A Canadian centre's experience with prone retroperitoneoscopic adrenalectomy

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Background: Minimally invasive adrenalectomy is the standard of care for the surgical management of benign adrenal disease. The transperitoneal laparoscopic approach (TLA) is the most common approach used worldwide; however, many centres have adopted a posterior retroperitoneoscopic approach (PRA), as it is reported to offer several advantages. We describe our experience with PRA.

Methods: We performed a retrospective review of the charts of patients who underwent minimally invasive adrenalectomy via PRA or TLA performed by a single endocrine surgeon between September 2010 and December 2019 at a tertiary academic centre in British Columbia, Canada. Patient and tumour characteristics, operative times and postoperative outcomes were compared between the 2 groups.

Results: During the study period, 58 patients underwent adrenalectomy via PRA, and 41 underwent adrenalectomy via TLA. The median American Society of Anesthesiologists score was higher in the TLA group than the PRA group (3.0 v. 2.6, $p = 0.02$). Adrenal glands were heavier in the TLA group than the PRA group (mean 63.4 g v. 19.2 g, $p < 0.001$). The mean anesthesia preparation time was shorter with PRA than with TLA (51.5 min v. 63.7 min, $p < 0.001$), as was mean operative time (77.9 min v. 118.4 min, $p < 0.001$) and mean hospital length of stay (2 d v. 4 d, $p < 0.001$). There was no difference in the complication rate between the 2 groups.

Conclusion: Our study shows that PRA offers shorter operative time and length of stay for appropriately selected patients. Thus, it has become the preferred approach at our centre for minimally invasive adrenalectomy.

Contexte : La surrénalectomie minimalement effractive est le traitement standard pour la prise en charge chirurgicale de la maladie surrénalienne bénigne. L'approche laparoscopique transpéritonéale (ALT) est la plus utilisée dans le monde; mais plusieurs centres ont adopté une approche rétropéritonéoscopique postérieure (ARP), car elle comporterait certains avantages. Nous décrivons ici notre expérience avec l'ARP.

Méthodes : Nous avons procédé à une revue rétrospective des dossiers de surrénalectomie minimalement effractive par APR ou ALT effectuée par la même personne entre septembre 2010 et décembre 2019 dans un centre hospitalier de soins tertiaire de Colombie-Britannique, au Canada. Les caractéristiques des individus et des tumeurs, le temps opératoire et l'issue des interventions ont été comparés entre les 2 groupes.

Résultats : Pendant la période de l'étude, 58 surrénalectomies par ARP, et 41 par ALT ont été effectuées. Le score médian de l'American Society of Anesthesiologists était plus élevé dans le groupe ALT que dans le groupe ARP (3,0 c. 2,6, $p = 0,02$). Le poids des surrénales étaient plus élevé dans le groupe ALT que dans le groupe ARP (poids moyen 63,4 g c. 19,2 g, $p < 0,001$). Le temps de préparation anesthésique a été plus bref avec l'ARP qu'avec l'ALT (51,5 min c. 63,7 min, $p < 0,001$), tout comme le temps opératoire (temps opératoire moyen (77,9 min c. 118,4 min, $p < 0,001$) et la durée moyenne du séjour hospitalier (2 j c. 4 j, $p < 0,001$). On n'a noté aucune différence quant au taux de complications entre les 2 groupes.

Conclusion : Selon notre étude, l'ARP permet d'abréger le temps opératoire et le séjour hospitalier chez les patients adéquatement sélectionnés. L'approche est donc désormais privilégiée dans notre centre pour la surrénalectomie minimalement effractive.

Minimally invasive adrenalectomy has been commonly practised in North America and around the globe for almost 3 decades. It is the gold standard operative approach for benign adrenal tumours and is also the preferred procedure to address solitary metastases for some groups.[1,2] The transabdominal laparoscopic approach (TLA), with the patient positioned lateral decubitus, was first described by Gagner and colleagues,[3] in 1992. It has been widely adopted owing to the familiarity of the approach to surgeons who perform other laparoscopic procedures. In addition to the familiar anatomy, ample working space and ability to address other intra-abdominal disease are advantages of this approach.

The posterior retroperitoneoscopic approach (PRA) was also introduced in the 1990s but has been less widely adopted. Walz and colleagues[4–6] described the technique using higher insufflation pressures (20–24 mm Hg v. 12–15 mm Hg), which vastly improved the exposure. The PRA has gradually gained traction over the years and has become the preferred approach of many endocrine surgeons worldwide.[7–15]

Previous studies outside of Canada have shown that the PRA technique is safe and has shown some advantages over TLA, such as shorter hospital stays, shorter operative times, less intraoperative blood loss and less postoperative pain, with similar complication rates.[9–11,16–20] To our knowledge, PRA has not been widely adopted in Canada, likely owing to a combination of comfort, knowledge and available training.[15] The purpose of this study was to report a Canadian experience with PRA.

