CASE REPORT

Renal Vein Variation, An Anatomical Dilemma for Donor Nephrectomy: A Case Report

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Abstract

Living donor nephrectomy demands a clear understanding of the renal vascular anatomy to optimize graft outcomes and for donor safety. We report the case of a 43-year-old healthy female kidney donor in whom preoperative imaging identified. The left renal vein (LRV) was draining into the left common iliac vein (LCIV). A smaller branch was connecting the LRV to the Inferior vena cava (IVC) at the level of L3. She also had a discrepancy in split renal function where the Right contributed 40% and the Left contributed to 60%. Abandoning the "left-side preference", a right donor nephrectomy was performed considering the anatomical variations and split function. The patient recovered well after an uneventful procedure. Inadvertent damage to dominant pathway of venous return in an anomalous IVC would have severely impeded systemic venous return from the lower extremities, leading to acute or chronic deep venous insufficiency, intractable leg edema, and deep vein thrombosis (DVT). Hence, personalized, meticulous vascular assessment with high-resolution CT venous phase angiography is essential to prevent catastrophic surgical strategy errors in donor nephrectomy.

Keywords: embryology; left renal vein; vascular mapping; living donor; nephrectomy

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Introduction

Living donor nephrectomy demands a clear understanding of the renal vascular anatomy to optimize graft outcomes and for donor safety. The density and range of variations of renal veins derive from the complex embryological origin where a dual parallel system of veins converge to form the single IVC tributary system. Variations in renal veins are more common on the right side ranging from 7.2 % to 33 % (1). Ironically, the left nephrectomy is preferred for living donors due to the length and strength of the left renal vein. They are less common in the left 0 to 9 % but more complex when encountered due to differences in embryological origin (1). Complex venous drainage is not an absolute contraindication for nephrectomy (2), however, undetected or improperly managed anatomical variations can lead to catastrophic intraoperative hemorrhage, graft vascular thrombosis or systemic venous compromise. Knowledge of vascular anomalies helps in planning of surgery and reduces undesirable donor morbidity. We present a case where on routine assessment of a living donor, the left renal vein (LRV) was found to be draining into the left common iliac vein (LCIV) and we discuss its embryology, importance of radiological recognition in surgical decision making.

Case Presentation

We report the case of a 43-year-old healthy female patient with no comorbidities who was screened as a potential living kidney donor. Her physical examination, baseline laboratory evaluations including serum creatinine, were normal. However, split renal function assessment via a Technetium-99m Diethylenetriaminepentaacetic acid (99mTc-DTPA) renal scan revealed a significant functional disparity: the Right kidney contributed 40% of the total renal function, while the Left kidney contributed 60%. A CT Renal Angiogram was performed for preoperative assessment of donor renal vasculature. The arterial phase demonstrated single renal arteries bilaterally. The venous phase demonstrated a single Right Renal Vein draining into the inferior vena cava (IVC) at the level of L1. However, the Left Renal Vein was running inferiorly and was draining into the left common iliac vein. A smaller branch was connecting the LRV to the IVC at the level of L3 (Figure 1).

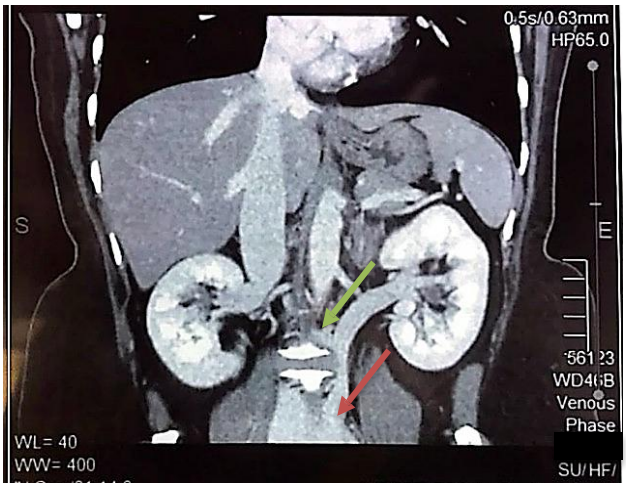


Figure 1: Coronal view of contrast enhanced CT phase showing drainage of LRV to LCIV (red arrow), smaller branch connecting to IVC (green arrow)

A right donor nephrectomy was planned considering the function and the anatomical variations. In this case the donor has a single right renal vein and artery each and the nephrectomy was performed uneventfully with minimal blood loss following which the donor recovered well.

