

Detection of adrenal veins on selective retrograde CT adrenal venography in comparison with digital subtraction angiography in subjects with established diagnosis of one-sided adrenal aldosterone-producing tumor confirmed by adrenal vein sampling, histopathology and clinical course



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ABSTRACT

Purpose: Adrenal vein (AV) sampling (AVS) is the diagnostic gold standard for primary aldosteronism (PA), but right-sided AVS is difficult. We compared detection of AVs by selective retrograde CT adrenal venography (SRCTAV) with digital subtraction angiography (DSA).

Materials and methods: Data on 29 subjects (11 males, mean age 55 y) with increased serum aldosterone concentrations (SAC) and a diagnosed right or left aldosterone-producing tumor (APT) by AVS who underwent laparoscopic adrenalectomy were retrospectively analyzed. Before AVS, visualizing AVs was attempted by DSA and SRCTAV (Aquilion). If after the adrenocorticotropic hormone loading test serum cortisol concentration (SCC) from either AV was >200 µg/dl, AVS was considered successful. If the SAC/SCC ratio for one side was ≥4 times higher than the other side, we diagnosed a one-sided APT.

Results: Left and right AV, respectively, were visualized in 29 (100%) and 22 subjects (76%) by DSA and 29 (100%) and 28 subjects (97%) by SRCTAV, with right-AV detection significantly higher by SRCTAV ($p < 0.05$). Cannulations were regarded successful in 28 subjects having both AVs observed on SRCTAV but not in the remaining subject whose adrenocortical scintigram was positive, however. Adrenalectomy was performed with a diagnosis of adenoma. Among 28 subjects with successful AVS, histopathological diagnoses included adenoma (25), nodular hyperplasia (2) and normal (1). After adrenalectomy, antihypertensive drug usage in 28 patients was reduced or stopped with decreases in SAC (97%).

Conclusions: Detection of AV was significantly higher by SRCTAV than DSA, especially on the right side, in 29 subjects diagnosed with one-sided APT.

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1. Introduction

Primary aldosteronism (PA) was first reported by Conn and Louis as the association of an adrenal cortical adenoma with hypertension, hypokalemia, and excessive urinary excretion of aldosterone [1]. It was thought to be a rare cause of arterial hypertension with a

prevalence of less than 1% among hypertensive patients. However, recently, the ratio of serum aldosterone concentration to plasma renin activity has been considered to be a useful screening test in the differential diagnosis of essential hypertension and PA [2]. Therefore, the need for adrenal vein sampling (AVS) has increased due to the realization that PA is more prevalent than previously believed. At present, PA is thought to be the most common form of secondary hypertension with its prevalence thought to range from 4.6% to 22% of hypertensive populations [3].

Because it was recently demonstrated that individuals with PA tended to have cardiovascular complications, damage to target organs, and metabolic syndrome with higher frequency than age- and

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sex-matched hypertensive subjects [4–6], an accurate diagnosis of PA should be considered essential.

Furthermore, in patients with PA, the accurate diagnosis of whether there is unilateral or bilateral autonomous production of aldosterone is important because treatment would differ between the two. For example, surgical adrenalectomy would be performed for cases in which production of aldosterone was unilateral and drug treatment would be administered to those with bilateral autonomous production of aldosterone. AVS from both adrenal veins (AVs) is considered the only reliable technique to distinguish between unilateral and bilateral autonomous productions of aldosterone [7–11]. However, AVS is an invasive and difficult technique. Right-sided AVS is especially difficult because the right AV is small and is difficult to distinguish from other vessels that may arise from the posterior wall of the inferior vena cava, such as the hepatic vein or right renal vein. Furthermore, the success of AVS is based on results of serum cortisol concentration (SCC) determined by the hormone loading test. However, these results are not immediately available since analyses are performed outside the institution. Therefore we cannot judge whether AVS has been successful during the examination. If failure of AVS occurs on either or both sides, information cannot be gained from the procedure, which must then be repeated. Therefore, improvement in the accurate detection of AVs before AVS is very important.

In this study, we compared detection rates of AVs by selective retrograde CT adrenal venography (SRCTAV) with those by digital subtraction angiography (DSA), both of which were performed just before AVS in subjects with an established diagnosis of either a right- or a left-sided aldosterone-producing tumor (APT) confirmed by histopathology of the extracted adrenal gland by adrenalectomy.

2. Materials and methods

Data on 29 subjects (11 males, mean age 55 y) with increased serum aldosterone concentrations (SAC) and a diagnosis of a right or a left APT based on AVS who underwent laparoscopic adrenalectomy were retrospectively analyzed. Written informed consent was obtained from all the subjects for all examinations.

Before AVS, visualization of the AV was attempted on SRCTAV in addition to DSA by radiologists and endocrinologists who were not AVS specialists and whose experience in the AVS procedure was less than 10 patients at the beginning of the study period. Thirty minutes after the adrenocorticotropic hormone loading test, if the SCC acquired from both the left and right AV was more than 200 µg/dl, AVS was regarded as successful. If the SAC:SCC ratio on one side was ≥ 4 times that on the other side, we made a diagnosis of a one-sided APT.

