

## Comparative Study of Laparoscopic and Open Adrenalectomy

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**Background:** Laparoscopic adrenalectomy (LA) had become the preferred operation for management of adrenal neoplasm. We conducted this cohort study to evaluate the outcome of laparoscopic and open adrenalectomy (OA).

**Methods:** A total of 67 patients with complete medical records were included in this study. Thirty patients underwent OA and the other 37 patients received LA. The intraoperative and perioperative data analyses focused on surgery time, blood loss, pain scale rating, resumption of oral feeding, hospital stay, complications and convalescence.

**Results:** LA was completed in all 37 patients without conversion to OA or mortality. The surgery times (203.4 vs. 192.9,  $p = 0.776$ ) were similar for both OA and LA groups. There was less blood loss in the LA group (355.0 vs. 104.0,  $p = 0.021$ ). The postoperative pain scale rating was lower in the LA group (5.6 vs. 4.5  $p = 0.035$ ) as was analgesia demand (57.4 vs. 3.7,  $p < 0.001$ ). Oral feeding resumed earlier in the LA group (91.7 vs. 16.4,  $p < 0.001$ ) and these patients had a shorter postoperative hospital stay (8.4 vs. 3.9,  $p < 0.001$ ). The complication rate in both groups was similar. In the LA group, patients with primary aldosteronism had shorter surgery times and less blood loss than patients with other tumor types ( $p < 0.05$ ).

**Conclusions:** LA results in good surgical outcome without increased risks. We suggest that LA should be the preferred choice for management of adrenal neoplasms. We also suggest that surgeons inexperienced in LA consider beginning with a case of primary hyperaldosteronism.  
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**Key words:** laparoscopy, adrenalectomy, adrenal neoplasm.

Adrenalectomy is indicated in most functional adrenal neoplasms and large incidentalomas. After Gagner reported the first experience in 1992,<sup>(1)</sup> laparoscopic adrenalectomy (LA) has been the standard procedure for management of benign adrenal neoplasms in many centers worldwide in the past decade.<sup>(2-4)</sup> However, its application in adrenal cancer and metastatic adrenal tumor is still controversial.<sup>(5,6)</sup>

Although there were some specific circumstances that indicated use of one particular approach, both retroperitoneal and transperitoneal approaches have been reported with satisfactory results.<sup>(7,8)</sup> Most research in the literature compares the outcome of LA to previous open surgery.<sup>(2-4,6)</sup> We present this study, undertaken in a single institution, to evaluate the results of open and LA.

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## METHODS

Thirty-seven patients underwent transperitoneal LA from January 2001 to December 2004. There were also 30 patients who had open adrenalectomy (OA) during the same period. The decision for OA or LA was dependant on the patient and therefore not randomized. All the patients underwent complete hormone studies, including blood cortisol, potassium, aldosterone, renin, adrenal corticotropin hormone levels, and urine vanillylmandelic acid (VMA), catecholamine and cortisol levels. Adrenal scans and image studies were also performed. The indications for adrenalectomy were functional tumor, nonfunctional tumor larger than 4-cm and incidentaloma less than 4-cm but with increasing size. Any patient with a tumor larger than 6-cm underwent OA and was excluded from the study.

### Transperitoneal anterior approach

The LA procedure was modified from the previous report.<sup>(3)</sup> Briefly, the patient was placed in a 60-degree semi-decubitus position and pneumoperitoneum was obtained by Veress needle. Three or four 2-mm to 10-mm ports were inserted, the adrenal vein was ligated with hemoclips, specimen was placed in a surgical glove and removed from the umbilical wound.

