CASE REPORT

Left Donor Nephrectomy in a Patient with Duplicated Inferior Vena Cava: A Case Report

C Lalinshan[1] J Arudchelvam[1,2] LEDI Kumari[1,] MRA Rahuman[1]

[1]*National Hospital of Sri Lanka*
[2]*Department of Surgery, Faculty of Medicine, University of Colombo*

Abstract

Duplication of the inferior vena cava (IVC) is a rare vascular anomaly of surgical significance. We report the case of a 31-year-old healthy female kidney donor in whom preoperative imaging identified a duplicated IVC. This anomaly was apparent on CT angiography, which allowed meticulous surgical planning. The patient subsequently underwent a left open donor nephrectomy without complications. Intraoperative findings confirmed the duplicated IVC, which was managed successfully by careful dissection and preservation of venous drainage. Both donor and recipient had uneventful recoveries. This case underscores the clinical importance of recognizing a duplicated IVC prior to nephrectomy, as early identification enables appropriate surgical strategy to avoid inadvertent vascular injury and ensures optimal outcomes for transplantation

Keywords: Nephrectomy; Inferior Vena Cava; Anatomical variations

DOI: https://doi.org/10.4038/slaj.v10iI.306

Sri Lanka Anatomy Journal 2025;10(I): 105–110

Corresponding author

C Lalinshan
email: lalinshan@gmail.com

Introduction

Inferior vena cava duplication is a congenital venous anomaly resulting from abnormal embryologic development. It is relatively rare, with a reported prevalence ranging from about 0.2% to 3% of the population (1). In this condition, two IVC channels are present: typically a right-sided IVC in the usual location and an additional left-sided IVC. The left IVC usually drains into the left renal vein, which then crosses anterior to the aorta to join the right IVC. Most individuals with duplicated IVC are asymptomatic, and the finding is often incidental on imaging. However, this anatomic variant holds considerable clinical relevance in surgery (2). Unrecognized duplicated IVC can complicate retroperitoneal surgeries such as nephrectomies or aortic surgery, as an unsuspected venous channel may be injured or ligated inadvertently (3). Early recognition and reporting of IVC duplication on preoperative scans are therefore critical. In the context of living donor nephrectomy, identifying a duplicated IVC preoperatively allows the surgical team to plan accordingly and modify the technique if necessary. We present a case of a living kidney donor with a duplicated IVC discovered on preoperative imaging, and we discuss its embryology, radiologic recognition, and surgical management implications.

Case Presentation

A 31-year-old woman with no significant past medical history was evaluated for living kidney donor. She was in excellent health and all laboratory evaluations were within normal limits. As part of the donor work-up, a CT renal angiography was performed to assess renal vasculature anatomy (Figure 1). Contrast-enhanced CT imaging demonstrated a duplicated inferior vena cava with a left-sided IVC ascending along the left para-aortic region and joining the left renal vein before crossing anterior to the aorta to join the right-sided IVC. The left renal vein was single and normally formed by the confluence of segmental renal tributaries at the renal hilum. No duplication of the left renal vein was identified. There were no supernumerary renal veins on either side. The left IVC was observed as a continuation of the left common iliac vein and drained into the left renal vein. The right and the left iliac veins did not join at any site. No other vascular anomalies were noted. Despite the presence of a duplicated inferior vena cava, the left kidney was selected for donation in accordance with standard donor nephrectomy principles, which prioritize procurement of the kidney with the longest possible renal vein to facilitate implantation. In this case, the left renal vein received the left-sided IVC before crossing to the right, thereby providing an adequate venous length for safe anastomosis. The right renal vein, although technically shorter and potentially easier to retrieve in certain anomalous configurations, would have provided limited length and potentially increased technical difficulty during recipient implantation.

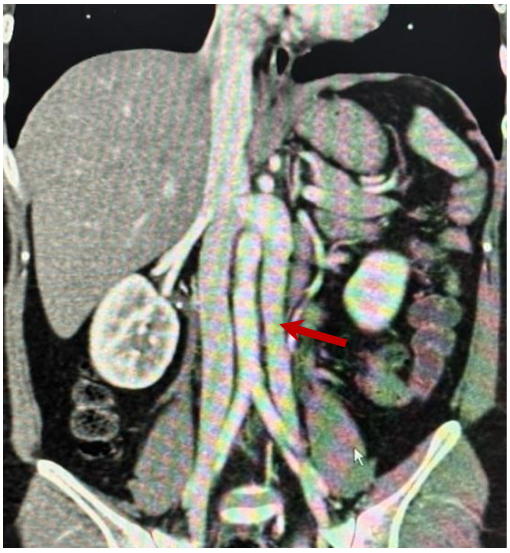

Figure 6: Coronal view of contrast enhanced CT venous phase showing duplex IVC(Arrow).

