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# Laparoscopic adrenalectomy by the anterior transperitoneal approach

## Results of 108 operations in unselected cases

**E. Lezoche,[1] M. Guerrieri,[1] A. M. Paganini,[1] F. Feliciotti,[1] P. Zenobi,[1] F. Antognini,[2] F. Mantero[3]**

[1] Istituto di Scienze Chirurgiche, University of Ancona, Ancona, Italy
[2] Servizio di Anestesia e Rianimazione, Ospedale Umberto I, Ancona, Italy
[3] Clinica di Endocrinologia, University of Ancona, Ancona, Italy

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**Abstract**
*Background:* The feasibility, safety, and results of 108 laparoscopic anterior transperitoneal adrenalectomies (six bilateral) were evaluated in a series of 105 patients. Three patients with a preoperative diagnosis of primary adrenal carcinoma were excluded from the study.
*Methods:* A total of 102 patients were included in the study based on exhaustive endocrinological and imaging assessment. Twenty-nine patients with nonsecreting adenoma, 34 with aldosterone-producing adenoma, 27 with cortisol-producing adenoma (five bilateral), 13 with pheochromocytoma (one bilateral), two with androgen-secreting adenoma, and three with metastases were considered eligible for adrenalectomy. Lesion size ranged from 3.5 to 12 cm. Concurrent surgical procedures were performed in 10 patients (9.8%).
*Results:* One (0.9%) intraoperative complication, a colon tear in a bilateral adrenalectomy, required conversion. There were two (1.9%) postoperative complications: one patient with thrombocytopenia developed hemoperitoneum and required a second laparoscopic procedure, and an intraabdominal abscess was treated medically. Mean postoperative hospital stay was 2.5 days (range, 1–7 days). Postoperative mortality was 0.9%; the patient with the colon tear died of sepsis 60 days after the operation. At a mean follow-up of 30 months (range, 1–62), normalization or improvement in hormone levels was observed in all patients with secreting adenomas, and significant improvement or cure was achieved in all patients with hypertension.
*Conclusion:* Patients with secreting and nonsecreting adrenal lesions can be treated safety and effectively by laparoscopy with the anterior transperitoneal approach.

**Key words:** Adrenalectomy — Adrenal surgery — Laparoscopy — Endocrine disorders

*Correspondence to:* E. Lezoche

In 1991, Clayman first described the technique of laparoscopic nephrectomy. This report was the first demonstration that retroperitoneal organs could be removed via a minimally invasive approach [5]. In 1992, Gagner reported three cases of laparoscopic adrenalectomy performed by the lateral approach with the patient in lateral decubitus position (lateral flank approach) [10]. Later, several reports appeared on adrenalectomies performed via this minimally invasive technique by the flank (or lateral), anterior, or posterior approach [3, 6, 7, 8, 9].

The aim of the present prospective study was to evaluate the feasibility, safety, and short- and long-term results in a series of 102 unselected patients who underwent 108 laparoscopic adrenal ablations (six bilateral) via the anterior transperitoneal approach.

## Patients and methods

A total of 105 patients with adrenal gland masses referred to the Istituto di Scienze Chirurgiche of the University of Ancona between January 1994 and April 1999 were considered for this study. Exclusion criteria, which entailed treatment by the traditional open approach in three patients, were (a) adrenal gland masses with a diameter >12 cm, (b) patients with an established preoperative diagnosis of primary adrenal carcinoma confirmed by fine-needle biopsy in suspicious cases, (c) high-risk patients who, due to their poor general condition, would not tolerate the pneumoperitoneum.

All patients with hypertension due to pheochromocytoma were treated preoperatively with alpha-adrenergic blockade (doxazosin), occasionally associated with beta-adrenergic blockade (propanolol). Patients with hyperaldosteronism were administered an aldosterone antagonist (potassium kanrenoate). Patients with cortisol-producing adenoma or incidentaloma received substitution medical therapy with hydrocortisone before and during surgery and with cortisone acetate thereafter for different periods according to individual needs.

