Difficulties in Laparoscopic Adrenalectomy

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Introduction

Laparoscopic adrenalectomy is the method of choice in the majority of adrenal lesions. The open surgical approach for adrenal lesions requires a long skin incision, which at times may require muscle and rib cutting. The laparoscopic approach is quick and safe, the magnification offers excellent visibility, and blood loss is substantially decreased if the surgical technique is meticulous. Adrenalectomy is also one of the few laparoscopic procedures in which, due to the quick access to the area in question, has a shorter operative time [1]. Although there is general agreement on use of this approach for benign and small lesions, the issue of the laparoscopic approach in adrenocortical carcinomas remains unresolved [2]. This chapter discusses operative technique and troubleshooting measures. The steps, which require attention before and during adrenalectomy include:

1. Preoperative preparation of the patient
2. Preoperative imaging to ascertain the possible nature of the disease and the status of the contralateral gland
3. Port placements to ensure unhindered dissection
4. Tips and tricks to identify the adrenal vein and prevent hemorrhage during the procedure

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Surgical Anatomy

The right gland is more superiorly located in the retroperitoneum. It is almost directly cranial to the upper pole of the right kidney. Surrounding structures include the liver anterolaterally, the duodenum anteromedially, and the inferior vena cava medially. It is also important to note that there is often a retrocaval extension of the gland on the right side. These facts are important for optimal port placement and dissection in relation to the vena cava. The left gland is crescentic and medial to the upper pole of the left kidney. The upper and anterior aspects are related to the stomach, tail of the pancreas, and splenic vessels [3]. During dissection of the splenic flexure, the above structures need to be protected.

The arterial supply to the adrenal gland originates from three sources. Superiorly, from the inferior phrenic artery, few branches directly originate from the aorta. At times, branches from the aorta also supply the adrenal. Most of the time, no definite artery can be identified. Frequently, both the adrenals are drained by a single adrenal vein. The adrenal vein is the key structure to be identified during adrenalectomy. On the left side it enters the cranial aspect of the left renal vein. On the right side, the adrenal vein enters the vena cava directly on its posterolateral aspect [3]. The significance of this lies in securing the adrenal vein during adrenalectomy. The short stump of the adrenal vein and its origin from the cava require care when applying lateral traction. In regards to the left adrenal vein, it arises from the inferomedial aspect of the gland to enter the renal vein. This vessel has a close relation to the upper polar renal artery, upper polar branch of the main renal artery, and the inferior phrenic artery. One should be cautious of these structures while securing the adrenal vein.

The Surgical Procedure

The authors prefer the transperitoneal approach. All the laparoscopic adrenalectomies at the authors' center are carried out via the lateral transperitoneal approach.

Transperitoneal Approach

Left Side

Once the pneumoperitoneum is created, the ports are placed (Fig. 12.1), the white line of Toldt is incised and the colon reflected. The key step for adequate exposure is dissection of the splenorenal ligament right down to the splenic hilum (Fig. 12.2). The colon should be reflected optimally to expose the renal vein. The adrenal vein is identified from its origin from the renal vein. The authors prefer to secure the renal vein with the help of either Allport® (Ethicon Endo-Surgery, Inc., Cincinnati, Oh) or Ligaclips (Ethicon Endo-Surgery, Inc., Cincinnati, OH). In the authors' initial cases, the Hem-o-lok clip™ (Teleflex Medical, Research Triangle Park, NC) was used for ligation. The next step to be followed is dissection posterior to the clips

