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Transplantation of a Pelvic Kidney from a Living Donor Using a Recipient Internal Iliac Artery to Reconstruct Multiple Renal Arteries

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Background	This case report describes the successful transplantation of a pelvic ectopic kidney with multiple vessels from a living donor, using the recipient's internal iliac artery for the ex vivo reconstruction of four renal arteries before implantation into the recipient using single arterial and venous anastomosis.
Summary	Renal transplantation has become the preferred treatment for patients with end-stage renal disease. Due to the growing demand, the selection criteria for donors and kidneys have expanded both for deceased and living donors to include donors and kidneys that would previously not be considered for transplantation. Among these are kidneys with abnormal vascular and ureteric anatomy, kidneys with stones, polycystic kidneys, and kidneys with cancer.[1-5] The pelvic kidney often presents complex anatomic, physiological, and pathological challenges. The use of a functioning pelvic kidney with complex vascular anatomy is a viable option for expanding the donor pool. Novel surgical techniques have been described regarding successfully implanting such kidneys.[6] We report a successful renal transplant utilizing a pelvic kidney from a living donor with multiple vessels after back table reconstruction using the recipient's internal iliac artery.
Conclusion	The aforementioned technique allows for the utilization of pelvic kidneys with complex anatomy with planned reconstruction and reduces the warm ischemic time as well as the chances of technical failure and graft thrombosis.
Key Words	kidney transplant; living donor; internal iliac artery; pelvic kidney
Abbreviations	BMI: body mass index, GFR: glomerular filtration rate, MAG3: mercaptoacetyltriglycine HLA: human leucocyte antigen, IIA: internal iliac artery, HTK: histidine tryptophan ketoglutarate, LDRT: living donor renal transplant

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NA conceptualized the case report and provided the images. MJ, SA, WH, and ZZ were part of the multidisciplinary time involved in decision-making pre- and postoperative care of the patient. JW prepared the manuscript. NA provided the photographs and illustrations. All authors reviewed and edited the manuscript and agreed on the final version prior to submission.

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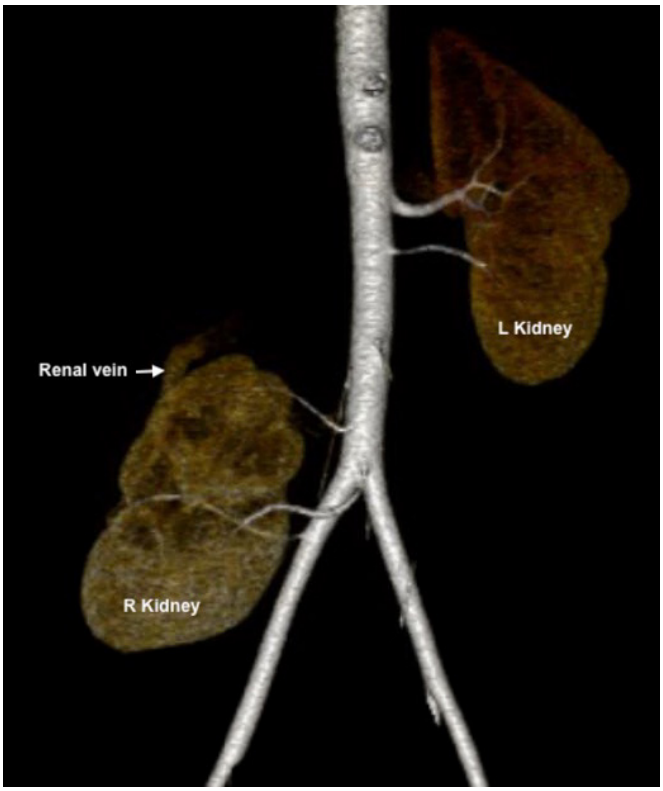
Case Description

The recipient is a 36-year-old male with a history of chronic kidney disease secondary to diabetic nephropathy. He had been on hemodialysis for two years. Apart from insulin-dependent diabetes mellitus and hypertension, there was no other comorbidity. He weighed 65.6 kg (BMI=24.8), and his physical examination was unremarkable. A CT angiogram showed normally patent iliac vessels; in particular, the internal iliac artery and its branches appeared healthy and patent.