The patients were informed of the technical aspects of the laparoscopic access, the potential complications, and the possible need for conversion to open surgery. All gave their signed consent.

In the course of the last 5 years, 108 laparoscopic adrenalectomies (six bilateral) were performed on 102 patients by the same surgical team skilled in advanced laparoscopy. The series included 63 women (mean age, 48.1; range, 21–75 years) and 39 men (mean age, 50.8; range, 19–73 years).

There were 59 right (54.6%) and 49 left (45.4%) adrenal tumors. The six bilateral tumors were removed via laparoscopic bilateral adrenalectomy. Five of them were treated for bilateral cortisol-producing hyperplasia; and one patient with multiple endocrine neoplasia (MEN 2A), previously subjected to resection of the left adrenal gland by open surgery elsewhere, was treated for bilateral pheochromocytoma recurrent on the left.

Eleven patients (10.8%) had had previous upper abdominal operations: five patients with right adrenal lesions had undergone either open cholecystectomy ($n = 2$), subtotal colectomy ($n = 1$), splenectomy ($n = 1$), or total gastrectomy ($n = 1$); five patients with left adrenal tumours had had either gastroduodenal resection ($n = 2$), open cholecystectomy ($n = 1$), open adrenal resection ($n = 1$), or splenectomy ($n = 1$); one patient had undergone sigma resection with temporary colostomy for peritonitis and cholecystectomy.

Ten patients (9.8%) presented with associated conditions (six gallbladder lithiases, two gallbladder adenomas, two ovarian cysts), which were treated in the course of the same laparoscopic procedure. Cholecystectomy (three cases) and left ovariectomy (two cases) were performed during five right laparoscopic adrenalectomies; in five patients undergoing left adrenalectomy, the gallbladder was also removed. Associated procedures were performed without positioning additional trocars apart from the standard four by simply changing the operative field and the table position.

The physical status of patients was classified according to the American Society of Anesthesiology (ASA) as ASA 1 in 79 cases, ASA 2 in 21 cases, and ASA 3 in two cases.

The following data were recorded for each patient: adrenal gland diameter, operative time, number of trocars employed, intraoperative complications, conversion to open surgery, morbidity, length of hospital stay, and pain medications administered. Operative time was measured from introduction to removal of the laparoscope.

## *Endocrinological and imaging study*

Exhaustive endocrinological evaluation was performed preoperatively in all patients. Baseline hormonal data included diurnal rhythm of plasma cortisol, urinary free cortisol (U.F.C.), plasma ACTH, DHEAS, 17OH progesterone, testosterone, supine and upright plasma renin activity (PRA), and aldosterone, urinary aldosterone, catecholamine excretion, and vanil mandelic acid. Different hormonal dynamic tests were performed based on the clinically suspected diagnosis: dexamethasone suppression test (overnight 1-mg or 8-mg test), CRH test, short ACTH stimulation test for cortisol and 17OH progesterone, and Captopril test for PRA and aldosterone.

Computerized tomography (CT) and/or magnetic resonance imaging (MRI) were performed in all patients. Twenty-nine patients (28.4%) underwent Se75 cholesterol or MIBG131 radioisotopic scintiscan.

Complete hormonal tests were also performed in patients with adrenal masses detected occasionally and unexpectedly during an imaging workup for extraadrenal complaints (incidentalomas) ($n = 12$). Preoperatively, 29 patients (26.8%) had a nonsecreting adrenal mass (mean size, 4.8 cm; range, 3.5–9), 34 (31.5%) had an aldosterone-producing adenoma (mean size, 4.4 cm; range, 2.5–5.8), 27 (25%) had a cortisol-producing adenoma (mean size, 4.9 cm; range, 2.5–10), 13 (12%) had a pheochromocytoma (mean size, 5.4 cm; range, 2.5–12), and two (1.9%) had an androgen-secreting adenoma (mean size, 5.5 cm; range, 4–7 cm). Three patients (2.8%) had exclusively adrenal metastatic lesions: one had a left adrenal metastasis from gastric carcinoma (6.5 cm), one had a right adrenal metastasis from melanoma (5.5 cm), and one had a right adrenal metastasis from gastric carcinoma (5 cm).

