

**Images – Duplicated inferior vena cava: A potential challenging anomaly for retroperitoneal surgery**

Alex Ng, Annie Tsung, Christopher Nguan, David Harriman

Department of Urologic Sciences, University of British Columbia, Vancouver, BC, Canada

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**Corresponding author:** Dr. David Harriman, Department of Urologic Sciences, University of British Columbia, Vancouver, BC, Canada; [david.harriman@ubcurology.com](mailto:david.harriman@ubcurology.com)

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**INTRODUCTION**

A duplicated inferior vena cava (IVC), also known as a persistent cardinal vein, is a rare congenital vascular anomaly with important implications for renal surgery. This abnormality can be found in both sexes, with a recent meta-analysis estimating an overall prevalence of 0.7% for this condition.<sup>1</sup> When duplication of the IVC occurs, the left IVC will usually cross the aorta and anastomose to the right IVC at the level of the renal veins.<sup>2</sup> This variant of vascular anatomy can be mistaken for a neoplasm or adenopathy,<sup>1</sup> and can lead to intra- and post-operative complications if not properly identified.

**CASE REPORTS**

Over the relatively short span of 6 months, 3 living kidney donors presented with duplicated IVC to our tertiary hospital's kidney transplant program. As part of routine pre-operative assessment, abdominal computed tomography (CT) imaging was performed on these patients. Two of these cases were recognized as duplicated IVC by the attending radiologist. The third case was only recognized upon review of the CT scan by the transplant urologist. All three left donor nephrectomies were performed laparoscopically, with careful attention taken during

**KEY MESSAGES**

- A duplicated inferior vena cava presents unique considerations for urologists performing retroperitoneal surgery, while minimizing perioperative complications.
- This condition can go unnoticed upon radiologic investigation; it is important that urologists are aware of this condition and carefully review preoperative imaging themselves.
- Recognition of a duplicated inferior vena cava facilitates successful retroperitoneal surgery with minimal perioperative complications.

medialization of the bowel and tenting of the ureter off the psoas muscle to ensure no injury to the left sided IVC. The gonadal vein drained directly into the left IVC in all three cases, so it was left medial and not raised off the psoas muscle with the ureter. The renal artery was found posterior to the IVC and renal vein in all cases. We did not aggressively chase the renal artery down to the origin of the aorta. The left renal vein and artery were both transected at the level where the renal vein entered the left limb of the IVC. We did not want to be too aggressive fighting for vessel length in these cases as we wanted to preserve the left IVC. Upon review of all kidneys on the back table, vessel length was deemed sufficient for direct implantation without the need for extension with adjunct vessels or grafts. In all three cases, left donor nephrectomy was successfully performed without incident, and all patients recovered without complication.

The IVC develops *in utero* through the development and regression of three sets of paired veins: the posterior cardinal, subcardinal and supracardinal veins.<sup>2</sup> In normal development, the right subcardinal vein eventually forms the suprarenal IVC, while the right supracardinal vein forms the infrarenal part of the IVC.<sup>2</sup> IVC duplication is caused by the persistence of both the left and right supracardinal veins, resulting in the formation of an IVC on either side of the aorta.<sup>2</sup>

There are three classifications of duplication of the IVC. Type I, or major duplication, is characterized by two identifiable symmetric trunks, with a preaortic trunk that is of the same size.<sup>1</sup> A Type II classification is assigned in the case of a minor duplication in which there are two symmetric trunks that are smaller in comparison to the preaortic trunk.<sup>1</sup> Lastly, Type III is characterized by an asymmetric duplication with a smaller left IVC, a larger right IVC, and a preaortic trunk that is the largest in size.<sup>1</sup> It is important to understand the different variations of duplicated IVC to recognize how this may present on preoperative imaging.

