Complications associated with laparoscopic adrenalectomy: Description and standardized assessment

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KEYWORDS
Adrenalectomy; Laparoscopic; Complications

Abstract

Objectives: Laparoscopic adrenalectomy (LA) is the procedure of choice for surgical management of the adrenal masses. Our objective is to show a standardized assessment of perioperative complications in one LA series.

Materials and methods: 322 LA were performed consecutively between June of 1993 and September of 2012 in patients diagnosed with suprarenal tumor. In order to evaluate perioperative complications, data were collected prospectively and analyzed retrospectively. Intraoperative complications were defined using Satava classification and Clavien–Dindo classification of postoperative complications.

Results: Twenty five LA showed perioperative complications (7.3%); 11 (3.2%) were intraoperative complications, most of them vascular diaphragmatic lesions (Satava Grade 2); and 14 (4.1%) were postoperative complications. Six patients showed complications requiring surgery (Clavien IIIa/IIIb) and/or support in Intensive Care Unit (Clavien IV). Conversion to open surgery was necessary in one case (0.3%). Despite all appropriate preoperative endocrine measures were taken, an uncontrolled hypertensive crisis and cardio-respiratory arrest recovered were developed during surgery in one patient carrier of pheochromocytoma who died from massive cerebral infarction at 5 days (Clavien V).

Conclusions: Standardized criteria of surgical complications are necessary. Standardization is possible by combined application of two tools. We believe that this evaluation concept of the surgery morbidity must be used systematically in order to achieve a new standard refined, concise and comparative for reports of adverse perioperative events.

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Descripción y evaluación estandarizada de complicaciones asociadas a adrenalectomía laparoscópica

Resumen

Objetivo: La adrenalectomía laparoscópica (AL) es el procedimiento de elección para el manejo quirúrgico de las masas adrenales. Nuestro objetivo es presentar una evaluación estandarizada de las complicaciones perioperatorias en una serie de AL.

Material y métodos: Entre los meses de junio de 1993 a septiembre de 2012 se realizaron 344 AL en pacientes con diagnóstico de tumor suprarrenal, de forma consecutiva. Los datos fueron recolectados de forma prospectiva y analizados retrospectivamente para evaluar las complicaciones perioperatorias. Las complicaciones intraoperatorias se definieron utilizando la clasificación de Satava y las complicaciones postoperatorias según la clasificación de Clavien-Dindo.

Resultados: Veinticinco AL presentaron complicaciones perioperatorias (7,3%), 11 fueron intraoperatorias (3,2%), siendo en su mayoría lesiones vasculares y del diafragma (Satava grado 2) y 14 postoperatorias (4,1%). Seis pacientes presentaron complicaciones que precisaron intervención quirúrgica (Clavien IIIa/IIIb) y/o soporte en la unidad de cuidados intensivos (Clavien IV). Hubo una conversión a cirugía abierta (0,3%). A pesar de que se tomaron todas las medidas endocrinológicas preoperatorias adecuadas, un paciente portador de un feocromocitoma desarrolló en el intraoperatorio una crisis hipertensiva incontrolable y paro cardiorrespiratorio recuperado, falleciendo a los 5 días por un infarto cerebral masivo (Clavien V).

Conclusiones: Las complicaciones quirúrgicas necesitan de un criterio común de estandarización mediante la aplicación combinada de 2 herramientas. Creemos que este concepto de evaluación de la morbilidad de la cirugía debe ser aplicado de forma sistemática, y de esta manera permitir a los cirujanos lograr un nuevo estándar de informes de eventos adversos perioperatorios refinado, conciso y comparativo.

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Introduction

Since its description in 1992, laparoscopic adrenalectomy (LA) has increased its indication as the procedure of choice for adrenal tumors.1-3 In fact, the criteria for its application have been extended to include pheochromocytomas, big masses, and even oncologic surgery.4-6

Tumors of the adrenal gland are rare, so there are few publications with a sufficient number of patients, and in many centers the LA is still an exceptional surgical procedure. The overall complication rate of the reported LA is approximately 10%.7 Despite the acceptance of the need for a standardized classification system for surgical complications, we have not yet been able to reach a consensus on this issue.