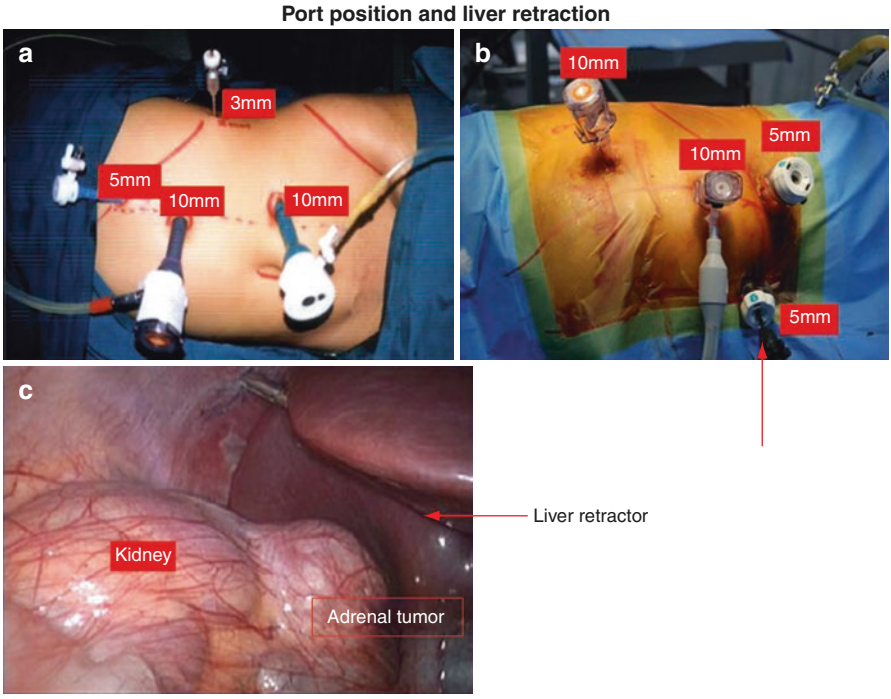


Fig. 12.1 (**a**) Left-side transperitoneal adrenalectomy with four ports (one 10 mm for camera, one 10 mm for working instruments, one 5 mm for retraction, and occasionally one 3 mm for lateral retraction). (**b**) Right transperitoneal adrenalectomy with 4-port approach. The ports mirror the left side; an additional 5-mm port helps in liver retraction. (**c**) 5 mm Allis locking forceps helps in retraction of the liver on the right side; note that the adrenal mass is easily visible through the peritoneum

along the psoas muscle (Fig. 12.3). Once this is done, the dissection should be outside the adrenal fascia; this helps in preventing fractures of the adrenal. The next step is dissection along the superior border of the aorta. As the adrenal does not have any definite blood supply, any suspicious blood vessels should be secured. The medial wall of the adrenal is dissected last. In all cases of adrenal lesions suspected to be pheochromocytomas, the adrenal vein should be secured first; in all other cases it is prudent to dissect and secure the adrenal vein last because of the concern that early ligation of the adrenal vein might cause congestion of the gland and subsequent oozing.

Right Side

The port placement mirrors that on the left side, except an extra port is required for retraction of the liver (Fig. 12.1). The lie of the colon differs on the right side as compared to the left, the landmarks to be identified in these cases are the inferior vena cava and the renal vein (Fig. 12.3). Once the kocherization of the duodenum is done, the inferior vena cava is traced, this is followed by identifying the renal vein.