Discussion

The variations of the renal venous anatomy are directly related to the development of the IVC and its tributaries (3). Between the 4th and 8th weeks of gestation, IVC develops from a series of longitudinal venous channels which appear in the embryo: The Posterior cardinal veins (PCV) (Figure 2) receive veins of lower limb buds (external iliac) and pelvis (internal iliac).

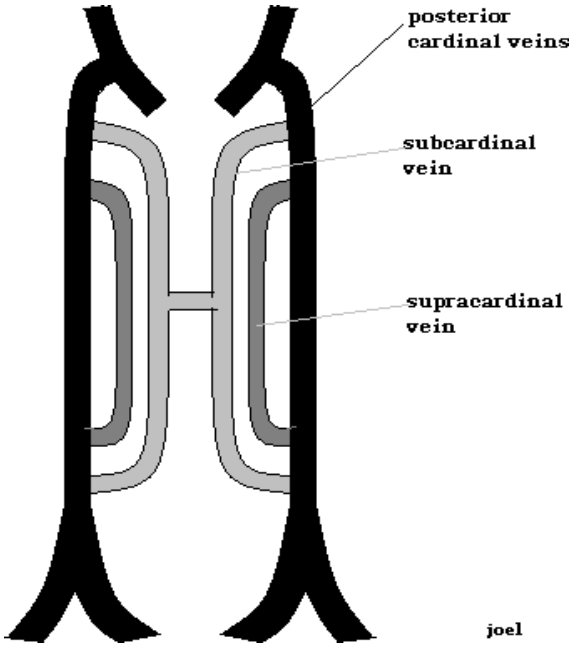


Figure 2: The cardinal veins

Caudal ends of the bilateral PCV become connected with transverse anastomosis which is the the future left common iliac vein. The PCV joins the anterior cardinal veins (ACV) to form the common cardinal vein (CCV) and drain into the sinus venosus which is the future right atrium (4). Caudal PCV and lower limb veins are together known as sacro cardinal veins. In addition, there are, Sub cardinal veins (SCV) and the Supra cardinal veins (SuCV). The SCV are the veins of developing kidneys. The SuCV are the thoraco lumbar veins. The SCV and SuCV connect at the cranial and caudal ends of the posterior cardinal veins (Figure 2). Most of these veins disappear during 6th to 10th week of gestation and the parallel venous system gets converted into unilateral right-sided Inferior Vena Cava (IVC) in the following manner depicted in Figure 3. At this time, two renal veins forms from an anastomosis between the subcardinal and supracardinal veins on either side, each on ventral and dorsal planes and form a collar of veins encircling the aorta (5). The ventral portion of this collar persists as the normal left renal vein. In case they do not merge, accessory renal veins are seen (4). If the dorsal portion of this collar persists, the left renal vein is posterior to the aorta forming a retroaortic left renal vein (RLRV). The two most common variants on the left are the circumaortic left renal vein (CLRV) and RLRV (6). RLRV is present in 1.7 to 3.4% of the population and of circumaortic vein is 2.4 to 8.7% (7). Double renal veins are common unlike triple and quadruple renal veins that are very rarely reported in literature (8).

When comparing the right and left renal veins overall incidence of variations is seen more commonly on the right renal vein, ranging from 7.2% to 33% and 0% to 9% on the left renal vein (8, 3).

In a study by Pandya *et al.,* with 200 healthy donors the standard pattern of drainage of renal veins was observed in only 67% of donors on the right side and 92% of donors on the left side (1). Supernumerary renal veins in the form of dual and triple renal veins were seen on the right side in about 32.5% of donors (dual right renal veins in 30.5% cases and triple right renal veins in 2.5% cases) (1).

