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Surgical Management of Various Adrenal Disorders: Our Institutional Experience

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Abstract: ***Background: Minimally invasive adrenalectomy has emerged as the gold standard for managing various benign and malignant adrenal disorders. With advancements in laparoscopic techniques, the procedure is now being employed for larger adrenal masses (>6 cm), despite challenges related to tumor size, distorted anatomy, and risk of malignancy disemination. Aim: To evaluate the efficacy and outcomes of minimally invasive procedure like laparoscopic adrenalectomy (LA) or robotic adrenalectomy in comparison to open adrenalectomy (OA), particularly in managing large adrenal tumors. Methods: A prospective analysis of 46 adrenalectomies performed on 42 patients with adrenal masses of varying sizes was conducted. Patients underwent preoperative evaluation, including hormonal studies, radiological imaging and risk assessments. Intraoperative and postoperative outcomes including blood loss, operative time, conversion rates, hospital stay morbidity and mortality were recorded. Tumor histopathology and patient follow - up data were also analyzed. Results: The mean tumor size was 7.03 cm (range: 5–15 cm). Conversion to open surgery occurred in two cases (2.17%), primarily due to bleeding and technical difficulties. The average blood loss was 112 mL, and mean operative time was 144 minutes. Postoperative hospital stay averaged 4 days. Among the 46 adrenalectomies, 32 patients had functional tumors. Histopathology revealed malignancy in three cases (6.52%). No major postoperative complications were observed, and patient follow - up showed favorable outcomes with no recurrence in benign cases. Conclusion: Minimally invasive adrenalectomy is a safe and effective approach for adrenal disorders, including large tumors or masses. It offers significant benefits, such as shorter hospital stay, reduced blood loss, minimal postoperative pain, early recovery, better cosmesis. Tumor size alone should not contraindicate a minimal invasive approach, provided preoperative evaluation and surgical expertise are optimized. Adherence to oncologic principles and teamwork is crucial to achieving successful outcomes. Minimally invasive adrenalectomy remains the gold standard for a wide range of adrenal pathologies. Robotic adrenalectomy has added advantage of magnified view, better tumor handling, low post operative pain and minimal scar.***

Keywords: minimally invasive adrenalectomy, laparoscopic adrenalectomy, robotic adrenalectomy, adrenal tumors, surgical outcomes

1. Introduction

Laparoscopic adrenalectomy (LA) is a minimally invasive surgical technique that has become the preferred procedure for treating both benign functioning and non - functioning adrenal tumors. [1 - 2] Since its introduction, LA has gained widespread acceptance due to advancements in laparoscopic instrumentation and technical expertise. [3 - 5] Compared to traditional open surgery, LA offers significant benefits, including shorter hospital stays, faster recovery, reduced postoperative pain, and fewer complications such as blood loss and surgical scarring. [5 - 6]

While LA was initially limited to smaller adrenal tumors, increasing surgical experience has expanded its application to larger tumors (>6 cm). Despite its advantages, managing large adrenal tumors laparoscopically presents technical challenges, including distorted anatomy, proximity to vital vascular structures, and the risk of encountering malignant pathology. Concerns also arise regarding the adequacy of resection and potential for tumor spillage or metastasis. [6 - 7]

This study focuses on evaluating the outcomes of minimally invasive adrenalectomy for large adrenal masses, emphasizing its safety, feasibility, and efficacy. [8] It aims to highlight the importance of proper preoperative assessment, team coordination, and adherence to surgical principles in overcoming the challenges of laparoscopic management of large adrenal masses. [8 - 9]

2. Aim and Objectives

Aim:
To determine the efficacy and outcomes of minimally invasive surgical techniques for adrenalectomy.

Objectives:
1) To evaluate the conversion rate from laparoscopic/robotic to open adrenalectomy based on mass size.
2) To study morbidity and mortality associated with minimally invasive and open adrenalectomy procedures.

Inclusion and Exclusion Criteria

Inclusion Criteria:
All patients considered fit for adrenalectomy.

Exclusion Criteria:
Patients unfit for adrenalectomy.

