# Laparoscopic Adrenalectomy versus Open Adrenalectomy for Benign Adrenal Tumours: Results from a Prospective Comparative Study

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***Objective:*** *The purpose of this study is to compare the operative and postoperative outcomes of laparoscopic adrenalectomy (LA) with open adrenalectomy (OA) for benign adrenal lesions less than 6 cm in size.*

***Patients and methods:*** *From March 2011, to January 2015, patients with adrenal tumours were allocated to either unilateral laparoscopic or open adrenalectomy. Patients with adrenal masses >6 cm, suspected adrenal malignancies, and adrenal metastasis were excluded. Demographic data, operative findings, operative complications, postoperative complications, and duration of hospital stay were recorded and compared in both groups.*

***Results:*** *Two groups of patients (18 in each group) were allocated in this study. Both groups were statistically similar regarding age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) score. Two patients in the laparoscopic group were converted to open resection. The mean operative time in the laparoscopic group was significantly higher. However, the mean operative blood loss, need for analgesics, time of passing flatus after surgery, the duration of hospital stay were significantly lower in the laparoscopic group. Postoperative complications, hemodynamic stability and need for blood transfusion showed no statistical difference in both groups.*

***Conclusions:*** *Laparoscopic adrenalectomy is a safe operative procedure offering faster recovery, and shorter hospital stay. Hence, we recommend laparoscopic adrenalectomy as the first line treatment for benign adrenal masses less than 6 cm in size.*

***Key words:*** *Laparoscopic adrenalectomy (LA), open adrenalectomy (OA), adrenal tumours.*

## Introduction:

Laparoscopic adrenalectomy was first described by Gagner and colleagues[1] in 1992. Subsequently, this approach has been performed with increasing frequency in many specialized centers.

Difficulty with open surgical exposure and the small size of the adrenal gland make this organ particularly amenable to a minimally invasive approach.[2]

Many advantages of this technique over open adrenalectomy have been proved[3-5] including decreased intraoperative blood loss, decreased postoperative pain, fewer intra- and postoperative complications, shorter hospital stay and faster recovery.

However, concerns related to technical difficulties, steep learning curve, longer operative duration, large sized masses, and radicality in malignant cases are still questionable.

## Patients and methods:

This study is a prospective randomized study. From March 2011 to January 2015, patients with adrenal tumours were allocated to either unilateral laparoscopic or unilateral open resection. Operations were done in the department of surgery in El Demerdash and Ain Shams specialized hospitals. The diagnosis was based on ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI). A full history and thorough physical examination were done to

all patients.

Exclusion criteria included patients with BMI >40, previous upper abdominal operations, patients classified as class III or IV in ASA score, patients with MRI showing suspected malignancy, adrenal metastasis, tumour size more than 6 cm in size, or incidentaloma less than 4 cm in size. All patients included in this study gave informed written consent. Patients in the laparoscopic group were informed that conversion to open resection might be required and a written consent was taken.

Routine laboratory preoperative investigations, chest x-ray, and ECG were done to all patients. Vanillyl mandelic acid, serum cortisol and plasma aldosterone were requested based on the clinical presentation. In all patients with pheochromocytoma, alpha adrenergic receptor blockade was administered ten days prior to surgery.

Perioperative enoxaparin sodium was given as prophylaxis for deep venous thrombosis (DVT). Prophylactic intravenous third generation cephalosporin was administered at the induction of anesthesia. A urinary catheter and a nasogastric tube were routinely inserted after the patient was put under general anesthesia.

**Surgical procedure:**

**Laparoscopic approach:**

All patients were treated by transperitoneal approach with the patient in a lateral decubitus position (on the side opposite to the tumour), rotated 60 degree. An open technique was used for placement of the first 10 mm trocar just lateral to the rectus abdominis muscle and 5 cm below the costal margin. A 30° laparoscope was inserted and carbon dioxide was insufflated. Another two trocars (5 mm) and one trocar (10 mm) were inserted under vision after insufflation of the abdomen. These trocars were inserted just below the costal margin lateral to the linea semilunaris and in a dorsal direction at the level of the midclavicular, anterior, and midaxillary lines. In some cases we used only 3 ports in left adrenalectomy, but in right adrenalectomy we used 4 ports in all cases. For right adrenalectomy, the liver was retracted and the adhesions of bowel and colon in the right upper quadrant were divided, then the diaphragmatic attachments of the right lobe were dissected until the liver was easily retracted superiorly and medially. Then the inferior vena cava (IVC) and the adrenal glands came into view.

