


Case Report

Two-step technique of early adrenal artery ligation in open adrenalectomy of giant right adrenal pheochromocytomas: Three case reports

Atsuhiko Ochi,¹  Bo Fan,¹ Natsuo Kimura,¹ Hisaki Watanabe,¹ Sari Toki,¹ Wataru Fukuokaya,¹ Daigo Okada,¹ Koichi Aikawa,¹ Tingwen Huang,¹ Koichiro Suzuki,¹ Naoki Shiga,¹ Yasuhide Kitagawa² and Hirokazu Abe¹

¹Department of Urology, Kameda Medical Center, Kamogawa, Chiba, and ²Department of Urology, Komatsu Municipal Hospital, Komatsu, Ishikawa, Japan

Abbreviations & Acronyms

AA = adrenal artery
AV = adrenal vein
CT = computed tomography
IVC = inferior vena cava
PCC = pheochromocytoma
RA = renal artery
VA = ventral aorta

Correspondence: Atsuhiko Ochi M.D., Department of Urology, Kameda Medical Center, 929 Higashi-cho, Kamogawa City, Chiba 296-8602, Japan. Email: ochi.atsuhiko@gmail.com

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

Received 1 October 2018;
accepted 27 October 2018.
Online publication 12 November 2018

Introduction: Surgical manipulation of a pheochromocytoma carries the risk of releasing catecholamines into bloodstream leading to severe intraoperative hypertension.

Case presentation: We present three patients with right adrenal pheochromocytoma over 10 cm diameter: a 40-year-old woman, 63-year-old man, and 66-year-old woman. They were diagnosed by 123I-MIBG scintigraphy and received preoperative antihypertensive treatment with 16 mg/day of doxazosin. Open adrenalectomy was performed with early right adrenal artery ligation between the inferior vena cava and ventral aorta (Step 1) as well as between the tumor and upper pole of the right kidney (Step 2). There was no severe intraoperative hypertension, and no recurrence was observed over 33 months, postoperatively.

Conclusion: Early adrenal artery ligation may stop tumor blood supply and significantly reduce the catecholamine release. Our technique was thought to be safe and useful for preventing severe intraoperative hypertension in giant right adrenal pheochromocytoma.

Key words: adrenal artery, adrenal vein, catecholamine, giant pheochromocytoma, open adrenalectomy.

Keynote message

Early AA ligation between the IVC and VA (Step 1) as well as between the tumor and the upper pole of the right kidney (Step 2) in giant right adrenal PCC is a safe open surgical procedure and aids tumor dissection without severe intraoperative hypertension.

Introduction

PCC is a rare catecholaminergic tumor with a prevalence of 0.1–0.6% in hypertension patients, derived from chromaffin cells of the adrenal medulla (80–85%) or the extra-adrenal paraganglia (15–20%).¹ Some PCCs are malignant, and release catecholamines that cause high blood pressure, which can sometimes cause paroxysmal hypertension or lethal cerebrovascular and cardiovascular disorders, so that complete resection is necessary.^{2,3} However, tumor dissection is difficult because intraoperative manipulation of a PCC causes catecholamines to be released into the bloodstream leading to severe intraoperative hypertension. Although both open and laparoscopic approaches have been used, the optimal procedure has not been standardized for safe dissection in a large PCC, especially in those over 10 cm in diameter.³ Here, we present three patients with right adrenal giant PCC who underwent open adrenalectomy along with the procedure of early AAs ligation, and in whom the tumor was successfully removed without severe intraoperative hypertension.

Case presentation

We present three cases of PCC: a 40-year-old woman, a 63-year-old man, and 66-year-old woman. The characteristics of the patients are shown in Table 1. The maximum diameter of the right adrenal tumor exceeded 10 cm in all patients. Urinary fractionated norepinephrine and metanephrine were high in two patients, and dopamine was high in one patient. Clinical diagnosis of PCC was made by uptake findings on 123I-MIBG scintigraphy, and CT showed no metastasis. Some AAs were recognized on contrast-enhanced CT (Fig. 1). The patients received preoperative antihypertensive treatment with 16 mg/day of doxazosin.

