THE RETROAOARTIC LEFT RENAL VEIN ABNORMALITIES IN CROSS-SECTIONAL IMAGING

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ABSTRACT
OBJECTIVE: The normal anatomic course of the left renal vein (LRV) from the kidney to inferior vena cava (IVC) is usually preaortic. It is called retroaortic left renal vein (RLRV) when located between the aorta and vertebra; the circumaortic left renal vein (CLRV) has both a preaortic and retroaortic course. In this study, we aimed to find the incidence and characteristics of LRV abnormalities in routine abdominal CT and MR examinations conducted in our clinic. MATERIALS AND METHODS: A total of 2189 abdominal CT and MR examinations, performed between April 2007 and June 2009, were reviewed retrospectively for retroaortic and circumaortic LRV abnormalities. RESULTS: LRV abnormalities were detected in 50 (2.3%) examinations. Forty-four of these (2%) were RLRV and 6 (0.3%) were circumaortic LRV abnormalities. CONCLUSIONS: Preoperative knowledge of LRV abnormalities facilitates the safe performance of surgery and reveals the clinical symptoms. It is easy to see LRV and its drainage way on routine CT and MR imagings.

Keywords: left renal vein, retroaortic, abnormality, radiologic imaging

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REZIOME
ЦЕЛЬ: Левая почечная вена в норме идет от почки к нижней полой вене, проходя перед аортой. Часть ее между аортой и позвонком называется ретроаортальной левой почечной веной; кольцевидная левая почечная вена может проходить перед, но и за аортой. Настоящее исследование ставит себе цель определить частоту и характеристики аномалий левой почечной вены, обнаруженных во время проведенных в нашей клинике рутинных компьютерной томографии исследований и ядерно-магнитного резонанса. МАТЕРИАЛ И МЕТОДЫ: Ретроспективно изучено 2189 абдоминальных исследований, проведенных с помощью компьютерной томографии и ядерно-магнитного резонанса. Исследования проведены в период: апрель 2007 – июнь 2009 г. с целью выявить аномалии ретроаортальной и кольцевидной левых почечных вен. РЕЗУЛЬТАТЫ: Аномалии левой почечной вены обнаружены в 50 (2.3%) случаях, 44 (2%) из них оказались аномалиями ретроаортальной почечной вены, а 6 (0.3%) - аномалиями кольцевидной левой почечной вены. ЗАКЛЮЧЕНИЕ: Дооперативное знание аномалий левой почечной вены способствует безопасному проведению оперативного вмешательства и раскрытию клинических симптомов. Левая почечная вена и ее ход легко визуализируются рутинными исследованиями с помощью компьютерного томографа и ядерно-магнитного резонанса.

Ключевые слова: левая почечная вена, ретроаортальный, аномалия, образная диагностика

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INTRODUCTION

The normal anatomic course of the left renal vein (LRV) from kidney to inferior vena cava (IVC) is usually preaortic. The retroaortic left renal vein (RLRV) is defined as the left renal vein located between the aorta and the vertebra on the drainage way to IVC. When there is a renal collar of LRV that is located both anterior and posterior to the aorta, it is called a circumaortic left renal vein (CLRV). RLRV abnormalities, although usually overlooked, are not rare.1 The retroaortic and circumaortic left renal veins are potentially hazardous anomalies of the left renal vein. If these are left unrecognized during abdominal surgery, they can cause severe hemorrhage and severe renal damage, nephrectomy, and even death.2 It is important to diagnose RLRV prior to retroperitoneal surgery.

During the development of the IVC, anastomotic communications develop between the subcardinal and supracardinal channels, which process is called subsupracardinal anastomosis.3 These connections form a collar of veins that encircles the aorta. The ventral portion of the circumaortic collar persists as the normal left renal vein. If the dorsal portion does not disintegrate it forms a retroaortic left renal vein (Fig. 1).4

Left renal vein anomalies are generally categorized into four types.5,6 In type I, the ventral preaortic limb of the left renal vein is obliterated, but the dorsal retroaortic limb persists and drains into the IVC in the orthotopic position.1,5-7 Type II results from obliteration of the ventral preaortic limb of the left renal vein, and the remaining dorsal limb turns into the RLRV which lies at the level of L4 to L5 and joins with the gonadal and ascending lumbar veins before draining into the IVC. Type III is the circumaortic left renal vein or venous collar. In type IV, the ventral preaortic limb of the left renal vein is obliterated, and the remaining dorsal limb becomes the RLRV which courses obliquely and caudally behind the aorta to drain into the left common iliac vein.1,5-7

Preoperative knowledge of the presence of major venous anomalies facilitates the safe performance of aortic surgery. A few cases showing clinical symp-

![Figure 1. Retroaortic (a) and circumaortic (b) left renal vein abnormalities, schematic illustration.](image1)

![Figure 2. Contrast enhanced axial CT (compression of the RLRV between the atherosclerotic aorta and the vertebral body).](image2)
toms with this abnormality have been reported in literature. Compression of the retroaortic left renal vein between the vertebral body and aorta (Figs 2a, 2b) can cause a number of urological symptoms such as haematuria, proteinuria, varicocele, pelvic congestion syndrome, and ureteropelvic junction obstruction (UPJO).8-10

To find the frequency of RLRV abnormalities, we retrospectively evaluated the existence of RLRV on routine abdominal CT and MR examinations performed in our clinic.

MATERIALS AND METHODS
A total of 2275 abdominal CT and MR imagings were reviewed retrospectively by three radiologists in our department on a 3-D workstation searching for left renal vein abnormalities. Eighty-six of these were excluded from the study: 84 were of poor diagnostic quality and two - for left nephrectomy.