Methods

We conducted a retrospective review of a prospectively maintained database of adrenalectomy procedures performed by a single surgeon (A.M.) at a tertiary academic endocrine surgery centre. We reviewed the charts of all patients who underwent minimally invasive adrenalectomy between September 2010 and December 2019. We excluded patients who underwent bilateral adrenalectomy and those who underwent a concurrent procedure, such as laparoscopic cholecystectomy, at the time of adrenalectomy. The project was approved by the institutional research ethics board.

Data collected included patient demographic and tumour characteristics, operative times and postoperative outcomes. In addition, we reviewed the hospital charts for the number of postoperative analgesia doses as a surrogate way to quantify postoperative pain.

The PRA and TLA procedures have been described in detail by Walz and colleagues[6] and Gagner and colleagues,[3] respectively. In brief, for TLA, 4 subcostal ports are generally used for right adrenalectomy and 3 subcostal ports for left adrenalectomy, with the patient in the lateral decubitus position. For PRA, patients are placed in a prone, half-jackknife position, and 3 incisions are placed beneath the 11th and 12th ribs. Higher insufflation pressures are used for PRA than for TLA. In our study, a LigaSure device (Medtronic) was used for most of the dissection, including ligation of the adrenal vein, with both approaches.

Patient and tumour characteristics that precluded the selection of PRA were tumour size greater than 5 cm, obesity and significant cardiorespiratory comorbidities.

Statistical analysis

We compared patient and tumour characteristics, including age, body mass index, American Society of Anesthesiologists (ASA) Physical Status Classification, tumour size and tumour weight, between the TLA and PRA groups. Clinical outcomes such as anesthesia time, operative time, length of stay and analgesia use were also compared.

Over the course of the study period, the surgeon's preferred approach for pheochromocytoma changed from TLA to PRA; hence, the majority of pheochromocytomas in the study were in the TLA group. For this reason, and because patients with pheochromocytoma are preadmitted the day before surgery for fluid resuscitation (which affects their length of stay), we performed a subset analysis excluding this group. We tested the significance of between-group differences based on normality, as determined by the Shapiro–Wilk test. We tested normal or log-normal variables using the t test, and intractably non-normal variables using the Wilcoxon rank-sum test. A p value < 0.05 was considered statistically significant. R version 4.0.2 (R Foundation for Statistical Computing) was used for all statistical analyses.

Results

During the study period, 109 patients underwent minimally invasive adrenalectomy, of whom 10 were excluded: 6 patients had bilateral adrenalectomy, 3 patients had concomitant minimally invasive surgery procedures, and in 1 patient the procedure was aborted. Of the remaining 99 patients, 58 (59%) underwent PRA and 41 (41%) underwent TLA. Adrenocortical carcinoma was not suspected in any patient preoperatively. Eighty patients (81%) had functional tumours, including 45 with primary aldosteronism, 24 with pheochromocytomas and 11 with Cushing syndrome. There were an additional 19 nonfunctional tumours (19%) (Table 1).

A comparison of patient characteristics between the 2 groups is shown in Table 2. There was no significant difference in age. The median ASA score was significantly higher in the TLA group than in the PRA group (3.0 v. 2.6, $p = 0.02$). There were no between-group differences in mean body mass index across all tumour

types. However, on subset analysis excluding patients with pheochromocytoma, the mean body mass index was significantly higher in the TLA group than in the PRA group (30.8 v. 26.9, $p = 0.04$). Adrenal glands excised via TLA were significantly heavier than those removed via PRA (mean 63.4 g v. 19.2 g, $p < 0.001$) (Table 3). All but 1 of the glands were benign on final pathologic examination. One case of adrenocortical carcinoma was reported on final pathologic examination, in the PRA group.

The mean anesthesia time was significantly longer for the TLA group than the PRA group (63.7 min v. 51.5 min, $p < 0.001$) (Table 4). When patients with pheochromocytoma were excluded, the same trend was seen, although the difference was no longer significantly different ($p = 0.07$). Mean operative times were shorter for the PRA group than the TLA group (77.9 min v. 118.4 min, $p < 0.001$), with the quickest PRA case taking 33 minutes from initial incision to completion of skin closure.

