CT Findings of Bilateral Inferior Vena Cava: Differentiation from Dilated Retroperitoneal Veins

Kyung Joo Park, M.D., Si Kyung Lee, M.D., Joo Hyuk Lee, M.D.

Department of Radiology, Kangnam General Hospital

Abstract

We experienced five cases of bilateral inferior vena cava for recent one year. We evaluated the CT findings of the cases and of dilated veins located in the left retroperitoneum (seven left gonadal, seven inferior mesenteric, and two left ascending lumber veins) in the viewpoints of the size, location and relation with the surrounding structures.

Bilateral inferior vena cava (IVC) may be asymmetric and the left IVC may be smaller than other retroperitoneal veins with a round contour. The left IVC was located anterior to the spinal body and corresponded with contralateral vena cava in the anteroposterior plane. The gonadal vein was located anterior or anterolateral side of the psoas and always crossed the ureter. Most of the inferior mesenteric vein showed similar location to the opposite site of the vena cava in the anterolateral side of the psoas muscle, medial to the left ureter without crossing. The left ascending lumbar vein was similarly located to the left vena cava but dilated in a short segment.

It is required to trace the vessel upward and downward and observe its continuity for correct differentiation. If it is impossible, some differential points suggested in the results of our study will be helpful for distinguishing them.

Index Words: Venae Cavae, abnormalities 982.14
Venae Cavae, CT
Veins, CT

INTRODUCTION

Bilateral inferior vena cava (IVC) is a relatively rare anomalous condition, which can be correctly diagnosed on the basis of computed tomography (CT) findings without angiography (1-4). Other retroperitoneal veins may be dilated in certain circumstances such as portal hypertension or postpartum state and located at the left side of the aorta similar to the left IVC (5-10). The recognition of these venous structures and their differentiation are important to radiologists and surgeons for imaging, intervention or operation. Generally these vessels can be distinguished by observing their caudal and/or cranial continuities on the consecutive CT sections. But, the paucity of the retroperitoneal fat, small size of the vessel and other factors may interfere with tracing the vessel (1, 5, 6).

We present CT findings of this anomaly and dilated veins and figure out some differential points among these structures with a brief review of anatomy.

MATERIALS AND METHODS

We performed 557 abdominal CT scans for
a year by Philips 305 CT system, and experienced five patients (six CT examinations) with bilateral IVC. All patients were examined after intravenous injection of contrast material. Diagnosis was made on the basis of CT findings as described in the literatures (1-3). In five pairs of bilateral IVC, we measured the diameter of the vessel at the mid portion of the renal vein and IVC bifurcation by the optical magnification of hard copies. We also assessed the location of the left IVC in its whole length. The right IVC was used as a reference in the anteroposterior (AP) plane, and the spine and psoas muscle in the mediolateral (ML) plane. We also observed the relative location of the vessel to left ureter.

Additionally, we selected the scans that showed the vein of a diameter over 5mm in the left side of the abdominal aorta that were vertically oriented similar to left IVC after reviewing another 200 abdominal CT scans. Each vein was discriminated anatomically by the observation of its cephalad and caudal continuities in consecutive CT section. The scans were excluded when a correct anatomic differentiation was difficult on the basis of CT findings. The size and location of the veins in the infrarenal levels were estimated by the same method as in the left IVC.

**RESULT**

The clinical and CT findings of five patients with double IVC are summarized in Table 1. Every left vena cava joined with the right counterpart at the renal vein level through a vascular structure after joining with the left renal vein. The size of the veins was variable (half to almost same as that of the right IVC) and the shape was oval or round. The smallest one (No 5) was measured about 1cm. The veins were located just anterior to the spinal body and at

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age/Sex</th>
<th>Clinical diagnosis</th>
<th>Right vena cava</th>
<th>left vena cava</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Short*</td>
<td>Long**</td>
</tr>
<tr>
<td>1</td>
<td>38/F</td>
<td>Stomach cancer</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>48/M</td>
<td>Lymphoma</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>64/M</td>
<td>Hepatoma</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>61/M</td>
<td>Stomach cancer</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>73/F</td>
<td>CBD cancer</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

* Short diameter in millimeters  
** Long diameter in millimeters

Fig. 1. Bilateral inferior vena cava  

a. At level of the left renal vein, note bulging contour at the joint of the left vena cava and left renal vein (arrows).  
b. On lower scan, a pair of venae cavae run on each side of the aorta.  
c. Each vena cava connects with its own common iliac vein.
Fig. 2. Asymmetric bilateral inferior vena cava. 
a,b,c. At the same level as Fig. 1, the left vena cava is quite smaller than the right, with a round contour.

