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# Bilateral accessory (aberrant) renal arteries associated with uncontrolled hypertension—Role of renin-angiotensin-aldosterone antagonist drugs for treatment goal: A case report

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## ABSTRACT

**Introduction:** Accessory (aberrant) renal arteries (ARAs) are extra vessels that supply the kidneys in addition to the usual single arteries. They typically arise from the abdominal aorta but can also originate from other abdominal/pelvic arterial systems. They are not uncommon and can be seen in up to 30% of adults. Accessory renal arteries can complicate various urological, abdominal surgery, interventional radiological, and transplantation procedures. The prevalence of ARA has been noted in patients with uncontrolled blood pressure, but the causative relationship has been a subject of interest and discussion. We present a case of a patient with resistant hypertension who was noted on investigation to have elevated serum plasma renin activity and bilateral aberrant renal arteries without stenosis. Blood pressure was easily controlled to goal with the addition of Spironolactone and Losartan. Accessory renal arteries should not be ignored in some cases of hypertension management.

**Case Report:** A 49-year-old woman had developed elevated blood pressure during her previous pregnancies, and hypertension persisted after pregnancy. Angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARB) could not be used at the time because of teratogenic considerations. Antihypertensive drugs as calcium channel antagonists, beta-blockers, direct vasodilators, and thiazide-based diuretics did not control the blood pressure to goal. Renal Doppler studies showed a slight increase in peak velocity on the right renal artery. A computed tomographic angiography (CTA) and magnetic resonance angiography (MRA) showed accessory renal arteries in both the right and left kidneys. Laboratory tests were unremarkable except for persistent hypokalemia and plasma renin activity was significantly elevated. The addition of Losartan 100 mg daily and Spironolactone 50 mg daily was needed to get blood pressure to goal.

**Conclusion:** Accessory renal arteries could lead to perfusion abnormalities, contribute to or exacerbate maintenance and control of blood pressure. Drugs affecting the renin-angiotensin-aldosterone pathway are important in the treatment of patients with accessory (aberrant) renal arteries if hypertension is renin mediated.

**Keywords:** Hypertension, Mineralocorticoid receptor antagonists, Renal artery, Therapeutics

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## INTRODUCTION

Hypertension causes severe cardiovascular complications that affect the brain, heart, and kidneys. Hypertension affects 29% of the US adult population and increases in prevalence with age to a rate of 31% at age 50 or greater. When present in a younger population, there is a need to not only treat hypertension but also to investigate reversible causes that may lead to curable or surgical treatments. The kidney is important in the physiological maintenance of blood pressure and the vascular supply to the kidneys is a major contributor in that role.

In "typical" anatomy, each kidney is supplied by one renal artery that arises from the abdominal aorta. When additional renal artery supplies the kidney, they are referred to as accessory, aberrant, or supernumerary renal arteries.

The literature is inconsistent with the distinction of accessory from aberrant renal arteries. Graves suggested that an artery to the kidney arising from the aorta in addition to the main artery should be designated as an accessory renal artery while any artery arising from sources other than the aorta should be denoted as an aberrant renal artery [1]. Others suggested that the aberrant renal arteries should only refer to ones that enter the kidney directly without going through the hilum [2]. Therefore accessory and aberrant renal arteries (ARA) have been used interchangeably. Multiple renal arteries are common and estimated in 30% of the human population [1–3] and very common in non-mammalian vertebrates [4]. Despite its prevalence, there is no consensus in the literature on the relationship between the presence of accessory renal arteries and arterial hypertension [5–11].

We report on a patient in which adequate blood pressure was not achieved and was noted to have double, bilateral aberrant renal arteries, and elevated plasma renin. The patient eventually responded well to antihypertensive drugs that primarily targeted the renin-angiotensin-aldosterone pathway.

## CASE REPORT

A 49-year-old white woman had developed hypertension in her two pregnancies and was treated with beta-blockers, diuretics, calcium channel antagonists, and direct vasodilators at the time. Antihypertensive medications affecting the renin-angiotensin-aldosterone pathway (ACE and ARB) were held back because of potential teratogenic implications. A family history of hypertension was noted in both parents. She did not smoke or abuse alcohol nor did she exercise regularly. She was obese with a body mass index (BMI) of 30 for many years and she had a history of obstructive sleep apnea treated with continuous (CPAP) at night which did not aid in the control of her blood pressure.