Sixty-eight of the 102 patients (66.7%) were clinically symptomatic, and hypertension was observed in 68 patients (66.7%).

In the 29 patients with incidentaloma, the indication for surgical ablation was related to the diameter (>5 cm) and to the rapid growth of the lesion, as monitored by ultrasonography (US) at 3-month intervals.

One patient with an aldosterone-producing adenoma was affected by von Willebrand's syndrome and required infusion of Dexamino-ISID-arginine-8-vasopressin (DDAVP) hormone (16 mg/die) preoperatively (2 h before), intraoperatively, and postoperatively (for 7 days). At 7 and 30 days following their discharge, patients were evaluated clinically and hormonally as outpatients. Subsequent follow-up visits were scheduled at 3-month intervals in the 1st year and every 6 months thereafter for clinical and hormonal examination; MR and/or CT were performed after 6 months and then once a year.

## *Surgical technique*

The patient is placed on the operative table in the supine positon, with containment devices on both sides to allow for tilting the table laterally, if required. The operation starts with the operative table in the horizontal position by inducing pneumoperitoneum with either the closed technique and the Veress needle or the open technique and the Hasson trocar, based on the presence of abdominal scars from previous operations. Four 10–12 mm trocars are generally employed; a fifth trocar may be used to improve the exposure of the operative field (the position of the first trocar varies according to lesion location).

## *Left adrenalectomy*

The first trocar is placed in paramedian position above the level of the umbilicus two finger breadths below the left costal arch. After careful exploration of the peritoneal cavity, three more trocars are introduced percutaneously under laparoscopic vision in the peritoneal cavity—the second trocar (used for bowel retraction) in the subxiphoid region right of the midline, the third trocar along the left midclavicular line above the level of the umbilicus, and the fourth in the flank region along the intermediate axillary line. The three trocars located at the umbilicus and on the left side of the patient are used to introduce the operating instruments and the telescope angled at 45°.

The descending colon is mobilized medially by dividing the peritoneal reflection along the left paracolic gutter with sharp dissection and electrocautery or, more recently, with the harmonic scalpel (Ethicon Endo-Surgery, Cincinnati, OH, USA), from the level of the sigmoid colon to the splenic flexure, which is also mobilized medially by dividing the splenocolic and phrenocolic ligaments. With the aid of a grasper entering the peritoneal cavity through the right-side trocar, the stomach is pushed anteriorly while the splenic flexure is pushed medially and aborally, thus placing the gastrocolic ligament under tension and widely dissecting it. By retracting the left colon toward the right, the posterior mesocolon is separated by blunt dissection from Gerota's fascia, which is then divided in the region of the superior pole of the kidney to reach the adrenal gland.

Exposure of the adrenal gland is obtained by employing a five-digit articulated retractor (USCC, Norwalk, CT, USA) introduced via the right-side trocar to gently raise the tail of the pancreas and the stomach. An ultrasound laparoscopic probe, which is particularly useful at the beginning of the learning curve, can be used to localize the left renal vein, which is followed until its junction with the left adrenal vein. This is carefully dissected free along its whole course to the gland. After blunt isolation, the left adrenal vein is closed with curved titanium clips (Origin Corporation, Menlo Park, CA, USA). Next, the gland is bluntly dissected and freed with electrocautery of the small arterial twigs providing the arterial blood supply to the gland, while any accessory vein or larger artery is divided.

Once it is completely mobilized, the adrenal gland is placed inside a specimen retrieval bag (USSC) for removal through the umbilicus trocar site. In case of large adenomas, the neck of the retrieval bag is extracted from the abdomen, and the gland is morcellated under direct visual control, avoiding tissue or liquid spillage outside the bag. This procedure generally allows fairly large specimens to be retrieved.

