

The Long-term Effect of Adrenal Arterial Embolization for Unilateral Primary Aldosteronism on Cardiorenovascular Protection, Blood Pressure, and the Endocrinological Profile

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Abstract

Primary aldosteronism (PA) is a major cause of secondary hypertension, divided into two subtypes: unilateral and bilateral. Unilateral PA (u-PA) is surgically-curable. Medical treatment with mineralocorticoid receptors antagonists is recommended as a second-line treatment when the patients are not candidate for surgical treatment. The present case was a 39-year-old woman with u-PA, who had refused surgery, had suffered from adverse effects of medical treatment. She was treated with transcatheter adrenal arterial embolization (TAAE). Her blood pressure had been well controlled without progression of cardiorenovascular damage for 12 years. TAAE can be the third treatment option for u-PA patients.

Key words: primary aldosteronism, adrenal arterial embolization

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Introduction

Primary aldosteronism (PA) is a major cause of secondary hypertension, and it accounts for 5-10% of all causes of hypertension (1). In addition, excess aldosterone has an adverse cardiorenovascular effect (2). PA patients have a higher incidence of cardiorenovascular complications compared to those with essential hypertension (3-11). PA is divided into two subtypes: unilateral and bilateral. The first-line treatment of unilateral PA is laparoscopic adrenalectomy (12, 13). However, some patients are unwilling or unable to undergo surgery. Transcatheter adrenal arterial embolization (TAAE) using ethanol as a nonsurgical therapy for APA had been performed. TAAE for endocrinologically active adrenal tumors is a minimally invasive procedure that can be used to suppress excess adrenal hormone production (14). In some previous reports, TAAE had been used

for PA patients refusing surgery or at high risk of surgical complications. There have, however, been few reports regarding the long-term effects of TAAE on cardiorenovascular protection, blood pressure, and the endocrinological profile. We herein report a case of unilateral PA without progressive cardiorenovascular damage and normalization of the blood pressure and serum potassium level by TAAE.

Case Report

A 39-year-old Japanese woman was introduced to our hospital in 1996 for severe hypertension of 5-year duration. She had been treated with antihypertensive drugs, sometimes more than 3 simultaneously, however, she had had a poorly controlled blood pressure (BP). Her BP was 202/106 mmHg on amlodipine (5 mg/day). The laboratory data demonstrated hypopotassemia (3.3 mEq/L). The plasma renin activity (PRA) was less than 0.2 ng/mL/h, and the plasma aldoste-

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Table 1. The Results of Adrenal Venous Sampling in 1997 and 2008.

1997	IVC	Right adrenal vein	Left adrenal vein
PAC(pg/mL)	172	219	583
Cortisol(ug/dL)	19	21	>80
A/C	9.1	10.4	<7.3
2008	IVC	Right adrenal vein	Left adrenal vein
PAC(pg/mL)	124	15,300	3,180
Cortisol(ug/dL)	13	541	366
A/C	9.5	28.3	8.7

A/C: PAC/Cortisol ratio which is used to determine the lateralization of aldosterone overproduction

rone concentration (PAC) was 209 pg/mL with an aldosterone to renin ratio (ARR) of more than 1,045 in the spine position. The patient's plasma ACTH (32 pg/mL) and cortisol levels (6 µg/dL) were within the normal ranges and there was normal diurnal change of plasma cortisol (4 µg/dL at 24:00). The plasma and urinary catecholamine levels were normal. The diagnosis of PA was confirmed by a furosemide and upright posture test and a rapid ACTH stimulation test. The PRA remained suppressed (0.3 ng/mL/h) after the furosemide and upright posture test. The PAC was 465 pg/mL, and plasma cortisol was 22 µg/dL with a PAC to cortisol ratio of 21 after the rapid ACTH stimulation test. Abdominal computed tomography (CT) imaging revealed a 3 mm right-sided adrenal tumor and no lesions in the left adrenal gland. Single helical CT was performed with 3 mm beam thickness and 3 mm/rot table feed. Adrenal venous sampling (AVS) was performed in 1997 (Table 1). At that time, right adrenal vein catheterization was unsuccessful. The contralateral suppression ratio, which is the PAC to cortisol ratio of the non-tumor side-adrenal vein/the PAC to cortisol ratio of the inferior vena cava, was less than 1. This suggested suppressed aldosterone production from the left adrenal gland due to the overproduction of aldosterone from the right adrenal gland. According to these findings, we diagnosed the patient with right-sided unilateral PA. Urinary albumin excretion increased (79 mg/g·Cr) and left ventricular hypertrophy (Cornell product: 2,730 mm·msec) was observed. She would not undergo right adrenalectomy. Medical treatment with spironolactone (50 mg/day) was initiated. Her BP was well controlled, however, mastodynia occurred as a side effect of spironolactone treatment. The change of spironolactone elevated the patient's BP. In 1997, TAAE using ethanol was performed for right unilateral PA, rather than adrenalectomy and medical treatment, in order to reduce the aldosterone level as well as the BP.

