Double inferior vena cava with interiliac vein: A case report and literature review

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Summary: The duplication of the inferior vena cava (IVC) is a rare, but well-recognized anomaly. Duplicated IVC has a significant relevance for retroperitoneal surgery and venous interventional radiology. We report a case of duplicated IVC, which was observed during routine dissection of an 84-year-old Japanese female cadaver. The interiliac vein between the duplicated IVC ran obliquely upwards from left to right. We performed systematic literature review of published reports based on Pubmed and Medline from 1967 to 2011. Of 109 cases with IVC anomalies identified by the literature search, 22 cases (20.2%) displayed no interiliac anastomosis. The interiliac vein connecting duplicated IVC existed in 74 cases (67.9%). According to the running direction of the interiliac vein, we found that the vein ran from left to right in 42 cases, coursed from right to left in 19 cases, and ran horizontally in 13 cases. Thirteen left IVC displayed symmetrical-to-normal connection with the bilateral common iliac veins. Awareness of these venous variations is necessary to reduce surgical risk and to determine strategy in interventional radiology.

Introduction

The duplicated inferior vena cava (IVC) was first described in 1916 at the gross anatomy laboratory in London¹. Since then, numerous reports of this anomaly have been published with the quoted incidence rate ranging from 0.3% to 3.0%²³. Most duplicated IVC cases are clinically silent and diagnosed incidentally by imaging performed for other reasons. However, these venous anomalies may have significant clinical implications, especially during retroperitoneal surgery and venous interventional radiology⁴. There were several case reports of deep venous thrombosis occurring in patients with duplicated IVC⁵. In particular, the pelvic venous variations of the anterior lumbar and sacral region could potentially cause unexpected hemorrhage with the increased use of the less invasive orthopedic anterior lumbar interbody fusion⁶. Awareness of these pelvic venous variations with coexistent IVC anomalies is necessary to reduce surgical risk and to determine strategy in interventional radiology. Herein we provide a case report of a duplicated IVC with interiliac anastomosis in a Japanese female cadaver. We also discuss the embryiological and clinical significance, and performed a systematic literature review of published reports to clarify the variation of IVC.

Findings

A case of duplicated IVC was identified in an 84-year-old Japanese female cadaver during dissection in a gross anatomy course. The right common iliac vein (12 mm in diameter) and an interiliac vein (13 mm in diameter) joined to form the right IVC at the level of the fifth lumbar vertebra. The right IVC ascended along the right side of the abdominal aorta. The right renal vein drained into the right IVC at the level of the second lumbar vertebra. The right IVC was 20 mm in diameter and 70 mm in length from its origin to the drainage point at the right renal vein, and its diameter increased to 25 mm after receiving the right renal vein (Fig. 1). The right IVC continued to ascend and ended at the inferior part of the right atrium of the heart.

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The left IVC arose by union of the left common iliac vein and interiliac vein at the level of the inferior edge of the fifth lumbar vertebra. The interiliac vein between the duplicated IVC ran obliquely upwards from left to right. The left IVC coursed cranially along the left side of the abdominal aorta and terminated on the left renal vein. It was 76 mm long with the diameter of 9 mm. The left renal vein was 9 mm in diameter before coalescence with the left IVC and 15 mm in diameter in the segment between the right and left IVC in front of the abdominal aorta (Fig. 1).

The right ovary vein was an incomplete duplicated that consisted of medial and lateral trunks. The two venous trunks ran upwards where approximately at the inferior pole of the right kidney they connected to a common trunk, which drained into the right renal vein, with the diameter of 3 mm. The left ovary vein, with the diameter of around 2 mm, drained into the left renal vein. The origin, the course and the territories of the other vessels appeared normal. The kidneys and the ureters were also normal.

**Discussion**

Embryogenesis of IVC is a complex process involving the development, regression, anastomosis and replacement of the three main embryonic veins. In the order of appearance, they are the posterior cardinal, the subcardinal and the supracardinal veins. The posterior cardinal veins appear first on the posterior aspect of the embryo. These veins regress, except for the distal aspects which become the iliac bifurcation. The subcardinal veins then appear anterior and medial to the posterior cardinal veins. The right subcardinal vein remains to form the suprarenal IVC, while the left subcardinal vein completely regresses. Subsequently, the supracardinal veins appear dorsally to the subcardinal veins. The left supracardinal vein then regresses, and the right supracardinal vein forms the infra-renal IVC. The normal IVC is converted to a unilateral, right-sided system, consisting of four components: (1) the infra-renal segment from the right supracardinal vein, (2) the renal segment from the right supracardinal anastomo-
sis, (3) the supra-renal segment from the right subcardinal vein, and (4) the hepatic segment from the right hepatic vein. Thus, double IVC is considered to be due to the persistence of both supracardinal veins\(^7\),\(^8\).