Analgesia use postoperatively, as measured by the number of narcotic doses given, was lower in the PRA group than in the TLA group (2.5 v. 3.0); however, the difference was not statistically significant ($p = 0.07$) (Table 4). Length of stay was shorter in the PRA group than in the TLA group (2.0 d v. 4.0 d, $p < 0.001$). On subset analysis excluding patients with pheochromocytoma, length of stay was still more than 1 day shorter for the PRA group (2.0 d v. 3.0 d, $p = 0.01$).

Table 1. Indications for adrenalectomy in patients who underwent PRA or TLA, subclassified between functional and nonfunctional tumours

Indication	Group; no. (%) of patients: PRA $n = 58$	TLA $n = 41$
Functional	50 (86)	30 (73)
Primary aldosteronism	36 (62)	9 (22)
Pheochromocytoma	6 (10)	18 (44)
Cushing's syndrome	8 (14)	3 (7)
Nonfunctional	8 (14)	11 (27)
Adenoma	3 (5)	3 (7)
Ganglioneuroma	0 (0)	4 (10)
Myelolipoma	0 (0)	3 (7)
Adrenocortical carcinoma	1 (2)	0 (0)
Organizing hematoma	1 (2)	0 (0)
Bronchogenic cyst	1 (2)	0 (0)
Mucinous cystadenoma	1 (2)	0 (0)
Hemangioma	0 (0)	1 (2)
Cyst	1 (2)	0 (0)
Lymphangioma	0 (0)	1 (2)

PRA = posterior retroperitoneoscopic approach; TLA = transperitoneal laparoscopic approach.

Table 2. Comparison of demographic and clinical characteristics between the 2 groups, by tumour type

Characteristic; indication	Group; mean ± SD*: PRA	TLA	*p* value
Age, yr			
All tumour types	52.6 ± 10.7	55.8 ± 12.8	0.2
Excluding pheochromocytoma	51.8 ± 10.7	55.2 ± 11.4	0.2
Pheochromocytoma	59.8 ± 7.2	56.6 ± 14.8	0.5
Primary aldosteronism	49.7 ± 9.2	54.8 ± 7.2	0.1
Cushing's syndrome	51.5 ± 8.7	59.0 ± 4.4	0.1
Nonfunctional	61.2 ± 14.7	54.5 ± 15.3	0.4
ASA score, median (IQR)			
All tumour types	3.0 (2.0–3.0)	2.6 (3.0–3.0)	0.02
Excluding pheochromocytoma	3.0 (2.0–3.0)	3.0 (2.0–3.0)	0.9†
Pheochromocytoma	3.0 (3.0–3.0)	4.0 (3.0–4.0)	0.2†
Primary aldosteronism	3.0 (2.0–3.0)	3.0 (3.0–3.0)	0.1†
Cushing syndrome	3.0 (2.0–3.0)	3.0 (3.0–3.0)	0.3†
Nonfunctional	2.5 (2.0–3.0)	2.0 (2.0–2.5)	0.5†
Body mass index			
All tumour types	26.7 ± 4.8	27.3 ± 8.0	1.0‡
Excluding pheochromocytoma	26.9 ± 4.9	30.8 ± 7.8	0.04‡
Pheochromocytoma	25.2 ± 4.2	22.9 ± 6.0	0.2†
Primary aldosteronism	27.8 ± 4.8	34.8 ± 8.2	0.02‡
Cushing syndrome	23.5 ± 4.7	23.1 ± 4.5	0.9‡
†Nonfunctional	26.4 ± 4.2	29.6 ± 6.5	0.2

ASA = American Society of Anesthesiologists; IQR = interquartile range; PRA = posterior retroperitoneoscopic adrenalectomy; SD = standard deviation; TLA = transperitoneal laparoscopic adrenalectomy.
*Except where noted otherwise.
†Wilcoxon rank-sum test.
‡*t* test.

Table 3. Comparison of pathologic tumour characteristics between the 2 groups, by tumour type

Characteristic; indication	Group; mean ± SD		*p* value
	PRA	TLA	
Gland size, cm			
All tumour types	5.3 ± 1.5	6.2 ± 2.6	0.2*
Excluding pheochromocytoma	5.3 ± 1.4	6.0 ± 1.8	0.1
Pheochromocytoma	6.0 ± 2.1 *n* = 5	6.6 ± 3.3	0.6
Primary aldosteronism	5.2 ± 1.2	5.3 ± 2.1	0.9
Cushing syndrome	4.5 ± 1.5	8.0 ± 1.7	0.05
Nonfunctional	6.7 ± 1.5	6.0 ± 1.2	0.4
Gland weight, g			
All tumour types	19.2 ± 13.9	63.4 ± 65.5	< 0.001†
Excluding pheochromocytoma	19.3 ± 14.4	64.5 ± 55.4	0.001†
Pheochromocytoma	18.6 ± 9.7 *n* = 5	61.9 ± 80.0	0.02*
Primary aldosteronism	16.9 ± 12.6	38.0 ± 43.9	0.1†
Cushing syndrome	16.4 ± 9.2	132.0 ± 56.6	0.002*
Nonfunctional	35.2 ± 19.1	65.6 ± 48.9	0.3*

