RJ INTERNAL MEDICINE

DOI: 10.63495/8500293 • e00010 • Published: 2026-05-01

Resistant Hypertension and Severe Hypokalemia Revealing Bilateral Adrenal Adenomas in Primary Aldosteronism: A Case Report

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ABSTRACT

Introduction: Resistant hypertension, defined as uncontrolled blood pressure despite multiple antihypertensive agents, necessitates evaluation for secondary causes. Primary aldosteronism (PA) is a common but underdiagnosed endocrine etiology, characterized by autonomous aldosterone production leading to hypertension, hypokalemia, and suppressed renin.

Case Presentation: A 60-year-old male presented with hypertension refractory to a five-drug regimen. Persistent hypokalemia (K as low as 2.4 mmol/L) and hypernatremia prompted biochemical testing, which revealed a markedly elevated aldosterone-to-renin ratio of 287.5 (aldosterone 23 ng/dL, renin 0.08 ng/mL/h). CT imaging confirmed bilateral lipid-rich adrenal adenomas. An electrocardiogram during severe hypokalemia showed significant QT prolongation (QTc 514 ms).

Treatment and Outcome: The patient was started on spironolactone. Follow-up at 14 days showed improved blood pressure (137/95 mmHg), sustained and normalized at three months (127/76 mmHg). Serial ECGs demonstrated correction of the QT interval following potassium repletion.

Conclusion: This case highlights that primary aldosteronism is a reversible cause of resistant hypertension, frequently associated with bilateral disease. It underscores the critical importance of screening with the aldosterone-to-renin ratio in all patients with resistant hypertension, particularly when hypokalemia is present, as targeted therapy leads to rapid clinical improvement.

INTRODUCTION

Resistant hypertension (RH), defined as blood pressure that remains above goal despite adherence to at least three maximally tolerated antihypertensive agents of different classes, is associated with significantly elevated cardiovascular and renal risk [1,2]. Among secondary causes, primary aldosteronism (PA) is increasingly recognized as a prevalent and modifiable etiology, accounting for 5-10% of all hypertensive cases and up to 20% of resistant hypertension [3,4]. PA is characterized by autonomous aldosterone secretion, leading to sodium retention, potassium wasting, and suppression of plasma renin activity [5]. Early identification and targeted treatment are

essential, as they can dramatically improve blood pressure control and potentially mitigate the excess cardiovascular morbidity linked to chronic aldosterone excess [6,7].

CASE DESCRIPTION

A 60-year-old male with a history of hypertension was followed longitudinally for persistent blood pressure elevation despite escalating pharmacologic therapy. Antihypertensive therapy was escalated sequentially as detailed in Table 1, ultimately including a five-drug regimen without adequate control.

Despite this optimized regimen, blood pressure remained labile and uncontrolled, with documented readings ranging from 130/79 to 180/97 mmHg. The patient was evaluated approximately every three months. Hypokalemia was first noted approximately 9 months before the diagnostic workup. Comprehensive metabolic panels over a 6-9 month period revealed persistent electrolyte abnormalities, and subsequent confirmatory endocrine testing was performed, with key results summarized in Table 1.

Diagnostic Evaluation

Given the triad of resistant hypertension, severe hypokalemia, and hypernatremia, PA was suspected. Biochemical screening, per Endocrine Society guidelines, was performed [5]. At the time of ARR testing, the patient remained on an ARB and beta-blocker, both of which can suppress renin and potentially elevate ARR. However, given the markedly suppressed renin and severe phenotype, the results were considered clinically meaningful.

The findings of a markedly elevated ARR with suppressed renin were highly suggestive of PA [8]. Confirmatory suppression testing was not pursued, consistent with Endocrine Society guidance that such testing is not mandatory in patients with spontaneous hypokalemia, suppressed renin, and elevated aldosterone, particularly when surgical intervention is not being considered [5]. Computed tomography of the abdomen identified bilateral lipid-rich adrenal adenomas (right: 3.2 cm, left: 2.7 cm). Figure 1.

During an episode of severe, symptomatic hypokalemia (K 2.4 mmol/L), serial 12-lead electrocardiograms were obtained. The initial ECG showed QT/QTc intervals of 514/423 ms (Bazett correction) (Figure 2A) [9]. Following intravenous potassium chloride repletion, serial follow-up ECGs demonstrated significant improvement, with normalization of the QT interval to 402/402 ms (Figure 2B) and subsequently to 402/434 ms. Cardiology evaluation, including echocardiography and stress testing, was otherwise normal.

