



## SURGICAL OUTCOMES OF ADRENALECTOMY FOR ADRENAL TUMORS: RETROSPECTIVE STUDY

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### ABSTRACT

**Purpose:** This study retrospectively reviewed 11 cases of adrenalectomy, focusing on surgical outcomes and clinical courses. **Methods:** Data from 11 patients who underwent adrenalectomy at our hospital between January 2017 and November 2024 were retrospectively analyzed using their medical records. The collected data included age, sex, tumor location, length of postoperative hospital stay, tumor size, tumor pathology, final diagnosis, operation time, operative blood loss, and type of operation. **Results:** The study included eleven patients, six males and five females, with a mean age of 49 years. The average tumor size was 5.2 cm. Five patients were diagnosed with functional adrenal tumors, while six had nonfunctional adrenal tumors. Compared to laparoscopic adrenalectomy, open surgery resulted in a significantly longer operating time, greater blood loss, and a prolonged hospital stay. **Conclusion:** When adrenal tumors show related symptoms despite unconfirmed hormonal activity, they should be considered functional, and adrenalectomy should be performed. Our findings suggest that laparoscopic adrenalectomy offers better postoperative recovery than open adrenalectomy, even with a limited number of cases. Open adrenalectomy should be considered after a thorough assessment of the patient's condition, including factors such as accompanying surgery or metastatic cancer.

**KEYWORDS :** systolic blood pressure (SBP), open adrenalectomy (OA), Laparoscopic adrenalectomy(LA)

### INTRODUCTION

The adrenal gland is an endocrine organ with two physiological functions. The cortex produces steroid hormones, including glucocorticoids such as cortisol, mineralocorticoids like aldosterone, and the androgen dehydroepiandrosterone. The inner adrenal medulla produces catecholamines. Adrenal masses discovered during routine studies can be categorized as either functional (hormone-secreting) or non-functional (which can be benign or malignant).(1)

Adrenalectomy is performed to address adrenal gland tumors. Traditionally, this procedure required a large laparotomy due to the small size and retroperitoneal location of adrenal glands. Gagner et al. in 1992 has performed laparoscopic adrenalectomy which significantly revolutionized this procedure [2]

For benign adrenal tumors, laparoscopic adrenalectomy is often preferred due to its benefits, such as reduced blood loss, shorter hospital stays, and quicker recovery times compared to open surgery.[3,4]

Over the past eight years, we retrospectively evaluated 11 cases of adrenal tumors operated on at Government Medical College Kota Rajasthan. Both laparoscopic and open adrenalectomies were performed, with a focus on assessing the surgical outcomes and clinical courses.

This study aims to compare the clinical results of laparoscopic versus open adrenalectomies and to identify the conditions that necessitate an open adrenalectomy.

### Method

All patients were thoroughly informed about the procedure, and consents for surgery were duly obtained.

We retrospectively analyzed data from 11 patients who underwent adrenalectomy at our hospital between January 2017 and November 2024. The variables considered included age, sex, tumor location, postoperative hospital stay, tumor size, tumor pathology, final diagnosis, operation time, operative blood loss, and type of operation. Operation time and blood loss were specifically evaluated based on anesthesia records.

Before performing adrenalectomies at our institute, several prerequisites were observed. Diagnosis was established through clinical examination, laboratory values, and imaging techniques such as ultrasonography and computed tomography. Metabolic evaluations were conducted by endocrinologists for all patients to test for functional adrenal masses.

For patients suspected or diagnosed with pheochromocytoma, preoperative catecholamine blockade was administered. Tablet Prazosin, 2.5 mg twice daily, was initiated 14 days prior to surgery, with the dose titrated to achieve a blood pressure less than 160/90 mmHg in a seated position on an outpatient basis. Once adequate alpha blockade was achieved, beta blockers such as atenolol (25 mg PO BID) or metoprolol (25-50 mg PO TID) were started to prevent reflex tachycardia and arrhythmias. Adequate hydration was ensured by administering of crystalloid the night before surgery to ensure plasma volume preoperatively expanded. Blood grouping and cross-matching were done, and blood was reserved in all cases. All patients received general anesthesia, and antibiotic prophylaxis was provided with cefotaxime (1 g IV).

Intraoperative patients' systolic blood pressure (SBP) levels of 180 mmHg or higher were classified as hypertensive crises, while SBP levels below 90 mmHg were classified as

hypotensive episodes. Data was gathered from the patient's anesthesia record.

