Laparoscopic Adrenalectomy: Where Do We Stand Now?

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Laparoscopic adrenalectomy (LA) has become the procedure of choice for the surgical removal of the vast majority of small sized adrenal tumors (≤ 6 cm), because of its significant and multiple advantages: reduced hospital stay and wound morbidity, decreased transfusion requirements, postoperative pain and complications. The role of LA in patients with large adrenal lesions or potential malignancy remains controversial. The aim of this article is to review the current and up-to-date surgical approaches for LA, which include: 1) transabdominal anterior or flank approach and 2) retroperitoneal technique with the patient in either lateral or prone position. Specific advantages and disadvantages are referred to for each of them. The choice of each of these techniques is determined particularly by the preference and the experience of the surgeon, but other objective criteria must be taken into consideration, such as the size of the adrenal and history of previous abdominal surgeries.

Keywords: Laparoscopic adrenalectomy; transperitoneal approaches; retroperitoneal approaches; surgical techniques

Since Gagner et al. (1992) reported the first laparoscopic adrenalectomy (LA), this minimally invasive surgical approach has rapidly established itself as the gold standard for the surgical treatment of the vast majority of small sized adrenal lesions (≤ 6 cm) (Ramacciato et al. 2008). The advantages of LA versus open adrenalectomy include reduced hospital stay and wound morbidity, decreased transfusion requirements, postoperative pain and complications (Fernández-Cruz et al. 1996; Lee et al. 2008). Another major breakthrough of the laparoscopic technique is that it can even be performed, in selective cases, as an outpatient procedure by highly skilled surgeons as was first described by Gill et al. (2000). Ambulatory LA can be safe and feasible, when the required surgical and anaesthetic experiences are both available (Edwin et al. 2001) and cost effective (Skattum et al. 2004; Gagné et al. 2007; Mohammad et al. 2009).

This article reviews the updated surgical approaches for LA: 1) transabdominal anterior or flank and 2) retroperitoneal technique with the patient in either lateral or prone position.

Indications

The most widely accepted indication for LA is a unilateral small sized (≤ 6 cm) benign adrenal lesion. This includes aldosteronoma, incidentaloma, Cushing’s syndrome, adrenal cyst, hormone – secreting tumours, myelolipomas, ganglioneuromas, and other conditions such as adrenal haemorrhage and Conn’s syndrome (Fernández-Cruz et al. 1996; Gill 2001; Ramacciato et al. 2008; Kuruba and Gallagher 2008; Lee et al. 2008; Turner and Miskulin 2009). However, bilateral LA is effective for bilateral adrenal hyperplasia, neoplasms or Cushing’s syndrome (Fernández-Cruz et al. 1996). The role of LA in patients with large adrenal lesions (> 6 cm), or potential malignancy remains controversial (Sturgeon and kebebew 2004; Cobb et al. 2005; Tsuru et al. 2005 ; Ramacciato et al. 2008; Toniato et al. 2007; Eto et al. 2008; Marangos et al. 2009). Pheochromocytoma is no longer considered a contraindication for LA, provided the appropriate drug treatment is carried out before surgery (alpha followed by beta-receptor or calcium channel blockers) (Toniato et al. 2007; Humphrey et al. 2008). The effectiveness of LA for adrenocortical carcinoma and metastatic adrenal disease remains debatable (Gagner et al. 1997; Fazeli-Matin et al. 1999; Sturgeon and Kebebew 2004; Cobb et al. 2005; Tsuru et al. 2005 ; Eto et al. 2008; Choh and Madura 2009; Marangos et al. 2009; Turner et al. 2009). When operating the adrenals for malignancy, the most important concern is whether the laparoscopic resection can achieve an equal oncological result in
comparison with open surgery, the long-term survival and the risk of topical recurrence. However, it is accepted that these operations should be performed only if there is no preoperative evidence of periadrenal infiltration or venous invasion (Gagner et al. 1997; Fazeli-Matin et al. 1999; Gill 2001; Ramacciato et al. 2008), by highly skilled laparoscopic surgeons and conversion to open surgery could be possibly required (Tsuru et al. 2005).

