

Original Article

In-Vitro Renal Artery Reconstruction and Auto-Transplantation in Reno-Vascular Disease Not Amenable to Non-Surgical Therapy

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Abstract

Introduction: Management of clinically significant renal artery stenosis (RAS) and renal artery aneurysms (RAA) are often quite challenging. Where interventional methods are not feasible or are unsuccessful, open surgery remains the last option to salvage renal function and avoid catastrophic complications.

Materials & Methods: We report our experience with 07 cases of renal artery stenosis or aneurysm (04 RAS, 03 RAA) where successful surgical reconstruction and auto-transplantation was done after failed medical and endovascular management. All patients with RAS were symptomatic with resistant hypertension with failed medical management. Initial attempts at renal artery angioplasty and stenting were also unsuccessful. The RAAs were also considered not amenable to management with covered stents due to their precise location in the renal hilum affecting segmental branching points. Open nephrectomy was done, followed by cold perfusion and back-table renal artery reconstruction. In vitro repair was done using autogenous great saphenous vein followed by auto-transplantation to the right iliac fossa. Reconstructed renal artery was anastomosed to external iliac artery (end-to-side).

Results: There were no significant in-hospital morbidity and no mortality. Average post-operative hospital stay was 07 days. Follow-up Doppler scans at 4, 8, 12 and 24 weeks showed no evidence of disease recurrence. Among the RAS patients, two had early resolution of the resistant hypertension with adequate control. Other two RAS patients who had bilateral RAS due to Takayasu arteritis are being worked up for contralateral reconstruction.

Conclusion: In vitro repair and auto-transplantation offers a viable and safe salvage option for complex renovascular pathology where medical and minimally invasive measures have failed.

Keywords: Renal artery stenosis, Renal artery aneurysm, Surgical repair

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Introduction

Renal artery stenosis (RAS) and renal artery aneurysms (RAA) are relatively uncommon pathologies with potentially devastating consequences^{1,2}. When detected and where clinically significant, the first line treatment

is either medical management or endovascular stenting. Open surgical reconstruction remains a bail-out option, where other options have failed or are not feasible^{3,4}. Definitive management of each condition can potentially avoid catastrophic complications and result in complete resolution with salvage of the affected kidney.

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Materials & Methods

We analyzed our experiences from a series of 07 cases with renal artery stenosis or aneurysm (04 RAS, 03 RAA), where successful surgical reconstruction was done after failed initial medical and endovascular management. All four patients with RAS were diagnosed with Takayasu disease with resistant hypertension. The baseline systolic blood pressures were all ≥ 200 mmHg while on ≥ 4 antihypertensives at maximal dosage. Three of the patients were female (24, 32 and 48 years) while one was male (16 years). Two patients had bilateral extensive RAS (Figure 1), while the other two had unilateral disease. All four patients were initially referred for maximal medical management and renal artery stenting. Once endovascular ballooning and stenting was done or attempted with no radiographic or clinical improvement, they were considered for open surgery.



Figure 1: Bilateral severe renal artery stenosis

The three patients with RAA were two female and one male aged 42, 48 and 61 years respectively. One female patient was asymptomatic and detected to have the RAA during routine imaging done for infertility. The other two patients were both symptomatic with recurrent episodes of loin pain. The diagnosis of RAA was confirmed by CT angiogram (Figure 2). The median RAA diameter was 2.9 cm (2.6-3.2). All three patients were initially referred for endovascular stenting but were considered not amenable for stenting due to the anatomy and morphology, where the RAA were located at the hilar region affecting multiple branches.

