A Retroaortic Left Renal Vein in a Female Cadaver

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Summary: We encountered a case of retroaortic left renal vein (RLRV) during an anatomical dissection course at our medical school in 2017. The case was a female cadaver who was 88 years old at death. Six roots of the left renal vein (RV) arose from the hilus of the kidney and joined to form one left renal vein, crossed dorsal to the abdominal aorta (AA) at the level of the second lumbar vertebra, and then drained into the inferior vena cava (IVC). Two roots joined at the right renal hilus to become the right RV to then drain into the IVC at the level of the first lumbar vertebral body. The reported frequency of RLRV is approximately 2%. Embryologically, the normal anastomosis of the left and right sub-cardinal veins results in the left RV traveling on the ventral surface of the AA. However, in the case presented here, the left RV traveled on the dorsal side of the AA due to the anastomosis of the left and right supra-cardinal veins and regression of the anastomosis between the left and right sub-cardinal veins. If both the dorsal and ventral anastomoses remain, the left RV travels on the dorsal and ventral sides of the aorta. Some of the clinical problems reported in association with RLRV are hematuria and abdominal pain, and the risk of damaging the RLRV during surgery of the posterior abdominal wall. Venous variants as reported herein should be kept in mind when interpreting imaging of the posterior abdominal wall or performing surgery or other invasive procedures near the RLRV.

Key words retroaortic left renal vein, inferior vena cava, kidney, renal artery, cadaver, dissection, anatomy

INTRODUCTION

A retroaortic left renal vein (RLRV) was found during routine anatomical dissection. This variation occurs in approximately 2% of the population. Clinically, the nutcracker phenomenon, caused by narrowing of the left RV between the descending aorta and the spinal column, places this vessel at risk during abdominal aortic surgery. Therefore, awareness of this variation has clinical and surgical significance.

CASE REPORT

The RLRV was found in a female Japanese cadaver whose age at death was 88 years old. (Figure 1, 2) The cause of death was cancer of an unknown primary origin. There were no scars around the skin of the abdomen.

Inferior vena cava (IVC)

The right and left common iliac veins joined at the position of the fourth lumbar vertebral body to become
the IVC. The fourth and third lumbar veins drained into the IVC posteriorly at the level of the fourth lumbar vertebral body where the left and right common iliac veins joined, and at the level of the third lumbar vertebral body, respectively. The left RV and the right ovarian vein flowed into the IVC at the level of the second lumbar vertebral body, the right adrenal vein flowed into the IVC at the level of the first lumbar vertebral body, and the hepatic veins drained into the IVC at the vena caval foramen.

**Morphology of the kidney**

The position of the upper border of the left kidney was at the level of the inferior border of the twelfth thoracic vertebra, with a length of 105.2 mm and width of 36.7 mm. The position of the upper border of the right kidney was at the level of the superior border of the twelfth thoracic vertebra, with a length of 106.45 mm and width of 40.7 mm. Although the right kidney was slightly larger than the left, no abnormality was seen in regard to shape or size.

**Left renal vein**

Six roots of the left RV arose from the hilus and
joined into one left renal, received the left ovarian vein (4.2 mm in diameter) and the left suprarenal vein (4.4 mm in diameter), crossed dorsal to the abdominal aorta (AA) slightly downward at the level of the second lumbar vertebra, and then drained into the IVC. The left RV dorsal to the AA received the first lumbar vein from the upper wall, and the ascending lumbar vein and the second lumbar vein from the lower wall. (Figure 3) At the upper wall of the left RV where it drained into the IVC, a small branch ascended behind the AA to become the hemiazygos vein. The diameter of the left RV was 9.00 mm where the six roots joined to become the single left RV with a maximum of 21.00 mm and a minimum of 14.80 mm posterior to the abdominal aorta. Total length of the left renal vein was 75.20 mm, with a part 23.30 mm in length behind the AA.

Right renal vein

Two roots joined at the right renal hilus to become the right RV, which received the right inferior phrenic vein and merged with the IVC at the level of the first lumbar vertebral body. The width of the right RV at the junction of the two roots was 13.60 mm and the length of the right RV from the right renal hilus to the point where the right RV drained into the IVC was 18.20 mm.

Left renal artery

Two left renal arteries were observed, the upper and lower renal arteries. The upper one arose from the AA just below the origin of the superior mesentery artery and drained into the renal parenchyma, which was above the renal hilus. The lower one originated from the AA at the level of the second lumbar vertebra, coursed behind the right suprarenal vein and drained into the renal hilus.

