include improved ability to perform cortical sparing adrenalectomy in patients with familial syndromes who may require bilateral adrenalectomy to avoid steroid dependence and for the posterior approach it may be useful in patients with glands located superior to the 12th rib.[59]

Another area of interest has been single-incision minimally invasive surgery. It has been used for both PRA and for the transabdominal approach. Reported studies have shown overall no significant difference in operative time and complications; however, significant benefits have also not been demonstrated.[60,61] Although this method has been shown to be feasible, further studies are needed to determine risks and benefits.

INDICATIONS FOR OPEN SURGERY

Since the introduction of minimally invasive adrenalectomy, its use for cases of suspected adrenocortical malignancy has been controversial. ACC is a rare malignancy, with an incidence of 1 to 2 per million per year with a high rate of recurrence and poor long-term survival.[62] Proponents of open surgery contend that ACC tends to invade through the tumor capsule with microscopic disease present at the gland surface, which laparoscopy can disrupt and spread.[21] The AACE/AAES recommends that open adrenalectomy be performed for suspected ACC with lymphadenectomy, with a goal to leave the capsule intact to reduce risk of local recurrence.[2,62] However, the European Society of Endocrine Surgeons position statement on malignant adrenal tumors states that laparoscopic resection may be performed for ACC or potentially malignant tumors with preoperative and intraoperative stage I–II ACC and diameter less than 10 cm.[63]

There are inconsistent data on the safety and efficacy of minimally invasive surgery for suspected ACC, which is hindered by the rarity of the disease. Studies have demonstrated increased recurrence rates and decreased disease-free and overall survival in patients undergoing laparoscopic adrenalectomy for ACC.[64–67] Other European studies have found that laparoscopic adrenalectomy may have an outcome similar to open adrenalectomy for ACC, with no significant difference in both local and distant recurrence rates and disease-free or overall survival.[68,69] The differing

data and recommendations demonstrate the continued controversy and regional differences.

SUMMARY

Minimally invasive adrenalectomy has become the standard operative approach for adrenal resection in the appropriate clinical setting. Both the laparoscopic transabdominal and posterior retroperitoneoscopic approaches have been shown to be safe and effective for most adrenal pathologies. PRA may be preferred in patients with prior abdominal surgeries or bilateral adrenal disease, whereas laparoscopic transabdominal adrenalectomy is recommended in the obese and morbidly obese. The authors continue to recommend that open adrenalectomy be performed for all patients with known or suspected ACC.

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