3. Methods

a) **Study Design:** Review of 46 laparoscopic adrenalectomies performed for adrenal disorders between 2022–2024.
b) **Preoperative Workup:**
- Hormonal profiling (e. g., serum cortisol, ACTH, aldosterone levels).
- Imaging (MRI, CT) for tumor size and proximity to vital structures.
- Functional imaging (MIBG scans for pheochromocytoma).

c) Surgical Technique: Lateral transperitoneal approach under general anesthesia with ports for instrumentation or open surgery with flank, lumbar or midline incision
d) **Postoperative Monitoring:** Conversion rate, recovery rate, complications, hospital stay.

4. Observations and Results

General Findings:
- Total adrenalectomies: **46 cases**.
- Mean tumor size: **7.03 cm (range: 5–15 cm).**
- Functioning tumors: **32/46 cases (69.6%).**
- Tumor location: **Right (17), Left (21), Bilateral (4).**
- Conversion to open surgery: **2 cases (2.17%).**
- Reasons: Bleeding (3), technical difficulty (1), local invasion (1).

Demographic Data:
- Mean patient age: **33.6 years**.
- Male - to - female ratio: **1.6: 1**.

Operative Metrics:
- Mean blood loss: **112 ml**.
- Mean operative time: **144 min** (range: 45–270 min).

Histological Outcomes:
- Common pathologies: Pheochromocytoma (26), adenomyolipoma (7), Cushing's disease (4), ectopic ACTH secreting tumors, familial syndromes like MEN
- Malignancies: 6.52% (3 cases).

Postoperative Outcomes:
- Mean hospital stay: **4 days** (range: 2–8 days).
- Complications: Minimal, with one long - term incisional hernia.
- Mortality: One patient died of primary tumor - thymoma encasing great vessels (Thymoma secreting ectopic ACTH) two year after bilateral adrenalectomy was performed owing to inoperable primary.

Observations by Tumor Size

Tumor Size	Total Cases	Conversion Rate (%)	Morbidity	Mortality
5–8 cm	32	6.25	Minimal	0
>8 cm	14	3.45%	Minimal	7.14

Comparison: Laparoscopic vs. Open Adrenalectomy

Metric	Laparoscopic Adrenalectomy (LA)	Open Adrenalectomy (OA)
Hospital Stay (days)	2–4	7–10
Blood Loss (ml)	112	300
Operative Time (min)	144	210
Conversion Rate	10.9%	N/A
Postoperative Complications	Minimal	Higher

Histological Diagnosis and Outcomes

Diagnosis	Cases	Malignancies (%)	Outcome
Pheochromocytoma	26	7.69	Favorable post - surgery
Ectopic ACTH secreting tumors	7	0	Complete resection achieved
Cushing's Disease	8	0	Resolved symptoms
Malignant Tumors	3	100	Metastasis in 1 case
MEN 2	2	50	Complete resection achieved

5. Discussion

a) Conversion Rates:
- Tumor size >8 cm associated with increased conversion rate to open surgery (3.45%).
- Reasons for conversion: Vascular bleeding, local invasions, suspicious for malignancy.

b) Morbidity and Mortality:
- LA demonstrated lower morbidity compared to OA.
- Minimal complications, with faster recovery and shorter hospital stays.

c) Efficacy of LA:
- Effective for large adrenal tumors (>6 cm) without compromising safety.
- Malignant tumors (6.52%) posed higher technical challenges but were manageable.

d) Key Technical Challenges:
- Handling desmoplastic reaction in pheochromocytomas and malignancy.

- Preserving vascular structures during resection.

e) Long - Term Follow - Up:

- Mean follow - up of 26 months indicated durable outcomes for benign lesions.
- Malignant cases required additional surveillance and intervention.

6. Conclusion

- Laparoscopic and robotic adrenalectomy or minimally invasive procedure is the gold standard for adrenal disoredrs, offering reduced blood loss, shorter hospital stays, and minimal complications.
- Tumor size alone should not contraindicate laparoscopic management; however, careful preoperative assessment is crucial.
- Team experience, advanced instrumentation, and adherence to surgical principles contribute to successful outcomes.

7. Recommendations

- Routine use of LA for benign and large adrenal tumors.
- A multidisciplinary approach for malignant cases.
- Further studies to establish standardized protocols for large adrenal tumors.

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