During an office visit, her blood pressure was elevated at 175/101 mmHg with a pulse rate of 74 beats per minute and no blood pressure or pulse differences between either the upper extremities or between the upper and lower extremities. Heart sounds were unremarkable with no murmurs. No fourth gallop heart sound, carotid, renal, epigastric, femoral, or costal bruits were appreciated. She had no abdominal or axillary striae and there was no edema in her lower extremities either. Chest X-ray was unremarkable without cardiomegaly, increased vascular marking, or rib notching. Recent laboratory test results showed these values in meq/L: Sodium 139, potassium 3.1, $HCO_3$ 27, blood urea nitrogen (BUN) 18, creatinine 0.80, and Calcium 9.7 in mg/dL.

The unprovoked hypokalemia necessitated evaluation for secondary hypertension. Plasma renin level was elevated at 12.1 ng/mL (normal 0.2–1.6 ng/mL). Urinalysis did not reveal any microalbuminuria. Renal ultrasonography and Doppler of normal renal arteries showed normal kidney sizes with no asymmetry, normal renal vascular resistive indices, and a slight increase in peak velocity in the right renal artery. Multidetector CT angiography with axial slices and intravenous contrast with multiplanar reformation rendered 3-D images showed normal origins of celiac, superior and inferior mesenteric arteries with accessory right and left renal arteries bilaterally with no stenotic lesions (Figure 1A and B). Also noted were scattered calcifications in the abdominal aorta without evidence of aneurysm or dissection. Magnetic resonance angiography (MRA) imaging was also diagnostic of the presence of bilateral

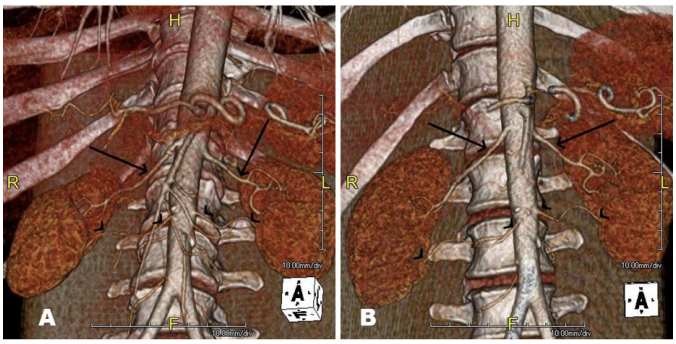


Figure 1: (A) Computed tomography angiography (CTA) with omnipaque 350 3D volume rendering demonstrating the main right and left renal arteries (long black arrows) as well as small caliber accessory renal artery on each side (black arrow heads). (B) Another view of the right and left small caliber accessory renal arteries (black arrow head) and right and left renal arteries (long black arrow) after removing the middle and distal segments and branches of the superior mesenteric artery (SMA) with omnipaque 350 contrast media.

accessory renal artery on each side supplying the lower poles of the kidneys (Figure 2A and B). No lesions were noted in the main renal or accessory renal arteries. No renin-producing tumors or adrenal masses were identified with any of the radiographic modalities.

The addition of Spironolactone 50 mg and Losartan 100 mg once daily resulted in the correction of serum potassium levels and blood pressure control. Final diagnosis was renin-mediated hypertension with bilateral accessory renal arteries controlled on ARB and Aldosterone antagonist.

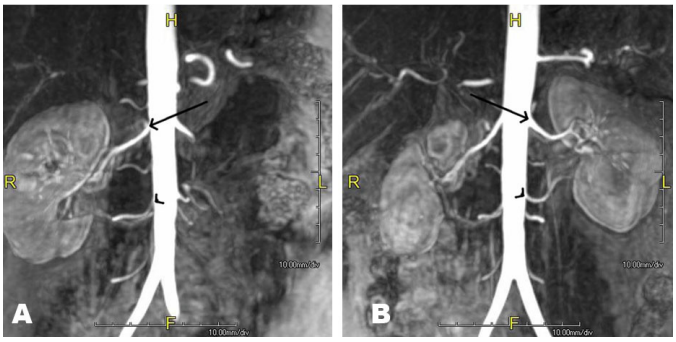


Figure 2: (A) Post-contrast magnetic resonance angiography (MRA). Maximum intensity projection (MIP) confirming the presence of right renal artery (long black arrow) and small accessory right renal artery supplying the lower pole (black arrowhead). (B) MIP confirming similar findings on the left side, presence of left renal artery (long black arrow) and left accessory renal artery (black arrow head).

