ORIGINAL RESEARCH

Vascular Reconstruction in Renal Transplantation in Kidneys with Vascular Variations

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Abstract

Objective: Kidney transplantation (KT) is the preferred treatment for end-stage kidney disease (ESKD). Although grafts with a single renal artery and vein are technically ideal, multiple renal arteries occur in approximately 14.5% of donors, increasing surgical complexity. Advances in vascular reconstruction have enabled the use of these grafts, thereby expanding the donor pool. This study reports our experience with vascular reconstruction in KT using grafts with multiple renal vessels.

Methods: A retrospective review was conducted of all KT with multiple renal vessels at a single centre. Demographic, operative, and postoperative data were obtained from a prospectively maintained transplant database. Patients with incomplete records or loss to follow-up were excluded.

Results: Seventeen recipients (14 males, 3 females; mean age 44.1 years) were included. Nine grafts were from living donors and eight from deceased donors. Most grafts had two renal arteries (88.2%), while two had three arteries (11.8%). Back-table side-to-side arterial reconstruction was the commonest technique in living donor grafts (88.9%), whereas deceased donor grafts were implanted using aortic patches (75.0%). Three vascular injuries (37.5%) occured in deceased donor grafts during the retrieval. Donor inferior vena cava extension was used to lengthen short right renal veins. Postoperative complications included two perinephric collections (11.8%), one ureteric stricture with hydronephrosis, one episode of pyelonephritis, and one death from sepsis.

Conclusions: Kidney grafts with multiple renal vessels can be transplanted successfully using appropriate vascular reconstruction techniques. Careful knowledge of renal vascular anatomy and meticulous reconstruction minimise complications and support expanding the donor pool.

Keywords: renal transplant; vascular variations; vascular reconstruction

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Introduction

Renal transplantation (KT) is the preferred modality of renal replacement therapy (RRT) for patients with end-stage kidney disease (ESKD), offering superior patient survival, improved quality of life, and better long-term outcomes when compared with dialysis. Successful KT depends on meticulous donor selection, careful graft preparation, and precise vascular anastomosis. Conventionally, donor kidneys with a single renal artery (RA) and a single renal vein (RV) are considered ideal for KT, because of the technical ease of the surgical procedure, which reduces the risk of vascular and urological complications.

However, anatomical variations of the renal vasculature are common, with multiple renal arteries occurring in approximately 14.5% the renal donors (1). The presence of multiple renal arteries and multiple renal veins presents additional technical challenges during donor nephrectomy and the KT. Therefore, the donors with multiple RA were considered a relative contraindication for donation in the past. These grafts often require complex vascular reconstruction or multiple arterial anastomoses, which increase the warm ischemia time, the risk of bleeding and the operative duration.

In addition, the kidneys with multiple renal vessels result in an increased risk of vascular thrombosis, ureteric complications, delayed graft function, and graft loss. Despite these concerns, lacks of suitable donors and improvement in reconstruction techniques and increasing surgical experience have enabled the successful transplantation of kidneys with complex vascular anatomy (2).

This case series describes our experience with KT using donor kidneys with multiple renal vessels at a single centre in Sri Lanka. We present the vascular reconstruction techniques employed, the intraoperative technical considerations, and the postoperative outcomes and complications. Our experience demonstrates the feasibility and safety of utilizing kidneys with multiple renal vessels, thereby expanding the donor pool without compromising the KT outcomes.

Methods

This study included all transplantations performed utilizing kidneys with multiple renal vessels. Patient demographic and clinical data were collected, including age, gender, donor type (living or deceased), number of renal arteries, number of renal veins, vascular reconstruction technique employed and postoperative complications. Data were obtained from a prospectively maintained computerized transplant database, ensuring systematic and standardized data collection throughout the study period. Additional information was retrieved from patients' medical records where necessary to verify the completeness and accuracy of the collected variables. Only patients with complete clinical and operative records were included in the analysis. Cases with incomplete or missing essential data, as well as patients who were lost to follow-up, were excluded from the study.

Results

A total of 17 recipients who underwent KT with a kidney graft with multiple renal vessels were included. The recipient cohort comprised 14 males (82.4%) and three females (17.6%), with a mean age of 44.1 years (range 16–67 years).

