Surgery in Motion

Transperitoneal Laparoscopic Adrenalectomy: Outline of the Preoperative Management, Surgical Approach, and Outcome

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1. Introduction

Minimally invasive techniques have profoundly changed the surgical approach to the adrenal gland. The clear discrepancy between the relatively small size of the target organ and the extent of the incision necessary to provide its adequate exposure and avoid resection may not be found in any other urologic ablative procedure than in adrenal surgery. Due to the establishment of laparoscopic approaches that...
circumvent this drawback while incorporating all advantages of the open approach, laparoscopic adrenalectomy has become the generally accepted standard of care for surgical management for the vast majority of cases in little over a decade [1–5]. It is safe to state that today adrenal surgery is the success story of laparoscopy in the realm of urology [6].

Since Gagner’s initial report on the laparoscopic approach for adrenalectomy in 1992, several authors have reported the feasibility and efficacy of the laparoscopic technique for the treatment of different adrenal diseases. The advantages of laparoscopic over open adrenalectomy are well documented and include a shorter hospital stay, a decrease in postoperative pain, shorter interval between surgery and return to preoperative activity level, and improved cosmetics [7].

The anatomic location of the adrenal gland in the upper retroperitoneal space, cranial and medial of the kidneys and in close proximity to the diaphragm, led to the development of various approaches, including lateral transperitoneal, anterior transperitoneal, lateral retroperitoneal, posterior retroperitoneal, and transthoracic approaches [8–10]. The lateral transperitoneal approach is the technique most often used for laparoscopic adrenalectomy [11]. Our results with laparoscopic lateral transperitoneal adrenalectomy for benign and malignant conditions of the adrenal gland are presented.

2. Methods

2.1. Diagnosis of adrenal masses

Ultrasound of the renal region may frequently give rise to suspect adrenal masses. The method of choice to securely diagnose adrenal masses and assess their size and relationship to the surrounding organs, however, is imaging via computed tomography (CT) or magnetic resonance imaging (MRI). If a pheochromocytoma is suspected 131I-metaiodobenzylguanidine (131I-MIBG) scintigraphy will complement these imaging techniques, specifically to detect extramedullary or multiple lesions. Further evaluation of serum and urine metabolic parameters should be performed to identify functional masses of the adrenal cortex and medulla, which may require specifically adjusted preoperative management or postoperative hormonal substitution. Generally, cooperation with an endocrinologist is recommended in the preoperative management of these patients.

2.2. Indications for laparoscopic adrenalectomy

Due to its proven efficacy, laparoscopic adrenalectomy is indicated for the removal of nonfunctional and functional solid adrenal masses of small to intermediate size. These include masses of the adrenal cortex (aldosteromas, glucocorticoid, androgen- and estrogen-producing adenomas) as well as solitary small pheochromocytomas. Hormone-inactive lesions >3 cm that demonstrate growth over time on serial imaging studies or tumors >4–5 cm without observation can be accessed and removed laparoscopically as well as rare lesions such as adrenal cysts or myelolipomas. Selected cases of bilateral adrenal hyperplasia may also be accessed using the laparoscopic approach. As with open surgery, increasing size and the suspicion of malignancy increase the difficulty of the procedure. The experience of the surgeon, the location of the mass in relation to other structures, its suspected composition, and the size of the mass should influence the decision-making process for open versus laparoscopic surgery. The upper size limit in very experienced hands may be as high as 10–14 cm; however, tumors >6–7 cm should be seen as the upper limit in the earlier stages of laparoscopic experience [1,2,5,8]. Special indications are the removal of malignant tumors or metastases. The criteria for performing laparoscopic surgery on these tumors include the ability to control the primary cancer, ability to resect any other metastatic lesion, and physical fitness of the patient to tolerate general anesthesia [12].

2.3. Contraindications for laparoscopic adrenalectomy

Among the absolute contraindications documented for laparoscopic adrenalectomy are extensive tumors infiltrating adjacent organs, which require en bloc resection. Likewise laparoscopically removing symptomatic pheochromocytomas during pregnancy is discouraged. Relative contraindications are morbid obesity, which may require excessive intrabdominal insufflation pressure, previous surgery with postoperative scarring, and presence of large pheochromocytomas. In case of the latter, the contraindication is due to the potential manipulation of the mass with consecutive catecholamine surges, which may be more pronounced in the laparoscopic approach. In addition, general contraindications include serious cardiac conditions (intracardiac shunts, severe aortic or mitral valve insufficiency), severe cardiac insufficiency (New York Heart Association class IV) and uncorrected coagulopathy [1,2,5,8].