The nephrectomy was performed via an open loin approach with the patient in a right lateral decubitus position. Upon entering the retroperitoneal space and mobilizing the left kidney, the duplicated left IVC was identified running parallel to the aorta (Figure 2).

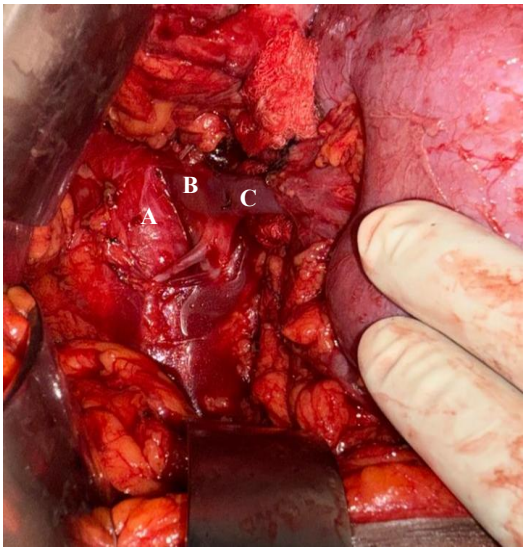

Figure 7: Intraoperative Image. A - Aorta, B - Right sided duplex IVC, C - Left renal vein

To maximize the length of the left renal vein, meticulous dissection was carried medially up to the junction of the left renal vein with the left-sided IVC. The renal vein was divided flush with the caval junction following application of satinsky clamp to ensure maximal venous length. Tributaries including the left gonadal, lumbar, and adrenal veins were carefully identified, double-ligated, and divided close to their origin to prevent unnecessary shortening of the renal vein. Care was taken to avoid excessive traction or skeletonization that could compromise venous integrity.

The left-sided IVC was carefully preserved and managed to maintain adequate venous outflow from the left lower extremity and pelvis, minimizing the risk of postoperative venous hypertension or limb edema.

The donor's postoperative course was uneventful. She did not experience any significant complications such as bleeding or venous congestion of the left leg. The donor was ambulating on the first postoperative day and was discharged home on the third postoperative day in good condition. The transplanted kidney was implanted into the recipient's right iliac fossa using standard techniques. Both donor and recipient remain in good health at their latest follow-up.

Discussion

The inferior vena cava (IVC) is the largest vein in the body, returning venous blood from the lower extremities, pelvis, and abdominal viscera to the heart. It is formed by the union of the right and left common iliac veins, typically at the level of the fifth lumbar vertebra. From its origin, the IVC ascends retroperitoneally along the right side of the vertebral column, to the right of the abdominal aorta, with key anatomical relations to adjacent organs. In the lower abdomen, the IVC lies posterior to the third part of the duodenum and head of the pancreas, and further cephalad it runs in a groove on the posterior surface of the liver. It travels through the central tendon of the diaphragm at the caval hiatus around the T8 vertebral level and has a short intrathoracic segment before draining into the right atrium. Unlike many veins, the IVC has no valves except for a rudimentary Eustachian valve at its junction with the right atrium (4).

As it ascends, the IVC receives numerous tributaries. Major contributors include the paired renal veins usually at L1–L2, the right suprarenal vein drains directly into IVC, whereas the left suprarenal joins the left renal vein. Three main hepatic veins draining the liver into the IVC just below the diaphragm, the inferior phrenic veins, lumbar veins, and the right gonadal vein draining into the IVC;

