

Retroaortic left renal vein: a clinically significant vascular variation with suggestion of a practical typological scheme

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Abstract

The retroaortic left renal vein (RLRV) is a rare vascular variant with a typical position of the vein between the abdominal aorta and the vertebral column. Despite usually asymptomatic, RLRV might be associated with posterior nutcracker syndrome, other vascular pathologies and may cause major surgical complications. An existing but not expected RLRV might hamper aortic surgical dissection and to cause a life threatening bleeding. A case of a RLRV was observed during routine dissection of a formalin fixed 62-year-old female cadaver. The left kidney was found to be ectopic and located lower than usual between the level of L1 and L4 vertebra. The left renal vein was formed in the renal hilum at the level of L2/L3 intervertebral disc, and then passed obliquely downwards behind the abdominal aorta to join in the inferior vena cava at the level of upper border of L4 vertebra. The length of the RLRV was 7.5 cm. The main tributaries were the left suprarenal and left ovarian veins. Measuring the diameters of the renal vein showed slight dilation at its origin. Based on the literature review, the vascular variation reported here can be classified as Type II – RLRV draining at a lower than normal level of the inferior vena cava. An extended classification scheme of the left renal vein variations is presented here as well as an optional typological scheme.

Keywords: classification; clinical significance; renal vein collar; retroaortic left renal vein

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Introduction

The retroaortic left renal vein (RLRV) is rare vascular variant with a typical position of the renal vein between the abdominal aorta and the vertebral column.^[1–4] The incidence of this variation ranges from 0.4 to 9.3% in the different groups examined.^[1,5,6] The complicated embryonic development of the inferior vena cava (IVC) and its tributaries is claimed to result in formation of RLRV.^[7,8] Though this anatomical variant is often asymptomatic, the abovementioned position leads to an increase in the venous pressure and distention of the renal vein.^[9,10] The RLRV may also cause symptoms such as abdominal and left flank pain and hematuria and this to be diagnosed as posterior nutcracker syndrome.^[9,11] The RLRV is also considered one of the major vascular variations that should be taken into consideration during retroperitoneal surgery, for its accidental damage can cause severe hemorrhage, emergency nephrectomy and even death.^[1,7,10,12,13] Even though RLRV is a rare venous variant, its prompt identification and understanding of other concomitant vascular variations are essential for clinical practice.

Case Report

A case of a RLRV was observed during routine dissection of a formalin fixed 62-year-old Caucasian female cadaver. The dissection took place in the Department of Anatomy, Histology and Embryology of the Medical University of Sofia.

The anterior abdominal wall was incised and the abdominal cavity was opened wide in an anatomical way. The abdominal viscera were defined, studied and consecutively removed, as well as the posterior parietal peritoneum, in order to facilitate the dissection of the retroperitoneal space and the posterior abdominal wall. The position of the kidneys was accessed and after a meticulous blunt dissection, their vessels were exposed. The right kidney was non-totopic, with its upper pole at the level of T12/L1 intervertebral disc and its lower pole at the middle of L3 vertebra. The hilum was facing antero-medially and the vessels had a typical position and overall anatomy. The left kidney was found to be ectopic and lying lower than the right kidney (Figure 1a). Its upper pole was at the level of lower bor-

