Laparoscopic Adrenalectomy: Indications, Technique, Complications and Follow-Up

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Abstract

Background: Developments in laparoscopic surgery have rendered it an efficient tool for many complex surgical procedures. In the last few years, laparoscopic adrenalectomy has become a more viable option for removal of adrenal pathology, with many surgeons preferring it to the conventional open technique.

Objectives: To describe the indications, technique, complications and follow-up of patients undergoing laparoscopic adrenalectomy in our department.

Methods: The hospital files of 30 patients who underwent the procedure were reviewed. There were 19 females and 11 males with a mean age of 45 years. Indications for surgery differed and included hypersecreting adenoma, pheochromocytoma, suspected malignancy, and incidentaloma.

Results: Of the 31 laparoscopic adrenalectomies performed, 11 were right, 18 were left, and 1 was bilateral. The conversion rate to an open procedure was 3%. The mean duration of procedure was 120 minutes. Only one patient required blood transfusion. Complications occurred in 20% of patients, all reversible. There was no mortality. Mean hospitalization duration was 3.4 days and median follow-up 17 months. There were no late complications. All patients operated on for benign diseases are alive.

Conclusions: Laparoscopic adrenalectomy appears to be a useful tool for the treatment of a range of adrenal pathologies.

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During the last decade, minimally invasive surgical techniques have been widely adopted for increasingly complex surgical procedures. The development of a new generation of surgical instruments, improvements in video technology, and increasing clinical experience have led to rapid progress in laparoscopic surgery. With these developments, not only is laparoscopic adrenalectomy technically feasible, but it is the preferred method of treatment for most adrenal pathologies [1–4].

The adrenal gland lends itself well to laparoscopic removal because it is small and adrenal tumors are most often benign. The open approach to the adrenal gland typically requires a large incision to expose a small working surface with its resultant postoperative morbidity. The application of laparoscopic techniques in surgery for the adrenal glands might essentially outdate all traditional open approaches almost in the same manner as laparoscopic cholecystectomy has replaced traditional open cholecystectomy.

There is general agreement that laparoscopy is superior to open surgery because it is associated with less pain, comparable safety, more overall patient satisfaction, a shorter hospital stay, and more rapid return to normal activity, as well as yielding superior cosmetic and long-term results [1–4]. As surgical skills improve, it will likely be comparable to open adrenalectomy in overall cost.

The laparoscopic approach requires advanced laparoscopic skills. Surgeons should be familiar with these techniques as well as with the open surgical approaches before attempting this procedure. The learning curve might take some time, since the number of adrenal surgical cases is relatively small for an individual surgeon.

In the present study we describe our experience with 31 laparoscopic adrenalectomies.

Materials and Methods

During a 3 year period from May 1998 to May 2001, 30 patients underwent laparoscopic adrenalectomy. There were 19 females and 11 males aged 21–76 years (mean 45). The tumors were on the right side in 10 patients, on the left side in 18, and bilateral in 2. Tumor size ranged from 1.5 to 8 cm (mean 4 cm).

Indications for surgery

The tumors comprised 5 aldosterinomas, 3 cortisol-producing adenomas, 1 bilateral hyperplasia, 4 pheochromocytomas, 4 adrenal metastases, 1 suspected lymphoma, and 12 incidentalomas. Symptoms and signs were different for the various pathologies. Diagnosis was made by identification of hormone levels and radiologic tests for localization.

All incidentalomas were asymptomatic. In the pre-surgical evaluation, three were found to be functioning (two aldosterone-secreting and one cortisol-secreting adenoma). All others were resected because of parameters suspicious of adrenocortical carcinoma (size greater than 4–5 cm, enlargement during follow-up, or radiologic factors).

Surgical technique

All adrenalectomies were performed using the lateral transperitoneal approach.

- *Left laparoscopic adrenalectomy:* The patient was placed in the lateral decubitus position with the left side up, and the surgeon and assistant were standing on the side opposite to the pathology. The surgical area was prepped and draped. A veress needle was inserted under the costal margin at the anterior axillary line and lateral to the rectus muscle, and CO_2 insufflation was initiated up to 15 mmHg. After insufflation, a

10 mm trocar replaced the veress needle, enabling the insertion of a 30° 10 mm laparoscope. Under vision, another two 10 mm trocars were inserted to allow the introduction of laparoscopic dissectors and scissors cautery.