the left gonadal vein drains into the left renal vein. Notably, the ascending lumbar veins in vertically alongside the spine and connect the iliac veins to the azygos venous system; these act as important collateral channels between the IVC and superior vena cava (5). The embryogenesis of the inferior vena cava is complex, involving the sequential development and regression of three paired venous channels: the posterior cardinal, subcardinal, and supracardinal veins. Posterior cardinal veins (PCV); joins anterior cardinal veins at the anterior end to form common cardinal vein. PCV receive veins of lower limb bud which is external iliac and pelvis. Sub cardinal veins (SCV) is are veins of developing kidneys. Supra cardinal veins (SuCV) form the thoraco lumbar veins. Caudal end becomes connected with transverse anastomosis. SCV and SuCV connect cranial and caudal ends posterior cardinal veins. Most of these veins disappear between the 6th and 10th week of gestation, and remodel to form the adult venous system (figure 3) (6). Duplicated IVC occurs when the left supracardinal vein fails to regress, resulting in two parallel venous channels persisting into adulthood (7).
Commonly-described anomalies of IVC include circumaortic left renal vein (1.5%–8.7%), azygous or hemiazygous continuation of IVC (0.6%), retro-aortic left renal vein (2.1%), double IVC (0.2%–3%) and isolated left-sided IVC (0.2%–0.5%) (1). A large proportion of cases are discovered incidentally, either on radiologic examinations or during surgeries performed for unrelated reasons. In our patient, the anomaly was detected on a dedicated CT angiogram during donor evaluation, underscoring the value of thorough preoperative imaging.

A left-sided IVC occurs when the normal right-sided venous channel regresses and the left-sided embryonic vein persists as the

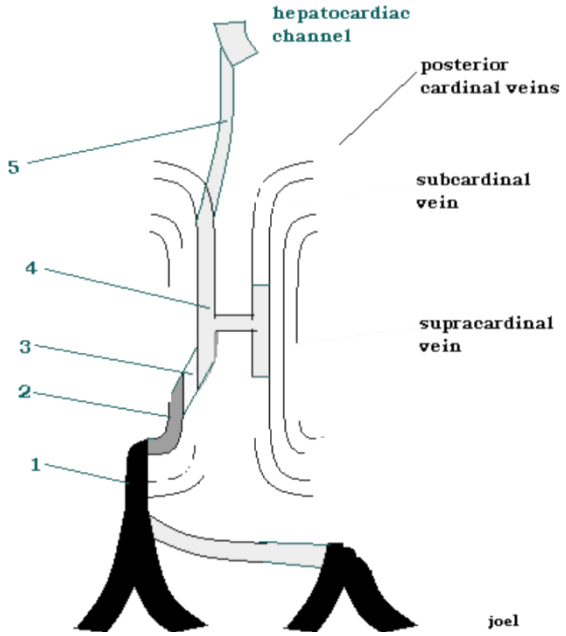

Figure 8: 1- Lower end of PCV (Sacro cardinal segment), 2- SuCV, 3- SuCV-SCV anastomosis, 4- Right SCV (Renal segment), 5- SCV - Right hepato cardiac channel anastomosis, 6- Right hepato cardiac channel

dominant cava. In embryologic terms, this usually means the right supracardinal vein involutes and the left supracardinal vein remains, leading to an IVC that courses along the left side of the aorta (4).

Azygos continuation of the IVC refers to a scenario where the upper segment of the IVC is absent or “interrupted,” and venous return from the lower body is shunted through the azygos system and often the hemiazygos on the left to reach the SVC. There are two closely related patterns here: one involving absence of the infrarenal IVC, and another involving absence of the suprarenal IVC. Both result in blood being rerouted through the paravertebral collateral veins (8).

On cross-sectional imaging, a duplicated IVC is identified by the presence of two venous structures flanking the abdominal aorta. Typically, the right-sided IVC follows its normal course to the right of the aorta, while a

left sided IVC is usually seen as a continuation of the left common iliac vein, crossing anterior to the aorta at the level of renal vein to join the right sided IVC (9).

A duplicated IVC has important clinical implications and may be misdiagnosed as lymphadenopathy, left pelvi-ureteric dilatation, retroperitoneal cysts, or bowel loops, potentially leading to inappropriate management. It should be considered in young patients presenting with DVT or pulmonary embolism without typical risk factors, as altered venous flow and anticoagulation dynamics may contribute. During endovascular interventions such as IVC filter placement, duplication must be recognized to allow bilateral filter insertion or placement above the confluence. Duplication also complicates retroperitoneal and transplant surgery, as associated supernumerary renal veins and anomalous tributaries increase dissection difficulty and hemorrhage risk, making meticulous pre-operative CT evaluation essential (10).

