

A Decade of Laparoscopic Adrenalectomy in a Regional Center

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ABSTRACT

Aim: To evaluate the laparoscopic approach to adrenalectomy throughout a decade in a single area, focussing on complication rates and the effect of surgeon experience. Given the relative rareness and pathological heterogeneity of adrenal tumors, there is still some debate as to whether the laparoscopic approach is suitable for all situations. Initially, laparoscopy was not recommended for pheochromocytomas, because of the possibility of adrenergic crisis. Subsequent questions were raised as to its appropriateness for large tumors (>6 cm) and metastatic deposits due to the technical difficulty of dissection. There has also been an increased number of incidental tumors ('incidentalomas') discovered while imaging for other reasons (e.g., on CT or MRI).

Materials and methods: De-identified data was collected of all laparoscopic adrenalectomies within the last decade via electronic and physical chart review, in addition to review of pathology reports.

Results: Ninety-seven adrenalectomies were performed. The complication rate was 8%, and 40% of cases were incidentalomas. Tumor pathologies noted were: non-secretory adenomas (35%), aldosterone-secreting adenomas (18.6%), adrenal metastases (17.5%), pheochromocytomas (13.4%), simple cysts (4.1%) and other pathologies (11.3%). The most significant decrease in operative time was between 2005–2008 and 2009 ($p < 0.0001$). No significant relationship between complications and size of a tumor, nor pathology of a tumor was found.

Conclusion and clinical significance: Laparoscopic adrenalectomy in this center has a complication rate similar to other published rates and appears to be a safe procedure for large tumors and various pathologies. There is also a demonstrable effect of surgeon experience on operative time.

Keywords: Adrenal, Adrenalectomy, Cohort, Endocrine, Laparoscopic, Retrospective.

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INTRODUCTION

Adrenal tumors are a rare and distinctly heterogeneous group of tumors. They can be differentiated by area of origin within the adrenal cortex or medulla; the degree of their symptoms or; into benign and malignant. For most tumors, the laparoscopic approach has been established as the mainstay of treatment.^{1,2} Still, there are a number of questions which have arisen in regards to when this approach is appropriate.

Laparoscopic adrenalectomy has been well established for benign cortical tumors, pheochromocytomas, and metastases. The only limiting factor for laparoscopy in these pathologies is the size of the lesion, with the limit being around 12 cm. There is still ongoing debate about the use of laparoscopy in adrenal carcinoma, with some authorities stating that only open technique should be used. Some data suggest that patients do better in terms of overall and disease-free survival with open adrenalectomy.³ The major risks contributing to the morbidity of the laparoscopic approach are open conversion, long operative time and increased blood loss.⁴ A large tumor size (defined as >6 cm) is found in the literature to be feasible and safe, but possibly with increased operative time and blood loss.⁵⁻⁸ The other question for the laparoscopic approach is concerning the pathology of the lesion. In the case of malignant tumors, there has been a question of seeding the tumor or spillage if the tumor capsule is broken. It has shown to be effective in some studies, but the decision to convert to an open should be made early to avoid these consequences.^{9,10} There have also been a number of studies looking into the effectiveness for metastatic deposits of the adrenal gland.^{11,12}

Even though one of the two cases reported in Gagner's original 1992 paper describing laparoscopic adrenalectomy was a pheochromocytoma, for some time it was disputed whether this was a safe approach.^{13,14} The pneumoperitoneum and possible increased handling of a tumor holds risks of the hypertensive crisis, for which invasive arterial pressure monitoring and treatment such as nitroprusside may be warranted. Subsequent studies have determined that the laparoscopic approach has equivalent if not better blood pressure stability.¹⁵

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A more novel indication for laparoscopic adrenalectomy is that of the adrenal incidentaloma. With the increasing availability of imaging, there has been an increase in the proportion of adrenal lesions diagnosed incidentally. Adrenalectomy has been recommended for tumors greater than 4 cm due to the risk of malignancy.¹⁶ The slightly increased use of partial adrenalectomy for small adrenal tumors has raised questions about whether asymptomatic tumors should be resected.¹⁷⁻¹⁹