## *Right adrenalectomy*

The first trocar is located in paramedian position above the level of the umbilicus two finger breadths below the right costal arch. Two more operating trocars are placed lateral to the right midclavicular line at the level of the umbilicus and along the posterior axillary line, respectively. During the procedure, the laparoscope can be introduced through the right-side trocar, which provides the best laparoscopic vision. The fourth trocar is placed in the subxiphoid region on the left of the midline and used for liver and gallbladder retraction.

The operating table is placed in anti-Trendelenburg position to facilitate exposure of the subhepatic region. After the separation of any omental adhesion to the gallbladder and the hepatoduodenal ligament, the operation begins by dividing the peritoneal reflection along the lateral side of the inferior vena cava. The incision is prolonged transversely to the peritoneum overlying the posterior margin of the liver. Liver retraction allows the surgeon to gain exposure of the upper portion of the adrenal gland. Tissue dissection along the lateral aspect of the inferior vena cava permits the

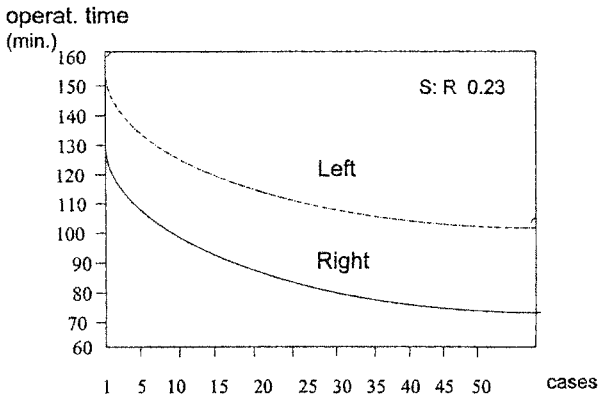


**Fig. 1.** The learning curve for left and right adrenalectomy is statistically significant according to the ordinary least-squares method.

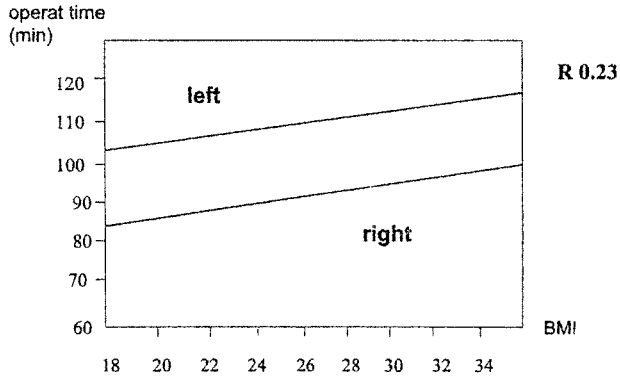


**Fig. 2.** BMI correlates significantly with operative time for both right and left adrenalectomy.

identification of the transversely oriented short adrenal vein directly entering the inferior vena cava. At the beginning of the learning curve, laparoscopic ultrasound was employed to facilitate identification of the adrenal vein. This vein is bluntly isolated, closed with curved titanium clips (Origin Corporation, Menlo Park, CA, USA), and divided. The gland is mobilized by blunt dissection and electrocautery of vessels until it is completely free. It is then placed into a specimen retrieval bag for removal through any of the right-side port sites.

After resection of the adrenal gland, the residual cavity is irrigated with Mitomycin C solution (10 mg in 200 cc of saline).

### *Statistical analysis*

We evaluated the learning curve, lesion diameter vs operative time, and body mass index (BMI) vs operative time by applying regression analysis with the ordinary least-squares method.

## Results

Complete ablation of the adrenal gland was performed in all patients. Conversion to open surgery was never necessary to remove the gland.

Lesion diameter ranged from 3.5 to 12 cm. Mean diameter was 5.1 cm for the right adrenal gland and 5.8 cm for the left.

Mean operative time was 85 min for right adrenalectomy (range, 45–190) and 112 min for left adrenalectomy (range, 70–300), with a statistically significant difference ($r < 0.23$). Bilateral adrenalectomy averaged 220 min (range, 170–280). For left and right adrenalectomy, the learning curve was statistically significant. The regression curve according to the ordinary least-squares method is shown in Fig. 1.

