Surg Endosc (2004) 18: 621–625
DOI: 10.1007/s00464-003-8827-0

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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Laparoscopic adrenalectomy for pheochromocytoma

A comparison to aldosteronoma and incidentaloma

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Received: 10 June 2003/Accepted: 17 August 2003/Online publication: 19 March 2004

Abstract
Background: Laparoscopic adrenalectomy is a safe and effective treatment for most surgical diseases of the adrenal gland. However it has been suggested that catecholamine effects associated with pheochromocytoma render the laparoscopic approach a more challenging and a more morbid procedure. The purpose of this study was to compare the operative characteristics and outcomes of laparoscopic adrenalectomy for pheochromocytoma to those of aldosteronoma and incidentaloma.
Method: Patient records and operative reports were retrospectively reviewed for demographics, diagnoses, operative management, and outcomes for patients undergoing laparoscopic adrenalectomy between June 1994 and July 2002 at two academic medical centers. A total of 74 patients were included and analyzed by diagnosis. Differences were considered statistically significant at $p < 0.05$.
Results: Twenty-eight patients with pheochromocytoma, 27 with aldosteronoma, and 19 with incidentally discovered nonfunctioning adrenal masses underwent laparascopic adrenalectomy. Patients undergoing resection for pheochromocytoma trended toward more operative blood loss (150 ml) compared to aldosteronoma (88 ml) and incidentaloma (75 ml). Eight patients were converted to an open procedure for a 10.8% conversion rate. The mean operative time was 171 min and there was a 10.8% perioperative complication rate. The mean hospital stay was 3.4 days. These results were not statistically significant between diagnostic groups.
Conclusion: Despite concern about increased operative times and morbidity associated with pheochromocytoma, our experience supports that laparoscopic adrenalectomy may be performed as safely as, and achieve outcomes similar to, those for other diseases.

Key words: Laparoscopic adrenalectomy — Pheochromocytoma — Aldosteronoma — Incidentaloma

Laparascopic adrenalectomy has become the standard of care for resection of surgical adrenal diseases. The laparoscopic approach has been shown to decrease postoperative length of hospital stay, decrease postoperative pain, and facilitate a quicker return to normal activity [1, 6, 14–16, 18]. Traditionally, an open anterior approach was utilized to address the unexpected 10% of bilateral disease and 10% of extra-adrenal location. Furthermore, surgeons were initially hesitant to resect pheochromocytomas laparoscopically because of the potential hemodynamic effects of catecholamine secretion during pnuemoperitomeum and tumor manipulation [2]. Surgeons were concerned that a laparoscopic approach would result in a more morbid procedure. Preoperative localization has improved with newer imaging techniques, and pre- and perioperative pharmacologic and anesthetic management have improved. These factors combined with maturation of laparoscopic techniques have led to more patients with pheochromoctyoma being safely resected laparoscopically.

The role of laparoscopic resection for pheochromocytoma continues to be defined. Some authors have reported series demonstrating the feasibility of laparoscopic pheochromocytoma resection [2, 4]. Other groups have demonstrated that a laparoscopic approach to pheochromocytoma resection yields results comparable to those of an open resection [13, 17]. Although these studies address the hemodynamic problems associated with catecholamine-secreting tumors, there is scant data that directly compare laparoscopic resection of pheochromocytoma to laparoscopic resection of other

Paper presented at the annual meeting of the Society of American Gastrointestinal Endoscopic Surgeons (SAGES), Los Angeles, California, USA, 13–15 March 2003

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Table 1. Patient demographics

			Gender	
	n	Age (yr)	Male	Female
Pheochromocytoma	28	53	11	17
Aldosteronoma	27	47	14	13
Incidentaloma	19	52	5	14

functional or nonsecreting tumors. One study reported increased operative time, increased blood loss, and longer return to normal activity for patients undergoing laparoscopic adrenalectomy for pheochromocytoma compared to patients undergoing the same procedure for different pathology [7]. The purpose of this study was to review a relatively large series of laparoscopically resected pheochromocytomas and analyze the results relative to laparoscopic resection of other hormone-secreting tumors and nonfunctioning incidentally discovered adrenal tumors.