The colonic flexure was first mobilized in order to open the retroperitoneal space and retract the colon away from the inferior pole of the adrenal gland. The spleen and splenorenal ligament were first dissected laterally, incising approximately 1 cm of peritoneal covering lateral to the spleen. The ligament was dissected to open the space between the spleen and kidney, and the dissection was carried up to the diaphragm, very close to the greater curvature of the stomach. Once the spleen was fully mobilized, it fell medially and the intraperitoneal space opened. The lateral edge and anterior portion of the adrenal gland became visible.

At this stage, a slow and meticulous dissection was performed around the adrenal gland, and the adrenal vein was exposed, clipped and divided. At this point, adrenal mobilization became easy and all small blood vessels were either clipped or cauterized. Once the adrenal gland was free, hemostasis was verified and the gland was extracted in a sterile plastic bag through the most anterior trocar, and all skin incisions were sutured.

- *Right laparoscopic adrenalectomy:* The patient was placed in the lateral decubitus position right-side up. CO_2 insufflation and trocar placement were similar to that described for left laparoscopic adrenalectomy, with an additional 5 mm trocar for a liver retractor. The liver was mobilized by dissecting the right hepatic triangular ligament, and retracted upwards and medially. This provided sufficient working space. The right adrenal gland was dissected next. In order to expose the adrenal vein, the dissection was done medially and upward, along the lateral edge of the vena cava. When exposed, it was clipped and, sometimes, when very short and broad, stapled and divided. The gland was further dissected, and blood vessels were either clipped or cauterized until the gland was freed and extracted.

Results

Thirty-one laparoscopic adrenalectomies were performed: 11 right, 18 left, and 1 bilateral. One was converted to open adrenalectomy (3%) when a very large invasive adrenal carcinoma was found, necessitating an extensive *en bloc* resection.

The duration of the procedure was 50–255 minutes (mean 120). Only one patient required blood transfusion (3 units). There was no mortality. Intraoperative complications included bleeding in one patient that required hemostasis and elevation of blood pressure; tachycardia in two patients and hypotension in one, all three of whom were suffering from pheochromocytoma.

Early complications

Early complications occurred in 20% of patients and were mostly minor. They included atelectasis in three, and urinary tract infection, atrial fibrillation, trocar site hematoma, and chylous drainage in one each. All complications were reversible and none of the patients required a second operation. Mean hospitalization duration was 3.4 days (range 1–14).

The final pathologies of the nine incidentalomas found to be non-secreting preoperatively were: non-functioning adenoma (n=6), adrenocortical carcinoma (n=1), pheochromocytoma (n=1), and metastasis from diagnosed lung cancer (n=1).

Follow-up

The median follow-up period was 17 months (range 4–41). One patient operated for benign functioning adenoma died of lung cancer. The remaining patients in this group are alive with no evidence of disease. The one patient with adrenocortical cancer is alive with no evidence of recurrent disease 31 months post-surgery. The patient with lymphoma received chemotherapy and is alive 4 months after the operation. One of the patients operated on for adrenal metastases died 4 months postoperatively, and four others are alive with disease. There are no late complications.

Discussion

Since its first description in 1992 [5,6], laparoscopic adrenalectomy has gradually become the gold standard treatment for the different surgical pathologies of the adrenal gland. The adrenal glands are small, friable, and highly vascular. They can be difficult to access safely due to their deep position in the retroperitoneum [7]. Knowledge of the unique anatomy of the adrenal glands is essential, and meticulous hemostasis and delicate tissue handling are necessary to make adrenal surgery a success.

Some initial concerns that the laparoscopic approach might be a dangerous and crude method of resecting the adrenals have proven incorrect, and it appears that laparoscopic techniques are ideally suited for adrenal surgery in many ways. The advantage of the laparoscopic approach to the adrenal lies in the fact that it allows a clearly magnified view for precise, hemostatic dissection in a minimally invasive fashion. Laparoscopic skin incisions are small compared to the large incisions necessary in the open approach, and most procedures require only three to four port sites. In addition, new instruments, such as ultrasonic shears, allow a relatively bloodless dissection by providing safe and efficient vascular control [8].