The diameter of the adrenal gland did not significantly correlate with operative time in either left or right adrenalectomy. However, the BMI did correlate significantly with operative time for both right and left adrenalectomy (Fig. 2). There was one intraoperative complication (0.9%)—a colon tear during a bilateral adrenalectomy for Cushing's hyperplasia—that required conversion to open surgery. The patient, who had previously undergone sigma resection with temporary colostomy for peritonitis and cholecystectomy elsewhere, died of *Candida* sepsis 60 days after the operation.

One (0.9%) of the 68 patients with clinically relevant hypertension needed intraoperative medical therapy to control hypertension and arrhythmia. There were no other cases of significant intraoperative hypertension, and postoperative hypotension was treated promptly.

Only one patient in the entire series (0.9%) required postoperative blood transfusion. Fifty-eight of the 102 patients (56.8%) required no postoperative pain medication, but i.m. Ketorolac was administered to 44 patients (43.2%) at a mean dose of 45 mg/patient (range, 30–60). All patients ambulated freely within 6–12 h of the operation. A liquid diet was administered on the 1st postoperative day.

Postoperative complications occurred in two patients (1.96%). A case of hemoperitoneum was due to laceration of Glisson's capsule in a patient with Werlhof's disease who had previously undergone surgery for splenectomy. The bleeding was resolved on the 1st postoperative day by reoperation via laparoscopic access. The second complication, an abdominal abscess that required a second admission, was treated by ultrasound-guided drainage and medical therapy.

All uncomplicated cases were discharged on the 2nd or 3rd postoperative day (mean hospital stay, 2.5 days) based on the need for postoperative hormonal treatment. All patients were able to resume their normal activities within 7 days of the operation.

Mean follow-up was 30 months (range, 1–62).

The three patients who underwent adrenalectomy for exclusively adrenal metastases received adjuvant chemotherapy at the oncology department of our hospital. All three died at 18, 13, and 6 months, respectively, of diffuse liver and pulmonary metastases. No local recurrences were observed.

One long-term complication (0.9%) requiring reoperation was related to a postoperative hernia at the umbilical port site.

Three months after the operation, resolution of hypertension was seen in 33 patients (48%) and significant improvement was noted in 35 others (52%), who received a single-drug regimen to control hypertension.

In all overt Cushing's patients, hypercortisolism sharply diminished 1 month after surgery, and normalization of hor-

mone plasma levels was observed in all 34 patients with aldosterone-producing adenoma.

## Discussion

In open surgery, access to the adrenal glands is obtained via the anterior, flank, posterior, and thoracoabdominal approach, based on mass size and endocrine function. Similarly, there are three options for laparoscopic access—anterior with the patient in supine position, and flank or posterior approach (retroperitoneal) with the patient in lateral decubitus [3, 9, 11, 21].

In open surgery, the advantages of the transperitoneal anterior approach are (a) wide exposure; (b) the possibility of performing bilateral adrenal gland exploration through the same incision; (c) in patients with pheochromocytoma, ability to explore the entire abdomen for associated disease in all areas where extraadrenal tumors might be located; (d) early ligature of the main adrenal vein. The disadvantages of this approach are related to the need for a long median or transverse abdominal incision, which may lead to the abdominal complications associated with wide access, such as wound infection and postoperative hernia, and with bowel manipulation (e.g., postoperative ileus, lesions of abdominal organs). For this reason, in earlier decades, adrenal lesions with a diameter of <5 cm have preferentially been treated with the posterior open access in order to minimize the complications of the transperitoneal approach.

It is generally recognized that minimally invasive approaches drastically diminish the risk of wound infection and the incidence of incisional hernias [2, 12, 14, 15, 18]. Furthermore, the laparoscopic technique induces fewer postoperative adhesions, which are among the most frequent causes of postoperative ileus; however, it is sometimes associated with direct trauma to the dissected organs [2, 18]. We chose the laparoscopic transperitoneal anterior access in order to combine all the advantages of the transabdominal access and to avoid the complications of a wide incision [9].

