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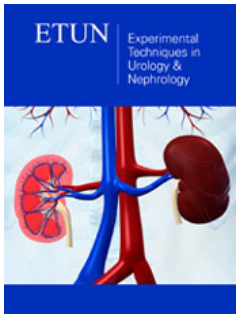
Biologic and Synthetic Grafts for Complex Vascular Reconstruction in Renal Allotransplantation and Autotransplantation

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Abstract

Complex vascular reconstruction during renal transplantation may require alternative conduit materials when conventional reconstruction is not feasible or suitable. We describe four cases illustrating the use of bovine pericardium and polytetrafluoroethylene (expanded PTFE; Gore-Tex) to address distinct vascular challenges in renal allotransplantation and reconstruction. In the first case, following renal vein stenting for nutcracker syndrome, the stented renal vein was excised, the Inferior Vena Cava (IVC) was reconstructed with a bovine pericardial patch, and the renal vein was reconstructed using tubularized bovine pericardium. In the second case, tubularized bovine pericardium was used to extend a short right renal vein in a living-donor kidney transplant when ABO compatible deceased-donor vascular conduit was unavailable. In the third case, a bovine pericardial patch was used to create a common arterial patch for a deceased donor kidney with three renal arteries. In the fourth case, an ePTFE graft was used to provide iliac arterial replacement and implantation site in the setting of severe iliac artery calcification, allowing implantation of three renal arteries onto the ePTFE graft. These cases demonstrate the versatility of biologic and synthetic materials for addressing complex venous and arterial reconstructive challenges and offer practical technical options for selected patients undergoing renal transplantation.

Introduction

Renal transplantation remains the epitome of treatment in end stage renal disease with superior outcomes [1]. Poised with the ongoing success, the approach to managing challenging urologic anatomic and vascular scenarios has made renal auto transplantation a solid option [2-5]. As the complexity and prevalence of diseases heightens, the technical mandate and precision must mirror such demand. Successful renal transplantation requires adequate arterial inflow, venous outflow, and urologic anatomy to accommodate. Complex venous anatomy, inadequate renal vein length, multiple renal arteries, unsafe urinary reservoir, and severe aortoiliac disease can substantially increase technical difficulty. These challenges may be encountered during re-transplantation, living-donor transplantation with short vessels, renal auto transplantation, or transplantation after previous vascular intervention.

Cadaveric and autologous vessels are preferentially utilized for reconstructive purposes, but availability may be limited. Biologic materials, including bovine pericardium, and synthetic conduits, including polytetrafluoroethylene (PTFE) graft, have proven safety and longevity in appropriate clinical settings [6-9]. We describe four cases involving bovine pericardium, and PTFE for complex vascular reconstruction during renal allo- and auto- transplantation. The objective is to highlight the technical applications of these materials and identify the clinical information required to evaluate their safety, patency, and durability.

Technical Descriptions

Case 1: Inferior Vena Cava (IVC) and Renal Vein (RV) reconstruction after renal vein stenting

A patient with a history of failed renal vein stenting for nutcracker syndrome underwent renal auto-transplantation. The Renal vein and stent were excised en bloc with a segment of the IVC as the stent tip was extending well into the lumen with the prongs piercing the caval wall. The IVC defect was repaired with a bovine pericardial patch using 4-0 polypropylene Suture in continuous fashion. The renal vein was reconstructed with tubularized (over 42F size chest tube) bovine pericardium to restore venous continuity. This configuration provided a patch repair of the caval defect and a biologic venous conduit after removal of the stented segment (Figure 1). Follow up Computed Tomography at 18months demonstrated continued patency of the reconstruction. Routine anticoagulation was not required after the use of bovine pericardium, aspirin 81mg solely was prescribed for 1 year.