The overall objective of this study was to retrospectively evaluate the laparoscopic treatment of adrenal tumors in Townsville, Queensland for the last 10 years. Specifically, we determined how many laparoscopic adrenalectomies were performed; what percentage of these belonged to particular pathological groups (aldosteronoma, pheochromocytoma, Cushing's disease, adrenal metastasis, incidentaloma, cyst) and what the complication rate was in this area (including conversion to open). We also examined whether operative time decreased with surgeon experience and whether the laparoscopic approach is appropriate for tumors >6 cm, metastases, pheochromocytomas, and incidentalomas <4 cm. The indications for surgery were collected (incidentaloma or symptomatic) and the number of partial adrenalectomies.

MATERIALS AND METHODS

De-identified data were collected of all laparoscopic adrenalectomies performed in one geographic area for the last decade. Cases which were converted to open were included in the study and the data collected included patient demographics (age, gender), length of stay, complications, pathology (benign or malignant tumor) and operative time. Operative time was considered as a knife to skin time until time to end of the closure. Both suspected pathology (preoperative diagnosis) and definitive pathology as per final report were collected. Tumors which were discovered as an incidental finding on imaging were determined to be incidentalomas. Data was collected from electronic medical records, physical charts, and pathology reports.

Microsoft Excel was used to collate data, and statistical software Statistical Package for the Social Sciences (SPSS)

version 21 was used for analysis. Data where appropriate are presented as percentages. Normality of data was determined using the Shapiro-Wilk Test, with data being non-parametric, Man-Whitney tests and Kruskal Wallis Test were employed to determine differences between two groups and more than two groups respectively. Association between categorical data was determined using the chi-squared test, with a *p* value of <0.05 considered as statistically significant.

Ethics for both sites included in this study (Townsville Hospital and Mater Hospital Townsville) was obtained from the Human Research Ethics Committee for each site. All data were collected in a de-identified manner

RESULTS

Over the last decade, 97 adrenalectomies were performed on 44 (45%) males and 53 (55%) females with a mean age of 54.5. The oldest patient was 89 years old, and the youngest was 22. The breakdown of pathologies is reported in Table 1, showing that the most common pathology was the non-secretory adenoma. Total 40% of cases were incidentalomas. Approximately, 92% of cases had no complication. The most common complication was damage to other organs (4.1%), with open conversion, intraoperative bleeding and postoperative bleeding only occurring once each (~1.0%). There was one instance of high blood pressure and heart rate intraoperatively during manipulation of a pheochromocytoma.

Statistical analysis as detailed above showed that the most significant decrease in operative time was comparing 2005–2009 (*p* <0.0001). Significant decreases were also seen when comparing 2005–2008 operative times to 2010–2011 (*p* <0.005), 2012–2013 (*p* <0.01) and 2014–2015 (*p* <0.005).

On examination of tumour pathology reports, 36.4% were <4 cm size; 28.4% were 4–6 cm size; and 33% >6 cm size. Total 13% of tumors <4 cm had complications as did 10% of tumors >6 cm, with 4 to 6 cm having only 4%. The only case of open conversion was in the >6 cm group. Incidentalomas and pheochromocytomas had the same rate of complication as this general group of adrenalectomies. Metastases had a 14% complication

Table 1: Breakdown of pathology

Pathology	Number of cases	Percentage of total cases (%)
Non-secretory adenoma	34	35.1
Aldosterone secreting adenoma	18	18.6
Adrenal metastases	17	17.5
Pheochromocytomas	13	13.4
Other †	11	11.3
Simple cyst	4	4.1
Adrenal cortical carcinoma	3	3

† Other pathologies: schwannoma (2), multinodular adrenal cortical hyperplasia, adrenal hemorrhage, ganglioneuroma, hemangioma and myelolipoma

rate and adenomas a 10%. Chi-squared analyses showed there was no relationship between complications and size of a tumor, nor pathology of a tumor. Four cases (~4%) were partial adrenalectomies, of which one was an incidentaloma. Complication rates were exactly equal for cases in the public or private hospital. 6% of cases predicted a pathology which was different on the final pathology.