Of the 17 kidneys, nine were from living donors and eight were from deceased (cadaveric) donors. Among the deceased donor

grafts, seven kidneys had two renal arteries, while one graft had three renal arteries. The latter sustained a middle renal artery injury, necessitating reconstruction. Venous multiplicity was less common, with two right-sided kidneys demonstrating dual renal veins. Among the live donors, 57.1% of the grafts were left kidneys and 42.8% were right kidneys. In all deceased donors, the RAs were retrieved with a cuff of the aorta (aortic patch) (Figure 1). In six (75.0%) deceased donor grafts, arterial anastomosis was performed with the donor aortic patch without modification. While in two (25.0%) cases, the patch required shortening (patch reconstruction) before implantation to reduce the length of the arteriotomy in the recipient iliac artery (Figure 2). There were three vascular injuries found in the deceased donor renal vessels (n-3/8, 37.5%), this included one middle renal artery injury, one upper polar artery injury, and one renal vein injury, all of which required repair before the KT.

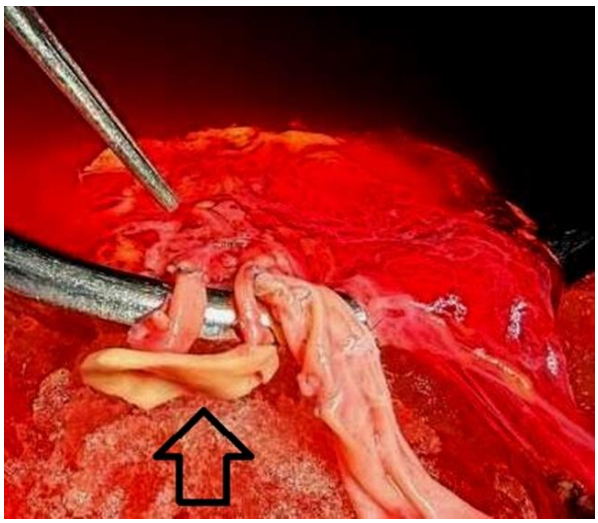


Figure 1: Two renal arteries with a cuff of the aorta (aortic patch)

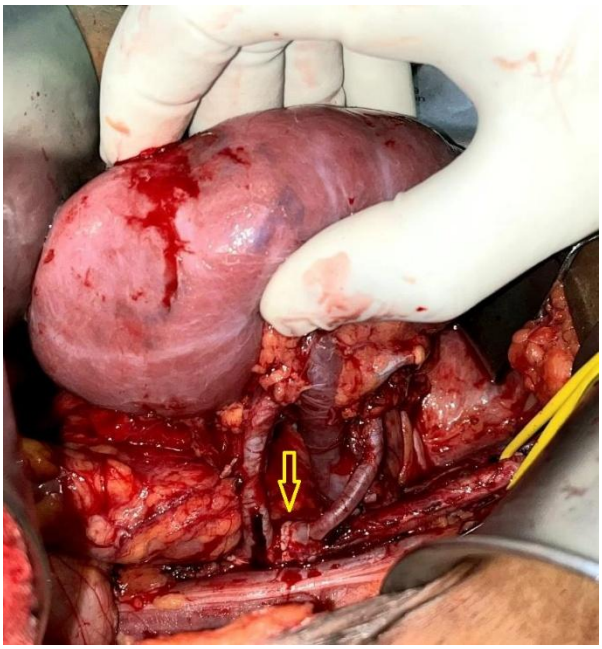


Figure 2: Patch shortening (patch reconstruction)

Among the nine living donor grafts, eight (88.9%) kidneys had two renal arteries, while one (12.5%) kidney had three renal arteries. The kidney which had three renal arteries was a right kidney. No living donor graft had multiple renal veins. In the eight (88.9%) live donor grafts, a side-to-side arterial reconstruction (Figure 3), creating a single arterial inflow for implantation was performed in the back bench. whereas the graft with three renal arteries required a side-to-side reconstruction of two arteries with a separate anastomosis for the third artery (Figure 4).

In the case of right kidneys from deceased donors, the donor inferior vena cava (IVC) was sutured in line with the renal vein on the back bench to elongate the venous length. A segment of the donor IVC was sutured in line with the right renal vein, creating a continuous venous extension (Figure 5) that effectively elongated the renal vein, this facilitates the anastomosis.