The inferior suprarenal artery from the renal artery was identified as the feeding artery of the right adrenal mass by enhanced CT and angiography. Approximately 0.3 mL of absolute ethanol was administered to the inferior suprarenal artery slowly as a single injection by hand. Immediately after embolization, the BP increased to 260/100 mmHg and premature ventricular contraction appeared, but transiently. Finally, embolization of the tumor was confirmed by CT imaging with the retention of contrast media in the mass. She

had complained of a headache and right flank pain for one week after TAAE. However, her BP decreased to a normal level and the serum potassium level normalized. Although the PAC decreased to approximately 100 pg/mL from 200 pg/mL, the PRA remained suppressed and the ARR remained over 200. Two weeks after TAAE, abdominal CT demonstrated that the density of the right adrenal mass changed had decreased, and three weeks after TAAE, the mass disappeared. During the first three years after TAAE, the patient's BP remained within the normal range without antihypertensive drugs (Fig. 1). In 1998, the PAC and serum potassium level remained in the normal ranges, however, her BP gradually increased. In 1999, she was prescribed a calcium channel blocker (nilvadipine 4 mg/day) and her BP remained in the normal range for approximately ten years. In 2008, her BP increased to more than 140/90 mmHg at home, the PAC elevated to 250 pg/mL and the PRA was 0.2 ng/mL/h in the supine position. The PAC was 107 pg/mL and the PRA was less than 0.1 ng/mL/h after the captopril challenge test. Abdominal CT revealed multiple nodules in the left adrenal gland and no findings in the right (Fig. 2). She underwent AVS again. AVS demonstrated the overproduction of aldosterone from the right adrenal gland (Table 1). Recurrence of PA was confirmed. However, the serum potassium level had remained within the normal range for 12 years after TAAE. UAE decreased from 79 to 18 mg/g·Cr. The Cornell product also decreased from 2,730 to 1,978 mm·msec. During the 12-year period after TAAE, the patient had gained weight and her body mass index (BMI) increased from 23.6 to 24.8 kg/m². Her HbA1C elevated from 4.6% to 6.5% (Table 2) and 75 g OGTT demonstrated a diabetic pattern. She was also diagnosed with a fatty liver according to the findings of abdominal ultrasonography. There were no clinical findings for the progression of other organ damage. Medical treatment with a low dose of SP (25 mg/day) was reinitiated and her BP has been controlled without an adverse effect of mastodynia.

Discussion

Unilateral adrenalectomy has been the most reliable method to cure patients with unilateral PA, such as aldosterone producing adenoma (APA). Furthermore, due to the recent improvement in surgical techniques, laparoscopic