The decision on the surgical approach was based on tumor size and suspected primary malignant adrenal neoplasms showing local advanced invasion or metastases on radiological imaging. These cases were approached through open adrenalectomy. Patients with adrenal tumors either functional or nonfunctional size up to 6 cm in diameter were planned for a laparoscopic approach.

For patients who underwent open adrenalectomy (OA), the incision choice was determined before hand based on tumor size and whether the tumor was benign or malignant. The surgical approaches used included the subcostal transperitoneal or roof-top (bilateral subcostal) approaches.

In the anterior subcostal approach, excellent exposure of the great vessels was provided, which was necessary if lymph nodes or venous tumor thrombus needed to be addressed. For tumors on the left side, the patient was positioned supine on the surgical table. If needed, a body roll was placed under the back at the level of the costal margin to enhance exposure.

An incision was made roughly two fingerbreadths below the costal margin and extended medially to the midline or further, depending on the necessary exposure. The external oblique, internal oblique, and transverse abdominal muscles, along with their corresponding fasciae, were divided laterally. The rectus muscle and the rectus sheath were divided medially. The peritoneum was then entered sharply, and the falciform ligament was divided after being clamped and ligated with a large-gauge vascular tie (no. 0 or 1 silk).

Descending colon was mobilized medially by incising the line of Toldt. The splenic flexure was mobilized by cutting the splenicocolic ligament. Additionally, the lienorenal ligament was divided to achieve the medial movement of the spleen.

The left adrenal vein was identified by dissecting out the left renal vein. Following the ligation and division of the left adrenal vein, medial attachments to the aorta were carefully dissected and ligated, with gentle lateral traction applied to the gland. The lateral and inferior attachments to the kidney were separated using blunt and sharp dissection from the renal capsule. Intraoperative hypertensive or hypotensive crises were managed by experienced anesthesiologists using appropriate inotropes, nitroprusside infusion, and IV crystalloids. After the removal of the left adrenal gland, the incision was closed using a running no. 1 polydioxanone suture in two layers. The deep layer included the transverse abdominal muscle, transverse fascia, internal oblique muscle and fascia, and posterior rectus sheath, while the superficial layer comprised the external oblique muscle and fascia, and the anterior rectus sheath. For right-sided tumors, the dissection was similar, except it required the medial displacement of the duodenum using the Kocher maneuver. A 24 F drain was placed in all cases for a day or two for drainage.

Laparoscopic adrenalectomy(LA) was performed using the transperitoneal approach. Patients were initially positioned supine and then shifted to either the left lateral or right lateral position after General anesthesia. [Figure 1] There was no significant difference in the surgical procedure compared to previous studies.[5][6]

For right-sided adrenalectomies, four trocars were used due to the necessity of liver traction, whereas for left-sided adrenalectomies, three trocars were sufficient. Trocar placement varied depending on the patient's anatomical structure. After creating the pneumoperitoneum, the primary camera port was placed first, followed by the placement of the

rest of the ports under direct vision to ensure the correct positioning of the working ports.

Dissection was performed using the Harmonic scalpel™ (Ethicon Endo Surgery INC - Johnson & Johnson, NJ, USA) or the LigaSure™ vessel sealing system. For areas requiring precise dissection, the monopolar Laparoscopic J Hook was used. Major feeding vessels and adrenal veins were ligated with Hem-o-Lok clips and then divided

During right adrenalectomies, the liver was lifted using a liver retractor, the liver triangular ligament was separated, and carefully removing the soft tissue between the inferior vena cava to allow full exposure of the adrenal gland, first step consisted of vascular control of the main adrenal vein and multiple adrenal arteries were carefully ligated.[figure 2]

The left adrenalectomy began with the medial reflection of the left colon from the retroperitoneum and spleen, allowing for the superior retraction of the adrenal gland. The adrenal vein draining into the left renal vein was initially ligated, followed by the meticulous ligation of multiple adrenal artery branches.

On either side, after ensuring complete hemostasis, a 20 Fr drainage tube was routinely placed under vision and resected adrenal tumor were then carefully removed through a separate incision without any breach.

The patients were categorized into two groups based on the type of surgery they underwent: laparoscopic adrenalectomy and open adrenalectomy surgery

The patients were divided into two categories based on the surgical method: laparoscopic adrenalectomy and open adrenalectomy. The outcomes compared between these groups included the duration of the operation, the amount of blood lost during surgery, and the length of the postoperative hospital stay.