## DISCUSSION

The main renal artery that supplies the kidney is typically 4–6 cm in length and about 5–6 mm in diameter. Kidneys with a renal artery diameter of greater than 5.5 mm do not present with accessory/aberrant renal arteries but their presence is probable when the primary renal artery diameter is less than 4.15 mm [12]. Any additional arterial supply from the aorta or branches to the kidney is referred to as an accessory or aberrant renal artery. Accessory/aberrant renal arteries are common in experimental vertebrae animals except for mammals. Frogs have 5–6 pairs of renal arteries while lizards and fowls have 3 or more pairs [4] and the advantages of such extra vessels are not clear.

Aberrant/accessory renal arteries are remnant vessels left behind from the cranial ascent of the kidney from the pelvic origins to the final location at L2–L3 in the retroperitoneum during embryogenesis [13, 14] and are more common in patients with renal fusion as horseshoe kidneys or those with renal ectopia.

Accessory/aberrant renal arteries occur bilaterally in 10–15% of cases, with single renal arteries arising from the abdominal aorta in 70% of cases, double renal arteries in 20%, triple renal arteries in 2.5%, and quadruple renal arteries in less than 1% [15].

The following characteristics are noted with accessory/aberrant renal arteries:

a. Most accessory/aberrant renal arteries are commonly located in the lower poles compared to the upper poles of the kidney.
b. Accessory/aberrant renal arteries tend to occur more frequently on the left kidney compared to the right side.
c. Accessory/aberrant renal arteries tend to be longer and usually of smaller caliber compared to normal renal arteries and portions of the kidney served by accessory/aberrant renal arteries can exhibit delayed kidney parenchymal excretion on angiographic and CTA studies.
d. Right side accessory/aberrant renal arteries are usually longer than the left since they have to course from the left side of the abdomen where the aorta is located.

A significant portion of published data on ARA is from anatomists describing variations in cadaveric autopsies and their presence should be noteworthy to minimize complications that might arise from various intra-abdominal and pelvic surgeries that include the kidneys, aneurysm repairs and renal transplantation that involve donor and recipient kidneys [12, 13, 16–18].

The role of aberrant vessels in cases of hypertension has not always been clear since 1937 when the association was initially made [16, 17, 19].

Accessory (aberrant) renal arteries being longer and smaller in diameter can create resistance that predisposes to hypoperfusion of the kidney and resultant activation of renin-angiotensin system. Glodny noted increased plasma renin activities in hypertensive patients with multiple renal arteries compared to matched controls with single renal artery [20].

A recent report comparing profiles of matched 344 hypertension with either single renal artery supplying each kidney or aberrant renal arteries showed higher blood pressure readings, higher renin concentration, increase left ventricular posterior wall and interventricular septum, left atrial dimensions, elevated creatinine, and cystatin in patients with ARA. This suggests that patients with ARA may have more end-organ damages than previously realized [11].

Diagnostic studies for accessory/aberrant renal arteries include CTA and MRA of abdominal vessels. Ultrasound of the kidneys with Doppler studies of aberrant renal arteries is sometimes limited by their low location in the abdominal cavity and proximity to adjacent bowel gases.

Our patient had uncontrolled blood pressure and bilateral aberrant renal arteries without stenosis and elevated plasma renin activity. Targeted treatment with medications that affected the renin-angiotensin-aldosterone system, therefore, led to better control and treatment to goal.

## CONCLUSION

Aberrant/accessory renal arteries are sometimes seen in radiographic evaluation of patients with hypertension. They may not be ignored as just anatomical variations as they may in some settings be associated with renin-dependent hypertension and respond to drugs acting on the renin-angiotensin-aldosterone axis.

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### Author Contributions

Basil Akpunonu – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Jeannine Hummell – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Joseph Akpunonu – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Written informed consent was obtained from the patient for publication of this article.

## Conflict of Interest
Authors declare no conflict of interest.

## Data Availability
All relevant data are within the paper and its Supporting Information files.

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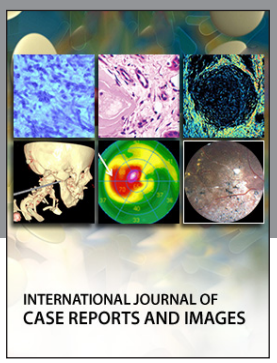




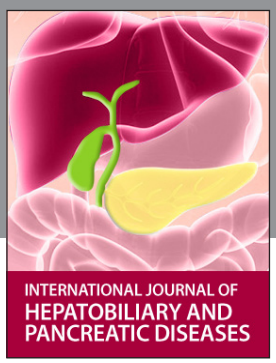




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