Case Report
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Abnormal patterns of the renal veins

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Abstract: Knowledge of the renal vascular anatomy may greatly contribute to the success of surgical, invasive and radiological procedures of the retroperitoneal region. Here, morphometric and histological studies of a human cadaveric specimen presented a complex, anomalous pattern of renal veins. The left renal vein had an oblique retro-aortic course and received two lumbar veins. It bifurcated near its drainage point into the inferior vena cava. The right renal vein received the right testicular vein. In addition, the left kidney was located at a low position. The spleen was enlarged. The present case is unique and provides information that may help surgeons or angiologists to apply safer interventions.

Key words: Renal veins, Kidney transplantation, Kidney, Inferior vena cava, Spleen

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Introduction

Normally, the venous drainage of each kidney proceeds through a single vein that drains into the inferior vena cava (IVC) at a right angle. The renal veins are formed near the hilum in front of the renal artery. The right renal vein is shorter (2-4 cm) than the left (6-10 cm). It receives blood only from the right kidney, whereas the left renal vein receives the left adrenal and gonadal veins in addition to the vein coming from the kidney. The left renal vein passes horizontally between the abdominal aorta and the superior mesenteric artery to reach the IVC. The most common spinal level for renal veins is between the first and second lumbar vertebra.

Although there are many published reports on the variants of renal veins, the complex venous variation reported here does not seem to have been cited in the literature previously. Additionally, the clinical aspects of the variations and their possible embryological reason are discussed.

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Case Reports

During the dissection of the retroperitoneal region of the cadaver of a 50-year old Iranian male, a complex picture of anatomical variations was observed. There was evidence of severe respiratory and peritoneal infection which may have been the cause of death. On his left side, three veins arose from the hilum of the kidney, and they subsequently joined to form the beginning of the renal vein. The left renal vein then passed downwards and medially for approximately 65 mm. After crossing the psoas muscles, it bifurcated. The two branches passed behind the aorta, and subsequently both of them terminated separately at the lower lumbar portion of the IVC on the vertebral column (Fig. 1A).

The upper tributary of the left renal vein joined the IVC approximately 35 mm lower than the right renal vein at an angle of 20° to the horizontal. The lower tributary, after a brief descending course, drained at an acute angle (40° to the horizontal) into the IVC from its dorsolateral aspect. It was considerably lower than the right renal vein (by 50 mm). The upper tributary joined the IVC at the level of the lower border of the L2 vertebra, and the lower tributary joined the IVC at the upper border of the L3 vertebra (Fig. 1A).

Before its division, the left renal vein received the left sup-

rarenal and testicular veins about 25 mm medial to its origin. In addition, the first left lumbar vein opened into the renal vein about 10 mm medial to the suprarenal vein drainage point superiorly. This lumbar vein showed a descending course and ran anterior to the vertebral column and posterior to the left crus of the diaphragm. The lower tributary of the left renal vein received a lumbar vein anterior to the vertebral column about 25 mm lateral to its termination.

On the right side, similar to the left, the renal vein was formed outside the renal hilum by the union of three segmental veins, and was 17 mm in length. It passed medially and opened into the IVC at the level of the lower border of the L1 vertebra. This vein followed a normal course, lying anterior to the renal artery and ureter.

The right testicular vein joined the IVC at the level of the upper tributary of the left renal vein (Fig. 1A). We could also see a connection between the right testicular artery and the right renal vein. Histological preparations from this connection and the area below that showed two additional testicular veins with a small diameter that accompanied the right testicular artery. All these structures were enclosed in a common sheath.