The donor was the recipient's 24-year-old sister, who, upon pretransplant workup, was found to have a right pelvic kidney and a normally placed left kidney. She denied any history of renal calculi, urinary tract infections, or hema-turia. She was normotensive, weighed 70.4 kg (BMI 28.9), and her physical examination was normal. Her serum cre-atinine was 86 umol/L, and her glomerular filtration rate (GFR) was measured by a cystatin-C clearance of 88 ml/min/1.73 m^2. Computed tomography (CT) angiogram showed a right-sided pelvic kidney at the level of the pelvic brim measuring 8.9 cm in craniocaudal dimension. The kidney was malrotated with renal hilum and pelvis facing posterolaterally. The kidney had three renal arteries—two originating from the abdominal aorta and one from the right common iliac artery supplying the upper middle and the lower pole, respectively. There was a single renal vein draining into the inferior vena cava. There was a single ureter arising from the posterolaterally-facing hilum. The right ovarian vein drained into the renal vein (Figure 1). The left kidney was normally positioned with two renal arteries and a single renal vein. The ectopic right kidney had a relative function of 48% on a conventional technetium-99m (^{99m}Tc) mercaptoacetyltriglycine (MAG3) scan.

The decision to select the right kidney for donation was taken in a multidisciplinary team meeting based on abnormal position and anatomy and the risk of future complications in the pelvic kidney. The donor and recipient were blood group compatible with four out of six human leukocyte antigen (HLA) mismatches (1A, 2B, and 1DR) and a negative cross-match. They were counseled about the increased risk of vascular thrombosis and premature graft failure.

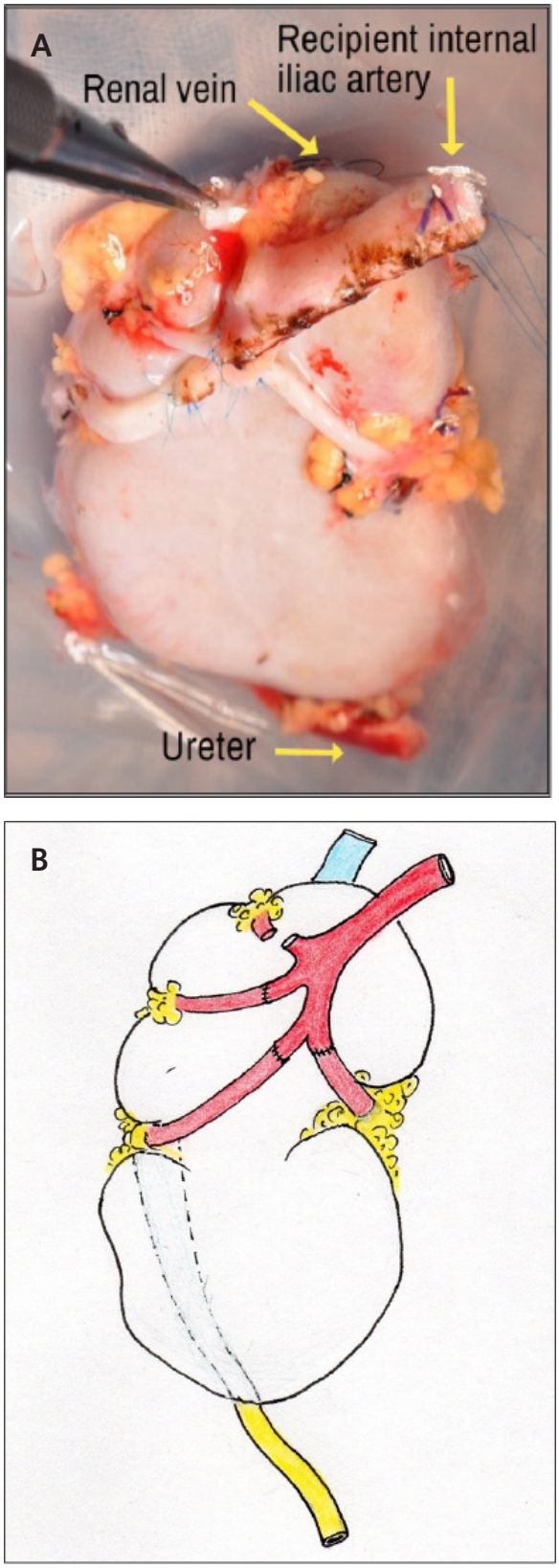
Figure 1. 3D Reconstructed CT Angiogram of Donor Kidneys Demonstrating Right Pelvic Kidney with Multiple Blood Supply and Malrotation. Published with Permission



An open donor nephrectomy of the right pelvic kidney was performed through a right lower quadrant skin crease incision. The dissection was relatively easier than anticipated. An additional fourth artery originating from the aorta and supplying the upper pole was discovered and preserved. An additional small caliber renal vein was ligated. The kidney was removed safely and flushed with a cold histidine tryptophan ketoglutarate (HTK) preservation solution on the back table.

The recipient's operation was performed through an extraperitoneal approach using a right iliac fossa skin crease incision. The internal iliac artery was excised with its terminal branches to reconstruct the donor renal arteries. On the back table, the four donor renal arteries were reconstructed on the branches of the internal iliac artery (Figure 2). An endarterectomy of the proximal internal iliac artery (IIA) was required to remove an atheromatous plaque.

