ANOMALOUS FORMATION OF INFERIOR VENA CAVA: EMBRYOLOGICAL AND CLINICAL SIGNIFICANCE

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ABSTRACT

Inferior vena cava (IVC) is the largest vein of the body and is formed by the union of the two common iliac veins at the level of the fifth lumbar vertebra, and returns blood to the right atrium from all parts of the body below the diaphragm. The anatomical variations of the IVC and pelvic vessels have been reported previously. The most common cause of these variations is the developmental anomalies of the abdominopelvic veins. The embryogenesis of IVC and pelvic veins is a complicated process involving development, regression, anastomosis and replacement of three pairs of venous channels: posterior cardinal, subcardinal and supracardinal veins. The aberrant development of

INTRODUCTION

Inferior vena cava (IVC) is formed by the union of right and left common iliac veins on the right anterior surface of fifth lumbar vertebra and conveys the venous blood to the right atrium from all parts of the body below the diaphragm. The anatomical variations of the IVC and pelvic vessels have been reported previously. The most common cause of these variations is the developmental anomalies of the abdominopelvic veins. The embryogenesis of IVC and pelvic veins is a complicated process involving development, regression, anastomosis and replacement of three pairs of venous channels: posterior cardinal, subcardinal and supracardinal veins. The aberrant development of
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these venous systems, for unknown reasons, causes anomalies of IVC and pelvic veins\textsuperscript{[1]}. The anomalies of abdominopelvic veins have been extensively studied by various methods like cadaveric dissection, computed tomography and magnetic resonance imaging techniques\textsuperscript{4}. The variations of IVC and pelvic veins approximately affect 4\% of the population\textsuperscript{5}. From necropsy material the incidence was estimated to be about 2-3\%, and the percentage of intraoperative findings varies in different series of studies, between 0.2 - 6 \%\textsuperscript{5-7}. The anatomical variations of the veins of abdomen and pelvis increase the risk of vascular injuries especially venous bleeding during surgical procedures in this region. The transperitoneal approach to the lumbar vertebra is a common procedure in the vertebral surgery. The aortic bifurcation and the venacaval junction are the main vessels that lie anterior to the lower lumbar vertebra which restrict the extensive exposure\textsuperscript{[8]}. Knowledge of anatomical variations of iliac veins is also important for cardiac surgeons for access via femoral vein and to the radiologists especially during lumbosacral epidural venography\textsuperscript{5}.

An understanding of normal anatomy of the iliac veins is important for surgeons and radiologists. As described in the standard textbooks, the internal iliac vein drains the pelvic viscera ascends posteromedial to the internal iliac artery. The external iliac vein is the proximal continuation of the femoral vein which drains the lower limb. Anterior to the sacroiliac joint the internal iliac vein joins the external iliac vein to form the common iliac vein which ascends obliquely to the right side of the fifth lumbar vertebra, to form the inferior vena cava. The right common iliac vein is shorter and nearly vertical, lying initially posterior and then lateral to its artery. The left common iliac vein is longer and oblique, and lying medial, then posterior to its artery\textsuperscript{1-3,9}.

We are reporting an extremely rare and interesting case where the right common iliac vein was absent and IVC was formed by union of right external iliac vein, right internal iliac vein and left common iliac vein. In addition, we have also found an uneven duplication of right external iliac vein through which right external iliac artery traversed. The awareness of such variation should be kept in mind in order to avoid complications during surgical and radiological procedures.

CASE REPORT

During routine cadaveric dissection on a 51 year old female cadaver for undergraduate teaching in the Department of Anatomy, Maulana Azad Medical College, New Delhi, we observed a variation in the veins of the posterior abdominal wall and pelvis. The vessels in this region were carefully dissected and the surrounding structures were cleaned and photographed. There were gross variations of the blood vessels on the right side of the pelvis while the left side vessels followed the normal course as described in standard anatomy textbooks.

This extremely rare anatomical variation showed an absence of the right common iliac vein. The right external iliac vein was traced down to the inguinal ligament and we confirmed its continuation with the femoral vein. The right external iliac vein was initially medial to the right external iliac artery in the pelvis and then curved upwards and laterally towards the right side of the midline at the level of the 5\textsuperscript{th} lumber vertebra to form a tributary of the IVC. In the terminal 2/3 of its course, the right external iliac vein split into 2 divisions a thin anterior division and a thick posterior division. The diameter
of the thin division was of 0.25 cm and was anterior and medial to the external iliac artery while the diameter of the thick division was of 1 cm and was placed posterior and medial to the external iliac artery. Thus the right external iliac artery traversed through the gap between the two divisions of the right external iliac vein.

