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Rare Coexistence of Double Inferior Vena Cava with Double Right Testicular Veins

Coexistencia Poco Frecuente de Vena Cava Inferior Doble con Vena Testicular Derecha Doble

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SUMMARY: The inferior vena cava (IVC) is the principal venous duct of the lower body, extending as a single vessel along the right side of the abdominal aorta and terminating in the right atrium. Double IVC is a rare anomaly that is typically detected incidentally during imaging or retroperitoneal surgery. In a cadaver of an elderly Chinese male, we observed a double IVC in which the right and left IVCs were parallel on both sides of the abdominal aorta. The left IVC eventually converges with the left renal vein, which subsequently crosses the abdominal aorta anteriorly to merge with the right IVC, returns to a single normal IVC, passes through the diaphragm, and terminates in the right atrium. No other apparent anomalies were present, except for two right testicular veins, the smaller of which drained into the right IVC and the larger drained into the right renal vein. Although individuals with anomalous IVC are typically asymptomatic, care must be taken to avoid errors during radiological imaging and retroperitoneal surgery. In such cases, a preoperative understanding of multiple anomalous vessels will help physicians to avoid potential risks during abdominal and retroperitoneal surgeries.

KEYWORDS: Anomalies; Coexistence; Double inferior vena cava; Double right testicular veins.

INTRODUCTION

The inferior vena cava (IVC) is the primary venous duct responsible for draining blood from the lower body into the heart. Its tributaries encompass the lower limbs, perineum, pelvic cavity, abdominal cavity, and viscera, except the gut. The IVC is formed by the confluence of the right and left common iliac veins at the level of the 5th lumbar vertebra. It ascends along the right side of the abdominal aorta, penetrates the diaphragm through the vena cava foramen, and empties into the right atrium.

The entire length of the IVC is divided into four segments: hepatic, suprarenal, renal, and infrarenal, all of which originate from the embryonic veins in the early stages of gestation between four and eight weeks. Sequential growth, anastomoses, and regression of four pairs of embryonic veins– vitelline, subcardinal, supracardinal, and posterior cardinal veins–are involved in IVC formation. Malfunction of the well-tuned developmental process of these vessels can result in an anomalous IVC. Approximately 60 types of IVC variants have been reported (Chaturvedi *et al*., 2007), of which double IVC has a prevalence of 0.2–3 % (Ang *et al*., 2013; Shammas *et al*., 2017). During routine dissection, we observed a double IVC coupled with double right testicular veins (RTVs) in an elderly Chinese male. However, the combination of these anomalies has rarely been reported. Individuals with anomalous IVC are typically asymptomatic (Jiang *et al*., 2021). However, caution is needed in clinical practice to avoid misdiagnosis and other complications, particularly when other anomalies coexist.

CASE REPORT

During a routine dissection study of medical students in the Human Body course, we found a double IVC in an old Chinese male cadaver. We carefully observed the IVC, its tributaries, and surrounding structures in the retroperitoneal space. We also measured the length and diameter of the IVC and its tributaries by using Vernier

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calipers. On the right side of the aorta, the right IVC followed the usual course of a normal IVC, which began caudally at the convergence of the right internal and external iliac veins and ended cranially at its junction with the right atrium (Fig. 1). The right IVC collected blood from the right renal vein at the level of the upper apex of the right kidney. Similarly, double testicular veins were found; one vein was much larger than the other. The larger one, approximately 4 mm in diameter, drained into the right renal vein. In contrast, the smaller, approximately 1.5 mm diameter, drained into the right IVC (Fig. 2). In the present case, the left IVC began at the convergence of the left internal and left external iliac veins. However, without immediate coalescence with its counterpart, it ascended to the left side of the abdominal aorta. Soon after, it ended at the left renal vein, which crossed the aorta anteriorly, 1 cm below the root of the superior mesenteric artery. The left testicular vein merged with the left renal vein at an angle formed by the left renal vein and the left IVC (Fig. 1). The right and left IVCs were approximately equal in width, measuring 1.85 cm in diameter. No anomalies of the azygos or hemiazygos veins or ureters were observed.