Figure 2. Renal Artery Reconstruction. Published with Permission



A) Back table reconstruction of donor renal arteries using the recipient's internal iliac artery and its branches; B) schematic (illustration by Niaz Ahmed)

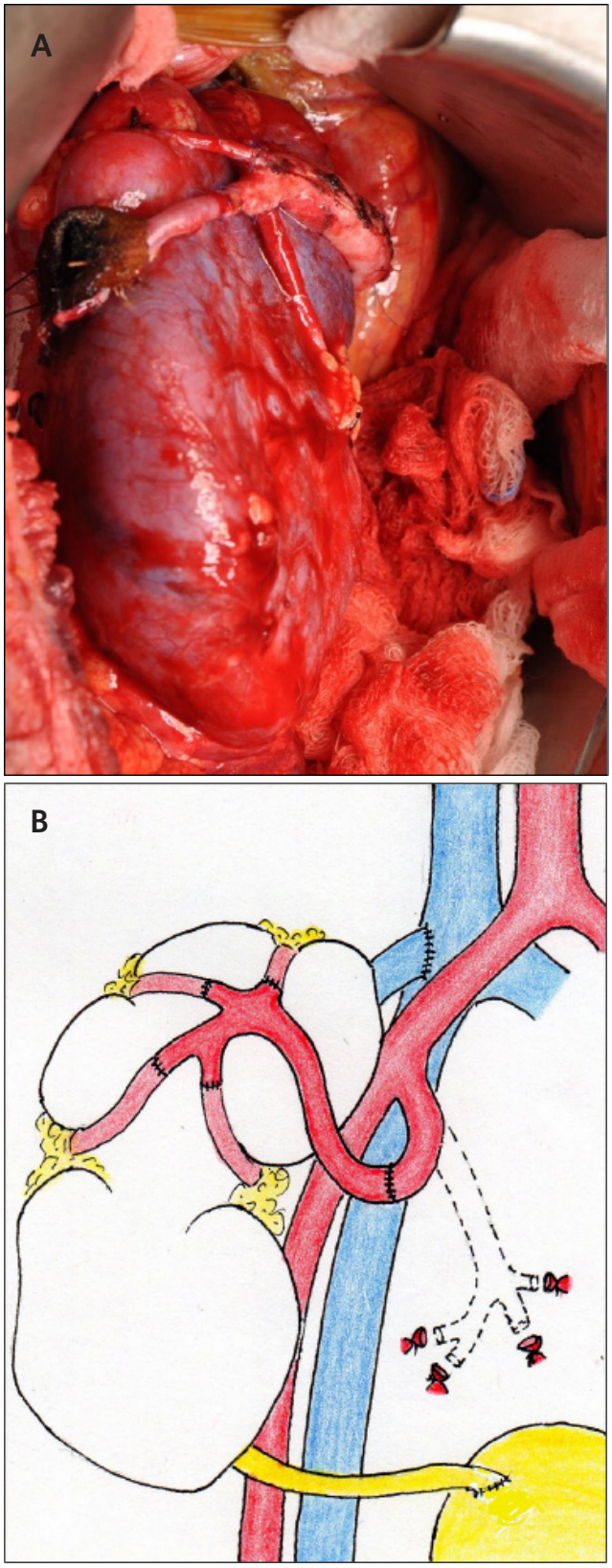
After reconstruction, the donor kidney was implanted in the right iliac fossa. The renal vein was anastomosed to the common iliac vein with Prolene 7.0, whereas the reconstructed renal artery was anastomosed to the internal iliac artery with Prolene 6.0. The anastomosis time was 36 minutes, and the cold ischemic time was 4 hours and 26 minutes. One thousand units of heparin were administered intravenously prior to the arterial anastomosis.

Reperfusion of the kidney was immediate and uniform, with urine production on the table (Figure 3). After a short while, the mid-polar artery showed no convincing flow; this was revised with an anastomosis to the external iliac artery with Prolene 7.0 with good results. Intraoperatively, the patient became hypotensive, which did not respond to fluid bolus and required inotropic support. The patient was managed in the surgical intensive care unit overnight before transfer to the renal transplant unit.

The patient received basiliximab induction followed by maintenance immunosuppression with tacrolimus, mycophenolate mofetil, and prednisolone per local protocol. Posttransplant, the patient developed acute tubular necrosis with slow graft function (SGF) despite acceptable urine output. Postoperative ultrasound scans of the transplanted kidney demonstrated uniform perfusion with normal resistive indices (0.60-0.75) and a normal renal artery velocity though it did not demonstrate all four arteries individually. The patient did not require dialysis. He was empirically treated for rejection with intravenous methylprednisolone 250 mg boluses for three days. At the start of the second week, the patient's creatinine level started to improve. He was discharged home on day 15 with a serum creatinine of 242 umol/L. At one year, the patient remains well with a baseline creatinine of 119 uM/L and eGFR of 60 mL/min.