Considerable evidence suggests the safety and efficacy of laparoscopic adrenalectomy. Unfortunately, however, no prospective randomized studies have evaluated this technique. Several retrospective studies have been published [1–6,8,9]. Jossart et al. [9] reviewed the English-language medical literature and summarized all series, including more than 20 laparoscopic adrenalectomies, to a total of 1,082 procedures. They concluded that it was safe and efficient even for large tumors up to 14 cm, with a conversion rate to open adrenalectomy of 0–18%. One of the largest retrospective comparisons between laparoscopic adrenalectomy and the open procedure was published by Thompson et al. [10], who performed a matched, case-control study comparing 50 patients undergoing laparoscopic adrenalectomy with 50 patients who underwent open adrenalectomy during a similar time period. They found the operative time to be significantly longer for laparoscopic adrenalectomy (167 vs. 127 minutes). The overall rate

of conversion to the open technique was 12%. However, a significant learning curve was found. The conversion rate for the last 23 procedures decreased to 4.5%. Laparoscopic adrenalectomy was also associated with a significant decrease in mean hospital stay (3.1 vs. 5.7 days), postoperative pain, and late morbidity (0 vs. 51%). Numerous other series confirm these results [11–13]. Overall, the reported mean operative time required for unilateral laparoscopic adrenalectomy varies from 116 to 295 minutes. Experience leads to a decrease in operative time. Overall, the conversion rate ranges from 0 to 14%, but decreases as the surgeon gains experience. Estimated blood loss is uniformly less with the laparoscopic compared to the open approach, 40–270 ml vs. 172–408 ml, respectively. The decrease in postoperative narcotic requirements associated with laparoscopic adrenalectomy was uniform in all studies. Laparoscopic adrenalectomy is associated with a decreased length of stay; overall the mean length of stay for the laparoscopic approach ranges from 1.7 to 5 days vs. 5.4 to 9 days for the open procedure. Our results were found to be comparable: mean operative time 120 minutes, conversion rate 3%, and mean hospital stay 3.4 days. There was minimal blood loss and only one patient required blood replacement.

The most impressive finding was that the complication rate for the laparoscopic group was 7% compared to 24% for the open group [9]. Complications associated with laparoscopic adrenalectomy are usually minor [8], such as port site bleeding, hematoma, subcutaneous emphysema, urinary tract infections, and deep vein thrombosis. More severe complications, such as significant bleeding secondary to vena cava injury or solid organ injuries caused by trocar retraction or insertion, rarely appear. In our study, 20% of the patients had minor complications, all of which were reversible, and there were no severe complications.

Long-term morbidity is avoided with the laparoscopic approach, since this technique avoids many wound-associated complications such as chronic pain, numbness, muscle laxity, and hernias in the scar. In the open group, respiratory complications, such as pneumonia or atelectasis, are most frequent. Wound infections have been reported in more than 3% of patients. Thompson and colleagues [10] reported a late complication rate of 54% for open adrenalectomy – chronic pain, flank numbness, and muscle laxity.

Four laparoscopic methods have been developed for approaching the adrenal gland: anterior or lateral transperitoneal and lateral or posterior retroperitoneal [14]. It is not clear which method is superior, if at all, and each has its own unique advantages. We personally prefer the lateral transperitoneal approach since it is much easier, allowing a large operative field and confident dissection through recognition of the many anatomic landmarks in the abdominal cavity. However, its most important advantage is that it enables the adrenal vein to be dissected early in the procedure.

The indications for surgical removal of the adrenal gland have not, and should not be, changed in the laparoscopic era, and include: endocrine active tumors, suspected malignancies – primary and at times metastatic, adrenal masses larger than 5–6 cm, and smaller ones that have been followed and observed to be growing. In the work by Jossart et al. [9], the indications for laparoscopic adrenalectomy were aldosteronoma (42.7%), Cushing syndrome (18.6%), incidentaloma (16.9%), and pheochromocytoma (14.7%). Other less common indications included angiomyolipoma, small carcinomas or metastases, virilizing adenoma, and macronodular hyperplasia. However, the use of laparoscopic adrenalectomy in some pathologies is still debated. Laparoscopy has been accepted for pheochromocytoma [15,16], but since the tumor is often relatively large and vascular, bleeding may occur more often. Carbon dioxide insufflation may also contribute to an increase in blood pressure in patients who have not been appropriately controlled preoperatively. Fernandez-Cruz et al. [17] studied 37 patients undergoing laparoscopic removal of various benign adrenal tumors, both functioning and non-functioning. Specifically, they found that CO_2 pneumoperitoneum, which can result in hypercarbia, did not necessarily result in increased catecholamine levels. Furthermore, even when levels were elevated no adverse hemodynamic changes occurred.