The connective tissue between the medial border of the adrenal gland and the IVC was carefully dissected. The antero-lateral wall of the IVC was exposed, and the right adrenal vein was localized, clipped, and divided **Figure (1)**. The adrenal gland was then dissected **Figures (2,3)** and removed in a bag.

On the left side, the dissection was started by dividing the splenecolic ligament and the leino-renal ligament to allow the spleen and distal pancreas to fall medially. The left adrenal gland was then identified in the retroperitoneal space. Then the left renal vein and adrenal vein were exposed. The left adrenal vein was then clipped and divided in all cases. We tried not to grasp the gland directly. Dissection was done using harmonic scalpel. Tube drain was inserted to be removed two days after the operation.

Open procedures were done via the anterior transabdominal approach through subcostal incision.

**Data collection:**

**Preoperative parameters:**

Both groups were compared for age, sex, ASA, and BMI.

**Intraoperative parameters:**

The following parameters were recorded: Operative time (Skin to skin) in minutes, total blood loss (by adding the blood aspirated to the weight of the gauzes used during surgery), blood transfusion needed, intraoprative complications, and conversion of laparoscopic to open resection.

**Postoperative care and parameters:**

All patients receive postoperative IV fluids, IV third generation cephalosporins,

proton pump inhibitors, and prophylaxis for DVT. Postoperative pethidine was given in the first 36 hours, and then ketorolac tromethamine 30 mg injection was given only on demand to compare the postoperative need for analgesics in both groups. A clear fluid diet was initiated once the patient passed flatus followed gradually by soft diet. The patients were discharged when they were passing flatus or stool, tolerating a soft diet, and fever free.

Postoperative outcome measures like duration of hospital stay, passage of flatus or stool, and resumption of oral liquids were noted and compared in both groups. Postoperative complications in both groups were also compared. Operative morbidities were defined as complications that contributed to prolonged hospital stay or led to additional procedures. Operative mortality was defined as death that occurred during the same hospital stay or within 30 days following the primary operation.

**Statistical analysis:**

Data were collected, revised coded and entered to the statistical package for social science (IBM SPSS) version 20; qualitative data were presented as numbers and percentages and compared together using chi-square test. Fisher exact test was used only when the expected count was found less than 5 in any cell; while quantitative data were presented as mean, standard deviations and ranges comparison between the two groups was done by using independent t-test. The confidence interval was set to 95% and the margin of error was set to 5%. So the P value was considered non significant at the level of >0.05; significant at the level of <0.05 and highly significant at the level of < 0.001.

**Results:**

**Patients flow:**

Thirty six [36 patients were included in this study; 18 having undergone laparoscopic adrenalectomy (11 right and 7 left), and also 18 having undergone open adrenalectomy (9 right and 9 left)].

**Preoperative parameters:**

The demographic data are shown in **Table (1)**. The two groups were well compared regarding age, gender, BMI, and ASA score.

The indications for adrenalectomy were; Cushing's syndrome (16 patients), pheochromocytoma (6 patients), Conn's syndrome (4 patients), myelolipoma (3 patients) [patients with myelolipoma were complaining mainly of hypochrondrial pain and back pain], adrenal cyst (3 patients) [complaining mainly of abdominal pain], incidentaloma ≥4 cm in size (4 patients). There were no significant differences between the indications for operation in both groups as shown in **Table (2)**.

The mean tumour size was 4.4 cm (range 2.5-6 cm) in the laparoscopic group and it was 4.6 cm (range 2.5-6 cm) in the open group showing no statistical difference.

**Intraoperative parameters Table (3):**

Two patients in the LA group were converted to open adrenalectomy. One of them was converted after accidental injury of the spleen during laparoscopic left adrenalectomy. This necessitated open conversion and splenectomy. The other conversion was due to failure to identify the right adrenal vein during laparoscopic right adrenalectomy. The preoperative diagnosis of these two cases was Cushing syndrome and Conn's syndrome respectively. These two patients were excluded from further analysis leaving 16 patients in the laparoscopic group.

The mean operative time of the LA group was 142 ±17.3 minutes, and that of the OA group was 124 ±10.6 minutes being highly significantly longer in the laparoscopic group ( P <0.001).

The mean estimated intraoperative blood loss was 200±65 ml (range 100 -1000 ml) in the LA group, while in the OA group, it was 350 ±137 ml (range 200 -1300ml) which was significantly higher (P =0.012).

Blood transfusion was given to two patients in the LA group (one in left and one in right adrenalectomy). The tumour was unexpectedly very vascular in both

cases with about 750 ml 1000 ml blood loss respectively. The procedures in these two cases were successfully completed without conversion and with nice postoperative course. Concerning the OA group, two patients required blood transfusion. Both patients were performing right adrenalectomy where considerable blood loss happened (850 ml, 1300ml) during dissection of the gland. However, both patients passed nice postoperative course.