The recovery of the donor was uneventful. She was discharged home on the fourth postoperative day. At one-year follow-up, the donor blood pressure was 113/69 mm Hg, serum creatinine 90 uM/L, and no proteinuria.

Figure 3. Kidney Reperfusion. Published with Permission



A) Implanted kidney after reperfusion; B) Schematic of vascular reconstruction and implantation (illustration by Niaz Ahmed)

Discussion

A pelvic kidney is a form of ectopic kidney resulting from arrested kidney migration during embryological development.[7] The definitive kidney or the metanephros in the embryo starts to form around the fifth week and structurally completes around 32–36 weeks of gestation. During its development, the kidney also rotates and ascends through a paravertebral course to its final position. During its ascent, the kidney derives its blood supply successively from the internal iliac artery, common iliac artery, abdominal aorta, and adrenal arteries. This explains the presence of multiple blood vessels in a pelvic kidney.[8] Pelvic kidneys are smaller, often malrotated, vertically tilted (up to 90°), and retain fetal cortical lobulation. The renal pelvis and the ureter are often dilated with apparent or real obstruction, which is attributed to malrotation and accessory vessels crossing the renal pelvis and ureter.[9]

Despite the abnormal anatomy, a pelvic kidney may be asymptomatic while maintaining its physiologic function. Occasionally these kidneys may be dysplastic, contributing only a small fraction of the total renal function.[9] There is also an increased risk of renal calculi and urinary tract infections.[10] Occasionally, a pelvic kidney can be misinterpreted as a pelvic tumor or lymphadenopathy.[11] In our donor, the discovery of a pelvic kidney was incidental. The kidney was lobulated with four renal arteries, two renal veins, and a single dilated ureter with the renal hilum and the pelvis facing posterolaterally. The kidney contributed 48% of total GFR.

Knowledge of the anatomy and blood supply of an ectopic kidney prior to the donor procedure helps plan the recipient's operation and minimize intraoperative blood loss and inadvertent segmental devascularization.[8] This can be achieved through computer tomography angiography (CTA) or magnetic resonance angiography (MRA). The relative function of the ectopic kidney can be assessed through isotope renography.[6] Our donor had a CTA to assess the anatomy and a technetium-99m (^{99m}Tc) mercaptoacetyltriglycine (MAG3) scan to assess the relative renal function.

Conclusion

While laparoscopic approaches have been described for surgery on or for removal of a non-functioning ectopic kidney, the operation to remove a pelvic kidney from a living donor is usually performed through an open technique. Varying levels of technical difficulties have been described for the donor operation. These mainly relate to the multiplicity of blood vessels, their abnormal position, a misshaped, malrotated kidney, and extraperitoneal adhesions. The latter may explain the non-ascent, rotation, and tilting of the pelvic kidneys.[12] An open approach was used in our donor, who had complex vascular anatomy. In this case, we did not encounter dense adhesion as had been described previously by Goldsmith et al.[12]

Various surgical techniques have been used to reconstruct and implant multiple blood vessels associated with a pelvic kidney. Goldsmith et al. reported using the inferior epigastric artery with an interposition graft for anastomosis of the additional mid-polar artery.[12] Li et al. used a venous interposition graft to aid end-to-side anastomosis to the common iliac vein.[13] A healthy internal iliac artery with its terminal branches may help reconstruct multiple renal arteries on the back table. This was planned and carried out successfully in our case. The no-flow in the mid-polar artery was probably due to the stretch caused by the short length of the conduit. This was ligated and separately anastomosed to the EIA using interrupted 6/0 Prolene with a satisfactory flow. The use of the internal iliac artery for the reconstruction of multiple renal arteries has been described, albeit not in the setting of a pelvic kidney.[14]

The patient was empirically treated for rejection, though the slow graft function may have been attributable to ischemia-reperfusion injury. The patient was a low-moderate immunological risk for rejection, with four out of six HLA mismatches (one donor recipient mismatch) and negative T and B-cell cross-match prior to transplant. A renal biopsy was intentionally avoided due to the high risk associated with the complex anatomy, vascularity, and orientation of the kidney.

The donor, in this case, was selected after multiple multidisciplinary meetings and an exhaustive search for an alternative donor. Only when no alternative donor could be found was this donor considered after the pros and cons were fully explained to both the donor and the recipient.

Lessons Learned

The combination of a normal functioning pelvic kidney, appropriate imaging, preoperative planning, and the application of novel surgical techniques will expand the donor pool to include pelvic kidneys as a potential option for renal transplantation with a good outcome. While such an approach has been successfully used in living donor renal transplants, pelvic kidneys from deceased donors discovered at procurement should be used cautiously.

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