It is currently suggested that laparoscopic adrenalectomy is indicated for pheochromocytoma patients with the following characteristics: a) a single, well-defined tumor; b) the tumor has a maximum diameter of 7–8 cm; and c) good preoperative blood pressure control.

The question as to the appropriateness of laparoscopy in the treatment of malignant tumors remains unresolved, and the answer will depend on the results of long-term outcome studies. Jossart and co-workers [9] performed laparoscopic adrenalectomies in 15 patients with adrenal metastases originating in renal cells, lung, colon, and melanoma. At a mean follow-up of 9.5 months, there were no port site or local recurrences. Ten patients are alive.

Concerning adrenocortical carcinomas or malignant pheochromocytomas, open adrenalectomy is the procedure of choice, given that such preoperative diagnosis is probable, allowing *en bloc* excision of the adrenal cancer and surrounding associated tissue and organs [18].

There are four situations [12] in which the laparoscopic route to the adrenal might not be the procedure of choice for surgical removal: a) the adrenal lesion is an adrenocortical carcinoma that invades surrounding tissues, b) the adrenal lesion is a malignant pheochromocytoma, c) the patient has a very large tumor (>10 cm in diameter) that may be difficult to remove laparoscopically and in which the risk for adrenocortical carcinoma increases in proportion to size, and d) the patient has a coagulation disorder.

Since the early 1980s, incidentally discovered adrenal masses have become a common clinical problem as a result of the more widespread use of computed tomography, magnetic resonance imaging, and ultrasonography [19–21]. In patients without a known extra-adrenal primary malignancy, the vast majority of these lesions are benign and non-hypersecretory. Resection of such incidentaloma is indicated when there is clear evidence of hormonal secretion or when there is a high suspicion for malignancy. While suspicion for malignancy is based on tumor size and specific radiologic signs, the size for adrenal tumors to be considered for excision has not been determined. Some

surgeons consider 4 cm large enough, while others do not resect tumors that are less than 6 cm.

To conclude, although it would appear that the open approach for adrenal disease will continue to have some place in the armamentarium of the endocrine surgeon, our series, like others, indicates that laparoscopic adrenalectomy is a successful treatment for a range of adrenal pathologies.

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Capsule

Rapid prion neuro-invasion following tongue infection

Food-borne transmission of prions can lead to infection of the gastrointestinal tract and neuro-invasion via the splanchnic and vagus nerves. Bartz et al. report that the transmission of transmissible mink encephalopathy (TME) is 100,000-fold more efficient by inoculation of prions into the tongues of hamsters than by oral ingestion. The incubation period following TME agent (hereinafter referred to as TME) inoculation into the lingual muscles was the shortest among the five non-neuronal routes of inoculation, including another intramuscular route. Deposition of the abnormal isoform of the prion protein, PrPSc, was first detected in the tongue and submandibular lymph node at 1–2 weeks following inoculation of the tongue with TME. PrPSc deposits in the tongue were associated with individual axons, and the initial appearance of TME in the brain stem was found in the hypoglossal nucleus at 2 weeks postinfection. At later time points, PrPSc was localized to brain cell groups that directly project to the hypoglossal nucleus, indicating the transneuronal spread of TME. TME PrPSc entry into the brain stem preceded PrPSc detection in the rostral cervical spinal cord. These results demonstrate that TME can replicate in both the tongue and regional lymph nodes but indicate that the faster route of brain invasion is via retrograde axonal transport within the hypoglossal nerve to the hypoglossal nucleus. Topical application of TME to a superficial wound on the surface of the tongue resulted in a higher incidence of disease and a shorter incubation period than with oral TME ingestion. Therefore, abrasions of the tongue in livestock and humans may predispose a host to oral prion infection of the tongue-associated cranial nerves. In a related study, PrPSc was detected in tongues following the intracerebral inoculation of six hamster-adapted prion strains, which demonstrates that prions can also travel from the brain to the tongue in the anterograde direction along the tongue-associated cranial nerves. These findings suggest that food products containing ruminant or cervid tongue may be a potential source of prion infection for humans.

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