



Laparoscopic adrenalectomy

Ascending the learning curve

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Abstract

Background: Soon after its introduction, laparoscopic adrenalectomy (LA) became the procedure of choice in the surgical management of most adrenal tumors. The aim of this study was to assess the outcome and learning curve of the first 100 cases operated by the same surgical team.

Methods: Retrospective analysis of prospectively collected data of 100 consecutive LAs was performed. The parameters studied were indication for surgery, side and length of operation, intra- and postoperative complications, size of tumor, conversion to open surgery, final diagnosis, and length of stay.

Results: Between 1996 and 2002, 100 LAs were performed in 90 patients. The procedures included 45 left, 35 right, and 10 bilateral resections for pheochromocytoma (29), Cushing's syndrome (27), Conn's syndrome (16), nonfunctioning adenoma (13), and others (5). Mean tumor size was 4.16 cm (range, 0.3–11). Overall major morbidity occurred in eight patients (9%); there was one mortality due to cerebrovascular accident in an elderly patient. Five cases (5%) were converted to open surgery. The mean length of stay for the whole group was 4.7 days (range, 2–25). In order to assess the learning curve, procedures were divided into three, equal consecutive groups ($n = 33, 33, \text{ and } 34$). Intraoperative complications in the intermediate and late groups were significantly less compared to those in the early group (2/33, 2/34, and 7/33, respectively; $p < 0.05$). Similarly, the mean operating time was significantly reduced between the early (169 min) and both intermediate (116 min) and late (127 min) groups ($p < 0.005$). The conversion rate was reduced between the three groups

(3/33, 2/33, and 0/34), but this was not significant ($p = 0.06$).

Conclusions: As expected, the outcome of LA is associated with a steep learning curve. According to this study, it seems that performance of approximately 30 cases by an experienced laparoscopic surgeon is required to master the procedure.

Key words: Laparoscopic adrenalectomy — Learning curve — Adrenal tumors

Since its introduction in 1991 [3], laparoscopic adrenalectomy (LA) has rapidly become the procedure of choice for the surgical management of most adrenal tumors. The laparoscopic approach was shown to be associated with several advantages when compared with the traditional “open” technique, including decreased postoperative pain, ileus, and hospitalization, faster return to normal activity, and better cosmesis [1, 4, 5, 7, 8].

The accepted indications for LA include functioning adrenal adenomas, secreting catecholamines (pheochromocytoma), aldosterone (Conn's disease), cortisol (Cushing's syndrome), androgen/estrogen; nonfunctioning adenomas > 4 or 5 cm; and bilateral adrenal hyperplasia, usually secondary to pituitary tumor. Debatable indications for LA include tumors with suspected malignancy and large tumors more than 10–15 cm in diameter (primary or metastatic) [1, 5, 8].

Contraindications for LA are few, usually relative, and include mostly technical considerations, such as a very large tumor, morbid obesity, or multiple adhesions.

Nevertheless, LA is still considered an advanced procedure requiring a higher level of skills with potentially lethal pitfalls. Therefore, the aim of this study was to assess the learning curve of LA as well as the outcome of the first consecutive 100 procedures performed by one surgical team.

Table 1. The learning curve in 100 consecutive laparoscopic adrenalectomies

	Group 1 (early) (<i>n</i> = 33)	Group 2 (intermediate) (<i>n</i> = 33)	Group 3 (late) (<i>n</i> = 34)	<i>p</i> value
Overall major morbidity	6 (18%)	1 (3%)	1 (3%)	< 0.03
Conversion	3 (9%)	2 (6%)	0	0.06
Mean length of procedure (min)	169	116	127	< 0.05

Patients and methods

All consecutive patients who were scheduled for LA were prospectively entered into a laparoscopic registry database. The following data were recorded: patient's age and gender, preoperative diagnosis, size of tumor, procedure, intra- and postoperative complications, operation time, final histological diagnosis, and length of stay. All patients underwent a full endocrine and imaging evaluation. The first 100 procedures were divided into three equal consecutive groups (*n* = 33, 33, and 34), and these groups were compared in relation to the collected data.

Data are presented as range and mean values. Statistical analysis included the unpaired, two-tailed Student's *t*-test and Fisher's exact test (Microsoft Excel 2000, Microsoft, Redmond, WA, USA). A *p* value less than 0.05 was considered significant. In all patients, we used the transperitoneal lateral approach using four ports for the right-sided lesions and three or four ports for the left-sided lesions, as previously described [4, 11].

During the study period, all patients who were candidates for adrenalectomy and treated by our surgical team were approached laparoscopically. Additionally, this surgical team, which included two attending residents and a chief resident, had previous experience with other more advanced laparoscopic procedures, such as antireflux, splenectomy, and colectomy.

Results

Between 1996 and 2002, 100 LAs were performed in 90 patients. There were 43 males and 47 females aged 6–81 years (mean, 50). The procedures included 45 left adrenalectomies, 35 right adrenalectomies, and 10 bilateral procedures. The indications for surgery were pheochromocytoma in 29 patients, Cushing's syndrome in 27, Conn's syndrome in 16, nonfunctioning adenoma in 13, and others in five (including single metastases from breast carcinoma, renal cell carcinoma, sarcoma, malignant melanoma, and one case of unsuspected adrenocortical carcinoma) (Table 1).