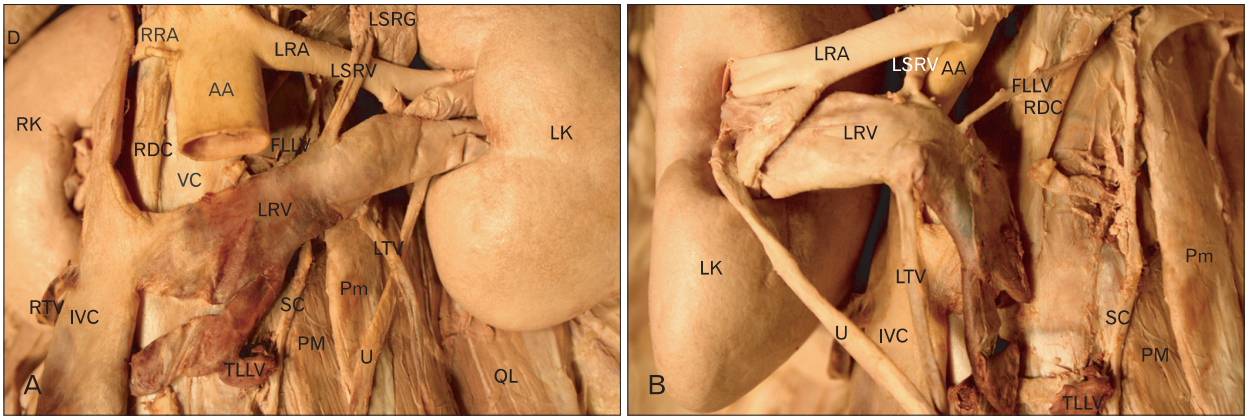

Fig. 1. Left retroperitoneal space dissection shows the abnormal drainage of a retro-aortic bifid left renal vein into the inferior vena cava. The variant termination of the 1st and 3rd lumbar veins into the left renal vein is also seen. (A) The abdominal aorta is dissected to show the bifid termination of the retro-aortic left renal vein. (B) The left kidney and structures that pass through its hilum are shown in their reflected position. AA, abdominal aorta; D, diaphragm; FLLV, first left lumbar vein; IVC, inferior vena cava; LK, left kidney; LRA, left renal artery; LRV, left renal vein; LSRG, left suprarenal gland; LSRV, left suprarenal vein; LTV, left testicular vein; PM, psoas major; Pm, psoas minor; QL, quadrates lumborum; RDC, right diaphragmatic crus; RK, right kidney; RRA, right renal artery; RTV, right testicular vein; SC, sympathetic chain; TLLV, third left lumbar vein; U, ureter; VC, vertebral column.

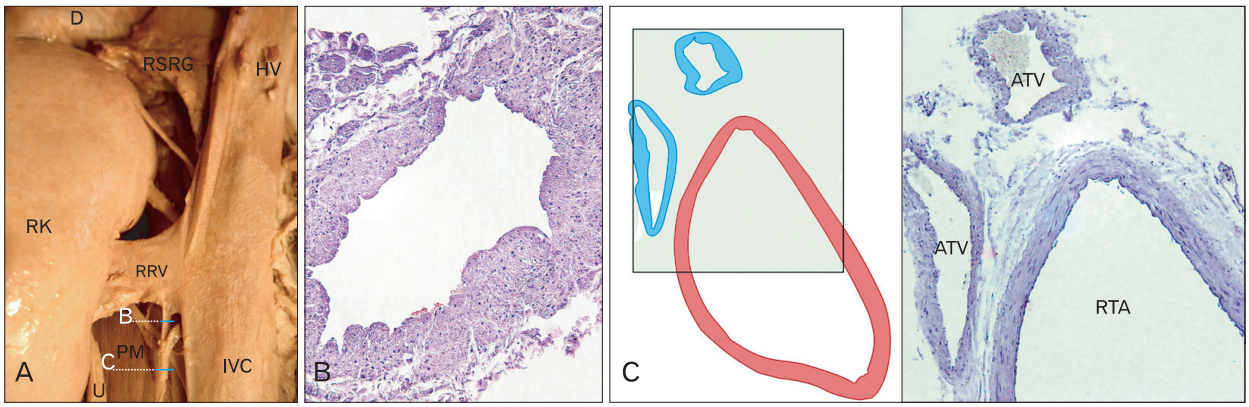

Fig. 2. Right retroperitoneal space dissection shows; (A) the abnormal drainage of additional testicular vein into the right renal vein. (B) Light micrograph illustrating a histological section of testicular vein before drainage into the right renal vein. (C) Right testicular artery with accompanying veins in a common sheath (right, schematic illustration; left, histological section) (B, ×200; C, ×100). ATV, additional testicular vein; D, diaphragm; HV, hepatic vein; IVC, inferior vena cava; PM, psoas major; RK, right kidney; RRV, right renal vein; RSRG, right suprarenal gland; RTA, right testicular artery; U, ureter.

These small veins united to form a larger vein, which opened into the right renal vein about 4 mm lateral to the IVC (Fig. 2).

Along with these variations, some other additional anatomical variants were also found. The lower pole of the left kidney was below the level of the right kidney. The lower pole of the right kidney was located at the level of the L2-L3 intervertebral discs, whereas the lower pole of the left kidney was at the level of the upper part of the L3 vertebra. The kidneys' size and shape were normal. An enlargement of the spleen beyond its normal size was also observed. The largest dimension of the spleen was approximately 160 mm (Fig. 3).