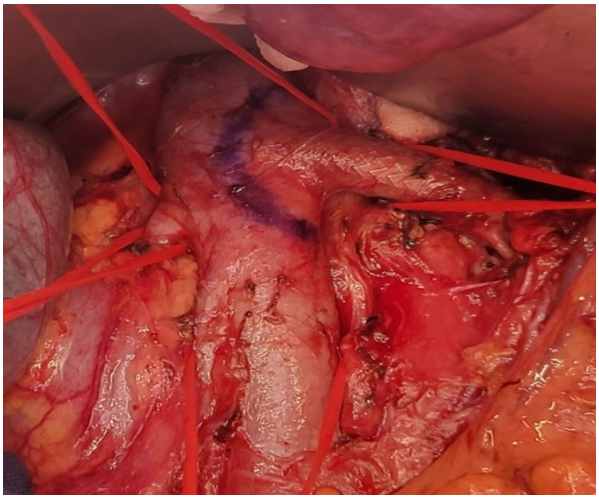


Figure 1A: Intra-operative image of the left renal vein and IVC after complete dissection depicting the intended resection.

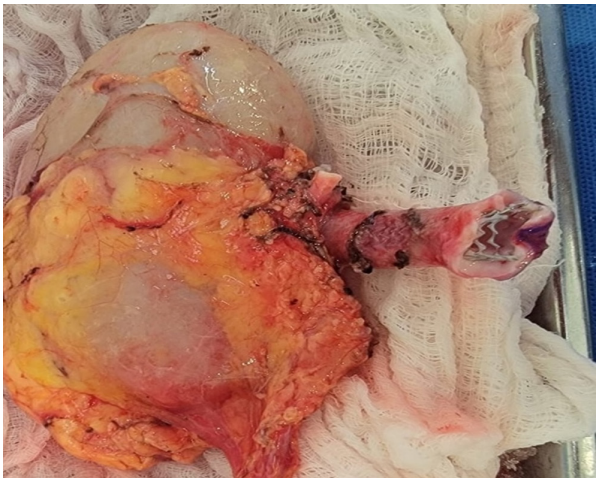


Figure 1B: The left kidney following extraction demonstrating the renal vein and embedded stent.

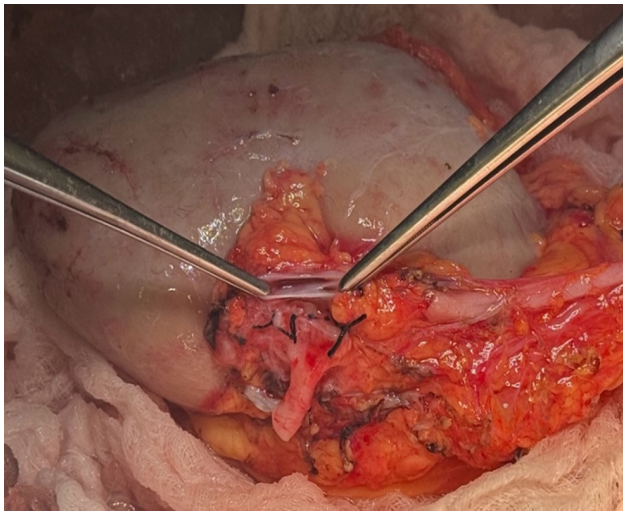


Figure 1C: Following resection, the renal vein stump is very short hence the need for extension/reconstruction.

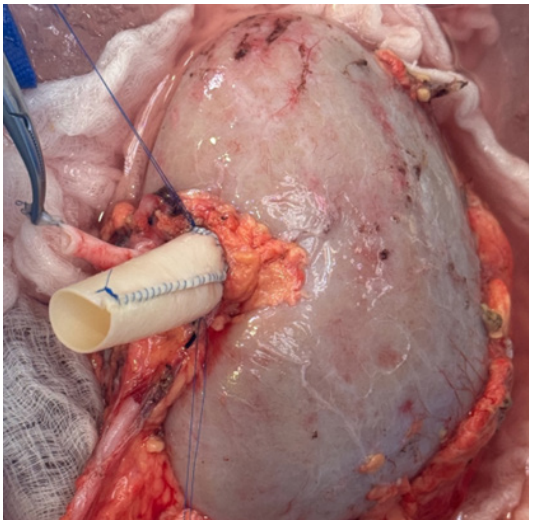


Figure 1D: Renal vein reconstruction using a tubularized Bovine patch (tubularized to size 42F)