Local tumor invasion of the surrounding tissues as detected by preoperative imaging or lesions greater than 12cm are considered contraindications for laparoscopic approach (Fazeli-Matin et al. 1999; Sung et al. 2001; Miccoli et al. 2004; Toniatò et al. 2007; Kuruba and Gallagher 2008; Ramacciato et al. 2008). A further advance is that obesity, age and cardiopulmonary dysfunction are no longer considered contraindications for laparoscopic procedures (Brunt et al. 1996; Fazeli-Matin et al. 1999). On the contrary, intracranial hypertension and coagulation disorders are conditions not conducive to laparoscopy (Gagner et al. 1997).

**Current Surgical Approaches**

First the patient is placed in a supine position wearing compression stockings and after the induction of general anesthesia, a urinary catheter and an orogastric tube are inserted. Electrocardiogram, pulse oximetry and arterial line pressure monitoring are essential for all patients. Occasionally, patients with pheochromocytomas, large tumors or underlying cardiac disease require central pressure line or pulmonary artery catheter placement intraoperatively. Preoperatively, antibiotics are administrated.

1a. Transperitoneal Surgical Lateral Approach

The patient is placed in a bean bag and moved into a lateral decubitus position with the side to be operated up and should be fastened with safety straps and tape. All pressure points (including axilla, arms, hips and legs) must be padded in order to prevent nerve compression injuries. The operating table should be flexed at the waist so that the space between the iliac crest and the lower rib cage open for the best possible port access and then tilted into the anti-Tredelenburg position in order to facilitate better exposure in the retroperitoneum. The two video monitors are positioned at the head of the patient on either side. The surgeon in most cases stands on the right side, the camera assistant across the surgeon or on the same side facing the operator opposite the side which is being operated, and the assistant across the surgeon or on the same side facing the front of the patient.

Creation of Pneumoperitoneum and Insertion of Trocars: Generally, a Veress needle is inserted in a closed fashion somewhat medial to the anterior axillary line about two fingerbreadths below the costal margin to access to the peritoneal cavity. After creation of the pneumoperitoneum is achieved by the insufflation of carbon dioxide gas at a pressure of 15 mmHg, a 10-mm direct-view trocar is placed to afford direct visualization of the peritoneal cavity. In thin patients, the open insertion technique in the midclavicular line subcostally or at the umbilicus may be used but it requires a larger incision.

