



Laparoscopic Adrenalectomy

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Abstract. Using the transperitoneal, laparoscopic approach, we performed 67 successful adrenalectomies between June 1993 and July 1995 at Greenslopes Hospital, Brisbane. There were 30 women and 37 men. Syndromes of primary adrenal hormone overproduction—primary aldosteronism ($n = 52$), pheochromocytoma ($n = 6$), and hypercortisolism ($n = 1$)—were present in 59 patients and apparently nonfunctioning adrenal tumors (of which one was malignant) in 8 patients. There was a significant difference in the time of operation between patients weighing < 80 kg and those weighing > 80 kg. Operations on males were slower than those on females, possibly explained by males being significantly heavier. Left-sided tumors outnumbered right-sided tumors; removal of right-sided adrenals took, on average, longer, but this difference was not significant.

The development of laparoscopic surgery has extended to include adrenalectomy [1]. Because of more rapid recovery from laparoscopic than from open procedures, as a result of less pain and easier mobilization, it appeals to patients in preference to the open techniques and clearly warrants further careful evaluation. We here report our experience with the first 67 laparoscopic adrenalectomies performed in the Hypertension Unit, Greenslopes Hospital, Brisbane, Australia.

Methods

Diagnosis

Screening for primary aldosteronism is performed using the plasma aldosterone (ng/100 ml) to plasma renin activity (ng/ml/hr) ratio. The diagnosis is confirmed or excluded using the fludrocortisone (0.1 mg q6h for 4 days) suppression test. Familial hyperaldosteronism type 1 [2] is diagnosed or excluded using the dexamethasone (0.5 mg q6h for 4 days) suppression test or by seeking the causative hybrid gene in peripheral blood DNA by Southern blot [3] or long polymerase chain reaction (PCR) [4] technique. Lateralization by adrenal vein sampling is performed in all patients independently of computed tomography (CT) scanning (3 mm slices), which cannot determine function [5]. Pheochromocytomas are diagnosed using 24-hour urinary catecholamine estimation and the clonidine suppression test using plasma catecholamines; they are localized by CT and nuclear medicine

(MIBG) scanning. Cortisol-secreting adenomas are recognized by plasma cortisol levels failing to demonstrate a circadian rhythm or to be suppressed after administration of dexamethasone (2.0 mg q6h for 2 days). Elevated random plasma levels of testosterone, DHEA sulfate, androstenedione, or estradiol associated with suppressed luteinizing hormone (LH) and follicle-stimulating hormone (FSH) were used to indicate the presence of excessive sex steroid production. Adrenal masses identified on CT that do not show excessive production of steroid hormones or catecholamines by the above criteria are categorized for convenience as “incidentalomas” [6, 7]. It is important to recognize that the diagnosis of incidentalomas depends on exclusion, and therefore the extent of the investigation performed should always be specified.

Operative Technique

The patients are placed in the true lateral position. The table is unbroken unless the distance between the ribs and iliac crest necessitates it for access. An indwelling catheter is inserted, and pneumatic calf stimulation is superimposed on graded compression stockings.

Normally we insert four 10 mm ports, but on several occasions we have used three or five ports. The laparoscope is inserted in the lateral rectus sheath along a line from the umbilicus to the adrenal. The working ports are approximately in the midclavicular and anterior axillary lines, and the fourth port is in the posterior axillary line. For the left adrenal, the splenic flexure of the colon must be well mobilized out of the way lest technical problems of access arise. Remembering that the pancreas is an anterior relation of the left adrenal, when the spleen is detached from the diaphragm using this approach its mobilization must be continued medially until the pancreas and, in most cases the splenic artery, are seen, both also requiring retraction medially. For the right adrenal, the liver must be detached from the diaphragm; then, with it retracted medially, we descend in the plane between the kidney and the liver. We do not normally see the inferior vena cava until later in the procedure. Two Satinsky clamps are readily available on the setup trolley in case a major vascular accident occurs. We do not divide the adrenal vein until the end of the operation in order to avoid venous engorgement of the gland, which interferes with subsequent histologic and biochemical ex-

amination. This requirement makes the operation somewhat more difficult than it might otherwise be.