Right renal artery

The right renal artery arose from the AA at the same level as the upper left renal artery and traveled upward toward the renal hilus.
DISCUSSION

The RV is normally a large vein and runs transversely in front of the renal artery. The left RV is longer than the right RV and runs just inferior to the origin of the superior mesenteric artery anterior to the AA. The left testicular (or ovarian), left inferior phrenic, and left suprarenal veins drain into the left RV. The left RV drains into the IVC at a higher position than the right one because the left kidney is slightly higher than the right kidney. The right RV is shorter and wider than the left RV and the descending part of the duodenum crosses in front of the right RV. The RV occasionally has other tributaries that include a communicating tributary and origin of theazygos vein [1].

The RV has fewer variations than the renal artery. The right RV has been found to have one to three accessory veins and the left RV may have one or two accessory veins. In addition, the left RV forms a retroaortic left RV and circumaortic left RV when it travels dorsal to the AA. Also, the left RV may anastomose with the splenic vein and receive the lumbar veins [2].

Detailed anatomical reports describing a retroaortic left renal vein are rare. The reported prevalences of retroaortic left RV were 1.8% (5/270) [3], 2% (2/100) [4], 2.1% (3/176) [5], 2.4% (12/500) [6], 3.4% (7/202) [7]. Based on these reports, a retroaortic left RV is seen in approximately 2% of individuals.

Embryologically, the venous system consists of the right and left cardinal veins. The anterior cardinal vein drains blood from above the heart and the posterior cardinal vein drains blood caudal to the heart. Those two veins join to become the common cardinal vein and drain into the heart. The IVC is formed by transformation of the posterior cardinal vein, and subcardinal and supracardinal veins which appear later. The posterior cardinal vein develops as the vein of the mesonephros, which atrophies with the mesonephros, and then disappears except for the common iliac vein and the junction of the superior vena cava (SVC) with the azygos vein. The right and left subcardinal veins run parallel and mesioventral to the posterior cardinal vein and flow into the posterior cardinal vein, which also communicates with the ipsilateral posterior cardinal vein through sinusoidal capillaries of the mesonephros. The right and left subcardinal veins anastomose to become the left RV, the other part of the subcardinal vein becomes the right RV, part of the IVC, the suprarenal vein, and testicular (ovarian) vein. In addition, the supracardinal vein runs parallel and mesiodorsal to the posterior cardinal vein, flows into the posterior cardinal vein as well as the subcardinal vein. Superior to the kidneys, the left and right supracardinal veins form an anastomosis between the azygos and hemiazygos veins. In the area around the kidney, the supracardinal-subcardinal veins anastomose and the left and right supracardinal venous anastomosis is formed. Caudal to the kidney, the left subcardinal vein disappears and the right subcardinal vein becomes part of the IVC [8].

The renal collar in this case consisted of the three different venous anastomoses described above surrounding the descending aorta, namely the left and right subcardinal venous anastomosis on the ventral side of the aorta, the left and right supracardinal venous anastomosis on the dorsal side, and the ipsilateral supracardinal-subcardinal venous anastomosis on both sides. The vein formed by the remnant of the left and right subcardinal venous anastomosis ventral to the abdominal aorta is the normal left vein. The retroaortic left RV in the present case is considered to be a remnant of the anastomosis between the left and right supracardinal veins dorsal to the abdominal aorta. Hoeltl et al. [9] classified RLRV into two types; type I has a single retroaortic but orthotopic left renal vein, type II has a single retroaortic left renal vein which lies at the level of L4 to L5 and joins the testicular (or ovarian) and ascending lumbar veins to drain the left kidney. The present case was classified as type I. When both the dorsal and ventral anastomosis remains, the left RV runs on both the dorsal and ventral sides of the aorta.

Various clinical problems have been reported in association with a retroaortic left RV, such as Nutcracker phenomenon, which might result in macroscopic or microscopic hematuria and abdominal pain [10, 11, 12]. There is also a report on the risk of damaging the RLRV during abdominal aortic aneurysm surgery [13, 14]. Therefore, further anatomical studies for this variation are needed.

CONCLUSION

We report a case of RLRV. This variation is due to a remnant of the anastomosis between the left and right supracardinal veins dorsal to the aorta with regression of the anastomosis between the left subcardinal veins ventral to the aorta. This variation might result in hematuria and could be at risk of injury during abdominal operations such as abdominal aortic aneurysm surgery.

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