### Analysis

Data were collected in a retrospective fashion for all patients by review of their medical records, including the anesthesia record, pathology report and surgical notes. Surgery time was defined as the period from the first incision to complete closure of the skin incision. Postoperative hospital stay was calculated by assigning the day of surgery as day 0. Blood loss was obtained from the anesthesia record. Postoperative wound pain was rated by visual analogue scale in the nursing record 48 hours after surgery. Convalescence was defined as complete return to normal daily activity. Patients were interviewed at the latest follow-up. A careful physical examination was performed to look for signs of abdominal wall complications related to surgery, such as chronic pain, numbness, hernia and muscular laxity. The resolution of clinical symptoms and hormone status were also recorded. Data are expressed

as mean plus or minus standard deviation and 95% confidence interval (95% CI). Statistical significance was analyzed by SPSS 11.5 software using analysis of variance, Post Hoc test, Wilcoxon's rank-sum test, independent Student t test and Fisher's exact test, with significance defined as  $p < 0.05$ .

## RESULTS

The demographic data are listed in Table 1. There was female preponderance in the LA group. The mean age, weight, height, body mass index, laterality of tumor and American Society of Anesthesiologist (ASA) score were all statistically insignificant between the two groups. The mean tumor size was smaller in the LA group ( $p > 0.05$ ). There was one patient with bilateral pheochromocytoma in each group and these patients only received right adrenalectomy due to the active uptake of the right adrenal gland by adrenal scan. Pheochromocytoma (n = 12) was the most common tumor type in the OA group followed by primary aldosteronoma. The most common tumor type in the LA group was primary aldosteronoma (n = 10) followed by pheochromocytoma. Indications for adrenalectomy were comparable for both groups (Table 2).

The difference in mean surgical time between the LA and OA groups was not statistically significant (192.9 minutes vs. 203.4 minutes,  $p = 0.776$ ). However, the LA group had decreased blood loss (104.0 ml vs. 355.0 ml.,  $p = 0.021$ ), more rapid resumption of oral feeding (16.4 hours vs. 91.7

**Table 1.** Demographics of Adrenalectomy Patients

	LA	OA	p-value
Number	37	30	
Mean Age (yr)	42.0 ± 13.1	46.0 ± 11.5	0.324
Gender			0.630
Male	15(40.5%)	15(50%)	
Female	22(59.5%)	15(50%)	
Laterality			0.809
Right	16(53.3%)	14(46.7%)	
Left	21(55.3%)	17(44.7%)	
Tumor size (cm)	3.3 ± 1.2	4.2 ± 2.6	0.318
ASA score	2.2 ± 0.5	2.4 ± 0.8	0.596
BMI (kg/m <sup>2</sup> )	24.7 ± 3.4	24.1 ± 4.2	0.402

**Abbreviations:** LA: laparoscopic adrenalectomy; OA: open adrenalectomy; ASA: American Society of Anesthesia; BMI: body mass index.

**Table 2.** Indications for Adrenalectomy

	LA	OA
Pheochromocytoma	9*	12*
Cushing's syndrome	8	3
Conn's adenoma	10	8
Cortical adenoma	6	5
Other†	5	3

**Abbreviations:** LA: laparoscopic adrenalectomy; OA: open adrenalectomy.

Conn's syndrome = primary hyperaldosteronism

\* one patient (each group) had bilateral pheochromocytoma

† including myelolipoma and ganglioneuroma

hours,  $p < 0.001$ ), decreased analgesia (morphine equivalent) use (3.7 mg vs. 57.4 mg.,  $p < 0.001$ ), lower pain scale rating (4.5 vs. 5.6,  $p = 0.035$ ), shorter hospital stay (3.9 days vs. 8.4 days,  $p < 0.001$ ) and quicker convalescence (3.8 weeks vs. 8.4 weeks,  $p < 0.005$ ). One patient with right pheochromocytoma and concomitant liver cirrhosis died of hepatic failure one week after OA. In the LA group, one patient with Cushing's syndrome had a splenic artery injury with blood loss of 800 ml and received a blood transfusion. There were no differences in major complications (5.4% vs. 3.3%,  $p = 0.63$ ). No patient in the LA group required conversion to open surgery. (Table 3)

Table 4 shows intraoperative and postoperative data according to tumor pathology for the LA group.