Surgical procedures were performed as follows. The patients were placed in the supine position under general endotracheal anesthesia. A midline incision was made from the xiphoid process to the umbilicus, and subsequently a transverse incision to the right lateral region (reversed L-shaped incision) was used to reach the peritoneal cavity. A self-retaining retractor was used, followed by dissection of the round ligament and falciform ligament of the liver. The mobilization of the colon and duodenum was performed to obtain complete visualization of the IVC and right side of the VA. After keeping the left renal vein and right RA between the IVC and VA, the connective tissue containing the right AAs was ligated (Fig. 2a) until the right side of the aortic hiatus was visualized (Step 1; Fig. 2b). If necessary, short hepatic veins were dissected and the liver was lifted to the head side. Next, pulling the right kidney to the caudal side, the connective tissue containing the right AAs from the RA was ligated between the tumor and the upper pole of the right kidney (Step 2; Fig. 2c). These procedures were performed without any pressure on the tumor. Following this, direct manipulation of the tumor did not induce

Table 1 Patient characteristics

Variables	Case 1	Case 2	Case 3
Age (years)	40	63	66
Sex	Female	Male	Female
Body mass index (kg/m ²)	24.9	25.1	22.7
Preoperative hypertension	Absent	Present	Absent
Tumor size (cm)	10.4 × 8.8	10.2 × 8.2	11.0 × 7.0
Preoperative urinary catecholamines			
Epinephrine (μg/day)	26.6	10.1	9.5
Norepinephrine (μg/day)	374.5	378.6	124.5
Dopamine (μg/day)	675.1	1355.7	58635.0
Metanephrine (mg/day)	0.96	0.23	0.17
Normetanephrine (mg/day)	13.2	11.7	0.26
Uptake on 123I-MIBG scintigraphy	Present	Present	Present
Preoperative medication: doxazosin (mg/day)	16	16	16

severe hypertension and it could be detached from the surrounding fat; the right central AV was ligated, and the tumor was removed.

Surgical and postoperative outcomes are shown in Table 2. Maximal systolic blood pressure was below 150 mmHg during the operation in all patients, and perioperative complications including hypotension were not observed. Pathological analysis revealed PCC, and the surgical margins were negative. No recurrence was observed during 33–50 months postoperatively.

Discussion

Direct surgical manipulation of the PCC causes the extrusion of tumor containing catecholamines into the bloodstream and leads to a sudden rise in the blood pressure. Severe intraoperative hypertension may force the surgeons to interrupt the surgical

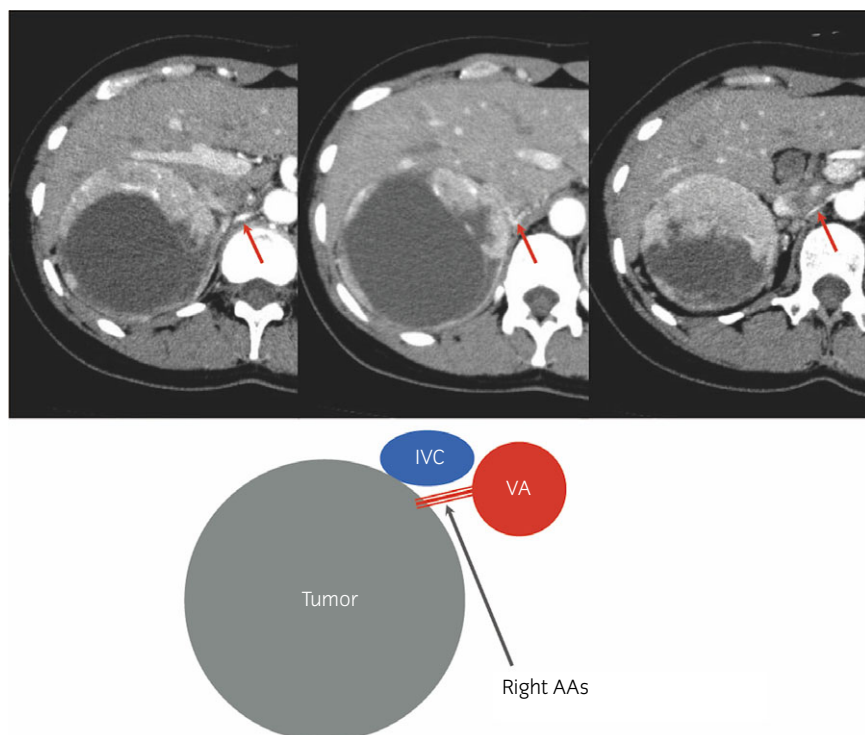


Fig. 1 Enhanced CT scan showing the AAs behind the IVC (red arrows).