The resection of metastatic processes in very advanced primary tumors of pulmonary or urothelial origin can be associated with port-site metastases; therefore, in these cases, laparoscopic adrenalectomy should be discouraged [12,13].

2.4. The transperitoneal laparoscopic adrenalectomy

The transperitoneal laparoscopic adrenalectomy has two distinct advantages. First, surgeons who access the adrenal gland laparoscopically already have gained skills for laparoscopic identification, inspection, and dissection of intra-abdominal organs and frequently have approached and removed the kidneys. The extension of the surgical field toward the adrenal glands is therefore straightforward. In addition, the anatomic landmarks for a safe procedure are well visualized. In our series, we have performed the transperitoneal lateral access due to our previous experience of >500 cases in the upper retroperitoneum including renal, adrenal, and retroperitoneal vascular cases. The anatomic landmarks for transperitoneal adrenalectomy are shown in Fig. 1.
For both the right and left adrenal gland, the arterial supply is variable and may include branches from the inferior phrenic arteries, aorta, and renal arteries. In most cases, large-caliber arteries are not seen during surgery. On the right side, this may be specially common for branches from the renal artery (a. suprarenales inferior dexter shown in Figs. 1 and 8). On the left side, the a. suprarenalis inferior sinister can be found more consistently. The arterial supply from the aorta (left and right adrenal artery) and from the inferior phrenic artery (aa. suprarenales superior) are more consistent and of relatively larger caliber.

The venous drainage is less variable, of larger caliber, and, in hormone-active tumors, of higher clinical relevance. The right adrenal vein is very short and empties into the vena cava. On the left side, the typical insertion can be seen on the left renal vein. As with the arterial side, variations may occur. It is important to remember that paraneoplastic neovascularization may occur and additionally add variability to the vascular anatomy.

2.5. Preoperative preparation

2.5.1. General recommendations

A mechanical bowel preparation is not necessary. In contrast to open surgery, the motility of the intestine remains virtually unaffected in laparoscopic procedures, as evidenced by a constant serotonin level during and after surgery. Prevention of thrombosis (low-molecular-weight heparin) is mandatory. Single-shot intravenous antibiotics using a cephalosporin should be administered at the beginning of the procedure.

2.5.2. Pharmacologic management in patients with pheochromocytoma

The preoperative medical treatment of choice is the long-acting α-adrenergic blocker phenoxybenzamine hydrochloride for a period of 5–14 d to control blood pressure preoperatively and to block catecholamine surges during intraoperative manipulation. An initial oral dose of 20–30 mg is given. This dose is slowly increased by 10–20 mg/d. The maximal dose may be as high as 160–320 mg/d to achieve adequate blood pressure; however, 20–100 mg/d is a typical dose. Only after satisfactory α-adrenergic blockade is established is this regimen complemented by β-adrenergic blockers such as propanolol at 20–40 mg three or four times daily when cardiac arrhythmia or tachycardia persists.

2.5.3. Pharmacologic management patients with Cushing disease

If unilateral adrenalectomy or bilateral subtotal adrenalectomy is performed, a single intraoperative dose of 100 mg hydrocortisone is administered. Postoperatively, 20–30 mg/d hydrocortisone (+0.05–0.2 mg flucortisone/d) should be given with continuous dose reduction.

2.5.4. Pharmacologic management patients with Conn disease

The treatment of choice is 200–300 mg/d of the aldosterone antagonist spironolactone for 2–3 wk preoperatively. Potassium may be substituted based on serum electrolyte findings.

2.6. Anesthesia

Laparoscopic adrenalectomy is performed under general anesthesia. Intraoperative invasive monitoring involves an intra-arterial line, central venous pressure monitoring, electrocardiogram, and urine output. In patients with pheochromocytoma, preoperative sedation reduces anxiety and, therefore, patient stress and possible catecholamine surges. Intravenous induction agents using propofol or ketamine and the inhalation agent halothane must not be used. A recommended regimen is the induction using intravenous thiopental and isoflurane as the inhalation agent. If during induction a vasopressor response occurs, α-adrenergic (phentolamine) and β-adrenergic (propanolol) blocking agents should be available.