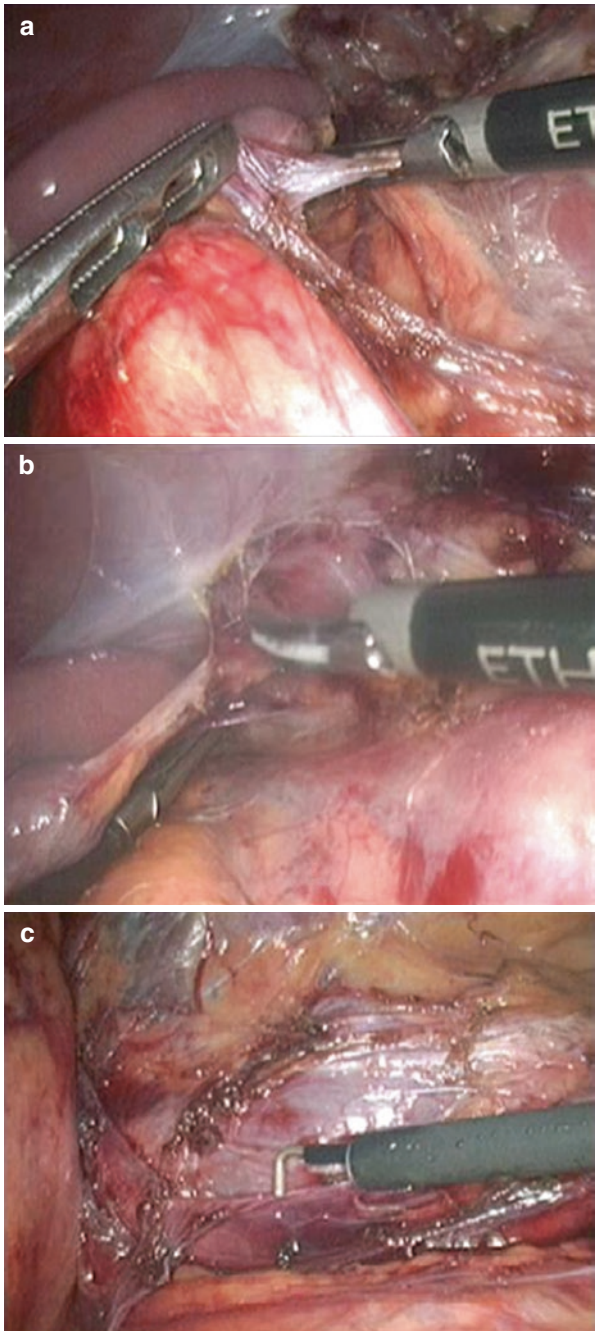
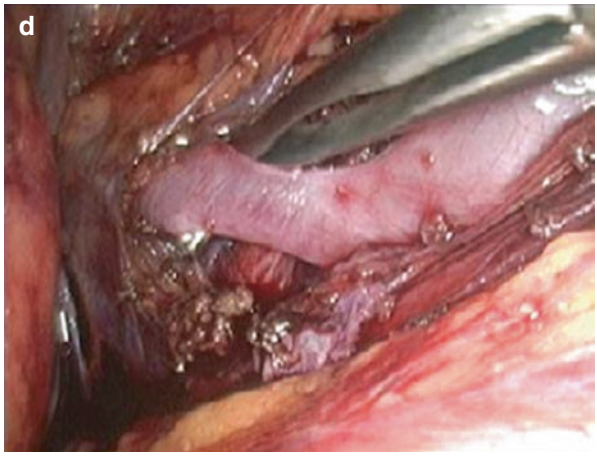
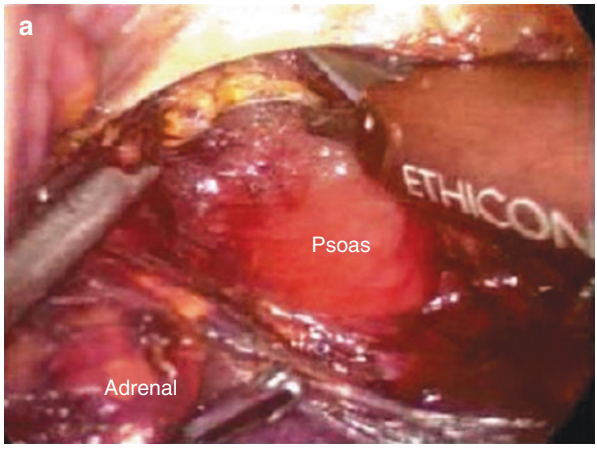


Fig. 12.2 (**a**, **b**) On the left side, aggressive dissection of the splenic flexure with division of splenocolic ligament makes the spleen fall off and provides exposure of the adrenal bed. (**c**) On the left side, the renal vein acts as a guide to identify the adrenal vein. (**d**) Dissection of adrenal the vein

Fig. 12.2 (continued)