**Right lateral transperitoneal adrenalectomy:** Usually, four 10-mm trocars are used to perform a right LA via the transperitoneal approach. After the insertion of the 10-mm optical trocar in the right anterior axillary line subcostally and the introduction of the 0° laparoscope through this cannula in order to perform a diagnostic laparoscopy and to inspect the placement of the other trocars under direct vision, the second 10-mm trocar is introduced 5 cm from the first, 2 cm anterior to the anterior axillary line. The two other 10-mm trocars are placed under the costal margin, 7cm on either side of the optical trocar (Fig. 1). A 30° instead of a 0° laparoscope may be necessary in cases of large tumours or obese patients. The dissection begins with the incision of the subhepatic peritoneum using scissors or coagulating hook. A fan retractor is inserted through the most medial trocar to retract the liver superior-medially, after the right triangular ligament is divided. Occasionally, it is necessary to mobilize the hepatic flexure of the colon. The right kidney is identified and Gerota’s fascia is incised with hook cautery. The hepatorenal ligament is incised for mobilizing the superior pole of the right adrenal gland. The inferior vena cava which must be identified early in the dissection, in order to avoid injury to this, leads directly to the right adrenal gland (Corcione et al. 2001). The right adrenal vein is ligated with clips, with two clips being left on the vena cava side, and then divided. The arterial branches to the adrenal gland are clipped and divided or electro coagulated if they are small. The dissection of the adrenal from the kidney is usually accomplished with a Harmonic scalpel or by the use of the Ligasure and then hemostasis is checked and the area of the adrenal bed is irrigated and suctioned. The specimen is placed in a plastic bag and extracted through the anterior trocar. A drain can be placed in the surgical bed. The fascial defects are closed if dilatating ports are not used, and the 10 mm trocar skin incisions are sutured, using absorbable sutures.
Left lateral transperitoneal adrenalectomy: The patient is positioned in a lateral decubitus position with the left side up. The procedure and the insertion of trocars are similar to the right adrenalectomy. However, depending on the surgeon’s experience and preference, left adrenalectomy can be done with either three or four trocars, whereas four ports are necessary for a right adrenalectomy. The splenic flexure of the colon and spleen must be mobilized from their retroperitoneum attachments and the splenocolic ligament divided before the most dorsal fourth trocar can be inserted. The Harmonic scalpel is useful for dissecting around the gland. The splenorenal ligament is divided close to the spleen so that the gravity allows the spleen and the tail of the pancreas to fall medially. The connective tissue between the spleen and the pancreatic tail is divided to expose the inferior pole of the left adrenal gland along with the left adrenal vein. Because the adrenal may be difficult to locate in patients with large amounts of retroperitoneal fat or small tumours, laparoscopic ultrasound could be useful. The adrenal vein is ligated with clips, or an endoscopic stapler (GI) can be used if the vein is very large, and is then transected. The superior pole of the gland is dissected and the left adrenal arteries are clipped and divided. The dissection of the adrenal from the kidney then proceeds and the removal of the specimen, hemostasis, and drainage of the operative area and closure of the port sites is similar to the procedure for the right adrenalectomy (Gagner et al. 1997; Jacobs et al. 1997; Yoneda et al. 2000; Suzuki et al. 2001; Ramacciato et al. 2008; Toniato et al. 2007; Humphrey et al. 2008; Berber et al. 2009).

1b. Transperitoneal Surgical Anterior Approach

The patient is left in the supine position, with legs apart. The operating table should be tilted in a slight anti-Trendelenburg position and 20°-30° rotated opposite the side to be operated. The surgeon stands between the patient’s legs. The first assistant is at the patient’s affected side, whereas the second assistant stands at the opposite side (Fig. 2). The video monitor is placed to the left of the patient’s head.

Creation of Pneumoperitoneum: Generally, a Veress needle is inserted above the umbilicus and creation of the pneumoperitoneum is obtained by the insufflation of carbon dioxide gas at a pressure of 12-15 mmHg. One 10-mm trocar is inserted right of the umbilicus for the right LA and left for the left LA, obliquely in the direction of the affected adrenal. A 10-mm laparoscope is inserted into the peritoneal cavity to visualize the insertion of the other trocars (Lezoche et al. 2000; Suzuki et al. 2001; Ramacciato et al. 2008).

Right anterior transperitoneal adrenalectomy: three 5 mm trocars are positioned in the following way: the first 5-mm trocar is inserted 12 cm lateral on the right side of the umbilicus, the second in the right subcostal position to allow the introduction of a liver retractor to elevate the right lobe of the liver and the third 4 cm above the umbilicus on the median line (Fig. 2). The abdominal cavity is visually explored. The hepatic flexure of the colon is dissected with a harmonic scalpel or coagulating scissors, mobilized and retracted inferiorly and the duodenum and vena cava are progressively exposed. Then the right renal vein is identified and the adrenal at the superior pole of the right kidney is exposed. Next the main adrenal vein must be identified and then skeletonized with a 5-mm dissector in order to allow placement of two clips. Dissection of the adrenal gland is progressing and the exposed arterial adrenal branches and accessory veins are controlled with 5-mm clips or with coagulating shears. Then, the procedure proceeds in a similar sequence to that of the transabdominal lateral approach.