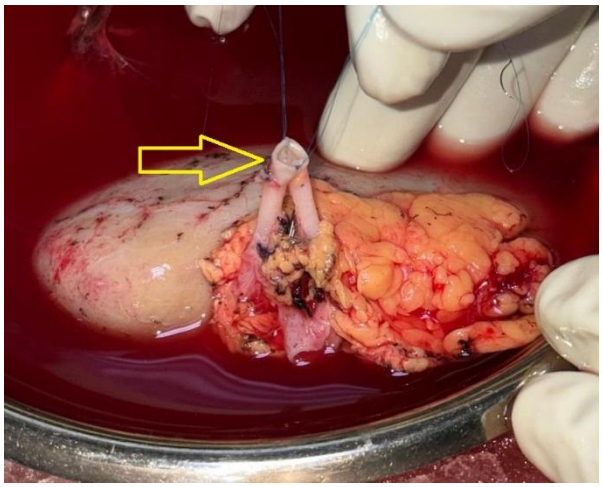


Figure 3: Side-to-side arterial reconstruction

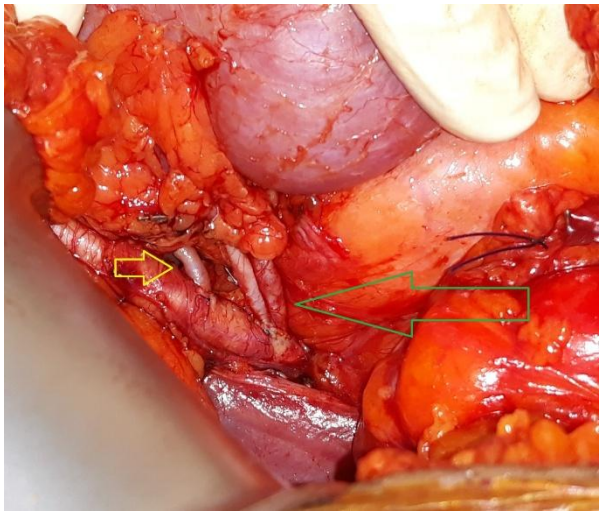


Figure 4: Image showing a side-to-side reconstruction of two arteries (green arrow) with a separate anastomosis for the third artery (yellow arrow)

During the follow up period, there were two (11.8%) perinephric collections, one (5.9%) ureteric stricture and hydronephrosis, one (5.9%) case of pyelonephritis. One patient with hydronephrosis died due to the sepsis.

Discussion

Renal transplantation (KT) is the preferred treatment for patients with end-stage kidney disease because it improves survival, and the quality of life. Successful KT depends on meticulous vascular anastomosis to establish arterial inflow and venous outflow. Anatomical variations, particularly multiple renal arteries require reconstruction before implantation.

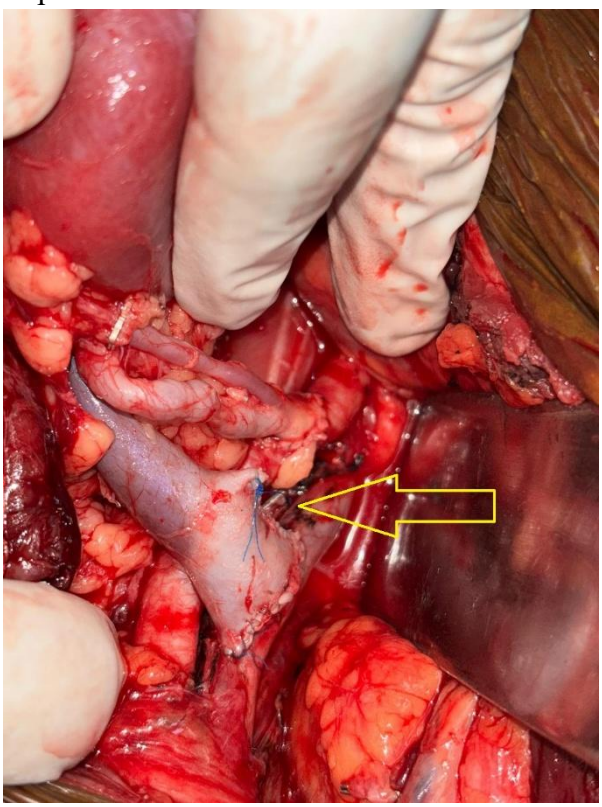


Figure 5: Inferior vena cava (IVC) reconstruction for the right renal vein

The renal arteries (RA) typically arise from the lateral aspect of the abdominal aorta at the level of the first to second lumbar vertebrae (L1–L2). They measure approximately 4–6 cm in length. The right RA is longer than the left RA due to its long course posterior to the inferior vena cava (IVC). At the renal hilum, each RA divides into segmental branches. When this division occurs before reaching the hilum, it is referred to as early branching (EB). In addition to the main RA, accessory renal arteries may arise directly from the abdominal aorta or the lilac arteries. The accessory renal arteries are classified as hilar arteries and the polar arteries. Hilar arteries enter the kidney through the renal hilum, whereas the polar

arteries enter the upper or lower pole of the kidney outside the hilum (1). Multiple renal arteries are encountered in approximately 14.5%-30.0% of donor kidneys and present a technical challenge during transplantation (1), (3). In the present study, kidneys with multiple arteries required back-table reconstruction, particularly in live donor transplants. This reconstruction is technically demanding and time-consuming. Additionally, in deceased donor renal grafts, suturing a long arterial patch also prolongs the procedure, resulting in increased ischemia time before graft implantation. These technical challenges contribute to extended operative duration and negatively influence transplant outcomes.