Treatment and Outcome

Given the imaging evidence of bilateral disease, the patient was started on the mineralocorticoid receptor antagonist spironolactone as first-line medical therapy [5,10]. He was counseled on the potential side effects of gynecomastia. At a 14-day follow-up, blood pressure significantly improved to 137/95 mmHg. The dose was carefully titrated based on serum potassium and blood pressure response. Table 2 outlines the clinical and laboratory course over the subsequent three months.

As illustrated, following intravenous potassium repletion and the initiation of spironolactone, serum potassium normalized and remained stable within the reference range. Follow-up ECG after treatment showed sustained QTc correction (QTc 434 ms). A subsequent ECG showed sustained correction of repolarization, with a QT/QTc of 402/434 ms, confirming resolution of the

hypokalemia-induced electrical disturbance. Blood pressure control was achieved and sustained, with average readings meeting the guideline-recommended goal [15]. This robust therapeutic response is characteristic of successfully treated PA [11].

DISCUSSION

This case exemplifies a common diagnostic delay in PA, where escalating conventional therapy precedes investigation of the underlying endocrine disorder [12]. The pivotal clues were the persistent and severe electrolyte abnormalities. It is critical to note that normokalemia does not exclude PA, but hypokalemia, when present, is a highly specific prompt for evaluation [13]. The biochemical hallmark is a significantly elevated ARR with suppressed renin, as demonstrated by our patient's ARR of 287.5 [8].

The presence of hypernatremia, while not a classic hallmark, can be explained by aldosterone-driven sodium retention stimulating thirst and ADH release, potentially leading to a reset osmostat, particularly if free water intake is relatively inadequate. It served as an additional clue to the mineralocorticoid excess state in this patient.

This case provides a clear illustration of the cardiac electrophysiological consequences of aldosterone excess [9]. The documented severe hypokalemia (K 2.4 mmol/L) and the associated ECG findings represent a potentially life-threatening condition, significantly increasing the risk for malignant arrhythmias [14]. The progressive normalization of the QT interval following potassium repletion, evidenced by serial improvement, powerfully demonstrates the reversible nature of this electrical disturbance upon addressing the underlying cause.

A critical point of discussion is the diagnostic pathway. While an elevated ARR is highly suggestive, it is not itself a confirmatory test. In this case, the decision to forgo formal confirmatory suppression testing was justified by the presence of spontaneous hypokalemia, suppressed renin, and a markedly elevated ARR, which together constitute strong biochemical evidence of PA per guideline recommendations [5]. Furthermore, while the finding of bilateral adenomas on CT is often assumed to represent bilateral hyperplasia, imaging alone cannot determine the functional lateralization of aldosterone production. The excellent clinical response to spironolactone, while supportive of the diagnosis, is not diagnostic in itself, as MRAs can also be effective in other forms of resistant hypertension [14].

Beyond hypertension control, targeted treatment of PA may ameliorate the associated increased risk of atrial fibrillation, heart failure, and other cardiovascular events [16,17]. This case reinforces the guideline recommendation to screen for PA in all patients with resistant hypertension [5].

Conclusion

Primary aldosteronism is a common and reversible cause of resistant hypertension, with bilateral adrenal disease representing a frequent subtype. This case illustrates several critical learning points: the importance of maintaining a high index of suspicion for PA in patients with resistant hypertension, the value of persistent electrolyte abnormalities (including hypokalemia and, less typically, hypernatremia) as diagnostic clues, and the potentially life-threatening cardiac electrophysiological consequences of severe hypokalemia. The markedly elevated aldosterone-to-renin ratio with suppressed renin was highly suggestive of PA, and the decision to forgo confirmatory suppression testing was appropriate given the severe phenotype and the

patient's preference for medical management. However, it is important to recognize that imaging alone cannot determine the functional source of aldosterone production, and the therapeutic response to spironolactone, while characteristic, is not diagnostic.

Early diagnosis and targeted therapy with mineralocorticoid receptor antagonists can normalize blood pressure, correct electrolyte disturbances, and reverse hypokalemia-induced electrical abnormalities such as QT prolongation. Clinicians should screen for PA using the aldosterone-to-renin ratio in all patients with resistant or severe hypertension, particularly when hypokalemia is present. A thoughtful diagnostic approach, understanding the limitations of screening tests, the role of confirmatory testing, and the need for subtype evaluation when considering surgery, is essential for optimal management and improved long-term cardiovascular outcomes.