Materials and methods

Cases of laparoscopic adrenalectomy from June 1994 to July 2002 from two academic medical centers with advanced laparoscopic surgery programs were reviewed. Medical records and operative reports were retrospectively reviewed for patient demographics, operative characteristics, pathology, and surgical outcomes. Seventy-four patients with pheochromocytoma, aldosteronoma, or nonfunctioning adrenal tumors (incidentaloma) were included and grouped according to diagnosis. Patients with pheochromocytoma were considered as our study population and results were statistically compared to those of patients with aldosteronoma or incidentaloma. The student's *t*-test was used for continuous variables and the Chi-square method was used for discrete variables. Differences were considered statistically significant at $p < 5\%$.

The majority of operations were performed by one surgeon at each institution (S.E. and A.P.). The preferred surgical approach was a standard transperitoneal laparoscopic procedure, which offers a greater working space, easier removal of larger tumors, and a more facile conversion to open adrenalectomy if necessary. Patients with pheochromocytoma and preoperative hypertension are routinely treated with preoperative pharmacologic alpha blockade and volume expansion. During surgery, blood pressure is strictly monitored by arterial line and intravenous alpha and beta blockade is administered as necessary.

Results

Twenty-eight patients with pheochromocytoma, 27 with aldosteronoma, and 19 with incidentalomas were analyzed. Patient demographics are shown in Table 1. The final pathologic diagnoses for incidentalomas were adenoma (79%), simple cyst (10.5%), and myolipoma (10.5%). The majority of patients with pheochromocytoma and aldosteronoma had left-sided lesions, whereas incidentalomas were found with a slightly higher incidence on the right (Fig. 1). When combining aldosteronomas and incidentalomas as a single entity, there was no significant difference in laterality compared to pheochromocytomas.

On pathological examination, pheochromocytomas had an average size of 5.2 cm (range, 1.3–105). The mean size of incidentalomas was nearly identical to that of pheochromocytomas at 5.1 cm (range, 3.0–10.3), ($p = 0.98$). As expected, aldosteronomas were smaller on average at 3.5 cm (range, 0.7–9.5) ($p = 0.03$). These data are represented graphically in Fig. 2.

Of the 74 patients, 68 successfully completed laparoscopic adrenalectomy, for a converion rate of 10.8%. Approximately 11% of pheochromocytoma resections were converted to an open procedure, which was not significantly different from the other diagnostic groups (Table 2). The indication for conversion in the three cases of pheochromocytomas included inability to obtain adequate exposure secondary to obesity or adhesive disease and left renal vein injury requiring emergent conversion. Similarly, the indication for conversion in the other study groups was technical difficulty in creating or maintaining exposure secondary to obesity manifested by an enlarged liver or excessive omental tissue.

The median blood loss across all cases was 100 ml. Cases with pheochromocytoma had nearly twice the median blood loss compared to those with aldosteronoma and incidentalomas (Fig. 3). This difference trended toward but did not reach statistical significance, with p values of 0.06 and 0.10, respectively. There was one pheochomocytoma resection that was complicated by left renal vein injury, causing excessive blood loss of 6500 ml and emergent conversion to an open procedure. Despite increased blood loss associated with pheochromocytomas, the operative times were similar for all three diagnostic groups—approximately 3 h (Fig. 4). The overall perioperative complication rate in this series was 10.8%. There were no deaths. Complication rates by diagnosis are given in Table 2. Three patients with pheochormocytomas were affected by complications, yielding a rate of 10.7%. The most serious complication was intraoperative left renal vein injury, as noted previously. This patient remained in the hospital for 10 days but suffered no long-term sequelae. Other complications included a postoperative ileus that prolonged hospital stay and a wound infection. Among the patients with aldosteronoma, one patient had a postoperative ileus requiring a 10-day hospital course, and another patient had an intraabdominal abscess. Two patients with incidentalomas had superficial wound infections. Another patient with an adenoma incurred colonic injury during trocar introduction. In this case, there was no spillage of colon contents and the repair was performed immediately laparoscopically without adverse consequences. This complication was independent of adrenal pathology.

