Evolution of Minimally Invasive Adrenal Surgery at a Tertiary Care Centre in Oman

Najeeb AbuDraz,1 Mohamed S. Al-Masruri,1 Ghalib Al Badaai,1 Yamam Al-Shamari,1 Omayma Elshafie,2 *Khurram M. Siddiqui1

1Urology Division, Department of Surgery, Sultan Qaboos University, Oman; 2Endocrinology Division, Department of Medicine, Sultan Qaboos University, Oman.

*Corresponding Author’s e-mail: Kmsiddiqui4@gmail.com

Abstract

Objective: We reviewed the case records of adrenalectomy cases at our institution between January 2010 and December 2020 and report the outcomes of both open and laparoscopic adrenalectomy (LA). Methods: This retrospective study included patients who underwent adrenal surgery from January 2010 to December 2020. We recorded demographic details, indications, surgical approach, intra operative data and complications. The final pathology and outcome at the last follow up was also documented. Data was analyzed through the SPSS program. Results: Fifty two patients underwent 61 adrenalectomy procedures. Six patients had bilateral procedure and 3 patients underwent redo surgery accounting for 55 subjects. Open adrenalectomy (OA) was performed on 11 patients and 44 patients underwent LA. Majority of the patients (27) were obese having BMI > 30. Functional adenoma was excised in 36 patients with final diagnosis of Conn’s syndrome in 15, Pheochromocytoma in 13 and Cushing syndrome in 9 patients. Five patients had surgery for oncological indications. Nonfunctional adenoma was excised in 13 patients, with a mean size of 8.9 cm (range 4-15 cm). The mean duration of surgery was less in laparoscopic procedure (199 min) compared to open (246 min). The mean estimated
blood loss in LA was significantly less (108ml vs 450 ml, p-value < 0.05). Out of 55 subjects only 1 patients developed Clavien-dindo grade 2 complication. **Conclusion:** At our institution both laparoscopic and open adrenalectomy were safely performed. There is a trend to perform LA and with experience the duration of surgery and EBL are demonstrating positive trend.

**Keywords:** Adrenal Gland Surgery; Laparoscopic Adrenalectomy; Open Adrenalectomy; Pheochromocytoma; Adrenal Metastasis; Nonfunctional Adrenal Tumors; Oman.

**Advances in Knowledge**
- This study looks at the transition of adrenal surgery from open approach to minimally invasive approach at our center.
- It provides objective evidence that adrenal surgery is feasible in Oman.
- This study demonstrates that laparoscopic adrenalectomy is being performed with good results comparable to any other good center in the world.

**Application to Patient Care**
- Adrenal gland is located in a difficult to access location and required large surgical incision. Laparoscopic surgery for adrenal gland has the unique advantage of providing excellent exposure without large incision. The advancements in surgical techniques for adrenalectomy and the results of laparoscopic adrenalectomy at our center provide an opportunity for our patients to benefit.
- This study shows that less blood loss, operative time and better cosmetic results of laparoscopic adrenalectomy make it the standard of care for most patient requiring adrenal surgery
- The complication rate is well within internationally acceptable range

**Introduction**
Laparoscopic adrenalectomy (LA) is now recognized as the gold standard approach for adrenal pathology. The post-operative analgesics requirements, hospital stay, surgical morbidity and better cosmetic results are the main driving forces.\(^1\,2\,3\) LA was first described by Ganger et al in 1992 for Cushing disease, since then the list of indications have now expanded to include almost all benign and malignant adrenal neoplasms.\(^4\) The growing experience and systematic training programs have resulted in marked reduction in the duration of surgery and morbidity.\(^5\) In this study
we reviewed our 10-years’ experience of open and transperitoneal laparoscopic adrenalectomy procedures at our institution. To our knowledge this is the first large case series from Oman comparing the open and laparoscopic approach for adrenalectomy.