PRA = posterior retroperitoneoscopic adrenalectomy; SD = standard deviation; TLA = transperitoneal laparoscopic adrenalectomy.
**t* test.
†Wilcoxon rank-sum test.

Complication rates were low overall and not significantly different between the 2 groups (Table 5).

Discussion

Our study shows that PRA is a safe alternative to TLA in patients undergoing minimally invasive adrenalectomy, with several advantages. This finding is in keeping with other studies.[8,15,21]

With a retroperitoneal approach, one can avoid the need to mobilize other organs such as the colon, spleen and tail of the pancreas, along with the associated risks of these mobilizations. Furthermore, this mobilization likely accounts for the longer operative times with TLA. We found significantly shorter operative times and shorter hospital length of stay with PRA. This, in turn, yields a medical and financial benefit to patients and health care systems. Adrenalectomy via TLA can be done as day surgery, particularly for nonfunctional tumours. Our institutional practice is to admit patients overnight for postoperative monitoring of hemodynamics and electrolytes and, for patients with Cushing syndrome, transitioning to oral steroid replacement. Furthermore, many of our patients live in geographically remote referral centres and thus are not appropriate for same-day surgery. Other authors have suggested the additional PRA advantage of not having to contend with intra-abdominal adhesions in patients with prior abdominal surgery.[4,12,13,20,22] For bilateral adrenalectomy, PRA provides the distinct advantage of no requirement to reposition and re-prep, and drape between sides, which makes for a much quicker operation compared to TLA.

At our institution, the majority of pheochromocytomas were excised via TLA before 2018. In more recent years, as both the surgeon and the anesthesia team became more comfortable and familiar with PRA, it has replaced TLA as the preferred approach for most pheochromocytomas. The anesthesia time is typically longer for this tumour than for other adrenalectomy cases, as placement of arterial lines and central venous catheters is typically necessary. Given the preponderance of pheochromocytomas in the TLA group, we ran a subset analysis that excluded them and found that, although there was still a trend toward longer anesthesia time with TLA than with PRA, the difference was no longer statistically significant. There was a trend toward shorter anesthesia time with PRA in most groups on subgroup analysis; however, the small samples of each individual group limited interpretation of the results. Regarding positioning, with experience we have found that positioning for PRA is similar to or faster than for TLA.

Previous studies have shown that patient characteristics, including burden of comorbidities, may limit the selection of PRA.[11,12] Our study confirmed a difference in burden of comorbidities between groups, based on ASA score. This suggests there may be preoperative selection of patients with fewer comorbidities for the retroperitoneoscopic approach, although this difference did not persist on subgroup analysis. It should be noted that patients with serious pulmonary disease may not tolerate the prone positioning and higher carbon dioxide insufflation pressures with PRA, and are offered only TLA by the principal author (A.M.). This may explain the longer anesthesia times seen in the TLA group.

Tumour characteristics also have an effect on approach selection. In our study, more patients with heavier tumours underwent TLA than PRA, likely owing to anatomic constraints and difficulty obtaining adequate exposure with PRA for larger adrenal tumours. The between-group

Table 4. Comparison of intraoperative and postoperative outcomes between the 2 groups, by tumour type

