An Anatomical Study of the Retroaortic Left Renal Vein

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Summary: Retroaortic left renal vein was found in a 55-year-old male cadaver during a student course anatomical dissection. This anomaly coursed dorsal to the abdominal aorta and opened into the inferior vena cava at the upper level of the 3rd lumbar vertebra. This retroaortic left renal vein connected directly to the azygos vein system and the 3rd lumbar vein. It also received the posterior suprarenal and posterior inferior phrenic veins.

Because of its anatomical location, the retroaortic left renal vein, and anomalous left renal vein coursing behind the abdominal aorta, has received a clinical attention for the surgical retroperitoneal operations and the misinterpretation of clinical diagnosis (Thomas, 1970; Brener et al., 1974; Moul et al., 1992) as well as the rise in internal pressure of the left renal vein. This anomaly has been detectable by clinicians using computerized tomography, magnetic resonance imaging and ultrasound examination, and thus, reported recently in many clinical cases (Hoeltl et al., 1990; Moul et al., 1992). Since the development of the retroperitoneal veins including the left renal vein is highly complex (McClure and Butler, 1925), a full understanding of the regional anatomy of this anomaly and its related veins is imperative not only for surgical operations but also for the knowledge of the venous morphogenesis. However, the retroaortic left renal vein has been described in detail by only 3 dissected cases in the anatomical literature (Kitamura et al., 1979; Izumiyama and Horiguchi, 1997).

Recently, we have found the retroaortic left renal vein during a student course dissection. Since this anomaly is not only rare case but also is seemed to be significant for understanding the development of the retroperitoneal venous system, we report here a detailed anatomy of this anomaly and its related vessels, and discuss its anatomical and embryological significance.

Materials and Methods

A total of 203 Japanese bodies were dissected in the anatomical practice during a period of 1993 through 1999 at the Kumamoto University School of Medicine. In this period, an anomalous left renal vein was found in the cadaver of a 55-year-old Japanese male who died from cancer of the rectum. This anomaly and its related vessels in the retroperitoneal cavity were carefully examined, and the findings were recorded by line drawings and photographs.

Observations

A single left renal vein emerging from the renal hilum at the middle level of the 2nd lumbar vertebra ran horizontally for a distance of 25 mm, then course obliquely caudal and dorsal to the abdominal aorta, and finally opened into the left margin of the inferior vena cava (IVC) at the upper level of the 3rd lumbar vertebra (Figs. 1, 2). This opening was 40 mm distal to the caudal side of the opening for the right renal vein and 22 mm in diameter, while the diameter of the IVC was 25 mm. The
length of the left renal vein was 75 mm.

As indicated in Figure 2, the left renal vein was formed by confluence of a small dorsal tributary (1.2 mm in diameter), the posterior renal vein (Okamoto, 1990; PR in Fig. 2), which was located at dorsal to the renal pelvis and artery, and received the ureteric vein (Ur in Fig. 2) and the posterior suprarenal vein (Okamoto, 1990; arrowheads in Fig. 2) from the dorsal part of the left adrenal gland. After the confluence, the left renal vein received the left suprarenal and testicular veins, and the left posterior inferior phrenic vein (new definition; double arrowhead in Fig. 2) which descended through the dorsal side of the left renal artery, receiving blood from the medial crus and left leaf of the diaphragm. On the dorsal side of the aorta, the left renal vein communicated with a common root of the azygos and hemiazygos veins at the cranial aspect and received the left 3rd lumbar vein at the caudal aspect just before the opening into the IVC. The azygos and hemiazygos veins communicated with the left 2nd lumbar vein and the ascending lumbar veins. The azygos vein joined with the hemiazygos and accessory hemiazygos veins at the middle level of the 11th and 9th thoracic vertebrae, respectively. The most cranial veins draining into the dorsal side of the IVC were the right 2nd lumbar vein and the azygos vein.

The right and left common iliac veins joined to form the IVC. The IVC ascended along its normal course to enter the right atrium and received the 4th, 3rd and 2nd lumbar veins on both sides, except the left 3rd one which drained into the left renal vein, as described above. The right and left 5th lumbar veins emptied into the right and left common iliac veins, respectively. The right renal and testicular veins took normal course to empty into the IVC. No left IVC was found.

The right and left renal arteries had a normal appearance and were branched from the aorta at the level of the disc between the 1st and 2nd lumbar vertebrae. In addition, the inferior phrenic, suprarenal and testicular arteries on right side were branched from the right renal artery. On both sides, ureters descended along their normal course. The right kidney was situated slightly higher than the left one.