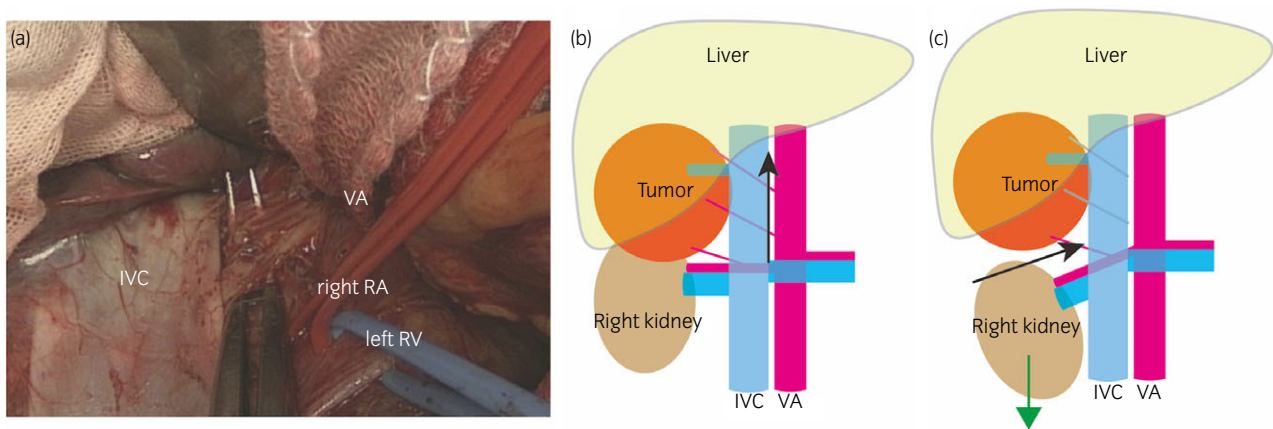


Fig. 2 (a) The connective tissue contained the right AAs from the VA. (b) The schema of right AA ligation between the IVC and the VA (black arrow). (c) The schema of right AA ligation between the tumor and the upper pole of the right kidney (black arrow). The right kidney was pulled to the caudal side (green arrow).

Table 2 Surgical and postoperative outcomes

Variables	Case 1	Case 2	Case 3
Operative time (minutes)	297	268	180
Estimated blood loss (mL)	390	600	230
Blood transfusion (mL)	None	None	280
Maximal systolic blood pressure (mmHg)	150	140	150
Perioperative complications	None	None	None
Follow-up period (months)	49	50	33
Tumor recurrence	None	None	None

procedure until the blood pressure is normalized.⁴ Traditionally, early AV ligation has been recommended for the laparoscopic adrenalectomy of PCC to reduce the release of excessive catecholamines.^{5,6} However, favorable results have been reported in laparoscopic adrenalectomy, where the adrenal tumor was dissected without previous ligation of the AV. Zhang *et al.* speculated that fine accurate manipulation of the tumor without direct pushing or grasping—the “no-touch technique”—could be safely performed before the ligation of the AV.⁷ Wu *et al.* have also described that prior control of AV is not a determining factor for dangerous hypertension.⁸ Their study demonstrated that there was no statistically significant difference in either blood pressure fluctuation or concentration of plasma catecholamines during laparoscopic adrenalectomy, between the two groups of early or late AV ligation. However, regardless of laparoscopic or open surgical approach, both dissecting a large PCC without touching as well as ligating the AV first may be difficult, especially the right central AV which usually flows into the IVC at the deep head side of the tumor.

