

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

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ABSTRACT: Objectives: This study aimed to review the case records and report the outcomes of open and laparoscopic adrenalectomy (LA) cases. **Methods:** This retrospective study included patients who underwent adrenal surgery from January 2010 to December 2020 at Sultan Qaboos University, Muscat, Oman. Demographic details, indications, surgical approaches, intra-operative data, complications, final pathology and outcome at the last follow-up were analysed. **Results:** A total of 52 patients underwent 61 adrenalectomies; six patients had a bilateral procedure while three patients had to undergo revision surgery resulting in a total of 55 individual procedures. Open adrenalectomy (OA) was performed on 11 patients and 44 patients underwent LA. Most patients (n = 27) were obese with a body mass index >30. Functional adenoma was excised in 36 patients with final diagnosis of Conn's syndrome in 15, pheochromocytoma in 13 and Cushing's syndrome in nine patients. Five patients had surgery for oncological indications. Non-functional 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 compared to open (199 versus 246 minutes). The mean estimated blood loss in LA was significantly less (108 versus 450 mL; $P < 0.05$). Out of 55 procedures, only one patient developed Clavien-Dindo grade 2 complication. **Conclusion:** Both LA and OA were safely performed at the researchers' institution. There is a growing trend for LA, and with experience, the duration of surgery and estimated mean blood loss are demonstrating a positive trend.

Keywords: Adrenalectomy; Laparoscopic Surgical Procedure; Adrenal Gland Neoplasia; Adrenal Cancer; Pheochromocytoma; Oman.

ADVANCES IN KNOWLEDGE

- This study provides evidence of equal safety and efficacy of laparoscopic adrenal surgery in comparison to open approach at the researchers' centre.
- Malignant as well as large benign adrenal tumours (up to 15 cm) can be managed effectively by laparoscopic approach.
- Laparoscopic adrenalectomies in Oman are being performed with good results comparable to any other renowned centre in the world.

APPLICATION TO PATIENT CARE

- This study shows that the reduced blood loss and operative time, alongside the better cosmetic results, make laparoscopic adrenalectomy the standard of care for most patients requiring adrenal surgery.
- The complication rate described in the present study is well within internationally acceptable range.

LAPAROSCOPIC ADRENALECTOMY (LA) IS NOW recognised as the gold standard for adrenal pathology. The reduced post-operative analgesic requirements, hospital stay and surgical morbidity, alongside better cosmetic results, are its main driving forces.^{1–3} Laparoscopic adrenalectomy was first described by Ganger *et al.* in 1992 for Cushing's syndrome; since then, the list of indications have expanded to include almost all benign and malignant adrenal neoplasms.⁴ The growing experience and systematic training programmes have resulted in a marked reduction in the duration of surgery and morbidity.⁵ The current study aimed to review 10 years' worth of experience of open and transperitoneal laparoscopic adrenalectomy procedures at the authors' institution. To the best of the authors' knowledge, this is the first study from Oman comparing the open and laparoscopic approaches for adrenalectomy.

Methods

This retrospective study was conducted at Sultan Qaboos University (SQU), Muscat, Oman, over a ten-year period from January 2010 to December 2020. It included all patients who had adrenal surgery.

Data were collected from electronic medical records and included demographic features, comorbidities, body mass index (BMI), preoperative diagnosis, intraoperative details including surgical approach (open/laparoscopic), duration of surgery, estimated blood loss and pathological diagnosis. The post-operative complications were also recorded and graded according to the Clavien-Dindo classification system. Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 21.0 (IBM Corp., Armonk, New York, USA). Data are presented in frequencies, mean, median and

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standard deviation. A *P* value of <0.05 was considered statistically significant.

Approval from the ethics review committee was obtained from SQU (MREC #1840) to conduct a retrospective chart review of all the adult patients who had adrenal surgery.