RESULTS
Retroaortic (type I and II) and circumaortic LRV (type III) abnormalities were detected as left renal vein abnormalities in our study. Of 2189 examinations in this study, 1316 were CT scans and 873 were MR examinations. We detected LRV abnormality in 50 (2.3%) examinations. Forty four of them (2%) were RLRV (type I and II) (Fig. 3) and 6 (0.3%) were circumaortic LRV abnormality (type III) (Fig. 4).

DISCUSSION
The left renal vein is longer than the right renal vein (75 mm versus 25 mm). It has a complicated embryological development. The left kidney is preferred in renal transplantation because of the greater length of the left renal vein. That is why it is important in such a surgery to know what precisely the course of the left renal vein is.4 When the aorta is surgically exposed, not finding the anterior left renal vein in the usual anatomic position raises the

![Figure 3](image1.png)

**Figure 3.** Type I of RLRV abnormality on a contrast enhanced CT examination.

![Figure 4](image2.png)

**Figure 4.** Circumaortic LRV on a non-contrast enhanced T1-weighted out-of-phase sequence MR examination. The left renal vein crossed the aorta anteriorly (a) and posteriorly (b) (type III).

A total of 2189 abdominal CT and MR examinations were included in the study. We used slice thickness of 5 mm for the CT scans (GE; HiSpeed Dual SYS, Germany), and 3-mm-thick slices for the MR examinations (1.5 T; Magnetom Symphony: Siemens, Germany) in routine abdominal imaging protocols. We looked for retroaortic and circumaortic left renal vein anomalies: a left renal vein that crossed the aorta anteriorly and drained into the IVC was designated as normal preaortic left renal vein (LRV), and a left renal vein located between the aorta and the vertebra draining into IVC was defined as retroaortic LRV (type I and II). The LRV that crossed the aorta anteriorly and also posteriorly, making a ring around the aorta and draining into the IVC at different levels was defined herein as circumaortic LRV (Type III).
probability of a retroaortic left renal vein. Overlook-
ing this anomaly during aortic and retroperitoneal
surgery can result in bleeding, nephrectomy, or
even death.\(^5\) Usually, no major venous abnor-
malities are found in patients undergoing retroperitoneal
and aortic surgery but preoperative assessment and
intra-operative awareness are important factors that
may prevent unexpected venous injuries.\(^4,7\)

The incidence of the left renal vein abnormalities
has been reported in a wide range of variations in
many studies. Yi SQ et al. described in their study
three anatomic variations: circumaortic, retroaortic
left renal vein and retropelvic tributary of the renal
vein in Japanese cadavers. They found that the
median incidence of RLRV was 1.7% and
2.2% in examined cadavers and 1.8% in examined clinical subjects.
The detection of circumaortic LRV abnormality
in CT/MDCT or angiography was relatively dif-
cult compared with that by cadaver dissection.
The median incidence of RLRV was 1.7% and
2.2% in examined cadavers and clinical subjects,
respectively.\(^11\)

Dilli A et al. found the incidence of left renal
vein abnormalities, RLRV and circumaortic left
renal vein abnormalities: 71/2644 (2.68%), 44/2644
(1.66%) and 27/2644 (1.02%), respectively.\(^12\)
Satyapal et al. and Yeşildağ et al. found the incidence
of RLRV to be 0.5% (in a total of 1008 cases)
and 2.3% (in 984 cases) and of circumaortic left
renal vein abnormalities to be 0.3% and 0.9%,
respectively.\(^13,14\) Reed et al. included 433 cases
in their study: the incidence of the retroaortic
left renal vein abnormality was 1.8%, and that of
circumaortic abnormality - 4.4%.\(^15\) Trigaux et al.
included 1014 cases in their study: the frequency
rate of RLRV abnormality in routine abdominal CT and MR images. The age of
the patients: the study was designed to
find the frequency rate of RLRV abnormality in routine
clinical conditions in different departments.

Radiological modalities such as ultrasonography
(US), color Doppler US, angiography, MRI and CT
can all be used to diagnose left renal vein abnor-
malities.\(^14,20\) Doppler US may show the turbulent
pattern of venous blood flow of the posterior LRV
branch behind the aorta. US and color Doppler
imaging modalities may be preferred because they
are relatively less expensive and noninvasive, but
they may be insufficient in overweight patients.
Nowadays, multi-detector CT (MDCT) has replaced
conventional angiography and venography in most
clinical conditions. MDCT is a reliable, easily ap-
plicable, and noninvasive tool for demonstration of
abdominal organs and vascular structures.\(^1,9\) Cadaver
studies can also be used to find the incidence of left
renal vein abnormalities.\(^11\) In our study, we used
routine abdominal CT and MR images. The age of
the patients was not taken into account because, as
it has been reported in many studies, there is no
statistically significant gender difference between
the ages and left renal vein variations.\(^12,14\) Also,
we included the non-contrast enhanced imaging in
the study. Although it was easier to see the renal
veins on contrast enhanced CT and MR images,
we could see all renal vein abnormalities on non-
contrast enhanced images easily.

The Retroaortic Left Renal Vein Abnormalities in Cross-sectional Imaging

CONCLUSIONS

Preoperative knowledge of the presence of LRV
abnormalities facilitates the safe performance of
aortic surgery and reveals clinical symptoms such
as haematuria, proteinuria, venous renal hypertension, varicocele, pelvic congestion syndrome and UPJO. In conclusion, the detection of RLRV, which is an important vascular variation, is crucial to avoid the complication of catastrophic hemorrhage before aortic, renal, and retroperitoneal surgery. It could be demonstrated by all radiological modalities mentioned above. It is easy to see LRV and its drainage way on routine CT and MR examinations.

REFERENCES