In 1992, Clavien et al. published a classification system for surgical complications,8 which provides a new approach for their categorization. This system was developed with the aim of achieving uniformity of information, providing a means for better comparison among the different medical centers and different surgical techniques. The scoring system was modified in 2004 to include the complications associated with increased risk of death and permanent disability.9 However, this classification system does not include intraoperative complications. In 2005 Satava suggested a simple classification to evaluate surgical errors during laparoscopic surgery.10

This study seeks to characterize and describe perioperative complications in a series of 344 LAs, conducted in the same urological center over a period of 19 years.

We rely on the combined application of two tools: the Satava classification10 of intraoperative complications, along with the modified Clavien classification9 of postoperative complications.

Materials and methods

Between June 1993 and September 2012 344 LAs were performed in patients with a diagnosis of adrenal tumor, consecutively. The data were collected prospectively and analyzed retrospectively to evaluate perioperative complications.

In all cases, we used computed tomography (CT) and/or magnetic resonance imaging (MRI) as the study of choice for the diagnosis, location, and characterization of adrenal masses. Endocrinological evaluation was conducted in all patients that included basal aldosterone, serum cortisol, free cortisol, renin and potassium levels, and catecholamines and metanephrines in urine over 24 h to identify functioning masses of the adrenal cortex and medulla. In the case of functioning masses, specific preoperative management or postoperative hormonal replacement was done when necessary. Our surgical technique has been described previously, using the transperitoneal pathway in all cases.2

Demographics, intraoperative and postoperative variables were analyzed, including operative time, tumor side and size, estimated blood loss (EBL), complications, hospital stay, and histological type of the tumor.

Perioperative complications were classified into intraoperative and postoperative. Intraoperative complications
were defined using the Satava classification (Table 1) and the postoperative complications according to the Clavien classification modified by Dindo (Table 2).

### Results

Of a total of 344 LAs performed at our institution over a period of 19 years, 25 patients had perioperative complications (7.3%). The demographic data are described in Table 3.

### Principio del formulario

Of the total complications, 11 were intraoperative (3.2%) and they were categorized by means of the Satava classification (Table 4). All the intraoperative incidents, except one case, were resolved during surgery without causing variations in the normal postoperative course. Diaphragm injuries were managed by intracorporeal suture repair, and a spleen laceration was resolved with suture in the same surgical procedure. Vascular lesions were controlled and repaired intracorporeally in five out of six patients. One patient required conversion to open surgery due to bleeding caused by injury of the vena cava during dissection of the right adrenal vein (patient with Cushing’s syndrome with a right 6.5-cm adrenal tumor). There were two intraoperative complications not recognized: an injury of the tail of the pancreas and a colon injury, which were diagnosed postoperatively and required surgery. These were analyzed as postoperative complications by means of the Clavien-Dindo classification, but they might also be classified as an unrecognized intraoperative complication (Satava 3).

There were a total of 14 postoperative complications (4.1%), which were defined according to the modified Clavien classification (Table 5). In patients who had more than one complication, we only took into account the most severe. There were five Clavien I complications that included pneumonia, electrolyte disorder, retroperitoneal hematoma, and two cases of small incisional hernia in a port site that did not require surgical treatment. Two cases showed retroperitoneal hematoma that determined transfusion of blood products (Clavien II).

Seven patients had complications requiring some type of surgery (Clavien Ilia/Ilb), support in the intensive care unit (ICU) (Clavien IV), and/or death (Clavien V). Of these, three patients with pheochromocytoma ≥5 cm in diameter had complications ≥Clavien III: one had a pancreatic fistula that required the installation of a drainage at 48 h postoperatively (Clavien Ilb), another one developed a cardiogenic shock requiring ICU treatment (Clavien IVA), and finally a patient showed intraoperatively uncontrolled hypertensive crisis and recovered cardiac arrest, dying after five days due to a massive stroke, despite adequate alpha blockade and beta adrenergic preoperative (Clavien V). Two patients had a retroperitoneal hematoma, which in one case required exploratory laparotomy due to hemodynamic instability (Clavien Ilb) and in another one only percutaneous drainage (Clavien Ilia).

One patient with metastasis of a renal cell carcinoma in the left adrenal gland developed postoperatively a pancreatic fistula which required the installation of a percutaneous drainage and papillotomy of Wirsung (Clavien Ilb).

