

Redefining the Role of Revascularization in Atherosclerotic Renal Artery Stenosis: A Case Report Demonstrating Transformative Clinical and Renal Outcomes

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Abstract

Background: Renal artery stenosis (RAS), primarily caused by atherosclerosis, leads to resistant hypertension, progressive renal dysfunction, and cardiovascular complications. Treatment options include medical therapy and revascularization, with the latter offering significant benefits in selected cases. This report details a successful staged revascularization approach, demonstrating notable clinical improvements in a patient with bilateral RAS.

Case presentation: A 65-year-old woman with persistent hypertension (SBP >180 mmHg) despite triple antihypertensive therapy presented with occipital headaches, dizziness, and exertional dyspnea. Renal Doppler ultrasonography and angiography confirmed critical bilateral RAS, with 95% stenosis in the right renal artery and 90% in the left. Laboratory tests revealed impaired renal function with a serum creatinine of 1.7 mg/dL and an estimated glomerular filtration rate (eGFR) of 34 mL/min/1.73 m². Given the severity of her condition, a staged revascularization strategy was implemented, with the right renal artery treated first, followed by the left artery three months later. Both procedures were performed successfully without complications. Post-intervention, the patient experienced a substantial reduction in blood pressure and symptomatic relief, with follow-up at three months showing improved renal function, reflected in decreased serum creatinine levels and increased eGFR.

Conclusion: This case demonstrates the significant benefits of staged revascularization in managing complex RAS, resulting in substantial improvements in blood pressure control, renal function, and symptom relief. It underscores the importance of a tailored approach in achieving optimal clinical outcomes in high-risk RAS patients.

Keywords: Renal artery stenosis, Revascularization, Angioplasty, Stents, Hypertension, Renovascular, Renal function

Background

Renal artery stenosis (RAS), primarily caused by atherosclerosis, is the narrowing of one or both renal arteries. Atherosclerotic RAS (ARAS) commonly affects the ostial and proximal sections of the main renal artery, with complex lesions that are difficult to visualize using 2D angiography [1]. Clinically, ARAS may present as secondary hypertension, potentially progressing to resistant hypertension; ischemic nephropathy with declining renal function; or cardiac

destabilization syndromes such as pulmonary edema, recurrent heart failure, or acute coronary syndromes. In the US, ARAS prevalence detected by Doppler ultrasound (DUS) ranges from 0.5% to 7%, and it accounts for 10–20% of end-stage renal disease cases requiring dialysis. Despite its rarity and diagnostic challenges, DUS remains an excellent initial detection tool, though its accuracy depends on factors like operator skill, patient body composition, and bowel gas presence [2,3].

Determining the appropriate treatment strategy for RAS patients is particularly challenging. Recommended treatment strategies include medical therapy and revascularization with or without stenting. The American Heart Association (AHA) guidelines recommend revascularization for specific patients with renal artery stenosis (RAS), particularly those with persistent hypertension that is either unresponsive to or intolerant of medical therapy [4]. Recent studies have further explored the advantages of revascularization in RAS within this population, as illustrated by this study [1,5]. The success of the procedure is evaluated based on both technical and clinical outcomes. Technical success is achieved when stent placement restores normal anatomy and blood flow in the renal artery. Clinical outcomes are assessed by improvements in clinical parameters such as blood pressure, reductions in serum creatinine levels, or relief of related symptoms [4,5]. Hence, this study aims to demonstrate the successful and significant clinical benefits of staged revascularization in a patient with bilateral RAS and resistant hypertension.

Case Presentation

A 65-year-old woman presented with resistant hypertension was referred to Dr. Soetomo General Hospital. Her systolic blood pressure was persistently elevated above 180 mmHg despite treatment with three antihypertensive medications. The patient also reported frequent occipital headaches and dizziness. Her medical history includes hypertension since 2016, diabetes mellitus managed with insulin since 2011, kidney stones treated with extracorporeal shock wave lithotripsy (ESWL), cervical cancer treated with hysterectomy in 2011 followed by chemoradiation in 2016.

Upon admission, the patient reported exertional dyspnea (DOE) but no other symptoms. Her blood pressure was 186/85 mmHg, with other vital signs within normal limits. Clinical examination revealed no abnormalities. Laboratory results showed reduced renal function (serum creatinine 1.7 mg/dL; estimated glomerular filtration rate (eGFR) of 34 mL/min/1.73 m²). The lipid profile showed elevated triglycerides at 211 mg/dL, along with total cholesterol of 195 mg/dL, HDL of 44 mg/dL, and LDL of 115 mg/dL. Chest X-ray and electrocardiography (ECG) findings were unremarkable despite the history of cardiomegaly and DOE.

