Plexus Medical Journal, Vol 4 (4) 2025: 149 -154
https://doi.org/10.20961/plexus.v4i4.2292
e-issn: 2828-4801

Reconstruction of Multiple Renal Arteries in Live Donor Kidney Transplantation: Moewardi Hospital Experience

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ABSTRACT

Background: *Kidney transplant is the procedure for end stage renal disease (ESRD). This treatment has longer survival advantage than dialysis. Anatomical variations in the renal vasculature like multiple renal arteries, may increase surgical difficulties and influence postoperative outcomes.*
Case Presentation: *We report a 46-year-old female living donor with two renal arteries on the left side of kidney. The recipient was her 25-year-old daughter with end stage renal disease due to systemic lupus erythematosus. A left open donor nephrectomy was completed without complications. The two renal graft arteries were side-to-side anastomosed each other, then an end-to-side anastomosis to the external iliac artery. The kidney achieved rapid reperfusion and returned to function immediately. Doppler ultrasound examination showed the normal perfusion. The creatinine level was 1.2 mg/dL on second day postoperative and stable at 0.8 mg/dL during a three-month follow-up.*
Conclusion: *This case highlights the feasibility of transplanting a kidney from a donor with multiple renal arteries, emphasizing the critical role of comprehensive preoperative evaluation and meticulous surgical planning in achieving optimal outcomes.*

Keywords: Multiple renal arteries; kidney transplantation; renal vascular reconstruction; live donor

INTRODUCTION

Kidney transplant is the procedure for end stage renal disease (ESRD). In comparison to remaining on dialysis, patients who will having a kidney transplant generally experience improved long-term survival outcomes (Abramyan & Hanlon, 2023). Patient with ESRD must be referred to meet a nephrologist and receive counseling regarding kidney disease and available therapy, including the kidney transplantation (National Kidney Foundation, 2015). Other option treatment for ESRD is a dialysis (peritoneal dialysis and hemodialysis) (Robinson et al., 2016). There was a longer survival advantage for kidney transplant than dialysis (Abramyan & Hanlon, 2023). Renal transplant patients generally experience a bigger quality of life compared to dialysis, likely due to their capacity to independently eliminate metabolic waste, maintain endocrine balance is a crucial factor in selecting suitable kidney donors for transplantation. Ideally, a single renal artery with adequate diameter and length is preferred to facilitate vascular anastomosis (Aremu et al., 2021). While each of the kidney is received blood supply by a renal artery, variation of anatomy can complicate the surgical procedure and impact postoperative outcomes (Aremu et al., 2021). To accurately assess renal vascular anatomy,

Computed Tomography Angiography (CTA) is determined to be the gold standard imaging modality (Aremu et al., 2021).

Anatomical variations of renal arteries are common, varying between 9% to 76% (Ertugrul & Aydin, 2019). The variations of renal artery significantly elevates the risk of complications due to increased technical complexity and prolonged anastomosis time during transplantation (Ertugrul & Aydin, 2019). During embryologic development, the renal arteries initially originate from the common iliac arteries as the kidneys ascend from the pelvis. As the kidneys move upward into the abdomen, they begin receiving blood supply from the aorta, and the earlier lower branches typically regress. However, due to this unique developmental process, kidneys may also receive branches from arteries such as gonadal, the middle suprarenal or inferior phrenic arteries, leading to various anatomical variations (Sevmis et al., 2020). Multiple renal arteries are relatively common, with general prevalence rates ranging from 6–30% (Sevmis et al., 2020). In the context of kidney transplantation, multiple renal arteries (MRAs) are observed unilaterally in 20.8%, bilaterally in 10.2%, and in total about 31% of cases (Sevmis et al., 2020). Renal artery variations in donor kidneys can significantly raise the risk of complications due to increased surgical complexity and extended anastomosis time (Nerli et al., 2019). Kidneys with MRAs (multiple renal arteries) are associated with bigger rates of prolonged warm ischemia time, vascular complications, and delayed graft function (Nerli et al., 2019). Therefore, meticulous surgical technique is essential to ensure successful transplantation outcomes.

The approach to reconstructing multiple renal arteries depends on their anatomical configuration (He & Mitchell, 2012). In some cases, additional vascular grafts may be needed. For kidneys with multiple renal arteries, smaller branches may be joined to a main artery or connected to the side of a major artery before the larger arteries are combined into a single ostium (He & Mitchell, 2012). The internal iliac artery and its branches may be an effective option for complex reconstructions (He & Mitchell, 2012). In deceased donor cases with multiple renal arteries, the use of a Carrel's patch allows the creation of a single arterial opening for anastomosis, simplifying the surgical procedure (Modi et al., 2024). However, the longer arterial pedicle associated with this technique may increase the risk of arterial kinking after transplantation (Modi et al., 2024).

This report aims to share variations and experience on kidney transplants, especially strategies in multiple renal arteries reconstruction in a living donor kidney transplant.

The consent for publication has provided research grants with numbers 1.503/VII/HREC/2025 by Health Research Ethics Committee of Dr. Moewardi General Hospital. Written informed consent was obtained from the patient for the publication of this case report, including the use of any accompanying clinical images.