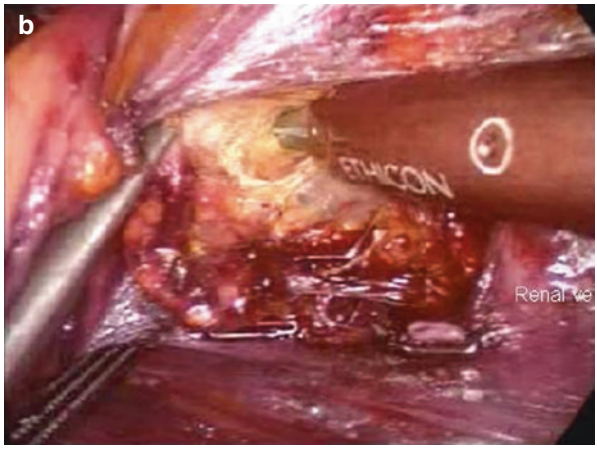


Fig. 12.3 (**a**, **b**) Once the adrenal vein is secured, the next step should be to identify the psoas; this helps in the dissection between the kidney and adrenal without injuring either. (**c**, **d**) The vena cava and renal vein are the landmarks for dissection on the right side

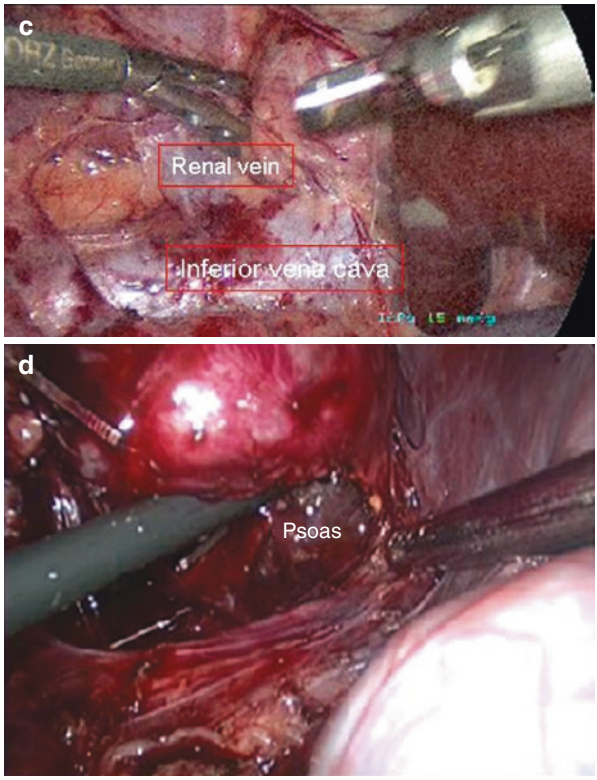


Fig. 12.3 (continued)

The adrenal gland is dissected on the superior border of the vena cava. The dissection on the under surface of the liver needs to be aggressive for proper identification and securing of the adrenal vein. The adrenal vein can be secured with Hem-o-lok™ clips (Fig. 12.4).

All adrenalectomy specimens should be bagged before retrieval, typically they are retrieved by extending one of the ports.

Although a variety of approaches have been described, all of them have their own advantages and disadvantages. In a nonrandomized, background-matched analysis, the authors of a study concluded that if a tumor was more than 5 cm and the surgeon not experienced, then the lateral transperitoneal approach was preferred. The lateral retroperitoneal approach was also preferred in cases with upper abdominal surgeries [4, 5].

In the *anterior transperitoneal approach*, the patient is in semi-lateral position. On the right side the hepatocolic ligament is incised, while on the left side the phrenicocolic ligament is incised.

In the *lateral transperitoneal approach*, the patient is in full lateral position. In this approach, the dissection is carried out till the diaphragm close to the curvature of the stomach. The spleen falls off the operating field, which helps to improve the exposure. On the right side, mobilization of the triangular ligament is carried out. The dissection is continued up to the diaphragm. This helps in allowing good exposure as the liver is shifted away from the operating field.