One significant advantage of the anterior laparoscopic access is a reduction of the risk of misdiagnosis of ectopic tissue in pheochromocytomas and cortisol-producing adenomas. According to Thompson [20], small extraadrenal pheochromocytomas not detected with any imaging study occur in ~5% of patients in isolated and sporadic cases. This small percentage represents the experience of one of the major referral centers and is probably higher in general practice. In any case, the anterior transperitoneal access allows the surgeon to explore the contralateral gland with intraoperative ultrasound to detect extraadrenal pheochromocytomas.

If the need arises to perform bilateral adrenalectomy [4], only two additional trocars are needed in our experience, and patient mobilization on the operative table is not required. Patients undergoing the anterior approach are placed on the operative table in supine position. This takes less time and, unlike the lateral and posterior accesses, does not require the risky repositioning of the unconscious patient. Furthermore, the supine position also constitutes an advantage when rapid conversion to open surgery is made necessary by an iatrogenic vascular lesion. No extra time is required to change the patient's position, and the anatomical site of bleeding is more readily identified after opening the abdomen because the transabdominal exposure of the working field is identical. Moreover, the supine position allows the surgeon to perform associated surgical procedures, such as cholecystectomy and ovariectomy, through the same port sites (with four or five trocars).

One criticism of the laparoscopic technique is related to the theoretical risk of neoplastic cell dissemination. However, since the widespread use of biochemical tests for adrenal hormones and noninvasive imaging methods (US, CT, and MRI) now result in the correct diagnosis of adrenal masses >4 cm in diameter suspicious for carcinoma in a very high proportion of cases (98%) [1, 16], the risk of neoplastic cell dissemination by the laparoscopic approach is not significant.

As compared with previous reports, our series was characterized by the removal of larger adrenal lesions (diameter >5 cm), which are at higher risk of malignancy. The laparoscopic removal of large masses was therefore performed with a surgical approach that take oncological principles into account and entails (a) early ligature of the main adrenal vein, which can be performed with the posterior approach only after wide mobilization of the gland; (b) a "no squeeze" technique and no direct manipulation of the gland before its complete devascularization; (c) removal of the gland in a bag; (d) washing of the residual cavity with Mitomycin C solution (10 mg/250 ml of saline) [19]. The first three of these considerations are very important not only for the oncological strategy but also for secreting adenomas and particularly for pheochromocytomas [13, 17].

The size of lesions did not influence the course of the operation; two adrenal tumors 12 cm in diameter were extracted successfully.

Coagulopathy was not considered to be an absolute contraindication for laparoscopy; a woman with von Willebrand's syndrome was treated with pre- and intraoperative DDAVP without complications.

We performed 11 laparoscopic adrenalectomies (10.8%) in patients previously operated on in the area of the upper abdomen; this is not a contraindication for laparoscopy if the surgeon has had extensive experience in laparoscopic abdominal procedures.

Mean operative time was 85 and 112 min for right and left adrenalectomy, respectively, and decreased in the last 40 adrenalectomies. Mean operative time for the bilateral adrenalectomies was 220 min. These times appear to be extremely reasonable because they include the whole learning curve. Anterior transperitoneal access requires a complex technique and broad surgical experience in colonic surgery. In fact, especially for left adrenalectomy, the splenic flexure must be widely mobilized. This maneuver strongly influences total operative time; this is the main reason why right adrenalectomy is a significantly shorter procedure.

For both left and right adrenalectomies, the statistical analysis demonstrated a significant correlation between operative time and BMI, which was particularly evident in patients who had a high liquid content in the tissues, such as those with cortisol-producing adenoma. On the other hand,

the size of the adrenal gland did not significantly influence the length of the operation. In our series, the mean diameter was 5.2 cm, and the largest gland measured 12 cm. We decided against removal by laparoscopy of glands exceeding this size even in the absence of any sign of malignancy and also when a malignancy had been ruled out by fine-needle biopsy. This decision was related to the technical difficulty of completely isolating the vascular connections of the gland according to the "no touch" technique.