The average hospital stay was 3.4 days, without significant differences among the diagnostic study groups. The mean length of stay for each diagnostic group is given in Table 2. Twenty-six percent of all patients and 21% of patients with pheochromocytoma were discharged within 2 days after surgery.

Discussion

Since its initial report in 1992 [5], laparoscopic adrenalectomy has become the preferred approach for

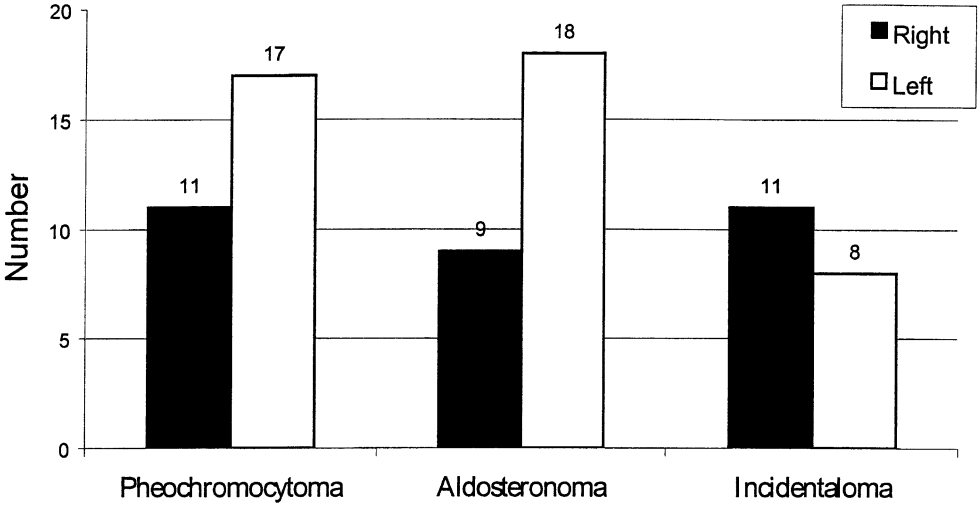

Fig. 1. Laterality of adrenal tumors based on diagnosis.

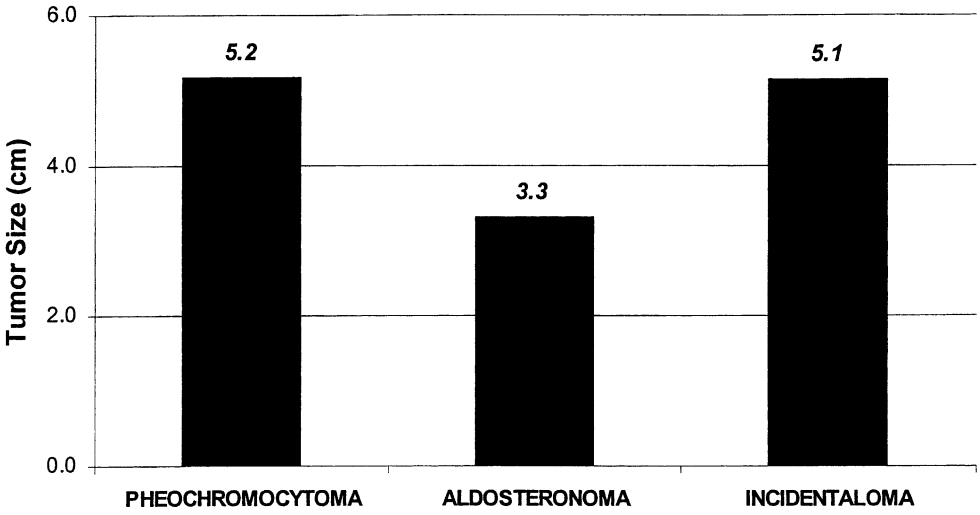

Fig. 2. Mean adrenal tumor size by diagnosis. Pheochromocytomas were statistically larger than aldosteronomas ($p = 0.03$) but not incidentalomas ($p = 0.98$).