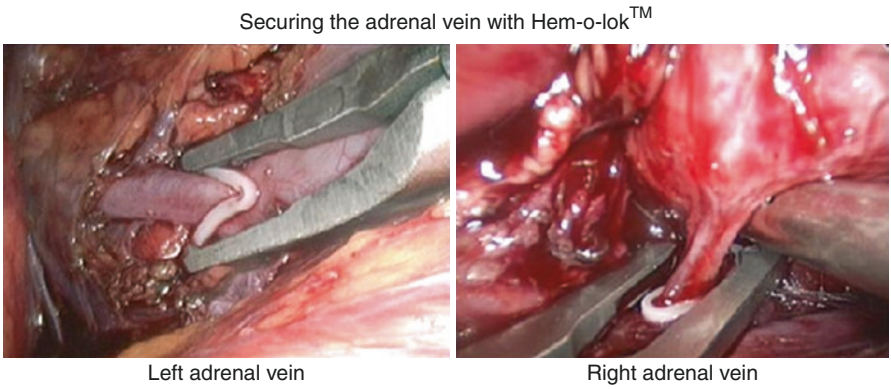


Fig. 12.4 The adrenal vein should be circumferentially dissected prior to clipping. This helps in proper application of clips

Retroperitoneal Approach

The patient is placed in a lateral decubitus position. A 15-mm incision is made under the 12th rib. The space is created with the help of a balloon dilator after finger dissection. The camera port is inserted and the rest of the ports are inserted under vision; a five-trocar approach has been described (one is 12 mm, two are 10 mm, and two are 5 mm). The kidney remains in contact with its peritoneal attachment. The psoas muscle acts as a landmark. The renal vein on the left side and the vena cava on the right side are identified to ascertain the position of the adrenal vein. The suction drain is kept at the conclusion of the procedure. The specimen is always bagged [6].

Key Steps to Avoid Problems in Laparoscopic Adrenalectomy

Preoperative Preparation of the Patient

Optimal preoperative preparation in patients undergoing surgery for pheochromocytoma is key to success and safety. The pillars of success are:

1. Correction of biochemical abnormalities
2. Volume repletion
3. Bowel preparation for transperitoneal approach

Patients to be operated for pheochromocytoma need special care. Alpha-adrenergic blockade should be started 2 weeks before surgery, preferably phenoxybenzamine, starting gradually with a dose of 10–20 mg twice per day. Some individuals may require beta blockade. Intraoperatively, high blood pressure can be treated with nitroprusside or a short-acting β(beta) blocker like esmolol. Volume repletion is important to prevent the postoperative hypotension secondary to loss of tonic vasoconstriction.

Patients with Cushing's syndrome require correction of electrolyte abnormalities and diabetes before surgery. It is prudent to estimate cortisol levels in these patients. These patients are prone to infection and they should be administered preoperative antibiotics. Occasionally they may need steroids, intraoperatively or postoperatively [3].

Imaging Studies

It is generally accepted that the plain film of the abdomen has little value in identifying and evaluating adrenal tumors, although calcification within an adrenal mass is commonly thought to signal malignancy. Ultrasound, although effective, may be of limited benefit in obese patients and patients having overlying bowel gas. Computed tomography (CT) generally is considered the method of choice in the radiodiagnostic evaluation of adrenal disease. The location, size, and shape of adrenal masses and nodules as small as 1 cm generally are demonstrated using conventional CT techniques. However, using thin-section CT scanning, nodules as small as 3–5 mm can be identified. Magnetic resonance imaging (MRI) improves adrenal imaging and provides prognostic help by appearance of the lesion on T1 and T2 imaging modes [7].

Exposure of the Adrenal Gland

Difficulties may arise due to inadequate exposure of the adrenal gland, leading to troublesome hemorrhage from the adrenal vein and the adrenal gland. These Most of the time the solution is proper port placement, adequate mobilization of the colon, and exposure of the splenorenal recess (Figs. 12.1–12.3).

Port Placement and Patient Positioning

The patient in a lateral position in a transperitoneal approach offers adequate exposure as the viscera tends to fall with gravity. The port position at the authors' center is as shown in Fig. 12.1. It resembles that of a transperitoneal nephrectomy, and typically the ports are placed more cranially as compared to the position in a nephrectomy. In addition, the colon should be reflected adequately so that the renal vein is adequately exposed. The adrenal bed is better exposed when the splenorenal ligament is taken down along the greater curvature of the stomach.