Of the 111 consecutive cases that came to our attention in the course of 5 years, only one was excluded from laparoscopic treatment due to lesion size. The other two contraindications were related to the serious general condition of one patient and to CT evidence of local and vascular carcinogenic invasion in another. In the three patients with metastases and in all cases where the major gland diameter was >5 cm—entailing the theoretical risk of a malignant lesion at histology—we always washed the operative field carefully with a solution of Mitomycin C [19]. In all the patients of this series, histology confirmed the benign nature of the lesion. In the three patients with metastatic lesions, no evidence of local or portal recurrence has been observed at a mean follow-up of 12 months.

The laparoscopic technique generally requires a clean operative field; and especially in cases of adrenalectomy, hemostasis must be performed carefully. In our series, intraoperative bleeding was minimal, and only one patient (0.9%) required postoperative blood transfusion.

Another advantage of the laparoscopic approach is that it allows better exposure of anatomical structures than open surgery and the other laparoscopic accesses [12, 15, 18], especially of the main adrenal vein on both sides, although this technique requires the use of a lens angled preferably at 30° or 45°. In the case of pheochromocytomas, we recommend the administration of postoperative pharmacological therapy for ≥1 week. We also consider early ligature of the main adrenal vein and adoption of the "no touch" intraoperative technique mandatory. In the present series, one patient, who was affected by pheochromocytoma, developed intraoperative hypertension and cardiac arrhythmia in spite of the careful "no touch" dissection of the gland. Both conditions were easily controlled by the anesthesiologist with medical therapy.

Postoperative pain was minimal, and 57% of patients required no pain medication. The laparoscopic approach allowed early oral feeding and ambulation, with there were no postoperative complications such as bronchopneumonic or wound infections and deep venous thrombosis.

Mean hospital stay was 2.5 days. This includes the first five patients in our series, who were discharged on the 4th or 5th day as a precaution. Hospital stay after laparoscopic adrenalectomy was much shorter than after open adrenalectomy; a significant number of patients were ready to be discharged on the 1st postoperative day with i.v. corticosteroid replacement therapy. All of the patients were able to resume their normal activities within 7 days of the operation.

Postoperative complications occurred in three patients (2.7%). One patient bled from a hepatic laceration, which required laparoscopic reoperation on the 1st postoperative day, but experienced no further problems. The patient developed fever on the 9th postoperative day and was readmitted. An intraabdominal abscess was diagnosed and treated with ultrasound-guided drainage and antibiotics. Finally, a colonic tear occurred during the pneumoperitoneum in a high-risk patient (ASA 3) with bilateral Cushing's hyperplasia. After laparotomy, the patient developed an ileal perforation and died 2 months later of *Candida* sepsis.

Mean follow-up was 30 months (range, 1–62). One surgical reoperation was required at 3 months for a hernia of the umbilical port site.

At follow-up, return to normal hormonal function was observed in all cases of hyperfunctioning adenoma. Cure of hypertension was observed at 3 months in 33 patients (48%), and 35 patients (52%) were switched to a single-drug regimen and/or were prescribed a significantly lower dosage to control hypertension. Severe hypertension was significantly reduced, especially in patients with aldosterone-producing adenoma.

Numerous recent reports of laparoscopic adrenalectomy [2, 3, 10, 12, 18] have focused mainly on the flank and posterior approach. They describe this procedure as suitable in a high proportion of patients, at least as safe as open surgery, and superior to the open technique in terms of clinical outcome (i.e., quality of life, hospitalization, morbidity, and mortality). Herein we have reported the results obtained in a significant number of patients who underwent laparoscopic adrenalectomy using the anterior transperitoneal access at a single institution by the same surgical team. Our results are not inferior to those reported by surgeons who used the other approaches. Therefore, if the ultimate goal of adrenalectomy is to perform it via a minimally invasive approach, our experience demonstrates that the anterior transperitoneal access is equally safe and effective, in comparison with the other minimally invasive approaches that have been reported.

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