Fig. 3. Left gonadal vein.
a. Dilated left gonadal vein joins with the left renal vein with a bulging contour (arrows)
b,c. The vein (arrows) located at the anterolateral side of the psoas muscle crosses the left ureter (open arrows) from medial to lateral side as it descends.
d. Below caval bifurcation, the vein (arrow) descends along the psoas, far-lateral to the left ureter (open arrow).

The 16 dilated retroperitoneal veins chosen by the criteria were 7 left gonadal, 7 inferior mesenteric, and 2 left ascending lumbar veins. The left gonadal veins (n=7) had the diameters of 0.6 to 1.1cm and were round in contour. Five were anterior (n=4) and lateral (n=1) to the psoas muscle in the ML plane. Two were located anterior to the psoas muscle at the caudal level, and gradually moved laterally to the muscle as they ascended. In the AP plane, four cases were located posteriorly to the IVC. Two were at the same level of IVC, and one was initially at the same level, and moved posteriorly as they descended. All the veins crossed the ureters from the medial (n=5) and anterior (n=1) to the lateral side as they descended (Fig. 3). In one case, the left ureter was not found due to previous left nephrectomy.

The size of the IMV (n=7) ranged from 0.6 to 0.8cm and they were round in contour. Five cases demonstrated the joining with the splenic vein, however, in two cases the segments anterior to the left renal vein were shown without further cephalad continuity. The location of the vein below the left renal vein in the ML plane was somewhat variable. Four were anterior, two were lateral to the psoas muscle, and one was anterior to the spinal body. In the AP plane, most (n=6) were matched with the IVC except one case located anteriorly. Most (n=5) of the
veins were located medial to the ureter in its whole visualized length (Fig. 4). One crossed the ureter from lateral to medial side as it descended. In one case, the left ureter was not opacified due to autonephrectomized kidney by previous tuberculosis.

The left ascending lumbar veins (n=2) were measured about 0.9 and 0.6cm. They were round or oval-shaped and dilated in short segments. They were located anterior to the psoas muscle or to the spine in the ML plane and posterior or the same level to the IVC in the AP plane. One was connected to the IVC at the just cranial part of its bifurcation. The other ascended behind the left renal vein and connected to retroperitoneal collaterals.

**Fig. 4.** Inferior mesenteric vein.  
a. At the cephalic end, the vein (arrows) meets with the splenic vein or SMV (thin arrow).  
b. The vein (arrow) is typically located anterior to the left renal vein and behind or to left of the duodenojejunal flexure (dj).  
c. On lower sections, the vein (arrow) is located quite similar to the left inferior vena cava, but anterior to the psoas muscle, runs medial side of the left ureter (open arrow).  
d. Below caval bifurcation, it is divided into two branches (arrows) still medial to the left ureter (open arrow).

**Fig. 5.** Left ascending lumbar veins.  
a,b. At infrarenal level, the location and the shape of the vein (arrows) is very similar to the left inferior vena cava. It ascends posterior to the left renal vein (rv)  
c,d. In another case, the vein (arrows) joins with the inferior vena cava (v) behind the aorta. Enlarged precaval lymph nodes (n) show lesser enhancement.
DISCUSSION

The IVC is formed by the successive development and regression of three paired veins, the posterior cardinal veins which are functionally replaced early in embryogenesis by the subcardinal and supracardinal veins. The left cardinal system usually involutes, and normal IVC is converted to a unilateral, right-sided system. It consists of four components: the postrenal segment from the right supracardinal vein, the renal segment from the right sub-supracardinal anastomosis, the prerenal segment from the right subcardinal vein, and the hepatic segment from the right hepatic vein (1, 11).

Bilateral IVC encompasses the gray zone between the right-versus left-sided dominance of the supracardinal system (1, 11). There is a normal IVC along the right side of the aorta with an additional left-side IVC. The left-side IVC almost always crosses the aorta at the level of the renal vein to join with the right-sided counterpart. The characteristic CT appearance is a single right-side IVC at levels above the renal veins, a vascular structure crossing the aorta usually at the level of renal veins, and a pair of vascular structures to the left and right of the aorta below the level of the renal veins, joining caudally with the common iliac veins on each side (1-4) (Fig. 1, 2).

The left gonadal, inferior mesenteric and left ascending lumbar veins are vertically oriented in the left retroperitoneum and are potentially confused with the left IVC (7).

The gonadal veins arise from either the ovarian or testicular venous plexus. They course cephalad out of pelvis to lie anterior to the psoas muscles. They parallel the course of the psoas muscles as they pass cephalad through the lower retroperitoneum and cross over the ureter usually at the level of the pelvic inlet. They drain into the renal vein in the left and into the infrarenal IVC in the right (5-8) (Fig. 3).