2.7. Surgical setup

The surgical equipment consists of the following instruments: a dissection forceps, alternatively bipolar forceps, monopolar Endo-scissors, a 5-mm multiclip applicator, and monopolar or bipolar coagulation. To aid in the exposure a fan-retractor is needed. The specimen is harvested using an Endo-catch bag. On the laparoscopic tower a monitor and a high-flow insufflator should be used, with the intra-abdominal pressure set at 12–14 cm Hg. A 0° and 30° three-chip camera should be used. Four 12-mm trocars, alternatively two 5-mm and two 12-mm trocars with a Visiport System provide access to the abdomen. The setup is demonstrated in Fig. 1.

2.7.1. Patient positioning

The patient is placed in the semilateral decubitus position with the side of the lesion elevated at 60° (Figs. 2, 3). The ipsilateral arm is secured using an arm board and the contralateral arm is fixed beside the trunk and well padded to avoid lesions of neural structures. Alternatively, with the aid of towels wrapped around them, both arms are placed beside the trunk. At the chest and hip of the nonaffected side,
two rests support the body when the affected side is elevated. Additional fixation is done using cloth tapes across the hips and the legs. Great care should be taken to generously pad all rests and cloth tapes. When the patient is positioned securely, the table is rolled to a classical flank position 90° to verify the stability of the system (Fig. 3).

2.7.2. Camera trocar placement
The table is rolled to 0° to achieve a supine position for entry into the abdomen. After a 12-mm supraumbilical horizontal skin incision is made, the Veress needle is introduced to insufflate the abdomen for closed trocar placement. The abdominal cavity is insufflated to 12–14 mm Hg using CO₂. Subsequently, the 12-mm camera port is inserted. By using the Visiport System, the 0° laparoscope is placed into the abdominal cavity under vision. After removal of the 0° laparoscope, the peritoneal space is explored with a 30° laparoscope through the 12-mm trocar. Finally, the patient is rolled to the initial semilateral position for additional trocar placement.

2.8. Left lateral transperitoneal technique
Three additional 12-mm trocars are used for a left adrenalectomy. Two trocars are placed along the medioclavicular line. The upper (second) trocar position is 2 cm below the costal margin. The lower (third) trocar position is 8–12 cm below the second trocar. The fourth trocar is placed below the xiphoid at the level of the umbilical camera port (Fig. 2). Alternatively, two 5-mm trocars at position three and four for the working instruments and one 12-mm trocar for retraction on position two may be used because in only very rare cases are 10-mm instruments needed (stapler or XXL Haemoloc clips).

The retractor is inserted by the subxiphoid trocar. The monopolar scissors and the atraumatic clamp are inserted. The line of Toldt is incised from the splenic flexure to the sigmoid junction (Fig. 4). The left colon is reflected medially. Subsequently, incision of the phrenocolic and the lienorenal ligament is performed (Fig. 5). The splenic attachments to the abdominal side wall and the diaphragma are released. By doing so, it is possible to visualize the upper pole of the left kidney. The retractor is most useful to medialize the colon and cranialize the spleen. We identify the main adrenal vein (left side = inferior vein) at its termination into the renal vein, where it is clipped and divided (Fig. 6). If the identification of the adrenal gland is difficult (eg, in obese patients) the gonadal vein is a useful landmark. It should be identified and followed cephalad to the renal vein. In most cases, the adrenal vein is almost opposite to the insertion of the gonadal in the renal vein. The venous stump is used to gently lift the adrenal gland. Further we identify and divide the small medial and superior adrenal vessels (Fig. 7). The adrenal gland is freed from its lateral and medial attachments. The specimen is extracted intact in an Endo-bag (Fig. 8). Extraction of the specimen may be performed either via the pararectal caudal trocar site or alternatively (eg, in larger specimen) through the camera port, which is extended in an inverse T-shaped incision.