Intraoperative hypertension occurred in three patients with pheochromocytoma (one in LA group and two in OA group) at induction of anesthesia and during manipulation of the gland. The highest pressure recorded was 230/150 mmHg in one patient in the OA group during manipulation of the right gland. The hypertensive crisis was of short duration and was controlled pharmacologically by the anesthesiologists without any complications. No intraoperative hypertensive episodes were observed. No patients developed hypotension after recovery from anesthesia or during the postoperative period.

**Postoperative recovery Table (4):**

The mean time of the first time of passing flatus after surgery for the LA group was 25 ±10.3 hours, and 37 ±14.5 hours in the OA group being significantly shorter in the LA group (P =0.011). The mean mg/day of ketorolac tromethamine analgesic given to the laparoscopic group was 44±18.5 mg/day, compared to 62 ±22.8 mg/day for the open group, being significantly higher in the OA group (P =0.017).

The postoperative hospital stay was significantly shorter in the LA group with a mean of 3.8 ±1.6 days, and that of the OA group was 5.7 ±2.5 days, (P =0.014).

**Postoperative complications Table (5):**

**General complications:**

Two cases of chest infection were reported (one in each group). Both patients were male (47 & 52 years), both were smokers and diabetics. They were successfully treated and discharged after 8 and 10 days respectively postoperatively. No cases of cardiac complications, DVT, or pulmonary embolism were recorded.

**Abdominal complications:**

One case of ileus was recorded in the OA group. This patient developed abdominal distension on the 4th day postoperatively, 9 days after removal of the drain. The distension improved after nasogastric tube insertion. Abdominal ultrasound revealed mild to moderate clear intraperitoneal fluid collection. The patient was managed conservatively and the condition resolved spontaneously. The patient was discharged 12 days postoperatively with a free follow up ultrasound and in an open bowel state. Wound infection occurred in two patients of the OA group, infection was controlled without subsequent complications. No port-site infection occurred in the LA group. However, one case of port-site hernia presented 3 months after the operation. Hernia repair was done with mesh insertion 6 months after the initial operation. No patients in the OA group presented with incisional hernia after the operation.

Histopathological evaluation revealed cortical adenoma (15 patients), pheochromocytoma (5 patients), aldosterone secreting adenoma (4 patients), myelolipoma (3 patients), and adrenal cysts (3 patients), the 4 cases of incidentaloma have been proved to be cortical adenoma (2 patients), angiomyolipoma (1 patient) and ganglioneuroma (1 patient) as shown in **Table (6)**.

**Discussion:**

Anatomically, the adrenal glands are relatively inaccessible. For this reason, the access to the glands in open resection necessitates long incisions, whether the approach is anterior or posterior. Subsequently significant pain and longer postoperative recovery is expected in this procedure. Although, the access to adrenal glands is difficult, the actual dissection of the gland is relatively less demanding. This fact theoretically makes laparoscopic