Fig. 1. The double IVC ascend on both sides of the aorta. After converging with the LIVC, the LRV crosses the aorta anteriorly to merge with the RIVC and returns to a single IVC.

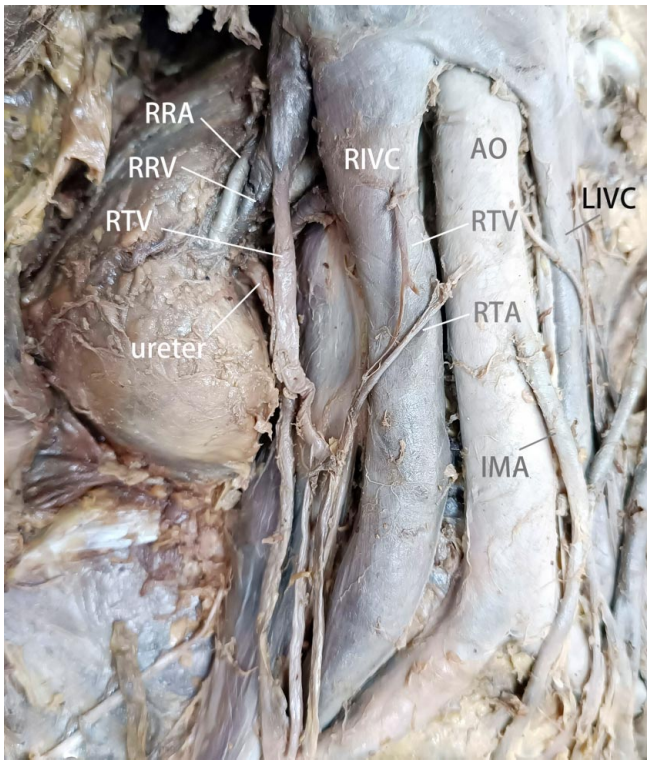

Fig. 2. Double RTV in the same cadaver, with the larger one draining into the RRV and the smaller one draining into the RIVC.

IVC (inferior vena cava), AO (aorta), LTV (left testicular vein), LTA (left testicular artery), RTV (right testicular vein), RTA (right testicular artery), SMA (superior mesenteric artery), IMA (inferior mesenteric artery), LRA (left renal artery), LRV (left renal vein), RRA (right renal artery), RRV (right renal vein).

DISCUSSION

Embryonic development of the IVC comprises four pairs of embryonic veins: vitelline, subcardinal, supracardinal, and posterior cardinal veins. Between four and eight weeks of gestation, scheduled growth, anastomosis, and regression of these veins lead to the final formation of the IVC. Misleading or interrupting this complex process results in IVC anomalies, which usually coexist with other venous anomalies. Approximately 60 IVC variants have been previously reported (Chaturvedi *et al*., 2007). Common anomalies include left IVC, double IVC, abnormal renal veins (circumaortic venous ring, retroaortic renal vein, and multiple renal veins), abnormal ureters (retrocaval and circumcaval ureters), and interruption of the IVC with azygos or hemiazygos continuation. The right and left supracardinal veins emerged in the 6th week and were predominant in the 8th week (Malaki *et al*., 2012). As the left supracardinal vein regresses, its right counterpart remains in the infrarenal

IVC segment. If the left supracardinal vein fails to regress or lacks anastomosis with the primitive cardinal veins, it becomes the left IVC. In exceptional cases, double IVC is found only on the right side of the aorta (Nagashima *et al*., 2006). This condition is occasionally accompanied by other variations such as the retroaortic right renal vein or hemiazygos continuation of the left IVC (Nagashima *et al*., 2006; Chaijaroonkhanarak *et al*., 2017).

This differs from the present case in which the right and left IVC were derived from the right and left supracardinal veins, respectively, and each IVC was located on either side of the aorta. Furthermore, the left IVC drains into the left renal vein, not directly into the right IVC (Li *et al*., 2022).

