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Mini review

Section 3. Adrenal
Laparoscopic partial adrenalectomy

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Abstract

Since corticosteroids are indispensable hormones, partial or cortical-sparing adrenalectomies may be adopted for the surgical treatment of adrenal diseases. In this article, we describe the technique and results of these procedures. Laparoscopic partial or cortical-sparing adrenalectomy has been performed in 10 patients. Seven cases had an aldosterone-producing adenoma (APA) and three had a pheochromocytoma. Three cases with an APA and a case with a pheochromocytoma had tumors located far from the adrenal central vein, and the vein could be preserved. Four cases with an APA and two with a pheochromocytoma had tumors located close to the adrenal central vein, and it was necessary to section the central vein to resect them. All endoscopic procedures were performed successfully. There were no postoperative complications. At follow-up, adrenal ^{131}I-adosterol scintigrams showed the preservation of remnant adrenal function in all patients. Laparoscopic partial or cortical-sparing adrenal surgery was safely performed, and adrenal function was preserved irrespective of whether the adrenal central vein could be preserved or not. We consider this to be a useful operative technique for selected cases. © 2002 Éditions scientifiques et médicales Elsevier SAS. All rights reserved.

Keywords: Adrenelectomy; Partial resection; Cortical-Sparing surgery; Laparoscopy; Aldosterone-producing adenoma; Pheochromocytoma

1. Introduction

Since the first laparoscopic adrenalectomy was performed in 1992 [1], this approach has been adopted worldwide, and a large number of these operations have been performed. Multiple reports have demonstrated a decreased hospital stay, narcotics requirement, blood loss, and recovery time, and overall increased patient satisfaction [2-5]. Recently, improvements in diagnostic imaging techniques, such as magnetic resonance imaging and computed tomography (CT), have allowed us to detect small tumors in the adrenal gland, and intraoperative ultrasonography has enabled us to make the surgical margin clear and confirm that no tumor exists in the remnant adrenal gland. Since corticosteroids are indispensable hormones and adrenocortical deficiency, moreover, necessitates lifelong corticosteroid replacement, which entails the risk of Addisonian crisis [8-10], partial adrenalectomies or cortical-sparing adrenalectomies may be valuable.

In this article, we describe the technique and results of laparoscopic partial adrenalectomy for aldosterone-producing adenomas (APAs) and laparoscopic cortical-sparing surgery for pheochromocytomas.

2. Patients

Laparoscopic partial or cortical-sparing adrenalectomy has been performed in 10 patients at the Department of Surgery of Teikyo University Hospital.

These patients consisted of four men and six women ranging in age from 34 to 74 years (mean age: 47 years).

Seven cases had an APA and three had a pheochromocytoma. Three cases with an APA and a case with a pheochro mocytoma had tumors located far from the adrenal central

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vein, and the vein could be preserved. Four cases with an APA and two with a pheochromocytoma had tumors located close to the adrenal central vein, and it was necessary to section the central vein to resect them. In cases of pheochromocytoma, one had bilateral pheochromocytomas in MEN type 2A. Laparoscopic left cortical-sparing adrenalectomy and right adrenalectomy were performed in this case.

3. Surgical technique

Under general anesthesia, patients are placed in the lateral decubitus position with the affected side up. A skin incision approximately 1.2 cm in length is made above the umbilicus, and a 12-mm trocar is inserted under direct vision. Carbon dioxide is then insufflated to a pressure of 10 mmHg, and a flexible laparoscope is inserted through the trocar. When the tumor is located in the left adrenal gland, two additional trocars are inserted through the flank under laparoscopic visualization. A 12-mm trocar is placed inferior and slightly medial to the tip of the 11th rib, and a 5-mm trocar is inserted anterior and medial to the initial trocar. When the tumor is in the right adrenal gland, three additional 12-mm trocars are placed to perform the operation. Under laparoscopic visualization, the second trocar is inserted into the right flank inferior and slightly posterior to the tip of the 11th rib. The third and fourth trocars are placed more anteriorly, approximately 2 cm below the costal margin, with the most medial port positioned at the lateral border of the rectus abdominis muscle.

Endoscopic scissors are used for sharp dissection. The affected adrenal gland is then exposed, and intraoperative ultrasonography is performed with a laparoscopic probe (model EUP-OL 334, Hitachi Medical Corporation, Tokyo, Japan). After thorough examination of the entire adrenal gland and reconfirmation that the tumor is truly solitary, partial adrenalectomy or cortico-sparing adrenalectomy is performed. When another tumor is found in the adrenal gland during surgery, we must abandon these operations and total adrenalectomies should be performed.