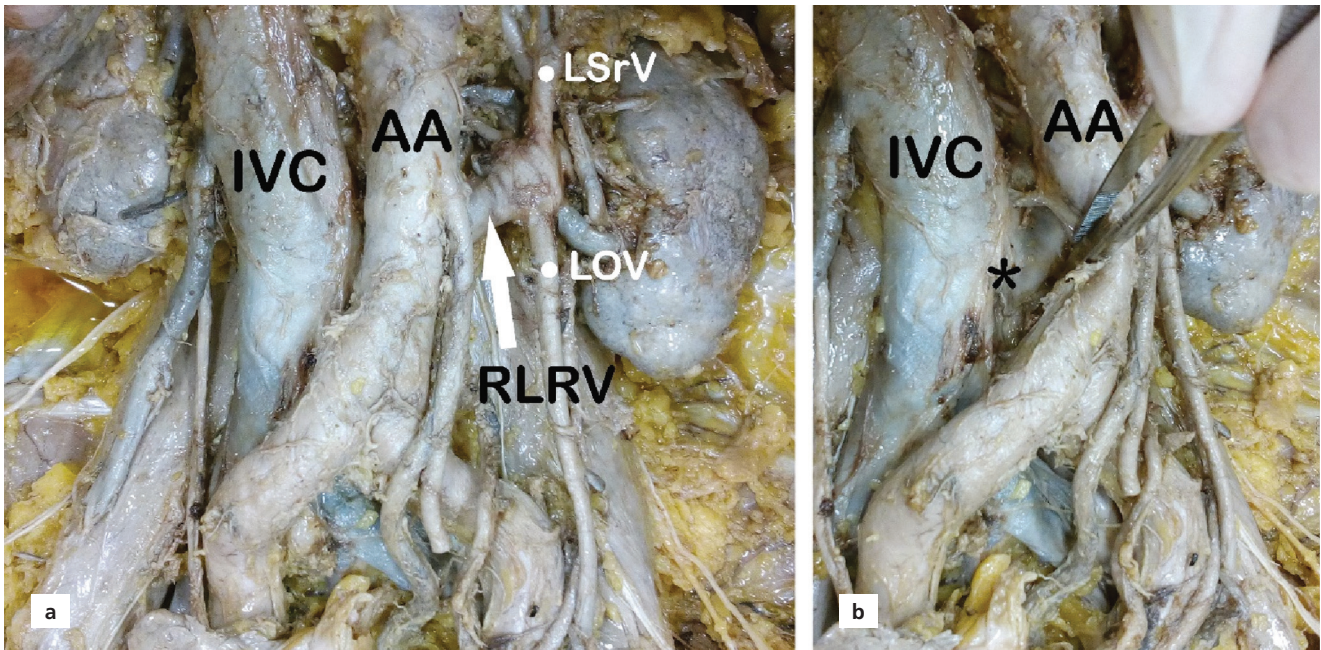


Figure 1. Photograph of the retroperitoneal space, presenting the formation and initial part of the RLRV (arrow) (a). In (b), the asterisk indicates the point where the RLRV joined the IVC behind the abdominal aorta. AA: abdominal aorta; IVC: inferior vena cava; LSrV: left suprarenal vein; LOV: left ovarian vein; RLRV: retroaortic left renal vein.

der of L1 vertebra and its lower pole – at the midpoint of L4 vertebra. The hilum was located at the level of L2/L3 intervertebral disk and was facing antero-medially. The left renal artery arose from the abdominal aorta at the level of L2 upper border and shortly after that divided into two renal arteries those are nearly of equal in size. Because of the left kidney ectopism, the two arteries descended almost vertically to reach the renal hilum. The left renal vein (Figure 1a) was formed outside the hilum by fusion of two primary tributaries. At the same confluent point, the left suprarenal vein from above and gonadal (ovarian) vein from beneath joined the left renal vein (Figure 1a). The left renal vein then passed infero-medially behind the abdominal aorta to join the IVC at the level of upper border of L4 ver-

tebra (Figure 1b). That was a point nearly 2 cm above the confluence of the common iliac veins. The length of the RLRV in our case was 7.5 cm, consistent with the findings in other studies.^[14,15] The long diameter of the vein was 2 cm at its proximal segment and 1.2 cm at the distal, suggesting a slight dilatation at its origin (normal range 1.2±0.2 cm).^[14]

Discussion

The variant left renal vein passing behind the abdominal aorta has been classified together with the anomalies of the IVC.^[1,7,8,12,13,16] Later, some classifications appeared, that grouped only the cases of an RLRV draining into a normal IVC (Figures 2a–d).^[12,17] Probably the most detailed classi-