Patients with a duplicated IVC are at risk of vascular injury during retroperitoneal surgery.<sup>2</sup> Awareness of a duplicated IVC is hence important for both radiologists and surgeons to ensure accurate identification of the anomaly and appropriate surgical planning to prevent perioperative complications. If unidentified, risks may be heightened.<sup>2,3</sup> As an example, one case report showed that a misdiagnosis of the left IVC as the left renal vein and subsequent inadvertent ligation of the left IVC led to deep vein thrombosis in the iliac and deep leg veins.<sup>4</sup> Preoperative identification is especially important for renal surgery, done by laparoscopic approaches, where a limited field of view can pose challenges for the identification of vascular anomalies.<sup>2</sup>

IVC duplication is most often discovered incidentally upon radiologic investigation.<sup>2</sup> Contrast-enhanced CT is the current preferred imaging modality for visualization of the kidneys, retroperitoneum, and vascular anatomy.<sup>5</sup> Detailed reconstruction in the axial, coronal and sagittal planes are routinely performed during CT scans. Careful review should allow urologists to identify key structures to help with surgical planning. Of special note for donor nephrectomy, the length of the renal vein should also be considered, as this may have bearing on whether to approve a potential kidney donor, decide to perform a procedure laparoscopically versus open, or

choose to perform the surgery on the contralateral side to ensure adequate vessel length for subsequent renal transplantation.<sup>1</sup>

If duplicated IVC is recognized on preoperative imaging, slight adjustments in standard surgical protocol for donor nephrectomy may need to be considered. Specifically, it may be that dissection cannot be carried out as medially as would normally be undertaken due to the left limb of the IVC being in the way of getting at the aorta. In our cases, the left gonadal vein drained directly into the left limb of the IVC, so it was not able to be used as a roadmap to get to the renal hilum as would typically be done. Only one of our cases had a lumbar vein that needed to be ligated prior to taking the renal hilum. The adrenal vein was present in all three cases but came off medially enough so that ligation was not necessary before taking the hilum. Should concerns for adequate vessel length exist, measures such as using third-party vessels or stapling the left IVC, presuming there are adequate collateral veins recognized on preoperative imaging, could be considered. These measures were not needed in our cases as vessels were short, much like would be found on a right living donor kidney, but adequate for direct implantation.

## CONCLUSIONS

The presence of a duplicated IVC presents unique considerations for urologic procedures. It is hence important that urology providers be aware of this variation in vascular anatomy to mitigate potential complications. Detailed review of imaging will allow providers to recognize such anomalies and to understand the course of other key structures encountered to ensure patient safety during retroperitoneal surgery.

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## FIGURES AND TABLES

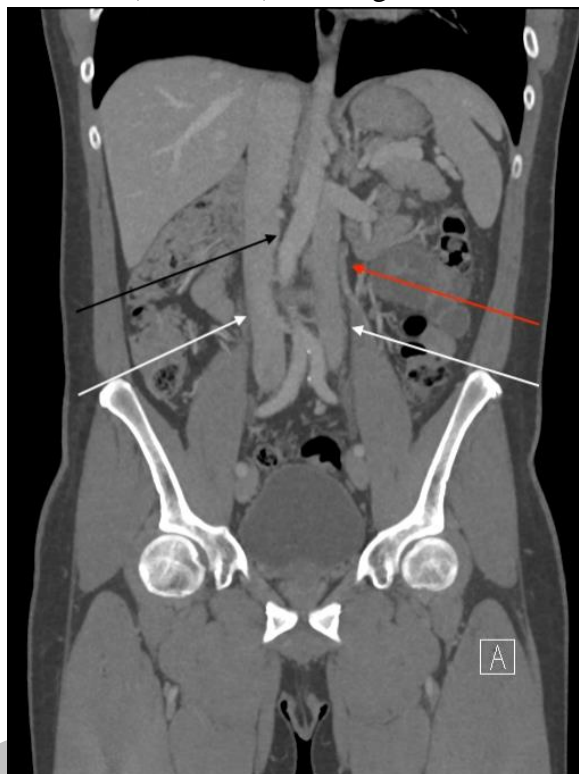
**Figure 1.** Arterial phase axial contrast-enhanced computed tomography scan demonstrating a duplicated inferior vena cava (white arrows) flanking the aorta (black arrow) at the level of the kidneys.



**Figure 2.** Arterial phase coronal contrast-enhanced computed tomography scan demonstrating a duplicated inferior vena cava (white arrows), aorta (black arrow), and the left renal vein (white dotted arrow).



**Figure 3.** Portal venous phase coronal images showing the duplicated IVC (white arrows), aorta (black arrow) and the gonadal vein (red arrow) draining into the left IVC.



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