The last patient presented on the 5th postoperative day with an acute abdomen. Exploratory laparotomy was performed which revealed a necrosis of ascending colon, by

### Table 1 Clavien–Dindo classification of surgical complications.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Any deviation from a normal postoperative course without the need for pharmacological, surgical, endoscopic, or radiological interventions. Treatments such as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy are allowed. This grade includes pressure ulcers.</td>
</tr>
<tr>
<td>Grade II</td>
<td>Requirement for pharmacological treatment with drugs other than those allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.</td>
</tr>
<tr>
<td>Grade III</td>
<td>Require surgical, endoscopic, or radiological intervention</td>
</tr>
<tr>
<td>Grade IIIa</td>
<td>Interventions that do not require general anesthesia</td>
</tr>
<tr>
<td>Grade IIIb</td>
<td>Interventions under general anesthesia</td>
</tr>
<tr>
<td>Grade IVa</td>
<td>Complications that involve vital risk for the patient and require management of intensive care (including complications of the central nervous system)</td>
</tr>
<tr>
<td>Grade IVb</td>
<td>Single organ dysfunction</td>
</tr>
<tr>
<td>Grade V</td>
<td>Multi-organ dysfunction</td>
</tr>
<tr>
<td>«d» suffix</td>
<td>Patient death</td>
</tr>
</tbody>
</table>

### Table 2 Satava classification of intraoperative complications.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>An error without consequences</td>
</tr>
<tr>
<td>Grade 2</td>
<td>An error with identification and immediate correction, which may lead to recovery</td>
</tr>
<tr>
<td>Grade 3</td>
<td>An unrecognized error leading to a significant consequence or complication</td>
</tr>
</tbody>
</table>

### Table 3 Demographic characteristics of the patients and perioperative results.

| Patients (n) | 25 |
| Age (years) | 53 (24–72) |
| Sex (male/female) | 10/15 |
| Operative time (min)* | 50 (30–240) |
| Estimated bleeding (mL)* | 80 (0–2500) |
| Tumor size (cm) | 6 (1.2–12) |
| Hospital stay (days) | 5 (2–14) |

*a Median.
which right hemicolectomy was conducted, with ileostomy and mucous fistula (Clavien IIIb). The patient evolved with controlled sepsis and reconstitution of the transit three months later.

### Discussion

The LA as a treatment for various benign and malignant diseases can be technically difficult and it requires advanced laparoscopic experience. To date, the only absolute contraindication for LA is still neoplastic lesions involving adjacent organs, and where open surgery is still the most appropriate indication.

The laparoscopic working group of the German Urological Association recommends that the LA due to malignant adrenal tumors should only be performed in high-volume centers by a surgeon who performs at least >10 LAs/year. Some researchers consider that the learning curve of the LA can be reached after 20 procedures. The upper size limit in very experienced surgeons can be as high as 10–14 cm; however, tumors >6–7 cm should be seen as the upper limit in the early stages of the laparoscopic experience.

Morbidity is the cornerstone of the evaluation of a surgical treatment. Surveillance of surgical complications and their definition may vary among institutions and surgeons. The absence of a consensus on the best way to communicate surgical complications has hampered proper evaluation of the work of the surgeon, and possibly progress in the surgical field.

Clavien and Dindo made significant efforts to standardize surgical morbidity. However, this classification includes only postoperative complications, which have a major impact on patient welfare. On the other hand, intraoperative incidents must be recorded and reported, even if they do not lead to postoperative morbidity or affect patient comfort postoperatively. The aim of communicating intraoperative incidents includes the primary need to reduce their occurrence, and it might contribute to a refinement of the strategy and surgical technique, as well as to the adjustment of the medication protocols supporting surgery.

Many of the postoperative complications do not refer to any particular intraoperative adverse event, but they often result from a series of “mistakes without consequences” that accumulate and ultimately result in a complication. To minimize or avoid mistakes, it is important to understand both the error itself and the factors leading to it, as the type of error that has been made.

Satava describes that when a mistake is made there are three possible outcomes. First a harmless error, which can go unnoticed or be recognized, but it is not significant enough to result in a complication (Satava grade 1). These errors are almost never reported. Then we have an error with immediate identification and correction; there is the possibility of recovering from the error with minimal or no consequences for patients (Satava 2). Finally, the error with a consequence is that where the surgeon not only made an error, but it was not recognized, and therefore recovery was not possible (Satava 3). The last chance for the surgeon will be to recognize the complication at a later time and try to remedy the error with the minimal consequence for the patient.