2.9. Right lateral transperitoneal technique
The trocars are placed in a mirror image as for the left-sided adrenalectomy. The liver retractor is inserted by the subxiphoid trocar. We mobilize and transect the triangular ligament. The liver is carefully retracted cephalad. The posterior peritoneum is transversely incised high along the surface of the liver, extending from the line of Toldt laterally up to the inferior vena cava medial (Fig. 8). The duodenum is subsequently mobilized medially to expose the renal hilum. Identification and isolation of the right main (medial) adrenal vein follows. On the right side, the identification and dissection of the hepatodiaphragm attachments is of utmost importance to be able to lift the liver as far cranially as possible to allow the inferior vena cava to be freed almost as far cranially as to the insertion of the hepatic veins to provide optimal exposure of the adrenal gland. In the next step, the adrenal vein is clipped and divided (Fig. 8). Subsequently,
division of the small inferior and superior adrenal vessels separates the adrenal gland from the vena cava. The adrenal gland is entrapped in the sack and removed after the complete mobilization.

2.10. Surgical tricks

Using bipolar forceps or the harmonic scalpel (ultrasound dissector) instead of the monopolar scissors, the periadrenal tissue is fulgurated and the multiple tiny arterial and venous branches feeding the adrenal gland are controlled securely and rapidly. However, the main adrenal vein and larger arteries should be clipped. Clipping may be done either by using titanium or resorbable Haemoloc clips.

Using the retractor the left colon is reflected medially and a plane between the tail of the pancreas, spleen, and upper pole of the left kidney is created.

During left-sided adrenalectomy, the use of the 30° optical system can be helpful to establish the correct layers between the upper pole of the kidney, the psoas muscle, aorta, and splenic hilum. On right-sided adrenalectomy the 30° optical system aids in identifying the very short adrenal vein.
Fig. 5 – Incision of the lienorenal ligament, reflection of the colon medially, and exposition and mobilization of the left kidney. LrL: lienorenal ligament; LK: left kidney.
Fig. 6 – Identification of renal and adrenal vein, division of the left adrenal vein after dissection and clipping. Identification of the renal and adrenal vein. The main adrenal vein is clipped and divided. AV: adrenal vein; VR: renal vein.
Fig. 7 – Division of one of the left superior adrenal arteries after dissection and clipping. Lifting the adrenal at the venous stump (left). Clipping of one of the left superior adrenal artery (middle). A second superior adrenal vein is clipped (right). AV: adrenal vein; AG: adrenal gland; RV: renal vein; AA: adrenal artery; AR: renal artery.
In very obese patients, longer instruments should be applied.

If a surgeon opts to perform a laparoscopic adrenalectomy after previous surgery (eg, cholecystectomy), the typical landmarks remain unchanged. Still, as mentioned, previous surgery in our opinion, and specifically in less experienced hands, represents a relative contraindication to the transperitoneal approach; if the surgeon is familiar with the retroperitoneoscopic approach this should be used; otherwise, an open access is the treatment of choice.

An additional 5-mm trocar is useful to insert to allow that, for example, an Endo-peanut is used to gently retract the mobilized inferior vena cava medially to aid in optimal exposure and clipping of the main adrenal vein.

Monopolar current should be used as little as possible, most importantly on the right side to avoid injury to the duodenum.

2.11. Complications and their management

Small vena caval lesions <2 mm can be compressed with an Endo-peanut for a few minutes. Hemostystptica application is a useful aid to control these minor bleedings. If hemostasis does not occur, the injury can be closed by suturing. The injury is closed with forceps, a fifth 5-mm trocar is inserted, and the defect is sutured using 4-0 nonresorbable monophilic sutures. Large defects require conversion. For conversion, we elevate the two pararectal trocars to raise the abdominal away from the viscera. Immediate incision of all layers of the abdominal wall is performed with the intra-abdominal trocars as guidance. Thus, a rapid and controlled access to the abdomen is possible within less than a minute. A median laparotomy is not necessary.

Bleedings from numerous small arterial and venous vessels in a fractured adrenal gland after laparoscopic mobilization can be controlled by increasing the pressure to 18 mm Hg and the use of bipolar coagulation.

Pleural injury and subsequent pneumothorax are sutured. A chest tube may be necessary postoperatively.

For splenic laceration and injury of the liver, an argon-beam coagulator, bipolar coagulation, haemostystptica or intermittently increasing the intra-abdominal pressure to 18 mm Hg can be used to control minor injuries. Injuries that require conversion are extremely rare.