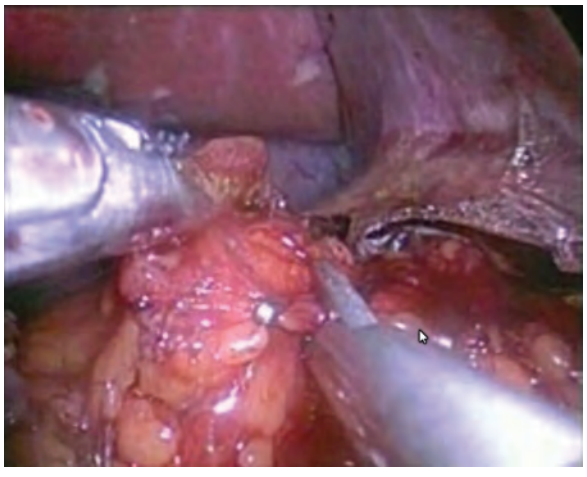

*Figure (1): Clipping of right adrenal vein.*

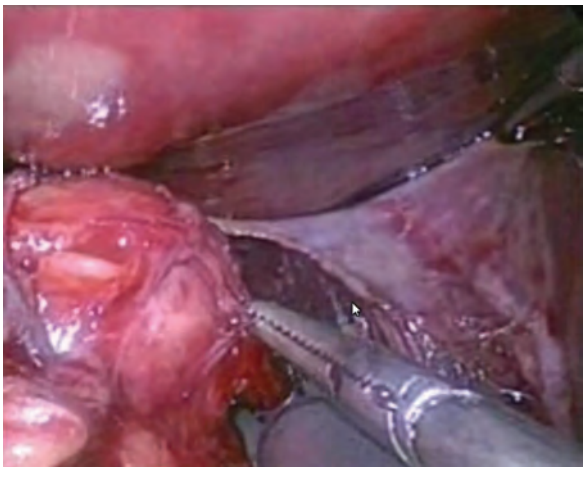

*Figure (2): Dissection of adrenal gland after clipping of right adrenal vein.*

*Figure (2): Adrenal gland nearly separated for removal.*

***Table (1): Demographics for laparoscopic and open adrenectomy groups.***

| | LA (n=18) | OA (n=18) | P value |
|---|---|---|---|
| Mean age (year) | 47.2±6.7 | 45.7±7.3 | 0.525 |
| Sex%<br>Male<br>Female | <br>8(44.4%)<br>10(55.6%) | <br>7(38.9%)<br>11(61.1%) | <br>0.735 |
| BMI | 29.3±3.2 | 28.2±2.2 | 0.238 |
| ASA score (%)<br>I<br>II | <br>9(50%)<br>9(50%) | <br>8(44.4%)<br>10(55.6%) | <br>0.739 |

procedure less traumatic with faster recovery. Although there are many retrospective studies comparing laparoscopic and open adrenalectomy, no prospective randomized trials are performed.[6]

We held this prospective study to evaluate our early experience in laparoscopic adrenalectomy by comparing the operative and postoperative outcomes of open and laparoscopic adrenalectomy. Both groups were comparable as regard; age, sex, BMI, ASA score and tumour size.

***Table (2): Indications for surgery.***

| | LA (n=18) | | OA (n=18) | | P-value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| Cushing syndrome | 7 | 38.89% | 9 | 50.00% | 0.502 |
| Pheochromocytoma | 3 | 16.67% | 3 | 16.67% | 1 |
| Conn's syndrome | 2 | 11.11% | 2 | 11.11% | 1 |
| Myelolipoma | 2 | 11.11% | 1 | 5.56% | 0.546 |
| Adrenal cysts | 2 | 11.11% | 1 | 5.56% | 0.546 |
| Incidentaloma | 2 | 11.11% | 2 | 11.11% | 1 |

***Table (3): Comparison between LA and OA concerning operative data.***

| | LA (n =16) | OA (n =18) | P value |
|---|---|---|---|
| Operative time | 142 ±17.3 | 124 ±10.6 | <0.001 |
| Blood loss | 200 ±65 | 350 ±137 | 0.012 |
| Number of patients receiving blood transfusion | 2 | 2 | 0.899 |
| Operative mortality | 0 | 0 | NA |

***Table (4): Comparison between both groups as regard postoperative recovery.***

| | LA (n=16) | OA (n=18) | P value |
|---|---|---|---|
| First flatus (mean hours) | 25 ±10.3 | 37 ±14.5 | 0.011 |
| Ketorolac tromethamine (mean mg/day) | 44 ±18.5 | 62.0 ±22.8 | 0.017 |
| Postoperative hospital stay (mean days) | 3.8 ±1.6 | 5.7 ±2.5 | 0.014 |

***Table (5): Comparison of postoperative complications in the LA and OA groups.***

| **Complications** | **LA (n=16)** | **OA (n=18)** | **P value** |
|---|---|---|---|
| Cardiac | 0 | 0 | NA |
| Chest infection | 1 | 1 | 1.000 |
| Pulmonary embolism | 0 | 0 | NA |
| DVT | 0 | 0 | NA |
| Wound infection | 0 | 2 | 0.146 |
| Ileus | 0 | 1 | 0.310 |
| Collection | 0 | 1 | 0.310 |
| Hernia | 1 | 0 | 0.310 |

Adrenal surgery is relatively unfamiliar. A Survey of general surgery residents[7] showed they performed an average 1.5 laparoscopic adrenalectomies during their training. This relative unfamiliarity made Maccabee et al.[8] stated that extratraining is needed to overcome the learning curve of this advanced procedure. Goitein et al.[9] stated that a minimum of 30 cases are required to master the technique. However, Reynolds et al.[10]

***Table (6): Comparison of histopathological evaluation in the LA and OA groups.***

| Histopathology | LA(n=16) | | OA(n=18) | | P value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| Cortical adenoma | 7 | 43.75 | 10 | 55.6 | 0.492 |
| Pheochromocytoma | 2 | 12.5 | 3 | 16.7 | 0.732 |
| Aldosterone secreting adenoma | 2 | 12.5 | 2 | 11.1 | 0.899 |
| Myelolipoma | 2 | 12.5 | 1 | 5.6 | 0.476 |
| Adrenal cysts | 2 | 12.5 | 1 | 5.6 | 0.476 |
| Angiomyolipoma | 0 | 0 | 1 | 5.6 | 0.338 |
| Ganglioneuroma | 1 | 6.25 | 0 | 0.0 | 0.359 |

stated that minimal extratraining is needed for laparoscopic adrenalectomy.