Statistics

Results were expressed as mean \pm SEM. Means were compared using Student's two-tailed *t*-test.

Results

Between June 1993 and July 1995 a total of 67 patients (54 ± 1.3 years; 37 men, 30 women) underwent unilateral laparoscopic adrenalectomy. The adrenals removed were either aldosterone producing ($n = 52$: 32 left, 20 right); pheochromocytoma ($n = 6$: 1 left, 5 right); cortisol-secreting, causing Cushing syndrome, ($n = 1$, left); incidentaloma with no excess of cortisol, aldosterone, catecholamines, or sex steroids ($n = 8$: 7 left, 1 right). All of the incidentalomas resembled steroid-secreting tumors (yellow on cut section, lipid-rich cells histologically), and one proved to be an adrenocortical carcinoma on histologic examination. This adrenal mass measured 4×3 cm on CT examination. A discrete adrenal mass was recognizable on CT examination in only 38% of 52 patients with primary aldosteronism, but aldosterone production was "lateralized" in all, seen by a comparison of the adrenal venous aldosterone/cortisol ratio with that in blood simultaneously collected from a peripheral vein [5, 9].

Convalescence

The postoperative inpatient stay was significantly ($p < 0.01$) shorter for laparoscopic adrenalectomy (5.1 ± 0.2 days) than for open surgery (9.8 ± 0.2 days; $n = 59$). The absence of muscle incisions permitted resumption of normal activities faster and with less discomfort.

Complications

Three patients developed a deep venous thrombosis (4.5%), two with a recognized pulmonary embolus (3%); each was successfully treated with anticoagulants. One patient had a postoperative haemorrhage (1.5%), and one patient developed a port site hernia subsequently repaired surgically (1.5%). In contrast, incisional hernia was much more frequent ($p < 0.05$) with the open approach, occurring in 8 of 59 patients (14%).

Operation Time

The mean operating time for this series was 123.9 ± 5.7 minutes (Table 1). The mean operation time for 1993 (152.1 ± 14.1 minutes) was significantly ($p < 0.01$) longer than for 1994 (109.7 ± 5.2 minutes). The operation time for men was significantly longer (140.1 ± 8.5 minutes) than for females (103.8 ± 5.6 minutes), possibly because the men (93 ± 2.4 kg) were heavier ($p < 0.01$) than the women (70.6 ± 2.6 kg). We find that the fat is more difficult to dissect away from the gland in men than in women. When we looked at weight specifically, there was a significant ($p < 0.01$) difference in the time of operations between patients who weighed < 80 kg (104.1 ± 5.4 minutes) and who weighed more than 80 kg (143.0 ± 8.9 minutes). When we included height and calculated body surface area, the results were

Table 1. Laparoscopic adrenalectomy; duration of operation.

Parameter	No.	Duration (min)	<i>p</i>
Total	67	123.9 ± 5.7	
1993	20	152.1 ± 14.1	< 0.01
1994	40	109.7 ± 5.2	
Weight < 80 kg	33	104.1 ± 5.4	< 0.01
Weight > 80 kg	34	143.0 ± 8.9	
Male	37	140.1 ± 8.5	< 0.01
Female	30	103.8 ± 5.6	
Left	42	118.6 ± 6.5	NS
Right	25	132.7 ± 10.7	

Results are means \pm SEM.

similar. We formed the impression that right adrenalectomy was technically easier than on the left side, but the mean operating time was in fact slightly but not significantly longer for the right side (132.7 ± 10.7 minutes) than the left (118.6 ± 6.5 min).