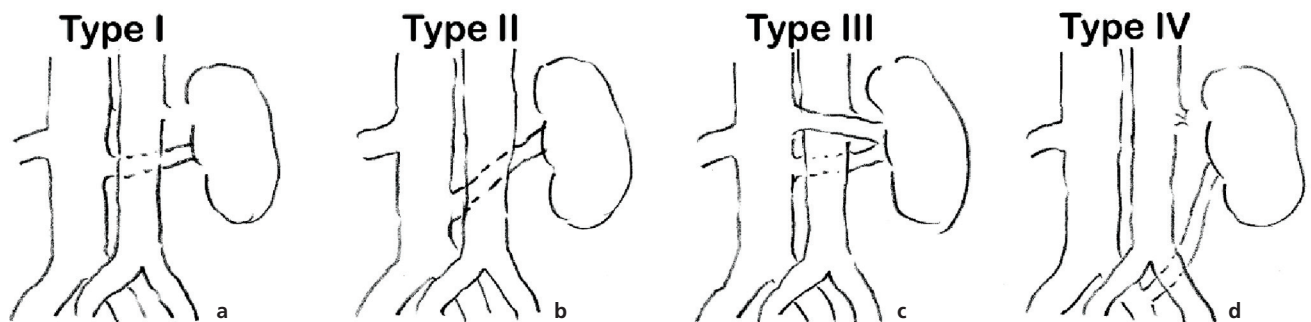


Figure 2. Current classification scheme of the RLRV: (a) RLRV Type I that drains into IVC at normal (orthotopic) position; (b) RLRV Type II that drains at a lower level of IVC (L4–L5); (c) circumaortic renal vein collar – composed of both preaortic and orthotopic retroaortic renal veins; (d) RLRV that drains much lower into the left common iliac vein.

fication of the renal vein variations is presented in the paper of Zhu et al.^[18] These authors have defined five types and many subtypes of the left renal vein variations. All these unusual venous patterns can be explained with complicated embryonic development of the veins in the retroperitoneal space between the 7th– 10th weeks of gestation.^[8,16,19,20] The main event in the development of the renal veins is formation of circumaortic renal vein collar formed from the intersupracardinal anastomosis dorsally, the intersubcardinal anastomosis and postsubcardinal anastomoses ventrally, and the suprasubcardinal anastomosis laterally. Moreover, the embryonic kidneys are drained by paired ventral and dorsal venous limbs, with the latter later regressing. The persist-

ence of the dorsal venous limb, as well as the dorsal part of the circumaortic venous collar are the possible embryological bases of RLRV development.^[8,16,20,21]

The most common classification system of RLRV includes four types (Figures 2a–d)^[1,2,13,17]: (1) RLRV Type I that drains into IVC at normal (orthotopic) position; (2) RLRV Type II that drains at a lower level of IVC (L4–L5); (3) circumaortic renal vein collar – composed of both preaortic and orthotopic retroaortic renal veins; (4) RLRV that drains much lower into the left common iliac vein. In the pertinent literature, however, some other left renal vein variations are described, that are not men-