DISCUSSION

Published complication rates range from 7.5–12%,²⁰⁻²² so a complication rate of 8% is comparable to the lower end of this range. It is also interesting to note that there was no difference between public and private complication rates.

Looking at the data for the operative time it is clear that as the number of cases performed by surgeons in this area increased, there was a decrease in operative time, particularly after 2008. Other procedures have been analyzed to look at the learning curve, including laparoscopic cholecystectomy,²³ laparoscopic colorectal surgery,²⁴ laparoscopic inguinal hernia repair²⁵ and laparoscopic fundoplication.²⁶ These studies all measured operative time and complication rate to determine a learning curve expressed as a number of cases before stabilization of these two variables. As an exercise, measuring the learning curve of a procedure is potentially useful for training purposes, but also is useful from a health economics perspective as operating theatre costs are likely higher during the learning phase.²⁷ In this study, half of the complications documented were within the first three years of adrenalectomy, before the significant decrease in surgeon time. Therefore, it would seem that the complications and operative time stabilized after 2008. Because the number of cases each surgeon performed per year was not recorded, we cannot express this as a number of cases. However, the same surgeons were operating for the whole decade and so we can say that there was a demonstrable learning curve.

The data in Table 2 shows the complication rate for each size group of a tumor. As there was no significant difference in complication rates between the three categories of tumor size it supports the idea that both small and large tumors can be approached laparoscopically. Despite early concerns about the feasibility and safety of approaching large tumors laparoscopically, our findings are backed up by a number of more recent papers and

supports the growing body of evidence stating that a large tumor size is not an absolute contraindication to laparoscopy.⁵⁻⁸

Quite a large number (40%) of cases were incidentalomas, demonstrating how increasing usage of broader imaging modalities (such as high-resolution CT) have changed the caseload for adrenalectomies.²⁸ There was also no significant difference in complication rate for different tumor pathologies, which would indicate that it is safe to use the laparoscopic approach for metastatic tumor deposits and pheochromocytomas. Interestingly there was one case of high blood pressure and heart rate when operating on a pheochromocytoma, demonstrating that despite the laparoscopic approach being the most appropriate^{14,29} the risk of an adrogenic crisis must be mitigated.^{14,15} There were also a small number of tumors where the final pathology did not match the expected pathology, mostly where asymptomatic tumors were predicted to be adenomas and had different characteristics after microscopic pathological examination (e.g., ganglioneuroma, pheochromocytoma, metastatic deposit).

There were only a small number of partial adrenalectomies in this study, and they were not predominantly used for incidentalomas. While Kaye, Storey 19 strongly support increased use of partial adrenalectomy for small tumors, it has not become common practice in most places, as demonstrated by the small number of cases in this study. While there is an increasing number of studies supporting the use of partial adrenalectomy as it retains functional adrenal tissue³⁰⁻³³ there are still instances where it is seen to be less effective³⁴ which may explain why it remains a less common procedure.

CONCLUSION AND CLINICAL SIGNIFICANCE

Overall, the results of this study add to the current body of research demonstrating that the laparoscopic approach to adrenalectomy is safe and effective in a variety of tumor sizes and pathologies. It also neatly demonstrates diminishing operative time as surgeon experience increased over a decade, demonstrating a considerable learning curve in performing this procedure. While there are now moves towards retroperitoneal and other novel approaches, it is useful to evaluate the usefulness of the standard laparoscopic approach now that it is possible to look at data over longer periods of time.

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Table 2: Tumor size and complications

Tumour size	Number of cases	Number of complications	Complication rate for size group (%)
<4 cm	32	4	13
4–6 cm	25	1	4
>6 cm	29	3	10

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