The mean tumor size was 4.16 cm (range, 0.3–11). There was no difference in the average size of the tumors resected between the three groups. The mean length of stay was 4.7 days (range, 2–25), with no difference in this parameter between the groups.

Five procedures (5%) were converted to open surgery. These conversions were due to inferior vena cava (IVC) injury in two cases due to tear of the accessory right adrenal vein and technical difficulty in two cases, with multiple adhesions in one and difficulty in anatomical definition in another case. The fifth patient was converted due to IVC and kidney invasion by a tumor that turned out to be an adrenocortical carcinoma that was not suspected preoperatively by CT scan. The conversion rate declined between the three groups, with three conversions in the early group (3%), two in the intermediate group (2%), and none in the late group. However, due to the small numbers, this did not reach statistical significance (*p* = 0.06).

Overall intraoperative and postoperative major morbidity occurred in eight patients (9%), including IVC injury in two patients, myocardial ischemia, intraoperative arrhythmia causing transient hemodynamic compromise, retroperitoneal hematoma, upper gastrointestinal bleeding, mild devascularization of the upper pole of a left kidney due to occlusion of a small renal polar artery that was adjacent to the adrenal tumor with no subsequent impairment of the kidney function, and prolonged gastric paresis with gastric dilatation. Of these patients, six were in the early group and one each in the intermediate and late groups, indicating a significant decrease in major morbidity rates between the first group and the latter two groups (*p* < 0.03).

Regarding intraoperative complications, when stratified by groups there were seven in the early group: minimal ischemia of the upper pole of the left kidney (one), small splenic capsule laceration for which bleeding was stopped by conservative measures not requiring blood transfusion (one), pneumothorax treated by a small 12-Fr chest drain that was subsequently removed after several hours (two), transient myocardial ischemia (one), and tear of an accessory right adrenal vein off the IVC (two). In the intermediate group, one patient suffered prolonged cardiac arrhythmia requiring appropriate medication and there was one case of small splenic capsule laceration, which was self-limiting and did not require blood transfusion. In the last group, there were two cases of pneumothorax that was treated as mentioned previously. These findings of 21, 6, and 6% intraoperative complications relative to the group sequence did reach statistical significance (*p* < 0.05).

There was one mortality (1%) due to a vertebrobasilar stroke in a 78-year-old hypertensive patient with an unsuspected adrenocortical carcinoma that was found to invade the IVC and the kidney, requiring conversion of the procedure and an en block resection of the adrenal mass, kidney, and part of the IVC wall.

The mean operative time was also significantly reduced between the early and both latter groups, from 169 ± 35 min to 116 ± 35 min and 127 ± 41 min, respectively (*p* < 0.005).

Discussion

Surgeon's performance and patients' outcome are suspected to show a learning curve pattern whenever a new technique or unfamiliar instrumentation are introduced. The steepness of such a learning curve is related to various factors, some of which most surgeons can control, such as proper theoretical followed by practical training, proctorship and mentoring, and previous

experience with other procedures that require similar skills. Indeed, when reviewing the evolution of laparoscopic surgery during the past decade, it is very clear that most surgeons gained their early experience from performing relatively simple procedures, such as cholecystectomy and appendectomy, before performing more complex procedures, such as colectomy and solid organ resection. In parallel, most institutions as well as the Society of American Gastrointestinal Endoscopic Surgeons established strict guidelines for granting privileges in various laparoscopic procedures in an attempt to reduce the expected learning curve while the new techniques and instrumentation of laparoscopic surgery were emerging.

In this study, we evaluated the learning curve in performing LA. Although widely utilized worldwide, this procedure is still considered an advanced one due to its complexity and potential life-threatening morbidity. Although at the time of the study strict guidelines were not yet established, we did not start LA until we had gained several years of experience with other procedures, starting with simpler ones, such as cholecystectomy and appendectomy, followed by more advanced ones, such as antireflux procedures, colorectal resections, and splenectomy.

We chose to perform 100 procedures before analyzing and comparing the results based on similar work that evaluated laparoscopic colorectal procedures, showing that approximately 60 cases are needed before mastering these procedures as reflected by a significant decrease in morbidity and length of procedure [10]. Our study indicates that 30 procedures are needed to overcome the learning curve of LA, providing the procedure is performed by surgeons who have gained previous experience in other complex procedures.

Interestingly, in another study, when comparison was made between the first and the last 20 patients the only parameter that was reduced was the estimated blood loss, whereas operating time and complication rate did not significantly change [8]. Possible explanations for these findings may include the smaller number of patients and the large number of surgeons (not residents) participating in the study.

Another issue that might be solved after overcoming the learning curve is the performance of LA for malignancy. Just as laparoscopy was accepted for the management of colorectal cancer after larger series indicated surgeons had moved beyond the learning curve [6, 12], LA for malignancy may also become more accepted as safe oncological outcome is demonstrated [9].

Regarding the “next generation” of surgeons who were trained to perform laparoscopy from the beginning of their residency, along with the increased use of surgical simulators, the learning curve will probably require a smaller number of patients before they can reach the required level of skill for performing this procedure.

However, with the recently introduced robotic systems and the increasing number of procedures that are performed using this technique [2], although mostly experimental, there may be a “second round” of a learning curve when and if more surgeons switch from traditional laparoscopy to such systems.

In summary, based on our study and as may be expected, LA is associated with a steep learning curve. According to our results, approximately 30 procedures are required to achieve a better outcome when performed by an experienced laparoscopic surgical team.

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