Left anterior transperitoneal adrenalectomy: three 5-mm trocars are positioned in the following way: the first 5-mm trocar is inserted 10 cm lateral of the umbilicus on the left para-median line, the second subcostally on the left axillary line in order to enable gastroepiploic and pancreatic mobilization and the third 5 cm above the umbilicus on the median line. The peritoneal cavity is visually explored. First the splenic flexure of the colon is mobilized by dividing the splenocolic ligament so that the left colon is taken down and retracted medially. Then the splenorenal ligament is divided and the tail of the pancreas and the spleen are retracted medially. Gerota’s fascia is incised to expose the upper pole of the left kidney and the adrenal. The dissection is carried out in a similar way as described for the lateral approach.

2. Retroperitoneal Approach

Retroperitoneal laparoscopic adrenalectomy can be performed by either a posterior (so-called lumbar or dorsal) or a lateral (or flank) approach.

2a. Retroperitoneal Posterior Approach

The patient is placed in a prone or semi-jack knife position. The procedure is similar for both adrenal sides. The surgeon stands on the right side for the right LA or on the left for the left LA. Initial access to the retroperitoneum
is achieved through open insertion of a balloon trocar which is introduced 2.5 cm lateral to the tip of the twelfth rib (or in some institutes the first access is made by the introduction of the balloon device below the edge of the last rib) and insufflated 25-30 times (Sung et al. 2001; Walz et al. 2006). A laparoscope is inserted into the balloon trocar to visualize the retroperitoneal space and then the balloon trocar is replaced by a standard 10 mm trocar. After the development of an adequate retroperitoneal working space by insufflation of CO₂ at 12-20 mmHg pressure, the other trocars are inserted under direct vision, as follows: below the edge of the twelfth rib, lateral to the eleventh rib and the last trocar is introduced between the ninth and tenth rib (Yoneda et al. 2000; Sung et al. 2001; Walz et al. 2006; Berber et al. 2009). An atraumatic retractor is introduced through the inferior trocar to retract the kidney downwards. The use of the laparoscopic ultrasonography may be helpful to define the upper pole of the kidney and the adrenal in cases where it is difficult to identify the adrenal because of the surrounding retroperitoneal fat. The adrenal vein is located at the posterior-medial aspect of the gland for the right LA and inferior - medially for the left LA. The dissection then proceeds in a sequence similar to that described for the transabdominal lateral approach.

2b. Retroperitoneal Lateral Approach

The patient is placed in a lateral position with the side to be operated up (Sung et al. 2001). Initial access to the retroperitoneum is achieved through open insertion of a balloon trocar which is introduced in the midaxillary line about 3 cm above the iliac crest between the external oblique muscles and the latissimus dorsi, and the retroperitoneal space is also expanded as for the posterior approach (Walz et al. 2006) (Fig. 3). The other trocars are then placed as described above. Occasionally, an additional fifth trocar may be necessary in order to retract the liver or in cases where the peritoneum has been lacerated (Bonjer et al. 2000). The procedure is then carried out in a similar way as for the posterior approach.

Discussion

The transperitoneal (lateral or anterior) and the retroperitoneal (lateral or posterior) approaches are all successfully being used for the management of adrenal masses (Brunt et al. 1996; Duh et al. 1996; Marescaux et al. 1996; Bonjer et al. 1997; Gagner et al. 1997; Fernández-Cruz et al. 1999). The choice of each of these techniques is determined particularly by the preference and the experience of the surgeon, but other objective criteria must be taken into consideration, such as the size of the adrenal (combined with the patient’s body habitus) and history of previous abdominal surgeries (Fernández-Cruz et al. 1996; Suzuki et al. 2001) as shown in Table 1.