ARTICLE INFORMATION

Published: 2026-05-01

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Acknowledgements: The authors acknowledge the use of AI for language polishing and minor editorial assistance in preparing this manuscript. The authors are solely responsible for the final content, clinical interpretations, and conclusions.

The full article and any supplementary material are available at rjmedicine.org/publications/e00010

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Table 1. Chronology of antihypertensive therapy escalation and the key laboratory and diagnostic findings.

Chronology of Antihypertensive Therapy Escalation

Step	Therapy	Dose	Clinical Response
1	Amlodipine	Titrated to maximum dose	Inadequate BP control
2	Add Losartan	Titrated to maximum dose	Continued suboptimal response
3	Switch to Combination Pill	Amlodipine/Valsartan 10/160 mg daily	Persistent hypertension
4	Add a beta-blocker	Metoprolol 50 mg daily	Added for tachycardia (HR 80-105 bpm)
5	Add Vasodilator (PRN)	Hydralazine 25 mg TID as needed	BP remained labile & elevated

Final Regimen: Four regular agents + one PRN. Met criteria for resistant hypertension.

Key Laboratory and Diagnostic Findings

Parameter	Patient Value(s)	Reference Range	Interpretation
Serum Potassium (K+)	2.4, 3.2, 3.1, 3.5, 3.3 mmol/L	3.5-5.0 mmol/L	Persistent hypokalemia
Serum Sodium (Na+)	151, 147, 149, 153 mmol/L	135-145 mmol/L	Persistent hypernatremia
Plasma Aldosterone	23 ng/dL	<15 ng/dL (in context of HTN)	Inappropriately elevated
Plasma Renin Activity (PRA)	0.08 ng/mL/hr	0.25-5.82 ng/mL/hr	Suppressed
Aldosterone-to-Renin Ratio (ARR)	287.5	0.9-28.9 (Ratio)	Markedly elevated

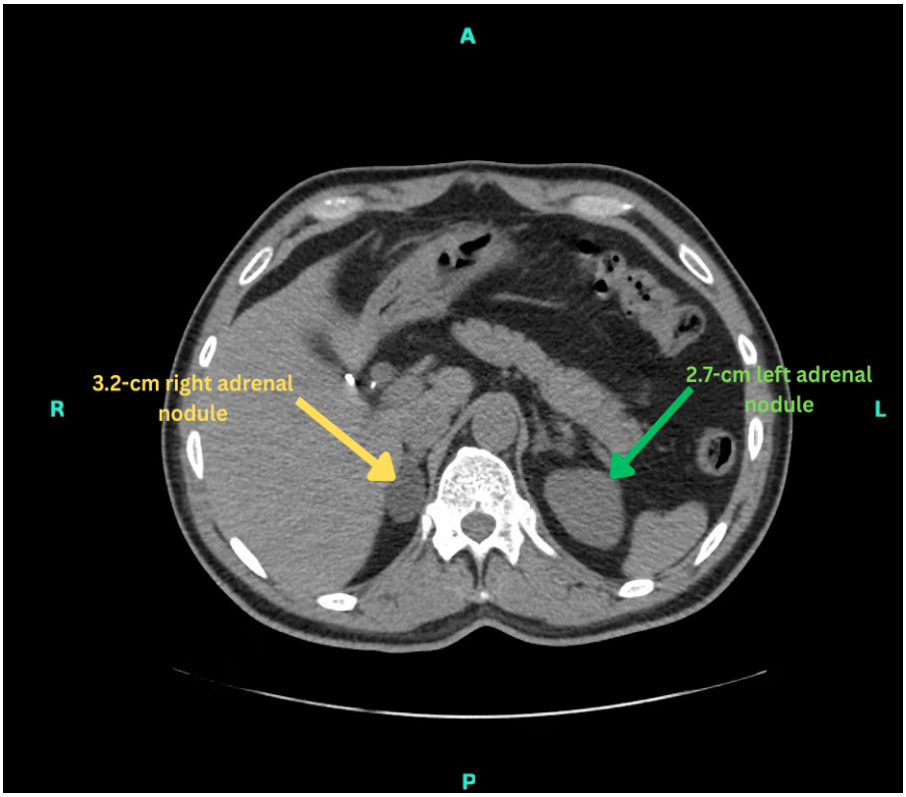

Figure 1. Non-contrast CT of the abdomen revealing bilateral adrenal adenomas. Bilateral adrenal lipid-rich adenomas. Axial non-contrast computed tomography images demonstrate a 3.2-cm right adrenal nodule (yellow arrow) and a 2.7-cm left adrenal nodule (green arrow). Both lesions are well circumscribed and homogeneous, with imaging characteristics consistent with lipid-rich adrenal adenomas. No evidence of local invasion or regional lymphadenopathy is present.