Results

A total of 52 patients underwent 61 adrenalectomies; six patients had a bilateral procedure and three patients underwent revision surgery, totalling 55 individual procedures. 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 (*n* = 36) underwent adrenalectomy for functional tumours. Five patients had surgery for oncological indication, including two for metastasis from other organs [Table 1].

The median tumour size was slightly larger in the open surgery group than the laparoscopic group (5 versus 6.5 cm). Non-functional adenoma was excised in 13 patients, with a mean size of 8.9 cm (range: 4–15 cm) [Table 2].

American Society of Anesthesia (ASA) 2 was the most common category in 38 patients (63%) patients. The majority of the patients were obese, with 27 (52%) having a BMI ≥30 [Table 3].

Laparoscopic adrenalectomy was performed in 44 patients and 11 underwent open adrenalectomy. The mean duration of open surgery was 246 minutes

(median = 241 minutes) while for the laparoscopic group is was 189 minutes (median = 197 minutes). In patients undergoing open surgery, the estimated mean blood loss (EBL) was 450 mL (range: 100–1000 mL) and in the laparoscopic group is was 108 mL (range: 50–500 mL; *P* <0.05). The unilateral adrenalectomy group was also independently analysed and a similar trend was found. When comparing the unilateral laparoscopic versus unilateral open adrenalectomy approaches, the mean duration of surgery was more (198 versus 248 minutes) and the EBL greater (108 versus 245 mL) for the latter approach.

After January 2017, there was a transition to a subspecialty-based approach and all adrenal procedures were referred to the urology service, which has had a lead surgeon with dedicated interest in adrenal surgery. To assess the impact of this intervention, two groups were created: time period 1 (before December 2017) and time period 2 (after January 2018). A reduction in the mean duration of surgery from 206 minutes to 145 minutes was found.

There were no complications for the majority of the patients but one patient developed clostridium-

Table 1: Frequency of diagnosis for adrenalectomies (N = 55)

Diagnosis	n (%)
Non-functional adenoma	13 (24)
Conn's syndrome	15 (27)
Pheochromocytoma	13 (24)
Cushing's syndrome	9 (16)
Adrenocortical neoplasia	3 (5)
Metastasis	2 (4)

Table 2: Distribution of tumour size across laparoscopic and open adrenalectomy groups

Tumour size information in cm	Laparoscopic adrenalectomy	Open adrenalectomy
Mean ± SD	5.8 ± 3.49	6.8 ± 2.22
Median	5	6.5
Range	1.5–15	3.8–11

SD = standard deviation

Table 3: Distribution of body mass index and American Society of Anesthesiologist categories of patients undergoing adrenalectomy

Characteristic	n (%)
BMI category in kg/m²	
≤18.5	3 (6)
18.6–24.9	13 (25)
25.0–29.9	9 (17)
≥30	27 (52)
ASA category*	
1	12 (20)
2	38 (63)
3	9 (15)
4	1 (2)

BMI = body mass index; ASA = American Society of Anesthesiologist.
*Total is 60 procedures (including patients who underwent more than one operation).

Table 4: Frequency of surgical complications (N = 55)

Clavien-Dindo grade	Total	Laparoscopic adrenalectomy	Open adrenalectomy
0	51	0	0
1	3	1	2
2	1	1	0
3	0	0	0

associated diarrhoea and three patients developed paralytic ileus (two in open and one in the laparoscopic group) [Table 4].

Three patients were treated for recurrence of disease. Two belonged 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 based on the histopathology findings and the patient underwent revision LA with free margins; these patients are doing well after four years of follow-up.