Transthoracic echocardiography (TTE) was performed and revealed concentric left ventricular hypertrophy and mild atrial regurgitation. Renal Doppler ultrasonography revealed stenosis in both renal arteries, with normal renal size and no evidence of stones or nodules. Doppler waveforms of the stenotic areas in the right and left renal arteries showed increased peak systolic velocities, measured at 335 cm/s in both the right and left RAs. Further diagnostic and therapeutic interventions were planned. The patient then scheduled for an elective arteriography with percutaneous transcatheter angioplasty (PTA) if necessary.

Diagnostic angiography was performed through femoral access and confirmed 95% stenosis in the right renal artery and 90% stenosis in the left renal artery. Given the severity and deteriorating renal function, we performed staged percutaneous transluminal angioplasty (PTA) with sirolimus drug-eluting stents (**Figure 1**). Due to procedural limitations, simultaneous revascularization of both RAs was not feasible. Based on the severity of the findings, we prioritized percutaneous transcatheter angioplasty (PTA) on the right RA.

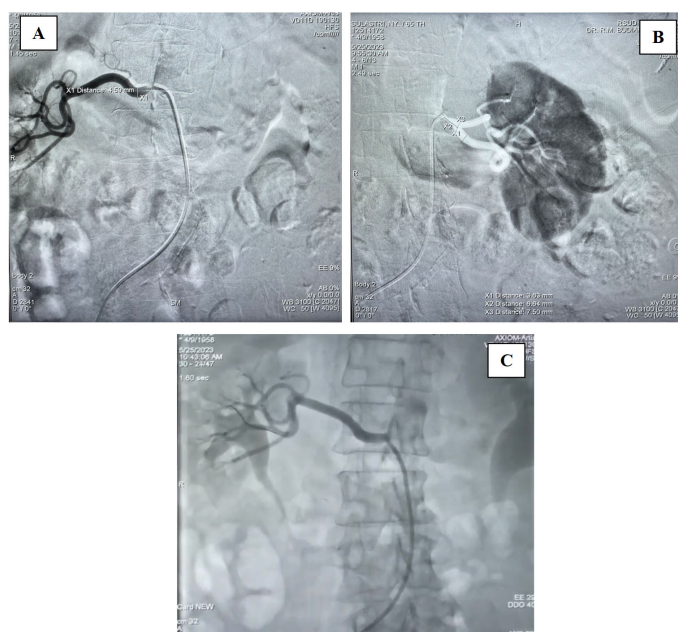


Figure 1. Renal Arteriography. (A) Critically stenosis 95% in osteal-proximal right renal artery. (B) Significant stenosis 90% in osteal-proximal left renal artery. (C) Right renal artery post PTA with stent showing successful revascularization.

The procedure included pre-stenting balloon dilation using a Sapphire Pro II 1.5 x 15 mm balloon and an NC Blue Medical 3.0 x 10 mm balloon. A Sirolimus drug-eluting stent (DES), (Angiolite), 4.5 x 16 mm, was also deployed and dilated from the ostial to the proximal segment of the right RA. The PTA procedure was completed successfully without complications.

Immediately after revascularization, the blood pressure improved to 158/80 mmHg, and no complications were observed. She was discharged on a medical regimen comprising dual antiplatelet therapy, a statin, and three antihypertensive medications: an ARB, a CCB, and a beta-blocker.

Three months later, her serum creatinine level decreased to 1.4 mg/dL, and her blood pressure remained stable without notable symptoms. The second PTA procedure was then planned. The same technique used in the first revascularization was applied. Sapphire Pro II 1.5 x 15 mm balloon and an NC Blue Medical 3.0 x 10 mm balloon were also used for pre-stenting dilation. A Sirolimus DES (Angiolite, 4.5 x 16 mm) was deployed to the left renal artery. No complication was observed after the procedure (**Figure 2**).

Following the procedure, the patient was managed with three antihypertensive medications (ARB, CCB, and beta-blocker). She was discharged a few days later and scheduled for follow-up at our outpatient clinic. At the follow-up, no further complications were noted, and the patient’s systolic blood pressure remained stable in 140/80 mmHg (**Table 1**).