**Table 3.** Perioperative and Postoperative Parameters

	LA Mean (95% CI)	OA Mean (95% CI)	<i>p</i> -value
<b>Intraoperative</b>			
Surg time (min)	192.89 (144.72-224.48)	203.43 (174.86-267.85)	0.776
Blood loss (ml)	104.04 (21.66-164.76)	355.00 (102.69-607.31)	0.021*
<b>Perioperative</b>			
Feeding time (hr)	16.38 (10.85-21.91)	91.70 (80.29-102.11)	< 0.001*
Pain scale rating	4.5 (3.4-5.6)	5.6 (4.9-6.3)	0.035*
Analgesics (mg)	3.68 (2.25-5.11)	57.37 (37.26-77.48)	< 0.001*
Length of stay (day)	3.9 (2.8-5.0)	8.4 (7.0-9.8)	< 0.001*
Convalescence (wk)	3.8 (2.7-4.9)	8.4 (6.2-10.6)	0.005*
Complications	2 (5.4%)	1 (3.3%)	0.634

**Abbreviations:** LA: laparoscopic adrenalectomy; OA: open adrenalectomy; CI: confidence interval; Surg, surgery.

\* Statistically significance  $p < 0.05$ , Student's t test.

**Tables 4.** Results of Stratified Tumor Pathologies of Laparoscopic Adrenalectomy

	Conn (n = 10)	Cushing (n = 8)	Adenoma (n = 11)	Pheo (n = 8)	<i>p</i> -value
Surgery time (min)	158.5**	220.2	172.0	238.7**	0.026*
Blood loss (ml)	51.8**	181.2**	60.0	153.7	0.083
Feeding time (hr)	12.1**	19.2**	15.0	20.2**	0.030*
Length of stay (day)	3.0**	4.5**	4.3	4.3	0.105
Tumor size (cm)	1.7**	2.8	3.5**	3.9**	0.027*
Complication	0	12.5%	0	12.5%	

**Abbreviations:** Conn: Conn's disease (primary hyperaldosteronism); Cushing: Cushing's syndrome; Pheo: pheochromocytoma.

\*  $p < 0.05$  (ANOVA test, between groups).

\*\* The mean difference is significant at the 0.05 level, Post Hoc Test.

The patients with primary aldosteronism had shorter surgery times, smaller tumor sizes, earlier resumption of oral feeding and shorter hospital stays ( $p < 0.05$ ). On the other hand, the patients with Cushing's syndrome had the longest hospital stays and more blood loss ( $p < 0.05$ ). Patients with pheochromocytoma had the longest surgery times ( $p < 0.05$ ). Two complications, including splenic artery injury and ileus, were noted in patients with Cushing's syndrome and pheochromocytoma, respectively.

## DISCUSSION

Laparoscopic surgery has had a great impact on urological operations. After the first laparoscopic nephrectomy,<sup>(9)</sup> laparoscopy was applied in almost all urological surgeries. LA is worthy of note among such surgeries. Before the 1990s, open adrenalectomy with a large wound was the only way to remove the deep seated but small adrenal tumor. Patients usually suffered from significant morbidity and slow recovery. Since Gagner described his first experience,<sup>(2)</sup> LA has been accepted as the treatment of choice worldwide.

Based on our results, LA has several significant advantages over the open approach. There was decreased blood loss due to the delicate dissection

and magnified effect of laparoscopy. Postoperative pain was less and cosmesis was better due to the smaller incision. Oral feeding was resumed earlier, the postoperative hospital stay was shorter and return to daily activity was quicker in patients in the LA group. Other studies have reported similar results.<sup>(10-12)</sup>

There are some disadvantages in performing LAs. One of the most important is the steep learning curve.<sup>(13)</sup> Some centers, including ours, did not have a mentor available for the first LA. The way we overcame this was to select a simple case and repeat preoperative simulation until the surgeon and the whole team had confidence to complete the operation. It was also helpful to review videotape of such procedures. Never feel embarrassment in converting to OA when there is risk to the patient or it is hard to proceed. Animal laboratory practice may help but does not always represent the clinical situation. The surgery time may become comparable with the open approach after one overcomes the learning curve.<sup>(10-12)</sup> The second drawback was the cost of laparoscopic instruments. However, if we take the more rapid return to work into consideration, the patient may gain more than he pays: the patient undergoing LA can return to work almost one month earlier (3.8 vs. 8.4 weeks). We believe that the patient can earn more within that month than the cost of the surgical instruments.