Methods
Ethics review committee approval was obtained from our institution to conduct a retrospective chart review of all the adult patients undergoing adrenal surgery our institution. Ten-year period from January 2010 to December 2020 was selected and using electronic medical record (EMR) of the hospital information system (Trakcare® United health care systems) we identified 55 eligible subjects.

Collected data included patient demographic features, comorbidities, Body mass index (BMI), preoperative diagnosis, intraoperative details including surgical approach (Open/Laparoscopic), duration of surgery, estimated blood loss, pathological diagnosis. The post-operative complications were also recorded and graded according to Clavien-Dindo classification system.

Data was analyzed using SPSS program version 21.0. The analysis was done using variable graph, pie-chart and frequency tables. Frequency tables provides information about mean, median and standard deviation. A p-value of <0.05 was considered as statistically significant.

Results
Fifty two patients underwent 61 adrenalectomy procedures. Six patients had bilateral procedure and 3 patients underwent redo surgery accounting for 55 subjects. Open adrenalectomy (OA) was performed on 11 patients and 44 patients underwent LA. There were 13 male and 39 female patients. The mean age was 44 years (range 15-70 years).

Majority of the patients (36) underwent adrenalectomy for functional tumors. Five patients had surgery for oncological indication including two for metastasis from other organs. The frequency of distribution of final diagnosis is illustrated in Fig1.
The median tumor size was slightly larger in the open surgery group (5 cm vs. 6.5 cm). The details of difference in size are illustrated in Table 1. Nonfunctional adenoma was excised in 13 patients, with a mean size of 8.9 cm (range 4-15 cm).

ASA 2 was the most common category in 63% patients. Majority of the patient were obese with 52% having BMI $>30$, the frequency of American society of anesthesia (ASA) score and BMI groups is shown in the Figure 2.

Laparoscopic adrenalectomy was performed in 44 patients and 11 underwent open adrenalectomy. The mean duration of open surgery was 246 min (median 241 min) vs. 189 min (median 197 min) in the laparoscopic group. In patient undergoing open surgery the estimated mean blood loss (EBL) was 450 ml (100 to 1000 ml) vs. 108 ml (range 50 ml to 500 ml) in the laparoscopic group ($p=0.05$).

We also independently analyzed the unilateral adrenalectomy group and found similar trend. The mean duration of surgery and EBL in unilateral laparoscopic vs. unilateral open adrenalectomy were 198 min vs. 248 min and 108 ml vs. 245 ml respectively.

We used operating time as a surrogate maker to reflect the surgical expertise. After January 2017, we transitioned to a subspecialty based approach and all adrenal procedures were referred to urology service having a lead surgeon with dedicated interest in adrenal surgery. To assess the impact of this intervention we created two groups, Time period 1(before December 2017) and Time period 2 (after January 2017). We found that the mean duration of surgery reduced from mean of 206 min to 145 min only.

There were no complications in majority of patients. One patient developed diarrhea related to clostridium infection and 3 patients developed paralytic ileus (2 in open and 1 in laparoscopic group). The frequency of complications according Clavien-Dindo system of classification of surgical complications is shown in Table 2.

Three patient were treated for recurrence of disease. Two of them belong to a family with von hippel-lindau (VHL) abnormality where the recurrence is not unexpected over a period of time. In
one patient there was a suspicion of cancer on the histopathology and the patient underwent revision LA with free margins and is doing well after 4 years of follow up.

Discussion
Adrenal surgery for a functional tumor like Cushing’s disease and Pheochromocytoma is exceptionally rewarding in terms of the physiological outcomes. The additional benefits of minimally invasive approach in terms of cosmetics, minimal blood loss, lesser analgesic requirement, hospital stay and higher patient satisfaction have certainly placed laparoscopic adrenalectomy (LA) at the pedestal of gold standard. In this study we looked at the safety and efficacy of intraperitoneal laparoscopic adrenalectomy at our institution and how it has evolved to be now a routine surgical procedure.