3. Patients treated and outcome

Between May 2000 and December 2005, 52 patients underwent laparoscopic adrenalectomy in the Department of Urology of the Medical Faculty of the Martin-Luther-University Halle-Wittenberg in Halle, Germany. The diagnosis, preoperative work-up, and surgical technique were performed as described in Table 1. In 18 patients we performed a complete laparoscopic dissection for cancer of the adrenal gland. In 34 patients benign adrenal masses (pheochromocytoma, Cushing syndrome, incidentaloma) were removed by laparoscopy.

<table>
<thead>
<tr>
<th>Laparoscopic adrenalectomy, benign diseases (n = 34)</th>
<th>Laparoscopic adrenalectomy, malignant disease (n = 18)</th>
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<tbody>
<tr>
<td>Incidentaloma (17)</td>
<td>Metastasis from RCC (8)</td>
</tr>
<tr>
<td>Conn syndrome (adenoma) (9)</td>
<td>Metastasis from lung cancer (3)</td>
</tr>
<tr>
<td>Pheochromocytoma (5)</td>
<td>Metastasis from melanoma (1)</td>
</tr>
<tr>
<td>Cushing disease (3)</td>
<td>Metastasis from colon (3)</td>
</tr>
<tr>
<td>Side: right/left: 14/20</td>
<td>Adrenal cancer (3)</td>
</tr>
<tr>
<td>No. men/No, women: 13/21</td>
<td>Side: right/left: 6/12</td>
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<tr>
<td>Mean age: &lt;61 yr (range, 56–74 yr)</td>
<td>No. men/No, women: 7/11</td>
</tr>
<tr>
<td>Mean age: &lt;60 yr (range, 55–72 yr)</td>
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RCC: renal cell carcinoma.
Laparoscopic adrenalectomy was completed successfully in 51 of 52 patients. One patient required conversion for excessive bleeding of the vena cava during the laparoscopic mobilization of a complex right adrenal mass. One 68-yr-old patient had a pulmonary embolism on the fifth postoperative day but fully recovered. Three patients had a hematoma in the right and left adrenal areas, which did not require intervention. Postoperative characteristics are listed in Table 2. All malignant specimens demonstrated negative margins by histopathology. During the mean follow-up of 21 mo (range, 2–61 mo), patients appear to have responded well to their laparoscopic adrenalectomy. No local or trocar site recurrences have developed.

4. Discussion

The advantage of any laparoscopic approach to the adrenal glands in terms of blood loss, operative time, cosmetics, and convalescence over open surgery is undisputed. In this manuscript, we report on the transabdominal lateral approach to the adrenal gland. All patients were treated using this approach. This was based on the large experience of >500 cases performed at our institution encompassing upper retroperitoneal surgery of the kidney (total and partial nephrectomies, nephroureterectomies, living donor nephrectomies), the pyelon (dismembered pyeloplasties), the retroperitoneal vessels, and the adrenal gland. For an individual urologist, we recommend that laparoscopic experience in the upper retroperitoneum of at least 50 to 75 cases should be acquired before laparoscopic adrenalectomy is attempted.

Some controversy exists as to the need for a bowel preparation. In our experience, a mechanical bowel preparation has not been shown to be mandatory because, in contrast to open surgery, the motility of the intestine remains virtually unaffected in laparoscopic procedures, as evidenced by a constant serotonin level during and after surgery [19]. Others, however, suggest that a mechanical bowel preparation should be performed in any case. No controlled trials so far have resolved this issue so the final answer has to be awaited.

The larger operative field of the transperitoneal approach in our opinion aids in a better orientation and visualization of familiar landmarks known to us from open surgery. This is in particular an advantage in the early learning curve of laparoscopic adrenalectomy. The more extensive working space is also useful for removal of larger adrenal masses >6–7 cm.

As mentioned, other approaches to the adrenal gland also exist. Authors advocating the retroperitoneoscopic approach correctly state the potentially better access and exposure in patients who had previous intraperitoneal surgery in whom postoperative adhesions occur frequently. Moreover, this approach obviates the mobilization of the colon. In such patients with small lesions, the retroperitoneoscopic approach is certainly a viable option. Morbidly obese patients might also benefit from a retroperitoneoscopic access; however, considerable laparoscopic skills are required because it may be difficult to identify the adrenal gland in voluminous surrounding perinephritic adipose tissue. A disadvantage of the retroperitoneoscopic approach is a potentially occurring peritoneal lesion with subsequent CO₂ influx and compression of the retroperitoneal space. Specifically in the earlier learning curve, such an event increases the difficulty of the procedure. However, in centers with appropriate experience in retroperitoneoscopic and transperitoneal technique, this does not present a major disadvantage.