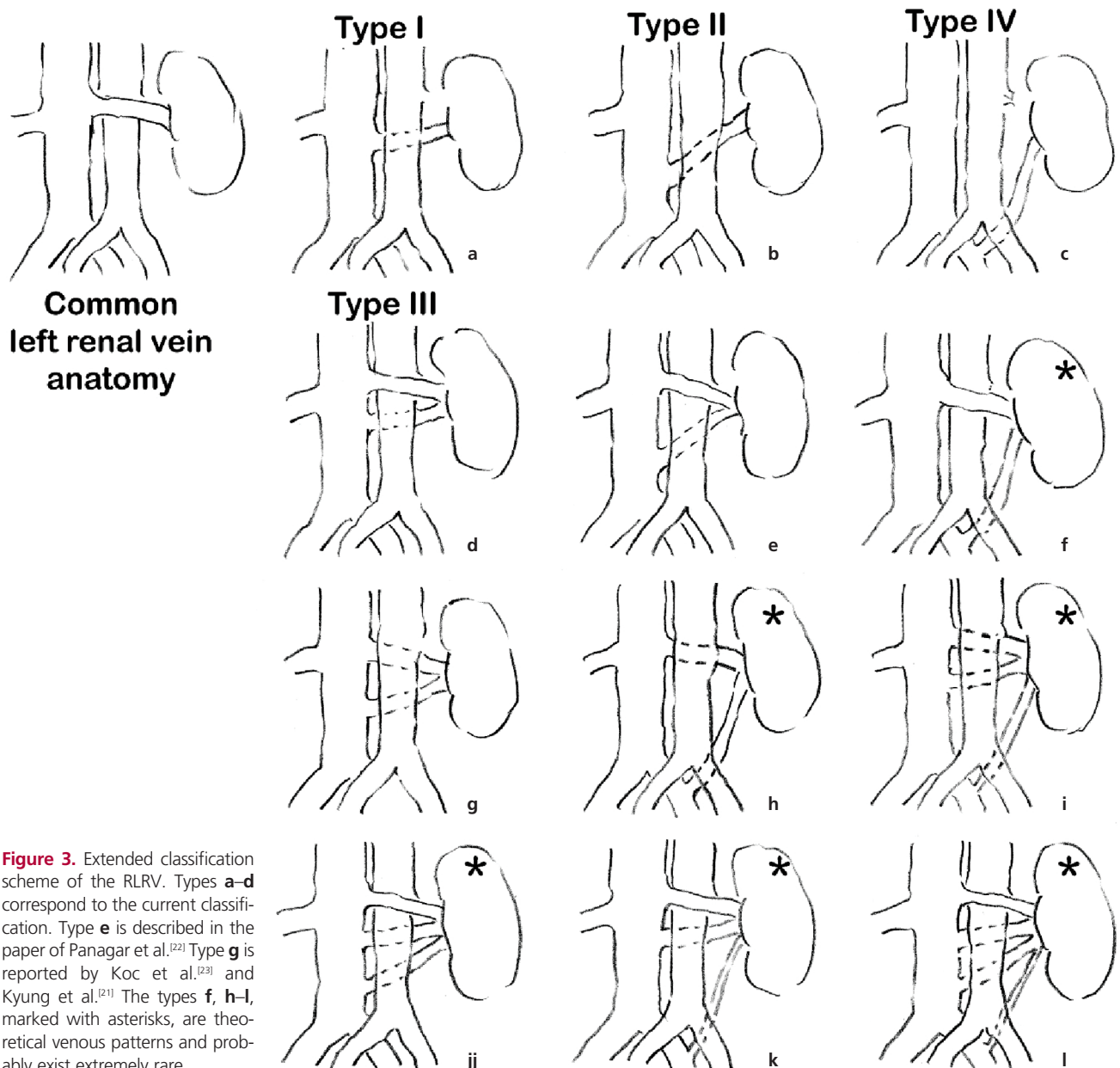


Figure 3. Extended classification scheme of the RLRV. Types a–d correspond to the current classification. Type e is described in the paper of Panagar et al.^[22] Type g is reported by Koc et al.^[23] and Kyung et al.^[21] The types f, h–l, marked with asterisks, are theoretical venous patterns and probably exist extremely rare.

tioned in this widespread classification. The circumaortic renal vein collar, for example, might be composed of preaortic renal vein and retroaortic renal veins draining at a lower level to IVC.^[22] Moreover, in the literature there are at least two reports of doubled RLRV.^[21,23] A case of tripled RLRV cannot also be excluded. All these additional variations can be explained with the developmental schemes presented in the paper of Kyung et al.^[21] Analyzing further the possible options for vascular development, much more extended classification might be presented (Figures 3a–l). After all, to memorize such an extended classification is not very practical, so instead, a typological scheme of the left renal vein variations can be extracted (Figure 4) with the following main conclusions:

- The RLRV can drain at orthotopic position to IVC, or at a lower level of IVC (L4–L5), or much lower into the left common iliac vein;
- A doubled or possibly tripled RLRV may exist with veins draining both at normal and lower levels to IVC;
- Any of the aforementioned RLRV might be accompanied by a normal pre-aortic left renal vein, thus forming a renal vein collar.