Clinical Outcome After Laparoscopic Adrenalectomy in 52 Patients with Primary Aldosteronism

Each of 18 patients hypokalemic before surgery were normokalemic after surgery and remained so. Assessing the outcome with regard to hypertension in 49 patients followed for 6 months or more after surgery, 45% were cured and 55% were significantly improved (blood pressure the same or lower on fewer medications). The cure rate among six women age 50 years or younger was 100%.

Discussion

Since the advent of laparoscopic adrenalectomy, the shortened hospital stay and easier recuperation have altered the patients' perception of operative intervention. For example, compared with a minimum postoperative stay of 7 days for open adrenalectomy, we suggest a minimum postoperative stay for a laparoscopic adrenalectomy of 3 days. The minimum postoperative stay after cholecystectomy is less than 24 hours, but laparoscopic adrenalectomy requires more extensive dissection, including mobilization of the spleen and colon on the left and of the liver on the right. In our unit postoperative endocrine studies are performed on the third and fourth postoperative days in order to evaluate function of the remaining adrenal. This scheduling requires that the patient stay until 10.00 a.m. on day 4. Patients who do not feel well enough to be discharged on day 4 remain for a longer period.

Comparing two time periods is probably the best way to demonstrate that increasing experience makes the task less tedious. Some laparoscopic procedures are now performed faster than by the open technique.

In recent years the number of patients diagnosed with primary aldosteronism by our unit has increased dramatically. The main factor causing this increase has been the use of the aldosterone/renin ratio, first described by Hiramatsu et al. in 1981 [8] as a screening test. Initially the ratio was measured only in hypokalemic hypertensives and subsequently in normokalemic resistant

hypertensive patients whose blood pressure was not controlled despite use of three or more antihypertensive medications. When a high percentage of these patients proved to have primary aldosteronism, the policy of the unit changed in 1991 to screening all hypertensive patients for primary aldosteronism, a policy we have also recommended to general practitioners practicing in this state. As a result of this policy, we are currently diagnosing more than 70 new patients with primary aldosteronism each year. At least 75% of these patients have never been hypokalemic. Clearly, early detection of normokalemic primary aldosteronism permits early application of specific treatment, with better control of hypertension and avoidance of side effects from nonspecific medications [9–11]. Because we encountered proved false negatives (positive fludrocortisone test: hypertension cured by unilateral adrenalectomy) with the popular saline loading test, we use the more tedious fludrocortisone suppression test to provide the definitive diagnosis [5, 9]. A sustained volume expansion is achieved, which in all conditions other than primary aldosteronism and reninoma leads to suppressed renin followed by suppressed aldosterone.

With the exception of patients now diagnosed by genetic testing with familial hyperaldosteronism type 1, adrenal vein sampling is performed in all patients. It is presently the only satisfactory way to lateralize posture-responsive and angiotensin-responsive primary aldosteronism with tumors too small to be seen on CT scanning, and so masquerading as bilateral adrenal hyperplasia. In the present series of 52 patients with primary aldosteronism, unilateral mass lesions were not identifiable on CT in 60%.

Importantly, CT scanning cannot define function. Therefore a demonstrable mass on CT may be an incidentaloma, and a small functioning tumor in the opposite adrenal may be undetectable using current imaging techniques [5, 9]. For this reason, the CT scan is used in our unit particularly to recognize adrenal masses 2.5 cm or more in diameter, a size we believe warrants removal in view of the low survival rate of patients with confirmed adrenal cancer.

Résumé

En utilisant l'abord transpéritonéal laparoscopique, nous avons réalisé avec succès 67 surrénalectomies entre Juin 1993 et Juillet 1995 à l'hôpital Greenslopes. Il y avait 30 femmes et 37 hommes. Pour les syndromes d'hyperproduction hormonale primitive, il y avait 52 cas d'hyperaldostéronisme, six cas de phéochromocytome et un cas d'hypercortisolisme. Il y avait également huit tumeurs non sécrétantes, l'une d'entre elles étant maligne. Il y avait une différence significative concernant la durée de l'intervention entre les patients en-dessous et au-dessus de 80 Kg. Les interventions prenaient plus de temps chez l'homme que chez la femme, fait expliqué peut-être par le poids supérieur chez les hommes. Les tumeurs du côté gauche étaient plus nombreuses que les tumeurs du côté droit, et la durée de l'intervention des tumeurs du côté droit était plus longue, mais ces différences n'étaient pas significatives.