Early branching (EB) of the renal artery occurs in about 26.7% to 29.1% of cases (4 to 5). Recognition of EB is important in live donor KT, because during the nephrectomy, EB arteries may be divided distal to the branching site, thus becoming multiple arteries requiring vascular reconstruction. Accurate preoperative identification of arterial branching patterns facilitates surgical planning and minimizes the risk of intraoperative complications. Variations in renal venous anatomy are also frequently encountered, with multiple renal veins reported in approximately 16.7% of individuals (6). These variations are significantly more common on the right side than on the left (16.6% versus 2.1%) (6). In the present study also, two of the eight deceased donor kidney grafts (25%) had double renal veins. Both of these grafts were right kidneys (100%). This also confirms the previous study findings.

Usually, each kidney is drained by a single renal vein that drains into the inferior vena cava (IVC) at the level of the first or second lumbar vertebra (L1–L2). The left renal vein is longer, measuring approximately 6–7 cm, and runs anterior to the abdominal aorta before draining into the IVC. In contrast, the right renal vein is shorter, measuring approximately 3–4 cm, due to the closer proximity of the right kidney to the IVC. The left renal vein also has a relatively thicker wall, making it technically more favourable for vascular anastomosis during KT.

During embryonic development, the kidneys receive their blood supply from a series of arteries known as the mesonephric arteries, which arise from the abdominal aorta and the iliac arteries. As development progresses, most of the mesonephric arteries gradually regress. Typically, one of the mesonephric arteries persists and develops into the main renal artery. The non-regression of the mesonephric arteries results in accessory renal arteries. During the KT the iliac vessels are approached extra peritoneally. The renal vein is first anastomosed to the external iliac vein in an end to side manner with a continuous 5/0 monofilament sutures e.g. polypropylene sutures. The arterial anastomosis is done to the external iliac artery in an end to side manner with 6/0 monofilament polypropylene continuous sutures. Instead of the external iliac artery, the internal iliac artery can be used for arterial anastomosis.

Usually, within the kidney, the segmental renal arteries do not have significant anastomosis. Therefore, when there are multiple renal arteries, when one artery is not perfused the segment of the kidney becomes ischemic. Therefore, all the arteries of the kidney should be reconstructed. Whereas the segmental renal vein tributaries, has intra renal anastomosis. Therefore, when there are multiple renal veins, additional renal veins (smaller) can be ligated. Several arterial reconstruction techniques have been described. A side-to-side (double-barrel) reconstruction is performed when the two renal arteries are of similar calibre and arise close together. This technique creates a single

common arterial ostium that facilitates one arterial anastomosis to the recipient external or internal iliac artery.

When one of the renal arteries (accessory) is small and is present at a distance from the main renal artery, the main artery can be anastomosed to the external or the internal iliac artery and the accessory artery can be anastomosed to the inferior epigastric artery. This is particularly important for the lower polar artery, because the lower polar artery frequently supplies the ureter. Failure to reconstruct the lower polar artery may increase the risk of ureteric necrosis and urinary leaks (7).

In deceased donor kidneys, the renal arteries can be taken with the cuff of the donor aorta (Carrel patch). The patch containing multiple arteries can be used to create a single arterial anastomosis to the iliac artery. This method reduces operative time. However, in cases where arteries are widely separated on the aortic patch, the patch can be shortened (patch reconstruction). This allows for a smaller arteriotomy on the recipient external iliac artery. The other techniques used for the reconstruction are the use of iliac artery grafts from the deceased donor and the use of synthetic conduits (2).

Venous reconstruction is particularly challenging with the right renal vein. Anatomically, the right renal vein is significantly shorter and thinner. This increases the risk of venous anastomotic complications, including renal vein thrombosis. To address these challenges, the donor inferior vena cava (IVC) is preserved and a longitudinal segment of the donor IVC is sutured in continuity with the right renal vein, creating a venous extension that effectively increases both the length and functional calibre of the right renal vein. This reconstruction facilitates a tension-free end-to-side anastomosis to the recipient iliac vein, improves graft positioning within the iliac fossa, and reduces the risk of bleeding (8).