The LA compared to traditional open surgery has lower morbidity and hospital stay, rapid convalescence, and better cosmetic effects. A literature review disclosed that the overall complication rate of the LA is approximately 10% (range 2.9–20) and a conversion rate of 3.5% (range 0–12), primarily due to vascular or visceral injury and technical limitations (diameter of the injury, adhesions, and obesity). The rate of perioperative complications in our series of 344 LAs is 7.3%. Table 6 shows the most representative series of laparoscopic adrenalectomies in recent years.

### Table 4 Intraoperative complications in our series of 344 LAs.

<table>
<thead>
<tr>
<th>No.</th>
<th>%</th>
<th>Satava classification system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaphragmatic injury</td>
<td>4</td>
<td>0.3</td>
</tr>
<tr>
<td>Renal vein injury</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Spleen laceration</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Adrenal vein injury (conversion)</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Vena cava injury</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Adrenal vein clip exit</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Total intraoperative complications</td>
<td>11</td>
<td>3.2</td>
</tr>
</tbody>
</table>

### Table 5 Postoperative complications in our series of 344 LAs.

<table>
<thead>
<tr>
<th>No.</th>
<th>%</th>
<th>Clavien classification system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retroperitoneal hematoma</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>Incisional hernia</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Pancreatic fistula</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Hypoatremia</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Intestinal injury</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Cardiogenic SOC</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Massive stroke (death)</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Total postoperative complications</td>
<td>14</td>
<td>4.1</td>
</tr>
</tbody>
</table>
The complications and recovery of the LA are not equivalent for all patients. Kissane et al. found that patients with hypercortisolism or another metabolic disorder have a greater risk of complications, especially pulmonary and will require more clinical resources. On the other hand, laparoscopic partial adrenalectomy appears to be a feasible procedure in our experience in 16 patients with aldosteronoma, in which there was no conversion to open surgery and the postoperative period was uneventful.

Pheochromocytoma and a tumor size larger than 5–6 cm in diameter have previously been described as independent predictive factors for conversion to open surgery and have been associated with increased postoperative morbidity in the LA. In our series, three patients with pheochromocytoma ≥5 cm in diameter showed complications ≥ Clavien III. In our experience, the most severe complications, including death, occurred in pheochromocytomas greater than 5 cm.

We described a significant increase in perioperative complications for obese individuals undergoing LA compared to healthy weight people, as well as prior open abdominal surgery and patient comorbidity proved to be independent predictors of postoperative complications.

We found in one of our published series that bilateral LA does not appear to increase the rate of complications. Out of 221 LAs performed from 1999 to 2005, 44 were bilateral. One patient had a lesion of the renal vein that was controlled with intracorporeal suture during surgery (2.2%).

Gaujoux et al. assessed the risk factors for conversion to open surgery in a series of 462 patients undergoing unilateral LA transabdominally, 15 procedures were converted to open surgery, overall morbidity was 11.5%, and six patients required reoperation. Major surgical complications were mainly due to bleeding and retroperitoneal collections, which were responsible for 6 of the 15 conversions to open surgery and of all reoperations. We did not include complications classified as minor (Clavien I). In the current series, we had a conversion to open surgery (0.3%) and it was due to intraoperative bleeding due to a lesion of the vena cava during dissection of the right adrenal vein (Satava grade 2) at the beginning of the experience.

We urologists need to understand in the best way as how to care for our patients based on the available evidence, to reduce morbidity and prevent mortality in the context of the risk models optimized. We believe that the most appropriate term to describe the surgical complications should be "perioperative complications", which includes the unfavorable intraoperative incidents and postoperative complications. An orderly and systematic description of the results of a surgical treatment could contribute to a better control of the quality of care and facilitate surgical research. The morbidity rate is a key parameter in the evaluation of any medical intervention, and its measurement is particularly important when assessing surgical innovations.

## Conclusions

Surgical complications require a common criterion of standardization by means of the combined application of two tools. In our series, we used the Satava classification of intraoperative complications and the modified Clavien classification of postoperative complications. We believe that this concept of assessing morbidity of surgery should be applied systematically, and thus allow surgeons to achieve a new refined, concise, and comparative standard of reports of perioperative adverse events.

## Conflict of interest

The authors declare that they have no conflict of interest.

## References