Discussion

A retro-aortic left renal vein is frequently encountered in radiological investigations and in the dissecting room. A study of 1,008 cases revealed that retro-aortic left renal veins were present in 0.5% of cases and additional renal veins in 0.4% of cases [1]. However, the bifid renal vein observed in our case was not one of the variants reported in this extensive study. In another case, Senecail et al. [2] reported a retro-aortic bifid left renal vein; however, unlike our case, it was accompanied by a circumaortic venous ring. In another report, the left renal vein passed posterior to the aorta and gave off three branches, while the right renal vein was double [3].

The course of the retro-aortic renal vein can vary considerably. It may drain into the IVC at the same level of its origin or more inferiorly. In our case, it drained at the level of L2 and L3 into the IVC. The patterns closest to this finding in the literature are found in reports of two research groups, except in their cases, the renal vein terminated into the common iliac vein [4, 5].

When the renal vein runs retroaortically, as reported in this case, it is not uncommon for a lumbar vein to enter the renal vein, and this could complicate surgical procedures in the lumbar region. A lumbar vein that joins the left renal vein was observed in 40% of cases [3, 6]. In our case however, two anomalous lumbar veins drained into the left renal vein. Because our specimen had communication with the lumbar veins, which are components of the azygos system, it is not inconceivable that there may be potential connections between the renal and azygos systems.

Previous studies have shown that the drainage of the left testicular vein into the left renal vein is rather constant, which is in accordance with our observations. However, there is no histological assessment of the small veins accompanying the testicular artery in the literature. In the present case, histological sections showed two additional veins together with the right testicular artery. These accompanying vessels were not visible on gross observation.

From the above literature review, it is evident that the complex arrangement of anatomical variants discovered in the specimen in the present study has not been previously reported, although similar individual variants have been reported.

Embryological basis

Interruption or complete arrest of any developmental

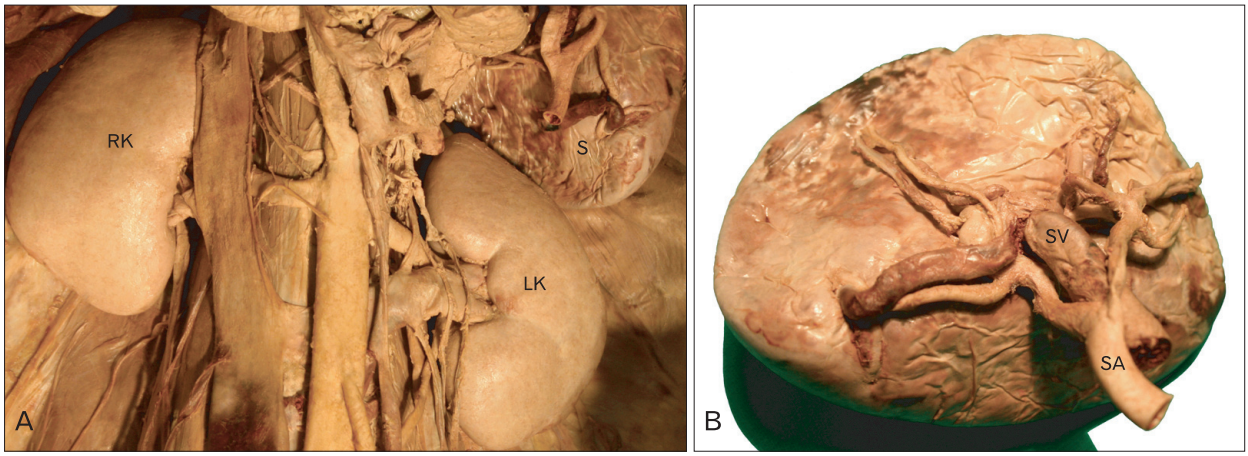

Fig. 3. Retroperitoneal space dissection. (A) The greatly enlarged spleen forced the left kidney below the level of the right kidney. (B) The isolated enlarged spleen. LK, left kidney; RK, right kidney; S, spleen; SA, splenic artery; SV, splenic vein.

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stage of the IVC may produce various anomalies in the drainage site, branches and course of the renal veins [7-9]. We suggest that the observed anomalies in the length and course of the left renal vein could be attributed to defects in the embryonic development of the renal segment and ventral parts of the renal collar. Hence, because of the regression of the renal segment, the right renal vein drained into the prerenal segment of the IVC. Furthermore, the left renal vein elongated and joined the IVC with an oblique course due to the adhesion of the prerenal segment to the postrenal segment and the persistence of the dorsal portion of the left sub-supracardinal anastomosis. Its retroaortic course would also occur if the ventral part of the sub-supracardinal anastomosis and the intersubcardinal anastomosis regressed, whereas the dorsal part of the sub-supracardinal anastomosis and the intersupracardinal anastomosis would persist. The bifurcation of the left renal vein can be explained by failure of the last temporary renal vein to regress during kidney ascent.