Table 2. Operative characteristics

	Conversion rate (%)	Complication rate (%)	Hospital stay rate (d)
Pheochromocytoma	10.7	10.7	3.7
Aldosteronoma	14.8	7.4	3.6
Incidentaloma	5.3	15.8	3.1
Total	10.8	10.8	3.4

resection of surgical adrenal disease. Although pheochromocytoma was initially considered a contraindication to laparoscopy, laparoscopic resection is evolving as the standard of care. Our series further supports the safety and efficacy of laparoscopic adrenalectomy for pheochromocytoma in comparison to other indications for adrenalectomy.

The combination of pneumoperitoneum during laparoscopy and the catecholamine effects of pheochromocytomas present a unique perioperative management challenge to maintain hemodynamic stability. It is well-known that during laparoscopy, carbon dioxide pneumopertioneum increases intraabdominal pressure and thus reduces systemic venous return. Furthermore, pneumoperitoneum may increase sympathetic tone and thus increase peripheral vascular resistance. Although the majority of patients undergoing laparoscopy for other indications tolerate this without difficulty, the additive effects of catecholamine surge from a pheochromocytoma during laparoscopy may increase operative risk of hemodynamic instability.

Hemodynamic shifts may be controlled with coordination between the surgical and anesthetic teams and appropriate anesthetic management by reducing hypertensive events during insufflation, surgical manipulation, and resection. Inabet et al. [10] directly compared intraoperative hemodynamic parameters for 22 patients undergoing adrenalectomy for pheochromocytoma by the open or laparoscopic technique. Despite increased numbers of intraoperative hypertensive events, increased mean arterial pressure, central venous pressure, and pulmonary capillary wedge pressure for patients undergoing laparoscopy, there was no significant change in cardiac index or left ventricular work. These data suggest that pneumoperitoneum is well tolerated in these patients and by itself is not a contraindication for

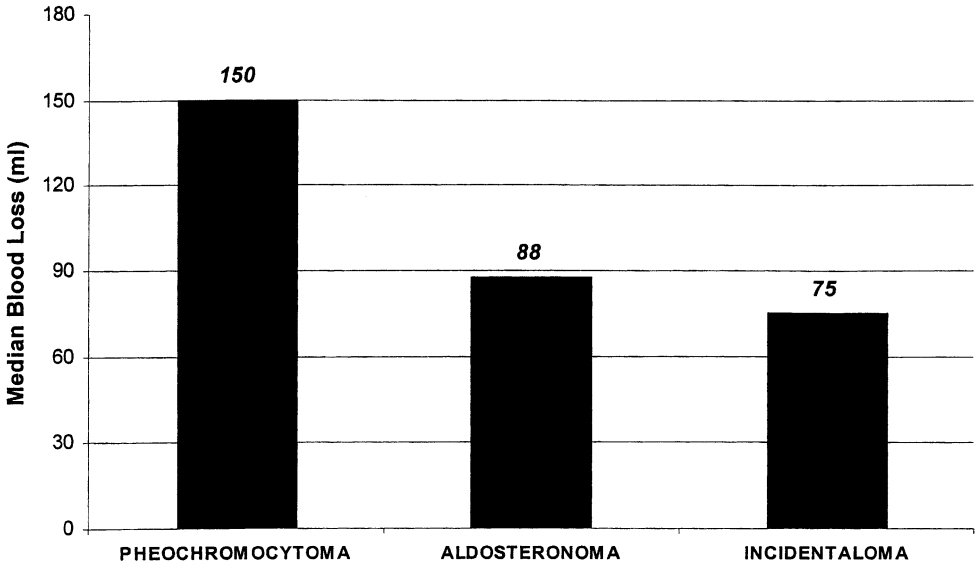

Fig. 3. Median operative blood loss for laparoscopic adrenalectomy by diagnosis. There was a statistical trend for increased blood loss for pheochromocytoma resection compared to aldosteronoma ($p = 0.06$) and incidentaloma ($p = 0.10$). There was large variability within each group (range: pheochromocytoma, 30–6500 ml; aldosteronoma, 20–400 ml; and incidentaloma, 20–1500 ml).