The inferior mesenteric vein (IMV) begins from the superior rectal vein. It runs across the common iliac vessels after joining with the sigmoid veins. It ascends under the cover of the peritoneum ventral to the left psoas muscle in the left side of accompanying artery. After passing anterior to the left renal vein and Gerota’s fascia, it drains into either the splenic vein at the splenoportal confluence or the superior mesenteric vein (6) (Fig. 4).

The ascending lumbar veins are paired and arise from the common iliac veins and presacral venous plexus. They parallel the spine as they ascend through the retroperitoneum and lie anteriorly or anterolaterally to the vertebra and posterolaterally to the aorta and IVC. The azygous/hemiazygous system forms its cephalad continuation at the diaphragmatic hiatus. They communicate with the IVC and internal and external venous plexi via lumbar and intercostal veins (7, 9) (Fig. 5) and show variable diameter along the course and short segmental dilatation (9, 12).

The incidence of bilateral IVC in our study was 1.1%. It is different from the reported cadaveric dissection results of 1.5 to 2.8% (1, 12) and CT result of 0.3% (1). This may be explained by the facts that dissection studies were capable of finding much smaller vessels and the resolution of the current CT scanner has been improved since the previous study.

Awareness of IVC anomaly and its differentiation is important in surgery as well as radiologic imaging and intervention. These anomalies may influence on the decisions of making a shunt for portal hypertension, choosing the site for inferior caval ligation or filter application in thromboembolic disease, repairing aortic aneurysms, and performing other retroperitoneal surgeries (2, 3, 13).

The large vessel of paraaortic location may
simulate an enlarged paravertebral lymph node when seen in cross section. But it is unlikely to cause serious difficulty as a long tubular structure is seen on several adjacent sections and it is enhanced as strongly as neighboring aorta (2, 3, 9). The cross-sectional shape of the left IVC may be round or oval and there is an asymmetry. The size of the left IVC was variable with the shortest dimension of about 1 cm, which can be smaller than that of the other dilated retroperitoneal veins. So the differentiation may not be easy by the shape and/or size only.

These structures can be distinguished by tracing upward and downward observing the continuity of the vessels. Left IVC joins with renal vein and left iliac vein, gonadal vein with renal vein, IMV with splenic or superior mesenteric vein, and ascending lumbar vein with IVC or lumbar veins.

Our study showed that we could differentiate the vessels by the location and relation with the ureter as described in the results.

Despite this result, we think that the vascular structures in the left paraaortic area must be traced upward and downward for their exact differentiation. Although our study had a small number of cases and showed some exceptions, our results would be helpful for differentiating the vessels especially when it is difficult to trace the vessels.

In summary, we analyzed the CT findings of five cases of double IVC and dilated retroperitoneal veins. We might suggest possible differential points of the vessels in terms of the location and relation with the surrounding structures.

REFERENCES

2. Royal SA, Callen PW. CT evaluation of anomalies of the inferior vena cava and left renal vein. AJR 1979; 132:759-763
양측성 하대정맥의 CT 소견 : 후복막강 정맥과의 감별

지방공사 강남병원 방사선과
박경주 · 이시경 · 이주혁

저자들은 최근 1년간 5예의 양측성 하대정맥을 경험한 바, 그 CT소견 및 좌측후복막강의 확장정맥과의 감별점을 조사하기 위해 양측 하대정맥 및 확장된 후복막강 정맥(좌측 상선정맥 7예, 하장간막정맥 7예, 좌측 상행요추정맥 2예)의 CT상 크기, 위치, 주위구조물과의 관계 등을 분석하였다.

양측성 하대정맥은 좌우 비대칭인 경우가 있고, 다른 후복막강정맥보다 작은 원형의 좌측하대정맥도 관찰되었다. 좌측 하대정맥은 척추체 전방에서 우측하대정맥과 같은 전후면상의 위치에서 관찰되었으며, 좌측 성선정맥은 요근의 전방 또는 측방에서 전후면상 하대정맥의 후방에 혼히 위치하고 좌측요관을 외측으로 횡단하였다. 하장간막정맥은 전후면상 하대정맥과 일치하나 대부분 요근의 전방 또는 측방에 위치하고 좌측요관을 횡단하지 않고 그 내측을 주행하며, 상행요추정맥은 위치상 좌측하대정맥과 감별이 어려우나 좌측의 부분에서 확장이 관찰되었다.

좌측하대정맥과 후복막강정맥들을 감별하기 위해서는 CT상에서 상하를 추적하여 어떤 구조물과 연결되는지를 관찰하여야 한다. 그러나 추적이 불가능한 경우에는 본 연구의 결과가 도움이 될 것으로 사료된다.