In our study, one encountered many challenges in the first ten cases; the two procedures that were converted to open conversion were the 2nd and the 8th cases. The operative time was higher in the first 10 cases. With additional cases done in the future, one may perform another study to compare retrospectively the first twenty patients with the next laparoscopic adrenalectomies done, to show if experience has changed the outcomes in laparoscopic adrenalectomy especially the operative time, rate of conversion, postoperative recovery, and complications.

Gagner and his colleagues[11] stated that laparoscopic adrenalectomy is technically difficult and it is recommended to tackle small glands first till adequate experiences reached.

In our study, tumours >6 cm were excluded for 2 reasons: First we didn't prefer to perform challenging cases in our early experience, 2nd large tumours may be malignant with high blood supply and thin capsule that may disrupt during manipulation with subsequent tumours spillage, local recurrence, and trocar implant. However, laparoscopic adrenalectomy for lesions >6 cm is debatable with authors accepting[12,13,14] and others refusing.[15,16] Some authors[17,18] proved that lesion >6 cm is associated with longer operative times, a greater blood loss, a higher conversion rate, and a higher risk of local recurrence in malignant cases. Dalvi et al.[18] concluded in their study that laparoscopic intervention for vascular and large adrenal glands is safe.

In our study, all cases of pheochromocytoma were challenging. This is because of their larger size when compared to other lesions, the need for especial preoperative preparation, expert anesthesiologists, and strict postoperative blood pressure monitoring. Mellon et al.[20] showed in their study that there is no difference between surgical outcomes following laparoscopic adrenalectomy for pheochromocytomas and outcomes following other indications for surgery. This was consistent with other studies[21,22] that showed laparoscopic resection of pheochromocytoma is safe and effective with shorter hospital stay, less need for anesthesia and better perioperative hemodynamic stability as documented by intraoperative hemodynamic indices including hyper-and hypotensive episodes. In our study, we had 6 cases of pheochromocytoma. All laparoscopic cases were done successfully without conversion. The hemodynamic stability intraoperatively and postoperatively showed no significant difference in both groups.

In our study, we found laparoscopic resection having clinical advantages as regard recovery of bowel movement and duration of hospital stay. Elfenbein and his colleagues[23] showed that laparoscopic approach is associated with sizeable reduction in postoperative morbidity and length of hospital stay.

A study carried by Romachandran and his colleagues[24] is consistent with our results. It showed the mean length of hospital stay was 3.95 ±0.32 days in the laparoscopic group and 10.16 ±0.83 in the open group (P <0.001). A recent study[25] showed the median hospital stay after adrenalectomy in the laparoscopic and open group was 4 and 11 days respectively.

In our study the operative time was significantly higher in the laparoscopic group matching with other study.[24] This can be attributed to our still early experience in laparoscopic approach for adrenalectomy. We expect operative time would decrease with more practice. On the other hand, Edwin et al.[22] showed in their study that median operative time did not differ between the two groups. Moreover, Yamashita et al.[25] showed the median operative time was significantly lower in the laparoscopic group. The median blood loss in the same study was 50 and 290 ml in the laparoscopic and open groups respectively. In our study, the mean blood loss was significantly lower in the laparoscopic group matching with other studies.[6,26] However, the need for blood transfusion was the same in both groups. Mellon et al.,[19] showed blood loss as well as the need for blood transfusion were not statistically different between both groups. According to our results, there was no statistically difference as regard intra-and postoperative complications. We showed also in our study that the need for analgesics was significantly lower in the laparoscopic group. This is consistent with other studies that showed laparoscopic adrenalectomy has fewer intra - and postoperative complications as well as decrease pain and narcotic use[26, 27].

**Conclusion:**

Laparoscopic adrenalectomy is a safe operative procedure offering faster recovery and shorter hospital stay. These satisfactory postoperative outcomes necessitate skilled and meticulous operative technique, expert surgeons and anesthesiologists, strict preoperative preparation and perioperative monitoring especially in cases of pheochromocytoma. Hence, one can recommend laparoscopic adrenalectomy as the first line treatment of benign adrenal masses less than 6 cm in size.

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