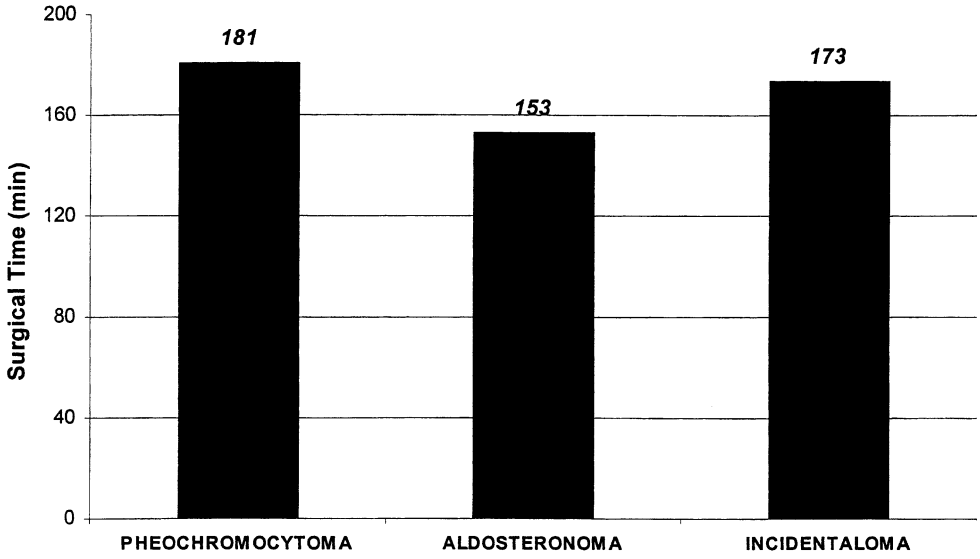

Fig. 4. Median duration of surgery for laparoscopic adrenalectomy by diagnosis. There was no difference between pheochromocytoma and aldosteronoma ($p = 0.67$) or incidentaloma ($p = 0.28$).

pheochromocytoma resection. Thus, with appropriate anesthetic management, this operation may be performed safely.

Operative blood loss during laparoscopic adrenalectomy for pheochromocytoma was greater compared to that for other diseases in our study. There are two likely explanations for this result. First, despite overall hemodynamic control, there are unavoidable episodic periods of hypertension that may cause small vessel bleeding in a highly vascularized tumor, more so than in a patient with normal blood pressure. Second, pheochromocytomas tend to be associated with a local desmoplastic reaction, creating adhesions and fibrosis. Thus, the dissection tends to be more technically challenging and may result in increased blood loss.

Despite the increased blood loss and perhaps more difficult dissection with pheochromocytomas, there was no significant difference in operative times or conversions to an open procedure. Interestingly, there was no statistical difference in operative times when comparing left versus right adrenalectomy. Similarly, the increased blood loss did not translate into increased morbidity. There were no major complications and the perioperative complications rate was similar across all patient groups. No patients had perioperative cardiac events and there were no deaths in this series. The average length of stay for all patients undergoing laparoscopic adrenalectomy was approximately 3 days. These results are similar to those reported in the literature [1, 4, 12, 13, 17, 18].

As with any laparoscopic procedure, both operative and perioperative management changes with advances on the learning curve. Our experience dates back to 1994 and our operative times and hospital stay have trended downward in recent years. Our current norm for postoperative care is discharge from the hospital within 1–2 days after surgery. In fact,

21% of all patients went home on the first postoperative day.

Another aspect of our study was the size of the pheochromocytomas resected laparoscopically. Many surgeons have traditionally used a size greater than 6 cm as a contraindication to laparoscopic resection due to the risk of malignancy. The average pheochromocytoma tumor size in our series was 5.2 cm, with 11 tumors (39%) greater than 6 cm. Other groups have resected tumors up to 10 cm without problems [3, 8, 9]. Our data support this theory and we rarely use size as a criterion for exclusion of a laparoscopic approach but rather as a consideration of malignant disease.

In summary, this work supports the use of laparoscopic adrenalectomy for resection of pheochromocytoma. With appropriate preoperative and perioperative hemodyamic control, experienced laparoscopic surgeons may achieve safe and effective resection with results similar to those achieved by laparoscopic adrenalectomy for other diseases.

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