CASE PRESENTATION

The donor is a 46-year-old female with one renal artery on the right side and two renal arteries on the left side. No contraindication was identified for kidney transplantation during medical examination. The GFR was 118 mL/min/1.73 m2. The anatomy of renal artery was visualized through CTA. Left kidney received vascular supply from two arteries (accessory renal artery and main renal artery), both entering through the hilum. The accessory artery was located ventrally, approximately 1.4 cm from the main renal artery origin. The main left renal artery measured 5.7 mm at its proximal segment and 5.5 mm distally, with a branching point located 2.5 cm from the origin. The accessory artery measured 3.2 mm distally and 5.1 mm proximally, also with a 2.5 cm distance to its first branching. No mural calcification or luminal stenosis was observed in either of the left renal arteries, indicating intact vascular wall integrity. While the right kidney received blood supplies from a single right renal artery. The right renal artery demonstrated a proximal diameter of 5.3 mm and a distal

diameter of 5.2 mm. The distance from the arterial origin to its first branching point was measured at 3.4 cm. Assessment of the renal veins showed that both the left and right renal veins had a distance of 3.5 cm from their origin with no abnormalities noted.

Figure 1. CT Angiography (CTA) showed left kidney receives vascular supply from two arteries (accessory renal artery and main renal artery)

Figure 2. Multiple renal arteries (accessory renal artery and main renal artery)

The recipient is her daughter, a 25-year-old who has end stage kidney disease due to systemic lupus erythematosus. Blood group compatibility was confirmed between the donor and recipient. The crossmatch was negative with an HLA mismatch. An HLA match of 8 out of 16 loci was observed between donor and recipient. She underwent hemodialysis for 11 months before the kidney transplantation.

After a comprehensive discussion, the left kidney was determined to be donated. A left open donor nephrectomy was completed without complications. The two renal graft arteries were side-to-

side anastomosed each other, then end-to-side anastomosed to the side of external iliac artery. An anastomosis was performed successfully between the renal vein and the external iliac vein.

A left open donor nephrectomy was completed without complications. The kidney was reperfused rapidly and returned to function immediately. Normal perfusion was confirmed on doppler ultrasound. Serum creatinine was 1.2 mg/dl at day 2 and stable at 0.8 mg/dl during the 3-month follow-up period.

Figure 3. Side-to-side anastomosis of two renal arteries from a left donor kidney graft

DISCUSSION

End-stage renal disease (ESRD) is a growing public health concern, with an annual incidence increase of 8%, significantly outpacing the 1.3% population growth rate (Demir & Merhametsiz, 2021). To reduce its associated morbidity and mortality, clinicians aim to provide the most suitable renal replacement therapy for eligible patients. Studies have shown that kidney transplantation offers the most effective form of renal replacement therapy, providing superior long-term survival compared to dialysis for patients with ESRD (Hryshchuk & Parii, 2024).

Renal vascular anatomical variations are a key consideration in kidney transplantation, as they influence the choice between the left or right kidney for donation. Such variations are relatively common, occurring in approximately 18% to 25% of kidney donors (Gebremickael et al., 2021). This study found that venous variations were present in both sides, while arterial variations were in the left side. This result is similar to previous study observed by Cinar et al (Cinar & Turkvatan, 2016). Accessory renal arteries are crucial in kidney transplantation, as failure to properly anastomose them can result in segmental kidney necrosis and may lead to graft rejection or the need to discard the kidney (Cinar & Turkvatan, 2016).

This study aims to share variations and experience on kidney transplants. In this study, the two renal graft arteries were side-to-side anastomosed each other, then end-to-side anastomosed to the side of external iliac artery. A previous study reported that in live donor renal transplantation, recipient vessels such as the great saphenous vein, the internal iliac artery (IIA), or gonadal vein may be utilized to reconstruct donor vessels when their length is insufficient (Modi et al., 2024). The advantages of living donation include cold ischemia time, optimal selection, and timing (Nerli et al., 2019). In living

donor nephrectomy, harvesting an aortic patch is not feasible for technical reasons. Therefore, careful dissection and retrieval of all renal arteries with sufficient length are essential. Each artery must be individually cannulated and promptly perfused ex situ to ensure optimal graft preservation (Nerli et al., 2019).

A systematic review and meta-analysis found that patients with multiple renal arteries (MRA) experienced longer warm ischemia and rewarming times compared to patient with a single renal artery, along with a bigger risk of delayed graft function (Bachul et al., 2017). Unlike renal veins, which have extensive internal connections and can be ligated more safely, renal arteries are end arteries; damage or ligation can cause localized ischemia and infarction (Bachul et al., 2017). The other previous study stated grafts with MRA have the same results as SRA (Sevmis et al., 2020). Study by Sevmis et al. demonstrated that MRA had no significant impact on surgical complications (vascular injury, vascular thrombosis, renal artery reconstitution, and acute tubular necrosis). In this study, the kidney was reperfused rapidly and returned to function immediately after left open donor nephrectomy was performed. Normal perfusion was confirmed on doppler ultrasound. Early procedure complications (urological and vascular) and delayed of graft function depends on surgical competences and experiences (Sevmis et al., 2020). Hu et al. propose that the surgery team must coordinate the procedure plan, considering that MRA may need longer surgery time and increase the risk of vascular complications (Hu et al., 2014).

Key limitations of this study include a short follow-up duration, absence of detailed assessment of surgical techniques, and the reliance on the surgeon's skill and experience as major factors influencing outcomes.

CONCLUSION

Transplantation of kidney graft with multiple renal arteries is possible. Evaluation of the donor and recipient vascular structures prior to and during renal retransplantation is a very important factor for achieving the expected outcomes.

ACKNOWLEDGMENT

The authors acknowledge the contributions of the surgical team and medical staff of Dr. Moewardi Hospital for their support and collaboration during the kidney transplantation procedure. We also thank the patient and her family for their cooperation and willingness to share their experience for educational purposes.

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