3.1. Partial or cortico-sparing adrenalectomy without sectioning the adrenal central vein

When the tumor is located on the margin of the adrenal gland, the adrenal central vein can be preserved. Therefore, adequate venous drainage of the remaining adrenal tissue is sufficient to preserve the function of the remnant gland.

After identifying the tumor, the adrenal gland with tumor is exposed well from the retroperitoneal space. Then, partial adrenalectomy or cortico-sparing adrenalectomy is performed with a harmonic scalpel (HS; Ethicon Endo-surgery Inc., Cincinnati, OH) or a vascular stapler (endoscopic linear cutter, Ethicon Endo-surgery Inc., Cincinnati, OH), leaving at least a 5-mm margin from the tumor's edge (Fig. 1).

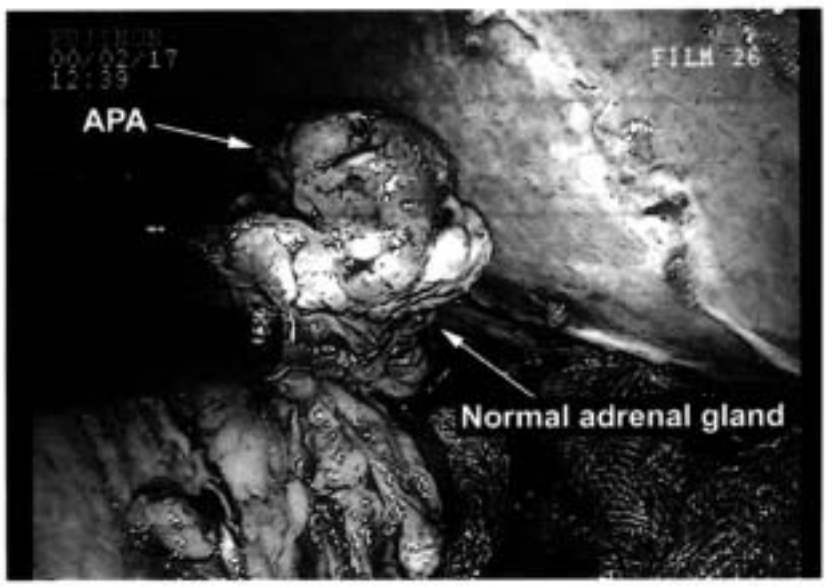

Fig. 1. Partial adrenalectomy for an aldosterone-producing adenoma (APA) is performed with a harmonic scalpel, leaving at least a 5-mm margin from the tumor's edge.

3.2. Partial or cortico-sparing adrenalectomy with sectioning of the adrenal central vein

When the tumor is close to the adrenal central vein, the vein must be divided (Fig. 2). It is important not to expose the remnant adrenal gland from the retroperitoneal space, because preservation of the drainage vein in the remnant adrenal gland is important for maintaining the function of the adrenal gland.

After identifying the adrenal central vein, it is clipped with a single-application clip applier (Ethicon Endo-surgery Inc., Cincinnati, OH) and sectioned. With the adrenal gland retracted upward, the tumor is exposed, and, leaving at least

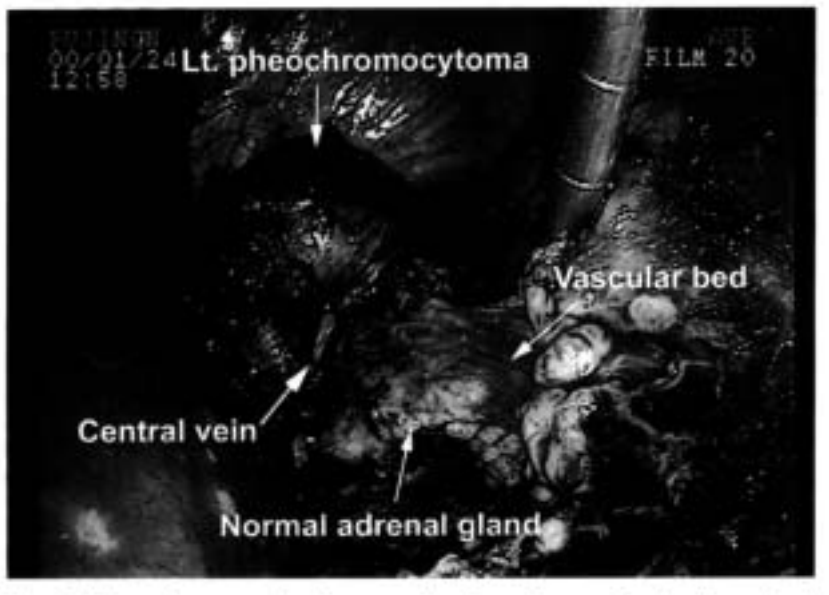

Fig. 2. When the tumor is close to the adrenal central vein, the vein is divided and cortical-sparing adrenalectomy is performed.