The right internal iliac vein was formed in the pelvis close to the greater sciatic foramen. It coursed upward and medially till the 5th lumbar vertebra and drained into the inferior vena cava as a separate tributary without uniting with the right external iliac vein. The Inferior vena cava was formed by the right external iliac vein, the right internal iliac vein and the left common iliac vein at the level of the right 5th lumbar vertebra.

Figure 1. Relations of the IVC and Aorta. The right external iliac artery traverses through the gap between the two divisions of the right external iliac vein (E1 and E2). The right side has the anomalies while the left side maintains the normal anatomical description.
DISCUSSION

The inferior vena cava (IVC) is a major vein which is responsible for venous drainage from the body below diaphragm. Anomalies of the inferior vena cava and iliac veins are infrequent and usually asymptomatic but if unidentified can lead to significant morbidity during surgical exploration. A large number of studies have been dedicated to the IVC and pelvic veins yet there are still wide diversity on tributaries and course of these veins. The absence of infra-renal IVC is a rare anomaly. We observed a unique variation in which right common iliac vein was absent and the IVC was formed by union of the right external iliac vein, the right internal iliac vein and the left common iliac vein. Another interesting finding revealed was the splitting of right external iliac vein in the terminal two third of its course through which the right external iliac artery traversed. This type of variation has not been reported in literatures though there are numerous reports regarding variations in the IVC and iliac venous anatomy. There have been similar kind case reports on the anomalous formation of the IVC. reported a cadaveric study where the IVC was formed by the union of three channels, two common iliac veins and an extra vein which in turn was formed by the two anomalous channels draining the internal iliac veins. In another study IVC was formed by common iliac veins at the L4
vertebral body level and there was an oblique venous channel from the left common iliac vein to the right common iliac vein at the L5 vertebral body level. In a radiologic study conducted by Lotz PR, the left common iliac vein was fenestrated in two cases. In one case two channels drained separately into the right common iliac vein and IVC. In the other case they rejoined distal to a more typical origin of the IVC. During CT imaging Chandrasekar et al. observed the absence of the infra-renal IVC and both common iliac veins.

It is mandatory to review the embryogenesis of IVC in order understand the possible causes of the anomalies of IVC. Phillips has summarised the work of early investigators in a comprehensive manner. The normal IVC is formed by four segments: hepatic, suprarenal, renal and infrarenal. The posthepatic IVC segment develop during sixth to eighth week of intrauterine life as a composite structure from continuous appearance and regression of three paired embryonic veins- the posterior cardinal vein, the subcardinal vein and the supracardinal vein. The posterior cardinal vein drains the lower limb and the abdomen, they are progressively replaced by subcardinal and supracardinal veins. Posterior cardinal vein forms the lowest part of IVC and common iliac veins. The proximal part of the left common iliac vein is derived from the anastomosis of posterior cardinal veins. The complex embryological development is such that variations and anomalies are common where embryological connections persist, either alone or in conjunction with aplasia or hypoplasia of normally developing channel.

In the present case there would have been defect or deviation in the development lower part of right posterior cardinal vein which leads to the absence of common iliac vein on the right side. The right external and internal iliac veins were joining separately inferior vena cava at the level of 5th lumbar vertebra. The pelvic vessels develop from the condensation of local mesenchyme. Proliferation of vascular cells, further differentiation and branching patterns depends on the role of various genetic factors in embryonic life. Anastomosis develops between vessels can regress or persist due to influence of hemodynamic factors leading to development of adult pattern of vessels. During the development process if the branch of the external iliac artery gets trapped within the developing venous plexus it may give rise to the variation as we have found in the present case.

Apart from academic interest, both surgeons and radiologists dealing with this region must have knowledge of these variations. Surgeons should be aware of the possible variations of the major veins of abdomen and pelvis in order to prevent inadvertent injury to these anomalous veins and to avoid significant haemorrhage during retroperitoneal and vertebral surgeries. The detailed knowledge of these anomalies is also important for cardiac surgeons while performing femoral vein catheterization for cardiac surgeries and radiologists during radiological procedures like lumbosacral epidural venography.

COMPETING INTERESTS

The authors declare that they have no competing interests.
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