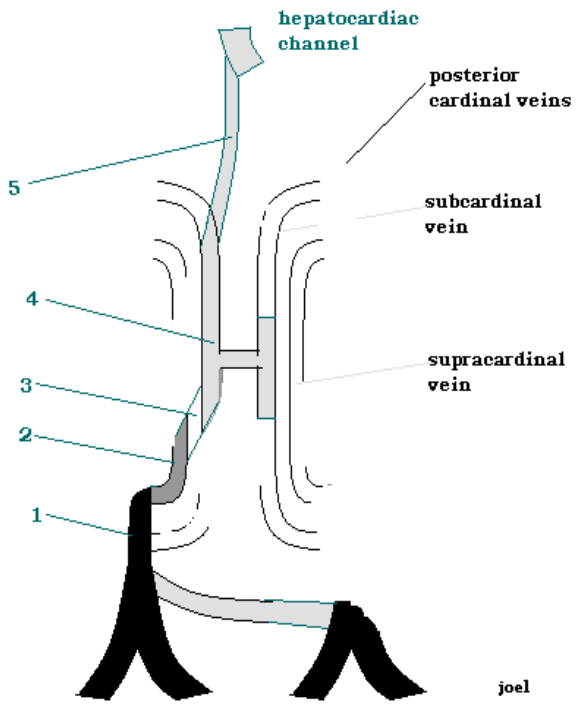


Figure 3: 1- Lower end of PCV (Sacro cardinal segment), 2- SuCV, 3- SuCV-SCV anastomosis, 4- Right SCV (Renal segment), 5-SCV - Right hepato cardiac channel anastomosis, 6- Right hepato cardiac channel

An accessory renal vein is where the extra renal vein drains into inferior vena cava separately in addition to the renal vein proper and are more common on the right side due to the persistence of mesonephric veins and a rarity on the left because the largest component of the venous system regresses on that side (9).

The literature describes few cases where the left renal vein directly drains to the Left common iliac vein. It has been described in one case in the study of 200 live kidney donors in the study by Pandya *et al.,* (1). Kaabneh *et al.,* reported a 21-year-old female kidney donor in 2017 with a single left renal vein draining to the left common iliac vein (LCIV) she underwent a left donor nephrectomy without undue complications due to preoperative identification of the anomaly (10). Brancatelli *et al.,* in 2000, reported one case of the retroaortic left renal vein joining the left iliac vein (11). Karaman *et al.,* studied a total of 1856 patients who underwent CT with or without urological symptoms and prospectively evaluated for the presence of RLRV and reported that three patients (0.16%) had this variation in his study (12). The surgical implication of the complex origin of the LRV is due to the fact that historically the left kidney has been favored by transplant surgeons due to its longer and stronger renal vein, which offers technical flexibility during implantation of the kidney. Failure to recognize a complex anomaly and attempting a left donor nephrectomy may have led to a spectrum of adverse outcomes, ranging from technical difficulty, prolonged operative time to catastrophic bleeding or venous outflow obstruction in the donor. Isolating, clamping, or dividing these two veins identified in this case could have compromised the systemic venous return of the lower extremities as it may be the dominant pathway of venous return in this anomalous drainage pattern. Such an injury would severely impede systemic venous return from the lower extremities, leading to acute or chronic deep venous insufficiency, intractable leg edema, and deep vein thrombosis (DVT). These complications would be catastrophic for a healthy donor who walked into the operating room with zero comorbidities and expects an uneventful recovery back to their daily livelihood; highlighting the importance of preoperative renal vasculature assessment in surgical decision making. The functional standpoint of this case was the reduction in split renal

function (40% Right 60% Left) also aligned in selecting a Right donor nephrectomy. Standard transplant guidelines dictate leaving the donor with the higher-functioning kidney to preserve long-term renal reserve (13). In a healthy individual, a normal split renal function assessment via 99mTc-DTPA is typically close to an equal split (50% Right /50% Left), albeit 45%/55% being generally considered acceptable (14). When evaluating a living kidney donor, this assessment acts as a crucial safety guard. It is recommended that the kidney with poorer split renal function to be selected for donor nephrectomy irrespective of vascular anatomy (2). In our case, both the functional and anatomical considerations favored a right donor nephrectomy, following which the donor recovered fully with no complications.

Conclusion

The clinical importance of this case lies at the intersection of donor safety and advanced vascular mapping. It challenges the traditional "left-sided preference" in living donor nephrectomy by highlighting a scenario where anatomical anomalies and functional disparities paradoxically aligned to protect the donor. Personalized, meticulous vascular assessment with high-resolution CT venous phase angiography is essential to prevent catastrophic surgical strategy errors.

Authors declare no conflict of interest

Author contribution

JA was involved in conceptualization, and review of the manuscript, KTSW was involved in writing the manuscript literature review and editing, PLW was involved in patient investigation and conceptualization.

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