Placing an additional port, which may be either a 3- or 5-mm port, improves the exposure. A retractor inserted through this port helps in retracting the kidney and delineating the mass in a better way, but one needs to be careful of injuring the spleen/liver through such laterally placed ports on the left side [8].

The port for retracting the liver should be inserted in the midline as high as possible near the xiphisternum and passed along the undersurface of the liver towards the lateral sidewall. Care must be taken to avoid injuring the gall bladder. Various instruments can be used to retract the liver; they include the fan retractors and

locking Allis 5-mm clamps. The authors use the locking Allis clamp for the purpose. The Allis clamp is closed and locked, thereby creating a self-retaining retractor that does not require an assistant to hold it (Fig. 12.1).

Mobilizing the spleen is a safe and feasible way of gaining adequate exposure on the left. While mobilizing the spleen, care must be taken not to tear the splenic capsule or to injure the diaphragm. If, however, in spite of extensive mobilization one finds a floppy spleen, a suprapubic trocar can be inserted and a sponge holder with gauze can be used for retracting the spleen and the pancreas.

Dissection of the Adrenal Vein

The adrenal vein is identified on the left side by identifying the renal vein. At times the renal vein can be identified by tracing the origin of the gonadal vein (Fig. 12.2). The gonadal vein almost always enters the renal vein opposite the entry point of the left adrenal vein. Therefore, upon reaching the left renal vein along the gonadal vein, dissection is performed medially along the anterior surface of the renal vein to identify the left adrenal vein. The key point in the dissection of the adrenal vein is that it should be dissected for a considerable length. The adrenal vein should always be dissected till the limit of the adrenal gland is seen (Fig. 12.2).

The adrenal gland should be dissected outside the periadventitial plane, if this plane is not followed, one runs the risk of causing parenchymal fractures and persistent oozing from the adrenal surface. On the left side, a combination of blunt and sharp dissection helps to free the gland from the aorta and the upper pole of the kidney (Fig. 12.3). Particular care should be taken while coagulating small adrenal vessels as they may cause tears in the adrenal parenchyma.

On the right side, the adrenal gland is more easily identified through the peritoneum (Fig. 12.1). The lower aspect is separated from the renal vein (with care taken to preserve the upper polar renal artery), the medial aspect is cleared from the inferior vena cava.

Adrenalectomy in Difficult Situations

Obese Patients

Markedly obese patients have increased chance of surgical complications; this fact assumes importance in patients with Cushing's syndrome with truncal obesity.

In their study, Fazeli-Matin et al. concluded that, compared to open surgery, the laparoscopic approach offers decreased blood loss, quicker return of bowel function, less analgesia, and shorter convalescence. They observed that abdominal wall obesity is located in the pannus, which in flank position shifts from the operative side, thus flank position offers the opportunity to use routine ports. They felt that a retroperitoneoscopy approach offers a shorter and more direct route to the kidney compared to the transperitoneal approach. The points in operating on these patients include the following: experience of the surgeon; adequate padding of all pressure

points; to maintain pneumoperitoneum, use of two carbon dioxide insufflators; and insufflation done with balloon dilators and kept anterior to the psoas fascia [9].