Although we did not preclude pheochromocytoma from LA initially, we found it challenging to manage such a tumor. The surgery time was prolonged due to the easy bleeding of this hypervascular tumor and potential hypertensive crisis.<sup>(14,15)</sup> The longest surgery time in the study was 360 minutes for a patient with right pheochromocytoma and he was readmitted one week postoperative for ileus. LA on a friable Cushing's adenoma was also difficult: we removed the tumor with adjacent fatty tissue to reduce directly grasping the adenoma. Many studies have reported the improved outcome of LA for Cushing's syndrome compared to OA, especially in wound healing.<sup>(12,16)</sup> As listed in Table 4, we recommend selecting a patient with aldosteronoma as the first case for the LA beginner. This tumor was one of the most common indications in some studies and is suitable for laparoscopic extirpation because it is small in size, benign, well-defined and confined in the adrenal gland.<sup>(15,17)</sup>

Adrenal cancer is still a controversial indication for LA. When dealing with malignant disease, it is critical that laparoscopic intervention does not compromise accepted oncological surgical principles. This study excluded metastatic adrenal tumors and tumors larger than 6-cm as potential malignant disease. Well-experienced laparoscopic surgeons in the literature have reported only small tumor cases.<sup>(4,5)</sup> Port site metastasis, local recurrence and open conversion have been reported.<sup>(18-20)</sup> It is too early to confirm the efficacy and safety of LA for adrenal cancer.

In conclusion, we compared the outcome of LA and OA in a cohort study and clearly showed the benefits of the laparoscopic approach. Based on our results, LA can be performed safely and efficiently, and we recommend that LA should be the treatment of choice for benign adrenal neoplasms without malignant potential. We also suggest that surgeons inexperienced in LA consider beginning with a case of primary hyperaldosteronism.

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## 腹腔鏡及傳統腎上腺切除手術之比較研究

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**背景：** 腹腔鏡腎上腺切除手術已經成爲腎上腺腫瘤標準手術，本文主要比較腹腔鏡及傳統腎上腺切除手術之差異及不同病理型態之分析。

**方法：** 本研究包含 67 名患者，其中 30 名患者接受傳統腎上腺切除手術，另外 37 名患者接受腹腔鏡腎上腺切除手術。手術中暨手術後之資料分析包括手術時間、出血、併發症、疼痛指數、進食時間、住院日數及恢復時間。

**結果：** 37 名患者接受腹腔鏡腎上腺切除手術皆順利完成手術。兩組手術時間相當 (203.4 vs. 192.9  $p = 0.776$ )，腹腔鏡腎上腺切除手術之患者出血較少 (355.0 vs. 104.0  $p = 0.021$ )，術後疼痛指數較輕 (4.5 vs. 5.6  $p = 0.035$ ) 且止痛藥使用亦少 (3.7 vs. 57.4  $p < 0.001$ )，進食時間較快 (16.4 vs. 91.7  $p < 0.001$ )，住院日數較短 (3.9 vs. 8.4  $p < 0.001$ )，兩組併發症比例相當。在腹腔鏡腎上腺切除手術之組別，原發性醛固酮瘤 (aldosteronoma) 之患者手術時間及出血相較其他腫瘤型態少 ( $p < 0.05$ )。

**結論：** 腹腔鏡腎上腺切除手術之預後良好且併發症並未增加。我們建議腹腔鏡腎上腺切除手術應爲腎上腺腫瘤之首選，剛開始以原發性醛固酮瘤爲佳。  
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**關鍵字：** 腹腔鏡，腎上腺切除手術，腎上腺腫瘤。

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