Resumen

En el Hospital Greenslopes de Brisbane, Australia hemos practicado 67 adrenalectomías exitosas utilizando el abordaje laparoscópico trasperitoneal en el período junio 1993 a julio 1995. Los pacientes incluyeron 30 mujeres y 37 hombres. Síndromes de hiperproducción de hormona adrenal primaria -aldosteronismo primario (52), feocromocitoma (6) e hipercortisolismo (1), fueron diagnosticados en 59 pacientes, y tumores adrenales aparentemente no funcionales (uno era maligno) en 8 pacientes. Se registró diferencia significativa en el tiempo operatorio entre los pacientes con peso corporal < 80 Kg y los que superaban este valor. Las operaciones practicadas en los hombres fueron más prolongadas que las practicadas en las mujeres, tal vez por ser los hombres significativamente más pesados. Los tumores del lado izquierdo fueron más numerosos suprarrenales izquierdas tomó más tiempo, en promedio, pero tal diferencia no fue significativa.

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Invited Commentary

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Many conventional open techniques are available for adrenalectomy. The posterior extraperitoneal approach first described by Young in 1936 [1] was increasingly accepted for benign adrenal disease during the 1970s because of improved postoperative recovery. The breakthrough of laparoscopic technique reached adrenal surgery in 1992 [2]. Since then, the pendulum of adrenal surgery has swung toward the laparoscopic approach, which is starting to be accepted as the procedure of choice for benign adrenal disease. This approach represents a significant benefit in terms of patient recovery compared with open surgery.

Rutherford and colleagues reported 67 consecutive patients with unilateral transabdominal laparoscopic adrenalectomy performed over a 2-year period. This study represents one of the largest published series of laparoscopic adrenalectomies. The authors are to be congratulated for their zero conversion rate and low morbidity of 7.5% (5 of 67 patients). The authors also cited several interesting aspects in their article. The duration of the operation was significantly longer in male than in female patients, possibly related to the heavier body weight of male patients. Other parameters, such as the underlying pathology and the size of the tumors, are also envisaged to have an effect on operating time. The decrease in operating time with increasing experience of operating surgeons is valid. It is our belief that the morbidity rate will also decrease with increasing operating experience.

The authors also compared the results of laparoscopic and open adrenalectomy in terms of hospital stay. The mean hospital stay of 5.1 days in the present series coincided with the reported series on the posterior approach [3]. In our experience, which is similar to that of others, most patients can go home within 72 hours after laparoscopic adrenalectomy. Laparoscopic adrenalectomy should

show an improvement in other parameters, including analgesic requirement and time off work, because of the less traumatic effects on the patient.

It is worth mentioning that endoscopic retroperitoneal adrenalectomy is a new and safe alternative laparoscopic tool [4]. It minimizes the amount of dissection required, avoids intraabdominal complications, and allows bilateral adrenalectomy without repositioning the patients. It is still too early to make any definitive comparison between the two laparoscopic procedures, although it is likely that the operative time and complication rate are similar for two approaches.

It is interesting to note that the number of patients diagnosed with primary hyperaldosteronism has increased dramatically because of implementation of screening in all hypertensive patients. Eighteen patients (35%) were hypokalemic before operation, and CT scan localization was positive in only 38% of patients. This figure accounts for most of the patients being operated on and may revolutionize the diagnosis of this condition. However, the 45% cure rate was apparently not as good as the 60% to 90% reported cure rate in other series [5]. The pathology of the adrenal gland may be indirect evidence of a correct diagnosis that was not documented in the current series. The role of routine screening of primary hyperaldosteronism in hypertensive patients warrants further evaluation.

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