In addition to the IVC anomaly, abnormal RTVs were observed, which followed two return routes. The primary route drains directly into the right renal vein and the secondary route drains into the right IVC. Gonadal veins arise from the caudal part of the subcardinal veins. Right subcardinal vein contributes to IVC formation and the left subcardinal vein contributes to left renal vein formation, RTV drains into the IVC, and the left testicular vein drains into the left renal vein. In this case, the double RTVs may have originated from duplication of the subrenal part of the right subcardinal vein (Nayak & Vasudeva, 2020). The incidence of multiple RTV has been reported to be 7.99 % (Nallikuzhy *et al*., 2018). Therefore, a thorough understanding of testicular vasculature is necessary to avoid misinterpretation of angiograms or to reduce the risk of complications during renal surgeries.

An abnormal IVC is discovered incidentally during diagnostic imaging or extraperitoneal surgery (Hadidi *et al*., 2016), as patients with IVC anomalies are always asymptomatic. However, vigilance should be maintained during imaging or other clinical procedures to avoid misdiagnoses or other clinical complications. For instance, left IVC can be misdiagnosed as lymphadenopathy, which can lead to unnecessary chemotherapy (Klinkhachorn *et al*., 2020). Because of the complicated blood flow in a double IVC, an individual with this anomaly is predisposed to develop deep vein thrombosis (DVT). To treat DVT, filters should be inserted into both IVCs or a single filter should be placed above the junction of the left and right IVCs to prevent recurrent pulmonary embolism (Kandpal *et al*., 2008). Identifying an anomalous IVC and its tributaries prior to retroperitoneal surgery, such as laparoscopic or donor nephrectomy, can also mitigate the risk of excessive bleeding (Dall *et al*., 2022) or other iatrogenic complications.

CONCLUSION

We report a rare case of double IVC during a routine dissection course in a Chinese man. The infrarenal segment of the IVC consists of two parallel venous ducts rather than a single duct. The right and left IVCs ascended to both sides of the abdominal aorta. After receiving the left IVC, the left renal vein crossed the aorta anteriorly, met the right IVC, and continued upward as a single renal and suprarenal segment of IVC. No anomalies were found in the ureters and azygos or hemiazygos veins, except for two RTVs: one drained into the right renal vein and the other into the right IVC. Although people with anomalous IVC and double RTV are always asymptomatic, radiologists and surgeons should exercise caution to avoid misdiagnosis and achieve smooth operation during retroperitoneal surgeries.

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ZHANG, Q.; HU, Y. & HU, C. Coexistencia poco frecuente de vena cava inferior doble con vena testicular derecha doble. *Int. J. Morphol., 42(6)*:1726-1729, 2024.

RESUMEN: La vena cava inferior (VCI) es el conducto venoso principal de la parte inferior del cuerpo, que se extiende como un solo vaso a lo largo del lado derecho de la aorta abdominal y termina en el atrio derecho. La VCI doble es una anomalía poco frecuente que suele detectarse de manera incidental durante la obtención de imágenes o de una cirugía retroperitoneal. En un cadáver de un hombre chino de edad avanzada, observamos una VCI doble en la que las VCI derecha e izquierda eran paralelas a ambos lados de la aorta abdominal. La VCI izquierda finalmente convergía con la vena renal izquierda, que posteriormente cruzaba anteriormente la aorta abdominal para fusionarse con la VCI derecha, formando una VCI normal única, que pasaba a través del diafragma y terminaba en atrio derecho. No se observaron otras anomalías aparentes, excepto dos venas testiculares derechas, la más pequeña de las cuales drenaba en la VCI derecha y la más grande en la vena renal derecha. Aunque las personas con VCI anómala suelen ser asintomáticas, se debe tener cuidado para evitar errores durante la obtención de imágenes radiológicas y la cirugía retroperitoneal. En estos casos, una comprensión preoperatoria de los vasos anómalos múltiples ayudará a los médicos a evitar posibles riesgos durante las cirugías abdominales y retroperitoneales.

PALABRAS CLAVE: Anomalías; Coexistencia; Vena cava inferior doble; Vena testicular derecha doble.

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