Discussion

The present study detailed gross anatomical findings concerning an anomalous left renal vein passing dorsal to the abdominal aorta and its associated venous system. Although the vein in question is referred to as a retroaortic left renal vein and is not extremely rare anomaly, it is important to be aware of this vein for retroperitoneal surgeons and radiologists (Hoeltl et al., 1990; Moul et al., 1992). The incidence of this anomaly reported in the literature ranges from 1.8% to 4.0% on dissections (Seib, 1934; Pick and Anson, 1940; Weinstein et al., 1942; Davis et al., 1958; Reis and Esenthaler, 1959; Davis and Lundberg, 1968). In the present study, the frequency is now estimated to be 0.49% for Japanese cadavers, although we encountered only one case out of 203 cadavers examined. In addition, Okamoto (1990) and Izumiyama and Horiguchi (1997) reported the incidence to be 0.74% and 0.75% in Japanese, respectively. Thus, the low percentage found in the present and previous studies in Japanese may be due to a difference between races.

It is well known that IVC or renal veins are formulated by the embryonal subcardinal, supracardinal veins and sub-supracardinal anastomosis (Arey 1974; Bannister et al., 1995). In the present study, we found that the retroaortic left renal vein was directly communicated with other parietal veins including the azygos systemic veins and the lumbar vein, which are derived from the supracardinal vein. Similar findings have been found in all cases of the retroaortic left renal vein reported (Kitamura et al., 1979; Okamoto, 1990; Morishima et al., 1996; Izumiyama and Horiguchi, 1997). Okamoto (1990) also found such close relationship between the supracardinal-derived veins and the left renal vein passing the retro-aortic course of the renal collar. Taken together, these findings indicate that the part of the retroaortic left renal vein receiving them is derived from the supracardinal vein. We also found that the left renal vein received a posterior renal vein which was located behind the renal pelvis and artery. Okamoto (1990) suggested that the posterior renal vein is the origin from the connection part between the subcardinal and supracardinal veins. Thus, the part of the retroaortic left renal vein receiving the posterior renal vein is considered to be derived from the sub-supracardinal anastomosis.

According to a detailed embryological description of the venous development in man by McClure and Butler (1925), the arrangement of the retroaortic left renal vein may be explained as follows: the development of the circumaortic venous ring or the so-called renal collar, which consists of the ventral intersubcardinal, subcardinal-supracardinal, and dorsal intersupracardinal anastomoses, is completed at early stage (8 weeks) of human embryogenesis (Fig. 3A). During normal development, the intersubcardinal and sub-supracardinal anastomoses persists and the intersupracardinal anasto-
mosis and the left supracardinal vein regresses; the ventral part of the circumaortic ring persists as the usual (normal) left renal vein (Fig. 3B). In contrast, persistence of the intersupracardinal and the left supracardinal vein, as well as regression of the intersubcardinal anastomosis give rise to a single retroaortic left renal vein (Fig. 3C).

Although the IVC is embryologically subdivided into several components such as hepatic, subcardinal (prerenal), sub-supracardinal anastomosis (renal) or supracardinal (postrenal) segments, their borders are not clear yet (Arey, 1974; Bannister, 1995). Previous our study of the persistence of the hepatic segment of the left IVC (left vena revehens) indicated that the lower boundary of the hepatic segment is the junction that unites the ductus venosus and the IVC (Yoshinaga and Kodama, 1997). In the present case, the position of the left renal vein leaving the hilus was the level of the 2nd lumbar vertebra, which was lower than the usual (the level of the disc between the 1st and 2nd lumbar vertebrae). In addition, the position of its opening into the IVC was lower than that of the right renal vein. Izumiyama and Horiguchi (1997) suggested that both the lower and more dorsal position of the left renal vein may cause the disappearance of ventral (normal) route of the left renal vein. The present findings indicate that the junction that unites the retroaortic left renal vein and the IVC is included in the supracardinal segment, although the boundary lines of the segment could not be determined. Based on the theory concerning the
development of the IVC and renal vein described above, it is possible that the pro- and retro-aortic left renal veins coexist. In that case, the retroaortic left renal vein must be situated at lower (more caudal) level than the usual left renal vein.

In conclusion, it is noteworthy that in the present case, all cardinal system, a part of the primitive embryonic venous system, except intersubcardinal anastomosis, participate in the formation of the IVC and renal vein including the suprarenal, gonadal and inferior phrenic veins. Furthermore, the present case has very important morphological significance to know the junction that unites components of the cardinal system.

References


Plate II

Fig. 2. Drawing of the infradiaphragmatic retroperitoneal vessels (ventral view). Note the retroaortic left renal vein (arrow) draining into the inferior vena cava (IVC) at upper level (asterisk) of the 3rd lumbar vertebra and receiving several veins including the left posterior suprarenal (arrowheads), suprarenal (S), testicular (T), posterior inferior phrenic (double arrowhead), and 3rd lumbar (L3) veins, as well as the azygos vein (AZ). Inset: Enlargement of the left renal hilum, showing the left posterior suprarenal (arrowhead), posterior renal (PR) and ureteric (Ur) veins. A: abdominal aorta, AG: adrenal grand, K: kidney, R2: right 2nd lumbar vein, R3: right 3rd lumbar vein, U: ureter.
Fig. 3. Schematic drawings of the transformation of the cardinal system from the renal venous collar at early embryonal stage (A) to the normal development of renal veins in adults (B). C represents the present case with the retroaortic left renal vein (asterisk). IVC: inferior vena cava.