Functional adrenal tumors present multiple challenges in the perioperative period. Significant number of patients are also obese. In our study 52% of our patients had BMI of ≥ 30, which is well known to be associated with intraoperative difficulties. Secondary hypertension is also one of the common presentation of adrenal tumors. Studies have shown that almost two third of the indications of surgery are for functional tumors exhibiting hypertension. In our study 67% patients had secondary hypertension related to either Cushing disease, Pheochromocytoma or Conn’s disease. Post operatively all patients were successfully weaned off the antihypertensive medications.

The evolution of laparoscopic adrenal surgery has witnessed an expansion of indications. Functional tumors like Pheochromocytoma which were initially regarded as out of bound are now routinely treated by key-hole surgery. In our series we successfully performed LA on 13 patient with Pheochromocytoma. Laparoscopic treatment of conditions like adrenocortical neoplasm has also been reported with comparable oncologic outcome. We performed LA in 3 cases of primary adrenocortical neoplasm with adequate surgical margins and acceptable oncologic control. Adrenalectomy for metastatic disease is increasing performed and can be considered as standard of care for some cancers with solitary adrenal metastasis. We performed laparoscopic metastatectomy in 2 patients with adrenal metastasis. One of them relapsed within one year but the other patient has no evidence of disease with more than 3 years of follow up. The limit of size
of the gland to undergo LA has always been debatable and some authorities have recommended the upper limit as > 6cm. Technical difficulty and suspicion of malignancy are regarded as factors responsible to cap the size limit. In our study we have performed LA for tumors up to 15 cms with no significant increase in operating time or blood loss. In these cases we did not encounter any incidental finding of cancer, in our opinion the advancements in radiology have increased our confidence. Modern CT scan and MRI of the adrenal gland using specific protocols now have excellent ability to predict the final pathology. In our cohort of LA for non-functional adenoma the mean size of the gland removed was 5.8cm.

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In our series the LA had also retained the advantage of shorter operative time with the mean duration of LA as 189 min compared to open adrenalectomy with the mean of 246 min. The EBL in LA is significantly less with the mean of 170ml comparing with 450ml in open procedure, with the significant p-value < 0.001.

We also looked a two time periods for LA, before December 2017 and after January 2017. This division was created to assess the impact of change in the referral system at our institution as from January 2017 onwards all cases of adrenal tumor were referred to a team dedicated to do LA. We found that the mean duration of surgery reduced from 206 min to 145 min. We must acknowledge the limitation here as the cases were not controlled for complexity of procedure.

The overall rate of complications of adrenalectomy, both open and laparoscopic was very low at our institution. Majority of patients did not have any complications. Out of 55 subjects one developed grade 2 Clavien-Dindo complications. There we no grade 3 or above complications. During follow up 3 patients had disease recurrence and underwent redo surgery. Two of them belonged to a family of patients with VHL abnormality and were predisposed to high risk of recurrence. One patient had suspicious pathology for adrenocortical cancer and had revision surgery.

Conclusion

Both laparoscopic and open adrenalectomy have been performed safely at our institution with low morbidity. The benefits of minimally invasive approach clearly favor laparoscopic approach
especially in term of duration of surgery and estimated blood loss. However in selected cases there is still a role of open approach.

**Authors’ Contribution**

NA and KMS designed the study. NA, MSM and YS collected the data. NA, MSM, GB and KMS performed the statistical analysis. NA and MSM drafted the manuscript. GB, OE and KMS critically reviewed the manuscript and revised the manuscript. All authors approved the final version of the manuscript.

**Conflict of Interest**

The authors declare no conflicts of interest.

**Funding**

No funding was received for this study.

**References**


Figure 1: The Distribution of Frequency of Diagnosis for Adrenalectomy

Figure 2: The Distribution of Body Mass Index (BMI) and American Society of Anesthesiologist (ASA) of the Patients undergoing Adrenalectomy
### Table 1: The distribution of tumor size in the two groups

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<th>Open Adrenalectomy N=11</th>
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<td>Range</td>
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<td>Standard deviation</td>
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### Table 2: The frequency of surgical complications in the two groups

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