As with hormone-active lesions of the adrenal cortex, pheochromocytoma can also be treated using a laparoscopic transperitoneal or retroperitoneal approach. A major concern of surgical treatment of pheochromocytoma is the intraoperative appearance of catecholamine surges. The establishment of the pneumoperitoneum seems not to be a risk for increased catecholamine levels. The surgeon should try to access, clip, and divide the main adrenal vein on either side as early in the procedure as feasible to avoid catecholamine-induced hypertensive events in the subsequent mobilization of the gland.

| Table 2 – Operative data: laparoscopic adrenalectomy, comparison with the literature |
|---------------------------------|---------------------------------|---------------------------------|
|                                 | Laparoscopic adrenalectomy (n = 1000)* | Laparoscopic adrenalectomy, benign diseases (n = 34) | Laparoscopic adrenalectomy, cancer (n = 18) |
| Size (cm)                       | 2.0–11 cm                          | 5.1–11.0 cm                      | 4.2–10.4 cm                      |
| Operating time (min)            | 130 min (range, 90–250 min)        | 125 min (range, 70–220 min)     | 140 min (range, 80–230 min)     |
| No. of complications (%)        | 10–45%                            | 2 (6%)                           | 3 (16%)                         |
| No. of conversions (%)          | 5–20%                             | 0                                | 1 (5%)                          |
| Estimated blood loss (cc)       | 50–1500 cc                        | 50–300 cc                        | 50–500 cc                       |
| Mean hospital stay (d)          | 5.1 d (range, 2–9 d)              | 4.9 d (range, 4–12 d)           | 4.6 d (range, 4–8 d)            |

Data obtained from references [3,5,6,11,14–18], which represent about 1000 laparoscopic adrenalectomies.
As discussed earlier, laparoscopic adrenalectomies are not restricted to benign lesions only. We in this report as well as others [10,12] have safely performed adrenalectomies for malignant conditions such as metastatic disease from lung, kidney, colon, and melanoma or primary malignant disease of the adrenal gland. We have exclusively used the transperitoneal approach, whereas the Cleveland Clinic group has used both the transperitoneal and retroperitoneal approach. It is important, however, to apply adequate imaging techniques to secure the treatment of organ-confined cancer only, either primary or metastatic, because only these should be approached laparoscopically. Adrenal vein neoplastic thrombosis should be excluded because it requires open surgery. Likewise, resection of metastatic processes to the adrenal have a higher incidence of port site metastasis if the primary tumor is in a very advanced stage and grade. A recent international survey showed that in 336 adrenalectomy reports there were four cases of tumor seeding (0.9%). Three of four cases had metastases from lung cancer (3 patients with pT3G3 to pT4G3 lung cancer and 1 patient with a primary adrenocortical mass causing Cushing syndrome [13]). Therefore we do not recommend laparoscopic removal of such tumors.

A review of the literature demonstrates that neither the retroperitoneoscopic nor the transperitoneal approach is superior to the other in terms of blood loss, hospitalization, operative time, convalescence, or analgetic medications. To a large degree, slight differences reported by groups advocating either approach are more likely to represent the preferred and therefore more commonly applied technique of either technique. In the hands surgeons with experience in both accesses and under controlled study conditions, it was shown that no significant difference was observed in all clinically relevant parameters [14,20].

In highly selected patients (eg, those with multiple intraperitoneal and retroperitoneal previous surgery) the transthoracic transdiaphragm approach has been described. This is, however, an infrequent case and only true experts in endoscopic surgery should use this approach [9].

5. Conclusion

Transperitoneal lateral adrenalectomy is the most commonly used technique for the safe and efficient removal of adrenal masses of benign and malignant types. Likewise, hormone-active tumors and pheochromocytomas can be resected with a safety that is comparable to the open approach. It has a relatively steep learning curve, in particular for surgeons who already have laparoscopic experience in the retroperitoneum. Appropriate selection of patients and adequate access secures successful treatment outcome.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.eururo.2006.01.014 and via www.europeanurology.com. Subscribers to the printed journal will find the supplementary data attached (DVD).

References