The incidence of RLRV varies greatly between the different groups examined. Karkos et al.^[1] mentioned that RLRV can be found in 0.8 to 3.7% in autopsy, on CT scans, and in surgical series. In a more detailed review of the literature with meta-analysis, Yi et al.^[6] estimated this vascular variation in 0.5–3.5% of cadaver dissections and 0.4–9.3% of clinical studies. Karaman et al.^[2] studied on MDCT angiographies the presence of RLRV in patients with urological symptoms (hematuria, abdominal/ left flank pain, varicocele on the left side) and calculated an incidence of 2.37%.

The variant left renal vein passing behind the aorta may remain unrecognized or to be named as posterior nutcracker phenomenon if an increased venous pressure, vein dilation and collateral formation is identified.^[9,24] When the dilatation becomes symptomatic, the posterior nutcracker syndrome is diagnosed.^[9,11,24] In the currently reported case, dilatation of the proximal segment of the vein was present, yet there was no data for any clinical manifestation.

The reported venous variation has a definite significance for aortic surgery.^[13,25,26] Brener et al.^[25] reported an injury to RLRV during aortic reconstruction in 40% of the operations. The complications varied from hemorrhage that can be controlled via reconstruction to nephrectomy, but such a venous injury is often fatal.^[26] To encounter an RLRV during reconstruction of abdominal aorta aneurysms is also not a rare case.^[27,28] A specific pathology is the rupture of the aortic aneurysm toward the RLRV with formation of an aorto-venous fistula.^[29–31]

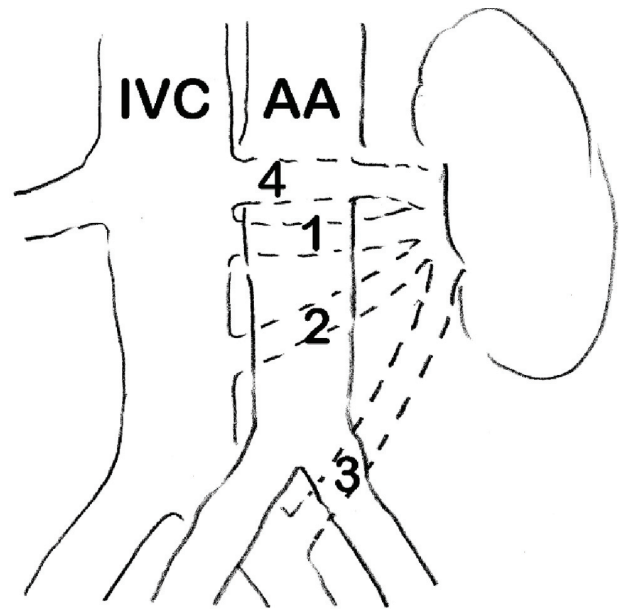


Figure 4. Typological scheme of the left renal vein variations. 1: retroaortic left renal vein draining at orthotopic level; 2: retroaortic left renal vein draining at lower level of the IVC; 3: retroaortic left renal vein draining at the level of left common iliac vein; 4: normal “preaortic” left renal vein.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

NK: data collection, conception and design of the article, drafting the article, approval of the final version; YT: data collection, drafting the article, approval of the final version; LM: analysis and interpretation of the data, article revision, approval of the final version; LJ: conception and design of the article, analysis and interpretation of the data, article revision, approval of the final version.

Ethics Approval

The studies using bone or cadaver specimens are regulated by Medical University of Sofia. There were no ethical violations in the creation of this work.

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