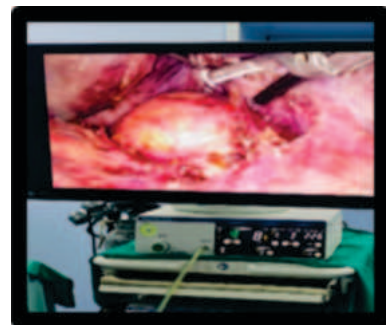


Figure 1

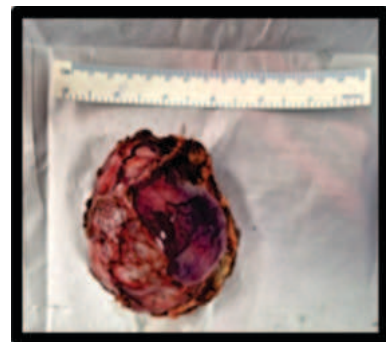


Figure 2

## RESULTS

A total of eleven adrenalectomies were performed over the past eight years, with six on the right side and five on the left side. None of the patients had tumors on both sides.

Of these eleven adrenalectomies, seven were performed using 3D laparoscopy, with one laparoscopic procedure converted to open surgery. The remaining three were performed using the open method.

The patients' mean age was 49.00 ± 11.34 years (range, 38–60 years). One patient, a 54-year-old female, had a history of previous abdominal surgery, having undergone a hysterectomy for uterine leiomyoma 8 years ago. The average tumor size was 5.2 cm, with the smallest tumor measuring 3 cm and the largest 8 cm. In one case, a 49-year-old male patient who initially underwent a laparoscopic adrenalectomy had to be converted to open surgery during the operation due to difficulty in obtaining a clear visual field caused by intraoperative bleeding. This patient was subsequently included in the open surgery group [Table 1]

Five patients were diagnosed with functional adrenal tumors, confirmed through metabolic work-ups. Of these, one patient with an aldosterone-producing adenoma presented with hypertension and hypokalemia, and another was diagnosed with an incidentaloma associated with hypertension. A patient with a cortisol-producing adenoma presented with hypertension, weight loss, and diabetes. Additionally, two patients were diagnosed with pheochromocytoma with headache and hypertension. In contrast, six patients had non-functional adrenal tumors. Among them, four were diagnosed with incidentalomas, specifically non-functional adrenal adenomas. One of these patients presented with hypertension, but the functional metabolic work-up was negative. The remaining two patients presented with an abdominal lump, which was subsequently identified as adrenal carcinoma. [Table 2]

In terms of complications, intraoperative significant blood loss occurred in one patient from the laparoscopic group which was converted to open to loss visual. Surgical site infections were noted in one patient from the laparoscopic group and two from the open group. Port site hernia one patient from the laparoscopic group after 90 days The mean hospital stay was shorter for the laparoscopic group, averaging 3.4 days compared to 9 days for the open group. [Table 3]

**Table 1 : Demographic Table**

Characteristic	Value
• Age (yr)	
Mean	49.00 ± 11.34 years
Range	Range, 38–60 years
• Sex(n)	
Male	6
Female	5
• Tumor Location	
Right	6
Left	5
Both	0
• Tumour size (cm)	
Mean	5.2 cm
Range	3-8.2 cm
• Previous abdominal surgery	
(+)	1
(-)	10
• Laparoscopic VS Open	
Laparoscopic	7
Open	3
Laparoscopic converted Open	1

**Table 2 Pathologic Final Diagnosis**

Pathology	No.
Functional adrenal Tumour	
Primary aldosteronism	2

Cushing's syndrome	1
Pheochromocytoma	2
Non-Functional Adrenal tumour	
Cortical Adenoma	4
Adrenal Cortical Carcinoma	2
Metastatic Adenocarcinoma	0
Total	11

**Table 3 : Comparison Of Operative Outcomes Between Laparoscopic And Open Surgery**

	Laparoscopic (n=7)	Open (n=4)
Mean operative time (min)	130 min [Range 100-190]	235 [Range 175-295]
Mean Intraoperative blood loss (ml)	90 ml [range 50-200]	180 ml [Range 130-230 ml]
Hypertensive Crisis (SBP > 180 mmHG)	2	0
Conversion to open procedure (n)	1	0
Complication		
Intraoperative significant blood loss	1	0
Intra abdominal collection In post operative	0	0
Surgical Site infection	1	2
Port site hernia / Incisional hernia	1	0
Mean Hospital Stay (days)	3.4 [range 3-6 days]	9 [Range 7 – 14 ]

**DISCUSSION**

In this study, we addressed the following questions: Does a laparoscopic adrenalectomy offer better postoperative recovery compared to an open adrenalectomy in the limited number of cases examined? Additionally, what specific conditions necessitate an open adrenalectomy?