Alternative techniques for renal vein reconstruction include the use of autologous vein grafts, such as the recipient's great saphenous vein or the donor iliac vein. Although these reconstructive procedures may increase operative time, they effectively restore venous length.

Conclusions

A thorough understanding of both arterial and venous anatomical variations is essential for the successful procurement and transplantation of renal allografts. Renal vascular anomalies are associated with increased technical complexity, prolonged operative time, greater intraoperative blood loss, and a higher risk of perioperative complications for both the donor and recipient. Therefore, meticulous preoperative vascular imaging and assessment is critical in living donor transplantation.

In contrast, deceased donor organ retrieval is usually performed without preoperative vascular imaging. Consequently, successful organ retrieval relies on the surgeon's knowledge of normal renal vascular anatomy and its anatomical variations. Failure to identify these variations may result in inadvertent injury to the renal arteries or renal veins, resulting in the graft becoming unsuitable for transplantation. In the present series, accidental vascular injuries occurred in three cadaveric renal grafts (37.5%), highlighting the importance of the knowledge of the renal vasculature. During the deceased donor organ retrieval, dissection should be confined primarily to the anterior surface of the abdominal aorta while avoiding unnecessary lateral dissection, as accessory renal arteries

frequently arise from the lateral aspect of the aorta and the iliac arteries. In addition, dissection over the anterior surface of the IVC should be minimized because the accessory right renal arteries may run anterior to the IVC and may be injured during dissection (9). Preservation of generous cuff of the aorta and the IVC facilitates back bench reconstruction and anastomosis.

This study included a relatively small number of cases of multiple renal arteries that required arterial reconstruction before KT. As a result, the limited sample size may reduce the generalizability of the results. To better evaluate the outcomes of renal artery reconstruction in KT, future studies should include a larger patient population. In addition, extended follow-up is essential to assess both short-term and long-term transplant outcomes.

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Authors declare no conflict of interest

Data available on reasonable request

Author contributions: JA conceptualisation, manuscript writing, images, literature survey and reviewed

References

1. Arudchelvam J, Laksiri W. "Anatomical variations of the renal vasculature and outcome of live donor nephrectomies: experience of a single surgeon." Sri Lanka J Surg 2021;39; 2:28-30. https://doi.org/10.4038/sljs.v39i2.8817
2. Tzakis AG, Mazzaferro V, Pan, CE, Gorden RD, Todo S, Makowka L, Starzl TE. Renal artery reconstruction for harvesting injuries in kidney transplantation with particular reference to the use of vascular allografts. *Transplant Int* 1, 80–85 (1988). https://doi.org/10.1007/BF00353824
3. Budhiraja V, Rastogi R, Asthana AK. "Renal artery variations: Embryological basis and surgical correlation." Rom J Morphol Embryol 2010;51: 533–536. PMID: 20809032
4. Gümüş H, Bükte Y, Ozdemir E, Centincakmak GM, Tekbas G, Ekici F, onder H, Uyar A . "Variations of renal artery in 820 patients using 64-detector CTangiography." Ren Fail 34 (2012): 286-290. https://doi.org/10.3109/0886022X.2011.647295
5. Dissanayake PH, Jayasekera RW. "Study of Renal Artery Patterns in a Sri Lankan Population." SLAJ 2018;2;II): 24-30. https://slaj.sljol.info/articles/10.4038/slaj.v2i2.5
6. Hostiuc S, Rusu M.C, Negoi I. "Anatomical variants of renal veins: A meta-analysis of prevalence." Sci Rep 2019; 9: 10802. https://doi.org/10.1038/s41598-019-47280-8
7. Dăescu E, Zăhoi DE, Motoc A, Alexa A, Baderca F, Enache A. Morphological variability of the renal artery branching pattern: a brief review and an anatomical study. Rom J Morphol Embryol. 2012;53(2):287-91. PMID: 22732797
8. Silva JCCB, Pestana JM, Verissimo MJM, Castro MJ. "Right renal vein elongation with the inferior vena cava for cadaveric kidney transplants: an old neglected surgical approach." International braz j urol 2005;31;6:519-525. https://doi.org/10.1590/S1677-55382005000600002
9. Kugapiragash R, Arudchelvam J. "Renal Artery Variation Encountered During A Deceased Donor Organ Surgery." Batticaloa Medical Journal 2025;19;2: 48-50.