Characteristic; indication	Group; mean ± SD*		*p* value
	PRA	TLA	
No. of doses of narcotic, median (IQR)			
All tumour types	2.5 (1.0–4.8)	3.0 (1.0–7.0)	0.07§
Excluding pheochromocytoma	2.5 (1.0–4.0)	4.0 (2.0–6.5)	0.07§
Pheochromocytoma	3.5 (1.0–7.5)	2.5 (1.0–7.5)	0.8§
Primary aldosteronism	2.5 (1.0–4.2)	4.0 (2.0–5.0)	0.4§
Cushing syndrome	1.5 (0.0–4.0)	35.0 (17.5–38)	0.2§
Nonfunctional	2.0 (0.0–4.5)	2.0 (2.0–6.5)	0.3§
Anesthesia time, min†			
All tumour types	51.5 ± 11.5	63.7 ± 17.3	< 0.001¶
Excluding pheochromocytoma	50.4 ± 10.6	54.8 ± 10.3	0.07¶
Pheochromocytoma	61.3 ± 15.2	75.0 ± 17.9	0.01
Primary aldosteronism	49.8 ± 8.3	57.1 ± 11.3	0.1
Cushing syndrome	58.5 ± 16.4	52.0 ± 5.6	0.4¶
Nonfunctional	45.2 ± 9.3	53.6 ± 10.9	0.09
Operative time, min‡			
All tumour types	77.9 ± 40.4	118.4 ± 47.4	< 0.001¶
Excluding pheochromocytoma	79.5 ± 41.6	105.4 ± 22.3	< 0.001¶
Pheochromocytoma	64.2 ± 26.9	135.1 ± 64.1	0.005¶
Primary aldosteronism	77.7 ± 44.9	103.7 ± 21.1	0.001¶
Cushing syndrome	67.0 ± 18.0	93.7 ± 12.5	0.04
Nonfunctional	99.9 ± 39.0	110.0 ± 25.3	0.5
Length of stay, median (IQR), d			
All tumour types	2.0 (2.0–3.0)	4.0 (3.0–5.0)	< 0.001§
Excluding pheochromocytoma	2.0 (2.0–3.0)	3.0 (2.0–3.5)	0.01§
Pheochromocytoma	2.0 (2.0–2.8)	5.0 (4.0–5.8)	< 0.001¶
Primary aldosteronism	2.0 (2.0–3.0)	3.0 (2.0–3.0)	0.08§
Cushing syndrome	4.0 (3.0–5.0)	7.0 (5.0–7.0)	0.3
Nonfunctional	2.0 (1.0–2.0)	2.0 (2.0–3.0)	0.009§

IQR = interquartile range; PRA = posterior retroperitoneoscopic adrenalectomy; SD = standard deviation; TLA = transperitoneal laparoscopic adrenalectomy.
*Except where noted otherwise.
†Time from patient entry into the operating room to initial incision.
‡Time from initial incision to completion of skin closure.
§Wilcoxon rank-sum test.
¶*t* test.

Table 5. Comparison of perioperative complications between the 2 groups

Complication	Group; no. of complications		*p* value
	PRA	TLA	
Pancreatic duct leak	0	1	
Conversion to open	1	1	
Incisional hernia	0	2	
Aldosterone insufficiency	1	0	
T12 neurapraxia	3	0	
Infarct, superior renal pole	1	0	
Urinary retention	1	0	
Total	7	4	0.2

PRA = posterior retroperitoneoscopic adrenalectomy; TLA = transperitoneal laparoscopic adrenalectomy.

differences in patient and tumour characteristics in this study may reflect a preoperative selection bias. Walz and colleagues[4] described their upper limit of tumour size that could be excised via PRA to be 7–8 cm, as tumours larger than this were difficult to manipulate in a small space and had a higher risk of malignant disease.

A major challenge to the adoption of PRA may be the surgeon's unfamiliarity with this approach. Some centres have advocated a strategy of mentorship, in person or via telementoring, to build the skills required to perform this procedure.[23,24] Vrielink and colleagues[21] suggested that 24–42 procedures were required to fulfill the entire surgical learning curve. Although there is a steep learning curve, with appropriate training, the retroperitoneoscopic approach is a safe option for minimally invasive adrenalectomy for an experienced endocrine surgeon and is our preferred approach for most adrenal tumours.

Limitations

Limitations of this study include its retrospective design, small data set, and the fact that the experience of only a single surgeon was studied. In addition, given that the

majority of pheochromocytomas were removed via TLA, some of the outcomes may be skewed owing to the perioperative complexity of excising this tumour. However, subgroup analyses were performed to mitigate this. This effect will likely be minimized in the future as more pheochromocytomas are removed via PRA. Our measurement of pain by number of narcotic doses used postoperatively is an approximating measurement of postoperative pain and does not account for patients' subjective interpretation of pain. In the early phase of the study, our centre's anesthesia group was unfamiliar with postoperative narcotic needs in this patient population, and patient-controlled anesthesia was implemented in both groups. Thus, the number of narcotic doses may overestimate pain control. Furthermore, we did not measure outpatient narcotic use.

Conclusion

Our findings suggest that PRA results in shorter operative time and a shorter hospital stay than TLA. Thus, it has become the preferred approach at our centre for minimally invasive adrenalectomy, when possible. Our study highlights that appropriate patient selection remains important for PRA; it may not be appropriate for patients with larger tumours or cardiorespiratory comorbidities.

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