Large Tumors and Malignancy

The opinions differ as far as adrenocortical carcinoma (ACC) is concerned. It is a deadly disease and complete resection is of utmost importance. Miller et al., in their retrospective study, concluded that laparoscopic approach should not be done in adrenocortical carcinomas [10]. The absolute contraindication for laparoscopic adrenalectomy is adrenocortical carcinomas with periadrenal invasion or venous thrombus. The relative contraindications include uncorrected coagulopathy, abdominal sepsis, intestinal obstruction, and unacceptable cardiopulmonary risk [11]. Although size alone is not a contraindication, there is considerable debate as to the size threshold for offering laparoscopic adrenalectomy as it is well known that the incidence of carcinoma increases with increasing size [12]. The estimation of risk of ACC for lesions more than 6 cm is 25% and for tumors between 4 and 6 cm is 6% and 2% for tumors <4 cm in size, as stated in the National Institutes of Health (NIH) consensus statement [13]. The authors' data revealed an incidence of 5.2% of ACC in tumors larger than 5 cm [14]. Other potential problems associated with offering laparoscopic adrenalectomy for large adrenal masses are anatomical considerations, handling of tumor, technical difficulty in dissecting large adrenal tumor, increased likelihood of complications and peritoneal dissemination of carcinoma. There is no well-defined arterial supply to the adrenal gland [11]. There will be more technical difficulty in dissection of the large adrenal mass, leading to higher chances of intraoperative hemorrhage. Direct handling of a larger tumor is more likely to lead to fracture during handling, resulting in troublesome bleeding and inadequate removal and peritoneal dissemination [11].

The prerequisites include proper preoperative diagnosis as suggested by Suzuki; findings of heterogeneous mass lesions and irregular mass lesions on CT may suggest a malignancy. The lesion should be completely removed; incompletely removed lesions have a uniformly poor prognosis [15].

Pediatric Patients

These patients should have a proper anesthesia checkup. It is advisable to have pediatric instruments (5-mm harmonic scalpel, pediatric suction and dissecting instruments). The working pneumoperitoneum pressures should be 8–10. The adrenal tumors are usually easily visible in the transperitoneal approach. In all these cases, a biochemical workup is prudent. The adrenal vein is secured with the help of an Allport® or Ligaclips.

Reports are available that describe this approach for neuroblastomas. Laparoscopic adrenalectomy for neuroblastomas is safe and feasible in children with good results; the prerequisite being adequate experience with advanced

laparoscopy. In a study by de Lagausie, adrenalectomy was performed in nine patients. The mean operative time was 85 min with no deaths. There was no instance of recurrence or metastasis. The authors noted that a transperitoneal approach is recommended because of the necessity of exploring the entire abdomen to detect and inspect enlarged lymph nodes. This approach also facilitates exploration of the aortocaval space and the hepatosplenic region. The results are good for stage I tumors [16].

Laparoscopic Adrenalectomy for Adrenal Metastasis

Most malignancies that metastasize to the adrenal are to the medullary portion (center) of the gland, rather than to the adrenal cortex. Adrenal metastases rarely penetrate through the capsule of the gland, making laparoscopic surgical resection much less likely to result in tumor fracture, which could potentially predispose a patient to increased rates of local recurrence or intraperitoneal dissemination To date, eight series totaling 98 patients have reported the use of laparoscopic adrenalectomy for metastasis with no port-site recurrences and only one patient (1%) developing peritoneal dissemination of disease [17].

Postoperative Management

Electrolyte values are checked the night of surgery and each morning; this is especially important for patients with Conn's or Cushing's syndrome. The urinary catheter can usually be removed on the first postoperative day when the patient is ambulatory. If a nasogastric tube was placed for open surgery, it can be removed with return of bowel sounds. Diet resumption is usually started on the first postoperative day for laparoscopic surgery and when bowel sounds resume for open surgery.

Blood pressure is carefully evaluated for hypertension or hypotension. Unexplained hypotension, confusion, lethargy, nausea, vomiting, or fever could represent addisonian crisis (adrenal insufficiency). Adrenal insufficiency is most commonly seen after surgery for Cushing's syndrome as a result of contra lateral cortisol suppression.

Conclusion

The key steps in adrenalectomy include adequate adrenal exposure; working along landmarks such as the renal vein, vena cava and psoas; early adrenal vein identification and clipping; and bagging of all specimens. Difficult situations such as pediatric cases, adrenocortical carcinomas, etc., should be done with discretion, depending on the experience of the surgeon. The surgeon should choose the approach (retroperitoneal or transperitoneal) with discretion. The surgeon should also not hesitate to convert to open surgery when needed.

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