Discussion

Renal artery stenosis (RAS) is the most common cause of secondary hypertension, particularly in refractory or persistent cases, with atherosclerosis accounting for over 90% of cases, especially in the elderly. Our patient presented with classic RAS features, including uncontrolled hypertension despite three antihypertensive agents, frequent headaches, and dizziness. Imaging confirmed severe bilateral stenosis, consistent with the link between atherosclerotic RAS and resistant or renin-dependent hypertension [7]. In this case, percutaneous revascularization with drug-eluting stents led to significant clinical improvement, demonstrated by better blood pressure control and a decline in serum creatinine levels. This underscores the importance of revascularization in restoring renal perfusion, preventing end-organ damage, and improving quality of life.

Accurate diagnosis is crucial in managing RAS effectively. While invasive angiography was once the gold standard, it carries risks such as contrast-induced nephropathy and embolization, particularly in patients with renal impairment. Non-invasive tools like Doppler ultrasonography (DUS), computed tomography angiography (CTA), and magnetic resonance angiography (MRA) are now preferred. DUS, used in this case, is a reliable screening method, with peak systolic velocity (PSV) above 180 cm/s indicating significant stenosis (>60%) [8,9]. Severe bilateral stenosis detected by DUS was confirmed via angiography, eliminating the need for further advanced imaging like renal frame counts (RFC) [2].

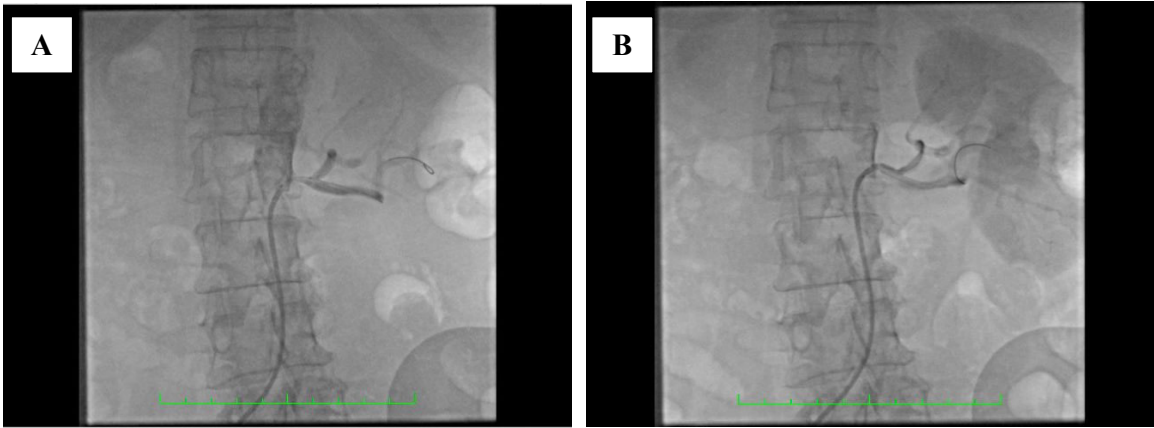


Figure 2. (A) Arteriography still showed significant stenosis 90% in osteal-proximal left renal artery. **(B)** Left renal artery post PTA with stent showing successful revascularization.

Table 1. Comparison of blood pressure and renal function before and after intervention.			
Time Point	Serum Creatinine (mg/dL)	eGFR (mL/min/1.73 m ²)	SBP/DPB (mmHg)
Pre-intervention	1.7	34	186/85
Post-intervention (first PTA)	1.5	38	158/80
Post-intervention (second PTA)	1.4	43	140/80

Despite its clinical importance, the role of revascularization remains controversial following large trials like ASTRAL, STAR, and CORAL, which reported limited benefit of revascularization over medical therapy [10,11]. However, these studies are criticized for selection bias, often excluding patients with severe stenosis or rapidly progressive disease who are most likely to benefit. Furthermore, such trials often fail to represent complex clinical scenarios where revascularization may yield substantial improvement. For example, in this case, this patient has been experiencing persistent hypertension, bilateral critical stenosis, and declining renal function made revascularization the most viable option to prevent further end-organ damage. This highlights the potential for targeted intervention in properly selected cases, where the severity of stenosis and clinical deterioration outweigh the risks of the procedure.

Our patient exhibited multiple indications for intervention—persistent hypertension, intolerance to medical therapy, and severe bilateral stenosis—strongly supporting revascularization [12]. Guidelines from the American Heart Association (AHA) and American College of Cardiology (ACC) recommend percutaneous renal intervention (PRI) for hemodynamically significant RAS associated with refractory or persistent hypertension, declining renal function, or medical therapy intolerance (Class IIa, Level of Evidence B) [13]. Given the critical stenosis and clinical presentation of this patient, right renal artery revascularization was prioritized, with precautions to minimize contrast-induced nephropathy through hydration and limiting contrast volume [14].