The transperitoneal approach allows the best visualization of the operative field and the surrounding anatomic strictures, offering wider surgical work space than the retroperitoneal technique (Duh et al. 1996; Jacobs et al. 1997; Ramachandran et al. 2006). The lateral transperitoneal approach in comparison with the anterior, has many advantages as less mobilization, decreased operative time and no extra trocars, even though bilateral adrenalectomy is performed by the anterior without any need for changing the position of the patient (Go et al. 1995; Brunt et al. 1996; Marescaux et al. 1996; de Cannière et al. 1997; Gagner et al. 1997; Gill 2001). In the lateral procedure, the patient is placed in the lateral decubitus position with the side being operated elevated and the weight of the adrenal facilitates its exposure avoiding the dissection upwards, so that the possibility of intraoperative injuries and haemorrhage is reduced (Gagner et al. 1992,1994; Marescaux et al. 1996; Gagner et al. 1997; Jacobs et al. 1997; Siperstein et al. 2000). The anterior transperitoneal approach offers the most familiar and conventional anatomical view providing better exposure for operating larger size of adrenal tumors but it demands additional trocars and effort to retract the adjacent organs and more dissection, in comparison with the other approaches (Fernández-Cruz et al. 1999; Takeda 2000).

The retroperitoneal approach is more challenging to learn than the transabdominal and there is a higher possibility for surgeons to become disoriented if they are not familiar with working in the retroperitoneum space (Takeda 2000; Suzuki et al. 2001). By the retroperitoneal technique, entry in the peritoneal cavity is avoided so that adhesions from previous operations or other intraperitoneal diseases are not involved in the procedure (Fernández-Cruz et al. 1999; Bonjer et al. 2000; Suzuki et al. 2001). Also, the possibility of complications such as visceral and vascular injury may be reduced and postoperative adhesions and peritonitis are minimized (Liapis et al. 2008). In addition, the retroperitoneal approach may be beneficial for obese patients or those with pre-existing cardiorespiratory deficiency, because of the avoidance of the hemodynamic and respiratory effects of carbon dioxide pneumoperitoneum (Wolf et al. 1995; Fernández-Cruz et al. 1996; Fareli-Matin
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et al. 1999). The main disadvantage of the retroperitoneal approach is the limited working space and therefore it is more difficult to manage large tumours via this technique (Fernández-Cruz et al. 1996, 1999; Bonjer et al. 1997, 2000). Additionally, the limited skin available can possibly make the port placement difficult and improper which may result in colonic injury because of the relatively fixed peritoneal fixation (Liapis et al. 2008). One of the main advantages of the lateral retroperitoneal approach over the posterior is that it can be converted to flank transperitoneal if the dissection becomes difficult to proceed (Fernández-Cruz et al. 1999). On the other hand, when the prone position is used the retroperitoneal technique allows the bilateral adrenalectomy without repositioning of the patient (Bonjer et al. 2000; Suzuki et al. 2001).

The lateral transperitoneal approach is the most widely utilized for LA (Gagner et al. 1994; Jossart et al. 2000; Suzuki et al. 2001), because it provides adequate working space and excellent exposure of the upper retroperitoneum. Additionally, gravity facilitates the retraction of the adjacent organs and allows satisfactory exploration of the peritoneal cavity and performance of concomitant procedures such as cholecystectomy or liver biopsy.

Conclusions

Laparoscopic adrenalectomy (LA) has become the procedure of choice for the surgical removal of the vast majority of small sized adrenal lesions (≤ 6 cm), because of its multiple vital advantages: reduced hospital stay and postoperative pain, and most importantly the decreases in wound morbidity, transfusion requirements, and complications. The role of LA in patients with large adrenal lesions or potentially malignancy remains controversial. The transperitoneal and the retroperitoneal approaches are all successfully being used for the management of adrenal masses. Specific advantages and disadvantages are referred to for each of them. For the patient, the appeal of laparoscopic techniques over open surgery is evident but the choice of the technique for LA is determined particularly by the preference and the experience of the surgeon, bearing in
mind that other objective criteria must be taken into consideration preoperatively, such as the size of the adrenal and history of previous abdominal surgeries.

References


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