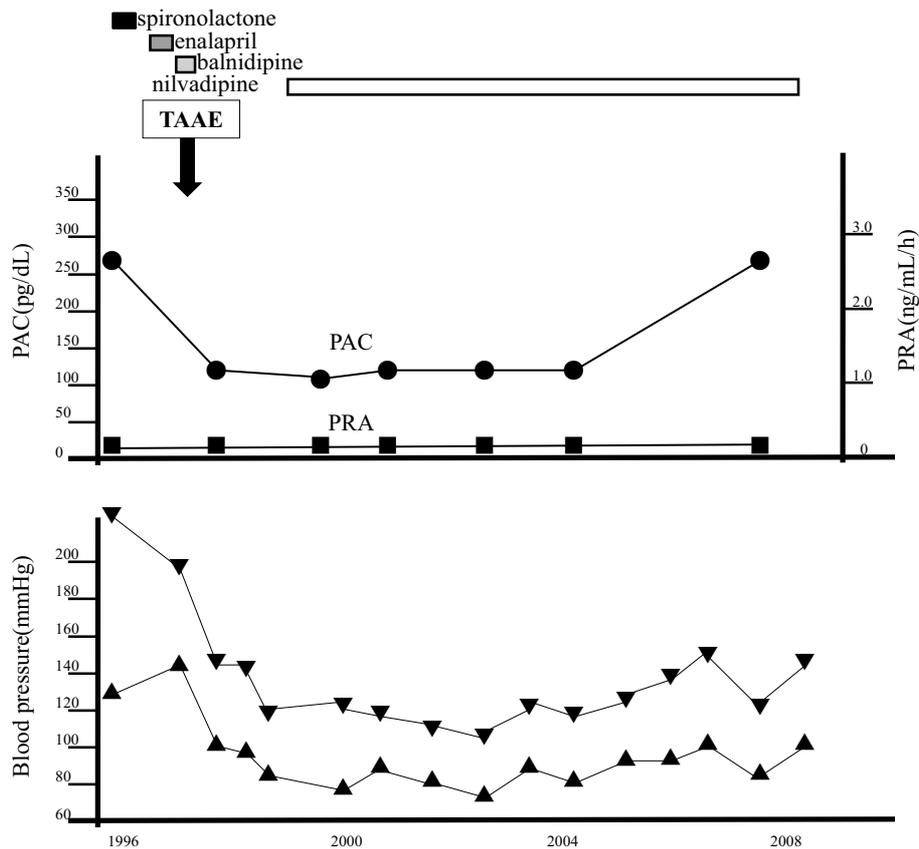


Figure 1. Clinical course after TAAE.

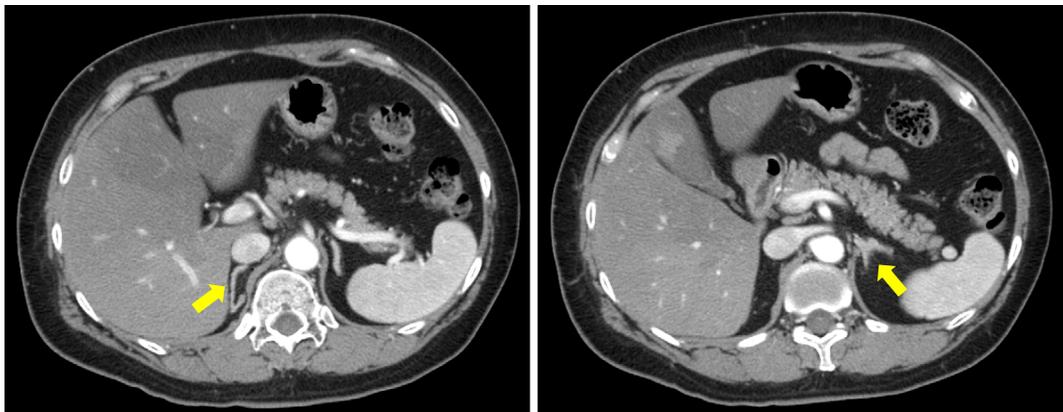


Figure 2. Abdominal CT scan in 2008 showed no right-sided adrenal tumor and left-sided adrenal nodular lesion (yellow arrows).

adrenalectomy is a less invasive procedure that can be performed in many hospitals (15-17). However, some PA patients are unable or unwilling to undergo surgery. According to the guideline of the Japan Endocrine Society and the Endocrine Society, medical treatment with MR antagonists is recommended for patients with unilateral PA who are unable or unwilling to undergo surgery (12, 13). Two types of MR antagonists, i.e., SP and eplerenone (EP), are currently available for the treatment of unilateral PA instead of surgery. SP often causes adverse effects. EP causes less adverse effects than SP, however, it was unavailable until 2007 in Japan. Moreover, the Japanese Pharmaceutical Affairs Law does not

allow the use of EP at a dose greater than 100 mg daily. EP treatment often requires additional antihypertensive agents. Therefore, a third treatment option is required for some patients with unilateral PA.

Mathias et al. first reported catheter intervention for APA (18). Their patient was thought to have high surgical risks and side effects following antihypertensive drug use. They performed transcatheter venous embolization, and their patient's BP was well controlled for twelve months with only one class of antihypertensive drug after the intervention. Hakotate et al. performed a clinical study comprising 33 cases of APA (tumor size ranging from 8 to 30 mm in

Table 2. Laboratory Data on Admission in 1997 and 2008.