Many classification systems have been proposed to improve the understanding of the different anomalies that may occur during the development of the IVC\(^9\),\(^10\). The most commonly used classification is based on the segment of the final vena cava that is abnormal. We proposed a simple classification of the IVC into three types, the normal (right), double, and left IVC (Fig. 2). In the case of double IVC, this anomaly was further classified according to the pattern of interiliac veins. An interiliac vein was defined as a vein that drained the blood from the common iliac veins into the contralateral side of the double IVC. Thus, the variations of the IVC were classified as follows: type 1, normal iliac communication; type 2a, double IVC with no interiliac vein; type 2b, double IVC with interiliac

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**Fig. 2.** Schematic drawing of the normal and anomalous inferior vena cava (IVC).

Type 1, normal IVC; Type 2a, duplicated IVC with no interiliac vein; Type 2b, duplicated IVC with interiliac vein from left to right IVC; Type 2C, duplicated IVC with interiliac vein coursing transversely; Type 3, left IVC with symmetrical-to-normal iliac connection.
deep venous thrombosis, particularly in young adults.5) Genetic factors and congenital IVC anomalies are a possible risk factor for venous thromboembolism, as in IVC filter placement, because the IVC serves as a venous connection in the lower body. However, the anatomical evaluation was limited in the lumbosacral area, with respect to the intervertebral disk.14,15) Thus, the anatomical evaluation was limited to normal development.13) However, the exact embryogenesis of the interiliac vein remains to be elucidated.

As to the running direction of the interiliac vein, we found that the vein ran obliquely upwards from right to left in 19 cases (17.4%). The vein coursed almost horizontally in 13 cases (11.9%).

Previous reports analyzed the interiliac vein anatomy in the lumbosacral area, with respect to the intervertebral disk.14,15) However, the anatomical evaluation was limited to normal vascular cases without anomalies. The interiliac vein might cause problems due to unexpected hemorrhage during retroperitoneal surgery, as in anterior lumbar interbody fusion, because it runs across in front of the anterior lumbar and sacral region.2) This vein serves as a decisive factor in determining the strategy for venous interventional radiology, as in IVC filter placement, because congenital IVC anomalies are a possible risk factor for deep venous thrombosis, particularly in young adults.3) Therefore, we simply classified pelvic venous variations according to the pattern of the interiliac vein. Clinically, this vein should be taken into account because they also have the potential to interfere with and cause problems during related surgery and interventional radiology. Awareness of these pelvic venous variations of IVC anomalies is necessary to reduce surgical risk and to determine strategy in interventional radiology. The aim of the present study was to evaluate and classify pelvic venous variations of congenital IVC anomalies.

Anatomical variations of the gonadal veins with the IVC anomalies have been reported previously.4) These anatomical variations were mainly complete or incomplete duplications. The gonadal veins may be misinterpreted as a double IVC because they run close to the ipsilateral IVC, particularly the left gonadal vein that drains into the left renal vein. Evaluation of the peripheral connection of these veins is crucial in distinguishing them from IVC anomalies because the gonadal veins definitely originate from the ovaries or testes. In contrast, the double IVC originates from the iliac veins, the connecting patterns of which are shown in the present study. In regard to this point, pelvic venous variations of IVC anomalies should also be appreciated. It was reported radiologically that the IVC anomalies were more common in men (39 of 3821 cases) than in women (12 of 2473 cases); men/women ratio is 2:1.9) The result from our study is in line with these findings. By analyzing 109 cases of IVC anomalies published in the literature, we found that the ratio of men/women is 72:37. However, the gender difference regarding IVC anomalies remains to be obscure.

The duplicated IVC is a rare but well-recognized congenital anomaly. Most cases are diagnosed incidentally on imaging for other reasons. However, this venous anomaly has significant clinical implications, especially during retroperitoneal surgery and venous interventional radiology. Thus, familiarity with these anatomical anomalies is vital for vascular surgeons, urologists and orthopedists to reduce the risk of serious hemorrhage during surgical treatment and to avoid operative complications.

References