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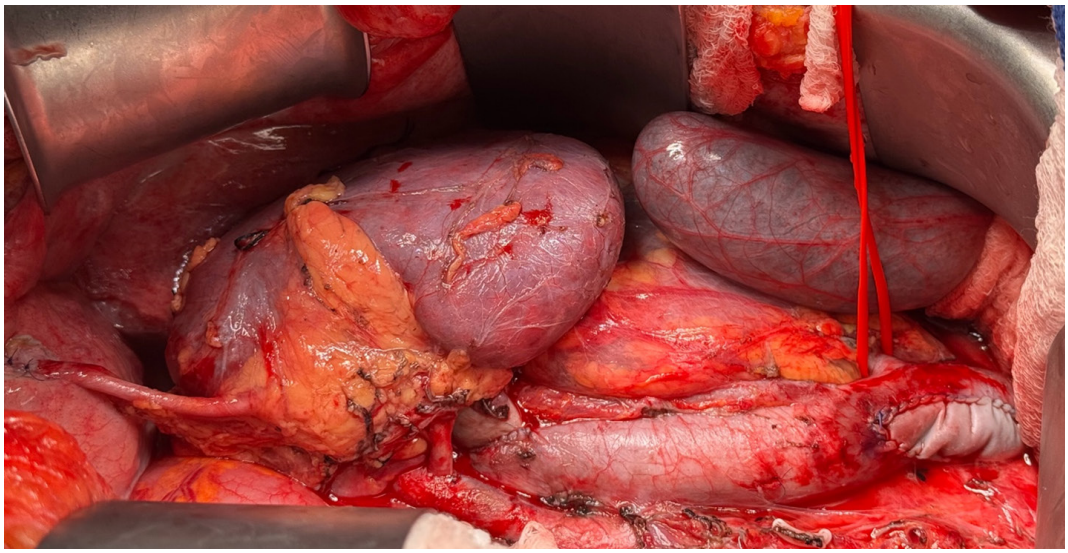


Figure 1E: Completed renal auto-transplantation and IVC Bovine patching.

Case 2: Extension of a short renal vein in a living-donor kidney allograft

A living-donor kidney allograft had a short right renal vein, limiting the available length for implantation. A banked blood group compatible deceased-donor vein vascular conduit was unavailable at the time of transplantation. Bovine pericardium was fashioned into a tubular conduit over a 42F chest tube using 5-0 polypropylene suture and anastomosed to the renal vein to provide additional length for venous implantation (Figure 2). This approach avoided the need for a donor-derived vascular conduit. The extended renal vein was then sewn end to side onto the external iliac vein using 5-0 polypropylene suture in a continuous manner. aspirin 81mg was used post operatively. At 14 months follow up, the patient continues to have excellent renal function (creatinine 1.35mg/dl) with no technical or vascular complications.



Figure 2: Post reperfusion of the renal allograft depicting the renal vein extension utilizing tubularized bovine pericardium

Case 3: Common arterial patch for a three-artery renal allograft

A renal allograft from a deceased donor with three renal arteries required reconstruction to facilitate implantation. A banked blood group compatible deceased-donor vein vascular conduit was unavailable at the time of transplantation. A bovine pericardial patch was used to incorporate the arterial orifices separately onto a common implantation patch. Separate arteriotomies on the bovine patch were created using a 2.5mm punch, and the arteries were sewn individually using 7-0 polypropylene suture. The patch was then sewn end to side onto the external iliac artery. This helped facilitate implanting all three arteries safely with the desired lengths, as opposed to separate anastomoses. The patient had an uneventful post-operative course. The patient remained on aspirin 81mg for 1 year post-operatively. At 13 months post-op, the patient remains with excellent graft function (creatinine 1.03mg/dl) with no vascular complications (Figure 3).



Figure 3A: Back table image of the kidney with multiple renal arteries of different sizes and length.

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Figure 3B: Post reperfusion of the renal allograft depicting the renal vein extension utilizing tubularized bovine pericardium



Figure 3C: Completion of the reconstruction of the three renal arteries to the bovine patch prior to implantation.