Discussion

Adrenal surgery for a functional tumour such as pheochromocytoma and Cushing's syndrome have excellent physiological outcomes. The additional benefits of a minimally invasive approach in terms of aesthetics, minimal blood loss, lesser analgesic requirement, reduced hospital stay and higher patient satisfaction have certainly set LA as the gold standard.⁶⁻⁸

Functional adrenal tumours present multiple challenges in the peri-operative period. In addition, a significant number of patients are obese. In the current study, 52% of the patients had a BMI ≥ 30 , which is well known to be associated with intraoperative difficulties.^{9,10} Secondary hypertension is also a common presentation of adrenal tumours. Studies have shown that almost two-thirds of the indications of surgery are for functional tumours in patients with hypertension.¹¹ In this study, 67% of the patients had secondary hypertension related to either Cushing's syndrome, pheochromocytoma or Conn's syndrome. Post-operatively, all patients were successfully weaned off the antihypertensive medications.

The evolution of laparoscopic adrenal surgery has witnessed an expansion of indications. Functional tumours such as pheochromocytoma, which were initially regarded as out of bounds, are now routinely treated via key-hole surgery.¹² In the current study, LA was performed successfully on 13 patients with pheochromocytoma. Laparoscopic treatment of conditions such as adrenocortical neoplasms have also been reported with a comparable oncologic outcome.¹³ LA was performed in three cases of primary adrenocortical neoplasm with adequate surgical margins and acceptable oncologic control. Adrenalectomy for metastatic disease is increasingly performed and can be considered as the standard-of-care for some cancers with solitary adrenal metastasis.¹⁴ Laparoscopic metastasectomy was performed in two patients with adrenal metastasis; one relapsed within one year, but the other patient had no evidence of disease with more than three years of follow-up. For

LA, the maximum size of the gland has always been debated with some recommending an upper limit of 6 cm.¹⁵ Technical difficulty and suspicion of malignancy are factors that limit the gland size that is feasible to be surgically removed.¹⁶ In the current study, LA has been performed for tumours up to 15 cm with no significant increase in operating time or blood loss. In these cases, incidental findings of cancer were not encountered. It is the advancements in radiology that have increased surgical confidence; modern computed tomography and magnetic resonance imaging scans of the adrenal gland using specific protocols can predict the final pathology.¹⁷ In the current cohort of LA for non-functional adenoma, the mean size of the gland removed was 5.8 cm.

In the current study, LA had also retained the advantage of a shorter operative time with the mean duration of LA as 189 minutes, compared to open adrenalectomy with a mean duration of 246 minutes. The EBL in LA is significantly less, with a mean of 170 mL compared to a mean of 450 mL during the open procedure ($P < 0.05$).

This study also examined two time periods for LA: before December 2017 and after January 2017. The purpose of this was to assess the impact of change in the referral system at the authors' institution. From January 2017 onwards, all cases of adrenal tumour were referred to a team dedicated to performing LA. It was found that the mean duration of surgery decreased from 206 minutes to 145 minutes. However, it should be noted that the cases were not controlled for complexity of procedure.

The overall rate of complications of adrenalectomy, both open and laparoscopic, was very low in the current study. The majority of patients did not have any complications. Out of 55 procedures, one patient developed grade 2 Clavien-Dindo complication; there were no grade 3 or higher-grade complications. During follow-up, three patients had disease recurrence and underwent revision surgery; two were members of 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 the researchers' institution with low morbidity. The benefits of a minimally invasive approach clearly favour a laparoscopic procedure, especially in terms of duration of surgery and EBL. However, in selected cases, open approach still has a role to play.

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 and revised the manuscript. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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References