From a surgical standpoint, a duplicated IVC in a donor requires special consideration but is not a contraindication to proceed with nephrectomy (11). The primary concern is to prevent inadvertent injury or ligation of the anomalous vein, which could lead to significant hemorrhage or loss of venous return from the left lower extremity. Awareness of the anomaly allows the surgeon to adapt the technique. Several operative strategies have been described in the literature for managing a duplicated IVC during donor nephrectomy. One approach is to preserve the continuity of the left IVC by ligating the left renal vein distal to the confluence, leaving the left IVC intact in the donor as done in the above-described patient (12). When the left IVC is ligated or resected, the donor's venous return from the left leg and left gonadal vein must rely on collateral pathways. In practice, this collateral circulation often suffices. Reports have documented that even if the infrarenal left IVC is removed, resultant symptoms are usually mild and transient (13). Other reports highlight that complications can still occur. One described complication in a male donor is persistent painful left scrotal swelling and bilateral hydroceles from venous congestion after left nephrectomy with an unrecognized duplicated IVC (14).

This case highlights why early preoperative identification of a duplicated IVC is important. Failure to recognize this anomaly prior to surgery can lead to a spectrum of adverse outcomes, ranging from technical difficulty and prolonged operative time to catastrophic bleeding or venous outflow obstruction in the donor. In the worst scenario, an unrecognized duplicated IVC could be mistakenly ligated under the assumption that it is a smaller tributary, which might result in acute venous hypertension in the left leg or kidney.

Conclusion

Duplicated inferior vena cava is an uncommon but clinically important anatomical variant that transplant surgeons and radiologists must keep in mind. Early detection through preoperative imaging is paramount. In the presented case, identification of a duplicated IVC before surgery enabled the team to modify the donor nephrectomy technique, resulting in a safe operation and excellent outcomes for both donor and recipient. A duplicated IVC should not disqualify an otherwise suitable donor. Key lessons include the need for detailed venous phase imaging in all donor evaluations, the value of preserving collateral drainage or minimizing venous stump in cases where the IVC is divided, and the importance of

counseling donors about potential postoperative venous congestion issues.

References

1. Ng WT, Ng SS. Double inferior vena cava: a report of three cases. Singapore Med J. 2009;50(6): e211–e213.
2. Gnaoulé D, Bravo-Tsri A, Toure A, et al. Incidental discovery of duplicated inferior vena cava in a septuagenarian: the radiologist's viewpoint. Radiol Case Rep. 2021; 16: 3196–3200.
3. Gerial EL Jr, Castro AP. Duplicated inferior vena cava in a hand-assisted laparoscopic donor nephrectomy patient: a rare case managed through a novel technique. NKTI Proc. 2008; 10: 109–115.
4. Li SJ, Lee J, Hall J, et al. The inferior vena cava: anatomical variants and acquired pathologies. Insights Imaging. 2021; 12: 123.
5. Tucker WD, Shrestha R, Burns B. Anatomy, abdomen and pelvis: inferior vena cava. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025.
6. Gupta P. A rare presentation of the double inferior vena cava with an anomalous retrocaval right ureter: embryogenesis and clinical implications. J Clin Diagn Res. 2013;7(10):[pages]. https://doi.org/doi:10.7860/JCDR/2013/4576.2810
7. Awashra A, Shubietah A, Rezkalla A, et al. Duplicated inferior vena cava: a rare anatomical variation. Clin Case Rep. 2025;13:e70411. https://doi.org/doi:10.1002/ccr3.70411
8. Petik B. Inferior vena cava anomalies and variations: imaging and rare clinical findings. Insights Imaging. 2015; 6: 631–639.
9. Jha P, Knipe H, Ranchod A. Duplication of the inferior vena cava. Radiopaedia.org [Internet]. 2012 Aug 21. Available from: Radiopaedia.org. https://doi.org/doi:10.53347/rID-19270
10. Li WR, Feng H, Jin L, et al. Duplication of the inferior vena cava: a case series. J Int Med Res. 2022; 50:3000605221100771.
11. Rizvi S, Prasad TK, Modi P. Retroperitoneoscopic left donor nephrectomy with duplicated inferior vena cava. Indian J Nephrol. 2012; 22:480.
12. Davari HR, Malek-Hosseini SA, Salahi H, et al. Management of infrarenal duplicated inferior vena cava during living-related kidney transplantation. Transpl Int. 2007; 20:478–479.
13. Pal BC, Modi PR, Rizvi SJ, et al. Pure retroperitoneoscopic donor nephrectomy in duplication of inferior vena cava: a series of four cases. Urol Ann. 2017; 9:335–338.
14. El Hennawy HM, Al Faifi AS, Al Atta E, et al. Successful completion of left laparoendoscopic single-site donor nephrectomy in a patient with duplicated inferior vena cava: case report and review of literature. Exp Clin Transplant. 2023; 21: 272–274.