The right AAs are divided into three groups: superior, middle, and inferior. The superior AAs branch from the inferior phrenic artery, and the middle and inferior AAs branch from the VA and the RA, respectively.⁹ The central AV is the main vein of the adrenal gland. Some other veins from the adrenal gland have been reported: the emissary vein which communicates with the renal capsule vein, the concomitant

veins which run to the inferior phrenic vein, the renal capsule vein, and portal system.¹⁰ As such, the blood supply of the right AAs mainly comes from the inner sides, but blood flows out not only via the central AV but also through other veins to the outer sides.

Therefore, in the operation of adrenal PCCs, early central AV ligation alone is inadequate to prevent excess catecholamines from flowing into the circulation. In the present report, the arteries recognized on preoperative enhanced CT (Fig. 1) were thought to be the superior and middle AAs, and our procedure might contribute to stop blood flow at the region between the IVC and the VA (Step 1). Moreover, the dissection of the connective tissue between the tumor and the upper pole of the right kidney might stop blood flow from the inferior AAs (Step 2). The blood supply of the tumor may be stopped by these procedures, and extremely reduce the catecholamines released from the tumor through the surrounding venous communications. These procedures can be performed without touching the tumor. Therefore, our technique can be effective when the tumor is very large and difficult to resect with laparoscopic surgery. It is also conceivable that our technique could be useful when conversion to open surgery is necessary.

In conclusion, although further study with more patients is required, our technique was thought to be safe and useful for preventing severe intraoperative hypertension in giant right adrenal PCC.

Conflict of interest

The authors declare no conflict of interest.

Disclosure

The protocol for this research project has been approved by a suitably constituted Ethics Committee of the institution and it conforms to the provisions of the Declaration of Helsinki. Committee of Kameda Medical Center, Approval No. 18-095. All informed consent was obtained from the subjects.

References

- 1 Lenders JW, Eisenhofer G, Mannelli M, Pacak K. Pheochromocytoma. *Lancet* 2005; **366**: 665–75.
- 2 Zuber SM, Kantorovich V, Pacak K. Hypertension in pheochromocytoma: characteristics and treatment. *Endocrinol. Metab. Clin. North Am.* 2011; **40**: 295–311.
- 3 Tsirlin A, Oo Y, Sharma R, Kansara A, Gliwa A, Banerji MA. Pheochromocytoma: a review. *Maturitas* 2014; **77**: 229–38.
- 4 Hodin R, Lubitz C, Phitayakorn R, Stephen A. Diagnosis and management of pheochromocytoma. *Curr. Probl. Surg.* 2014; **51**: 151–87.
- 5 Fernandez-Cruz L, Taura P, Saenz A, Benarroch G, Sabater L. Laparoscopic approach to pheochromocytoma: hemodynamic changes and catecholamine secretion. *World J. Surg.* 1996; **20**: 762–8.
- 6 Salomon L, Rabii R, Soulie M *et al.* Experience with retroperitoneal laparoscopic adrenalectomy for pheochromocytoma. *J. Urol.* 2001; **165**: 1871–4.
- 7 Zhang X, Lang B, Ouyang JZ *et al.* Retroperitoneoscopic adrenalectomy without previous control of adrenal vein is feasible and safe for pheochromocytoma. *Urology* 2007; **69**: 849–53.
- 8 Wu G, Zhang B, Yu C *et al.* Effect of early adrenal vein ligation on blood pressure and catecholamine fluctuation during laparoscopic adrenalectomy for pheochromocytoma. *Urology* 2013; **82**: 606–11.
- 9 Packiam V, Hatcher D, Shalhav A. Robotic, laparoscopic, and open approaches to the adrenal gland (benign). In: Smith Jr JA, Howards SS, Preminger GM *et al.* (eds). *Hinman's Atlas of Urologic Surgery (4th edition)*. Elsevier, Philadelphia, 2017; 253–68.
- 10 Mikaelsson CG. Venous communications of the adrenal glands. Anatomic and circulatory studies. *Acta. Radiol. Diagn. (Stockh)*. 1970; **10**: 369–93.