The anastomosis of the lumbar veins with the left renal vein has been explained previously [8].

We assume that the enlarged spleen inhibited the left kidney from reaching its normal location. This abnormal location is of particular interest because these two coexisting anomalies have never been reported in association with the other variations described in this paper.

Clinical significance

Because abnormalities of vessels, especially veins, are clinically dormant, venous bleeding is a troublesome intraoperative hazard. Accidental injury to anomalous lumbar and retroaortic renal veins might cause a great amount of bleeding during the removal of enlarged malignant retroperitoneal lymph nodes in the lumbar region. The bleeding can be aggravated by oblique course of the renal vein. Hence, the depiction of the venous variants in preoperative imaging facilitates the dissection of these veins and helps to avoid or reduce venous injuries and subsequent bleeding during operations.

Because of the close proximity of the retro-aortic left renal vein to the pancreas, this vein can be indirectly affected by malignant disease of the pancreas. Therefore, the retroaortic left renal vein is an important vessel to consider in the evaluation and staging of retroperitoneal tumours.

Haematuria, thrombosis, pain, left renal vein hypertension, and varicocele are some of the clinical entities associated with a retroaortic left renal vein [10]. Anomalous lumbar and retroaortic renal veins are vulnerable to injury in orthopaedic procedures of the lumbar spine and any damage that arises may be difficult to manage and repair.

A bifid renal vein that has two points of drainage into the IVC may provide an alternative collateral route of drainage into the IVC if the IVC has been interrupted in an area between these two drainage points. Anomalous multiple renal veins is a contraindication for donor nephrectomy because this anomaly is associated with a higher risk of thrombosis of the graft renal vein [11].

The understanding of these variations may also provide safety guidelines for endovascular procedures, such as angioplasties and therapeutic embolisation. In laparoscopic nephrectomy, the left kidney is preferred owing to its longer vein. Furthermore, it is technically easier to remove and provides a more optimal vessel for venous reanastomosis in the recipient. However, a right nephrectomy may be performed if the left kidney has a complex anomalous venous pattern.

During diagnostic and surgical approaches at the level of the left kidney, not only must the vascular variants be considered, but the associations of these with congenital splenomegaly must also be suspected. Anatomical knowledge of the presented variants is of immense importance for the appropriate selection of operative techniques during surgical interventions as well as for postoperative management.

References

1. Satyapal KS, Kalideen JM, Haffejee AA, Singh B, Robbs JV. Left renal vein variations. Surg Radiol Anat 1999;21:77-81.
2. Senecail B, Bobeuf J, Forlodou P, Nonent M. Two rare anomalies of the left renal vein. Surg Radiol Anat 2003;25:465-7.
3. Malcic-Gürbüz J, Akalin A, Gümüşcü B, Cavdar S. Clinical implications of concomitant variations of the testicular, suprarenal and renal veins: a case report. Ann Anat 2002;184:35-9.
4. Benedetti E, Troppmann C, Gillingham K, Sutherland DE, Payne WD, Dunn DL, Matas AJ, Najarian JS, Grussner RW. Short- and long-term outcomes of kidney transplants with multiple renal arteries. Ann Surg 1995;221:406-14.
5. Jetti R, Jevoor P, Vollala VR, Potu BK, Ravishankar M, Virupaxi R. Multiple variations of the urogenital vascular system in a single cadaver: a case report. Cases J 2008;1:344.
6. Kumar S, Neyaz Z, Gupta A. The utility of 64 channel multidetector CT angiography for evaluating the renal vascular anatomy and possible variations: a pictorial essay. Korean J Radiol 2010;11:346-54.
7. Bass JE, Redwine MD, Kramer LA, Huynh PT, Harris JH Jr. Spectrum of congenital anomalies of the inferior vena cava:

cross-sectional imaging findings. Radiographics 2000;20:639-52.
8. Field S, Saxton H. Venous anomalies complicating left adrenal catheterization. Br J Radiol 1974;47:219-25.
9. Macchi V, Parenti A, De Caro R. Pivotal role of the sub-supracardinal anastomosis in the development and course of the left renal vein. Clin Anat 2003;16:358-61.
10. Arslan H, Etlik O, Ceylan K, Temizoz O, Harman M, Kavan M. Incidence of retro-aortic left renal vein and its relationship with varicocele. Eur Radiol 2005;15:1717-20.
11. Holden A, Smith A, Dukes P, Pilmore H, Yasutomi M. Assessment of 100 live potential renal donors for laparoscopic nephrectomy with multi-detector row helical CT. Radiology 2005;237:973-80.