Table 1
Patients with aldosterone–producing adenoma

Case	1	2	3	4	5	6	7
Age	41	39	47	39	42	65	74
Sex	F	M	M	F	F	M	F
Operating Time (min)	155	150	121	133	121	120	130
Blood loss	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Tumor size[a] (mm)	22	18	20	30	25	20	20
Tumor location and cutting line							

[a] Maximal diameter of tumor

a 5-mm margin from the tumor's edge, partial adrenalec tomy or cortico-sparing adrenalectomy is performed with a HS or a vascular stapler.

The specimen is placed in a plastic bag (Endo Pouch, Ethicon Endo-surgery Inc., Cincinnati, OH) and removed through the 12-mm upper umbilical incision. Finally, the remnant adrenal gland is examined once again by laparoscopic ultrasonography to ensure that no tumor tissue remains in the gland.

4. Results

The operating time, estimated blood loss, tumor size, tumor location, and cutting line of partial or cortico-sparing adrenalectomy in each patient are summarized in Tables 1 and 2. None of the cases required conversion from laparoscopy to laparotomy. Blood pressure and heart rate were within normal limits throughout the operation, except during tumor manipulation. Hemostasis of the remnant adrenal gland was perfect in all cases. There were no postoperative complications.

The mean follow-up time in the patients with APA and pheochromocytoma has been 24 months (range: 6–36) and 33 months (range: 30–36), respectively. The serum aldosterone levels in the patients with APA and the catecholamine levels in the patients with pheochromocytoma returned to within their normal range.

The adrenal ^{131}I-adosterol scintigrams showed preservation of remnant adrenal function in all patients (Fig. 3).

5. Discussion

When partial or cortical-sparing adrenalectomy is performed, sufficient venous drainage is important. Preservation of the adrenal central vein allows good function of the remnant adrenal gland. When the adrenal central vein is divided, preservation of the vascular bed adjacent to the remnant adrenal gland is necessary for its irrigation and recovery of function. In these cases, procedures that do not expose the remnant adrenal gland from the retroperitoneal space are most important. Such delicate procedures are most accurately performed by laparoscopic techniques, because

Table 2
Patients with pheochromocytoma

Case	1	2	3
Age	30	34	62
Sex	F	F	F
Operating Time (min)	180	160	200
Blood loss	100	155	150
Tumor size[a] (mm)	53	45	50
Tumor location and cutting line			

[a] Maximal diameter of tumor

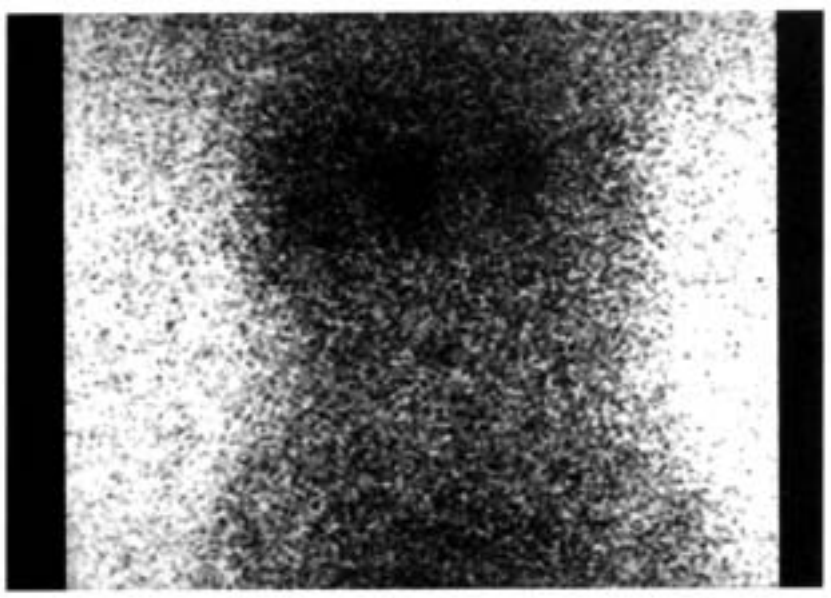

Fig. 3. The adrenal ^{131}I-adosterol scintigrams show preservation of remnant adrenal function in cases in which left partial adrenalectomy was performed with sectioning of the adrenal central vein.

the operative field is clearly visualized on a video monitor that allows high magnification of the surgical field.