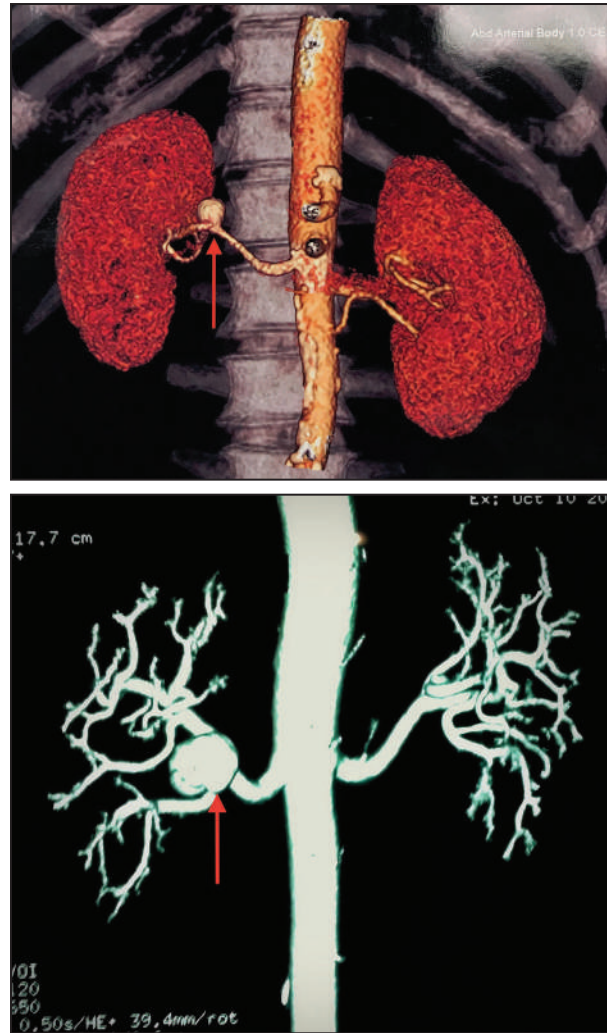


Figure 2: Right renal artery aneurysm at the hilum

Surgical approach

All patients in our series underwent comprehensive pre-operative imaging evaluation utilizing high-resolution computed tomographic angiography (CTA) and/or magnetic resonance angiography (MRA) to delineate the exact anatomical configuration of the renovascular pathology. This imaging protocol enabled detailed assessment of aneurysm morphology, branch vessel involvement, and the extent of stenotic disease, which proved crucial for surgical planning and graft design. The imaging findings were extensively reviewed in our unit multidisciplinary conferences involving vascular surgeon, interventional radiologists, rheumatologist and nephrologists to ensure optimal treatment selection. Surgical correction was considered as the bail-out option due to either failure or non-feasibility of non surgical options discussed above.

The operative procedure commenced with standard open nephrectomy through a retroperitoneal approach in order to access the diseased kidney with maxcimal access to diseased tissue. Laparoscopic nephrectomy was not considered due to the complex nature of the renovascular pathology.

The explanted kidney was then subjected to cold perfusion using Histidine-Tryptophan-Ketoglutarate (HTK) solution with high pressure perfusion in the back table. This preservation solution was chosen for its superior organ protection capabilities, low viscosity characteristics, and proven efficacy in maintaining cellular viability during the period of cold ischemia. The aneurysmal or stenotic segments were completely excised and reconstructed using autogenous great saphenous vein harvested from the thigh. Reconstruction was done using 7/0 polypropylene suture (Figure 3). Complex reconstruction was required in RAA affecting hilar region to restore each individual segmental branch. Excised segments were sent for histology to confirm the underlying pathology.

Following back-table reconstruction, the kidney was transplanted in to the right iliac fossa. The reconstructed renal artery was anastomosed to external iliac artery (end-to-side), using 6/0 polypropylene suture. The venous anastomosis was similarly performed in an end-to-side fashion to the external iliac vein, utilizing 5-0 polypropylene suture. Ureteral anastomosis was completed using standard ureterovesical implantation techniques with anti-reflux mechanisms using 5/0 polydioxone suture, over a 5 French ureteric stent.

Post-operatively, all patients were started on long-term antiplatelet therapy (aspirin 75mg nocte). Anti-inflammatory medication given for the Takayasu disease patients with RAS were continued as per discussion with the relevant medical team. Urinary catheter was removed on day-07 while the ueretric stent was removed at 4 weeks post-operative as an out-patient procedure. Routine surveillance was done with clinical assessment coupled with doppler imaging at 4, 8, 12 and 24 weeks.