- Lee J, El-Tamer M, Schiffner T, Turrentine FE, Henderson WG, Khuri S, et al. Open and laparoscopic adrenalectomy: Analysis of the National Surgical Quality Improvement Program. *J Am Coll Surg* 2008; 206:953–9. <https://doi.org/10.1016/j.jamcollsurg.2008.01.018>.
- Elfenbein DM, Scarborough JE, Speicher PJ, Scheri RP. Comparison of laparoscopic versus open adrenalectomy: Results from American College of Surgeons-National Surgery Quality Improvement Project. *J Surg Res* 2013;184:216–20. <https://doi.org/10.1016/j.jss.2013.04.014>.
- Eichhorn-Wharry LI, Talpos GB, Rubinfeld I. Laparoscopic versus open adrenalectomy: Another look at outcome using the Clavien classification system. *Surgery* 2012; 152:1090–5. <https://doi.org/10.1016/j.surg.2012.08.020>.
- Gagner M, Lacroix A, Bolté E. Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. *N Engl J Med* 1992; 327:1033. <https://doi.org/10.1056/NEJM199210013271417>.
- Al-Qurayshi Z, Robins R, Buell J, Kandil E. Surgeon volume impact on outcomes and cost of adrenal surgeries. *Eur J Surg Oncol* 2016; 42:1483–90. <https://doi.org/10.1016/j.ejso.2016.06.392>.
- Thompson GB, Grant CS, van Heerden JA, Schlinkert RT, Young WF Jr, Farley DR, et al. Laparoscopic versus open posterior adrenalectomy: A case-control study of 100 patients. *Surgery* 1997; 122:1132–6. [https://doi.org/10.1016/s0039-6060\(97\)90218-x](https://doi.org/10.1016/s0039-6060(97)90218-x).
- Terachi T, Matsuda T, Terai A, Ogawa O, Kakehi Y, Kawakita M, et al. Transperitoneal laparoscopic adrenalectomy: Experience in 100 patients. *J Endourol* 1997; 11:361–5. <https://doi.org/10.1089/end.1997.11.361>.
- Assalia A, Gagner M. Laparoscopic adrenalectomy. *Br J Surg* 2004; 91:1259–74. <https://doi.org/10.1002/bjbs.4738>.
- Dancea HC, Obradovic V, Sartorius J, Woll N, Blansfield JA. Increased complication rate in obese patients undergoing laparoscopic adrenalectomy. *JLS* 2012;16:4–549. <https://doi.org/10.4293/108680812X13291597715862>.
- Kazaure HS, Roman SA, Sosa JA. Obesity is a predictor of morbidity in 1,629 patients who underwent adrenalectomy. *World J Surg* 2011; 35:1287–95. <https://doi.org/10.1007/s00268-011-1070-2>.
- Gumbs AA, Gagner M. Laparoscopic adrenalectomy. *Best Pract Res Clin Endocrinol Metab* 2006; 20:483–99. <https://doi.org/10.1016/j.beem.2006.07.010>.
- Thomson BN, Moulton CA, Davies M. Laparoscopic adrenalectomy for pheochromocytoma: With caution. *ANZ J Surg* 2004; 74:429–33. <https://doi.org/10.1111/j.1445-1433.2004.03024.x>.
- Moinzadeh A, Gill IS. Laparoscopic radical adrenalectomy for malignancy in 31 patients. *J Urol* 2005; 173:519–25. <https://doi.org/10.1097/01.ju.0000149038.89467.30>.
- Solaini L, Ministrini S, Tomasoni M, Merigo G, Gaverini G, Bertoloni GP, et al. Adrenalectomy for metastasis: Long-term results and predictors of survival. *Endocrine* 2015; 50:187–92. <https://doi.org/10.1007/s12020-015-0596-8>.
- Tsuru N, Suzuki K, Ushiyama T, Ozono S. Laparoscopic adrenalectomy for large adrenal tumors. *J Endourol* 2005; 19:537–40. <https://doi.org/10.1089/end.2005.19.537>.
- Qureshi AH, Junejo NN, Siddiqui K, Zaidi SZ. Adrenocortical oncocytoma. *J Coll Physicians Surg Pak* 2014; 24:947–8.
- Wang F, Liu J, Zhang R, Bai Y, Li C, Li B, et al. CT and MRI of adrenal gland pathologies. *Quant Imaging Med Surg* 2018; 8:853–75. <https://doi.org/10.21037/qims.2018.09.13>.