The treatment strategy for adrenal tumors is significantly influenced by whether the tumors are functional. This determination is typically made through a hormonal work-up. As recommended by various clinical guidelines, the American Association of Clinical Endocrinologists (AACE) and the American Association of Endocrine Surgeons (AAES) organizations,[7] several tests can be employed for this purpose. These include the 2-day low-dose dexamethasone suppression test, the urinary free cortisol test, the urinary metanephrine-to-creatinine ratio, and the renin-to-aldosterone ratio. If these tests reveal hormonal excess, surgical intervention is generally indicated for the adrenal tumor.

In our study, although the hormonal work-up was negative for one patients with hypertension, no other cause for their hypertension could be identified. Consequently, we proceeded with adrenalectomy, which significantly relieved their hypertensive symptoms and yielded excellent results.

Since Gagner successfully performed the first laparoscopic adrenalectomy (LA) in 1991, the transperitoneal approach has become the most widely used method for treating adrenal neoplasms.[8][9] Laparoscopic adrenalectomy offers several advantages, including decreased postoperative pain, reduced ileus, shorter hospitalization, earlier return to work, and better cosmetic results. It also guarantees lower morbidity rates (ranging from 5 to 20%) and mortality rates (below 0.5%).[10][11][12].

Open adrenalectomy (OA) is linked to higher mortality rates (2–4%) and increased morbidity, including complications such as bleeding, pulmonary and cardiac issues, pulmonary

thromboembolism, and wound infections. Consequently, this approach is generally reserved for treating large tumors (diameter greater than 6 cm) and primary malignancies. [13][14][15] The superiority of the laparoscopic adrenalectomy in postoperative recovery has been confirmed in several studies [16]. In our study, we observed comparable results. Laparoscopic surgery demonstrated a significantly shorter operating time, reduced operative blood loss, and a shorter postoperative hospital stay compared to open adrenalectomy. Therefore, in response to the question regarding postoperative recovery, we can affirm that even in a limited number of cases, postoperative recovery following laparoscopic adrenalectomy was superior to that of open adrenalectomy.

Nevertheless, open surgery is strongly recommended if adrenal carcinoma is suspected or confirmed, given the aggressive nature of malignant tumors and the benefits of en-bloc resection. [17][18] However, these criteria are currently debated, as several large-scale studies have shown that open surgery and laparoscopic adrenalectomy yield comparable results. [19] Despite this, previous studies and the 2013 guidelines published by the Society of American Gastrointestinal and Endoscopic Surgeons advocate for open surgery until more conclusive evidence favors laparoscopic adrenalectomy for adrenal carcinoma. [20]

A recent retrospective study involving 201 patients across 13 tertiary care cancer centers concluded that laparoscopic adrenalectomy is a viable option for adrenocortical carcinomas smaller than 10 cm. [21] However, the study emphasized that if local invasion or enlarged lymph nodes are detected, open surgery should be the preferred approach, regardless of tumor size.

In our study, we performed open adrenalectomy on adrenal masses larger than 6 cm when there was suspicion of adrenal carcinoma. In answering our question about when to decide on performing an open adrenalectomy, the patient's condition, including tumor size greater than 6 cm or the presence of metastatic cancer, should be considered. As mentioned earlier, the criteria for open surgery are controversial; therefore, more extensive studies are needed to determine the appropriate circumstances for choosing open surgery, despite its disadvantages in terms of postoperative recovery.

This study summarizes the initial decade of adrenalectomy practice at our hospital. It has main limitations. The relatively small number of patients limits the statistical significance of our findings. As adrenal tumor surgeries are infrequent, single-hospital studies often lack sufficient sample sizes. Future research should aim to integrate surgical data from multiple hospitals to draw more comprehensive and meaningful conclusions. We will continue to follow up with more adrenalectomy cases in future studies.

However, this study is valuable as it provides foundational data for future investigations into the accumulation of surgical expertise. As we continue to refine our techniques and improve surgical outcomes, this data will help identify the factors contributing to these advancements.

## CONCLUSION

For the treatment of adrenal pathology, it is recommended that a multidisciplinary team—including endocrinologists, urologist and anesthesiologists—be routinely involved, particularly in referral units. If the hormonal activity of adrenal tumors is unconfirmed but related symptoms are present, the tumor should be considered functional, and an adrenalectomy should be performed. Laparoscopic adrenalectomy generally offers better postoperative recovery than open adrenalectomy. However, open adrenalectomy should be considered for large tumors, suspected metastatic cancer.

**Conflict Of Interest:** No potential conflict of interest relevant to this article was reported

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