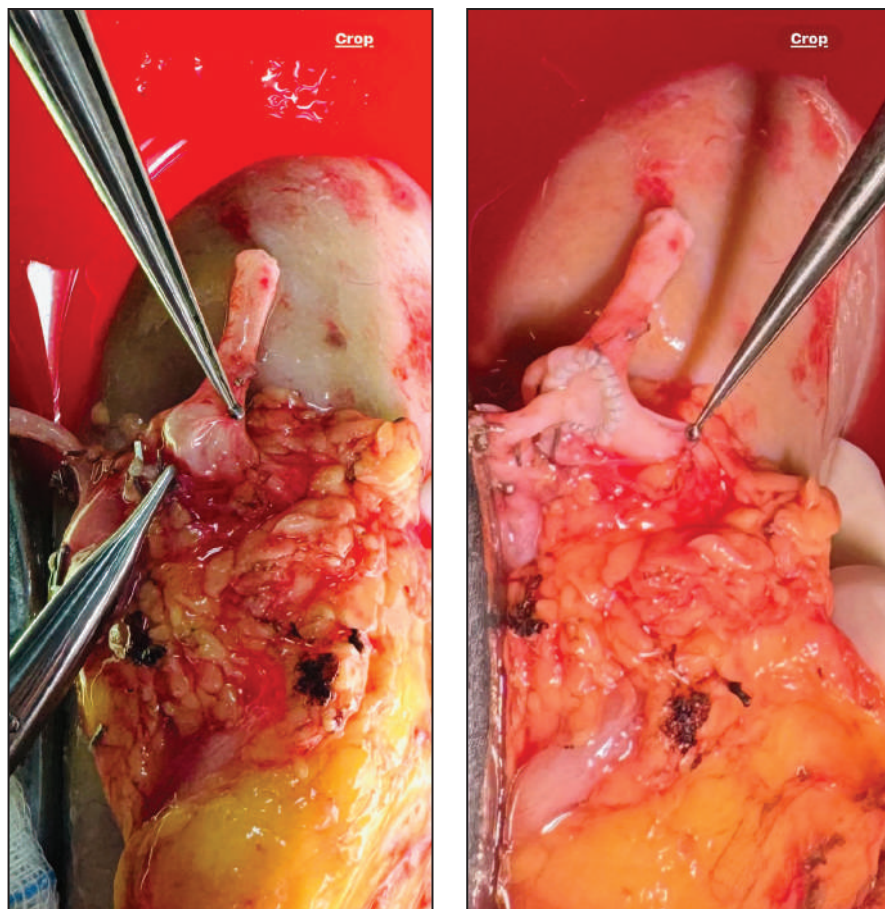


Figure 3: In-vitro reconstruction of renal artery aneurysm

Results

There were no significant in-hospital morbidity or mortality associated with the surgical procedures. All patients were discharged between days 05-07. At 06-months follow up, all patients were well in terms of surgical outcome. Follow-up Doppler at 4, 8 and 24 weeks showed no evidence of disease recurrence with excellent perfusion and arterial integrity.

Among the RAS patients, two had early resolution of their resistant hypertension with blood pressure control requiring only two antihypertensives with SBP <140 mmHg. Other two RAS patients who both had bilateral RAS showed partial resolution of symptoms and still remain on 3 anti-hypertensives with significantly better control of hypertension.

Discussion

Complex renovascular conditions, especially resistant renal artery stenosis (RAS) and renal artery aneurysms (RAA), remain a significant challenge in vascular surgery⁵. While endovascular intervention and medical therapy remain first-line therapeutic options, the overall response rates remain low and also pose technical limitations or failure of intervention in patients with extensive disease, difficult anatomy, or inflammatory conditions like Takayasu arteritis^{6,7}. In such cases, in-vitro renal artery reconstruction with auto-transplantation offers a precise surgical option that blends vascular and transplant techniques for better outcomes⁵.

Auto-transplantation of the reconstructed kidney into the iliac fossa avoids reconstruction in the diseased region of tissue and allows implantation of the reconstructed vessels in to virgin territory. In Takayasu arteritis, this region often has dense scarring and fragile tissues, increasing risks during in-situ repair. Moving the kidney to the iliac fossa allows for safer and more accessible vascular reconstruction, better tissue handling, and easier follow-up with imaging⁵.

We treated four patients with RAS from Takayasu arteritis, highlighting the disease's complexity. This condition often affects the aorta and its branches bilaterally, making blood pressure control and kidney perfusion difficult. While less invasive endovascular options are appealing, they often fail in Takayasu due to ongoing inflammation. Our own experience mirrors this, with balloon angioplasty and stenting showing early technical and clinical failure with non-resolution of symptoms^{6,7}. After surgery, two patients with resistant hypertension who had unilateral RAS, showed clear improvements in blood pressure control and disease control. The other two, with bilateral disease, showed partial resolution

and may require staged operations for the contralateral side. However, at present, they remain well controlled on antihypertensives and anti-inflammatory medication for Takayasu disease⁸.

RAA come with their own set of challenges due to their rarity and varied presentation. While small (<2 cm), asymptomatic aneurysms can often be monitored, intervention is typically required for those larger than 2 cm, symptomatic, or in women of childbearing age. All three of our RAA patients met these criteria—two had symptoms, and one was being evaluated for infertility.

The aneurysms' location near the hilum and involvement of multiple branches made them poor candidates for endovascular repair. Although open in-situ repair was possible, explantation and in-vitro reconstruction allowed complete aneurysm removal, tailored branch repair, and kidney protection via hypothermic perfusion⁹. These results show that this approach is safe and effective, as shown in centers experienced with both vascular and transplant surgery^{8,9}.

Long-term monitoring is still important due to risks like graft narrowing, aneurysm recurrence, or thrombosis. We used autologous saphenous vein grafts to reduce immune reactions and improve patency, though these can still degenerate over time.

Our results align with reports from transplant centers showing over 90% graft survival at 5 years, especially in non-atherosclerotic disease⁸. Surgical repair clearly offers better long-term results than endovascular methods alone in Takayasu arteritis, especially when done during periods of low disease activity^{6,7}.

Limitations

Despite encouraging outcomes, our case series is limited by small numbers and short follow-up. Larger, long-term studies are needed to confirm these findings.

Conclusion

Resistant RAS and significant RAA both pose unique challenges in definitive management, especially where initial medical and interventional management options have failed. While in-situ repair has also been described in certain centres, we believe in-vitro reconstruction and auto-transplantation facilitates a better surgical repair of the diseased artery segments and also allows the re-implantation to be done in virgin territory. In vitro repair and auto-transplantation offers a viable and safe salvage option for complex renovascular pathology where medical and interventional measures have failed with very encouraging early results.

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