Intraoperative ultrasonography is very useful and important for selecting the cases, since we can detect the location

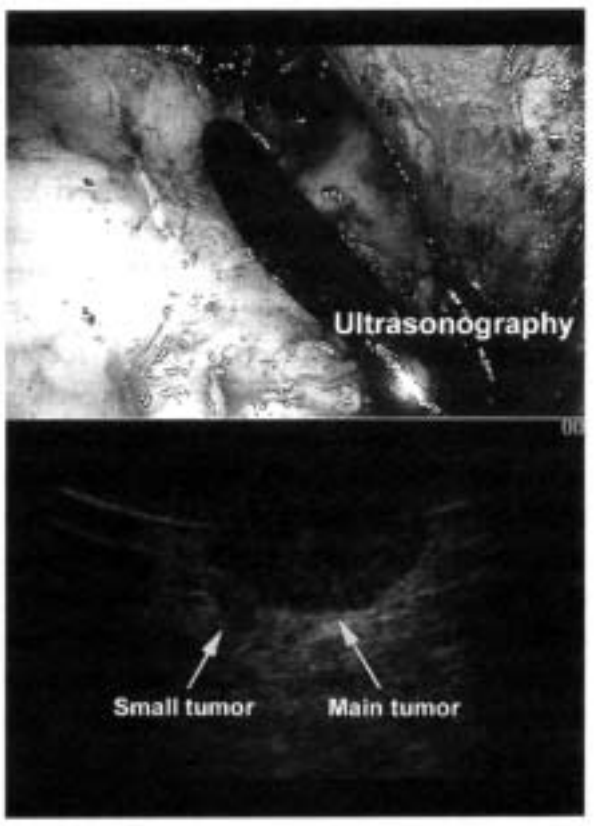

Fig. 4. Another 4-mm tumor is identified near the main tumor using intraoperative ultrasonography.

of the tumor and confirm that no tumor exists in the remnant adrenal gland. The resolution of intraoperative ultrasonography is high, and tumors of less than 5 mm diameter can be confirmed. In one patient, partial adrenalectomy was abandoned and changed to total adrenalectomy, since another 4-mm tumor was identified near the main tumor using intraoperative ultrasonography (Fig. 4).

Since enucleation of APAs yields the same outcome as total adrenalectomy [11], laparoscopic partial adrenalec tomy is indicated for these tumors. Among them, cases in which the tumor is removed without sectioning the adrenal central vein are best indicated, since adequate venous drainage of the remaining adrenal tissue is important in preserving the function of the remnant gland [12-14] and the procedure is easy to perform [12]. However, we have described the successful performance of laparoscopic partial adrenalectomy, including sectioning of the adrenal central vein, in patients with APA, and preservation of the function of the remnant adrenal gland was confirmed by ^{131}I-adosterol imaging in all patients [15]. Therefore, we consider laparoscopic partial adrenalectomy to be indicated for minute APAs whether the adrenal central vein is divided or not. Another good indication for partial adrenalectomy is weak-functioning adrenocortical adenoma, or the so-called preclinical Cushing syndrome. Because the attached adrenal gland in such a preclinical case is not so atrophic as in typical Cushing's syndrome, a partial adrenalectomy can be undertaken. A CT scan can reveal the adrenal abnormality very precisely [16]. When only a solitary tumor on the functioning side of the adrenal is detected, it is a candidate for partial adrenalectomy.

On the other hand, when the adrenal tumor is a pheochromocytoma in a carrier of the MEN type 2 gene, adrenal medullary disease is usually diffuse and bilateral at cellular level [6,7], and such cases have traditionally been treated by total bilateral adrenalectomy to prevent the risk of recurrence [7]. The postoperative adrenocortical deficiency, however, necessitates lifelong corticosteroid replacement, which entails the risk of Addisonian crisis [8-10]. Therefore, cortical-sparing surgery is recently being recommended, whether the adrenal central vein can be preserved or not. Although the postoperative function of the remnant adrenal gland is excellent for the cases without sectioning of the adrenal central vein, adequate postoperative function was not obtained immediately after cortical-sparing surgery with sectioning of the adrenal central vein. The venous drainage of the remnant adrenal gland was insufficient. However, the function of the remnant adrenal gland was gradually recovered, and corticosteroid replacement therapy was tapered and stopped after a while.

Tumor manipulation during pheochromocytoma surgery is complex, and the patients have to tolerate prolonged hypertensive attacks [17-19], and the risk of hypertensive attack during cortical-sparing surgery is even greater than during total adrenalectomy. Therefore, the control of patients' blood pressure using α-blockers is important. The blood pressure and heart rate of all of our three pheochromocytoma patients were within normal limits throughout the operations. The delicate procedure could be performed safely and easily without any complications in endoscopic surgery.

Laparoscopic partial or cortical-sparing adrenal surgery was safely performed, and adrenal function was preserved. We consider this to be a useful operative technique for selected cases.

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