2.1. DSA and SRCTAV protocol

AVs were catheterized percutaneously via the femoral vein using a 5 French sheath introducer, and a specific catheter for the AV on each side was used. When the catheter was cannulated into an AV, DSA was performed with manual injection of contrast material followed by SRCTAV (Fig. 1). Selective multidetector row CT (MDCT) angiography (Aquilion, 4 slice, Toshiba Medical) with an invasive angiographic system was performed with a helical scan. A total of 10–15 ml of contrast material was injected at a rate of 1.5–2.0 ml/s. Detection of the AV on SRCTAV was regarded as successful when the adrenal gland was simultaneously enhanced with the AV or visualization of the vein in the adrenal gland could be confirmed (Fig. 2).

If detection of the AV was confirmed as successful on SRCTAV, AVS was performed using the free-fall method before and 30 min after the adrenocorticotropic hormone loading test. If we could not detect the AV on SRCTAV, we again attempted cannulation of the AV.

We compared the detectability of AVs by SRCTAV with that by DSA using the SCC acquired from the hormone loading test in AVS, which is regarded as the gold standard. Furthermore, we also evaluated the histopathological findings of specimens after laparoscopic adrenalectomy, SAC and serum potassium concentration and decreases in usage of antihypertensive drugs before and after laparoscopic adrenalectomy.

2.2. Histopathological diagnosis

All subjects underwent laparoscopic adrenalectomy performed by urologists. All specimens were evaluated by histopathologists using macro evaluation (Fig. 3) and hematoxylin and eosin staining for diagnosis of adrenocortical adenoma and to differentiate adrenocortical adenoma from idiopathic hyperaldosteronism, which is characterized by nodular hyperplasia (Figs. 4 and 5).

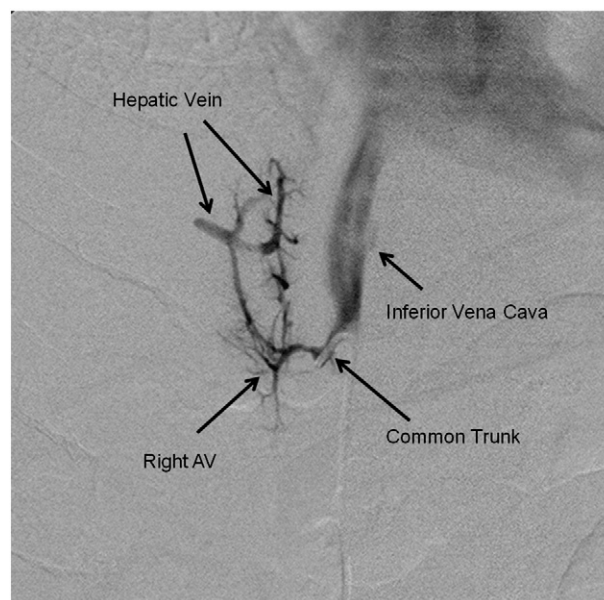


Fig. 1. Right adrenal vein (AV) image on digital subtraction angiography (DSA). It is difficult to identify the right AV because of the presence of a common trunk with the hepatic vein. The right AV is especially prone to misdiagnosis because of its anatomical location.

2.3. Statistical analysis

Statistical analysis was performed using SPSS statistical software (SPSS Japan, Inc., version 17.0). Chi square tests were used to compare the percentages of detection of the left and right AV on SRCTAV with those detected on DSA with regard to the hormone loading test as the gold standard. We used the paired *t* test to compare the SAC before and after adrenalectomy in each subject. A two-tailed *p* value < 0.05 was considered significant.

3. Results

Among the 29 subjects who underwent laparoscopic adrenalectomy, in 28 subjects the SCC acquired from both the left and right AV was more than 200 µg/dl at 30 min after the adrenocorticotropic hormone loading test and AVS was regarded as successful.

3.1. Detectability of AVs on DSA and SRCTAV with regard to the hormone loading test as the gold standard

The left and right AV could be visualized in 29 (100%) and 22 subjects (76%), respectively, on DSA and in 29 (100%) and 28 subjects (97%), respectively, on SRCTAV. Rate of detection of the right AV was significantly higher by SRCTAV than by DSA (*p* < 0.05) (Fig. 6).

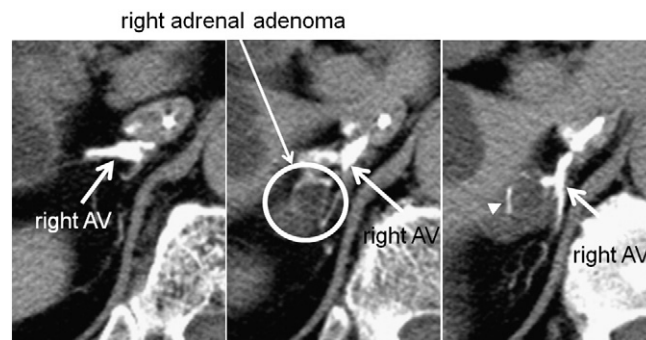


Fig. 2. Typical images of selective retrograde computed tomographic adrenal venography (SRCTAV) acquired from a subject with right adrenal adenoma. Using SRCTAV, the right adrenal vein (AV) (arrows) can be clearly identified and anatomical information can also be acquired. Also the vein in the adrenal gland could be visualized (arrowhead).

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