Renal artery revascularization and stenting, as the currently preferred treatment, offers high technical success rates exceeding 95%. Atherosclerotic renal artery stenosis (ARAS) often involves bulky aorto-ostial plaques, making balloon angioplasty alone insufficient due to recoil effects. Stenting overcomes this limitation, supporting its use as the standard treatment approach. In addition, recent advancements in sirolimus drug-eluting stents (DES) have significantly improved outcomes by reducing restenosis rates and enhancing procedural success, particularly in complex lesions such as aorto-ostial stenosis. While studies like the GREAT trial demonstrated a trend toward lower restenosis rates with DES compared to bare-metal stents (6.7% vs. 14.6%, $p=0.30$), achieving optimal long-term outcomes depends on proper stent sizing, implantation technique, and lesion assessment. These advancements highlight the potential of DES to improve patency rates and procedural safety, especially when combined with adjunct tools like intravascular ultrasound (IVUS) and embolic protection devices (EPDs) [15,16]. In our case, the use of sirolimus DES allowed for durable patency and significant clinical improvements. Despite technical success, clinical improvements in blood pressure and renal function remain variable, with blood pressure improving in more than 70% of cases and renal function stabilizing or improving in 25-50% of cases [4,5,17,18]. Proper patient selection is

critical to achieving these outcomes, as patients with rapidly progressive disease, severe bilateral stenosis, or recurrent cardiovascular symptoms such as pulmonary edema tend to derive the most benefit from revascularization. In this case, the patient's bilateral critical stenosis and declining renal function met these criteria, leading to remarkable improvement in blood pressure and renal markers.

In this patient, three-month follow-up demonstrated a >20% improvement in serum creatinine and sustained reduction in systolic blood pressure, underscoring the role of individualized intervention in appropriately selected patients [19]. Complications are rare but include catheter-related plaque disruption, dissection, renal infarction, thrombosis, or restenosis. Advancements in stent technology have significantly reduced these risks. In this case, a transient intraoperative rise in blood pressure was successfully managed without further adverse events. This case also illustrates that while randomized trials offer insights into broad populations, individualized patient assessments remain essential in clinical decision-making. Revascularization, when performed in the appropriate clinical context, has the potential to provide transformative benefits, particularly for patients with limited alternatives. The success in this patient underlines the value of tailoring treatment based on the interplay of clinical presentation, imaging findings, and anticipated prognosis [20].

Prognosis after revascularization depends on several factors, including adequate obstruction relief, renal viability, and pre-existing damage. Favorable predictors include severe bilateral stenosis, rapid renal function decline, and obstructive imaging patterns [4,5]. Our patient demonstrated these predictors, achieving blood pressure stabilization and renal function improvement. This case underscores the need for individualized assessment in RAS management. While large trials cast doubt on universal benefits, careful patient selection ensures favorable outcomes. Advances in diagnostic and procedural techniques will continue to refine the role of intervention in this complex condition, balancing efficacy and safety.

Conclusion

In conclusion, this case demonstrates the significant advantage of successful staged revascularization with sirolimus drug-eluting stents in the management of severe bilateral renal artery stenosis (RAS), particularly in patients with refractory hypertension and impaired renal function. While large randomized trials have questioned the routine use of revascularization over medical therapy, this report highlights the critical importance of individualized assessment and treatment. The successful interventions in this patient resulted in substantial and sustained improvements in blood pressure control, renal function, and symptomatic relief. This case reinforces the potential of revascularization

as a transformative approach in selecting patients with RAS, advocating for further refinement of patient selection criteria and procedural techniques to optimize outcomes.

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Ethical Approval and Consent to Participate

We declare that this case report adheres to ethical standards and guidelines. Appropriate permissions, including written informed consent, were obtained.

Conflict of Interest

The authors declare no conflicts of interest.

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Not applicable.

Authors Contribution

Conceptualization, ZA, MRA, YA, WW, JNE, RMB, NL, and RMP; Methodology, ZA, MRA, YA, and WW; Analysis, JNE, RMB, NL, and RMP; Investigation, ZA, MRA, YA, WW, JNE, RMB, NL, and RMP; Resources, JNE, RMB, NL, and RMP; Data Curation ZA, MRA, and YA; Writing-original draft preparation, ZA, MRA, YA, WW, JNE, RMB, NL, and RMP; Writing-review and editing, ZA, MRA, YA, WW, JNE, RMB, NL, and RMP; Visualization, ZA, MRA, YA, WW, and RMP; Supervision, JNE, RMB, NL, and RMP; Administration ZA, MRA, YA, WW, and RMP. All authors have read and agreed to the published version of the manuscript.

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