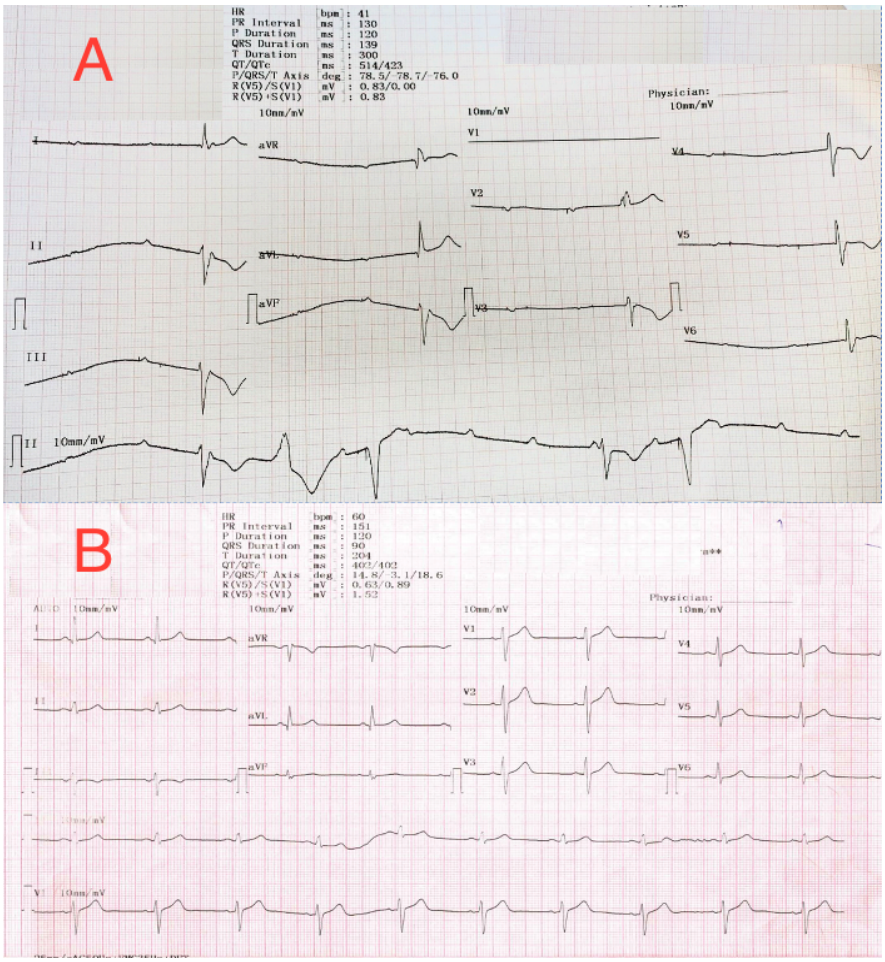

Figure 2. A: ECG during severe hypokalemia (K 2.4 mmol/L) showing prolonged QTc (514 ms) and prominent U waves. 12-lead ECG during profound hypokalemia (K 2.4 mmol/L) showing a markedly prolonged QT interval (QT/QTc: 514/423 ms), flattened T waves, ST-segment depression in inferior/lateral leads, and prominent U waves. B: ECG after initial potassium repletion showing normalized QTc (402 ms). Follow-up 12-lead ECG after initial IV potassium repletion shows significant improvement with a normalized QT interval (QT/QTc: 402/402 ms) and resolution of U waves.

Table 2. Follow-up course: spironolactone titration, potassium stabilization, and blood pressure control.

Time Point	Spironolactone Dose	Serum Potassium (mmol/L)	Blood Pressure (mmHg)	Clinical Notes
Baseline (Pre-Rx)	0 mg	2.4 - 3.3 (fluctuating)	150-180 / 90-97	Severe hypokalemia, resistant HTN
Initiation	25 mg daily	--	--	Therapy started; counseled on gynecomastia risk
Week 2	25 mg daily	4.1	137/95	Significant improvement
Month 1	Titrated to 50 mg daily	4.3	138/90	Potassium normalized; dose increased for optimal BP control
Month 2	50 mg daily	4.2	135/88	Sustained normokalemia; BP at goal
Month 3	50 mg daily	4.4	127/76	Potassium and BP stable; goal BP (<130/80 mmHg) achieved