Case 4: Using non ringed expanded PTFE as an iliac replacement for severely calcified iliac arteries

A patient with severe iliac artery calcification had no targets for renal artery implantation. An extended PTFE graft was used as an interposition graft/iliac replacement. The diseased external iliac artery was excised preserving the internal iliac, and an 8mm Gore-Tex ePTFE non-ringed graft was used and sewn end to end with the proximal and distal iliac using 6-0 Gore-Tex sutures (Figure 4). The three renal arteries (deceased donor kidney) were anastomosed to the ePTFE graft, allowing implantation of the renal allograft despite extensive calcification of the native iliac vessels. Post-operatively, he was initiated on aspirin and clopidogrel for 1 year. Planned CT angiogram 3 months post-operatively demonstrated patency of the iliac and renal graft with no evidence of vascular stenosis or thrombosis. At 13 months follow up, the patient has excellent graft outcome (Creat 1.10 mg/dl) with no vascular complication.



Figure 4A: The diseased segment of iliac excised.

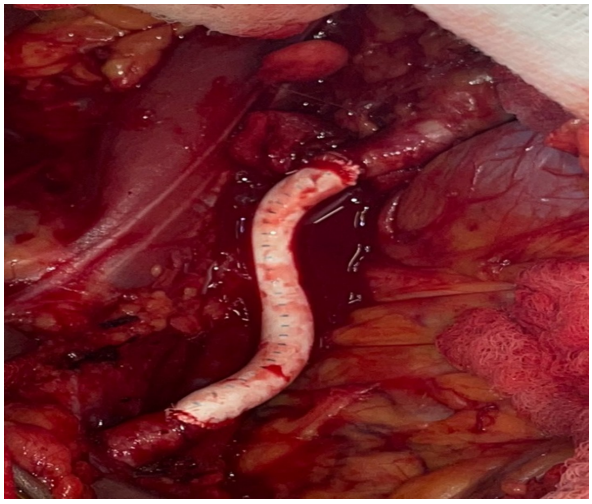


Figure 4B: An 8mm ePTFE graft as a replacement of the patient's iliac artery.

Discussion

This constellation of cases exhibits distinct applications of biologic and synthetic materials for complex vascular reconstruction during renal transplantation. As our outcomes improve and patient and graft longevity increases, we are equally poised with re transplantation, re-operative fields, and more challenging anatomy. Evidence supporting the use of Bovine pericardium (BP) spans vascular and cardiothoracic surgery. Data

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supporting BP for its favorable handling characteristics, elasticity, and lower risk of infection, stenosis, and thrombosis is well established, and PTFE grafts have been the mainstay of choice for a large aspect of vascular conduits. Biologic and synthetic materials are not interchangeable. They differ in handling, compliance, suture retention, thrombogenicity, infection risk, and expected durability [6]. Material selection should be based on the location and size of the defect, required flow, available native and donor vessels, contamination risk, immunosuppression, and the feasibility of postoperative surveillance.

Conclusion

Bovine pericardium and ePTFE may provide alternative conduits for selected patients undergoing complex renal transplantation. Potential applications include IVC and renal vein reconstruction, extension of a short renal vein, creation of a common arterial patch, and arterial implantation when severe iliac calcification or intimal dissection is encountered. These techniques should be individualized to the anatomic challenge and operative circumstances, rather than applied as a standardized approach.

Ethical Approval and Patient Consent

We conducted a retrospective review of medical records and imaging after approval from MedStar Georgetown University Hospital review board committee. Informed consent had been obtained from patients for intraoperative pictures and postoperative imaging.

Funding

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Conflict of Interest

No conflict of interest to declare.

Author Contributions

1. Study concept and design: Talal Al-Qaoud
2. Acquisition of data: Talal Al-Qaoud, David Walls, Shekhar Gogna
3. Drafting of the manuscript: Talal Al-Qaoud, David Walls, Shekhar Gogna
4. Critical revision of the manuscript for important intellectual content: Talal Al-Qaoud
5. Statistical analysis: None.
6. Obtaining funding: None.
7. Administrative, technical, or material support: None.
8. Supervision: Talal Al-Qaoud.

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