Biochemistry	1997	2008		1997	2008
TP (g/dL)	7.5	7.7	T-Cho (mg/dL)	173	205
Alb (g/dL)	4.7	4.7	HDL (mg/dL)	31	43
T-Bil (mg/dL)	0.3	0.7	TG (mg/dL)	210	177
AST (U/L)	10	23	FPG (mg/dL)	93	137
ALT (U/L)	10	36	HbA1c (JDS, %)	4.3	6.5
LDH (U/L)	276	176			
ALP (U/L)	135	211			
Na (mEq/L)	138	140			
K (mEq/L)	3.5	4.0			
Cl (mEq/L)	101	103			
Ca (mg/dL)	10.2	10.2			
P (mg/dL)	4.1	3.4			
BUN (mg/dL)	9	12			
Cr (mg/dL)	0.5	0.4			

Complete Blood Counts		1997	2008
WBC (/ μ L)		5,500	3,950
RBC ($\times 10^6$ / μ L)		4.18	4.07
Hb (g/dL)		13.1	12.7
Ht (%)		38.7	36.8
Plt ($\times 10^4$ / μ L)		253	242

TP: Total Protein, Alb: Albumin, T-Bil: Total Bilirubin, AST: Aspartate Transaminase, ALT: Alanine Aminotransferase, LDH: Lactate Dehydrogenase, ALP: Alkaline Phosphatase, BUN: Blood Urea Nitrogen, Cr: Creatinine, T-Cho: Total Cholesterol, HDL: High Density Lipoprotein, TG: Triglyceride, FPG: Fasting Plasma Glucose, HbA1c: Hemoglobin A1c, WBC: White Blood Cells, RBC: Red Blood Cells, Hb: Hemoglobin, Ht: Hematocrit, Plt: Platelets

diameter) treated with TAAE (19). They defined primary success as the persistence of the PAC and PRA within the normal ranges for a follow-up period of longer than 6 months. The primary success rate was 82% (27/33 PA patients). Their patients had no severe complications and were followed up for a median of 45 months (range=8-94). Nine patients had normalized BPs after embolization and 10 had reduced BPs. However, the improvement of the cardiorenovascular damages by TAAE was not evaluated in their study.

It is unclear whether TAAE resulted in complete remission in the present case, however, it was considered to achieve partial remission at least, judging from the reduction of the aldosterone level and the disappearance of the adrenal mass on CT imaging. The period of BP normalization in the present case was only observed in the first three years, however, the BP was controlled using only one class of antihypertensive drug during the last 9 years. Even after the confirmation of PA recurrence in 2008, the patient's serum potassium level was still within the normal range and the BP could be controlled by a low dose of SP without side effects. This suggests that the severity of PA after recurrence might be lower than before TAAE. PA patients have a high risk of cardiorenovascular disease compared to EHT patients (3-11). Milles et al. reported that PA patients experienced more cardiovascular events than EHT patients independent of the BP (5). In the present case, the increased UAE and LVH improved and no other organ damage was observed during this period, although her body weight and BMI had increased, and she developed diabetes and fatty liver when PA recurred. The reduction of the aldosterone level appeared to prevent the progression of cardiorenovascular damage. TAAE may be a third treatment option for unilateral PA patients who are not suitable for adrenalectomy or MR antagonist treatment.

The long-term recurrence rate of PA after TAAE remains unknown. Hakotate et al. have defined recurrence as rein-

creased plasma aldosterone levels higher than the normal range and resuppressed renin activity for more than 6 months after TAAE (19). Using their criteria, the recurrence rate of their patients was 3% (1/33) during the observational period (median =45 months; range 8-94 months). However, their criteria were not sufficient for diagnosing PA. To diagnose PA correctly, confirmatory tests are needed. According to the guideline of the Japanese Society of Hypertension, the captopril challenge test, furosemide and upright test, saline infusion test and oral sodium loading test are recommended (20). In the present case, the patient was diagnosed with current unilateral PA 12 years after undergoing TAAE by the captopril challenge test.

There have been few reports regarding the recurrence of PA. One treatment of TAAE may be insufficient to ablate all tumor cells in the present case, and if so, then the remaining tumor cells can proliferate. There is the possibility of multiple lesions of APA. Shigematsu et al. demonstrated multiple, highly active aldosterone production nodules, not only in unilateral adrenal hyperplasia, but also in adjacent tissues of APA (21). Even in the case of surgical treatment, Calvo-Romero et al. reported a case with recurrence in the ipsilateral adrenal gland after partial unilateral adrenalectomy (22). These findings suggest that patients with TAAE must be carefully followed up.

In summary, TAAE for unilateral PA in the present case was effective for BP control and the prevention of organ damage. Catheter interventions, such as TAAE, may be a third treatment option for unilateral PA patients who are unsuitable for adrenalectomy or MR antagonist treatment, even though the benefits may only be temporary.

The authors state that they have no Conflict of Interest (COI).

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